

55th Northeast Regional Stock Assessment Review Committee

December 3 – December 7, 2012

Northeast Fisheries Science Center

Woods Hole, MA

SARC 55

Report from Center of Independent Experts (CIE) reviewer

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1. Executive summary

1.1 Georges Bank Cod

Two variants of the stock assessment were presented, one assuming a natural mortality M of 0.2 at all ages in all years., the second assuming a ‘ramping’ of M through the intermediate years of the time series to a higher averaged level of 0.4 at all ages in the recent years. The second model exhibited less retrospective bias and there was some circumstantial data that could be seen as pointers to changes in natural mortality but the evidence was inconclusive. The panel considered bias correction using Mohn’s Rho on the model with constant M would correct the bias without giving unmerited credence to a change in M over time. The panel was keen to stress however that the decision did not indicate it believed an unchanging M was certain. Instead it considers further research in this area (e.g. telemetry tagging studies and research into poor condition factor in spring) to be very relevant to this stock. The assessment assuming $M = 0.2$ and with bias correction was accepted.

Reference points were set on the assumption of $M = 0.2$ at all ages. The reasoning was that even if there had been a change in M in recent times there was little evidence of a permanent regime shift so the long term equilibrium should reflect circumstances for the majority of the historical time series. No stock-recruit relationship has been identified for this stock and so a proxy F_{msy} is used. It was not clear to the panel on what basis the F_{msy} proxy value of $F_{40\%SPR}$ was chosen but equally it had no basis on which to change the value.

1.2 Gulf of Maine Cod

Two models were presented, the Age Structured Assessment Program (ASAP) and statistical catch-at-age (SCAA) models. These models differed primarily in the period of historical data used by the models, (the ASAP model used data from 1982 while the SCAA model used landings at age data from the 1970s and catch weight data back to 1932). Related to this, the SCAA model was presented with stock-recruit models derived from the data; the ASAP model however was presented without a stock-recruit relationship.

The panel concluded it was unable to accept the SCAA model variants because of uncertainty over the stock-recruit relationships used. The relationships derived were both strongly influenced by the landings data from the 1970s. This indicated a period of high stock size and low recruitment during the 1960s but, because there were no similar data points from other periods, the panel was left unsure whether they were the result of a stock-recruit relationship or environmental drivers unique to that period. A desk study to throw more light on this issue is recommended.

The ASAP models (base version with $M=0.2$ at all ages and in all years and the M_{ramp} version) did not have a retrospective bias and results for the state of the stock in the final year (2011) were very similar. By the conclusion of the panel meetings the SARC panel could see no objective way to decide in favor of either version. In addition the short term projections resulting from the two models differed sufficiently in their catch totals and SSB results for 2013 that the choice between versions was not seen as

inconsequential. In conclusion the panel felt the only course of action open to it was to put forward both versions to the Scientific and Statistical Committee.

Using the same reasoning as for Georges Bank cod, reference points were set on the assumption of $M = 0.2$ at all ages. Again an Fmsy proxy value of $F_{40\%SPR}$ was accepted.

1.3 Process and procedure

Two assessments seem to be seen as the appropriate number for a SARC group to review. When a stock has more than one model and/or more than one version of a model put forward for review this does increase the workload for the panel. If working groups are unable to conclude on one (or two) alternatives and the SARC panel is expected to decide between five or more alternative assessments, it might be necessary to consider whether four to five days of panel meetings will be sufficient to work through the alternatives.

2. Background

The 55th Stock Assessment Review Committee (SARC 55) was convened to review the stock assessments performed for Gulf of Maine cod (GOM cod) and Georges Bank cod (GB cod) at the Northeast Fisheries Science Center (NEFSC), Woods Hole, MA, from December 3rd – December 7th, 2012. Apart from closed sessions in the early and latter part of the last day, the meetings were open to the public and also made available via a conference call. The stocks presented were adjacent cod stocks now both assessed by a common assessment model (Age Structured Assessment Program or ASAP) and there were obvious synergies in having both reviewed in the same meeting. The GOM cod stock had also been assessed using the statistical catch-at-age (SCAA) model. All models had alternative assessment runs brought forward to the SARC review, contrasting results when natural mortality was assumed constant through time and when it was assumed to have increased over time to a new higher level. The results put forward using the SCAA model also differed from the ASAP model in using stock-recruit relationships derived through use of landings data that predated the start of the data time series used by the ASAP models.

3. Individual Reviewer Activities

19-23 November 2012: reading background documents including SAW55 Working Group Reports.

26-30 November 2012: reading GOM cod and (once available on 27 November) GB cod reports.

2 December 2012: Travel to Falmouth.

3 December 2012: Together with SARC chair and the other CIE reviewers attended a pre-meeting with J. Weinberg and P. Rago (NEFSC) to discuss meeting logistics.

3-7 December 2012: Panel meetings, held in the Steven H. Clark conference room, Northeast Fisheries Science Centre. The meeting opened at 13:00 on 3 December and closed to the public at approximately 16:30 on 7 December. During the meeting I asked questions of clarification and contributed to discussions. A feature of the SARC 55 assessments was that rather than a single assessment being presented for each stock two or more alternatives were put forward. I provided my opinions on whether and how an individual assessment (or reduced set of assessments) could be chosen for the basis of advice (for details see below).

