Individual CIE Report

Independent peer review of the SAW/SARC 65 sea scallop & Atlantic herring stock assessments

Prepared for the Center for Independent Experts

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August 2018

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Executive Summary

- This document is the individual Center for Independent Experts (CIE) Reviewer Report of the SAW/SARC 65 review of the sea scallop (*Placopecten magellanicus*) and Atlantic herring (*Clupea harengus*) stock assessments. The review was conducted during late June 2018, the report was written during June and July 2018 and solely represents the views of the independent CIE reviewer Geoff Tingley.

- Background documents and the two draft assessment documents were provided in advance of the review meeting.

- The assessments for the Atlantic herring and sea scallop stocks were clearly presented and well documented, including detailed descriptions of the input data and an appropriate level of coverage of the uncertainties. The assessment teams were well led and fully engaged with the review in a highly professional and constructive manner.

- During the review, the SARC panel identified some shortcomings in the assessments and worked with the assessment teams to develop alternative model runs that addressed a small number of important issues during the review meeting.

- The stock assessments for both the Atlantic herring and sea scallop were of a high standard and are appropriate to use for the development of management advice.

- The stock of sea scallops has continued to increase in size and there are no sustainability concerns of this stock given the current management approach. Sea scallops are not experiencing overfishing and are not overfished.

- In contrast, the stock status of Atlantic herring has been declining fairly rapidly and while currently neither overfished nor experiencing overfishing, without a reduction in fishing mortality (F) or an increase in recruitment (or both), this stock is highly likely to breach these management reference points in the near future.

- There are a number of areas where further development work on data quality may yield improved model fits and a reduction in uncertainty. These include new biological data for sea scallops, revisiting some existing survey data for both assessments, and looking at new, focused survey work for both stocks. Appropriate recommendations have been made to address these various opportunities.

- Concerns about the retrospective pattern seen in the Atlantic herring assessment continue, albeit at a lower level in this assessment. While analytical corrections can and have previously been appropriately used, it may be that other approaches could also assist in reducing this. This pattern appears, in part, to be linked to recent recruitment uncertainty and seeking a way to generate a juvenile index that could inform the model may be worth exploring.

- Specific recommendations aimed at improving the stock assessment approaches for these stocks are made by the reviewer under Term of Reference 8 (Appendix 2) for both stocks.

Background

This review of the 2018 Stock Assessment Reports for sea scallop (*Placopecten magellanicus*) and Atlantic herring (*Clupea harengus*) was conducted as part of an independent review for the Center for Independent Experts (CIE) of the benchmark assessments for these stocks at the SARC 65 review meeting.

All views expressed in this report are solely those of the independent CIE reviewer.

The key assessment reports, with supporting background documents and reports, were broadly comprehensive, well written and clearly presented. The support provided by the SAW/SARC staff was of a high standard and much appreciated by this reviewer.

The sea scallop fishery off New England uses one principle gear-type, a toothless dredge, but operates in a number of separate areas where stocks can have different biological attributes. This stock has been increasing rapidly since the introduction of large closed areas as part of the management approach and are currently at the highest levels since records have been kept.

The Atlantic herring fishery is now principally a demersal trawl fishery, with a small coastal fixed net component. Atlantic herring is mostly used for bait in the lobster trap fishery. In recent years, this stock has been experiencing poorer than average recruitments and the stock status has been declining as a result.

Description of Review Activities

This review was undertaken by Geoff Tingley between the 10th June and 28th July 2018 as part of the SARC 65 review of the 2018 Stock Assessment Reports for Atlantic herring and sea scallop. The timing of the review meeting proceeded as scheduled.

The supporting documentation for the review of the assessment were provided to the reviewer in electronic format adequately in advance of the review meeting, although the principal draft assessment documents were not available two weeks prior to the meeting as intended. These documents included material pertaining to the development of the assessments, plus additional relevant documents detailing aspects of the stocks, sampling and other related science necessary for a full understanding of these fisheries and their assessment. Copies of the various presentations and additional work conducted during the review meeting were also provided as and when available. All documents provided are listed in the Bibliography (Appendix 1).

The assessment was reviewed against the specific, individual reviewer Terms of Reference (ToR) provided by the CIE (Appendix 2).

The background information relevant to this review is presented in three appendices to this review report, as required by the ToR. These are, *Appendix 1*: Bibliography of documents; *Appendix 2*: CIE Statement of Work (which includes background information and its own appendices describing the (1) Stock Assessment Terms of Reference for SAW/SARC-65, (2) draft Agenda for the review meeting, (3) Individual Independent Peer Review Report Requirements, and (4) SARC Summary Report Requirements); and *Appendix 3*: Panel membership, SARC attendance and the Agenda used during the review meeting.

On the morning of 26th June 2018, immediately prior to the start of SARC 65 review meeting, the SARC panel met with James Weinberg and Russell Brown (NEFSC) to review and discuss the meeting agenda, reporting requirements and meeting logistics.

The review meeting took place as scheduled between 26th and 29th June 2018. The meeting was conducted in an open, friendly and constructive manner throughout. Presentations were made with questions asked by members of the panel and other attendees. Discussions were open, professional and friendly, being focused on clarification and clarity around the assessments under review. A number of NOAA staff worked particularly hard to rapporteur the meeting and assist with the production of the summary reports.

Final outputs from all additional model runs developed during the four-day meeting and responses to panel questions were completed by the end of the meeting and immediately made available to the panelists.

With one or two exceptions, there was a very high degree of agreement between the individual panel members on these assessments.

Summary of Findings

Both the Atlantic herring and sea scallop assessment teams should be commended for their thorough and professional approach to processing the basic data and developing and applying the models for these assessments to enable the development of advice to managers. The sea scallop assessment was particularly challenging given the spatial complexity of the stock and fishery.

Areas of exception of potential importance specifically included the acceptance of the time series of the dredge survey without more development for the scallop assessment, and for the Atlantic herring assessment, the treatment of uncertainty in *M* and options for improvement in the acoustic abundance index. These areas are discussed in some detail and appropriate recommendations made.

Each assessment used a different modelling framework but they each followed the approach used in previous assessments of these stocks.

Additional model runs for each assessment were developed during the review meeting. These model runs were to address the need to develop reference points based on meat weight for sea scallops and to provide for sensitivities to the use a single fixed natural mortality rate (*M*) in the Atlantic herring base case model, when *M* had been shown to be poorly defined. The additional model runs for the Atlantic herring stock provide an improved understanding of uncertainty against which to provide management advice, while the sea scallop model runs provided the required information to develop meat weight-based reference points. As a result, this reviewer finds that the assessments of both the Atlantic herring and sea scallop stocks constitute the best scientific information available from which to provide advice to fishery managers.

The types, amount and quality of data available to assess sea scallop stock are more than sufficient to enable a high-quality assessment to be developed. It is worth noting, however, that two geographical areas are not covered or are poorly covered by this assessment. These include

the Gulf of Maine and the Canadian area of the Georges Bank, both of which were fully discussed by the SARC panel and appropriate recommendations made.

For the Atlantic herring assessment, there were also considerable quantities and varieties of data to draw on. There are a number of short duration abundance indices currently used, not all of which may be improving the fit of, or providing much information to, the models. A reconsideration of which of these time series to include based on data quality criteria may be beneficial. There is also potential to reanalyze and improve the bottom trawl survey acoustic time series to be considerably more informative in this assessment. The retrospective patterns in the assessment, while adequately managed, remain a concern.

By the end of the review meeting, the approach to modeling was considered thorough and sound, and appropriately addressed uncertainty to the principle assumptions through the range of sensitivities explored. The ranges of input data available and used were clearly described. The overall outcome of these assessments, as reviewed, is that they both meet the description of best available science and are of sufficient quality to be used to inform management.

