NOTE TO THE READER: This is the 1st edition of this report which was originally published July 28, 2011, but was found to have errors. Corrections were made and a 2nd edition was released September 7, 2011.

PLEASE SEE THE 2ND EDITION OF THIS REPORT WHICH CAN FOUND AT: http://nefsc.noaa.gov/publications/crd/crd1111/crd1111.pdf

CORRECTION September 7, 2011: The first edition of this report, released in July 2011, had some incorrect values in the Georges Bank winter flounder chapter. The report was corrected in September 2011. The corrections did not change the stock status conclusions (i.e., not overfished and overfishing is not occurring). Corrections were made to the estimates of SSB_{MSY}, $1/2SSB_{MSY}$, and MSY. This required revising the statement about rebuilding in the Projection section, the last Special Comment, and two Figures (B1, B5) which show biomass reference points. The reference points needed to be corrected because they were based on an incorrect alpha value from an early run of a stock-recruit model made by the SAW Working Group. The corrected report uses a revised alpha value that is consistent with final modeling decisions made during the peer review meeting by the SARC-52 review panel.

CORRECTION July 29, 2011: The caption for Figure A5 in the Southern New England Winter Flounder section was corrected to read "recruitment is in thousands of age-1 fish." The caption incorrectly read "recruitment is in millions of age-1 fish." This change did not affect any conclusions about stock status.

Northeast Fisheries Science Center Reference Document 11-11

52nd Northeast Regional Stock Assessment Workshop (52nd SAW):

Assessment Summary Report

by Northeast Fisheries Science Center

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NOAA National Marine Fisheries Service, 166 Water St., Woods Hole, MA 02543.

US DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

July 2011

Northeast Fisheries Science Center Reference Documents

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Editorial Treatment: To distribute this report quickly, it has not undergone the normal technical and copy editing by the Northeast Fisheries Science Center's (NEFSC's) Editorial Office as have most other issues in the NOAA Technical Memorandum NMFS-NE series. Other than the four covers and first two preliminary pages, all writing and editing have been performed by the authors listed within. This report was reviewed by the Stock Assessment Review Committee, a panel of assessment experts from the Center for Independent Experts (CIE), University of Miami.

Information Quality Act Compliance: In accordance with section 515 of Public Law 106-554, the Northeast Fisheries Science Center completed both technical and policy reviews for this report. These predissemination reviews are on file at the NEFSC Editorial Office.

This document may be cited as:

Northeast Fisheries Science Center. 2011. 52nd Northeast Regional Stock Assessment Workshop (52nd SAW) Assessment Summary Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-11; 51 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/

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SAW-52 ASSESSMENT SUMMARY REPORT

Introduction

The 52nd SAW Assessment Summary Report contains summary and detailed technical information on three stock assessments reviewed in June 2011 at the Stock Assessment Workshop (SAW) by the 52nd Stock Assessment Review Committee (SARC-52): three stocks of winter flounder (*Pseudopleuronectes americanus*) from Southern New England/Mid-Atlantic, Georges Bank, and Gulf of Maine. The SARC-52 consisted of 3 external, independent reviewers appointed by the Center for Independent Experts [CIE], and an external SARC chairman from the NEFMC 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-52 are available at website: http://www.nefsc.noaa.gov/nefsc/saw/ under the heading "SARC 52 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 the precautionary approach, 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

Based on the Review Panel reports (available at http://www.nefsc.noaa.gov/nefsc/saw/ under the heading "SARC 52 Panelist Reports"), the SARC review committee concluded that for the **SNE/MA** winter flounder assessment all Terms of Reference were addressed satisfactorily. The statistical catch-age model used for SNE/MA assessment is considered to be a scientifically credible approach and provides a reasonable basis for fisheries management advice. In 2010, this stock was overfished but overfishing was not occurring.

The Terms of Reference for the **GBK** winter flounder assessment were satisfactorily addressed. The VPA model used was a scientifically credible approach and provides a reasonable basis for fisheries management advice. A statistical catch-age model should be considered for the GBK stock as there may be more uncertainty here associated with catch and discards than would be appropriate for the assumption of true known catches as is made in a VPA analysis. In 2010 the GBK winter flounder stock was not overfished and overfishing was not occurring.

The Terms of Reference for the **GOM** winter flounder assessment were partially addressed. The GOM statistical catch-age model could not account for conflicting trends in the catch and survey information, and was not accepted. However, the accepted fall back analysis of the area-swept method provides a reasonable gauge of overfishing status and provides time trends in biomass. Overfishing does not appear to be taking place in 2010. It was not possible at the meeting to determine whether or not the stock is overfished.

For all of these assessments, the SARC felt that the discussion of stock vulnerability could have addressed biological issues more directly (e.g., life history, longevity, fecundity, productivity, or whether the species or stock is overly susceptible to fishing or environmental conditions). While the length-based calibrations between vessels were informative and appeared appropriate, this method might be considered for additional peer review. A method was developed for combining information on winter flounder across regions to help inform the spawner-recruit relationships used in developing projections and biological reference points (for details on the method see the Review Panel Summary Report and the Appendix of the Stock Assessment Report).

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.

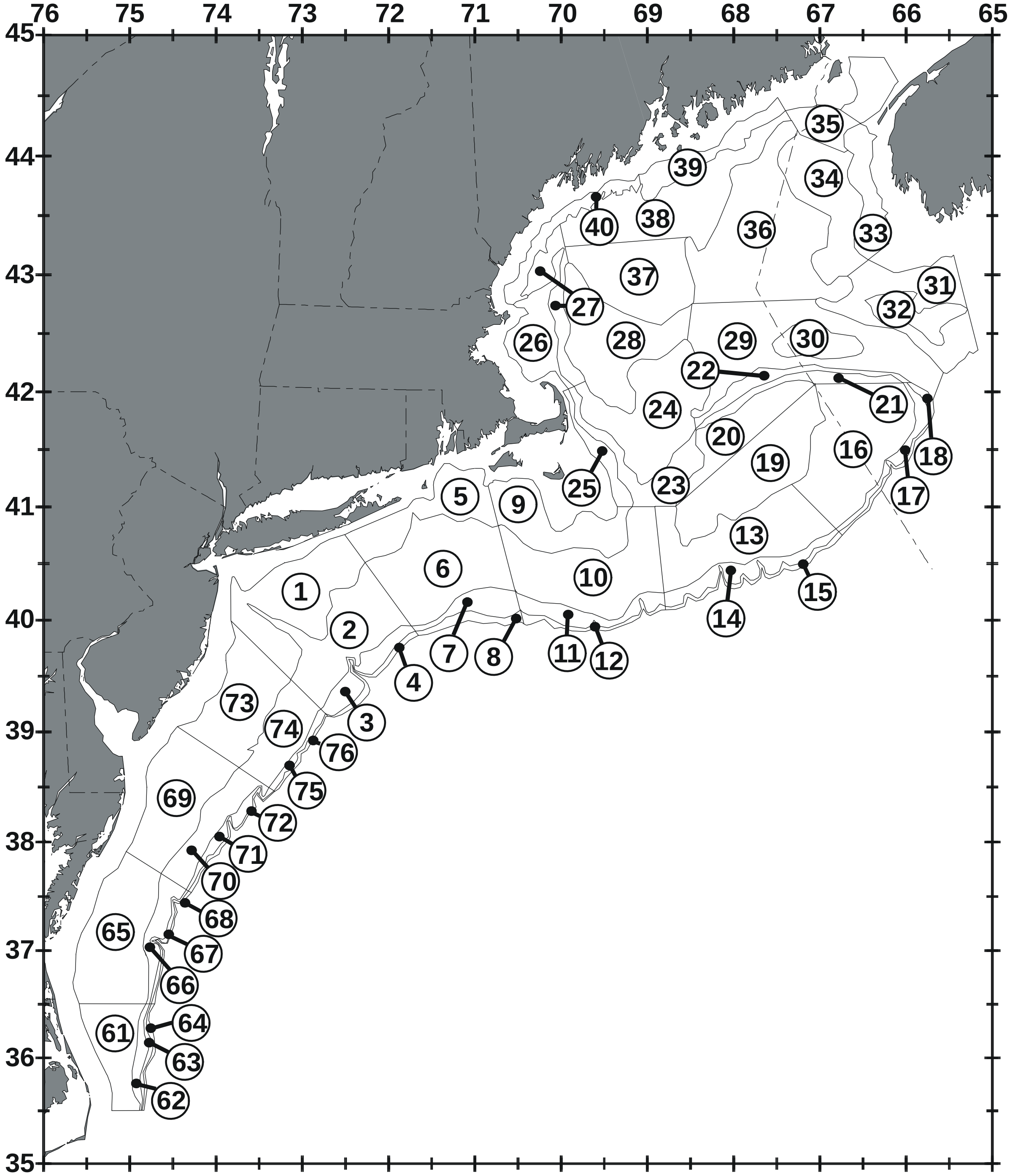


Figure 1. Offshore depth strata sampled during Northeast Fisheries Science Center bottom trawl research surveys.

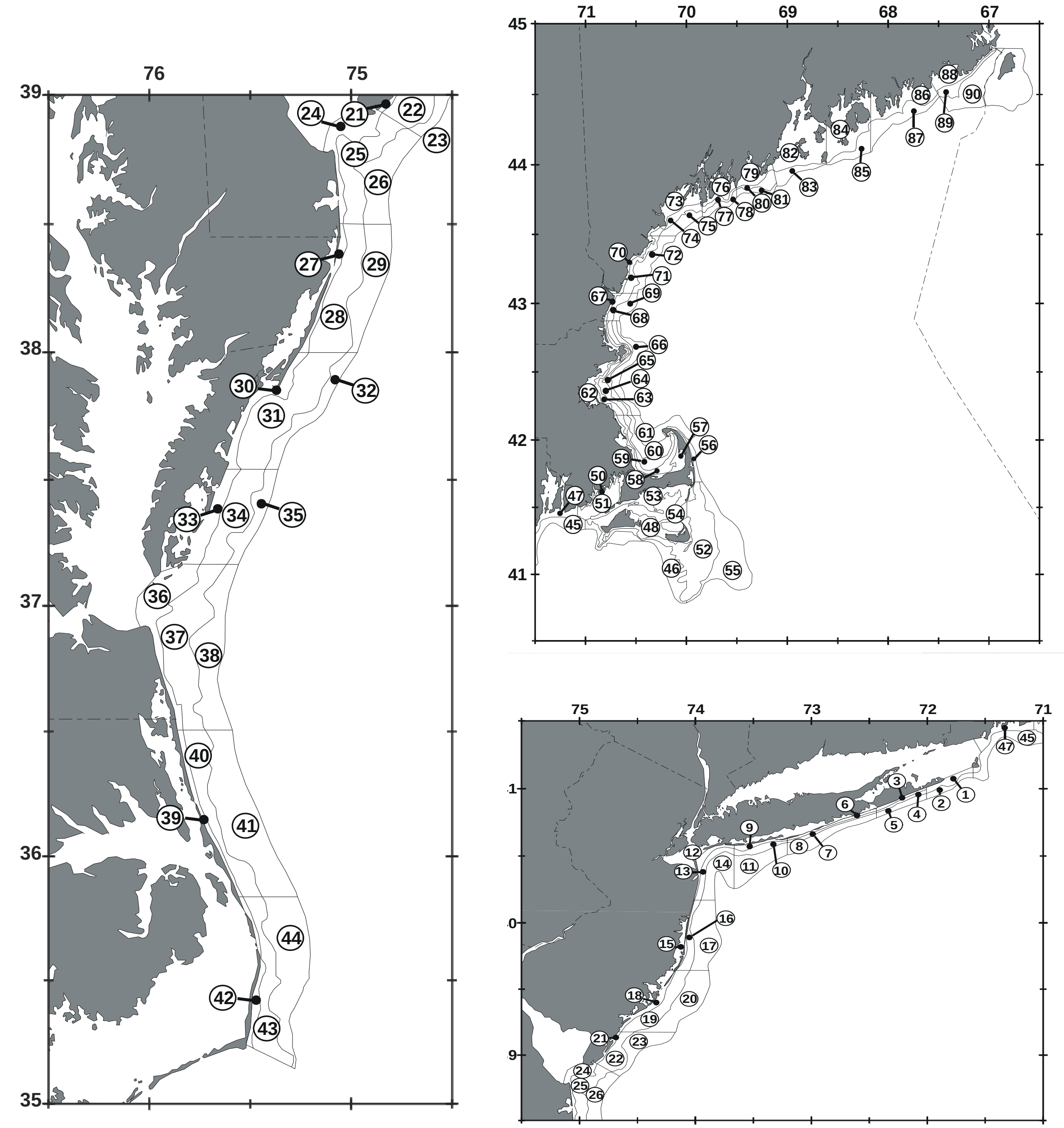


Figure 2. Inshore depth strata sampled during Northeast Fisheries Science Center bottom trawl research surveys.

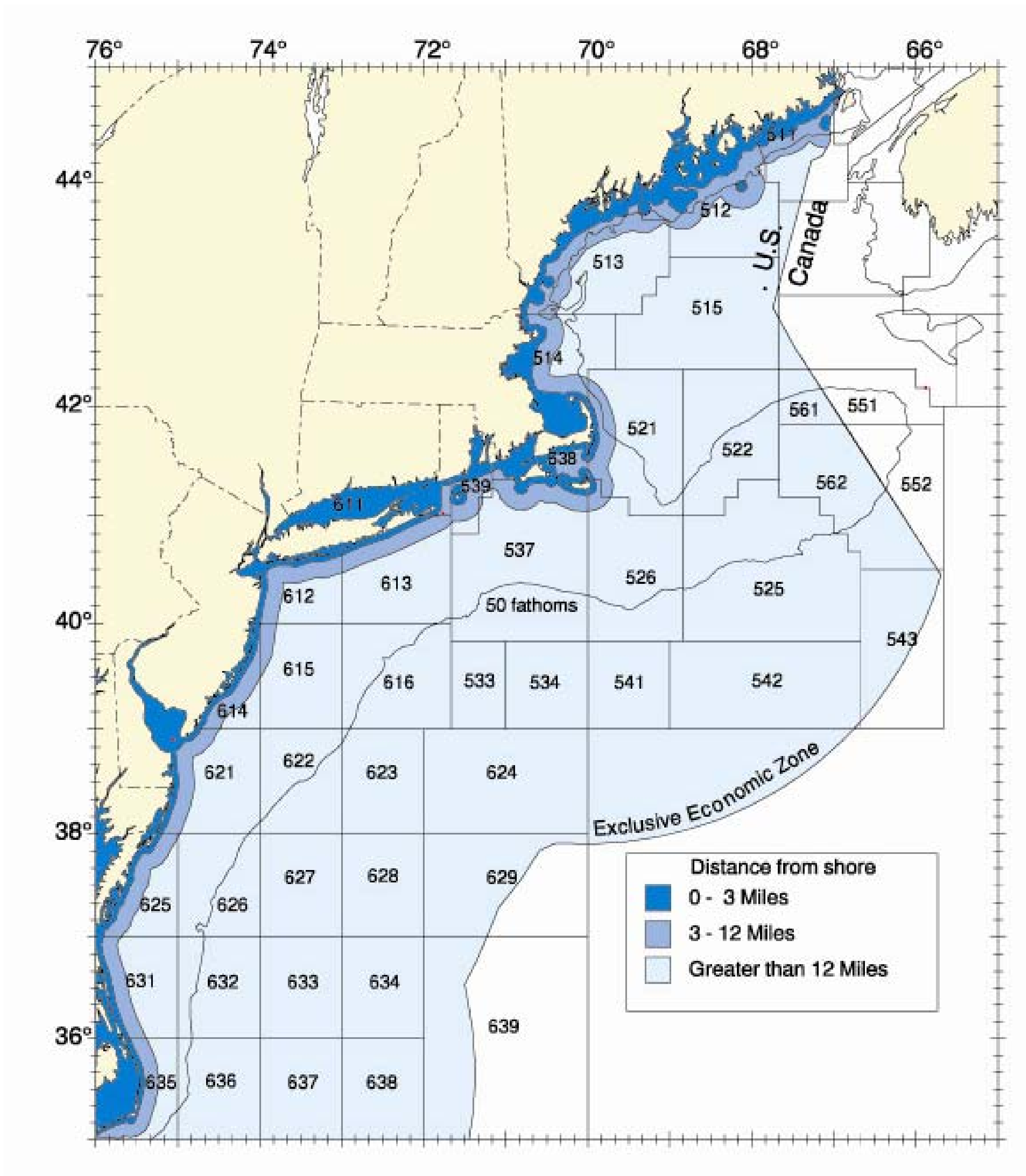


Figure 3. Statistical areas used for reporting commercial catches.

A. SOUTHERN NEW ENGLAND / MID-ATLANTIC (SNE/MA) WINTER FLOUNDER ASSESSMENT SUMMARY FOR 2011

State of Stock: In 2010 the SNE/MA winter flounder stock was overfished but overfishing was not occurring. The current assessment provides a new assessment model, a new assumption for the instantaneous natural mortality rate (M), and new biological reference points. The recommended biological reference points are $F_{MSY} = F_{THRESHOLD} = 0.290$, $SSB_{MSY} = B_{TARGET} =$ 43,661 mt, 1/2 $SSB_{MSY} = B_{THRESHOLD}$ = 21,831 mt, and MSY = 11,728 mt. The 2010 estimate of Spawning Stock Biomass (SSB) is 7,076 mt, 16% of B_{TARGET} and 32% of $B_{THRESHOLD}$. The 2010 estimate of fishing mortality (F, ages 4-5) is 0.051, 18% of $F_{THRESHOLD}$ (Figures A1-A3).

