Center for Independent Experts (CIE) Independent Peer Review Report

Pacific Cod in the Eastern Bering Sea
Stock Assessment Review

Seattle, 26–30 April 2021

Arni Magnusson

Prepared for:

The Center for Independent Experts

Executive Summary

The Eastern Bering Sea (EBS) Pacific cod review workshop, conducted via Google Meet, was a comprehensive evaluation of a variety of topics related to the assessment of this stock. A key outcome was that the stock assessment was accepted by all reviewers as the best scientific information available and an ensemble of five models, including the base model, was recommended as the basis of scientific advice.

Another focus area of the review workshop arose from the first day of presentations and panel discussions, where it became apparent that over the last few years there has been a distinct northward shift in the geographic distribution of the stock. The evidence is found in recent years of data from trawl surveys, tag recoveries, and increasing catches in the Western Bering Sea (WBS). From these data, it appears that a substantial part of the stock is now in Russian waters, at least for a part of the year. This may introduce complications for the stock assessment and management of the stock, as discussed in this review report.

An empirical approach was developed during the review workshop to estimate the CV for survey biomass index, which seemed too low in the baser model. Another development that was presented at the review workshop was a new CPUE index that was calculated using a Vector-Autoregressive Spatio-Temporal (VAST) algorithm to calibrating the annual catch rate index from the commercial fishery in a way that gives appropriate weighting to data points based on their spatial location.

The expert elicitation approach that was used to assign ensemble model weights had been laid out before the review workshop and minor modifications were made by the reviewers. The ensemble approach incorporates uncertainty regarding model assumptions and available data, which could not be captured by any one model.

1 Background

The stock assessment report from December 2020 (Thompson et al. 2020) describes the data, assessment model, results, and the basis for the scientific advice. This report also lists comments and recommendations from earlier review workshops, specifically the Groundfish Plan Team, SSC, and from Alistair Dunn, a consultant. The report also contains responses to those comments and recommendations.

Before the review workshop, the stock assessors had compiled recommendations from earlier reviews to produce a list of TORs (topics) and subtopics (recommendations) that the CIE reviewers were invited to prioritize. This was done after the initial presentations and panel discussions. The revised list of TORs and subtopics was used to navigate the review workshop and is also used to structure this review report.

In addition to the TORs and subtopics prepared before the meeting, the CIE reviewers asked for two new subtopics to be covered in the review:

> ** Highlight the evidence for a recent northward shift in the distribution of EBS Pacific cod and the consequences of such a shift for the stock assessment and management of this stock. [in TOR 2 - Movement]*
>
> ** Consider density dependence in a variety of life history processes to include in assessment models. [in TOR 4 - Miscellaneous]*

2 Review Activities

Following the Performance Work Statement (see Appendix 2), this reviewer read the documents deemed necessary in preparation for the review, participated actively in the review meeting, raised the subtopic of reviewing the evidence for a recent northward shift in the stock distribution, proposed the development of model 21.cie, and authored this independent review report.

3 Findings

TOR 1 - Ensemble Modeling

**** Recommended subtopic: Develop the models to include in an ensemble.***

This subtopic was an overarching question during the review workshop: given everything we know about the stock, which model(s) should be used as the basis of scientific advice. The model run that was presented as the base model (19.12a) was thoroughly scrutinized during the workshop and this reviewer agrees this model is the best model for advisory purposes.

Using the base model as the foundation, four additional model variations were developed during the workshop, for a total of five models (Table 1).

Table 1. Models chosen by the CIE review panel to be included in the model ensemble.

Model	Description
19.12a	base
19.12	base + time-varying q
20.8a	base + dome-shaped survey
20.9a	base + fleet cpue from vast
21.cie	base + estimated survey cv

The purpose of the additional models is to examine the effects of alternative assumptions and data components on the model fit and the resulting advice. Models 19.12 (base + time-varying q) and 20.8a (base + dome-shaped survey) were included to consider alternative ways to model the survey dynamics, which are of high importance in this stock assessment. These model variations have also been included in earlier sensitivity analyses of this stock.

Model 20.9a incorporates fleet CPUE from VAST analysis, a data component that was recently developed and presented at this review. This approach is both interesting and promising, calibrating the annual catch rate index from the commercial fishery in a way that gives appropriate weighting to data points based on their spatial location. On the other hand, the analysis seemed at a somewhat early development stage, as some of the details behind the analysis were missing from the presentation and an evaluation of different statistical options within the method were also not presented. The decision to include model 20.9a is both to support further development and use of the VAST method to analyze CPUE data and to see quantitatively how including the commercial catch rates affects this assessment.

