Center for Independent Experts (CIE) External Peer Review

SARC 61

61st Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC) Benchmark stock assessment for Atlantic surfclam

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Report to Center for Independent Experts

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Executive summary

- This report is a peer review of the benchmark assessment for Atlantic surfclam presented at the SARC-61 Review in July 2016.
- Good data are available on commercial landings, effort and catch composition since 1965, and adjustment is made for incidental mortality of surfclams not retained in dredge catches. Catch data are considered to be accurate because of the cage tagging system. The panel recommended review of meat weight conversions and adjustments for incidental mortality.
- Trends of declining LPUE relate to a very small area relative to the total stock, and although local depletion may be real this is not indicative of stock trends as a whole.
- A fishery-independent dredge survey of the surfclam resource has been undertaken since 1985, with considerable attention paid to dredge efficiency and selectivity. This is used as the primary source of information on stock abundance in the assessment, using experimental data to supply prior information on dredge efficiency for scaling of biomass. There has been a change in survey platform from a small research dredge deployed from a research vessel (1985-2011) to a modified commercial dredge deployed from a commercial vessel (2012 onwards).
- An integrated statistical catch-at-age model has been fitted to survey and commercial data, applied separately to northern (Georges Bank) and southern stock areas before combining results. Extensive sensitivity analyses show that there is robust estimation of stock trends, but the scale of stock biomass is uncertain. Under all scaling scenarios, fishing mortality is very low, as corroborated by the small spatial footprint of the fishery and comparison of catch data with swept area biomass estimates.
- Scale-independent biological reference points are developed for the fishery. Current stock biomass is well above both target and threshold levels, and fishing mortality is well below the overfishing limit under both current and recommended biological reference points.
- Stock projections indicate that stocks will remain within target levels over the next 5-10 years.
- The current stock definition is probably at a larger spatial scale than that at which population dynamics underlying stock productivity occur, but there is no basis for defining assessment or management at smaller spatial scales at present. The review panel endorsed the approach of modelling northern and southern stock areas separately and then combining the results for the purposes of status determination. Investigation of small scale spatial structure in stock dynamics is nevertheless recommended, considering implications for assessment and management at larger scales.
- This benchmark assessment of Atlantic surfclam provides a sound scientific basis for fishery management.
- Recommendations for future research are made.

Recommendations

Commercial catch data

1. The current conversion of reported landings quantities takes no account of the size composition of the landings. Seasonally adjusted length-weight relationships should be applied to make this conversion, using size composition data from biological sampling of landings.

2. Landings data are assumed to be accurate. Using comparisons of logbook data with observer records, and considering sources of variability such as meat weight conversions, consider whether this assumption is accurate. Also use observer records to consider whether the assumption that discarding no longer occurs is correct. After adjustment of fisheries removal data for incidental mortality (next recommendation) examine whether or not fishery removals should be treated as known without error.

3. The current adjustment for incidental mortality applies a constant multiplier for landings, which does not take account of the interaction between size-selectivity of the dredges and the size composition of the stock. Re-calculate this incidental mortality using available data on dredge efficiency, selectivity and size composition of the stock based on survey and/or catch data. Apply the adjustment to whole catch including discards.

NEFSC clam surveys

4. Find an effective statistical approach to imputation of missing data in survey strata to replace the current ad hoc 'borrowing' strategy. This should extend beyond GLM/GAM approaches to include consideration of geostatistical approaches, such as kriging, which make use of information on local patterns which may not be dependent on stratum boundaries.

5. In future surveys, ensure that at least some strata are surveyed in adjacent years to allow for estimation of year effects in the analysis of survey data.

6. Consider fixing the positions of some survey stations between years to allow local cohorts to be followed between years for a greater understanding of population processes at the smallest spatial scales.

7. For the sake of continuity and the value of consistency in long-term monitoring, keep the current survey configuration (vessel, gear) constant for future surveys, even if potential improvements in efficiency or other aspects of gear performance are identified.

8. Continue to address survey design improvements, addressing quantification of surfclam habitat, re-stratification of the Georges Bank and inclusion of new areas such as Nantucket Shoals. Whilst doing this, it is extremely important to consider also any implications for the consistency in long-term monitoring performance of the survey.

Changes in life-history parameters

9. Consider changes in growth patterns over time by calculating growth performance indices that account for the negative correlation of the von Bertalanffy parameters K and L_∞. Candidate indices include the ω index of Gallucci & Quinn (1979) or the φ' index of Pauly (1981).

Spatial scale of stock dynamics

10. Analyze patterns of spatial variability in population and fishery processes, applying geostatistical approaches such as directional semivariograms to survey and VMS data as appropriate. Identify patch scale, and use this as the basis for exploring the implications of mismatches in spatial scale between stock assessments, management and the population processes underlying stock productivity.
11. Use survey and commercial catch data to examine stock dynamics in locations subject to local depletion (as identified by LPUE declines), considering recruitment patterns, spatial and temporal scales of recovery and implications for the sustainability of exploitation at local and larger scales.
12. Shelve the TOR on stock definition for future stock assessments in favor of examining spatial variability at smaller spatial scales (recommendation 10), and consider the contribution of stocks in state waters to overall stock dynamics.

Assessment model, status determination and projections

13. Consider how to parameterize regional sub-structure within the catch-at-age model for more efficient modelling of shared parameters such as survey efficiency.
14. Review characterization of uncertainty around stock status determination, particularly in relation to stock biomass ratios.
15. Extend treatment of uncertainty in stock projections to include other parameters than recruitment deviations. Examine the effects of recruitment autocorrelation in stock projections.

Background

The purpose of SARC-61 is to provide an external peer review of a benchmark stock assessment for Atlantic surfclam (*Spisula solidissima*). The species is a large, relatively long-lived bivalve mollusk distributed from the Gulf of St Lawrence to Southern Virginia, and is the target of a commercial dredge fishery that operates throughout the stock area within the US EEZ, managed through an Individual Transferable Quota (ITQ) system. The fishery on Georges Bank was previously closed owing to Paralytic Shellfish Poisoning (PSP), but has been an important component of the overall fishery since 2015.

The Atlantic surfclam stock assessment working group addressed ten Terms of Reference (TOR – see p.26) considering commercial and survey data, their incorporation into an analytical assessment model to estimate stock biomass and fishing mortality, the development of biological reference points, determination of stock status and projection of stock trends. Together, these aspects provide a scientific basis for management of the fishery. This report is my peer review of the assessment for the Center for Independent Experts (CIE), working to the Statement of Work set out at Appendix 2, p.20).

