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60th Northeast Regional Stock Assessment Workshop (60th SAW)

Assessment Summary Report

by the Northeast Fisheries Science Center

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NOAA Fisheries, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543

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Table of Contents

SAW-60 ASSESSMENT SUMMARY REPORT

Introduction

The 60th SAW Assessment Summary Report contains summary and detailed technical information on two stock assessments reviewed during June 2-5, 2015 at the Stock Assessment Workshop (SAW) by the 60th Stock Assessment Review Committee (SARC-60): scup (*Stenotomus chrysops*) and bluefish (*Pomatomus saltatrix*). The SARC-60 consisted of three 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-60 are available at website: http://www.nefsc.noaa.gov/nefsc/saw/ under the heading "SARC 60 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-60 Review Panel reports (available at http://www.nefsc.noaa.gov/nefsc/saw/ under the heading "SARC 60 Panelist Reports").

For **scup** all of the ToRs were met and the assessment results can be used as a basis for management. The assessment was based on an age-structured population model (ASAP). In 2014 overfishing was not occurring and the stock was not overfished. The SARC Panel felt that the assessment represents a robust summary of scup population dynamics, but noted uncertainty regarding the steepness of the estimated rise in biomass since 2000, possible "cryptic" biomass, and in the accuracy of the Biological Reference Points. If trends in F or recruitment were to change in the medium term, further investigations are recommended to ensure that the stock does not become over-exploited. The Panel felt that attempts to incorporate environmental data into the assessment could be pursued further, and do not yet provide adequate predictions of scup habitat use.

For **bluefish** all of the ToRs were met and the assessment results can be used as a basis for management. The assessment was based on an age-structured population model (ASAP), with the NEFSC survey index split in 2008/2009 to account for the change in research survey vessels. In 2014 overfishing was not occurring and the stock was not overfished. The Panel noted improvements made since the previous assessment regarding quality of age data and the splitting of commercial and recreational fleets. The Panel noted that the model is strongly driven by one index (MRIP) which provides the majority of the information on older ages, and recommended that an attempt be made to develop additional informative indices. The Panel accepted the continued use of MSY proxy reference points, and recommended basing bluefish stock status determination on spawning stock biomass instead of total biomass.

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:

$N_{t+1} = 1{,}000{,}000 e^{-2} = 135{,}335$ 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 rebuild 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 sought 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).

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 five 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.

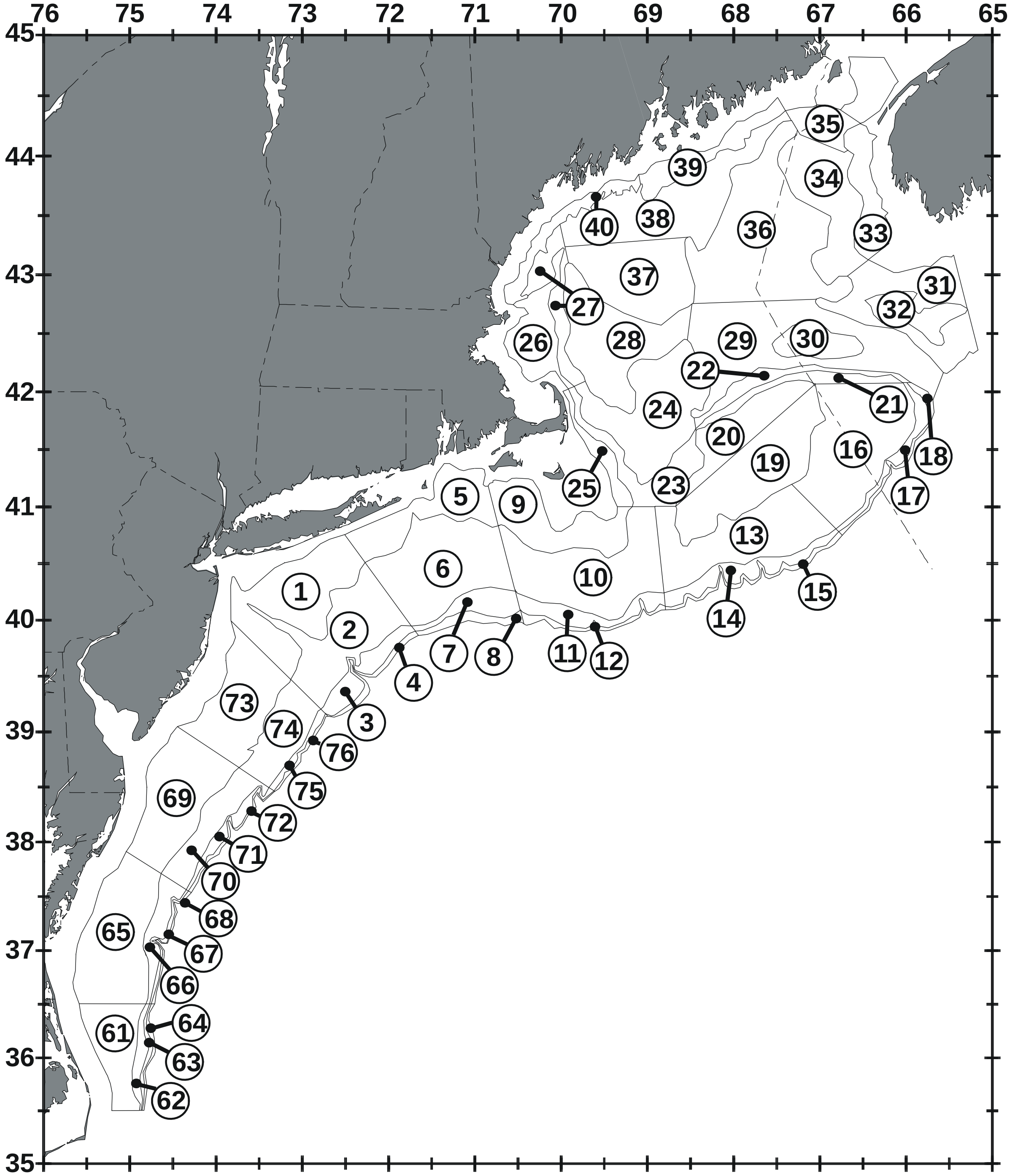


Figure 1. Offshore depth strata sampled during Northeast Fisheries Science Center bottom trawl research surveys. Some of these may not be sampled presently.

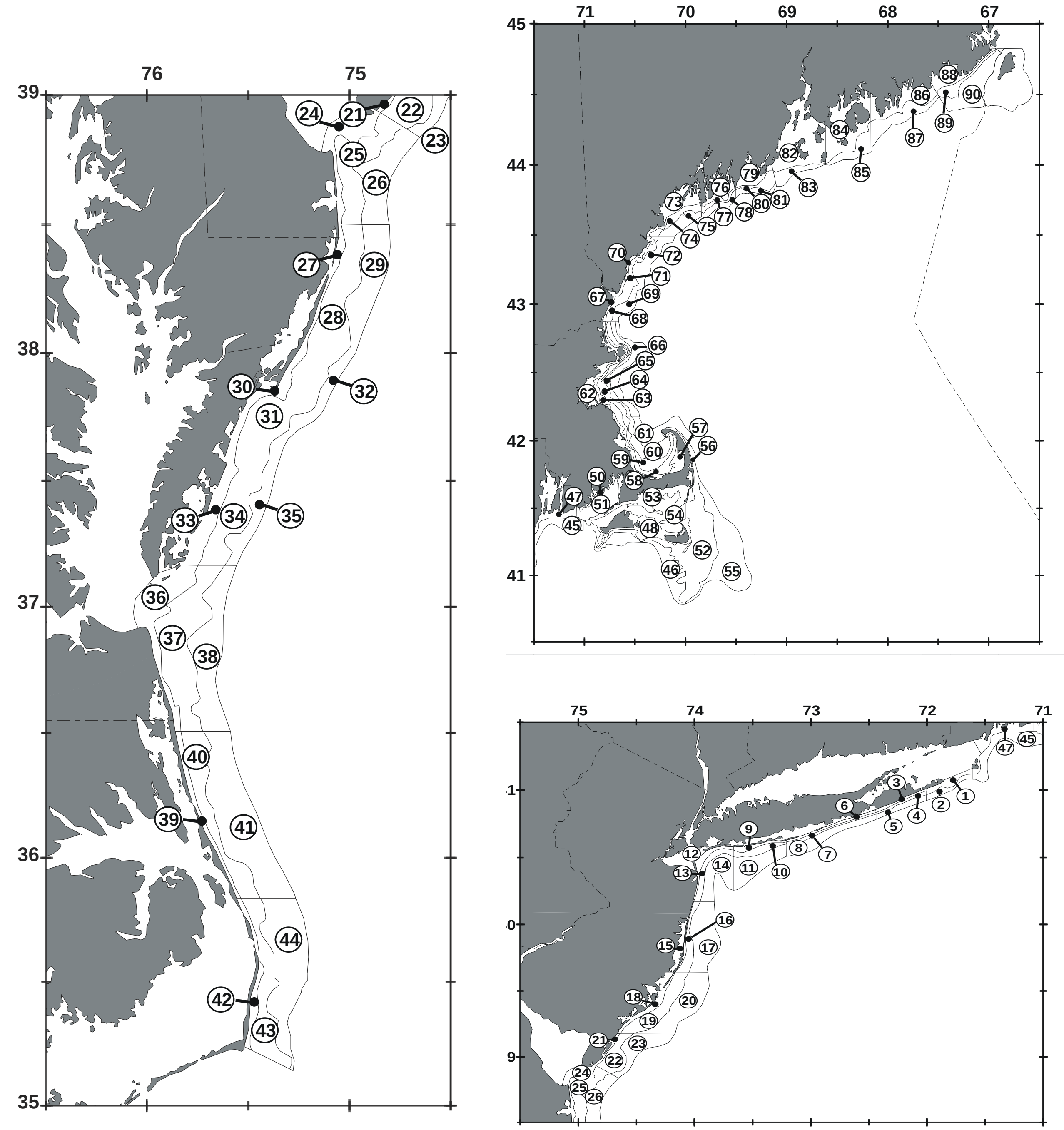
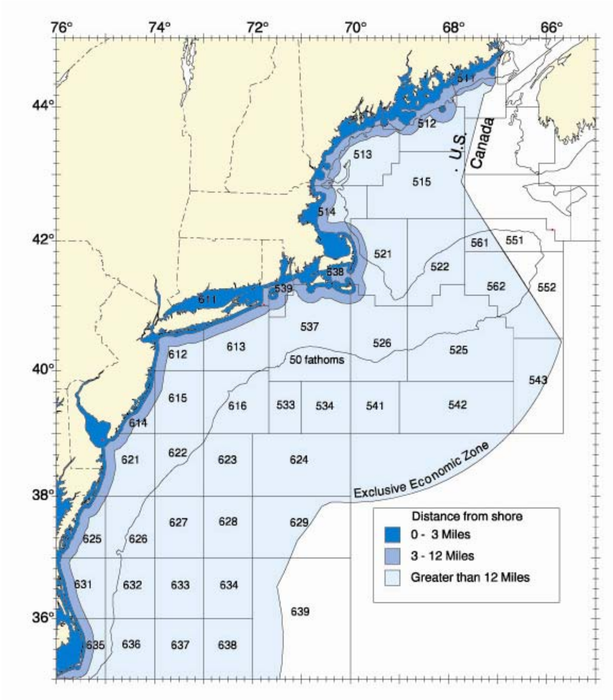


Figure 2. Inshore depth strata sampled during Northeast Fisheries Science Center bottom trawl research surveys. Some of these may not be sampled presently.