Model 21.cie was developed during the review workshop, as an empirical approach to model the survey CV in a maximum likelihood framework, where σ is the standard deviation of the residuals. The resulting survey CV was higher than that used in the base model and, by definition, made the confidence intervals around the observed survey indices more consistent with the model fit. The effective sample sizes of the age and length compositional data were adjusted accordingly.

Further conclusions regarding the general plausibility and performance of these models are covered in the next section, where the reviewers ranked the models for their use in a model ensemble.

**** Recommended subtopic: Evaluate the use of ensemble modeling in the NPFMC management system, and specifically whether the structural uncertainty and historical challenges in identifying a robust base model make Pacific cod a good application for ensemble modeling.***

A model ensemble approach had already been developed and was presented at the review workshop. It is based on expert elicitation and uses a questionnaire and qualitative scores to calculate quantitative model weights, averaging the scores assigned by the individual reviewers. The reviewers were invited to make minor modifications to the questionnaire and the scoring scale. Since reviewers can give different scores that are then averaged, the approach allowed the review process to move forward at the appropriate pace without having to reach an exact consensus on each score. Overall, the model ensemble approach proved to be efficient and balanced, fueling constructive and insightful discussions.

Table 2. Expert scores from the CIE review panel and the resulting weights for the model ensemble.

Factor 1: Allow *Q* to vary?		no	yes	no	no	no
Factor 2: Allow domed selex?		no	no	yes	no	no
Factor 3: Use fishery CPUE?		no	no	no	yes	no
Factor 4: Estimate survey CV?		no	no	no	no	yes
Criterion	Emph.	19.12a	19.12	20.8a	20.9a	21.cie
General plausibility of the model	3	2	1	0.6667	1	1.3333
Acceptable retrospective bias	3	2	2	1.3333	1	2
Uses properly vetted data	3	2	2	2	0	2
Acceptable residual patterns	3	2	2	2	2	1
Comparable complexity	2	2	1	1	2	2
Fits consistent with variances	2	1	2	1	0	2
Dev sigmas estimated appropriately	0					
Incremental changes	0					
Objective criterion for sample sizes	0					
Change in ageing criteria addressed	0					
Density dependence (other than R) addressed	0					
Regime shifts addressed	0					
Average emphasis:		0.9375	0.8438	0.6875	0.5000	0.8438
Model weight (Ensemble CIE):		0.2459	0.2213	0.1803	0.1311	0.2213

The base model, with constant q and asymptotic survey selectivity, excluding the commercial CPUE and using the original survey CV values, was considered more plausible than the alternative models (Table 2). The base model 19.12a and model 21.cie showed better retrospective consistency, the CPUE data analysis was deemed less properly vetted than other data components, model 21.cie did not fit the most recent years of the survey index, and models 19.12 and 20.8a are penalized for introducing additional estimated parameters. The final model weights sum to one.

After querying the survey experts about the possibility of time-varying q and dome-shaped selectivity, it can be concluded that the base model 19.12a seems like a more parsimonious and robust way to model the survey dynamics than models 19.12 and 20.8a.

In the case of EBS Pacific cod, the survey data are of high quality and good spatial coverage, so it can be concluded that there is no particular reason to include the commercial catch rates as a biomass index. In a traditional selection of one final model, model 20.9a would therefore be excluded from the scientific advice, but a model ensemble approach allows the scientific advice to incorporate the information from the commercial CPUE to a small extent.

Although the estimation of survey CV in model 21.cie is statistically sound, this model's lack of fit to the most recent survey years is concerning. This model has a considerably more pessimistic view of the current stock status than the other models, but the fitted survey index trend of model 21.cie goes far below the observed survey index in the most recent years. The reason this model has a pessimistic view of the current stock status is that the latest cohorts are estimated as small, and this signal is primarily coming from the age and length composition. These conflicting signals about recent recruitment (Figure 1) can be seen as a relevant source of uncertainty and a warning sign that makes it appropriate and precautionary to include that model in the ensemble, given the information at hand.

