39th Northeast Regional Stock Assessment Workshop (39th SAW)

Assessment Summary Report

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INTRODUCTION

The *SAW Assessment Summary Report* is one part of a report produced by the Northeast Regional Stock Assessment Workshop process. The *Assessment Summary Report* summarizes the technical information contained in the other part of the report produced by the SAW process, the *SAW Assessment Report* and is intended to serve as scientific advice for fishery managers on resource status.

An important aspect of scientific advice on fishery resources 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 simply 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 a stock's biomass falls below the biomass threshold ($B_{THRESHOLD}$) the stock is in an overfished condition. The Sustainable Fisheries Act mandates plans for rebuilding the stock should this situation arise.

Since there are two dimensions to the status of the stock– 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 is increased 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. This philosophy is embodied in the Sustainable Fisheries Act — stocks should be 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, 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 schematic below depicts how status criteria are interpreted in this context.

Overfishing guidelines are based on the precautionary approach to fisheries management and encourage the inclusion of a control rule in the overfishing definition. Control rules, when they exist, are discussed in the Advisory Report chapter for the stock under consideration. 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.

BIOMASS

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

GLOSSARY OF TERMS

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

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.

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 x (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 x (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:

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

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) $\frac{1}{2}B_{MSY}$, 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. 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.

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.
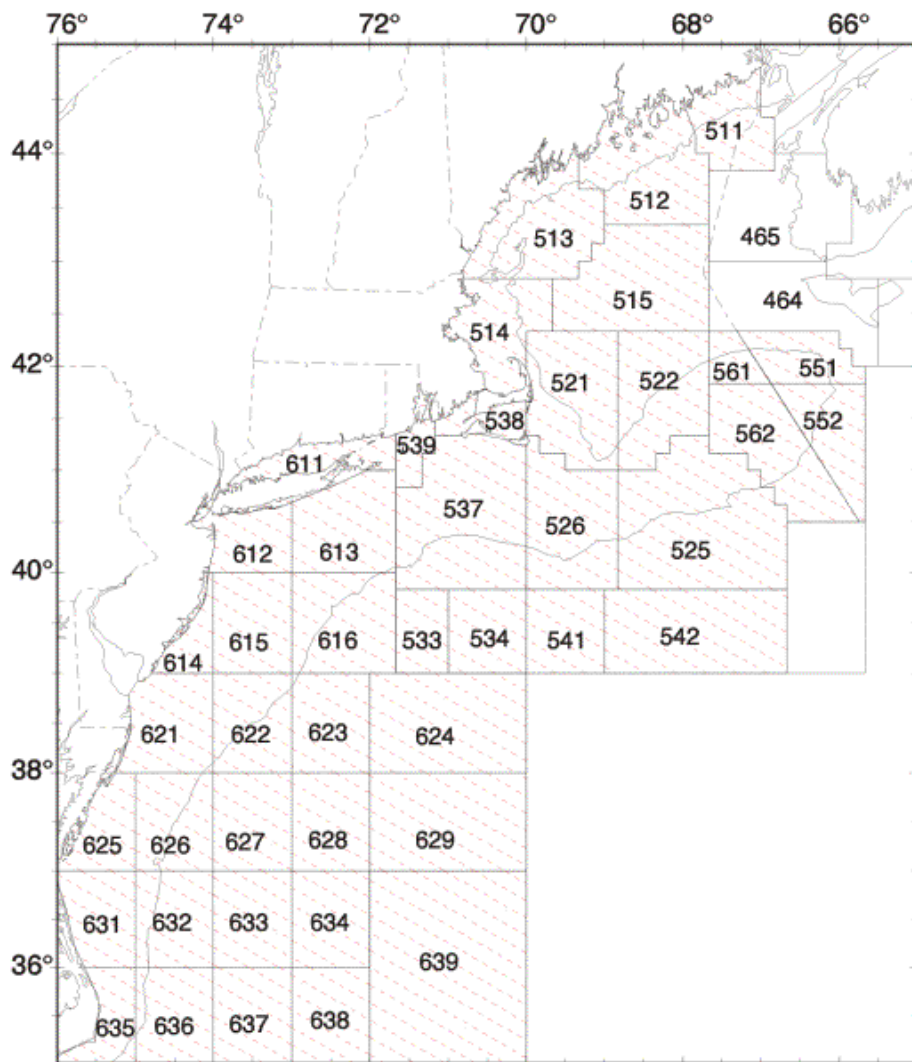
Figure 1. Catch reporting (statistical) areas used in the assessments.

