50th Northeast Regional Stock Assessment Workshop
(SAW 50)

Stock Assessment Review Committee (SARC) Meeting
1 – 6 June 2010
Northeast Fisheries Science Center
Wood's Hole, Mass

SARC 50 PANEL SUMMARY REPORT

28 June 2010

Review Panel
R. O'Boyle (chair)
M. Bell
P. Sullivan
K. Trzcinski
J. Wheeler

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INTRODUCTION

Background

The Stock Assessment Review Committee (SARC) of the 50th Stock Assessment Workshop (SAW 50) met at the Northeast Fisheries Science Center (NEFSC), Woods Hole, MA during 1st – 5th June 2010 to review Northeast regional benchmark stock assessments of monkfish *(Lophius americanus)*, pollock (*Pollachius virens*) and sea scallop (*Placopecten magellanicus)*, guided by the SAW 50 Terms of Reference (Annex 2 of the SAW 50 Statement of Work provided below).

The SARC review panel (herein called the "Panel") consisted of R. O'Boyle (Beta Scientific Consulting Inc.), M. Bell (ICIT, UK), P. Sullivan (Cornell U.), K. Trzcinski (Fisheries and Oceans Canada) and J. Wheeler (Fisheries and Oceans Canada). R. O'Boyle and P. Sullivan are also members of the New England Fisheries Management Council's Scientific and Statistical Committee (SSC).

The SARC was assisted by the NEFSC SAW Chairman, J. Weinberg, his staff, and P. Rago (NEFSC). Documentation for the monkfish assessment was prepared by the NEFSC Southern Demersal Working Group (SDWG), and the presentations at the meeting were made by A. Richards and P. Nitschke (NEFSC). Similarly, documentation for the pollock assessment was prepared by the NEFSC Northern Demersal Working Group (NDWG), and the presentation at the meeting was made by L. Brooks (NEFSC). Finally, documentation for the scallop assessment was prepared by the NEFSC Invertebrate Working Group (IWG), and the presentation at the meeting was made by D. Hart (NEFSC).

A number of rapporteurs recorded the discussion to assist the Panel in its deliberations, including M. Traver and L. Alade (monkfish), T. Chute (scallop), J. Blaylock and J. Nieland (pollock).

Review of Activities

The Northeast Regional Stock Assessment Workshop (SAW) is a process consisting of three phases:

1. preparation of stock assessments by SAW Working Groups and/or by ASMFC Technical Committees / Assessment Committees
2. SARC peer review of assessments by a panel of external experts who judge the adequacy of the assessments as a basis of scientific advice to managers
3. presentation of the results and reports to the Northeast Region's fishery management bodies

Regarding the first phase, the SDWG met during 12 – 15 April 2010 to prepare the assessment of the monkfish stock. This is the first time since July 2007 that a benchmark assessment has been reviewed for this stock. The previous pollock assessment benchmark was conducted during the November 2007 – August 2008 GARM III review. To prepare the pollock assessment, the NDWG held three meetings: 1) meeting with pollock fishermen (22 January 2010), a data review meeting (22 – 23 February 2010) and a models meeting (29 March - 2 April 2010). The NDWG also met by correspondence and WebEx (30 April 2010) to review the assessment report and updated analyses. Regarding scallop, the benchmark assessment was last reviewed during the 45th SAW (4 - 9 June 2007). The IWG prepared the assessment reports in the months leading up to this SARC 50 meeting.

Regarding the second phase of the SAW process, early in May 2010, the NEFSC provided the Panel with extensive background documentation on each species. This included the prior assessments, documentation on the biology and fishery, information on the surveys and so on. The first assessment reports from the working groups were made available on or about 18 May 2010 with a complete set of working papers available soon thereafter (see bibliography below).

The Panel held an organizational teleconference on 19 May 2010 to prepare for the SARC meeting.

The SARC was convened during 1st – 5th June 2010, the agenda of which is summarized in Table 1 (see full agenda in annex 3 of the SAW Statement of Work below).

Table 1. Summary of SARC/SAW 50 Agenda during 1 – 5th June 2010

	1st June Tuesday	2nd June Wednesday	3rd June Thursday	4th June Friday	5th June Saturday
Morning	Monkfish assessment	Pollock assessment	Pollock revisit Pollock Assessment Summary Report Review	Scallop Assessment Summary Report Review	Panel Report Discussion (closed meeting)
Afternoon	Scallop assessment	Monkfish/Scallop revisits	Pollock Assessment Summary Report Review Monkfish Assessment Summary Report Review	Panel Report Discussion (closed meeting)	Panel Report Discussion (closed meeting)

The Panel devoted Friday afternoon and Saturday to developing consensus points for each stocks' Terms of Reference as well as observations on the SARC process. It was agreed that each panelist would use these points to draft a section of this report, which would then be compiled and edited by the SARC chair. The report was finalized subsequent to Panel review of the compiled document.

SARC Process

The Panel reached consensus on all Terms of Reference for each stock. It acknowledges the significant work that the working groups had undertaken to prepare for the SARC review. It also appreciates the professionalism and cooperation of NEFSC staff at the SARC meeting which significantly assisted the peer review. Notwithstanding this, the Panel considers that improvements in the peer review process could be made and offers the following comments to aid future peer reviews.

The SARC peer review is a critical step in the process, which includes considerable in-depth analysis and discussion of complex issues in the working groups. Given the limited time available to review assessments, the rationale for rejecting an assessment must be very strong. Further, there is not much room for rejecting an assessment when the alternative is perhaps worse. The present protocol stipulates that when an assessment is rejected, the previous formulation is to be used as a basis for management advice. This approach does not work well when the previous formulation is recognized as being tentative and inferior to the proposed formulation; it is more appropriate when there has been a gradual maturation of an assessment formulation. In the latter case, the SARC review has scope for rejecting working group proposed improvements, requiring a fallback to the previous formulation. The Panel recognizes that it may be difficult to identify when an assessment may fail but the NEFSC should give consideration to how best to deal with this situation.

For both the pollock and monkfish assessments, various hypotheses were discussed to describe the sometimes conflicting signals in the data, often motivated by the desire to explain retrospective patterns. Choices were made based upon expert judgment and the need to expedite the review process. The Panel considers that a more productive method would be to adopt a risk analysis approach (e.g. Francis and Shotton, 1997; Quinn and Desiro, 1999) in which the consequences of alternative model formulations for management decisions are formally determined. Under this approach, the risk of being overfished and overfishing occurring would be computed under various management scenarios and model formulations. The Panel recommends this approach for the pollock stock but it is more generally applicable. It could be argued that it is not the mandate of the SARC to undertake these analyses but rather have them undertaken later in the process. Notwithstanding this, it is the SARC's role to fully articulate the conflicting (and viable) hypotheses and provide the analytical basis for a risk analysis. The Panel strongly encourages exploration of a risk analysis approach in future assessments and in particular when a suite of potential models are being considered as the basis for management advice.

The Panel notes that identification of hypotheses to explain conflicting trends in the data was a particular problem with the monkfish review. Resolution was difficult due to a relatively unstructured approach to understanding and exploring issues in the assessment. There was a strong retrospective pattern in the northern management area that could be explained by any one of a number of changing biological processes or overly constrained model assumptions. In this situation, it is important to clearly identify the competing hypotheses, examine the probability of each and determine the risk to the resource that each might imply. At the SARC 50 meeting, the Panel formulated a table to document the competing hypotheses proposed to explain the retrospective patterns and

their associated probabilities in an attempt to organize discussion at the meeting. This approach should be adopted more formally within the working groups. The Panel recognizes that it is likely that these hypotheses were extensively discussed by the SDWG for monkfish but organizing this in tabular form as background for the Panel would have made this discussion more transparent to the SARC review and would have aided identification of logical pathways forward for this assessment.

The Panel encourages inclusion in future terms of references of issues that reflect on-going or historical concerns beyond just catch and / or surveys. For instance, it would be useful to consider a term of reference to address previous assessment concerns. Another useful addition would be to address comments provided by the SSC. The Panel appreciates the addition of the cooperative survey and diet analyses to the terms of reference, which allowed focused discussion during the meeting on these important issues.

The Panel considers that there was not enough time to fully evaluate the research recommendations. It could only identify those issues which it considered a priority to address. In the case of monkfish, it was evident that new research will be required to address assessment deficiencies. The paucity of time available to consider research recommendations is unfortunate. The scheduling of benchmark assessments should be dependent upon progress on resolving issues identified during the assessments. Thus it is important to identify those issues requiring priority attention. Future SARCs could be facilitated by having the working groups identify their priorities for research perhaps utilizing the tabulation of hypotheses as described above.

MONKFISH

Synopsis of Panel Review

The Panel accepts the monkfish assessment but expresses serious concerns regarding the high levels of uncertainty throughout the assessment. Uncertainties in landings, discards, commercial length frequencies, aging methods, life history, growth, and natural mortality are propagated through the SCALE assessment model and lead to greater uncertainties in estimates of stock size, recruitment, fishing mortality, biological reference points, and stock projections. The compounding nature of these uncertainties implies increased risk of not achieving the biological reference points.

The 2010 assessment is an update of the 2007 assessment, with minor modifications. The SDWG has identified uncertainties in results from the SCALE model, in particular strong retrospective patterns in the northern management area. The Panel recommends that a more systematic approach be taken to examining and communicating the sources of uncertainty within the model and the consequences of these uncertainties for interpreting the dynamics and formulating management actions.

