SUMMARY REPORT ON THE 42nd NORTHEAST REGIONAL STOCK ASSESSMENT WORKSHOP (SAW-42) STOCK ASSESSMENT REVIEW COMMITTEE (SARC) MEETING

by

Andrew I.L. Payne
SARC-42 Chair (appointed by CIE)

CEFAS
Pakefield Road
Lowestoft
Suffolk NR33 0HT
United Kingdom
www,cefas.co.uk
tel: +44-1502-524344
e-mail: a.i.l.payne@cefas.co.uk

supported by

John Casey, Vivian Haist, and Yan Jiao
SARC-42 Panel Members (appointed by CIE)

Contents Page

1. Executive Summary and Recommendations

SARC-42convened from 28 November to 4 December 2005 at the NEFSC Woods Hole Laboratory, with a Chair and three panellists, helped by the SAW-42 Chair and an NEFSC Technical Advisor. Three assessments were reviewed, silver hake, Atlantic mackerel, and shortfin (*Illex*) squid, and an MSVPA-X model was evaluated, all against Terms of Reference set in advance.

For *silver hake*, management advice was presented relative to MSY proxies based on levels of the fall survey index, a credible basis for developing advice. However, reference points, estimated for a period when the survey index on which they were based was relatively stable, were considered inappropriate. A serious hindrance to understanding stock status is the absence in recent years of larger, older fish. Further, the assessment did not attempt to use analytical assessment models, but rather focused on an evaluation of survey and ancillary (e.g. discard) data to investigate changes in fish distribution, and to estimate upper bound estimates for *F*. The panel does not agree with the output from any of the methods of obtaining an upper bound estimate of *F*, and hence with the calculated lower bounds of *SSB*. Analytical modelling should be tried again in future. Some of the Terms of Reference had been partially addressed, but some were hampered by the absence of an analytical assessment.

For *Atlantic mackerel*, basic documentation was rather inadequate: there were few details of the assessment models used. It was, however, useful to have the results of the earlier ADAPT-VPA assessment provided to show the transition to the new ASAP model. Nevertheless, provision of uncertainty estimates around data and model would aid evaluation of the assessment. A key issue with the assessment is the uncertainty in the magnitude of the (seemingly large) 1999 year class, which dominates survey and commercial catches. However, issues related to changed targeting practice recently, associated potential changes in spatial distribution of mackerel, and retrospective patterns in the assessment raise concerns whether fishing mortality is being estimated well. Notwithstanding these concerns, the general focus and development of the mackerel assessment is based on sound scientific criteria. Re-estimated reference points and associated catch projections, though seemingly appropriate from an evaluation perspective, clearly need to be subjected to a risk analysis with full consideration of the uncertainties to help stakeholders understand the stock dynamics better. Terms of Reference were closely adhered to.

In terms of shortfin squid, standard analytical methods tend to be difficult to apply, so most of the assessment focused around developing sound, novel analytical approaches that reflect the unique life history better. More and better data are needed to underpin the analyses. Current reference points are based on surplus production analysis, which is not appropriate, so an alternative method of deducing such threshold values, based on a maturation rate – natural mortality model, was presented. However, they cannot be used immediately, despite the superiority of the method in calculating an *F*-based reference point. Considerable effort has been put into improving age determination, standardization of landings per unit effort, and developing in-season and per-recruit models. However, more work is needed before the output from any model can be applied effectively to management. The SARC panel would like consideration again to be given to the potential of using both spring and fall survey indices as complementary indicators of population status. Further, a quantitative or qualitative assessment of environmental variation and associated escapement could be beneficial in understanding stock dynamics better. Finally, the Terms of Reference had all been addressed, though the absence of an acceptable management model had hampered progress against some.

The *predator-prey MSVPA-X model* represents the result of an impressive effort to compile available data on species abundance and diet composition for the prey species menhaden and the predators bluefish, weakfish and striped bass. Development of this model has been made with the objective of aiding understanding of the dynamics rather than providing advice or recommendations for ecosystem management. All Terms of Reference had been well met.

Undoubtedly the new process facilitates speedy production of this report and is a huge improvement in its predecessor, but it is thought advisable that now that the meeting lasts a full week, it could effectively straddle a single weekend and be structured to allow just one presentation to the review panel daily. Evaluating presentations against clear Terms of Reference is an excellent idea, though it is felt that such ToRs should perhaps be more stock-specific in future. The presentation and discussion arrangements for the meeting and report writing worked well, and stakeholder presentation was given and appreciated. Documentation was generally comprehensive, and the level of preparedness of those charged with making the presentations was excellent.

2. Background, preliminaries and documentation

The panel met from 28 November to 4 December 2005 in the Stephen H. Clark Conference Room of the NEFSC Woods Hole Laboratory, with a Chair and three panellists, as listed in Appendix 1. The Statement of Work for SARC-42 is outlined in Appendix 2, the Terms of Reference for each stock or model in Appendix 3, detail of what was expected to be contained in this Summary Report in Appendix 4, the final agreed Agenda in Appendix 5, and the Bibliography consulted prior to and during the meeting, and referred to in the Panellists' reports, in Appendix 6. The panellists' own comprehensive reports are in Appendix 7 (John Casey), Appendix 8 (Vivian Haist), and Appendix 9 (Yan Jiao).

The documentation for the meeting in terms of draft agenda, assessment reports for review, and background papers arrived electronically from Woods Hole by mid-November, and the SAW Chairman Fedexed hard copy of the most important material to arrive at the consultants' places of work 12 days before the meeting convened. All electronic material was provided in easily accessible form, generally as pdf files. The NMFS contact for the SARC was Jim Weinberg (SAW Chair), who not only competently facilitated the distribution and circulation of documentation and was responsible for all “housekeeping”, but also ensured a ready and appreciated supply of refreshments at the meeting. He also generated electronic links through a shared drive for panellists at the meeting, restricting the costly and time-consuming need to produce hard copy, although hard copy was available to those who requested it, including observers. Access to a printer was also possible through the shared drive. Jim also ensured the availability of a large locator map for the panellists, who were not so knowledgeable about US and NE Atlantic geography as the presenters and other participants.

Between mid-November and the commencement of the meeting, panellists and Chair familiarized themselves with the documentation, specifically the methodology and assumptions inherent in the three assessments, and the detail of the new MSVPA-X model constructed with a view to providing answers to “what-if” questions posed by managers and decision-makers responding to the burgeoning need of the public for more holistic (e.g. multispecies and ecosystem-based) management. Jim Weinberg also provided all panellists with valuable background on the (new and) standard meeting procedures (including the assessment working groups) and clear direction of what was expected as output from the review meeting itself. As the staffer charged with presenting the output of the review to a future Management Council meeting, his sage counsel was of great value in focusing discussions, and also in setting out the format of this report. Given that this current CIE review format was new to everyone, including Jim, it was vital that all understood the requirements and that input be provided in a user-friendly format. Jim also engaged me before I left the UK in electronic discussion about the meeting agenda, specifically how I wished to assign responsibilities between CIE consultants for stocks and models, and ensured the readiness at the appropriate times of the relevant staffers and those interested in the debate. An evening meeting on 27 November in Woods Hole, at which final arrangements were made and clarifications given by Jim and the NMFS NEFSC Technical Advisor Paul Rago, followed up this electronic discussion.

The Terms of Reference (Appendix 3) were the same for the three assessments (though perhaps should in the future be targeted more stock-specifically, to aid presenters and reviewers), and Jim explained that the process by which such Terms of Reference were set was well known. However, their generic nature clearly made it difficult for some of the assessments to meet them with the rigour demanded by this new process. The relevance of this comment will become very clear in Section 4 of this report, in which is summarized the review panel’s consensus on how all Terms of Reference were met by each assessment and group. In our opinion, the SARC-42 process has changed for the better from that of previous SARCs: the panel of international scientists is now charged with not only reviewing the basis of the science and assessments, but in major part with evaluating performance against the Terms of Reference. Best management advice, or comments on it, is not given specifically by either the assessment group or the review panel, that correctly being the domain of the Management Councils, although the given Terms of Reference do allow some flexibility for providing comment that will assist those charged with formulating that advice. The Terms of Reference for the MSVPA-X model exercise were completely different, given the way this scientific work had been commissioned and is being managed and driven to aid decision-making, so Appendix 3 also lists some background as to how those Terms of Reference were set.

3. Conduct of the meeting

The meeting was convened at 13:00 on 28 November 2005. In formally opening the meeting, explaining some housekeeping rules, and welcoming the panellists, Jim Weinberg set the scene for what was to follow. He then handed the meeting over to me and I explained what I wanted to achieve for each stock (as per the Terms of Reference – Appendix 3). Specifically, I stressed that I would seek to determine the extent to which each assessment working group had met their Terms of Reference, and if they had fallen short on certain of these, how the SARC panel would try to find out the reason. I also stressed that, again in keeping with the Terms of Reference, I would evaluate whether previous SARC's research recommendations had been met; again, if they hadn't, we would try to determine why not and, if appropriate, add them to the recommendations to be addressed intersessionally (before the stock is subject to its next review).

After the preliminaries of personal identification by panel members and those present (which was repeated on each occasion fresh faces appeared in the audience), the agenda was confirmed, and the order of debate stayed the same as initially agreed. Thus, the meeting commenced with a presentation on silver hake by Larry Jacobson (Paper A1), followed by in-depth discussion by panellists. The presentation was usefully constructed so that clarity and comments could be sought and made throughout, by both panellists and visitors from the floor. The same process was followed for Atlantic mackerel (presenter Bill Overholtz, Paper B1), and shortfin (*Illex*) squid (presenter Lisa Hendrickson, supported by Dvora Hart; Paper C1). The MSVPA-X presentation was shared by Lance Garrison and Matthew Cieri (Papers D2, 3, and 4).

For each stock, one panellist was designated as SARC leader, to liaise with myself as SARC Chair, the presenters, and the assigned rapporteurs in ensuring that the issues raised and the targeted output were achieved to time and quality. The rapporteurs were nominated in advance for each stock, and their reports were ultimately uploaded to the shared directory for the use of panellists and the SAW Chair. The SARC leaders and rapporteurs were respectively John Casey and Laurel Col (silver hake), Vivian Haist and Chris Legault (Atlantic mackerel), and Yan Jiao and Rich Seagraves (shortfin squid). For the MSVPA-X model, the assigned rapporteur was Patrick Kilduff, and the whole SARC panel, including myself, involved themselves in interaction on his notes. The system worked very well and allowed me as Chair to concentrate solely on whatever issue was on the table in the knowledge that production of "*aides memoire*" was in capable hands and that all such documents would be accurate and available in good time. Following the presentations and initial discussions, each group was reconvened a second time (briefly, for generally about 1–2 hours two days after its initial session) to pick up the few issues that could not be resolved at the first session, to allow presenters opportunity to add material that they felt would add value to the panel's deliberations, to allow the SARC panel to probe deeper, having "slept on" the initial presentations, and to ensure specifically that answers were provided to whether the Terms of Reference had been met and whether previous SARC recommendations had been followed (if not, why not?).

During the meeting itself, I actively solicited comment from the floor, and was rewarded by the enthusiastic participation of several stakeholders and managers, as well as NMFS scientists, giving valued input to the assessment presentations and discussions. In my opinion, it is crucial that stakeholder input in particular be sought at reviews of this nature, because scientists worldwide ignore such opinion at their peril! Hopefully, the several stakeholders who made time to attend the SARC benefited as much as the panel and assessment scientists did from their interventions.

From mid-Thursday afternoon until the panel left early Sunday afternoon, there was closed discussion by the panel on the material with which they had been presented, and dedicated writing time for this report, including Appendices, with a view to reaching consensus (or not) within Section 4 of this report and to ensuring that the interpretation of each panel member was consistent. This process was conducted in the following manner:

(i) All panellists independently developed their own report on each stock or model (finally produced here as Appendices 7, 8 and 9);
(ii) the Chair highlighted on hard copy what he saw as the main points made by the three panellists as his suggestion for section 4 of this report;
(iii) all panellists read each others' reports, noting particularly the Chair's highlighted sections;
(iv) all panellists discussed the likely agreed consensus (or lack of it);
(v) the Chair drafted the substantive Summary Report for each stock or model on the basis of the consensus reached;
(vi) panellists read, commented on, and agreed this draft before the meeting ended on Sunday 4 December (with opportunity given to draft new wording to be returned to the Chair within a few days).

Each SARC panellist and Chair then took his/her own advanced draft and the draft Chair report back home, finalized the former and made final comments on the latter, and returned both reports to the Chair by 7 December.

I have to stress that despite the difficulties inherent in formulating any agreed summary or consensus from a set of sometimes disparate formats and views, I was very satisfied with the manner in which the closed part of the meeting at Woods Hole was conducted, especially with the willingness of the panellists to engage in discussion, and their frankness during such debate. Indeed, the time set aside for these panel discussions in Woods Hole facilitated the whole process leading up to the submission of the final document to the CIE.

I adjourned the Woods Hole meeting of the SARC-42 panel early Sunday afternoon 4 December 2005.

The new process involves SARC panel presence at the review for almost seven days which, given that some reviewers have to travel from afar means that, on this occasion, two weekends were lost (to our families!). Perhaps if this current arrangement is to continue, consideration could be given to scheduling the SARC so that it convenes midweek, rather than on the Monday, and ends the same time the following week, precluding the loss of a second weekend by panellists from afar. Of course, such a structure of the meeting might have to be amended so that local presenters would not have to give up any of their own weekend for the purpose of presentations and discussions, but such an arrangement should be possible given careful prior planning. Further, having two assessments presented and in-depth debated in a single day (in this case, Atlantic mackerel and shortfin squid) was a pretty tall order for SARC panel concentration levels, so there may be merit in scheduling a single assessment per day in the new meeting format, allowing closed discussion time on the same assessment within any new scheduling arrangements for future SARCs.

The current process seemingly requires the contracting by the CIE of a number of practicing experts in stock assessment and management, and of a Chair conversant with the techniques, but not necessarily as technically astute in the detailed analyses. The duties of the Chair are clearly specified in the Statement of Work (Appendix 2), namely to become conversant with the material presented, to ensure smooth running of the meeting, and to summarize the consensus (if possible) findings and recommendations of the panellists for consideration by the customer. All these I believe were achieved, but I have to say that the last was only possible through the agreement while at Woods Hole of all panellists to deadlines that allowed me to meet my own tight deadline for completion. Deadlines have to be tight, but international reviewers by their very description tend to have broad commitments that can upset the best-laid plans for producing a summary report. This new system seemingly facilitates the process, so I endorse it.

Finally, in terms of my own limitations regarding cutting-edge experience of stock assessment technology and of my knowledge of the SARC process itself, I record my gratitude specifically to Paul Rago and Jim Weinberg for the support they provided me at the meeting. Paul was always on hand to advice, and Jim went out of his way to ensure that chairing the meeting was indeed a pleasure and, hopefully, a success.

4. Substantive Summary Report

This section of the report is drawn from the far more comprehensive reports (Appendices 7, 8 and 9) of each panellist, this section being discussed and agreed as a fair reflection of consensus before finalization. Divergences of opinion were rare and are noted, but it should be stressed that what follows is almost complete unanimity of views between panel members and Chair. Please note that no attempt was made to prioritize the suggestions for future research (Section 3 of each assessment).

A. Silver hake

A1 General comments

The overriding issue with this assessment is the inconsistency in the observations of there being few older and larger fish in the NEFSC surveys and the commercial catch, the apparent ongoing high levels of recruitment, and recent low levels of catch. The assessment provided to this SARC did not attempt to use analytical assessment (e.g. surplus production or age-structured) models, but rather focused on a valued evaluation of survey and ancillary (e.g. discard) data to investigate changes in fish distribution, and to estimate upper bound estimates for *F*. The panel does not agree with the output from any of the methods of obtaining an upper bound estimate of *F*, and hence with the calculated lower bounds of *SSB*. However, the panel does support the view that a change in ageing protocol is not the cause of the apparent disappearance of older fish. It is therefore suggested that alternatives to decreased catchability as the reason for the lack of older fish be considered and presented in future assessments. The panel agree that the analyses of survey data presented support the notion that there have been geographic changes in silver hake distribution in the fall survey. The panel also agree that there is merit in attempting another analytical assessment for silver hake in future, probing model assumptions rigorously in advance of application.

Management advice for silver hake is presented on this occasion relative to MSY proxies, which are related to levels of the fall survey index, a credible basis for developing advice. The current reference points were estimated from the average fall survey index for a period when the index was relatively stable (1973–1982), suggesting seemingly sustained productivity. However, if stock dynamics have changed or are changing, conclusions based on such reference points are highly tenuous, so new thresholds should be sought.

A2 Discussion relative to Terms of Reference

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

Recreational catches of hake are small. In the commercial fishery, sampling coverage seems to be rather low, and there is concern about whether landings data from the fishery in the 1960s and 1970s truly reflect the actual removals from the stock at the time. The recent low level of silver hake landings may well be partially attributable to trip limits, i.e. market forces. Especially for the historical data, though, the extent to which landings are pure *Merluccius bilinearis* is questioned, but it is considered unlikely that offshore hake (*M. albidus*) constitute a significant proportion of the current landings of “silver hake”/”whiting”. The discard data are based on low-coverage observer trips for 2002–2004 and a well-constructed method using a Discard/Kept ratio (D/K). Discarding of silver hake is clearly rife, especially in the north in the years studied. Application of the D/K method to historical data, if possible, might be revealing. There is also a historical age-reading bias that likely has a significant effect on catch-at-age information, and this issue (with others) may also be implicated in the current concern regarding the recent truncation of older/larger fish in the series. Further, potential changes in catchability as a consequence of survey gear modification may need more investigation. Overall, however, the data and methods used to characterize the time-series of catch and catch-at-age are appropriate, but the caveats referred to above in terms of their accuracy still apply.

