CIE Independent Peer Review Report

on

Gulf of Alaska Walleye Pollock Stock Assessment Review

Prepared by

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I. Executive Summary

The CIE review for the Gulf of Alaska (GOA) walleye pollock (*Gadus chalcogrammus*) stock assessment, held in Seattle, WA from May 22-25, 2017, was aimed to evaluate the current stock assessment program and make recommendations for improvement. This review is the first CIE review since 2012. The Alaska Fisheries Science Center (AFSC) provided all the necessary logistics support, documentation, data, and background information for the review. The scientists involved in the process were open to suggestions and provided additional information upon request. The review contact, Dr. Martin Dorn, accommodated all the requests I had made. The whole review process was open and constructive and most materials were sent to me in a timely manner. As a CIE reviewer, I am asked to evaluate the GOA pollock stock assessment with respect to the Terms of Reference.

I would like to commend the effort of the GOA pollock stock assessment team for continuing to develop and update the existing stock assessment model based on newly acquired information and understanding, to evaluate the quality and quantity of input data, to be willing to consider alternative model configurations and parameterizations, and to address the uncertainty associated with the input data and model structure.

Overall, I believe the current stock assessment framework provides rather robust assessment results for the GOA pollock stock with respect to various uncertainties in data and models. The assessment appears to be scientifically sound and adequately addresses management requirements. However, I believe some important questions still need to be addressed and there is room to further improve the current stock assessment program for the GOA pollock.

My specific recommendations/comments for further improving the GOA pollock stock assessment program include (1) using season as time step to better capture the strong seasonality of the GOA pollock fishery and life history, and conducting a comparative study to evaluate possible differences in stock assessments using “year” and “season” as time steps; (2) modeling non-stationary process in natural mortality, which is likely more realistic than a temporally invariant natural mortality for the GOA, using a mean (representing an average process) and time-specific deviations from that average process, adding an additional penalized likelihood function to the objective function for penalizing the time-specific parameters deviating from zero, and/or using auxiliary information on the time-specific deviations to help estimate the deviations; (3) conducting a careful evaluation of annual variability in fishery selectivity, once a model is run with random-walk selectivity over years, to identify possible temporal trends in fishery selectivity to decide possible time blocks for the fishery selectivity, which can greatly reduce the number of parameters to be estimated; (4) evaluating possible time-varying catchability coefficients for the SSB and age-1 and age-2 abundance indices estimated in the Shelikof Strait Acoustic-trawl survey; (5) conducting an extensive computer simulation study to optimize the design for each survey program to make them more cost-effective, possibly leading to reduced survey duration and costs; (6) using spatial delta-GLMM method to standardize survey abundance outside the stock assessment model to remove the spatiotemporal trend in selectivity/catchability/availability; (7) evaluating the possibility of having meta-population structure in the inshore area and its potential impacts on the fishery-independent AFSC and Alaska Department of Fish and Game (ADFG) survey programs and stock assessment; (8)

conducting more modeling diagnosis of relative importance of different likelihood functions for different input data sets and how they should be weighted in model fitting (quantity versus quality); (9) evaluating temporal and spatial variability in key life history parameters such as length-at-age, weight-at-age, and maturity-at-age for a better projection of stock biomass and SSB; (10) continuing to evaluate if a bottom-moored echosounder array can provide a survey comparable index of abundance; (11) conducting retrospective analysis for all models (not just a base case scenario) considered in the stock assessment to evaluate the nature (positive or negative) and magnitude of retrospective errors; (12) conducting an extensive computer simulation study based on the data collected in the past to evaluate the effectiveness of the current survey designs in capturing spatiotemporal dynamics of walleye pollock stock in the GOA, and to identify alternative survey designs; (13) conducting habitat suitability modeling to identify suitable habitats for the GOA pollock, using substrate map and ocean observatory data (or model data) to outline the distribution of potential suitable habitat in the GOA and help improve survey design; (14) analyzing among-model variations (for all the final models used in different years of stock assessment) to improve understanding of the model performance and possible management implications of making changes to the models over the time; (15) evaluating the performance of the projection done in the past assessment, retrospectively, to evaluate their performance in achieving the management objectives; (16) keeping the assessment model structure relatively stable over time and using alternative modeling framework such as SS3 to confirm and cross-validate the stock assessment results; and (17) continuing to develop multiple-species stock assessment model to explore possible influence of biotic and abiotic environmental variables on the dynamics of the GOA pollock and to cross-check with the results derived from the single stock assessment model.

Further general and specific comments and recommendations can be found in Section V of this report.

II. Background

Walleye pollock (*Gadus chalcogrammus*), a key species in the Alaska groundfish complex, supports important fisheries in the eastern Bering Sea, Aleutian Islands area, and the Gulf of Alaska (GOA). It yields the largest catch by volume in the USA fisheries. The fisheries are currently assessed and managed as three separate stocks: Bering Sea, Aleutian Islands, and GOA stocks; as supported by observed larval drift patterns from spawning grounds and genetic studies (Grant and Utter 1980; Mulligan et al. 1992; Bailey et al. 1997). Walleye pollock (hereafter referred to as pollock) are not considered to be genetically homogeneous in the GOA (Olsen et al. 2002; Dorn et al. 2012). Genetic differentiation increases with distance. The pollock may have a metapopulation structure in the GOA. The spatial structure of this stock in the GOA supports assessing and managing the pollock in the central and western parts of the GOA (central/western/west Yakutat) separately from the pollock in the eastern portion of the GOA (southeast outside). The stock assessment reviewed by this CIE review is focused on the central and western parts of the GOA (central/western/west Yakutat).