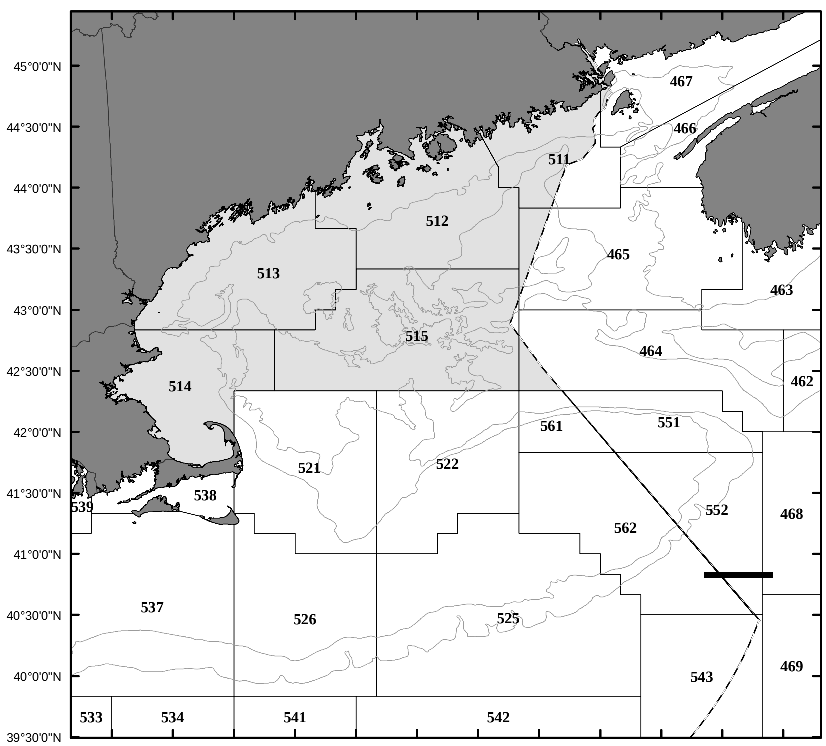


Figure 3. Statistical areas used for reporting commercial catches.

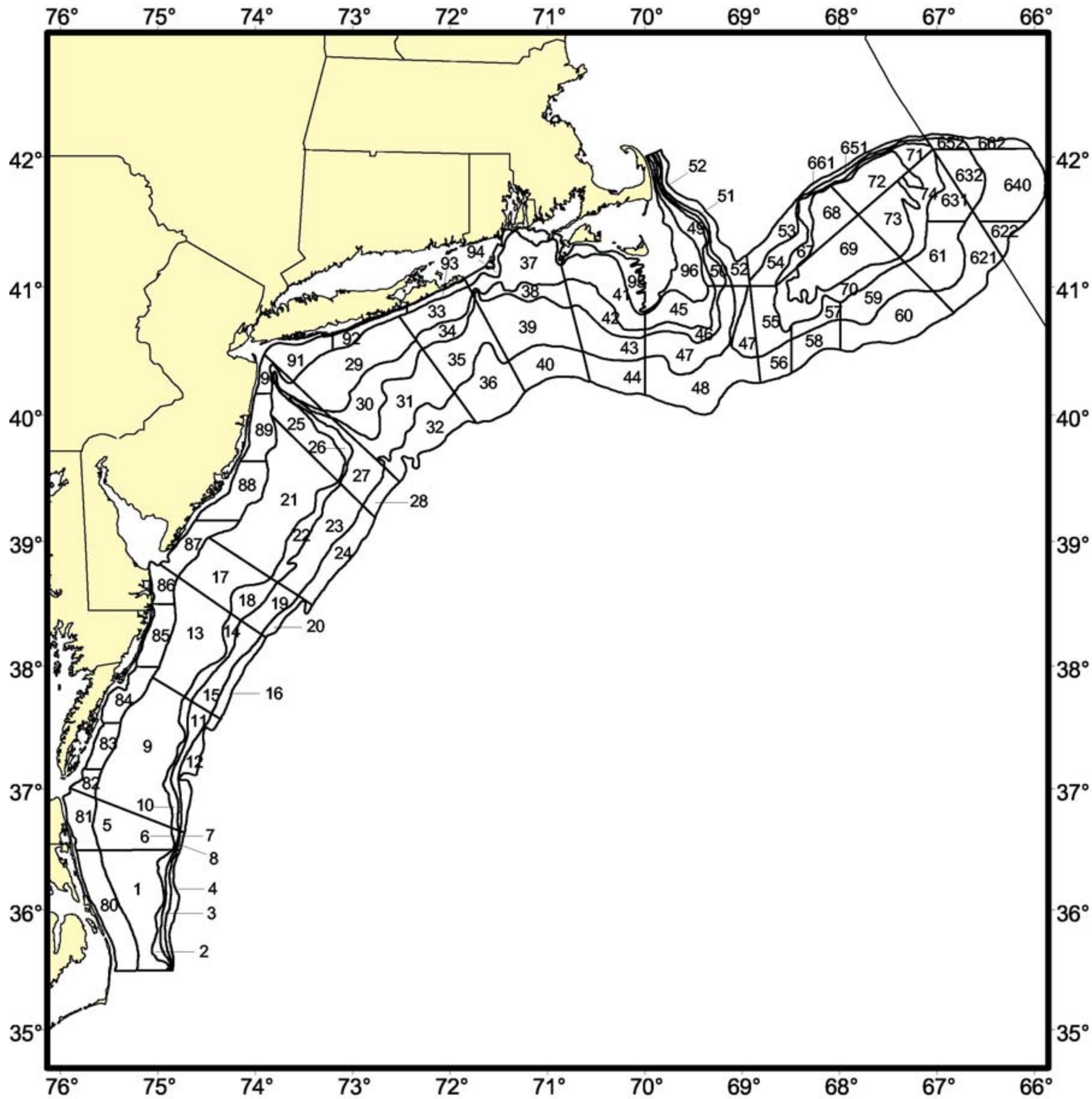


Figure 4. Northeast Fisheries Science Center clam resource survey strata, along the east coast of the US.

A. SCUP ASSESSMENT SUMMARY FOR 2015

State of Stock: The scup stock was not overfished and overfishing was not occurring in 2014 relative to the biological reference point estimates from the 2015 SAW-60 assessment (Figure A1). Spawning stock biomass (SSB) was estimated to be 182,915 mt in 2014, about 2 times the SAW-60 biomass reference point $SSB_{MSY\ Proxy} = SSB_{40\%}$ = 87,302 mt (Figure A2). There is a 90% chance that SSB in 2014 was between 153,000 and 222,000 mt. Fishing mortality on the fully selected age 3 fish was 0.127 in 2014, below the SAW-60 reference point $F_{MSY\ Proxy} = F_{40\%} = 0.220$ (Figure A3). There is a 90% probability that the fishing mortality rate in 2014 was between 0.093 and 0.149. The average recruitment from 1984 to 2014 is 109 million fish at age 0. The 2014 year class is currently estimated to be about 112 million fish (Figures A2 & A4).

Projections: Projection Option A is proposed as the most realistic and assumes that given recent patterns in the fishery, it is likely that 75% of the 2015 Acceptable Biological Catch (ABC) will be caught. Projection option B assumes that 100% of the 2015 ABC will be caught.

A) If the catch of scup in 2015 equals 75% of the specified ABC = 0.75 * 15,320 = 11,490 mt (= 25.331 million lbs), the 2015 median (50% probability) landings are projected to be 10,058 mt (= 22.174 million lbs) and discards are projected to be 1,432 mt (= 3.157 million lbs). The table below shows the projected spawning stock biomass and catch for Option A in 2015 if the stock is subsequently fished at the fishing mortality threshold = $F_{MSY} = F_{40\%} = 0.220$ in 2016-2018. The projected OFLs in 2016-2018 are 16,238, 14,556, and 13,464 mt (35.799, 32.090, and 29.683 million lbs).

Option A: Total Catch (OFL), Landings, Discards, Fishing Mortality (F)
and Spawning Stock Biomass (SSB) in 2015-2018
Catches and SSB in metric tons

Year	Total Catch OFL	OFL CV (%)	Landings	Discards	F	SSB
2015	11,490	fixed	10,058	1,432	0.143	187,477
2016	16,238	14	13,840	2,398	0.220	170,002
2017	14,556	13	12,214	2,342	0.220	154,083
2018	13,464	13	11,156	2,308	0.220	141,077

B) If the catch of scup in 2015 equals 100% of the specified ABC = 15,320 mt (= 33.775 million lbs), the 2015 median (50% probability) landings are projected to be 13,412 mt (= 29.568 million lbs) and discards are projected to be 1,908 mt (= 4.206 million lbs). The table below shows the projected spawning stock biomass and catch for Option B in 2015 if the stock is subsequently fished at the fishing mortality threshold = F_{MSY} = $F_{40\%}$ = 0.220 in 2016-2018. The projected OFLs in 2016-2018 are 15,745, 14,199, and 13,230 mt (34.712, 31.303, and 29.167 million lbs).