The scope for future improvements in the assessment of monkfish is dependent on making substantial progress in the determination of age, growth and natural mortality. Future assessments should benefit from increased survey catchability of monkfish by the *RV Henry Bigelow*.

Evaluation of Terms of Reference

1. *Characterize the commercial catch including landings, effort, LPUE and discards. Describe the uncertainty in these sources of data*

The Panel concluded that this Term of Reference was met to the extent possible given the available data.

It is acknowledged that landings data prior to 1990 are uncertain, primarily due to both underreporting (prior to the mid 1970s and which cannot be quantified) and the bycatch nature of the fishery, especially in the northern management area. The Panel notes that the catch data are given considerable weight within the SCALE model, thus making them a very important component of the assessment.

There are multiple markets for monkfish, some for tails only and some for other body parts. As body parts only are often landed, conversion to whole weight must be made, leading to uncertainty due to variability in conversion factors.

Discard estimates, available since 1989, are based upon information that varies widely among management areas and gear types. Data from 1989 – 1991 are used to estimate discards during 1980 – 1989, assuming constant discards rates during this period. There is evidence to suggest that discard rates may have been higher prior to market development in the late 1980's; if so, this is not accounted for in catch data. Also, the SDWG assessment assumes that Post Capture Mortality (PCM) is 100 percent which may or may not be the case.

A key concern raised in the SDWG assessment is that although the catch has decreased in recent years, there has not been a corresponding expected expansion of the length distribution into larger size-classes within the fishery.

Landings per unit effort data are not used in the SCALE model as the time series is short and it is difficult to define targeted monkfish trips due to the by-catch nature of the trawl fishery in some areas. The Panel agrees with this decision.

Aging accuracy has been identified as a major problem for monkfish; samples since 2007 have not been aged. Although the SCALE model does not rely on age-specific information on a yearly basis, it does require accurate aging to develop an age-length key. Uncertainties in ages translate directly into uncertainties in model results. This is addressed further under Term of Reference (TOR) 4.

2. Report results of 2009 cooperative monkfish survey and describe sources of uncertainty in the data and results

The Panel concluded that this Term of Reference was met.

It agrees with the treatment of the 2009 cooperative survey results but expresses concern that data from this, and previous cooperative surveys, are not used to the fullest extent.

Cooperative surveys, conducted in 2001, 2004 and 2009, were initiated due to low catch rates of monkfish in the NEFSC surveys. Standardization between cooperative surveys is difficult as each survey has a different estimate of efficiency due to the use of different vessels and gears. However, one vessel (*FV Mary Kay*) participated in all surveys. Thus, the efficiency of this vessel to catch monkfish should be well known and future comparisons of survey abundance estimates may be more informative.

The cooperative surveys were originally designed to sample depths greater than 300 m where monkfish are known to occur but are not sampled by the NEFSC surveys. As such, these surveys could be useful in defining outer stock boundaries. Due to a variety of factors, including the difficulty of industry vessels to fish at these depths, this objective has not been met. This is unfortunate as high catch rates are clustered along the deep water boundary in all of the cooperative surveys.

The cooperative surveys provide an important source of information independent of the fishery, NEFSC surveys, and model formulations. An analysis presented during the meeting indicates that the 2009 cooperative survey estimate is consistent with the SCALE model retrospective - adjusted biomass for the northern management area. The Panel encourages detailed review and further analysis of existing cooperative survey data. Notwithstanding this, the Panel acknowledges that the future utility of cooperative surveys is somewhat tempered by the apparent higher monkfish catchability of the *RV Henry Bigelow* which is seven to eight times that of the *RV Albatross*. However, this should not preclude continuing the cooperative surveys until such time as an index of monkfish abundance is established using the *Bigelow*.

3. Characterize other survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, length data, state surveys). Describe the uncertainty in these sources of data

The Panel concluded that this Term of Reference was met.

It acknowledges that most surveys experience low catch rates of monkfish. For instance, the *Albatross* caught approximately 100 monkfish annually in each of the spring and fall surveys. It is encouraging that the *Bigelow* has a higher catchability of monkfish than the *Albatross* - 7.13 times by number and 8.06 times by weight. The *Albatross* / *Bigelow* conversion adds uncertainty to the 2010 assessment as only one year of data are available for the *Bigelow*. It will require time to develop a *Bigelow* abundance index of monkfish.

The Maine / New Hampshire (ME/NH) fall survey is included in the 2010 assessment model. This index has a relatively short time series (since 2000) and includes inshore areas only. The Panel notes that its inclusion as an index of abundance implies that trends in the inshore area are reflective of the population in the northern management area

Uncertainty in the assessment is due not just to generally low survey catch rates but also to a lack of larger monkfish, especially in the northern management area, in the survey catches. Despite a reduction in commercial catch due to management measures, there has not been an expansion of the size frequency distribution in the survey catches into older age groups, as would be expected based upon growth and reduced fishing mortality. The Panel acknowledges that this is a key source of uncertainty in the assessment.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and characterize the uncertainty of those estimates

The Panel concluded that this Term of Reference was met, although there is considerable uncertainty in the estimates of fishing mortality, recruitment and population biomass.

Large retrospective patterns in the northern management area may result from the strong recruitment during the early 2000s not translating into the presence of large fish in more recent catches. It is possible that similar uncertainties exist in the southern management area but may not be as evident due to the lack of a strong recruitment pulse. The Panel considers that the sources of uncertainty in the assessment are neither well characterized nor documented (see Panel comments under SARC Process above). Further analyses are required to fully explore the sources and consequences of this uncertainty.

The SCALE model was used in 2007 with a number of caveats. It is used again in this assessment with minor modifications. The Panel acknowledges that the SCALE model is superior to the previously used survey-based approach as it allows for the integration of a wide array of information and for the exploration of uncertainties. However, the Panel encourages exploration of alternative approaches such as SS3, CASA, and others as appropriate.

During the SARC meeting, adjustment of the 2009 population numbers for the retrospective pattern was discussed. The swept area biomass estimates from the cooperative survey tended to corroborate the retrospective - adjusted estimates from the SCALE model. However, it was noted that the retrospective pattern appeared to be getting less severe in recent years. The Panel decided to use the unadjusted 2009 population estimates for determination of stock status and use in projections. However, it

recommends that adjusted estimates be provided to indicate the impact on future stock status if the retrospective pattern continues (see TOR 6).

It is not clear if standard data exploration techniques have been employed in the assessment (e.g. catch curve analysis). In this assessment, the SCALE model indicates an increasing trend in abundance in recent years that is not apparent in any of the survey indices or in the fishery length frequencies. This caused considerable concern for the Panel. Confirming this trend through standard data exploration can serve as a useful reality check on the model results.

If SCALE is to be used in the future, the Panel recommends that a table of hypotheses be developed which explore the potential causes, implications and uncertainties associated with the assessment. Are uncertainties more likely caused by observation error (landings, discards, etc.) or by process error (growth, mortality, age, etc.)? Candidate hypotheses can then guide research to elucidate causes that are most likely.

During the SARC review, the assumed growth model used within SCALE was identified as a likely cause of the retrospective patterns. While SCALE does not use annual age-length keys, it is dependent upon a fixed growth model. The linear growth model used in SCALE assumes no aging uncertainty, yet aging has been identified as a major cause of concern, especially of the older age groups. Age, growth and mortality interact and share joint uncertainty. The assumption that M=0.30 caused further concern, given an assumed M=0.15 for a similar species in the Northeast Atlantic. The Panel strongly recommends that priority be given to reconciling the uncertainties in age, growth and natural mortality of monkfish.

5. Update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, and F_{MSY}; and estimates of their uncertainty). Comment on the scientific adequacy of existing and redefined BRPs

The Panel concluded that this Term of Reference was met.

The SDWG updated the BRPs developed in 2007. Overfishing reference points were calculated using an age-based yield per recruit model to update the value of F_{MAX}. In the 2007 assessment, biomass reference points were developed using SCALE model results, where B_{TARGET} was the average biomass during the model period, and $B_{THRESHOLD}$ was the lowest biomass from which the stock has been observed to increase.

Redefined BRPs based upon the methodology employed for the New England groundfish stocks (GARM III) were also provided by the SDWG. Overfishing is still defined as occurring at or above the F_{MAX} proxy of F_{MSY}. The overfished reference point is based upon the long-term projected biomass corresponding to this proxy.

The Panel considers that the redefined BRPs are scientifically superior to the 2007 BRPs (either as is or updated) as they are based upon stock dynamics as described in the integrated SCALE model. However, while the Panel considers the scientific basis of the redefined reference points to be adequate, it notes their dependence upon the high level of uncertainty in the assessment model. The uncertainties in the results of the SCALE model carry through into the BRPs, creating high uncertainty and low confidence in the latter.

6. *Evaluate stock status with respect to the existing BRPs, as well as with respect to updated or redefined BRPs (from TOR 5)*

The Panel concluded that this Term of Reference was met. The Panel notes that, based upon existing BRPs from the 2007 assessment, monkfish are not overfished and overfishing is not occurring in either the northern or southern management areas. Similarly, based upon redefined BRPs from this assessment, monkfish are not overfished and overfishing is not occurring in either the northern or southern management areas.

The Panel decided not to adjust 2009 stock size for the retrospective pattern but noted that recent patterns are in a negative direction and should be used to understand potential risks to the resource. As noted in the SARC Assessment Summary Report, in the northern management area, if the 2010 assessment suffers from a similar retrospective bias as the average over the past seven years, a projection at the proposed ACT = 10,750 t using adjusted 2009 stock sizes indicates a 65% chance that total biomass will fall below the adjusted $B_{THRESHOLD}$ by 2016.