Description of review activities

Online access (http://www.nefsc.noaa.gov/SARC/SARC-61-pdfs/) to documents relating to SARC 61 was made available to reviewers about three weeks ahead of the review meeting (see bibliography of review material at Appendix 1, p.19). This included background material such as academic papers and previous surfclam assessment documents, and the appendix to the 2016 surfclam stock assessment as a working document. The full stock assessment report and outputs from model runs were made available about ten days prior to the meeting.

The review meeting took place at the Northeast Fisheries Science Center (NEFSC), Woods Hole, 19-21 July 2016 (see Agenda at Appendix 4, p.34), chaired by Michael Wilberg of the University of Maryland Center for Environmental Science (also a member of the Scientific and Statistical Committee of the Mid-Atlantic Fishery Management Council). The meeting was introduced and guided by Jim Weinberg (NEFSC) as the SAW Chair. Jim made clear that the standard against which the stock assessment work should be judged is its credibility as a scientific basis for management.

Following introductions, day 1 of the meeting (19 July) was taken up with a presentation of the stock assessment by Dan Hennen (NEFSC) as the assessment lead, covering the first six Terms of Reference (TORs) during the day. Questions of clarification were dealt with during the presentation, with more substantive discussion at the end of each TOR.

Day 2 (20 July) commenced with responses by Dan Hennen and Larry Jacobson (NEFSC) to requests from the reviewers for additional analyses relating to model inputs, swept area estimates, MCMC outputs and recruitment patterns. Dan Hennen then completed the stock assessment presentation, covering the remaining TORs. Questions and discussion points raised by the reviewers were fielded alongside the presentation. Public comments were taken at the end of the morning session, with points raised by Tom Alspach (Sea Watch International), Dave Wallace (Wallace & Associates) and Eric Powell (University of Southern Mississippi). After further responses to requests for additional work (OFL calculations, stock projections), the afternoon session was taken up with editing the Assessment Summary Report, with plenary inputs from all SARC panel members.

The final day (21 July) was devoted to drafting the SARC Summary Report. In an initial plenary session, the SARC panel (CIE reviewers and SARC Chair) agreed the points to be covered under each TOR. Writing tasks for each TOR were then allocated as follows:

- Michael Bell: TOR-2 (survey), TOR-4 (depth distribution and biological parameters), TOR-9 (stock definition)
- Martin Cryer: TOR-5 (analytical stock assessment model), TOR-8 (stock projections)
- Coby Needle: TOR-1 (commercial catch), TOR-3 (benthic habitat), TOR-7 (stock status)
- Michael Wilberg: TOR-6 (biological reference points), TOR-10 (research recommendations)

A full draft was completed by 5:00 pm. Minor amendments were agreed by the SARC panel over email and the report was sent to the SAW Chair on 28 July.

My contributions to the review were to read all background material and working papers ahead of the meeting, to ask questions and participate fully in all discussions during the meeting, and to contribute to the drafting of the Assessment Summary Report and SARC Summary Report as detailed above. Consensus amongst the reviewers was not sought, but there was agreement between the reviewers about the main points, as reflected in the SARC Summary Report. I agree fully with this Summary Report; my individual report here amplifies my own views on the assessment.

Summary of findings

TOR-1 Commercial catch and effort data

Estimate catch from all sources including landings and discards. Map the spatial and temporal distribution of landings, discards, fishing effort, and gross revenue, as appropriate. Characterize the uncertainty in these sources of data.

This TOR was met in full. The assessment applies to Atlantic surfclam within the US Exclusive Economic Zone (EEZ), from Cape Hatteras in the south to Georges Bank in the north. As defined in US fisheries law, the EEZ extends from 3 nm out to 200 nm from shore, waters inshore of the 3 nm boundary coming under state jurisdiction. State landings are excluded from the assessment, but the report presents landings data for 1965-2015 for both EEZ and state waters. Since 1994 EEZ landings are estimated to comprise at least 90% of the total.

Total catch was estimated to be the sum of landings, discards and incidental mortality of clams not retained in the dredge. The review panel considered several possible sources of uncertainty in these figures:

- Landings data reported in units of industry cages are thought to be accurate owing to the use of cage tagging and the ITQ system in place since 1990. In the assessment report landings are given as meat weights for ease of comparison with survey data. This appears to be a constant conversion (from NEFSC, 2013: 1 cage = 32 bushels, 1 bushel = 7.71 kg meat weight). Given: (i) individual weight will likely have an approximately cubic relationship with shell length (e.g. Figure 58 of the assessment report), (ii) the length composition of landings is not constant between years (see Figure 165 in Part XIII of the assessment report), and (iii) there will be seasonal changes in meat content, the use of a constant conversion factor is not appropriate. I note that the surfclam assessment working group (WG) list examination of the bushels to meat weight conversion as a research recommendation (TOR-10). Given other uncertainties, and given that the influence of fishing mortality on dynamics at the stock scale appears to be very low (see below p.14), inappropriate use of a constant scaling factor for applying meat weight as the common currency in the assessment is highly unlikely to have had any effect on inferences about stock status. Nevertheless, it would be straightforward to implement a corrected conversion procedure in future assessments (accounting for length composition and seasonal distribution of landings), and I recommend that this is done.

- Landings data are taken from mandatory logbooks. The panel accepted that Atlantic surfclam landings data are likely to be accurate relative to many other fisheries, and that there is little or no incentive for misreporting. However, in the absence of independent verification, the quality of these data is hard to assess. As with the meat weight conversion, any unquantified uncertainty in landings is highly unlikely to have impacted the assessment of stock status, but it would be rigorous to examine the likely scale of any uncertainty, e.g. by comparison of logbook records with observer data, and to consider if the assumption of catches known without error is supportable in the assessment model.

- Discard data exist for 1979 to 1993, a period when a minimum size was in force, and it is assumed that there has been no discarding in the years that followed. This assumption may well be justified given the abandonment of a minimum legal size requirement, the low selection for small surfclams by commercial gear (judging by the curve shown for the modified commercial dredge used in recent surveys, Figure 49 of the assessment report), and the lack of incentive for high-grading given that the fishery is not limited by its quota, but there are no independent data to verify this. As with the quality of landings data, there is no suggestion that uncertainties about discarding are a likely source of bias or error in the assessment, but it would be useful to use observer data to provide evidence about discarding practices.