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

There was no attempt to estimate fishing mortality based on traditional age-structured models. Instead, estimation methods are based on fall survey data, and used to characterize *F* for northern, southern, and combined stock components. One method (using a simple biomass index based on the 3-year running mean kg tow^{-1}, and an exploitation index based on the same running mean and estimates of landings) is the one currently used to specify management targets and thresholds, and to define overfishing and overfished stock conditions. A second method is based on relative catch rates from both the fall and supplemental survey series, which for various reasons (see Appendix 8 in particular) is not considered by the panel to be appropriate for use as representing the state of the resource. Instead, it is suggested that the use of a stratum-raised swept-area biomass estimate from the trawl survey, with validated efficiency conversions, may provide a more appropriate lower bound of trawlable biomass. A third method relies on historical landings and concurrent survey data, and may well be the better estimator of those provided. However, it is the SARC panel’s contention that the estimates provided for fishing mortality and lower bound biomass should not be accepted as true representations of stock status of silver hake in the two management areas. Based on the analyses presented, recent exploitation rates are relatively low and stock biomass levels seemingly relatively high, but scientifically justifiable absolute estimates of these parameters derived from the information given are not possible.

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

There was no attempt to update or re-estimate biological reference points (BRPs) despite the concern raised above that they are currently based on a period of high, relatively stable density, and when the catches in both management units were in decline. Alternative threshold indices should be sought following this review. Age structure in the catch, which is truncated at present, is regrettably not being taken into account in evaluating the current index of exploitation, a dangerous situation in terms of optimal fisheries management when stock productivity might be changing.

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

This objective was not possible given the current availability of information on the stock and the lack of stock biomass estimates for recent years.

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

Objective 5a was not possible given the current level of availability of information on the stock and the absence of an analytical assessment. Objective 5b does not apply to the silver hake stock.

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

Survey information covering the offshore component of the population is limited to two supplemental transects, with limited utility and range, although depth is clearly a more significant predictor of large silver hake distribution than temperature. In investigating the *bathymetric demography of silver hake*, an extensive analysis of the relationships between location, depth, size, and age based on bottom-trawl survey data was revealing. No attempt was seemingly made to *survey spawning aggregations on the southern flank of Georges Bank*, nor to *investigate distribution and movements in relation to the physical oceanography*, nor to *quantify age-specific fecundity*. However, apart from the middle of the three, these last recommendations are not, in the opinion of the SARC-42 panel, priority fields of silver hake research now.

A3 Suggestions for future work

- Investigate the stock structure of silver hake and develop theories on stock integrity (are the two management units really appropriate for assessment?)
- Seek to derive more appropriate biological reference points
- Collect more data on age, investigate and incorporate historical ageing errors, and re-investigate the application of an age-structured analytical model
- If feasible, derive reference points from the output of such an analytical model
- Develop the use of the D/K ratio for estimating discards historically

- Investigate the feasibility of using a stratum-raised swept-area biomass estimate from the fall biomass survey to provide a lower bound estimate of trawlable biomass
- Deduce confidence limits for survey-based estimates of catches
- Examine the results of all surveys deeper than the current NMFS survey for information on silver hake distribution
- Evaluate the effect of gear changes on survey catchability, perhaps developing priors for issues such as trawl door changes
- Investigate spatial distribution, stock structure, and movements of silver hake within Georges Bank, the Gulf of Maine, and the Scotian Shelf in relation to physical oceanography
- If the Supplemental survey is to continue, estimate its efficiency relative to NEFSC surveys by conducting side-by-side tow comparisons
- Consider including some interaction terms in GAM or GLIM analyses of survey data (e.g. depth and time of day interactions)

B. Atlantic mackerel

B1 General comments

It was unfortunate that the assessment report itself contained few details of the assessment models, neither ADAPT-VPA nor ASAP, making evaluation of so-called “standard” assessment methods rather difficult for international reviewers not as familiar with local processes as the assessment working group. It was also noted that considerable research effort has been devoted to moving from the former (ADAPT-VPA) to the current (ASAP) model, presumably because of the great uncertainty in evaluating current population status. Further, values of reference points given in the executive summary of the assessment report and in the assessment summary report itself could not be found in the main body of the assessment. Consequently, we considered the basic documentation rather inadequate.

However, against that background, it was deemed useful to have the results of the ADAPT-VPA provided to show the transition to the new ASAP model. In future, though, provision of uncertainty estimates around data and model would aid evaluation of the assessment. A key issue with the current assessment is the uncertainty in the magnitude of the (seemingly large) 1999 year class, which dominates survey and commercial catches. However, issues related to changed targeting practice recently, associated potential distribution changes of mackerel, and retrospective patterns in the assessment raise concerns whether fishing mortality is being estimated well. Notwithstanding these concerns, the general focus and development of the mackerel assessment is based on sound scientific criteria.

B2 Discussion relative to Terms of Reference

1 <u>Characterize the commercial and recreational catch including landings and discards</u>

Information on commercial landings and recreational catches is presented to satisfy this Term of Reference. Little information is, however, provided on the extent of discarding in the time-series, though at least recently this is believed to be low. Historically, foreign fleets dominated the catch record. Commercial landings in both the US and Canada burgeoned in the period 2000–2004, associated with the arrival of a strong 1999 year class, but recreational landings have been comparatively small and are declining. The commercial fishery is prosecuted by both bottom trawlers and midwater trawlers, the latter method gradually assuming ascendancy. Concomitant with the increasing catches, older fish are becoming scarcer in the catch-at-age distribution.

Sampling levels appear to be adequate, and the overall time-series of catches-at-age are seemingly good representations of the removals by the fisheries. Survey data have been collected in a controlled and standardized way throughout the time-series, although the change in gear (doors) in 1986 may have influenced catch rates and catchability in a manner not taken into consideration fully by the assessment. This issue needs to be evaluated further. Spring and winter surveys have been used traditionally to tune the assessments, but there is some contrast in the time-series signal from each season's surveys. In contrast to this statement, the relative strength of year classes at different ages seems to be fairly consistent in the spring surveys and commercial landings.

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

Estimates of fishing mortality, spawning stock biomass and total stock biomass over time are provided on the basis of the ASAP model base case run with *M* constant over all age groups and years. Biomass levels so determined are relatively high (total biomass 2 900 000 t, SSB 2 300 000 t), and fishing mortality rates relatively low ($F = 0.5$), seemingly plausible estimates, but retrospective analysis reveals some overestimation of SSB and underestimation of *F* recently. This retrospective pattern will also mean almost certainly that the analytical estimates of uncertainty provided in the assessment will be underestimated. It is noted that it was such a retrospective bias that caused the last assessment of the stock (with ADAPT-VPA) to be rejected.

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

F-based biological reference points are re-estimated in the new model and changed, F_{MSY} from 0.45 to 0.16, MSY from 326 000 t to 89 000 t, and SSB_{MSY} from 887 000 t to 644 000 t. The SARC panel has some concern about the validity of these reference points given recent levels of catch in the same ballpark as MSY. The surplus production determined from a Beverton and Holt stock/recruitment (s/r) relationship yields an average annual value of 148 000 t. Despite the apparently low value of the steepness parameter in this s/r relationship, it is agreed that such a value can serve as a proxy for an upper bound on surplus production, but not as an annual target, given that pulses of good recruitment are needed to drive surplus production. However, hearing the views of various stakeholders present at the SARC, the panel concludes that provision of a risk analysis with full consideration of the uncertainties will help stakeholders understand the stock dynamics better.

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

Catch estimates were presented on the basis of stock biomass and the estimated *F* reference point ($0.75F_{MSY}$) for the period 2006–2008. There is apparent potential for doubling the catch from its current level of ~100 000 t, but this result needs to be viewed in the context of the considerable uncertainty in the estimate of current biomass. These uncertainties need to be presented in future assessments. Doubled catch levels are also in excess of the calculated average surplus production, so caution is required in advising such a level of exploitation.

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

As the deterministic projections were conducted on the basis of a constant s/r relationship and predicted TACs, uncertainties need to be stated clearly in future assessments. SSB is predicted to decline slowly, but again there is no uncertainty evaluation. There is no recovery or rebuilding schedule for this stock, nor were other TAC/*F* strategies evaluated.

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

No analysis or *exploration of logbook data for information on catch rates and geographic distribution* was carried out, a decision fully justified in the assessment document. An attempt was made to *explore Canadian trawl survey indices for use in VPA calibrations*, but the outcome was not of value. *Acoustic surveys of the mackerel stock* may well have merit in future, but not until the new RV “Bigelow” becomes available to the survey unit. Finally, no progress was made in *examining estimates of* Z *from RV survey data with a view to using them in better estimating* M. This limited progress in taking up previous research recommendations is not, however, felt to have limited the value or scientific integrity of the current assessment, although the first and last of these four recommendations may well have merit for the future (see below).

B3 Suggestions for future work

- Develop Bayesian priors for changes in relative catchability at size/age associated with the 1986 survey vessel door change by analysing side-by-side tow data collected for various species
- Try to estimate age-specific fishing selectivities rather than fixing them in the ASAP
- Investigate the uncertainty in the back-transformed index
- Collect more age composition data
- Better consider the uncertainties in the data when presenting uncertainties for biomass and BRPs
- Although discarding seems to be slight, improve its estimation through better observer coverage
- Consider the use of environmental variables to adjust the NEFSC winter and Canadian survey indices for changes in availability
- Explore the use of environmental covariates to help explain recruitment deviations from the s/r relationship
- Try to ascertain better the reasons for the scarceness of larger/older fish in recent commercial catches and surveys
- By examining predation rates, investigate whether the assumption of constant *M* at age over time is reasonable
- If the RV “Bigelow” becomes available, re-open the possibility of deriving acoustic indices of mackerel biomass

C. Shortfin (*Illex*) squid

C1 General comments

Because standard analytical methods tend to be difficult to apply to short-lived semelparous species such as squid, most of the assessment presentation focused on the development of sound, novel analytical approaches that reflect the unique life history better. This work is valuable and should be continued, specifically the collection of better data (including tow-by-tow information) to underpin the analyses. Current reference points are based on surplus production analysis, which is not appropriate, so an alternative method of deducing such threshold values, based on a maturation rate – natural mortality model, was presented. However, because such thresholds were based on a single sample and growth rates vary over seasons and years, they cannot be used immediately, despite the superiority of the method in calculating an *F*-based reference point. The presenters also provided an “in press” scientific paper (Appendix 6: Bibliography Paper C3) that suggests that ageing error could be the reason why more *Illex* are mature than predicted by the maturation model, but there other equally plausible explanations for this phenomenon that they need to consider too.

Laudable and considerable effort has clearly been put into improving age determination, standardization of landings per unit effort, and developing the in-season and per-recruit models. However, more work is needed to generate the confidence necessary to apply the output from any model effectively to *Illex* management. The SARC panel was also concerned on reading seemingly conflicting statements in the assessment summary and substantive summary report regarding the validity (or not) of using fall survey information as a relative index of *Illex* spawner escapement. It is the consensus view of the SARC panel that consideration again be given to the potential of using both spring and fall survey indices as complementary indicators of population status. Further, a quantitative or qualitative assessment of environmental variation and associated escapement could be beneficial in understanding stock dynamics better.

C2 Discussion relative to Terms of Reference

1 Characterize the commercial and recreational catch including landings and discards

Overall, the information provided on landings is well documented and credible. There is no recreational fishery for *Illex*. Discarding of the species seems to be fairly low, most discarding taking place in the *Illex* fishery itself as well as in the offshore fishery for *Loligo*, the latter being the likely source of most of it. Some discarding of *Illex* also takes place in the silver hake fishery. There do not seem to be any stock-wide estimates of trends in abundance or biomass, although several research surveys take the species. From this information and the landings (1963–2005), it is obvious that *Illex* is widely distributed and spawns in two pulses throughout the year, so because the main surveys in which it is caught are seasonal, conclusions on stock status based on survey results alone is rather tenuous.

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

As stated above, *Illex* age determination is imprecise, and this conclusion is well demonstrated by the results presented for a double-blind-ageing precision study. Consequently, estimates of *M* determined with such data can only be considered as preliminary. Similarly, estimates of *F* and biomass from the in-season assessment model updated with data from 2003 and 2004 are still likely unreliable. The underlying basic assumptions of the previously used surplus production model approach to assessment and management are not met, so it is appropriate that development of a different class of assessment model be continued. However, although significant progress has been made towards developing such an improved assessment, the uncertainty generated by the current data limitation precludes its immediate use as a provider of management-usable values of *F* and stock biomass. In particular, more and better data are needed to support the effective calculation of seasonal growth rate and maturity.

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

Existing *Illex* biological reference points are based on surplus production analysis, which is inappropriate for the species given the two overlapping cohorts produced annually and the fact that the survey results likely do not reflect stock abundance accurately. Further, TAC-based management is unlikely to be an effective method of controlling this fishery, specifically because of the large interannual fluctuations in abundance, unless an early indication of in-season biomass can be obtained. However, if better data on the species' dynamics and on its interaction with other fisheries become available, then closed area/season or management procedure approaches may become effective, but such data are not yet available. For now, the best that can be said is that the revised reference points determined from per-recruit models are preliminary.

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

This is not possible at present using the model presented by the working group. There may be scope to explore alternative management, an example being the in-season assessment methods and harvest control rules currently applied in Europe for short-lived species such as anchovy and sandeel.

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

The *Illex* stock does not have rebuilding or recovery schedules, and models that allow short-term projection have not yet been developed sufficiently.

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

An admirable number of the previous research recommendations were addressed intersessionally, but others could not be followed up due to data inadequacy or lack of funding. In summary, in terms of *continued model development*, all three models presented at SARC-37 had been improved and tested further; *operating model development* could not be continued until a better assessment model has been created; further growth rate data are required to make more progress in *evaluating the relationship between growth rates and sea temperature*; work was initiated to *investigate biological indicators of low or high productivity regimes*; an insufficiency of quality data precluded rigorous *evaluation of seasonal and latitudinal clines in growth rate*; a *cooperative research programme* for 2003 and 2004 was completed and the results incorporated in the modelling analyses; a *pre-season survey with commercial vessels* was completed in 2000 and the results utilized in the analyses presented; and catch rates had been *evaluated by vessel using VTR and Weighout databases as a means of standardizing nominal landings per unit effort*.

C3 Suggestions for future research

- Collect more and better data on age and maturity throughout the year, to aid improvement of the in-season model
- Investigate the sensitivity of the in-season model to data input and estimate the uncertainty of the model parameters, and with simulated data determine whether there are errors or bias in the simulator or the estimator
- For the maturation-mortality model, look to develop priors for the M_{sp} parameter
- Consider using robust likelihoods in models to account for the occasional large deviations from assumptions
- Re-evaluate sampling and survey design as applied to the species
- Conduct another pre-season survey with industry in an attempt to evaluate pre-season population size
- Evaluate the utility of the relative abundance and biomass indices from the NEFSC winter survey
- Re-analyse fishery catch rate standardization (see Appendix 8)
- Conduct a quantitative or qualitative study based on environmental stimuli and both escapement and growth rate to attempt to predict the next year's or next season's population size, or to investigate changes in stock productivity associated with environmental conditions
- Investigate the feasibility of using a variant on the in-season assessment methods and harvest control rules currently applied in Europe for short-lived species such as anchovy and sandeel

D. MSVPA-X model

D1 General comments

The predator-prey MSVPA-X model represents the result of an impressive effort to compile available data on species abundance and diet composition for the mid-Atlantic coastal/estuarine ecosystem. We commend the project contributors for achieving this first significant step towards understanding the predator-prey dynamics of this ecosystem, and note that, as with MSVPA models used elsewhere, data limitation rather than model limitation limits the utility to generate management support. Development of this model has been made with the objective of aiding understanding of the dynamics rather than providing advice or recommendations for ecosystem-based management.

As currently formulated, the MSVPA-X model is designed to update the Atlantic menhaden VPA, the focus species of the model, on the basis of predation by three predators, striped bass, weakfish, and bluefish. No predator interaction term is provided, nor is there feedback information on the effect of prey abundance on predator abundance; indeed, the model is not designed to do so. Predation is dependent on the abundance and distribution of menhaden and its preference as prey by the three predators. The model does not attempt to recalculate the abundance estimates of any of the four species. Abundance and mortality rates in the model are also similar to those in the underpinning single-species assessments, and uncertainties (in parameters and around projections) are not clearly stated.

D2 Discussion relative to Terms of Reference

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

The model input data are adequate for testing model performance as currently formulated, although the derivation of some of the input parameters raises questions about the utility of the model output. The data input from the menhaden eXtended Survivors Analysis (XSA) has been peer-reviewed, so is appropriate, but it may be possible to derive the input from the more recent statistical catch-at-age model (ASAP) applied to the stock. The other selected prey groupings chosen for the model also seem reasonable. Overall, a good job has been done by the model developers with the data available to them, showing creativity in application, even though some may question whether data use has been stretched a bit far. For instance, we question the use for all ages of a value for menhaden *M*1 of 0.4, and wonder if it would be possible to better evaluate the sensitivity of the model to this and other assumptions and to uncertainties in the input data. We also question why the predator numbers-at-age matrices from their own assessments were not used, but reconstructed in this application.

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

The SARC panel believes that the best available information is used to estimate predator and prey species abundances, although the use of length composition and distribution data of commercial landings to reflect population length composition and distribution may not be valid, given that fisheries tend to target larger fish and predators to target generally smaller fish of the same species. There are obviously many gaps in the database, so educated extrapolation has had to be employed in model development and formulation, but such models depend on similar means of data-gap filling until better information becomes available. Similarly, assumptions made in the model regarding diet and feeding selectivity seem reasonable, even though they are based on a mixture of subjective expert judgement and the results of rigorous data analysis, and the model developers show that they understand that diet, prey biomass and feeding selectivity vary extensively by season and year.

3. Review model formulation (overall setup, data handling, VPA calculations, assessment options, sensitivity analyses, recruitment model options, and forward projection options) of model as configured

The main difference between this MSVPA formulation and the original ICES MSVPA formulation is in the means by which diet composition and suitability are treated. In contrast to the ICES formulation, MSVPA-X does not employ diet information from a specific year (the “year of the stomach” in the case of

ICES), but uses diet information to develop type and size preferences and spatial overlap parameters. The current model construction focuses on menhaden population dynamics, and the issue of predator mortality as a consequence of prey non-availability is not considered (predator populations are treated in the model as static). Natural variation in recruitment vs. predation mortality is another issue that could be considered. However, the MSVPA-X model is structured to be flexible with respect to the use of alternative VPA formulations, and the projection component flexible with respect to future recruitment and harvest scenarios. Results are presented from a number of useful sensitivity runs, although it may be informative also to generate sensitivity analyses for alternative stock reconstruction formulations (which trend to be very sensitive to models and model formulations) for menhaden, striped bass, and weakfish.

