# Summary Report of the 56th Northeast Regional Stock Assessment Review Committee (SARC 56)

**Stock Assessment Review Committee (SARC) Meeting**
**19-22 February 2013**
**Northeast Fisheries Science Center**
**Wood's Hole, Massachusetts**

**Prepared by the Stock Assessment Review Committee**
**Benchmark Assessments for Atlantic Surfclam and White Hake (SAW/SARC 56)**

**19 March 2013**


**SARC 56 Panel Members**

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# 1. Introduction

## 1.1 Background

The 56th SARC (Stock Assessment Review Committee) met in the Aquarium Conference Room at NOAA's Northeast Fisheries Science Center in Woods Hole, MA from 19 – 22 February 2013 to review stock assessments for Atlantic surfclam (*Spisula solidissima*) and white hake (*Urophycis tenuis*). The review committee was composed of Dr. Edward Houde (MAFMC SSC and University of Maryland Center for Environmental Science, Chair) and three scientists appointed by the Center for Independent Experts: Mr. Martin Cryer (Ministry for Primary Industries, New Zealand), Mr. Michael Smith (Centre for Environment, Fisheries & Aquaculture Science, United Kingdom) and Dr. Kevin Stokes (New Zealand).

The SARC was assisted by the NEFSC Stock Assessment Workshop (SAW) Chairman, Dr. James Weinberg, his staff, especially Ms. Anne O'Brien, and Dr. Paul Rago (NEFSC). Supporting documentation for the Atlantic surfclam assessment was prepared by the NEFSC Invertebrate Subcommittee, and presentations at the meeting on surfclam were made primarily by Drs. Daniel Hennen and Larry Jacobson (NEFSC), with supporting presentations by Dr. Eric Powell (Invertebrate Subcommittee, University of Southern Mississippi) and Mr. Thomas Alspach (Invertebrate Subcommittee, Sea Watch). Materials for the white hake assessment were prepared by the White Hake Working Group and presentations were made by Drs. Kathleen Sosebee and Gary Shepherd (NEFSC). Rapporteurs were provided for each session of the SARC meeting by the NEFSC. A total of 44 persons participated in the SARC 56 meeting.

## 1.2 Review of Activities and SARC Process

Before the meeting, assessment documents and supporting materials were made available to the SARC Panel via a server on the NEFSC website. On the morning of 19 February 2013, before the meeting, the SARC panel met with Drs. Weinberg and Rago to review and discuss the meeting agenda (See Appendix, Annex 3), reporting requirements, and meeting logistics. During the SARC meeting, background and working documents were available electronically and in print. The meeting opened on the morning of Tuesday 19 February, with welcoming remarks and comments on the agenda by Dr. Weinberg and Dr. Houde. All participants and audience members were introduced at the opening of the SARC meeting and at each of the sessions during the first three days of the meeting. Following introductions, sessions on 19 February were devoted to presentations and discussion of the Atlantic surfclam assessment. White hake assessment and discussion sessions were conducted on the morning and afternoon

of 20 February, followed by continued discussion of the Atlantic surfclam assessment in the late afternoon. In that session, the SARC Panel requested additional analyses on surfclam that were conducted by Drs. Hennen and Jacobson and provided to the Panel on 21 February.

Follow-up discussion on the white hake assessment took place in the morning of 21 February. At that time, the SARC Panel requested additional analyses to clarify white hake *BRP*s that were conducted by Drs. Sosebee and Shepherd. The afternoon of 21 February was spent reviewing and editing the white hake and Atlantic surfclam Assessment Summary Reports and hearing results of the follow-up surfclam analyses. A draft of the surfclam Assessment Summary Report was completed on 21 February. The SARC Panel spent the final day, 22 February, deliberating on whether the SAW WGs had addressed Terms of Reference (ToR) in each of the assessments and drafting elements of this Panel Summary Report.

The SARC Panel and SAW WGs worked collectively during the meeting to reach agreement and consensus on the surfclam and white hake assessments. The meeting was collegial. Considerable time was devoted to facilitate dialog among SARC Panel members, working group scientists, NEFSC assessment scientists, MAFMC staff, and industry representatives.

Subsequent to the SARC meeting, the Panel was provided with follow-up analyses of white hake *BRP*s and associated risk levels by NEFSC staff. The completion of, the Assessment Summary Report for white hake, with contributions by the NEFSC staff and the SARC Panel, was accomplished by correspondence on 11 March. The SARC Panel completed drafting this Summary Report by correspondence, evaluating each ToR that had been addressed by the SAW WGs. The SARC Chair compiled and edited the draft Summary Report, which was distributed to the Panel for final review before being submitted to the NEFSC. Additionally, each of the CIE Panelists drafted and submitted an independent reviewer's report to the NEFSC.

The SARC Panel agreed that each of the assessments (Atlantic surfclam and white hake) was effective in delineating stock status, determining *BRP*s and proxies, and in projecting probable short-term trends in stock biomass, fishing mortality, and catches. Issues and concerns related to each of the stock assessments are discussed below. The SARC process was effective in structuring a critical review of the work of the SAW WGs and in identifying areas of concern and needs for additional work in future assessments.

## 2. Review of Atlantic surfclam

The Atlantic surfclam (*Spisula solidissima*) is a filter-feeding bivalve that inhabits sandy habitats on the continental shelf from the Gulf of St. Lawrence to Cape Hatteras, NC

(Merrill and Ropes 1969; Cargnelli et al. 1999; Jacobson and Weinberg 2006). High abundances of surfclams are found on Georges Bank (GBK) and from the coast of New Jersey (NJ) southward along the Delmarva Peninsula (DMV). In the mid-Atlantic region, surfclams are found from the intertidal zone to depths of about 60 m, although abundance is low in depths greater than 40m. Surfclams can reach sizes > 200 mm shell length and are relatively long-lived with a maximum age in excess of 30 years (Jones et al. 1978). Growth appears to vary seasonally and regionally (Weinberg 2005). Recruitment to the fishery occurs at about 120 mm shell length and ages 6 and 7 yr in the southern and northern (Georges Bank, GBK) areas, respectively. Sexual maturity varies by region but can occur as early as 3-months of age (~5 mm shell length, SL, Chintala and Grassle 1995) or as late as 4-years of age (~85 mm shell length, Sephton 1987). Surfclams are broadcast spawners and settlement occurs after about a 3-4 week planktonic larval period.

All Atlantic surfclams in the EEZ are currently assessed and managed as a single unit stock, although there are differences between regions in biological characteristics and fishing activity. Management of the Atlantic surfclam fishery in the EEZ is achieved under an individual transferable quota (ITQ) system that was implemented in 1990, under the auspices of the Mid-Atlantic Fishery Management Council. Relatively small fisheries in state waters are managed by state authorities.

Annual landings from the EEZ have been stable since the mid 1980s, ranging between 19 and 25 thousand mt. The EEZ landings have been at or below quota in recent years. Since 1979, most (85-100%) landings have been from the Mid-Atlantic Bight. In 2011, 15% of landings were taken from southern New England and Long Island. Fishing on GBK has recently been instituted after 20 years of closure due to high prevalence of paralytic shellfish poisoning (PSP), but landings from GBK accounted for only 5% of the total in 2011. New technology that is able to detect PSP at sea and an experimental fishery in 2009 to 2011 may be precursors to increased fishing on GBK. Trends in landings per unit effort (LPUE) during the past decade are generally downward for the area south of GBK. LPUE in the GBK experimental fishery were five times higher than elsewhere.

In SAW/SARC 56 and in previous stock assessments (e.g., SAW/SARC 49; NEFSC 2010), stock definition has been a repeatedly debated issue. The stock is managed as a single unit. Some scientists and managers propose that surfclams on GBK and those to the south are sufficiently distinct and reproductively isolated that they should be assessed and managed as two stocks. This issue was investigated to an extent and debated vigorously by the Invertebrate Subcommittee WG. It also was addressed, but not resolved, in SAW/SARC 56.

## 2.1. Synopsis of Panel Review

The SARC Panel agreed with the SAW WG's conclusion that the Atlantic surfclam stock is neither overfished nor was it experiencing overfishing in 2011. Overall, the whole stock appears to be lightly fished, with *F* levels well below target. The GBK component is nearly virgin, with *F* levels near zero. The surfclam has been remarkably resilient to fishing, at least at the levels of *F* that have been applied, apparently because only a small geographical area within the stock's range is fished.

In the present assessment, a statistical catch-at-age and length model (implemented in Stock Synthesis (SS3)) replaced the biomass dynamic model (implemented in KLAMZ) used previously. Both models appear to track trends in stock abundance, although estimated levels of abundance and biomass differed substantially between the two modeling approaches. An historical retrospective analysis by the SAW WG showed that the biomass trajectory from the age-structured SS3 model differed substantially from that based on KLAMZ, especially in the late 1980s when SS3 suggested a very high biomass and KLAMZ suggested a lower biomass.

The surfclam resource in the EEZ is monitored and surveyed in six regions: Georges Bank (GBK), Southern New England (SNE), Long Island (LI), New Jersey (NJ), Delmarva (DMV) and southern Virginia (SVA) and two stock assessment areas (northern = GBK and southern = remaining regions). Surfclams and fisheries in state waters were not included in this assessment. Stock assessment results from the two areas were combined to evaluate the status of the stock for the entire EEZ.

Estimated exploitable biomass of the entire resource during 2011 was 1,060 thousand mt (2,337 million lbs). Biomass in the south during 2011 was 703 thousand mt while biomass on GBK was 357 thousand mt. Estimated annual fishing mortality during 2011 for the entire resource was $F = 0.027$, which is far below the management threshold $F = M = 0.15$. Light exploitation on GBK in 2009-2011 generated very low fishing mortality ($F_{2011} = 0.009$). Estimated fishing mortality in the southern area during 2011, while higher than on GBK, was only $F = 0.037$.