Pollock is a semipelagic schooling fish widely distributed in the North Pacific Ocean ecosystem with the largest concentration found in the eastern Bering Sea. On average, pollock was found in around 75% of survey stations covered in the Alaska Fisheries Science Center (AFSC) bottom trawl survey program in the GOA (Dorn et al. 2016), suggesting they are widely distributed in the GOA. The largest spawning concentrations in the GOA occur in Shelikof Strait and the Shumagin Islands (Dorn et al. 2012, 2016). Pollock is a relatively fast growing and short-lived species and represents a major biological component in the current Bering Sea ecosystem. Their spawning takes place in the early spring on the outer continental shelf. Larvae are epipelagic, mainly in the upper water column and moving downward as they grow. Age and length at 50% maturity for females are approximately 4 years old and 40 cm fork length, respectively. Pollock feed on krill, zooplankton and other crustaceans when they are young and include juvenile pollock and other teleosts with increased sizes. The cannibalism of pollock, particularly adults feeding on juveniles, is well documented. The major predators for the GOA pollock include arrowtooth flounder (*Atheresthes stomias)*, Pacific halibut (*Hippoglossus stenolepis*), and Pacific cod (*Gadus microcephalus*) (Dorn et al. 2016).

The commercial fishery for the GOA pollock started as a foreign fishery in the early 1970s, and developed rapidly during the late 1970s and early 1980s. A large spawning aggregation was found in the Shelikof Strait in 1981, and pollock roe was the main product of the fishery. The fishery became fully domestic by 1988 after a short time period of joint venture operation in the mid-1980s. The current GOA pollock fishery is entirely shore-based with approximately 90% of the catch taken with pelagic trawls. The bycatch in the GOA pollock fishery is rather low. However, the large increase in Chinook salmon bycatch in 2010 led to the development of a cap of 25,000 Chinook salmon bycatch for the GOA Walleye Pollock fishery.

The AFSC fishery-independent bottom trawl surveys for the GOA started in 1981. The GOA have rougher terrain than the EBS, which mandates trawl gear be more rugged. At present, the GOA is surveyed on a biennial schedule covering depth from the shelf to 1000 m. Stratified random design is used in GOA and the survey does not target a specific species. For each survey, there are 825 stations surveyed by three boats in the GOA. The survey is designed to minimize variance of biomass estimates for important groundfish species. Thus, the Neyman method is used to allocate sampling efforts among strata based on survey CPUEs from 5 previous surveys, weighed by the value of important species. Within a selected survey grid, the first sample is normally taken from the trawlable bottom of the sampling area. If no trawlable area is found, the grid is deleted from the future selection. Pollock were caught in over 75% of the survey hauls (Dorn et al. 2016). Relative abundance is calculated as catch standardized by area swept. Standard protocol is used to take biological samples (Cahalan et al. 2010).

It is important to note that the survey takes about two months to complete and survey abundance has not been standardized to remove the possible impact of temporally-variant vessels, temperature and other environmental variables, and equipment (e.g., sensors) on survey catchability. Standardizations may not be necessary for many fishery-independent survey programs. However, for the GOA survey, there are too many factors varying over a relatively long time duration within a survey season, which may call for a thorough study to evaluate their impacts on survey abundance.

For the GOA pollock, 139,044 otoliths sampled from 1982 to 2016 have been aged with the number of otoliths aged above 3,500 in most years (ranging from 375 in 1982 to 6,460 in 1990). These otolith samples were collected from the AFSC and ADFG bottom trawl surveys, Shelikof Strait acoustic-trawl survey, and fisheries. Ageing precision was calculated from comparing 20% of a randomly selected sample read by two of the readers. On-going and future research efforts include employing various methods to validate annulus and using near infrared spectroscopy for age determination to explore its feasibility for speedy age determination.

The GOA pollock stock is assessed using a statistical age-structured assessment model. This model integrates and synthesizes data on catch and catch age composition from the fishery, abundance index and age composition of catch in the fishery-independent bottom trawl surveys done by AFSC and ADFG, and abundance indices and biological information derived from echo-integrated trawl surveys conducted by the AFSC.

Each stock assessment considers the base-case model and alternative models, which are often designed to evaluate sensitivity of the stock assessment model on alternative values/assumptions/hypotheses for life history parameters, temporal variability of fishery and survey catchability and selectivity patterns, and mode configurations. Potential impacts of changing biotic (e.g., prey/predators) and abiotic environmental conditions on the dynamics of GOA pollock stock have also been evaluated. The GOA pollock stock was at a relatively low abundance until the late 1970s, but increased rapidly to a peak in the early 1980s followed by a rapid decline. The stock appears to have stabilized since 1995 at relatively low productivity.

A Climate-Enhanced, Age-based model with Temperature-specific Trophic Linkages and Energetics (CEATTLE) multiple-species stock assessment model has been developed for the pollock to explore possible influence of biotic and abiotic environmental variables. This exercise also evaluates potential trophic interactions between the pollock and their major predators and identifies possible impacts of their predator dynamics on the pollock (Gaichas et al. 2015). Although the work is still considered preliminary for the GOA pollock, it shows great potential in incorporating environmental variability in the assessment and management of GOA pollock.

