Independent peer review of SARC 59 benchmark stock assessment of Gulf of Maine haddock and Atlantic sea scallops

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Executive Summary

The SARC59 Review Workshop took place in Woods Hole, Massachusetts between July 15th and July 18th, 2014 and reviewed the benchmark stock assessments for **Gulf of Maine haddock** and **Atlantic sea scallops.** During the meeting, the SARC review panel, which was composed of three appointed reviewers from the Center of Independent Experts (CIE), and a chair from the New England Fisheries Management Council Scientific and Statistical Committee**,** considered whether the assessments provided a scientifically credible basis for developing fishery management advice. Criteria considered to reach a decision on that include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions were correct/reasonable.

The haddock fishery in the Gulf of Maine is managed under the US Groundfish Fishery Management Plan and the authority for managing New England groundfish stocks lies with the New England Fishery Management Council. The SARC 59 Gulf of Maine haddock stock assessment used an age-structured forward computation statistical model to estimate stock size and exploitation. $F_{40\%}$ was adopted as a proxy for F_{MSY} together with the corresponding $SSB_{40\%}$ and yield for SSB_{MSY} and MSY. Based on those benchmarks the assessment estimated that the stock was not overexploited and overexploitation was not taking place. A small number of short-term projections that were run as part of the assessment also suggested that the stock was not at risk of being overexploited in the near future.

The sea scallop fishery in the US EEZ is managed under the Atlantic Sea Scallop Fishery Management Plan (FMP) which was implemented on May 15, 1982. The SARC 59 scallop stock assessment focused on the two main portions of the Atlantic sea scallop stock and fishery which are in Georges Bank and the Mid-Atlantic. A size-structured statistical model was used to assess the stock, which for the purpose of this analysis was assessment as three separate components, Mid-Atlantic, George Bank closed areas, and Georges Bank open areas. Probabilistic F_{MSY}, B_{MSY}, and MSY were calculated and based on those benchmarks the stock, taken as the sum over the three components, was not considered to be overfished and overfishing was not taking place. A small number of projections presented at the meeting indicated that the stock was not at risk of being overexploited in the near future.

Both stock assessments have broadly met the TORs and produced results that can be used to provide scientific advice and support fishery management decisions.

Background

Haddock is found in the US waters from the mid-Atlantic Bight north to Canadian border and within that area, there are two recognised stocks of haddock; one in the Gulf of Maine and one in Georges Bank. The reviewed stock assessment focussed on the Gulf of Maine stock which extends from the northern tip of Cape Cod east to the US/Canadian border and north to the coast of Maine. The New England Fishery Management Council (NEFMC) has the management authority of New England groundfish stocks including haddock.

A plethora of management measures have been used over the years to manage exploitation of the Gulf of Maine haddock stock from minimum mesh size, minimum landing size, and spawning closures to Annual Catch Limits and effort restrictions. Severe declines in stock abundance that were noted in the late 1960s led to the prohibition of targeted fishing by 1974. However, fishing was again permitted in 1975 and the approaches used to manage exploitation continued to change frequently.
The haddock stock assessment report describing the latest stock assessment and stock status results was prepared by the SARC 59 Stock Assessment Working Group (WG) that met on June 2-6, 2014. The assessment used an age-structured forward computation statistical model to estimate stock size and exploitation and a similar projection model to calculate benchmarks and run short-term projections. $F_{40\%}$ was adopted as a proxy for F_{MSY} together with the corresponding $SSB_{40\%}$ and yield for SSB_{MSY} and MSY. Based on those benchmarks the assessment estimated that the stock was not overexploited and overexploitation was not taking place. A small number of short-term projections that were run as part of the assessment also suggested that the stock was not at risk of overexploitation

Atlantic sea scallops are found on the eastern North American continental shelf from Cape Hatteras to the Gulf of St. Lawrence and Newfoundland. The SARC 59 stock assessment focused on the two main portions of the sea scallop stock and fishery which are in Georges Bank and the Mid-Atlantic. The sea scallop fishery in the US EEZ is managed under the Atlantic Sea Scallop Fishery Management Plan (FMP) which was implemented on May 15, 1982. Atlantic sea scallops were formally declared overfished in 1997, and a number of measures were adopted to rebuild the stock within ten years. The recovery rate of the stock was quicker than originally estimated and the stock was rebuilt by 2001. A combination of closed areas and other technical measures to reduce exploitation contributed to the quick recovery. The most recent estimates of stock status indicated that the stock was not overexploited and overexploitation was not taking place.

An area-based management system is in place which sets criteria for closing and reopening parts of the Georges Bank and Mid-Atlantic areas; the closures in the former area apply to both groundfish and scallops while in the latter the closed areas are specific for the scallop fishery.

The 2014 stock assessment of Atlantic sea scallops was prepared by the Invertebrate Subcommittee (IS) which had a number of meetings between March and June 2014.
The 2014 assessment used three size-structured model to complete the analysis required; it used CASA (Catch-At-Size Analysis) model for the estimation of current and past population size and mortality, SAMS (Scallop Area Management Simulator)

model to do the projections and the SYM model (Stochastic Yield Model, Hart 2013), to calculate reference points. It also used survey results in an empirical assessment to produce absolute abundance estimates separately from the model calculations. For the purpose of this analysis the stock was assessed as three separate components, Mid-Atlantic, George Bank closed areas, and Georges Bank open areas. Probabilistic F_{MSY}, B_{MSY}, and MSY were calculated and based on those benchmarks the stock, taken as the sum over the three components, was not considered to be overfished and overfishing was not taking place. A small number of projections presented at the meeting indicated that the stock was not at risk of being overexploited in the near future.

Three CIE reviewers were commissioned to conduct an impartial and independent peer review of the **Gulf of Maine haddock** and **Atlantic sea scallop** stock assessments, and this review should be in accordance with the SoW and stock assessment ToRs listed in Appendix 2. Each CIE reviewer was also contracted to produce an independent peer review report. This document is my peer review report and presents my comments on the SARC 59 assessment and supporting material. Further details on the reviewer's role and the review request of the Center for Independent Experts are presented below and in Appendix 2.

Description of the Reviewer's Role in the Review Activities

I was contracted to

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 at the Woods Hole, Massachusetts scheduled during the tentative dates of July 15-18, 2014.
3) Conduct an independent peer review in accordance with this SoW and the assessment ToRs (listed in **Annex 2**).
4) No later than August 1, 2014, 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 to 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 assessment ToR in **Annex 2**.

This document provides the outcome of that review.

Findings

GULF OF MAINE HADDOCK

TOR 1. Estimate catch from all sources including landings and discards. Include recreational discards, as appropriate. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data. Investigate the utility of commercial or recreational LPUE as a measure of relative abundance.

Both commercial and recreational fishing contribute to catches of haddock and estimates of landings from both fisheries were provided for the assessment. Direct landings estimates were available starting in 1977 for commercial fisheries and 1981 for recreational fisheries, however, historic landings record for this series extends back to 1930.

Commercial data by gear type were also available and seasonal trends in landings were documented. Uncertainty in commercial landings data due to misreporting/underreporting of statistical areas was calculated while contribution from other factors such as home consumption was considered minimum. There was not enough information to use to calculate the uncertainty due to unreported catches. Landings-at-age series were also produced based on data from biological sampling of landings. However, information of length/age distribution of catches is patchy with more gaps in earlier years and a number of assumptions or aggregation of data were needed to calculate total landings at age. That means that there is considerable uncertainty about those values which, although the analysis tried to characterize, it is not clear how successful it was.

Direct estimates of commercial discards were available from observers starting in 1989 and analysis of the data also provided estimates of uncertainty. Unfortunately, although age information is being collected for discards, that was not available for this assessment; so an ALK from a survey was used to allocate catch to age classes. That required a calculation of a selectivity ogive which was again calculated using length information from survey and observer data in an "alternate tow" approach. The selectivity ogives were estimated using data from the last five years and those were assumed to represent selectivity in earlier years. Both the assumptions (ALK and selectivity same as survey) are likely to introduce errors, especially the assumption about the appropriate ALK. To avoid that, it is recommended that the age information from the discarded fraction of catches that has been collected become available for future assessments.

The approach used to calculate the length frequencies in discards assumes that all discards are below the minimum landing size and the WG suggested that occurrences when these assumptions were violated are infrequent. However, the results in Figures A56-58 show that a significant proportion of discards was above the MLS for two or three of the five years they considered. Also, Figure A.53 show that at least for sink gillnets a big proportion of discards were above the MLS for 8 out of the 20 years they plotted. It is not clear what uncertainty that violation of the assumption introduced in the results. Given the fact that the amount of discarded fish was small this approach is still acceptable but it is recommended that other options are considered in future assessments to calculate the discards or they could be estimated by the model. The same comment holds for the calculation of commercial discards prior to 1989.

Discard mortality is also largely unknown and the assumption made was that there is 100% mortality of discards in commercial fisheries.

Total landings have been dominated by commercial landing in the past but the contribution from the recreational fisheries has increased in recent years. The amount of discards from this fishery has also increased.

CVs were calculated for recreational catches to represent uncertainty and maps showing the distribution of fishing activity were produced. Concentration indices for the spatial distribution of the recreational catches were also provided showing that the recreational fishery is more concentrated than the commercial fishery.