Option B: Total Catch (OFL), Landings, Discards, Fishing Mortality (F)
and Spawning Stock Biomass (SSB) in 2015-2018
Catches and SSB in metric tons

Year	Total Catch (OFL)	OFL CV (%)	Landings	Discards	F	SSB
2015	15,320	fixed	13,412	1,908	0.194	185,916
2016	15,745	13	13,398	2,347	0.220	166,355
2017	14,199	12	11,883	2,316	0.220	150,702
2018	13,230	12	10,935	2,295	0.220	138,072

The biological inputs to the scup stock assessment are based on well-founded assumptions (e.g., for natural and discard mortality) and precisely estimated parameters (e.g., growth, age, maturity, and mean weights). Further, the research survey index CVs used in model calibration have been increased by 50-100% (depending on assessment model fit diagnostics) to account for process error. Twenty-five alternative configurations of the assessment base model were examined to evaluate robustness, including starting years, impact of NEFSC calibration factors, natural mortality, fishery selectivity, and time-varying survey catchability. This broad set of configurations produced a range about +/- 40% in the estimate of terminal year SSB of about 183,000 mt (= 403 million lbs). The internal retrospective average error (for the terminal 7-years) of the assessment is low, at less than 10% for both SSB and F. The analytically derived CV for the 2014 SSB is 11%, the CV for the 2014 F is 15%, and the CV for the 2014 age 1 and older stock size total number is 15%. Given these properties of the 2015 scup stock assessment, it was concluded that an approximate doubling of the analytically derived 2016-2018 OFL CVs to 30% is a reasonable and sufficient adjustment to account for additional uncertainty in the assessment such as the magnitude of domed fishery selection, the magnitude of commercial fishery discards and recreational catch during the early part of the assessment model time series, and potential error in the ageing process.

Catch: The otter trawl is the principal commercial fishing gear. Commercial landings of scup peaked in 1960 at 22,200 mt, then decreased during the 1960s and ranged between about 5,000 and 10,000 mt until the late 1980s. Commercial fishery quotas were implemented in 1997, and landings then ranged between 1,200 mt and 8,100 mt and averaged 4,000 mt during 1997-2014. Reported 2014 commercial fishery landings were 7,228 mt (= 15.935 million lbs), about 77% of the commercial quota, and 68% of the total catch. A new SBRM discard estimate time series is used in the 2015 SAW-60 scup assessment. The commercial discard mortality rate is assumed to be 100%. Estimated 2014 commercial fishery live discards were 1,140 mt = 2.513 million lbs (CV = 14%), about 11% of the total catch.

Scup is the object of a major recreational fishery, with the greatest proportion of catches taken in Massachusetts, Rhode Island, Connecticut and New York. Estimates of the recreational catch in numbers were obtained from the NMFS Marine Recreational Fishery Statistics Survey (MRFSS) for 1981-2011, and from the NMFS Marine Recreational Information Program (MRIP) for 2004-2014. The estimated recreational landings during 1981-2014 averaged about 2,300 mt per year. Estimated 2014 recreational fishery landings were 2,025 mt = 4.464 million lbs (CV = 13%), about 64% of the recreational harvest limit, and 19% of the total catch. A discard mortality rate in the recreational fishery of 15% has been used in this and previous assessments, resulting in a time series average discard mortality of about 126 mt per year. Estimated 2014 recreational fishery dead discards were 227 mt = 0.500 million lbs (CV = 14%), about 2% of the total catch.

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

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Max[1]	Min[1]	Mean[1]
Commercial landings	3.7	4.1	4.2	2.4	3.7	4.9	6.8	6.8	8.1	7.2	8.1	1.2	4.6
Commercial discards[2]	0.6	0.9	1.4	1.7	3.2	2.6	1.2	1.0	1.3	1.1	3.5	0.4	1.7
Recreational landings	1.2	1.7	2.1	1.7	1.5	2.7	1.6	1.8	2.4	2.0	6.2	0.5	2.2
Recreational discards[2]	0.3	0.4	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.0	0.4	0.1
Total Catch	5.8	7.1	8.0	6.1	8.6	10.5	9.9	9.9	12.0	10.6	16.8	3.1	8.6
Commercial quota	5.7	5.5	4.2	4.2	3.9	5.0	8.0	5.7	10.7	10.0	10.7	1.1	4.7
Recreational harvest limit	1.8	1.9	1.3	0.9	1.2	1.4	2.0	3.9	3.4	3.2	3.9	0.6	1.6
Spawning Stock Biomass[1,3]	121	130	142	164	178	209	209	205	199	183	209	4	73
Recruitment (age 0)[1]	197	222	218	185	98	107	142	75	61	112	222	29	109
F (age 3)[1]	0.061	0.084	0.086	0.053	0.068	0.079	0.079	0.086	0.120	0.127	1.527	0.053	0.567

1: Over the period 1984-2014
2: Dead discards
3: On June 1

Stock Distribution and Identification: The Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plan defines the management unit as all scup from Cape Hatteras, North Carolina northeast to the US-Canada border (MAFMC 1999).

Data and Assessment: The assessment model for scup changed in 2008 from a simple index-based model to a complex statistical catch-at-age model (ASAP SCAA; Legault and Restrepo 1998; NFT 2013a) incorporating a broad range of fishery and survey data (NEFSC 2009). The model assumes an instantaneous natural mortality rate (M) = 0.2. The fishery catch is modeled as four fleets: commercial landings, recreational landings, commercial discards and recreational discards. The time series of commercial discard and recreational catch estimates has been revised since the 2008 assessment. The ASAP model configuration and settings were significantly revised for the 2015 SAW-60 assessment based on previous recommendations and exploratory analyses.

Indices of stock abundance from NEFSC winter, spring, and fall, Massachusetts DMF spring and fall, Rhode Island DFW spring and fall, University of Rhode Island Graduate School of Oceanography (URIGSO), Connecticut DEEP spring and fall, New York DEC, New Jersey DFW, and Virginia Institute of Marine Science (VIMS) Chesapeake Bay and VIMS juvenile fish trawl surveys were used in the 2008 model calibration (NEFSC 2009) and in subsequent assessment updates through 2012 (Terceiro 2012). The NEAMAP spring and fall bottom trawl, RIDFW spring and fall survey age compositions, and RI Industry Cooperative trap survey data were considered during the assessment. After the process of building the 2015 population model, the NEFSC spring, MADMF spring, RIDFW spring and fall, and VIMS ChesMMAP surveys were omitted from the model calibration.

There is no consistent retrospective pattern in F, SSB, or recruitment evident in the scup assessment model. However, there are some indications of poor model fit from lack of correspondence among surveys (higher than expected variance when accounting for potential process error, some residual patterns), and there is uncertainty in the absolute magnitude of recent stock size estimates (although the terminal year estimates are calculated to be relatively precise with CVs equal to or less than 15%). It was decided, however, that the run provided the best balance between good retrospective diagnostics, acceptable fishery and survey fit diagnostics, and stability over most configurations, and recommended use of the ASAP model final run for status evaluation.

Despite changes in model assumptions, configurations, and estimation procedures, the ‘historical’ retrospective analysis indicates that the general trends in stock biomass, recruitment, and fishing mortality have been consistent for the last decade. Estimates of SSB are in line with the previous 2012 projection (Terceiro 2012), F is lower than from the 2012 projection, and catch is lower than from the 2012 projection, as the fishery in 2014 took about 75% of the ABC.

Biological Reference Points (BRPs): The 2008 Data Poor Stocks Working Group (DPSWG) Peer Review Panel (NEFSC 2009) recommended that $F_{40\%}$ be used as the proxy threshold fishing mortality reference point and spawning stock biomass at $F_{40\%}$

($SSB_{40\%}$) be used as the default target stock biomass reference point for scup. The 2008 (old) reference points are $F_{MSY\ Proxy} = F_{40\%} = 0.177$ and $SSB_{MSY\ Proxy} = SSB_{40\%} = 92{,}044$ mt = 202.923 million lbs (Figure A1), and stock biomass threshold of ½ $SSB_{MSY\ Proxy}$ = ½ $SSB_{40\%}$ = 46,022 mt = 101.461 million lbs. MSY at $F_{MSY\ Proxy} = F_{40\%} = 0.177$ is estimated to be a total catch of 16,161 mt (35.629 million lbs), of which 13,134 mt (28.956 million lbs) are landings and 3,027 mt (6.673 million lbs) are discards.

The new biological reference points and status determination for scup from SARC-60 are based on the accepted ASAP model. The recommended reference points are $F_{40\%}$ as the proxy for F_{MSY}, and the corresponding $SSB_{40\%}$ as the proxy for the SSB_{MSY} biomass target. The $F_{40\%}$ proxy for $F_{MSY} = 0.220$; the proxy estimate for $SSB_{MSY} = SSB_{40\%}$ = 87,302 mt = 192.468 million lbs; the proxy estimate for the ½ SSB_{MSY} biomass threshold = ½ $SSB_{40\%}$ = 43,651 mt = 96.234 million lbs; and the proxy estimate for MSY = $MSY_{40\%}$ = 11,752 mt = 25.909 million lbs (9,445 mt = 20.823 million lbs of landings and 2,307 mt = 5.086 million lbs of discards).

Reference points were calculated using the non-parametric yield and SSB per recruit/long-term projection approach. The cumulative distribution function of the 1984-2014 recruitments (corresponding to the period of input fishery catches-at-age) was re-sampled to provide future recruitment estimates (mean = 109 million age 0 fish) for the projections used to estimate the biomass reference point and projected OFLs.

Fishing Mortality: Fishing mortality, estimated at true age 3 (model age 4) where full selection occurs (S=1), varied between F = 0.5 and F = 2.0 during the 1960s and 1970s. Fishing mortality next peaked at about F = 1.5 in the 1990s. Fishing mortality decreased after 1994, falling to less than F = 0.150 since 2000, with F in 2014 = 0.127. There is a 90% probability that F in 2014 was between 0.093 and 0.149.

