Center for Independent Experts Independent Peer Review Report

On

AFSC Approaches to Survey Biomass-based Stock Assessments

Prepared by

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I. Executive Summary

The External Independent Peer Review for the AFSC Approaches to Survey Biomass-based Stock Assessments was a desk review. The AFSC prepared the documentation, and the members of the North Pacific Fisheries Management Council Groundfish Plan Team's Survey Averaging Working Group (SAWG) met with the CIE reviewers on February 16, 2023 via WebEx to answer the questions the CIEs had.

The Desk Review was conducted based on a set of predefined Terms of Reference (ToRs) aiming to evaluate the random effects (RE) modeling work done by the SAWG. The CIE reviewers were asked to provide comments and suggestions for each of the ToRs for improving the survey biomass-based stock assessments. As a CIE reviewer, I read all the materials provided, attended the WebEx to ask clarification questions, and conducted an independent and impartial review of the RE modeling work that had been done by the SAWG.

Based on the review, I conclude that overall, the AFSC Approaches to Survey Biomass-based Stock Assessment are scientifically sound and adequate in providing information to address management needs for Tier 4/5 fish stocks in North Pacific. However, I believe more studies are needed to further test the RE models and evaluate their performance and robustness with respect to different assumptions. It is important to develop diagnostics tools for the RE model because the traditional residual analysis may not be appropriate for the RE models with both process and observational errors explicitly considered. Sensitivity analysis and retrospective analysis should be conducted for survey biomass-based stock assessment to evaluate the consistency and robustness of the RE modeling results and subsequent catch advice. I recommend that the SAWG develop a general protocol and guideline for developing and configuring RE models to provide survey biomass-based stock assessment. I support the ongoing research conducted by the SAWG, including exploration of the Tweedie distribution to address a large number of zero observations commonly seen in survey data, inclusion of additional observation error terms to better quantify modeling errors, and experimental implementation of one-step-ahead residual analysis to improve the RE diagnostics. I also support and applaud the SAWG's effort to test and unify all the existing RE model computer programs and develop the "rema" R Package, making the survey biomass-based stock assessment more transparent and reproducible. The R package appears to work well and provides a flexible and extensible framework for users to fit various RE models (i.e., simple Random Effort model (RE), Random Effect Multi-area model (REM), and REM with an additional longline survey (REMA)) to provide catch advice and ABC apportionment for Tier 4/5 fish stocks in North Pacific.

My detailed research recommendations to further improve the RE model for the survey biomass-based stock assessment for Tier 4/5 fish stocks in North Pacific can be found under each ToR and in the section of Conclusions and Recommendations.

II. Background

Traditional model-based assessments may not be possible for Tier 4/5 fish stocks with limited data available in the North Pacific Fisheries Management Council (NPFMC). To address the management needs for these fish stocks, the NPFMC Groundfish Plan Team's Survey Average Working Group (SAWG) developed random effect (RE) models to analyze fishery-independent survey data for the survey biomass-based assessment of these stocks. The RE models have been used since 2013 for survey biomass-based stock assessment for these data-limited groundfish and crab stocks and provide apportion estimates of Acceptable Biological Catch (ABC) by area. The RE models treat the process errors as random effects with the underlying state dynamics being modelled as a random walk.

Three primary RE model variants were developed since 2013 (Monnahan et al. 2021) including (1) The RE model using a single time series of trawl survey data; (2) The RE multi-area (REM) model incorporating multiple strata simultaneously; and (3) The REM with an incorporation of an additional longline survey (REMA). Although underlying statistical models and assumptions are similar for these three models, Mannahan et al. (2021) found some inconsistencies in modeling and coding. The SAWG conducted the work to unify all the three RE model variants for improving the transparency and reproducibility of RE model-based stock assessment. The new modeling platform was implemented with an R package (i.e., rema), coded in Template Model Builder, to provide a general framework for the Tier 4/5 finfish and crab stock assessments and ABC apportionments. The CIE review is designed to evaluate the RE model and its variants in their suitability and scientific soundness to provide the information to address the management needs for the Tier 4/5 stocks.

