Northeast Fisheries Science Center Reference Document 06-01

42nd Northeast Regional Stock Assessment Workshop (42nd SAW)

42nd SAW Assessment Summary Report

January 2006

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A Report of the 42nd Northeast Regional
Stock Assessment Workshop (42nd SAW)

42nd SAW Assessment Summary Report

U.S. DEPARTMENT OF COMMERCE
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Northeast Fisheries Science Center Reference Documents

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The stock assessments which are the subject of this document were peer reviewed by a panel of assessment experts known as the Stock Assessment Review Committee (SARC). Panelists were provided by the Center for Independent Experts (CIE), University of Miami. Reports from the SARC panelists and a summary report from the SARC Chairman can be found at *http://www.nefsc.noaa.gov/nefsc/saw*.

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SAW-42 ASSESSMENT SUMMARY REPORT
INTRODUCTION

The 42nd SAW Assessment Summary Report contains summary and detailed technical information on the three assessments and one multispecies predator prey model reviewed in November/December 2005 at the Stock Assessment Workshop (SAW) by the 42nd Stock Assessment Review Committee (SARC-42): silver hake (*Merluccius bilinearis*), Atlantic mackerel (*Scomber scombrus*), northern shortfin squid (*Illex illecebrosus*) and the MSVPA-X model. The SARC-42 consisted of three external, independent reviewers and a SARC chairman, all appointed by the Center for Independent Experts. The SARC evaluated whether each Term of Reference (listed in the Appendix) was completed successfully based on scientific criteria and whether the work provided a scientifically credible basis for developing fishery management advice. The reviewers' report for SAW/SARC-42 is available at website: http://www.nefsc.noaa.gov/nefsc/saw/ under the heading "Recent Reports".

The SARC accepted part of the silver hake assessment. Three approaches were used in the assessment to estimate fishing mortality (F) and stock biomass. Two of these approaches were new and were designed to derive lower bounds for biomass and upper bounds for F: (1) a comparison of catches in the NEFSC survey with those in a Supplemental Finfish survey; and (2) a method based on the assumption that landings must be less than stock biomass. The third approach was the existing method which uses standard biomass and exploitation indices derived from NEFSC fall bottom trawl survey data and commercial landings. The results of the two new approaches were not accepted by the SARC because the approaches depended on key assumptions that were not well supported. Thus, the assessment was based on the existing method which was used for determining stock status. The SARC concluded that although the silver hake assessment was able to evaluate stock status, more work should be done to evaluate the appropriateness of the existing threshold criteria.

The SARC accepted the Atlantic mackerel stock assessment, and indicated that the assessment was scientifically-sound and provided a credible basis for developing management advice. It was noted that estimates of fishing mortality and biomass from the new mackerel assessment model (ASAP) model had a retrospective pattern, raising concerns about whether these quantities were estimated well. The SARC felt that a suitable description was provided regarding the transition from an earlier assessment model to the ASAP model, but that more details and documentation should have been provided in the mackerel assessment report.

The *Illex* squid assessment was not able to estimate fishing mortality rate, stock biomass, or to determine stock status. The SARC indicated that the available data on *Illex* were not adequate to estimate these quantities; nevertheless, significant advances in modeling had taken place. The SARC advocated finding a new approach for evaluating overfishing, and deemed the existing criteria inappropriate for this short-lived species.

With respect to the MSVPA-X model, the reviewers concluded that all of the Terms of Reference were met; however, they stressed that it would not be appropriate to use the present model as a basis for quantitative fishery management advice about menhaden or its predators.

Rather, they felt that the MSVPA-X model was a valuable tool for understanding predator-prey dynamics and for exploring "what if" scenarios.

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 a stock's biomass falls below the biomass threshold ($B_{THRESHOLD}$) the stock is in an overfished condition. The Sustainable Fisheries Act mandates that a plan be developed for stock rebuilding 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.

		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	$F = F_{TARGET} <= F_{MSY}$

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 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.