Spawning Stock Biomass: Spawning stock biomass (SSB) decreased from about 68,000 mt in 1963 to about 5,000 mt in 1969, then increased to about 27,000 mt during the late 1970s. SSB declined through the 1980s and early 1990s to less than about 4,000 mt in the mid-1990s. With greatly improved recruitment and low fishing mortality rates since 1998, SSB increased to greater than 100,000 mt = 220 million lbs since about 2003. SSB was estimated to be 182,915 mt = 405 million lbs in 2014. There is a 90% probability that SSB in 2014 was between 153,000 and 222,000 mt (337 and 489 million lbs).

Recruitment: Since 1984, recruitment estimates from the model are influenced mainly by the fishery and survey catches-at-age, and averaged 109 million fish during 1984-2014. The 1999, 2006, and 2007 year classes are estimated to be the largest of the time series, at 222, 222, and 218 million age 0 fish. Following below average recruitment in 2012 and 2013, the 2014 year class is estimated to be above average at 112 million age 0 fish.

Special Comments:

The general results (e.g., highest estimated stock size and low F in the last decade) are robust to all proposed alternative model configurations. However, there are some indications of poor model fit from lack of correspondence among surveys (higher than expected variance when accounting for potential process error, some residual patterns), and there is uncertainty in the absolute magnitude of recent stock size estimates (although the terminal year estimates are calculated to be relatively precise with less than or equal to 15%). Alternative survey catchabilities (e.g., relative, absolute using wing or door spread), starting years, commercial and recreational selectivity patterns (see note below), and time-varying survey catchability configurations can produce about a +/- 40% range of terminal year SSB.

During the evaluation of the accepted model, sensitivities were examined which highlighted some additional risk. The main one of relevance to management is the choice of selectivity pattern. The base model has a strong domed selectivity pattern which could result in an increasingly cryptic biomass given current stock trajectory. Conclusions regarding current stock status are robust to alternative selectivity patterns but decreased recruitment or increased F in the future could lead to divergence between domed and flattop selectivity model results.

Changes in scup distributions with respect to bottom temperature, body size and abundance within the NEFSC survey were examined to identify potential effects on availability. A thermal habitat model was developed to estimate proportions of thermal habitat suitability for scup sampled during fall and spring NEFSC and NEAMAP surveys. These analyses did not reveal strong effects that could be directly linked to a trend in availability. These habitat-based estimates of availability were used to inform catchability in evaluations of sensitivity of the final ASAP model.

The 2015 SAW-60 scup assessment includes new research survey time series. The VIMS NEAMAP spring and fall trawl and RI Industry Cooperative trap surveys are now included in the assessment documentation and model.

References:

Legault CM, Restrepo VR. 1998. A flexible forward age-structured assessment program. ICCAT. Col. Vol. Sci. Pap. 49:246-253.

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NOAA Fisheries Toolbox (NFT). 2013. Age Structured Assessment Program (ASAP) version 3.0.11. (Internet address: http://nft.nefsc.noaa.gov).

Terceiro, M. 2012. Stock assessment of scup for 2012. US Dept of Commerce, NEFSC Ref Doc 12-25; 104 p.

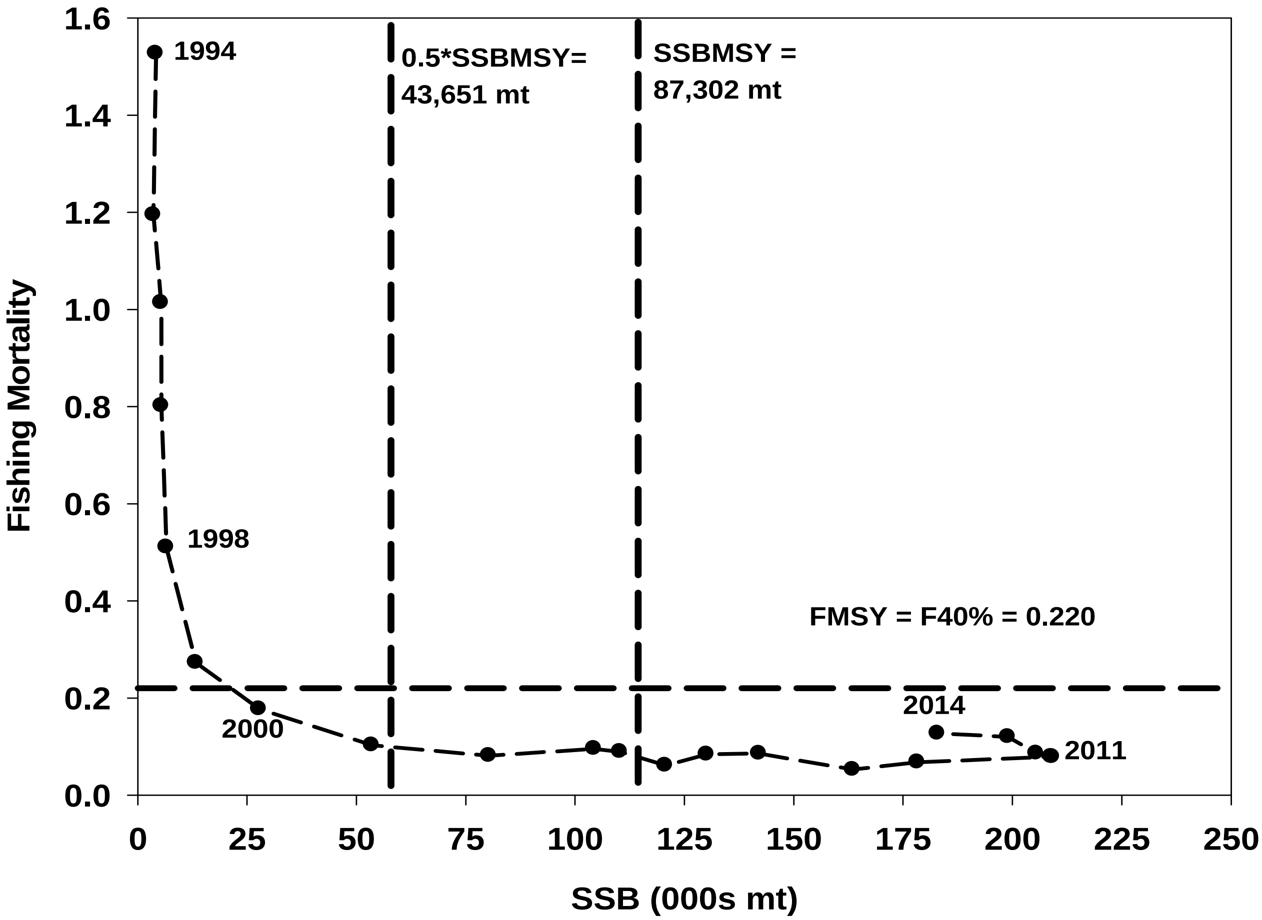

Figure A1. Status determination plot for scup: spawning stock biomass (SSB) and fully-recruited fishing mortality relative to the SAW/SARC-60 (2015) biological reference points.

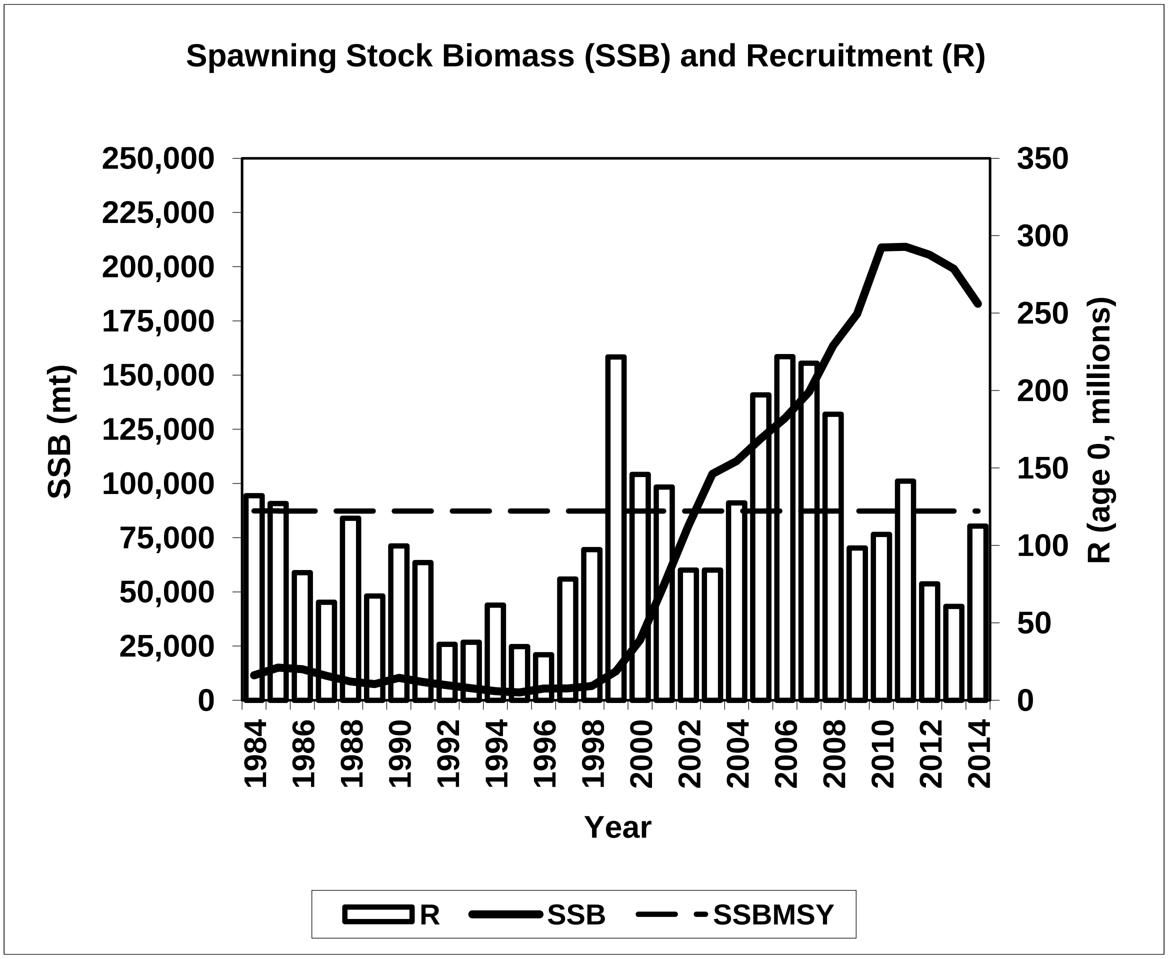

Figure A2. Spawning Stock Biomass (SSB; solid line) and Recruitment (R at age 0; vertical bars) for scup. The horizontal dashed line is the $SSB_{MSY\ Proxy} = SSB_{40\%}$ = 87,302 mt. Note this figure only shows years where fishery age data are available in the model.