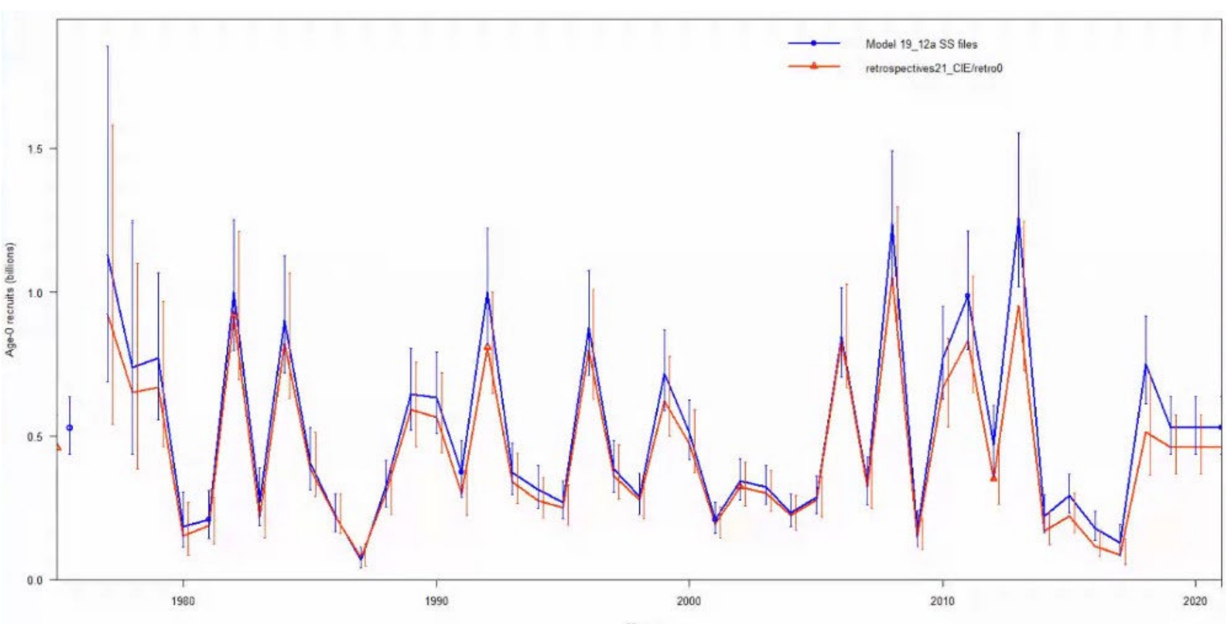

Figure 1. Estimated recruitment in the 19.12a base model and the 21.cie model.

**** Recommended subtopic: Consider whether to apply the sloping harvest control rule before or after ensemble averaging of SSB and other reference points.***

After a presentation on this topic, the review panel examined a few hypothetical scenarios to explore whether it was more appropriate to apply the HCR before or after ensemble averaging. Without going very deep into the statistical intricacies, the conclusion for this reviewer was that it did not make a big difference and would require further investigations and examples to produce convincing arguments for selecting one approach over the other.

TOR 2 - Movement

**** CIE subtopic: Highlight the evidence for a recent northward shift in the distribution of EBS Pacific cod and the consequences of such a shift for the stock assessment and management of this stock.***

In previous years, the Bering Sea trawl surveys showed the main density of the EBS Pacific cod in the southern part of the survey area (blue patches in Figure 2, left panel) but in later years the main density has moved to the northern and northwestern edge of the survey area (blue patches in Figure 2, right panel). Thus, there is clear evidence from the trawl surveys that the distribution of the EBS Pacific cod has shifted north and northwest.

