Center for Independent Experts (CIE) Reviewer's Independent Peer ReviewReport on the 2015 assessment of Alaskan sablefish (*Anoplopoma fimbria*)

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Center for Independent Experts

Review meeting
Ted Stevens Marine Research Institute
17109 Pt. Lena Loop Rd
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1 Executive summary

TOR a. Evaluation, findings, and recommendations on quality of input data and methods used to process them for inclusion in the assessment.

In general, the data that support the assessment appear to be of very high quality. The methods of data processing are carefully considered. It is positive that there appears to be a continual investigation of new methods for processing / imputing / removing data.

I would not recommend using commercial catch rate data in either the assessment or apportionment unless there is convincing evidence that the survey is missing seasonal fluctuations in the regional biomass. Similarly I would not recommend using nominal (unstandardized) indices of abundance in the assessment.

The longline survey accounts only for measurement error and appears to be overly precise. This may be an important driver of the overly precise estimates of model predicted absolute biomass.

TOR b. Evaluation, findings, and recommendations of the analytical approach used to assess stock condition and stock status.

The assessment model provides excellent fit to the data. It is unlikely the model code contains significant errors as it provides very similar results to two independent statistical catch at age models (SS3 and a spatially explicit model with high mixing) and behaves as expected with various modifications. The assessment does however provide unrealistically precise estimates of absolute stock size and should better account for uncertainties relating to natural mortality rate, possible recruitment compensation and depredation.

TOR c. Evaluation, findings, recommendations on estimation and strategies for accounting for whale depredation

Are the data and methods used in estimating depredation effects sufficient?

The general framework appears defensible but the equations used to derive total removals from depredation may need further consideration and development.

Should depredation estimates be used in the assessment model, and if so, how?

Depredation should be accounted for in CPUE standardization, historical removals and the ABC.

TOR d. Evaluation, findings, recommendations of areal harvest apportionment strategy as related to movement and optimizing spawning stock biomass

Are there biological reasons to adjust apportionment by area?

Tagging data suggests that there is very high stock mixing which means that the principal considerations for apportionment are economic – policy related rather than biological – scientific related.

Is stability more important than close alignment to annual areal abundance changes?

This is a policy decision and is unrelated to the scientific merits of data-collection, data processing and assessment.

TOR e. Recommendations for further improvements

Even though it appears that a spatially aggregated assessment is a reasonable basis for providing core management advice, the spatially explicit assessment model should continue to be developed. The spatial model can be used to quantify value of information (e.g. regional depredation estimates), design tagging studies, explore the possible weaknesses of the spatially aggregated assessment model and investigate apportionment strategies.

2 Introduction

2.1 Background

The 2015 Sablefish (*Anoplopoma fimbria*) Stock Assessment Review was conducted at the Ted Stevens Marine Research Institute, Juneau, Alaska from Tuesday May 10th to Thursday May 12th, 2016. The review panel comprised three CIE reviewers: Dr Noel Cadigan, Dr Neil Klaer and I. The meeting was chaired by the Program Leader, Habitat and Ecological Process Research Program, Dr Mike Sigler. The primary author of the assessment was Fisheries Research Biologist, Dr Dana Hanselman.

The assessment and background documents were made available online (http://www.afsc.noaa.gov/REFM/Stocks/plan_team/2016sablefishCIE/), two weeks in advance of the meeting on the 26th of April 2016.

The meeting was conducted primarily in a presentation format with the panel addressing the various subject matter experts. There were general discussion points throughout and the first day included public comments.

The consensus report was authored by the three CIE reviewers and Dr Sigler and structured by the terms of reference. The consensus report was essentially recommendations only. The summary recommendations were discussed openly on the final day of the meeting. More general comments, suggestions and context were left to the individual reviewer reports.

