Summary Report of the 63rd Northeast Regional Stock Assessment Review Committee (SARC 63)

Stock Assessment Review Committee (SARC) Meeting

February 21 – 23, 2017

Northeast Fisheries Science Center
Woods Hole, Massachusetts

Prepared by the Stock Assessment Review Committee
Benchmark Assessment for Ocean Quahog
(SAW/SARC 63)

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SARC 63 Panel Members

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1. Introduction

1.1 Background

The 63rd SARC (Stock Assessment Review Committee) meeting was held in the Aquarium Conference Room at NOAA's Northeast Fisheries Science Center in Woods Hole, MA from 21-23 February, 2017, to review the stock assessment for Ocean Quahog. The review committee (SARC Panel) consisted of three scientists appointed by the Center for Independent Experts: Martin Cryer, Mike Bell and Anthony Hart, and was chaired by Edward Houde, a member of the Mid-Atlantic Fishery Management Council's Scientific and Statistical Committee. The Panel reviewed the benchmark stock assessment of the Ocean Quahog (*Arctica islandica*), guided by the SAW 63 Terms of Reference and Statement of Work.

The SARC Panel was ably assisted by staff of the NEFSC, including James Weinberg, Russell Brown, and Sheena Steiner. Supporting documentation for the Ocean Quahog assessment was prepared by the SAW 63 Ocean Quahog Working Group. WG members are identified in the stock assessment report and in Appendix 5 of this report. Presentations at the meeting were made by lead assessment scientist Dan Hennen (NEFSC) and coordinated by Working Group Chair Larry Jacobson (NEFSC). With

input from the SARC Panel, Dan Hennen, Larry Jacobson and Jim Weinberg were the primary drafters of the SARC 63 Assessment Summary Report.

Thanks to Toni Chute and Alicia Miller (NEFSC staff) who served as meeting rapporteurs. And, thanks to Chris Legault (NEFSC) for able assistance with editing and revising the SARC 63 Assessment Summary Report. Twenty-four persons participated in the SARC 63 meeting (Appendix 5).

On day 3 of the SARC Review, the SAW Chair and Lead Scientist informed the Panel about adjustments to retrospective analysis. The Lead Scientist presented a revised figure of retrospective patterns in "spawning output," that indicated lesser shifts in scale than the original figure, but the same lack of retrospective trends over time. No serious retrospective behavior was indicated and the adjustments and corrections will have no substantial or consequential effects on the assessment outcome.

1.2 Review of Activities and SARC Process

Two weeks prior to the meeting, assessment documents and supporting materials were made available to the SARC Panel via a server on the NEFSC website. The Panel met with James Weinberg and Russell Brown (NEFSC) on the morning of February 21, 2017, before the meeting commenced to review the meeting agenda, reporting requirements, and meeting logistics. During the SARC meeting, background and working documents were available electronically and in print.

The meeting opened on Tuesday, February 21, with welcoming remarks and presentation of the agenda by Jim Weinberg and Ed Houde. Participants and audience members introduced themselves. Following introductions, sessions on February 21 and the morning of February 22 were devoted to presentation and discussion of the ocean quahog assessment. The SARC Panel and NEFSC staff met in the late morning-afternoon of 22 February to review and edit the Assessment Summary Report that was drafted by NEFSC staff. The SARC Panel worked privately on February 23 to begin drafting its individual reports and the SARC 63 Panel Summary Report. In its February 23 work, the Panel developed consensus points for each of the Terms of Reference as well as observations on the SARC process. Individual panelists used consensus points to draft sections of the Panel Summary Report.

This SARC 63 Panel Summary Report was completed by correspondence. It evaluates each ToR that had been addressed by the Ocean Quahog WG. SARC Chair Ed Houde compiled and edited the draft Panel Summary Report, which was shared with the Panel for contributions, editing, and final review before being submitted to Jim Weinberg (SAW Chair) at NEFSC. Additionally, each Panelist drafted and submitted an independent reviewer's report to the Center for Independent Experts and to the NEFSC.