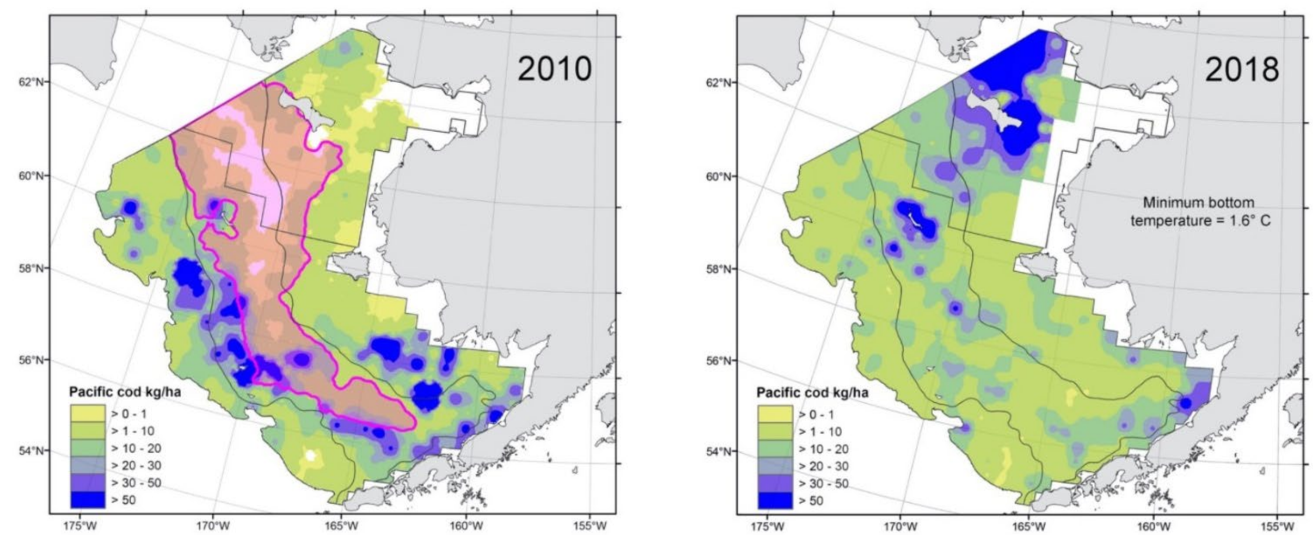

Figure 2. Distribution of Pacific cod in the 2010 and 2018 Bering Sea trawl surveys. From Stevenson and Lauth (2019), cited in this CIE review workshop presentation by Nielsen et al. (2021).

The results from the most recent surveys indicate that a substantial part of the stock was outside the survey area, in Russian waters, as the national maritime boundary cuts through the area with the highest Pacific cod density (Figure 2, right panel). The extended range could be a result of feeding migrations into waters that have become warmer in recent years. At the same time, Russian catches in the Western

Bering Sea tripled between 2012 and 2018 (Table 3, Figure 3).

Table 3. Russian catches of Pacific cod in the Western Bering Sea. From EBS Pacific cod assessment (pers. comm. S. Barbeaux, cited in Thompson et al. 2020) and MSC report (Lajus et al. 2019).

From EBS Pacific cod assessment

Year:	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Catch (t):	11124	16252	16260	15397	18065	23068	19799	21420	31664	45793

From MSC report

Zone	Parameter	2012	2013	2014	2015	2016	2017	2018
Western Bering Sea	TAC	21,200	25,600	36,900	25,300	27,400	36,200	66,000
	Catch	19,150	20,390	25,550	23,350	25,010	33,590	58,280
	% of TAC	90.3	79.6	69.2	92.3	91.3	92.8	88.3

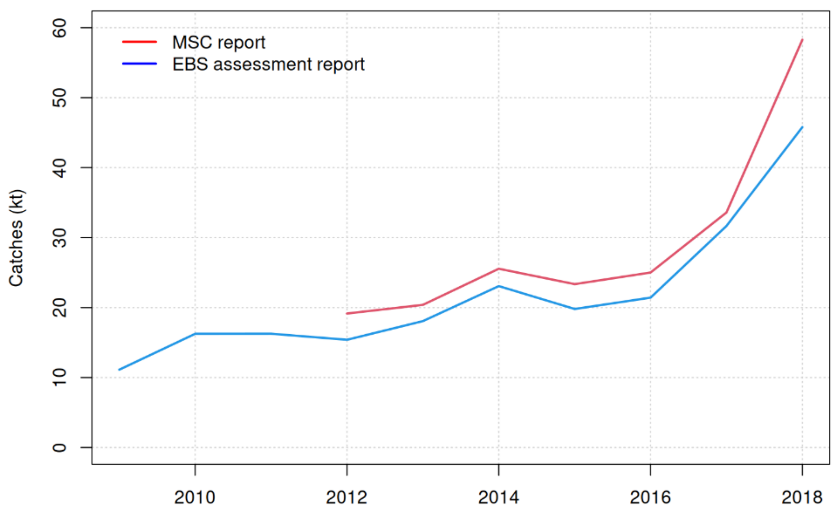

Figure 3. Russian catches of Pacific cod in the Western Bering Sea. From EBS Pacific cod assessment (pers. comm. S. Barbeaux, cited in Thompson et al. 2020) and MSC report (Lajus et al. 2019).

In addition to signs of a shifting distribution from the trawl surveys and Russian catches, a considerably high proportion of Pacific cod tagged in US waters in recent years have been recovered in Russian waters (pers. comm. McDermott, cited in Thompson et al. 2020, Nielsen et al. 2021). As a fourth source of information, genetic studies could be conducted to confirm whether the Pacific cod near the US side and Russian side of the international boundary are indeed the same stock.