Some future improvements in input data development and selection based on quality criteria may be warranted, especially for time-series presented as indices of abundance, which would be advisable in time for the next assessment of these stocks.

Recommendations for research and development work for future assessments for these stocks were considered, discussed and are made here and prioritized on a personal basis.

Detailed findings and recommendations are presented below within each section of the ToR as set out in Appendix 2.

Comments addressing the Individual Terms of Reference

A: Sea scallop

1. *Estimate catch from all sources including landings, discards, and incidental mortality. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.*

    - This Term of Reference (ToR) was fully met.
    - Landings and effort data for all important fishery areas were presented.
    - Discards and post-release discard survival were discussed in detail. Incidental mortality was considered and included in the model. Discard mortality was incorporated into the assessment as a component of incidental mortality and so discards were not separately included in the development of the catch history.
    - The catch history was well defined and uncertainties adequately if mostly qualitatively considered during the assessment. This would have benefitted from more quantitative consideration for landings, discards and the possible scale of illegal, unregulated or unreported (IUU) removals (poaching).
    - Sea scallops occurring in the Canadian waters of Georges Bank were acknowledged as likely to be the same biological stock but were not included in this assessment. Despite this exclusion, it would have been helpful to the panel to have had more information about this area to inform on the scale of the stock and fishery (e.g., catch history, spatial extent, and survey-based biomass estimates) as well as the basis for stock structure assumptions. The importance of this is in ensuring that the perspective of the stock status in US waters is correctly understood.

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 was fully met.
    - Several time series used as indices of abundance were presented and discussed. Each time series had specific issues associate with applicability for use as a biomass index.
    - Uncertainty in the biomass indices was well understood in most areas, and where not understood, the need for further work was clear and acknowledged by the assessment team. Uncertainty in the efficiency of the dredge used for the dredge survey needs further work. Confidence intervals for survey biomass estimates were fully presented at the request of the SARC.
    - The dredge survey provides a long-term time series of abundance estimates important to the assessment. From observations of the fishing and also from the fit of the model, it appears that this survey may be both overestimating local abundance at sometimes and underestimating local abundance when scallop density is particularly high. These issues should be investigated and, if real, corrected by, for example, restratification of the survey area for existing datasets and/or the use of model-based approaches to determine local spatial abundance.
    - There are some indications that the selectivity of the optical survey might not be constant. Changes in size-specific densities both within and between surveys may

be occurring and should be investigated. Any such investigation should include a review of the protocol for viewing the optical data and recording results to ensure that within and between reader variation is understood and minimized so that the survey is producing an internally consistent time-series and that this is fully comparable with the other survey indices.

3. *Summarize existing data, and characterize trends if possible, and define what data should be collected from the Gulf of Maine area to describe the condition and status of that resource. If possible provide a basis for developing catch advice for this area.*

    - This ToR was fully met.
    - The data available from the stock and fishery in the Gulf of Maine (GoM) are not currently adequate to enable the Scallop Area Management Simulator (SAMS) model to be applied for this area. A review of precisely what data would be needed to enable the SAMS model to be run should be conducted.
    - Biological data that will be required but are not currently collected in a consistent manner specifically include size frequency, growth and age data. These data should be collected from the fishery (e.g., at-sea observers and port sampling) and during any future surveys as a matter of urgency and priority. These data will be required and as each season passes the opportunity to build up an informative time series of data passes too, so there is some urgency to begin data collection.
    - With no adequate fishery-independent abundance index available for the GoM, there should be a focus on developing a single survey time series for use as an abundance index to inform assessment models. This should be developed to be proportionate to the current and likely future size and scale of the fishery in this area. Combinations of surveys and fishery monitoring should be fully considered, e.g., using an optical survey with biological data coming from the fishery.
    - Improved and cost-effective collection of fishery monitoring data, including catch (landing and discard) data, should be explored. With limited research options available, this will assist in the development of appropriate and informative fishery-dependent information to support assessment, including approaches to give representative LPUE as well as patterns of spatial density distribution.
    - The range and scale of uncertainties for the stock in this area suggest that multi-year projections are unlikely to be sufficiently accurate to be reliable at present. Single year projections may still be informative until the uncertainties can be better defined and reduced.

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

    - This ToR was fully met.
    - Environmental drivers of population change were considered during the assessment. These included temperature-mediated spatial distribution, and the short- and longer-term implications of climate change. Spatial differences in growth were also presented and discussed, including some aspects of density-dependent growth.

- As there were no bases for understanding causative relations between the scallop population and these possible drivers, they were, correctly, not directly integrated into the model.
- A number of important ecological factors were considered in some detail during the assessment. Information was presented on predators and predation, parasites, disease, invasive organisms and unusually slow growth of scallops in the southern Nantucket Lighthouse area (SNL). The presentations and discussions explained the decisions to not directly integrate these factors into the assessment, which is probably appropriate at this point. Specific factors were, however, clearly incorporated into some parameters (such as natural mortality) within the modelling framework.
- The assessment explicitly acknowledged spatial aspects both in the modelling (spatial environmental differences in the SAMS model) and in data (e.g., SNL slow growth area).

5. *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 retrospective analyses (historical, and within-model) to allow a comparison with previous assessment results and previous projections.*

    - This ToR was fully met.
    - A size-structured model (CASA) was used to assess the scallop stock. This applied the same basic approach as used previously.
    - Three spatially discrete assessments were undertaken: (i) the Mid-Atlantic Bight, (ii) Georges Bank open areas, and (iii) Georges Bank closed areas.
    - Three other areas of lesser importance to the scallop population were not assessed. These were (i) the southeast corner of Nantucket Lightship (SNL) area - growth rates have been extremely low and other life history parameters may also be unusual as a result; (ii) the Gulf of Maine – inadequate data; (ii) Canadian waters of Georges Bank – different jurisdiction, data availability not clear to the SARC panel.
    - This assessment included a number of changes intended to address previous underestimation of the survey indices by the model, and included how natural mortality (*M*) and growth were addressed in the model. Components of *M* were estimated for some age groups in the different areas while for others *M* was fixed. Generally, mean values of *M* were fixed while the deviates were estimated. Growth estimates were derived from data blocked into appropriate time periods.
    - This assessment was better able to fit the survey indices, through applying increased juvenile mortality. This approach was supported by the pattern of size frequencies and indices in the latter years and thus improved fits to the indices resulted.
    - These changes, specifically including variable growth and natural mortality, were not completely successful in addressing the model underestimation of the survey indices. This is especially visible for the Mid-Atlantic Bight and Georges Bank open areas. There are likely three factors that contribute to this as they may be confounded in the model: (i) observation error; (ii) natural mortality; and (iii)

fishing mortality (*F*), although the relative importance of each has not been determined and may differ between years and or between surveys.

- Annual estimates of additional mortality were calculated by the CASA model. These additional mortality terms were not directly accounted for by fishery landings. Most of this additional mortality arrears to be due to natural causes (assumed to be principally predation and disease), but there remains a small proportion that may be due to unaccounted fishing-related mortality. The additional mortality is included in the natural mortality calculations.
- It is likely that, even given the difficulties in ageing, there is sufficient information in the data and opportunities to further age scallops, that an age-based model could be developed and that this may have a number of benefits over the current length-based approach. This should be explored as part of the development of the next benchmark assessment for this stock. Other panel members also suggested space-time models could also be developed; some thought should be given on how to prioritize these different approaches.
- While there were some retrospective patterns, these were not sufficient to cause concern about the acceptability of the assessment. Where patterns were observed, they could be explained by differences between the survey indices (noise and conflict), which again highlights the need to try and improve the survey indices.

