Independent Peer Review Report on the *Red Hake Stock Structure Research Track Assessment*

March 9-12th, 2020
Northeast Fisheries Science Center
Woods Hole, Massachusetts

By

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Prepared for:
The Center for Independent Experts

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Executive summary

The Red Hake Stock Structure Research Track SARC met in the Aquarium Conference Room at NOAA's Northeast Fisheries Science Center (NEFSC) in Woods Hole, MA during March 9–12th, 2020. The review was hosted by the NEFSC. The draft red hake structure report was sent in advance of the review together with supporting appendices. The report was clear and reasonably comprehensive. At the review meeting, the Working Group (WG) Chair and WG members delivered excellent scientific presentations and responded carefully to all questions of the review panel.

A very helpful and complete summary of the chronological evolution of the stock hypotheses through time was reported for the red hake within the Terms of reference 1 (TOR1). It concisely explains the rationale behind the current stocks considered for management, e.g., the southern and the northern stocks. This TOR was addressed adequately.

A considerable amount of work was performed to collect and analyse new data in the context of different stock structure hypotheses (TOR2), although tagging and genetic data were not available. I have minor concerns about the interpretation of some of the analyses, but I believe that this work nevertheless presented an overall impressive series of new data analyses (for a data-poor species) and completed the tasks at hand.

A complete summary of data and analyses were presented in the context of stock structure delineation in an attempt to confirm the current management units (TOR3). The null hypothesis was based on the defined current management units, the southern and the northern stocks. Many of the presented results supported the current management units, although few supported one stock. I fully agree with the conclusion of the WG that there was not sufficient evidence to reject the current management units. This TOR was fully met.

Experimental studies (TOR4) were designed to assess the red hake catchability in the different surveys. First, fish abundance estimates in the HabCam camera survey were compared to towed gear survey abundance estimates, in order to assess the catchability of the survey design. This experiment was only conducted during the 2015 survey but it gives important information. Such a valuable study for a data-poor species should be continued and results explored for a series of consecutive years, as suggested by the working group. Experiments were also performed on the chain sweep and the wingspread effect on catchability and led to the following important conclusions: 1) the catch efficiency was not affected by a wider or narrower wingspread than the optimal 13 metres target; 2) the area swept by the wings must be considered when estimating biomass; and 3) the chain sweep study could accurately estimate the maximum catchability of red hake.

The current assessment model (AIM) was correctly performed but the model did not exhibit any significant values for any of the current management units (TOR5). I fully concur with the conclusion that this model should not be implemented in future assessments.

An alternative approach was carried out using an established model and recent survey data (2009-2018). While the approach seemed to be pertinent for data-poor species, I had a few concerns. The time period chosen to test this model and establish reference points correspond to the time

period during which new biological data support the idea that the dynamics of the considered stocks changed, either due to a spatial-dynamic migration (shift in distribution northward) or to a large change in productivity (especially in the northern stock). Covering different time periods for both stocks and comparing them to the period already investigated will give valuable information before considering the current estimated reference points into management. The model also considered a single M value, which might not be representative of what currently happens in both stocks, and conducting a sensitivity analysis of the model to the input parameters will be valuable. I would therefore recommend further analyses before the acceptance of the current reference points.

A series of research recommendations have been proposed to clarify several pending questions on the stock structure of red hake with suggested priorities. These recommendations are highly valuable, and I fully agree that they should be implemented.

Background

Red hake is a non-targeted fishery species (by-catch) distributed along the Northeast continental shelf of the U.S., from Southern New England to the Gulf of Maine in the north. It is considered to be a data-poor species. Historically, the species has been exploited at a very low level. Catches are mainly reported from the squid, whiting and other fisheries, and do not exceed 1-5% of the total biomass caught in those fisheries.

The species is migratory at all life stages (active or passive dispersion) and mainly spawn in the Georges Bank area. It has very complex dynamic recruitment dynamics, exhibiting passive transport of larva over vast distances and a distinct distribution of young-of-the-year from the adults.

Historically, the stock structure considered for assessments has evolved from three-stock to two-stock management units based on changes in life-history traits over a relatively long-time period. No genetic or tagging data were presented to confirm the stock structure currently implemented. The current management units are composed of Southern and Northern stocks.