The WG had investigated and debated, but did not reach a consensus on whether to accept a one (i.e., whole EEZ) or two (i.e., GBK and the combined southern regions) stock hypothesis, choosing instead to bring the issue to the SARC Panel. The WG provided a summary of its arguments for the SARC Panel to consider. The Panel concluded that material presented to it (Tables A17 and S18, Working Group, Stock Assessment Workshop SAW 56 2013. Stock Assessment Report of Atlantic Surfclam. Working Paper #1. SAW/SARC 56) was not sufficiently informative to allow it to reach any conclusion on stock definition. However, the Panel notes that delaying a decision on stock definition did not prevent the WG from conducting its stock assessment by subareas, nor would it preclude area-based management. The WG assessment team had modeled the whole stock as well as the southern and GBK components separately,

providing a reasonable sense of trajectories in *F* and *B*, and thus stock status, during a 5-yr projection.

The SARC Panel evaluated the WG's efforts on each of the ToRs, finding that the Invertebrate Subcommittee had addressed the ToRs effectively and that the results and conclusions have utility and relevance for management needs. In the summary below, the Panel presents its consensus findings and recommendations on each of the ToRs.

**Special Comments:**

Despite decades of steady fishing, fishing mortality rates for surfclams in the southern region are estimated to be low. The explanation for low estimated *F* is that the fishery is concentrated in small areas for economic reasons and most of the stock is not impacted. This explanation of low *F* estimates has been offered in previous assessments and agrees with previous assessment results.

Although uncertain in terms of absolute biomass (scale), estimated trends in biomass were relatively certain. Point estimates of $B_{MSY}$ and $B_{2011}$ and their ratio are uncertain due to difficulties in estimating scale and $B_{MSY}$ in a stock where fishing mortality is light. However, the ratio $B_{2011}/ B_{1999}$, where $B_{1999}$ is a $B_{MSY}$ proxy, is relatively stable because estimates of $B_{2011}$ and $B_{1999}$ generally vary together. In contrast, fishing mortality estimates are not robust because they compare the scale of catch against an absolute but uncertain scale of biomass. Currently, this is not a serious problem for surfclams because overall *F* is low and almost certainly less than $F_{Threshold} = M = 0.15$.

The estimate of natural mortality ($M = 0.15$) is uncertain. The SARC Panel noted that the total mortality (*Z*) on lightly exploited GBK must approximate *M* and requested that the WG provide catch-curve estimates of *Z* from survey data on GBK. NEFSC staff generated a series of seven estimates in the period 1986 to 2011, indicating median $Z = M = 0.099$. The Panel recommends that better estimates of M, its probable regional variability, and its implications be obtained in future stock assessments.

## 2.2 Evaluation of Terms of Reference for Atlantic Surfclam

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

The SARC Panel agreed that the WG addressed this ToR.

The commercial surfclam fishery in the US EEZ operates under a fisheries management plan (FMP) and quota system, implemented through ITQs, since 1990. Landings are

made in tagged 'industry cages' and recorded in these volumetric units. Cage volumes are converted to bushels, and subsequently to meat weights and numbers at length for use in this stock assessment. The ITQ system also requires logbooks with a spatial resolution of one ten minute square (TMS) to be completed. In comparison with landings of many other species, catch data for surfclam are considered precise. However, some concerns were expressed regarding consistency of the volumetric reporting unit (bushels) and potential for variability or drift in conversion factors which could result from seasonal (or longer term) changes in surfclam condition factors and changes in the size distribution of harvested surfclams. Industry fishing practices aimed to ensure consistently high surfclam size and meat yields may counter variability in conversion factors. The SARC Panel recommends that further work be undertaken to monitor and improve conversion factors.

Landings are single species, and to ensure efficient fishing operations, the fishery avoids areas where surfclams exist together with ocean quahog (*Arctica islandica*), resulting in little or no by-catch in fisheries for either of these species. Minimum landing sizes were in place from 1982-1990, during which time discards occurred and were estimated, but since then discards have declined and are now considered negligible (zero). Incidental mortality of surfclams contacted but not retained by the dredge is considered low because the total area fished is low relative to the spatial distribution of the resource as a whole. Catches are adjusted upward by 12% to take account of incidental mortality. The 12% figure is considered to be an upper bound by the SAW WG. It was pointed out by the SARC Panel that incidental mortality could also be related to fishing effort which has approximately doubled in the last 10-15 years. Catch data were treated as exact in the analytical assessment process. Data on landings value were also presented in absolute and standardized metrics.

Numerous figures and tables in the WG report summarize catch and effort data through space and time. Spatial and temporal patterns were well described both regionally and by TMS, but further analyses may be useful if focused at the relatively small scales where the fishery is intensively prosecuted. Confidentiality rules restrict presentation of commercial data for areas where three or fewer vessels are operating, so data for some areas were not provided. The approach of fitting smoothers to LPUE time series data in cases where less than 2 vessels were operating was effective in enabling a coherent perception to be maintained while protecting personal data.

Total landings have remained relatively stable around 20,000 mt (meat weight) for the last 25 years, while total fishing effort (hours fished) has more than doubled since 1991. LPUE has generally declined by around 50% or more in the Delmarva, New Jersey and Long Island regions since 1991. It had peaked at high levels in 2004 in Southern New England, but rapidly declined and is now at a similar level (c. 50-100 bu $hr^{-1}$) to other regions in the southern area. The data presented characterize changes in distribution and level of landings, showing overall decline in LPUE in the last 20 years that was more pronounced in the southerly regions and a northerly shift of fishing effort. Historically,

Delmarva was the most important region, but New Jersey assumed this role for landings and effort from the mid-1980s onward as Delmarva declined. In recent years Southern New England has marginally overtaken Delmarva. Surfclam fishing on GBK was prohibited due to Paralytic Shellfish Poisoning (PSP) until recently when experimental fishing resulted in high LPUEs in 2010 and 2011.

Uncertainties in the commercial data were partially described and characterized, but not formally quantified.

*ToR 2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, relevant cooperative research, etc.). Investigate the utility of commercial LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data.*

The SARC Panel agreed that the SAW WG met this term of reference in presenting survey data and characterizing their uncertainty and considering the utility of commercial LPUE data, although the utility of the latter was not explicitly investigated.

Survey data were well described with sections relating to: estimation of effective survey fishing time and dredge efficiency; survey abundance trends in total and by region; size and age composition; survey and commercial gear selectivity; shell length to meat weight relationships and age and growth.

Substantial work has been undertaken historically and in the current assessment timeframe to improve estimation of survey dredge efficiency, which is a major source of uncertainty in the assessment model. This includes intensive (remote) monitoring and modeling of the dredge setup in terms of physical characteristics such as dredge angle and voltage supplied to the pump, as well as cooperative surveys, where a succession of tows by a commercial clam dredger is used to deplete a previously surveyed site, permitting estimation of the survey dredge efficiency. This field program has been augmented by methodological developments to better model these data. One panelist commented that these constituted an 'heroic effort', although also noting that alternative ways of analyzing dredge efficiency data might improve the analysis. The Panel noted that the derivation of a revised prior on dredge efficiency was a major step forward and the SAW WG (and Industry cooperation) should be praised for their work in this regard. This work highlighted uncertainty in the survey dredge efficiency as a major cause of scaling uncertainty in the assessment and plans to utilize a commercial dredger with higher dredge efficiency to conduct future surveys may improve this situation. These plans also include moving from approximately triennial surveys to rolling annual surveys for different areas of the stock.

Trends in survey abundances of commercial-sized (≥120mm) and smaller clams and size compositions were presented and described briefly. The SAW noted that regional abundances reflected generally low recruitment during recent years in Delmarva, New Jersey and Georges Bank, average levels in Southern Virginia and Southern New England

and high levels in Long Island. Length compositions were considered compatible with these trends. Age composition data were estimated and presented for years when surveys occurred between 1982 and 2011, with the SAW noting that 'strong' and 'recognizable' recruitment events could be tracked, often for many years. The Panel, noting a lack of information in the SAW report on clam ageing and verification, was provided with additional reference material suggesting that ageing is reliable. Panel members nonetheless noted that survey length and age data, and commercial length data may not be fully representative in a spatially structured stock and that this could have implications in the model weighting/fitting.

The survey follows a stratified random design, with contingencies for re-sampling tows where ground proves to be unsuitable, such tows being recorded and used to characterize the proportion of fishable ground. Surveys generally occur triennially, and full coverage is not always achieved. Gaps in coverage are 'filled' by averaging data from the same stratum in the previous and/or next survey. The SAW WG noted that a model based approach had been investigated (a previous research recommendation), but appeared to over-represent un-sampled years and strata and was not used in this SAW/SARC 56 assessment. Data for two state surveys carried out in New York and New Jersey waters were presented in the SAW report (Appendix A), but were not used in the assessment model. Both surveys, like commercial LPUE, showed declines in biomass, but relatively stable length distributions.

Selectivity for the survey dredge and commercial dredge (as rigged for the Cooperative Research program) catches was estimated using a generalized additive mixed model in this assessment. This differs from previous methodology and allows more flexibility in the fitted curve and permits a random station effect that accounts for the wide between-station variability, which is essentially a nuisance factor. This model confirmed that dome shaped selectivities (noted in the previous assessment, SARC 49, NEFSC 2010) for the survey dredge occurred across all experimental stations and provided parameter inputs for use in the KLAMZ model bridge-building exercise, although not in the current SS3 model where selectivities were estimated internally.

Shell length to meat relationships were analyzed as generalized linear mixed models, with a random station term again useful to account for systematic station effects and the model providing appropriate specification and treatment of variance structure on the transformed scale. Theoretically, this improved model fit and provided similar results to the previous SARC 49 assessment, with some differences in meat yield between regions and stations that could be interpreted as responses to environment and depth.