Given the new model and assumptions in the current assessment, comparison of the 2010 estimates of SSB and F estimates with the existing 2008 GARM III reference points (NEFSC 2008) is not appropriate. The existing biological reference points from the 2008 GARM III assessment are $F_{40\%} = F_{THRESHOLD} = 0.248$, $SSB_{40\%} = B_{TARGET}$ = 38,761 mt, 1/2 $SSB_{40\%}$ = $B_{THRESHOLD}$= 19,381 mt, and $MSY_{40\%}$ = 9,742 mt.

Projections: Projections of future stock status were made based on the current assessment results using mean weight, maturity, and fishery selectivity patterns at age estimated for the most recent 5 years in the assessment (2006-2010) to reflect current conditions in the stock and fishery. Recruitment was projected using the stock-recruitment model for the MSY-based BRPs. The projections assumed the FMP Framework 44 fishing year (May 1) catch of 842 mt would be landed as a calendar year (Jan 1) catch in 2011. A catch of 842 mt in 2011 is projected to provide median F in 2011 = 0.100 and median SSB in 2011 = 9,177 mt. Projections at F = 0.000 in 2012-2014 indicate less than a 1% chance that the stock will rebuild to SSB_{MSY} = 43,661 mt by 2014.

Catch: Commercial fishery landings reached an historical peak of 11,977 metric tons (mt) in 1966, then decreased through the 1970s, peaked again at 11,176 mt in 1981, and then steadily decreased to 2,128 mt in 1994. Commercial landings then increased to 4,556 mt in 2001 but have decreased since then to only 174 mt in 2010 (Figure A4). The Proportional Standard Error (PSE) of commercial landings has averaged less than 1%. Recreational fishery landings peaked in 1984 at 5,510 mt, but decreased substantially thereafter, with only 28 mt estimated for 2010. The PSE of the recreational landings has averaged about 27%. Commercial fishery discards for 1981 to 1993 were estimated from length frequency data from the NEFSC and MADMF trawl surveys, commercial port sampling of landings at length and Fishery Observer sampling of landings and discards at length. The Standardized Bycatch Reporting Method (SBRM) has been used for estimation of SNE/MA winter flounder commercial fishery discards for 1994 and later years. Commercial fishery discard losses peaked in the early 1980s at 1,000-1,500 mt per year and then decreased to less than 200 mt per year since 1997. A discard mortality rate of 50% was applied to the commercial live discard estimates. The PSE of the commercial fishery discards has averaged 27%. Recreational fishery discard losses peaked in 1984-1985 at about 700,000-750,000 fish or 150-200 mt and then decreased to less than 100,000 fish or 20 mt per year since 2000. A discard mortality rate of 15% was applied to recreational live discard estimates. The PSE of the recreational discards has averaged 30%.

Catch and Status Table (weights in 000s mt, recruitment in millions, arithmetic means): SNE/MA Winter Flounder

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Max[1]	Min[1]	Mean[1]
Commercial landings	4.6	3.1	2.3	1.6	1.3	1.7	1.6	1.1	0.3	0.2	11.1	0.2	3.9
Commercial discards	<0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.2	1.5	<0.1	0.5
Recreational landings	0.5	0.2	0.3	0.2	0.1	0.1	0.1	0.1	0.1	<0.1	5.5	<0.1	1.4
Recreational discards	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Catch used in assessment	5.1	3.4	2.8	1.9	1.6	2.0	1.9	1.3	0.5	0.4	15.8	0.4	5.9
Spawning Stock Biomass[2]	8.1	6.0	5.6	4.9	4.5	5.2	6.2	5.9	5.7	7.1	20.1	3.9	8.0
Recruitment (age 1)	15.1	7.4	7.5	15.6	14.2	8.3	7.5	13.5	8.7	8.7	71.6	7.4	25.2
F (ages 4-5)	0.70	0.63	0.55	0.46	0.37	0.42	0.34	0.24	0.09	0.05	1.16	0.05	0.65

1: Over the period 1981-2010
2: On March 1 annually

Stock Distribution and Identification: Winter flounder (*Pseudopleuronectes americanus*) is a demersal flatfish species commonly found in North Atlantic estuaries and on the continental shelf. The species is distributed between the Gulf of St. Lawrence, Canada and North Carolina, U.S., although it is not abundant south of Delaware Bay. Information from tagging, meristics, and life history studies suggest extensive mixing occurs among the localized Southern New England and Mid-Atlantic populations, and so the populations in the region are combined into a single stock complex for assessment purposes. Within the SNE/MA stock complex, winter flounder undergo annual migrations from estuaries, where spawning occurs in the late winter and spring, to offshore shelf areas of less than 60 fathoms (110 meters). The current SNE/MA stock complex extends from the coastal shelf east of Provincetown, MA southward along the Great South Channel (separating Nantucket Shoals and Georges Bank) to the southern geographic limits of winter flounder off Delaware.

Data and Assessment: The age-structured assessment model for SNE/MA winter flounder has changed from an ADAPT VPA model to an ASAP SCAA model (NFT 2011). A new value for natural mortality has been adopted, changing from M = 0.20 to M = 0.30 for all ages and years. New biological reference points have therefore also been estimated, with F_{MSY}, SSB_{MSY}, and MSY now based on a stock-recruitment model. Indices of recruitment and stock abundance from the NEFSC winter, spring, and fall, Massachusetts spring, Rhode Island spring, University of Rhode Island, Connecticut spring, Delaware and New Jersey trawl surveys were used in the ASAP calibration.

Biological Reference Points (BRP): F_{MSY}, SSB_{MSY}, and MSY were estimated from a stock-recruitment model using a range of values for steepness (slope of the stock recruitment curve near the origin) which was consistent with the stock-recruitment data. It is anticipated that steepness should be similar between the three stocks. Therefore, when computing the BRPs, values of steepness were chosen which were constructed to be as similar as possible between stocks, while also providing good fits to the stock recruitment data for each stock. For the SNE/MA stock, steepness was set at 0.6. These BRP estimates are direct MSY based estimates. The recommended biological reference points for SNE/MA winter flounder are F_{MSY} = $F_{THRESHOLD}$= 0.290, SSB_{MSY} = B_{TARGET} = 43,661 mt, 1/2 SSB_{MSY} = $B_{THRESHOLD}$ = 21,831 mt, and MSY = 11,728 mt. For comparison, $F_{40\%}$ computed using the same biological and fishery characteristics is 0.327, with $SSB_{40\%}$ = 29,045 mt and $MSY_{40\%}$ = 8,903 mt (Figures A5-A7).

Fishing Mortality: During 1981-1993, fishing mortality (F ages 4-5) varied between 0.61 (1982) and 0.95 (1993) and then decreased to 0.47 by 1999. Fishing mortality then increased to 0.70 by 2001, and then decreased to 0.05 in 2010, generally tracking the decrease in fishery catch (Figure A8). The fishery selectivity pattern during 1981-1993 was estimated to be 0.01 at age 1, 0.24 at age 2, 0.75 at age 3, was fixed at 1.00 at age 4, was estimated at 1.00 at age 5, 0.99 at age 6, and 1.00 at age 7+. The pattern during 1994-2010 was estimated to be 0.01 at age 1, 0.19 at age 2, 0.70 at age 3, was fixed at 1.00 at age 4, was estimated at 0.97 at age 5, 0.89 at age 6, and 0.67 at age 7+. There is an 80% probability that F for ages 4-5 in 2010 was between 0.04 and 0.06 (Figure A9). Retrospective analysis for the 2003-2010 terminal years indicates retrospective error in fishing mortality ranged from -38% in 2006 to -13% in 2009.

Recruitment: Recruitment at age 1 decreased nearly continuously from 71.6 million age-1 fish in 1981 (1980 year class) to 7.5 million fish in 2002 (2001 year class). Recruitment has averaged 10.5 million during 2003-2010 (Figure A10). Retrospective error in recruitment at age 1 ranged from +78% in 2005 (2004 year class) to -11% in 2009 (2008 year class).

Spawning Stock Biomass: SSB decreased from 20,100 mt in 1982 to a record low of 3,900 mt in 1993 and then increased to 8,900 mt by 2000. SSB has varied between 4,500-8,000 mt during 2001-2009 and was 7,076 mt in 2010 (Figure A10). There is an 80% probability that SSB in 2010 was between 6,433 mt and 8,590 mt (Figure A11). Retrospective error in SSB ranged from +42% in 2004 to +12% in 2009.

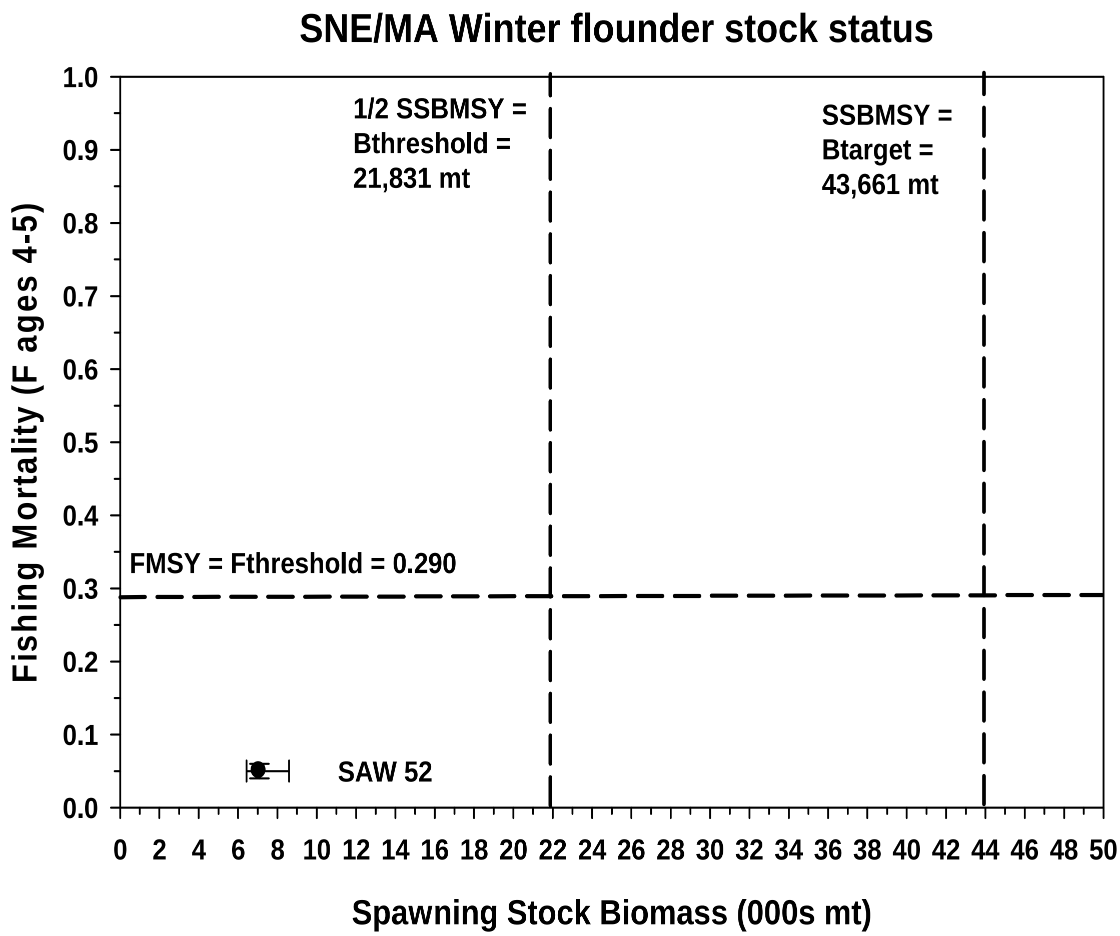
Special Comments: A considerable source of vulnerability for SNE/MA winter flounder is the continued weak recruitment and low reproductive rate (e.g., recruits per spawner). Recruitment estimates for the last decade are lower than those predicted by the stock recruitment model (Figures A5 and A12). If the weak recruitment and low reproductive rate continues, productivity and rebuilding of the stock will be less than projected.

Stock-recruit modeling suggests that warm winter temperatures can have a negative effect on recruitment of SNE/MA winter flounder.

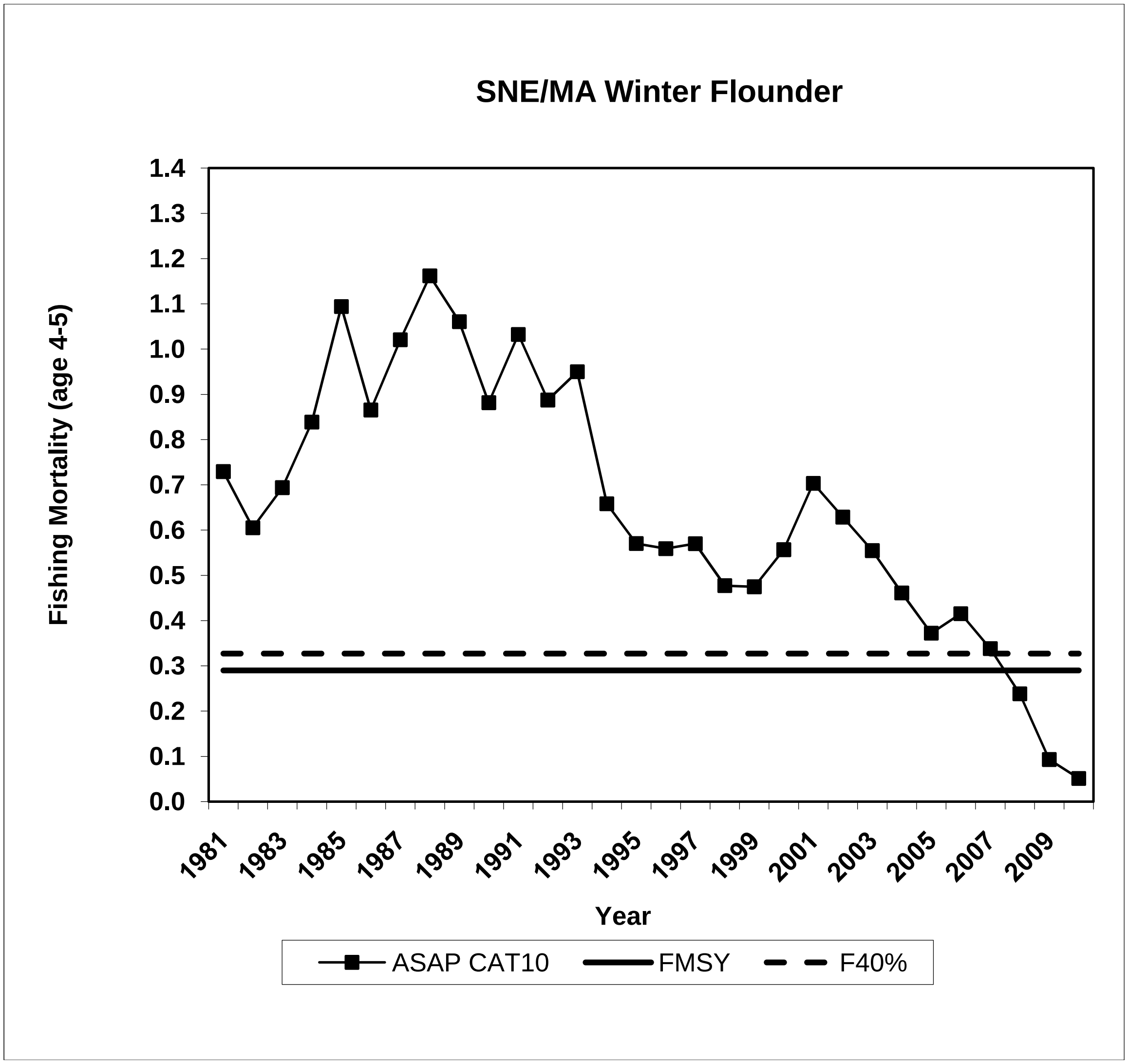
References:

NEFSC. 2008. Assessment of 19 Northeast groundfish stocks through 2007. Report of the 3rd Groundfish Assessment Review Meeting (GARM III), Northeast Fisheries Science Center, Woods Hole, Massachusetts. August 4-8, 2008. NEFSC Ref Doc. 08-15. 884 p.