Similarly to the data for commercial discards, length frequency information and ALK were not available for recreational fisheries. Therefore, those from surveys were adjusted and used to calculate landings at age. Recreational discards at age were calculated using direct observations to construct a selectivity ogive and a survey-filter method to calculate length frequencies distributions. The assumption used for discard mortality is that it is either 50% or 100%.

One important finding of the analysis was that weights-at-age in the commercial catch data show considerable reduction over the years with higher decline at older ages. A similar pattern was found using the data from the recreational fishery. The WG was not able to explain the reason for that decline. They indicated that such decline was not accompanied by a decline in maturity age. Food availability might have contributed to this so analysis of data from stomach sampling is recommended. Use of a multispecies model to explore predator prey dynamics and simulate any observed decline in prey (stock decline, change in prey distributions, etc.) is also recommended.

As mentioned already, selectivity curves for both recreational and commercials fisheries were calculated. However, changes in minimum landing size for both the commercial and recreational fishery that took place in 2013 were not considered in the calculation since information was not available on the effects of this new measure.

Standardized landings per unit effort (LPUE) indices were developed for both the commercial and recreational fishery but the number of regulatory changes that have taken place in the past 30 years raises questions about the utility of the LPUE as an index of haddock biomass. The SAW 59 WG recommended that the LPUE indices not be used in the SAW 59 assessment models and therefore, the latest stock assessment does not include LPUEs. The reasons for excluding the LPUEs were explained in detail and I support their choice not to use them.

The data presented are appropriate to support the stock assessment and although some improvements would be recommended the quality and amount of data were adequate.

Recommendation 1. Analysis of age information from commercial discards collected by observers is recommended to include it in future stock assessment and improve estimates of ALK.

Recommendation 2: It is suggested that the WG reconsiders the approach currently used to calculate the length frequency of commercial discards since its assumptions do not fit well the observed pattern in the discard data.

Recommendation 3: Further work is recommended to explore possible reasons for the decline in the weight at age including analysis of data from stomach sampling and use of multispecies models to explore predator-prey dynamics and simulate any observed decline in prey (stock decline, change in prey distributions, etc.).

TOR 2. Present the survey data being used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.). If available, consider whether tagging information could be used in estimation of stock size or exploitation rate. Characterize the uncertainty and any bias in these sources of data.

The first part of this ToR has been met. The second was not covered.

Data from three fishery independent surveys that operate in the Gulf of Maine were used in the calculations: the NEFSC bottom trawl survey, Massachusetts Department of Marine Fisheries (MADMF) bottom trawl survey and the Maine-New Hampshire (MENH) inshore groundfish survey. Each of them took place twice a year so it contributed two series, one from the spring survey and one from the autumn survey.

The NEFSC survey is the longest time series covering more than 40 years. Indices at age together with CVs were calculated for both the spring and fall survey. The survey parameters for this survey changed in 2009 when the vessel was replaced by another one. Calibration work and other elaborate methodology were followed to make the survey results before and after 2009 compatible. Although the approach is valid, it is not clear why this is needed. Data starting in 2009 could be used in the model as a separate index. That will also reduce uncertainty in the survey points that is due to uncertainty in the assumptions and parameters used in the calibration work. I would suggest that future stock assessments consider such an approach.

Maps showing the location of the sampling stations together with the areas where the fisheries operate show a very good overlap. The only exception to that is the offshore area at 42.5 N and between 67-69 W. Although omission probably does not introduce significant error, it is recommended that some sampling is also done in that area to improve coverage. Selectivity patterns and estimates of total mortality were also calculated using the survey.

Indices at age for the other two surveys were also constructed and the features of each survey and area they sample were described. The ALK from the NEFSC was used in the calculation for both surveys since age at length information from each of the two surveys either were not considered representative of the whole haddock stock or were incomplete. The indices from the MADMF survey have not been used in past assessments due to the limited overlap of the survey and haddock distribution in the Gulf of Maine and the WG indicated that those indices should be used with caution. A similar suggestion was also made for the MADMF indices at age.

A maturity ogive constructed using data collected in the MADMF was different from the NEFSC maturity ogive. It was not clear whether that reflected biological differences in the sub stock sampled in the MADMF survey or it was a result of differences in the macroscopic determination of maturity between the two surveys. This information could be relevant to the discussions about changes in weight at age that have been observed. It is recommended that further analysis is done to get more clarity on the reasons behind this difference (e.g. differences in the biological parameters of the population in sub areas in the Gulf of Maine, measurement error/bias).

Some tagging data are available for this stock although the objectives of the relevant studies were not to calculate fishing mortality or produce direct estimates of the stock size (See further discussion as part of the next ToR). The WG did not cover tagging data under this ToR.

The data presented and relevant analysis are appropriate.

Recommendation 4. It is recommended that future assessments consider breaking the abundance series from the NEFSC survey into more than one series to reflect changes in the survey configuration.

Recommendation 5. If possible, survey design should aim to cover the area at 42.5 N and between 67-69 W, which does not appear to be sampled at the moment.

Recommendation 6. It is recommended that further analysis is done to get more clarity on the reasons behind the difference between the maturity ogive constructed using data collected in the MADMF and that constructed using data from the NEFSC survey (e.g., differences in the biological parameters of the population in sub areas in the Gulf of Maine, measurement error/bias).

TOR 3. Evaluate the hypothesis that haddock migration from Georges Bank influences dynamics of GOM stock. Consider role of potential causal factors such as density dependence and environmental conditions.

This ToR has been met.

The haddock stock in Georges Bank is larger than the stock in Gulf of Maine and due to their proximity, a question has been raised about the possibility of spillover effects from the Georges Bank stock to the Gulf of Maine one. In-depth review of available scientific information was conducted focusing on four key areas: information on exchange rates from previous studies, potential recruitment synchrony between the two stocks, potential to detect good recruitment years of Georges Bank stock in surveys in the Gulf of Maine that track year-classes, analysis of the effects of assuming that there is net movement of fish to the Gulf of Maine would have on management advice for the Gulf of Maine stock.

Based on this work it was concluded that exchange rates were not well characterized and recruitment synchrony did not provide strong evidence to support the spillover hypothesis; that is also the case for the year-class-tracking data from surveys.

The analysis of the effects of such hypothesis on management advice highlighted the risks to the Gulf of Maine stock of getting the rate of net movement to Gulf of Maine wrong. Even a 1% net movement rate from Georges Bank to Gulf of Maine would mean that the allowed catches in Gulf of Maine should be doubled. If the net rate is wrong, such high increase in catches would have significant effects on the status of the stock.

Tagging data from past studies were also analysed but the findings were of questionable reliability since none of the tagging studies had been designed to measure mixing rates.

The analysis done is appropriate. The role of causal factors was considered but to a limited extent given that the data did not support extensive analysis/exploration of that aspect of the ToR. I agree that further work would be needed if one is to provide more precise statements on stock mixing. If mixing remains a concern then genetics, otolith microchemistry, and tagging studies (if the return rate can be improved) would be recommended to improve the evidence base.

Recommendation 7: If mixing remains a concern, I would recommend that genetics, otolith microchemistry, and tagging studies (if the return rate can be improved) are considered to improve the evidence base.

TOR 4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-3), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections.

This ToR was met.

A new stock assessment model was used to assess the population status. The previous stock assessment (2012) was conducted using ADAPT-VPA but given difficulties in calculating catch-at-age series and the amount of imputation required to do so the group felt that another method that does not assume that catches were known exactly would be more appropriate to use for this stock. The model chosen was the statistical catch-at-age model ASAP.

In line with the ToR, the previous model was rerun using the latest input data and assumptions about its parameterization. To link the old model to the new one, several runs were made with ADAPT progressively increasing the assumptions/inputs that differ from those used in 2012 to create a bridge between the model used in 2012 and an ADAPT model that would be the closest to the parameterisation of the ASAP model. Such changes included using the updated series of catch-at-age estimates, modification of the way in which the plus-group was calculated and adding three more years of catch data. Of those changes, the only one that led to changes in the predictions of the model relative to the 2012 one was the change in the method used to calculate the plus group, but the overall results remained the same. Retrospective analysis did not reveal any consistent patterns so the final results were not adjusted to address bias of the model.

The ASAP is an age-structured, forward computation model that treats catch composition data as uncertain (both catch-at-age and survey age composition were described with a multinomial distribution) and calculates the best fit by minimizing an objective function (negative log-likelihood). Discards in the recreational fishery are also captured in the model (not covered in the past). Catch-at-age information only for the years when those were available was provided as input and the selectivity-at-age was freely estimated for fish of age 7 or younger. Selectivity of the fishery was assumed to change over the years to simulate management changes. Recruitment of this stock is highly episodic and not well described with stock recruitment relationships so recruitment was modelled as deviation from the geometric mean.

Several model configurations of the ASAP model were considered (70 runs in total) to explore variability in model results and identify assumptions to which the model might be more sensitive. This included the starting year for the assessment, inclusion of LPUEs, and inclusion of state surveys, splitting the NEFSC survey data in two series, and modelling the two fisheries separately.