In the closed sessions of 7 December (08:30-10:00 and 16:30-20:00) panelists provided their views to the chair on the various items in the statement of work.

9-10 December: Return travel to Scotland.

15-21 December: Provided further contributions to the draft consensus report.

21 December: Submission of my draft individual reviewer report.

4. Georges Bank Cod Review

TOR 1. Estimate catch from all sources including landings and discards. Characterize the uncertainty in these sources of data and take into account the recommendations and subsequent work from the March 2012 MRIP workshop. Evaluate available information on discard mortality and, if appropriate, update mortality rates applied to discard components of the catch.

This term of reference was addressed adequately for the purposes of the assessment.

The quality of the catch data and the improvement of that quality over time was clearly conveyed. One concern is the use of the new discard mortality rates derived from the Delphi method. Discard mortality rates are very uncertain and it seems precautionary, but not overly precautionary, to assume 100% discard mortality. There was, however, no indication from the analysts that the new discard mortality rates had affected the retrospective pattern of the assessment, unlike for GOM cod (see below).

TOR 2. Present the survey data and calibration information being used in the assessment (e.g., indices of abundance, recruitment, state surveys, age-length data, etc.). Consider model-based (e.g. GLM) as well as design-based analyses of the survey data in developing trends in relative abundance. 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.

This term of reference was addressed adequately for the purposes of the assessment.

The model-based analyses of the survey data were presented but mainly in the presentations to the SARC panel and little was said about them in the assessment report. However, the view of the analysts, that to use the model-based indices in the assessment would lead to a double smoothing of the values

and that to best reflect uncertainty in the survey data the design-based indices should be used, is accepted.

The reasons for not using the commercial LPUE index are accepted, i.e. lack of Canadian data (approx 25% of landings), significant regulatory changes since 1994 and spatial shifts in the Fishery due to these and implementation of sector management since May 2010.

The reasons for not using the recreational LPUE index in the report are accepted, i.e. uncertainty over the unit of measurement in the early years, restricted geographical coverage of the sector and only a small number of vessels that have contributed to the time series consistently.

It would have been good to see scatter plots of logged survey indices and line plots of standardized survey numbers by age as demonstrated by one of the SARC 53 review panelists with respect to GOM cod. These do give a quick visual means to assess the ability of surveys to track cohorts.

TOR 3. Summarize the findings of recent workshops on stock structure of cod of the Northeastern US and Atlantic Canada.

This term of reference was addressed adequately.

The presentation of the workshop was thorough. However, this is an area where more research would be appropriate and indeed it was stated to the SARC 55 that work investigating stock structure is ongoing. Suggestions for possible investigations are

- Producing geospatial smoothes of the survey CPUE values to confirm (or refute) consistent segregation of GOM and GB cod concentrations at time of spawning.
- Investigate evidence for asynchrony between the GOM and GB areas through use of a pairwise test, after Holmes et al. (2008). That is SSB and recruitment indices can be log-transformed and the resultant trends for the different areas compared by fitting a GAM to the ratio between them. The resulting smoother is then compared to a constant fit of this ratio by a standard F-test. Investigation of sub-stock (metapopulation) structure can be tested by forming indices for each putative sub-population, applying a smoother to all indices and comparing to a model in which the smoothers were constrained to be parallel.

TOR 4. Investigate the evidence for natural mortality rates which are time- and/or age-specific. If appropriate, integrate these into the stock assessment (TOR 5).

This term of reference was addressed adequately for the purposes of the assessment, however a number of areas of further work seemed apparent.

An explanation for the decrease through time of the condition index in spring may be relevant to this question. Has the reduction in spring condition been enough to affect survivorship? There is also clear evidence for a reduction over time in mean weight at age in this stock. If the cause can be identified it may shed light on possible mechanisms for a change in natural mortality, or other factors affecting stock health, such as the stock-recruit relationship (through poorer condition fish producing less viable eggs).

TOR 5. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Consider feasibility of survey catchability estimates, the starting year for the assessment, estimation of the stock recruitment curve, inclusion of multiple fleets, and whether to use domed or flat selectivity-at-age for the NEFSC surveys. Provide a summary of steps in the model building process. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, catch recruitment and fishing mortality.

This term of reference was addressed adequately for the purposes of the assessment.

The steps from the previous ADAPT model, through a VPA-like ASAP model, to adoption and specification of the base and Mramp ASAP models were well described, the rationale for the selection of flat topped selectivity curves for the surveys and fishery was clear and it is accepted that a reliable stock-recruitment curve could not be estimated because of a lack of contrast in the SSB and recruitment data.

The retrospective analysis figures for the base and Mramp runs were very useful because they show that the Mramp model formulation has produced considerable retrospective patterning, although the Mohn's rho values for the Mramp run are that much lower than for the base run. Given the end points in the runs to 2009 and 2010 in the Mramp version it is questionable whether even a version employing the bias correction suggested would have handled the retrospective issue.

The panel considered bias correction using Mohn's Rho on the model with constant M would correct the bias without giving unmerited credence to a change in M over time. The panel was keen to stress however that the decision did not indicate it believed an unchanging M was certain.