- The surfclam assessment WG estimates incidental mortality as an additional 12% on top of landings (the panel noted that the use of a constant multiplier for landings means that the adjustment will have had no effect on the current assessment outcome, particularly given low fishing mortality and that trends but not scale were determined in the assessment model). Incidental mortality is defined as the killing of clams that are in the path of the dredge but are not caught. This constant 12% adjustment factor has been applied in previous assessments. Based on estimated dredge efficiency (*e*) of 0.73 and estimates of indirect mortality due to contact with the dredge (*c*) in the range 0.05-0.5, the WG calculated that this adjustment factor is at about the correct level. This calculation did not, however, include the effects of size-selectivity of the dredge, which could lead to very different adjustment factors depending on the size composition of the stock. For example, assuming that the dredge efficiency estimate is for fully selected clams, for values of *e*=0.73 and *c*=0.2, incidental mortality is $\frac{c(1-e)}{e}=\frac{0.2(1-0.73)}{0.73}=0.074$ for large clams, whereas for smaller clams at 50% (*s*=0.5) selection the equivalent calculation is $\frac{c(1-s\cdot e)}{s\cdot e}=\frac{0.2(1-0.5\cdot 0.73)}{0.5\cdot 0.73}=0.35$. If clams that are not fully selected by the dredge are a significant component of the stock encountered by the fishery, calculation of overall incidental mortality may be significantly underestimated. The relationship of *c* (indirect mortality) with clam size also merits consideration, as this could either dampen or exaggerate the effect on incidental mortality, depending on the direction of the relationship. Again, given other uncertainties and low levels of fishing mortality, correct adjustment for incidental mortality has not been an important issue for this assessment outcome. However, it would be rigorous and straightforward to implement an unbiased adjustment for incidental mortality in future, based on selectivity and efficiency estimates for commercial dredges coupled with size composition data for the stock contacted by the fishery using either or both of survey and commercial length-sampling data. Further to this, the panel noted that the adjustment factor should apply to the entire catch, i.e. including discards rather than just landings.

Taken together, these sources of uncertainty suggest that it is appropriate to reconsider the assumption that fishery removals are known without error.

The assessment report also presents information on fishing effort and revenue, LPUE, size composition of landings, and spatiotemporal trends in fishery statistics. I am content with the methodology applied in this data treatment and with the representation of the data in the assessment report. The analyses showing patterns at a ten-minute square (TNMS) level are very useful to see, given the sedentary nature of the stock and the likelihood that important stock and fishery dynamics may occur at smaller spatial scales than that at which overall statistics are summarized. Figures 8-13 of the assessment report clearly demonstrate the northwards movement of the fishery over time. Patterns of effort and LPUE are particularly interesting, in that they demonstrate the response of the fishery to declines in catch rates that are presumably due to a combination of local depletion and changes in stock distribution. It would, however, have been useful to see a rather fuller interpretation of LPUE trends in the assessment report. At first sight, the overall trend of almost continuous decline in LPUE since the 1986 looks alarming, and is completely at odds with the overall assessment outcome. This is particularly so given that hyper-stability of LPUE would be expected in a fishery targeting a sedentary stock. It became clear during the assessment meeting that, although these LPUE trends may well be indicative of stock depletion at a local level, the very small spatial footprint of the fishery in relation to the stock area means that the trends are not indicative of declines at the scale of the stock as a whole, and that costs and other distance-related factors mean that the fishery is slow to respond to declines in stock availability in the most accessible areas. The report rightly comments that LPUE is a poor index of stock biomass for a patchy and sessile stock, but it would be useful to see further interpretation to forestall initial impressions of alarming declines and to more fully justify the non-inclusion of this index in the analytical model.

TOR-2 Survey indices and logbook data

Present the survey data being used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.). Use logbook data to investigate regional changes in LPUE, catch and effort. Characterize the uncertainty and any bias in these sources of data. Evaluate the spatial coverage, precision, and accuracy of the new clam survey.

This TOR was met in full. Analyses of logbook data for regional trends in LPUE, catch and effort were reported under TOR-1 in the assessment report, and my comments on these aspects is given above. Section III of the assessment report covering TOR-2 deals with the NEFSC clam surveys and their use in constructing indices of abundance.

The NEFSC clam survey has been conducted since 1982. Surveys have been undertaken in June-July at intervals of 1-3 years. Up to 2011 the survey used a standard NEFSC survey hydraulic dredge (the 'research dredge' or RD) deployed from the research vessel *RV Delaware II*. An impressive amount of work has been undertaken to characterize the efficiency and selectivity of the RD using depletion and comparative fishing experiments and to quantify effective time fishing using sensor data. These aspects have been extensively reviewed in previous assessments, and received less attention during this SARC. Following the retirement of *RV Delaware II* in 2011, the NEFSC clam survey has been conducted using a different survey platform, the commercial vessel *ESS Pursuit* deploying a modified commercial dredge (referred to as the MCD) for 2012 onwards. Compared with the RD, the MCD is larger, has a higher efficiency but lower selection for small clams. Dredge efficiency has been characterized using depletion experiments, with a median value of 0.59 for the MCD compared with 0.23 for the RD (Figure 50 of the assessment report). There is considerable uncertainty around efficiency estimates, particularly for the RD, and this is reflected in the priors for survey efficiency used in the assessment model. There is also considerable uncertainty about the scaling between the RD and MCD surveys, in the absence of comparative fishing to provide calibration.

One panel member questioned whether the MCD survey data should be included at this early stage, with only two annual index values for the southern area (2012 and 2015, with the partial 2012 survey actually being completed in 2013) and one for Georges Bank (partial in 2013, completed in 2014). The panel concluded, however, that given the availability of efficiency estimates for both dredges, however uncertain, it was appropriate to include the surveys in the assessment. Given its much greater fishing power relative to the RD, the MCD had been expected to increase the precision of the survey estimates. This has not yet transpired, presumably owing to splitting of surveys between years (technical problems prevented completion of surveys in the years to which they nominally apply) and perhaps also to the patchiness of the resource. The assessment scientists emphasized the importance of not changing the survey gear or vessel, even for the sake of improvements, as this could result in a loss of information for as much as a decade. This position was endorsed in public comments during the meeting (Eric Powell, University of Southern Mississippi), suggesting that the greater efficiency of the MCD will lead to a decrease in uncertainty over time, a gain which would be lost by switching to another vessel or gear. I agree with this point-of-view and strongly recommend maintaining consistency in the set-up of the survey going forward into the future.