The objectives of the "Red Hake Stock Structure Research Track" review panel was to assess whether or not the "Red Hake Stock Structure" Working Group had satisfactorily completed six terms of references (TOR). These TORs included: the review and summary all relevant literature on the existing stock structure of red hake in the northwest Atlantic (TOR1); the identification and evaluation of any new and/or existing data relevant to the stock structure of red hake (TOR2); the recommendation of the most likely biological stock structure among a set of alternatives from TOR2, considering the current management units as null hypothesis (TOR3); the evaluation of existing experimental data on survey catchability of red hake, the examination of the sufficiency of catchability data and, if appropriate, the incorporation of the catchability estimates into the assessment (TOR4); the application of the existing assessment model framework to the stock structure based on TOR3 and 4, and the evaluation of existing reference points (TOR5); and the identification of gaps in the existing research with respect to red hake stock structure and development of a prioritized list of research recommendations to address these gaps, with comments on the feasibility and time horizon of the proposed research recommendations (TOR6).

The SARC meeting and the participants were well prepared and helpful. The meeting agenda was consequently followed appropriately. All the TOR were adequately addressed by the WG and were successfully accomplished.

Review process and role of reviewer

The Red Hake Stock Structure Research Track SARC met in the Aquarium Conference Room at NOAA's Northeast Fisheries Science Center (NEFSC) in Woods Hole, MA during March 9–12th, 2020. The review was hosted by the NEFSC.

The draft "Red hake stock structure" report was sent a few weeks in advance of the review meeting (together with supporting appendices), which gave sufficient time to understand the rationale behind the research questions related to the red hake stock structure (See Annex 1 for the list of documents provided).

The objective of the meeting was to evaluate the stock structure of the red hake based on historical as well as new data analyses. In this process, external reviewers were selected by the Center for Independent Experts (CIE) to assist the review process. The external reviewers were: Haritz Arrizabalaga, Manuel Hidalgo, and Christophe Pampoulie. The chair of the external review panel was John Wiedenmann, a representative of the New England Fisheries Management Council Scientific and Statistical Committee.

The meeting started on March 9th with a welcome and introductions, followed by the presentation of the week's agenda and technical aspects of the review meeting. The SARC was assisted by the NEFSC Stock Assessment Workshop (SAW) Chairman, James Weinberg, Michelle Traver, and Russ Brown.

Several documents were prepared by the Red Hake Working Group (WG) and were presented by its chair David Richardson (NEFSC). Other WG members also presented material and contributed to the discussions on various topics, including Steve Cadrin (U. Mass Dartmouth), Tim Miller (NEFSC), Rich McBride (NEFSC), Larry Alade (NEFSC), Toni Chute (NEFSC), and Kathy Sosebee (NEFSC). Materials and documents were also provided through a website link. The rapporteurs of the meeting were provided by the NEFSC. The Terms of Reference for the review were clearly defined and provided in Appendix 1 of the Performance Work Statement (See Annex 2 Appendix 1 of this document).

A total of 28 people attended the meeting (See list in Annex 3). The first two days of the meeting were dedicated to the evaluation of TORs 1-6. The morning of day three was dedicated to clarification and discussion about TOR5. The rest of the meeting was devoted to drafting the panel responses to the TORs that were included into the Red Hake Stock Structure Research Track SARC summary report.

The role of the external reviewers was clearly set out in the CIE Statement of Work (See Annex 2, Appendix 3 and 4). The external reviewers were each asked to deliver an independent report to the CIE and to contribute to the summary report produced by the SARC review panel. During this process, I read all the documents made available by the Working Group, which helped me to get comfortable with Red Hake biology and the assessment processes. I also participated actively in all discussions during the review meeting, reviewed all TORs, and drafted the panel responses to the TORs with the other external reviewers, which were later included into the Red Hake Stock Structure Research Track SARC summary report.

Summary of Findings for each TORs

TOR1: Review and summarize all relevant literature on the existing stock structure of red hake in the northwest Atlantic.

This TOR was fully met.

Cnsiderable amount of work was done in gathering a precise and complete chronology of the evolution of stock structure implemented in the assessment of the red hake from the 1960s to the present day. The review was quite complete and therefore helpful to fully understand the rationale behind the stock structure currently considered in the assessment. A detailed description was also given on the reasons to move from the previous three-stock boundaries to a two-stock boundary, supported by several biological parameters and practical management reasons. This decision seems sound, but one must remember that practical management reasons often lead to biological units not matching management units, and that this can have severe consequences on the respective stocks.

TOR2: Identify and evaluate any new and/or existing data relevant to the stock structure of red hake including but not limited to the species' life history (i.e. spawning, distribution, abundance, growth, maturity and natural mortality), morphometrics, and genetics.

This TOR was fully met.