Figure 2. Year-round area closures (shaded polygons) and seasonal groundfish rolling area closures (open polygons).
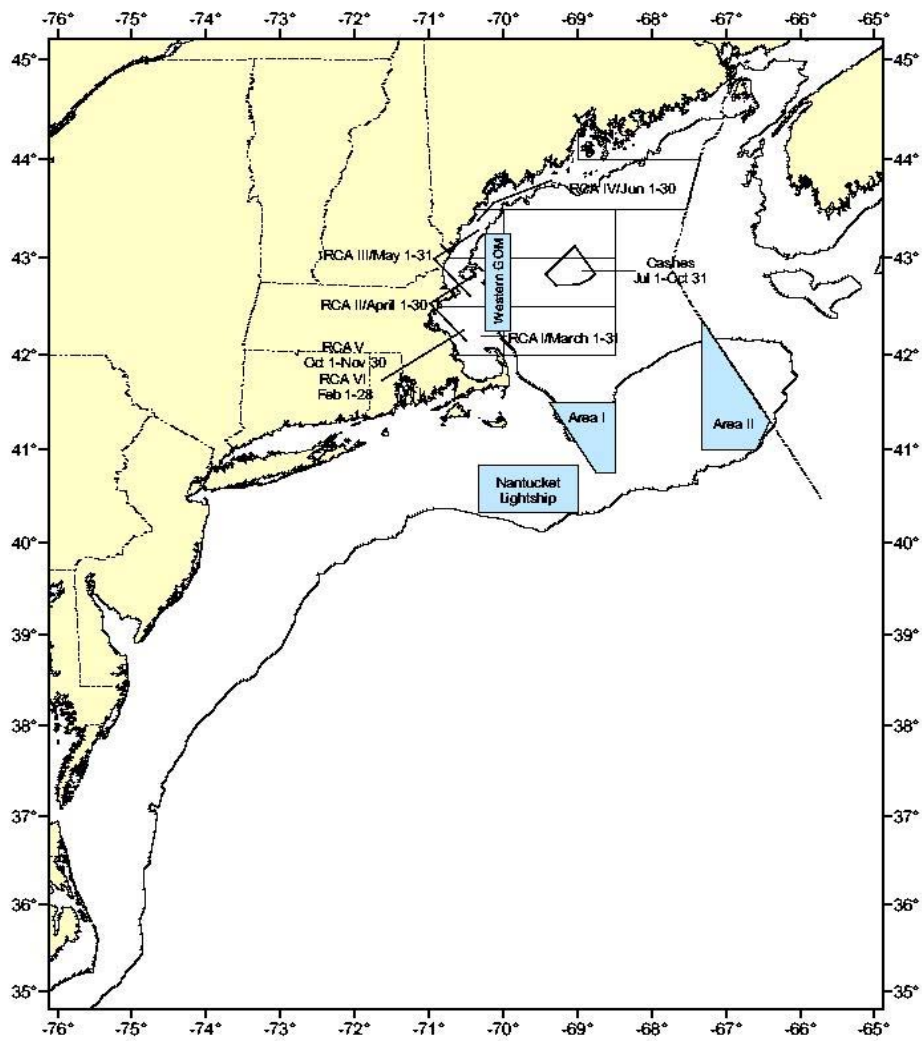