Without knowing the reason(s) for the retrospective pattern, it is not possible to state whether or not the current assessment is biased. The biomass reference points were re-estimated during the meeting, adjusted for the retrospective patterns. Under both the unadjusted and adjusted scenarios, monkfish in both the northern and southern management areas are not overfished and overfishing is not occurring.

It is important to note that these analyses are subject to high uncertainty in the assessment and the related concerns regarding BRPs (see TOR 5). The Panel recommends further exploration of retrospective patterns based upon hypothesis-driven model formulations.

7. *Evaluate monkfish diet composition data and its implications for population level consumption by monkfish*

The Panel concluded that this Term of Reference was met.

Ecosystem considerations are important to include in single species assessments and in this case provide a valuable contribution to the understanding of monkfish as a voracious piscivore within the ecosystem.

The Panel considers that the potential implications of the consumption of commercial species by monkfish are well described. However, it is not clear if population level impacts on monkfish are occurring due to predation by other species. If such information is available, it would be valuable to integrate these impacts into the population dynamics of monkfish.

8. *Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).*
    a. *Provide numerical short-term projections (through 2016). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions to examine important sources of uncertainty in the assessment.*

b. *Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.*
c. *Describe this stock's vulnerability to becoming overfished, and how this could affect the choice of ABC*

The Panel concluded that this Term of Reference and its three sub-sections were met. Projections were made for 2011 – 2016 using AGEPRO, assuming F in 2010 equal to the estimated F in 2009 from SCALE, fishing at $F_{THRESHOLD}$ and at proposed ACTs and ABCs with stochastic long-term recruitment.

The Panel emphasizes that projections are highly uncertain due to uncertainties in data sources (eg: under-reported landings, and unknown discards in the 1980's), uncertainties in life history (eg: age and growth, and natural mortality), and consequent uncertainties in the SCALE model results (eg: retrospective patterns).

Based upon its life history, monkfish are not particularly vulnerable to becoming overfished. However, the projections indicate that monkfish in the northern management area are vulnerable to overfishing or becoming overfished during 2011 – 2016 if total catches approach the proposed ABC. The high level in projection uncertainty translates into high level of risk in using these projections.

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

The Panel concluded that this term of reference was met in that the SDWG reported on the status of previous research recommendations. In its 2010 Assessment Report, the SDWG identified approximately 30 research recommendations from SAW 34 (2001), SAW 40 (2004), and the 2007 Data Poor Stocks Workshop. Due to time constraints, these were not presented during SARC 50.

The Panel notes that most research recommendations since the 2007 assessment have not been addressed. It is not clear if this was due to resource limitations.

The Panel recommends that the list of recommendations indicated for deletion be re-examined. For example, there are several recommendations regarding exploratory analyses within the SCALE model, to which the response is "SCALE is not currently configured to be able to do this". Rather than deleting these recommendations, reconfiguration of the model should be considered.

Given time constraints, there was insufficient time for the Panel to fully evaluate the research recommendations. Based upon its review of the monkfish presentation, the Panel identifies three high-priority areas for future research:

1. Although it has been identified previously, it is critically important to validate aging, growth, and natural mortality
2. Evaluation of the sampling of the fishery length frequencies is required to ensure that it is adequate and not a cause of the retrospective pattern
3. If SCALE is to be used in future assessments, adjustments need to be made to the model to adequately respond to research recommendations and other identified limitations; if this is not possible, alternative models and approaches should be considered

SEA SCALLOP

Synopsis of Panel Review

The Panel accepts the sea scallop assessment as a sound scientific basis upon which to base fishery management decisions. The assessment was marked by a rigorous examination of data sources, biological parameters and other input values, and associated uncertainties, and the assessment outcomes were well supported by the available information. Strong analytical frameworks were defined for estimating fishing mortality, stock biomass and recruitment (CASA model), for defining biological reference points (SYM model) and for performing stock projections to inform ABC decisions (SAMS model). An innovative approach was developed for quantifying uncertainties around BRPs relative to exploitation levels, facilitating the incorporation of risk assessment into fishery management decisions. The SAMS model allows complex spatial management scenarios to be addressed for the purposes of comprehensive management planning.

The principal uncertainty surrounding the assessment concerns the current high productivity levels, apparent especially in the Mid-Atlantic Bight. It will be important to establish whether current productivity depends on temporary environmental factors, in which case the situation may revert to previous lower levels of productivity, or is determined principally by a stock-recruitment relationship given high current biomass levels.

Evaluation of Terms of Reference

1. Characterize the commercial catch including landings, effort, LPUE and discards; describe the uncertainty in these sources of data

The Panel concluded that this Term of Reference was met.

Sea scallop landings data are well characterized for the two principal areas, Georges Bank (GB) and the Mid-Atlantic Bight (MAB), with data series starting at the beginning of the 20th century. Recent patterns in both areas show landings rising to a peak in the early 1990s before falling rapidly to much lower levels in the mid-1990s. Landings increased again during 1998 - 2003, driven principally by harvests in the MAB, and have remained high since then. Historically, GB was the largest component of the scallop resource, but the bulk of the fishery now occurs in the MAB responding to recent high productivity in this area.

Discarding occurs due to capture of undersized scallops and some highgrading. Some information is available on discard size-frequency and discard mortality, but these are poorly known for the data series as a whole and discards are not included explicitly in the assessment model (TOR 3). Instead, they are included with other non-yield mortality sources in a simple estimate of incidental mortality.

Data on commercial size composition show strong shifts in selection towards larger scallops in recent years. Scallops smaller than 90 mm shell height were an important component of the landings up to the late 1990s, but were rarely taken from 2002 onwards.

Data on days fished in the scallop fishery show increases in fishing effort from the mid - 1960s to the early 1990s before decreases, first in response to low catch rates, then to effort reduction measures. Effort has since increased, especially in the MAB and has remained relatively stable over recent years, with some shifts between regions. Landings per unit of effort (LPUE) showed declines between the mid - 1960s and mid - 1990s, with occasional increases in response to strong recruitments. Large increases in LPUE have been seen since the late 1990s, and LPUE has been particularly high in the special access areas.

The Panel considers that commercial catch and effort data were characterized to the extent possible given the available information sources, and uncertainty in the data was adequately described.

2. Characterize the survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, length data, etc.). Describe the uncertainty in these sources of data. Document the transition between the survey vessels and their calibration. If other survey data are used in the assessment, describe those data as they relate to the current assessment (Exclude consideration of future survey designs and methods)

The Panel concluded that this Term of Reference was met.

An annual scallop dredge survey is undertaken by NEFSC, covering GB and the MAB with a stratified random design. Data on unlined dredge catches for 1975, 1977 and 1978 and lined dredge catches for 1979 onwards are included in this assessment. Uncertainty within surveys was expressed by confidence intervals around annual biomass and abundance indices for GB and the MAB, calculated using standard methods for stratified random surveys. Generalized linear mixed models applied to paired tow data show convincingly that the survey is robust to changes in vessels and dredge modifications, but recent data have been adjusted for effective tow distance and for use of rock chains on hard ground. Dredge efficiency was estimated by sampling of survey tows using the HabCam towed digital camera. Use of efficiency-corrected swept area biomass estimates from the surveys allows information on absolute scale to be incorporated in the stock assessment (TOR 3). Survey catch composition data were also included in the assessment, in the form of shell height frequencies for scallops ≥40 mm.

SMAST video survey data for scallops were available for 2003 onwards, providing information on both scallop density and shell height frequency. Selectivity of ‘large camera’ survey data was estimated by comparison with ‘small camera’ survey data, and the ‘large camera’ data were taken forward into the assessment with fixed selectivity. Uncertainties owing to measurement errors in shell height and to edge effects in the camera field of view were rigorously characterized.

The NEFSC winter bottom trawl survey for 1992 - 2007 was also used in the assessment model for the MAB (TOR 3), but results of this survey were not otherwise reported during SARC 50.

The Panel considers that the survey data used in the assessment were well characterized, with rigorous examination of sources of uncertainty and calibration issues. The Panel recommends that a table of the weightings given the CASA modeling elements be included in the Assessment Report.

3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and characterize the uncertainty of those estimates

The Panel concluded that this Term of Reference was met and that the final assessment results provide a sound scientific basis for decisions about fishery management.

The stock assessment depends crucially on certain biological parameters, including the shell height/meat weight relationship, age and growth and natural mortality. These parameters were updated based on recent data and variability and uncertainty in the parameters was addressed.

Age and growth were re-evaluated, and evidence provided that shell rings are laid down annually rather than twice annually as has been inferred elsewhere (related to semi-annual spawning). Growth was described in terms of transition probabilities between 5 mm shell height classes based on observed increment data. This has the benefit of depending neither on a particular growth model nor on the ability to determine the absolute age of scallops as early growth rings may be obscure.

Natural mortality was re-considered in this assessment, including an evaluation of its uncertainty. The statistical properties of the estimator for M were explored, given information on uncertainty about the separation time for articulated shells after death. This provided a new value for M = 0.12 for GB. A life-history invariant relationship was used to infer M = 0.15 for MAB. The Panel agrees with the IWG's proposed changes in M.