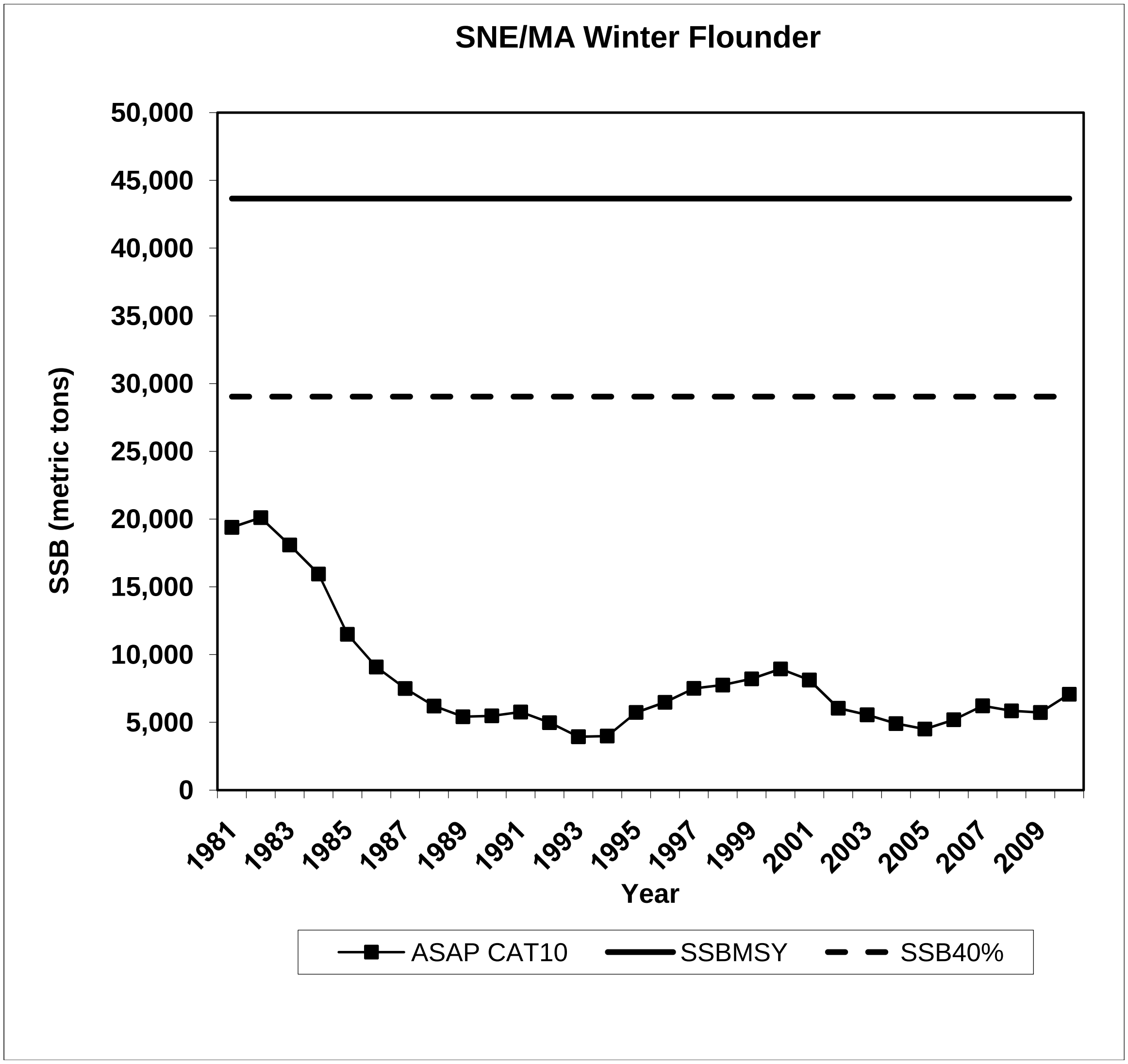
NOAA Fisheries Toolbox (NFT) 2011. Age Structured Assessment Program (ASAP), version 2.0.21. [Internet address: http://nft.nefsc.noaa.gov/ASAP.html].



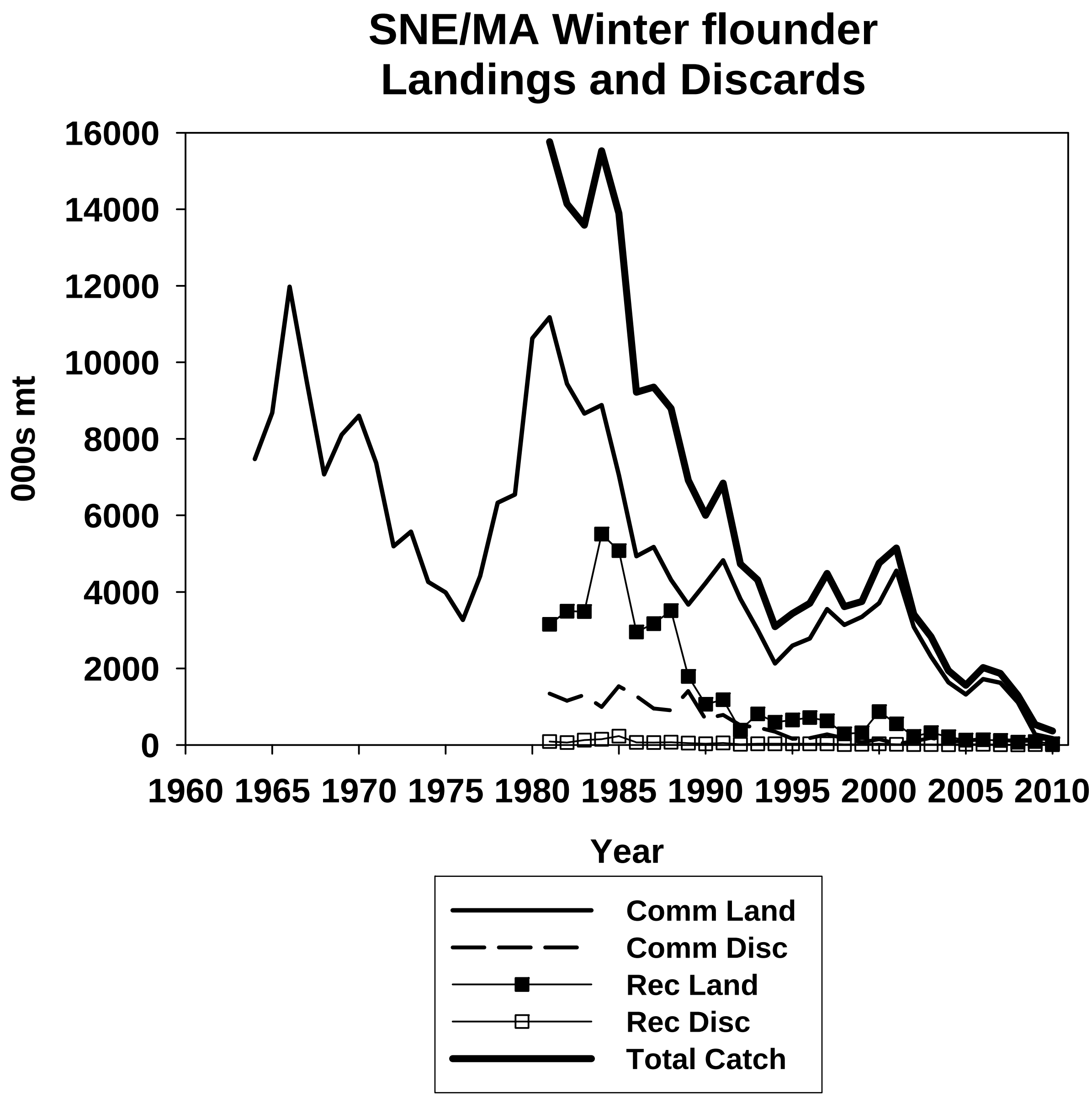
A1. 2011 SAW 52 stock status in 2010 for SNE/MA winter flounder with respect to MSY-based BRPs; error bars on SSB and F are 80% confidence intervals.



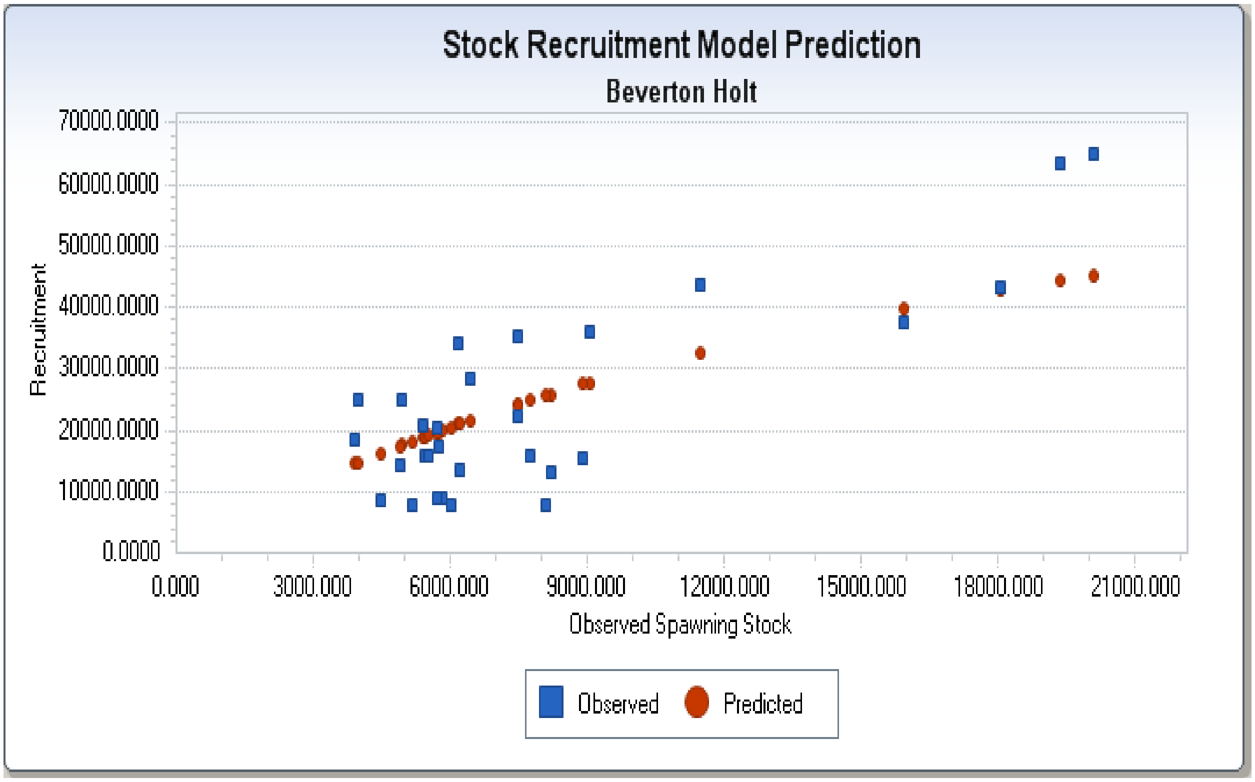
A2. Estimated trend in Fishing Mortality and associated BRPs for SNE/MA winter flounder. ASAP CAT10 is the 2011 SAW 52 final assessment model. The MSY-based BRP is recommended for stock status determination.



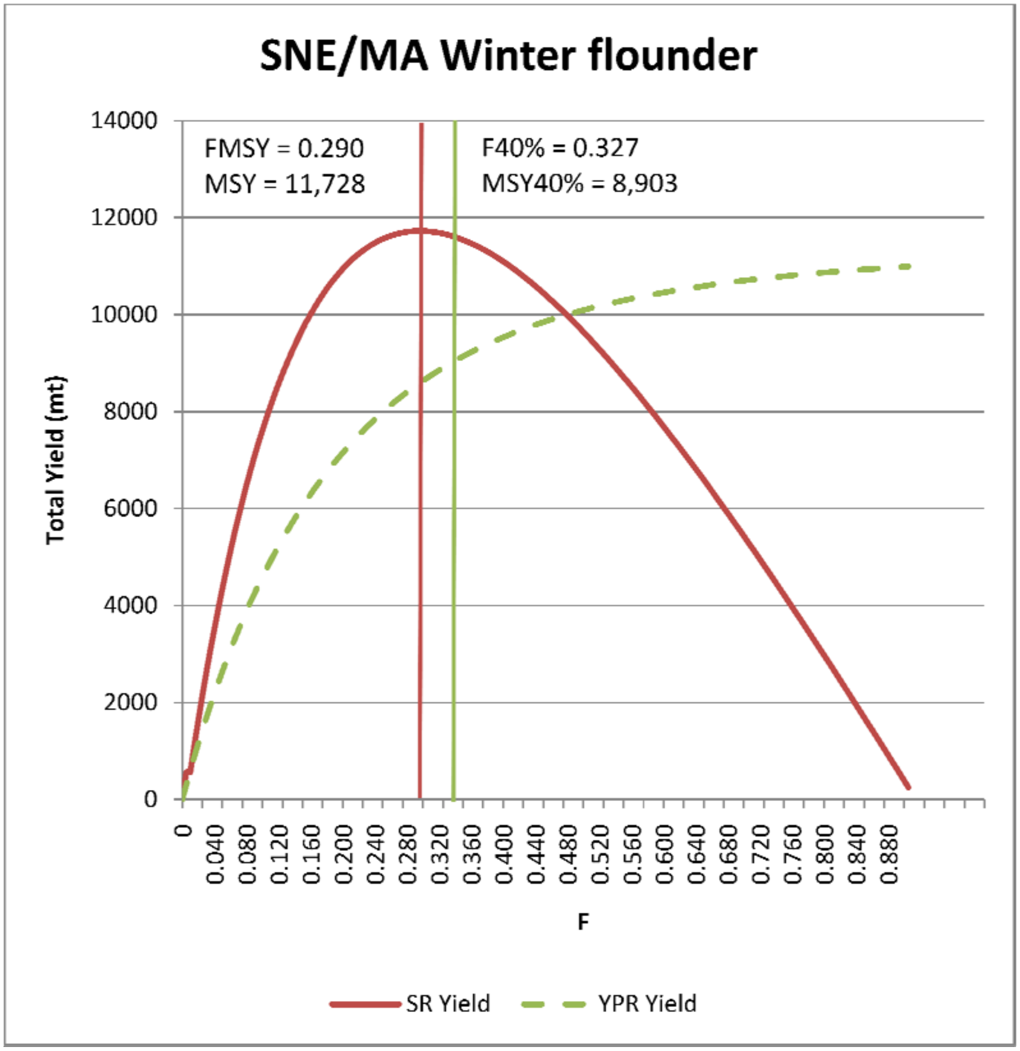
A3. Estimated trend in Spawning Stock Biomass (SSB) and associated BRPs for SNE/MA winter flounder. ASAP CAT10 is the 2011 SAW 52 final assessment model. The MSY-based BRP is recommended for stock status determination.



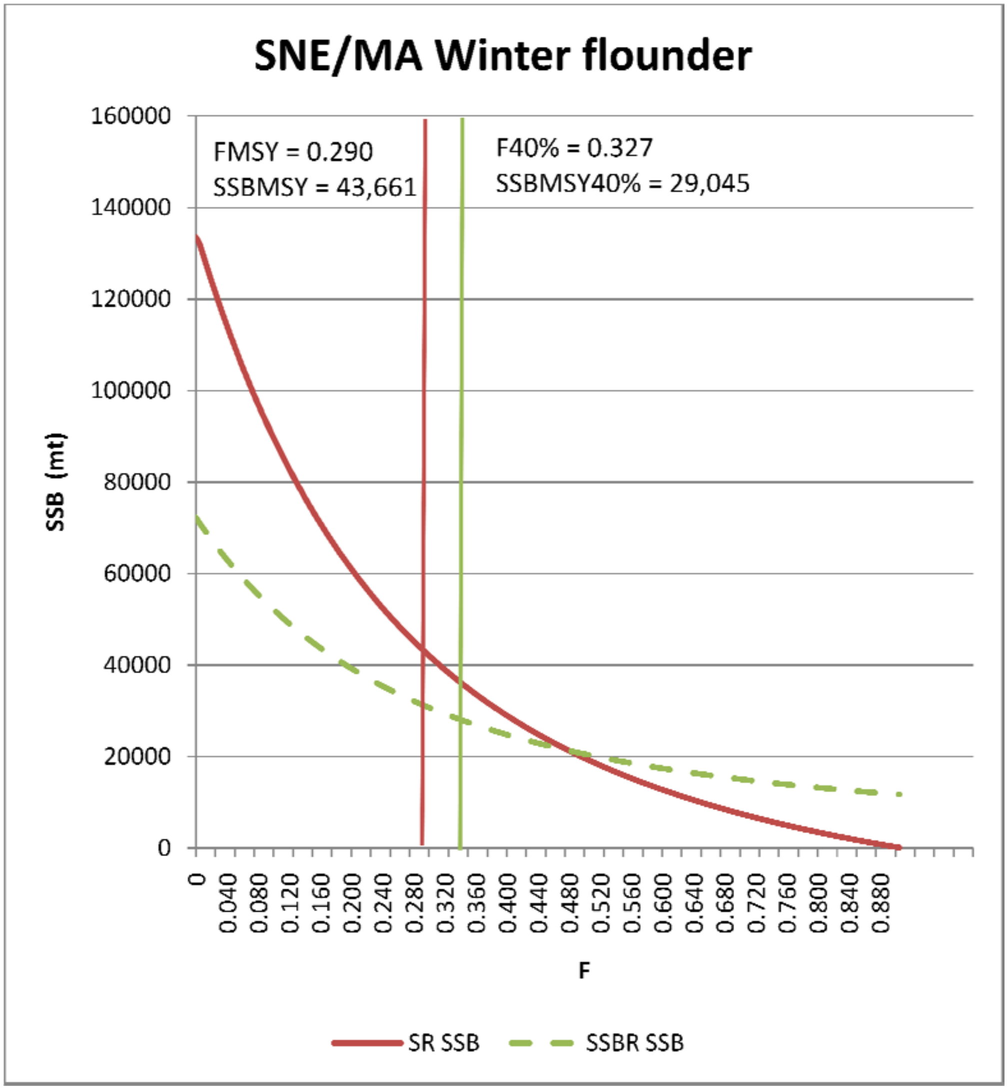
A4. Commercial landings (1964-2010), commercial discards (1981-2010), recreational landings (1981-2010), recreational discards (1981-2010), and total fishery catch (1981-2010) for SNE/MA winter flounder.