2.2 Review activities

The subject of presentations included assessment data, assessment assumptions and estimates, assessment model behavior, options for allocation, estimation of depredation and ecosystem modelling/indicators/considerations. Each CIE took notes with a particular reviewer dedicated to drafting the summary report for certain terms of reference (TOR a: Niel Klaer, TOR b: Noel Cadigan, TOR c and d: myself). TOR e was drafted by all panel members on the final day of the meeting. During the following week the summary report was subject to minor edits by the Chair, Dr Sigler and the three panelists, and I drafted my individual review report and submitted a draft on May 26, 2016.

3 Review of 2015 Alaska sablefish assessment

3.1 Terms of reference for the peer review

Alaska Sablefish Assessment

a. Evaluation, findings, and recommendations on quality of input data and methods used to process them for inclusion in the assessment.

b. Evaluation, findings, and recommendations of the analytical approach used to assess stock condition and stock status.

c. Evaluation, findings, recommendations on estimation and strategies for accounting for whale depredation

    a. Are the data and methods used in estimating depredation effects sufficient?

b. Should depredation estimates be used in the assessment model, and if so, how?

d. Evaluation, findings, recommendations of areal harvest apportionment strategy as related to movement and optimizing spawning stock biomass

a. Are there biological reasons to adjust apportionment by area?

b. Is stability more important than close alignment to annual areal abundance changes?

e. Recommendations for further improvements

3.2 A: Evaluation, findings, and recommendations on quality of input data and methods used to process them for inclusion in the assessment

Assessment data were provided to assessment scientists in a timely fashion, well before the end of 2015, providing plenty of time to conduct the model fitting and explore alternative scenarios prior to review.

In general the assessment data were excellent. The assessment benefits from multiple fishery independent indices (trawl and longline) gathered over a comprehensive range of years, areas and depths. Relatively complete size and age composition data are also available for a long duration subsequent to the major development in the fishery in the 1970s. In general the indices that are used to infer relative abundance show good agreement and are not strongly inconsistent with size composition and catch-at-age data.

In some instances CPUE were imputed using ad-hoc approaches such as auto-regressive models (ARIMA). It would be beneficial to use cross-validation to test the relative performance of each prospective CPUE imputation method and possibly also consider simpler, more robust options such as linear interpolation.

There is one compelling reason for using relative abundance data other than the survey: that the survey does not capture the mean relative abundance in each area over the course of a year (i.e. there are seasonal changes outside of the survey). If there is no evidence for this phenomenon, I would recommend using only survey data (ignore fishery CPUE) to inform the assessment. Often fishery catch rate data do not reflect biomass changes and this may not be fully captured by the covariate data that are available. Fishery catch rate data have been observed to be hyperstable (real biomass declining faster than the fishery index) for target species and hyperdeplete (real biomass declining slower than the fishery index) for non-target species (Harley et al. 2001, Walters 2003) and should be considered as a secondary option if fishery independent indices are unavailable (or perhaps used in sensitivity analysis).

3.3 B: Evaluation, findings, and recommendations of the analytical approach used to assess stock condition and stock status

Of the many stock assessments that I have reviewed this was arguably the most comprehensive, supported by excellent data and subject to careful consideration of alternative modelling assumptions. The fits to the various data were very good to excellent and there was little evidence of model misspecification or pathological model behavior such as strong patterns in residual errors or consistent retrospective patterns in model predictions.

The outstanding negative feature of the model is that it provides unrealistically precise estimates of stock biomass (CV~ 5%). Simulation studies have consistently found stock assessments of similar structure to provide unreliable estimates of absolute current biomass (Deroba et al. 2015). This may suggest the model is on a particular end of the bias-variance trade-off.