Based on the information available, the GOA pollock (W/C/WYK regions) is classified as Tier 3 in the NPFMC (North Pacific Fisheries Management Council) tier system for which mortality reference points are calculated based on the spawning biomass per recruit (SPR) and biomass reference points are estimated by multiplying the SPR by average recruitment of a reference time period (The Plan Team for the Groundfish Fisheries of the Gulf of Alaska 2016).

The annual process for conducting the GOA pollock stock assessments includes calls for new model proposals and two fully reviewed drafts of the stock assessment report. The review for the stock assessment reports is usually done by the stock assessment plan team and SSC. The last time when the GOA pollock stock assessments had a CIE review was in 2012.

The base-case model has been selected and used for setting the Overfishing Level (OFL) and Allowable Biological Catch (ABC) for the GOA pollock. Based on Dorn et al. (2016) stock assessment, the 2017 ABC recommendation for pollock in the Gulf of Alaska (W/C/WYK regions) follows a Tier 3 assessment and is 203,769 t, which is a decrease of 20% from the 2016 ABC. For pollock in southeast Alaska (Southeast Outside region), the ABC recommendation for both 2017 follows a Tier 5 assessment, which estimated biomass in 2017 from a random effects model fit to the 1990-2015 bottom trawl survey biomass estimates in Southeast Alaska, and is 9,920 t (The Plan Team for the Groundfish Fisheries of the Gulf of Alaska 2016). TAC is currently allocated to three management districts in the central and western GOA based on the distribution of biomass and is divided among two time periods, from mid-January through May and from late August through October. This spatiotemporal division of TAC is intended for Steller sea lion protection measures. The fishery is 100% allocated to the inshore sector, which consists of catcher vessels delivering shoreside (Dorn et al. 2016).

No formal management strategy evaluation (MSE) has been done as part of the GOA pollock stock assessment, although relevant MSE studies were done previously (e.g., A'mar et al. 2008, 2009a, 2009b, 2010).

This review is the first CIE review since 2012. The AFSC provided all the necessary logistics, support, documentation, data, and background information. The scientists involved in the process were open for suggestions and provided additional information upon request. Dr. Martin Dorn, who is the review contact, worked hard to accommodate all the requests the CIE reviewers made and engaged in very constructive dialogs with the CIE reviewers. The whole process was very open and constructive.

As a CIE reviewer, I am charged to evaluate the GOA pollock stock assessment with respect to the Terms of Reference that was provided by the CIE. This report is prepared following the required format including 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 Terms of Reference (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 Statement of Work (SoW).

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 GOA pollock stock assessment with respect to the pre-defined Terms of Reference.

About two weeks prior to the review workshop in the AFSC in Seattle, I received the GOA pollock stock assessment report and relevant appendix and information including background papers/reports on the various monitoring programs, previous stock assessment reports, peer-reviewed scientific papers addressing various scientific and technical issues identified in previous studies and stock assessments, and previous CIE reports and replies/comments from the Plan Team and the SSC.

I read the stock assessment report by Dorn et al. (2016) for the stock and all other relevant documents that were sent to me (see the list in Appendix I). I also collected and read references relevant to the topics covered in the reports and the SoW prior to my trip to the AFSC.

The CIE review workshop was held from May 22 to May 25, 2017, in the AFSC in Seattle, WA (see Appendix II for the schedule). The first two days of the review were attended by scientists and managers from various organizations (see the List of Participants in Appendix III), and the last two days of the review were attended by the three CIE reviewers, Dr. Martin Dorn (CIE review contact) and Dr. Jim Ianelli (CIE review Chairperson).

Presentations were given during the first two days of review to provide the CIE reviewers with background information on the fishery-dependent groundfish sampling program, fishery-independent bottom trawl survey programs (both federal and state of Alaska), fishery-independent acoustic and trawl survey, ageing methods for pollock, pollock management issues, stock structure, pollock ecosystems including major predators and prey, and stock assessment history and current status (see the list of presentations in Appendix I). I was actively involved in the discussion during the presentation by (1) questioning and asking for clarification on monitoring/sampling program design, data collection methods, statistical analysis, and interpretations; (2) making observations of the process; and (3) making comments and suggestions for alternative approaches and analyses. I had also been interacting with relevant scientists who presented the talks and asked for further clarifications and references during the breaks and through emails. I also provided relevant references to scientists who wanted to discuss in detail the questions I raised at their presentations.

After all the presentations and discussions over the first two days had ended, the CIE reviewers met with each other. We went through a list of questions we had developed over the first two days and met with Dr. Martin Dorn and Dr. Jim Ianelli to discuss these questions and ask for clarification. After the meetings with Drs Dorn and Ianelli, the CIE reviewers held another round of discussion to ensure that we had all the information and a good understanding of the stock assessment for writing the CIE report.

I was actively involved in developing test run scenarios, discussing outputs and their implications, and identifying issues related to test runs. I also discussed relevant issues with the fellow CIE reviewers.

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) *Evaluation of the ability of the stock assessment model, with the available data, to provide parameter estimates to assess the current status of pollock in the Gulf of Alaska.*

The GOA pollock stock is assessed using a statistical age-structured assessment model. This model integrates and synthesizes the following fishery-dependent and fishery-independent data: (1) total fishery catch from 1970 to 2015; (2) age composition data of fishery catch from 1975 to 2015; (3) biomass and its age composition data estimated in Shelikof Strait acoustic-trawl survey from 1992 to 2016; (4) biomass and age composition data estimated in the summer acoustic survey from 2013-2015; (5) swept-area-estimated biomass and age composition estimated in the NMFS bottom trawl survey from 1989 to 2016; and (6) abundance from 1989 to 2016 and age composition from 2000 to 2014 estimated in the ADFG trawl survey. The fishery data were collected from the whole stock area, while different fishery-independent survey programs only covered certain parts of the stock area in the GOA. In formulating likelihood functions, log-normal distributions were assumed for errors associated with observed fishery catch and biomass/abundance derived in various fishery-independent survey programs; while multinomial distributions were assumed for errors associated with observed age composition data derived in fishery and survey programs.