Part XIV (appendix) of the assessment report considers the impact on the analytical assessment of the change in survey platform, addressing the question of what would be the outcome if the MCD had been used throughout the survey time-series. The prime concern was about whether lower selectivity of the MCD at small sizes results in a loss of information. Survey data for 1982-2011 were adjusted to reflect the difference in selectivity between the RD and the MCD. The conclusion was that there was no impact on the assessment outcome compared with the 2013 assessment. Whilst I am not overly concerned that loss of information is a significant issue for the assessment, I am also not convinced that this analysis actually has the power to address the issue. Effectively, the analysis just applies a transformation to the RD data, such that recovering the same assessment together with the transformation parameters is not a real test of the survey difference. Importantly, the test takes no account of a change in sampling variability at low selection values by the MCD, which is likely to be the source of any loss of information. Further, the analysis does not address the potentially more important question of the impact of switching surveys within the time series. However, given that the RD and MCD data are the best available source of information on stock trends and will remain so, and that any further simulation analyses are unlikely to add anything beyond what should already be apparent from effective characterization of uncertainty around assessment outcomes, I recommend that this analysis should not be pursued any further.

The panel noted two further issues with the survey data. The first is relatively minor, concerning the use of 'semi-random' sampling stations in the survey. The panel noted that stations included in a stratified random survey should be truly random. My own point of view is that data from these semi-random sampling stations may still be useful if the spatial patterns of variability are properly accounted for in any survey estimates, and this is particularly relevant to the second issue, which is that of data 'borrowing'.

This is a long-standing issue, relating to the use of data from adjacent years to fill gaps of missing data for strata not represented in particular years of the survey. The WG recognize that this ad hoc imputation strategy is unsatisfactory, likely resulting in 'smearing' of signals between years, but attempts at statistical approaches to imputation (e.g. using negative binomial models) have not been judged successful so far. It would have been useful to see more information in the assessment report about why the results were not judged credible, but the panel accepted that the continuation of the borrowing strategy is a sensible pragmatic approach to including the survey data in the assessment at present, and probably has not impacted the quality of the assessment adversely. Clearly, it remains a priority for the future, and I recommend further exploration of statistical approaches to imputation. Given the lack of progress with GLM/GAM approaches, I recommend exploring the use of geostatistical approaches such as kriging; this implies going beyond stratum-based imputation to an approach based on spatial proximity and spatial patterns of variability. Geostatistical analysis, including the construction of directional semivariograms, is in any case highly recommended for exploring the spatial scales at which stock abundance varies, which is crucial information when considering the potential for mismatches in scale between important population and fishery processes and how they are represented in the stock definition and stock assessments (see below, p.13). For future surveys, it is worth noting that if spatial coverage is limited by available survey time and resources, priority should be given to ensuring that at least some spatial strata are covered in both of adjacent years. This is particularly relevant for estimation of year effects in GLM/GAM approaches to modelling of survey data.

TOR-3 Extent of benthic habitat

Determine the extent and relative quality of benthic habitat for surfclams in the Georges Bank ecosystem to refine estimates of stock size based on swept area calculations.

This TOR was met in full. Surveys on Georges Bank frequently encounter areas of rocky habitat supporting low densities of surfclams. TOR-3 addresses the concern that if these areas of unsuitable habitat are not properly accounted for in swept area biomass calculations this could lead to overestimation. This assessment followed previous assessments in reducing the area represented by the survey on Georges Bank by 12%, based on the proportion of 'untowable' (usually because of rocky ground) stations, under the assumption that untowable = poor surfclam habitat supporting zero surfclams. The WG reviewed several potential methods for delineating surfclam habitat, anticipating a re-evaluation of the NEFSC clam survey that might include re-stratification and extension to additional areas such as the Nantucket Shoals. Potential methods described in Section XXIV of the assessment report included the use of ancillary data on survey tows (haul and gear codes, bycatch of substrate, shell and live animals), acoustic data, underwater camera observations (HabCam), published surficial sediment data, presence of dead shell and use of oceanographic data. The WG stressed that work is ongoing and will be tabled for a future subcommittee to consider re-stratification of the Georges Bank survey. In the meantime, the WG reviewed the proportion of stations recorded as untowable in surveys since 1999, coming up with a figure of 14% of random stations, slightly higher than the 12% figure used in the assessment. I support their recommendation for improved recording of untowable stations, clearly identified in the survey database. I also support the approach of identifying the assessed surfclam stock as the fishable stock, which clearly represents a bias towards precautionarity. The panel noted, however, that it may be important to address this bias if surfclam biomass estimates are used in other applications such as ecosystem modelling.

TOR-4 Changes in depth distribution

Quantify changes in the depth distribution of surfclams over time. Review changes over time in surfclam biological parameters such as length, width, and growth.

This TOR was met in full. The WG presented clear evidence that the distribution of surfclam habitat is shifting into deeper waters in the southern part of its range. In New Jersey, for example, the median depth of catch for surfclam in the NEFSC survey has shown a strong trend of increase over 1982-2015, this representing both decreased catches in shallow water and increased catches in deeper water. This has resulted in a bigger overlap between surfclam and ocean quahog habitat in some areas (Long Island and New Jersey), which may be an issue for both fisheries which have previously experienced low bycatch levels of the non-target species.

These shifts are thought to be a consequence of increasing ocean temperatures. The WG also considered whether these changes have been accompanied by a growth response, and demonstrated some significant changes in the von Bertalanffy growth parameters L_∞ and K since the early 1980s. Given the negative correlation between these parameters, these trends are somewhat difficult to interpret in isolation. I recommend examining growth performance indices that combine information from both parameters, such as the ω index of Gallucci & Quinn (1979) or the φ' index of Pauly (1981). A recent paper by Ragonese *et al.* (2012) considers a number of alternative growth performance indices applied to Mediterranean hake.