Von Bertalanffy growth parameters were estimated using survey age and length information for each region and year. Regressions of growth parameters through time, weighted by inverse standard error of the parameter, showed declines in $L_\infty$ through time in Delmarva and both $L_\infty$ and $K$ in New Jersey, the latter indicative of both lower

maximum size and longer time needed to reach it. These were considered by the SAW WG as indicative of deteriorating environmental conditions in the more southerly regions of surfclam geographical distribution.

It was noted *a priori* by the SAW WG that commercial LPUE may not represent relative abundance because both the fishery and stock are spatially structured, with the fishery targeting a few areas of relatively high density within economically viable ranges of ports and processing facilities, while other areas of the stock remain lightly exploited or unfished, and redistribution of the stock between fishing episodes is minimal (by recruitment only). Despite the fishing pattern, commercial LPUE data from important TMS show striking similarity to the overall stock trends estimated in the analytical assessment. The SARC Panel therefore recommends that a more formal investigation of commercial LPUE be undertaken for future assessments, possibly including spatially standardized indices as 'ghost variables' in the SS3 assessment model.

The SARC Panel notes that uncertainty in the NEFSC survey data used in the assessment model was formally and probabilistically characterized in the modeling process.

ToR 3. *Evaluate the current **stock** definition in terms of spatial patterns in biological characteristics, population dynamics, fishery patterns, the new cooperative survey, utility of biological reference points, etc. If appropriate, recommend one or more alternative stock definitions, based on technical grounds. Integrate these results into TOR-4.*

The SARC Panel agreed that the SAW WG had addressed this ToR, although the WG could not reach consensus on whether a two-stock definition was or was not appropriate and passed that decision or interpretation to the SARC Panel.

The SAW WG had clearly given considerable thought to the issue, but differences in interpretation by WG members were obvious. The Panel could not and did not choose to draw any conclusions on whether a one- or two-stock definition was appropriate. In order to provide a balanced commentary, the WG presented tables (A17 and A18) of pros and cons to both single- and two-stock alternatives. However, the summary tables provided to the Panel were not sufficient or compelling and provided little direct evidence for either case. The Panel concluded that a decision on stock structure (one or more) requires a much more in-depth analysis on recruitment dynamics, sources, sinks, for which evidence may not yet be fully available. The Panel also noted that spatial variability could be addressed by managers, regardless of whether there are one or two stocks, i.e., spatial approaches to management.

The two compartment modeling approach currently used by the SAW WG was sufficiently flexible to accommodate both alternative stock definitions and provide a basis for management. The Panel noted that a single stock definition did not preclude the use of two (or more) stock assessments in support of management.

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

The SARC Panel agreed the SAW WG met this ToR in a general sense, but that some aspects could have been covered more fully. The presentations were prefaced with extremely useful context and simple calculations that strongly suggested the stock was large and only very lightly exploited. The Panel liked this approach because it provided some comfort for modeling conclusions.

The SAW WG used "summary biomass" (clams >120 mm shell length, 6 or 7 years and older, depending on Area) rather than total or spawning stock biomass. Because SSB includes some very small clams that are not included in "summary biomass", and total biomass includes all clams, "summary biomass" is lower than the total and spawnng stock biomass indices specified in the ToR, potentially by quite a large margin. This probably does not matter for the assessment of stock status because exploitation is light, but it would not be difficult to generate estimates of total biomass and SSB (or change the ToR for the next assessment).

The SAW WG considered an historical retrospective analysis where the current age-structured model implemented using SS3 is compared with previous biomass dynamics KLAMZ model outputs, and reviewed the performance of historical projections. The historical retrospective analyses showed that the biomass trajectory from the age-structured SS3 model differs substantially from that of the KLAMZ model, especially in the late 1980s when the age-structured model suggested a very high biomass and the KLAMZ models suggested a low biomass. The main additional data included in the age-structured model was (conditional) age at length. The SARC Panel thought the new, age-structured model may be over-fitting to, or over-influenced by, these data and would have been pleased to have been presented with more information on runs with different data weightings. The Panel acknowledged there are no concrete rules for data weighting, but was concerned that relatively little weight appeared to be given to the survey data and the fit was locally poor (although generally retaining overall trends). Conversely, the fit to age distributions was tight, even though traditional distributions of numbers at age were not explicitly included in the objective function. There was a fair bit of residual pattern in the fits to length distributions suggesting the model was not picking up a secondary peak of small clams that appeared consistently in the late 1990s. Overall, despite some evidence supporting the quality of age estimates that was provided during the SARC meeting, the Panel concluded from these features that too much weight was probably put on the age data during fitting and that this required further exploration.

Estimates of absolute biomass from the age-structured model are very uncertain as might be expected from a stock with a low exploitation rate. The Panel thought the key information to reduce uncertainty on biomass should be the strong prior on survey catchability (equivalent to survey dredge efficiency in this model), but the model settled on a mean catchability of >0.3, substantially greater than all measures of central tendency in the prior (0.1 to 0.23). There was substantial sensitivity in estimated biomass, but not in biomass relative to the adopted reference level of $B_{1999}$ (i.e., biomass status). The reasons for the shift in catchability were not clear and it seemed to the Panel that the necessary "information" was probably coming from the age data (and was potentially misleading). The Panel thought this needed further analysis. There was insufficient time during the review to do a thorough analysis but projections forcing high and low catchability (respectively, low and high biomass scenarios) showed that the general conclusion of a lightly exploited stock was robust to the assumed value for catchability (and, hence, biomass) and plausible distribution of catch among areas.

The SARC Panel thought that sensitivity of the model to the assumed level of *M* should have been more thoroughly explored. The Panel from the previous Atlantic surfclam assessment (SARC 49, NEFSC 2010) commented that assuming *M*=0.15 may overstate the productivity of this stock and this Panel had similar concerns. The Panel requested some catch curve analyses from GBK where fishing has been zero or minimal for many years and received these plots late in the SARC review. Most annual plots suggested *M*<0.15 and the average suggested 0.098 to 0.130, depending on whether recent years with putative poor recruitment are excluded. Overall, these analyses suggest that *M* is quite likely to be <0.15 and the Panel suggested additional analyses by cohort (yearclass) and in different regions of the southern area. The Panel thought an age-structured model with good fits to age data would be a good tool to assess natural mortality, especially as a single model with *M* assumed 0.10 gave quite different, and somewhat confusing, results. The Panel thought this was an area for further investigation and model development.

Patterns in LPUE in many regions of the fishery were, on the face of things, quite similar to the estimated trends in biomass in the southern area although no explicit "ghost fits" were shown. The Panel thought the WG could consider more fully whether LPUE might be a usable index of abundance, even though fishing is spatially focused. At least, model runs including LPUE indices should be tried. The Panel agreed with the WG's interpretation that parallel declines in estimated biomass and LPUE at relatively low levels of catch would suggest a decline caused by low recruitment and/or poor environmental conditions for surfclams.

The Panel thought that the progression of model building from simple to more complex, through the assessment of data weighting choices, and to underpin the choice of a base model, should be supported by more detail and diagnostics than were presented in the SAW WG report, especially as this is a new model using new data. This should include tables of objective functions, weights, contributions to likelihoods and SDNRs for the

main data sets, and the main parameter estimates. Such tables can be dense, but they provide valuable comparisons among models and can be used to show a logical progression in model choices.

The Panel notes that primary modeling was on the southern area only, not the GBK, due to catch history differences and a general lack of data for the GBK. The assessment of the GBK area used many parameters derived from assessment of the southern area. Whole area assessment results are a simple sum of the two areas. The Panel agreed with the SAW WG that, given the lack of data for GBK, this is a viable approach.

Overall, the conclusions on stock status that can be drawn from the modeling are robust to most uncertainties. Fishing mortality rates are low (generally <0.04 on recruited year classes) and mostly without trend. The *F* levels on GBK are essentially zero, since almost no fishing has occurred there in the past two decades.

ToR 5. *State the existing* ***stock status*** *definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for* $B_{MSY}$, $B_{THRESHOLD}$, $F_{MSY}$ *and MSY) and provide estimates of their uncertainty. This should be carried out using the existing stock definition and, if possible, for the recommended "alternative" stock definitions from TOR-3. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the appropriateness of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.*

The SARC Panel agreed that the SAW WG met this ToR. The WG stated the existing definitions and updated them based on the newly fitted age-structured population models implemented in SS3. All *BRP*s were estimated as combined results for separate stock assessment models developed for the southern and northern (GBK) areas. Both biomass and fishing mortality *BRP*s are proxies. $F_{MSY}$ is assumed equal to *M* which, in turn, is assumed equal to 0.15 based (somewhat loosely) on observed longevity. It seems probable that *M* may be lower than 0.15 and this should be explored in future assessments. The summary biomass in 1999 is assumed to be equal to the average unexploited summary biomass and $B_{MSY}$ is assumed to be half of this amount. The rationale for $B_{1999}$ was explained during the review but was not clear. It may be an adequate reference point under low exploitation. Previous assessment models indicated that $B_{1999}$ was near the maximum of the biomass trajectory, but this is not the case in the most recent assessment based on SS3. Projected asymptotic summary biomass at $F$=0 was reported to be similar to $B_{1999}$. While not fully convinced about the choice of $B_{1999}$ as a biological reference point for biomass, the Panel did not feel it could offer an alternative. It would be helpful if the SAW WG could establish a clear, agreed rationale.

The SAW WG concluded that the stock is neither overfished nor experiencing overfishing. The SARC Panel concurred with these conclusions and believes they are robust to many uncertainties.

ToR 6. *Evaluate stock status with respect to the existing assessment model and with respect to any new assessment model. Determine stock status based on the existing stock definition and, if appropriate and if time permits, for "alternative" stock definitions from TOR-3.*

The SARC Panel agreed the SAW WG met this ToR.