The stock assessment considers the base-case model and alternative models which are often designed to evaluate sensitivity of the stock assessment model on alternative values/assumptions/hypotheses for life history parameters (e.g., growth, natural mortality), temporal variability of fishery and survey catchability and selectivity patterns, and model configurations. Potential impacts of changing biotic (e.g., prey/predators) and abiotic environmental conditions on the dynamics of GOA pollock stock have been evaluated. The GOA pollock stock was at a relatively low abundance until the late 1970s, peaked in the early 1980s following a rapid increase, and then declined rapidly. The stock appears to have stabilized since 1995 at a relatively low productivity. This most recent stock assessment suggests that the GOA pollock stock is not overfished and overfishing is not occurring. This conclusion seems to be robust regarding various assumptions made on the model configurations and parameterization.

I would like to commend the great efforts of the GOA pollock stock assessment team for continuing to develop and update the stock assessment model, evaluating the quality and quantity of input data, considering alternative model configurations and parameterizations, and addressing the uncertainty associated with the input data and model structure. Overall, I believe the current stock assessment framework provides rather robust assessment results for the GOA pollock stock with respect to various uncertainties in data and models. The assessment appears to be scientifically sound and adequately addresses management requirements. In particular, I would like to commend the efforts of Dr. Dorn and his colleagues for their efforts and openness in addressing uncertainty and potential issues in the assessment and in exploring alternative model configurations and parameterizations. However, I believe some important questions still need to be addressed and there is room for improving the current stock assessment framework. Specifically, I would like to make the following suggestions:

The current stock assessment framework uses year as a time step. However, given the strong seasonality of fishery and life history, the model with season as its time step may better capture the dynamics of fishery and life history for the GOA pollock. Some of the stock assessments conducted for other fisheries with strong seasonality have suggested that using an appropriate time step can greatly improve the quality of the stock assessment (Cao et al. 2016). I would suggest to modify the stock assessment model and computer codes to include a "season" option for the time step and conduct a comparative study to evaluate possible differences in stock assessments using "year" and "season" as time steps.

Like most age-structured models, natural mortality was estimated outside the stock assessment model for the GOA pollock. Various approaches were used to estimate the natural mortality, which provides a range of estimates (Dorn et al. 2016). Natural mortality is currently assumed to vary with ages, but not with time in the stock assessment. However, multi-species models and changes in predators/prey abundance in the GOA ecosystem strongly suggest a temporally varied natural mortality for the pollock in the GOA. This non-stationary process in natural mortality can be modeled using a mean (representing an average process) and time-specific deviations from that average process, representing non-stationary processes (Thorson et al., 2015). Thus, annual M can be modeled as a function of mean value of M ($\bar{M}$) and M deviation (*Mdev*) of year *y*: $M_y = \bar{M} e^{Mdev_y}$ This approach is commonly used for modeling recruitments in the integrated assessment models (Methot and Taylor, 2011), where an additional penalized likelihood function is added to the objective function for penalizing the time-specific parameters deviating from zero. When the data inputted to the assessment model are informative, these time-specific parameters can be estimated with slightly under-estimated variation, i.e., standard deviations of these time-specific parameters (Methot and Taylor 2011). Additionally, when auxiliary information on the time-specific deviations is available, such as environmental indices (e.g., predator abundance, temperature, prey abundance), these data can be easily incorporated into the assessment model to help estimate the deviations (Schirripa et al. 2009; Cao et al. 2016).

A random walk over years is incorporated in the stock assessment model to quantify possible variability among years. This model configuration adds 92 parameters to be estimated, which is about 45% of the total number of parameters to be estimated in the stock assessment model. Once a model is run with random-walk selectivity over years, I suggest a careful evaluation of resultant annual variability in fishery selectivity to identify possible temporal trends in fishery selectivity. The identified temporal pattern can be used in the future to decide the time block for the fishery selectivity, which can greatly reduce the number of parameters to be estimated.

Although the Shelikof Strait is the major spawning ground for the GOA pollock, it is likely that some other spawning grounds may exist and the proportion of the total SSB this survey captures may vary over time, which suggests a time-varying catchability. I suggest that some studies be conducted to evaluate possible time-vary survey q for this acoustic-trawl survey. Similar work should also be done for age-1 and age-2 fish indices derived from this survey.

Finishing a survey in a given year takes a long time because of the large geographic area of the GOA for almost all the fishery-independent monitoring programs. The starting and ending time for the Shelikof Strait acoustic survey has been found to be important in accurately capturing the spawning stock biomass in the Shelikof Strait area. The time required to finish a survey in a given year may introduce additional uncertainty to the data quality. I strongly recommend that a computer simulation study (e.g., Cao et al. 2014; Li et al. 2015) be conducted to optimize the design for each survey program to make them more cost-effective, leading to a reduction in the survey duration.