6. *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. 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 was fully met.
    - A different model (SYM) is used to estimate the biological reference points and uses outputs from the other models. While appearing a rather complex approach, this appears to be correctly set up, includes uncertainty and provides appropriate outputs. The configuration of the three models works together to ensure consistency and also enables cross checks to be made.
    - There is a minor inconsistency in how recruitment is handled. The stock recruitment relationship uses age-3 scallops as recruits, while the CASA assessment model has recruitment set at age-1. Given the difficulties of adequately estimating and predicting juvenile mortality, the use of age-3 recruits as an index of recruitment is appropriate. It may be appropriate to explore whether the assumed age of recruitment in these two components of the assessment could be rationalized.
    - At this assessment a new proposal was made to use spawning stock biomass (SSB), estimated as gonad weight, as the measure of stock status. It was agreed by the SARC that this approach was more biologically justified than the previous approach based on meat weight as a proxy for stock biomass. It was also agreed that introducing the proposed gonad weight-based SSB approach needed some time to enable the implications of changing the methodology on the understanding of current and future changes in stock status to be better defined. Thus, both the previous meat weight stock biomass and gonad weight SSB approaches should be

run in parallel at this time, with the intention of switching to the gonad weight-based spawning stock biomass by or at the next benchmark assessment, provided that no insoluble, unacceptable issues were identified. Further development of gonad-based SSB metrics should occur, with comparison with meat weight-based metrics before full implementation. These include, for example, updating the shell height-to-gonad weight relationships for all areas, and especially for those areas where these data are unavailable or old (e.g., the GoM and SNL areas) and evaluating the regional impacts of these changes. This reviewer fully supports the panel recommendation that both time series be reported for the present assessment, and that the stock biomass based on meat weights be used as the criterion for determining stock status for this 2018 assessment.

- While the calculation of MSY-based management quantities is required, this is not an approach that makes much sense for this stock or the fishery for it. Variation in the spatial patchiness in scallop density and spatially differing parameters that define scallop population dynamics (e.g. *M* and growth) create difficulties in adequately estimating key components that drive the estimation of stock status (e.g., the stock-recruit relationship). The fishery is currently managed using an adaptive, spatial approach, which is an appropriate way of delivering sustainable management.

7. *Make a recommendation about what stock status appears to be based on the existing model (from previous peer reviewed accepted assessment) and based on 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).*
    c. *Include descriptions of stock status based on simple indicators/metrics.*

- This ToR was fully met.
- The previous model was appropriately updated with new data of acceptable quality, including area-based shell height-to-weight relationships, growth, and *M*.
- Both the new gonad weight-based SSB and the previous meat weight-based stock biomass were developed, presented and reported, as were appropriate reference points. The meat weight-based stock biomass method used in previous assessments was applied to estimate biological reference points in this, the 2018 assessment, as recommended by the SARC panel.
- The SYM model output, incorporating the updated input data, was used to assess the stock status of the sea scallop relative to the accepted reference points. As can be clearly seen in the phase-plane (Kobe) plot provided, the sea scallop stock was neither overfished nor experiencing overfishing at this assessment.

8. *Develop approaches and apply them to conduct stock projections.*
    a. *Provide numerical annual projections (through 2020) and the statistical distribution (i.e., probability density function) of the catch at FMSY or an FMSY proxy (i.e. the overfishing level, OFL) (see Appendix to the SAW TORs). 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 which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions. Identify reasonable projection parameters (recruitment, weight-at-age, retrospective adjustments, etc.) to use when setting specifications.*

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

- This ToR was fully met.
- The SAMS model was used to simulate spatially discrete population projections. This model is used for this purpose as it permits the degree of spatial analysis that is required for management and that the other two models (CASA and SYM) do not permit.
- An important uncertainty is the way in which scallop biomass is distributed in the various and differently managed spatial areas, and how this changes over time. Much of the biomass can be found in areas which have been closed to fishing for some time or in areas that have recently been opened to fishing. At this time, this issue is difficult to adequately address as the data required to be able to estimate the stock dynamics and biological reference points at the same spatial scale as the SAMS model are not available.
- Three different models are used in this assessment, CASA to estimate regional historical biomass and *F* rates, SYM to estimate biological reference points (based on CASA outputs), and SAMS to project abundance, biomass and landings at a spatial scale suitable for management. As briefly noted under ToR 6, this remains a consistent and appropriate approach as the structure of each model is similar and is coherent where necessary. They are each used to address distinct questions within the assessment and management framework.
- The use of the most current survey information as a starting point for SAMS projections is rational and appropriate because the surveys will usually be more up-to-date than the CASA output.
- The population dynamics of scallops in recent years has been dominated by two very large cohorts. These are the 2012 year class on Georges Bank, primarily located in the Nantucket Lightship area, and the 2013 year class in the Mid-Atlantic Bight, centered on the Elephant Trunk rotational area off Delaware Bay. Densities of scallops as high as these have rarely been observed. Projections of abundance and landings for these very high density areas are therefore subject to higher uncertainty than normal projections, but it is not possible to define the scale of this uncertainty.
- Projections suggest that without further strong recruitments, as these very large cohorts age, the stock biomass will begin to fall.
- It was emphasized in the meeting that the fully-recruited *F* prior to 2005 is not directly compared to the SARC 65 recommended F_{MSY} estimate due to changes in the size-selectivity in the fishery over time.
- There was a brief discussion on the inconsistencies between the legal requirements for management metrics compared those needed to operate the current sustainable

approach to management. Metrics to address both needs were developed and presented, a pragmatic approach that should continue.

- There was general agreement that, under the current approach to area management, the *F* calculated across all areas, will tend to underestimate the true value of *F* in areas where fishing occurs and overestimate *F* in areas with little or no fishing. It is therefore possible that, under some circumstances, open areas could experience overfishing even if overfishing was not occurring on the whole-stock. The re-opening of long-term closures will tend to reduce the differences between the whole-stock and re-opened area *F*s, with overall *F* likely to increase.

9. *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.*

- This ToR was fully met.
- The SAW reviewed previous research recommendations and added some new ones. It was suggested that the SAW should establish priorities for research recommendations during the SAW process to get a wider perspective and save time at SARC meeting.
- As part of the review of research recommendations, earlier recommendations now considered redundant were removed from the list during the SARC review meeting. This should also continue be done as part of the SAW process and should be documented for the SARC meeting.

Sea Scallop Research Recommendations (NEFSC 2014), with progress commentary

- Investigate methods for better survey coordination between the various survey programs. -Some progress has been made coordinating the RSA dredge and Habcam surveys with NEFSC surveys.
- Evaluate effects of uncertainty in identifying dead scallops in optical surveys and improve procedures for identifying dead scallops. - No real progress has been made aside from improving quality of imagery in optical surveys.
- Collect data to refine estimates of incidental mortality. Analytical procedures were improved in this assessment but further progress awaits collection of more data. - Several studies have been funded and reported in this assessment and the incidental mortalities were updated. However, there is still need for better estimates of incidental mortality on hard-bottom habitats on Georges Bank and the Gulf of Maine.
- Improve training of annotators used in optical surveys to identify and count specimens. For example, develop and consistently apply criteria for identifying inexact shell height measurements. Formalize QA/QC procedures including revaluation of annotator accuracy. Develop and maintain reference images for training and testing. - Some progress has been made on improved training for NEFSC Habcam annotators, but is still needed in developing formal QA/QC procedures.
- Continue work to improve and simplify survey design and analytical procedures for HabCam. Ideally, procedures might be automated to the extent possible and integrated into routine survey operations. - Some progress has been made on survey designs and the analytical procedures have been automated. In addition, automated annotation

software utilizing deep learning computer vision algorithms are under development (e.g., Chang *et al*. 2016).