Catch at size analysis (CASA) was used as the assessment model, applied separately to GB and MAB stocks. This is a size-based model, based on modeling transitions between shell height classes over annual time steps. Age determination of scallops enters the model only in the construction of the size transition matrices from growth increment data, hence age structure is not used and there is no dependence on determining the absolute ages of scallops. The model was tuned using NEFSC dredge survey (unlined for 1975, 1977 and 1978, lined for 1979 onwards), the SMAST large camera survey (2003 onwards) and, for MAB, the NEFSC winter bottom trawl survey (1992 - 2007). Survey data allowed informative priors on absolute scale of abundance and biomass to be included in the assessment. The CASA model was previously used in 2007 (SARC 45), and 14 changes to the model specification were presented at this meeting (see Assessment Report). Of all these changes, the use of yearly commercial meat weight anomalies had the largest effect on assessment outcomes. The Panel endorses the use of the CASA model and the refinements used. It notes the need to document all model changes in the Assessment Report, giving information on their rationale and impact on assessment outcomes.

Good fits to the survey and commercial size-frequency and trend data were reported. However, there were moderate retrospective patterns, most evident for the MAB where there was a tendency for fishing mortality estimates to be revised upwards over time and for biomass estimates to be revised downwards. Possible sources of this pattern were explored during the meeting; it was hypothesized that the model fails to account for higher mortality experienced in the younger stages of some large year - classes. This was most notable for the 2001 year - class in the MAB, first apparent in the surveys in 2003, but there was evidence of a more general tendency for the early stages

of some large year - classes to be under-represented in the model. It was suggested that unaccounted mortality of large recruitments may be due either to density-dependence of natural mortality or to discarding/incidental fishing mortality, but these possibilities remain to be verified. Another source of retrospective pattern for the MAB concerned conflicting signals between the SMAST large camera survey abundance, which showed a sharp decline in 2009, and the NEFSC dredge survey abundance, which showed an increasing trend. This conflict remains unresolved, and it will be important to identify its likely sources as new survey data enter future assessments.

Abundance, biomass and fishing mortality estimates from the CASA model were validated against simple data-based estimators and found to be reasonable. Model abundance and biomass estimates were comparable with expanded direct survey estimates, and model fishing mortality estimates were consistent with both a length-based equilibrium estimator and an empirical exploitation index. Changes in commercial selectivity in the two areas were consistent with the introduction of spatial management.

While standard errors were tabulated for all model estimates, it should be noted that the IWG was reluctant to report them as it felt that they did not adequately reflect the true uncertainty in the model. For this reason, inflated values were used in the projections (TOR 6). The Panel agrees that this is likely the case but considers them useful to report in order to monitor relative uncertainty and how future changes to model structure and model inputs might change this uncertainty. The Panel also notes that in future, it would be useful to provide discussion on this uncertainty around model outcomes, with appropriate caveats.

Likelihood profiles were constructed for natural mortality and large camera survey selectivity. The Panel considers that these analyses were informative, both providing support for the model input values (including the increased values for M) and illustrating the tensions between the data sources. It recommends that, to aid model diagnosis, a table of likelihood components and weights be included in the Assessment Report. Overall, the Panel agrees that the IWG has provided characterization of uncertainty in the assessment, although it remains unclear how uncertainty in the input values was used in the model.

4. Update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, and F_{MSY}; and estimates of their uncertainty). Comment on the scientific adequacy of existing and redefined BRPs

The Panel concluded that this Term of Reference was met and that the resulting BRPs provide a sound basis for fishery management.

Previous BRPs for scallops (SARC 45) were based on per recruit analyses, using F_{MAX} as a proxy for F_{MSY} and calculating the B_{MSY} proxy as biomass per recruit at F_{MAX} multiplied by median recruitment from the CASA model. The IWG provided updates of these BRPs based on the new CASA model, and included an adjustment from January 1st to mid-year for the biomass reference point, but proposed adoption of BRPs based instead on a new approach involving a Stochastic Yield Model (SYM). The SYM approach addresses concerns about the imprecision of determining F_{MAX} using a very flat yield per recruit curve (which results from the shift in commercial selectivity towards larger scallops) and also meets the need for a risk-based approach to fishery management (e.g.

inclusion of uncertainty in BRPs and stock projections). Furthermore, unlike the previous proxy-based approach, SYM incorporates stock-recruitment relationships, which may be important considering the evidence for strong recruitment in MAB over the recent period when biomass has also been high.

The SYM is based on a Monte Carlo approach, incorporating information on uncertainty among the parameters (including correlation structure when appropriate). Probability density functions were calculated for all relevant parameters, including M, selectivity, growth parameters, shell height/meat weight relationship, discard and incidental fishing mortality, and stock-recruitment relationship (Beverton-Holt parameters). Parameters were drawn from their distributions for each run, and yield curves were calculated by combining yield per recruit and stock-recruitment relationships. The IWG considered that, given uncertainty, MSY is best represented by the maximum of the median yield curve rather than the mean of individual MSY estimates. Outputs from SYM were used to characterize uncertainty in the BRPs as well as in the input values. This allows the trade-off between the probability of overfishing and the expected yield to be measured, facilitating the incorporation of risk assessment into fishery management decisions (see TOR 6).

BRPs were developed for GB and the MAB separately and for the scallop stock as a whole, although only the latter was used to assess stock status (see TOR 5). The IWG cautioned that the estimated MSY depends on the assumption that increased recent recruitment in the MAB results from increased biomass levels, i.e. a stock-recruitment relationship. If, instead, this is a result of temporary (and currently unknown) environmental factors, then this would result in MSY being overestimated.

The Panel endorses the new SYM-derived BRPs, and commends the IWG for developing an innovative approach that will prove useful in scallop fishery management and may find application in assessments for other species. It suggests that SYM be applied using F_{TARGET} as a control variable rather than realized F. It suggests that, for the benefit of the SSC, it would be useful to construct plots of historical fully-selected F in relation to F_{MSY}, similar to what has been provided for pollock. Thought should be put into developing a consistent metric of fishing mortality to represent changes over time, possible candidates being biomass-weighted averages or calculation of an exploitation index for scallops ≥80 mm shell height.

5. Evaluate stock status with respect to the existing BRPs, as well as with respect to updated or redefined BRPs (from TOR 4)

The Panel concluded that this Term of Reference was met.

GB and the MAB are treated as a single management unit, so that their status is considered in relation to BRPs for the scallop stock as a whole. Based on SYM model outputs, the stock is not overfished, and overfishing is not occurring, although the probability of overfishing is only marginally less than 50%. It is worth noting that, consistent with stock biomass being around B_{MSY} and current landings being close to MSY, current fishing mortality is close to (but fractionally under) F_{MSY}. This situation requires careful monitoring, and particular attention needs to be paid to the biological basis for current high productivity. Current productivity is at unprecedently high levels, particularly in the MAB, and without understanding whether this relates to stock-

recruitment relationships or environmental conditions, it is impossible to be certain how long this state may hold.

Overfishing is estimated to occur if the previous F_{MSY} proxy or its updated value is used although the same overfished status conclusion (not overfished) would have been reached if the previous $B_{THRESHOLD}$ or its updated value is used.

6. Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).

a. Provide numerical short-term projections (through 2014). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions to examine important sources of uncertainty in the assessment.

b. Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.

c. Describe this stock's vulnerability to becoming overfished, and how this could affect the choice of ABC

The Panel concluded that this Term of Reference was met.

Sea scallop stock projections were conducted using the Scallop Area Management Simulator (SAMS) model, versions of which have been used since 1999. The SAMS model simulates size-based population dynamics (consistent with the CASA model) and also incorporates spatial structure in the form of two regions (GB and MAB) and 16 sub-regions, each of which can be involved in rotational or long-term closures to the fishery. Initial conditions for the projections were based on the 2009 NEFSC dredge survey, with dredge efficiency chosen to match the 2009 CASA biomass estimates. Bootstrapping of survey data was used to describe stochasticity around starting conditions. Growth was modeled using area-specific increment data. Other parameters were modeled using the same approach as the SYM model. Given that the CASA model was considered to underestimate the uncertainty in fishing mortality, standard errors were multiplied by two for the purposes of the SAMS model.

The spatial structure makes the projections complex, but is necessary to accommodate spatial management of the fishery and is also suited to the sedentary nature of the species. The SAMS model will be used by the Scallop Plan Development Team to evaluate the possible management alternatives and thus only example projections were provided at the meeting assuming a combination of permanent and rotational closures. These projections indicate that biomass and landings would increase slightly from 2009 under status quo management, and that given recent selectivity patterns, the stock's vulnerability to being overfished is low.

The Panel approves the new approach to informing ABC decisions derived under TOR 4, taking into account uncertainty in both current fishing mortality and the BRP. This method quantifies the risk of overfishing and loss of yield at a specified fishing mortality. The Panel also approves the SAMS projection method, noting that it was extensively reviewed and approved at SARC 45. It notes that projections are more appropriately performed as part of a comprehensive planning procedure. As such, it is

not currently possible to say whether or not the example projections are realistic, but the Panel agrees that the approach developed by the IWG provides a sound basis for management planning.

Regarding vulnerability, early maturity (age 2) and high reproductive potential should make scallops relatively robust to exploitation. According to the assessment presented by the IWG, the stock currently appears to be at negligible risk of being overfished. However, as noted above (see TOR 5), this conclusion is drawn under the current conditions of high productivity, especially in the MAB, and it is possible that the situation could revert to lower productivity as observed in the past. There is an appreciable (almost 50%) probability that overfishing is occurring, but this is not unexpected given that the fishery appears to be harvesting the stock at close to MSY levels (i.e. at close to the maximum production).