Ideally, a fishery-independent survey program should not have a temporal trend in selectivity, catchability and/or availability. This allows the abundance index derived from such a survey to be used as an unbiased indicator for changes to stock biomass over time. Gear selectivity is unlikely to differ from year to year because the same gear has been used in the survey. However, catchability and/or availability might differ from year to year because of long survey durations, large areas covered by survey programs, use of bottom trawl to survey a semi-pelagic species, and large variations in environmental variables over the large survey area and long survey duration. I suggest modifying the model to accommodate potential temporal trends in selectivity/catchability/availability. A random walk over years can take into account temporal variability in surveys. Once the modeling work is done, a careful analysis can be undertaken to evaluate possible temporal trends for possible identification of time block for the survey catchability and selectivity. Alternatively, I suggest standardizing survey abundance outside the stock assessment model to remove the temporal trend in selectivity/catchability/availability, which has already been done for the ADFG bottom trawl survey. The temporal trend in selectivity/catchability/availability identified in the standardization can also be compared with the temporal trend derived in the assessment model to identify possible differences. This can improve our understanding of parameter estimation in the assessment.

The current setting of catchability q for the AFSC bottom trawl survey assumes a mean of 0.85 with a narrow range defined. This value was derived from experts' opinions, although the process and selection of experts are not well documented. I believe a wide range of values should be given to this q (or freely estimated in the model) in the estimation.

The two fishery-independent bottom trawl survey programs, AFSC and ADFG bottom trawl surveys, cover different areas with the ADFG survey covering inshore and shallow water areas and the AFSC survey covering offshore waters. However, this is not reflected in the stock assessment. The probability of possible meta-population structure in the inshore area and its potential impacts on the stock assessment also need to be carefully evaluated.

There is a need for more in-depth diagnosis of the relative importance of likelihood functions for different input data sets and how they should be weighted in model fitting.

There is also a need to evaluate temporal and spatial variability in key life history parameters such as length-at-age, weight-at-age, and maturity-at-age (e.g., Williams et al. 2016). Because of the dynamics of the ecosystem over time and space in the GOA, the spatiotemporal variability may be large and need to be considered in the stock assessment. The mix-effect model developed by Dr. Jim Ianelli for projecting weight-at-age data for the population projection is a good way to count for possible factors that may influence the weight-at-age data, which may yield better estimates of stock biomass (Ianelli et al. 2016). However, it is important to have a retrospective evaluation of the performance of this model when data become available with time.

It is good that retrospective error is not an issue for this species. However, the potential for this stock assessment to have retrospective errors is rather high because of possible temporal changes in natural mortality, fishery selectivity and survey selectivity. I suggest that a retrospective analysis be performed for all of the scenarios (not just for the base-case scenario as is done in the current assessment).

I would like to commend the research effort to evaluate if a bottom-moored echosounder array can provide a survey comparable index of abundance. The preliminary results are very promising and worth to continue testing. In addition to field testing, I would also suggest conducting an extensive computer simulation study based on the acoustic data collected in the past to evaluate the likelihood of success in selecting different mooring locations for the development of a reliable abundance index and to identify possible sources and statistical property of estimation errors. This study is very promising in developing a cost-effective abundance index of high quality, which has the potential to replace the very expensive and time-consuming acoustic survey.

(2) Evaluation of the strengths and weaknesses in the stock assessment model for GOA pollock.

The current stock assessment model is developed, configured and parameterized for the GOA pollock. It is a standard statistical age-structured model and easy to understand. Built-in constraints and assumptions are readily defined and easy to see and understand. Seeing if the model fits the data poorly is not difficult with some relatively simple model diagnoses. The sensitivity of modeling results with respect to model assumptions, and quality and quantity of input data can be evaluated relatively easily. In summary, this is not a black-box type of models and is relatively simple and straightforward stock assessment model with its behavior and performance well understood. Yet, it is also quite flexible incorporating data from various sources and of different quality and quantity. The model can also yield all the necessary information for the fishery management.

Because the model is an in-house-developed model, revisions/modifications of the model to incorporate possible changes in the fishery assessment and management are relatively easy. It can also serve as an avenue for training a new generation of stock assessment scientists who can develop their own models based on the needs rather than use canned software to do stock assessments. Thus, this type of models is good for training and education purposes and can carry forward the institutional memory of the trace of how a stock assessment is evolved over time.

The GOA pollock stock assessment currently estimates model parameters using maximum likelihood function and is not a full Bayesian model. Uncertainty estimates may not be reliable (tend to be under-estimated), which limits the full consideration of uncertainty in stock assessment and management. A full Bayesian model may be more desirable and suitable for incorporating uncertainty of different sources (e.g., uncertainty associated with natural mortality).

Some assumptions on the stock assessment model may not be suitable. For example, the current stock assessment model fixed the survey catchability coefficients or limited catchability within a very small range based on expert opinions for the AFSC bottom trawl survey. This can have a very large impact on the modeling results. It is important to conduct detailed studies to evaluate potential impacts of such an assumption by comparing the results derived from a free estimated catchability scenario to those derived from a tightly constrained catchability.

The biomass-based and fishing mortality-based biological reference points are currently estimated independently outside the stock assessment model. Although the most recent fish life history and fishery parameters are used in the reference point estimation, a separate estimation of reference points may be problematic and prone to error. Such separate estimation may also make the consideration of uncertainty in determining stock and fishery status difficult. It would be better to extend the stock assessment model to include the estimation F- and B-based biological reference points to ensure the comparability of current F and B estimates with the relevant biological reference points to decide the status of the fishery and stock.