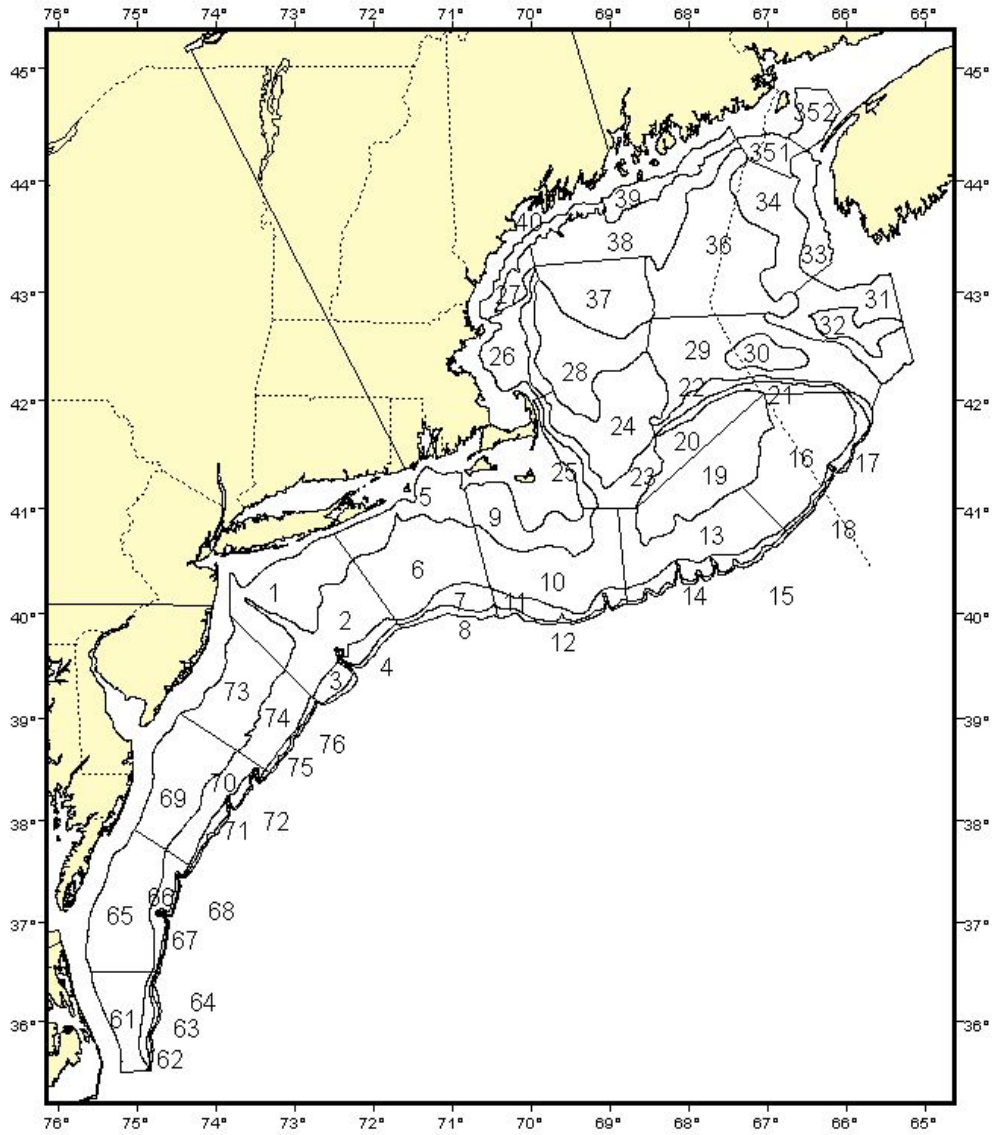
Figure 2. Year-round area closures (shaded polygons) and seasonal groundfish rolling area closures (open polygons).