GLOSSARY

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 [$1,000,000 \times (1 - 0.00548)^{365}$] 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:

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

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.

F**ishery 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.

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.

C. NORTHERN SHORTFIN SQUID (*Illex*) ASSESSMENT SUMMARY FOR 2005

State of Stock: It was not possible to evaluate current stock status because there are no reliable current estimates of stock biomass or fishing mortality rate.

Projection for 2005: No projection were made.

Landings and Status Table (landings in '000 mt): Northern Shortfin Squid (*Illex*)

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Max	Min	Mean
US EEZ Domestic Landings[1]	14.1	17.0	13.6	23.6	7.4	9.0	4.0	2.7	6.3	26.1	26.1	2.0	12.3
US EEZ Foreign Landings[2]	0	0	0	0	0	0	0	0	0	0	24.7	0	6.2
Total US EEZ Landings[2]	14.1	17.0	13.6	23.6	7.4	9.0	4.0	2.7	6.3	26.1	26.1	1.5	13.0
Subareas 3+4 (Canada) Landings[2]	1.0	8.7	15.6	1.9	0.3	0.4	0.1	0.3	1.1	2.0	162.1	0.1	16.3
Total Landings (All areas)[2]	15.1	25.7	29.2	25.5	7.7	9.4	4.1	3.0	7.5	28.1	179.3	1.6	29.3
Escapement Index in Numbers, NEFSC Fall Survey[3] (number/tow)	8.0	10.8	5.8	14.6	1.4	7.4	4.5	6.4	28.5	5.1	28.5	0.6	9.2
Escapement Index in Biomass, NEFSC Fall Survey[3] (kg/tow)	0.7	0.9	0.5	1.4	0.2	0.7	0.3	0.4	1.9	0.4	9.3	0.1	1.6
Average body weight (g),NEFSC Fall Survey[3]	84	87	89	94	136	94	72	70	69	82	327	69	149

[1]Min, max, mean for 1987-2004.
[2]Min, max, mean for 1968-2004.
[3]Min, max, mean for 1967-2004.

Stock Distribution and Identification: The *Illex illecebrosus* population is assumed to constitute a unit stock throughout its range of exploitation from Cape Hatteras to Newfoundland (Dawe and Hendrickson 1998; Hendrickson and Holmes 2004). Spawning occurs throughout the year (Dawe and Beck 1997; Hendrickson 2004) and stock structure is complicated by the overlap of seasonal cohorts. This highly migratory, oceanic species tends to school by size and sex and, based on age validation studies (Dawe et al. 1985: Hurley et al. 1985), is a sub-annual species. A statolith-based aging study of squid caught in a research survey conducted in U.S. waters indicated that the oldest individual was about seven months (215 days) of age (Hendrickson 2004). Spawning occurs on various places on the US shelf, including on the fishing grounds during the fishing season.

Catches: During 1973-1982, total stock landings (NAFO Subareas 3-6) averaged 71,900 mt and were predominately taken from the northern stock component in Subareas 3+4 (Hendrickson et al. 2005). Total landings (US and foreign) during this time peaked at 179,300 mt. Since 1982, total landings have been dominated by the domestic fishery, with the exception of 1997. Prior to 1967, U.S. landings of squid (*Illex* and *Loligo*) averaged about 2,000 mt per year. A directed foreign fishery for *Illex* developed in 1968 in U.S. waters, continued through 1982, and ended in 1987 (Figure C1). Domestic landings increased to 18,350 mt from 1988 to 1994, and then averaged 14,900 mt during 1995-1997. In 1997, Subarea 3+4 landings off Canada were nearly equal to US

EEZ landings and were at their highest levels since 1981. In 1998, US EEZ landings (23,600 mt) reached the highest level observed since 1977, resulting in a fishery closure because the TAC (19,000 mt) was exceeded. US landings dropped by 69% between 1998 and 1999. During 2000-2002, US landings declined from 9,011 mt to 2,723 mt; the lowest level since 1988. In 2003, US landings were 6,400 mt. In 2004, US landings reached the highest level on record (26,100 mt) and the fishery was closed near the end of the fishing season because the quota (24,000 mt) was reached. Preliminary US landings for 2005 are 11,429 mt.