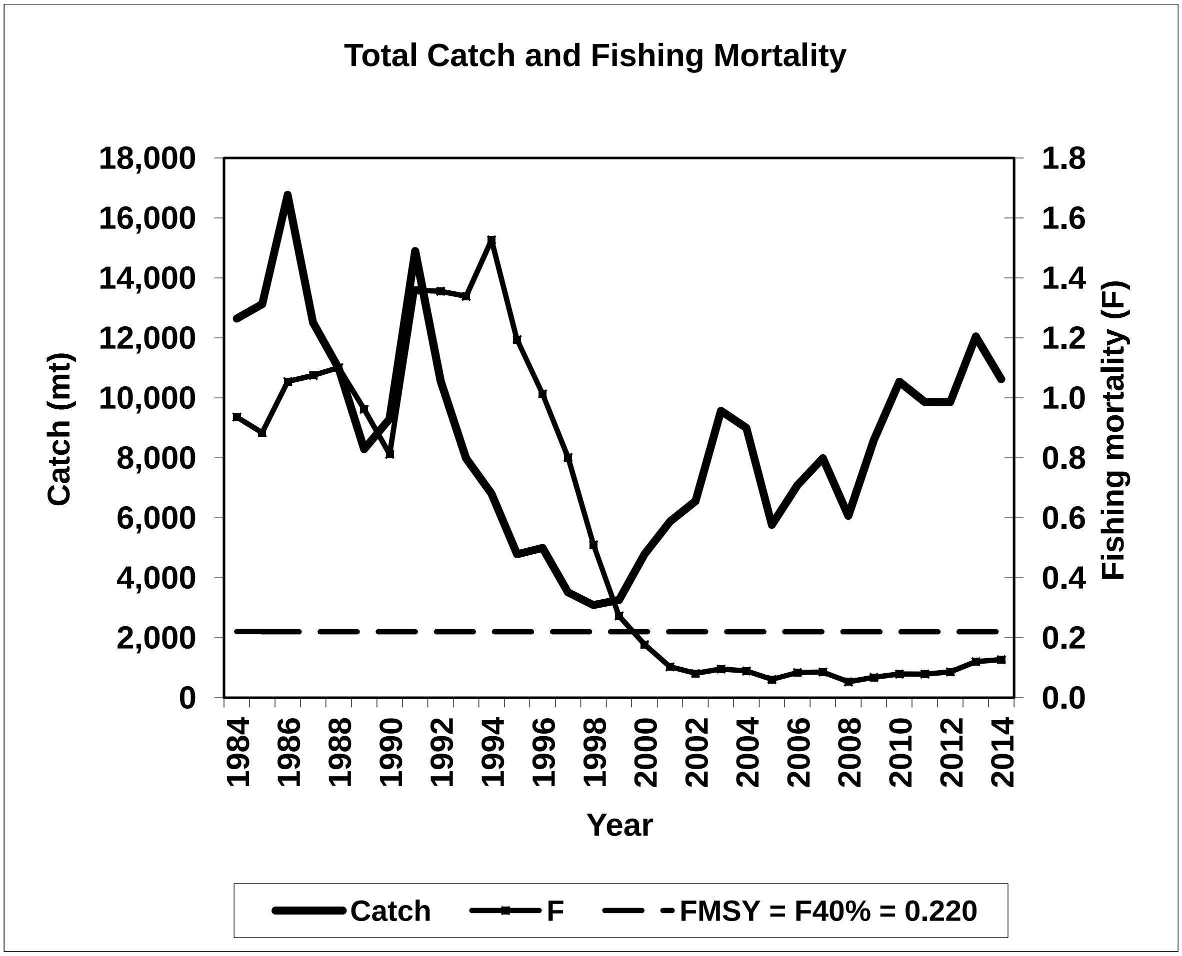

Figure A3. Total fishery catch and fishing mortality (F, peak at age 3) for scup. The horizontal dashed line is the $F_{MSY\ Proxy} = F_{40\%} = 0.220$. Note this figure only shows years where fishery age data are available in the model.

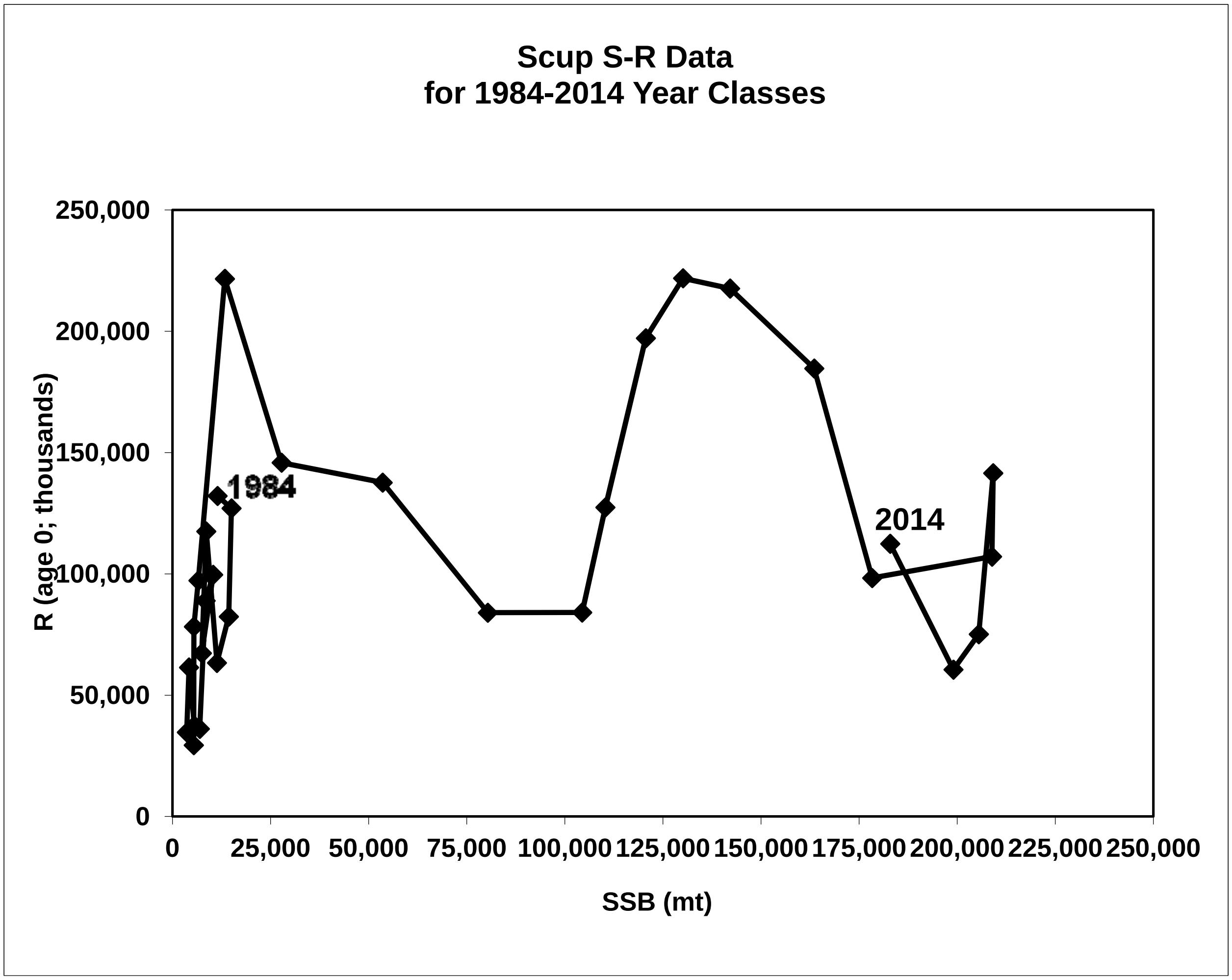

Figure A4. Spawning Stock Biomass (SSB) and Recruitment (R) scatter plot for scup. Note this figure only shows years where fishery age data are available in the model.

B. BLUEFISH ASSESSMENT SUMMARY FOR 2015

Status of the Stock: Bluefish (*Pomatomus saltatrix*) is not overfished and overfishing is not occurring in 2014 (Figure B1). Spawning stock biomass (SSB) in 2014 was estimated to be 86,534 mt, which is greater than the SSB threshold (½ $SSB_{MSY\ PROXY}$ = 55,614 mt) and less than the SSB target ($SSB_{MSY\ PROXY}$ = 111,228 mt). Fully-selected fishing mortality in 2014 was estimated to be 0.157, below the F threshold ($F_{MSY\ PROXY} = F_{40\%SPR}$ =0.170).

Projections: Short-term, 3-year projections were carried out under several different F scenarios with recruitment sampled from the full 1985-2014 time series of estimated recruitment from the accepted ASAP model. Removals in 2015 were assumed equal to the 2015 annual catch limit (ACL) of 9,772 mt (21.5 million lbs). All projections indicated the population would remain above the proposed SSB threshold with 100% probability (Table B1).

The overfishing limit (OFL) for 2016 was estimated to be 10,528 mt (23.2 million lbs) with a CV of 0.10 (Table B1, Figure B2). A qualitative inflation was applied for known sources of uncertainty that are not adequately captured in the projection process, including retrospective bias and uncertainty in the F_{MSY} proxy estimate, resulting in a recommended CV of 0.15.