2. Review of Ocean Quahog Assessment

Ocean quahog is managed as a single stock in the EEZ. It is an Individual Transferable Quota (ITQ) fishery, designated as such in 1988. For modeling purposes, the ocean quahog stock in US waters was

divided into a southern (Southern New England to Cape Hatteras) and northern component (Georges Bank). Additionally, a small inshore fishery off the coast of Maine is included in the management plan. Ocean quahog occurs primarily from 20-80 m depth in US waters and is almost entirely found in the EEZ. Ocean quahog is extraordinarily long-lived, commonly living to age 200 years and more. Accordingly, its annual natural mortality is low (assumed to be $M = 0.02$, approximately 2% per yr.). Growth after recruitment is slow but continues throughout life. Sexual maturity begins at age 6 years with some individuals not mature until age 14 years. Survey catches indicate that low levels of recruitment occur during most years, although estimates of recruitment and its spatial distribution are poorly known.

The fishery occurs from Virginia to Maine, with only light exploitation on Georges Bank because of potential toxicity associated with paralytic shellfish poisoning. The fishery has been managed through quotas since 1979. The fishery is managed by ITQ, except in Maine waters where it is managed under a state quota. The EEZ landings peaked at 22.5 thousand mt meats in 1992 and over recent years have varied between lows of 13.6 thousand mt in 2005 and 2015 and a high of 22.5 thousand mt in 1992. The present EEZ quota, set at 24.2 thousand mt since 2005, has never been landed. The ocean quahog fishery is subject to mandatory reporting of landings and effort (trip-level detail at ten-minute squares) available from logbooks. Based on logbook data, fishing effort has shifted from southern areas in Delmarva to New Jersey to Long Island. The Long Island region now supports the bulk of landings. The geographical shift of the fishery corresponds with declining catch rates in the southern regions of the fishery.

Data from the NEFSC clam survey, 1982-2016, provided information on trends in biomass. Estimates of survey dredge efficiency, derived from depletion fishing experiments conducted in collaboration with industry, were used to calculate priors to guide the estimation of catchability, q, for surveys in the stock assessment model, providing information on the absolute scale of biomass. Discards are assumed to be zero in the ocean quahog fishery (based on logbook data), but there is some discarding of ocean quahogs in the Atlantic surfclam fishery, roughly equivalent to 1.5% of surfclam landings (from observer records). Incidental mortality from dredging was assumed to amount to 5% of the landings weight.

A stock synthesis model (SS3), utilizing both commercial and survey data, was applied to support the SARC 63 assessment. Previous assessments relied on a delay-difference model (KLAMZ). In SARC 63, a bridge was built between the previous KLAMZ and new SS3 model to compare assessment outcomes, which were similar. The new biological reference points from SS3 are $F_{Target} = F_{Threshold} = 0.019$; $B_{Target} = 0.5B_0$, and $B_{Threshold} = 0.4B_0$, applied to the whole EEZ stock. According to these criteria, the stock is not currently overfished and overfishing is not occurring.

2.1 Synopsis of Panel Review

Based on the SARC 63 assessment, The SAW WG concluded that the Ocean Quahog stock is neither overfished nor did it experience overfishing in 2012-2016, the period since the last benchmark assessment. The CIE Panel concurred with that conclusion. Outcomes based on the new SS3 model, the previous KLAMZ model, and empirical analyses all supported the conclusion. The Panel also

concluded that the SAW WG had reasonably and satisfactorily completed all tasks specified in the ToRs.

2.2 Evaluation of Terms of Reference for Ocean Quahog

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

The Panel agreed that this ToR was met satisfactorily.