TOR 6. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, F_{MSY} , and MSY) and provide estimates of their uncertainty. Consider alternative parametric models of the stock recruitment relationship. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the appropriateness of existing BRPs and any "new" (i.e., updated, redefined, or alternative) BRPs.

The ToR was met, however the existing definitions for "overfished" and "overfishing" are not stated in the executive summary under ToR 6 which would be useful.

The panel accepted that parametric stock recruitment relationships could not be obtained for this stock but no scatter plot of the stock-recruit relationship is included in the report. This together with the parametric fits normally associated with cod (Ricker and Beverton – Holt) should be included given the decision to use non-parametric biological reference points is an important one.

Reference points were calculated for F40%SPR as the basis for stock determination. The basis for choosing a given F%SPR is not entirely clear but equally there were no compelling reasons to change

to another F%SPR value.

TOR 7. Evaluate stock status with respect to the existing model (from the most recent accepted peer reviewed assessment) and with respect to a new model developed for this peer review. In both cases, evaluate whether the stock is rebuilt.

- 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 (from Cod TOR-6).**

The ToR was met. Whether based on the old assessment model, or the new assessment model, inclusion of the latest data lead to the conclusion the stock is overfished and undergoing overfishing.

TOR 8. Develop and apply analytical approaches to conduct single and multi-year stock projections to compute the pdf (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.**
- c. Describe this stock’s vulnerability (see “Appendix to the SAW TORs”) to becoming overfished, and how this could affect the choice of ABC.**

ToRa was partially met. Stochastic projections were provided based on the final accepted model fit and the new reference points provided under ToR 6. Only projection medians were provided and the annual probabilities of exceeding threshold BRPs for F and probabilities of falling below threshold BRPs for biomass were not provided.

ToRb was addressed through considering projections where $M = 0.2$ both short and long term, $M = 0.2$ in the long term but 0.4 in the short term and $M = 0.4$ both short and long term. The panel concluded that in the long term M should be 0.2 because the long term equilibrium should reflect circumstances for the majority of the historical time series. The projection based on $M = 0.2$ was chosen by the panel on the basis it was not certain the retrospective bias seen in the assessment in recent years could be attributed to a higher M ; a projection based on $M = 0.2$ and with starting values from the bias corrected base ASAP model would account for the bias without a need to accept that higher M values represented the true state of nature, and this approach could also accommodate a different, as yet unidentified and transitory effect.

ToRc was met. A description of vulnerability issues, including current truncated age structure, evidence for low hatching rate for first and second time spawners and the two decades of poor

recruitment for this stock was included in the assessment report. The considerations are in this case the vulnerability to continued overfishing as the stock is currently considered overfished.

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

There were three previous research recommendations (from GARM III) for Georges Bank cod. One was dealt with directly, for the second one the working group exploited synergies between the Georges Bank and GOM cod assessments and for the third the working group cites a NOAA funded project.

- Continued exploration of retrospective pattern and methods to account for it.

This was addressed through exploration of the Mramp version of the ASAP model and also one employing a catch multiplier.

- Historical data be used to hindcast recruitment estimates as far back in time as possible for use in the estimation of reference points and projections.

The working group did not conduct the hindcasting citing the results and conclusions of the GOM cod assessment (ASAP model) and the perceived quality of Georges Bank catch data prior to 1978. If two of the recommendations for new research from the working group (last two recommendations below) are completed it would seem relevant to re-visit the hindcasting idea.

- Investigate the effect of uncertainty in maturity at age in the estimation of SSBmsy. Research into incorporating trends in biological parameters (weights, maturity) into projection methodology.

The working group cite the NOAA funded FATE (Fisheries and the Environment) proposal as attempting to address this area of research.

The research recommendations of the SAW 55 working group were as follows (those marked 'general' were recommendations that also applied to GOM cod):

- To further address the retrospective issue
 - Conduct 'forensic accounting' analysis of 'missing catch' i.e. lost/unreported VTRs, lost/unreported dealer data, underestimated discards.
 - 100% observer coverage (for 3-5 years) of the fisheries that either target GB cod or have cod as bycatch to ascertain potential underestimation of GB cod discards.
 - Conduct a designed discard mortality study of cod that pass through the trawl via trouser trawl experiment, including blood analysis to determine stress levels compared to control group. [general]

These are all good recommendations. Whether 100% observer coverage is financially possible is a question for budget holders.

- Inclusion of the tagging analysis formally within the stock assessment model. [general]

This line of research is described as a longer term project and it would seem there are more pressing issues to address for both the Georges Bank and GOM cod assessments.

- Explore the appropriate weighting of the proportions at age data (constant versus age specific). [general]

Differences in proportions at age could have a significant impact on estimates of total mortality and it is therefore important to ensure the best means possible are being used for their calculation.

- Incorporating the Bigelow/Albatross calibration coefficients within the assessment model so that coefficients can be re-estimated as data on year-classes are updated. [general]

As such calibration coefficients tend to be very uncertain it seems sensible to maximise the amount of data available for their estimation.

- Exploration of a random errors approach to the internal fitting of stock – recruitment relationships. [general]
- Simulations (conditioned on data) of the internal estimation of stock - recruitment functions to explore potential bias in the fitting of these relationships. [general]

Given the lack of an accepted parametric stock-recruit relationship and the debate over use of older catch data to help define such a relationship, this line of research would be very valuable.