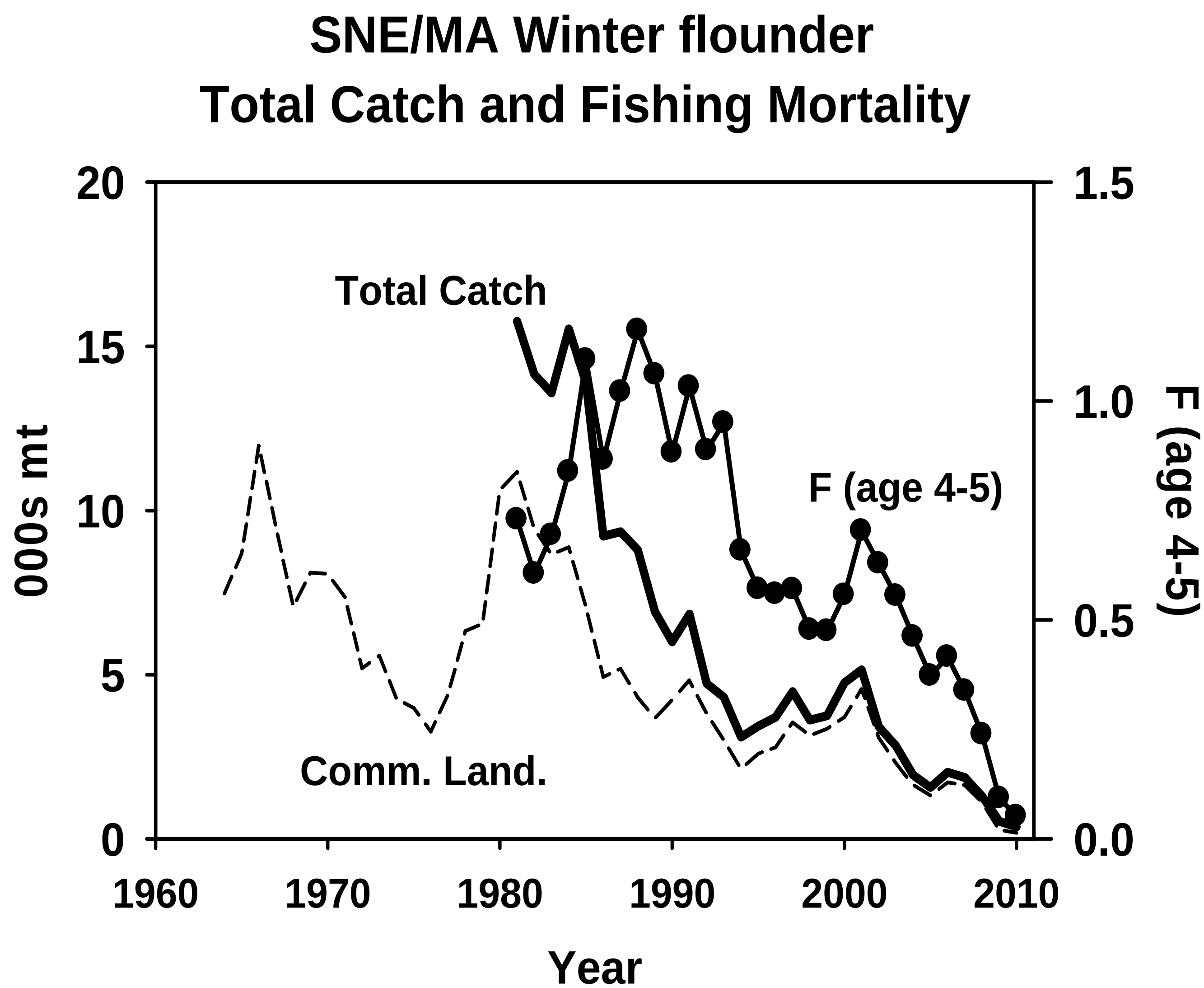
A5. Final stock-recruitment model for SNE/MA winter flounder. Spawning stock is in mt; recruitment is in thousands of age-1 fish.



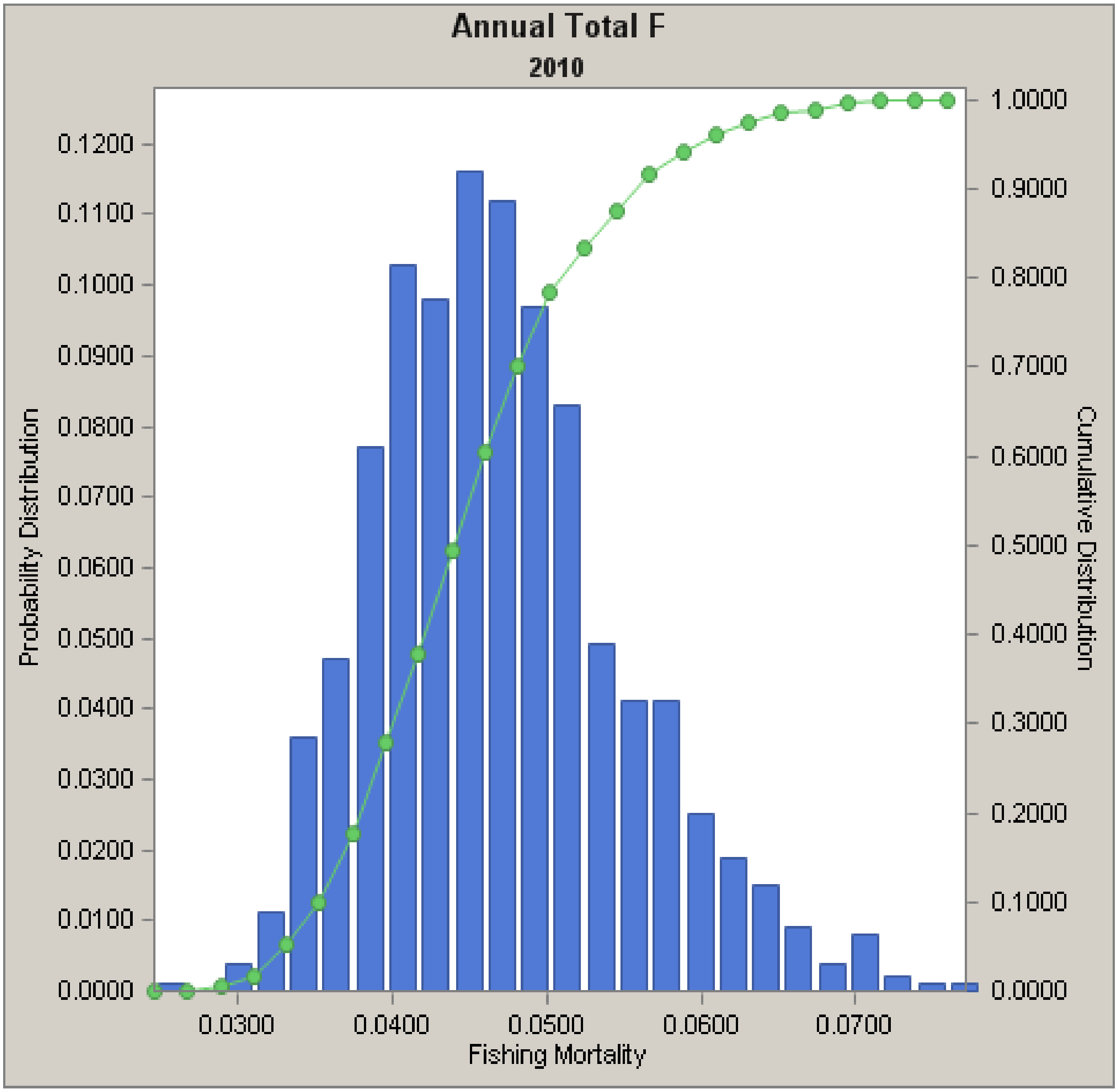
A6. Comparison of fishing mortality versus total yield relationship for stock-recruitment model based BRPs (F_{MSY}, MSY) and yield per recruit model based BRPs ($F_{40\%}$, $MSY_{40\%}$).



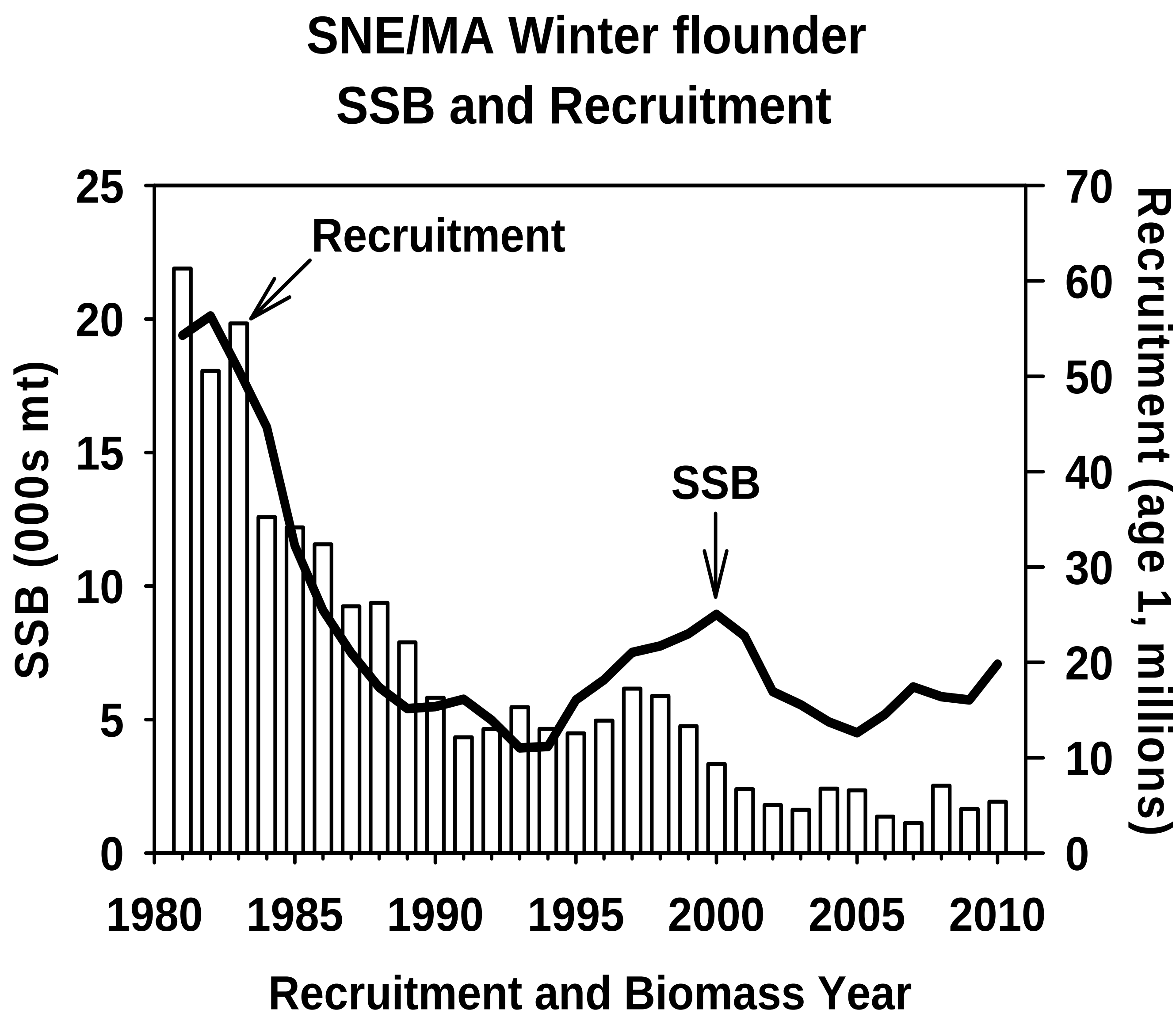
A7. Comparison of fishing mortality versus SSB relationship for stock-recruitment model based BRPs (F_{MSY}, SSB_{MSY}) and yield per recruit model based BRPs ($F_{40\%}$, $SSB_{40\%}$).



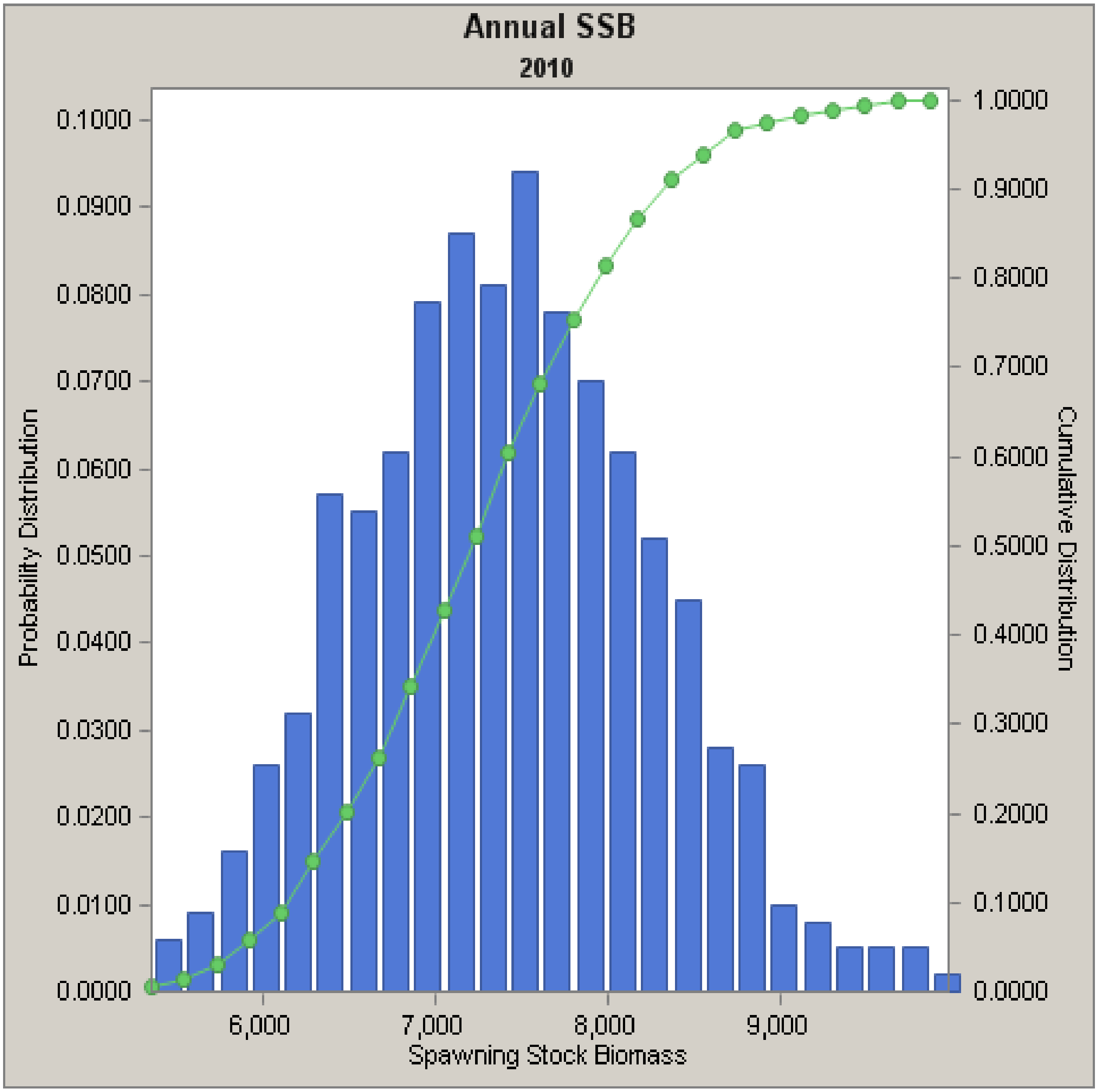
A8. Total catch (landings and discards, 000s mt), commercial landings (000s mt) and fishing mortality rate (F, age 4-5) for SNE/MA winter flounder.