Observer data for 1995-2004 indicate that discarding of *Illex* occurs primarily in the *Illex* and offshore *Loligo* fisheries and is higher in the latter. During this time period, annual discards from both fisheries combined ranged between 53 and 1,565 mt, 0.5% - 6.0% of the annual *Illex* landings by weight. Annual discards were highest during 1998 (453 mt) and 2004 (1,565 mt), when USA *Illex* landings were highest.

Data and Assessment: *Illex illecebrosus* was last assessed in 2003 at SAW 37 (NEFSC 2003). It was not possible in the current assessment to estimate fishing mortality or stock size. Although new models show promise, the results could not be accepted because required seasonal maturity and age data are lacking.

Biological Reference Points: The current FMP specifies B_{MSY} as 39,300 mt and F_{MSY} as 1.22 per year (MAFMC 1998). These reference points were based on results from a biomass dynamics model that utilized U.S. fishery data for 1982-1993 (NEFSC 1996). However, this model is now considered inappropriate to use to derive biological reference points for the *Illex* stock because the model does not address the semelparous (living for only a single season or year) life history of *Illex*.

SFA Control Rule: The Amendment 8 control rule (MAFMC 1998) states that when the stock biomass exceeds B_{MSY}, the overfishing threshold is F_{MSY}, and target F is 75% of F_{MSY}. Below B_{MSY}, target F decreases linearly and is set to zero when stock size is at the biomass threshold of 50% of B_{MSY}.

Fishing Mortality: No estimates of fishing mortality are available. Despite a shorter fishing season, fishing effort (days fished), an indicator of fishing mortality, was twice as high in 2004 as in 2003, due to a doubling in the number of vessels participating in the fishery and four times the number of trips.

Recruitment: Statolith-based age data suggest that spawning occurs throughout the year (Dawe and Beck 1997: Hendrickson 2004) and that recruitment to the fisheries is continuous. However, absolute estimates of recruitment during 2003 and 2004 are not available.

Stock Biomass: The current level of stock biomass is unknown. The NEFSC autumn bottom trawl survey occurs primarily after the U.S. *Illex* fishery and can be considered to provide a relative index of spawner escapement because the survey occurs near or after the end of the fishing season. The Autumn survey relative abundance index for *Illex* was a record high in 2003, but was very low in 2004 (Figure C2).

Special Comments: *Illex illecebrosus* is a highly migratory, transboundary species with a maximum observed age of 215 days for squid from U.S. waters. The overfishing definition currently in place for this stock, F_{MSY}, addresses yield rather than ensuring adequate spawning escapement for this sub-annual species.

Adequate escapement of spawners is needed to ensure sufficient recruitment in the subsequent year. The magnitude of escapement could be affected by increased exploitation.

Alternative approaches to managing the *Illex* fishery, including constant quota, constant effort, real-time management, and constant escapement should be investigated.

Cooperative research projects with the *Illex* fishing industry such as the collection of tow-based fisheries and biological data and electronic logbook reporting (Hendrickson et al. 2003) should continue because these high resolution data are needed to improve the assessment models. Based on promising new models, the collection of in-season maturity and age data are essential for improvement of the assessment.