It is highly likely that outliers may exist in fisheries data, which may introduce biases or large errors in stock assessment because log-normal and multinomial likelihood functions tend to be sensitive to outliers in data (Chen et al. 2000). Using robust likelihood functions may be more appropriate because they are not sensitive to outliers yet yield similar results as log-normal and multinomial functions when there is no outlier (Chen et al. 2000; Chen et al. 2003)

(3) *Review of the use of indices from spatial delta-GLMM models rather than area-swept estimates as abundance indices for the bottom trawl survey.*

A fishery-independent survey is often expected to yield reliable abundance index, which is linearly proportional to the targeted fish stock biomass over time. This assumption is critical for the development and use of design-based abundance index in stock assessment. However, this assumption is likely to be violated for the GOA pollock because of long survey durations, changes in charted vessels, differences in capacity of the three vessels used over time, large areas covered by the survey programs, possible fish movement, and limitation of trawlable areas in certain areas. Thus, a design-based abundance index or swept-area stock biomass estimates may not be suitable for the GOA pollock. This calls for standardizing survey abundance index over space and time to remove factors influencing survey catchability to develop a model-based abundance index (Helser et al. 2004; Thorson et al. 2015). A general linear model (GLM) and/or general additive model (GAM) are often developed to include variables that are considered to be important in influencing survey catchability (e.g., temperature, bottom type, location, depth etc.) for developing a standardized survey abundance index. We believe such indices may remove annual variations in catchability, thus improving the quality of input data. However, such an approach does not consider possible autocorrelations over space and time of survey stations, which exist in the survey program. The delta-GLMM models (Thorson et al. 2015) consider the autocorrelations over space and time for a survey and are considered to be better for a traditional GLM and GAM. In studies done for other species (e.g., Cao et al. 2017), the delta-GLMM model derived abundance indices have shown to capture the dynamics of fish populations more effectively. I support exploring the use of spatial delta-GLMM models to develop abundance index for the survey program. However, for this fishery, some comparative studies may need to be done to evaluate difference and identify possible implications of using this model-based abundance index in the GOA Walleye Pollock stock assessment.

(4) *Review of the use of biomass and size composition estimates from the acoustic survey that have been corrected for net selectivity.*

I would commend the efforts for improving estimates of biomass and size composition by correcting net selectivity in the acoustic-trawl survey. It is important to correct for the under-estimated small fish as a result of their escaping from an area with much larger mesh sizes other than codend, which has small mesh sizes, of the survey trawl net. I believe the approach used in the GOA pollock stock assessment is appropriate and encourage its continuous use for future stock assessment.

(5) *Potential evaluation of an equivalent walleye pollock assessment model in Stock Synthesis*

Stock Synthesis (SS) provides a very flexible modeling framework for stock assessment. Given the data available, it is straightforward to implement SS3 for the GOA pollock stock assessment. However, I would discourage replacing the current statistical age-structured stock assessment model with SS3, because SS3 is complicated, general and may be difficult to fully understand, making it a block box type of stock assessment models. Nevertheless, I would encourage the use of SS3 for comparing with the results derived from the statistical age-structured model. A comparative study of results derived from these two models can help improve the understanding of the performance of the age-structured model, confirm the results, and identify possible issues and model misspecifications.

V. Conclusions and Recommendations

I would like to commend the great efforts of all the participants in the GOA pollock CIE review for providing necessary background information on pollock life history, fishery-dependent and fishery-independent monitoring programs, ageing work, stock assessment history, and management issues. I was impressed by the breadth of expertise and experience of the participants, the amount of effort spent collecting, processing and compiling the data, the openness of discussion for considering alternative approaches/suggestions, and the constructive dialogs between the CIE reviewers and other participants throughout the review. Most materials were sent to me in a timely manner.

Overall, I believe the GOA pollock stock assessment provides robust assessment results, especially with regard to the various uncertainties in data and models on temporal trends. The assessment appears to be scientifically sound and adequately addresses management requirements. In particular, I would like to commend the efforts of Dr. Martin Dorn and his colleagues for their effort and openness in discussing potential issues and uncertainty in the assessment and in exploring alternative approaches and future research needs. However, I believe some important questions still need to be addressed and there is still room for improving the current stock assessment. I have made the following general comments and specific recommendations.

General comments

The CIE was instructed to review the GOA pollock stock assessment program rather than to evaluate this particular stock assessment to decide if it is acceptable for determining the stock and fishery status and for developing management regulations. An important issue that needs to be addressed is how the final model can be determined for the development of management regulations. I see limited discussion on this topic in the current stock assessment report. The following four criteria were used to select the final model in the past:

- *"Does the model make full use of the information in the size composition data?*
- *Has the seasonal structure of the model been justified statistically?*
- *Is the model sufficiently parsimonious?*
- *Does the model make plausible estimates of biomass?"*

These measures are important and good indicators of model performance, but they are qualitative measures and may be subjective. The Plan Team and SSC may need to discuss and recommend a set of criteria that are well defined and measurable for choosing the final stock assessment model and scenarios for sensitivity analysis.

Four fishery-independent survey programs have yielded data for the GOA pollock stock assessment. These surveys have had a long history. However, I have seen limited effort in evaluating the effectiveness of these surveys in providing abundance and biological information for the stock assessment. Some extensive studies are needed to evaluate the performance of the survey programs in capturing spatiotemporal population dynamics of fish species such as Walleye pollock in the GOA. For example, a habitat suitability modeling approach (e.g., Tanaka and Chen 2016) can be used to identify suitable habitats for the GOA Walleye pollock, based on substrate map and ocean observatory data (or physical oceanographic model data), to outline potential habitat maps in the GOA and evaluate whether survey sampling stations cover all the effective habitat for pollock in different age groups. Such an approach can also be used to project possible changes in pollock spatial distribution if key habitat variables (e.g., temperature) change. The estimated spatial distribution from such a study can help evaluate and improve survey designs.