The data and new analyses presented covered fisheries dependent data, trawl survey data, life-history data, spawning and larvae, young of the year distribution and An Index Model (AIM) analyses. Most of the presented new data analyses supported a two-stock structure except for the AIM. Although I fully agree with the conclusion drawn from these new analyses, I have concerns about the interpretation of some of these data and will discuss these concerns below as well as the important findings.

The fisheries dependent data were suggested to support the two-stock structure due to the discontinuity of catch across Georges Bank, the unique set of vessels working in each region and the fact that the catch trends were consistent within two-stocks. Red hake is a non-targeted species (by-catch) which is mainly caught during the whiting, squid and scallop fisheries. Therefore, fisheries dependent data are likely not reflecting properly the red hake spatial distribution. These fisheries dependent data are unlikely to reflect the actual abundance and distribution of red hake but simply the fisheries dynamic related to the targeted species. dynamics. This was probably the reason for the two-stocks low probability observed for the landings per unit effort with the fishery-dependent dataset. I would therefore recommend interpreting the fisheries dependent data with caution in the context of stock structure.

In contrast, the trawl surveys clearly depicted the dynamics of the red hake in this region and revealed several important facts. The abundance of red hake drastically decreased in the Southern stock, exhibiting an historical low level, while the northern stock survey index reflected an historical high biomass. These results were interpreted as possible evidence of a distribution shift of adult red hake towards the north and west. These changes were possibly explained by changes in temperature. In addition, habitat modeling exploration showed that the occupancy probability is now higher in the Georges Bank and Gulf of Maine (Northern stock) compared to the Southern New England (Southern stock). A general size-truncation was also

observed in both stocks. I fully support the interpretation of these data and would recommend pursuing similar analyses in the future.

The Management Unit Estimator approach developed in order to assess the potential number of stocks in the region was quite confusing. This approach was based on survey indices and was not consistent among the different tests. I'm also not sure that any conclusions could be drawn from this analysis since the one-stock hypothesis could not be tested.

Age data and growth parameters estimated from the spring and fall trawl surveys were presented. The analyses were based on early aging data collected from 1970 to 1985 and data from a more recent period (2008-2018). The age data therefore presented major gaps in terms of time period. The available age-data seemed to provide evidence of persistent differences among the southern and northern stocks' median length-at-age. These differences were nevertheless more pronounced in the earlier period (1970-1985).

Although I fully agree on the specific findings, I have the following concerns:

- It seems that there is a strong possibility of misidentification between red and white hake. This has been suggested in the draft report as well as during the review meeting. It was also noted that this misidentification problem was more pronounced in the early-period data (1970-1985). I was wondering what effect the misidentification would have on the decline in sizes and the observed reduced length-at-age. If the effect is prominent, it is highly possible that the observed growth differences between the two-time periods investigated was indeed due to a better identification of red hake during the most recent years.
- When looking at the different data (graphs and table) provided for the growth analysis, I thought that the growth difference between the two stocks was not clear in recent years. It is difficult to estimate if these slight differences were significant or not. I would recommend using a formal statistical model to assess the relative importance of these growth differences over time (e.g., Von Bertalanffy).

To summarize my concerns, the observed growth results might be due to the following reasons which should be considered: 1) the identification of the red hake was much better in recent years, leading to better estimates of growth in both stocks and therefore to lower growth differences; 2) the decrease in the asymptotic length-at-age in the northern stock was due to the migration of southern stock fish in this area (supported by the shift in distribution); 3) the decrease in the asymptotic length-at-age in the northern stock was due to a density-dependence effect related to the increase in biomass.

One important finding is the fact that larvae of red hake can now be identified properly, based on a method published in an international journal. However, the species identification of larvae collected in the historical samples were not re-examined and I would recommend doing so in the future.

All the other analyses presented (larval and Young-of-the-Year distribution and abundance, larval drift and particle tracking models, spawning seasonality) revealed that the dynamics of both stocks has drastically changed over time, with a notable shift in abundance, distribution,

and productivity. This has led to the suggested "one potential migration pattern" for the red hake which, I believe, should be investigated in the future. At present, this is a hypothesis which is not confirmed, and could have an important effect on the definition of management units.

The approach using An Index Model (AIM) was inconclusive as none of the models exhibited a significant P-value. Therefore, this analysis suggested that the change in the population trends was probably not driven by the relative fishing mortality. I fully agree with this conclusion.

TOR3: Recommend the most likely biological stock structure among a set of alternatives from TOR2. Consider the current management unit as null hypothesis.