Splitting the NRFSC survey series into two was meant to reflect the operational changes that had been made in this survey over the years. As mentioned earlier, calibration of the different segments of the series was undertaken and the series was treated as a single one. The series was split into two and the model was rerun using both series. The results changed considerably when two non-overlapping series were used. The fit of the model to the series was slightly better but the retrospective error increased. The main problem appears to be the imprecisely estimated survey selectivity. It was suggested that the presence of two large year classes within one of the series might contribute to that imprecision. They also concluded that splitting the series was not appropriate. It is not clear why a third segment was not created to represent the change in trawl door in 1984 and whether this configuration would not be appropriate if problems with the simulation of recruitment were resolved. Therefore, I would recommend that this possibility is revisited in future assessments (see recommendation in previous ToR).

Although there are two main fisheries (commercial and recreational), the ASAP model was run assuming a single, combined, fishery. A simulation with two separate selectivities/fisheries was run and the results were similar to the run with the combined fishery. Based on those results the final assessment was done using a combined fishery. However, although the sensitivity results were very similar, that was not the case for the last year of the calculations; the model with the combined selectivity predicted that F decreased while the model with the two fisheries suggested that it remained the same as previous years or was slightly higher (Fig. A.2.19). Unfortunately, the results for SSB were not provided so the effects on that parameter are not known. Given that the contribution of the recreational fishery was low until recently but increase in the past couple of years, this inconsistency in the results possibly highlights the problems of trying to simulate two different behaviors/activities with a single selectivity. That is also important because the discarding rate/pattern from those two fisheries is different. It is recommended that future stock assessments (and any projections done to provide management advice from this assessment) simulate each fishery separately.

Model results discussed during the review meeting and sensitivity analysis showed that the model produces a better fit at lower M values pointing to values of natural mortality that are different from the one assumed. The model assumes that M is the same for all ages and does not allow for density- or age-dependant changes in it. Given the importance of this parameter, more work is needed to improve the realism in the simulation of mortality in the model. Incorporation of a stock recruitment function to introduce density dependence will also help with that.

Regarding recruitment, results show that there is no clear link between recruitment (year 1) and stock size. It was not clear whether attempts to link stock size to age 2 or age 3 fish (assuming that fish are recruited in the fishery at age 3) have been made. If not, I would suggest that further analysis is done to check whether a link between stock size and fish at the age just before they enter the fishery could be found.

Retrospective analysis showed small retrospective errors for the final model configuration therefore, the model results were not adjusted.

The approach adopted is appropriate and the range of assumptions and model parameterisations considered increase confidence in the model results. Although improvement of certain assumptions and aspects of the model is recommended the findings of this assessment could support management advice.

Recommendation 8: It is recommended that future stock assessments (and any projections done to provide management advice from this assessment) simulate each fishery separately.

Recommendation 9: Further studies to better describe natural mortality are recommended.

Recommendation 10: Incorporation of a stock recruitment function to introduce density dependence in survival of young fish will improve the quality of the stock assessment. Given difficulties in finding a relationship between stock size and age 1 class size, I would suggest that, if not already done, analysis is undertaken to look at possible links between stock size and fish at the age just before they enter the fishery.

TOR 5. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

This ToR has been broadly met.

Yield Per Recruit analysis was used to calculate reference points in the past stock assessment and was also used for this stock assessment. The reference points used in the previous assessment were those that correspond to a spawning potential ratio of 40% and the overfishing definition was Fmsy= $F_{40\%}$.

The inputs to the YPR analysis used for this assessment included the time invariant maturity ogive, the time and age invariant natural mortality value (M=0.2), the selectivity-at-age from the third selectivity block and the average catch and stock weights from 2009-2013; the latter was chosen as the most representative given declines in weight at age that were observed in the recent past. A stochastic version of this analysis was also conducted taking into account the uncertainty in those inputs. The fact that selectivity peaks at older ages means that yield at recruit curves do not show a maximum (or it is at very high Fs) so calculation of Fmsy is not well supported by this approach. However, lack of a stock recruitment function restricts the range of approaches that could be used.

The Working Group did not recommend different proxies so $F_{40\%}$ was again used as a proxy for Fmsy. The value of $F_{40\%}$ is exactly the same as the one found in 2012: 0.46. Stochastic projections for that F calculated the SSBmsy and MSY. The CVs for all these values were also provided. The cumulative density function for recruitment between 1977 and 2011 was used to calculate recruitment in the projections.

MCMC simulations were used to produce 1000 estimates of number at age in 2014 (using the final configuration of the ASAP model) and calculate the distribution of SSB_{MSY} and MSY. The reference points corresponding to $F_{40\%}$ and their 90% confidence intervals are SSB_{MSY} = 4,108 mt (1,774 – 7,861 mt) and MSY = 955 mt (421 – 1,807 mt).

The analysis was correct and the choice of reference points reasonable given the constraints discussed above. However, even with this approach, use of separate selectivities would be recommended to appropriately capture the different characteristics of each fishery. Also, I would recommend that a projection run is done with the selectivity for the commercial fishery and one with the selectivity for the recreational fishery (capturing discards as well). This will provide boundaries within which one would expect the MSY to fall and will also provide a sense for how different the two MSYs are.

Recommendation 11: Use of separate selectivities would be recommended to appropriately capture the different characteristics of each fishery in benchmark calculations.

Recommendation 12: If the calculation cannot be done with two selectivities, I would recommend that a projection is run with the selectivity for the commercial fishery and one with the selectivity for the recreational fishery (capturing discards as well). This will provide boundaries within which one would expect the MSY to fall and will also provide a sense for how different the two MSYs are.

TOR 6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model developed for this peer review. In both cases, evaluate whether the stock is rebuilt (if in a rebuilding plan).

This ToR was met.

a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.

As described above both the existing model, VPA, and the new model, ASAP, were run using updated input data. The stock status based on the results of the VPA and the existing BRP estimates was that the stock is not overexploited but overfishing is taking place. In particular the proxy for Fmsy, F40%, was equal to 0.46 while $F_{current}$ was equal to 0.82. The SSB_{MSY} is 4,904 mt while $SSB_{current}$ is 3,070 mt which is greater than half of the SSB_{MSY} (the limit under which the stock is considered overexploited)

b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

The stock status based on the results of the ASAP model and the new estimates of the BRP were different from that predicted based on the VPA results. The new stock status is that the stock is not overexploited and overexploitation is not taking place. Specifically, the proxy for Fmsy, F40%, was equal to 0.46 while $F_{current}$ was equal to 0.39. The SSB_{MSY} is 4,108 mt while $SSB_{current}$ is 4,153 mt.

It was not clear what factor contributed to the change in stock status predicted by the new model. However, it is worth noting that the estimates of the BRP for the old model were not updated using the new input data so, one cannot tell if the F_{MSY} would have changed if they had been updated. Therefore, it is not possible to reach conclusions using the estimates from the old model.

The process followed to estimate the stock status using the new model is appropriate.

TOR 7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level) (see Appendix to SAW TORs for definitions).

a. *Provide numerical annual projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F,* *and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment, migration from Georges Bank).*

The same model used for the long term projections to calculate BRP estimates together with the cumulative density function for recruitment were also used for short-term projections. Sensitivity analysis showed that variability in recruitment during the projection years was not an important factor because of their small contribution to the SSB and yield. Two assumptions about harvest level between 2015-2017 were tested (F at Fmsy, or 0.75Fmsy), and two about harvest in 2014 (either that F was equal to Fmsy or total removals were equal to 500 mt). The projections were run for the same assumption about the 2012 year class as the preferred ASAP model but also with a model that constrained the 2013 year class size.

A model which allowed for mixing to be tested was not considered more plausible than the ASAP model so the latter was used for the projections.

The choice of the scenarios to test is reasonable and covers well the main uncertainties. It is not clear though whether the model accounted for the new MLS and the effects it will have on the level of discards. That would need to be clarified. The same comments about mortality, selectivity, etc. made in a previous ToR apply here so, they will not be repeated.

b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.

The WG chose the projections with preferred ASAP parameterization as the most realistic. The size of the 2012 year class remains the main source of uncertainty and projections were made to evaluate the effects of that uncertainty.

c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

The WG focused on the effect of different factors on the choice of ABC. They highlighted discard mortality in recreational fisheries and the size of the 2012 size class as two important factors to note when deciding on the ABC. They also reemphasized that setting catch limits higher, based on the presumption that permanent movement of haddock from Georges Bank to the Gulf of Maine take place, could lead to overfishing if such movement does not occur.

I agree with the points they made. The WG did not refer to the 2013 year class however, which is also of considerable size.

Given that two strong years might be entering the fishery soon, I would recommend that another column be added in the table with the results to show what amount of the total caches will need to be discarded every year because it will be below the MLS.

Clearly, more projections need to be done to address things such as contribution from each fishery and contribution of the 2012/2013 year classes (taking into account data from the spring survey in 2014). However, the assessment team clarified that more projections would be run to support the decision on ABC. On that basis, the work described in the assessment meets this ToR and covers the key issues well.

Recommendation 13: I would recommend that another column be added in the table with the results from the projections to show the amount of total caches that will be discarded every year because it will be below the MLS.