Figure 3. NEFSC trawl survey strata used in the assessments.

A. BLACK SEA BASS ASSESSMENT SUMMARY

State of Stock: The stock is not overfished (current index $> 0.5 * B_{msy}$ proxy index) and overfishing is not occurring (F2003 $< F_{max}$ proxy for F_{msy}). Recent recreational landings have been equivalent to the average since 1981 while commercial landings are limited by quota. Survey biomass indices declined in 2003 and 2004 from the 2002 index, which was the highest in the time series (1968-2004); the average of exploitable biomass in 2002-2004 (1.43 kg/tow) exceeded the biomass threshold of 0.98 kg/tow (1977-1979 average). The recruitment index (age 1) in 2004 was below the time series average but the 2000 and 2002 indices were the highest in the series. Average exploitation rate from October 2002 through October 2003 was less than 17% (F=0.21), based on tag recaptures; from May 2003 to April 2004 exploitation rate was less than 21% (F=0.26).

Forecast for 2005: No forecasts were performed.

Catch and Status Table (weights in '000 mt): Black Sea Bass

Year	1996 Mean	1997	1998	1999	2000	2001	2002	2003	Max[1]	Min[1]	
Commercial landings	1.5	1.1	1.2	1.3	1.2	1.3	1.6	1.4	2.0	0.9	1.3
Recreational landings	1.8	1.9	0.5	0.8	1.8	1.6	2.0	1.9	5.6	0.5	1.6

[1]Over period 1984-2004.

Stock Distribution and Identification: Studies have indicated two stocks, one between Florida and Cape Hatteras, NC and another north of Cape Hatteras to Cape Cod , MA (Musick and Mercer, 1977, Shepherd 1991). The Mid-Atlantic Fisheries Management Council and the Atlantic States Marine Fisheries Commission share joint management of the northern stock.

Landings: Commercial landings increased from around 2,600 mt prior to 1948 to a peak of 9,900 mt in 1952, but then fell to about 1,000 mt per year in the early 1970s. Commercial landings increased moderately during 1975-1979, varying between 1,700 and 2,400 mt per year, and have remained relatively constant in recent years (900-2,000 mt). Landings in 2003 were 1,396 mt (Figure A1).

Data and Assessment: The Coastal/Pelagic Working Group concluded that data were adequate to conduct an assessment of the stock. The status of the resource was evaluated from NEFSC spring survey indices. Exploitation rates were estimated with tag recapture models for two periods, October 2002 to September 2003 and May 2003 to April 2004.

Biological Reference Points: Yield per recruit remained unchanged with estimates of $F_{0.1} = 0.19$ (15.7 % exploitation) and $F_{max} = 0.33$ (25.6 % exploitation) (Figure A6). MSY and Bmsy were not estimated. A 3-point moving average of NEFSC spring survey biomass per tow for fish greater than or equal to 22 cm provides a proxy for exploitable biomass, with the period 1977 to 1979 (0.98 kg/tow) serving as a proxy

for the biomass threshold. Average exploitable biomass index for 2002-2004 (0.94) remains above the ½ Bmsy proxy (Figure A4).

Fishing Mortality: Fishing mortality (F) for 2003 estimated from tag recapture models was less than 0.26. Exploitation rates from tagging data indicate that exploitation was between 15 and 20% (Figure A2). Relative F based on survey indices was well below the value necessary for stock replacement (replacement ratio=0) (Figure A5).
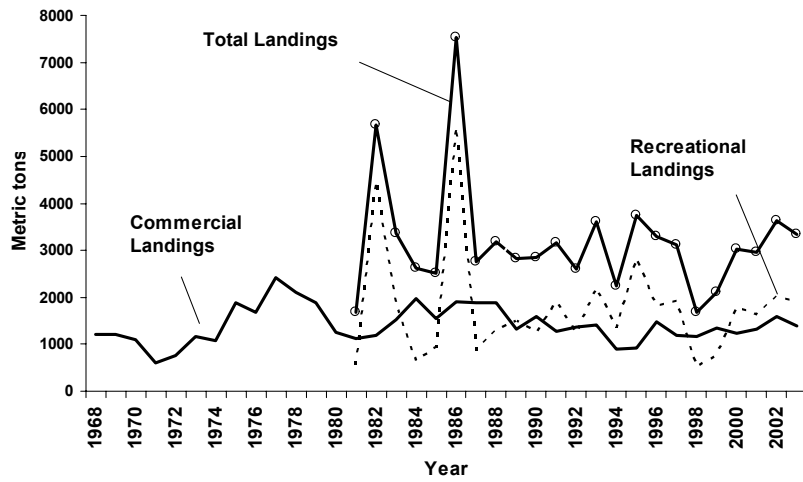
Recruitment: The NEFSC spring survey recruitment index (mean number per tow) in 2004 (0.08 per tow) was below the average for the last decade (0.187 per tow) (Figure A3).