This TOR was fully met.
The new and historical data were presented in the context of stock structure delineation, considering the current management units as the null hypothesis. While most of the data supported the current management units, a few suggested the presence of only one stock (otolith chemistry, larval and young-of-the-year distribution, spawning migration). Clearly, I think that these data should be investigated on a per time-period basis since the dynamics of the stocks has changed in recent years. It is likely that the red hake stock structure is currently changing due to several factors and one should keep in mind that the number of management units might be revised in a future Stock Structure Track Assessment. At the moment, I fully agree with the conclusion of the WG that there is not sufficient evidence to reject the null hypothesis but would highly recommend implementing a genetic/genomic approach.

TOR4: Evaluate existing experimental data on survey catchability of red hake. Examine the sufficiency of catchability data and, if appropriate, incorporate the catchability estimates into the assessment.

This TOR was fully met.
A HABCAM survey was performed to assess red hake abundance and compare it to abundance in a towed gear survey. The HABCAM survey showed no evidence that red hake evaded or reacted to the HABCAM vehicle, which supported that the abundance estimates were unbiased. I agree with the WG conclusion that the HABCAM study provided important information and should be continued. It would be interesting to perform this survey in the spawning region to assess fish distribution during the spawning time of red hake. It is recommended that this type of survey would have to be conducted during more years, comparing both the HABCAM data to the trawl data as suggested by the WG. The confusion between red hake and spotted hake should also be investigated more.

A chain sweep study was performed based on previously established peer-reviewed methods. This study clearly demonstrated that the chain sweep study could accurately estimate the maximum catchability of red hake.

The wing spread study did not show any real effect on the catchability of red hake. The catch efficiency was not affected by a wider or narrower wingspread than the optimal 13 metres target and the area swept by the wings must be considered when estimating biomass. I agree with these conclusions.

All these experimental studies were performed adequately and correctly addressed the objective of this TOR. Performing these experimental studies for a longer period will certainly lead to the implementation of catchability estimates in the assessment.

TOR5: Apply the existing assessment model framework to the stock structure based on TOR 3 and 4 to ensure its utility in subsequent management track assessments. Evaluate existing reference points. Consider alternate assessment approaches if existing model framework does not perform well, and consider alternate reference points as needed.

This TOR was largely met.
The current assessment model (AIM) used for red hake was tested in the context of the management units currently defined to ensure its usefulness in subsequent management track assessments (TOR5-part A). The AIM analyses were correctly performed, but the model did not exhibit any significant values for any of the management units tested during the process. These results might therefore reflect the fact that fisheries are not currently driving the stock biomass, a necessary condition for this type of model. The AIM model was therefore not recommended for future assessments, which I fully support.

An alternative approach (TOR5-part B) was carried out using an established model and based on recent survey data (2009-2018). While the approach seemed to be pertinent for data-poor species, there are a few concerns. The time period chosen to test this model and establish reference points corresponds to the time period during which biological new data support the idea that the dynamics of the considered stocks changed (non-stability in the stocks), either due to a spatially-dynamic migration (shift in distribution northward) or to a large change in productivity (especially in the northern stock). Covering different time periods for both stocks and comparing them to the period already investigated will give valuable information before considering the current estimated reference points for management. The model also considers a single M value, which might not be representative of what currently happens in both stocks and a sensitivity analysis of the model to the input parameters will be valuable to conduct before accepting the reference points.

During the years investigated, the southern stock was at an historically low level while the northern stock exhibited an historically high biomass. A shift in distribution of red hake to the north-northeast area has been suggested, and one can wonder if fisheries are indeed driving the stock dynamics as would be assumed for assessment models. In this context, one hypothesis could be that the decrease in biomass of the southern stock is due to a shift in distribution towards the northern region and the increase of biomass in the north (increase in survey index) is due to this shift in distribution and not necessarily to an increase of productivity in the northern stock. Since the red hake stock is a poor stock, there is indeed no evidence for any of the dynamic scenarios, and I therefore believe that this might affect the model and reference points estimated which requires stability in the stock. There is no sufficient support for any of these scenarios at present. The dynamics within and between stocks has not been stable during the recent years which the model was based upon, and, this might affect the reference point. This will likely affect the SSB-R relationship used for the calculations.

TOR6: Identify gaps in the existing research with respect to red hake stock structure. Develop a prioritized list of research recommendations to address these gaps. Comment on the feasibility and time horizon of the proposed research recommendations.