TOR-5 Analytical stock assessment

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

This TOR was met to the extent possible given available data and modelling framework. The integrated catch-at-age model applied to commercial and survey data for surfclams was first applied in the 2013 assessment (NEFSC, 2013). The 2015 assessment was a benchmark assessment, and the WG reviewed the assessment inputs, impacts of changing the survey platform, prior information on survey efficiency, errors around growth curves, relative weighting of age and length composition data, age determination error, recruitment deviations, and selectivity parameters. The outcome is an assessment that is demonstrated to show a robust estimation of trends in relative biomass, but huge uncertainty in the scale of absolute biomass. I strongly support the assessment as the best available scientific basis for fishery management of surfclams – this was set out by the SAW Chair as the criterion against which the assessment should be judged, and on this basis I commend the WG for producing a robust and defensible assessment and for clearly exploring and demonstrating the terms in which the outcomes should and should not be interpreted.

The model was implemented in SS3 (Methot, 2015), applied separately for northern (Georges Bank) and southern stock areas (see TOR-9, p.16). SS3 provides a very general and flexible framework within which stock assessment models can be defined, and the use of this software for the surfclam assessment appears to follow a general move towards its application in stock assessments conducted by NEFSC. SS3 is not the only software available for this type of statistical catch-at-age modelling, but given the complexity of this type of modelling, the move towards building expertise through the standard use of particular software does seem sensible, and provides an additional layer of quality control on assessments. The application to surfclam did not make use of SS3's capabilities in modelling regional sub-populations, which does represent some inefficiency in terms of not sharing parameters (e.g. relating to survey performance) between southern and northern regions, which were assessed as entirely separate entities. However, I support the WG's pragmatic approach to dealing with the difficulties of different survey years for the MCD in the two regions; in future, with further experience of applying SS3, it may prove possible to define a combined model that accounts for these discontinuities, but I do not believe that the nature of the assessment outcomes or the overall quality of the assessment has in any meaningful way been impacted by the decision to combine outputs from the two regions after separate modelling.

The conclusion that the assessment is robust, and the best that is currently possible, is notwithstanding the fact that the spatial scale at which population processes are modelled is probably much larger than that at which they occur in practice. One consequence of this mismatch may be that the age and length composition data for the survey and commercial catch have much less influence on the assessment than the survey index. I support the greater weight placed on the survey index in driving the assessment, and note that given recruitment and cohort dynamics that must occur at the 'bed' scale (which is currently an unknown spatial scale for surfclam), it is unlikely that either the survey or the commercial fishery (which occupies a very small portion of the total stock area) will provide an adequate description of stock dynamics at any larger spatial scale. The survey must cover a large area over a limited time, and stations are randomized within geographical strata that may well be large in comparison with any meaningful definition of a surfclam bed, thus the power to determine even regional stock dynamics on the basis of compositional changes must be very low. The difficulty in reconciling commercial catch composition with stock dynamics represented in survey catch composition is one likely reason that the scaling of catch in relation to stock biomass is currently so uncertain. I recognize that it is impractical to consider assessment and fishery management at small spatial scales appropriate to patch dynamics in surfclam, or to attempt to capture these dynamics in the surfclam survey. However, I recommend that there be a sensitivity analysis of the response of the assessment model and the management model to population processes occurring at smaller spatial scales. As recommended above (p.11), geostatistical analysis could provide a basis for characterizing spatial patterns of variability in stock abundance, perhaps considering size or age classes separately. It is worth noting that maps of the spatial distribution of recruits show significant spatial correlation, indicating that survey resolution may well be sufficient to represent patch/bed scale in surfclams. Alongside this, analysis of spatial patterns in VMS data could be used to characterize targeting behavior and the scales at which fishing mortality occurs. If logistically possible, inclusion of some fixed stations in the survey would allow the fate of local cohorts to be followed, providing insight into regulatory factors operating at meaningful scales. Related to this topic, I note that the parameterization of the stock-recruitment relationship in the assessment model effectively provides recruitment that is independent of stock size. This is likely to be appropriate because of (i) the modelling of recruitment at large spatial scales, which means that any density-dependent feedbacks which may occur at small spatial scales are effectively averaged out, and (ii) recruitment being more likely to be determined by environment (e.g. oceanographic factors relating to delivery of larvae to suitable grounds for settlement) than by supply of larvae in a broadcast spawner.

Although, as driven primarily by survey indices and by the wide priors on survey dredge efficiency, the assessment is considered robust in terms of relative biomass trends and highly uncertain in terms of absolute biomass scale, the conclusion that fishing mortality is very low does appear to be corroborated by all available data sources. Supplementary analyses presented during the SARC meeting showed that the proportion of the total stock area estimated to be swept by the commercial fishery is similar in scale to the estimated fishing mortality. An empirical estimate of fishing mortality, obtained by dividing the total commercial catch by the total swept area biomass estimate, was also similar to the analytical assessment output. Similar survey age composition between the Georges Bank, which was unfished for about 20 years, and the southern stock area which has been continuously exploited, also suggests that fishing mortality has not played an important role in stock dynamics in the fished area. The question remains, however, whether local depletion in some areas, evident in the LPUE declines noted above (p.9), has longer term consequences for the sustainability of exploitation in these areas. Characterization of stock dynamics in areas subject to local depletion is an important topic for future research. The shift of the fishery and stock northwards and to deeper water looks likely to be a consequence of changing ocean temperatures rather than depletion, but it is important to understand the scales and locations at which exploitation may affect stock dynamics.

TOR-6 Biological reference points

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, particularly as they relate to stock assumptions.

This TOR was met in full, and the panel commended the WG for their creative approach in defining robust and workable BRPs based on trend information, in the face of great uncertainty about the absolute scale of stock biomass of surfclams.

The assessment defined threshold and target values for stock biomass and a threshold value for fishing mortality, these being the BRPs required under the FMP. Given the assessment outcome, the starting point for defining new reference points was that they should be scale independent. This rationale was accepted by the review panel, who noted that the scale independence should result in stock status determination being stable over future assessments. As emphasized by Dan Hennen and Larry Jacobson during the SARC meeting, scale independence is easily achieved for stock biomass, but more problematic for fishing mortality. For stock biomass, the recommended biomass target is half the virgin spawning stock biomass (0.5 SSB_0) and the threshold is 0.25 SSB_0, levels that are in line with standard guidelines. SSB_0 is estimated in the analytical assessment model, and scale independence is achieved through proportionality of the terminal SSB estimate to SSB_0 – the target is reached when SSB_{terminal} / SSB_0 = 0.5, and the threshold is reached when SSB_{terminal} / SSB_0 = 0.25. This replaces the current reference points that refer to B_{1999}, a value that has no theoretical justification beyond being a relatively high biomass. I concur with the review panel in endorsing this choice of BRPs for stock biomass. One potential pitfall in calculating the biomass reference points in this way for the surfclam stock as a whole, when separate models are fitted to Georges Bank and the southern area separately, is that the relative scaling of the two stock components remains uncertain. The panel was satisfied with the WG's approach, which was to use the geometric mean of SSB to combine the two areas, which is less sensitive to scaling issues than the weighted arithmetic mean.