As a CIE reviewer, I am charged to evaluate the AFSC approaches to survey biomass-based stock assessments with respect to a set of predefined ToRs. This report includes an executive summary (Section I), a background introduction (Section II), a description of my role in the review activities (Section III), my comments on each item listed in the ToRs (Section IV), a summary of my comments and recommendations (Section V), and references (Section VI). The final part of this report (Section VII) includes a collection of appendices including the Performance Work Statement.

III. Description of the Individual Reviewer's Role in the Review Activities

My role as a CIE independent reviewer is to conduct an impartial and independent peer review of the AFSC approaches to survey biomass-based stock assessments with respect to the defined ToRs.

Prior to the review, all the documents were made available to me through a shared Google folder (https://drive.google.com/drive/u/1/folders/1ki1XyVfeKhCBy8fAJRLQBEJiFc4HKZA6). I read the following document which details recent advances in the methodology. Monnahan et al. 2021. Improving the consistency and transparency of Tier 4/5 assessments. https://meetings.npfmc.org/CommentReview/DownloadFile?p=86098951-a0ed-4021-a4e1-95abe5a357fe.pdf&fileName=Tiers%204%20and%205%20assessment%20considerations.pdf

and its presentation which was presented in the September 2021, North Pacific Fishery Management Council Groundfish Plan Team meetings https://meetings.npfmc.org/CommentReview/DownloadFile?p=02281578-6fca-4f7b-a33b-0f129152a7e4.pdf&fileName=PRESENTATION_Tier%204%20and%205%20Consideration.pdf

I also read other materials and presentations about the AFSC approaches to survey-biomass based stock assessments, background information papers and reports/presentations, and other relevant documents (e.g., SSC review reports) that were sent to me (see the list in Appendix I). I have also researched and organized references relevant to the topics covered in the reports and the Performance Work Statement (PWS) prior to my review.

The review is a desk review and there is no direct interaction between the CIE reviewers and the SAWG. A one-hour meeting was organized via WebEx by the AFSC on Feb. 16, 2023 to answer the questions the CIE reviewers had. The WebEx was attended by the AFSC staff, the SAWG and two CIE reviewers. I asked some questions for further clarifications and requested additional information during the meeting. Dr. Sandra Lowe, Supervisory Research Fish Biologist, hosted the WebEx and provided additional information requested by the CIE reviewers at the WebEx.

IV. Summary of Findings

My detailed comments on each item of the ToRs are provided under their respective subtitles from the ToRs (see below).

1) *Evaluate survey-averaging methods used to support survey biomass-based approaches for data-moderate stocks in the North Pacific.*

   The SAWG is clearly aware of the pros and cons of using survey-averaging methods to support survey biomass-based stock assessment for Tier 4/5 fish stocks in the North Pacific. The issues identified, research conducted and improvements made since 2013 have shown that the SAWG understands potential issues associated with such approaches. *I conclude that the integrated modeling framework and associate R package represent the best available science, given all the constraints in data and various sources of uncertainty*.

   Survey-average methods are commonly used for fish stocks when classic fish population dynamics models cannot be used in stock assessment because of reasons such as poor model fitting/diagnostics (e.g., strong retrospective patterns), lack of reliable fishery-dependent data (e.g., unreliable catch/discard), poor understanding of fishing processes and life history, and/or limited biological data (e.g., little biological data such as age compositions). Because survey-averaging methods (and other survey index based methods) do not explicitly incorporate biological and fishery processes and assume no assumptions on fish population dynamics, they are usually used as "Plan B" when a population dynamics-model-based stock assessment cannot be conducted (Legault et al. 2023).

   For Tier 4/5 fish stocks, because of data limitations, it may be difficult or impossible to use classic stock assessment models. In this case, survey-averaging methods are an option to

support biomass-based approaches to inform Tier 4/5 fish stock management. However, I have the following recommendations to improve the utility of such a method in the Tier 4/5 stock assessment.

a) There is a need to develop a protocol that clearly justifies when a survey-averaging method should be used, to make the process more transparent.
b) Some empirical reference points (e.g., lower 25th percentile for the limit reference point) may need to be developed to be compared with the survey-averaging assessment results to help determine the stock status.
c) Key sources of uncertainty should be explicitly identified and considered in using the survey-averaging stock assessment results to inform management needs. For example, possible changing survey catchability over time and space, as a result of climate-induced changes in fish distributions and movement phenology.
d) Systematic and stratified random survey designs are used on fishery-independent monitoring programs in North Pacific. The different designs call for the use of different methods/models for the quantification of uncertainty estimates.
e) The uncertainties estimated in the RE modeling work are currently not used and explicitly considered in model selection and catch advice. This is not necessarily bad, but such information, if correctly quantified, can inform the reliability of the estimates and may be useful in providing catch advice and stock status determination.