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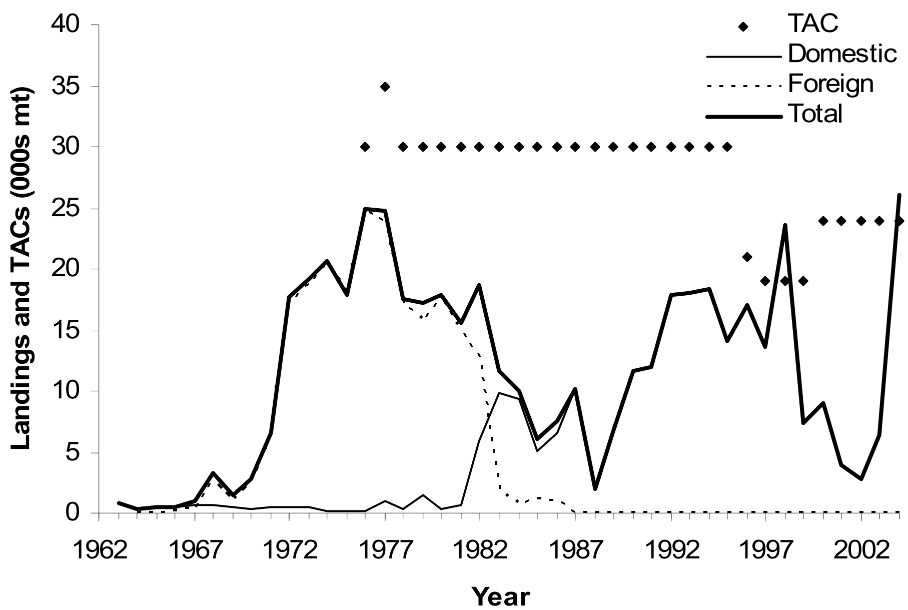
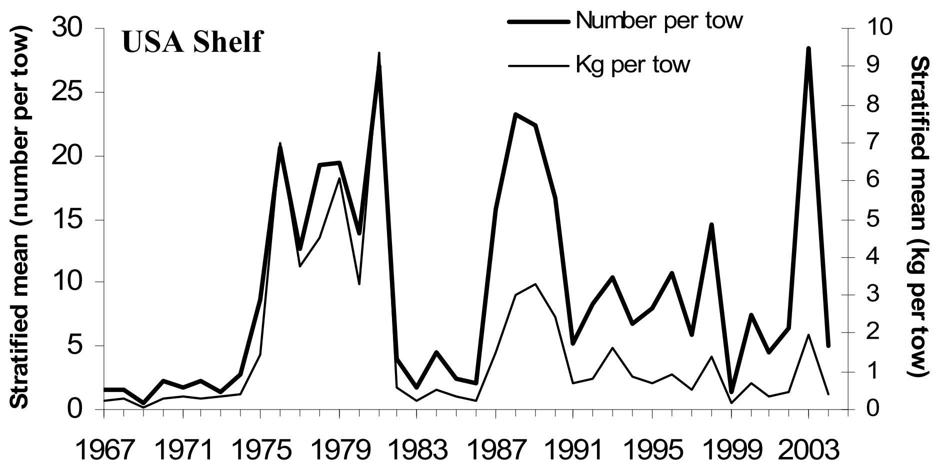
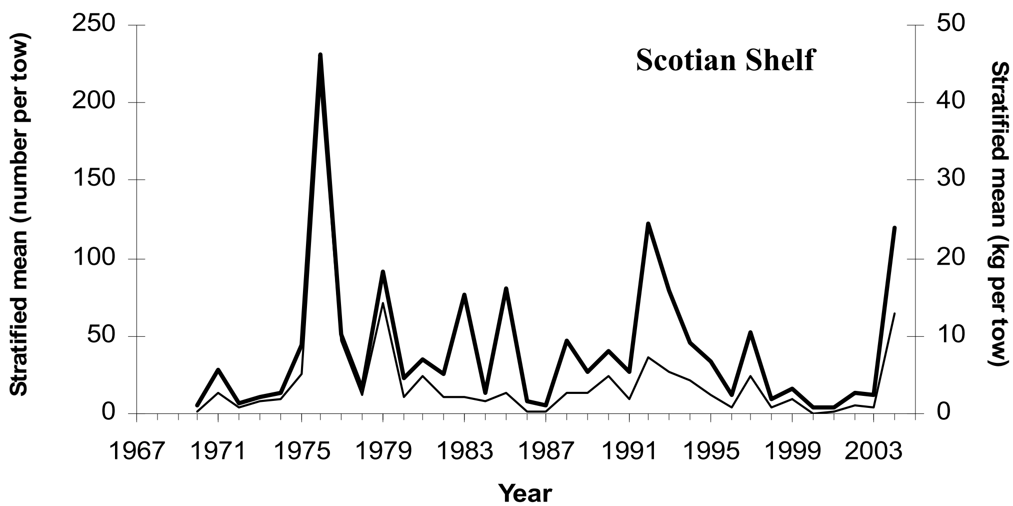
C1. Annual *Illex* landings and TACs for the USA stock component (Subareas 5+6).