Problems with scale independence for the fishing mortality reference points arise from the fact that a scale is inherently required in referring catches to stock biomass. The WG used management strategy evaluations (MSE) to identify a good proxy for F_{MSY} based on operational properties. These simulations indicate that a value of F = 0.12 provided high yield with low inter-annual variability, high stock biomass and infrequent fishery closures, and is also lower than the value of $M = 0.15$, which is treated as an upper bound for F_{MSY}. The rationale for achieving scale independence in status determination referring the currently estimated F to F_{MSY} was to select the period 1982-2015 as a period when the fishery has demonstrably not harmed the stock (note comments above about catch not driving stock dynamics over this period, p.14), then, out of all the sensitivity runs from which the scale uncertainty was determined, select the run which gave the highest absolute value of $F_{1982\text{-}2015}$, and find the ratio of F_{MSY} to this highest possible value of $F_{1982\text{-}2015}$ to provide a multiplier for $F_{1982\text{-}2015}$ from the current assessment to provide a relative F_{MSY} applicable to the current assessment. This procedure generates a value of $F_{threshold} = F_{MSY} = 4 \times F_{1982\text{-}2015}$, where the value of $F_{1982\text{-}2015}$ is that from any current assessment. MSY was not calculated by the WG, but the panel pointed out that this approach is effectively choosing a 'worst case' scaling factor rather than being truly scale independent, thus it is possible to calculate MSY in the same currency. Larry Jacobson undertook some supplementary analyses during the SARC meeting and presented some preliminary values (not quoted here, in case of revision over a more considered time scale). In common with other panel members, I believe that the approach taken provides an appropriate fishing mortality BRP and associated MSY value for use as an overfishing limit (OFL), and that this is a sound scientific basis for management of the surfclam fishery.

TOR-7 Stock status

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

a. *When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.*
b. *Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).*

This TOR was met in full. Despite uncertainties about scale, stock status is not in doubt: stock biomass is more than two times higher than the threshold and fishing mortality is well under the threshold under both current (SARC-56) and recommended (SARC-61) BRPs. Multiple sources of information corroborate the conclusion that fishing mortality is very low (see p.13). Confidence intervals based on the log-normal distribution applied to the point estimates and their CVs suggest that 95% CI for SSB_{2015} / SSB_0 have some overlap with the $SSB_{threshold}$, i.e. a small but measurable probability of the stock being in an overfished state. Some skepticism of this finding was expressed at the meeting, and although the calculation of CI were checked and found to be technically correct, neither the SARC panel nor public attendees considered an overfished state to be a plausible possibility. It is recommended that there be a thorough review of the method of quantifying uncertainty around stock status in relation to the biomass threshold.

TOR-8 Stock projections

Develop approaches and apply them to conduct stock projections.

a. *Provide numerical annual projections (five years) and the statistical distribution (e.g., probability density function) of the OFL (overfishing level) (see Appendix to the SAW TORs). Consider cases using nominal as well as potential levels of uncertainty in the model. 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.*
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 met in full. The WG provided extensive projections under a range of catch assumptions and scalings for biomass, and determined that neither overfishing nor an overfished state is likely over the next ten years. Panel discussions centered around incorporation of uncertainty in the projections. Stochasticity in the projections was provided through modelling of recruitment variability. At the panel's request, further projections were performed using a more pessimistic recruitment scenario based on the ten worst recruitment deviations in the time-series. The outcome of the projections was not seriously affected. It was pointed out, however, that given 30 age-classes present in the stock and being exploited by the fishery, assumptions about recruitment are not critical to the outcome of projections over a 5-10 year time horizon.

The panel accepted that the projections presented by the WG are a fair representation of likely stock trajectories over the next 5-10 years, but recommend that a wider range of uncertainties be considered, including autocorrelation of recruitment and extending stochasticity to include other parameters.

TOR-9 Stock definition

Evaluate the validity of the current stock definition. Determine whether current stock definitions may mask reductions in sustainable catch on regional spatial scales. Make a recommendation about whether there is a need to modify the current stock definition.

This TOR was not met. The issue of whether Georges Bank and the southern stock area should be treated as one unit stock or two caused considerable contention within the WG during the previous assessment (NEFSC, 2013). The two stock argument revolved around recognition of biological differences between areas and the difficulty of defining an effective MSY at a larger scale than that at which processes underlying stock productivity occur. Arguments in favor of one stock focused on the clinal nature of biological differences, as would be expected across a large stock area, meaning that any particular sub-divisions are likely to be arbitrary rather than reflecting genuine discontinuities, and the suggestion that smaller scales of management could unnecessarily constrain the flexibility of fishing vessels to operate throughout the current range of the fishery and would increase the probability of management interventions.

Those in favor of one stock also argued that different areas can be modelled separately but managed together based on combined results. In the absence of any further basis for resolving the issue, the 2016 WG has chosen not to make a recommendation on stock definition, instead just re-presenting the same tables of points for and against the two stock definition as were presented at SARC-56. The pragmatic decision to model Georges Bank and the southern area separately and combine the outputs for development of BRPs and status determination is effectively aligned with the one stock view-point, which remains the default position. The panel accepted that this pragmatic decision has had no adverse impact on the quality of the assessment. My own view is that the issue of mismatch in spatial scale between stock definition, stock assessment modelling and population dynamic processes is in no way addressed by a north-south split or by other possible splits at a similar spatial scale. I recommend that this TOR be shelved for the next assessment, in favor of a fuller exploration of spatial scales of variability in stock and fishery processes based on geostatistical analysis of survey, catch and VMS data, and examining the implications of these for assessment and management at larger spatial scales (as already suggested above, p.13). It was also pointed out during the meeting that there is no real biological distinction between state waters and the federal EEZ; although this is not critical at current high stock and low fishing mortality levels, consideration should be given to the contribution of surfclam stocks in state waters to overall stock dynamics.