Spawning Stock Biomass: SSB was not estimated in the current assessment. However, preliminary mean weight per tow of black sea bass ≥ 22 cm (approximately age 2) in the 2004 NEFSC spring survey decreased to 0.94 kg/tow, yet remained above average for the 1986-2003 period (Figure A4).

Special Comments: Uncertainty in the tag reporting rates may potentially result in under-estimated exploitation rates. Also, discard losses in the commercial fisheries were not estimated and remain an uncertain component of the fishery. In light of decreasing biomass indices since the peak in 2002, the Working Group recommends caution in exploitation of the resource.

Sources of Information: Musick, J.A. and L. P. Mercer. 1977. Seasonal distribution of black sea bass, *Centropristus striata*, in the Mid-Atlantic Bight with comments on the ecology and fishery of the species. Transactions of the American Fisheries Society. 106: 12-25. Shepherd, G.R. 1991. Meristic and morphometric variation in black sea bass north of Cape Hatteras, North Carolina. North American Journal of Fisheries Management. 11: 139-148.
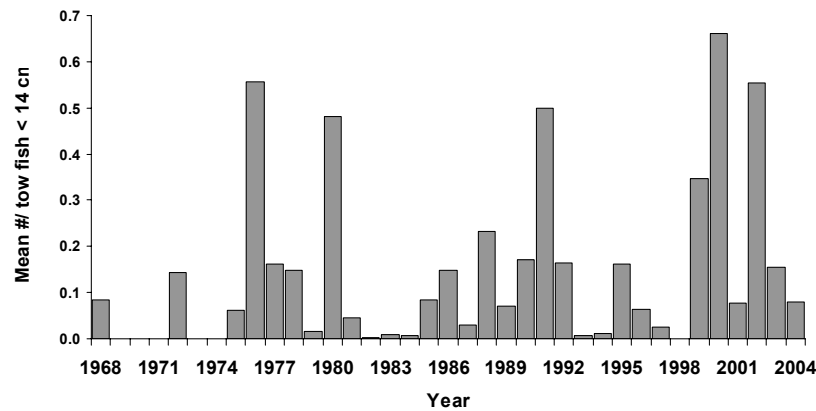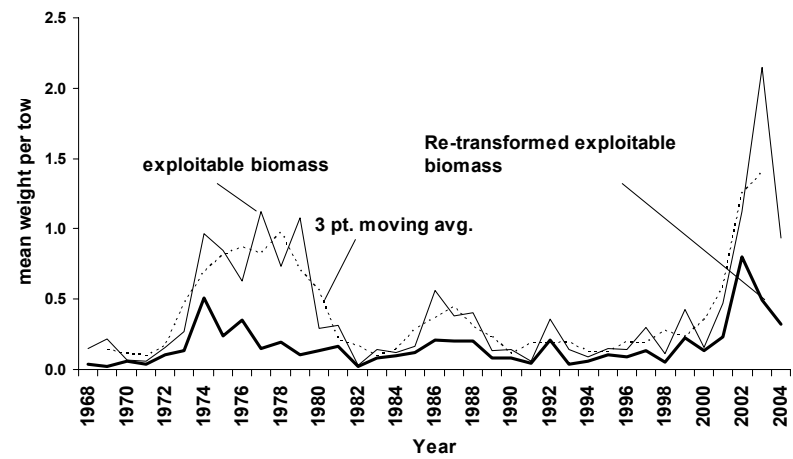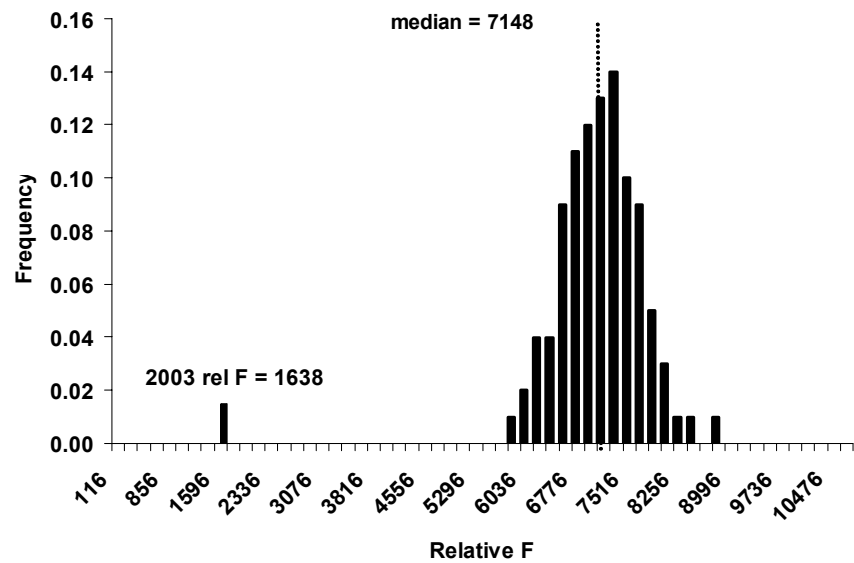
A1. Landings