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

The Panel concluded that this Term of Reference was met.

The IWG reported progress against eleven research recommendations emanating from SARC 45. Good progress has been made with refining estimates of natural mortality, and this was included as part of the current assessment. The Panel commended the IWG for their progress on this topic and endorsed the ongoing work using information from the closed areas. Evaluation of the accuracy of the SAMS model was undertaken changes in assumptions about growth, natural mortality and incidental mortality may make the model forecasts more realistic. Efforts to implement a seasonal growth model within CASA resulted in poor model performance so that the current assessment retains the annual growth model.

A number of recommendations from SARC 45 were not addressed. The Panel recognizes that not all recommendations are high priority and time and resources may have been limiting. The focus of many of the recommendations was on improving the assessment model rather than addressing invalid assumptions or improper assessment configurations.

Three interlinked priority areas were identified by the Panel:

1. Inclusion of discard estimates and post-capture mortality into the assessment. Discards were not included in the model, being considered implicitly using an incidental mortality term. Discard data should be included in the assessment, and some account taken of the size-specific nature of discarding and incidental mortality processes. This may be particularly important in the light of the failure of the CASA model to account for the mortality experienced by strong year - classes evident in the surveys, notably the 2001 year - class in theMAB.
2. Research into the biological and environmental basis for changes in productivity in GB and the MAB. This might include analyses of historical spatial patterns within the stock, changes in these patterns over time and consideration of oceanographic and climatic factors and their possible impacts on stock-recruitment processes. Age determination for archived shell material from the 1980s and 1990s may usefully contribute to these analyses.

3. Research should continue into the sources of retrospective pattern in the assessments, especially for the MAB. Further examination of sources of unaccounted mortality may be promising in this respect, considering both post-capture mortality and natural mortality for strong recruitments.

The Panel endorses the list of eleven recommendations for the future drawn up by the IWG. Several aspects of the work presented as part of the 2009 assessment are innovative, notably the treatment of uncertainty in the biological reference points and the uncertainty in M. The Panel urges the IWG to make these methods and analyses accessible to a wider scientific readership by publishing in the peer-reviewed scientific literature.

POLLOCK

Synopsis of Panel Review

The Panel accepts the pollock assessment and considers that the newly proposed assessment method (ASAP) is a significant improvement over the previous one (AIM). It was evident that the ASAP model and the pollock assessment had been given thorough exploration which built confidence in the model and the assessment results. It will be important to see how this assessment matures over the coming years. There is, however, significant concern over the presumed large and as of yet unobserved adult biomass (i.e. cryptic biomass) and the implications for management decisions. For this reason, the Panel recommends a risk analysis approach (e.g. Francis and Shotton, 1997; Quinn and Deriso, 1999) to determination of the consequences of assumptions on this biomass for management. In addition, the Panel emphasizes the need for research that would confirm (or not) its existence.

Evaluation of Terms of Reference

1. *Characterize the commercial and recreational catch including landings, effort, LPUE and discards. Describe the uncertainty in these sources of data, including consideration of stock definition*

The Panel concluded that the Term of Reference was met.

Landings were presented from 1960 to 2009 in tabular form and from 1964 to 2009 in figures. Considerable effort was put into estimating commercial discards which averaged 3% of U.S. commercial landings. Discard to kept ratios were calculated for all species and discard estimates were stratified by area, half year, gear, and mesh. Discards prior to 1989 were assumed to be negligible as there were no regulations to encourage discards. There may have been some discarding in the southern part of the management unit prior to 1989 but it was thought to be limited. Post catch mortality is assumed to be 100% and the discarding is mostly of undersized fish. The Panel recommends a more complete examination of discards from 1970 to 1988.

Care needs to be taken to ensure that catch sampling is adequate as the ASAP assessment model is fundamentally an age-based approach. Sampling protocols may need to be changed to respond to upcoming management changes (e.g. sector allocations) in the fishery.

The Panel notes that the stock definition is a refinement of that used in the last assessment as it now only considers pollock in US waters. This stock definition caused the NDWG difficulty with attributing catches in the Bay of Fundy and Georges Bank, particularly prior to and after the implementation of the Hague line (uncertainty as to which side of the line US and Canadian landings were caught in statistical units 523 & 524). Pre-1985 landings with and without those assumed to have occurred in the Canadian zone of the stock unit might not differ by more than 1kt for U.S. landings and 2 - 3 kt for Canadian landings, but this needs to be researched further. At the meeting, the Panel suggested two model runs to test the sensitivity of the results to uncertainty in these

data. The first was to double the coefficient of variation (CV) of the total catch prior to 1985 while the second was to decrease the catch by 50% during this period. The effect of these sensitivity runs was to decrease the estimate of the 2009 standing stock biomass - by 7% (from 196 kt to 182 kt) in the doubled CV run and 16% (from 196 kt to 164 kt) in the decreased catch run. The overall temporal trends in biomass remained the same. The Panel thought that this was a useful exercise and indicates that the assumptions made in this assessment on the allocation of historical landings across the LeHague Line should not be cause for concern. For completeness however, it recommends that adjustments be made to the Canada / US transboundary catch prior to 1985 by the next assessment.

Scientists and managers need to recognize the complexity of the pollock stocks due to extensive movement, as tagging data suggest that pollock in U.S. waters and on the western Scotian Shelf can be considered a unit stock based upon connectivity. While joint US / Canada management may not be possible at this time, collaborative research might be fruitful in characterizing the nature of this stock and its movements (e.g. systematic tagging studies).

2. Characterize the survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Describe the uncertainty in these sources of data, including consideration of stock definition

The Panel concluded that this Term of Reference was met.

The most recent index of abundance from the spring and fall survey is from a new NMFS research vessel, the *RV Henry Bigelow*. The NDWG did not estimate a calibration coefficient for this vessel as there were few fish caught in the survey on which to base an analysis. Thus the catchability was assumed to be the same as for the previously used *RV Albatross*. However, pollock catch rates may be lower using the Bigelow due to lower tow speeds (3 kts on the *Bigelow* compared with 3.8 kts on the *Albatross*), potentially allowing large pollock to escape the survey net. A lower catchability of pollock using the *Bigelow* would reduce sampling effectiveness and has implications for the NMFS survey time series.

While the NDWG decided not to use the Maine / New Hampshire survey, the Panel recommends that future assessments consider incorporating this survey as a recruitment index, following more detailed analysis of this survey gear's selectivity on ages 1 - 3.

The estimated dome-shaped selectivity for the NMFS survey suggests that there is cryptic biomass that is not being caught (i.e. biomass that is not observed by the survey but is assumed to exist). This assumption has significant consequences for management of the stock. The Panel recommends that survey, tagging or other monitoring studies be undertaken to confirm the presence of this cryptic biomass. The rationale for a decline in the survey selectivity from ages 8 to 9+ is consistent with the assumption that large, faster swimming pollock can avoid capture by the NMFS survey. While this is not an unreasonable assumption, it needs to be confirmed.

3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and characterize the uncertainty of those estimates

The Panel concluded that this Term of Reference was met.

ASAP is a significant advance over AIM. It includes age / size structure, has a greater range of fishery and survey information and a statistical framework to evaluate the contribution of input and parameters.

There was considerable model exploration by the NDWG and a comparison undertaken to an alternative Statistical Catch at Age (SCAA) formulation which gave similar results in terms of relative stock trends. The current model formulation and assessment was well explored and justified. Also, the envelope analysis using the swept area estimates from the NMFS surveys provided bounds on the population biomass and independent corroboration of the ASAP results.

In general, the uncertainty in the ASAP model was well estimated. This started with the inclusion of data and associated CVs and effective sample sizes, but was also explored through different data assumptions, assumptions about selectivity, and a retrospective analysis. Notwithstanding these examinations, the predicted presence of a cryptic biomass is a major concern. The model is estimating biomass at older ages that is not 'observed' by either the fishery or surveys due to domed selectivities. The Panel considers it somewhat paradoxical that the fishery has shifted exploitation from younger to older age groups over time, yet according to the ASAP model, the oldest of these age groups (9+) are not available to capture. It is comforting that the overfished status does not change when a flat-topped NMFS survey selectivity is used in the ASAP model, although B_{MSY} (from 91.0 kt to 58.0 kt) and MSY (from 16.2 kt to 11.2 kt) changed. This is due to the fact that 2009 spawning biomass also changes (from 196 kt to 77 kt). The Panel recommends that the retrospective pattern be explored and documented further. It is particularly important to better understand if the cryptic biomass is related to the selectivity assumptions and to what degree. It would thus be useful to include a retrospective analysis using an assumed NMFS survey flat-topped selectivity in the Assessment Report.

The Panel notes that the SCAA formulation developed by D. Butterworth and R. Rademeyer was configured differently from the NDWG's ASAP formulation and produced larger biomass estimates throughout the time series. The Panel would have liked to have seen more details of the Butterworth and Rademeyer model during the SARC but recognizes that only a summary was available to the NDWG at the time of the SARC 50 meeting. The Panel also feels that the pollock assessment using the ASAP model should be more fully explored through consideration of alternative weightings on the inputs to determine their consequences for the model results. For example, the current ASAP model puts high weight on the catch data. It would be useful to determine how the results would be affected if the model was fit more closely to the survey data. The Panel recommends that the model weightings be fully documented in the Assessment Report.