TOR-10 Research recommendations

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 met in full. The WG considered five research recommendations arising from the previous assessment:

1. The best spatial and temporal distribution to use for surfclam assessment models was not explicitly determined. The WG chose instead to model the north and south stocks separately and to combine the results for status determination, this being adopted on a pragmatic basis.
2. Biomass reference points were fully re-considered, applying a scale-independent approach based on SSB_0.
3. Analyses of survey data quantified the shift of surfclam into deeper offshore waters.
4. Regime shift was addressed within the catch-at-age model by consideration of two growth stanzas in sensitivity runs for the southern area model.
5. Various approaches were considered for quantifying surfclam habitat on Georges Bank, and the WG agreed that the current approach based on untowable survey stations is adequate

The WG made further recommendations for including Nantucket Shoals in the future surveys, re-stratification of Georges Bank for greater survey efficiency and re-examination of coefficients for conversion of reported landings quantities to meat weights. I endorse all these suggestions, and note that the examination of meat weight conversions (see also p.7) could usefully be undertaken alongside analysis of the effects of stock size composition on the calculation of incidental mortality (see p.9).

Further research recommendations of the panel are listed in the SARC summary report, and my own list of recommendations is given on p.4.

Conclusions

SARC-61 successfully completed its TOR and provided a stock assessment, development of biological reference points and stock projections that will provide a sound scientific basis for management of the Atlantic surfclam resource. The surfclam assessment working group members are congratulated for achieving a robust and defensible basis for management in the face of considerable uncertainty in the assessment, particularly in the absolute scale of stock biomass.

Acknowledgments

I would like to thank the Atlantic surfclam assessment working group for their hard work before and during the SARC-61 Review, and for their willingness to respond to questions and requests for analyses during the meeting. Particular thanks to Dan Hennen and Larry Jacobson for clear presentations and their openness and responsiveness during the meeting. Thanks also to Jim Weinberg and Sheena Steiner for excellent organization and arrangement of the meeting, and for getting material to the review team in good time. I am grateful to my fellow review panel members Martin Cryer, Coby Needle and Mike Wilberg for being a pleasure to work with, and particularly to Mike for excellent chairmanship. Many thanks also to Roberto Koeneke and Manoj Shivlani for smooth and friendly administration of the contract and travel arrangements.

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APPENDIX 1: Bibliography of materials provided during the review meeting

Background documents:

Methot, R.D., 2015. *User Manual for Stock Synthesis—Model Version 3.24s*. NOAA Fisheries Toolbox. 152 pp.

Methot, R.D. & Wetzel C., 2013. *Appendix A: Technical Description of the Stock Synthesis assessment program.* NOAA Fisheries Toolbox. 37 pp.

Munroe, D.M., Narváez, D.A., Hennen, D., Jacobson, L., Mann, R., Hofmann, E.E., Powell, E.N. & Klinck, 2016. Fishing and bottom water temperature as drivers of change in maximum shell length in Atlantic surfclams (*Spisula solidissima*). *Estuarine, Coastal and Shelf Science*, **170**, 112-122.

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Serchuk, F.M. & Murawski, S.A., 1997. The offshore molluscan resources of the northeastern coast of the United States: surfclams, ocean quahogs, and sea scallops. *NOAA Technical Report NMFS 127*, 45-62.

Weinberg, J.R., 2005. Bathymetric shift in the distribution of Atlantic surfclams: response to warmer ocean temperature. *ICES Journal of Marine Science*, **62**, 1444-1453.

Zhang, X., Haidvogel, D., Munroe, D., Powell, E.N., Klinck, J., Mann, R. & Castruccio, F.S., 2015. Modeling larval connectivity of the Atlantic surfclams within the Middle Atlantic Bight: Model development, larval dispersal and metapopulation connectivity. *Estuarine, Coastal and Shelf Science*, **153**, 38-53.

Zhang, X., Munroe, D., Haidvogel, D. & Powell, E.N., 2016. Atlantic surfclam connectivity within the Middle Atlantic Bight: Mechanisms underlying variation in larval transport and settlement. *Estuarine, Coastal and Shelf Science*, **173**, 65-78.

Working papers:

NEFSC, 2016. Stock Assessment of the Atlantic Surfclam. SAW/SARC 61. July 19-21, 2016, NOAA Fisheries, Northeast Fisheries Science Center. Woods Hole, MA. 474 pp.

NEFSC, 2016. SAW-SARC 61 Assessment Summary Report Atlantic Surfclam. SAW/SARC 61. July 19-21, 2016, NOAA Fisheries, Northeast Fisheries Science Center. Woods Hole, MA. 12 pp.

Presentations:

Working Group, Atlantic Surfclam, 2016. *Atlantic Surfclam Assessment 2016*. PowerPoint presentation, 78 slides.

Jacobson, L., 2016. *Surfclam Swept Area Data.* PowerPoint presentation, 7 slides.

Jacobson, L., 2016. *Overfishing Limits Based on Trends.* PowerPoint presentation, 3 slides.

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

61st Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC)
Benchmark stock assessment for Atlantic surfclam

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 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 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 **Atlantic surfclam** *(Spisula solidissima)*. 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 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. Knowledge of sedentary invertebrates, their fishery management and ecosystem issues would be useful.

Requirements 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 "Requirements 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.

Requirements 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.

Requirements 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 that address stock status and 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, country of birth, country of citizenship, country of permanent residence, country of current residence, dual citizenship (yes, no), passport number, country of passport, travel dates.) to the NEFSC SAW Chair for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/ 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 31, 2016. Each reviewer's duties shall not exceed 12 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 June 13, 2016	Contractor sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
No later than July 5, 2016	NMFS Project Contact will provide reviewers the pre-review documents
July 19-21, 2016	Each reviewer participates and conducts an independent peer review during the panel review meeting in Woods Hole, MA
July 21, 2016	SARC Chair and reviewers work at drafting reports during meeting at Woods Hole, MA, USA
August 4, 2016	Reviewers submit draft independent peer review reports to the contractor's technical team for review
August 4, 2016	Draft of SARC Summary Report, reviewed by all reviewers, due to the SARC Chair *
August 11, 2016	SARC Chair sends Final SARC Summary Report, approved by reviewers, to NMFS Project contact (i.e., SAW Chairman)
August 18, 2016	Contractor submits independent peer review reports to the COR and technical point of contact (POC)
August 25, 2016	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 $23,000.