- Quantify and improve accuracy of SAMS projection models used to specify harvest levels. Recent projections appear to overestimate stock size to some extent. - New features such as density-dependent juvenile natural mortality and increased adult natural mortality will reduce the degree of overestimation on stock size.
- Reduce uncertainty about stock size estimates from surveys and the CASA model. In particular, continue work on density dependent natural mortality for small scallops in stock assessment, reference point and projection models. - Interannual variations in juvenile natural mortality is now explicitly included in this assessment.
- Collect additional biological data on a regional basis including growth increments from shells collected during historical dredge surveys, seasonality of spawning based on observer data, natural mortality on large scallops due to disease and senescence, and size-specific reproductive output.
- (1) Refine models that predict scallop recruitment based on chlorophyll and predator data in order to improve estimates from stock assessment and projection models. (2) Investigate statistical approaches to estimating year class strength directly from survey data.
- Archived shells from the 1980s and 1990s were analyzed for this assessment, which documents changes in growth over time. (1) A funded project is investigating the effects of changes in climate and predator abundance on scallop recruitment, but was not completed in time for this assessment. (2) No progress.
- Investigate and quantify the utility of multiple scallop surveys. - This was discussed during the 2015 sea scallop survey review.

New research recommendations

1. Further investigate methods for better survey coordination between the various survey programs, including survey design, timing, and standardized data formatting for easier sharing.
2. Investigate changes in dredge efficiency and saturation due to high scallop densities or high bycatch rates.
3. Analyze past juvenile scallop mortality events and develop better methods to model time-varying mortality in the assessment models.
4. Collect information needed for the management of the GOM fishery and development of appropriate reference points including biological parameters, fishery-independent surveys, and fishery-dependent data.
5. Continue development of scallop aging methods and examination of scallop growth processes including density dependent effects.
6. Improve training of annotators used in optical surveys and develop standardized QA/QC procedures for data collected from imagery.
7. Investigate use of software for automated annotation of imagery from optical surveys.
8. Investigate methods to better estimating biomass and abundance variances from Habcam optical surveys including development of Bayesian geostatistical methods.
9. Investigate and estimate current and historical unreported landings and effects of spatially heterogeneous fishing mortality on mortality estimates.

10. Develop a spatially-explicit methodology for forecasting the abundance and distribution of sea scallops by incorporating spatial data from surveys, landings, and fleet effort (a.k.a. GEOSAMS).
11. Investigate and parameterize sub-lethal effects of disease, parasites, or discarding on mortality, growth, and landings.
12. Revive and streamline previously-developed methods for interpreting VMS data.
13. Further refine and test methods for forecasting LPUE.
14. Continued investigation of discard mortality, particularly during warm water periods, by incorporating environmental data.
15. Continue improvements of observer recordings for vessel fishing behavior including deck loading and shucking dynamics in responses to disease or poor scallop health.
16. Continue investigating the extent of incidental fishing mortality, particularly on hard bottom habitats.

B: Atlantic herring

1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize uncertainty in these sources of data. Comment on other data sources that were considered but were not included.

- This ToR was fully met.
- Catches by the fishery were presented in a spatio-temporal format for the US and Canadian fleets and the two gear types. Spatio-temporal information was presented in some detail and used to describe both the behavior of the fishery as well as possible impacts of key environmental drivers.
- Information on the quantities of discards were provided and discussed. This information was, however, rather too minimalistic and future assessments would probably benefit from a more detailed consideration of discards by gear-type, area and size (or age).
- Illegal or unreported catches were briefly discussed, especially for such catches prior to about 1977, but broadly considered of little significance to the assessment. Impacts were not explored in the model runs, but indications of the scale of such removals suggest that including these as an alternative catch history would make little difference to the assessment outcome.
- Survey catch-at-age and fleet landings-at-age were described in detail, as were the stock age structure and maturity-at-age.
- Data presented for the by-catch of other fish in the herring fishery showed that this is a small proportion of the total catch. It was noted that by-catch of some species may be sufficiently large to impact the population of those species and may require more detailed consideration. By-catch caps are in place for some species that may provide adequate protection to those populations to some extent.

2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, food habits, etc.). Characterize the uncertainty and any bias in these sources of data.

- This ToR was fully met.
- Multiple different regional surveys were fully described, although some of these survey time series were of relatively short duration. More consideration of the quality and usefulness of each of these survey series to this assessment is warranted.
- One of the SARC panel was particularly concerned about the appropriateness of using bottom trawl surveys to monitor a semi-pelagic stock. This was discussed in some detail by the meeting, with, in the end, most participants satisfied that this was appropriate. This reviewer was satisfied that the bottom trawl survey time series was important to the assessment and should be continued until such time as better methodology has been developed and has established an alternative index.
- Selectivity and catchability were fully investigated and were used to inform the development of time series used as abundance indices.
- Uncertainties associated with all of the surveys used, or considered for use in the assessment, were described, with confidence intervals presented on all plots. For one survey, the time series had been split into two to address a vessel calibration issue. In addition, a further selectivity break was introduced at this assessment to address door changes in the same survey, producing three separate times series. This approach reduced the bias that would have been caused by the vessel and gear changes in the single time series.
- Additional diagnostics on the ability of surveys to track year class strength were requested by the panel. These were found helpful by the panel in examining year class trends and understanding model fit. It was proposed that this should be a standard diagnostic for this assessment, which would be appropriate.
- Acoustic data collected during a demersal bottom trawl survey was used and shown to be informative in the assessment. This dataset needs further work to develop it into a relative biomass index, which has the potential to become a key index in future assessments of this stock. Specifically, the non-standard nature of the survey design (from an acoustic perspective) needs to be considered to minimize biases that undoubtedly exist in the current data.
- A number of other potential sources of abundance index data were examined and prioritized for possible future consideration. Unused fishery-dependent information, such as acoustics from lobster boats, may be able to provide additional biomass or abundance indices and should be examined for future assessments.

3. Estimate consumption of herring, at various life stages. Characterize the uncertainty of the consumption estimates. Address whether herring distribution has been affected by environmental changes.

- This ToR was fully met.
- Consumption of herring by the main fish predators was clearly documented and presented. The quantity and quality, including the age, of information available for characterizing predation by marine mammals, birds and larger finfish (such as sailfish and tuna) were also discussed, but these are less comprehensive and are also dated for various reasons (e.g., a lack of current estimates of marine mammal population sizes). It was indicated that the scale of the mammal, seabird and large

fish predation was likely to be smaller than that of predation by the main fish predators.

- Some specific interest in the relationship between this herring stock and tuna was noted. Consumption of herring by tuna was therefore discussed in as much detail as the available information permitted, especially given the declining stock status of herring. The reviewers' interpretation of this discussion and available information was that the population of tuna in the region was likely small (compared to that of the main fish predators of herring) and that tuna consumption would thus be a very small component of the overall consumption of herring by all predators. It was also noted that the fishery was responsible for a minority of removals compared to the natural predators, and would thus likely have a relatively low impact on food availability to tuna. The consumption data for tuna appear to be rather old and may benefit from being updated with new data.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Incorporate ecosystem information from TOR-3 into the assessment model, as appropriate. Include retrospective analyses (both historical and within-model) to allow a comparison with previous assessment results and projections, and to examine model fit.