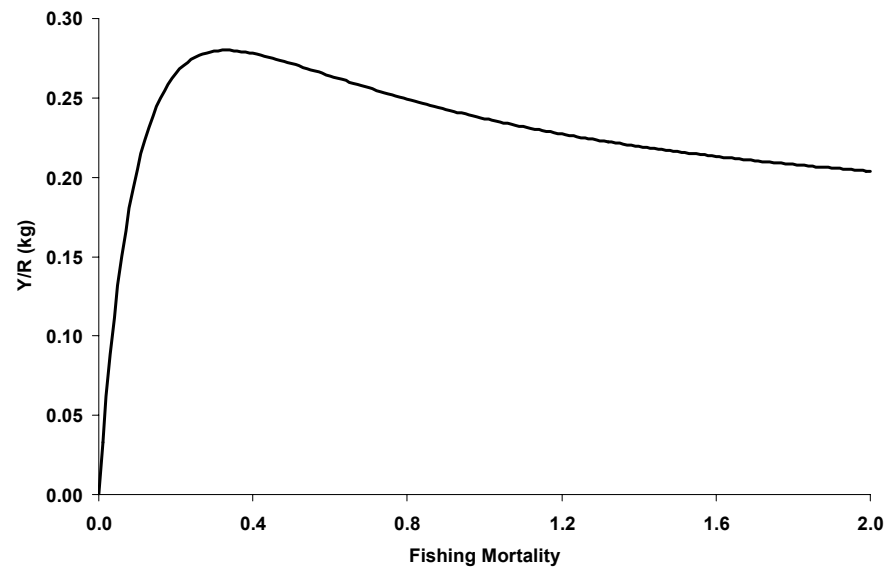

A2. Exploitation
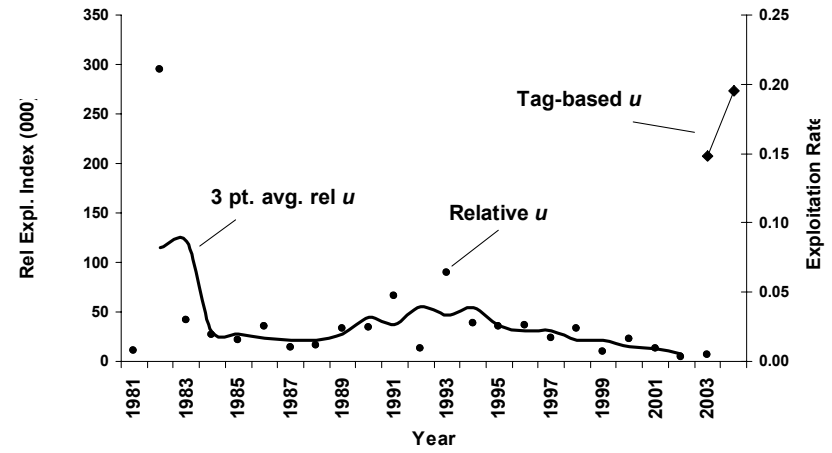
A3. Recruitment Index

A4. Biomass (Spring survey)