Landings, estimates of fishing effort, and locations of catches are based on logbook records and presumed to be accurate in this ITQ fishery. Landings and effort have declined over the past three decades, a reflection of market conditions and limited demand. Logbook records are readily available for use in stock assessments. The SAW WG indicated there is no incentive to misrepresent catch. Each "cage" of landed ocean quahogs is tagged and labeled to specify landed weight and origin of catches. Catch rates have declined in the southern subregions (DMV and NJ) and the fishery is now concentrated off Long Island where 70-80% of landings were recorded in the 2005-2015 period.

The assessment assumes that discarding is zero. This is apparently true for the directed fishery although limited observer data from the Atlantic surfclam fishery indicate that, in 2015 and 2016, about 1500 lb of ocean quahog was discarded per 100,000 lbs of surfclam landed. The Panel accepts the SAW conclusion that discards are minor and not a concern in assessing ocean quahog.

Incidental mortality is assumed to amount to 5% of the weight of ocean quahog landings. Accordingly, catches are adjusted upward by 5% to account for gear-induced, incidental mortality. It is possible that incidental mortality is size-dependent, but this possibility was not addressed in the assessment. The Panel agreed that incidental mortality was not likely to have significant consequences in the ocean quahog assessment.

Distribution of ocean quahog landings has shifted north in the past three decades. This shift is well documented in the SARC 63 assessment report. Fishery-independent survey results indicate that the northward shift in ocean quahog landings probably is a response of the fishery to declining abundance in the southern subregions. These declines were indicated by decreasing effort and LPUE in the southern subregions.

ToR 2. *Present the survey data being used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.). 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.*

The Panel considered this TOR to be satisfactorily completed. While the treatment of survey data is satisfactory, the Panel believes improvements are possible. In particular, data from the fishery-independent surveys would benefit from further explorations and analysis to ensure they provide the

best possible estimation of abundance as a key time-series index to feed into the SS3 population dynamics model.

All available data were presented, along with details of the survey methodology, the time periods which contained information, and historical summaries of prior time series. Mean numbers per tow were "tabulated" and presented by individual regions with asymmetric CLs to characterize the uncertainty. Regional differences in trends of both abundance and fishable biomass do exist. Evaluating trends is complicated by changes that were instituted in dredge surveys in recent years.

It was made evident to the Panel that the sampling design for the ocean quahog survey was considered suboptimal because it was not designed solely for this species. Considerable discussion ensued as to the nature of improvements, and many of the research recommendations are made with the goal of improving this critical index, and thus mitigating some of the criticisms of issues such as "data borrowing".

The Panel considered the important factors that influenced the survey abundance index to be region, depth, speed, tow duration, and dredge characteristics (e.g. gape width, selectivity, differential pressure, angle of tilt). It was considered that, while these had been acknowledged and investigated as part of the determination of selectivity and length-weight relationships (Equation 1, Table 13, Assessment Report), alternative treatments of the data were possible and potentially desirable. For example, the survey data could be modelled purely as an abundance index, standardized for the key factors of region, depth, speed, tow duration, dredge characteristics etc.., but without the size-frequency data, or a composite metric of area swept based on speed and duration.

ToR 3. *Describe the relationship between habitat characteristics (e.g., benthic, pelagic, and climate), survey data, and ocean quahog distribution, and report on any changes in this relationship.*

The Panel agreed that this ToR was met satisfactorily. The relationship between ocean quahog abundance and habitat characteristics were described. Temporal shifts in ocean quahog distribution had already been addressed as part of the recent Atlantic surfclam assessment (SARC/SAW 61, NEFSC 2017).

A regression tree approach was used to model the relationship between 1997-2011 survey catch data (numbers per swept area) and environmental data. A comprehensive set of environmental variables was compiled, including data on depth, temperature, seabed topography, sediment type and chlorophyll concentration. Latitude and longitude were not included in the predictor set, lending confidence that model inferences were based on actual habitat characteristics rather than geographic proxies. The model appeared to perform well, as judged by cross-validation with data not included in the model, although correlations among the predictor variables make inferences about causality difficult. Fits to the survey data were generally good, but some unexplained variance was noted that could benefit from additional analysis. Survey data for Georges Bank and southern stock areas (Long Island and Southern New England) were modelled separately, but the ranking of importance of environmental variables was similar in both. The Panel noted that it would be useful to cross-reference

between the outcomes of this analysis and the 'borrowed' values used to fill data gaps in the survey strata (see ToR 2).