The SARC Panel agrees with the SAW WG that the stock is neither overfished nor experiencing overfishing. The Panel did not have sufficient information to make a determination on the alternative stock definitions offered by the SAW WG (under their ToR 3), but the same conclusions would be probable if two stocks were assumed (i.e., neither the northern nor southern areas is overfished or experiencing overfishing). The SARC Panel thought that the SAW WG should not have sought a decision on stock definition from the Panel, when the WG, in detailed and thoroughly informed working group meetings, could not reach a consensus. At the low exploitation levels now in effect, the Panel believes there is no urgent need for an updated stock definition because spatial or area management could be undertaken using the survey and stock assessment results regardless of whether one or multiple stocks were biologically defined. More research could undoubtedly be done on this issue.

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.*

The SAW WG updated the existing KLAMZ model with new data but did not report updated *BRP*s and conclusions on stock status.

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

The new age-structured modeling approach (in SS3) was used to derive *BRP*s and to evaluate stock status. The new assessment indicated that the stock was lightly fished and that the stock is neither overfished nor experiencing overfishing. The SAW WG evaluated biomass and status in two areas (GBK and southern area) and for the whole stock. In each case, the WG concluded that the stock is neither overfished nor experiencing overfishing. The SARC Panel concurred with these conclusions.

ToR 7. *Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).*

The SARC Panel agreed that the SAW WG had met this term of reference.

Stock projections under three scenarios (*F*=0.15, *status quo* catch, or quota) were provided in the SAW report. The assessment scientists also brought forward new text and figures to more fully address this ToR (Surfclam_Extra1_ TOR7_Projections.doc). Projected landings from the GBK area were assumed to be one million bushels under both *status quo* and quota scenarios, reflecting likely fleet and processor limitations. Catches were calculated as landings plus 12% incidental mortality.

Whole stock projections were calculated as the sum of the two (southern + northern) areas. However, surfclams in these areas had different growth and selectivity (at age) characteristics and numbers at size was not a projection output, so fishing mortality was not computed directly for the combined projection. Rather, it was approximated as the numerically weighted average of the fishing mortality in each (sub-) area.

No probability density function was calculated for the OFL, because this is based on an assumption ($F_{MSY}$ proxy = *M*, where *M* is assumed to be 0.15) rather than an estimation. At the Panel's request, a pdf of catches at the OFL (*F*=0.15) was provided by NEFSC staff. The other projection scenarios were catch based, so catches were defined and therefore had no pdfs.

a. *Provide numerical annual projections (3-5 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).*

Stochastic projections were provided for each exploitation scenario which took account of estimated uncertainties in the base case stock assessment. Terminal year distributions of abundance and recruitment were carried forward into projections because age-at-full-selection is greater than the projection period. Confidence limits were derived and sensitivity analysis was conducted, although these were not presented in the SAW report or Summary Assessment Report.

Projections under all three scenarios showed very low probabilities of the stock being over-fished in any of the projected years. There was some discussion regarding the exact calculation of probability levels which the WG and SARC Panel believe may have been over-estimated due to the likely occurrence of correlation between threshold and realized biomass pairs in the projections.

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.*

Of the projections carried out by the SAW WG, the *status quo* catch scenario was considered the most likely, because the fishery is market-limited and recent landings have been consistently below quota. Projections under this scenario showed the lowest probabilities of the stock being over-fished.

The SARC Panel believes that projected landings are quite realistic, given the nature of the fishery and its management. Projections of landings, fishing mortality, summary biomass and recruitment are probably less realistic for the GBK area under the OFL scenario, but for other ABC scenarios the assumed GBK landings of 1,000,000 bushels are based on industry advice.

The SAW WG did not consider multiple states of nature although some projections and alternative model runs were provided by NEFSC staff at the SARC Panel's request. States of nature investigated included alternative biomass scales reflecting alternative survey dredge efficiencies. No projections were conducted based on models run with alternative *M* specification or alternative data weightings. The Panel notes that a simple attempt during the SARC meeting to fit the new model at lower *M* was not successful and time did not permit further exploration. At the SARC 49 previous surfclam assessment using the KLAMZ model, alternative *M* runs were conducted and used as alternative states of nature for projections. The Panel recommends further exploration.

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 SAW WG did not explicitly report on this sub-ToR.

The Panel notes that *M* is assumed to be 0.15 $y^{-1}$ and that, as also was pointed out by the SARC 49 Panel, this may overstate productivity. At this SARC (56) meeting, attempts to explore model fits at lower *M* gave confusing results and further work is obviously required. It would have been desirable to follow through on this work in the current assessment to provide alternative states of nature in the projections. The SARC Panel recommends that such analyses and model runs be conducted to better understand vulnerability in Atlantic surfclam.

The stock's susceptibility to fishing is limited because the fishery exploits surfclams only over a very restricted part of their range due to economic drivers. Only relatively large and old clams are taken, while maturation can occur at very young ages. Further, the FMP limits catches from increasing substantially, even if economic drivers were to change.

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

The SARC Panel agreed that the SAW WG met this term of reference.

A total of eight previous research (and monitoring) recommendations were outlined in the SAW report; some progress had been made on four of these and no progress had been made on the remaining four (numbered iv, v, vii and viii in the SAW report). A brief summary of progress on substantive matters follows.

(i) *Continue surf clam recruitment research*. The new assessment model incorporates length and age, permitting estimation of recruitment. This is important in working towards the research recommendation to continue recruitment research. It also provides an improved basis for projections.

(ii) *Obtain port samples from SNE and GBK regions*. Port sampling (of commercial lengths) was undertaken in SNE and GBK from 2010 onwards, fulfilling this recommendation.

(iii) *Determine the extent of surfclam habitat on GBK*. Exploratory work on remote imaging of habitats and automated identification has been undertaken and constitutes some progress towards meeting the recommendation to determine how much of GBK is good habitat for surfclams. The SARC Panel notes that work using data on bad tows from the surveys can also be claimed as additional progress on this topic. The remote imaging work has not received further funding.

vi) *Commercial length data should be accessible*. These data were summarized in the SAW report and are available on request through NEFSC.

Seven new research recommendations were put forward by the SAW WG. One of these (new number v) repeats number iii above and the SARC Panel encourages this work. The others are as follows:

*i) Biomass reference points need to be reconsidered.*

The Panel noted that the 1999-based biomass reference point should at least be better justified and may warrant reconsideration. Further, the *M* value used as a basis for the $F_{msy\ \mathrm{proxy}}$ should be evaluated. Consideration of reference points under regime change might also usefully be considered, as might reference points for alternative spatially and temporally structured stocks, models and management.

*ii) Has surfclam biomass shifted offshore into deeper water over time?*

The Panel noted that research into the distribution of surfclams is relevant with respect to climate change and exploitation opportunities and to interactions with other resources/fisheries (e.g. for Ocean quahog).

iii) *Look into a better way to implement regime change into the SS3 model. Look into patterns which may match other species and climate indices.*
The SARC Panel noted the need for understanding of processes related to climate change or other factors affecting stock productivity and distribution and that if appropriate these should be included in assessment or management advisory models. The Panel recommends that if an evaluation of management under changing environmental conditions is required this would best be undertaken using management strategy evaluation (MSE) rather than in the context of assessment modeling *per se*.

iv) *Determine the best spatial and temporal distribution to use for surfclam assessment models.*
The Panel notes that the best or most appropriate spatial and temporal scales for assessment are determined by stock structure (e.g., recruitment dynamics, variation in biological characteristics, etc) and by management considerations. Further research to define stock structure of surfclams would be useful in this context, but the SARC Panel does not believe that a lack of such information impedes management, at least under the current low levels of exploitation.

v) *Look at habitat on GBK.*
See iii under previous research recommendations.

vi) *Given the increasing importance of GBK re-evaluate the optimal sampling design for the survey.*
The SARC Panel notes the need to not compromise comparability with previous survey indices, but agrees with the recommendation.

vii) *Look into area specific recruitment streams for SS3 and how to accommodate the 2012 and 2013 surveys.*
The SARC Panel noted that the current CAA assessment implemented in SS3 is structured into two areas and could be structured to accommodate more areas to the extent that data permit. This structure can accommodate separate recruitment streams. If the assessment requires a multi-area model with separate recruitment streams, but shared parameter estimation, movement, etc, then a modification would be required to the SS3 framework.

## 3. Review of White Hake

White hake (*Urophycis tenuis*) is a demersal gadid species distributed from Newfoundland to North Carolina, and is most abundant in the Gulf of Maine (Bigelow and Schroeder 1953; Collette and Klein-McPhee 2002; Sosebee 2006). White hake is

managed as a single stock in United States waters. Based on a genetics study in Canadian waters, there is evidence for both population structure within and mixing among stock units (Roy et al. 2012). There is no definitive information on stock structure and mixing for white hake in US waters.

United States commercial landings of white hake averaged around 16,400 mt in the first decade of the 20$^{th}$ century, then declined to a low of 1,131 mt in 1967. Landings subsequently increased, peaking at 8,509 mt in 1992. United States landings have since declined both due to lower abundance and management measures implemented to reduce effort on groundfish stocks in the Gulf of Maine and Georges Bank. Foreign landings of white hake have generally been low, ranging from no landings to 1,683 mt, with an average of 362 mt. Discards have been substantial, averaging 1,256 mt in the 1960s, but declining to less than 200 mt since that time. Catch data are a source of uncertainty in this stock assessment because of potentially mixed landings of red hake (*Urophycis chuss*) and white hake and uncertain identification to species. The small recreational catches, averaging less than 12 mt and imprecisely estimated, are not included in the assessment.

## 3.1 Synopsis of Panel Review

With a high degree of certainty, white hake is not overfished and overfishing is not occurring. Spawning stock biomass (SSB) in 2011 is estimated to be 26,877 mt which is 83% of the revised $SSB_{MSY\ proxy}$ (32,400 mt). The 2011 fully selected fishing mortality ($F$) is estimated to be 0.13 which is below the revised $F_{MSY\ proxy}$ (0.20). This quite favorable determination of stock status is a change from the previous stock assessment in which white hake was judged to be overfished and subject to overfishing in 2007(NEFSC 2008, GARM III)(see Special Comments).