- This ToR was fully met.
- A range of models were used to thoroughly explore issues in model fitting. The assessment included runs to investigate sensitivity to various assumptions and uncertainties and the drivers of the retrospective pattern. These included the sensitivity of the assessment to *M*, survey index calibration, sequential removal of surveys from the assessment, fleet selectivity, and predation estimates as proxy for abundance.
- The sensitivity analyses were able to explain the scale difference between this assessment and the previous one in 2015.
- The assessment model of choice was ASAP, the same model framework as used previously for this stock. The assessment team clearly understood the model framework and were able to explain what had been done and why to the panel.
- A number of changes were made to the ASAP model for this assessment. The most important of these were assumptions about *M* and selectivity, and use of the acoustic data time series for the first time. These changes were thoroughly explained by the assessment team.
- Fish diet studies over a number of years were used to estimate consumption of herring by key fish predators. This was used as a check on the scale of *M* but was not used in the model. While interesting and more believable than previous work, the analysis was restricted to what were believed to be key fish predators and some possible important species were omitted due to lack of suitable data, including some large fish predators, marine mammals and seabirds. This was considered to be an interesting and useful approach, and ways of further developing this work were discussed by the SARC.
- The most recent (5) recruitment estimates were among the lowest in the time series, noting the very high uncertainty for those in the last two years. This is indicative that the short-to-medium-term prognosis for the stock is likely to be relatively poor.

- No adjustment for retrospective pattern was made in this assessment, as the unadjusted biomass values were within the 80% confidence interval threshold for implementing adjustment. While not triggering adjustment, the retrospective pattern remains an issue for this assessment. Following a detailed discussion, the panel concurred in recommending that possible incompatibility issues in the input data were sought and corrected rather than solely relying in the *post-hoc* Mohn's rho adjustment when the pattern becomes unacceptably large.
- With relatively high uncertainty about the value of *M* and its importance in this stock, as demonstrated in the presentations and discussion, presenting only one model run with *M* fixed at 0.35 was insufficient, especially as the likelihood profile for *M* minimized at about 0.45. The panel requested a sensitivity analysis to see the response of the stock to alternative assumptions about *M*. Bracketed sensitivities (higher and lower *M*) were developed. While *M* remains fixed, this should be a standard sensitivity analysis in future assessments.
- Various outputs were presented with a range of confidence intervals (CIs) which, made comparisons between runs and models difficult at times. CIs should be standardized.
- Two other models were also developed and presented, a state-space model (SAM) and a preliminary model implemented in Stock Synthesis (SS3). These were not considered as suitable for the provision of advice at this time, but both showed promise for future use.

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. 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 was fully met.
- A similar approach to that used in the previous assessment was followed to generate F_{MSY} estimates. However, this approach was considered an inadequate basis for management in this assessment as there was no acceptable stock recruit relationship, and the fallback approach of selecting an $F_{40\%}$ proxy was used. $F_{40\%}$ proxies are widely used in many managed fisheries elsewhere in the world.
- Updated reference points were determined principally following temporal changes in selectivity in the fishery (the fishery now appears to be preferentially taking older/larger fish), with the assessment indicating that *MSY* and SSB_{MSY} have changed. This is appropriate.
- A review of options to develop alternative, improved approaches to estimate reference points would be appropriate. For example, the panel noted, that length-based methods are used for some data-limited stocks.

6. Make a recommendation about what stock status appears to be based on the existing model (from previous peer reviewed accepted assessment) and based on 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).

c. Include descriptions of stock status based on simple indicators/metrics.

- This ToR was fully met.
- Updated reference points were provided. The panel requested a phase-plane (Kobe) plot for ease of interpretation and comparison.
- The Atlantic herring stock is currently not overfished and overfishing is not taking place with at least a 50% probability. However, with the recent pattern of poorer than average recruitment (see ToR 4), it is expected that the stock will continue to decline to breach these management thresholds without a reduction in F or an increase in recruitment, or both.
- Due to the change in the way the reference points were estimated in this assessment (based on an $F_{40\%}$ proxy rather than formal stock recruitment relationship), the reference points estimated in this assessment are not directly comparable to those estimated for previous assessments.

7. Develop approaches and apply them to conduct stock projections.

a. Provide numerical annual projections (through 2021) and the statistical distribution (i.e., probability density function) of the catch at FMSY or an FMSY proxy (i.e. the overfishing level, OFL) (see Appendix to the SAW TORs). 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 which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions. Identify reasonable projection parameters (recruitment, weight-at-age, retrospective adjustments, etc.) to use when setting specifications.

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

- This ToR was fully met.
- The assessment team used the ASAP assessment model to develop short-term projections, drawing on the long-term geometric mean recruitment. Given the recent pattern of below average recruitment, these projections are likely to be overly optimistic. A further set of projections were requested that used half of the long-term geometric-mean recruitment, which is more comparable to recent levels of recruitment. This provides managers with more information about the uncertainty that they will have to deal with in the short- to medium-term.
- The projections were examined during the SARC review meeting. These included those that incorporated alternative future catches and an alternative, lower average recruitment. Lower catches appeared to result in less pessimistic projections, and the lower level of recruitment (more pessimistic projections) appeared to better represent current stock conditions. The lower catch, lower recruitment scenario therefore appears to be the more realistic of the sets of projections.

8. If possible, make a recommendation about whether there is a need to modify the current stock definition for future assessments.

- This ToR was fully met.
- There is currently insufficient information available to advise on changes to stock structure assumptions. This is reflected in the assessment report.
- Data were presented and a spatial model developed in SS3 was explored. The analysis was inconclusive given the lack of available information described above.
- Stock structure should receive further attention in future assessments once more and better data have been collected. Aspects to consider include, genetic separation, rates of movement and distinguishing stock-specific harvesting from mixed catch fisheries.

9. For any research recommendations listed in SARC and other recent peer reviewed assessment and review panel reports, review, evaluate and report on the status of those research recommendations. Identify new research recommendations.

- This ToR was fully met.
- At the request of the SARC panel, the SAW reviewed previous research recommendations, removed redundant earlier recommendation (following discussion), added some new ones (including some suggested by the panel), and then prioritized the list. It is suggested that the SAW should establish a process of reviewing and prioritizing research recommendations prior to the SARC review meeting.
- The list of updated research recommendations for Atlantic herring (with the assessment team priorities in bold) is extensive and probably needs some further prioritization or reduction.

Atlantic Herring Research recommendations (2018)

- **Further research on the use of acoustic technology for inclusion in stock assessment, including information using industry-based platforms.** Specifically:
  - Investigate methods for converting herring acoustic indices to biomass;
  - Investigate refinements in target strength conversion to abundance estimates in acoustic data;
  - Evaluate statistical design implications in acoustic data from surveys and ships of opportunity;
  - Additional research to better understand species identification using acoustic signals.
- Investigate use of length data, stock structure and movement within assessment models (e.g., SS3)
- **Evaluate data collected in study fleet program for informing assessment data. Development research ideas that can be addressed within the context of the study fleet.**
  - Explore fisheries selectivity in greater depth. Perhaps with the study fleet and with historical perspective from the industry;

  - Research on depth preferences of herring in the water column through time to inform selectivity and catchability.
- Continue work related to understanding sources of variation in stomach contents, especially as this relates to the (GAMM) models used to develop an index of herring abundance.

General Assessment Recommendations

- **Evaluate the ability of state-space models to reliably estimate observation and process error variances under a range of scenarios, as well as their ability to estimate quantities of management interest.**
  - Develop a list of standards for evaluating data for possible use in stock assessment. Also develop standards for evaluating model diagnostics and inclusion criteria of indices.
  - Develop protocols for multi model inference to provide management advice from stock assessments based on NEFSC experience as well as other input (e.g., model averaging approaches).
  - Develop simulations to evaluate diagnostics that are useful under different scenarios (e.g., use of likelihoods, retrospective patterns for diagnostics, etc.).