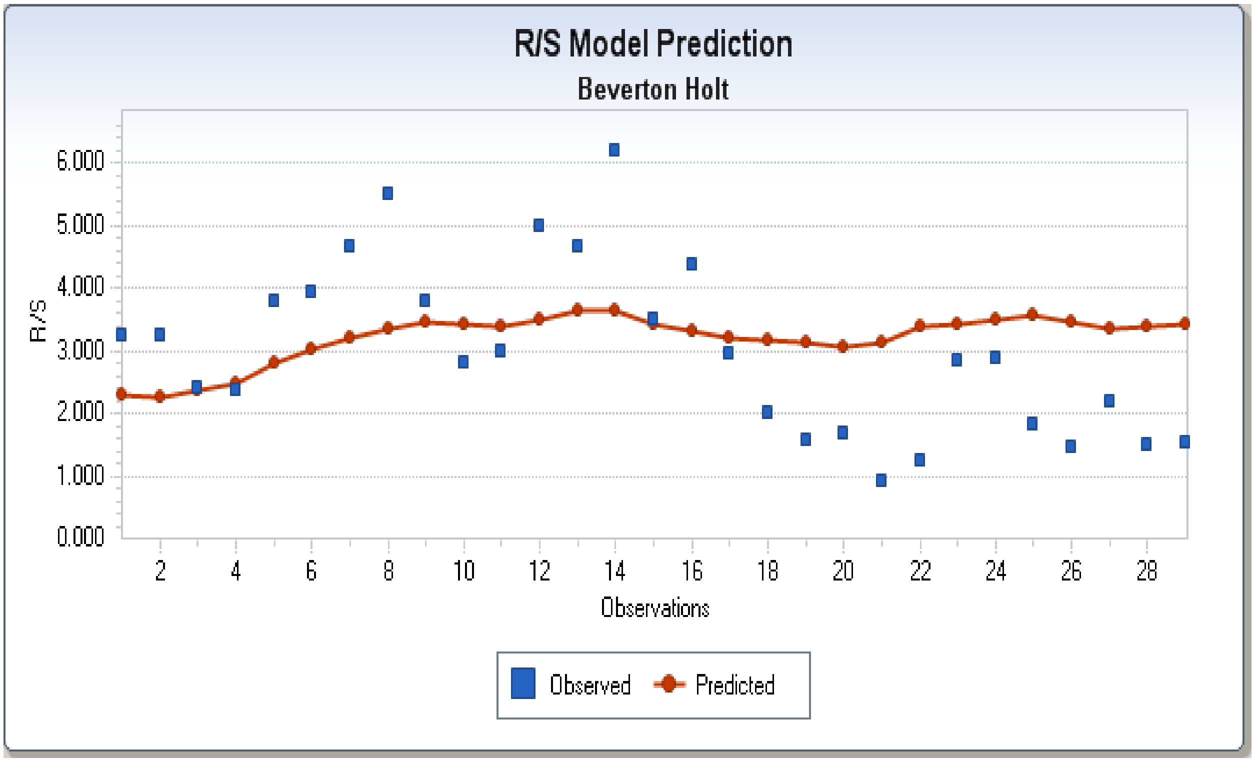
A9. MCMC distribution of the estimate of the 2010 Fishing Mortality of SNE/MA winter flounder.



A10. Spawning stock biomass (SSB, 000s mt, solid line) and recruitment (millions of fish at age-1, vertical bars) for SNE/MA winter flounder.



A11. MCMC distribution of the estimate of the 2010 Spawning Stock Biomass (SSB) of SNE/MA winter flounder.



A12. Time series trend in Recruits per Spawner (R/S) for SNE/MA winter flounder; most recent years are on the right side of the plot.

B. GEORGES BANK WINTER FLOUNDER ASSESSMENT SUMMARY FOR 2011

State of Stock: In 2010, the stock was not overfished and overfishing was not occurring, based on the new biological reference point (BRP) estimates of: F_{MSY} ($F_{THRESHOLD}$) = 0.42, SSB_{MSY} (B_{TARGET}) = 10,100 mt, and 1/2 SSB_{MSY} ($B_{THRESHOLD}$) = 5,050 mt, MSY = 3,700 mt. The 2010 estimate of spawning stock biomass (SSB) is 9,703 mt, which is well above the $B_{THRESHOLD}$ and at 96.1% of the B_{TARGET}. The 2010 estimate of fishing mortality (average F on ages 4-6) is 0.15 and is well below the $F_{THRESHOLD}$ of 0.42 (Figure B1). There was an 80% probability that the 2010 average F was between 0.12 and 0.21 and that the 2010 SSB estimate was between 7,304 mt and 12,578 mt.

Given the new model and assumptions in the current assessment, comparison of the 2010 estimates of SSB and F with the existing reference points is not appropriate. The BRPs derived from the 2008 assessment (NEFSC 2008) were: $F_{40\%}$ ($F_{THRESHOLD}$) = 0.26, $SSB_{40\%}$ (B_{TARGET}) = 16,000 mt, 1/2 $SSB_{40\%}$ ($B_{THRESHOLD}$) = 8,000 mt, and $MSY_{40\%}$ = 3,500 mt.

Projections: A projection of future stock status was made based on the VPA results using mean weights, maturity, and fishery selectivity patterns at age estimated for the most recent 5 years (2006-2010) to reflect current conditions in the stock and fishery. Stochastic projections were run for 2011-2017 because rebuilding of the stock, with at least 75% probability, is required by 2017. Recruitment was projected using the results from a Beverton-Holt stock-recruitment model, which fixed steepness (h) at 0.78, resulting in an F_{MSY} estimate of 0.42. The projections assumed the FMP Framework 44 fishing year (May 1) catch of 2,118 mt would be landed as a calendar year (Jan 1) catch in 2011.

The projection results indicate that rebuilding to SSB_{MSY} (= 10,100 mt) is expected to be achieved with 76% probability in the current year (2011), assuming a 2011 catch of 2,118 mt.

Catch: Total landings during 1964-2010 were predominately from the U.S groundfish trawl fishery, with lesser amounts reported by the USSR (during 1965-1977), for the U.S scallop dredge fishery, and as bycatch in the Canadian bottom trawl fisheries for cod and haddock (1-24% of the total). Total landings reached a peak of 4,500 mt in 1972, and averaged 3,200 mt during 1973-1984, but then declined to their lowest level (780 mt) in 1995 (Figure B2). Following an increase to 3,100 mt in 2003, landings declined to 800 mt in 2007. Landings were 1,000 mt in 2008 and 1,300 mt in 2010. During 1995-2010, the proportional standard error (%) due to the allocation of Georges Bank winter flounder landings to Statistical Areas using Vessel Trip Reports, ranged between 0.7 and 1.3%.

U.S. discards during 1989-2010 were estimated using the Standardized Bycatch Reporting Methodology (Wigley et al. 2007) and were hindcast for 1964-1988. Discards for the Canadian scallop dredge fleet were estimated by the CA Division of Fisheries and Oceans for 2004-2010 and were hindcast for 1982-2003. Discards from the Canadian groundfish trawl fleet were not available. During the assessment period, 1982-2010, total discards of winter flounder averaged 15% of the total landings. Discards were higher during 1982-1991 than thereafter and were primarily from U.S. fisheries (i.e., primarily from the large mesh ($\geq$ 5.5 in. codend mesh size) fleet during 1964-1975 and the scallop dredge fleet during 1976-2010). However, after 1991, discards were primarily from the Canadian scallop dredge fishery. Total discards have slowly increased since 1995. The precision (CVs) of U.S. discard estimates for 1992-2010 ranged between 0.09 and 0.49 (average = 0.26), but the precision of the Canadian estimates is unknown.

Catches during 1964-2010 and were dominated by landings from the U.S. groundfish bottom trawl fleet. Catches increased during 1964-1972, reaching a peak of 4,600 mt in 1972, but then declined to 2,000 mt in 1976 (Figure B3). During 1977-1984 catches ranged between 3,300 and 4,300 mt then gradually declined to a time series low of 800 mt in 1995. Catches increased again to 3,300 mt in 2003 then declined to 1,000 mt in 2007, followed by a slight increase to 2,000 mt in 2009. Total catch in 2010 was 1,500 mt. Catches prior to 1964 were likely higher because U.S. landings alone reached a peak of 4,100 mt in 1945, close to the 1964-2010 peak catch of 4,600 mt and without accounting for discards or landings from international fleets.

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

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		Max[1]	Min[1]	Mean[1]
U.S. landings	1.7	2.1	2.8	2.7	2.0	0.8	0.8	0.9	1.7	1.3		4.0	0.7	2.1
CA landings	0.5	0.2	0.3	0.2	0.1	0.1	<0.1	<0.1	<0.1	<0.1		0.5	<0.1	0.1
Total	2.2	2.3	3.1	2.9	2.1	0.9	0.8	0.9	1.7	1.3		4.5	0.8	2.3
U.S. discards	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1		0.3	<0.1	0.1
CA discards	0.2	0.2	0.2	0.1	0.1	0.1	<0.1	0.1	0.3	0.1		0.3	<0.1	0.1
Total	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2		0.5	0.1	0.2
U.S. catch	1.7	2.1	2.8	2.8	2.1	0.9	1.0	1.0	1.8	1.4		4.3	0.7	2.2
CA catch	0.7	0.4	0.5	0.3	0.2	0.2	<0.1	0.1	0.3	0.1		0.7	0.0	0.2
Total	2.4	2.5	3.3	3.1	2.3	1.1	1.0	1.1	2.1	1.5		4.3	0.8	2.4
Spawning Stock Biomass[2]	10.7	10.2	9.5	5.5	5.3	5.9	6.2	6.5	7.9	9.7	17.4	26.3	1.2	10.7
Recruitment (age 1)	9.0	7.3	6.1	5.5	5.6	10.5	15.6	18.8	4.0	22.5	3.4	4.0	0.2	9.0
F (ages 4-6)	0.52	0.55	0.85	0.63	0.56	0.20	0.21	0.23	0.23	0.15	7.9	13.4	0.5	0.52

[1] During 1964-2010 for landings (includes pre-2001 USSR landings), discards (no CA discards available prior to 1982) and catches; during 1982-2010 for F, SSB and R
[2] On April 1 annually

Stock Distribution and Identification: Winter flounder (*Pseudopleuronectes americanus*) is a demersal flatfish species commonly found in North Atlantic estuaries and on the continental shelf. The species is distributed between the Gulf of St. Lawrence, Canada and North Carolina, U.S., although it is not abundant south of Delaware Bay. On Georges Bank, winter flounder are generally found at depths less than 82 m (Collette and Klein-MacPhee 2002). Tagging studies (e.g., Howe and Coates 1975) indicate that there is limited mixing of fish among the three current stock units, with about 1%-3% between the GOM and SNE/MA, about 1% between GBK and SNE/MA, and <1% between GOM and GBK. Meristics studies based mainly on fin ray counts also indicate a separate Georges Bank stock (Kendall 1912; Perlmutter 1947; Lux et al 1970). Growth and maturity studies also support the distinction of at least three stock areas (Lux 1973; Howe and Coates 1975; Witherell and Burnett 1993), with Georges Bank fish growing and maturing the fastest. The stock area extends from Georges Bank westward to about midway along the Great South Channel.

Data and Assessment: Similar to the 2008 assessment (NEFSC 2008), an ADAPT VPA model was run with catch-at-age data (ages 1-7+) for 1982-2010. Swept-area stock abundance from the

NEFSC spring and fall surveys (1982-2010) and the Canadian spring surveys (1987-2010), for ages 1-7+, were used in the VPA calibration. For the U.S. surveys, length-based, stock-specific calibration coefficients were used to convert catches by the SRV *H.B. Bigelow* to SRV *Albatross IV* catches. Major model changes included: the addition of discards from the Canadian scallop dredge fleet, a new maturity schedule, a new assumption for the instantaneous natural mortality rate (M = 0.3 instead of 0.2), and new MSY-based biological reference points (BRPs).

Biological Reference Points: F_{MSY}, SSB_{MSY}, and MSY were estimated from a stock-recruitment model using a range of fixed values (Table B1) for steepness (slope of the stock recruitment curve near the origin) which was consistent with the stock and recruitment data. Based on the assumption that steepness should be similar between the three winter flounder stocks, values of steepness were chosen which were constructed to be as similar as possible between stocks, but which also provided good fits to the stock-recruitment data for each stock. For the Georges Bank stock, steepness was set at 0.78 (further details in Appendix of the 2011 SAW-52 Stock Assessment Report). The new BRP estimates are direct MSY-based estimates. The recommended biological reference points are: $F_{MSY} = F_{THRESHOLD} = 0.42$, $SSB_{MSY} = B_{TARGET}$ = 10,100 mt, 1/2 $SSB_{MSY} = B_{THRESHOLD}$ = 5,050 mt, and MSY = 3,700 mt. For comparison, $F_{40\%}$, computed using the same biological and fishery characteristics, is 0.32, $SSB_{40\%}$ is 11,300 mt, and $MSY_{40\%}$ is 3,200 mt.

The existing biological reference points from the 2008 assessment (NEFSC 2008) are: $F_{40\%}$ ($F_{THRESHOLD}$) = 0.26, $SSB_{40\%}$ (B_{TARGET}) = 16,000 mt, 1/2 $SSB_{40\%}$ ($B_{THRESHOLD}$) = 8,000 mt, $MSY_{40\%}$ = 3,500 mt. However, given the new model assumptions in the current assessment (assumed M = 0.3 rather than 0.2), comparison of the 2010 estimates of SSB and F estimates with the existing reference points is not appropriate.

Fishing Mortality: Fishing mortality (fully recruited F, ages 4-6) increased from 0.42 in 1982 to a peak of 1.2 in 1984, and then ranged between 0.57 and 0.92 during 1985-1993 (Figure B4). Fishing mortality decreased to 0.26 in 1999, but then increased again to 0.85 in 2003. Following a decline to 0.20 in 2006, fishing mortality remained stable at low levels (0.21-0.23) during 2007-2009, and then declined to a record low of 0.15 in 2010. A retrospective analysis for the 2001-2009 terminal years indicated that the retrospective error in fishing mortality ranged from -48% in 2002 to +42% in 2009.

Spawning Stock Biomass: SSB decreased from a peak of 17,400 mt in 1982 to a record low of 3,400 mt in 1995, and then increased again to 13,800 mt in 2000. SSB varied between 5,300 and 10,700 mt during 2001-2009, and was 9,703 mt in 2010 (Figure B5). Retrospective error in SSB ranged from -13% in 2008 to +43% in 2002.

Recruitment: Recruitment at age 1 increased from 13.8 million fish in 1982 to a peak of 26.3 million fish in 1988, but then declined to 5.2 million fish in 1993 (Figure B6). Recruitment has averaged 10.5 million during 2003-2010. Retrospective error in recruitment at age 1 (R) ranged from +78% in 2005 (2004 year class) to -11% in 2009 (2008 year class).

Special Comments:
Stock-recruitment data showed no significant relationship with temperature or other environmental factors examined, unlike the SNE/MA winter flounder stock.

The stock-recruitment data for this stock are less informative than the SNE/MA data for predicting recruitment at low spawner levels making estimation of the spawner-recruit relationship difficult without external information (Table B1).

The revised assessment model alters the historical perception of stock status. Four changes from the previous assessment are: 1) a change of M from 0.2 to 0.3 and 2) a new maturity schedule, 3) the addition of Canadian discards, and 4) a change to MSY-based BRPs rather than proxies. The assessment indicates that the stock has not been overfished since 1996. This contrasts with the 2008 assessment which indicated the stock was overfished in 2007.