In addition to the above it is recommended to:

- Re-visit the stomach data available to NEFSC to see if it contains enough information to explain
 1. The drop in spring condition over time.
 2. The reduction in mean weights at age over time.
 The data were used to consider predation on cod (in addressing ToR 4) but may contain evidence to help explain the above outcomes as well. Comparison between stomach data taken from Georges Bank and GOM cod could help with ongoing work into defining stock structure (dependent on the geographic uniqueness of prey items) and may point to factors that make one or other stock more vulnerable to changes in environmental factors such as water temperatures.
- Provide analyses on whether there have been changes in the location and quality of preferred habitat for cod on Georges Bank. If evidence is found, to then consider the implications for straying (i.e. inter-stock mixing), M and spawning potential.
- Conduct telemetry tagging studies to obtain estimates of M.

5. Gulf of Maine Cod Review

TOR1: Estimate catch from all sources including landings and discards. Characterize the uncertainty in these sources of data and take into account the recommendations and subsequent work from the March 2012 MRIP workshop. Evaluate available information on discard mortality and, if appropriate, update mortality rates applied to discard components of the catch.

This term of reference was addressed adequately for the purposes of the assessment.

The detail of reporting was exceptionally good.

One concern is the use of the new discard mortality rates derived from the Delphi method. During the GOM cod presentation the use of the new discard mortality rates were shown to lead to a greater retrospective pattern than when assuming 100% discard mortality rate. Discard mortality rates are very uncertain and it seems precautionary, but not overly precautionary, to assume 100% discard mortality.

TOR 2: Present the survey data and calibration information being used in the assessment (e.g., indices of abundance, recruitment, state surveys, age-length data, etc.). Consider model-based (e.g. GLM) as well as design-based analyses of the survey data in developing trends in relative abundance. 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.

This term of reference was addressed adequately for the purposes of the assessment.

Again the detail of reporting was very good. The explanation for the results seen in the commercial CPUE indices was very well presented. It is accepted that the commercial CPUE indices are the result of targeting a concentration of fish that has contracted geographically and can not be used to represent changes in abundance for the stock over the wider area.

Scatter plots of logged survey indices allowing a quick visual means to assess the ability of surveys to track cohorts was appreciated.

The MADMF inshore survey clearly has a higher catchability of fish at age 1 (and in the fall fish at age 0) than the NEFSC bottom trawl survey. Younger fish concentrating in more inshore waters is seen elsewhere (e.g. west of Scotland). If the data from these surveys could be combined it would give a more complete picture of the varying abundance of the stock throughout its age range.

The reasons for not using the recreational LPUE index in the report are accepted, i.e. regulation changes, availability of landings data only, restricted geographical coverage of the sector and only a small number of vessels that have contributed to the time series consistently.

TOR 3: Summarize the findings of recent workshops on stock structure of cod of the Northeastern US and Atlantic Canada.

This term of reference was addressed adequately. For further comments see under ToR 3 for Georges Bank cod for the same comments apply equally to both assessments.

TOR 4: Investigate the evidence for natural mortality rates which are time- and/or age-specific. If appropriate, integrate these into the stock assessment (TOR 5).

This term of reference was addressed adequately for the purposes of the assessment.

The information provided on M was based on tagging, life history information and from total mortality from the survey catch curve analysis. The evidence was inconclusive and the results of the tagging study relied on assumptions about tag return rates from fishers and tagging induced mortality rates, both of which were contentious. With the evidence available the review panel was unable to reach a decision on

whether M has remained constant or varied with time. Therefore both the base and Mramp versions of the ASAP model were brought forward to consider short term projections.

Research into evidence (or the lack thereof) for environmental drivers that might affect mortality rates (additionally spawning potential and/or recruitment) is recommended.

TOR 5: Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Consider feasibility of survey catchability estimates, the starting year for the assessment, estimation of the stock recruitment curve, inclusion of multiple fleets, and whether to use domed or flat selectivity-at-age for the NEFSC surveys. Provide a summary of steps in the model building process. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, catch recruitment and fishing mortality.

This term of reference was addressed adequately for the purposes of the assessment.

The explanation of the steps made in the transition from the SAW 53 assessment to the current ASAP assessment was very clear from a presentation made to the review panel. The design of the SCAA model was also clearly documented and the outcomes leading to the choice of assumptions input to the final SCAA model submitted to the review panel well presented. Historical retrospective analysis was presented and clearly documented as were historical projections. The inclusion or exclusion of different survey series was clearly explained.

Unfortunately the working group had been unable to form a consensus over various aspects of this ToR. Analysts using the ASAP model were unwilling to consider data prior to 1982 because of concerns over data quality whereas analysts using the SCAA model believed the benefits of using older data outweighed the risks. This difference in approach also led to the ASAP model variants being presented without a stock-recruit relationship but the SCAA model variants being offered with Ricker and Beverton-Holt stock-recruit relationships (with the Ricker relationship as the preferred choice). In the end the SCAA model results were rejected because of concerns over both stock recruit relationships. The stock-recruit relationship obtained from both the ASAP and SCAA models using the longer time series of data indicated a period of high stock size and low recruitment during the 1960s but, because there were no similar data points from other periods, the panel was left unsure to whether they were the result of a stock-recruit relationship or environmental drivers unique to that period.