The northward shift poses a problem for the stock assessment if a substantial part of the population is outside the defined geographic range of the assessment, in Russian waters. This would cause a negative bias in the observed survey index and total catches, which have in fact both been declining in recent years. A bias could also affect the age and length composition data if, for example, older and larger fish are the ones making long-distance feeding migrations into Russian waters. A solution to these problems could be to combine US and Russian data from trawl surveys and the commercial fisheries.

In addition to biased estimates, the northward shift can also pose a problem for the management of the stock, if the fishing mortality rates (F) are higher on one side of the boundary. In a hypothetical scenario where F increases to high levels on the Russian side in the path of the feeding migrations, the population could decline on the US side even if a sustainable level of F is applied. A solution to this problem could be if the two countries agree on a similar target F for the shared stock.

**** Recommended subtopic: Comment on avenues for incorporating spatial dynamics and movement.***

Rather than adding spatial dynamics and movement into the stock assessment model, it is recommended that a variety of spatial analyses should be conducted to monitor and understand shifts in the geographic distribution of the stock. This applies both to shifts within US waters and the stock range extending into Russian waters. The approaches can include sophisticated analytical models, but also basic plots of densities in surveys, catches in the Western Bering Sea, and locations of tag recoveries.

**** Recommended subtopic: Consider how to inform the dynamics of movement or abundance between the Northern Bering Sea and the Eastern Bering Sea, specifically from additional experiments and analyses, data analyses that include these assumptions (i.e., VAST), and how these can best be used within the different models as indices of abundance.***

The review workshop did not assign much time on this topic, but the reviewers agreed that it would be useful to gain better understanding of fish movement between the NBS and EBS areas, as well as identification of spawning areas within NBS. Overall, fish movement within the geographic range of the stock assessment may in many cases not pose any significant problems. Local depletion is one factor to consider, though, when an increase in stock abundance is mainly in the north, but most of the fishing takes place further south.

TOR 3 - Fishery CPUE

**** Recommended subtopic: Consider how best to further analyze CPUE, including development of spatio-temporal analyses of fleet specific CPUE indices that may help inform the model or supplement the trawl survey biomass indices.***

The VAST approach seems promising as method to analyze CPUE, calibrating the annual catch rate index from the commercial fishery in a way that gives appropriate weighting to data points based on their spatial location. However, it is not apparent that commercial CPUE will add useful information to the stock assessment, given that a high-quality survey is already in place.

TOR 4 - Miscellaneous

**** Recommended subtopic: Consider incorporation of dome-shaped survey selectivity.***

The reviewers queried the survey experts about the possibility of the survey selectivity having a dome shape, related to the survey procedure and the behavior of the fish. All in all, there is no convincing evidence that the survey is dome-shaped, but to take this possibility into account, one such model is included in the model ensemble. The commercial fleet selectivity is already estimated as dome-shaped and having the survey selectivity also dome-shaped can give the model more flexibility than is warranted by the data. The base model is therefore a more robust and useful basis for management purposes.

**** CIE subtopic: Consider density dependence in a variety of life history processes to include in assessment models.***

Density dependence can have a variety of effects on recruitment, growth, natural mortalities, and other aspects of the fish population dynamics, as well as on the fishery and survey. The base model allows recruitment to be estimated freely, according to the information in the data about cohort sizes, and those recruitment fluctuations may or may not turn out be related to density dependence. The base model also incorporates time-varying length-weight coefficients estimated from the data, so changes in growth may or may not be related to density dependence. The review workshop did not identify a simple setting in the SS3 model settings that would allow specific examination of possible density-dependent effects. Overall, it seems that the base model has the flexibility to take density dependence into account, if the data suggest that is the case.

TOR 5 - Age Data

**** Recommended subtopic: Attempt to resolve problems with using fishery age compositions.***

A good tool to examine discrepancies in the age data would be to fit a simple statistical catch-at-age model. Residual patterns and other diagnostics from that model can be used to guide the examination of possible errors in the age data, or at least pinpoint where exactly discrepancies occur in the age data. Findings from this examination can then be used to make informed choices to update the data preparation or consider making specific changes in the base model.

TOR 6 - Compositional Data

The review workshop did not look into compositional data, beyond what is described in TORs 1–5 above.

4 Conclusions and Recommendations

The general conclusion of this review is that the base model encapsulates the best scientific information available, while the ensemble of five models captures the overall uncertainty about model assumptions and available data.