I support and applaud the SAWG's effort to test and unify all the existing RE model computer programs and develop the "Rema" R Package, making the survey biomass-based stock assessment more transparent and reproducible. The R package appears to work well and provides a flexible and extensible framework for users to fit various RE models (i.e., simple RE, REM, and REMA) to provide catch advice and ABC apportionment for the North Pacific Tier 4/5 fish stocks.

The RE modeling research effort is similar to the research for the index-based stock assessment performed by NOAA Fisheries Northeast Fisheries Science Center. I suggest that the SAWG contact Dr. Chris Legault, who chaired the index-based stock assessment working group for information sharing and exchanging. The work by the index-based stock assessment working group can be found at https://www.fisheries.noaa.gov/new-england-mid-atlantic/population-assessments/stock-assessment-working-group-index-based-methods-and-control-rules

2) *Given the available data, evaluate the "random-effects" model now used for many assessments*

   i) *Is this time-series/Kalman filter approach the best estimate of current biomass for management?*

      Given the data limitation for Tier 4/5 fish stocks, I conclude that the RE models currently used provide the best available information to inform their management.

The SAWG developed a modeling framework and relevant computer program that is flexible and extensible for users to fit RE, REM and REMA models, depending on the data availability. The SAWG considered many sources of uncertainties and evaluated their potential impacts on the biomass estimates. Although more extensive study is still needed, the analyses and applications that have been done so far clearly show the utility of the RE model in addressing management needs for Tier 4/5 fish stocks in the North Pacific.

ii) *Are the distributional assumptions appropriate (e.g., lognormal) and how should process error estimation be handled?*

It is difficult to make a general statement about the appropriateness of a statistical distributional assumption. The statistical property of process errors and observational errors is likely to differ for different fish stocks, the appropriateness of a distributional assumption for errors may need to be evaluated for each target fish stock. The SAWG has been developing procedures to evaluate RE modeling residuals (e.g., one-step ahead residual analysis) because the traditional residual analysis to evaluate the distributional assumptions in modeling may be inappropriate. I suggest that a suite of model fit diagnostics (e.g., residual patterns, sensitivity analyses, retrospective patterns) be conducted to evaluate alternative distributional assumptions and the robustness of outputs with respect to changes in distributional assumptions.

For state-space models which explicitly consider both observational and process errors in stock assessment, it is usually difficult to separate observational and process errors in modeling. The SAWG has noted this difficulty in their work and added an additional observation error term in the estimation to avoid the underestimation of observational errors. The SAWG has also noted the need to validate the RE models and provided an experimental implementation of one-step ahead residuals in the most recent RE model to evaluate model fits.

I suggest that the SAWG develop a simulation study with known statistical properties of observational and process errors to evaluate the performance of the RE models with different assumed distributional assumptions for the observational and process errors. Such a simulation study can identify potential impacts of mis-specifying distributional assumptions for observational and process errors and evaluate the ability of RE models in defining (and separating) observational and process errors. The study results can be used to inform the use and interpretation of the RE models and identify possible uncertainties in providing catch advice using the RE stock assessment results.

I also suggest that the SAWG develop a general protocol and guideline outlining all of the steps for compiling survey data, identifying RE models, making statistical assumptions, fitting RE models, conducting model fit diagnostics (including residual patterns, sensitivity analysis and retrospective analysis), selecting the final RE model(s), and interpreting models. Such a protocol makes the RE model-based stock

assessment process more transparent and reproducible, ensuring the provision of the best available information for fisheries management.