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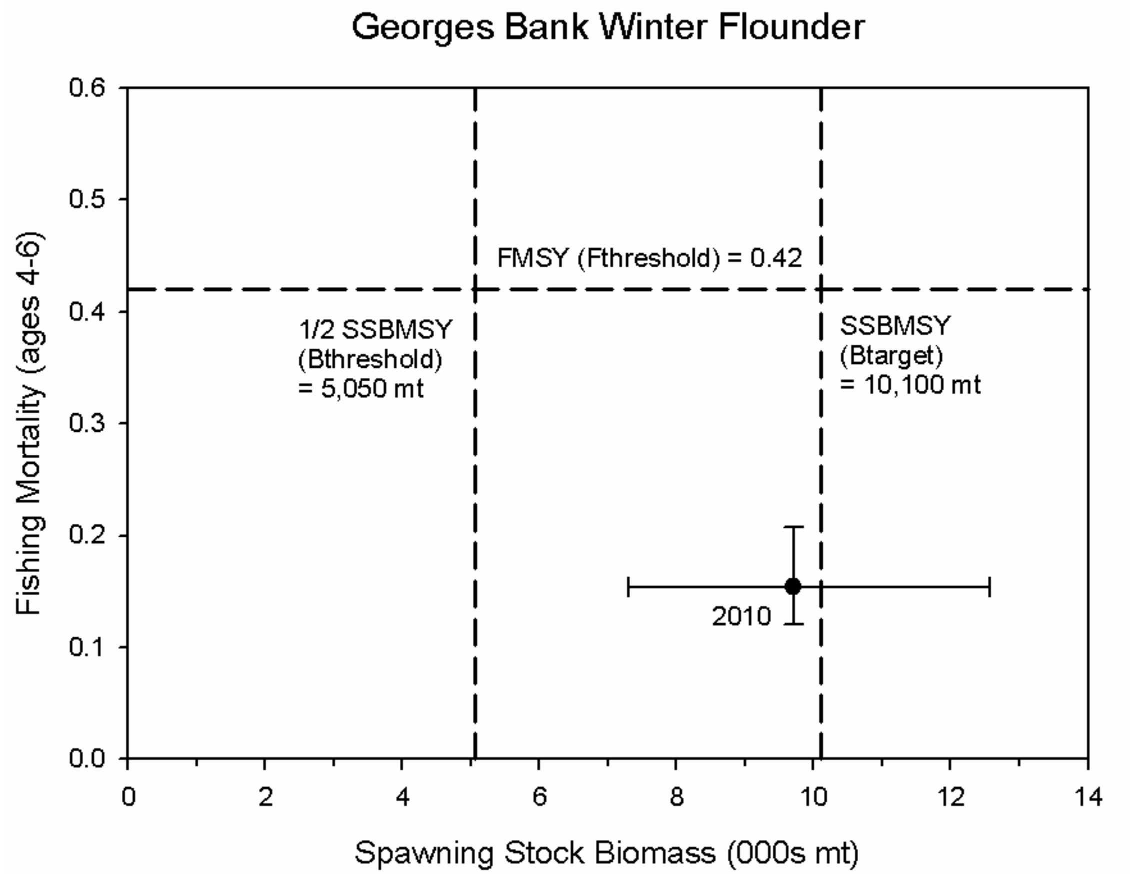
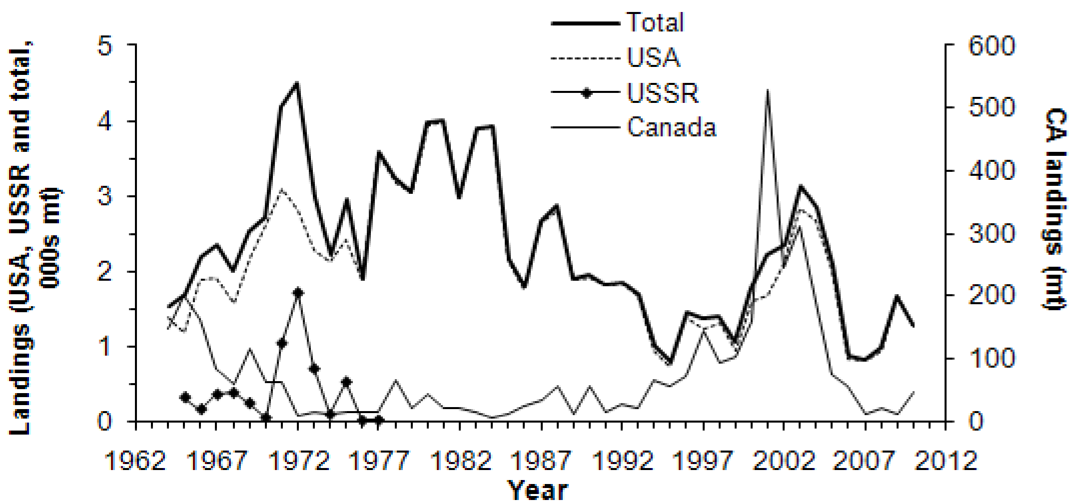
Table B1. AIC profile for unfished steepness (*h*) values from Beverton-Holt stock-recruitment models for the 1982-2009 year classes of Georges Bank winter flounder.

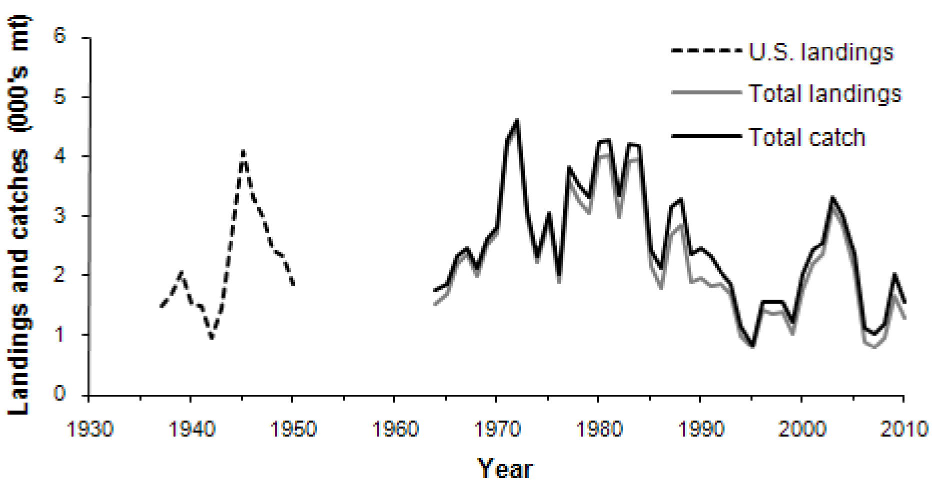
Fixed (*h*)	AIC	F_{MSY}	SSB_{MSY}	MSY
0.60	583.217	0.26	19,785	4,910
0.65	581.230	0.30	15,144	4,318
0.70	579.698	0.34	12,437	4,003
0.75	578.518	0.38	10,673	3,824
0.76	578.317	0.39	10,341	3,799
0.77	578.126	0.41	9,798	3,777
0.78	577.945	0.42	9,524	3,757
0.79	577.774	0.43	9,269	3,740
0.80	577.611	0.44	9,030	3,725
0.85	576.917	0.51	7,742	3,678
0.90	576.390	0.60	6,621	3,672
0.95	575.996	0.74	5,476	3,706



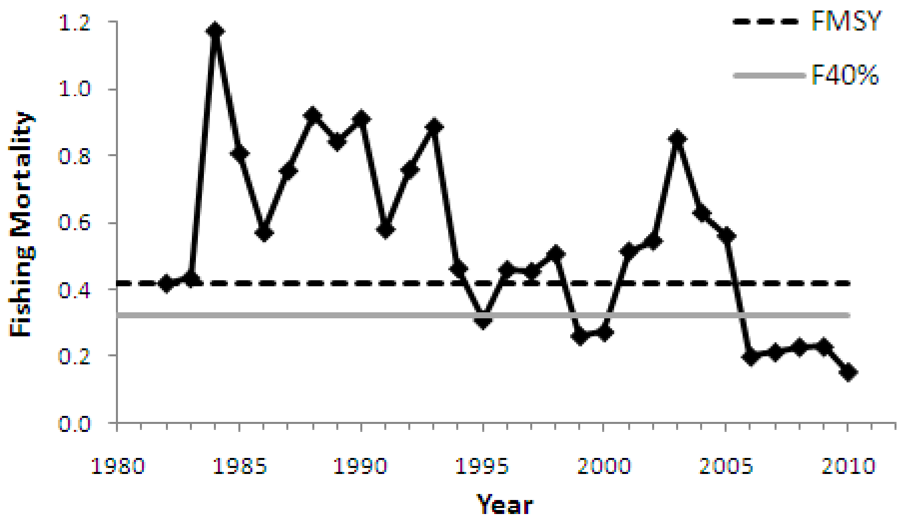
B1. Stock status for Georges Bank winter flounder, during 2010, based on F_{MSY} and SSB_{MSY} reference points. 80% confidence intervals are shown for the 2010 SSB and F estimates.



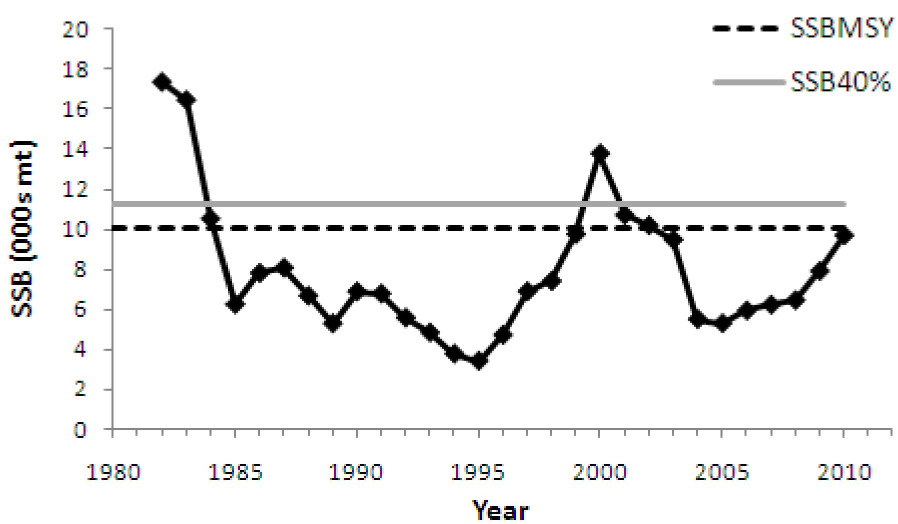
B2. Landings of Georges Bank winter flounder, by country, during 1964-2010.



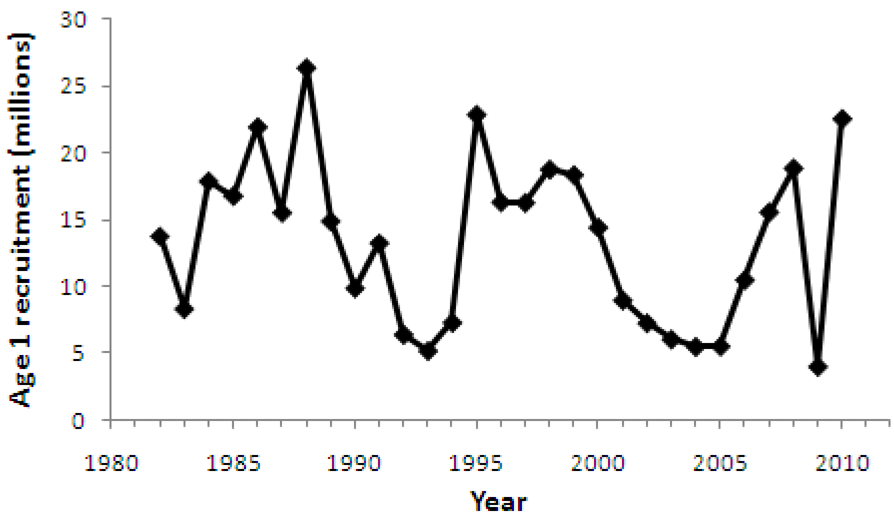
B3. U.S. landings of Georges Bank winter flounder during 1937-1950 and total landings and catches during 1964-2010.



B4. Trends in average fishing mortality rates (ages 4-6) for Georges Bank winter flounder during 1982-2010. The MSY-based BRP is recommended for stock status determination.



B5. Trends in spawning stock biomass (SSB, 000s mt) for Georges Bank winter flounder during 1982-2010. The MSY-based BRP is recommended for stock status determination.



B6. Trends in age 1 recruitment (Jan. 1 stock numbers in millions) for Georges Bank winter flounder during 1982-2011.

C. GULF OF MAINE (GOM) WINTER FLOUNDER ASSESSMENT SUMMARY FOR 2011

State of Stock:
The assessment of GOM winter flounder stock is based on an empirical swept-area model utilizing data from the 2010 NEFSC fall survey, the MADMF fall survey, and the Maine-New Hampshire fall inshore survey. Using a survey trawl efficiency value of 0.6 the estimated stock biomass in 2010 of fish greater than 30 cm was 6,341 mt (80% CI 4,230 - 8,800 mt). The overfished status remains unknown because a biomass reference point or proxy could not be determined and an analytical assessment model was not accepted.

In 2010 overfishing was not occurring for the stock (Figure C1). A proxy BRP value of the overfishing threshold was derived from a length-based yield per recruit analysis that assumes all fish above 30 cm are fully recruited to the fishery and that natural mortality is 0.3. Using $F_{40\%}$ (0.31) as a proxy for F_{MSY}, the corresponding threshold exploitation rate is 0.23. The overfishing status is based on the ratio of 2010 catch (195 mt) to survey based swept area estimate of biomass for winter flounder exceeding 30 cm in length (6,341 mt). Exploitation rate in 2010 was estimated at 0.03 (80% CI 0.02 - 0.05), which is less than the threshold exploitation rate (0.23). The conclusion that overfishing was not occurring in 2010 is robust to the range of uncertainty in the biomass estimate (Figures C7 and C8).

The biomass estimate for 2010 is 16% lower than that for 2009 using the same survey methods but this difference is not statistically significant (Figures C3 and C5).

The most recent biological reference points for this stock were F_{MSY}=0.43 and B_{MSY}=4,100 mt; these estimates came from the assessment at SARC 36 in 2003. It is not appropriate to compare the 2010 exploitation rate and stock size estimates to those earlier BRP values which should no longer be used.

Projections: Projections were not possible.

Catch: Commercial landings were near 1,000 mt from 1964 to the mid 1970s. Thereafter commercial landings increased to a peaked of 2,793 mt in 1982, and then steadily declined to 350 metric tons (mt) in 1999 (Figure C2). Landings have been near 650 mt from 2000 to 2004 and about 300 mt from 2005 to 2009. Landings have declined to a record low of 140 mt in 2010. Recreational landings reached a peak in 1981 with 2,554 mt but declined substantially thereafter. Recreational landings have generally been less than 100 mt since 1994, with exception of 2008 where the landings were estimated at 103 mt. A discard mortality of 15% was assumed for recreational discards. Discards were estimated for the large mesh trawl (1982-2010), gillnet (1986-2010), and northern shrimp fishery (1982-2010). A discard mortality of 50% was assumed for commercial fishery. In general the total discards are a small percentage (time series average 11%) of the total catch (Figure C2). There has been a substantial decline in the total catch compared to the early 1980s (recent catch is roughly 5% of the 1980s catch).

Catch Table (weights in 000s mt,): GOM Winter Flounder

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Max[1]	Min[1]	Mean[1]
Commercial landings	0.7	0.7	0.8	0.6	0.3	0.2	0.3	0.3	0.3	0.1	2.8	0.1	0.9
Commercial discards	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.4	<0.1	0.1
Recreational landings	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	3.0	<0.1	0.5
Recreational discards	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Catch used in assessment	0.8	0.7	0.8	0.7	0.4	0.2	0.3	0.4	0.4	0.2	6.2	0.2	1.3

1: Over the period 1982-2010

Stock Distribution and Identification: Winter flounder (*Pseudopleuronectes americanus*) is a demersal flatfish species commonly found in North Atlantic estuaries and on the continental shelf. The species is distributed between the Gulf of St. Lawrence, Canada and North Carolina, U.S., although it is not abundant south of Delaware Bay. Gulf of Maine winter flounder undergo annual migrations from estuaries and near shore areas, where spawning occurs in the late winter and early spring, to offshore shelf areas of less than 60 fathoms (110 meters). The current Gulf of Maine stock extends from the coastal shelf east of Provincetown, MA northward to the Bay of Fundy, including NEFSC statistical areas 511-515.

Data and Assessment: GOM winter flounder models developed in ADAPT VPA, SCALE, and ASAP (NFT 2011) were too unreliable for stock status determination. The population models have difficulty with the conflicting data trends within the assessment, specifically the large decrease in the catch over the time series with very little change in the indices or age structure in both the catch and surveys. A new value for natural mortality has been adopted, changing from M = 0.20 to M = 0.30 which was used in the estimation of the $F_{40\%}$ reference point. A combined survey 30+ cm biomass area swept estimate using the NEFSC, MADMF and the Maine-New Hampshire surveys was used to estimate biomass. The fall surveys were selected over the spring surveys because some portion of the stock is located within estuaries, which are not surveyed during the spring.

Uncertainty in the individual estimates of survey abundance and swept area trawl footprints were characterized empirically and used to construct an overall estimate of uncertainty in the aggregate biomass estimate. The efficiency value of 0.6 was supported by comparison of VPA estimates of efficiency for the Georges Bank winter flounder while making the assumption that the same fraction of each stock is available to the respective surveys. The NEFSC fall survey (expressed in Albatross equivalents) had an efficiency estimate of 0.3. Calibration experiments between the FSV Bigelow and the R/V Albatross revealed a biomass conversion coefficient of ~2. Thus an efficiency estimate for the Bigelow survey estimate in 2010 of 0.6 was supported. An analysis of catch rates in overlapping areas by the NEFSC and MADMF surveys demonstrated similar catchabilities for winter flounder by the two surveys. Sensitivity analyses were conducted with efficiencies of 0.8 and 1.0. The sampling distributions of biomass and fishing mortality are approximated by integrating over the factors which constitute the primary sources of uncertainty. These factors include the sampling variability in the NEFSC, MADMF and the Maine-New Hampshire spring and fall bottom surveys for 2009 and 2010. The second major source of variability for the survey estimates is the variation in the size of the area swept by an average tow.

Biological Reference Points (BRP): Biological reference points for stock biomass are unknown.

A proxy value of the overfishing threshold was derived for the 2011 assessment from a length-based yield per recruit (NFT 2011) analysis that assumes all fish above 30 cm are fully recruited to the fishery and that natural mortality is 0.3 (Figure C4). Von Bertalanffy parameters were estimated from the spring and fall NEFSC survey age data (n = 2,035) from 2006 to 2010. Maturity at length information is estimated from the spring MDMF survey (L_{50}=29cm). The reference points were converted to exploitation rates to be consistent with the swept area biomass approach. Using $F_{40\%}$ (0.31) as a proxy for F_{MSY}, the corresponding threshold exploitation rate is 0.23. This serves as a proxy for the overfishing threshold (Figure C1). Current practice is to set catch advice based on 75% F_{MSY}. 75% of the estimated $F_{40\%}$ exploitation rate is 0.17. The previous estimates of F_{MSY} (from SARC 36 in 2003) used an M of 0.2 and observed average weights at age.

MSY could not be estimated.