Atlantic Herring Research Recommendations (SARC 2012), with progress commentary

- More extensive stock composition sampling including all stocks (i.e., Scotian Shelf) - no additional work completed. Research in other areas suggests that parasite composition may be informative.
- Develop (simple) methods to partition stocks in mixed stock fisheries - no simple methods completed. Work ongoing using SS3 model to address mixed stock issue.
- More extensive monitoring of spawning components - work completed at NEFSC examining extended spawning season in a subset of the mixed stock. Egg survey data analyzed for use as SSB index.
- Analyze diet composition of archived mammal stomachs. Improve size selectivity of mammal prey. Also sea birds - no work completed for assessment, however additional information added to recent herring MSE.
- Consider alternative sampling methods such as HabCam - Acoustic index evaluated and used in the 2018 assessment model.
- Research depth preferences of herring - evaluation attempted using Study Fleet information, but data incomplete for such analysis. Acoustics has offered some insights (e.g., Jech and Stroman 2012).
- Simulation study to evaluate ways in which various time series can be evaluated and folded into the model - on-going work under SEA GRANT funding to Essington and Deroba related to the sampling and subsequent utility of diet data. Similarly, Trijoulet et al. (In review, Ecology) have done some simulation/estimation studies to inform how diet data should be treated in the fitting of multi-species stock assessment models.

- Evaluate use of length-based models (Stock Synthesis and Chen model) - SS3 initiated but needs additional work before consideration for use in assessment. Chen model no longer supported.
- Develop indices at age from shrimp survey samples - average age-length key developed for application to survey samples. Will make request for a collection of age samples in the shrimp survey.
- Evaluate prey field to determine what other prey species are available to the predators that could explain some of the annual trends in consumption - some work done regarding sand lance but otherwise not completed.
- Develop statistical comparison of consumption estimates and biomass from model *M* - no additional work completed.
- Consider information on consumption from other sources (i.e., striped bass in other areas) and predators inshore of the survey - no additional work completed. No information available.
- Investigate why small herring are not found in the stomachs of predators in the NEFSC food habits database - no additional quantitative work completed, however discussions suggest a potential spatial mismatch between our survey coverage and small herring.
- Develop an industry-based LPUE or some other abundance index (Industry Based Survey) - no additional work completed, however ongoing discussion regarding use of acoustic information collected by industry.
- Develop objective criteria for inclusion of novel data streams (consumption, acoustic, larval, etc.) and how can this be applied - criteria for inclusion already in place, although not completely documented. (see new recommendations).

Atlantic Herring Research Recommendations (CIE 2012), with progress commentary

- Alternative catch scenarios could be developed to account for uncertainty in the stock boundary, particularly including catches from the Scotian Shelf. This would also allow examination of whether catch underestimation (e.g., inclusion of Scotian shelf catch) can contribute to the reduction in the retrospective pattern and contribute to or explain the need for increased *M* - no additional work completed.
- Look at the effect of adding a penalty to encourage the NMFS survey trawl door-change q ratios to be similar in spring and fall - no indication based on calibration experiment that this is necessary.
- Using simulation/estimation methods, evaluate consequences of alternative harvest policies in light of uncertainties in model formulation, presence of retrospective patterns, and incomplete information on magnitude and variability in *M* (see term of reference 9) - considered to some extent in recent MSE work.

Individual reviewer research recommendations

Sea scallop

There is a long list of research recommendations for sea scallops. The reviewer has carefully considered this and only offered recommendations considered of importance to the quality of the assessment.

1. Re-stratify the bottom dredge survey time series to ensure that variation in local density is not creating problems with the survey biomass estimates. This should be done for each survey and should improve the consistency of the time series and the fit of the model. This should be done prior to or as part of the next assessment for this stock.
2. In addition to the restratification of the survey (above), the size frequency information should also be considered for restratification for the same reasons. The survey size frequency information should be reweighed by a suitable, recognized methodology (e.g., using the square root of the catch) to balance the information content of the different data sources (i.e., to account for spatial variation in survey observations).
3. Collect appropriate quantities and frequencies data to enable the further work on the gonad weight-based SSB approach to assessing stock status and the associated biological reference points to proceed. This should specifically include more information on the shell height-to-gonad weight relationship for all areas, and especially for those areas with inadequate data currently (GoM and SNL areas). The timing of the collection of these data and the implications for the reliability of the estimation of stock status should be fully addressed in the sampling program.
4. Gulf of Maine: (i) start collecting key biological information now, using an observer program, port sampling and any available research surveys. Review the approaches used in other areas for suitability and use the SAMS model to prioritize the most important information to be collected where appropriate.
5. Gulf of Maine: (ii) identify a single biomass survey design and methodology from which to build a new and consistent time series. The reviewer suggests that a future-proofed optical survey using a current or future Habcam is likely to be the best approach, with biological data coming from the fishery.
6. Some concerns about changes in the selectivity of the optical surveys were identified (ToR 2). It is recommended that a review of the systems, process and protocols is conducted to ensure that the quantification of biomass from the optical surveys is based on all processes measuring the same sizes of scallops, both within and between the different time series.
7. Accepting that there are difficulties in ageing scallops, it remains likely that there is sufficient information in the available data, and opportunities to further age scallops, to enable the development of an age-based model. Such a model may have a number of benefits over the current length-based approach. It is recommended that this approach be incorporated as part of the next benchmark assessment for this stock.
8. Given the substantive growth in this stock, it is recommended that the decision to exclude the stock component on the Canadian part of Georges Bank from this assessment be reviewed prior to the next assessment of this stock.

Atlantic herring

There is a very long list of research recommendations for Atlantic herring. The reviewer has carefully considered this and only offered recommendations in those areas considered of importance to the quality of the assessment.

1. Bottom trawl survey acoustic data – (i) develop this as a relative index of abundance, which has the potential to become a key index in future assessments of this stock. Focus on reducing the bias in the data caused by the non-standard acoustic track from the bottom trawl survey using appropriate statistical methods and by reducing uncertainty in the estimation of target strength using Bayesian methods. (ii) The survey timing and spatial coverage should be kept as consistent as possible between years and corrected as far as is possible using Bayesian methods when there have been differences between surveys.

   There are a number of advantages to developing a relative rather than an absolute index, including avoiding often intractable issues associated with, for example, incomplete spatial coverage, variable spatial coverage between years, and uncertainties in acoustic selectivity and target strength.

2. Input data – when reviewing the input data, increase the quality threshold to exclude poorer quality data, including for surveys and composition data. This stock has sufficient data and improved fits and reduced uncertainties may be achievable.

3. Given the length of some of the survey time series, it is recommended that process error be estimated for surveys where possible and incorporated into the model to seek better fits.

SARC 65 CIE Appendix 1: Bibliography

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SARC 65 CIE Appendix 2: Statement of Work

Statement of Work

National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service (NMFS)
Center for Independent Experts (CIE) Program
External Independent Peer Review

65th Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC)
Benchmark stock assessment for Sea scallop and Atlantic herring

Background

The National Marine Fisheries Service (NMFS) is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards. (http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf).
Further information on the CIE program may be obtained from www.ciereviews.org.

Scope

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 Atlantic States Marine Fisheries Commission (ASMFC) technical committees), assessment peer review (by the SARC), public presentations, and document publication. This review determines whether or not the scientific assessments are adequate to serve as a basis for developing fishery management advice. Results provide the scientific basis for fisheries within the jurisdiction of NOAA's Greater Atlantic Regional Fisheries Office (GARFO).

The purpose of this meeting will be to provide an external peer review of a benchmark stock assessment for **Sea scallop and Atlantic herring**. The requirements for the peer review follow. This Statement of Work (SOW) also includes: **Appendix 1**: TORs for the stock assessment, which are the responsibility of the analysts; **Appendix 2:** a draft meeting agenda; **Appendix 3:** Individual Independent Review Report Requirements; and **Appendix 4:** SARC Summary Report Requirements.