With the exception of a modest shift in median depth in the New Jersey region, no changes in the distribution of ocean quahogs were noted between 1982 and 2011. Increases in the co-occurrence of Atlantic surfclams and ocean quahogs appear to be due entirely to shifts the distribution of the former species towards deeper water. The Panel noted that ocean quahog may be buffered from climatic changes by living in deeper water and deeper in the sediment. It was speculated that ocean quahog may be susceptible to ocean acidification, although it was noted that this was not the case for surfclams. Any population response by ocean quahog is likely to be manifest in terms of recruitment, rather than survival processes.

ToR 4. *Evaluate age determination methods and available data for ocean quahog to potentially estimate growth, productivity, and recruitment. Review changes over time in biological parameters such as length, width, and condition.*

The Panel considered this TOR to be satisfactorily completed. Annual growth rings are considered detectable in this species and are valuable for the assessment. The Panel was provided with the latest findings from the image analysis software used to enumerate growth rings. This suggested the possibility of also detecting daily rings in smaller quahogs.

New growth data and alternative growth models were investigated and the effects of different models on the outcomes of the model-estimated biomass and fishing mortality were evaluated in MSE. The rationale behind the use of the growth models was well presented and the substantial issue of non-asymptotic growth was identified as a key area for further investigation. Panel members provided information and published reports to the ocean quahog assessment WG, which detailed information on development of non-asymptotic growth models for invertebrate species.

Morphological metrics were analyzed and modelled for year and regional effects. Regional differences in morphology were observed, but found to be minor. Temporal changes were not observed and it was unlikely that major changes in condition of ocean quahogs had occurred, given these results.

The panel noted that the size-frequency and survey data abundances, coupled with the growth model, enabled (forced) the SS3 model to estimate a large peak in recruitment in the late 1990s. This estimate is very uncertain, and cannot be considered a definitive estimate of actual recruitment patterns, as it could affect any estimates of risk in the projections. This might become important if the stock were to be reduced to a biomass level near the threshold reference point, an unlikely event given the time scale of ocean quahog population processes.

The validated age data on 5 individuals showed that variable growth was likely. Variable growth also could indicate differences in productivity between regions. This possibility needs to be explored in future assessments, as the ageing method develops.

ToR 5. *Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR 4, as appropriate) and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections*.

The Panel agreed this ToR had been met and noted the difficulties in modelling a long-lived animal experiencing such low fishing mortality, especially for estimating population scale.

The primary assessment approach used integrated statistical catch-at-age models implemented in the software package Stock Synthesis III (SS3). The Panel agreed with the working group that SS3 was an appropriate choice for this assessment, and a substantial improvement over the previous biomass dynamic models (KLAMZ), because it allowed the integration of biomass indices, size compositions, dredge efficiency estimates from depletion experiments, and other information. The model was split into separate regions for Georges Bank and other regions (collectively called the southern region) and the results were combined within the model to provide management advice for the assumed stock. The Panel agreed that this is a good structure for the model and overcomes some of the difficulties inherent in combining the results from multiple models (a problem that occurred in the Atlantic surfclam assessment, SARC 61). No biomass indices from LPUE data were used in the assessment; the Panel agreed that this was appropriate (because of fishing behavior and the small proportion of the stock area fished).