Fishing Mortality: Exploitation rate in 2010 was estimated at 0.03 (80% CI 0.02 - 0.05) using the 2010 ratio of catch (195 mt) to the 30+ area swept biomass (6,341 mt; 80% CI 4,230 - 8,800 mt) from the fall surveys (Figure C6). An assumed efficiency of 60% was used to construct this estimate from the NEFSC fall survey, the MADMF fall survey, and the Maine-New Hampshire fall inshore survey.

Recruitment: Recruitment is unknown.

Spawning Stock Biomass: Spawning stock biomass is unknown.

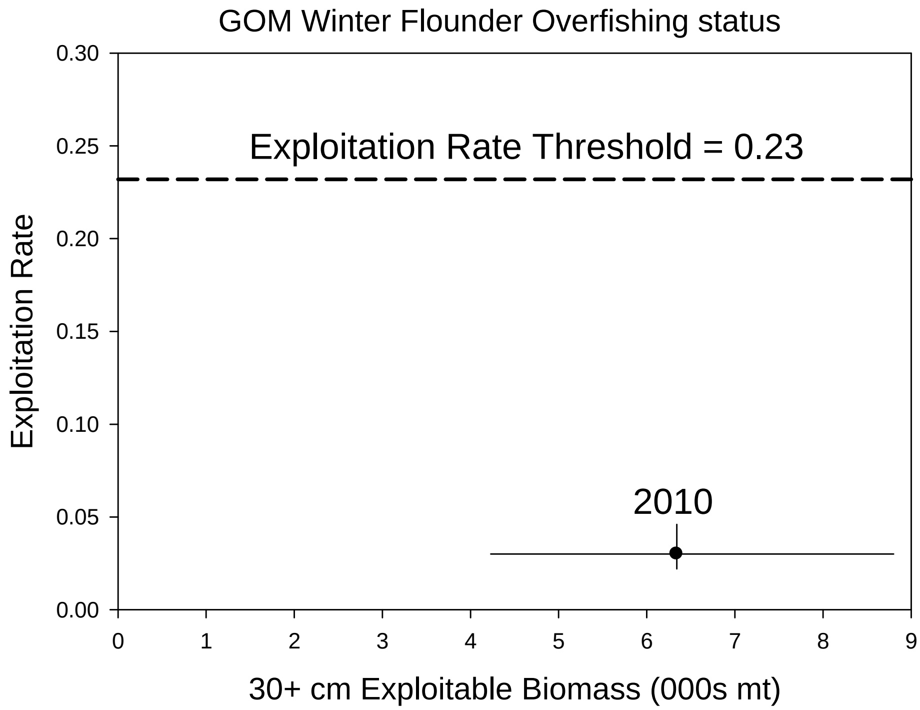
Special Comments: There is considerable uncertainty with the GOM winter flounder assessment. There was a major effort to develop an ASAP assessment model for GOM winter flounder; however, no version of the model was satisfactory. The attempted analytical models had difficulty estimating population scale due to the conflicting data trends within the assessment, specifically the large decrease in the catch over the time series with very little change in the indices or age structure in both the catch and surveys. The scaling of the population estimates was sensitive to the weighting imposed on the catch at age compositions. The ASAP model did allow errors in the fit to the catch at age and improved fit to the survey indices without the split in survey catchability (See GARM III). However this resulted in a lack of fit to the plus group in the catch at age composition. The stock assessment report will summarize the ASAP model application, but its results are not used for the determination of stock status.

An analytic assessment was not accepted in GARM III (NEFSC 2008) resulting in the status of the stock being unknown in 2008.

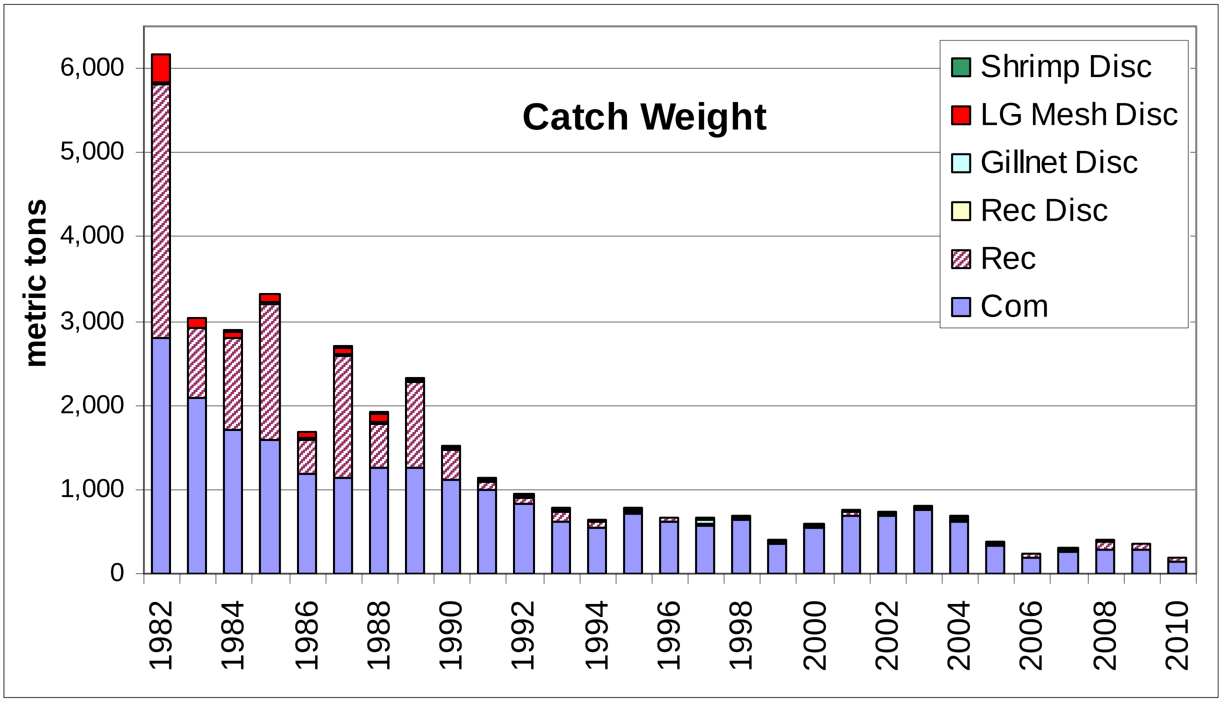
References:

NEFSC. 2008. Assessment of 19 Northeast groundfish stocks through 2007. Report of the 3rd Groundfish Assessment Review Meeting (GARM III), Northeast Fisheries Science Center, Woods Hole, Massachusetts. Aug. 4-8, 2008. NEFSC Ref Doc. 08-15. 884 p.

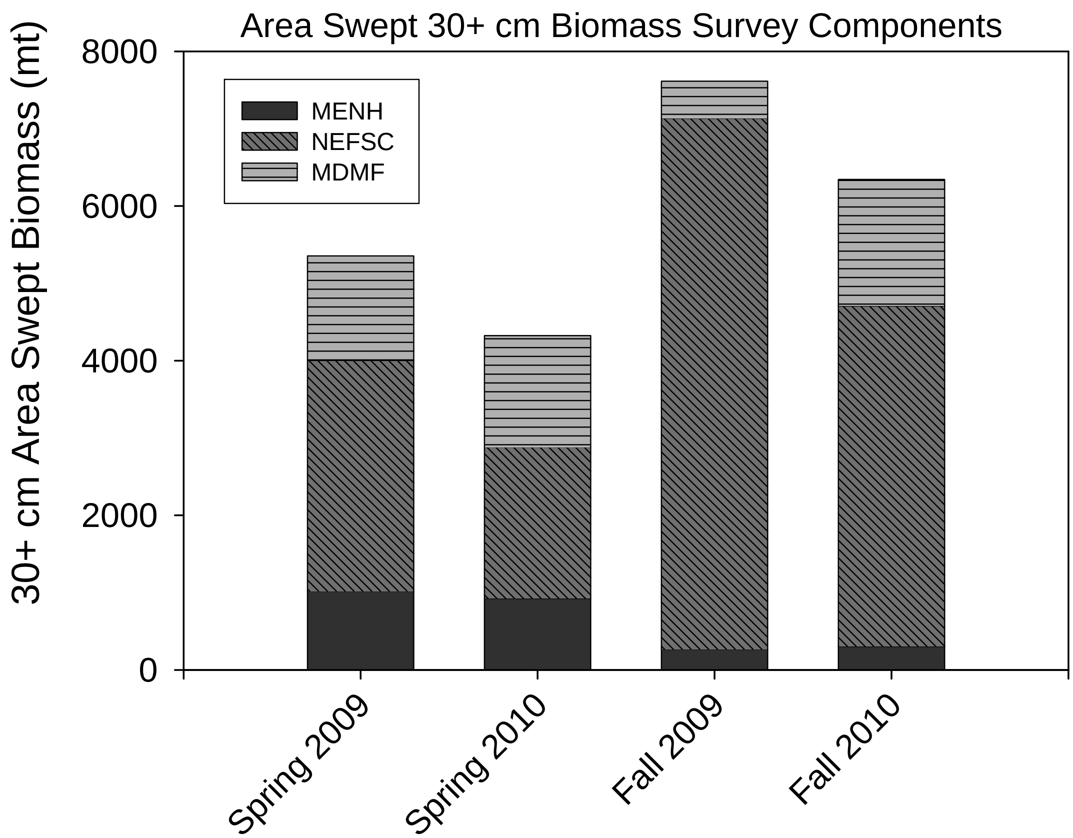
NOAA Fisheries Toolbox (NFT) 2011. [Internet address: http://nft.nefsc.noaa.gov/].



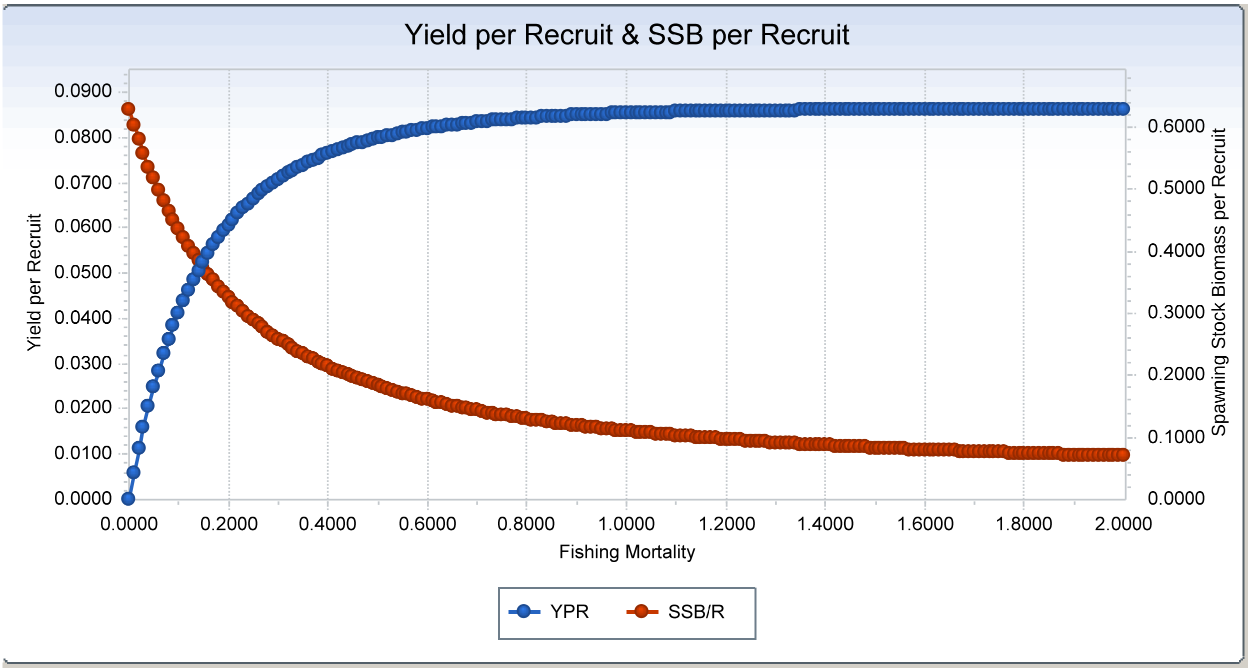
C1. Stock status for GOM winter flounder in 2010 with respect to a proxy for F_{MSY}. 80% confidence intervals are shown for biomass and exploitation rate. $F_{40\%}$ = 0.31, which corresponds to an exploitation rate of 0.23.



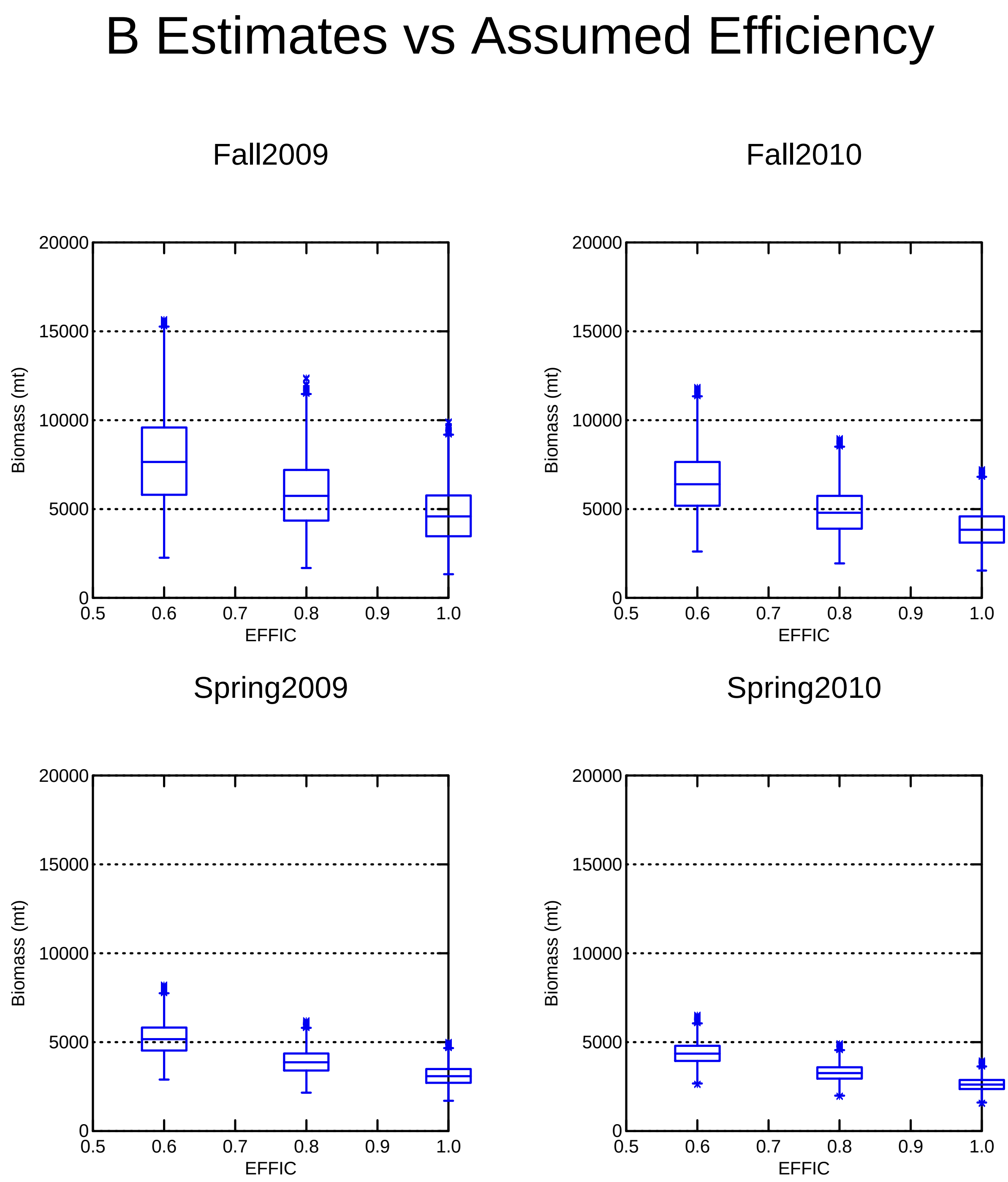
C2. GOM winter flounder composition of the catch by weight in metric tons from 1982 to 2010.