This TOR was fully met.
A list of research recommendations ranked by priority level was provided to the review panel. The ranking was based on previous experience with methods (otolith chemistry) or relevance of the research questions for the red hake stock structure assessment. I fully agree with the WG that the highest priority among these recommendations is the initiation of a genetic/genomic study. It will help resolve uncertainties about the current dynamics of the red hake stock in recent years (origin of the larva in the GOM region; shift in distribution of southern stock fish into the northeast region; origin of early life stages), and potentially clarify if changes have been drastic since the 1960s by comparing the current collected samples to archived samples. It will definitively confirm or reject the currently defined management units.

In this context and being concerned about the recent changes in the stocks' dynamics, I would highly recommend investigating further the stock structure using a Next Generation Sequencing (NGS)/genomic approach. This approach will lead to the generation of many Single Nucleotide polymorphisms (SNPs), both neutral and under selection, which seems to be necessary to fully fathom the stock structure of red hake and understand its dynamics. Going for NGS will also potentially reduce the number of individual samples necessary to perform these analyses (usually around 30-35 samples per location). It might therefore lead to the possibility of increasing the sampled locations, which seems to be a necessity in this very dynamic system. NGS and genomic studies have also recently emphasized that "local adaptation" can occur in the face of gene flow in very dynamic stock(s) (example of cod and herring on both sides of the Atlantic and across the North Atlantic). These events are often attributed to chromosomal rearrangements leading to "gene-linkage groups" also called "Genomic Islands of divergence", among which genes are often associated with environmental parameters such as temperature, salinity, and oxygen level. I do believe that this approach will be highly relevant for the stock structure identification. In addition, a temporal scale can be implemented by using archived samples such as otolith, larva and any other tissues collected in the past. Therefore, temporal stability can be assessed. Ultimately, this technique could also be used to assign larvae, juvenile and adults to potential spawning aggregations (if the spawning grounds are sampled).

I fully agree with the list of recommendations provided and will make one more recommendation. In the case of this data-poor non-targeted species, I do believe it is essential to maintain all the scientific surveys, which will help to better understand the dynamics of the current stocks, and to explain the reasons of the observed changes in the distribution, dynamics and productivity of both the southern and northern management units.

ANNEX 1: List of provided material for the review

Northeast Fisheries Science Center. 2011. 51st Northeast Regional Stock Assessment Workshop (51st SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-02; 856 p.

DRAFT REPORT. Red Hake Stock Structure Working Group. By the Northeast Fisheries Science Center, 11 February 2019.

Appendix 1. Informing spatial structure of red hake (Urophycis chuss) stocks and the fleetsthat fish for them. Authors: Andrew Jones, Anna Mercer, David Richardson.

Appendix 2. Application of the management unit estimator to red hake trawl survey data. David Richardson.

Appendix 3. What size at age says about red hake stock structure. Richard S. McBride, Woods Hole Laboratory, NOAA Fisheries. DRAFT, not for wide distribution, 2 January 2020.

Appendix 4. An empirical approach to assessing northern and southern red hake. Timothy J. Miller.

Figures_RedHakeSSWG_11February2020.docx

Tables_RedHakeSSWG_11February2020.docx

Application of An Index Method (AIM) to Data Rich Situations: Can Simple Methods Capture Major Features of Complex Assessments? Paul J. Rago and Christopher M. Legault.

Red Hake Stock Structure Research Track Terms of Reference (v. 2/27/2020).

SARC 54 PANEL SUMMARY REPORT. 54th Northeast Regional Stock Assessment Workshop (SAW 54) Stock Assessment Review Committee (SARC) Meeting 5 - 9 June 2012 Northeast Fisheries Science Center Wood's Hole, Mass.

Text_FinalReport_Red Hake. SSWG. 11February2020.docx

Northeast Fisheries Science Center Reference Document 11-01. 51st Northeast Regional Stock Assessment Workshop (51st SAW): Assessment Summary Report (2nd Edition). Aug. 2011.

Northeast Fisheries Science Center Reference Document 12-18. 54th Northeast Regional Stock Assessment Workshop (54th SAW) Assessment Report. Dec. 2012.

Northeast Fisheries Science Center Reference Document 18-02. 2017 Northern and Southern Silver Hake and Red Hake Stock Assessment Update Report. by Larry Alade and Michele Traver.

Red Hake Stock Structure Research Track Assessment Peer Review Meeting. Clark Conference Room, NEFSC, Woods Hole, MA. March 9-12, 2020. Meeting Agenda.

Various Powerpoint presentations, covering each WG TOR for this meeting.

ANNEX 2: Copy of the Performance Work Statement

Performance Work Statement (PWS)

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

Red Hake Stock Structure Research Track

Background

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

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards[1]. Further information on the Center for Independent Experts (CIE) program may be obtained from www.ciereviews.org.