Because the results from work under ToR 4 were not conclusive, two variants of the ASAP model remained, a 'base' version with $M = 0.2$ at all ages in all years and an Mramp version where the M value increases from 0.2 to 0.4 by 2003 before staying at this higher value. On the evidence presented to the review panel the panel was unable to choose one of these two versions in preference to the other.

TOR 6: State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, F_{MSY} , and MSY) and provide estimates of their uncertainty. Consider alternative parametric models of the stock recruitment relationship. If analytic model-based estimates are unavailable, consider

recommending alternative measurable proxies for BRPs. Comment on the appropriateness of existing BRPs and any “new” (i.e., updated, redefined, or alternative) BRPs.

The ToR was met.

The panel accepted that parametric stock recruitment relationships could not be obtained for this stock (see under ToR 5 above).

Reference points were calculated for F40%SPR as the basis for stock determination. The basis for choosing a given F%SPR is not entirely clear but equally there were no compelling reasons to change to another F%SPR value.

The decision by the panel to progress both the base ASAP and Mramp ASAP models lead to two Bmsy and MSY values. The Fmsy value remained the same in both cases.

TOR 7: Evaluate stock status with respect to the existing model (from the most recent accepted peer reviewed assessment) and with respect to a new model developed for this peer review. In both cases, evaluate whether the stock is rebuilt. 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 (from Cod TOR-6).

The ToR was met. Based on the previous reference points, the previous assessment indicated that the Gulf of Maine cod stock was overfished and overfishing was occurring. Based on the reference points derived from the two new models, the new assessments indicate that the Gulf of Maine cod stock is still assessed to be overfished and overfishing is occurring.

TOR 8: Develop and apply analytical approaches to conduct single and multi-year stock projections to compute the pdf (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.**
- c. **Describe this stock’s vulnerability (see “Appendix to the SAW TORs”) to becoming overfished, and how this could affect the choice of ABC.**

ToRa was partially met. Stochastic projections were provided based on the final accepted model fit and the new reference points provided under ToR 6. Only projection medians were provided and the annual probabilities of exceeding threshold BRPs for F and probabilities of falling below threshold BRPs for biomass were not provided.

ToRb was addressed through considering projections where $M = 0.2$ both short and long term, $M = 0.2$

in the long term but 0.4 short term and $M = 0.4$ both short and long term. The panel concluded that in the long term M should be 0.2 because the long term equilibrium should reflect circumstances for the majority of the historical time series. With the evidence presented to them the panel concluded both the projection based on $M = 0.2$ and that based on $M = 0.4$ in the short term were equally likely.

For ToRc there was a convincing explanation of how the stock has contracted geographically and is easily found and targeted. The most recent survey indices are at or near the lowest values in their time series and recruitment indices from the surveys have been below average for some time. As stated in the assessment summary report, if weak recruitment and low reproductive rates of Gulf of Maine cod continue, productivity and rebuilding of the stock will be less than projected. The considerations are in this case the vulnerability to continued overfishing as the stock is currently considered overfished.

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

There was one previous research recommendations (from GARM III) for GOM cod.

- That historical data be used to hindcast recruitments as far back in time as possible for use in the estimation of reference points and projections.

This had been explored extensively using both the ASAP and SCAA models. A lack of consensus over whether the hindcast values were fit for purpose and enabled valid reference points to be established caused the most fundamental differences between the ASAP and SCAA models recommended to the review panel.

Nine research recommendations were brought forward from SARC 53 of which six were either partially or fully addressed.

- Examine historical and contemporary estimates of cod catch in the lobster fishery. No information was available for evaluation during the SAW 55 working group but work is ongoing and the WG recommended that this research recommendation be carried forward.
- Consider the inclusion of the inshore strata data when switching to the Bigelow survey time series. The SAW 55 working group concluded these inshore strata should be excluded based on analysis indicating that their inclusion had minimal influence on the trends in both survey indices. Figure A90 of the report demonstrates this.
- Consider the incorporation of the Maine/New Hampshire Inshore Trawl (ME/NH) Survey. Ageing of the survey samples is still ongoing.
- Compare maturity ogives from the ME/NH and NEFSC surveys. ME/NH survey maturity information were presented at the SAW 55 data meeting and summarized in the assessment report. It showed fish captured in the ME/NH tend to mature at a smaller size relative to those captured in the NEFSC survey.

- Examine the reproductive information collected from the ME/NH survey for the early years to see if it could suggest the presence of a spawning aggregation.

This data was summarized in the assessment report. It does suggest the possibility of spawning aggregations at both the southern and northern extents of the survey.

- Examine the impacts of excluding the Commercial LPUE index from the assessment.

This workstream was investigated under ToR 2 and a presentation given to the review panel clearly indicated how the fishing effort and cod abundance since the mid-2000s has become concentrated on the Stellwagen Bank area. Because of this concern and that over the effect of regulatory changes (seasonal closures, trip limits, etc), the decision by the working group to not use the Commercial LPUE index in the assessment is accepted.

- Re-assess stock definition.

Research on this subject was presented under ToR3 and is ongoing. Recommendations for possible future work in this area have been included under ToR 3 for Georges Bank cod.