The Panel requested that the AIM analysis be updated during the meeting. An assessment using the AIM approach, as used in the previous assessment, indicates that the pollock stock is overfished and overfishing is occurring. This may be due to a mismatch between the biomass in the NMFS fall survey (the only one used in the AIM) and catch biomass, caused by a shift in the fishery selectivity towards the older age groups over time. The Assessment Report needs to more fully document the difference in stock status indicated by the AIM and ASAP models and the rationale for this difference.

4. Update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, and F_{MSY}; and estimates of their uncertainty). Comment on the scientific adequacy of existing and redefined BRPs

The Panel concluded that this Term of Reference was met.

The BRPs were completely redefined, using the approach employed on some GARM III stocks and having a solid scientific basis. The BRPs are now based on the F_{MSY} proxy of $F_{40\%}$. Given that the steepness parameter of the stock – recruitment relationship was not well defined, the time series of long-term recruitment was used in the determination of B_{MSY}.

These BRPs are heavily dependent upon assumptions on the shape of the fishery selectivity curve as well as the time blocks during which each fishery selectivity is assumed to apply. The NDWG provided a time trend in the F_{MSY} proxy to illustrate how the overfishing definition responds to changes in fishery selectivity over time. The Panel recommends that the historical trend in $B_{THRESHOLD}$ (0.5 * B_{MSY}) also be estimated to illustrate how the overfished definition has responded to historical changes in fishery selectivity.

The Panel accepts the redefined BRPs. Previous BRPs were based on the AIM approach, which does not incorporate age structure and uses only the NMFS fall survey data. Compared to the current approach which is based upon the ASAP model results and projections using AGEPRO, the AIM approach makes limited use of available data.

5. Evaluate stock status with respect to the existing BRPs, as well as with respect to updated or redefined BRPs (from TOR 4)

The Panel concluded that this Term of Reference was met.

When a dome-shaped survey selectivity was used, the stock is not overfished and overfishing is not occurring. When flat-topped survey selectivity was assumed, the stock is also not overfished and overfishing is not occurring. This gave the Panel reassurance that 2009 stock status was being correctly identified. However, the BRPs changed significantly under the two selectivity assumptions, which have consequences for the projections (see TOR 7):

	Dome-shaped Survey Selectivity	Flat-topped Survey Selectivity
B_{MSY}	91.0 kt	58.0 kt
$F_{40\%}$ age 5 - 7	0.25	0.22
MSY	16.2 kt	11.2 kt

It should be noted that $F_{40\%}$ at ages 5 – 7 was chosen as the historical change in fishery selectivity on these age groups has been limited, facilitating consideration of temporal trends in the overfishing reference point. The Panel notes that when the survey selectivity is assumed to be flat, the fishery selectivity becomes less domed. It encourages further examination of this phenomenon.

The Assessment Report presented the $F_{40\%}$ for ages 5-7 during 1970 – 2009. The equivalent changes in $B_{THRESHOLD}$ (0.5 * B_{MSY}) were not available to allow examination

of historical trends in the overfished state. The Panel recommends that this analysis be included in the Assessment and Summary reports.

As noted under TOR 4, the previous BRPs derived from AIM would have ascribed the 2009 stock status as overfished and overfishing occurring, this perhaps due to a mismatch between the survey and fishery selectivities.

6. Evaluate pollock diet composition data and its implications for population level consumption by Pollock

The Panel concluded that the Term of Reference was met. Consideration of the broader ecosystem implications of pollock diet was a very interesting and valuable contribution to the SARC meeting.

While it is important to see ecosystem considerations in assessments, it was not clear to the Panel if there were population level impacts on the SARC 50's species of interest (e.g. additional mortality due to predation or competition). If so, there is value in future integration of these types of impacts into the population dynamics of these species.

The Panel recommends that the ecosystem consequences of the presence / absence of cryptic pollock biomass be explored. At the meeting, it queried whether or not the ecosystem could support an additional 50 kt of large pollock. It encourages further examination of the consequences of this possibility.

7. Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).

a. Provide numerical short-term projections (through 2017). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions to examine important sources of uncertainty in the assessment.

b. Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.

c. For a range of candidate ABC scenarios, compute probabilities of rebuilding the stock by 2017.

d. Describe this stock's vulnerability to becoming overfished, and how this could affect the choice of ABC

The Panel concluded that this Term of Reference was met. Projections of spawning stock biomass and landings at $F_{STATUS\ QUO}$ = 0.07, 0.75*F40% = 0.19 and F40% = 0.25 were presented. Overfished state did not occur under any scenario to 2017.

The Panel wishes to highlight uncertainties in these projections. They are based upon an assumption that recruitment during the projection period is relatively independent of spawning stock biomass. Recruitment would be expected to be influenced by density dependent processes at low stock sizes. The projections of stock biomass are appropriate if the survey and fishery selectivity assumptions are true. However, density dependent influences on recruitment could become an issue if flat-topped survey selectivity is true but a domed selectivity was used to undertake the projections. This

could create a situation in which the stock biomass was in reality lower than was projected, perhaps to levels where recruitment would be reduced.

The Panel recommends that it would be useful when making stock projections to more explicitly formulate the consequences to the pollock stock of different model assumptions in a decision table similar to that employed in risk assessment (e.g. Quinn and Deriso, 1999). In the current situation, there were four possible scenarios to consider – two assumed survey selectivities (domed and flat-topped) times two true survey selectivities (domed or flat-topped). The Panel considers that the risk of pollock being overfished is highest amongst these scenarios when a domed survey selectivity is assumed but a flat-topped selectivity is true.

Assumption	**True**	**False**
Domed survey selectivity	Low risk	*High risk*
Flat survey selectivity	Low risk	Low risk

The Panel did not have time to fully explore this approach but encourages further exploration of its use when making stock projections to describe the consequences of one assumed scenario when an alternative one is true. This could inform decisions on future harvest levels.

The Panel considers that pollock spawning aggregations may make segments of the population more vulnerable to exploitation. It notes that loss of the Eastern Scotian Shelf stock component as an example of this. Some consideration of this in management would be prudent.

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

It is unclear to the Panel whether or not there are research recommendations additional to those of the NDWG, making it difficult for the Panel to state whether or not this Term of Reference was met.

The Panel concluded that the priorities for research are:

1. confirm the presence / absence of the cryptic biomass
2. acquire a better understanding of stock structure

The Panel did not have time to fully explore how these priorities should be investigated but notes that a range of research activities are possible for each - selectivity studies, systematic tagging, alternative surveys (e.g. cooperative), cameras on *Bigelow* tows for the former and systematic tagging, otolith chemistry for the latter. The Panel considers that it is also important to undertake analyses of the consequences of different stock structure hypotheses on management decisions, perhaps employing a decision table as presented above.

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WP1-Appendices. Invertebrate Subcommittee, 2010. *Appendices to the Sea Scallop Assessment Report for 2010.* 50th Northeast Stock Assessment Workshop, Appendices to Assessment Report.

WP2. Invertebrate Subcommittee, 2010. *B. Sea Scallop Assessment Summary for 2010.* 50th Northeast Stock Assessment Workshop, Assessment Summary Report.

Pollock background documents

C1. Northeast Fisheries Science Center, 2008. *Pollock in subareas 5 and 6.* pp. 642-657 in: *Assessment of 19 Northeast Groundfish Stocks through 2007 Report of the 3rd Groundfish Assessment Review Meeting (GARM III), Northeast Fisheries Science Center, Woods Hole, Massachusetts, August 4-8, 2008.* Northeast Fisheries Science Center Reference Document 08-15.

C2. Thompson, N., 2009. *Update on status of pollock, including Autumn 2008 NEFSC survey data.* Unpublished memo to Pat Kurkul.

C3. Mayo, R.K., 1998. *Pollock.* pp. 67-69. in: *Status of Fishery Resources off the Northeastern US for 1998.* Northeast Fisheries Science Center.

C4. Northeast Fisheries Science Center, 1993. *Pollock.* pp. 7-38 in: *Report of the 16th Northeast Regional Stock Assessment Workshop (16th SAW): Stock Assessment Review Committee (SARC) Consensus Summary of Assessments.* Northeast Fisheries Science Center Reference Document 93-18.

C5. Mayo, R.K., 2001. *Scotian Shelf/Georges Bank/Gulf of Maine Pollock.* pp. 155-161. in: *Assessment of 19 Northeast Groundfish Stocks through 2000: A Report to the New England Fishery Management Council's Multi-Species Monitoring Committee.* Northeast Fisheries Science Center Reference Document 01-20.

C6. Mayo, R.K., Col, L. & Traver, M., 2005. *Georges Bank/Gulf of Maine Pollock.* pp. 359-371 in: *Assessment of 19 Northeast Groundfish Stocks through 2004: 2005 Groundfish Assessment Review Meeting (2005 GARM), Northeast Fisheries Science Center, Woods Hole, MA, 15-19 August 2005.* Northeast Fisheries Science Center Reference Document 05-13.

C7. NOAA, 1989. *Stock Assessment Information for Pollock, Pollachius virens (L.), in the Scotian Shelf, Georges Bank, and Gulf of Maine Regions.* NOAA Technical Memorandum NMFS-F/NEC-65.

C8. Neilson, J.D., Stobo, W.T. & Perley, P., 2006. Pollock (*Pollachius virens*) stock structure in the Canadian Maritimes inferred from mark-recapture studies. *ICES Journal of Marine Science*, **63**, 749-765.