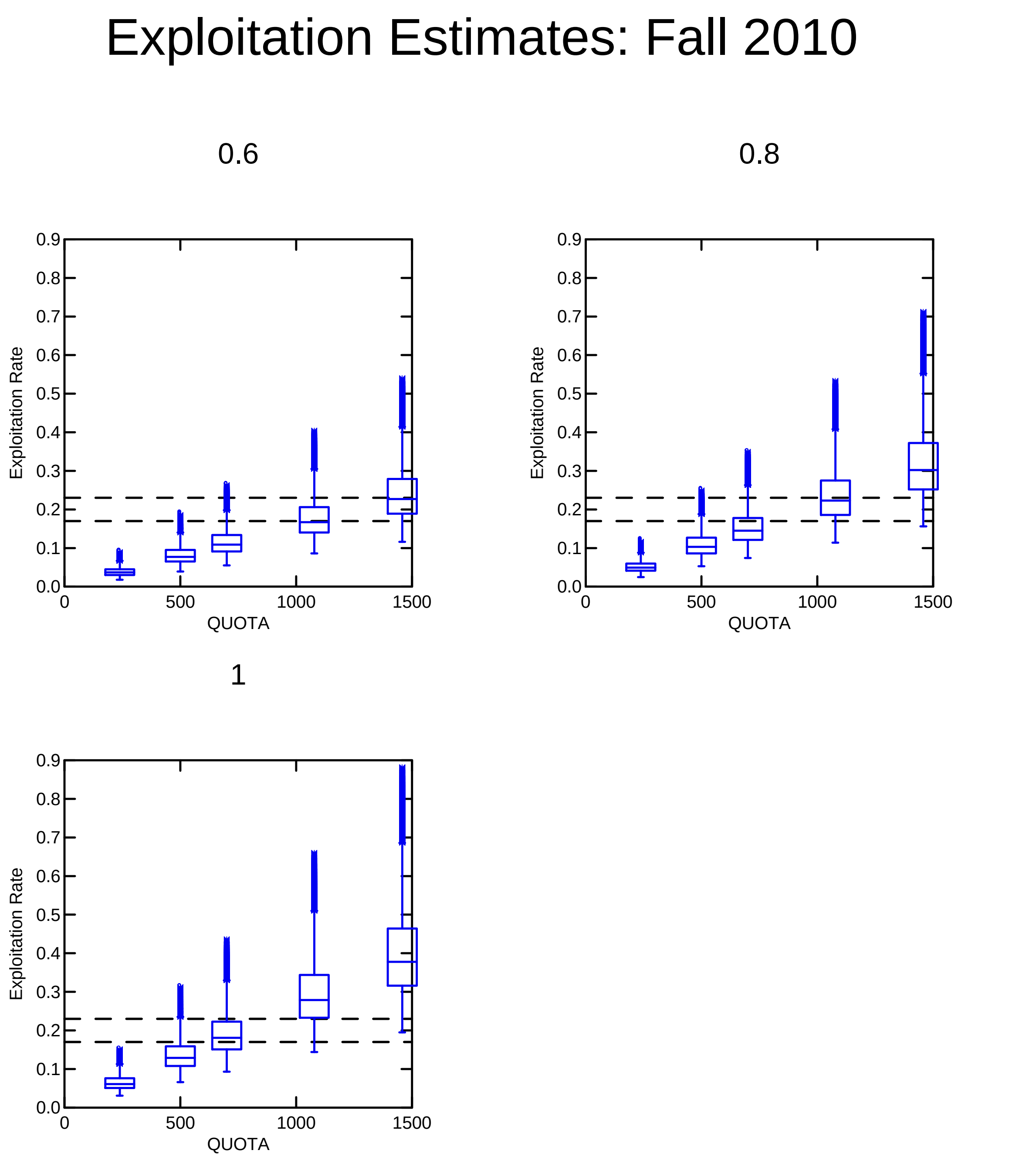
C3. 30+ cm area swept biomass estimates for the spring and fall surveys from 2009 to 2010 assuming efficiency is 0.6. The NEFSC survey used a TOGA tow criteria of 132x.



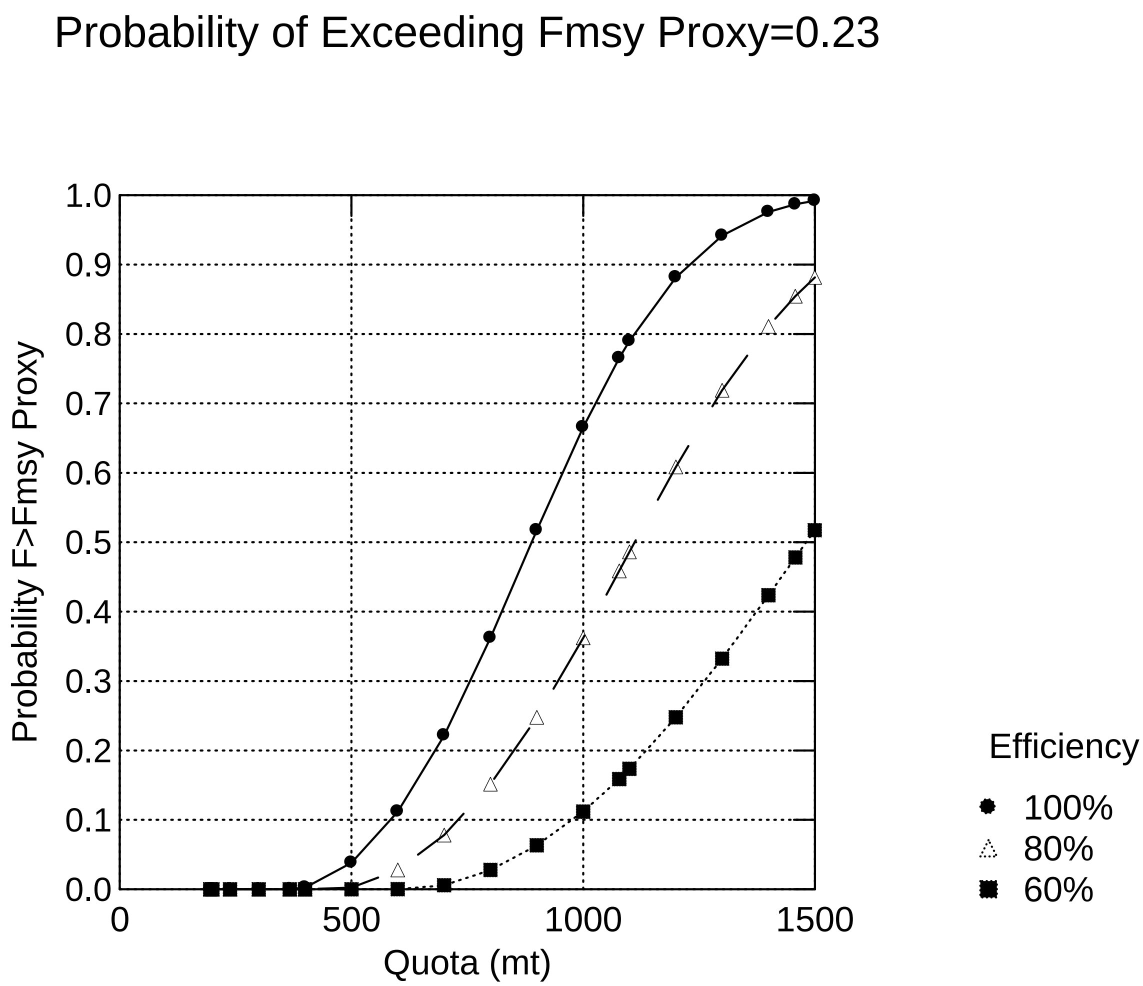
C4. Length-based yield per recruit analysis using von Bertalanffy parameters estimated from the spring and fall 2006-2010 NEFSC surveys, maturity at length from the MDMF survey and assuming a natural mortality of 0.3. $F_{40\%}$ was estimated at 0.31. The SSB/R line (red) decreases as F increases.



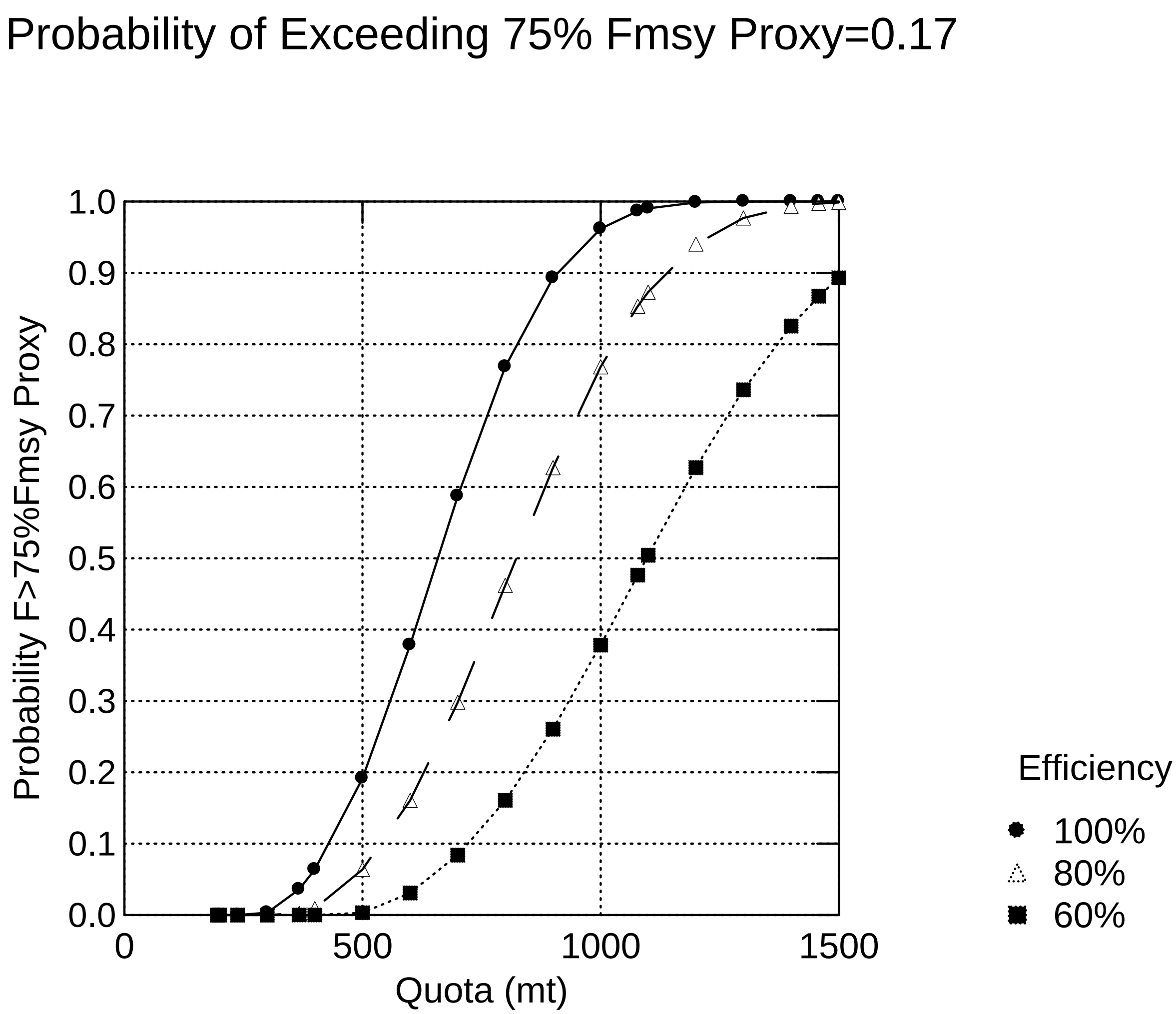
C5. Sensitivity of swept area 30+ cm biomass estimates for Gulf of Maine winter flounder for varying seasons and years under three alternative assumed values of trawl efficiency for all three surveys**.**



C6. Estimated exploitation rates for Gulf of Maine winter flounder for Fall 2010 based on three assumed gear efficiencies (0.6, 0.8, and 1.0) and 5 levels of catch (the 2010 catch of 195 mt, an assumed quota of 500 mt, assumed quota of 700 mt, 75% OFL of 1,078 mt and the OFL of 1,458 mt based on $F_{40\%}$). Dashed lines represent length-based exploitation rate estimates of $F_{40\%}$ (0.23) and 75% of $F_{40\%}$ (0.17). SSB per recruit is derived using GOM winter flounder growth and maturation relationships and an assumed knife edge selection curve at 30 cm.



C7. Estimated probability of exceeding F_{MSY} proxy ($F_{40\%}$), expressed as an exploitation rate of 0.23, and assuming efficiencies of 60%, 80% and 100% based of the fall 2010 survey across a range of quotas.



C8. Estimated probability of exceeding 75% of F_{MSY} proxy ($F_{40\%}$), expressed as an exploitation rate of 0.17, and assuming efficiencies of 60%, 80% and 100% based of the fall 2010 survey across a range of quotas.

Appendix: Assessment Terms of Reference

TORs for SAW/SARC52 (June 6-10, 2011)

(file vers.: 12/17/2010)

A. Winter flounder (Southern New England Stock)

1. Estimate catch from all sources including landings and discards. Characterize the uncertainty in these sources of data.

2. Present survey data being considered and/or used in the assessment (e.g., regional indices of abundance, recruitment, state and other surveys, age-length data, etc.). Characterize uncertainty in these sources of data.

3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-5), and estimate their uncertainty. Include area-swept biomass estimates. Investigate if implied survey gear or catchability estimates are reasonable. Include a historical retrospective analysis to allow a comparison with previous assessment results.

4. Perform a sensitivity analysis which examines the impact of allocation of catch to stock areas on model performance (in TOR-3).

5. Examine the effects of incorporating environmental factors in models of population dynamics (e.g., spring water temperatures in an environmentally-explicit stock recruitment function).

6. 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}, $B_{THRESHOLD}$, and F_{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.

7. Evaluate stock status (overfished and overfishing) with respect to the "new" BRPs (from TOR 6), and with respect to the existing BRPs (from a previous accepted peer review) whose values have been updated.

8. Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs) under a set of alternative harvest scenarios. If the stock needs to be rebuilt, take that into account in these projections.
   a. Provide numerical short-term projections (3-5 yrs, or through the end of the rebuilding period, as appropriate). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions about the most important uncertainties in the assessment (e.g., terminal year abundance, variability in recruitment).
   b. Take into consideration uncertainties in the assessment and the species biology to describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming or remaining overfished, and how this could affect the choice of ABC.
   c. Develop plausible hypotheses (e.g., mixing among the three stocks) which might explain any conflicting trends in the data and undertake scenario analyses to evaluate the consequences of these alternate hypotheses on ABC determination.

9. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in recent SARC reviewed assessments and review panel reports. Identify new research recommendations.

B. Winter flounder (Georges Bank Stock)

1. Estimate catch from all sources including landings and discards. Characterize the uncertainty in these sources of data.

2. Present survey data being considered and/or used in the assessment (e.g., regional indices of abundance, recruitment, state and other surveys, age-length data, etc.). Characterize uncertainty in these sources of data.

3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-5), and estimate their uncertainty. Include area-swept biomass estimates. Investigate if implied survey gear or catchability estimates are reasonable. Include a historical retrospective analysis to allow a comparison with previous assessment results.

4. Perform a sensitivity analysis which examines the impact of allocation of catch to stock areas on model performance (in TOR-3).

5. Examine the effects of incorporating environmental factors in models of population dynamics (e.g., spring water temperatures in an environmentally-explicit stock recruitment function).

6. 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}, $B_{THRESHOLD}$, and F_{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.

7. Evaluate stock status (overfished and overfishing) with respect to the "new" BRPs (from TOR 6), and with respect to the existing BRPs (from a previous accepted peer review) whose values have been updated.

8. Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs) under a set of alternative harvest scenarios. If the stock needs to be rebuilt, take that into account in these projections.
    a. Provide numerical short-term projections (3-5 yrs, or through the end of the rebuilding period, as appropriate). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions about the most important uncertainties in the assessment (e.g., terminal year abundance, variability in recruitment).
    b. Take into consideration uncertainties in the assessment and the species biology to describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming or remaining overfished, and how this could affect the choice of ABC.

c. Develop plausible hypotheses (e.g., mixing among the three stocks) which might explain any conflicting trends in the data and undertake scenario analyses to evaluate the consequences of these alternate hypotheses on ABC determination.

9. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in recent SARC reviewed assessments and review panel reports. Identify new research recommendations.

C. Winter flounder (Gulf of Maine Stock)

1. Estimate catch from all sources including landings and discards. Characterize the uncertainty in these sources of data.

2. Present survey data being considered and/or used in the assessment (e.g., regional indices of abundance, recruitment, state and other surveys, age-length data, etc.). Characterize uncertainty in these sources of data.

3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-5), and estimate their uncertainty. Include area-swept biomass estimates. Investigate if implied survey gear or catchability estimates are reasonable. Include a historical retrospective analysis to allow a comparison with previous assessment results.

4. Perform a sensitivity analysis which examines the impact of allocation of catch to stock areas on model performance (in TOR-3).

5. Examine the effects of incorporating environmental factors in models of population dynamics (e.g., spring water temperatures in an environmentally-explicit stock recruitment function).

6. 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}, $B_{THRESHOLD}$, and F_{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.

7. Evaluate stock status (overfished and overfishing) with respect to the “new” BRPs (from TOR 6), and with respect to the existing BRPs (from a previous accepted peer review) whose values have been updated.

8. Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs) under a set of alternative harvest scenarios. If the stock needs to be rebuilt, take that into account in these projections.
    a. Provide numerical short-term projections (3-5 yrs, or through the end of the rebuilding period, as appropriate). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a

range of assumptions about the most important uncertainties in the assessment (e.g., terminal year abundance, variability in recruitment).

b. Take into consideration uncertainties in the assessment and the species biology to describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming or remaining overfished, and how this could affect the choice of ABC.

c. Develop plausible hypotheses (e.g., mixing among the three stocks) which might explain any conflicting trends in the data and undertake scenario analyses to evaluate the consequences of these alternate hypotheses on ABC determination.

9. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in recent SARC reviewed assessments and review panel reports. Identify new research recommendations.

Appendix to the SAW TORs:

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

(The text below is from DOC National Standard Guidelines, Federal Register, vol. 74, no. 11, January 16, 2009)

On "Acceptable Biological Catch":

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":

"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)

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