4. Develop research recommendations for data collection, model formulation, and model results presentation

An extensive and well-considered list of research recommendations is provided and prioritized in one of the documents provided to the SARC panel (D5). Many relate to improving existing data series, updating models, and expanding the MSVPA-X model structure. Because some are simple and relatively inexpensive to implement, they are fully supported by the SARC. Examples include: collection of historical data across the whole distribution of menhaden; collection of more predator stomachs in the areas where menhaden are primarily distributed; testing the sensitivity of model projections to prey availability; developing cross-validation analyses to investigate whether predicted menhaden population size over time follows the same trends as the single-species model; analysing recruitment vs predation mortality variability; evaluating the effects of uncertainty in input data, model output, and projected menhaden population sizes; and increasing the model's biological and ecological realism. In addition, it would be informative to see what would happen if the model incorporated analyses of the response of predator populations to prey abundance and inter-predator interactions. Finally, incorporation of stochasticity into the assessment and projections may be instructive.

5. Evaluate whether or not the model and associated data are of sufficient quality to develop recommendations to management

The results from the current formulation of the model are restricted to an evaluation of the potential response of menhaden to changes in predator abundance. They are also constrained to some extent by data availability and, as a result, model output is not of sufficient quality to develop recommendations to managers (and in terms of developing recommendations *per se*, will probably not be in the foreseeable future). However, even in its present formulation, the value of the model outputs to managers could be enhanced if the error structure of input data, parameter estimates and outputs could be incorporated.

The model is designed to undertake alternative, more sophisticated and informative evaluations, and it can be adapted to undertake such evaluations if additional appropriate input data and parameters can be derived. The SARC panel encourages further development along these lines.

5. Final comments

The CIE and NMFS provided us with adequate time in Woods Hole almost to complete this summary report, and the enthusiasm and dedication of the whole panel undoubtedly helped. Geographical time-lag between reviewers will always be a problem with meeting deadlines after such a meeting breaks up unless all panellists live in the same time zone, but given the new schedule and process set by NEFSC and the CIE, this will likely not negatively impact the timing of delivery of future reports.

The main objective of SARC-42 was to evaluate the assessments provided for the three stocks in question, and the efficacy of the newly constructed MSVPA-X model for Atlantic menhaden and its predators striped bass, weakfish, and bluefish. Associated with this primary objective was to evaluate the extent to which the Terms of Reference had been met by the various assessment and modelling groups. Those charged with making the presentations, and the teams associated with their work, gratifyingly tried very hard to help us meet our objectives timeously. Nonetheless, as a totally independent group, the SARC was willing and able to advise on the output and assessments from an international perspective. Of the stocks considered, and despite the limitations clearly outlined for some of them (related *inter alia* to the fact that the research surveys are not designed to provide indices specifically for the stocks here being assessed), the assessments presented were considered to have at least improved understanding of stock dynamics for the three stocks at the present time, although suggestions for further development and modelling were made, for future consideration.

Overall, the efforts of all three assessment working groups and the associated subcommittees were appreciated by the SARC as likely a reflection of the high quality of assessment expertise available in the USA. A recommendation to help future SARC panels would be to ask assessment groups and presenters to provide full background data and documentation for all assessments so that panellists can replicate the results independently. Hopefully, the suggestions and recommendations made at the meeting and herein for future assessment will be viewed positively by the researchers. What we have done is to look at what data are available or missing, and to advise new ideas for research and analysis, perhaps including models, that could enhance the assessments in years to come, especially if better data are forthcoming. The development of the MSVPA-X model is exciting, but it was gratifying to be told by the developers themselves that they, like us, believe that the local MSVPA model is not designed to provide management recommendations *per se*, but simply to provide educated response to “what-if” type questions posed by managers. As in the rest of the world, the use of such models to manage stocks independent of single-species-based assessment is probably a long way off.

The meeting overall was conducted in excellent spirit, despite rigorous and probing debate. The panel functioned excellently as a unit, feeding off each others' strengths and abilities, and I certainly enjoyed the opportunity to talk in depth to the other three panellists, the presenters, and the observers on a formal and an informal basis. I therefore wholeheartedly enjoyed the meeting and consider myself privileged to have been selected to chair it. My personal thanks are due to the CIE, who effectively organized my accommodation and facilitated many of the arrangements, to Jim Weinberg for his efficiency in making and delivering the meeting arrangements and reference material, and for keeping us focused, to Paul Rago, for supporting me with local assessment knowledge, to the other three panellists for putting up with me and my requests, and to all presenters and observers for their valuable, hugely appreciated, contributions to the meeting. The technical support we were provided with by the NEFSC IT group also smoothed our task considerably. Indeed, without everyone's contributions, the meeting output could not have been as comprehensive and scientifically rigorous as it turned out to be.

Andrew I.L. Payne
Chair SARC-42
9 December 2005

Appendix 1: Panellists

Chair:

Dr Andrew I. L. Payne	(Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, Suffolk NR33 0HT, UK)

Panel members:

Dr John Casey	(Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, Suffolk NR33 0HT, UK)
Dr Vivian Haist	(Consultant, 1262 Marina Way, Nanoose Bay, British Columbia, Canada)
Dr Yan Jiao	(Department of Fisheries and Wildlife Science, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, USA)

Appendix 2: Statement of Work for Chair and Panellists

Subcontract between the University of Miami and the chair and each panellist

General

The Northeast Regional Stock Assessment Review Committee (SARC) meeting is a formal, multiple-day meeting of stock assessment experts who serve as a panel to peer-review tabled stock assessments and models. The SARC is the cornerstone of the Northeast Stock Assessment Workshop (SAW) process, which includes assessment development (SAW Working Groups or ASMFC technical committees), assessment peer review, public presentations, and document publication.

The Center for Independent Experts (CIE) shall provide a chair and three panellists for the 42nd Stock Assessment Review Committee panel. The panel will convene at the Woods Hole Laboratory of the Northeast Fisheries Science Center (NEFSC) in Woods Hole, Massachusetts, the week of 28 November 2005 (28 November – 2 December) to review three assessments (Atlantic mackerel, *Scomber scombrus*; silver hake, *Merluccius bilinearis; Illex* squid, *Illex illecebrosus)* and a predator-prey model called MSVPA-X, that involves menhaden, striped bass, weakfish and bluefish. In the days following the review of the assessments and the MSVPA-X model, the panellists will write the independent review reports, and then the panel shall use these independent review reports to write the SARC Summary Report.

Specific Activities and Responsibilities

The CIE's deliverables shall be provided according to the schedule of milestones in the table below. The main CIE deliverable will be the SARC Summary Report that will provide key information for a presentation to be made by NOAA Fisheries at meetings of the New England and Mid-Atlantic Fishery Management Councils early in 2006. The SARC Summary Report shall be an accurate and fair representation of the CIE panel viewpoint on each of the Terms of Reference of the SAW (please refer to Appendix 3 for the Terms of Reference).

The SARC panellists' duties shall occupy a maximum of 14 days per person (i.e. several days prior to the meeting for document review; the SARC meeting in Woods Hole; and the several days following the meeting to produce the independent review reports and the SARC Summary Report).

The SARC chair's duties shall occupy a maximum of 19 days (i.e. several days prior to the meeting for document review; the SARC meeting in Woods Hole; several days following the meeting to lead the preparation of the SARC Summary Report; and several days after the meeting to finalize the SARC Summary Report).

Charge to Panel

The panel is to determine whether each Term of Reference of the SAW was or was not completed successfully during the SARC meeting. Specifically, the panellists should determine: (i) whether the work that was presented is acceptable based on scientific criteria (e.g. consider whether the data were used properly, the analyses and models were carried out correctly, and whether the conclusions are correct/reasonable); and (ii) whether the work provides a scientifically credible basis for developing fishery management advice. The chair shall identify or facilitate agreement among the panellists for each Term of Reference of the SAW, where possible.

Roles and responsibilities

1. Prior to the meeting

(SARC chair and panellists)
Review the reports produced by the Working Groups and read background reports.

2. During the meeting

(SARC chair)
Act as chairperson, where duties include control of the meeting, coordination of presentations and discussion, making sure all Terms of Reference of the SAW are reviewed, control of document flow, and facilitation of discussion.

(SARC panellists)
For the three stock assessments, participate as a peer reviewer in panel discussions on assessment validity, results, recommendations, and conclusions. From a scientist/reviewer's point of view, determine whether each Term of Reference of the SAW was completed successfully. Terms of Reference that are completed successfully are likely to serve as a basis for providing scientific advice to management. For the predator-prey model MSVPA-X, conduct a thorough review of the input data, and model assumptions, formulation and function.

3. After the review assessment meeting

(SARC panellists)
Each panellist shall prepare an independent review report addressing each Term of Reference of the SAW for each of the stock assessments reviewed and the MSVPA-X model. These independent review reports will be included as appendices of the SARC Summary Report. These reports need to specify whether each Term of Reference of the SAW was or was not completed successfully during the SARC meeting, using the criteria specified above in the Charge to Panel statement.

During the meeting, additional questions that were not in the Terms of Reference but that are directly related to the assessments or the MSVPA-X model may be raised. Comments on these questions should be included in a separate section at the end of the independent report produced by each panellist.

(SARC chair)
Prepare a document summarizing the background to the work to be conducted as part of the SARC-42 process and summarizing whether the process was adequate to complete the Terms of Reference of the SAW. If appropriate, the chair will include suggestions on how to improve the process. This document will constitute the introduction to the SARC Summary Report.

(SARC chair and panellists)
The entire panel will prepare the main body of the SARC Summary Report. Each panellist and the chair will read all panellists' independent review reports with the purpose of discussing whether the panellists hold similar views on each Term of Reference and whether their opinions can be summarized into a single conclusion for all or only for some of the Terms of Reference of the SAW. For terms where a similar or a consensual view can be reached, the SARC Summary Report will contain a summary of such opinions. In cases where multiple and/or differing views exist on a given Term of Reference, the SARC Summary Report will note that there is no agreement and will specify - in a summary manner – what the different opinions are and the reason(s) for the difference in opinions.

The chair's objective during this Summary Report development process will be to identify or facilitate the finding of an agreement rather than forcing the reviewers to reach an agreement if they cannot reach one. The chair is not required to express the chair's opinion on each Term of Reference of the SAW, specifically because the chair's role is not that of an independent reviewer.

The contents of the SARC Summary Report will be approved by the panellists by the end of the SARC Summary Report development process, prior to the panel's dismissal and departure. The chair will complete all final editorial and formatting changes prior to the final submission of the SARC Summary Report to the CIE, in consultation with the panellists, as the chair deems necessary. The chair will provide the panellists with a final copy of the final SARC Summary Report provided to the CIE.

See Appendix 4 for further details on report contents and milestone table below for details on schedule.

The milestones and schedule are summarized in the table below. The SARC panellists shall begin writing their independent review reports as items are completed during the Workshop, and the SARC chair and panellists shall develop the SARC Summary Report when the SAW-42 open meeting is concluded.

No later than 9 December 2005, the SARC Chair should submit the SARC Summary Report to the CIE for review[1]. The SARC Summary Report shall be addressed to "University of Miami Independent System for Peer Review", and sent to Dr David Sampson, via e-mail to David.Sampson@oregonstate.edu and to Mr Manoj Shivlani via e-mail to mshivlani@rsmas.miami.edu

Milestone	**Date**
Workshop at Northeast Fisheries Science Center (NEFSC) (begin writing SARC Summary Report, as soon as Workshop ends)	28 November – 2 December 2005
SARC Chair and reviewers meet to prepare draft SARC Summary Report	3–4 December
SARC Chair provides the draft SARC Summary Report to CIE for review	9 December
CIE provides reviewed SARC Summary Report to NMFS COTR for approval	20 December
COTR notifies CIE of approval of reviewed SARC Summary Report	21 December
CIE provides final SARC Summary Report with signed cover letter to COTR	22 December
COTR provides final SARC Summary Report to NEFSC contact	22 December

The SAW Chairman will assist the SARC chair prior to, during, and after the meeting in ensuring that documents are distributed in a timely fashion.

NEFSC staff and the SAW Chairman will make the final SARC Summary Report available to the public. Staff and the SAW Chairman will also be responsible for production and publication of the collective Working Group papers, which will serve as a SAW Assessment Report.

NEFSC Contact person and SAW Chairman:
Dr James R. Weinberg, NEFSC, Woods Hole, MA. 508-495-2352, James.Weinberg@noaa.gov

Submission and Acceptance of Consultants' Report

The CIE shall provide via e-mail the final SARC Summary Report in pdf format to Dr Joseph Powers (joseph.powers@noaa.gov) for review by NOAA Fisheries and approval by the COTR, Dr Stephen K. Brown, by 20 December 2005. The COTR shall notify the CIE via e-mail regarding acceptance of the report by 21 December 2005. Following the COTR's approval, the CIE will provide the final SARC Summary Report with signed cover letter to the COTR by 22 December 2005.

[1] All reports will undergo an internal CIE review before they are considered final.

Appendix 3: Terms of Reference

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.

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.

***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).

3. Review model formulation (overall setup, data handling, VPA calculations, assessment options, sensitivity analyses, recruitment model options, and forward projection options) of model as configured.

4. Develop research recommendations for data collection, model formulation, and model results presentation.

5. Evaluate whether or not the model and associated data are of sufficient quality to develop recommendations to management.

---

* **Background Information on the Expanded Multispecies VPA model (MSVPA-X)**

The MSVPA-X is a new model that has been developed to aid the ASMFC better quantify predator and prey interactions and account for these effects on both predator and prey populations. In developing the model, the ASMFC had an Internal Review of the MSVPA-X to evaluate the model formulation, input data, and gap filling procedures and to develop recommendations on how to utilize the model and results in the Commission's stock assessment for individual species. The Internal Review Panel was formed primarily of the scientists involved with the ASMFC multispecies projects, but also included an expert on the "standard" ICES MSVPA, and two stakeholders involved with the ASMFC process.

To provide SARC reviewers with a framework from which to evaluate the model using the Terms of Reference listed below, the recommendations of the ASMFC Internal Review Panel have been included to preface the Terms of Reference. Although the model will be able to estimate multispecies benchmarks, and explore trophic relationships between species, the MSVPA-X is not designed to address all ecosystem level questions or local depletion issues. The Panel was comfortable with using the model for the following purposes:

- Improve single-species models for single-species population adjustments (i.e. age- and year-specific inclusion of *M*)
- Insight on multiple species benchmarks based on species trade-offs
- Investigate predation mortality versus catch for important prey species by age class
- Determine the tradeoffs among harvesting strategies when fisheries exist for both predator and prey
- Develop short-term projections for explicitly modelled species
- Provide guidance for rebuilding predator stocks
- Evaluate change in predator management and its effects on prey and competing predators
- Explore potential feedbacks between lack of prey, abundance of alternative prey, and fishing mortality on the predator populations
- Longer projections can be performed as an exploratory tool to investigate linkages among species but should not be used as a management tool

- Examine the role of predator consumption in reduced prey recruitment to the fishery

However, the Panel noted this model should not address the following issues:

- Setting reference points or harvest limits for single species from MSVPA-X
- Estimations of absolute abundance for explicitly modelled species
- Examining local abundance or depletion
- Long-term projections are subject to the limitations of recruitment variability for the prey population and predator populations

Appendix 4: Contents of SARC Summary Report

1. The main body of the report shall consist of an introduction prepared by the chair that will include the background, a review of activities and comments on the appropriateness of the process in reaching the goals of the SARC. Following the introduction for each assessment reviewed, the report should address whether each Term of Reference of the SAW was completed successfully. For each Term of Reference, the SARC Summary Report should state why that Term of Reference was or was not completed successfully. The report should state: (i) whether the work that was presented is acceptable based on scientific criteria (e.g. consider whether the data were used properly, the analyses and models were carried out correctly, and whether the conclusions are correct/reasonable); and (ii) whether the work provides a scientifically credible basis for developing fishery management advice. If the panel does not reach an agreement on a Term of Reference, the report should specify – in a summary manner – what the different opinions are and the reason(s) for the difference in opinions. For the predator-prey model MSVPA-X, the report should include a thorough review about input data quality, and model assumptions, formulation and function.

2. The report shall also include as separate appendices the independent review reports prepared by each panellist, the bibliography of all materials provided during SAW 42, and any papers cited in the panellists' reports, along with a copy of the statement of work.

   The report shall also include as a separate appendix the Terms of Reference used for SAW 42, including any changes to the Terms of Reference or specific topics/issues directly related to the assessments and requiring Panellist advice.

Appendix 5: Agenda

42[ND] NORTHEAST REGIONAL STOCK ASSESSMENT WORKSHOP (SAW 42) STOCK ASSESSMENT REVIEW COMMITTEE (SARC) MEETING

Stephen H. Clark Conference Room – Northeast Fisheries Science Center
Woods Hole, Massachusetts

28 November – 4 December 2005

	TOPIC Presenter	SARC Leader	Rapporteur
Monday, 28 November (1:00 – 5:00 PM)			
Opening and Welcome Introduction Agenda Conduct of Meeting	**James Weinberg**, SAW Chairman **Andrew Payne**, SARC Chairman		
Silver hake (A)	**Larry Jacobson**	**John Casey**	**Laurel Col**
SARC Discussion	**Andrew Payne**		
Tuesday, 29 November (8:30 AM – 12:00)			
Mackerel (B)	**William Overholtz**	**Vivian Haist**	**Chris Legault**
SARC Discussion	**Andrew Payne**		
Tuesday, 29 November (1:15 – 5:00 PM)			
Illex squid (C)	**Lisa Hendrickson**	**Yan Jiao**	**Rich Seagraves**
SARC Discussion	**Andrew Payne**		
Wednesday, 30 November (8:30 AM – 12:00)			
MSVPA-X model (D)	**Matthew Cieri** **Lance Garrison**	**SARC Panel**	**Patrick Kilduff**
SARC Discussion	**Andrew Payne**		

Wednesday, 30 November (1:15 PM – 5:00)

Revisit Assessments and Model: Silver hake

Thursday, 1 December (8:30 AM – 12:00)

Revisit Assessments and Model: Mackerel, and MSVPA-X model

Thursday, 1 December (1:15 PM – 5:00)

Revisit Assessments and Model: *Illex* squid

SARC Report writing (closed)

Friday, 2 December (9:00 AM – 5:00) – Sunday 4 December

SARC Report writing (closed)

Appendix 6: Bibliography

Substantive (recent, in draft form) and Background Documentation

A1: **Silver hake (*Merluccius bilinearis*) assessment report**. 124 pp.