The SAWG has already started to test the use of the Tweedie distribution to deal with the data with many zero observations. I would like to encourage that the SAWG continues this effort. A well designed simulation study may be necessary to have a fair comparison of models with different distributional assumptions.

iii) Can multiple surveys be combined appropriately and what about catchability and selectivity?

Multiple surveys can certainly be combined in the RE models. However, some fishery/biological and statistical assumptions need to be made to integrate multiple surveys. For examples, all the surveys included should have consistent and comparable survey designs and target the same fish stock. We also need to know possible differences in catchability and selectivity among surveys. Some assumptions on the spatio-temporal stationarity of survey catchability need to be made. Because of differences among fish stocks, such assumptions need to be evaluated for each individual fish stock before the surveys can be integrated/combined to produce the survey biomass estimates for catch advice. The residual pattern evaluation, sensitivity analysis and retrospective analysis need to be conducted to evaluate possible violations of assumptions, explicitly and implicitly made when combining the survey data. A list of all the implicit and explicit assumptions should be listed to ensure the transparency and reproducibility of the RE-model-based stock assessment.

3) Evaluate use of models for biomass for stock complexes

i) How to estimate total biomass (i.e., multiple models, or run together, or haul level)

The workflow proposed in Monnahan et al. (2021) is pretty comprehensive and considers all the key issues that may influence the survey biomass-based assessments for stock complexes. I recommend the continuous use and testing of the protocol. However, I did not see model diagnostics explicitly included in the workflow. I also did not see a careful evaluation of life history for key species in a stock complex, which should be done prior to combining all of the stocks into a stock complex. An evaluation of possible differences in survey catchability/selectivity may also need to be included in the workflow.

The use of RE model to estimate stock biomass for stock complexes needs to be cautious regarding which biological/fishery assumptions need to be made. For a stock complex with relatively constant structure (e.g., species compositions and stock complex structure are relatively stable over time and space), the estimation of its biomass is similar to that for a single fish stock. However, if the stock complex structure varies greatly over space and time, timing of the surveys may have large impacts on survey results and subsequently the RE estimated biomass. Thus, it is important to understand the stock complex structure and its variability. A careful

analysis of survey data at haul levels may provide some evidence of spatial variability in the stock complex structure. It may be also informative to evaluate possible differences between biomass estimates from fitting the RE model to the stock complex data (i.e., treat stock complex as if it is a single fish species stock) versus the summation of individual species biomasses estimated from fitting the RE model to individual fish species. I believe that it may be difficult to come up with a general approach that is applicable to all stock complexes. Rather, the most appropriate approach for a stock complex can only be identified via an in-depth analysis of stock complex structure and different modeling approaches.

Given the complexity of issues and the possibility of multiple approaches available, I suggest that a sensitivity analysis be conducted to evaluate the impacts of the key factors/choices made in the modeling process in identifying the final model/approach for estimating the total biomass of a stock complex.

ii) How to estimate aggregate M for ABC/OFL

An estimate of natural mortality for a stock complex is not an easy task. This is especially true for a stock complex with multiple species of varying trophic levels and life history processes. I suggest that a careful evaluation of key life history parameters be done to identify the range of natural mortalities for each species in the stock complex. If the M is similar among species, a simple average of M may be sufficient for developing ABC/OFL. However, if M values are very different among species in the stock complex, as identified in the workflow by Monnahan, et al. (2021), an average M weighted by species survey abundance/biomass may be used for the stock complex. However, this approach implicitly assumes that survey catchability is similar for all species in a stock complex. If the survey catchability differs, the difference should be considered in the estimation of a weighted M.

4) Evaluate use of random effects models for apportionment

An appropriate use of RE models for apportionment depends on some assumptions for spatial stationarity of surveys in sampling fish stock area. Factors that may need to be considered include possible spatial variability in survey catchability, fish movement phenology, survey design and timing. The current use of the RE model in apportioning catch seems suitable. However, I would recommend that the implicit assumptions be listed and some discussion be included on potential implications of violating these assumptions.