Stock Distribution and Identification: Bluefish is a migratory pelagic species found in most temperate and tropical marine waters throughout the world. Along the U.S. Atlantic Coast, bluefish commonly occur in estuarine and continental shelf waters from Maine to Florida. Bluefish are a schooling species that migrate in response to seasonal changes, moving north and inshore during the spring, and south and offshore in the late autumn. The bluefish fishery is believed to exploit a single stock or population of fish. The management unit comprises the state and federal waters of the entire U.S. Atlantic Coast.

Catches: Bluefish are predominantly a recreationally caught species, with recreational harvest making up approximately 80% of total removals in recent years (Figure B3). Commercial landings increased steadily from 2,125 mt (4.7 million lbs) in 1950 to a peak of 7,825 mt (17.2 million lbs) in 1981 before declining to levels comparable to the beginning of the time-series. Commercial landings from 2010-2014 averaged 2,436 mt (5.4 million lbs), with 2,236 mt (4.93 million lbs) being landed in 2014. Data on commercial discards rates were limited, but indicated commercial discards were negligible over the time series. Recreational data are available from 1981 onward. Recreational harvest has also declined over this time period, from a peak in 1983 at 24.8 million fish to a low of 3.7 million fish in 1999. Recreational harvest has increased slightly since then, with the most recent 5-year average equal to 5.6 million fish. Both total numbers and the proportion of fish released alive by anglers have increased over this time period: 18% were released alive from 1981-1985 (an average of 5.0 million fish), while 62% were released alive from 2010-2014 (an average of 9.2 million fish). Fish that are released alive from the recreational fishery are assumed to have a 15% mortality rate. Total removals from the recreational fishery therefore include both harvested fish (retained or discarded dead) and 15% of fish released alive. Total recreational removals peaked in 1986 at 25.3 million fish (equal to 47,434 mt or 104 million lbs), declined to a low of 4.8 million fish in 1999 (5,935 mt or 13.1 million lbs), and rebounded after that, to an average of 7 million fish (9,068 mt or 20.0 million lbs) over the last five years.

Data and Assessment: The previous benchmark assessment (NEFSC 2005) was conducted using ASAP, a forward-projecting statistical catch-at-age model. The current assessment uses the same model, with updates to the way the catch-at-age matrices were constructed and changes to the model configuration. The model uses data from 1985-2014, and fits to total catch in weight, catch-at-age, and indices of abundance. Total catch includes commercial landings, recreational landings, and recreational release mortalities. The catch-at-age matrices were completely reconstructed to incorporate new age data, including archived historical samples that had not been processed at the time of the last assessment, and to correct ageing errors in the earliest years of the time series. Fishery removals were modeled as two fleets, recreational and commercial, each with a single selectivity period. Selectivity for both fleets was estimated at age, with selectivity fixed at 1 for age-1 in both fleets.

Eight fishery-independent and one fishery-dependent indices were used in the model. Age-0+ fishery-independent indices included the NEFSC fall trawl survey (split at 2008/9 when the survey vessel was replaced and the inner inshore strata became inaccessible), the NEAMAP fall inshore trawl survey, the Connecticut Long Island Sound trawl survey, the New Jersey ocean trawl survey, and the North Carolina Pamlico Sound independent gillnet survey. Young-of-year indices included the SEAMAP fall trawl survey and a composite index developed from state seine indices from New Hampshire to Virginia. A recreational catch-per-unit-effort index was developed from the MRIP intercept data. The model was fit to total index CPUE and index age composition data.

At the SARC-60 review of bluefish the review panel discovered a model misspecification in the selectivity parameters for the MRIP index. A parameter in the function describing the curve for selectivity was fixed when it was intended to have been freely estimated by the model. This was causing patterning in the age composition residuals for this index. The final revised model corrects this misspecification. The values presented in this summary report reflect the output from the revised model as accepted at the review.

The model exhibited a minor retrospective pattern. Estimates of retrospective bias-adjusted SSB and F were within the credible intervals of the accepted model estimates, so a retrospective adjustment was not deemed necessary.

Biological Reference Points: The biological reference points estimated in the previous assessment (SARC-41) were MSY reference points for F and total biomass (F_{MSY}, B_{MSY}). However, MSY reference points require a reliable stock-recruitment relationship. The stock-recruitment relationship is poorly defined for bluefish, due to the lack of information on recruitment at small stock sizes, with steepness estimated to be close to one for most model runs. Therefore, in SARC-60 SPR-based reference points were used as a proxy for MSY reference points. $F_{40\%SPR}$ was set as the F_{MSY} proxy for the overfishing threshold. $F_{40\%SPR}$ was calculated using average SSB and catch weights-at-age, and a single composite F-weighted average selectivity from 2012-2014. The biomass target ($SSB_{MSY\ PROXY}$) was established by projecting the population forward until an equilibrium spawning stock biomass was reached, with recruitment drawn from the 1985-2014 time-series of model-estimated recruitment. The overfished biomass threshold was set at ½ $SSB_{MSY\ PROXY}$.

Reference Point	SARC-41 Definition[1]	SARC-41 Value	Updated Definition[1]	Updated Value
$\mathbf{F_{Threshold}}$	F_{MSY}	0.19	$F_{MSY\ Proxy} = F_{40\%SPR}$	0.170
$\mathbf{B_{Target}}$	B_{MSY}	147,052 mt	Equilibrium SSB under $F_{40\%SPR}$	111,228 mt
$\mathbf{B_{Threshold}}$	½ B_{MSY}	73,526 mt	½ $SSB_{MSY\ Proxy}$	55,614 mt

[1]: Note that the SARC-41 biomass reference points refer to total biomass, while the SARC-60 (2015) biomass reference points refer to spawning stock biomass.

The MSY_{Proxy}, associated with equilibrium catch at the F_{MSY} proxy, is 13,967 mt. MSY as established by the SARC-41 assessment was 14,647 mt.

Fishing Mortality: Fully selected F (F_{full}) peaked in 1987 at 0.477, and has declined gradually since then, with a time series average of 0.284 (Figure B4). The 2014 F_{full} is 0.157 (90% credible interval 0.133 – 0.215).

Biomass: Spawning stock biomass has declined since the beginning of the time-series, from a high of 154,633 mt (341 million lbs) in 1985 to a low of 52,774 mt (116 million lbs) in 1997, before increasing again (Figure B4). The time-series average for spawning stock biomass is 79,449 mt (175 million lbs). Spawning stock biomass in 2014 was 86,534 mt with a 90% credible interval of 62,279 – 90,735 mt (208 million lbs, 90% credible interval of 137 – 199 million lbs).

Total biomass in 2014 was 94,328 mt (208 million lbs) with a 90% credible interval of 69,213 – 98,818 mt (153 - 281 million lbs).

Recruitment: Age-0 abundance has varied without trend over the time-series, with few exceptionally strong or exceptionally weak year classes (Figure B5). Recruitment averaged 24.0 million fish from 1985-2014. Recruitment in 2014 was slightly above average, equal to 29.6 million fish. The estimated recruitment from 2005-2014 has shown a tendency towards lower inter-annual variability.

Special Comments: The accepted model captures the dynamics of the bluefish stock well and accurately reflects trends in spawning stock biomass and fishing mortality.

SARC-60 recommends basing stock status determination on spawning stock biomass and SSB-based reference points. The previous benchmark assessment (NEFSC 2005) used total biomass.

The accepted model indicates SSB is well-above the SSB overfished threshold with an increasing trend in recent years. F in 2014 is below the F overfishing threshold, but the proximity of the terminal estimate of F to the F threshold is sensitive to changes in the data and model structure.

The model is strongly informed by the fishery-dependent recreational CPUE index (developed from access point intercepts, which are also used to develop the catch time-series). The index also includes age-structure information which is partially shared with the recreational catch-at-age.

$F_{40\%SPR}$ is commonly used as an F_{MSY} proxy for demersal species, while bluefish is a more productive pelagic species. Bluefish recruit to the fishery before they are fully mature, but the fishery exhibits a dome-shaped selectivity that offers protection to the spawning stock.

References

NEFSC. 2005. Northeast Regional Stock Assessment Workshop (41st SAW). 41st SAW Assessment Report. U.S. Dept. Commerce, Northeast Fisheries Science Center Ref. Doc. 05-14; 237 p.

Catch and Status Table: Bluefish

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Min[1]	Mean[1]	Max[1]
Commercial landings (thousands of metric tons)[2]	3.2	3.3	3.4	2.7	3.1	3.3	2.5	2.2	2.0	2.2	1.9	4.6	7.8
Recreational landings (millions of fish)	7.9	7.0	8.4	6.7	5.2	6.1	5.1	5.5	5.5	5.8	3.7	8.2	24.4
Recreational discards (millions of fish)[3]	1.9	1.9	2.2	2.0	1.3	1.5	1.4	1.3	1.2	1.5	0.5	1.2	2.2
Total catch used in assessment (thousands of metric tons)	16.7	14.7	17.3	16.4	12.2	14.2	11.5	10.8	11.3	9.8	9.3	18.3	54.1
Spawning stock biomass (thousands of metric tons)	87.5	75.1	72.1	87.9	77.5	82.8	81.8	86.1	91.5	86.5	52.8	79.4	154.6
Fully selected fishing mortality[4]	0.234	0.243	0.284	0.220	0.193	0.224	0.192	0.179	0.177	0.157	0.157	0.284	0.477
Recruitment (age 0) (millions of fish)	30.6	32.2	24.5	23.1	17.6	18.6	17.8	16.7	25.1	29.6	13.5	24.0	48.1

[1]: Calculated over the years 1985-2014
[2]: Commercial discards were considered negligible and were not used in the assessment. They are not presented here.
[3]: Recreational discards reflect a 15% release mortality rate
[4]: F on fully selected ages

Table B1. Short-term projections of catch and biomass for bluefish under various F scenarios, with the associated probability that biomass in 2018 will be above the biomass threshold.