There are two credible and relatively easy fixes for this problem. Sensitivity analyses suggest that the model estimates of biomass are sensitive to two primary axes of uncertainty: natural mortality rate and the catch rate index of the longline survey; that are currently assumed to be known too precisely. The assessment assumes a point value of natural mortality rate *M*, which both the value and lack of imprecision are not well justified. Model likelihood profiles indicate that there is broad credibility for natural mortality rate values in the range of 0.07 – 0.12 which lead to +/- 20% changes in estimates of current biomass, approximately. Simply placing a prior on *M* (acknowledging that this is unknown)(e.g. log-normal with mean 0.1, CV 0.25) is likely to substantially widen posterior probability intervals for spawning stock biomass to better reflect a credible level of uncertainty in these estimates. Similarly the primary relative abundance index derived from the longline survey has very small standard errors which reflects the low measurement error but does not reflect uncertainties from observation processes such as depredation and seasonal fluctuations in biomass. It would be valuable to consider how credible uncertainty over these processes can be modelled to better characterize the precision of the longline survey index.

Tagging data are not currently used in the model. These data can be extremely informative regarding exploitation rate and natural mortality. Future models should investigate integration of these data (e.g. an integrated multiyear Brownie model, Hilborn 1990).

Tagging data suggest very high rates of stock mixing implying that a spatially aggregated model is appropriate. If there is evidence for spatial variability in population density, it may be beneficial to investigate a spatially implicit model (fleet catchability and selectivity by area). If there is evidence for contrasting trends in abundance among areas it may be necessary to consider a spatially explicit assessment model.

Currently the model does not account for catches taken from the commercial fishery in Northern BC. Given that tagging indicates movement from this area it may be necessary to include these in population-wide estimates of catches. This may be important as estimates of BC catches have been constant at around 4,000-4,500 tonnes for the last 15 years while Alaskan catches have dropped to around 16,000t, implying an increasing exploitation rate in BC waters.

The assessment assumes that there is no relationship between spawning stock biomass and recruitment. SPR reference points and predictions of stock trajectory are undertaken based on recruitment that is assumed to follow a similar mean and variance of model estimated recruitment since 1977. This time period includes a number of very high recruitment estimates, the likes of which have not been estimated since 2000. It may be important to communicate uncertainty from this assumption in management recommendations by modelling recruitment based on other time-periods or by assuming a stock-recruitment relationship (acknowledging that this would imply sablefish belong to a different management tier and control rules).

3.4 C. Evaluation, findings, recommendations on estimation and strategies for accounting for whale depredation

- **Are the data and methods used in estimating depredation effects sufficient?**

  Although I am not experienced in estimation of- and accounting for- depredation by mammals, the general framework for estimating depredation (presented by Petersen and Hanselman) appears to be defensible. The decision to remove depredated sets from the survey may be a good interim solution before more sophisticated approaches can be investigated. It is possible that the catch rates of depredated sets are not representative of non-depredated sets in terms of their decline relative to relative abundance. If for example, depredation occurs in high fish density areas and these areas decline more rapidly as overall abundance changes, clearly removing these from the index standardization may bias the resulting index. A possible solution is to include covariates of depredation in the CPUE standardization and account for this phenomenon simultaneously in survey index calculation.

In terms of estimation of the depredation effect, there are several phenomena that may lead to negative bias (I can't think of factors that might lead to positive bias). The most important of these is that depredation is more likely to occur in high CPUE sets. It is reasonable to assume that whales are actively feeding in areas where prey density (and thus CPUE) is higher. This may be case of a 'non-ignorable' missing data problem, where the probability that data are missing (depredation) is directly related to variable of interest (CPUE). Without an independent covariate of CPUE (a control observation) it may be the case that the magnitude of depredation is always underestimated using the data and method presented. A possible avenue for investigation would be the use of covariates of whale biomass (e.g. from a simple whale biomass dynamics model) to support the estimation.