A2: **Silver hake assessment summary report for 2005**. 13 pp.

A4: **Assessment of the silver hake resource in the Northwest Atlantic in 2000**, by J. K. T. Brodziak, E. M. Holmes, K. A. Sosebee, and R. K. Mayo (2001). Northeast Fisheries Science Center Reference Document 01-03. 134 pp.

A5: **Silver hake advisory report**. *In* The 32nd Northeast regional stock assessment workshop (32nd SAW). Public Review Workshop, pp. 23–27. Northeast Fisheries Science Center Reference Document 01-04.

B1: **Mackerel assessment report**. 67 pp.

B2: **Atlantic mackerel assessment summary for 2005**. 9 pp.

B3: **Atlantic mackerel**. *In* 30th Northeast regional stock assessment workshop (30th SAW). Stock Assessment Review Committee (SARC) Consensus Summary of Assessments, pp. 273–310. Northeast Fisheries Science Center Reference Document 00-03.

B4: **Atlantic mackerel**. In Report of the 20th Northeast regional stock assessment Workshop (20th SAW), pp. 60–96. Northeast Fisheries Science Center Reference Document 95-18.

B5: **Stock assessment of the Northwest Atlantic mackerel stock**, by W. J. Overholtz (1991). *In* Papers of the 12th Northeast regional stock assessment workshop (12th SAW). Appendix to Northeast Fisheries Science Center Reference Document 91-03.

C1: **Assessment of northern shortfin squid (*Illex illecebrosus*) on the USA shelf during 2003 and 2004**. 88 pp.

C2: **Northern shortfin squid (*Illex*) assessment summary**. 5 pp.

C3: **An age-based cohort model for estimating the spawning mortality of semelparous cephalopods with an application to per-recruit calculations for the northern shortfin squid, *Illex illecebrosus***, by L. C. Hendrickson and D. R. Hart (in press). Fisheries Research.

C4: **Northern shortfin squid (*Illex illecebrosus*)**. *In* 37th Northeast regional stock assessment workshop (37th SAW). Stock Assessment Review Committee (SARC) Consensus Summary of Assessments, pp. 434–517. Northeast Fisheries Science Center Reference Document.

C5: **Northern shortfin squid (*Illex*) advisory report**. *In* 37th Northeast regional stock assessment workshop (37th SAW). Stock Assessment Review Committee (SARC) Advisory Report, pp. 39–44. Northeast Fisheries Science Center Reference Document.

(A,B,C)1: **Post-meeting comments by Dr Dana Hanselman** (Alaska Fisheries Science Center) (11/11/2005) from the Northern Demersal, Coastal/Pelagic and Invertebrate Subcommittee Meeting, October 2005. 2 pp.

D1: **MSVPA-X summary report**. 27 pp.

D2: **Expanded MultiSpecies Virtual Population Analysis (MSVPA-X) stock assessment model report**. 153 pp.

D3: **Appendix D1: Sensitivity Analyses** (Appendix to main report D2). 148 pp.

D4: **Appendix D2: Single-species research recommendations** (Appendix to main report D2). 11 pp.

D5: **Multispecies VPA (MSVPA-X) internal peer review**. Special Report 84 of the Atlantic States Marine Fisheries Commission. v + 12 pp.

Bibliography referred to in panellists' reports

Bull, B., Francis, R. I. C. C., Dunn, A., McKenzie, A., Gilbert, D. J., and Smith, M. H. 2003. CASAL (C++ algorithmic stock assessment laboratory): CASAL User manual v2.01–2003/8/01. NIWA Technical Report, 124. 223 pp.

Campana, S. E., Chouinard, G. A., Hanson, J. M., and Fréchet, A. 1999. Mixing and migration of overwintering Atlantic cod (Gadus morhua) stocks near the mouth of the Gulf of St. Lawrence. Canadian Journal of Fisheries and Aquatic Sciences, 56: 1873–1881.

Fournier, D. A., Sibert, J. R., Majkowski, J., and Hampton, J. 1990. MULTIFAN: a likelihood-based method for estimating growth parameters and age composition from multiple length frequency data sets illustrated using data for southern bluefin tuna (*Thunnus maccoyii*). Canadian Journal of Fisheries and Aquatic Sciences, 47: 301–317.

Huse, G., and Gjosæter, H. 1999. A neural network approach for predicting stock abundance of the Barents Sea capelin. Sarsia, 84: 457–464.

Myers, R. A., Barrowman, N. J., Hilborn, R., and Kehler, D. G. 2002. Inferring Bayesian priors with limited direct data: applications to risk analysis. North American Journal of Fisheries Management, 22: 351–364.

NRC. 1998. Improving fish stock assessment. National Academy Press. Washington, D.C.

Stokes, T. K., Butterworth, D. S., Stephenson, R. L. (Co-conveners), and Payne, A. I. L. (Guest Editor). 1999. Confronting uncertainty in the evaluation and implementation of fisheries-management systems. ICES Journal of Marine Science, 56: 795–796.

Appendix 7: Panellist report – John Casey

42nd NORTHEAST REGIONAL STOCK ASSESSMENT REVIEW COMMITTEE (SARC-42)

Report on the 2005 Assessments of Silver hake (*Merluccius bilinearis*), mackerel (*Scomber scombrus*) shortfin squid and (*Illex illecebrosus*) in the Northeast United States and the multispecies model MSVPA-X

John Casey

Prepared for

University of Miami

Independent System for Peer review

The Centre for Fisheries and Aquaculture Science
Lowestoft Laboratory
Pakefield Road
Lowestoft
Suffolk NR33 0HT
England, United Kingdom
Phone +44 1502 524251
e-mail j.casey@cefas.co.uk
www.cefas.co.uk

Cefas

Contents

Page

1. Background

This report reviews the 2005 assessments Silver hake (*Merluccius bilinearis*), Atlantic mackerel (*Scomber scombrus*), and shortfin squid (*Illex illecebrosus*) in the Northeast United States, and the multispecies model MSVPA-X, at the request of the University of Miami. The author was provided with draft stock assessment reports and web access to relevant files and documents and participated in the 42nd Northeast regional Stock Assessment Workshop (SAW 42) Stock Assessment Review Committee (SARC-42) meeting.

2. Review activities

The SARC-42 meeting was held at the Aquarium Conference Room – Northeast Fisheries Science Center, Woods Hole, Massachusetts from 28 November to 4 December 2005.

The meeting was the first of the "new model" of SARC reviews where panel members were jointly asked to complete their individual reports before closure of the meeting and to jointly produce a SARC summary report, which, if possible, should reflect a consensus viewpoint on each of the items under discussion. The meeting was open, and was attended by observers including members of the fishing industry. The assessments of the stocks were presented to the Panel, and the assessment reports were discussed with respect to the validity of the data, assessment procedures, results, recommendations, and conclusions. Specifically the panel focused on whether each Term of Reference of the SAW was completed successfully. For the predator-prey model MSVPA-X, the panel thoroughly reviewed the input data, and model assumptions, formulation and function.

This report forms one out of three independent reviews of each of the assessments. The consensus view of the panel was compiled by the SARC Chair (Dr Andrew I. L. Payne), and is presented as the Substantive Summary Report. The independent reports of the other panellists are attached at Appendices 8 and 9.

3. Assessment of silver hake (*Merluccius bilinearis*)

3.1 Comments in relation to the Terms of Reference of the 42nd SAW

3.1.1. <u>Characterize the commercial and recreational catch including landings and discards</u>

Landings
There is some concern that the sampling coverage of the commercially caught silver hake has been relatively low and whether the reported catches of silver hake during the 1960s and 1970s when landings were much higher than at present were a true representation of the actual removals of silver hake at that time. There was also considerable discussion on the potential for offshore hake (*Merluccius albidus*) to be misidentified as silver hake in the commercial and survey catches. From the discussion, I conclude that this is

highly unlikely to be the case for survey catches. However, the possibility remains that offshore hake did form a component of the reported silver hake landings in the past. Despite the relatively low level of sampling, offshore hake are unlikely to represent a significant component of the reported silver hake catches in recent years.

Discards
Estimates available for 2002–2004 only are based on observer trips, low sampling and the D/K ratio method. Discard estimates are undertaken using a method that is appropriate for the level of sampling available and for the available time-series. It is not clear whether extrapolation to earlier years is appropriate. Discard estimates are high in both areas, but especially in the northern management area.

Survey data
Survey data have been collected in a controlled and standardized way throughout the time-series of the surveys. There remains some concern about potential changes in catchability of silver hake and other species influencing survey catch rates over time, but especially in relation to the change of trawl doors in 1986. Nevertheless, the survey data are a good representation of the relative changes in distribution and stock density of silver hake throughout the survey area.

Age estimation
Results of age-reading experiments indicate a bias in age determination of silver hake over time. This may have had a significant effect on the estimates of catch-at-age.

Conclusions on catch data
The data and methods used to characterize the time-series of catch and catch-at-age are appropriate, but the relatively low level of sampling of landings and discards casts some doubt on the validity of the time-series of estimates of catch-at-age. Survey data provide vital information on the trends in the stock over time, although as with most surveys the precision of annual metrics is low.

This term of reference was completed successfully, although concerns regarding the accuracy of the time-series of annual commercial landings and discards of silver hake remain. In addition the potential catchability changes with survey gear modification were a concern.

3.1.2 <u>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</u>

No attempt was made to estimate fishing mortality rates using traditional age-structured models. Instead, three methods were employed to estimate fishing mortality, spawning stock biomass and total stock biomass for the northern, southern and combined stock components. Method 1 is that currently used to specify management targets and thresholds and to define over-fishing and over-fished stock conditions. Methods 2 and 3 are new methods designed to provide lower bound estimates for stock biomass and upper bound estimates of fishing mortality.

Method 1. This method does not attempt to derive estimates of instantaneous fishing mortality rates, but provides two indices based on NEFSC fall survey data. Index 1 is a simple biomass index based on the three-year running mean kg tow^{-1} and index 2 is an exploitation index derived from the 3-year running mean kg tow^{-1} and the landings estimates. According to the current management targets and thresholds the assessment indicates that the stock in both management areas is not overfished and overfishing is not taking place. I agree that using these criteria this is the case. However, I do have some reservations regarding the appropriateness of the agreed procedure (see ToR dealing with biological reference points).

Method 2. This method derives lower bound estimates for biomass and upper bound estimates of fishing mortality for the southern stock component based on the relative catch rates from the NEFSC fall and supplemental survey series. The method is described in the assessment document (A1), but in summary the catch rates observed from the supplemental (transect) surveys are used together with catch rates from NEFSC fall survey catch rates for tows in the same vicinity (strata) to derive an efficiency correction that can be applied to the catch rate estimates from the fall survey which are then used to derive an estimate for lower bounds on biomass and upper bounds on F.

The analysis indicates that the supplemental survey trawl is about 32 times more efficient than the NEFSC survey trawl. The resulting lower bound biomass estimate for the southern stock component during 2001–2004 ranged from 265 000 t to 366 000 t and the upper bounds on fishing mortality over the same period ranged from 0.02 to 0.04.

While noting the arguments in the assessment document, and particularly those that imply that the lower bound for biomass is likely to be an underestimate, and by implication fishing mortality is likely to be an overestimate, I recommend that these estimates are not accepted as true representations of the status of the resource or its exploitation rate and as such should not provide the basis for any management decisions. The reasons for these recommendations are as follows:

1. The term lower bound estimate for biomass is inappropriate since the use of the unadjusted catch rates from the NEFSC survey would give even lower biomass estimates and hence higher fishing mortality estimates than those estimated using this method.
2. While I can accept that the NEFSC fall survey trawl is relatively inefficient with respect to catching silver hake, even if the supplemental trawl is 100% efficient, there is no guarantee that the transect surveys were random with respect to silver hake.

I would suggest that a stratum-raised swept-area biomass estimate from the fall NEFSC survey could provide an appropriate lower bound estimate of trawlable biomass for silver hake. Such an estimate would have the advantage that it could be used to examine trends in trawlable biomass over time. Relative exploitation rates derived from catch/trawlable biomass would also indicate the relative change in exploitation rate.

Method 3. This method is designed to derive lower bounds for biomass and upper bounds for fishing mortality based on historical landings and concurrent survey data. The method indicated that over 2001–2004, lower bounds for biomass in the northern stock component ranged from 31 000 t to 125 000 t and the upper bound for *F* ranged from 0.02 to 0.04. Over the same period the lower bounds for biomass in the southern stock component ranged from 48 000 t to 90 000 t, and the upper bound for *F* ranged from 0.10 to 0.14.

I conclude that Method 3 may be a more appropriate estimator for a lower bound on biomass and an upper bound on fishing mortality than Method 2. However, I recommend that the estimates derived by this method are not accepted as true representations of the status of the resource or its exploitation rate and as such should not provide the basis for any management decisions. The reasons for these recommendations are as follows:

1. The method is dependent on the assumption that survey catchability has remained constant over time. This may not be the case even though it has been shown that any effects attributable to vessel or gear changes are not statistically significant. If the data are noisy, then the probability of detecting a statistically significant effect is reduced.
2. Landings do not exceed biomass in any year, which may not be the case.
3. Uncertainty in the true level of historical catch either through overestimation which would result higher estimates of biomass, or through underestimation which would lead to lower biomass estimates, make the derived estimates uncertain.

Conclusions on estimates of fishing mortality and biomass estimates
The estimated fishing mortality and lower bound biomass estimates should not be accepted as true representations of the status of the stocks in the two management areas or of their actual exploitation rates. For the southern stock, both methods result in estimates of lower bounds for biomass and upper bounds for *F* that are quite different.

I agree that whichever method is used, the indications are that recent exploitation rates are relatively low, but that scientifically acceptable absolute estimates cannot be derived using the available information.

3.1.3 <u>Evaluate and either update or re-estimate biological reference points, as appropriate</u>

The SAW did not attempt to update or re-estimate biological reference points.

I note that the existing agreed reference point for biomass is based on the 3-year running mean estimate of kg tow^{-1} from the NEFSC fall survey. This is a measure of average stock density over time and used as such is an accepted metric that is used for other stocks. I also note that the threshold is based on a period where the trawl survey density was relatively stable. However, for the southern stock component, this was also a period where the annual landings were undergoing a steep decline. I suggest it would be more appropriate to derive a threshold index from a period where both catch and survey estimates of stock density were both relatively stable, and that an alternative based on these criteria be investigated as a basis for a threshold biomass reference point.

In addition, I also suggest that indices based on stratum-area-raised, swept-area trawlable biomass would be a more appropriate metric for detecting trends in stock biomass and establishing reference points. In my opinion, this would be particularly appropriate if the distribution of the stock within the survey area varies over time, which appears to be the case for silver hake.

With regard to threshold exploitation rates, I note that the current index of exploitation does not take into account the age structure in the catch. All indications are that the age structure of the stock and the catch is becoming progressively truncated, but that the stock density index is being maintained by strong year-classes. Unless the age-structure is explicitly considered in the assessment of biomass and exploitation rate, there is a danger of both growth-overfishing and recruitment-overfishing. The current metric does not make any distinction between the two.

3.1.4 <u>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</u>

Using the existing target exploitation levels, the predicted upper limits for landings for 2005 were 17 270 t for the northern stock component and 28 260 t for the southern stock component. The information to permit a similar calculation for 2006 is not yet available.

3.1.5 <u>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</u>

This term of reference was not addressed by the SAW. I note that the data and information available to the SAW was inadequate to address it.

3.1.6 <u>Review, evaluate and report on the status of the SARC/Working Group Research Recommendations offered in previous SARC-reviewed assessments</u>

The recommendations for research offered by the previous SARC are commented on in turn below.

*1) Develop survey information that covers the offshore range of the population***.** This was successfully addressed with the development of the supplemental (“Transect”) survey during 2003–2005 that sampled relatively deep water along two transects. I note that these surveys have limited geographical coverage and that their location may not be random with respect to silver hake.

2) Conduct surveys of spawning aggregations on the southern flank of Georges Bank. This research recommendation has not been addressed.

3) Investigate bathymetric demography of population.
The 2005 assessment report includes an extensive analysis of relationships between location, depth, size and age based on bottom trawl survey data. The results indicate a change in the distribution of the relative density of silver hake over time. It remains unclear whether the observed change in distribution is a northward and offshore shift in the distribution of the population, or a disappearance of fish from the more southerly and inshore areas of their overall range. The distribution and relative abundance of silver hake to the north of the assessment area should be examined. This may be available in Canadian surveys of the Grand banks and Flemish Cap

4) Investigate spatial distribution, stock structure and movements of silver hake within Georges Bank, the Gulf of Maine, and the Scotian shelf in relation to physical oceanography.
This research recommendation was not addressed. I suggest that it is worth trying to establish the extent of the geographic distribution of silver hake in the northwest Atlantic.

5) Quantify age-specific fecundity of silver hake.
This research recommendation was not addressed.

3.1.7 Recommendations for future silver hake assessments

Much of the uncertainty associated with the stock status of silver hake is associated with the following:

1. The conflicting signals arising from commercial catch-at-age data and indices from research vessel surveys.
2. The quality of the catch data, including landings and discards and the estimates of catch-at-age.
3. The apparent disappearance of old fish from the survey and commercial catches, and the increase in recruitment of young fish. I note, however, that it is not only old fish that are disappearing from the catches and surveys, because there is strong evidence from surveys and the commercial landings that age groups 4 and older are becoming more scarce.
4. The stock structure. In the northeastern USA, two stock components are managed separately, but no account is taken of the overall geographic range of silver hake in the Northwest Atlantic.

Aspects of any of the above issues could potentially improve the assessment, and I suggest the following for consideration:

a) Investigate the potential catchability changes in the surveys attributable to survey gear modifications.

b) Investigate the reasons for the paucity of larger older fish in the commercial catches and survey.

c) I would suggest that a stratum-area-raised swept-area biomass estimate from the fall NEFSC survey could provide an appropriate lower bound estimate of trawlable biomass of silver hake.

d) Investigate spatial distribution, stock structure and movements of silver hake within Georges Bank, the Gulf of Maine, and the Scotian shelf in relation to physical oceanography.