C2. Annual relative abundance and biomass indices of *Illex* on the USA shelf near the end of the US fishing season (top), based on NEFSC September-October bottom trawl surveys, and on the Scotian Shelf near the start of the fishing season (bottom), based on Canadian July bottom trawl surveys. Scotian Shelf survey indices were not standardized for gear and vessel changes that occurred in 1982, 1983 and 2004.





APPENDIX. TERMS OF REFERENCE

Terms of Reference for the 42nd Northeast Stock Assessment Workshop

(approved: (11/10/05)

SAW/SARC 42
November 28- December 2, 2005
NEFSC, Woods Hole, MA

Atlantic mackerel - Coastal and Pelagic Working Group

1. Characterize the commercial and recreational catch including landings and discards.
2. Estimate fishing mortality, spawning stock biomass, and total stock biomass for the current year and characterize the uncertainty of those estimates. If possible, also include estimates for earlier years.
3. Evaluate and either update or re-estimate biological reference points, as appropriate.
4. As needed by management, estimate a single-year or multi-year TAC and/or TAL by calendar year or fishing year, based on stock biomass and target mortality rate.
5. If possible,
    a. provide short term projections (2-3 years) of biomass and fishing mortality rate, and characterize their uncertainty, under various TAC/F strategies and
    b. evaluate current and projected stock status against existing rebuilding or recovery schedules, as appropriate.
6. Review, evaluate and report on the status of the SARC/Working Group Research Recommendations offered in previous SARC-reviewed assessments.

Silver hake - Northern Demersal Working Group

1. Characterize the commercial and recreational catch including landings and discards.
2. Estimate fishing mortality, spawning stock biomass, and total stock biomass for the current year and characterize the uncertainty of those estimates. If possible, also include estimates for earlier years.
3. Evaluate and either update or re-estimate biological reference points, as appropriate.
4. As needed by management, estimate a single-year or multi-year TAC and/or TAL by calendar year or fishing year, based on stock biomass and target mortality rate.

5. If possible,

    a. provide short term projections (2-3 years) of biomass and fishing mortality rate, and characterize their uncertainty, under various TAC/F strategies and

    b. evaluate current and projected stock status against existing rebuilding or recovery schedules, as appropriate.

6. Review, evaluate and report on the status of the SARC/Working Group Research Recommendations offered in previous SARC-reviewed assessments.

Illex squid - Invertebrate Working Group

1. Characterize the commercial and recreational catch including landings and discards.

2. Estimate fishing mortality, spawning stock biomass, and total stock biomass for the current year and characterize the uncertainty of those estimates. If possible, also include estimates for earlier years.

3. Evaluate and either update or re-estimate biological reference points, as appropriate.

4. As needed by management, estimate a single-year or multi-year TAC and/or TAL by calendar year or fishing year, based on stock biomass and target mortality rate.

5. If possible,

    a. provide short term projections (2-3 years) of biomass and fishing mortality rate, and characterize their uncertainty, under various TAC/F strategies and

    b. evaluate current and projected stock status against existing rebuilding or recovery schedules, as appropriate.

6. Review, evaluate and report on the status of the SARC/Working Group Research Recommendations offered in previous SARC-reviewed assessments.

Multispecies predator-prey MSVPA-X model – ASMFC

1. Evaluate adequacy and appropriateness of model input data, including fishery-dependent data, fishery-independent data, selectivities, etc. as configured.

2. Evaluate assumptions for data gap filling when reliable data are not available (diet, biomass of prey species, feeding selectivity).