C9. North East Fisheries Science Center, 2010. *Pollock Data Meeting.* Unpublished background document.

C10. Clay, D., Stobo, W.T., Beck, B. & Hurley, P.C.F., 1989. Growth of juvenile pollock (*Pollachius virens* L.) along the Atlantic coast of Canada with inferences of inshore-offshore movements. *Journal of Northwest Atlantic Fishery Science*, **9**, 37-43.

C11. Chase, P., Brown, R., Politis, P., Sherman, S. & King, J., 2010. *Comparison of surveys.* North East Fisheries Science Center, unpublished background document.

C12. North East Fisheries Science Center, 2008. *Technical Documentation for ASAP Version 2.0.* NOAA Fisheries Toolbox.
C13. Stone, H., Nelson, C., Clark, D. & Cook, A., 2009. *2008 Assessment of Pollock in 4VWX+5.* Canadian Science Advisory Secretariat, Research Document 2009/001.
C14. Nies, T.A., 2010. *Management of the Northeast Multispecies Fishery 1977-2009.* New England Fishery Management Council, Pre-Decisional Information.

Pollock working papers

WP1. Northern Demersal Working Group, 2010. *C. Stock Assessment of Pollock in US Waters for 2010.* 50th Northeast Stock Assessment Workshop, Assessment Report.
WP2. Northern Demersal Working Group, 2010. *C. Pollock Assessment Summary for 2010.* 50th Northeast Stock Assessment Workshop, Assessment Summary Report.

STATEMENT OF WORK

(v. 5 April 2010)

External Independent Peer Review by the Center for Independent Experts
50th Stock Assessment Workshop/ Stock Assessment Review Committee (SAW/SARC)
Monkfish, Sea scallop, and Pollock

Statement of Work (SOW) for CIE Panelists
(including a description of SARC Chairman's duties)

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.com.

Project Description: The purpose of this SARC50 meeting will be to provide an external peer review of benchmark stock assessments for monkfish (also called goosefish, *Lophius americanus*), sea scallop (*Placopecten magellanicus*), and pollock (*Pollachius virens*). Goosefish are piscivorous, and they rest partially buried on soft bottom substrates and attract prey using a modified fin ray that resembles a fishing pole and lure. Sea scallops are relatively large filter-feeding bivalves that rest on the bottom. Pollock are fast swimming, schooling fish. This review determines whether the scientific assessments are adequate to serve as a basis for developing fishery management advice. Results form the scientific basis for fishery management in the northeast region. This meeting satisfies Prioritization criteria 1-3. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**. The SARC Summary Report format is attached as **Annex 4.**

The SARC50 review panel will be composed of three appointed reviewers from the Center of Independent Experts (CIE), a reviewer from the New England Fishery Management Council's Science and Statistics Committee (SSC) and an independent chair from SSC of the New England or Mid-Atlantic Fishery Management Council. The reviewer from the NEFMC SSC is expected to perform duties similar to those described

herein for CIE reviewers and on a similar schedule. The SARC panel will write the SARC Summary Report and each CIE and SSC reviewer will write an individual independent review report.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. In general, CIE reviewers for SARC meetings shall have working knowledge and recent experience in the application of modern fishery stock assessment models (e.g., statistical catch-at-age, delay-difference, and traditional VPA). Reviewers should also have experience in evaluating measures of model fit, identification, uncertainty, and forecasting, as well as in development and application of biological reference points. Direct experience with the biology and population dynamics of species on the agenda would be beneficial.

Specifically for the monkfish assessment, reviewers should be familiar with length-based statistical assessment models and methods for experimentally estimating trawl capture efficiency, and survey trawl calibration studies. Familiarity with statistical methods for ageing fish, and monkfish in particular, is desirable.

For the scallop assessment, reviewers should be familiar with methods for assessing invertebrates, especially length-based approaches. Expertise in the implications of spatially distinct harvest patterns for stock dynamics and implications for appropriate harvest rates and biological reference points is essential.

For the pollock assessment, reviewers should be familiar with methods for estimating relative abundance of a schooling fish, statistical catch at age models, and potentially methods for model averaging.

Each CIE reviewer's duties shall not exceed a maximum of 17 days to complete all work tasks of the peer review described herein.

Not covered by the CIE, the SARC chair's duties should not exceed a maximum of 17 days (i.e., several days prior to the meeting for document review; the SARC meeting in Woods Hole; several days following the open meeting for SARC Summary Report preparation).

Location and Date of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled at the Woods Hole Laboratory of the Northeast Fisheries Science Center (NEFSC) in Woods Hole, Massachusetts during June 1-5, 2010.

Charge to SARC panel: The panel is to determine and write down whether each Term of Reference of the SAW (see **Annex 2**) was or was not completed successfully during the SARC meeting. To make this determination, panelists should consider whether the work provides a scientifically credible basis for developing fishery management advice. Criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are

correct/reasonable. Where possible, the chair shall identify or facilitate agreement among the reviewers for each Term of Reference of the SAW.

If the panel rejects any of the current Biological Reference Point (BRP) proxies for B_{MSY} and F_{MSY}, the panel should explain why those particular proxies are not suitable and the panel should recommend suitable alternatives. If such alternatives cannot be identified, then the panel should indicate that the existing BRPs are the best available at this time.

Statement of Tasks:

1. Prior to the meeting

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

Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein:

Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/sponsor.html).

Pre-review Background Documents: Approximately two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers

are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

2. During the Open meeting

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs can not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

(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. For the assessment, review both the Assessment Report and the draft Assessment Summary Report.

During the question and answer periods, provide appropriate feedback to the assessment scientists on the sufficiency of their analyses. It is permissible to discuss the stock assessment and to request additional information if it is needed to clarify or correct an existing analysis and if the information can be produced rather quickly.

(SARC CIE reviewers)
For each stock assessment, participate as a peer reviewer in panel discussions on assessment validity, results, recommendations, and conclusions. From a 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. If a reviewer considers any existing Biological Reference Point proxy to be inappropriate, the reviewer should try to recommend an alternative, should one exist.

During the question and answer periods, provide appropriate feedback to the assessment scientists on the sufficiency of their analyses. It is permissible to request additional information if it is needed to clarify or correct an existing analysis and if the information can be produced rather quickly.

3. After the Open meeting

(SARC CIE reviewers)

Each CIE reviewer shall prepare an Independent CIE Report (see **Annex 1**). This report should explain 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 SARC panel" statement.

If any existing Biological Reference Points (BRP) or their proxies are considered inappropriate, the Independent CIE Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRPs are the best available at this time.

During the meeting, additional questions that were not in the Terms of Reference but that are directly related to the assessments may be raised. Comments on these questions should be included in a separate section at the end of the Independent CIE Report produced by each reviewer.

The Independent CIE Report can also be used to provide greater detail than the SARC Summary Report on specific Terms of Reference or on additional questions raised during the meeting.

(SARC chair)

The SARC chair shall prepare a document summarizing the background of the work to be conducted as part of the SARC 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 (see **Annex 4**).

(SARC chair and CIE reviewers)

The SARC Chair and CIE reviewers will prepare the SARC Summary Report. Each CIE reviewer and the chair will discuss whether they 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 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 panel to

reach an agreement. The chair will take the lead in editing and completing this report. The chair may express the chair's opinion on each Term of Reference of the SAW, either as part of the group opinion, or as a separate minority opinion.

The SARC Summary Report (please see **Annex 4** for information on contents) should address whether each Term of Reference of the SAW was completed successfully. For each Term of Reference, this report should state why that Term of Reference was or was not completed successfully. The Report should also include recommendations that might improve future assessments.

If any existing Biological Reference Point (BRP) proxies are considered inappropriate, the SARC Summary Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRP proxies are the best available at this time.

The contents of the draft SARC Summary Report will be approved by the CIE reviewers by the end of the SARC Summary Report development process. The SARC chair will complete all final editorial and formatting changes prior to approval of the contents of the draft SARC Summary Report by the CIE reviewers. The SARC chair will then submit the approved SARC Summary Report to the NEFSC contact (i.e., SAW Chairman).

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in **Annex 2**.

Other Tasks – Contribution to SARC Summary Report: Each CIE reviewer will assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. CIE reviewers are not required to reach a consensus, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate during the panel review meeting in Woods Hole, Massachusetts during June 1-5, 2010, and conduct an independent peer review in accordance with the ToRs (**Annex 2**).
3) No later than 18 June 2010, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr.

Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and Dr. David Sampson, CIE Regional Coordinator, via email to david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

30 April 2010	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
18 May 2010	NMFS Project Contact will attempt to provide CIE Reviewers the pre-review documents by this date
1-5 June, 2010	Each reviewer participates and conducts an independent peer review during the panel review meeting in Woods Hole, MA
4-5 June 2010	SARC Chair and CIE reviewers work at drafting reports during meeting at Woods Hole, MA, USA
18 June 2010	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
21 June 2010	Draft of SARC Summary Report, reviewed by all CIE reviewers, due to the SARC Chair *
28 June 2010	SARC Chair sends Final SARC Summary Report, approved by CIE reviewers, to NEFSC contact (i.e., SAW Chairman)
2 July 2010	CIE submits CIE independent peer review reports to the COTR
9 July 2010	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

* The SARC Summary Report will not be submitted, reviewed, or approved by the CIE.

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.