The SARC Panel agreed that the present assessment and its results provided useful and relevant advice for management of white hake in US waters. The Panel did have some questions and concerns about *BRP*s that had been derived by the SAW WG. Discussions among the Panel and SAW WG members during and following the SARC meeting, additional analyses by NEFSC staff, and deliberations by the Panel led to consensus recommendations by the Panel (see Evaluation of ToR 5 below).

In SAW/SARC 56, the assessment model put forward by the white hake working group was a statistical catch-at-age model (ASAP) incorporating formulations that differed from the previous GARM III Statistical Catch-at-Age (SCAA) model. The previous assessment (GARM III, NEFSC 2008) of Gulf of Maine-Georges Bank white hake was conducted using a SCAA, age-structured production model (ASPM) that incorporated commercial landings and discards. Results from the previous SCAA and new ASAP model formulations using revised data were similar in trend and magnitude.

The SARC 56 assessment includes revised and updated catch estimates and utilizes NEFSC spring and autumn survey data indices. In the previous assessment, catch data distinguishing white hake were derived from survey species proportions at length to apportion mixed red and white hake catch data. At the SAW/SARC 51 (NEFSC 2011), the red hake assessment was based on nominal red hake landings and estimated discards. Accordingly, to be consistent the same approach was used for white hake in SARC 56. The revised catches reported in SARC 56 had a substantial impact on the assessment results. A comparison of assessment model outcomes is shown below.

| | GARM III | SARC 56 |
|---|---|---|
| $F_{MSY}$ proxy (F40%) | 0.125 (on age 6) | 0.20 (on age 6) |
| SSB/R | 5.94 | 6.19 |
| Mean Recruitment | 8.0 million | 5.5 million |
| $SSB_{MSY}$ proxy | 56,300 mt | 32,400 mt |
| F pattern | Domed | Asymptotic at age 6 |
| MSY | 5,800 mt | 5,630 mt |

In SARC 56, based on the demographic and selectivity parameters, the SPR-based *F* reference point of *F*40% corresponds to fully selected *F* = 0.20. The SARC panel recommended that F40% (i.e. fully selected *F* = 0.20) be retained as the proxy for $F_{MSY}$.

The SARC Panel noted that estimates of fishing mortality have varied over a wide range since the 1970s but presently are well below the $F_{MSY\ proxy}$ = 0.20. The improving condition of the stock is indicated by the more than three-fold increase in spawning stock biomass from a time series low of 7,850 in 1997 to 26,877 mt in 2011. Recent recruitments, although not high, are near the time-series average.

The SARC Panel agreed that, under a short-term recruitment assumption, projections at 75%$F_{MSY}$ provide an optimistic outlook for the fishery, with increasing SSB and catches from 2012 to 2015.

**Special Comments:**

- The estimated increases in spawning stock biomass from 2007 to 2011 during a period when *F* was low and recruitment was near the long-term average is not judged as due to a change in the model but is supported by the increases in abundance of white hake in the survey and landings data.
- The Panel notes that although recent recruitment has been sampled for reasons of short term projections, biological reference points were based on recruitments from the entire time series. The SARC Panel believes there is no clear reason at this time to derive reference points based on a reduced time

series of recruitment.

- The SAW WG recommended an $F_{MSY\ proxy}$ of *F*35% based on simulations under fishing mortalities associated with *F*35% and *F*40%, indicating a central tendency for risk that SSB would be reduced below 20% of virgin biomass of less than 5%. The WG chose *F*35% on the basis that there was little difference in risk for *F*35% and *F*40%, and *F*35% offered higher yield opportunities. Upon further review of the risk, the SARC Panel identified a greater difference in risk levels between the reference points than originally indicated by the WG. Risk increased steeply as *F* was increased from *F*40% to *F*35% and as stock-recruitment steepness was decreased from $h = 0.8$ to $h = 0.7$. Consequently, the SARC Panel recommended that in the absence of more detailed evaluation of risks in response to stock-recruitment assumptions and other model sensitivities the $F_{MSY\ proxy}$ of *F*40% currently in place should remain.

## 3.2 Evaluation of Terms of Reference for White Hake

*ToR 1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of fishing effort. Characterize the uncertainty in these sources of data. Analyze and correct for any species mis-identification in these data. Comment on the consistency of the approach to identify the catch of white hake with respect to that used in the red hake assessment.*

The SARC Panel agreed the SAW WG had met this ToR and undoubtedly improved the understanding of catches of white hake since the last assessment.

For the time period covered by the stock assessment model (1963 to date), catches (including discards) and landings from all commercial sources were analyzed in great detail and carefully summarized. Estimates of recreational landings were available but were estimated imprecisely and always low (average less than 12 mt), and were not included in the assessment. The temporal and spatial distributions of landings and effort were categorized. Discards and foreign landings have been at low levels in the past four decades but were included in the model. One source of uncertainty is the potential for mis-identification or confusion with red hake, especially for small individuals. The recent red hake assessment (SARC 51, NEFSC 2011) was based on nominal landings because previous methods of apportioning seemed to overstate historical white hake catches. The same approach was proposed for white hake and the SARC Panel was assured that the two assessments were consistent in this regard. The SAW WG produced a credible time stream of catches for white hake since 1963 (landings were very much greater in the 1900s) and described the various uncertainties. However, the WG did not quantify uncertainty numerically and did not present alternative catch streams that could represent alternative states of nature in the modeling and projections.

Age and length data were available for the fishery allowing characterization of the catches by age and length. A pooled age-length key, ALK, was used for some components of the time series (see ToR 3 and 4, below). White hake are landed headed and gutted (i.e., without otoliths) which increases uncertainty in length and age determination of the landings.

*ToR 2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Investigate the utility of commercial or recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data.*

The SARC Panel agreed the SAW WG met this ToR. The WG presented the survey data, including regional indices of abundance over the range of the survey (North Carolina to Maine). Data from state and shrimp surveys were examined but not included in the assessments (fits and residuals are shown only for the NEFSC surveys). The Panel was not made aware of a rationale for the decision to exclude state and shrimp survey abundance indices from the model. Recreational data from MRFSS and MRIFS, representing small and variable catches (< 12 mt annual average), were included in the catch data, although not included in the assessment. The Panel agrees it is unlikely that recreational LPUE would be useful, given the very high variability. Commercial LPUE were investigated, including statistical (GLM) analyses and filtering of the data by different targeting criteria. LPUE indices were not fitted in the final model and it is unclear if LPUE were included in any development work.

A general observation is that many abundance indices were considered and described, but only the NEFSC spring and fall surveys were offered to the model. It would have been useful to include a short section or table in the WG report outlining the rationale for these choices. Even more useful would have been a variety of model fits including the abundance indices with different weightings, including zero weights ("ghost fits"). Similarly, the rationale for, and impact of, other modeling choices (e.g, catch history) could have been more explicit and transparent.

*ToR 3. Evaluate the utility of pooled age-length keys for development of a stock assessment model.*

The SARC Panel agreed the SAW WG had met this ToR. The WG conducted a sensitivity analysis of different possible approaches of pooling age-at-length data across years. This analysis was done specifically for this white hake assessment in response to the GARM III Review panel's suggestion that pooling might dampen or obscure recruitment signals. The sensitivity analysis suggests that pooling ALK information in this stock assessment does not substantially affect the results; recruitment patterns are robust to pooling choices, especially in statistical catch-

at-age models. Choice of model structure makes a much larger difference to the results.

*ToR 4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, recruitment, catch and fishing mortality.*

The SARC Panel agreed that the SAW WG generally met the ToR. However, the Panel thought the documentation of the new assessment model would have benefited from additional detail on model development and selection. The Panel thought this especially important because the new assessment model (ASAP) and revised data lead to different reference points and status determination than derived from the previous model (ASPM) reported in GARM III (NEFSC 2008).

At the previous assessment (GARM III, NEFSC 2008) the ASPM (now termed SCAA at SAW/SARC 56) model was used for final stock status definition due to problems in configuring the ASAP model (then under development). In particular, the use of a common (or "pooled") ALK to provide age information in the early period (1963/4 to 1985) to promote convergence and improve diagnostics of the ASAP assessment was not deemed satisfactory by the GARM III Review Panel. AT SAW/SARC 56 the SAW WG therefore investigated the use of annual and pooled (across years) ALKs (for surveys and commercial catches) using two models: VPA/ADAPT (not used for assessment *per se*) and ASAP (used for the final, base case). The SAW WG found larger differences between models than attributable to choice of data in age-length keys and chose to proceed using ASAP with pooled ALKs. The SAW WG did note, however, that more work is needed to examine pooling and model sensitivity. The SARC Panel generally agrees but urges the WG to focus on evaluating the sensitivity of the model rather than trying to understand the finer detail of the effect of pooling ALKs.

Work on the old ASPM (now termed SCAA) model allowed an examination of the effects of revised and new data but this examination was not conducted using the new ASAP model. The analyses provided were helpful in determining that changes from the previous assessment (GARM III) are due primarily to commercial selectivity now being estimated as asymptotic from age 6 (Fig B134 of SAW white hake report) as well as to a revised catch stream, additional catch-at-age data, and the use of pooled ALKs.

The SAW report, as noted above, is very brief in describing the ASAP model development and selection process. Few diagnostics were reported for the final base case run, no final MCMC diagnostics were included, and no materials or explanations were provided during the SARC Panel meeting. Upon request, the

Panel was provided MCMC diagnostics by NEFSC staff; the Panel found them to be acceptable. Unfortunately, there was no time available during the SARC review for materials on model development and selection to be prepared. The SAW report on white hake (SAW Report, white hake 2013) does briefly cover details of the final model (p23) but the SARC Panel would have benefited from summary tables of model configuration, estimated parameters, contributions to log likelihoods, etc, to aid rapid reading and appraisal. In future, the SARC Panel recommends that such material be included as standard. Additionally, it would be useful to see not only a statement of model configuration but also explanations of why parameters were fixed or not, and why particular selectivity blocking and parameterization were used.