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

The WG reviewed past research recommendations and indicated those that have either been addressed or are no longer relevant. They also made a number of new recommendations all of which are sound and would improve the quality of the assessment although I do not consider all of them to be of the same priority. Based on the model findings and sensitivity runs, work to estimate mortality of discards in the recreational fishery still remains important as it is needed to improve understanding of the recruitment process. I also support their suggestion for conducting all Northeast region haddock assessments at the same time.

In addition to that, it is recommended that work is undertaken to produce better estimates of natural mortality at age. The decline in weight at age that was observed in recent years is of concern and I believe this is also an area that warrants more attention.

ATLANTIC SEA SCALLOPS

TOR 1. Estimate removals from all sources including landings, discards, incidental mortality, and natural mortality. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these assumptions and sources of data. If possible using sensitivity analyses, consider the potential effects that changes in fishing gear, fishing behavior, and management may have on the assumptions.

This ToR has been adequately met.

The analysis considered landings as well as discarding and incidental mortality as part of the calculation of removals.

Landings were calculated for each year and by fishing area (4 main areas) and gear type. Landings from grounds that have primarily remained closed to fishing in Georges Bank as well as grounds open to fishing were also provided.

Based on that information the WG focused the analysis on the Georges Bank and Mid-Atlantic areas and ignored catches in the other two areas. That was a reasonable choice given that landings from the two other areas were less than 1% in recent (and almost all of past) years.

For the period since 1994 landings information was based on vessel trip reports and dealer reports. Prior to 1994 such information was collected during port interviews. Information on the size composition of catches was also available from dealer reports and information collected from observers.

Estimates of discards (mt meats) were derived for seven fleets using Northeast Fishery Observer Program (NEFOP) and Northeast Fishery Science Center (NEFSC) commercial landings (i.e., dealer) data for the 1989 to 2013 time period. Discard estimates were also derived for scallop dredge fleets at a finer stratification level using NEFOP and Vessel Trip Report (VTR) data for the 1994 to 2013 time period. The amount of meat discarded was below 5% of total catches for most of the years except for a few for which that ratio was around 10%. Although considerable work was done to estimate discards, those values were not included in the estimation of the current size and mortality of the population. The reason was that a) discards were low in comparison to landings and b) the mortality of discarded scallops was considered to be low. However, the ratio of discards to catches was only calculated in weight, and as the assessment report pointed out, that ratio is expected to increase if it is in number of individuals instead of weight. Future assessments need to provide those estimates so a more informed decision could be made about the significance of discards in previous years. Also, coverage (observers) in closed areas has been patchy in the past so that can also add to the uncertainty in discard calculations. The information about discard mortality was limited and that also means that one cannot tell with confidence whether the assumption about low mortality rate is reasonable. Although inclusion of discards in the removals is unlikely to change the main conclusions of the assessment, more work in this area is recommended to improve the way in which this process is captured in the analysis.

Incidental mortality due to dredging was considered highly uncertain but a formula to describe incidental mortality was constructed for the stock assessment model based on existing estimates of such mortality. The magnitude of incidental mortality is not well defined so it remains a source of uncertainty. Given the amount of catches taken with dredges the value of this parameter is relevant. So, if possible, better estimation of incidental mortality is recommended.

Similarly, the methodology used to calculate natural mortality leads to considerable uncertainty in the values of natural mortality. However, existing surveys and data might be able to provide material to improve those estimates so analysis of existing data or addition of a relevant objective in future surveys is recommended to refine the values of natural mortality.

Size frequencies (shell height) of landed and discarded scallops have also been calculated but size frequencies for total catches were not provided. Changes in the size frequency of landed scallops have been interpreted as a change in selectivity of the fleet over the years. However, those changes could just reflect a change in the size-structure of the population as it recovers over the years.

Data on growth at length collected in surveys during recent periods have highlighted that the range of growth at a given length was greater than that found using samples from periods when fishing pressure was high. That is because the former sample includes more fast growers than the latter sample. The assumption used in the report was that growth of scallops was different during those two periods and hence, a different growth curve was constructed to describe growth at different time periods. However, it is not clear whether the change in observed growth at size was because fast growers were removed from the population at times of high fishing pressure so they were not appropriately represented in the survey samples, and not because of a change in the growth patterns. It is recommended that both samples from surveys and commercial operations are analysed to decide whether there has been a change in the growth pattern. If that's not possible, it is recommended that future work use simulation modelling to assess whether the observed patterns in survey data could have been produced even if the growth pattern had remained the same. This work would ensure that the effects of fishing are not counted in the model twice.

Lastly, a single growth pattern was assigned to all areas in a given year/period. However, discussions with the assessment team indicated that growth might differ among key fishing grounds. That is another topic which would benefit from further work to refine the assumptions that would be used in future stock assessments.

Although there are a few areas in which further work would improve the findings of the assessment, I consider that the amount and quality of information on removals is appropriate. Some more work could have been done in response to the second part of this ToR (I have provided some recommendations) but this ToR has adequately met.

Recommendation 14: It is recommended that future assessments calculate the ratio of discards to catches in number of individuals instead of (or in addition to) weight so a more informed decision could be made about the significance of discards.

Recommendations 15: Further work to get better estimates of discard mortality is also recommended.

Recommendation 16: Existing surveys and data might be able to provide material to improve the estimates of natural mortality so analysis of existing data or incorporation of a relevant objective in future surveys is recommended to refine the values of natural mortality.

Recommendation 17: It is recommended that shell samples from surveys and commercial operations are analysed together to decide whether there has been a change in the growth pattern. If that's not possible, it is recommended that future work use simulation modelling to assess whether the observed patterns in survey data could have been produced even if the growth pattern had remained the same. This work would ensure that the effects of fishing are not counted in the model twice.

Recommendations 18: It is not clear if the same growth pattern should be assigned to all areas so work to explore this further is recommended.

TOR 2. Present the survey data being used in the assessment (e.g., regional indices of relative or absolute abundance, recruitment, size data, etc.). Characterize the uncertainty and any bias in these sources of data.

This ToR has been met.

The assessment used data from a scallop survey to provide estimates of stock biomass and number of individuals. The survey has been conducted every year since 1979 on Georges Bank and the Mid-Atlantic Bight using a scallop dredge and a random-stratified design. Mean standard errors were calculated to characterise the uncertainty in point estimates.

The efficiency of the dredge was calculated both for sand and gravel/cobble habitat using a Habcam towed camera system. Estimates of the dredge selectivity were also available. Given that different vessels had been used over the years to do the surveys, the WG compared catches per tow and average catches achieved with each vessel to identify any bias that might have been introduced and adjusted the data accordingly. The uncertainty in those calculations was also provided.

Certain strata were excluded from the survey to reflect the limited availability of scallops in those areas (marginal scallop habitat) and reduce the uncertainty in mean estimates of abundance from such areas; the survey estimates were then inflated so the survey would be representative of all strata (those surveyed and those excluded). It was not clear how much the overall uncertainty changed due to that inflation; such areas represented only a small portion of the total habitat so it is unlikely that they will affect the findings of the assessment, but it is important to ensure that certain areas with variable scallop abundance over time are adequately represented in the survey.

Abundance indexes from a towed camera survey (Habcam) and one from a video drop camera survey using a systematic grid design were also included in the stock assessment for Georges Bank and the Mid-Atlantic. The former information has not been used in past stock assessments.

Length composition data were also produced for each survey. The measurement error in the length composition indices from the latter two surveys were adjusted using information on length composition from the first (dredge) survey. All survey indices were assumed to be independent of each other and to represent absolute abundance.

Although such an assumption is not exactly correct since the results of the dredge survey have been used to inform the other two surveys, additional runs that took place during the peer-review meeting showed that such an assumption has a small effect on assessment finding so it is not considered to create a problem. However, alternative parameterisation of the assessment model could be considered in future assessments.

The analysis of the survey data and way in which uncertainty was characterised in the assessment is appropriate and meet the requirement of this TOR. There are some concerns about additional data presented under this ToR which are also relevant to other ToRs but I have discussed here (below).

The decline in abundance of young scallops (recruitment) that the length composition data of the survey shows is not consistent with the assumption used in the stock assessment that natural mortality is density independent and has the same value for all size groups. Future work is recommended to consider whether mortality is size or density dependent and capture such effects in future stock assessments.

As said, the survey data have been used appropriately to meet this ToR. However, overall, it is not clear whether these data have been utilised to the maximum to help improve knowledge in other areas of the assessment. For example, it might be possible to use some of the survey data to improve the estimates of natural mortality or provide more information about recruitment. It is recommended that future work consider such opportunities.

Recommendation 19: Alternative parameterisation of future assessment models to go around the fact that the surveys to which the model is fit are not independent is recommended.

Recommendation 20: Future work is recommended to consider whether mortality is size or density dependent and capture such effects in future stock assessments.

Recommendation 21: It is recommended that ways to maximise the knowledge that can be gained from the survey data are explored. For example, it might be possible to use some of the survey data to improve the estimates of natural mortality or provide more information about recruitment.

TOR 3. Investigate the role of environmental and ecological factors in determining recruitment success. If possible, integrate the results into the stock assessment.

This ToR has been met.

Phytoplankton availability and predator (sea star, *Astropecten americanus*) spatio-temporal distribution are two factors considered since they could potentially affect scallop recruitment success in mid-Atlantic. So work under this ToR focused on those two factors; no other environmental or ecological factors were identified.