A less likely source of negative bias in the depredation effect is unobserved predation that would serve to lower estimates of CPUE in sets labelled 'non-depredation' and hence reduce the magnitude of the estimated depredation effect. Similarly, false positive reporting of predators (or falsely assuming that observing predators means depredation is occurring) would make CPUE comparable between sets labelled depredated and non-depredated and would also reduce the magnitude the depredation effect. While the latter two phenomena are probably less important, all of these may contribute to an underestimation of depredation that is meaningful in the context of management advice. This may be considered one axis of structural uncertainty (a form of dead discarding) not considered by the assessment model that would almost certainly inflate estimates of absolute stock size (and perhaps the ABC) and ideally should be reflected in the uncertainty in model estimates of these quantities.

If the reduction from depredation R (a rate), is calculated from depredated catches D and commercial landings C by

(1) $R=D/(C+D)$

if the proportion of sets in which there is depredation P is known, the 'correct' calculation of total depredation T, from R and C is

(2) $T=P*C*(1/(1-R)-1)$

not

(3) $T=P*C*R$

as presented. Note that even the 'correct' calculation (Eqn. 2) assumes that on average equal commercial catches were observed in depredated and non-depredated sets. It may be better to drop the P term altogether and use total commercial catches in sets where depredation was observed to avoid bias in estimates of T. This equation may require more careful consideration (i.e. for Peterson and Hanselman in prep).

- **Should depredation estimates be used in the assessment model, and if so, how?**

Absolutely depredation should be accounted in the stock assessment - it is an important source of mortality and a key axis of structural uncertainty. It should be accounted for in both index calculation and total removals. Possibly the best approach would be to treat depredation as a form of dead discarding. It would be necessary to account for this additional source of mortality both in the historical extractions from the model but also the management advice. ABC recommendations should be adjusted to account for the expected losses due to whales.

3.5 D. Evaluation, findings, recommendations of areal harvest apportionment strategy as related to movement and optimizing spawning stock biomass

- **Are there biological reasons to adjust apportionment by area?**

  Tagging data provide compelling evidence that the stock is well mixed throughout it spatial range. This is confirmed by a spatially explicit model that provides very similar estimates of stock size and trajectory as the spatially aggregated assessment model. The core result is that apportionment is more likely to be determined by economic (policy) considerations than biological/scientific ones of which this review is focused.

- **Is stability more important than close alignment to annual areal abundance changes?**

  In many fisheries management settings there is a trade-off between stability in yield / biomass and maximizing expected yields. The decision about what the correct trade-off should be in any given fishery is very much the remit of the managers and falls outside of the scope of a review of the scientific merits of a data-collection, data processing and assessment framework.

It may be beneficial to use the spatially explicit model to test scenarios under which apportionment may have biological consequences and therefore establish the value of collecting additional data to identify whether those scenarios are credible. Given explicit management objectives for apportionment, the more complex spatial models may be used to investigate the success of various apportionment options.

3.6 E. Recommendations for further improvements

Spatial assessment modelling

The spatially explicit model (Fenske et al. in prep) should continue to be developed to provide answers regarding apportionment and possibly implications for spatially heterogeneous depredation. A spatial operating model can also be used to prioritize regional fishery data collection protocols, establish suitable design of tagging studies and investigate assessment biases due to phenomena such as variable regional recruitment trends.

If there is little evidence for varying trends in abundance among areas but spatially explicit objectives are required (for example apportionment objectives relating to catch rates and fishing efficiency), a spatially implicit stock assessment model (with fleets as areas) could provide the answers required for relatively little extra model complexity.

Currently the movement rate assumed by the spatially explicit assessment model are calculated *apriori* from the tagging data and an assumed fishing mortality rate over areas. It would be useful to compare the spatial fishing mortality rate estimates of the spatial assessment model with those assumed for the *apriori* calculation of movement rates. If these are substantially different it may be necessary to reiterate the assessment with revised movement rates or consider a fully integrated spatial assessment model in which tags are used to directly estimate fishing mortality rates simultaneously with the other assessment data.