4 Assessment of mackerel (*Scomber scombrus*)

4.1 Comments in relation to the Terms of Reference of the 42nd SAW

The assessment report contained no details of the assessment model adopted, presumably because it is a relatively well-known and understood method in the NE USA. The members of the SAW should recognize that reviewers from different parts of the world may not be entirely familiar with so-called standard assessment methods. The documentation was generally inadequate. There are values for reference points in the executive summary of the assessment report and the assessment summary that are not detailed in the main body of the assessment report. This gives the reviewer little or no opportunity to properly scrutinize the methods and results.

4.1.1 <u>Characterize the commercial and recreational catch including landings and discards</u>

Landings
The sampling levels appear to be adequate. Age data were pooled and applied to recreational and commercial landings. The time-series of catch-at-age data are believed to be adequate representations of the removals by the fishery. I note that there has been a decline in the proportion of older fish in the commercial landings in recent years.

Discards
Discards are not estimated, but are believed to be small relative to the overall landings.

Survey data
Survey data have been collected in a controlled and standardized manner throughout the time-series of the surveys. There remains some concern regarding the potential changes in catchability of mackerel and other species influencing survey catch rates over time, especially in relation to the change of

trawl doors in 1986. Nevertheless, the survey data are a good representation of the relative changes in distribution and stock density of mackerel throughout the survey area.

Spring and winter surveys have traditionally been used to tune the assessment. The survey data are log-transformed for use in the assessment, to get rid of large year-effects. I note that there is some contrast between the signals for the spring and winter surveys; the spring survey showing a gradual increase in kg and number per tow over time, whereas the log-transformed winter survey indices are rather stable over time and the coverage is not as consistent as during the spring survey.

I also note that the commercial landings and spring survey catch-at-age indices are relatively consistent in representing the relative strength of most year classes at different ages.

Conclusions on catch data
The data and methods used to characterize the time-series of catch and catch-at-age are appropriate. Survey data provide vital information on the trends in the stock over time, although as with most surveys the precision of annual metrics is low.

This term of reference was completed successfully, although I consider that the potential catchability changes in the surveys attributable to survey gear modifications should be investigated further.

4.1.2 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

The previous assessment reviewed by SARC-30 in 1999 utilized VPA calibrated with both the winter and spring survey catch-at-age indices. That assessment was not accepted by the SARC primarily because of a strong retrospective bias in overestimating stock size and underestimating fishing mortality, and because of problems of scale.

Two main approaches were undertaken in the present assessment to estimate biomass and fishing mortality of mackerel, VPA and ASAP forward projection. The results of VPAs calibrated with both the winter and spring survey series or the spring survey series alone indicated that despite reasonable model fits, the strong retrospective bias remained, and using only the spring survey for calibration resulted in problems of scale in SSB. Because of the problems with the VPA model formulation, the more flexible modelling approach (ASAP) was utilized.

Various ASAP model runs were formulated to explore aspects of scale and goodness of fit. None of the formulations resulted in a clear choice of preferred model. Goodness of fit varied considerably according to model formulation. The ASAP “base case” run was accepted as the most plausible.

I note that the recent estimates for total and spawning stock biomass are likely to be overestimates since the assessment exhibits a reasonable strong retrospective pattern despite having good fits to the survey indices and catch data. I also note that the retrospective pattern could be reduced if a relatively strong dome-shaped exploitation (partial recruitment) pattern for the fishery in recent years was addressed. The assessment report argues that there is no justification for assuming such a dome-shaped exploitation pattern. However, the relative paucity of larger older fish in the commercial catches could conceivably result in older fish being less available to the fishery and the surveys because of fish aggregation and highly mobile behaviour.

The assessment assumes that natural mortality is constant over all age groups and years. Given that there is strong evidence of large changes in predation on mackerel over time, this assumption is questionable and attempts should be made to investigate whether it is reasonable.

Conclusions on estimates of fishing mortality and biomass estimates.
The accepted "base case" run estimates for total biomass, spawning stock biomass and fishing mortality for 2004 are 2.9, 2.3 million t, and $F = 0.05$, respectively. These estimates appear to be the plausible, but given the retrospective bias, SSB is likely to be overestimated and fishing mortality is likely to be underestimated. I note that the summary report estimates that the precision of the estimate of F in 2004 ($F = 0.05$) has a confidence interval ranging from 0.035 to 0.063. Similarly, the estimate for SSB for 2004 of 2.3 million t has a confidence interval ranging from 1.49 to 3.14 million t. This does not mean that the true values for F and SSB lie within these ranges.

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

Fishing-mortality-based biological reference points were re-estimated. F_{msy} was revised downwards from $F = 0.45$ to $F = 0.16$. MSY was revised down from 326 000 t to 89 000 t, and SSB_{msy} was revised from 887 000 t to 644 000 t. $F_{0.1–0.25}$ and $F_{40\%} = 0.24$.

I have some concern about the validity of these reference points because recent levels of catch have been in the region of the newly estimated MSY (89 000 t), with much lower estimated fishing mortality rates than F_{msy}, although the stock appears to be much larger than B_{msy}. The implication is that fishing mortality rates could increase significantly above current levels. However, given the uncertainty in F and SSB estimates coupled with the recent truncation of the age range in the catches and surveys, I do not feel confident in the absolute value of the derived estimates.

Three surplus production models were employed to estimate surplus production over the time-series of fishery data. Two were rejected as uninformative because the data surface from the ASAP model was very flat over a wide range of SSB, resulting in very high values of K and B_{msy}. The results accepted as being useful by the SAW came from a Beverton & Holt stock recruitment relationship giving an estimate of average surplus production of about 148 000 t. I agree with the SAW suggestion that this value can serve as a proxy for an upper bound on surplus production. However, I consider that it should not be used as an annual target catch because surplus production over time appears to have been dependent on pulses of good recruitment and the stock/recruit relationship is not well defined.

4.1.4 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

The deterministic projections for catch at the management target *F* of *F* = 0.12 in 2006, 2007 and 2008 are much higher than recent catch levels, and much higher than the estimated average surplus production. Furthermore, they are highly dependent on the estimates of the strengths of the strong 1999 and relatively strong 2002 and 2003 year classes, which are poorly determined. The target *F* also implies a significant increase in the fishing mortality rate over levels estimated for recent years. The assessment report does not document the confidence intervals for the predicted catch estimates, and as such should be treated with caution.

4.1.5 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

Under the projected catch levels given in 4.1.4 above, spawning stock biomass is projected to slowly decline from the estimate of 2.6 million t to 2.0 million t by 2008. These estimates are also highly dependent on the estimated strengths of the strong 1999 and relatively strong 2002 and 2003 year classes, which are poorly determined. The uncertainty in the estimates has not been characterized. The SAW provided no other scenarios for *F* and biomass. It would be helpful in assessing the results of projections if the precision of the estimates could be evaluated and included in the assessment report.

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

Recommendations from SARC-30

a. Explore logbook data for information on catch rates and geographic distribution
No analysis was completed on this recommendation. The SAW report contains some justification for not addressing it. While I agree that the fishery catch rate data may not be very useful in describing the distribution of the stock, it can be useful in looking at where the exploitation is taking place with respect to the distribution of the stock as seen in surveys. In addition, although catch rates for pelagic shoaling species may not be very informative if they are based on fishing time, if searching time is taken into account in

conjunction with spatial data, this may provide valuable information for assessment purposes. I feel that this would be worth pursuing.

b. Explore Canadian trawl survey indices for use in VPA calibrations
The SAW reports that several additional trawl survey indices and egg indices were explored as tuning indices, but currently they do not appear useful in resolving assessment issues with this stock (pers. comm. F. Gregoire, DFO 2005). I note that the results of these exploitations were not included in the SAW report.

c. Explore the feasibility of acoustic surveys for monitoring stock size
The SAW reports that several attempts have been made to use acoustics to survey mackerel during recent winter cruises on the RV “Delaware II”. To date there has been little success, but this does not preclude the use of acoustics on this species, especially with the RV “Bigelow” in future. I note that these attempts are not documented in the SAW report and that acoustic surveys for mackerel have been undertaken in other areas. I feel that this is an option that should be pursued.

d. Examine estimates of Z calculated from research vessel survey data with respect to their usefulness in estimating natural mortality
No progress was made on this recommendation during the interim period. A superficial examination of survey *Z* estimates undertaken by myself during the SARC indicates that there appears to have been an increase in survey *Z* estimates since the trawl doors were changed on the survey trawl in 1986. The reasons for this should be investigated.

4.1.7 <u>Recommendations for future work</u>

a) Investigate the potential catchability changes in the surveys due to survey gear modifications.

b) Investigate the reasons for the paucity of larger older fish in the commercial catches and survey.

c) Investigate the likelihood of significant changes in natural mortality by examining information on predation rates more closely to investigate whether the assumption of constant *M* at age over time is reasonable.

d) Explore logbooks for information on catch rate and geographic distribution.

e) Explore the feasibility of acoustic surveys for monitoring stock size

f) Examine estimates of *Z* calculated from research vessel survey data with respect to their usefulness in estimating natural mortality.

5 Assessment of shortfin squid (*Illex illecebrosus*)

Owing to the life history characteristics for this stock, the SAW adopted a rather novel and interesting approach to the assessment. The assessment is undertaken using an in-season assessment model that utilizes estimates of maturity and natural mortality derived using an age-based cohort model. Results from the latter are also used as input to the estimation of biological reference points. Both models were discussed during the SARC, with extensive discussion on the latter. A major constraint on the assessment is the lack of appropriate data and parameter estimates. The approach taken is scientifically justifiable, but the results of the analyses cannot yet be considered as reliable estimates of the true biomass or the exploitation rate.

5.1 Comments in relation to the Terms of Reference of the 42nd SAW

5.1.1 Characterize the commercial and recreational catch including landings and discards

Catches
The information on landings is well documented. Discards are estimated to be low and will not have much influence on the assessment results.

Survey data
There are no stock-wide estimates of trends in abundance or biomass for shortfin squid, although information is available from several seasonal research surveys on the USA and Scotian Shelf. As the species is widely distributed, shows two periods of spawning throughout the year, and the surveys are seasonal, it is unclear what the signals from survey series are indicating with respect to stock status. The assumptions made by the SAW are reasonable.

Conclusions on catch and survey data
The SAW has used all the information at its disposal to characterize the catches of *Illex* from the assessment area.

5.1.2 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

Ageing of *Illex* is imprecise, and the SAW has made use of a double-blind-ageing precision study to try to estimate the error to incorporate into the maturation / natural mortality model to be used as an input parameter for the assessment and for the estimation of reference points. I agree with the conclusions of the SAW that the estimates of natural mortality can only be considered preliminary.

The in-season assessment model was updated with data for 2003 and 2004 and I agree that the resulting model estimates of fishing mortality and stock size are not reliable.

Conclusions on estimates of fishing mortality and biomass estimates
The SAW has made significant progress towards an improved assessment methodology, but because of the uncertainty of some parameter estimates, primarily due to a lack of appropriate data, the assessment does not yet

provide reliable estimates of fishing mortality or stock biomass. In particular, data on seasonal growth rates and maturity of *Illex* are an essential requirement to progress towards obtaining reliable estimates of fishing mortality and stock biomass.

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

Biological reference points for *Illex* are estimated using per-recruit models that require input natural mortality rates that have been estimated by the maturity/natural mortality model. Furthermore, seasonal changes in growth rates will affect the reference point estimates. Hence, I agree with the SAW that the reference point estimates from the per-recruit models should be considered preliminary and that seasonal growth rate data are required to test the sensitivity of the per-recruit models to changes in growth rates throughout the year.

I note that the current management agreement (Amendment 8) is based on estimates of F_{msy} and B_{msy} that were calculated using a biomass dynamic model for which bootstrap analysis indicated poorly determined parameter estimates. In addition the model assumed constant *M*, which for *Illex illecebrosus* is inappropriate. I agree with the SAW that proxies based on maximum surplus production for MSY-based reference points should be obtained, and that such proxies should be derived from a model that accounts for the semelparous life history of *Illex*.

5.1.4 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

This ToR was not attempted by the SAW. The semelparous life history of *Illex* has so far prevented meaningful predictions to be undertaken. I suggest that the SAW consider a variant on the in-season assessment methods and harvest control rules that are currently used in Europe for the management of the fisheries for North Sea sandeel and for anchovy in the Bay of Biscay.

5.1.5 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

This ToR was not attempted by the SAW. The data and methods available for the assessment, together with the semelparous life history of *Illex*, do not permit meaningful predictions to be undertaken.

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

a) Continue model development, with the objective of producing sound statistical models for stock assessment purposes
I note that the models presented at SARC-37 were improved upon and tested further, and that considerable effort had been expended by the principal authors of the SAW assessment report to achieve this. These models require seasonal age and maturity data before further model testing can be done.

b) Consider the development of "operating models" which can be used to test the effectiveness of alternative management strategies
I agree with the findings of the SAW that this research recommendation cannot be accomplished until a reliable stock assessment model is available.

c) Evaluate the relationship between growth rates and sea temperature to define possible changes in stock productivity associated with environmental conditions
This recommendation was not addressed, but it is certainly worth pursuing. A funding source for the collection and analysis of growth rate data is required before further progress can be made.

d) Define biological indicators of low or high productivity regimes
This recommendation has not been addressed in the context of different regimes, but has been successfully addressed with respect to annual variations in stock biomass.

e) Evaluate seasonal and latitudinal clines in growth rates
This recommendation was not completed, but it is certainly worth pursuing. A funding source for the collection and analysis of growth rate data is required before further progress can be made.

f) Evaluate and design cooperative research programs with commercial vessels for sampling of size, weight and possible age of Illex during the fishing season
This recommendation was satisfactorily completed.

g) Continue with cooperative ventures for pre-season survey to obtain possible indices of upcoming stock abundance and productivity
A pre-season *Illex* survey was conducted using commercial vessels in 2000 with funds from an external grant. External funding is needed to conduct a second *Illex* pre-season survey.

h) Evaluate catch rates by vessel by using VTR and Weighout databases to improve procedures for standardization of nominal LPUE
This recommendation was satisfactorily completed.

5.1.7 Recommendations for future work

I agree with all of the recommendations made in the stock assessment report and offer the following additional two recommendations for consideration:

a) With respect to providing in-year management advice for *Illex illecebrosus*, I suggest that the SAW investigates the in-season assessment methods and harvest control rules currently used in Europe for the management of the fisheries for North Sea sandeel and for anchovy in the Bay of Biscay, to determine their suitability for *Illex*.

b) Evaluate the relationship between growth rates and sea temperature to define possible changes in stock productivity associated with environmental conditions.

6. Multispecies predator-prey MSVPA-X model

The MSVPA-X model is a development of the MSVPA developed in ICES, with modifications to the consumption model to include estimation of diet linkages through temperature effects on predator metabolism, suitability and spatial overlap of predators and prey. The present implementation of the model includes four predator groups, striped bass, weakfish, bluefish, and other predator species, and a single prey species, Atlantic menhaden.

The present formulation is limited in scope because it focuses on the historical population response of a single prey species, menhaden, to the populations of four predator species or species groups whose historical population sizes are pre-determined inputs to the model. The formulation incorporates no predator interaction or any feedback of prey abundance on predator abundance.

The main potentially useful output from the model as it is currently formulated is to derive the historical trends in the stock for menhaden. However, the differences in the historical stock trajectory are likely only to be influenced by changes in predation mortality in response to the historical abundance of predators input to the MSVPA-X.

6.1 Comments in relation to the Terms of Reference of the 42nd SAW

6.1.1 <u>Evaluate adequacy and appropriateness of model input data, including fishery-dependent data, fishery-independent data, selectivities, etc. as configured</u>

Predator populations: The model input data are adequate for testing the performance of the model as it is currently formulated. However, the derivation of some input parameters as used at present, calls into question the utility of the model outputs. The authors have devoted considerable effort to deriving the required inputs and I feel they have done an excellent job with the data available. However, because of limited availability of appropriate data, they have been creative with the data that were available, but in some instances may have stretched the data rather too much. I have a particular concern that the spatial overlap indices may be misleading, because using distribution of commercial catch may not be representative of the age structure or relative distribution of the populations, and weight-at-age is a crucial parameter in the estimation of predation and mortality rates.

The assumption of $M = 0.4$ for all ages for $M1$ is questionable and if possible should be evaluated.

I note that the single-species assessments for the predators we recalculated for input to the MSVPA-X model. As the estimated historical populations for the predators remain fixed in MSVPA-X, it would probably be more appropriate to use the peer-reviewed outputs from the accepted assessments for these species. This is especially true as the output with respect to menhaden will be dependent on the predator population estimates input to the model.

The prey groupings chosen for MSVPA-X seem reasonable based on my understanding of the community structure in the area of concern.

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

The feeding selectivity parameters input to the MSVPA-X (type and size selection and spatial overlap) are a key component of the model inputs. I consider that the methods used to derive these are appropriate given the available data, but note that the estimates are obtained through a mixture of subjective expert judgement and from the results of data analyses.

There are considerable gaps in the database for the biomass and range of those species included in the category of other prey species, and in some cases the required inputs had to be derived by extrapolation. While this may give misleading estimates, I see no alternative unless additional appropriate information can be found to fill the existing gaps.

6.1.3 Review model formulation (overall set-up, data handling, VPA calculations, assessment options, sensitivity analyses, recruitment model options, and forward projection options) of model as configured

I did not have the opportunity to gain “hands-on” experience with the software; hence I am unable to comment on its user-friendliness. The main difference between this formulation and the ICES MSVPA is how diet composition and suitability indices are treated. In contrast to the ICES formulation, MSVPA-X does not employ diet information from a specific year directly, but uses diet information to develop the type and size preference and spatial overlap parameters. In the absence of diet information on all ages and species within a given year, the approach used here appears to be appropriate and acceptable.

The formulation as it is at present has limited scope because predator populations are static in the model and the prey species of primary interest has no influence on predator abundance. In summary, the utility of the model in its present formulation is largely restricted to reconstructing the historical trends in the menhaden stock, and to addressing questions relating to the fate of the menhaden stock under various assumptions about the relative future changes in predator stocks.

The present model formulation does not provide any additional information for predator species that cannot be obtained from single-species assessments and forecasts, because there is no feedback effect of prey abundance on predator populations or any interaction between predators. For the main prey species, the scope to provide management advice that adds value to a single-species forecast for menhaden is limited. There is a clear need to develop the model further to incorporate a feedback mechanism whereby the effects of prey abundance on predator populations and predator interactions can also be evaluated. Such a development will potentially allow medium- to longer-term evaluations of stock development at different exploitation rates, which would be a much more valuable tool for fishery managers. If possible too, it would be desirable to incorporate stochasticity into the assessment and projections.