A5. Relative F with Replacement Ratio = 0

A6. Yield per Recruit

BLACK SEA BASS

B. SEA SCALLOP ASSESSMENT SUMMARY

State of the stock: During 2003, sea scallops were not overfished (current index $> 0.5B_{MSY}$ proxy index) but overfishing was occurring (F2003 $> F_{MAX}$ the proxy for F_{MSY}). Recent landings have been the highest on record. The combined (Mid-Atlantic and Georges Bank) survey biomass index has been increasing in recent years, and in 2003 was the highest in the time series (1982-2003); the 2003 biomass index of 7.6 kg/tow exceeded both the biomass overfishing threshold of 2.8 kg/tow and the biomass target of 5.6 kg/tow. Recruitment (age 2) in recent years (1998-2003) has been well above average, especially in the Mid-Atlantic, and the recruitment index in 2003 was the highest on record. Average exploitation rates were 22% (F = 0.26) in 2002 and 25% (F = 0.30) in 2003.

Forecast for 2005: No forecasts were performed.

Catch and Status Tables

U.S. Landings (MT meats)

Year	1996	1997	1998	1999	2000	2001	2002	2003	Min[2]	Max[2]	Mean[2]
Georges Bank	2,045	2,326	2,016	5,155	5,437	4,952	5,694	4,922	982	9,982	4,700
Mid-Atlantic Bight	4,999	2,910	2,948	4,653	8,860	15,768	17,612	19,660	1,610	19,660	6,716
Other[1]	847	768	600	338	326	461	586	525	326	1,138	648
Total	7,892	6,005	5,565	10,146	14,623	21,180	23,891	25,107	5,565	25,107	12,064

[1]Includes Gulf of Maine and Southern New England. [2]1982-2003.

Survey Trends for Stock Biomass (NMFS sea scallop survey, kg/tow)

Year	1996	1997	1998	1999	2000	2001	2002	2003	Min[2]	Max[2]	Mean[2]
Georges Bank	1.332	1.612	4.000	4.306	8.131	7.010	8.051	7.529	0.457	8.131	2.482
Mid-Atlantic Bight	0.773	0.533	1.101	2.281	4.005	4.519	5.122	7.603	0.454	7.603	1.821
Combined	1.033	1.035	2.451	1.978	5.926	5.678	6.485	7.569	0.496	7.569	2.072

Fishing Mortality (annual instantaneous rates, rescaled catch-biomass method)

Year	1996	1997	1998	1999	2000	2001	2002	2003	Min[2]	Max[2]	Mean[2]
Georges Bank	0.25	0.20	0.08	0.16	0.10	0.10	0.08	0.09	0.08	1.70	0.69
Mid-Atlantic Bight	1.15	0.94	0.73	0.45	0.45	0.63	0.54	0.48	0.45	1.58	0.94
Combined	0.58	0.35	0.18	0.27	0.22	0.28	0.26	0.30	0.22	1.55	0.79

Stock Distribution and Identification: The US sea scallop stock was assessed based on two regions, Georges Bank and Mid-Atlantic Bight, and then combined. Based on Amendment 10 to the Sea Scallop Management Plan, overfishing and overfished status was evaluated for the stock as a whole.

Landings: Sea scallop landings have been increasing since 1998, and the 2003 landings of 25,107 mt was a new record (Figure B1). Georges Bank landings in 1999-2003 have been around their 1982-2003 mean, while recent landings in the Mid-Atlantic Bight have been well above average.

Data and Assessment: The status of the resource was evaluated from NEFSC sea scallop survey indices. Fishing mortality was estimated using the rescaled catch-biomass method.

Biological Reference Points: Reference points from a length-based yield-per-recruit model were updated based on new estimates of selectivity for scallops to 3.5" and 4" rings to account for recent

fishery selectivity patterns. The new calculations gave similar results to the currently used age-based reference points ($F_{MAX} = 0.24$).