Requirements

NMFS requires three reviewers under this contract (i.e. subject to CIE standards for reviewers) to participate in the panel review. The SARC chair, who is in addition to the three reviewers, will be provided by either the New England or Mid-Atlantic Fishery Management Council's Science and Statistical Committee; although the SARC chair will be participating in this review, the chair's participation (i.e. labor and travel) is not covered by this contract.

Each reviewer will write an individual review report in accordance with the SOW, OMB Guidelines, and the TORs below. All TORs must be addressed in each reviewer's report. No more than one of the reviewers selected for this review is permitted to have served on a SARC panel that reviewed this same species in the past. The reviewers shall have working knowledge and recent experience in the application of modern fishery stock assessment models. Expertise should include forward projecting statistical catch-at-age (SCAA) 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 (BRPs) that includes an appreciation for the varying quality and quantity of data available to support estimation of BRPs. For scallops, knowledge of sessile invertebrates, length-structured models, and spatial management would be desirable. For herring, knowledge of migratory pelagic species and SCAA models would be useful.

Tasks for Reviewers

- Review the background materials and reports prior to the review meeting
- Attend and participate in the panel review meeting
    - The meeting will consist of presentations by NOAA and other scientists, stock assessment authors and others to facilitate the review, to provide any additional information required by the reviewers, and to answer any questions from reviewers
- Reviewers shall conduct an independent peer review in accordance with the requirements specified in this SOW and TORs, in adherence with the required formatting and content guidelines; reviewers are not required to reach a consensus.
- Each reviewer shall assist the SARC Chair with contributions to the SARC Summary Report
- Deliver individual Independent Review Reports to the Government according to the specified milestone dates
- 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 below in the "Tasks for SARC panel."
- If any existing Biological Reference Points (BRP) or their proxies are considered inappropriate, the Independent 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 Report produced by each reviewer.
- The Independent 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.

Tasks for SARC panel

- During the SARC meeting, the panel is to determine whether each stock assessment Term of Reference (TOR) of the SAW 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 TOR 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 tasks in accordance with the SOW and Schedule of Milestones and Deliverables below.

Tasks for SARC chair and reviewers combined:

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 about stock status recommendations and descriptions of assessment uncertainty.

The SARC Chair, with the assistance from the reviewers, will write the SARC Summary Report. Each 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 will not be submitted, reviewed, or approved by the Contractor.

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.

Foreign National Security Clearance

When reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for reviewers who are non-US citizens. For this reason, the reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 40 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/ and http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html. The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance

The place of performance shall be at the contractor's facilities, and at the Northeast Fisheries Science Center in Woods Hole, Massachusetts.

Period of Performance

The period of performance shall be from the time of award through August 17, 2018. Each reviewer's duties shall not exceed **16** days to complete all required tasks.

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

No later than May 21, 2018	Contractor sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
No later than June 12, 2018	NMFS Project Contact will provide reviewers the pre-review documents
June 26-29, 2018	Each reviewer participates and conducts an independent peer review during the panel review meeting in Woods Hole, MA
June 29, 2018	SARC Chair and reviewers work at drafting reports during meeting at Woods Hole, MA, USA

July 13, 2018	Reviewers submit draft independent peer review reports to the contractor's technical team for review
July 13, 2018	Draft of SARC Summary Report, reviewed by all reviewers, due to the SARC Chair *
July 20, 2018	SARC Chair sends Final SARC Summary Report, approved by reviewers, to NMFS Project contact (i.e., SAW Chairman)
July 27, 2018	Contractor submits independent peer review reports to the COR and technical point of contact (POC)
Aug. 3, 2018	The COR and/or technical POC distributes the final reports to the NMFS Project Contact and regional Center Director

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

Applicable Performance Standards

The acceptance of the contract deliverables shall be based on three performance standards: (1) The reports shall be completed in accordance with the required formatting and content (2) The reports shall address each ToR as specified (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel

All travel expenses shall be reimbursable in accordance with Federal Travel Regulations (http://www.gsa.gov/portal/content/104790). International travel is authorized for this contract. Travel is not to exceed $12,000.

Restricted or Limited Use of Data

The contractors may be required to sign and adhere to a non-disclosure agreement.

NMFS Project Contact

Dr. James Weinberg, NEFSC SAW Chair
Northeast Fisheries Science Center
166 Water Street, Woods Hole, MA 02543
James.Weinberg@noaa.gov Phone: 508-495-2352

Appendix 1. Stock Assessment Terms of Reference for SAW/SARC-65

The SARC Review Panel shall assess whether or not the SAW Working Group has reasonably and satisfactorily completed the following actions.

A. Sea scallop

1. Estimate catch from all sources including landings, discards, and incidental mortality. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

2. a. 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. Summarize existing data, and characterize trends if possible, and define what data should be collected from the Gulf of Maine area to describe the condition and status of that resource. If possible provide a basis for developing catch advice for this area.

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

5. 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 retrospective analyses (historical, and within-model) to allow a comparison with previous assessment results and previous projections.

6. 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.

7. Make a recommendation[a] about what stock status appears to be based on the existing model (from previous peer reviewed accepted assessment) and based on 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).
    c. Include descriptions of stock status based on simple indicators/metrics.

8. Develop approaches and apply them to conduct stock projections.
    a. Provide numerical annual projections (through 2020) and the statistical distribution (i.e., probability density function) of the catch at F_{MSY} or an F_{MSY} proxy (i.e. the overfishing level, OFL) (see Appendix to the SAW TORs). 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 which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions. Identify reasonable projection parameters (recruitment, weight-at-age, retrospective adjustments, etc.) to use when setting specifications.
c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

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

[a]NOAA Fisheries has final responsibility for making the stock status determination based on best available scientific information.

B. Atlantic herring

1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize uncertainty in these sources of data. Comment on other data sources that were considered but were not included.

2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, food habits, etc.). Characterize the uncertainty and any bias in these sources of data.

3. Estimate consumption of herring, at various life stages. Characterize the uncertainty of the consumption estimates. Address whether herring distribution has been affected by environmental changes.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Incorporate ecosystem information from TOR-3 into the assessment model, as appropriate. Include retrospective analyses (both historical and within-model) to allow a comparison with previous assessment results and projections, and to examine model fit.

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. Make a recommendation[a] about what stock status appears to be based on the existing model (from previous peer reviewed accepted assessment) and based on 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).
   c. Include descriptions of stock status based on simple indicators/metrics.

7. Develop approaches and apply them to conduct stock projections.

a. Provide numerical annual projections (through 2021) and the statistical distribution (i.e., probability density function) of the catch at F_{MSY} or an F_{MSY} proxy (i.e. the overfishing level, OFL) (see Appendix to the SAW TORs). 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 which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions. Identify reasonable projection parameters (recruitment, weight-at-age, retrospective adjustments, etc.) to use when setting specifications.
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. If possible, make a recommendation about whether there is a need to modify the current stock definition for future assessments.

9. For any research recommendations listed in SARC and other recent peer reviewed assessment and review panel reports, review, evaluate and report on the status of those research recommendations. Identify new research recommendations.

[a]NOAA Fisheries has final responsibility for making the stock status determination based on best available scientific information.

Clarification of Terms
used in the Stock Assessment Terms of Reference

Guidance to SAW WG about "Number of Models to include in the Assessment Report":

In general, for any TOR in which one or more models are explored by the WG, give a detailed presentation of the "best" model, including inputs, outputs, diagnostics of model adequacy, and sensitivity analyses that evaluate robustness of model results to the assumptions. In less detail, describe other models that were evaluated by the WG and explain their strengths, weaknesses and results in relation to the "best" model. 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. It should be highlighted whether any models represent a minority opinion.