Some progress was made to describe the link between recruitment and each of those factors but results were considered preliminary. Therefore, the results of this analysis were not included in the stock assessment. The work presented responded well to the term of reference for the mid-Atlantic but it was not clear whether the same analysis could cover or be extended to Georges Bank. Extension of the analysis to consider whether recruitment in Georges Bank is also linked to such effects would be useful.

The effects of climate change on habitat availability and distribution of sea scallops is another factor that is relevant to this ToR but was not covered in the assessment. It is recommended that future assessments make a reference to such consideration and discuss whether it could be of significance.

Recommendation 22: Climate change is a factor that is relevant to this ToR but was not covered. It is recommended that future assessments make a reference to it and discuss whether its effects on this stock could be of significance.

TOR 4. Estimate annual fishing mortality, recruitment and stock biomass for the time series, and estimate their uncertainty. Report these elements for both the combined resource and by sub-region. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections.

This ToR has been met.

A catch-at-size (CASA) statistical model was used for the assessment; this was a length-based model that assumed constant mortality and estimated recruitment since a stock recruitment equation was not provided. The model was fit to the survey data described earlier in this report and used growth matrices (growth at size) to represent growth and transition from one length class to the other. The model has been used in past assessments but this time three CASA models were run; one for Mid-Atlantic (as in the past) and two for Georges Bank. The latter means that the population in closed areas was assessed separately from the population in open areas.

The model is appropriate and since it does not use age, it facilitates simulation of processes for which the link to age is not available. The fact that its parameterisation did not include a recruitment function or allow for density dependent effects (e.g., in mortality) reduces its flexibility, and as the results showed, the model was not able to capture well signals of high recruitment that the survey data showed. More work to incorporate density dependent processes in the model has started but only preliminary results were presented at the assessment. It is recommended that such features are included in future assessments. As discussed in the following ToR, the fact that recruitment every year is estimated by the model without a link to abundance could introduce bias in other calculations that use those estimates.

Also, the model assumed that abundance estimates from the survey data reflected absolute abundance with very small uncertainty. The choice of the CV for the catchability for those data was ad hoc and potentially underestimated uncertainty that was introduced when the surveys were adjusted based on information that was also uncertain. The values for catchability the model predicts are close to their boundaries which also indicate that there might be a problem with that part of the model configuration. Additional calculations run during the review meeting indicated that the choice of the CV did not change the results much so it would not affect the overall findings of the assessment. However, further consideration is recommended to ensure that the assumptions about the accuracy of the surveys in representing absolute abundance are realistic.

Sensitivity runs were done to evaluate the effects of choice of parameter values for natural mortality, survey priors, and incidental mortality. The choice of the value for natural mortality affected more the results for the closed area in Georges Bank but did not change the overall picture drastically. The model results were less sensitive to the choice of the value of the other two parameters. However, it is not clear whether incidental mortality is correctly calculated in the model. For example, results for when incidental mortality was doubled for the Georges Bank open area showed that such an assumption would make a small difference in model predictions for the period from 2000 to 2010 when catches with dredges ranged from 5 000 mt to 15 000 mt and the population was greater than earlier years. However, for the period between 1988 and 1992, when catches with dredges were of similar size, the choice of the value of incidental mortality does not make any difference. It is not clear what the reason is for this results so further work to ensure that the model simulates that process correctly is recommended.

As mentioned in previous ToRs, the analysis used different growth patterns in different time periods to reflect changes in growth observed in samples collected in surveys. It is not clear whether that assumption represents reality or just a bias in the survey data. More work was recommended on this in a previous ToR. As a first step though, it is recommended that the model is also run with one growth pattern at a time to check how sensitive the model results are to the choice of the growth pattern.

The selectivity that the model estimated for the fishery changes considerably over the years with its peak moving from about 70 mm scallops in 1980s to 130 mm in recent years. It is not clear whether changes in gear technology or the new spatial management would be enough to explain such difference in selectivity. Future work should consider this as well as the possibility of high-grading happening and how that affects assumptions about the level of discarding and whether it should be included in the stock assessment.

Retrospective analysis showed that the model tends to overestimate the stock abundance. Also additional retrospective analysis requested during the meetings showed that the model tends to underestimate fishing mortality. The estimates of the model have not been adjusted for that so they might be overoptimistic about the size of the stock. The bias seems to be reducing in recent years so it is unlikely that it would affect the model predictions much. However, it seems that under certain conditions, model predictions might be characterized by a high degree of retrospective error. Further exploration of the model's behavior is recommended to understand those factors that could lead to high retrospective error.

The level of detail in the model is appropriate for the stock and splitting the stock into three sub-areas for assessment provided a more detailed (and possibly more realistic) view of the population behaviour. One aspect that was briefly discussed at the assessment review is regarding connectivity among the three sub-stocks especially in relation to recruitment. Currently, the model gets its signals about recruitment from the length-based survey data provided for the relevant area. Depending on how recruitment is distributed across the whole area (and direction of travel) some alternative assumptions might be needed to capture that element of stock connectivity into the calculations at the sub-stock level.

The analysis also included an empirical assessment that calculated the stock size using model free techniques. Comparison of the results from these calculations and those with CASA shows that the CASA model predicted higher current abundance for Georges Bank and lower abundance for the Mid-Atlantic relative to that predicted in the empirical assessment. Of particular interest is the fact that the abundance trend for Georges Bank that the CASA model produced is considerably different from the one from the empirical model, highlighting again the difficulties that the CASA model has in simulating rapid and big changes in population size. Some of the additional work recommended above might improve that characteristic of the CASA model. Overall, though, both approaches produced estimates of current abundance that were very close to each so that lends additional support to the model estimates.

The analysis is sound and makes good use of the data.

Recommendation 23: It is recommended that the way in which incidental mortality is captured in the stock assessment model is checked to ensure that it is correct.

Recommendation 24: It is recommended that the model is also run with one growth pattern at a time (different growth at different time periods is used at the moment) to check how sensitive the model results are to the choice of growth pattern.

Recommendations 25: Future work should consider whether changes in gear technology or the new spatial management would be enough to explain such considerable changes in selectivity over the years

Recommendation 26: It would be useful to understand whether high-grading is happening and how that could affect assumptions about level of discarding.

Recommendations 27: Further exploration of the model behavior is recommended to understand those factors that could lead to high retrospective error.

Recommendations 28: It is recommended that future assessments explore alternative assumptions about recruitment in each area and whether it is linked to stock dynamics in other areas and capture those elements of the stock dynamics into the calculations at the sub-stock level.

TOR 5. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for BMSY, BTHRESHOLD, FMSY and MSY) and provide estimates of their uncertainty. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

Work under this ToR is adequate to support management decisions but there are aspects of it that would require further consideration in the future.

The previous stock assessments introduced a new model, SYM, for calculating reference points. This was done because changes in selectivity patterns meant that yield per recruit curves (that were used until then to calculate BRP) did not provide much information about maximum sustainable exploitation (flat yield curves). SYM uses a stock-recruitment function and accounts for uncertainty in key processes such as recruitment and natural mortality; it uses Monte-Carlo simulations to propagate the uncertainty of inputs to the estimation of yield per recruit and yield curves.

Median (and mean) per recruit and yield curves were calculated as the median (mean) of these quantities as a function of fishing mortality. The probabilistic F at MSY was taken as the fishing mortality that maximizes the median yield curve. The probabilistic MSY and B at MSY were the median yield and biomass at F_{MSY} over all runs.

The current assessment kept the same model and BRPs as the previous assessment.

The model incorporates mortality from discards and that is considered an improvement in comparison to CASA, which did not explicitly account for discards. SYM is an appropriate model given the stock and fleet dynamic but further refining of the assumptions used in the calculations would be recommended (see comments below).

The process followed made good use of all relevant information and provided an appropriate way to capture and reflect uncertainty. As mentioned in previous ToRs the use of a single value of natural mortality for all size classes is probably not the most appropriate way to simulate natural mortality so, this is as an area in which improvement could be made. Also, the stock-recruitment relationships were calculated assuming that recruitment from each area (Georges Bank, mid- Atlantic) remains in that area (no transfer of larvae to other areas, etc.). It was not clear why/whether such an assumption was correct or what the level of uncertainty about that assumption is. An explanation on why the median yield curves (and not the mean yield curve) was chosen would be useful as well as presentation of the results for F for both the mean and median yield curve to facilitate comparison. It is recommended that future assessments incorporate those considerations into the analysis. Also, values of fishing mortality were not allowed to exceed 1 and that led to some convergence issues (estimates of fishing mortality were hitting the upper boundary). Use of a higher upper limit for F was recommended to avoid skewed distributions.

The main concern here is about the information on the stock recruitment function included in the calculations. Beverton-Holt stock recruitment curves are fitted to the recruitment estimates of the CASA model and that provides the stock-recruitment parameters used in the SYM. However, given that CASA cannot simulate well the peak recruitment events that the survey data reflect, it is not clear how well the recruitment estimates from CASA describe the recruitment processes for sea scallops. Another option would be to try to calculate stock recruitment curves from direct observations to test the accuracy of the curves constructed based on the results from the CASA model. Given the sensitivity of the model estimates of BRP to the choice of the parameters of the stock recruitment function, further work to improve the accuracy of those values and include them in future stock assessments is recommended.