Scope

The Northeast Regional Stock Assessment Review Committee (SARC) meeting is a formal, multiple-day meeting of stock assessment experts who serve as a panel to peer-review tabled stock assessments and models. The SARC peer review is the cornerstone of the Northeast Stock Assessment Workshop (SAW) process, which includes assessment development, and report preparation (which is done by SAW Working Groups or Atlantic States Marine Fisheries Commission (ASMFC) technical committees), assessment peer review (by the SARC), public presentations, and document publication. This review determines whether or not the scientific assessments are adequate to serve as a basis for developing fishery management advice. Results provide the scientific basis for fisheries within the jurisdiction of NOAA's Greater Atlantic Regional Fisheries Office (GARFO).

1 http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf

The purpose of this meeting will be to provide an external peer review of red hake stock structure. The requirements for the peer review follow. This Performance Work Statement (PWS) also includes: **Appendix 1**: The Terms of Reference (TORs) of this review; **Appendix 2:** a draft meeting agenda; **Appendix 3:** Individual Independent Review Report Requirements; and **Appendix 4:** Assessment Summary Report Requirements.

Requirements

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

Each reviewer will write an individual review report in accordance with the PWS, OMB Guidelines, and the TORs below. All TORs must be addressed in each reviewer's report. No more than one of the reviewers selected for this review is permitted to have served on a Stock Assessment Review Committee (SARC) panel that reviewed this same species in the past. The reviewers shall have working knowledge and recent experience in the evaluation of biological and ecological data commonly used in stock delineation for marine fishes including but not limited to life history traits, morphometric data, seasonal and spawning distribution data, otolith microchemistry data, and genetics. In addition, knowledge and experience with data limited assessment and population dynamics would be valuable.

Tasks for Reviewers

- Review the background materials and reports prior to the review meeting
    - Two weeks before the peer review, the Assessment Process Lead will electronically disseminate all necessary background information and reports to the CIE reviewers for the peer review.
- Attend and participate in the panel review meeting
    - The meeting will consist of presentations by NOAA and other scientists, stock assessment authors and others to facilitate the review, to provide any additional information required by the reviewers, and to answer any questions from reviewers
- Reviewers shall conduct an independent peer review in accordance with the requirements specified in this PWS and TORs, in adherence with the required formatting and content guidelines; reviewers are not required to reach a consensus.
- Each reviewer shall assist the SARC Chair with contributions to the Assessment Summary Report
- Deliver individual Independent Review Reports to the Government according to the specified milestone dates

- This report should explain whether each research track Term of Reference was or was not completed successfully during the SARC meeting, using the criteria specified below in the "Tasks for SARC panel."
- If any existing Biological Reference Points (BRP) or their proxies are considered inappropriate, the Independent Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRPs are the best available at this time.
- During the meeting, additional questions that were not in the Terms of Reference but that are directly related to the assessments may be raised. Comments on these questions should be included in a separate section at the end of the Independent Report produced by each reviewer.
- The Independent Report can also be used to provide greater detail than the Assessment Summary Report on specific stock assessment Terms of Reference or on additional questions raised during the meeting.

Tasks for Review panel

- During the SARC meeting, the panel is to determine whether each research track Term of Reference (TOR) 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 research track TOR.
- If the panel rejects any of the current BRP or BRP proxies (for B_{MSY} and F_{MSY} and MSY), the panel should explain why those particular BRPs or proxies are not suitable, and the panel should recommend suitable alternatives. If such alternatives cannot be identified, then the panel should indicate that the existing BRPs or BRP proxies are the best available at this time.
- Each reviewer shall complete the tasks in accordance with the PWS and Schedule of Milestones and Deliverables below.

Tasks for SARC chair and reviewers combined:

Review both the Assessment Report and the draft Assessment Summary Report. The draft Assessment Summary Report is reviewed and edited to assure that it is consistent with the outcome of the peer review, particularly statements about stock status recommendations and descriptions of assessment uncertainty.

The SARC Chair, with the assistance from the reviewers, will write the Assessment Summary Report. Each reviewer and the chair will discuss whether they hold similar views on each research track 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 Assessment 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 Assessment 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 Assessment 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 research track Term of Reference, either as part of the group opinion, or as a separate minority opinion. The Assessment Summary Report will not be submitted, reviewed, or approved by the Contractor.

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

Foreign National Security Clearance

When reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for reviewers who are non-US citizens. For this reason, the reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, country of birth, country of citizenship, country of permanent residence, country of current residence, dual citizenship (yes, no), passport number, country of passport, travel dates.) to the NEFSC Assessment Process Lead for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/ and http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html. The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance

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

Period of Performance

The period of performance shall be from the time of award through April 2020. Each reviewer's duties shall not exceed **14** days to complete all required tasks.