The base model accepted by the working group appeared to be appropriate, but the Panel felt that additional detail on the working group's deliberations that led the group to accept the base model would have been helpful. The model presented to the Panel was labeled BASE8, indicating that development through at least seven iterations had occurred. Only limited documentation of the process leading to BASE8 was provided to the Panel, but understanding this process could be useful because it would provide the rationale for modeling choices relating to structure or data that may be important. In addition, the Panel agreed that more detail of the methods used should have been provided in the assessment report, including the actual equations used by SS3 for key estimations (in an appendix). The Panel agreed this was a common issue with complex stock assessments conducted using integrated packages, but thought the aim should be to provide a report with sufficient detail to enable a new analyst to replicate the assessment model with little need for input from the current analyst. The Panel was satisfied with the level of detail provided during the SARC 63 meeting.

Model fits to the length compositions were very good but the fits to the biomass indices were relatively poor. There is good reason to think that at least one of the survey data points (for the southern area in 1994) is problematic and probably biased by changes to survey gear performance in that year. In addition, the change between biomass estimates from one survey to the next (positive or negative) was often much larger than would be expected for such a long-lived animal. Because of these particular circumstances, the Panel considered that the relatively poor fit to the biomass indices in the base model was acceptable and appropriate. The Panel did not think that completion of some surveys over two years using the new dredge and "data borrowing" for unsampled strata among adjacent surveys were likely to be problematic for this assessment (because of the stability of ocean quahog populations). Nevertheless, the Panel agreed that it would be valuable to improve the biomass

surveys to inform the stock assessment model. The Panel noted that work to improve the survey is already underway.

Parameter estimates were presented as those at the maximum of the posterior density (MPD) and their uncertainties were estimated from the model's Hessian matrix. This is an approximate method for a Bayesian model and it would have been better to estimate the Bayesian posterior distributions of estimated and derived parameters using Markov Chain Monte Carlo (MCMC) methods. In addition to providing better estimates of uncertainty (and correlation between parameters), MCMCs are particularly useful for diagnosing some problems in model convergence or stability, and in providing for stochastic projections. Running MCMCs can be time-consuming, and model development is almost always conducted using MPD fits, but the Panel agreed that MCMC(s) should be the norm for a Bayesian assessment model. If there are software impediments or other impediments to running MCMCs routinely, these problems should be solved as a priority.

Internal and historical retrospective analyses were conducted and showed patterns of concern in retrospective behavior by the SS3 model. Toward the end of the SARC Panel review, one assessment report figure (Figure 102) was adjusted by the Lead Presenter. The new figure indicated lesser shifts in scale than the original and, encouragingly, the same lack of retrospective trends over time. No serious retrospective behavior is indicated and the adjustment will have no consequential effects on the assessment outcome.

The scale of absolute abundance (and, hence, fishing mortality) was somewhat uncertain in the model, but trends in relative biomass and fishing mortality were much more certain. A wide range of sensitivity analyses were conducted and these demonstrate that the model-estimated trends and the working group's conclusions from the model were robust to many of the modelling choices. Likelihood profiling was used to identify conflicts among data sources, priors, and penalties, and to understand the key drivers of the fits and, in particular, biomass scale. Empirical, area swept biomass estimates with q=1 were broadly consistent with the biomass estimates from the model, giving the Panel some confidence that the model-based estimates of biomass and fishing mortality were not grossly biased.

For two main reasons, the Panel agreed that the focus on trends and ratios in the assessment, especially for assessing stock status, was appropriate. First, almost all of the information on biomass scale was from the priors on survey catchability and there is reason to believe that the depletion estimates of catchability (q) are not equivalent to catchability during the survey. Second, sensitivity and retrospective analyses show that the model's estimates of trends in biomass and fishing mortality were much more stable than the estimates of absolute values.

ToR 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.*

The Panel agreed that this ToR was met satisfactorily.