- Evaluate the level, schedule and variability of natural mortality.

This was considered and reported on under TOR 4 and lead to the two versions of the ASAP model with differing assumptions on M being taken forward to advice. Clearly more work to allow selection of a single model in this respect is needed. Recommendations are for analysis on changes in the location and quality of preferred environment and habitats for cod (and the potential implications on M) and telemetry tagging programs.

- Study of the behaviour of fishers in response to changes in the distribution of the stock and to changes in management.

It was the study of the contraction of GOM cod onto sand lance grounds (Stellwagen Bank area) and the response of fishers to concentrate on the same area that lead to the rejection of the commercial LPUE indices for use in the assessment.

The research recommendations of the SAW 55 working group were as follows (those common between GOM and Georges Bank cod were commented on under the Georges Bank cod section)

- Reconsider historical tagging data using modern analytical methods similar to that in Miller (2012) to allow comparisons of the estimates of natural and fishing mortality.

This would seem a very sensible avenue of research given the continued uncertainty about natural mortality levels.

- Studies which incorporate electronic tags and acoustic arrays to confirm or refine currently used estimates of discard mortality/survival (i.e. post capture mortality), particularly in the recreational fishery.

This was assigned a low priority by the working group but if the level of discard mortalities assumed are affecting the retrospective pattern of the assessment it would seem a worthwhile course of research.

- Studies to provide information on the natural mortality of cod and inferred temporal trends. Specifically, predator population estimates (i.e. pinnipeds) specific to Gulf of Maine/Georges Bank and focused stomach collection and analyses of fish and other predators to evaluate whether or not natural mortality may have changed.

This is highly recommended given that the review panel was unable to rule out an assessment assuming an increased rate of M in recent years, but equally that the evidence for a raised M value was inconclusive.

In addition to the working group recommendations it is recommended to:

- Conduct a desk study to throw more light on the issue of whether the data points of high stock size and low recruitment during the 1960s are evidence of a density dependent stock-recruit relationship or environmental drivers. A collection of abstracts was made available to the panel review and could be used as the starting point for the desk study.
- As for Georges Bank cod, provide analyses on whether there have been changes in the location and quality of preferred habitat for cod in the Gulf of Maine. If evidence is found to consider the implications for straying (i.e. inter-stock mixing), M and spawning potential.
- Conduct telemetry tagging studies to obtain estimates of M .

6. Conclusions

6.1 Assessments

The assessment for Georges Bank cod was carried out to a high standard. The conclusion that the stock is overfished is robust to alternative interpretations of the data so long as it is accepted natural mortality is likely to equal 0.2 on average over the longer term. The conclusion the stock is undergoing overfishing is also robust. These conclusions are strengthened on acceptance bias correction of the assessment is necessary. As stated above the choice of the base ASAP model with bias correction is seen as a way to correct for a retrospective bias without giving undue support to the theory of an increase in M over time when that idea is still in doubt. As such it is a convenient technical fix which does not get to the root cause of the retrospective bias seen in the Georges Bank cod assessment.

The assessment for Gulf of Maine cod was equally carried out to a high standard. The difference in stock status and reference points between applying a stock-recruit relationship based on historic data and using an MSY proxy highlights the significance of interpretation of data. While it is recommended research be conducted to provide context to the stock-recruit data points of the 1960s, not accepting a stock-recruit relationship is considered the best decision given the current scientific evidence available. Further, consequence analysis shows the models put forward are more precautionary than the stock-recruit relationship based models and reference points such that the dangers to the stock of their not representing the true state of nature are less. Under an F proxy scenario the conclusion that the stock is undergoing overfishing is robust to alternative interpretations of the data. So is the conclusion that the stock is overfished so long as it is accepted natural mortality is likely to equal 0.2 on average over the longer term. Data on fleet behavior and from the surveys indicate the stock to be vulnerable because of a contraction in its spatial range to the western part of the Gulf of Maine and because of low recruitments in recent years.

6.2 Process

The review process went smoothly enough and there was good cooperation and constructive suggestions from all those present from the floor. There were two problems, however, which were

linked. The volume of information for the independent reviewers was considerable; there were two competing modeling frameworks to consider for Gulf of Maine cod and across both stocks each model had at least two versions put forward for consideration to a lesser or greater extent. Taken together the working group reports might reasonably have been expected to represent the assessment of four stocks. The number of modeling frameworks and model versions reflected a lack of consensus within the working group on key issues. The requirement for intellectual rigor to address all aspects of the assessments should be seen as positive but the presentation of options and their pros and cons (or of opinion and counter opinion) and the discussion surrounding these inevitably took time which, combined with the volume of work to review, could only lead to a compression of the time available to the review panel to reflect on and consolidate its reasoning. Having said this I do not wish to argue that the two cod stocks should not have been taken together for there were obvious synergies to reviewing both.

7. Recommendations

7.1 Georges Bank cod

Surveys

Screening of survey results to validate cohort tracking.

Environmental drivers and natural mortality

Re-visit the stomach data available to NEFSC to see if it contains enough information to explain:

- The drop in spring condition over time.
- The reduction in mean weights at age over time.

Provide analyses on whether there have been changes in the location and quality of preferred habitat for cod on Georges Bank. If evidence is found to consider the implications for straying (i.e. inter-stock mixing), M and spawning potential.