5) Are other methods more appropriate and make recommendations for improvements (i.e., simple moving averages, ARIMA models, spatial-temporal models)

It will be very informative and insightful to conduct some simulation studies to compare different modeling approaches such as the RE model, spatial-temporal models, simple moving average, the ARIMA model, and other index-based models (Legault et al. 2023). However, the comparison results may be species-dependent. Thus, the simulation study should be carefully designed and the results carefully interpreted. For a simulation study,

we can develop a management strategy evaluation (MSE) framework to simulate survey data with desirable statistical properties. We can then apply the RE models and other index-based models to the simulated data with known statistical properties. A suite of performance measures needs to be developed to compare the performance of different index-based models. Many factors need to be considered in developing the simulation scenarios, including life history characteristics, fishing history, recruitment dynamics, and survey data quality and quantity, which might influence the performance of the RE and other index-based models (Legault et al. 2023).

We can also use data-rich fish stocks (e.g., Tiers 2 and 3 stocks) to compare the RE model with the classic stock assessment models. For data-rich fish stocks, we may be able to apply both the RE models and classic age-structured models (e.g., SS3 and age/length-structured stock assessment models) and compare their differences in the stock status determination and catch advice.

V. Conclusions and Recommendations

Based on the materials and the information provided for this review, I found that the SAWG had done a comprehensive study to develop and improve the RE modeling framework. Their work is scientifically sound and the developed modeling framework is flexible and extensible for different modeling configurations.

I support and applaud the SAWG's effort to test and unify all of the existing RE models and computer programs and develop the "rema" R Package, making the survey biomass-based stock assessment more transparent and reproducible. The R package appears to work well and provides a flexible and extensible framework for users to fit various RE models (i.e., simple RE, REM, and REMA) to provide catch advice and ABC apportionment for Tier 4/5 fish stocks in the North Pacific.

The RE modeling research effort is similar to the research effort for the index-based stock assessment by NOAA Fisheries Northeast Fisheries Science Center. I suggest that the SAWG contact Dr. Chris Legault, who chairs the index-based stock assessment working group for information sharing and exchanging. The work of the index-based stock assessment working group can be found at https://www.fisheries.noaa.gov/new-england-mid-atlantic/population-assessments/stock-assessment-working-group-index-based-methods-and-control-rules

Overall, I conclude that the RE modeling framework developed by the SAWG represents the best available science to survey biomass-based stock assessment for providing catch advice for the North Pacific Tier 4/5 fish stocks. However, I believe it is necessary to further develop and evaluate the performance of the RE models. I provide the following research recommendations that the SAWG may consider to further improve the RE models,

a) Further develop model diagnostics tools and approaches including one-step ahead residual analysis, sensitivity analysis and retrospective analysis to evaluate the

robustness of the model with respect to the model assumptions and identify the optimal model configurations for Tier 4/5 stock assessment;

b) Develop a general protocol and guideline for the RE model selection;
c) Develop simulation studies, preferably in a management strategy evaluation framework, to evaluate the performance of the RE models with different assumptions about error statistical properties and survey catchability/selectivity and compare with other index-based stock assessment approaches;
d) For data-rich stock assessments (e.g., Tiers 2 and 3), apply both the RE models and classic age-/length-based stock assessment models to compare their differences in stock status determinations and ABC/OFL advice;
e) Evaluate the potential impact of shifting stock distributions on the spatio-temporal stationarity of survey catchability and subsequently on the RE modeling results;
f) Further improve the existing workflow for stock complexes;
g) Explore different empirical biological reference points based on the RE model-estimated historical survey biomasses for fish stock status determination and ABC/OFL advice;
h) Evaluate the possible impact of spatial non-stationarity of survey catchability/selectivity on the use of the RE models for apportionment; and finally.
i) Consider the use of uncertainties estimated in the RE modeling work in stock status determination and catch advice.

VI. References

Legault, C., J. Wiedenmann, J. Deroba, G. Fay, T. Miller, E. Brooks, R. Bell, J. Langan, J. Cournane, A. Jojnes, and B. Muffley. 2023. Data-rich but model-resistant: an evaluation of data-limited methods to manage fisheries with failed age-based stock assessments. Canadian Journal of Fisheries and Aquatic Sciences. https://doi.org/10.1139/cjfas-2022-0045