The SARC Panel does not disagree with the SAW WG modeling decisions but notes the importance of explaining and justifying, not just reporting what was done in a final model run. Without sufficient information on model development and selection, it is difficult to be fully confident in the final base case, especially when the WG recognizes the need for further work on pooling of ALKs and when no mention is made, for example, of ASAP model sensitivity to *M*, selectivity options, or changes to catch streams.

The SAW WG reported retrospective analyses using the base case assessment run. These show a consistent but very small pattern of underestimation of *F* and overestimation of *SSB* and a consistent overestimation of number of recruits. The WG also considered historical projections; these show consistency in trends and status although absolute levels of *SSB* and *F* are different due to changes in catch data and selectivity assumptions.

As reported at the SARC 56 meeting, model development included considerations of selectivity estimation, alternative start dates, variations in weighting, etc. The SARC Panel agreed with the consensus view of the SAW WG that base run model fits appeared satisfactory and that there were few residual patterns to cause concern. The base case run was numbered as model 60, suggesting that model exploration was extensive. The Panel agreed that the model was acceptable as a basis for commenting on stock status and for making projections. The Panel suggested that the start date in the model runs might better be 1964 given the high residuals in 1963. The lead WG analyst noted the WG had reached the same conclusion, but too late in the process to make the change. The SARC Panel recommends further work on sensitivity testing of the ASAP model that could provide a fuller view on uncertainty that is important for *BRP* definition, status determination, and projections.

*ToR 5. State the existing **stock status** definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for $B_{MSY}$, $B_{THRESHOLD}$, $F_{MSY}$ and MSY) and provide estimates of their uncertainty. If*

*analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.*

The SARC Panel agreed that the SAW WG met its ToR and provided carefully constructed arguments in support of changing the $F_{MSY}$ proxy from $F40\%B_0$ to $F35\%B_0$. In its review, given more detailed and additional information, the SARC Panel did not agree with the decision of the SAW WG.

The SAW WG suggested new reference points based on its new assessment model run with new and updated data (see ToR 4 above), and an exploration of the risks associated with alternative $F_{MSY}$ proxies (*F*40% and *F*35%). The SAW report explained its arguments for adopting *F*35%, a departure from the *F*40% proposed in the previous assessment. Briefly, the SAW WG adopted the method of Clark (1991, 1993) to investigate, under three stock-recruitment assumptions regarded as plausible by the WG, the risks of falling below $20\%B_0$ under alternative constant *F* scenarios. The WG provided the *F* values associated with a 5% probability of falling below $20\%B_0$ for each of three stock-recruitment assumptions and also provided values of *F*35% and *F*40%. The SAW report, however, did not give the explicit risks associated with *F*35% and *F*40% under the three stock-recruitment scenarios. As reported, the *F*35% exceeded the *F* value associated with 5% probability of falling below $20\%B_0$ in the third stock-recruitment scenario (Beverton-Holt with steepness $h = 0.7$). The risk associated with *F*35%, therefore, is greater than 5%, the acceptable risk level adopted by the SAW WG. While not explicit in its report, it is implicit that the SAW WG-adopted 5% threshold is not an absolute threshold to be avoided under any of its stock-recruitment assumptions, but represents an average or central tendency across a range of plausible stock-recruitment scenarios.

The SARC Panel accepted the application of Clark's method by the SAW WG but wished to see the probabilities of depletion associated with *F*40% and *F*35% runs. The Panel was comfortable with the SAW WG-adopted risk criterion of a 5% probability of falling below $20\%B_0$ and discussed 10% as a more common limit (though usually as an absolute rather than an average or central tendency). Accordingly, in its initial discussion, before seeing the actual probabilities associated with *F*40% and *F*35%, the Panel tentatively agreed with the SAW WG-proposed *BRPs*.

The SARC Panel requested and was provided with calculated probabilities of depletion associated with *F*35% and *F*40%. The Panel was unclear as to whether results in the SAW report were based on the final assessment run (run 60) or a prior run. During the SARC meeting, for run 60, reported risks for *F*40% under the three stock-recruitment scenarios were all 4% or less. However, for *F*35%, when steepness was reduced from 0.8 to 0.7, the reported probability of

depletion increased from 4% to 11%. The Panel noted the sharp increase in risk at *F*35% as steepness decreased. Given the lack of exploration of sensitivity in the assessment to catch streams and *M*, the Panel was reluctant to agree to a departure from the existing *F*40% without further exploration.

On the day following the report on *F* levels and risks, it was discovered that errors possibly had been reported to the SARC Panel. The Panel agreed to await recalculated values by NEFSC assessment scientists. Additionally, the Panel requested a calculation and results at steepness *h* = 0.6 to allow a simple exploration of the risk surface in relation to *F*X% and *h*. The NEFSC provided a report to the Panel that was circulated by e-mail on 27 February 2013. That report included a summary table, copied below. The estimated probability of falling below 20%$B_0$ at *F*35%, and given *h* = 0.7, was corrected to 9.7% from the previously reported value of 11% (actually 10.2%). This outcome did not affect the Panel's consideration of the relative merits of *F*40% and *F*35% as $F_{MSY}$ proxies, which was based on the lack of sensitivity testing and the steepness of the response surface rather than absolute values of the probability of falling below 20%$B_0$.

| steepness | SSB0 | 0.2*SSB0 | SSBmsy | percent below 0.2*SSB0 F35%=0.24 | F40%=0.20 | F that results in ~5% draw |
|---|---|---|---|---|---|---|
| 0.6 | 139,200 | 27840 | 51300 | 26.1 | 7.2 | 0.19 |
| 0.7 | 128,100 | 25620 | 42960 | 9.7 | 2.0 | 0.22 |
| 0.8 | 119,200 | 23840 | 36940 | 4.1 | 0.7 | 0.24-0.25 |
| emp.cdf | 81,700 | 16340 | 28450 (F35) or 32400 (F40) | 0.0 | 0.0 | 0.35-0.36 |

These results, if definitive, indicate that i) as in the SAW report, the *F* that meets the 5% criterion when *h* = 0.7 is 0.22; ii) *F*35%, at 0.24, must therefore result in risk levels higher than 5% when *h* = 0.7; and iii) there is an expected increase in the probability of depletion as *h* declines and this is most notable at F35%.

While the risk at *F*35% with *h* = 0.6 is high, the SARC Panel does not suggest 0.6 is a plausible value of *h* for white hake without seeing supporting analysis; 0.7 and 0.8 are regarded as sensible, plausible values. The Panel requested the calculations for *h* = 0.6 to assess the shape of the risk surface, which is clearly non-linear. Exploration of the non-linearity, given alternative *M* assumptions or other sensitivities, has not been undertaken but is recommended.

Given these results, the SARC Panel could have reverted to the argument put forward by the SAW WG that at *F*35% the risk of depletion calculated using the method of Clark is of the order of 5% across a range of plausible stock-recruitment scenarios, and hence is a credible candidate for $F_{MSY\ proxy}$. However, the Panel is concerned that insufficient analysis had been conducted to support

a departure from the existing *F*40% BRP. The Panel therefore recommends retaining the *F*40% *BRP*. The Panel also recommends further investigation of risk levels associated with plausible scenarios, including fuller exploration of model sensitivities. The Panel believes the method of Clark, or a similar simulation approach, is suitable and that adoption of a given percentage risk level as a "central tendency" is reasonable if evaluated across a range of carefully considered and plausible scenarios.

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

The SARC Panel agreed that the SAW WG addressed this ToR (see also ToR 5, above).

a. *If possible update the ASPM with new data and evaluate stock status (overfished and overfishing) with respect to the relevant BRP estimates.*

   The SAW WG explored the behavior of the old ASPM (now referred to as SCAA) assessment model and reported details in a separate appendix (B1) to the SAW report (SAW 56 WG. 2013, white hake, Working Paper #1.SAW/SARC 56). The SCAA was updated by incorporating the new data and inputs, and its behavior was well explored; results of sensitivity testing are provided in Appendix B1. Tables Appendix B1.2 and B1.3 clearly indicate that under a wide range of tests the white hake stock is neither overfished nor subject to overfishing.

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

   The SAW WG suggested adopting *F*35% = 0.24 as an $F_{MSY\ proxy}$. The corresponding $SSB_{MSY\ proxy}$ would be 28,450 mt (see SAW report p27). The WG-proposed base case assessment estimates the fully selected $F_{full}$=0.13 (0.11-0.16) in 2011 and *SSB* in 2011 to be 26,877 mt (23,127 - 30,729), well above the ½ $B_{MSY\ proxy}$ overfished threshold. Adopting reference points based on *F*35% would therefore indicate the stock is neither overfished nor experiencing overfishing.

   If *F*40% is adopted as a proxy (see ToR 5, above), the relevant $F_{MSY\ proxy}$ = 0.20 and $B_{MSY\ proxy}$ = 32,400 mt. Adopting reference points based on *F*40% would therefore also indicate the stock is neither overfished nor experiencing overfishing.

*ToR 7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., the probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).*

a. *Provide numerical annual projections (3-5 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).*

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

The SARC Panel noted that the SAW WG only briefly addressed this ToR. In the SAW report a short paragraph describes projections run at the proposed *F*35% proxy and at 0.75*F*35%, from 2012 to 2016, using the distribution of numbers-at-age derived from the base case MCMC (see ToR 4, above). No tables or figures showing projection results were included in the SAW report but the brief text included numerical results consistent with those presented during the SARC meeting. During the SARC meeting, the Panel was also provided some additional projections using recent recruitment resampling.