Recommendation 29: It is recommended that future assessments provide an explanation of why the median yield curves (and not the mean yield curve) were chosen and present the results for F for both the mean and median yield curves to facilitate comparison.

Recommendation 30: Values of fishing mortality were not allowed to exceed 1 in the calculations of benchmarks and that led to some convergence issues (estimates of fishing mortality were hitting the upper boundary). Use of a higher upper limit for F is recommended to avoid skewed distributions.

Recommendation 31: Work is recommended to calculate stock-recruitment curves from direct observations to test the accuracy of the curves constructed based on the results from CASA model and improve estimates of the stock-recruit parameter values.

TOR 6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model or model formulation developed for this peer review.

This ToR was met.

a. Update the existing model with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.

b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

The existing model for stock assessment was the same as the one proposed to use for the 2014 stock assessment. So, one model was run with the updated input values. The definition of stock status was given for the whole stock (Georges Bank and mid-Atlantic). The estimated fishing mortality in 2013 was 0.32 and that is below both the previous and new F_{MSY} estimates (0.38 and 0.48, respectively). The estimated biomass in 2013 was 132,561 mt of meats. B_{MSY} was estimated as 125,358 in the previous assessment and 96,480 mt of meats in this assessment. Given that the stock is considered overfished if the biomass is less than half of B_{MSY} and the model results show that the current stock biomass is above that, the stock was not considered overfished.

However, the assessment also provided reference points for the two main fishing grounds separately. Those results showed that the Fmsy for Georges Bank is below the Fmsy for the whole area. This information is important since it indicated that there might be a risk of Georges Bank stock being overexploited if a uniform fishing effort is applied across the whole area for management purposes. Therefore it is recommended that the spatially disaggregated estimates of reference points are presented to managers as well as the combined one.

The conclusions reached under the ToR are sound and based on appropriate calculations.

Recommendation 32: It is recommended that the spatially disaggregated estimates of reference points are presented to managers as well as the ones for the entire stock.

TOR 7. Evaluate the realism of stock and catch projections and compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level).

Although only a small set of projections were run, the assessment team explained that more projections would be carried out by the Scallop Plan Development team at a later date. On that basis, the work presented responds to this ToR.

A size-structured model, SAMS, was used to run projections similar to CASA but at a finer spatial scale and it assumed that growth, mortality, and recruitment were area-dependent. Also, in this case recruitment was not calculated using a Beverton-Holt equation as it was with the SYM model. Instead, it was described using a log-normal distribution with mean and covariance matching that observed in NEFSC dredge survey time series.

a. Provide numerical annual 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. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).

Projections were conducted using SAMS and a different model was run for each sub area to reflect the different fishing mortality patterns that are exhibited in each sub-area. The parameterization is appropriate but it was not clear how much uncertainty increased (if at all) when biological processes had to be described at a finer spatial scale. It would be useful to provide some more narrative on that. Notwithstanding that, the use of area specific parameter values is considered an appropriate choice.

An example simulation, based on expected management during 2014-2016, predicted gradual increases in biomass and landings.

b. Comment on the realism of the projections. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.

The projection model captures key sources of uncertainty such as uncertainty in natural mortality and growth values. However, it did use the predictions about stock size from CASA and as mentioned earlier those might be optimistic. Also, the uncertainty in those estimates was underestimated. The fact that SAMS does not allow for density dependent mortality might also lead to projections that are somewhat optimistic; that might be counter-balanced by the fact that the mean, variance and covariance of the recruitment in a subarea were set to be equal to those observed in the historical time-series between 1979-2013, so big changes in recruitment from what had been already observed were less probable. Further work to incorporate a stock recruitment function is recommended.

c. *Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.*

Based on a small number of projections presented at the meeting, the stock does not appear to be at risk of being overexploited in the near future. However, given the possibility that projection results might be optimistic, the outcomes of the projection need to be considered cautiously.

Recommendation 33: Work to develop a stock-recruitment function to include in the calculations is recommended.

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

Progress has been made to address research recommendations from the assessment (SARC-50). Various survey programs plan to undertake collection of data so it is important that the work is coordinated to maximise the benefits but also to consider whether field work can be adjusted to address some of the recommendations/comments from the reviewers. (E.g.. develop better understanding of the effects of environmental factors on recruitment success, improve estimates of natural mortality). New work that the IS has identified is well placed to address some of the knowledge gaps and improve accuracy in model inputs and assumptions, especially the following three:

- Investigate methods for better survey coordination between the various survey programs.
- Evaluate effects of uncertainty in identifying dead scallops in optical surveys and improve procedures for identifying dead scallops.
- Collect data to refine estimates of incidental mortality.

In addition, further analysis of data to test the hypothesis of different growth patterns at different time periods is recommended. Further work to improve estimates of natural mortality and stock-recruitment parameter is also recommended. Finally, work to identify the best way to capture interdependencies among the different sub-areas (e.g. through transfer of young scallops) would be recommended.

Conclusions/Recommendations

- Two stocks were assessed in the SARC 59; Gulf of Maine haddock and Atlantic sea scallops.
- The stocks have been assessed in the past so this meeting aimed to provide updated estimates of stock status.
- The same stock assessment models used in past assessments were also applied in the current assessment of Atlantic sea scallops. A new modelling framework was introduced for the Gulf of Maine haddock.

- The data used were appropriate and represented well the fisheries that affected the stocks and biological parameters of the population. The models made good use of the relevant data.
- The group was able to calculate benchmarks for both species and the information provided characterised the uncertainty in model predictions well.
- Some improvements in the way key biological processes and characteristics of the fisheries are described would increase the robustness of the assessment results but the findings presented were still appropriate and can support management advice.
- The assessment predictions indicated that, for both species, the stock is not overexploited and overexploitation is not taking place.
- Based on results from short term projections the WG also concluded that the stocks are not at risk of being overexploited in the near future.
- The interpretation of the assessment results was sound.

Below, I have provided a list of recommendations for further action/work.

GULF OF MAINE HADDOCK

ToR 1

Recommendation 1. Analysis of age information from commercial discards collected by observers is recommended to include it in future stock assessment and improve estimates of ALK.

Recommendation 2: It is suggested that the WG reconsiders the approach currently used to calculate the length frequency of commercial discards since its assumptions do not fit well the observed pattern in the discard data.

Recommendation 3: Further work is recommended to explore possible reasons for the decline in the weight at age including analysis of data from stomach sampling and use of multispecies models to explore predator-prey dynamics and simulate any observed decline in prey (stock decline, change in prey distributions, etc.).

ToR 2

Recommendation 4. It is recommended that future assessments consider breaking the abundance series from the NEFSC survey into more than one series to reflect changes in the survey configuration.

Recommendation 5. If possible, survey design should aim to cover the area at 42.5 N and between 67-69 W, which does not appear to be sampled at the moment.

Recommendation 6. It is recommended that further analysis is done to get more clarity on the reasons behind the difference between the maturity ogive constructed using data collected in the MADMF and that constructed using data from the NEFSC survey (e.g., differences in the biological parameters of the population in sub areas in the Gulf of Maine, measurement error/bias).

ToR 3

Recommendation 7: If mixing remains of concern, I would recommend that genetics, otolith microchemistry, and tagging studies (if the return rate can be improved) are considered to improve the evidence base.

ToR 4

Recommendation 8: It is recommended that future stock assessments (and any projections done to provide management advice from this assessment) simulate each fishery separately.

Recommendation 9: Further studies to better describe natural mortality are recommended.

Recommendation 10: Incorporation of a stock recruitment function to introduce density dependence in survival of young fish will improve the quality of the stock assessment. Given difficulties in finding a relationship between stock size and age 1 class size, I would suggest that, if not already done, analysis is undertaken to look at possible links between stock size and fish at the age just before they enter the fishery.

ToR 5

Recommendation 11: Use of separate fishery selectivities would be recommended to appropriately capture the different characteristics of each fishery in benchmark calculations.

Recommendation 12: If the calculation cannot be done with two selectivities, I would recommend that a projection is run with the selectivity for the commercial fishery and one with the selectivity for the recreational fishery (capturing discards as well). This will provide boundaries within which one would expect the MSY to fall and will also provide a sense for how different the two MSYs are.

ToR 7

Recommendation 13: I would recommend that another column be added in the table with the results from the projections to show the amount of the total caches that will be discarded every year because it will be below the MLS.

ToR 8

Recommendations for additional research have already been covered above including:

- work to produce better estimates of natural mortality at age (Recommendation 9)
- work to better understand the reasons behind the decline in weight at age (Recommendation 3)

I also support the WG recommendations for further work especially:

- work to estimate mortality of discards in the recreational fishery and
- work to improve understanding of the recruitment process.

ATLANTIC SEA SCALLOPS

ToR 1

Recommendation 14: It is recommended that future assessments calculate the ratio of discards to catches in number of individuals instead of (or in addition to) weight so a more informed decision could be made about the significance of discards.

Recommendations 15: Further work to get better estimates of discard mortality is also recommended.

Recommendation 16: Existing surveys and data might be able to provide material to improve the estimates of natural mortality so analysis of existing data or incorporation of a relevant objective in future surveys is recommended to refine the values of natural mortality.