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

Schedule	Milestones and Deliverables
Within 2 weeks of award	Contractor selects and confirms reviewers
Approximately 2 weeks later	Contractor provides the pre-review documents to the reviewers
March 9-12, 2019	Panel review meeting
Approximately 2 weeks later	Contractor receives draft reports
Within 2 weeks of receiving draft reports	Contractor submits final reports to the Government

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

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

Travel
All travel expenses shall be reimbursable in accordance with Federal Travel Regulations (http://www.gsa.gov/portal/content/104790). International travel is authorized for this contract.

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

NMFS Project Contact
Michele Traver, NEFSC Acting Assessment Process Lead
Northeast Fisheries Science Center
166 Water Street, Woods Hole, MA 02543
Michele.Traver@noaa.gov
Phone: 508-495-2195

Appendix 1. Red Hake Stock Structure Research Track Terms of Reference

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

1. Review and summarize all relevant literature on the existing stock structure of red hake in the northwest Atlantic.

2. Identify and evaluate any new and/or existing data relevant to the stock structure of red hake including but not limited to the species' life history (i.e. spawning, distribution, abundance, growth, maturity and natural mortality), morphometrics, and genetics.

3. Recommend the most likely biological stock structure among a set of alternatives from TOR2. Consider the current management unit as null hypothesis.

4. Evaluate existing experimental data on survey catchability of red hake. Examine the sufficiency of catchability data and, if appropriate, incorporate the catchability estimates into the assessment.

5. Apply the existing assessment model framework to the stock structure based on TOR 3 and 4 to ensure its utility in subsequent management track assessments. Evaluate existing reference points.

6. Identify gaps in the existing research with respect to red hake stock structure. Develop a prioritized list of research recommendations to address these gaps. Comment on the feasibility and time horizon of the proposed research recommendations.

SAW Assessment TORs:

Clarification of Terms
used in the Stock Assessment Terms of Reference

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

In general, for any TOR in which one or more models are explored by the Working Group, give a detailed presentation of the "best" model, including inputs, outputs, diagnostics of model adequacy, and sensitivity analyses that evaluate robustness of model results to the assumptions. In less detail, describe other models that were evaluated by the Working Group and explain their strengths, weaknesses and results in relation to the "best" model. If selection of a "best" model is not possible, present alternative models in detail, and summarize the relative utility each model, including a comparison of results. It should be highlighted whether any models represent a minority opinion.

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

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

ABC for overfished stocks. For overfished stocks and stock complexes, a rebuilding ABC must be set to reflect the annual catch that is consistent with the schedule of fishing mortality rates in the rebuilding plan. *(p. 3209)*

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

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

On "Vulnerability" (DOC Natl. Stand. Guidelines. Fed. Reg., v. 74, no. 11, 1-16-2009):

"Vulnerability. A stock's vulnerability is a combination of its productivity, which depends upon its life history characteristics, and its susceptibility to the fishery. Productivity refers to the capacity of the stock to produce Maximum Sustainable Yield (MSY) and to recover if the population is depleted, and susceptibility is the potential for the stock to be impacted

by the fishery, which includes direct captures, as well as indirect impacts to the fishery (e.g., loss of habitat quality)." (p. 3205)

Participation among members of a Stock Assessment Working Group:

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

Appendix 2. Draft Review Meeting Agenda

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

Red Hake Stock Structure Research Track Assessment

March 9-12, 2020

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

DRAFT AGENDA* (version: December 3, 2019)

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

Monday, March 9th, 2020

Time	Topic	Presenter(s)	Rapporteur
1:00 – 1:30pm	Welcome/Description of Review Process Introductions/Agenda/Conduct of Meeting	Michele Traver, Acting Assessment Lead TBD, Chair	
1:30 – 2:30pm	Review of Current Assessment and Historical Designations (TOR #1)	Toni Chute Dave Richardson, WG Chair	TBD
2:30 – 3:30pm	New Data and Analyses (TOR #2)	Dave Richardson, WG Chair	TBD
3:30 – 3:45pm	Break		
3:45 – 5:00pm	New Data and Analyses (TOR #2) cont.	Dave Richardson, WG Chair	TBD
5:00 – 5:30pm	Discussion/Review/Summary	Panel	TBD
5:30 – 5:45pm	Public Comment	Public	TBD
5:45pm	Adjourn		