The requested projections shown during the SARC meeting are only for the *F*35% SAW WG-suggested $F_{MSY\ proxy}$, and for 0.75 of the $F_{MSY\ proxy}$. No runs were available using the SARC Panel's suggested $F_{MSY\ proxy}$ of *F*40% = 0.20. The runs do, however, include recruitment resampling only for the period 1995-2009, as suggested by the Panel. Recruitment after 1995 was lower than the long-term average and it was agreed this formed a more credible basis for short-term projections. However, the most recent recruitment estimates (2010 and 2011) in the projections are the recent average rather than model year-class estimates and the later (2007-2009) estimates used in the projections will in any case be shrunk towards the long-term mean because the model has few composition data to fit them. The few projections shown during the SARC meeting did not include any confidence intervals or probabilistic information on falling below thresholds. The SAW WG did not consider any alternative states of nature in the projections. As the modeling presented at the SARC meeting (see ToR 4, above) did not allow exploration of alternative states of nature (e.g., exploring the impact of catch stream bias, variation in *M*, etc) it was not possible in the time available to define any alternative states of nature for projections. The SARC Panel recommends that the WG continue to extend and expand its projection analyses.

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 SARC Panel notes that the SAW WG did not explicitly address this part of the ToR. The Panel notes that the current level of *F* is well below reasonable estimates of $F_{MSYproxies}$ and below the assumed *M*. It is probable therefore that the stock is at low risk of experiencing overfishing at least in the short term. The SAW WG did not comment on whether assumed *M* could be too high but, based on longevity considerations and using standard methodology, the assumed value of 0.2 seems reasonable. The Panel notes that white hake is primarily a bycatch species in mixed-species fisheries and thus could be susceptible to overexploitation by those fisheries, depending on quota compatibility across stocks, technological interactions, and the efficacy of monitoring.

*ToR 8. Evaluate the validity of the current **stock** definition, taking into account what is known about migration among stock areas. Make a recommendation about whether there is a need to modify the current stock definition for future stock assessments.*

The SARC Panel agreed that the SAW WG addressed this ToR. The WG did not make an explicit recommendation or suggest a need to modify the current stock definition for assessment purposes. For the purposes of the 2013 assessment the SAW WG accepted the single stock definition of white hake in US waters. It reviewed available information relevant to white hake stock structure in US and Canadian waters and carefully examined fine spatial and temporal detail from the NEFSC surveys. The WG recognized that based on genetics studies in Canadian waters (Roy and Hurlburt 2012) there is evidence for population structure, but there is no genetics information for US waters. The WG noted that there are likely (at least) two reproductive groups within the defined assessment unit and probable mixing between sub-stock components The WG did not pursue investigations as data are limited and provide little basis for alternative assessment modeling approaches.

The SARC Panel agrees that, based on the information available, treating the white hake stock as a single unit is appropriate at this time.

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

The SAW WG reported that thirteen previous research recommendations from SARC 28 and SARC 33 were evaluated. Most had either been addressed or shown to be no longer relevant. Some had been carried forward. The WG listed eight

research recommendations for SAW/SARC 56, some of which were continuations:

*i) Further comparison of the SCAA and ASAP models. Perhaps institute a comparison using a simulated population and a common model configuration.*
*ii) Review of general SAW/SARC working group procedures which could for example include how new models are evaluated, the ability to modify models in real time, and policies for model testing prior to meetings using simulated data.*
*iii) Complete ageing of samples collected by the Observer Program, the shrimp survey and state surveys (ME/NH survey).*
*iv) Continue production ageing of NEFSC Survey samples.*
*v) Conduct sensitivity testing of the ASAP model using the shrimp and ME/NH survey indices.*
*vi) Further explore swept area biomass estimation for white hake.*
*vii) Develop improved calibration methods to adjust total fish length for fish with heads removed.*
*viii) Consider conducting cooperative research to collect intact fish from commercial gear.*

The SARC Panel noted that (i) and (ii) were general methods/process issues rather than specific to white hake. Recommendation (i) may in part overlap current international work on testing assessment methods using simulated data sets. The Panel supports (ii) as a general recommendation and notes that it could be extended also to consider standardized outputs and contents for SAW reports and SAW WG record keeping in line with Panel comments made on ToR 4, above).

The Panel supports recommendation (iii). The Panel views recommendation (iv) as routine and necessary work, rather than as “research”. Similarly, recommendation (v) is viewed as standard model exploration unless the intention is to examine the utility of the shrimp trawl and Maine/New Hampshire survey indices in the assessment process; such work (investigation of the value of information) is encouraged as a part of good research planning.

The Panel did not support recommendation (vi); it is unclear how swept area biomass indices would be useful in the white hake assessment and the recommended work is both difficult and expensive.

The Panel did not see value *per se* in extrapolating fish lengths from heads (*vii*) and thought the approach would be highly uncertain. However, the Panel recognized that collection of heads rather than bodies has the advantage of providing otoliths for ageing and, if such samples were collected, using them to

develop a length estimation procedure might be useful. The Panel considered recommendation (viii) on cooperative research as a way of collecting direct length measurements with associated otolith samples as a better approach than recommendation (vii). The Panel noted that recommendations (vii) and (viii) could be replaced by a single recommendation to investigate means of collecting improved biological samples from commercial fishing operations, leaving open options on cooperative research or modified observer programs. Some Panel members favored recommending research to better define the stock(s) of white hake in US waters, for example through genetics investigations similar to those in Canadian waters that have demonstrated complex stock structure.

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# 5. Appendices

:
*Task Order T37-05, final 7 January 2013*

## Statement of Work

**56th Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC): Benchmark stock assessments for Atlantic surfclam and White hake**

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

**BACKGROUND**

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

**SCOPE**

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

The purpose of this panel review meeting will be to provide an external peer review of stock assessments for Atlantic surfclam (*Spisula solidissima*)and white hake (*Urophycis tenuis*). Atlantic surfclam is a marine bivalve found along the US east coast. White hake is a demersal gadoid species found from Newfoundland to Southern New England, and common on muddy bottom throughout the Gulf of Maine. The last peer reviewed benchmark assessment of Atlantic surfclam was in 2009 as part of SARC 49. The last peer reviewed assessment of white hake took place in GARM III in 2008, followed by a more recent data update in early 2012.

## OBJECTIVES

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

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

**Requirements for the reviewers:** Three reviewers shall conduct an impartial and independent peer review of the Atlantic surfclam and white hake stock assessments, and this review should be in accordance with this SoW and stock assessment ToRs herein. The reviewers shall have working knowledge and recent experience in the application of modern fishery stock assessment models. Expertise should include statistical catch-at-age, state-space and index methods. Reviewers should also have experience in evaluating measures of model fit, identification, uncertainty, and forecasting. Reviewers should have experience in development of Biological Reference Points that includes an appreciation for the varying quality and quantity of data available to support estimation of Biological Reference Points. For surfclams, familiarity with dynamics of sessile

species and spatial management is desirable. For white hake, familiarity with gadid fish stocks would be desirable.

**PERIOD OF PERFORMANCE**

The period of performance begins on the award date, and the contractor shall complete the tasks and deliverables as specified in this statement of work. Each reviewer's duties shall not exceed a maximum of 16 days to complete all work tasks of the peer review described herein.

Not covered by the CIE, the SARC chair's duties should not exceed a maximum of 16 days (i.e., several days prior to the meeting for document review; the SARC meeting in Woods Hole; several days following the open meeting for SARC Summary Report preparation).

**PLACE OF PERFORMANCE AND TRAVEL**

Each reviewer shall conduct an independent peer review during the panel review meeting scheduled in Woods Hole, Massachusetts during February 19-22, 2013.

## STATEMENT OF TASKS

**Charge to SARC panel:** During the SARC meeting, the panel is to determine and write down whether each stock assessment Term of Reference (ToR) of the SAW (see **Annex 2**) was or was not completed successfully. To make this determination, panelists should consider whether the work provides a scientifically credible basis for developing fishery management advice. Criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable. **If alternative assessment models and model assumptions are presented, evaluate their strengths and weaknesses and then recommend which, if any, scientific approach should be adopted.** Where possible, the SARC chair shall identify or facilitate agreement among the reviewers for each stock assessment Term of Reference of the SAW.

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

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

**Tasks prior to the meeting:** The contractor shall independently select qualified reviewers that do not have conflicts of interest to conduct an independent scientific peer review in accordance with the tasks and ToRs within the SoW. Upon completion of the

independent reviewer selection by the contractor's technical team, the contractor shall provide the reviewer information (full name, title, affiliation, country, address, email, and FAX number) to the COR, who will forward this information to the NMFS Project Contact no later than the date specified in the Schedule of Milestones and Deliverables. The contractor shall be responsible for providing the SoW and stock assessment ToRs to each reviewer. The NMFS Project Contact will be responsible for providing the reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact will also be responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

Foreign National Security Clearance: The reviewers shall participate during a panel review meeting at a government facility, and the NMFS Project Contact will be responsible for obtaining the Foreign National Security Clearance approval for the reviewers who are non-US citizens. For this reason, the reviewers shall provide by FAX (not by email) the requested information (e.g., first and last name, contact information, gender, birth date, country of birth, country of citizenship, country of permanent residence, whether there is dual citizenship, passport number, country of passport) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/.

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

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

Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

(SARC chair)
Act as chairperson, where duties include control of the meeting, coordination of presentations and discussions, making sure all stock assessment Terms of Reference of the SAW are reviewed, control of document flow, and facilitation of discussion. For each assessment, review both the Assessment Report and the draft Assessment Summary Report. The draft Assessment Summary Report is reviewed to assure that it is consistent with the outcome of the peer review, particularly statements that address stock status and assessment uncertainty.

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

(SARC CIE reviewers)
For each stock assessment, participate as a peer reviewer in panel discussions on assessment validity, results, recommendations, and conclusions. 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. From a reviewer's point of view, determine whether each stock assessment Term of Reference of the SAW was completed successfully. Terms of Reference that are completed successfully are likely to serve as a basis for providing scientific advice to management. If a reviewer considers any existing Biological Reference Point or BRP proxy to be inappropriate, the reviewer should try to recommend an alternative, should one exist. Review both the Assessment Report and the draft Assessment Summary Report. The draft Assessment Summary Report is reviewed to assure that it is consistent with the outcome of the peer review, particularly statements that address stock status and assessment uncertainty.