	Catch (MT)			Spawning Stock Biomass (MT)			$P(SSB_{2018}) >$
F Scenario	2016	2017	2018	2016	2017	2018	$SSB_{threshold}$
$F_{MSY\ Proxy}$ = 0.170	**10,528***	10,578	11,023	83,936	82,200	85,400	1.00
90% $F_{MSY\ Proxy}$ = 0.153	9,533	9,698	10,218	84,448	83,736	88,045	1.00
F_{2014} = 0.157	9,768	9,908	10,413	84,327	83,371	87,416	1.00
F_{low} = 0.100	6,351	6,716	7,326	86,064	88,715	96,865	1.00
$F_{0.1}$ = 0.187	11,510	11,423	11,772	83,426	80,701	82,839	1.00
$F_{35\%SPR}$ = 0.191	11,740	11,617	11,941	83,307	80,352	82,247	1.00

*****: The OFL for 2016, derived from catch projections under the F_{MSY} proxy.

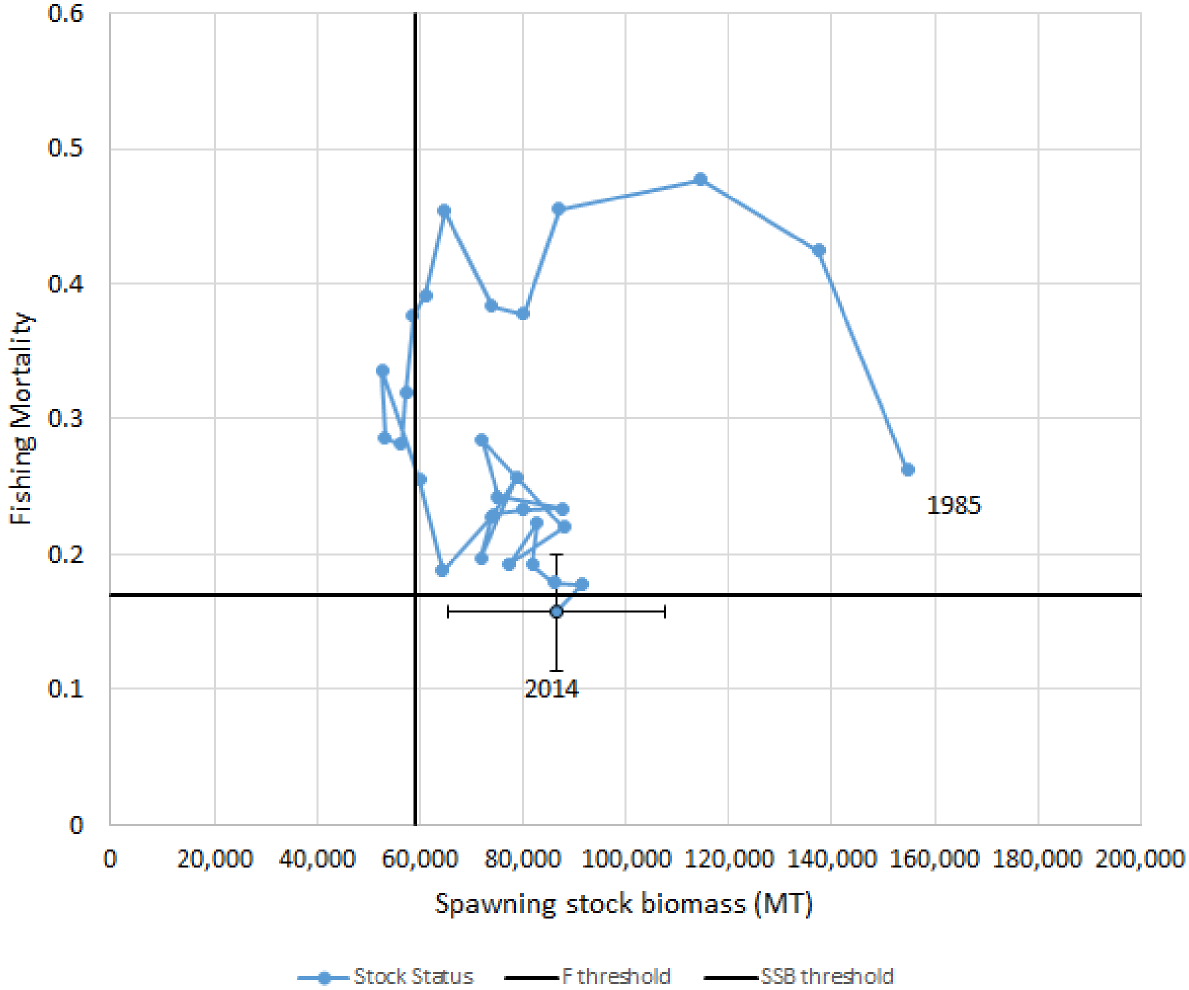

Figure B1. Estimates of annual spawning stock biomass and fishing mortality for bluefish plotted with the SSB and F thresholds from this assessment (solid lines). Error bars around the 2014 status point are the 95% confidence intervals.

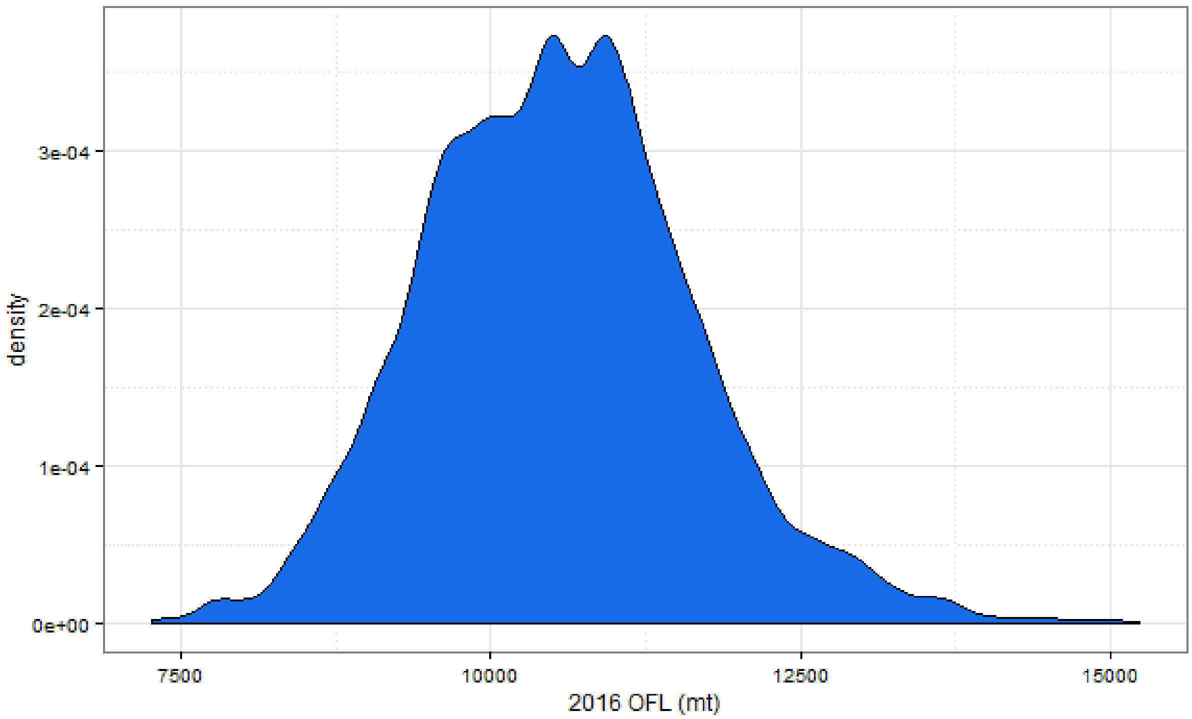

Figure B2. Distribution of 2016 overfishing limit (OFL) estimates from stochastic projections.

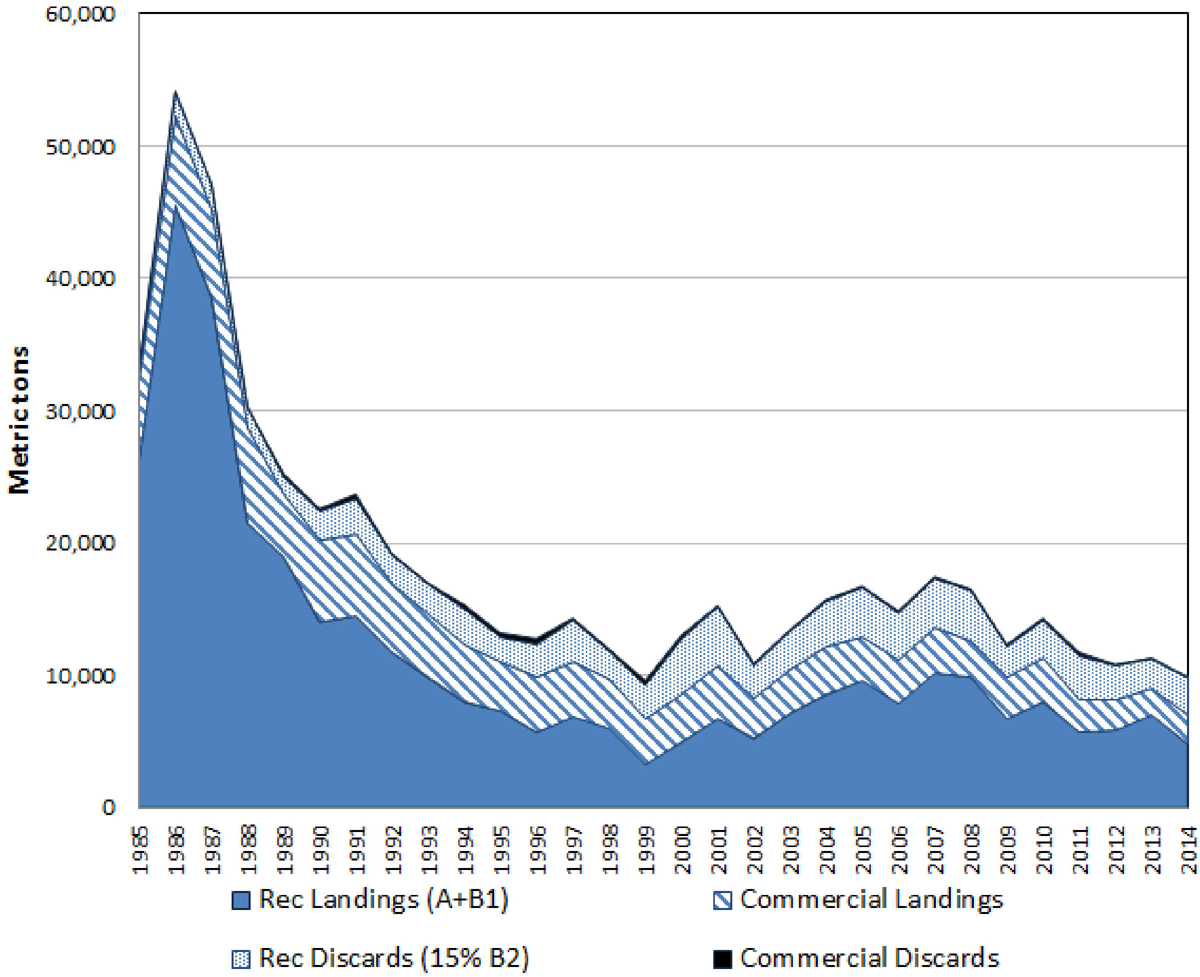

Figure B3. Total catch of bluefish by fleet and disposition. Estimates of commercial discards were minimal and uncertain, and were not included in the model.