Outliers are likely to exist in input data used in the assessment given that the data are derived from different sources and are subject to different levels of errors. They may bias parameter estimation in stock assessment. Robust likelihood functions can reduce impacts of outliers in size composition and survey abundance index.

Although SS3 is very flexible and has been tested and used in the assessment of many fisheries stocks, the results derived need to be carefully evaluated because of its black box nature. I would discourage replacing the current statistical age-structured stock assessment model with SS3 because SS3 is complicated, too general and may be difficult to fully understand. A comparative study of results derived from these two models can help improve the understanding of performance of the age-structured model, confirm the results, and identify possible issues and model misspecifications.

A Bayesian approach has not been fully incorporated in the GOA pollock stock assessment. Thus, uncertainty in the assessment has not been completely included in the assessment and stock projection under different harvest strategies. I would encourage the use of full Bayesian estimator in future stock assessment.

It is important to make the estimation of F- and B-based biological reference points within the statistical age-structured stock assessment model so that the same parameters can be used in the estimation of current F and B and F- and B-based biological reference points, making them comparable. Such an integration can also allow the full consideration of uncertainty in the evaluation of stock and fishery status once the model moves to the full Bayesian stock assessment model.

I support the use of the spatial delta-GLMM to develop standardized abundance indices from the fishery-independent survey data for the GOA pollock stock.

A Climate-Enhanced, Age-based model with Temperature-specific Trophic Linkages and Energetics (CEATTLE) multiple-species stock assessment model has been developed for the pollock to explore possible influence of biotic and abiotic environmental variables. This exercise also evaluates potential trophic interactions between the pollock and their major predators and identifies possible impacts of their predator dynamics on the pollock. Although the work is still considered preliminary for the GOA pollock, it shows great potential in integrating environmental variability in the assessment and management of GOA pollock.

<u>Specific recommendations</u>

Although I have provided detailed comments and recommendations under each TOR, I would like to re-iterate the following recommendations.

- Given strong seasonality of fishery and life history, a model with season as its time step may better capture the dynamics of fishery and life history for the GOA pollock. I would suggest conducting a comparative study to evaluate possible differences in stock assessments using “year” and “season” as time steps.

- Natural mortality was estimated outside the stock assessment model. I would suggest that annual M can be modeled as a function of the mean value of M ($\bar{M}$) and M deviation (*Mdev*) of year *y*: $M_y = \bar{M} e^{Mdev_y}$ This approach is commonly used for modeling recruitments in the integrated assessment models (Methot and Taylor, 2011), where an additional penalized likelihood function is added to the objective function for penalizing the time-specific parameters deviating from zero. Additionally, when auxiliary information on the time-specific deviations is available, such as environmental indices (e.g., predator abundance, temperature, prey abundance), these data can be easily incorporated into the assessment model to help estimate the deviations.

- Once a model is run with random-walk selectivity over years, I suggest a careful evaluation of resultant annual variability in fishery selectivity to identify possible temporal trend of fishery selectivity. The identified temporal pattern can be used in the future to decide the time block for the fishery selectivity, which may greatly reduce the number of parameters to be estimated.

- Although the Shelikof Strait is the major spawning ground for the GOA pollock, it is likely that some other spawning grounds may exist and the proportion of the total SSB this survey captures may vary over time, which suggests a time-varying catchability. I suggest that some studies be conducted to evaluate possible time-vary survey q for this acoustic-trawl survey. Similar work should also be done for age-1 and age-2 fish indices derived from this survey.

- I recommend that a computer simulation study (e.g., Cao et al. ???; Li et al. ???) be conducted to optimize the design for each survey program to make them more cost-effective, leading to a reduction in survey duration.

- I suggest modifying the model to accommodate potential temporal trends in selectivity/catchability/availability. A random walk over years can take into account temporal variability in surveys. Once the modeling work is done, a careful analysis can be done to evaluate possible temporal trends to identify a time block for the survey catchability and selectivity. Alternatively, I suggest standardizing survey abundance outside the stock assessment model (e.g., using spatial delta-GLMM method) to remove the temporal trend in selectivity/catchability/availability, which has already been done for the ADFG bottom trawl survey. The temporal trend in selectivity/catchability/availability identified in the standardization can also be compared with the temporal trend derived from the assessment model to identify possible differences. This can improve our understanding of parameter estimation in the assessment.

- There is a need for more in-depth diagnosis of relative importance of different likelihood functions for different input data sets and how they should be weighted in model fitting.

- There is a need to evaluate temporal and spatial variability in key life history parameters such as length-at-age, weight-at-age, and maturity-at-age as well as project those variabilities in the population projection.

- I suggest continuing to evaluate if a bottom-moored echosounder array can provide a survey comparable index of abundance. In addition to field testing, I would also suggest conducting an extensive computer simulation study based on the acoustic data collected in the past to evaluate the likelihood of success in selecting different mooring locations to develop a reliable abundance index and to identify possible source and statistical property for estimation errors. This study is very promising in developing a high quality cost-effective abundance index, which has the potential to replace the very expensive and time-consuming acoustic survey.

- I recommend that retrospective analysis be conducted for all models (not only for the base case scenario) considered in the stock assessment to evaluate the nature (positive or negative) and magnitude of retrospective errors.