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

**Tasks after the panel review meeting:**

SARC CIE reviewers:
Each CIE reviewer shall prepare an Independent CIE Report (see **Annex 1**). This report should explain whether each stock assessment Term of Reference of the SAW was or was not completed successfully during the SARC meeting, using the criteria specified above in the "Charge to SARC panel" statement. If alternative

assessment models and model assumptions were presented, evaluate their strengths and weaknesses and then recommend which, if any, scientific approach should be adopted.

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

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

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

SARC chair:
The SARC chair shall prepare a document summarizing the background of the work to be conducted as part of the SARC process and summarizing whether the process was adequate to complete the stock assessment Terms of Reference of the SAW. If appropriate, the chair will include suggestions on how to improve the process. This document will constitute the introduction to the SARC Summary Report (see **Annex 4**).

SARC chair and CIE reviewers:
The SARC Chair, with the assistance from the CIE reviewers, will prepare the SARC Summary Report. Each CIE reviewer and the chair will discuss whether they hold similar views on each stock assessment Term of Reference and whether their opinions can be summarized into a single conclusion for all or only for some of the Terms of Reference of the SAW. For terms where a similar view can be reached, the SARC Summary Report will contain a summary of such opinions. In cases where multiple and/or differing views exist on a given Term of Reference, the SARC Summary Report will note that there is no agreement and will specify - in a summary manner – what the different opinions are and the reason(s) for the difference in opinions.

The chair's objective during this SARC Summary Report development process will be to identify or facilitate the finding of an agreement rather than forcing the panel to reach an agreement. The chair will take the lead in editing and completing this report. The chair may express the chair's opinion on each Term of Reference of the SAW, either as part of the group opinion, or as a separate minority opinion.

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

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

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

## DELIVERY

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

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

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate during the panel review meeting at the Woods Hole, Massachusetts during February 19-22, 2013.
3) Conduct an independent peer review in accordance with this SoW and the assessment ToRs (listed in **Annex 2**).
4) No later than March 8, 2013, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to Dr. David Die ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each assessment ToR in **Annex 2**.

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

| | |
|---|---|
| January 15, 2013 | Contractor sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact |
| February 5, 2013 | NMFS Project Contact will attempt to provide reviewers the pre-review documents |
| February 19-22, 2013 | Each reviewer participates and conducts an independent peer review during the panel review meeting in Woods Hole, MA |
| February 22, 2013 | SARC Chair and CIE reviewers work at drafting reports during meeting at Woods Hole, MA, USA |
| March 8, 2013 | Reviewers submit draft independent peer review reports to the contractor's technical team for independent review |
| March 8, 2013 | Draft of SARC Summary Report, reviewed by all CIE reviewers, due to the SARC Chair * |
| March 15, 2013 | SARC Chair sends Final SARC Summary Report, approved by CIE reviewers, to NEFSC contact (i.e., SAW Chairman) |
| March 22, 2013 | Contractor submits independent peer review reports to the COR who reviews for compliance with the contract requirements |
| March 29, 2013 | The COR distributes the final reports to the NMFS Project Contact and regional Center Director |

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

The SAW Chairman will assist the SARC chair prior to, during, and after the meeting in ensuring that documents are distributed in a timely fashion.

NEFSC staff and the SAW Chairman will make the final SARC Summary Report available to the public. Staff and the SAW Chairman will also be responsible for production and publication of the collective Working Group papers, which will serve as a SAW Assessment Report.

**Modifications to the Statement of Work:** Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any

permanent substitutions. The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on substitutions. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

**Acceptance of Deliverables:** The deliverables shall be the final peer review report from each reviewer that satisfies the requirements and terms of reference of this SoW. The contract shall be successfully completed upon the acceptance of the contract deliverables by the COR based on three performance standards:

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

Upon the acceptance of each independent peer review report by the COR, the reports will be distributed to the NMFS Project Contact and pertinent NMFS science director, at which time the reports will be made publicly available through the government's website. The contractor shall send the final reports in PDF format to the COR, designated to be William Michaels, via email William.Michaels@noaa.gov

**Support Personnel:**

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

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

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

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

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

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

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

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

3. The reviewer report shall include the following appendices:

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

# Annex 2: 56th SAW/SARC Stock Assessment Terms of Reference

## A. Atlantic surfclam

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

2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, relevant cooperative research, etc.). Investigate the utility of commercial LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data.

3. Evaluate the current **stock** definition in terms of spatial patterns in biological characteristics, population dynamics, fishery patterns, the new cooperative survey, utility of biological reference points, etc. If appropriate, recommend one or more alternative stock definitions, based on technical grounds. Integrate these results into TOR-4.

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

5. State the existing **stock status** definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for $B_{MSY}$, $B_{THRESHOLD}$, $F_{MSY}$ and MSY) and provide estimates of their uncertainty. This should be carried out using the existing stock definition and, if possible, for the recommended "alternative" stock definitions from TOR-3. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the appropriateness of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

6. Evaluate stock status with respect to the existing assessment model and with respect to any new assessment model. Determine stock status based on the existing stock definition and, if appropriate and if time permits, for "alternative" stock definitions from TOR-3.
   a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.
   b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).
   d. Provide numerical annual projections (3-5 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important

uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).

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

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

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

## B. White hake

1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of fishing effort. Characterize the uncertainty in these sources of data. Analyze and correct for any species mis-identification in these data. Comment on the consistency of the approach to identify the catch of white hake with respect to that used in the red hake assessment.

2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Investigate the utility of commercial or recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data.

3. Evaluate the utility of pooled age-length keys for development of a stock assessment model.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, recruitment, catch and fishing mortality.

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

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

   a. If possible update the ASPM with new data and evaluate stock status (overfished and overfishing) with respect to the relevant BRP estimates.

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

7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., the probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).
    d. Provide numerical annual projections (3-5 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).
    e. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.
    f. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

8. Evaluate the validity of the current **stock** definition, taking into account what is known about migration among stock areas. Make a recommendation about whether there is a need to modify the current stock definition for future stock assessments.

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

## Annex 2 (cont.):

### *Appendix to the Assessment TORs:*

**Explanation of "Acceptable Biological Catch"** (DOC Natl. Standard Guidelines, Fed. Reg., vol. 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)

**Explanation of "Vulnerability"** (DOC Natl. Standard Guidelines, Fed. Reg., vol. 74, no. 11, 1/16/2009):

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

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

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

# Annex 3: Meeting Agenda

56th Northeast Regional Stock
Assessment Workshop (SAW 56)
Stock Assessment Review Committee (SARC) Meeting

February 19-22, 2013

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

AGENDA* (version: 15 Feb. 2013)

| TOPIC | PRESENTER(S) | SARC LEADER | RAPPORTEUR |
|---|---|---|---|
| **Tuesday, Feb. 19** | | | |
| 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. Atlantic Surfclam) | | |
| | Daniel Hennen/Larry Jacobson | TBD | Toni Chute |
| 12:30 – 1:30 PM | Lunch | | |
| 1:30 – 3:30 PM | Assesssment Presentation (A. Atlantic Surfclam) | | |
| | Larry Jacobson/ TBD (Others) | TBD | John Deroba |
| 3:30 – 3:45 PM | Break | | |
| 3:45 – 4 PM | Public Comments | | |
| 4 - 6 PM | SARC Discussion w/ Presenters (A. Atlantic Surfclam) | | |
| | Edward Houde, SARC Chair | | Jon Deroba |
| **Wednesday, Feb. 20** | | | |
| 9 – 10:45 AM | Assessment Presentation (B. White Hake) | | |
| | Katherine Sosebee | TBD | Kiersten Curti |

| | | | |
|---|---|---|---|
| 10:45 – 11 AM | Break | | |
| 11 – 12:30 PM | (cont.) Assessment Presentation (B. White Hake) | | |
| | Katherine Sosebee | TBD | Kiersten Curti |
| 12:30 – 1:45 PM | Lunch | | |
| 1:45 – 2 PM | Public Comments | | |
| 2 – 3:30 PM | SARC Discussion w/presenters (B. White Hake) | | |
| | Edward Houde, SARC Chair | | Alicia Miller |
| 3:30 -3:45 PM | Break | | |
| 3:45 – 6 PM | Revisit with presenters (A. Atlantic Surfclam) | | |
| | Edward Houde, SARC Chair | | Alicia Miller |
| 7 PM | (Social Gathering – Coonamessett Inn) | | |

**Thursday, Feb. 21**

| | | |
|---|---|---|
| 8:30 – 10:15 | Revisit with presenter (B. White hake) | |
| | Edward Houde, SARC Chair | Michelle Traver |
| 10:15 – 10:30 | Break | |
| 10:30 – 12:45 | Review/edit Assessment Summary Report (B. White hake) | |
| | Edward Houde, SARC Chair | Michelle Traver |
| 12:45 – 2 PM | Lunch | |
| 2 – 2:45 PM | (cont.) edit Assessment Summary Report (B. White hake ) | |
| | Edward Houde, SARC Chair | Julie Nieland |
| 2:45 – 3:00 PM | Break | |
| 3:00 – 6:00 PM | Review/edit Assessment Summary Report (A. Surfclam) | |
| | Edward Houde, SARC Chair | Julie Nieland |

**Friday, Feb. 22**

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

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

## Annex 4: Contents of SARC Summary Report

1.

The main body of the report shall consist of an introduction prepared by the SARC chair that will include the background, a review of activities and comments on the appropriateness of the process in reaching the goals of the SARC. Following the introduction, for each assessment reviewed, the report should address whether each Term of Reference of the SAW Working Group was completed successfully. For each Term of Reference, the SARC Summary Report should state why that Term of Reference was or was not completed successfully.

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

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

2.

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

3.

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

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