Fishing Mortality: Fishing mortality (F) for 2003 estimated by the rescaled catch-biomass method was F = 0.30 (25% exploitation rate), which is above the overfishing threshold $F_{MAX} = 0.24$ (Figure B2).

Recruitment: Recent (1998-2003) recruitment for the stock as a whole has been above average, based on the NEFSC scallop survey recruitment indices (Figure B3). In the Mid-Atlantic Bight, recruitment was high during 1998-2003 and the recruitment index from the NEFSC scallop survey for 2003 was the highest value observed during the 1979-2003 time series. Recruitment in the Georges Bank region was above average during 1998-2001 and below average during 2002-2003.

Spawning stock biomass: The NEFSC biomass index (7.6 kg/tow) is computed from the biomass of sea scallops capable of spawning (Figure B4).

Special comments: Scallop density data from the SMAST video survey during 2003 were used to better estimate efficiency of the NEFSC survey dredge in sampling scallops and to improve the accuracy of stock assessment results. New efficiency estimates are for individual regions and for the stock as a whole. Estimates from video and dredge surveys were similar after adjustment for dredge efficiency.

Measurement errors in video survey shell height data were evaluated in a joint SMAST/NEFSC experiment. Analytical approaches were devised to accommodate shell height data with measurement errors.

To improve safety, NEFSC may use chains to exclude rocks from survey dredge tows on rocky ground. Additional fieldwork would increase the precision of factors used to adjust for rock chain effects on survey catch data.

A forward-projecting length-based assessment model (CASA) is presented for review and potential use in future assessments. The model shows promise with relatively precise estimates, no retrospective bias, and ability to use catch and shell height composition data from the commercial fishery and multiple surveys, LPUE, and results from cooperative surveys and experiments.
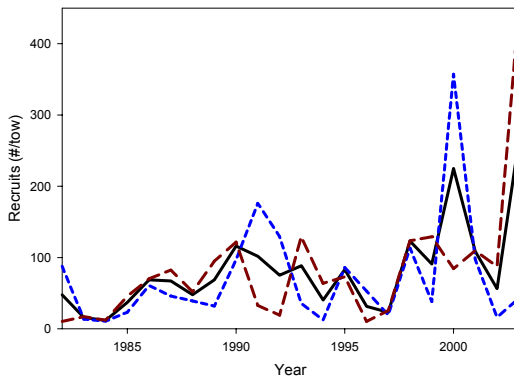
B1. Sea scallop landings (mt meats), 1982-2003.
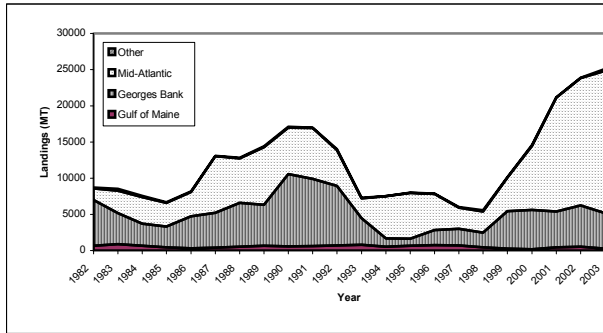
B2. Trends in fishing mortality, 1982-2003.
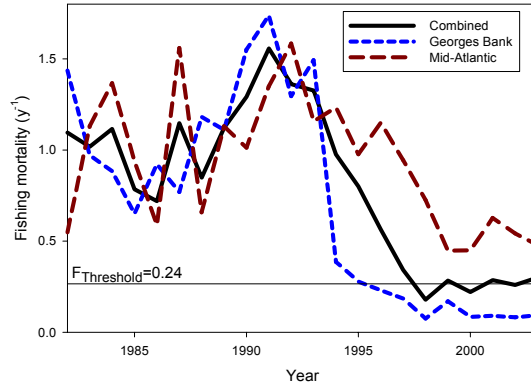
B3. Trends in scallop recruitment, 1982-2003.

B4. Trends in scallop biomass, 1982-2003.