6.1.4 <u>Develop research recommendations for data collection, model formulation, and model results presentation</u>

I agree with the recommendations given in the MSVPA assessment report (D2). I also recommend that consideration should be given to the following:

a) Attempt to develop the model to incorporate the response of predator populations to prey abundance on predator populations and inter-predator interactions.
b) Investigate the possibility of incorporating stochasticity into the MSVPA-X assessment and projections.

6.1.5 <u>Evaluate whether or not the model and associated data are of sufficient quality to develop recommendations to management</u>

The results from the model in its present formulation are of limited value for the development of management recommendations. The parameter estimates that are key model inputs are likely to be imprecise or very imprecise because of the shortages of appropriate data. If provision can be made to undertake stochastic stock projections, the utility of the results to managers may be increased. Data quality would be less of an issue if the error structure of input data and parameter estimates could be incorporated into the model formulation.

Appendix 8: Panellist report – Vivian Haist

Northeast Regional Stock Assessment Review: Silver Hake, Mackerel, and *Illex* squid stock assessments and the predator-prey MSVPA-X model

SARC-42, November 28 - December 4, 2005
Woods Hole, MA

Prepared for:
The Center for Independent Experts,
University of Miami

Prepared by:
Vivian Haist
Haist Consultancy
1262 Marina Way,
Nanoose Bay, BC
Canada V9P 9C1
haistv@shaw.ca

December 06, 2005

Contents **Page**

1. Summary

This report presents results of an independent peer review of three east coast stock assessments (silver hake, Atlantic mackerel, and *Illex* squid) and the MSVPA-X predator-prey model, conducted for the Center for Independent Experts, University of Miami. The assessments and MSVPA-X model were reviewed during the Northeast Regional Stock Assessment Review Committee meeting (SARC-42), held at Woods Hole, MA, November 28 – December 4, 2005.

The SARC-42 process was thorough, rigorous, and allowed adequate time to review the three assessments and the MSVPA model. The Panel report summarizing meeting activities and recommendations represents consensus view. This report is consistent with the Panel report, though focused to those issues I feel are most relevant to the assessment uncertainties.

Overall, the reviewed stock assessments are based on scientifically credible analyses, and as such provide a sound basis for developing fishery management advice. Although there are some considerable gaps in the data and the information available to fully understand the dynamic nature of the biological systems and their underlying processes, these are acknowledged in the assessments.

2. Background

This document reports on an independent peer review of three east coast stock assessments (silver hake, Atlantic mackerel, and *Illex* squid) and a predator-prey MSVPA model. The review was conducted for the Center for Independent Experts (CIE), University of Miami, and follows review guidelines summarized in the Statement of Work (SoW, Appendix 2). The three stock assessments and the MSVPA model reviewed during the Northeast Regional Stock Assessment Review Committee meeting (SARC-42) had previously been developed and reviewed by the relevant Working Groups (SAW Working Groups or ASFMC technical committees).

3. Description of Review Activities

My primary activities in conducting this review included: 1) becoming familiar with all current and background documents (Appendix 6) prior to the review meeting, 2) participation in question and discussion during presentation of the stock assessments and the MSVPA model (November 28 – Dec. 1, 2005), 3) preparation of this report documenting my findings and conclusions, and 4) participation in discussions with the other members of the SARC-42 review panel (Appendix 1) to determine consensus and non-consensus opinions with respect to the review Terms of Reference (ToR, Appendix 3) and the SoW (Dec. 2–4, 2005).

This report forms one component of the SARC-42 Summary Report. Section 4 of the main report presents the Review Panel conclusions relative to the ToR and SoW questions: 1) was the work presented acceptable based on scientific criteria; and 2) does the work presented provide a scientifically credible basis for developing fishery management advice?

4. Summary of findings

4.1 Overview

This was the first east coast SARC Panel that I have participated in. I found the process provided adequate time for thorough review of the stock assessments and the MSVPA model, relative to the ToR for each. For SARC-42, the review process was revised from previous formats so that a report that summarized consensus and non-consensus opinion among the Review Panel could be prepared. This resulted in a longer review meeting, and with this format, presentation and discussions of only one assessment per day would have been advantageous (rather than having all presentations within a two-day interval).

The Panel members encompassed a broad range of stock assessment expertise, which resulted in a broad-scoped review. The new component to this review – reading other reviewers reports, discussing them and writing a consensus summary – resulted in lively discussion and a stronger basis for the overall review process. There were no significant areas where the Panel members did not have consensus opinion.

4.2 Silver Hake

The overriding issue with the silver hake assessment is the inconsistency in the observations of few older (age 3 and older) fish in the NEFSC surveys and the commercial catch, apparent ongoing high levels of recruitment, and recent low levels of catch. Alternative hypotheses that might account for these apparent inconsistencies include: 1) shifts in distribution of older fish such that they are less vulnerable to the surveys and fisheries; 2) changes in ageing methodology such that recent ageing is biased low relative to earlier ageing; 3) increased natural mortality (potentially on all age classes) in recent years; and 4) increased survey catchability of younger fish. For the current silver hake stock assessment, the first two of these hypotheses are investigated.

The issue of conflicting signals in data observations is not new, and perplexed the previous silver hake assessment. The current assessment did not attempt to use analytical assessment models (e.g. surplus production or age-structured) but rather focused on evaluating survey and ancillary data to investigate changes in fish distribution and to estimate upper bound estimates for fishing mortality rates. This alternate approach to the assessment was appropriate, given problems with analytical models in the previous assessment, but unfortunately did not resolve the question of whether decreased catchability is the reason for decreased survey abundance of older fish.

Although some interesting analyses were presented in the assessment document, there are some conclusions suggested that I do not believe are supported by the analyses. In particular, I do not agree with either of the two methods used to obtain upper bound estimates for fishing mortality rate, and therefore lower bound estimates for stock biomass (see comments below). Note, however, that advice relative to reference points does not depend on these analyses.

I do agree with the conclusion that changes in ageing protocols are not the cause of the apparent disappearance of older fish.

Analyses of survey data presented in the assessment support the notion that there have been geographic changes in silver hake distribution in the surveys. However, no conclusive evidence was shown that indicates that the shifts in geographic distribution have resulted in decreased catchability of older silver hake on the surveys.

The assessment did not present alternatives to decreased survey catchability as potential reasons for the lack of older fish. For example, increased natural mortality (predation) or increased catchability of younger (especially age 0 and age 1) fish in the survey could explain the conflicting observations.

Management advice is presented relative to MSY proxy reference points. These relate to levels of the fall survey index (and an exploitation rate index based on catch and fall survey indices) relative to defined reference levels for these measures. These reference points provide a basis for determining that the stock is not overfished and that overfishing is not occurring. Given acceptance of the MSY proxy reference points (not evaluated or discussed in the current assessment), the assessment provides a credible basis for developing management advice. The current reference points were estimated from the average fall survey abundance index during a period when the stocks (index) were relatively stable and catches were declining (1973–1982). If stock dynamics are changing, say with higher natural mortality rates, new reference points may be required.

4.2.1 Discussion relative to Terms of Reference

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

Information presented relative to this ToR was adequate. A new methodology was used to calculate fishery discards for 2001–2004. This method is likely superior to that used previously, and it should be applied to the entire observer data series to update all discard estimates (to support catch estimation for future analytical assessments). Discards are significant, recently almost as high as landings in the northern region. Information on recreational catch is summarized from a previous assessment and not updated, but recent catch levels are low. Catch by commercial fishing vessels appears well known, although details of how historical catches (in particular foreign catches) were calculated are not given.

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*

The stock assessment presents two methods to calculate upper bound estimates of fishing mortality and lower bound estimates for stock biomass. I don't feel that either method is scientifically rigorous, and hence the resulting fishing mortality and stock biomass estimates should not be accepted. Note however, that assessment advice relative to BRPs is not dependent on these estimates.

The first approach to estimating lower bounds for stock biomass involves calculation of a relative efficiency coefficient between a Supplemental survey and the NEFSC spring survey. This efficiency coefficient is then applied to the NEFSC survey data to obtain swept-area biomass estimates. The primary reason this approach may not result in a true lower bound on stock biomass is that the efficiency estimation assumes locations fished during the Supplemental survey tows are random with respect to silver hake distribution (as is the case for the NEFSC survey tows). This is certainly not true, in that the Supplemental survey locations were selected to have a high likelihood of catching fish. The extent to which the Supplemental survey tows are "non-random" with respect to silver hake is not known, so the degree of bias this will introduce to the relative efficiency calculations is not known. It is noteworthy that about 25% of the NEFSC survey tows caught no silver hake whereas all Supplemental survey tows caught silver hake. Also, catches during the March Supplemental survey tows (2004 and 2005) were higher by at least a factor of two compared with January and May Supplemental survey tows, suggesting temporal trends in abundance need to be considered when estimating relative efficiency (i.e. use side-by-side tows to minimize all potential factors that could bias catch rate differences).

The second approach to estimating minimum stock biomass is based on the assumption that landings (L_t) must be less than stock biomass B_t, and this relationship is used to estimate a catchability term (q) that relates biomass to the abundance index (I_t):

$$L_t < B_t \quad \text{where} \quad B_t = qI_t \quad .$$

The assumption that landings must be less than stock biomass is not necessarily correct (especially at high total mortality, as is the case here) and will depend on the timing of the fishery, timing of recruitment to the fishery, and timing of the survey that generates the abundance index. The following table shows a simple simulation with constant fishing and natural mortality rates (*F* = 1.5, *M* = 0.2, applied at a constant rate throughout the year) and two recruitment scenarios.

	Number of fish					
	Scenario 1			Scenario 2		
Month	Total population	Recruit	Catch	Total population	Recruits	Catch
1	100.0	15	13.4	100.0	85	21.6
2	99.8	15	13.4	160.6	85	28.6
3	99.6	15	13.4	213.1	85	34.7
4	99.5	15	13.3	258.7	85	40.1
5	99.4	15	13.3	298.3	0	34.8
6	99.3	15	13.3	258.9	0	30.2
7	99.2	15	13.3	224.7	0	26.2
8	99.1	15	13.3	195.0	0	22.7
9	99.0	15	13.3	169.3	0	19.7
10	99.0	15	13.3	146.9	0	17.1
11	98.9	15	13.3	127.5	0	14.9
12	98.9	15	13.3	110.7	0	12.9
13	98.8			96.1		
		Total catch	159.9		Total catch	303.5

The recruitment levels were set so that stock abundance and hence catches would not decrease from year to year. The simulation is based on numbers of fish, but if the influx of smaller fish from recruitment balances growth, then numbers are a good approximation of biomass. Clearly, the total annual landings are not greater than stock abundance throughout the year.

A second source of potential bias in this approach to estimating the catchability parameter (*q*) and thus minimum stock biomass is that there may have been changes in survey catchability (as suggested in the previous silver hake stock assessment). The magnitude and direction of potential bias attributable to these factors is unknown.

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

Results were presented relative to existing BRPs. These are based on indices using the fall survey abundance indices and catch estimates, and so do not depend on stock models. The information presented is appropriate for developing management advice relative to the existing BRPs. However, the validity of the existing BRPs in terms of stock conservation and sustainable utilization were not assessed in this review, and should perhaps be re-evaluated given potential changes in stock productivity (particularly if natural mortality rates are changing).

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*

Analyses relative to this ToR were not attempted in the current silver hake assessment.

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.*

Stock projections were not done because analytical assessment models were not used in this assessment. The silver hake stocks are not under rebuilding or recovery schedules, so the second part of this ToR is not relevant.

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

Previous recommendations included:

a) Develop survey information that covers the offshore range in the population.
b) Conduct surveys of spawning aggregations on the southern flank of Georges Bank.
c) Investigate bathymetric demography of the population.
d) Investigate spatial distribution, stock structure and movements of silver hake within Georges Bank, the Gulf of Maine, and the Scotian shelf in relation to physical oceanography.
e) Quantify age-specific fecundity of silver hake.

Analyses relative to these recommendations were limited to investigations of factors related to silver hake distribution and temporal changes in those, as indicated through the NEFSC survey data. Further work to investigate the offshore component of the stock beyond the NEFSC survey range would be highly useful for future silver hake assessments.

4.2.2 Suggestions for future assessments

Continue to explore age-structured analyses, and in particular model alternate hypotheses that could explain data inconsistencies. Specifically, evaluate alternative assumptions about survey catchability (both older fish less available/catchable and younger fish more available/catchable), and changes in natural mortality. It may not be possible to determine which of alternate model formulations is more likely. In that case it may be useful to run forward projections (say at fixed catch levels) for a variety of scenarios to see if potential management decisions are sensitive to uncertainty in stock dynamics.

Analyses to develop priors for the effect of door changes on relative catchabilites (see more detailed discussion in Mackerel section) could benefit this assessment.

Incorporate ageing errors (including how these have changed over time) in age-based stock reconstruction models. Re-ageing of structures collected during the 1970s and early 1980s suggest fish were over-aged by 1–2 years relative to current ageing protocols. The re-ageing was restricted to fish originally aged 6 and older. This should be extended to look at some fish that are younger in their original estimates (say ages 2–5) so that a complete ageing error matrix can be developed.

Estimate the relative efficiency of NEFSC surveys and the Supplemental survey with side-by-side tow comparisons (e.g., have the NEFSC vessel conduct the same tows as the Supplemental survey vessel during its spring survey time period).

The age-structured analysis reported in the 2000 assessment document included three series of survey *q*'s, where the three periods were determined based on model residuals. It would be more appropriate to allow changes in relative catchabilities only where there are changes in vessels and/or fishing gear, and ideally priors would be developed for the magnitude and direction of changes.

Consider including some interaction terms in the GAM or GLIM analyses of survey data (e.g. depth and time of day interactions).

4.3 Atlantic Mackerel

Documentation of analytical methods and modelling results was very limited in the mackerel assessment report, and this made review of the assessment more difficult than it needed to be. It would have been useful to have the model equations and the objective function, likelihoods, and priors. Additionally, model residuals for all fitted data (preferably standardized residuals, as they are easier to interpret than observed and predicted values) would have aided interpretation of modelling results. I appreciate that the working group that had reviewed the assessment did look at more detailed model outputs, but that information would be useful to external reviewers as well.

It was useful that VPA results were presented in the assessment, because this provided a clear transition to the new age-structured assessment model (ASAP). I fully support the move to a statistical catch-age framework and the additional flexibility this allows.

A key issue in the mackerel assessment is the uncertainty in the magnitude of the (large) 1999 year class which has dominated both the survey and the commercial catch since 2000. Because the magnitude of this cohort is somewhat uncertain, the future yield that can be taken from this year class is also uncertain. Note that the assessment clearly shows this uncertainty, both through the results from the retrospective analysis and from results of some sensitivity analyses (in particular the run where winter survey data were included). The uncertainty in the magnitude of the 1999 year class is largely the result of modelling separate survey catchabilities to account for the change in fishing doors in 1986. While this leads to considerable uncertainty in the stock assessment, the survey data support the need for the additional model parameters (an abrupt increase in survey catches of age 1 and age 2 fish beginning in 1986). Some ideas on ways to decrease this uncertainty are given in the "suggestions for future assessments" section.

The analyses presented in the mackerel assessment document are acceptable and based on scientific criteria. The move to a statistical catch-at-age model is positive, and uncertainties are presented through retrospective and sensitivity analyses. As such, the assessment provides a scientifically sound basis for providing management advice.

4.3.1 Discussion relative to Terms of Reference

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

Information on commercial landings and recreational catches is presented and satisfies this ToR. No information is provided about discards, but these are believed to be low, so they would not likely have much impact on overall removals. Information describing the historical and current distribution of catch and fishing effort would be useful for helping reviewers understand the fishery and how it has changed over time.

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*

The estimates of fishing mortality, spawning stock biomass and total stock biomass are presented along with analytical estimates of their uncertainty (standard error approximation based on Hessian). The assessment document and summary note that, given the retrospective pattern, these standard error estimates will underestimate the true uncertainties. This can be extended to include the additional uncertainty suggested by the alternative stock reconstructions from the sensitivity runs. Clearly, current abundance and fishing mortalities are not well determined by the data, given large changes in their estimates with small changes in model formulation.

Although the information presented relative to fishing mortality and stock biomass is based on scientifically credible analyses, the key point to note about the estimates is their great uncertainty.

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

Standard BRPs (MSY, F_{msy}, and SSB_{msy}) were updated based on the Beverton-Holt (B-H) stock recruitment relationship estimated for the base case ASAP run. The analysis used to re-estimate BRPs is scientifically defensible, although the caveat about uncertainty in estimates noted in the previous section also applies here. The base case estimate of the B-H steepness parameter was quite low (~0.5) for this species relative to results from meta-analyses (Myers *et al*., 2002). If the steepness parameter estimate were biased low, the BRPs would tend to be conservative (underestimate F_{msy}

and MSY). It is appropriate that the BRPs are re-estimated based on this new assessment.

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*

Catch estimates are presented based on stock biomass and the estimated *F* reference point (0.75*F_{msy}) for 2006 through 2008. Results suggest the potential for large increases in catch while remaining consistent with the *F* reference point (from ~100 000 t currently to >200 000 t). As previously noted, there is considerable uncertainty in the estimate of current biomass and hence the estimates of future yield, in part due to uncertainty in the magnitude of the 1999 year class.

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*

Short-term projections were conducted assuming catches would be consistent with the *F* reference point (0.75**F*msy). Alternate TAC/*F* strategies were not evaluated. The Atlantic mackerel stock does not have a recovery or rebuilding schedule.

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

Previous recommendations were:

a) Explore logbook data for information on catch rates and geographic distribution.
b) Explore Canadian trawl survey indices for use in VPA calibrations.
c) Explore the feasibility of acoustic surveys for monitoring the stock.
d) Examine estimates of *Z* calculated from research vessel survey data with respect to their usefulness in estimating natural mortality.

Little progress was made on addressing these previous research recommendations. Previous analyses suggest that the fishery cpue is unlikely to be a useful index of local abundance. Mackerel acoustic surveys have not been successful to date, but additional work might lead to more positive results. Information from Canadian scientists suggests that Canadian mackerel indices are not likely to improve the stock assessment at this time.