The existing limit BRPs (SARC 48) were described based on a finfish proxy for $F_{Threshold}$ ($F_{45\%}$ for rockfish = 0.022) and expert opinion for $SSB_{Threshold}$ (= $0.4*B_{1978}$). No estimate of F_{MSY} for ocean quahog is possible because the stock-recruit curve cannot be estimated, so a new F_{MSY} proxy was developed using a comprehensive management strategy evaluation (MSE) simulation that included a wide range of assumptions about the life history parameters and growth of ocean quahog and the uncertainty associated with both stock assessments and management decision-making. Model based estimates of the unfished biomass, B_0, are now possible using the SS3 model so these were applied in the new $SSB_{Threshold}$ BRP (using SSB rather than fishable biomass in the old $B_{Threshold}$ proxy). Despite uncertainties about modeled biomass scale that are likely to continue, the SS3 model will be able to reliably estimate terminal biomass relative to the new $SSB_{Threshold}$.

Although the values of the old and new limit BRPs are similar, the Panel agreed that the new limit BRPs are substantially better than the old ones because each has a more solid theoretical basis.

The Panel noted the closeness of the biomass target ($0.5*B_0$) and biomass threshold ($0.4*B_0$). The Panel was informed that, under US legislation, this potentially could trigger a rebuild plan soon after biomass declined below its B_{msy} target. The Panel agreed that the proximity of the target and threshold reference points could theoretically be problematic and resource intensive for the management process, but only if ocean quahog biomass declines substantially below its current high level. The Panel also agreed that, although the biomass threshold of $0.4*B_0$ appeared conservative, it was defensible for an animal of such low productivity. These questions regarding appropriate target and threshold reference points should be considered by the relevant decision-making groups when BRPs are next reviewed for ocean quahog.

ToR 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-6).

The Panel agreed that this ToR was met in full. All of the analyses that were conducted indicated that the stock was not overfished nor was it experiencing overfishing. This result was consistent across sensitivity runs.

Stock status against existing BRP estimates was effectively determined using both existing (KLAMZ) and newly proposed (SS3) assessment models. Stock status based on the "new" BRPs and their estimates was effectively determined using the newly proposed model. These status determinations were carried out appropriately, including dealing with the change in biomass currency from fishable biomass in the KLAMZ model to SSB in the SS3 model. In all cases, and across a comprehensive set

of sensitivity runs, the outcomes were consistent in indicating that the stock was neither overfished nor experiencing overfishing.

ToR 8. *Develop approaches and apply them to conduct stock projections.*

(a) Provide numerical annual projections (5 - 50 years) and the statistical distribution (e.g., probability density function) of the OFL (overfishing level), including model estimated and other uncertainties. 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.

The Panel considered this TOR to be satisfactorily completed. Projections of stock biomass were made for the years 2017 to 2066 based on three different harvest policies that encompassed the range between expected and maximum sustainable landings from the fishery. Assumptions about the likely level of average recruitment, based on the uncertainty in the 2017 estimated biomass, were considered sensible and realistic for this analysis. The Panel also requested that an extra projection for zero recruitment over the projection period be incorporated as part of the sensitivity analysis. This was completed by the WG during the SARC meeting.

Projections indicated that biomass will remain above the threshold for the entire resource, including the scenario of $F = F_{Threshold}$ (OFL Catch). Sensitivity analysis was comprehensive, using different growth models, mortality, and recruitment assumptions to derive both point and cumulative probability estimates of overfishing. Distributions of biomass were assumed lognormal and variances equal to delta method variances; one million draws were taken from these distributions to investigate the projection scenarios. The status of each performance indicator for the resource, i.e., the $SSB/SSB_{Threshold}$ and $F/F_{Threshod}$ ratios, were shown for all projection years, and all sensitivity scenarios.

Projections showed unequivocally that biomass had virtually no probability of reaching the threshold level, even when F was set at the threshold level, and recruitment was set to zero. The outcomes indicate that the stock's vulnerability to overfishing is exceedingly low, even under the less conservative assumptions about F. Therefore, the Panel believes that the ocean quahog stock status will be relatively insensitive to the choice of ABC (Acceptable Biological Catch).

ToR 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.*

The Panel concluded that this ToR was met in full. Progress was noted against 21 research recommendations from the previous assessment (SARC 48). A list of 14 additional recommendations was compiled.