Several recommendations raised in this review are related to the evidence for a recent northward shift in the distribution of EBS Pacific cod into Russian waters. Today, the range of the stock appears to include the Eastern, Northern, and Western Bering Sea. Genetic studies could be conducted to confirm whether the Pacific cod near the US side and Russian side of the international boundary are indeed the same stock. To address the issues that emerge from a straddling fish stock, it seems wise to strengthen collaborative efforts to explore approaches to combine the data from US and Russian fisheries and surveys in one stock assessment or aggregated analysis and, separately, explore whether an agreement can be reached between the countries about applying a similar target F for the shared stock.

It is recommended that a variety of spatial analyses should be conducted to monitor and understand shifts in the geographic distribution of the stock. This applies both to shifts within US waters and the stock range extending into Russian waters. The approaches can include sophisticated analytical models, but also basic plots of densities in surveys, catches in the Western Bering Sea, and locations of tag recoveries.

The VAST approach seems promising as method to analyze CPUE, calibrating the annual catch rate index from the commercial fishery in a way that gives appropriate weighting to data points based on their spatial location. However, it is not apparent that commercial CPUE will add useful information to the stock assessment. This method may nevertheless be advantageous for other stocks that do not have a high-quality survey in place.

A good tool to examine discrepancies in the age data would be to fit a simple statistical catch-at-age model. Residual patterns and other diagnostics from that model can be used to guide the examination of possible errors in the age data, or at least pinpoint where exactly discrepancies occur in the age data. Findings from this examination can then be used to make informed choices to update the data preparation or consider making specific changes in the base model.

Overall, the review process was both efficient and dynamic and the format of six-hour workdays was helpful. This helped to maintain a good pace and focus within the constraints of a remote meeting and also to accommodate the time zone differences. Given the breadth of topics that were covered, it was useful to have three reviewers with slightly different backgrounds to scrutinize the work and raise questions, and likewise a broad team of NOAA scientists who were quick to address and follow up on the questions raised during the review.

Appendix 1: Bibliography of Materials Provided for Review

Thompson, G. 2021 Cross-conditional model averaging: A potential tool for improving stock assessment estimates. Draft manuscript.

Thompson, G., Conner, J., Shotwell, K., Fissel, B., Hurst, T., Laurel, B., Rogers, L., Siddon, E. 2020. Assessment of the Pacific cod stock in the Eastern Bering Sea.

Spies, I., Gruenthal, K.M., Drinan, D.P., Hollowed, A.B., Stevenson, D.E., Tarpey, C.M. and Hauser, L., 2020. Genetic evidence of a northward range expansion in the eastern Bering Sea stock of Pacific cod. Evolutionary applications, 13(2), pp.362-375.

O'Leary, C., Kotwicki, S., Hoff, G., Thorson, J., Kulik, V., Ianelli, J., Lauth, R., Nichol, D., Conner, J., Punt, A. Estimating spatiotemporal availability of transboundary fishes to fishery-independent surveys DRAFT NOT FOR CIRCULATION.

Pre-recorded presentations made available in advance of review:

Conner—survey data. Author: Jason Conner works in the Groundfish Assessment Program (GAP) of the AFSC.

Stone and Anderl—ageing. Authors: Kali Stone and Delsa Anderl work in the Age and Growth Unit of the AFSC.

Kraski—North Pacific Observer Program. Author: Joel Kraski works in the Fishery Monitoring and Analysis Division of the AFSC.

Furuness—catch accounting system and inseason management. Author: Mary Furuness works in the NMFS Alaska Region office.

Nielsen—tagging. Author: Julie Nielsen (Kingfisher Marine Research) is a contractor with GAP/AFSC.

Correa—somatic growth variability. Author: Giancarlo M. Correa is a PhD student of Lorenzo Ciannelli at Oregon State University.

Thorson—ADT movement models. Author: Jim Thorson leads the Habitat and Ecosystem Processes Research Program of the AFSC.

Thorson—VAST fishery CPUE model. Author: See above.

Shotwell—Ecosystem and Socioeconomic Profile (ESP). Author: Kalei Shotwell works in SSMA/AFSC.
Thompson—assessment background as context for the ToR. Author: See above.

Additional presentations:

Merrigan, G. Additional information on Bering Sea p-cod fisheries from the Freezer-Longline Coalition

(FLC = Catcher-processor hook-and-line vessels).

O'Leary, C. Estimating spatiotemporal availability of transboundary fishes to fishery-independent surveys.