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) each CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) each CIE report shall address each ToR as specified in **Annex 2**,
(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Contracting Officer's Technical Representative (COTR)
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-713-2363 ext 136

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Key Personnel:

Dr. James Weinberg, NEFSC Stock Assess. Workshop (SAW) Chair, (NMFS Project Contact)
National Marine Fisheries Service, NOAA
Northeast Fisheries Science Center
166 Water St., Woods Hole, MA 02543
james.weinberg@noaa.gov Phone: 508-495-2352

Dr. Nancy Thompson, NEFSC Science Director
National Marine Fisheries Service, NOAA

Northeast Fisheries Science Center
166 Water St., Woods Hole, MA 02543
nancy.thompson@noaa.gov Phone: 508-495-2233

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of whether they accept or reject the work that they reviewed, with an explanation of their decision (strengths, weaknesses of the analyses, etc.).

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Findings of whether they accept or reject the work that they reviewed, and an explanation of their decisions (strengths, weaknesses of the analyses, etc.) for each ToR, and Conclusions and Recommendations in accordance with the ToRs. 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 Independent Review Report should state why that Term of Reference was or was not completed successfully. To make this determination, the SARC chair and CIE reviewers should consider whether the work provides a scientifically credible basis for developing fishery management advice.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including a concise summary of whether they accept or reject the work that they reviewed, and explain their decisions (strengths, weaknesses of the analyses, etc.), conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the SARC Summary Report that they feel might require further clarification.

   d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The CIE independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not others read the SARC Summary Report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include as separate appendices as follows:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work
   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

ANNEX 2:

Assessment Terms of Reference for SAW/SARC50 (June 2010)

(file vers.: 12/22/09-c)

A. Monkfish

1. Characterize the commercial catch including landings, effort, LPUE and discards. Describe the uncertainty in these sources of data.

2. Report results of 2009 cooperative monkfish survey and describe sources of uncertainty in the data and results.

3. Characterize other survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, length data, state surveys). Describe the uncertainty in these sources of data.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and characterize the uncertainty of those estimates.

5. Update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, and $F_{MSY;}$ and estimates of their uncertainty). Comment on the scientific adequacy of existing and redefined BRPs.

6. Evaluate stock status with respect to the existing BRPs, as well as with respect to updated or redefined BRPs (from TOR 5).

7. Evaluate monkfish diet composition data and its implications for population level consumption by monkfish.

8. Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).
    d. Provide numerical short-term projections (through 2016). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions to examine important sources of uncertainty in the assessment.
    e. Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.
    f. Describe this stock's vulnerability to becoming overfished, and how this could affect the choice of ABC.

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

B. Sea scallop

1. Characterize the commercial catch including landings, effort, LPUE and discards. Describe the uncertainty in these sources of data.

2. Characterize the survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, length data, etc.). Describe the uncertainty in these sources of data. Document the transition between the survey vessels and their calibration. If other survey data are used in the assessment, describe those data as they relate to the current assessment (Exclude consideration of future survey designs and methods).

3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and characterize the uncertainty of those estimates.

4. Update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, and $F_{MSY;}$ and estimates of their uncertainty). Comment on the scientific adequacy of existing and redefined BRPs.

5. Evaluate stock status with respect to the existing BRPs, as well as with respect to updated or redefined BRPs (from TOR 4).

6. Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).
    d. Provide numerical short-term projections (through 2014). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions to examine important sources of uncertainty in the assessment.
    e. Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.
    f. Describe this stock's vulnerability to becoming overfished, and how this could affect the choice of ABC.

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

C. Pollock

1. Characterize the commercial and recreational catch including landings, effort, LPUE and discards. Describe the uncertainty in these sources of data, including consideration of stock definition.

2. Characterize the survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Describe the uncertainty in these sources of data, including consideration of stock definition.

3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and characterize the uncertainty of those estimates.

4. Update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, and $F_{MSY;}$ and estimates of their uncertainty). Comment on the scientific adequacy of existing and redefined BRPs.

5. Evaluate stock status with respect to the existing BRPs, as well as with respect to updated or redefined BRPs (from TOR 4).

6. Evaluate pollock diet composition data and its implications for population level consumption by pollock.

7. Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).
    e. Provide numerical short-term projections (through 2017). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions to examine important sources of uncertainty in the assessment.
    f. Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.
    g. For a range of candidate ABC scenarios, compute probabilities of rebuilding the stock by 2017.
    h. Describe this stock's vulnerability to becoming overfished, and how this could affect the choice of ABC.

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

Appendix to the SAW TORs:

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

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

On "Acceptable Biological Catch":

Acceptable biological catch (ABC) is a level of a stock or stock complex's annual catch that accounts for the scientific uncertainty in the estimate of [overfishing limit] OFL and any other scientific uncertainty…" *(p. 3208) [In other words, OFL ≥ ABC.]*

ABC for overfished stocks. For overfished stocks and stock complexes, a rebuilding ABC must be set to reflect the annual catch that is consistent with the schedule of fishing mortality rates in the rebuilding plan. *(p. 3209)*

NMFS expects that in most cases ABC will be reduced from OFL to reduce the probability that overfishing might occur in a year. (p. 3180)

ABC refers to a level of ''catch'' that is ''acceptable'' given the ''biological'' characteristics of the stock or stock complex. As such, [optimal yield] OY does not equate with ABC. The specification of OY is required to consider a variety of factors, including social and economic factors, and the protection of marine ecosystems, which are not part of the ABC concept. (p. 3189)

On "Vulnerability":

"Vulnerability. A stock's vulnerability is a combination of its productivity, which depends upon its life history characteristics, and its susceptibility to the fishery. Productivity refers to the capacity of the stock to produce MSY and to recover if the population is depleted, and susceptibility is the potential for the stock to be impacted by the fishery, which includes direct captures, as well as indirect impacts to the fishery (e.g., loss of habitat quality)." (p. 3205)

Annex 3: Meeting Agenda

50th Northeast Regional Stock Assessment Workshop (SAW 50)
Stock Assessment Review Committee (SARC) Meeting
June 1-5, 2010

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

FINAL AGENDA* (version: 27 May 2010)

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR

Tuesday, June 1

8:45-9 AM			
Opening			
Welcome	**James Weinberg**, SAW Chair		
Introduction	**Robert O'Boyle**, SARC Chair		
Agenda			
Conduct of Meeting			
9-11	Assessment Presentation (A. Monkfish)		
	Anne Richards	**John Wheeler**	**M. Traver**
11-11:15	Break		
11:15 -Noon	SARC Discussion w/ presenters (A. Monkfish)		
	Robert O'Boyle, SARC Chair		**M. Traver**
Noon – 1:15	Lunch		
1:15–3:30	Assessment Presentation (B. Sea Scallop)		
	Dvora Hart	**Mike Bell**	**T. Chute**
	Larry Jacobson		
3:30-3:45	Break		
3:45-5:30	SARC Discussion w/ presenters (B. Sea Scallop)		
	Robert O'Boyle, SARC Chair		**T. Chute**

Wednesday, June 2

8:45-10:45 Assessment Presentation (C. Pollock)
Liz Brooks **Kurtis Trzcinski** **J. Blaylock**

10:45-11 Break

11 -Noon SARC Discussion w/ presenters (C. Pollock)
Robert O'Boyle, SARC Chair **J. Blaylock**

Noon – 1:15 Lunch

1:15–3:15 Revisit w/ presenters (A. Monkfish)
Robert O'Boyle, SARC Chair **L. Alade**

3:15-3:30 Break

3:30-5:30 Revisit w/ presenters (B. Sea Scallop)
Robert O'Boyle, SARC Chair **T. Chute**

7:00 (social)

Thursday, June 3

8:45-10:45 Revisit w/ presenters (C. Pollock)
Robert O'Boyle, SARC Chair **J. Nieland**

10:45–11 Break

11-Noon Review/edit Assessment Summary Report (C. Pollock) **J. Nieland**
Robert O'Boyle, SARC Chair

Noon–1:15 Lunch

1:15–3 cont. Review/edit Assessment Summary Report (C. Pollock)
Robert O'Boyle, SARC Chair **J. Nieland**

3–3:15 Break

3:15–5:45 PM Review/edit Assessment Summary Report (A. Monkfish)
Robert O'Boyle, SARC Chair **Alade/Traver**

Friday, June 4

9-11:30	Review/edit Assessment Summary Report (B. Sea Scallop) **Robert O'Boyle**, SARC Chair **T. Chute**
11:30–1:00	Lunch
1–5:30 PM	SARC Report writing. (closed meeting)

Saturday, June 5

9–5:30 PM	SARC Report writing. (closed meeting)

*Times are approximate, and may be changed at the discretion of the SARC chair. The meeting is open to the public, except where noted.

ANNEX 4: Contents of SARC Summary Report

1. The main body of the report shall consist of an introduction prepared by the SARC 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.

   To make this determination, the SARC chair and CIE reviewers should consider whether the work provides a scientifically credible basis for developing fishery management advice. Scientific criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable. If the CIE reviewers and SARC chair do not reach an agreement on a Term of Reference, the report should explain why. It is permissible to express majority as well as minority opinions.

   The report may include recommendations on how to improve future assessments.

2. If any existing Biological Reference Point (BRP) proxies are considered inappropriate, include recommendations and justification for alternative proxies. If such alternatives cannot be identified, then indicate that the existing BRPs are the best available at this time.

3. The report shall also include the bibliography of all materials provided during the SAW, and any papers cited in the SARC Summary Report, along with a copy of the CIE Statement of Work.

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