Nine out of the 21 existing recommendations were reported as having been completed. These included changes to the survey, estimation of survey selectivity and catchability, development of a length-structured model, and simulation modelling to determine proxy MSY reference points. One research recommendation was dropped as being no longer relevant; this related to the previous survey platform. Significant and ongoing progress was reported for seven recommendations. These related to age and growth studies, maturity, investigation of spatial structure and incorporation into assessment models, survey design and evaluation of the use of underwater photography to survey ocean quahog. No progress was noted for four recommendations, relating to fecundity-at-size, the relationship of dredge efficiency with depth, ocean quahog density and substrate type, and incorporation of size-selectivity in the Patch Depletion model.

The Panel endorsed the significant progress that has been made against a very substantial list of recommendations and the positive impact this has had on the assessment, including the model, survey and the biological parameters and data that underpin these. In relation to the mismatch of spatial scale identified between the assessment and ocean quahog demographic processes, the Panel noted that several ongoing research recommendations are addressing this issue and strongly supports further research action on the issue. Priority for outstanding research recommendations should be accorded to biological parameters and further understanding of survey dredge efficiency in relation to ocean quahog density and bottom type.

The Panel also endorsed the list of new research recommendations, particularly in relation to growth and age determination, spatial processes and recruitment processes. During the meeting an informally rationalized and prioritized list of research recommendations was compiled by the WG Chair, at the request of the Panel. Those recommendations were grouped into age and growth, survey, and fishery topics, roughly prioritized. There was no opportunity for a full discussion during the meeting, but the Panel agreed that the list provides an effective basis for further discussion on priorities within the WG. Again, the Panel identified survey performance, age and growth, spatial processes, and recruitment processes as areas that do need attention.

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3.2 *Working Papers*

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Working Group, Stock Assessment Workshop (SAW 63) 2017. Stock Assessment Summary Report of Ocean Quahog. SAW/SARC 63. February 21-23, 2017. NOAA Fisheries, Northeast Fisheries Science Center. Woods Hole, MA. 10p.

Working Group, Stock Assessment Workshop (SAW 63). 2017. Term of Reference 9 – Revised Research Recommendations. 2p.

3.3 *Presentations*

Working Group, Ocean Quahog. 2017. Ocean Quahog Assessment 2017. PowerPoint presentation. 90 slides.

4. Appendices

Appendix 1. 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

63rd Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC) Benchmark stock assessment for Ocean quahog

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 **Ocean quahog**. 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. For ocean quahogs (a bivalve), knowledge of long-lived, sedentary invertebrates 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 April 7, 2017. Each reviewer's duties shall not exceed 14 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 January 17, 2017	Contractor sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
No later than February 7, 2017	NMFS Project Contact will provide reviewers the pre-review documents
Feb. 21 - 23, 2017	Each reviewer participates and conducts an independent peer review during the panel review meeting in Woods Hole, MA
February 23, 2017	SARC Chair and reviewers work at drafting reports during meeting at Woods Hole, MA, USA
March 9, 2017	Reviewers submit draft independent peer review reports to the contractor's technical team for review
March 9, 2017	Draft of SARC Summary Report, reviewed by all reviewers, due to the SARC Chair *
March 16, 2017	SARC Chair sends Final SARC Summary Report, approved by reviewers, to NMFS Project contact (i.e., SAW Chairman)
March 23, 2017	Contractor submits independent peer review reports to the COR and technical point of contact (POC)
March 30, 2017	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 $20,000.

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 2. Stock Assessment Terms of Reference for SAW/SARC-63

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

A. Ocean quahog

1. Estimate catch from all sources including landings and discards. Map the spatial and temporal distribution of landings, discards, and fishing effort, 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, 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. Describe the relationship between habitat characteristics (e.g., benthic, pelagic, and climate), survey data, and ocean quahog distribution, and report on any changes in this relationship.