Appendix 2: 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

Virtual Panel Review of the Stock Assessment for Pacific Cod in the Eastern Bering Sea

April 26-30, 2021

Background

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

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards. (http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf). Further information on the CIE program may be obtained from www.ciereviews.org.

Scope

The fishery for Pacific cod in the Eastern Bering Sea is among the most commercially important in the U.S. EEZ. Recent developments of note include a substantial northward migration of the stock, to waters outside the area that has been surveyed annually by the NMFS Alaska Fisheries Science Center (AFSC) since 1982. Efforts at modeling this movement have been hampered by the scarcity of both survey data from the northern region and tagging data in general. Conflicts between fishery age composition data and the other data used in the assessment models also pose problems for the assessment. Ensemble modeling has been advocated as a potential solution to the problem of structural

uncertainty in the assessment models, but attempts to date have been mostly unsuccessful.
The goal of this review will be to ensure that the stock assessment represents the best available science to date and that any deficiencies are identified and addressed. The specified format and contents of the individual peer review reports are found in **Annex 1**. The Terms of Reference (TORs) of the peer review are listed in **Annex 2**. Lastly, the tentative agenda of the virtual panel review meeting is attached in **Annex 3**.

Requirements
NMFS requires three (3) reviewers to conduct an impartial and independent peer review in accordance with the PWS, OMB guidelines, and the TORs below. The reviewers shall have a working knowledge of, and recent experience in, the following areas:

- The Stock Synthesis modeling framework;
- Movement (migration) models;
- Ensemble modeling (model averaging); and
- Federal fisheries science requirements under the Magnuson-Stevens Fishery Conservation and Management Act.

The chair, who is in addition to the three reviewers, will be provided by the AFSC; although the chair will be participating in this review, the chair's participation is not covered by this contract.

Tasks for Reviewers

1) 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 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.

2) Additionally, two weeks prior to the peer review, the CIE reviewers will participate in a test to confirm that they have the necessary technical (hardware, software, etc.) capabilities to participate in the virtual panel in advance of the review meeting. The AFSC NMFS Project Contact will provide the information for the arrangements for this test.

3) Attend and participate in the virtual panel review meeting. The meeting will consist of presentations by NMFS scientists, review of model runs conducted during the course of the evening, and discussion among the reviewers, assessment scientists, other scientists involved in the assessment or management process, and members of the public.

4) After the virtual panel review meeting, reviewers shall conduct an independent peer review report in accordance with the requirements specified in this PWS, OMB guidelines, and TORs, in adherence with the required formatting and content guidelines; reviewers are not required to reach a consensus.

5) Each reviewer should assist the Chair of the meeting with contributions to the summary report.

6) Deliver their reports to the Government according to the specified milestones dates.

Place of Performance
The place of performance will be held remotely, via Google Meets video conferencing.

Period of Performance
The period of performance shall be from the time of award through June 2021. The CIE reviewers' 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 two weeks of award	Contractor selects and confirms reviewers
Approximately 2 weeks later	Contractor provides the pre-review documents to the reviewers
April 26-30, 2021	Virtual panel review meeting
Approximately 3 weeks later	Contractor receives draft reports
Within 2 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; and (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel
No travel is necessary, as this meeting is being held remotely.

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

NMFS Project Contact:
Grant Thompson
grant.thompson@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 the science reviewed is the best scientific information available.
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.
a. Reviewers must describe in their own words the review activities completed during the panel review meeting, including a brief summary of findings, of the science, 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 summary report that they believe might require further clarification.
d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.
e. The report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The report shall represent the peer review of each TOR, and shall not simply repeat the contents of the summary report.
3. The report shall include the following appendices:

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

Annex 2: Terms of Reference for the Peer Review

The Terms of Reference were compiled from recommendations submitted by the Groundfish Plan Team for the Bering Sea and Aleutian Islands, the Scientific and Statistical Committee, and Alistair Dunn (a consultant contracted by the Freezer Longline Coalition). These were organized into six general topics, with three specific recommendations per topic. After reading the background materials and receiving the initial set of presentations during the review, the reviewers will prioritize the six topics and identify at least one recommendation per topic to be addressed by the review. The reviewers will then address as many of the topics (and the identified recommendation(s)), in priority order, as time allows.

Topic 1: Movement

Recommendation 1a:

Comment on avenues for incorporating spatial dynamics and movement.

Recommendation 1b:

Consider how to inform the dynamics of movement or abundance between the Northern Bering Sea and the Eastern Bering Sea, specifically from additional experiments and analyses, data analyses that include these assumptions (i.e., VAST), and how these can best be used within the different models as indices of abundance.