Habitat mapping

A presentation on habitat mapping provided a first look at data that could be used to better account for density (e.g. CPUE standardization, Echave et al. 2013) and also inform apportionment. Habitat maps should continue to be explored and where possible validated by survey and commercial catch rate data.

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Appendix 2: A copy of the CIE statement of work

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

Alaska Sablefish Assessment

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

Potential changes to the Alaska sablefish assessment have been proposed. These changes include development of a new fishery catch per unit effort (CPUE) index, incorporation of estimates of whale depredation, and alternatives to the methods for apportionment of catch by area. These changes could have a significant impact on the assessment and on stakeholders. The authors request a review of these potential new changes to the assessment and guidance on best practices for implementation. The Terms of Reference (TORs) of the peer review and the tentative agenda of the meeting are below.

Requirements

NMFS requires three reviewers to conduct an impartial and independent peer review in accordance with the SOW, OMB Guidelines, and the TORs below. The reviewers shall have working knowledge and recent experience in the application of 1) Stock assessment/Population Dynamics; 2) Generalized

Linear Mixed Modeling/Generalized Additive Modeling/Generalized Linear Modeling; 3) Fisheries Management, and 4) Spatially-explicit assessment modeling

Tasks for reviewers

Review the following background materials and reports prior to the review meeting:

NOAA. 2009. Independent review reports, N. Klaer, M. Armstrong, and J. Casey. https://www.st.nmfs.noaa.gov/Assets/Quality-Assurance/documents/peer-review-reports/2009/2009_04_02%20Armstrong%20Alaska%20sablefish%20assessment%20review%20report.pdf

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Hanselman, D.H., J. Heifetz, K.B. Echave, and S.C. Dressel. 2015. Move it or lose it: Movement and mortality of sablefish tagged in Alaska. Can. J. Fish. Aquat. Sci. 72(2): 238-25.

Heifetz, J., J. T. Fujioka, and T. J. Quinn II. 1997. Geographic apportionment of sablefish, *Anoplopoma fimbria*, harvest in the northeastern Pacific Ocean. *In* M. Saunders and M. Wilkins (eds.). Proceedings of the International Symposium on the Biology and Management of Sablefish. pp 229-238. NOAA Tech. Rep. 130.

Peterson, M.J., F. Mueter, D.H. Hanselman, C.R. Lunsford, C. Matkin, and H. Fearnbach. 2013. Killer whale (*Orcinus orca*) depredation effects on catch rates of six groundfish species: Implications for commercial longline fisheries in Alaska. ICES J. Mar. Sci. 70: 1220-1232.

Shotwell, S. K., D. H. Hanselman, and I. M. Belkin. 2014. Toward biophysical synergy: investigating advection along the Polar Front to identify factors influencing Alaska Sablefish recruitment. Deep-Sea Research Part II Topical Studies in Oceanography 107:40–53

Attend and participate in the panel review meeting

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

Each reviewer may assist the Chair of the meeting with contributions to the summary report, if required by the TORs

Deliver their reports to the Government according to the specified milestone dates

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, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/ 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 NOAA Fisheries Alaska Fisheries Science Center in Juneau, Alaska.

Period of Performance

The period of performance shall be from the time of award through June 30, 2016. 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.

Within two weeks of award	Contractor selects and confirms reviewers
No later than April 26, 2016	Contractor provides the pre-review documents to the reviewers
May 10-12, 2016	Panel review meeting
May 27, 2016	Contractor receives draft reports
June 10, 2016	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

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. Travel is not to exceed $23,000.

Restricted or Limited Use of Data

The contractors may be required to sign and adhere to a non-disclosure agreement.

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 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 Statement of Work
Appendix 3: Panel membership or other pertinent information from the panel review meeting.

Appendix 3: Panel membership or other pertinent information from the panel review meeting.

CIE panelists
Neil Klaer
Noel Cadigan (Memorial University)
Tom Carruthers (University of British Columbia)

Meeting chair
Mike Sigler (NOAA)