Lack of progress on previous research recommendations did not limit the value or scientific integrity of the current assessment. Note that the final recommendation, to evaluate survey-based *Z* estimates to inform estimates of natural mortality, are unlikely to be successful until the issue of the effect of changes in survey catchability are resolved to allow more precise estimates of recent fishing mortality rates.

4.3.2 Suggestions for future assessments

Develop priors for the change in relative catchability associated with the 1986 change in survey vessel doors by analysing the experimental (side-by-side tow) data. The priors could be size-based and developed for species groups rather than individual species to increase sample sizes. Size- or age-related effects are likely important. The use of the data to develop priors has the advantage over analyses that looked for significant effects because the power of the experiment(s) is likely low. The estimated prior distributions can then be used in Bayesian age-structured analyses to inform the magnitude and direction of the changes in relative catchability.

There may be potential and value to estimating priors for other survey changes (e.g. for use of RV "Albatross" vs. RV "Delaware II"). Then survey data can be treated as independent observations for the different categories (with priors for differences) rather than attempting (perhaps badly) to convert results from one to equivalent units of the other.

The current mackerel age-structured analysis estimates two sets of age-specific catchability parameters to model vessel door effects. Rather than treating the age-based effects as independent processes, it may be advantageous to model an age-based (or size-based) process. For example, the ratios of age-specific survey catchability (ratio for door-type 1 to door-type 2) could be modelled as a linear function of age (or size). This would decrease the number of additional model parameters to two, and may result in more stable estimates of the door effects on relative catchability.

The age-specific fishing selectivities were fixed in the ASAP analysis (at VPA-based estimates). These should be estimated (could be modelled to be asymptotic, if that is the belief). Note that during the SARC meeting a run was done where selectivities were estimated, and this had minimal effect on the analysis, so there is no concern about this relative to the current assessment.

The move to the ASAP model is a positive step. It would be useful in evaluating model performance to have standardized (Pearson) residuals presented for all model residuals. Also, formulation of the objective function in terms of likelihoods (rather than use of emphasis terms) will be useful if Bayesian estimation (e.g. MCMC results) is used to estimate uncertainty in the future.

4.4 **Illex** ***Squid***

Novel analytical approaches are being developed that reflect the unique life history of *Illex* squid. Standard analytical methods are not expected to work well for this species because of inconsistencies between assumptions of those models and *Illex* population dynamics. Although the Invertebrate Working Group did not accept outputs from the new models, the assessment scientists working on this species should be encouraged to continue model development, and especially new data collection programmes. The rejection of model outputs (e.g. new BRPs) is primarily the result of inadequate data to support the analyses at this time. The modelling approaches are scientifically sound, and their further development should continue to be supported.

Data currently available for the *Illex* squid stock assessment is very limited, but ongoing data collection programmes (e.g. tow-by-tow fishery information) will continue to build the base of useful information. Some new, well-designed (not necessarily large) data collection programmes could yield significant new knowledge and understanding of *Illex* life history and fisheries.

Current BRPs were calculated based on surplus production model analysis. An alternative method, based on a new maturation rate – mortality model and YPR/EPR calculations, is presented in this assessment. The new approach is superior to the previous surplus production analyses because it is based on maintaining spawning potential and incorporates key aspects of *Illex* biology (in particular multiple annual cohorts, post-spawning mortality, continuous recruitment). However, the parameter estimates from the maturation – mortality model may be of limited validity because; 1) they are based on only a single sample of age/maturity data (May 2000), and 2) growth rates appear to vary across seasons, and this needs to be explicitly modelled in the BRP calculations. The Invertebrate Working Group appropriately rejected the revised BRP calculations because of the above-noted concerns. Therefore, while it is premature to adopt the revised estimates until additional data are collected and analysed, it is important to acknowledge the new approach to BRP estimation as superior.

The paper “An age-based cohort model for estimating the spawning mortality of semelparous cephalopods...” focuses on ageing error as the reason that more older *Illex* are mature than is predicted by the maturation model. I feel the case that ageing error is the source of difference between observations and model predications is overstated, given that there are equally plausible alternative explanations. These include: 1) the model assumes constant weekly recruitment of cohorts that contributed to the May 2000 sample, which clearly will not be true, and 2) the parametric form (quadratic) of the maturation function may not be flexible enough to capture the true age-maturation relationship. The ageing error matrix is calculated based on the assumption that age overestimation and underestimation is equally likely, which may not be true.

4.4.1 <u>Discussion relative to Terms of Reference</u>

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

The information presented adequately fulfills this ToR requirement. Commercial landings data are summarized for US and Canadian waters 1963–2005, and geographic and temporal distributions of the fisheries are described. Estimates of *Illex* squid discards from 1995 to 2004 were calculated for both *Loligo* squid and *Illex* squid fisheries based on observer discard observations. Although discard estimates are imprecise, results suggest that discards are relatively small compared with landings. Recreational catch estimates are not provided, although they would be inconsequential.

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*

The assessment does not provide estimates of fishing mortality or stock biomass, because there is currently no basis for estimating these quantities. Surplus production models have been used in previous *Illex* assessments, but it is appropriate that they are not used here. The basic underlying assumptions of surplus production models are not met for the *Illex* fishery.

Relative abundance indices from the NEFSC fall survey are provided as potential estimates of post-fishery escapement. However, as noted in the assessment document, the survey occurs during a season when *Illex* are migrating out of the survey region (off the shelf), and the bottom trawl gear is inefficient at catching the pelagic *Illex*, so the survey-based index may not provide an accurate estimate of post-fishery escapement.

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

Existing *Illex* squid BRPs are based on surplus production analyses, which is an inappropriate method for estimating reference points for this species. The reasons for this are: 1*) Illex* squid appear to have two overlapping cohorts each year – production models work best when a population consists of multiple cohorts so that production trends are smoothed relative to more variable individual cohort signals; 2) *Illex* abundance indices from NEFSC trawl surveys are unlikely to reflect stock abundance.

TAC-based management is unlikely to be an effective method for controlling this fishery, given larger interannual fluctuations in abundance. Potential management systems that may be more effective and implementable include: 1) a closed area/season system designed to allow adequate spawning; and 2) a Management Procedure approach (see Stokes *et al*., 1999, and papers therein) based on in-season abundance estimates. Either of these approaches would likely require more information (data) about *Illex* and its interactions with the fisheries than is currently available.

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*

Stock biomass estimates are not available to allow these calculations. Current target fishing mortality rates should not be used for management.

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.

The *Illex* squid stock does not have rebuilding or recovery schedules. Models that would allow short-term projections were not available.

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

Many of the previous research recommendations were completed (continued model development, biological indicators of low and high productivity regimes, cooperative research programmes with industry, co-operative pre-season surveys, comparison of VTR and weighout catch data), while others were not because of data inadequacies or lack of funding (operating models to evaluate alternative management strategies, growth rates in relation to sea temperatures, season, and latitude). The SARC-37 recommendations provide a well-developed list of priority research areas where additional knowledge would greatly improve the ability to manage this resource.

4.4.2 Suggestions for future assessments

Probably the single most useful set of data that could be collected to learn more about the *Illex* fishery relative to the species life history is biological data (maturity, length, and weight of aged individuals) from the fishery. It will be worthwhile to give design of a fisheries sampling programme some consideration. Often catch sampling is designed to collect samples throughout a fishery, including gear types, locations, depths and season. While this is useful to characterize the catch, it may not allow analyses to determine how age and growth change temporally and spatially. To that end, a sampling design that focuses on limited components of the fishery (say one gear, 3 time periods [early fishery, mid-fishery and end-fishery weeks], and 2–3 locations/depths) may be more informative than samples spaced throughout the fishery.

Fishery catch rate standardization: Statistical significance may not be the best criteria to use in developing GLIM (or GAM) models, given the objective of the analysis is to develop indices related to abundance – possibly use a specified increase in the R^2 value as the criteria for accepting a more complex model (often in fisheries data standardization an increase of 0.5% or 1% is used). Investigate having separate models for the two fishing fleets – fleets may behave differently and one may provide more useful indices (i.e. one may be more reflective of relative abundance, it is possible that FT catch rates are more related to processing capacity than *Illex*). Also, pursue the idea that the LPUE index may be useful to index relative *Illex* abundance between years (if so, this might eventually be used for in-season TAC adjustments)

The poor performance of the in-season model on simulated data should be explored further to ascertain that there are no errors or bias in either the simulation model or the estimation model. Even with high correlation between N_0 and F, when data are simulated without random or systematic errors and the estimator is started at the correct (simulated) parameter values, the estimation should not move to a different solution.

For the maturation-mortality model, the non-spawning and spawning mortality parameters (M_{ns} and M_{sp}) are highly confounded, so analyses are based on fixing M_{ns} at different values and estimating M_{sp}. It may be possible to develop priors for the M_{sp} parameter (e.g. based on the average time a female is mature prior to dying), which would allow direct estimation of M_{ns}.

It may be worth considering using robust likelihoods in the *Illex* models to account for the occasional large deviation from model assumptions (e.g. occasional very young *Illex* that are mature). An example of a robust (improper) likelihood (normal distribution with multinomial variances) is given in Fournier *et al*. (1990), and application of robust likelihoods in a generalized fisheries model in Bull *et al*. (2003).

4.5 Multispecies predator-prey MSVPA-X model

The predator-prey MSVPA analysis represents a major effort to compile all available data on species abundance and diet composition for the mid-Atlantic coastal/estuarine ecosystem. The contributors to this project should be commended for this significant first step towards understanding the predator-prey dynamics of this system. Limitations to the utility of this type of model for multispecies management result from data limitations (especially diet composition data over broad spatial and temporal scale) rather than modelling limitations.

Evaluation of a model of this type needs to consider its objectives. Thus comments on the model given an objective of “aiding understanding of predation-prey dynamics in the ecosystem” would be quite different than for an objective of “providing advice for ecosystem management”. An ASMFC Internal Review Panel (for MSVPA-X) developed a list of specific objectives they felt the MSVPA-X could satisfy (Appendix 3), which is an appropriate basis for this review.

As currently formulated, the MSVPA-X model is designed to update the Atlantic menhaden VPA on the basis of predation by three predator species (striped bass, weakfish, and bluefish). Predation is dependent on the availability (abundance and distribution) and relative selectivity (prey preferences) of menhaden and alternative prey species. Abundance estimates for the predators and alternative prey species are not updated in the MSVPA-X analysis. This is likely the single biggest limitation of this model as there is considerable uncertainty in the predator and alternative prey species abundance estimates, prey preferences are likely to change with changes in the relative abundance of alternative prey species, and prey abundance may impact predator abundance.

4.5.1 Discussion relative to Terms of Reference

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

This ToR relates to the species that are directly modelled with the XSA model. For the current version of the MSVPA-X model this includes menhaden and two predator species (striped bass and weakfish).

Data inputs for the menhaden XSA appear adequate, because they are consistent with those used in the menhaden stock assessment, which has been peer-reviewed. A more rigorous approach would be to use a statistical catch-at-age model (e.g. ASAP), as was used in the most recent stock assessment. This would facilitate exploration of uncertainty in the menhaden assessment.

Striped bass and weakfish stocks are reconstructed using the XSA model, which results in slightly different stock reconstructions from those obtained in the stock assessments. Given that the predator stock reconstructions do not change through the iterative MSVPA-X modelling, it is not clear why the numbers-at-age matrices from the stock assessment were not used here.

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

It appears that the best available information is used to estimate bluefish and other prey species abundances. The use of length composition data from commercial landings to reflect population length composition does not appear valid, because commercial fisheries tend to target larger fish while predators often target the smaller fish of that species (e.g. herring commercial fishery length distributions, section 2.5.5.1). Likewise, the use of commercial and recreational fisheries data to infer species distributions may also be biased if the fisheries target the larger fish and the predators target the smaller fish of the species.

Assumptions made regarding diet and feeding selectivity are reasonable, given the available data. The real issue here is that the available data do not allow inferences about how diet and feeding preferences change when the relative abundances of prey species change.

3. *Review model formulation (overall setup, data handling, VPA calculations, assessment options, sensitivity analyses, recruitment model options, and forward projection options) of model as configured*

The MSVPA-X model is structured to be flexible with respect to using alternative VPA formulations, and the forward projection component of the model is flexible with respect to future recruitment and future harvest scenarios.

Results are presented from a number of sensitivity runs including: retrospective bias; dropping individual prey species; changing menhaden *M*1; prey type and prey size selectivity; predator and prey spatial overlap; changing parameters of the evacuation rate model; changing predator weight-at-age.

It would have been informative to see sensitivity results where alternative stock reconstruction formulations (different VPS methods, alternative formulations of XSA, statistical catch-at-age models) were used for menhaden, striped bass, and weakfish. Generally, stock reconstructions are highly sensitive to the models and model assumptions employed in the analyses. Absolute biomass is generally less well determined than biomass trends, and the impact of these uncertainties on MSVPA-X results are worth investigating.

4. *Develop research recommendations for data collection, model formulation, and model results presentation*

Long lists of research recommendations are provided and prioritized in the Internal Peer Review report (D5). Many of these, in particular the high priority recommendations, relate to obtaining existing data series, updating models, and expanding the MSVPA-X model structures. These recommendations are relatively simple and inexpensive to implement, they will extend and improve the analysis, and they should certainly be supported. Other research recommendations would be costly to implement and should be further developed to determine if there is value in pursuing them (e.g. conduct a coast-wide diet and abundance study).

5. *Evaluate whether or not the model and associated data are of sufficient quality to develop recommendations to management*

Neither the model nor the associated data are of sufficient quality to develop recommendations to management.

5. Additional questions not in Terms of Reference

For two of the reviewed stock assessments, *Illex* squid and silver hake, there was discussion during the review meeting about whether the existing Biological Reference Points (BRPs) were appropriate for the stocks. For both, although the existing reference points may be questionable, there was no obvious approach to developing more appropriate ones at this time.

For the *Illex* squid resource, the presenters of the assessment and the Review Panel concurred that existing BRPs were not appropriate. The current BRPs are based on *B*msy and *F*msy targets, but it is not possible to estimate *Illex* squid biomass.

For silver hake the current BRPs are MSY proxies based on; 1) NEFSC survey index levels, and 2) an exploitation rate index based on catch and the NEFSC survey index. Discussion of the utility of these BRPs occurred during the Review Panel discussions. These discussions related to the selected reference period, rather than the approach taken to develop MSY proxy reference points. Over the reference period (1973–1982), stock indices were relatively stable but catches were declining, therefore not reflecting a period of stability. Also, stock productivity may be changing, suggesting that a re-evaluation of reference points may be revealing.

6. Conclusions

Overall, the reviewed stock assessments are based on scientifically credible analyses, and as such provide a sound basis for developing fishery management advice. Although there are some considerable gaps in the data and the information available to understand fully the dynamic nature of the biological systems and their underlying processes, these caveats are acknowledged in the assessments.

Appendix 9: Panellist report – Yan Jiao

Report on the 2005 SARC-42 — Assessments of Silver Hake, Mackerel, Shortfin Squid and MSVPA-X in the Northeast United States

---

Yan Jiao

Prepared for

University of Miami

Independent System for Peer Review

Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute & State University
Blacksburg, VA
24061
Phone 540 2312749
Email: yjiao@vt.edu
http://www.fishwild.vt.edu/jiao.htm

Contents **Page**

Executive Summary

The 2004 assessments of silver hake, Atlantic mackerel, and shortfin squid in northeastern United States waters and the MSVPA-X model were reviewed as part of the SARC-42 (Stock Assessment Review Committee 42) process. The Assessment Review Panel met at Woods Hole, Massachusetts, from November 28 to December 4 2005. The assessments of the stocks were presented to the Panel, and the validity of the data, assessment procedures and results were discussed. A proposed new assessment method for shortfin squid, some new investigations on the survey data for silver hake, and a new multispecies VPA model for menhaden was presented and discussed. The Panel members then prepared their individual reviews.

In general, there was limited reference to uncertainty for both the input and output of the models. Compilations of reports on data uncertainty and estimation uncertainty in the future are suggested.

The silver hake assessment is considered inadequate for evaluating stock status. The current approaches used to estimate biological reference points B_{msy} and F_{msy} tend to be risky. The method can be considered for current use, but the years used to derive B_{msy} and F_{msy} need to be reconsidered. An appropriate age-structured model and a production model are suggested for consideration for stock assessment in future.

The Atlantic mackerel assessment is moving in the right direction; the data and assessment are considered adequate for evaluating stock status, but the estimated reference points changed dramatically this year, which resulted in several stakeholders expressing concern. The projected SSB in the next few years is higher than the current SSB, and is higher than historical values. An SSB based on the most recent years' data is suggested, such as keeping SSB above its average value between 1990 and 2000. This will bridge the influence of changing models and reference points. Estimation of uncertainty for the parameters, population size, and biological reference points is encouraged. An estimate of risk corresponding to different TACs is suggested; it would provide more information for managers.

The shortfin squid data and assessment are considered inadequate for evaluating stock status and deriving reference points. There is obvious room for improvement in the stock assessment of this short-lived semelparous species, but more data collection and modelling are needed before the method can be used to evaluate stock status. A quantitative or qualitative study based on environmental stimuli and escapement is suggested.

The MSVPA-X assessment model is not considered adequate for use in evolving recommendations on reference points for use by fishery managers, but it can provide answers to questions related to ecosystem considerations associated with management actions in future.

Some key recommendations are summarized below:

- Investigate stock structure of silver hake; collect adequate age composition data from surveys and commercial catches of silver hake that could support development of an age-based assessment.
- Investigate methods for extracting more accurate recruitment signals from surveys of Atlantic mackerel and shortfin squid.
- Obtain better estimates or signals of initial population size of shortfin squid and consider further developing an “operating model”; the latter was suggested by a previous SARC, but was considered impossible at the time. However, as more data and knowledge become available, this suggestion needs revisiting. Considerations of environmental stimuli and the influence of escapement on initial population size are encouraged; these considerations should help in the development of an “operational model”.
- Further develop tagging studies to investigate mortality, selectivity and migration of silver hake and mackerel.
- Further develop the MSVPA-X with more considerations of ecological reality, and test the predictability of the model.

1. Background

This report reviews the 2005 assessments of silver hake, Atlantic mackerel and shortfin squid in northeastern US coastal waters, and the MSVPA-X, at the request of the Center for Independent Experts of the University of Miami. I was provided with draft stock assessment reports and web access to relevant files and documents, and participated in the 42nd Northeast regional Stock Assessment Workshop (SAW 42) Stock Assessment Review Committee (SARC-42) Meeting.