Recommendation 1c:

Develop movement models.

Topic 2: Ensemble modeling

Recommendation 2a:

Evaluate the use of ensemble modeling in the NPFMC management system, and specifically whether the structural uncertainty and historical challenges in identifying a robust base model make Pacific cod a good application for ensemble modeling.

Recommendation 2b:

Develop the models to include in an ensemble.

Recommendation 2c:

Consider whether to apply the sloping harvest control rule before or after ensemble averaging of SSB and other reference points.

Topic 3: Age data

Recommendation 3a:
Attempt to resolve problems with using fishery age compositions.

Recommendation 3b:
Consider how best to include the fisheries age and size composition data, including consideration of fleet specific age composition data in the model.

Recommendation 3c:
Investigate whether a change in growth contributed to the ageing bias fit for 2008 and onward in the complex models as ageing bias and growth may be confounded.

Topic 4: Fishery CPUE

Recommendation 4a:
Discuss standardization of fishery CPUE using alternative statistical methods, including a discussion of historical changes in the fishery that may affect the relationship of the index to abundance.

Recommendation 4b:
Develop a fishery CPUE index.

Recommendation 4c:
Consider how best to further analyze CPUE, including development of spatio-temporal analyses of fleet specific CPUE indices that may help inform the model or supplement the trawl survey biomass indices.

Topic 5: Compositional data

Recommendation 5a:
Consider methods (e.g., bootstrapping) to estimate uncertainty and variance in the composition data,

with the results then used to estimate initial sample sizes for each season, fleet, combination for input into the assessment model.

Recommendation 5b:
Review methods to scale the composition data and include consideration of methods that scale observer samples to the catch by vessel, location, and time of event.

Recommendation 5c:
Consider analyses of the size- and age- composition data to identify if there are specific locations or time periods when a recruitment signal may be apparent to assist in informing the assessment model of the strength of recent recruitment.

Topic 6: Other

Recommendation 6a:
Consider incorporation of dome-shaped survey selectivity.

Recommendation 6b:
Consider the diagnostic plots of fits and residuals (including normalised or Pearson residuals) for the age and size composition data and make recommendations on how the model fits may be improved.

Recommendation 6c:
Consider inclusion of other survey information (e.g., the IPHC and sablefish surveys).

Annex 3: Tentative Agenda

Google Meet link: TBD
Phone: TBD

DRAFT AGENDA TBD

Virtual Panel Review of the Stock Assessment for Pacific Cod in the Eastern Bering Sea

Virtual Panel
April 26-30, 2021
Point of contact: Grant Thompson (grant.thompson@noaa.gov)

Appendix 3: Panel Membership

Ingrid Spies ……………..………………….Chair, NOAA Fisheries, Alaska Fisheries Science Center
Grant Thompson……..Assessment Author, NOAA Fisheries, Alaska Fisheries Science Center
Steve Barbeaux………Assessment Author, NOAA Fisheries, Alaska Fisheries Science Center
Henrik Sparholt……..………………………………………..Reviewer, University of Copenhagen
Yan Jiao……..………………..…………………………….………………..…Reviewer, Virginia Tech
Arni Magnusson……………………   …………………….……………………………………Reviewer
Thomas Helser……..……...…………………NOAA Fisheries, Alaska Fisheries Science Center
Jason Conner……..……..……………………..NOAA Fisheries, Alaska Fisheries Science Center
Delsa Anderl……..……...……………………NOAA Fisheries, Alaska Fisheries Science Center
Joel Kraski……..……...………………………NOAA Fisheries, Alaska Fisheries Science Center
Chad See……..……………………….……………………...……Freezer Longline Coalition
Kalei Shotwell……..……..………………..….. NOAA Fisheries, Alaska Fisheries Science Center
Tim Loher…………………..…………………………..……International Pacific Halibut Commission
Craig Kastelle……..……..…………………….. NOAA Fisheries, Alaska Fisheries Science Center
Kali Stone……..……..………………….….NOAA Fisheries, Alaska Fisheries Science Center
Suzanne Mcdermott……..……..………… NOAA Fisheries, Alaska Fisheries Science Center
Julie Neilsen…………………………………………………………University of Alaska Fairbanks
Mary Furuness……..……...………….……..……………………………… NOAA Fisheries
Gerry Merrigan……..……………………….……………….……...…Freezer Longline Coalition
Giancarlo Correa…………………………...……...………………………University of Oregon