4. Evaluate age determination methods and available data for ocean quahogs to potentially estimate growth, productivity, and recruitment. Review changes over time in biological parameters such as length, width, and condition.

5. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR 4, 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.

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-6).

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

   a. Provide numerical annual projections (5 – 50 years) and the statistical distribution (e.g., probability density function) of the OFL (overfishing level), including model estimated and other uncertainties. 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 "Clarification of Terms used in 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.

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 3. Review Meeting Agenda

63rd Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC)
Benchmark stock assessment for A. Ocean quahog

February 21-23, 2017

Stephen H. Clark Conference Room – Northeast Fisheries Science Center

Woods Hole, Massachusetts

AGENDA* (version: Feb. 15, 2017)

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR

Tuesday, Feb. 21

10 – 10:30 AM

Welcome	**James Weinberg**, SAW Chair
Introduction	**Edward Houde,** SARC Chair
Agenda	
Conduct of Meeting	

10:30 – 12:30 PM	Assessment Presentation (A. Ocean quahog)	
	Dan Hennen	**Toni Chute**

12:30 – 1:30 PM Lunch

1:30 – 3:30 PM Assessment Presentation (A. Ocean quahog)

Dan Hennen **Toni Chute**

3:30 – 3:45 PM Break

3:45 – 5:45 PM SARC Discussion w/ Presenters (A. Ocean quahog)

Ed Houde , SARC Chair **Toni Chute**

5:45 – 6 PM Public Comments

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

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR

Wednesday, Feb. 22

9:00 – 10:45 Revisit with Presenters (A. Ocean quahog)

Ed Houde, SARC Chair **Alicia Miller**

10:45 - 11 Break

11 – 11:45 Revisit with Presenters (A. Ocean quahog)

Ed Houde , SARC Chair **Alicia Miller**

11:45 – Noon Public Comments

12 – 1:15 PM Lunch

1:15 – 4 Review/Edit Assessment Summary Report (A. Ocean quahog)

Ed Houde , SARC Chair **Alicia Miller**

4 – 4:15 PM Break

4:15 – 5:00 PM SARC Report writing

Thursday, Feb. 23

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 Feb. 22-23, we ask that the public refrain from engaging in discussion with the SARC.

Appendix 4. 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 5. 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 6. SAW 63 Working Group Members and Attendees at the SARC 63 Panel Meeting

NAME	AFFILIATION	EMAIL
Ed Houde	U Maryland Center for Environmental Science	ehoude@umces.edu
Anthony Hart	Western Australian Fisheries	Anthony.Hart@fish.wa.gov.au
Mike Bell	Heriot-Watt University – Intl Centre for Island Tech	M.C.Bell@hw.ac.uk
Martin Cryer	Ministry for Primary Industries, Wellington	Martin.Cryer@mpi.govt.nz
Russ Brown	NEFSC	Russell.brown@noaa.gov
Jim Weinberg	NEFSC	james.weinberg@noaa.gov
Larry Jacobson	NEFSC	larry.jacobson@noaa.gov
Dan Hennen	NEFSC	Daniel.hennen@noaa.gov
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Toni Chute	NEFSC	toni.chute@noaa.gov
Mark Terceiro	NEFSC	mark.terceiro@noaa.gov
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Joe Myers	Bumble Bee/Snow's Foods	joseph.myers@bumblebee.com
Tom Hoff	Wallace & Associates	tbhoff@verizon.net
Daphne Munroe	Rutgers University	dmunroe@hsrl.rutgers.edu
Tom Alspach	Sea Watch International	talspach@goeaston.net
Eric Powell	University of Southern Mississippi	eric.n.powell@usm.edu
Roger Mann	VIMS	rmann@vims.edu
D.H. Wallace	Wallace & Associates	DHWallace@aol.com
Doug Potts	NMFS/GARFO	douglas.potts@noaa.gov
Gary Shepherd	NEFSC	gary.shepherd@noaa.gov