Monnahan, C., J. Sullivan, C. Tribuzio, G. Thompson, P. Hulson. 2021. Improving the consistency and transparency of Tier 4/5 assessments. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://meetings.npfmc.org/CommentReview/DownloadFile?p=86098951-a0ed-4021-a4e1-95abe5a357fe.pdf&fileName=Tiers%204%20and%205%20assessment%20considerations.pdf

VII. Appendices

VII-1. Bibliography of materials provided for review

- Hulson, P.J. F., K. B. Echave, P. D. Spencer, and J. N. Ianelli. 2021. Using Multiple Indices for Biomass and Apportionment Estimation of Alaska Groundfish Stocks. NOAA Technical Memorandum NMFS-AFSC-414

- Monnahan, C., J. Sullivan, C. Tribuzio, G. Thompson, P. Hulson. 2021. Improving the consistency and transparency of Tier 4/5 assessments. September 2021 Plan Team Draft

- Sullivan, J., C. Monnahan, P. Hulson, J. Ianelli, J. Thorson, and A. Havron. 2022. REMA: a consensus version of the random effects model for ABC apportionment and Tier 4/5 assessments. September 2022

- Report of the working group on methods for averaging surveys: Updated through 2013

Presentation slides included

- Tier 4 and 5 assessment considerations by Cole Monnahan, Jane Sullivan, Cindy
- Tribuzio, Grant Thompson and Pete Hulson, September 2021 Joint Groundfish Plan Team Meeting

- Evaluation of statistical models for estimating abundance from a series of resource surveys by
- Paul Spencer, Grant Thompson, Jim Ianelli, and Jon Heifetz. Alaska Fisheries Science Center

- A consensus version of the random effects model for Tier 4/5 and apportionment by
- Jane Sullivan, Cole Monnahan, Pete Hulson, Jim Ianelli, James Thorson, and Andrea Havron. September 2022 Joint Groundfish Plan Team Meeting

- Report of the working group on methods for averaging surveys

Other materials

- Minutes of the Joint Plan Teams for the Groundfish Fisheries of the Gulf of Alaska (GOA) and Bering Sea Aleutian Islands (BSAI) September 21 - 24, 2015

- Minutes Joint Plan Teams for the Groundfish Fisheries of the Bering Sea Aleutian Islands and Gulf of Alaska, September 10-11, 2013

- Joint Groundfish Plan Teams MINUTES, September 19-20, 2022 – Alaska Fishery Science Center Seattle, WA

- Scientific and Statistical Committee Final Report To The North Pacific Fishery Management Council. September 30th – Oct 1st & Oct 4 – 6th, 2021

- Scientific and Statistical Committee Final Report To The North Pacific Fishery Management Council. October 3rd – 5th, 2022

Appendix VII-2. Performance Work Statement

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

AFSC Approaches to Survey Biomass-based Stock Assessments

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

Stocks in Alaska federal waters that have reliable survey biomass estimates, but lack sufficient data for an age or length based stock assessment, are assessed using only of exploitable biomass estimates and an estimate of natural mortality. Historically, exploitable biomass estimates for catch advice varied widely, from the most recent survey estimate, to a variety of moving averages. Starting in 2015, a working group tested via simulations a "random effects" model, which essentially is a close approximation of the univariate Kalman Filter model against a variety of alternatives and recommended it for use by the NPFMC. The method has been

[1] https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/memoranda/2005/m05-03.pdf

expanded to stock complexes, multiple survey indices, and regional apportionment of Acceptable Biological Catch (ABC).

Given that the adoption of this approach has direct implications on management advice, it is important that the methods represent the best available science and are statistically sound. Therefore, the CIE reviewers will conduct a peer review of the current methods based on the Terms of Reference (TORs) referenced below. Given the direct impacts to Alaska fisheries, it will be important for NMFS to have a transparent and independent review process of the model used in these assessments.

Requirements
NMFS requires two reviewers to conduct an impartial and independent desk review in accordance with this Performance Work Statement (PWS), OMB Guidelines, and the ToRs below. The reviewers shall have working knowledge and recent expertise in the application of fish stock assessment methods, particularly survey-based data-moderate assessments. The CIE reviewers shall have expertise in random effects models, and times-series approaches such as Kalman filter methods. In addition, the CIE reviewers should understand design-based and model-based survey estimation methods. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Tasks for reviewers
Each CIE reviewer shall complete the following tasks in accordance with the PWS and Schedule of Milestones and Deliverables herein.