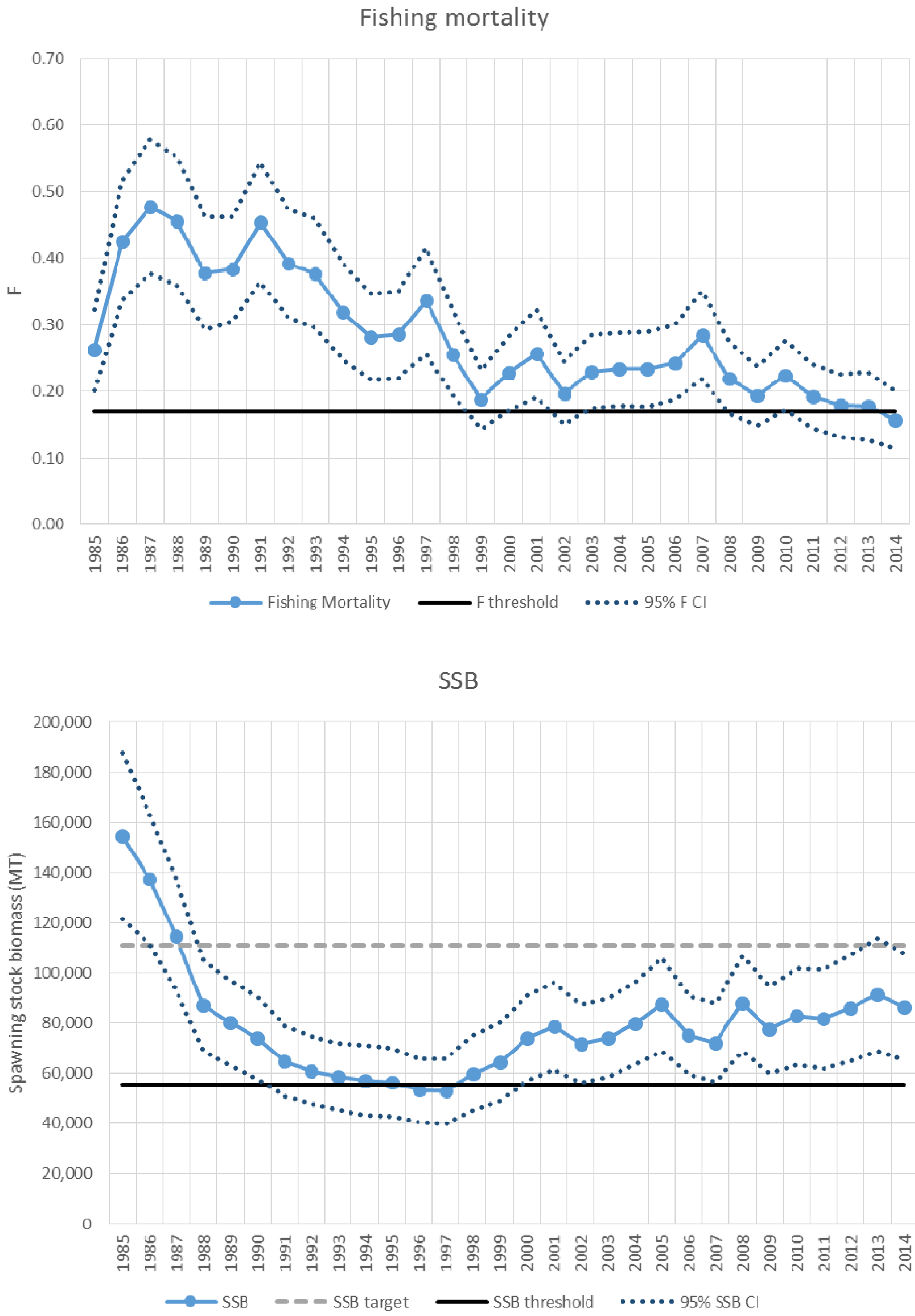

Figure B4. Fully selected fishing mortality (top) and spawning stock biomass (bottom) of bluefish plotted with their respective thresholds and 95% confidence intervals.

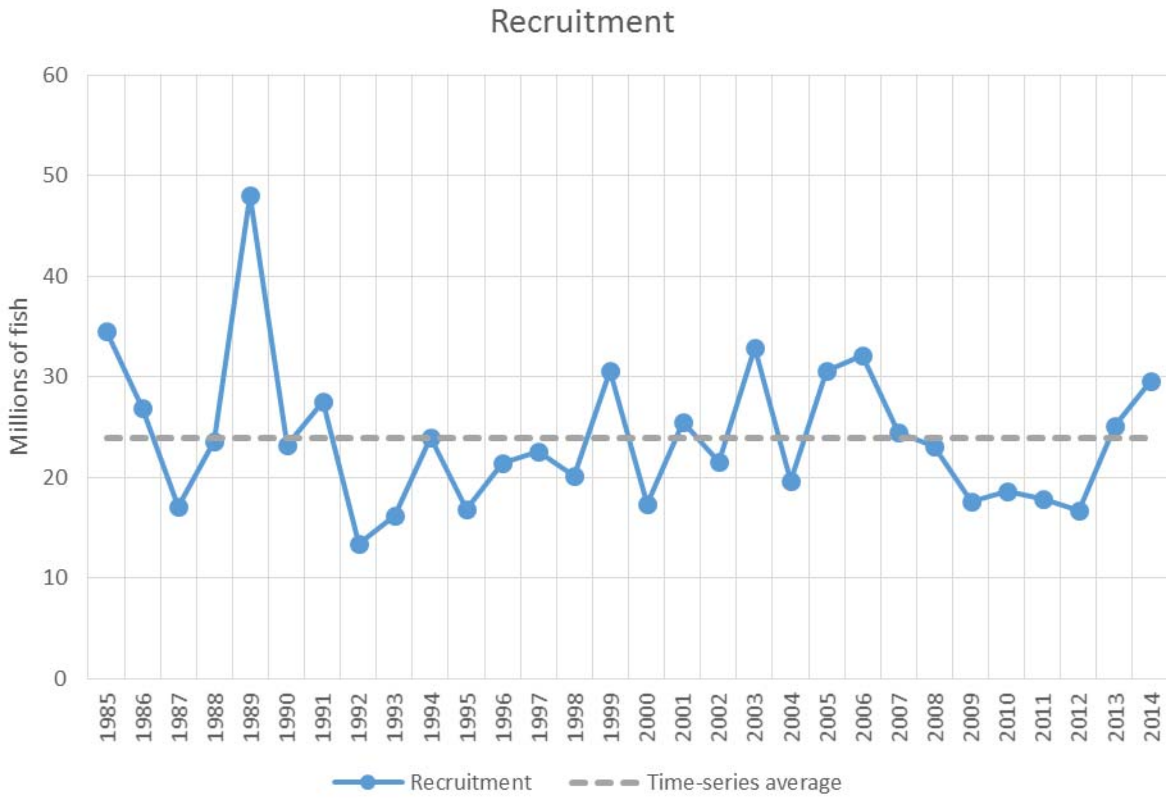

Figure B5. Recruitment (age-0 fish) of bluefish plotted with the time-series average.

Appendix: Stock Assessment Terms of Reference for SAW/SARC-60, June 2-5, 2015

(v. 10/16/2014)

A. Scup

1. Estimate catch from all sources including landings and discards. Include recreational discards, as appropriate. 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 being used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.). Characterize the uncertainty and any bias in these sources of data.

3. Describe the thermal habitat and its influence on the distribution and abundance of scup, and attempt to integrate the results into the stock assessment.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Include a historical retrospective analysis 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) (see Appendix to SAW TORs for definitions).

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

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, SSC, and Working Group research recommendations listed in most recent SARC reviewed assessment and review panel reports. Identify new research recommendations.

B. Bluefish

1. Estimate catch from all sources including landings and discards. Evaluate and if necessary update the discard mortality estimate. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

2. Present and evaluate data and trends on life history information including, age, growth, natural mortality, food habits, and maturity.

3. 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.), evaluate the utility of the age-length key for use in stock assessment, and explore standardization of fishery-independent indices. Investigate the utility of recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data, including exploring environmentally driven changes in availability and related changes in size structure. Explore the spatial distribution of the stock over time, and whether there are consistent distributional shifts.

4. Estimate relative fishing mortality, annual fishing mortality, recruitment, total abundance, and stock biomass (both total and spawning stock) for the time series, 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. Explore alternative modeling approaches if feasible.

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 review 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; 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 2005 and the research recommendations contained in its 23 September 2013 report to the MAFMC. Identify new research recommendations.

Appendix to the SAW Assessment TORs:

Clarification of Terms used in the SAW/SARC Terms of Reference

On "Overfishing Limit" and "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 annual catch that is consistent with 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)

Interactions 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.

One model or alternative models:

The preferred outcome of the SAW/SARC is to identify a single "best" model and an accompanying set of assessment results and a stock status determination. If selection of a "best" model is not possible, present alternative models in detail, and summarize the relative utility each model, including a comparison of results.

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