On "Acceptable Biological Catch" (DOC Nat. Stand. Guidelines. 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 the annual catch that is consistent with the schedule of fishing mortality rates in the rebuilding plan. *(p. 3209)*

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

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

On "Vulnerability" (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 Maximum Sustainable Yield (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)

Participation among members of a Stock Assessment Working Group:

Anyone participating in SAW 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.

Appendix 2. Draft Review Meeting Agenda

{Final Meeting agenda to be provided at time of award}

65th Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC) Benchmark stock assessment for A. Sea scallop and B. Herring

June 26-29, 2018

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

DRAFT AGENDA* (version: Dec. 22, 2017)

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR

Tuesday, June 26

10 – 10:45 AM
Welcome/Description of Review Process **James Weinberg**, SAW Chair
Introductions/Agenda **TBD,** SARC Chair
Conduct of Meeting

10:45 – 12:45 PM Assessment Presentation (A. Scallops)
Dvora Hart **TBD**

12:45 – 1:45 PM Lunch

1:45 – 3:45 PM Assesssment Presentation (A. Scallops)
Dvora Hart **TBD**

3:45 – 4 PM Break

4 – 5:45 PM SARC Discussion w/ Presenters (A. Scallops)
TBD, SARC Chair **TBD**

5:45 – 6 PM Public Comments

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR

Wednesday, June 27

8:30 – 10:30 AM	Assessment Presentation (B. Herring) **Jon Deroba**		**TBD**
10:30 – 10:45 AM	Break		
10:45 – 12:30 PM	Assessment Presentation (B. Herring) **Jon Deroba**		**TBD**
12:30 – 1:30 PM	Lunch		
1:30 – 3:30 PM	SARC Discussion w/presenters (B. Herring) **TBD,** SARC Chair		**TBD**
3:30 – 3:45 PM	Public Comments		
3:45 -4 PM	Break		
4 – 6 PM	Revisit with Presenters (A. Scallops) **TBD,** SARC Chair		**TBD**
7 PM	**(**Social Gathering**)**		

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR

Thursday, June 28

8:30 – 10:30	Revisit with Presenters (B. Herring)	**TBD,** SARC Chair **TBD**
10:30 – 10:45	Break	
10:45 – 12:15	Review/Edit Assessment Summary Report (A. Scallops)	**TBD,** SARC Chair **TBD**
12:15 – 1:15 PM	Lunch	
1:15 – 2:45 PM	(cont.) Edit Assessment Summary Report (A. Scallops)	**TBD,** SARC Chair **TBD**
2:45 – 3 PM	Break	
3 – 6 PM	Review/edit Assessment Summary Report (B. Herring)	**TBD,** SARC Chair **TBD**

Friday, June 29

9:00 AM – 5:00 PM	SARC Report writing

*All times are approximate, and may be changed at the discretion of the SARC chair. The meeting is open to the public; however, during the Report Writing sessions we ask that the public refrain from engaging in discussion with the SARC.

Appendix 3. Individual Independent Peer Review Report Requirements

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 report must contain a background section, description of the individual reviewers' roles in the review activities, summary of findings for each TOR in which the weaknesses and strengths are described, and conclusions and recommendations in accordance with the TORs. The independent report shall be an independent peer review, and shall not simply repeat the contents of the SARC Summary Report.

   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, but especially where there were divergent views.

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

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

3. The 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.

Appendix 4. SARC Summary Report Requirements

1. The main body of the report shall consist of an introduction prepared by the SARC chair that will include the background and 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 or not 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 reviewers should consider whether or not the work provides a scientifically credible basis for developing fishery management advice. If the 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 (BRPs) 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.

SARC 65 CIE Appendix 3: Panel membership, SARC attendees, and Agenda.

SARC 65 Panel Members

NAME	AFFILIATION	EMAIL
Patrick Sullivan (Chair)	Cornell University	pjs31@cornell.edu
Cathy Dichmont	Cathy Dichmont Consulting, Australia	cathy.dichmont@gmail.com
Coby Needle	Marine Laboratory, Aberdeen, Scotland	needlec@marlab.ac.uk
Geoff Tingley	Gingerfish Ltd, New Zealand	fishinnz@hotmail.co.uk

SARC 65 Attendee List

Russell Brown	NEFSC	russell.brown@noaa.gov
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Jonathon Peros	NEFMC	jperos@nefmc.org
Deirdre Boelke	NEFMC	dboelke@nefmc.org
Dvora Hart	NEFSC	deborah.hart@noaa.gov
Jui-Han Chang	NEFSC	jui-han.chang@noaa.gov
Jon Deroba	NEFSC	Jonathan Deroba@noaa.gov
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Gary Shepherd	NEFSC	gary.shepherd@noaa.gov
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Mary Beth Tooley	O'Hara Corp.	mbtooley@oharacorporation.com
Brooke Wright	SMAST	brooke.wright@umassd.edu

Agenda (as used during the review meeting)

65th Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC) Benchmark Stock Assessment for A. Sea scallop and B. Herring

June 26-29, 2018

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

AGENDA* (version: 6/22/2018)

TOPIC	PRESENTER(S)	RAPPORTEUR

Tuesday, June 26

10 – 10:45 AM
Welcome/Description of Review Process **James Weinberg**, SAW Chair
Introductions/Agenda **Patrick Sullivan,** SARC Chair
Conduct of Meeting

10:45 – 12:45 PM Assessment Presentation (A. Scallops)
Dvora Hart, Jui-Han Chang,
Jonathon Peros **Alicia Miller**

12:45 – 1:45 PM Lunch

1:45 – 3:45 PM Assesssment Presentation (A. Scallops)
Dvora Hart, Jui-Han Chang **Toni Chute**

3:45 – 4 PM Break

4 – 5:45 PM SARC Discussion w/ Presenters (A. Scallops)
Patrick Sullivan, SARC Chair **Toni Chute**

5:45 – 6 PM Public Comments

Wednesday, June 27

8:30 – 10:30 AM Assessment Presentation (B. Herring)
Jon Deroba **Dan Hennen**

10:30 – 10:45 AM Break

TOPIC PRESENTER(S) RAPPORTEUR

10:45 – 12:30 PM Assessment Presentation (B. Herring)
Jon Deroba **Dan Hennen**

12:30 – 1:30 PM Lunch

1:30 – 3:30 PM SARC Discussion w/presenters (B. Herring)
Patrick Sullivan, SARC Chair **Brian Linton**

3:30 – 3:45 PM Public Comments

3:45 -4 PM Break

4 – 6 PM Revisit with Presenters (A. Scallops)
Patrick Sullivan, SARC Chair **Brian Linton**

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

Thursday, June 28

8:30 – 10:30 Revisit with Presenters (B. Herring)
Patrick Sullivan, SARC Chair **Tony Wood**

10:30 – 10:45 Break

10:45 – 12:15 Review/Edit Assessment Summary Report (A. Scallops)
Patrick Sullivan, SARC Chair **Tony Wood**

12:15 – 1:15 PM Lunch

1:15 – 2:45 PM (cont.) Edit Assessment Summary Report (A. Scallops)
Patrick Sullivan, SARC Chair **TBD**

2:45 – 3 PM Break

3 – 6 PM Review/edit Assessment Summary Report (B. Herring)
Patrick Sullivan, SARC Chair **TBD**

Friday, June 29

9:00 AM – 5:00 PM SARC Report writing

*All times are approximate, and may be changed at the discretion of the SARC chair. The meeting is open to the public; however, during the SARC Report Writing sessions we ask that the public refrain from engaging in discussion with the SARC.