1. Pre-review Background Documents: Review the following background materials and reports prior to the review:

The following document details recent advances in the methodology.
Monnahan et al. 2021. Improving the consistency and transparency of Tier 4/5 assessments.
https://meetings.npfmc.org/CommentReview/DownloadFile?p=86098951-a0ed-4021-a4e1-95abe5a357fe.pdf&fileName=Tiers%204%20and%205%20assessment%20considerations.pdf

This document is summarized in a presentation at the September 2021, North Pacific Fishery Management Council Groundfish Plan Team meetings.
https://meetings.npfmc.org/CommentReview/DownloadFile?p=02281578-6fca-4f7b-a33b-0f129152a7e4.pdf&fileName=PRESENTATION_Tier%204%20and%205%20Consideration.pdf

Two weeks before the peer review, the NMFS Project Contact will send by electronic mail or make available at an FTP site to the CIE reviewer all necessary background information and reports for the peer review. In addition to the documents cited above, the Project Contact will provide pertinent case study example stock assessments that highlight the different use of the methods. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE on where to send documents. The CIE reviewer shall read all documents in preparation for the peer review, for example:

2. Webinar: Additionally, approximately two weeks prior to the peer review, the CIE reviewers will participate in a webinar with the NMFS Project Contact and other staff to address any clarifications that the reviewers may have regarding the ToRs or the review process. The NMFS Project Contact will provide the information for the arrangements for this webinar.

3. Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the PWS and ToRs, and shall not serve in any other role unless specified herein. Modifications to the PWS and ToRs can not be made during the peer review, and any PWS or ToRs modifications prior to the peer review shall be approved by the Contracting Officer's Representative (COR) and the CIE contractor.

4. Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the PWS. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Place of Performance
Each CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Period of Performance
The period of performance shall be from the time of award through May 2022. Each reviewer's duties shall not exceed 10 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.

Within two weeks of award	Contractor selects and confirms reviewers
Two weeks prior to the review	Contractor provides the pre-review documents to the reviewers. Reviewers participate in Webinar.
March 2022	Each reviewer conducts an independent peer review as a desk review
Within two weeks after review	Contractor receives draft reports
Within two weeks of receiving draft reports	Contractor submits final reports to the Government

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
Since this is a desk review travel is neither required nor 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 Contacts:
Sandra Lowe/Chris Lunsford
Supervisory Fish Biologists
NOAA/NMFS/AFSC
Sandra.lowe@noaa.gov, **Chris.Lunsford@noaa.gov**

Annex 1: Peer Review Report Requirements

1. The report must be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether or not the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role 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.

3. The reviewer report shall include the following appendices:
    a. Appendix 1: Bibliography of materials provided for review
    b. Appendix 2: A copy of the CIE Performance Work Statement

Annex 2: Terms of Reference for the Peer Review

AFSC approaches to biomass based stock assessments

CIE reviewers are contracted to complete their independent peer review based on the ToRs. Therefore, the CIE-NMFS review and approval process is based on whether the CIE independent reports addressed each ToRs. The AFSC requests a desk review in March 2022 to review the current data-moderate stock assessment methods used in the North Pacific, specifically related to survey averaging methods. CIE reviewers shall address the following Terms of Reference (ToR) during the peer review and in the CIE reports.

6) Evaluate survey-averaging methods used to support survey biomass-based approaches for data-moderate stocks in the North Pacific.
7) Given the available data, evaluate the "random-effects" model now used for many assessments
    i) Is this time-series/Kalman filter approach the best estimate of current biomass for management?
    ii) Are the distributional assumptions appropriate (e.g., lognormal) and how should process error estimation be handled?
    iii) Can multiple surveys be combined appropriately and what about catchability and selectivity?
8) Evaluate use of models for biomass for stock complexes
    i) How to estimate total biomass (i.e., multiple models, or run together, or haul level)
    ii) How to estimate aggregate M for ABC/OFL
9) Evaluate use of random effects models for apportionment
10) Are other methods more appropriate and make recommendations for improvements (i.e., simple moving averages, ARIMA models, spatial-temporal models)