2. Review activities

The SARC-42 meeting was held in the Stephen H. Clarke Conference Room of the Northeast Fisheries Science Center, Woods Hole, Massachusetts, from November 28 to December 4, 2005.

The meeting followed the “new model” of SARC reviews with a smaller panel than previously, although with the same number of invited reviewers. The meeting was open, and was attended by observers including members of the fishing industry. The draft assessment of each stock was presented to the Panel and other attendees, and the input data, models, parameter estimates and biological reference points were evaluated through open discussion. A conclusion was then drawn on whether to accept the assessment as a basis for management of the fisheries. The Terms of Reference for each stock were reviewed to ensure that they had been addressed fully, and recommendations from the previous SARC report were reviewed to determine the extent to which they too had been addressed.

3. Findings

3.1 Silver hake

3.1.1 Summary

A previous ADAPT-VPA model was rejected by the SARC, but I consider it still worth attempting to apply another age-structured model (NRC, 1998). The failure of the ADAPT-VPA may be because of the assumptions used in the model, while other statistical age-structured models could avoid some of the problems in the ADAPT-VPA. The approaches presented at the meeting were at times dangerous. An absolute lower bound on biomass based on the catch data from 1973 to 1982 is risky because those were years of big landings, whereas landings in recent years have been low. The method can be considered for current use, but the years used to derive B_{msy} and F_{msy} need to be reconsidered. We were presented with several new methods and studies on discard estimation, changes in stock distribution, and boundary estimation of relative biomass and exploitation rate, which were most valuable.

3.1.2 Terms of Reference

(A) *Characterize the commercial and recreational catch including landings and discards*

Recreational landings are minor, based on the results from the last assessment (Bibliography, A4), and were not re-estimated. Discards averaged about 4000 t y^{-1} during the period 2001-2004, based on the discard-to-kept ratio approach.

Concern at the recent truncation of older, larger fish in the commercial and NMFS survey data was raised. Ageing error was discussed, and attempts to re-age older fish from archived otoliths show that newly obtained ages average 1 or 2 years less than the original ages assigned. However, these slight biases do not seem to explain the age truncation seen in the survey, and the presence of older fish in the earlier part of the survey time-series show that more large fish than currently observed were present historically. The assumption of misidentification of offshore hake as silver hake was also addressed by the working group, and it was not considered likely that such older fish were misidentified because the otoliths of the two species are distinct, and no misidentified otoliths have been found in recent years. The older silver hake in the collection also seem to fall on the same age-length growth curve as the younger silver hake, indicating that they are most likely not offshore hake, although growth curves for offshore hake were not examined. The ages of silver hake in the commercial samples are not determined, and catch is not sorted by species, so it may include offshore hake, especially from the area along the shelf edge where offshore hake are more prevalent. The decrease in the numbers of large silver hake in commercial landings was discussed by the working group, and it was noted that the closure of areas for lobster pot fisheries could be influencing the catch composition because large fish were historically caught in such areas.

(B) *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*

No estimates of fishing mortality, spawning stock biomass or total stock biomass for the current year were provided. Trends in biomass and mortality were estimated for all years based on a biomass index and relative exploitation rate. Stock biomass levels are relatively high and fishing mortality rates are relatively low, based on this analysis.

(C) *Evaluate and either update or re-estimate biological reference points, as appropriate*

Reference points proposed by the New England Fishery Management Council's Whiting Monitoring Committee and in overfishing definitions for silver hake during recent years were reviewed and used in the assessment. The definitions of overfishing and overfished based on the current method are dangerous.

(D) *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*

It was not possible to complete work on this term of reference because stock biomass levels were not estimated for recent years in the report presented. Modelling is suggested for better setting biological reference points and future TACs.

(E) *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

Stock projections were not possible based on the current approach.

(F) *Review, evaluate and report on the status of the SARC/Working Group Research Recommendations offered in previous SARC-reviewed assessments*

- Develop survey information that covers the offshore range of the population.

  This research recommendation has been addressed. The Supplemental ("Transect") survey during the years 2003–2005 sampled relatively deep water along several transects. The results presented show that depth was a more significant predictor of large silver hake distribution than temperature, and a concern was that the NMFS survey does not effectively cover deeper habitat. More work will be done on this subject in the near future.

- Conduct surveys of spawning aggregations on the southern flank of Georges Bank.

  This research recommendation was not addressed.

- Investigate bathymetric demography of population.

  The current assessment includes extensive analysis of relationships between location, depth, size and age, based on bottom trawl survey data.

- Investigate spatial distribution, stock structure and movements of silver hake within Georges Bank, the Gulf of Maine, and the Scotian shelf in relation to physical oceanography.

  This research recommendation was not addressed.

- Quantify age-specific fecundity of silver hake.

  This research recommendation was not addressed.

3.1.3 Recommendations for future silver hake assessments

- Investigate stock structure of silver hake and develop theories on stock integrity (Campana *et al*., 1999);
- Collect more age composition data from surveys and commercial catches of silver hake to facilitate development of an age-based assessment.
- Confidence limits for survey-based estimates of recreational catch should be presented.
- The presence of silver hake in stratum 99 of NMFS surveys as well as in special deep-water surveys needs to be examined in order to determine if the NMFS survey is missing silver hake in deeper water, and additional tows at existing NMFS deep-water stations would be beneficial. All available surveys of water deeper than NMFS surveys should be examined for information on the distribution of silver hake.
- Review effects of gear changes in the NMFS survey on the catchability of silver hake by size.
- Develop a study to determine the extent of movement of silver hake along the coast, especially around Georges Bank.
- The next assessment should present the results of an age-structured model, and if possible reference points should be derived from model results.

3.2 Atlantic Mackerel

3.2.1 Summary

Considerable research effort has been devoted to changing the assessment model from ADAPT-VPA to ASAP. ADAPT-VPA was regarded as inappropriate for assessing mackerel because of the great uncertainty in the evaluating current population status. In the ASAP framework, sensitivity analysis on the weightings should be investigated, and weightings based on sample sizes or CVs are suggested. Uncertainty estimation on data input and model output should be shown or investigated in future stock assessments.

3.2.2 Terms of Reference

(A) *Characterize the commercial and recreational catch including landings and discards*

Atlantic mackerel were heavily exploited by distant-water fleets during the 1970s. Annual landings decreased to <50 000 t during the period 1978–1984. More recently, landings by both the USA and Canada have increased as world demand has increased. Historical landings were dominated by foreign fleets. The reason for commercial sampling intensity decreasing in 2004 is unknown, but sampling improved again in 2005. The commercial fishery is by both bottom and midwater trawl, but it is becoming more based on the latter. There has been a conversion of the fleet to midwater trawling, especially in terms of the larger vessels. There are few old fish in the recent fishery catch-at-age distribution, possibly an under-representation of old fish in the sampling, changes in distribution attributable to environmental cues and the location of the recent fishery mostly inshore, and schooling by size possibly becoming more pelagic and deeper as fish get older.

In both the US and Canada discarding is not thought currently to be large. In the years of ICNAF there were certainly discards, but they cannot be quantified. It is anticipated that as observer coverage increases on directed fishery boats, estimation accuracy of discards should improve.

(B) *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*

Estimates of fishing mortality, spawning stock biomass and total stock biomass over time were done on the basis of the ASAP model. Stock biomass levels are relatively high and fishing mortality rates are relatively low, based on current analysis. Retrospective analysis showed that SSB has sometimes been overestimated and F has sometimes been underestimated in recent years.

(C) *Evaluate and either update or re-estimate biological reference points, as appropriate*

Fishing-mortality-based biological reference points were re-estimated during SARC-42. Fishing mortality reference points are $F_{0.1}$ = 0.25 and $F_{40\%}$ = 0.24. Reference points from model-estimated B-H parameters are MSY = 89 000 t, SSB_{msy} = 644 000 t, and F_{msy} = 0.16. Surplus production in the mackerel stock was available sporadically during the period 1962–2004. The current surplus production over time was estimated using a production model, but in future it is suggested that an age-structured model be used for the purpose. BRPs estimated prior to SARC-30 used a bootstrap method and were F_{msy} = 0.45, F_{target} = 0.25, MSY = 326 000 t, and SSB_{msy} = 887 000 t (NEFMC, 1998). The difference between these values and those now proposed is huge, mainly because of the change in the underlying model. Considering the current relative population abundance index from surveys and the lower levels of harvesting in the most recent years, the new BRPs are considered to be acceptable. Risk analysis with full consideration of the uncertainties will help the different stakeholders involved in the fishery understand the stock dynamics better.

(D) *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*

These were done on the basis of current biomass and BRP estimation. Deterministic TAC estimates for 2006–2008 were conducted by inputting an estimated catch of 95 000 t in 2005 and a target fishing mortality of 0.12 (Amendment 8; $F_{target} = 0.75 * F_{msy}$) in 2006–2008. The uncertainties around these estimates need to be presented in future assessments.

(E) *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

Deterministic projections for the period 2006–2008 were conducted on the basis of a constant s/r relationship and the TACs predicted above. Uncertainties around these projections are needed for future assessments.

(F) *Review, evaluate and report on the status of the SARC/Working Group Research Recommendations offered in previous SARC-reviewed assessments*

- Explore logbook data for information on catch rates and geographic distribution.

  No analysis was completed to address this recommendation. The assessment working group feel that logbook data are not appropriate for analysing catch data and geographic distribution because of the improved targeting technology and the aggregation of the fishery.

- Explore Canadian trawl survey indices for use in VPA calibrations.

  The author explored the use of several additional trawl survey indices and egg production indices from Canadian trawl surveys as tuning indices, but currently they do not appear to be useful in resolving assessment issues for this stock. VPA was replaced by ASAP as the stock assessment model currently used.

- Explore the feasibility of acoustic surveys for monitoring stock size.

  Several attempts have been made to use acoustics to survey mackerel during recent winter cruises on the RV "Delaware II". To date there has been little success, but this does not preclude the future use of acoustics on this species, especially with the future availability of RV "Bigelow".

- Examine estimates of *Z* calculated from research vessel survey data with respect to their usefulness in estimating natural mortality.

  This research recommendation was not addressed.

3.2.3 <u>Recommendations for future Atlantic mackerel assessments</u>

- Investigate uncertainty in the back-transformed index.
- Collect adequate age composition data from surveys and from commercial catches of mackerel to improve age-based assessment.
- Estimate the uncertainties in population biomass and BRPs by considering the uncertainties in the data.
- Discard estimation needs to be improved by improving observer coverage of the fishery.
- Review the effects of gear changes in the NMFS survey on catchability of mackerel by size.
- Consider the use of environmental variables to adjust the NEFSC winter and Canadian surveys for changes in availability, and consider their use as tuning indices in modelling.
- Explore the use of environmental covariates to help explain recruitment deviations from the stock/recruitment relationship.

3.3 Shortfin squid (Illex)

3.3.1 <u>Summary</u>

Considerable effort has been devoted to determining the age of squid, standardizing the LPUE, and developing in-season and per-recruitment models. The BRPs presented at SARC-42 cannot be accepted as a basis for fishery management for the following reasons: there is no biomass prediction from the in-season model; the uncertainty of the estimated BRPs is large; estimated *F*-based BRPs from in-season and per-recruitment models are considerably higher than that from production model, which may lead to misinterpreting the current TAC.

The currently used production model for BRPs and TACs is not biologically reasonable. Although the working group felt that the relative exploitation index (discussed during SARC-42) for *Illex* may not be useful because the fall survey takes place after most of the squid fishery has passed; the spring survey is considered to track availability of the stock rather than stock abundance; and the survey indices do not encompass the entire habitat range for the *Illex* stock. However, the Panel felt that the exploitation index could be reconsidered as a complementary indicator of population status, considering the reality of the stock assessment. A quantitative or qualitative study based on environmental variation and escapement considerations is suggested (Huse and Gjosæter, 1999).

3.3.2 Terms of Reference

(A) *Characterize the commercial and recreational catch including landings and discards*

There is no recreational fishery for *Illex*. Observer data for the period 1995–2004 indicate that discarding of *Illex* occurs primarily in the *Illex* and offshore *Loligo* fisheries, and is higher in the latter. *Illex* discards appear to be relatively low overall and are not considered to be a significant source of uncertainty in the assessment relative to other sources. Landings and discards from the USA fishery and landings from the fisheries involving the northern stock component (Scotian Shelf and Newfoundland) were all updated for 2003 and 2004. The only other small-mesh fishery that interacts with *Illex* is the silver hake fishery, but *Illex* discards from this fishery are not believed to be significant.

(B) *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*

Considerable effort has been put into developing the in-season and per-recruitment models. However, no estimates of fishing mortality, spawning stock biomass or total stock biomass for the current year were done.

(C) *Evaluate and either update or re-estimate biological reference points, as appropriate*

The BRPs presented at SARC-42 cannot be accepted as a basis for fishery management. The currently used BRPs are from the production model and are not updated. The relative exploitation index for *Illex* may not be useful because it is based on the fall survey, which takes place after most of the fishery has occurred. Also, the spring survey index is considered to track availability of the stock rather than stock abundance. In addition, the WG considered that the survey indices do not encompass the entire habitat range for the *Illex* stock.

(D) *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*

The current TAC used is based on BRPs from the production model and has not been updated. The in-season and per-recruitment models presented during SARC-42 cannot solve this problem at the moment.

(E) *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

Stock projections were not possible based on the presented in-season modeling approach.

(F) *Review, evaluate and report on the status of the SARC/Working Group Research Recommendations offered in previous SARC-reviewed assessments*

- Continue model development, with the objective of producing sound statistical models for stock assessment purposes.

  All three models presented at SARC-37 were improved upon and tested further. These models require more seasonal age and maturity data before further model testing can be done.

- Consider the development of "operating models" which can be used to test the effectiveness of alternative management strategies.

  This research recommendation cannot be accomplished until a reliable stock assessment model is available. Please see the suggestions on constructing models for stock assessment in the summary and recommendation sections.

- Evaluate the relationship between growth rates and sea temperature to define possible changes in stock productivity associated with environmental conditions.

  This was not completed, but efforts will continue after more growth rate data have been collected.

- Define biological indicators of low or high productivity regimes.

  Some work has been done to address this recommendation and further work will be conducted.

- Evaluate seasonal and latitudinal clines in growth rates

This was not completed, but it will be continued after more growth rate data have been collected.

- Evaluate and design cooperative research programs with commercial vessels for sampling of size, weight and possible age of *Illex* during the fishing season.

  Cooperative research surveys from 2003 and 2004 have been completed, and the data have been used in SARC-42 modelling analysis.

- Continue with cooperative ventures for pre-season survey to obtain possible indices of upcoming stock abundance and productivity.

  A pre-season *Illex* survey was conducted using commercial vessels in 2000. More pre-season surveys are suggested.

- Evaluate catch rates by vessel by using VTR and Weigh out databases to improve procedures for standardization of nominal LPUE

  This recommendation was addressed in the documents presented,

3.3.3 <u>Recommendations for future shortfin squid assessments</u>

- Collect adequate age and maturity data throughout the season to improve our understanding of the *Illex* biology and to improve the in-season model presented.
- Investigate the sensitivity of the in-season model to data input and estimate the uncertainty of the model parameters.
- Continue pre-season fishery surveys to estimate initial population size.
- Evaluate the utility of relative abundance and biomass indices from the NEFSC winter survey.
- Conduct a quantitative or qualitative study based on environmental stimuli and escapement to predict next year or season’s population size.

3.4 MSVPA-X

3.4.1 <u>Summary</u>

A lot of effort has been devoted to collecting and analysing data, and developing the MSVPA model. The MSVPA-X assessment model is not considered adequate for use in evolving recommendations for use by fishery managers, but it could provide answers to questions related to ecosystem considerations associated with management actions in future. No BRPs were presented at SARC-42. The estimated population abundance and mortality rates are similar to those estimated from the single-species eXtended Survival Analysis (XSA) model, except for the results on age 0 menhaden.

The MSVPA-X presented by the research group showed that the focus of the model is menhaden. This should be clarified in the stock assessment model report and in the summary report. Uncertainties of the estimated parameters and model projections should be studied and shown in future stock assessments.

3.4.2 Terms of Reference

(A) *Evaluate adequacy and appropriateness of model input data, including fishery-dependent data, fishery-independent data, selectivities, etc. as configured*

There are limitations on the diet data, but a sensitivity analysis of the model output on the uncertainty of diet composition and prey preference will help to evaluate whether the current assumption of constant diet composition and prey preference lack reality in the model construction.

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

Diet, prey biomass and feeding selectivity will obviously vary largely among seasons and among years because of ecosystem changes over time. The presented menhaden population dynamics, based on historical data collected from different sources, seems acceptable, but this will not be good enough for projection.

(C) *Review model formulation (overall setup, data handling, VPA calculations, assessment options, sensitivity analyses, recruitment model options, and forward projection options) of model as configured*

The current model construction focuses on menhaden population dynamics, and the predator mortality variation caused by prey availability is not included. The assumption of menhaden natural mortality needs to be further addressed. Recruitment natural variation versus predation mortality needs to be re-considered. The use of historical food composition analysis does not seem appropriate for forward projection of menhaden population dynamics.

(D) *Develop research recommendations for data collection, model formulation, and model results presentation*

- Collect historical data from research on where menhaden were distributed during their lifetime for the historical menhaden predation mortality estimation and population simulation.
- Collect new predator stomach composition data along menhaden distributions for future menhaden population dynamics simulations.
- Test the sensitivity of the model projection to prey availability.
- Develop cross-validation analysis, which will help to identify whether without the calibration using the fishery-dependent and -independent abundance indices of menhaden and predator species, the predicted menhaden population size over time still follows the trends based on the single-species model, i.e. test the predictability of the MSVPA-X on the prediction of menhaden population dynamic modelling.

- Analyse the recruitment variability against predation mortality variability.
- Consider data uncertainty, estimate model output uncertainty, and uncertainty in the projected menhaden population dynamics.
- Increase biological and ecological reality in future model improvements.

(E) *Evaluate whether or not the model and associated data are of sufficient quality to develop recommendations to management*

A lot of effort has been put into collecting data, analysing data and developing the MSVPA model. The MSVPA-X assessment model is not considered adequate for use in evolving recommendations for use by fishery managers, but it can provide answers to questions related to ecosystem considerations associated with management actions in future.