Recommendation 17: It is recommended that shell samples from surveys and commercial operations are analysed together to decide whether there has been a change in the growth pattern. If that's not possible, it is recommended that future work uses simulation modelling to assess whether the observed patterns in survey data could have been produced even if the growth pattern has remained the same. This work would ensure that the effects of fishing are not counted in the model twice.

Recommendations 18: It is not clear if the same growth pattern can be assigned to all areas so work to explore this further is recommended.

ToR 2

Recommendation 19: Alternative parameterisation of future assessment models to go around the fact that the surveys to which the model is fit are not independent is recommended.

Recommendation 20: Future work to consider whether mortality is size or density dependent and capture such effects in future stock assessments is recommended.

Recommendation 21: It is recommended that ways to maximise the knowledge that can be gained from the survey data are explored. For example, it might be possible to use some of the survey data to improve the estimates of natural mortality or provide more information about recruitment.

ToR 3:

Recommendation 22: Climate change is a factor that is relevant but was not covered in the discussion about environmental factors. It is recommended that future assessments make a reference to it and discuss whether its effects on this stock could be of significance.

ToR 4

Recommendation 23: It is recommended that the way in which incidental mortality is captured in the stock assessment model is checked to ensure that it is correct.

Recommendation 24: It is recommended that the model is also run with one growth pattern at a time (different growth at different time periods is used at the moment) to check how sensitive the model results are to the choice of growth pattern.

Recommendations 25: Future work should consider whether changes in gear technology or the new spatial management would be enough to explain such considerable changes in selectivity over the years as those used in the calculations.

Recommendation 26: It would be useful to understand whether high-grading is happening and how that could affect assumptions about the level of discarding.

Recommendations 27: Further exploration of the model behavior is recommended to understand those factors that could lead to high retrospective error.

Recommendations 28: It is recommended that future assessments explore alternative assumptions about recruitment in each area and whether it is linked to stock dynamics in other areas and capture those elements of the stock dynamics into the calculations at sub-stock level.

ToR 5

Recommendation 29: It is recommended that future assessments provide an explanation of why the median yield curve (and not the mean yield curve) was chosen and present the results for F for both the mean and median yield curves to facilitate comparison.

Recommendation 30: Values of fishing mortality were not allowed to exceed 1 in the calculations of benchmarks and that led to some convergence issues (estimates of fishing mortality were hitting the upper boundary). Use of a higher upper limit of F is recommended to avoid skewed distributions.

Recommendation 31: Work is recommended to calculate stock-recruitment curves from direct observations to test the accuracy of the curves constructed based on the results from CASA model and improve estimates of the stock-recruit parameter values.

ToR 6

Recommendation 32: It is recommended that the spatially disaggregated estimates of reference points are presented to managers as well as the ones for the entire stock.

ToR 7

Recommendation 33: Work to develop a stock-recruitment function to include in the calculations is recommended.

ToR 8

Recommendations for additional research have already been covered above including:

- further analysis of data to test the hypothesis of different growth patterns at different time periods (Recommendation 17);
- work to improve estimates of natural mortality and stock-recruitment parameter (Recommendations 16, 20, 31, 33);
- work to identify the best way to capture interdependencies among the different sub-areas (Recommendation 28); and
- consider whether field work can be adjusted to address some of the recommendations/concerns from this review.

I also support the IS recommendations for further work especially:

- Investigate methods for better survey coordination between the various survey programs.
- Evaluate effects of uncertainty in identifying dead scallops in optical surveys and improve procedures for identifying dead scallops.
- Collect data to refine estimates of incidental mortality.

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Appendix 2. Statement of Work for Dr Yiota Apostolaki

59th Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC): Benchmark stock assessments for Gulf of Maine haddock and sea scallops

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

BACKGROUND

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 Representative (COR), 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 independently 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.org.

SCOPE

Project Description: The Northeast Regional Stock Assessment Review Committee (SARC) meeting is a formal, multiple-day meeting of stock assessment experts who serve as a panel to peer-review tabled stock assessments and models. The SARC peer review is the cornerstone of the Northeast Stock Assessment Workshop (SAW) process, which includes assessment development and report preparation (which is done by SAW Working Groups or ASMFC technical committees), assessment peer review (by the SARC), public presentations, and document publication. This review determines whether the scientific assessments are adequate to serve as a basis for developing fishery management advice. Results provide the scientific basis for fishery management in the northeast region.

The purpose of this meeting will be to provide an external peer review of benchmark stock assessments for **Gulf of Maine haddock** and **sea scallops**.

OBJECTIVES

The SARC review panel will be composed of three appointed reviewers from the Center of Independent Experts (CIE), and an independent chair from the SSC of the New England or Mid-Atlantic Fishery Management Council. The SARC panel will write the SARC Summary Report and each CIE reviewer will write an individual independent review report.

Duties of reviewers are explained below in the "**Requirements for CIE Reviewers**", in the "**Charge to the SARC Panel**" and in the "**Statement of Tasks**". The draft stock assessment Terms of Reference (ToRs) which are carried out by the SAW WGs are attached in **Annex 2**. The draft agenda of the panel review meeting is attached in **Annex 3**. The SARC Summary Report format is described in **Annex 4.**

Requirements for the reviewers: Three reviewers shall conduct an impartial and independent peer review of the **Gulf of Maine haddock** and **sea scallop** stock assessments, and this review should be in accordance with this SoW and stock assessment ToRs herein. The reviewers shall have working knowledge and recent experience in the application of modern fishery stock assessment models. Expertise should include statistical catch-at-age, state-space and index models. Reviewers should also have experience in evaluating measures of model fit, identification, uncertainty, and forecasting. Reviewers should have experience in development of Biological Reference Points that includes an appreciation for the varying quality and quantity of data available to support estimation of Biological Reference Points. SARC 59 will address fishery stock assessments of **Gulf of Maine haddock** and **sea scallop.** For scallops, knowledge of sessile invertebrates and spatial management would be desirable. For GOM haddock, understanding of fish movements and exchange between stocks would be desirable.

PERIOD OF PERFORMANCE

The contractor shall complete the tasks and deliverables as specified in the schedule of milestones within this statement of work. Each reviewer's duties shall not exceed a maximum of 16 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 16 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).

PLACE OF PERFORMANCE AND TRAVEL

Each reviewer shall conduct an independent peer review during the panel review meeting scheduled in Woods Hole, Massachusetts during July 15-18, 2014.

STATEMENT OF TASKS

Charge to SARC panel: During the SARC meeting, the panel is to determine and write down whether each stock assessment Term of Reference (ToR) of the SAW (see

Annex 2) was or was not completed successfully. 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. **If alternative assessment models and model assumptions are presented, evaluate their strengths and weaknesses and then recommend which, if any, scientific approach should be adopted.** Where possible, the SARC chair shall identify or facilitate agreement among the reviewers for each stock assessment Term of Reference of the SAW.

If the panel rejects any of the current BRP or BRP proxies (for B_{MSY} and F_{MSY} and $MSY_{)}$, the panel should explain why those particular BRPs or 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 or BRP proxies are the best available at this time.

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

Tasks prior to the meeting: The contractor shall independently select qualified reviewers that do not have conflicts of interest to conduct an independent scientific peer review of stock assessments prepared by SAW WGs or ASMFC Technical Committees in accordance with the tasks and ToRs within the SoW. Upon completion of the independent reviewer selection by the contractor's technical team, the contractor shall provide the reviewer information (full name, title, affiliation, country, address, email, FAX number, and CV suitable for public distribution) to the COR, who will forward this information to the NMFS Project Contact no later than the date specified in the Schedule of Milestones and Deliverables. The contractor shall be responsible for providing the SoW and stock assessment ToRs to each reviewer. The NMFS Project Contact will be responsible for providing the reviewers with the background documents, reports for review, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact will also be 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 COR prior to the commencement of the peer review.

Foreign National Security Clearance: The reviewers shall participate during a panel review meeting at a government facility, and the NMFS Project Contact will be responsible for obtaining the Foreign National Security Clearance approval for the reviewers who are non-US citizens. For this reason, the reviewers shall provide by FAX (or by email if necessary) the requested information (e.g., 1.name [first, middle, and last], 2.contact information, 3.gender, 4.country of birth, 5.country of citizenship, 6.country of permanent residence, 7.whether there is dual citizenship, 8.country of current residence, 9.birth date [mo, day, year], 10.passport number, 11.country of passport) 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/.

Pre-review Background Documents and Working Papers: 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 SARC chair and CIE reviewers the necessary background information and reports (i.e., working papers) for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the COR on where to send documents. The reviewers are responsible only for the pre-review documents that are delivered to the contractor in accordance to the SoW scheduled deadlines specified herein. The reviewers shall read all documents deemed as necessary in preparation for the peer review.

Tasks during the panel review meeting: Each reviewer shall conduct the independent peer review of the stock assessments in accordance with the SoW and stock assessment ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs shall not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR and contractor.** 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 stock assessment 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 discussions, making sure all stock assessment Terms of Reference of the SAW are reviewed, control of document flow, and facilitation of discussion. For each assessment, review both the Assessment Report and the draft Assessment Summary Report. The draft Assessment Summary Report is reviewed and edited to assure that it is consistent with the outcome of the peer review, particularly statements that address stock status and assessment uncertainty.