Restricted or Limited Use of Data
The contractors may be required to sign and adhere to a non-disclosure agreement.

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Appendix 1. Terms of Reference for the SAW Working Group (61st SAW/SARC Stock Assessment)

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

A. Atlantic surfclams

1. Estimate catch from all sources including landings and discards. Map the spatial and temporal distribution of landings, discards, fishing effort, and gross revenue, as appropriate. Characterize the uncertainty in these sources of data.

2. Present the survey data being used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.). Use logbook data to investigate regional changes in LPUE, catch and effort. Characterize the uncertainty and any bias in these sources of data. Evaluate the spatial coverage, precision, and accuracy of the new clam survey.

3. Determine the extent and relative quality of benthic habitat for surfclams in the Georges Bank ecosystem to refine estimates of stock size based on swept area calculations.

4. Quantify changes in the depth distribution of surfclams over time. Review changes over time in surfclam biological parameters such as length, width, and growth.

5. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR 3, as appropriate) and estimate their uncertainty. Include a historical retrospective analysis 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, particularly as they relate to stock assumptions.

7. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to any new model or models developed for this peer review.
    a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.
    b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

8. Develop approaches and apply them to conduct stock projections.
    a. Provide numerical annual projections (five years) and the statistical distribution (e.g., probability density function) of the OFL (overfishing level) (see Appendix to the SAW

TORs). Consider cases using nominal as well as potential levels of uncertainty in the model. 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.
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. Evaluate the validity of the current stock definition. Determine whether current stock definitions may mask reductions in sustainable catch on regional spatial scales. Make a recommendation about whether there is a need to modify the current stock definition.

10. 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.

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

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

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

ABC for overfished stocks. For overfished stocks and stock complexes, a rebuilding ABC must be set to reflect 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}

61st Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC): Benchmark stock assessment for A. Atlantic surfclam

July 19-21, 2016

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

AGENDA* (version: Dec. 31, 2015)

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR

Tuesday, July 19

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

10:30 – 12:30 PM Assessment Presentation (A. Surfclam)
Dan Hennen **TBD**

12:30 – 1:30 PM Lunch

1:30 – 3:30 PM Assesssment Presentation (A. Surfclam)
Dan Hennen **TBD**

3:30 – 3:45 PM Break

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

5:45 – 6 PM Public Comments

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

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR

Wednesday, July 20

9:00 – 10:45 Revisit with Presenters (A. Surfclam)
TBD, SARC Chair **TBD**

10:45 - 11 Break

11 – 11:45 Revisit with Presenters (A. Surfclam)
TBD, SARC Chair **TBD**

11:45 – Noon Public Comments

12 – 1:15 PM Lunch

1:15 – 4 Review/Edit Assessment Summary Report (A. Surfclam)
TBD, SARC Chair **TBD**

4 – 4:15 PM Break

4:15 – 5:00 PM SARC Report writing

Thursday, July 21

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. During “SARC Report writing”, on July 20 and 21, the public should not engage 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.

APPENDIX 3: SARC 61 panel members and attendees

Role	Name	Affiliation	E-mail
SARC Chair	Michael Wilberg	University of Maryland, CES	wilberg@umces.edu
SAW Chair	Jim Weinberg	NEFSC	
CIE Reviewers	Michael Bell	Heriot-Watt University, Orkney, UK	M.C.Bell@hw.ac.uk
	Martin Cryer	Ministry for Primary Industries, Wellington, New Zealand	Martin.Cryer@mpi.govt.nz
	Coby Needle	Marine Scotland Science, Aberdeen, UK	C.Needle@MARLAB.AC.UK
Presenters	Dan Hennen	NEFSC	Daniel.hennen@noaa.gov
	Larry Jacobson	NEFSC	larry.jacobson@noaa.gov
Panel members	Russ Brown	NEFSC	Russell.brown@noaa.gov
	Jessica Coakley	MAFMC	jcoakley@mafmc.org
Administrator	Sheena Steiner	NEFSC	sheena.steiner@noaa.gov
Rapporteurs	Toni Chute	NEFSC	toni.chute@noaa.gov
	Michele Traver	NEFSC	Michele.traver@noaa.gov
Attendees	Tom Alspach	C	talspach@goeaston.net
	Jon Deroba	NEFSC	jonathan.deroba@noaa.gov
	Wendy Gabriel	NEFSC	wendy.gabriel@noaa.gov
	Bob Glenn	Mass. Division of Marine Fisheries	Robert.glenn@state.ma.us
	Tom Hoff	Wallace & Associates	tbhoff@verizon.net
	Chris Legault	NEFSC	chris.legault@noaa.gov
	Daphne Munroe	Rutgers University	dmunroe@hsrl.rutgers.edu
	Charles Perretti	NEFSC	Charles.perretti@noaa.gov
	Doug Potts	NMFS/GARFO	douglas.potts@noaa.gov
	Eric Powell	University of Southern Mississippi	eric.n.powell@usm.edu
	Mike Simpkins	NEFSC	Michael.simpkins@noaa.gov
	Mark Terceiro	NEFSC	mark.terceiro@noaa.gov
	Dave Wallace	Wallace & Associates	DHWallace@aol.com

APPENDIX 4: Agenda for the review meeting

61st Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC): Benchmark stock assessment for A. Atlantic surfclam

July 19-21, 2016

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

AGENDA* (version: 7/7/2016)

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR

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Introduction	**Michael Wilberg,** SARC Chair		
Agenda			
Conduct of Meeting			

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Dan Hennen **Michele Traver**

12:30 – 1:30 PM Lunch

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Michael Wilberg, SARC Chair **Michele Traver**

5:45 – 6 PM Public Comments

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

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR

Wednesday, July 20

9:00 – 10:45 Revisit with Presenters (A. Surfclam)
Michael Wilberg, SARC Chair **Toni Chute**

10:45 - 11 Break

11 – 11:45 Revisit with Presenters (A. Surfclam)
Michael Wilberg, SARC Chair **Toni Chute**

11:45 – Noon Public Comments

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Thursday, July 21

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 on July 20 and 21, we ask that the public refrain from engaging in discussion with the SARC.