Conduct telemetry tagging studies to obtain estimates of M.

7.2 Gulf of Maine cod

Stock-Recruit relationship

Conduct a desk study to throw more light on the issue of whether the data points of high stock size and low recruitment during the 1960s are evidence of a density dependent stock-recruit relationship or environmental drivers.

Environmental drivers and natural mortality

Provide analyses on whether there have been changes in the location and quality of preferred habitat for cod in the Gulf of Maine. If evidence is found to consider the implications for straying (i.e. inter-stock mixing), M and spawning potential.

Conduct telemetry tagging studies to obtain estimates of M.

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Appendix 2 : Statement of Work

55th Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC): Benchmark stock assessments for Georges Bank cod and Gulf of Maine cod

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. The purpose of this panel review meeting will be to provide an external peer review of stock assessments for Georges Bank cod and Gulf of Maine cod. Atlantic cod, *Gadus morhua*, is a demersal gadoid species found on both sides of the North Atlantic. In U.S. waters, cod are assessed and managed as two stocks: Gulf of Maine, and Georges Bank and southward. Both stocks support important commercial and recreational fisheries. The last peer reviewed benchmark assessment of Gulf of Maine cod was in 2010 as part of SARC 53. The last peer reviewed assessment update of Georges Bank cod took place in 2012. The SARC 55 review panel will be composed of three independently appointed reviewers, and an independent chair from the Science and Statistical Committee (SSC) of the New England or MidAtlantic Fishery Management Council. The SARC panel will write the SARC Summary Report and each reviewer will write an individual independent review report. 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.

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 Georges Bank cod and Gulf of Maine cod 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. SARC 55 will address fishery stock assessments of Georges Bank cod and Gulf of Maine cod, therefore familiarity with forward projecting models and estimation used for North Atlantic stocks including cod stocks off North America and Europe is 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 December 3-7, 2012.

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. Where possible, the SARC chair shall identify or facilitate agreement among the reviewers for each stock assessment Term of Reference of the SAW.

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

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

Tasks prior to the meeting: The contractor shall independently select qualified reviewers that do not have conflicts of interest to conduct an independent scientific peer review 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. 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 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 December 3-7, 2012 (Tuesday through Saturday).

- 3) Conduct an independent peer review in accordance with this SoW and the assessment ToRs (listed in **Annex 2**).
- 4) No later than December 21, 2012, each CIE reviewer shall submit an independent peer review report addressed to the “Center for Independent Experts,” and sent to Mr. Manoj Shivilani, 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.

October 12, 2012	Contractor sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
November 19, 2012	NMFS Project Contact will attempt to provide reviewers the pre-review documents
December 3-7, 2012	Each reviewer participates and conducts an independent peer review during the panel review meeting in Woods Hole, MA
December 7, 2012	SARC Chair and CIE reviewers work at drafting reports during meeting at Woods Hole, MA, USA
December 21, 2012	Reviewers submit draft independent peer review reports to the contractor’s technical team for independent review
December 21, 2012	Draft of SARC Summary Report, reviewed by all CIE reviewers, due to the SARC Chair *
December 28, 2012	SARC Chair sends Final SARC Summary Report, approved by CIE reviewers, to NEFSC contact (i.e., SAW Chairman)
January 3, 2013	Contractor submits independent peer review reports to the COR who reviews for compliance with the contract requirements
January 6, 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

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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: 55th SAW/SARC Stock Assessment Terms of Reference

A. Gulf of Maine cod stock

1. Estimate catch from all sources including landings and discards. Characterize the uncertainty in these sources of data and take into account the recommendations and subsequent work from the March 2012 MRIP workshop. Evaluate available information on discard mortality and, if appropriate, update mortality rates applied to discard components of the catch.
2. Present the survey data and calibration information being used in the assessment (e.g., indices of abundance, recruitment, state surveys, age-length data, etc.). Consider model-based (e.g. GLM) as well as design-based analyses of the survey data in developing trends in relative abundance. 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. Summarize the findings of recent workshops on stock structure of cod of the Northeastern US and Atlantic Canada.
4. Investigate the evidence for natural mortality rates which are time- and/or age-specific. If appropriate, integrate these into the stock assessment (TOR 5).
5. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Consider feasibility of survey catchability estimates, the starting year for the assessment, estimation of the stock recruitment curve, inclusion of multiple fleets, and whether to use domed or flat selectivity-at-age for the NEFSC surveys. Provide a summary of steps in the model building process. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, catch recruitment and fishing mortality.
6. State the existing stock status definitions for “overfished” and “overfishing”. Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, F_{MSY} , and MSY) and provide estimates of their uncertainty. Consider alternative parametric models of the stock recruitment relationship. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the appropriateness of existing BRPs and any “new” (i.e., updated, redefined, or alternative) BRPs.
7. Evaluate stock status with respect to the existing model (from the most recent accepted peer reviewed assessment) and with respect to a new model developed for this peer review. In both cases, evaluate whether the stock is rebuilt.
 - 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 (from Cod TOR-6).
8. Develop and apply analytical approaches to conduct single and multi-year stock projections to compute the pdf (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.
 - c. Describe this stock’s vulnerability (see “Appendix to the SAW TORs”) to becoming overfished, and how this could affect the choice of ABC.
9. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in recent SARC reviewed assessments and review panel reports. Identify new research recommendations.