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 stock assessment 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 or BRP proxy to be inappropriate, the reviewer should try to recommend an alternative, should one exist. Review both the Assessment Report and the draft Assessment Summary Report. The draft Assessment Summary Report is reviewed and edited to assure that it is consistent with the outcome of the peer review, particularly statements that address stock status and assessment uncertainty.

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.

Tasks after the panel review meeting:

SARC CIE reviewers:

Each CIE reviewer shall prepare an Independent CIE Report (see **Annex 1**). This report should explain whether each stock assessment 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 stock assessment 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 stock assessment 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, with the assistance from the CIE reviewers, will prepare the SARC Summary Report. Each CIE reviewer and the chair will discuss whether they hold similar views on each stock assessment 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 SARC 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 stock assessment 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 Points (BRP) or 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).

DELIVERY

Each reviewer shall complete an independent peer review report in accordance with the SoW. Each reviewer shall complete the independent peer review according to required format and content as described in **Annex 1**. Each reviewer shall complete the independent peer review addressing each stock assessment ToR listed in **Annex 2**.

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**.

5) 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.

6) Participate during the panel review meeting at the Woods Hole, Massachusetts scheduled during the tentative dates of July 15-18, 2014.
7) Conduct an independent peer review in accordance with this SoW and the assessment ToRs (listed in **Annex 2**).
8) No later than August 1, 2014, 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 to 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 assessment ToR in **Annex 2**.

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

June 10, 2014	Contractor sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
July 1, 2014	NMFS Project Contact will attempt to provide reviewers the pre-review documents
July 15-18, 2014	Each reviewer participates and conducts an independent peer review during the panel review meeting in Woods Hole, MA
July 18, 2014	SARC Chair and CIE reviewers work at drafting reports during meeting at Woods Hole, MA, USA
August 1, 2014	Reviewers submit draft independent peer review reports to the contractor's technical team for independent review
August 1, 2014	Draft of SARC Summary Report, reviewed by all CIE reviewers, due to the SARC Chair *
August 8, 2014	SARC Chair sends Final SARC Summary Report, approved by CIE reviewers, to NEFSC contact (i.e., SAW Chairman)
August 15, 2014	Contractor submits independent peer review reports to the COR who reviews for compliance with the contract requirements
August 22, 2014	The COR distributes the final 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 COR within 10 working days after receipt of all required information of the decision on substitutions. The COR 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 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: The deliverables shall be the final peer review report from each reviewer that satisfies the requirements and terms of reference of this SoW. The contract shall be successfully completed upon the acceptance of the contract deliverables by the COR based on three performance standards:

(1) each report shall be completed with the format and content in accordance with **Annex 1**,
(2) each report shall address each stock assessment ToR listed in **Annex 2**,
(3) each report shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Upon the acceptance of each independent peer review report by the COR, the reports will be distributed to the NMFS Project Contact and pertinent NMFS science director, at which time the reports will be made publicly available through the government's website.

The contractor shall send the final reports in PDF format to the COR, designated to be William Michaels, via email William.Michaels@noaa.gov

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Annex 1: Format and Contents of Independent Peer Review Report

1. The independent peer review 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 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 ToR of the SAW was completed successfully. For each ToR, the Independent Review Report should state why that ToR was or was not completed successfully. To make this determination, the SARC chair and 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 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 independent report shall be an independent peer review of each ToR, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

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

Annex 2: 59th SAW/SARC Stock Assessment Terms of Reference

A. Gulf of Maine (GOM) haddock

1. Estimate catch from all sources including landings and discards. Include recreational discards, as appropriate. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data. Investigate the utility of commercial or recreational LPUE as a measure of relative abundance.

2. Present the survey data being used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.). If available, consider whether tagging information could be used in estimation of stock size or exploitation rate. Characterize the uncertainty and any bias in these sources of data.

3. Evaluate the hypothesis that haddock migration from Georges Bank influences dynamics of GOM stock. Consider role of potential causal factors such as density dependence and environmental conditions.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-3), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections.

5. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model developed for this peer review. In both cases, evaluate whether the stock is rebuilt (if in a rebuilding plan).
    a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.
    b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level) (see Appendix to SAW TORs for definitions).
    d. Provide numerical annual projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment, migration from Georges Bank).
    e. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.
    f. Describe this stock's vulnerability (see "Appendix to the SAW TORs") 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 most recent SARC reviewed assessment and review panel reports. Identify new research recommendations.

Annex 2 (cont.):

B. Sea scallop

1. Estimate removals from all sources including landings, discards, incidental mortality, and natural mortality. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these assumptions and sources of data. If possible using sensitivity analyses, consider the potential effects that changes in fishing gear, fishing behavior, and management may have on the assumptions.

2. Present the survey data being used in the assessment (e.g., regional indices of relative or absolute abundance, recruitment, size data, etc.). Characterize the uncertainty and any bias in these sources of data.

3. Investigate the role of environmental and ecological factors in determining recruitment success. If possible, integrate the results into the stock assessment.

4. Estimate annual fishing mortality, recruitment and stock biomass for the time series, and estimate their uncertainty. Report these elements for both the combined resource and by sub-region. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections.

5. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model or model formulation developed for this peer review.
    a. Update the existing model with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.
    b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

7. Evaluate the realism of stock and catch projections and compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level).
    a. Provide numerical annual 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. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).
    b. Comment on the realism of the projections. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.
    c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") 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 most recent SARC reviewed assessment and review panel reports. Identify new research recommendations.

Annex 2 (cont.): ***Appendix to the SAW Assessment TORs:***

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

On "Acceptable Biological Catch" (DOC Nat. Stand. Guidel. Fed. Reg., v. 74, no. 11, 1-16-2009):

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 annual catch that is consistent with 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" (DOC Natl. Stand. Guidelines. Fed. Reg., v. 74, no. 11, 1-16-2009):

"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)

Rules of Engagement among members of a SAW Assessment Working Group:

Anyone participating in SAW assessment working group meetings that will be running or presenting results from an assessment model is expected to supply the source code, a compiled executable, an input file with the proposed configuration, and a detailed model description in advance of the model meeting. Source code for NOAA Toolbox programs is available on request. These measures allow transparency and a fair evaluation of differences that emerge between models.

One model or alternative models:

The preferred outcome of the SAW/SARC is to identify a single "best" model and an accompanying set of assessment results and a stock status determination. If selection of a "best" model is not possible, present alternative models in detail, and summarize the relative utility each model, including a comparison of results.

Annex 3: Draft Agenda

59th Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC): Benchmark stock assessments for A. Gulf of Maine haddock and **B. sea scallops**

July 15-18, 2014

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

DRAFT AGENDA* (version: Feb. 4, 2014)

TOPIC PRESENTER(S) SARC LEADER RAPPORTEUR

Tuesday, July 15

10 – 10:30 AM
Welcome — **James Weinberg**, SAW Chair
Introduction — **SARC Chair** — **TBD**
Agenda
Conduct of Meeting

10:30 – 12:30 PM — Assessment Presentation (Stock A.)
TBD TBD **TBD**

12:30 – 1:30 PM — Lunch

1:30 – 3:30 PM — Assesssment Presentation (Stock A.)
TBD TBD **TBD**

3:30 – 3:45 PM — Break

3:45 – 5:45 PM — SARC Discussion w/ Presenters (Stock A.)
SARC Chair **TBD**

5:45 – 6 PM — Public Comments

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR

Wednesday, July 16

9 – 10:45 AM Assessment Presentation (Stock B.)
TBD TBD **TBD**

10:45 – 11 AM Break

11 – 12:30 PM (cont.) Assessment Presentation (Stock B.)
TBD TBD **TBD**

12:30 – 1:45 PM Lunch

1:45 – 3:15 PM SARC Discussion w/presenters (Stock B.)
SARC Chair **TBD**

3:15 – 3:30 PM Public Comments

3:30 -3:45 PM Break

3:45 – 6 PM Revisit with presenters (Stock A.)
SARC Chair **TBD**

7 PM **(**Social Gathering **)**

Thursday, July 17

8:30 – 10:15 Revisit with presenter (Stock B.)
SARC Chair **TBD**

10:15 – 10:30 Break

10:30 – 12:30 Review/edit Assessment Summary Report (Stock B.)
SARC Chair **TBD**

12:30 – 1:45 PM Lunch

1:45 – 2:15 PM (cont.) edit Assessment Summary Report (Stock B.)
SARC Chair **TBD**

2:15 – 2:30 PM Break

2:30 – 5 PM Review/edit Assessment Summary Report (Stock A.)
SARC Chair **TBD**

Friday, July 18

9:00 AM – 5:00 PM SARC Report writing. (closed meeting)

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

The NMFS Project contact will provide the final agenda about four weeks before meeting.
Reviewers must attend the entire meeting.

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 Working Group 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 Points (BRP) or BRP proxies are considered inappropriate, include recommendations and justification for alternatives. If such alternatives cannot be identified, then indicate that the existing BRPs or BRP proxies are the best available at this time.

3. The report shall also include the bibliography of all materials provided during the SAW, and relevant 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 assessment 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.

Appendix 3: Panel Membership

Jean Jacques Maguire (Chair)
Panayiota Apostolaki
Vivian Haist
Coby Needle