Tuesday, March 10th, 2020

Time	Topic	Presenter(s)	Rapporteur
8:30 – 8:45am	Welcome/Logistics	Michele Traver, Acting Assessment Lead TBD, Chair	
8:45 – 10:45am	New Data and Analyses (TOR	Dave Richardson,	TBD

	#2) cont.	WG Chair	
10:45 – 11:00am	Break		
11:00 – 12:30pm	Catchability (TOR #4)	Dave Richardson, WG Chair	TBD
12:30 – 1:30pm	Lunch		
1:30 – 3:30pm	Stock Structure Proposals (TOR #3)	Dave Richardson, WG Chair	TBD
3:30 – 3:45pm	Break		
3:45 - 5:00pm	Stock Structure Proposals (TOR #3) cont.	Dave Richardson, WG Chair	TBD
5:00 – 5:30pm	Discussion/Review/Summary	Panel	TBD
5:30 – 5:45pm	Public Comment	Public	TBD
5:45pm	Adjourn		
7:00pm	Dinner Social		

Wednesday, March 11th, 2020

Time	Topic	Presenter(s)	Rapporteur
8:30 – 8:45am	Welcome/Logistics	Michele Traver, Acting Assessment Lead TBD, Chair	
8:45 – 10:45am	Model Proposals (TOR #5)	Dave Richardson, WG Chair	TBD
10:45 – 11:00am	Break		
11:00 – 12:00pm	Research Recommendations (TOR #6)	Dave Richardson, WG Chair	TBD
12:00 – 12:30pm	Discussion/Review/Summary	Panel	TBD
12:30 – 12:45pm	Public Comment	Public	TBD
12:45 – 1:45pm	Lunch		
1:45 - 5:00pm	Assessment Summary Report Writing	Panel	
5:00pm	Adjourn		

Thursday, March 12th, 2020

Time	Topic	Presenter(s)	Rapporteur
9:00 – 5:00pm	Report Writing	Panel	

Article I.

Section 1.01 Appendix 3. Individual Independent Peer Review Report Requirements

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

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

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

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

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

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

3. The report shall include the following appendices:

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

Appendix 4. Assessment Summary Report Requirements

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

   To make this determination, the SARC chair and reviewers should consider whether or not the work provides a scientifically credible basis for developing fishery management advice. If the reviewers and SARC chair do not reach an agreement on a Term of Reference, the report should explain why. It is permissible to express majority as well as minority opinions.

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

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

3. The report shall also include the bibliography of all materials provided during the SAW, and relevant papers cited in the Assessment 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.

ANNEX 3: List of panel members and participants

Red Hake Stock Structure Research Track SARC:
Chair: John Wiedenmann, New England Fisheries Management Council Scientific and Statistical Committee.
External reviewers selected by the Center for Independent Experts (CIE):
Haritz Arrizabalaga, AZTI Technalia, Spain.
Manuel Hidalgo, Instituto Español de Oceanografía, Spain.
Christophe Pampoulie, Marine and Freshwater Research Institute, Iceland.

Jim Weinberg - Northeast Fisheries Science Center, SAW Chair
Michele Traver - Northeast Fisheries Science Center, Assessment Process Lead
Russ Brown - Northeast Fisheries Science Center Population Dynamics Branch Chief
Brian Linton - Northeast Fisheries Science Center (rapporteur)
Alicia Miller - Northeast Fisheries Science Center (rapporteur)
Charles Perretti - Northeast Fisheries Science Center (rapporteur)

Working group members:
David Richardson - Northeast Fisheries Science Center (Chair)
Larry Alade - Northeast Fisheries Science Center
Steve Cadrin - University of Massachusetts Dartmouth School of Marine Science and Technology
Toni Chute - Northeast Fisheries Science Center, Red Hake lead analyst
Nicole Lengyel Costa - New England Fisheries Management Council
Katie Marancik - Northeast Fisheries Science Center
Richard McBride - Northeast Fisheries Science Center

Participants:
Kathy Sosebee - Northeast Fisheries Science Center
Andy Beet - Northeast Fisheries Science Center
Mark Terceiro - Northeast Fisheries Science Center
Jon Deroba - Northeast Fisheries Science Center
Andy Applegate - New England Fisheries Management Council
Ariele Baker - Northeast Fisheries Science Center
Andrew Jones - Northeast Fisheries Science Center
Jennifer Couture - New England Fisheries Management Council
Gary Shepherd - Northeast Fisheries Science Center
Chris Legault - Northeast Fisheries Science Center
Mike Simpkins - Northeast Fisheries Science Center