B. Georges Bank cod stock

1. Estimate catch from all sources including landings and discards. Characterize the uncertainty in these sources of data and take into account the recommendations and subsequent work from the March 2012 MRIP workshop. Evaluate available information on discard mortality and, if appropriate, update mortality rates applied to discard components of the catch.
2. Present the survey data and calibration information being used in the assessment (e.g., indices of abundance, recruitment, state surveys, age-length data, etc.). Consider model-based (e.g. GLM) as well as design-based analyses of the survey data in developing trends in relative abundance. 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. Summarize the findings of recent workshops on stock structure of cod of the Northeastern US and Atlantic Canada.
4. Investigate the evidence for natural mortality rates which are time- and/or age-specific. If appropriate, integrate these into the stock assessment (TOR 5).
5. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Consider feasibility of survey catchability estimates, the starting year for the assessment, estimation of the stock recruitment curve, inclusion of multiple fleets, and whether to use domed or flat selectivity-at-age for the NEFSC surveys. Provide a summary of steps in the model building process. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, catch recruitment and fishing mortality.
6. State the existing stock status definitions for “overfished” and “overfishing”. Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, F_{MSY} , and MSY) and provide estimates of their uncertainty. Consider alternative parametric models of the stock recruitment relationship. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the appropriateness of existing BRPs and any “new” (i.e., updated, redefined, or alternative) BRPs.
7. Evaluate stock status with respect to the existing model (from the most recent accepted peer reviewed assessment) and with respect to a new model developed for this peer review. In both cases, evaluate whether the stock is rebuilt.
 - 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 (from Cod TOR-6).
8. Develop and apply analytical approaches to conduct single and multi-year stock projections to compute the pdf (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. Describe this stock’s vulnerability (see “Appendix to the SAW TORs”) to becoming overfished, and how this could affect the choice of ABC.
 9. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in recent SARC reviewed assessments 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, $OFL \geq ABC$.]

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: DRAFT Agenda

55th Northeast Regional Stock Assessment Workshop (SAW 55)

Stock Assessment Review Committee (SARC) Meeting

December 3-7, 2012

Stephen H. Clark Conference Room – Northeast Fisheries Science Center

Woods Hole, Massachusetts

Draft AGENDA* (version: 3 Oct. 2012)

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR
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Monday, Dec. 3

1 – 1:30 PM

Welcome	James Weinberg , SAW Chair		
Introduction	Patrick Sullivan , SARC Chair		
Agenda			
Conduct of Meeting			

1:30 – 3:30

Assessment Presentation (A. GOM cod)			
	Mike Palmer	TBD	TBD

3:30 – 3:45

Break

3:45 – 6

Assessment Presentation (A. GOM cod)			
	Mike Palmer	TBD	TBD

Tuesday, Dec. 4

9 – 10:45	SARC Discussion w/ presenters (A. GOM cod) Patrick Sullivan , SARC Chair	TBD
10:45 – 11	Break	
11 – 12:15	Assessment Presentation (B. GBK COD) Loretta O’Brien TBD	TBD
12:15 – 1:30	Lunch	
1:30– 3:45	(cont.) Assessment Presentation (B. GBK COD) Loretta O’Brien TBD	TBD
3:45 – 4	Break	
4 – 5:45	SARC Discussion w/ presenters (B. GBK COD) Patrick Sullivan , SARC Chair	TBD
7	social event --location TBD	

Wednesday, Dec. 5

9 - 11	Revisit w/ presenters (A. GOM cod) Patrick Sullivan , SARC Chair	TBD
11 – 11:15	Break	
11:15 – 12:30	Revisit w/ presenters (B. GBK COD) Patrick Sullivan , SARC Chair	TBD
12:30 – 1:45	Lunch	
1:45 – 2:15	(cont.) Revisit w/ presenters (B. GBK COD) Patrick Sullivan , SARC Chair	TBD
2:15 -2:30	Break	
2:30 – 5:30	Review/edit Assessment Summary Report (A. GOM cod) Patrick Sullivan , SARC Chair	TBD

Thursday, Dec. 6

9 - 12	Review/edit Assessment Summary Report (B. GBK COD) Patrick Sullivan , SARC Chair	TBD
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12 – 1:15 **Lunch**

1:15 – 5 SARC Report writing. (closed meeting)

Friday, Dec. 7

9:00 - 3 PM (cont.) 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 any papers cited in the SARC Summary Report, along with a copy of the CIE Statement of Work.

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

Appendix 3: Panel Membership

Patrick J Sullivan (Chair). Email: pjs31@cornell.edu. [

Noel Cadigan. Email: Noel.Cadigan@mi.mun.ca.

John Casey, CEFAS Fisheries Laboratory, Lowestoft, Suffolk, NR33 0HT, UK. Email: john.casey@cefas.co.uk. Phone 00 44 1502 524238 (direct)

Steven Holmes, 14 Gardenston Street, laurencekirk, Kincardineshire, AB30 1UG, UK. Email: s.holmes@marlab.ac.uk. Phone 00 44 1224 29 5507 (direct).

The following NEFSC staff assisted the panel throughout the meeting:

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