- I suggest standardizing survey abundance index using the spatial delta-GLMM method.

- Given the importance of the survey data in the assessment, I suggest conducting an extensive computer simulation study based on the data collected in the past to evaluate the effectiveness of the current survey designs in capturing spatiotemporal dynamics of Walleye pollock stock in the GOA, and to identify alternative survey designs.

- I believe that once a model is run with random-walk fishery selectivity over years, the temporal trend of selectivity plots needs to be examined closely to identify any temporal patterns. The identified temporal pattern can be used in the future to decide the time block for fishery selectivity, which may greatly reduce the number of parameters to be estimated in the current stock assessment model.

- I suggest conducting habitat suitability modeling to identify suitable habitats for the GOA pollock, using substrate map and ocean observatory data (or model data) to outline potential habitat maps in the GOA and help improve survey design.

- I suggest more effort be put towards model diagnosis on relative importance of various likelihood functions.

- Multiple model configurations were used over the time. I recommend analyzing among-model variations (for all the final models used different years) to better understand the model performance and possible management implications of making changes to the models over the time.

- Recent assessments incorporate the model projection. I recommend that the performance of the projection done in the past assessment be evaluated, retrospectively, to evaluate their performance in achieving the management objectives.

- I suggest that the assessment model structure be kept relatively stable over time. If a new model needs to be used, it should be run in parallel to the old model to identify changes in stock assessment results derived from changes in model configurations.

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VII-1. Appendix 1: Bibliography of materials provided for review

(1) Documents received prior to the review

STOCK ASSESSMENT REPORT

Dorn, M, K. Aydin, B. Fissel, D. Jones, W. Palsson, K. Spalinger, and S. Stienessen. 2016. Assessment of the Walleye Pollock Stock in the Gulf of Alaska National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

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(2) <u>Documents received during the review</u>

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(3) Presentations at the review

- "Overview: Gulf of Alaska Pollock" presented by Dr. Martin Dorn
- "Gulf of Alaska Bottom Trawl Survey" presented by Dr. Wayne Palsson
- "Gulf of Alaska Acoustic-Trawl Surveys Overview" presented by Dr. Chris Wilson
- "Development and applications of bottom-moored echosounders" presented by Dr. Alex De Robertis
- "Ecosystem Considerations Report" presented by Kerim Aydin
- "GOA Walleye Pollock (*Gadus chalcogrammus*) Age Determination at the Alaska Fisheries Science Center" presented by Delsa Anderl
- "Gulf of Alaska pollock assessment" presented by Martin Dorn
- "GOA pollock: ADMB vs SS smackdown" presented by Martin Dorn
- "Dynamic changes in eastern Bering Sea groundfish stocks and relative impacts of growth and recruitment and consequences for fisheries management" presented by Jim Ianelli
- "Spatio-temporal index standardization for survey data" presented by Curry Cunningham and Jim Ianelli

VII-2. Appendix 2: Statement of Work for Dr. Yong Chen

Statement of Work

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

Fisheries Stock Assessment for Walleye Pollock in the Gulf of Alaska

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. 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 Alaska Fisheries Science Center's (AFSC) Resource Ecology and Fisheries Management Division (REFM) requests an independent review of the integrated stock assessment that has been developed for Gulf of Alaska walleye pollock. The fishery for these species is managed by the North Pacific Fisheries Management Council. The ABC for pollock in the Gulf of Alaska is 203,769 t in 2017. The catch limits are established using Automatic Differentiation (AD) Model Builder software that uses survey abundance data and survey and fishery age and length composition data with a harvest control rule to model the status and productivity of these stocks and set quotas. Having these assessments vetted by an independent expert review panel is a valuable part of the AFSC's review process. The Terms of Reference (TORs) of the peer review and the tentative agenda of the meeting are below.

Requirements for CIE Reviewers

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 fisheries stock assessment processes and results, including population dynamics, separable age-structured models, harvest strategies, survey methodology, and the AD Model Builder programming language. Experience with the Stock Synthesis Assessment Model would also be helpful. They should also have experience conducting stock assessments for fisheries management.

Statement of Tasks

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

Dorn, M.W., K. Aydin, B. Fissel, D. Jones, W. Palsson, K. Spalinger, S. Stienessen. 2016. 1. Assessment of the walleye pollock stock in the Gulf of Alaska. In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. pp. 45-174. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, AK 99510.
https://www.afsc.noaa.gov/REFM/stocks/assessments.htm

NPFMC. 2017. GOA Introduction. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish
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https://www.afsc.noaa.gov/REFM/stocks/assessments.htm

Other materials relevant to the review of the pollock assessment will be made available by May 8, 2017, such as working documents, publications, and similar material.

- Attend and participate in the panel review meeting
    - The meeting will consist of presentations by NOAA and other scientists, stock assessment authors and others to facilitate the review, to provide any additional information required by the reviewers, and to answer any questions from reviewers
    - The review meeting is a public meeting and stakeholders that attend may provide perspectives and information relevant to the pollock assessment.
- 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 Alaska Fisheries Science Center, Seattle, Washington.

Period of Performance
The period of performance shall be from the time of award through July 14, 2017. 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 May 8, 2017	Contractor provides the pre-review documents to the reviewers
May 22-25, 2017	Panel review meeting
June 16, 2017	Contractor receives draft reports
June 30, 2017	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 $10,000.

Restricted or Limited Use of Data

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

NMFS Project Contact:

Martin Dorn
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Seattle, WA 98115-6349
Phone: (206) 526-6548

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.

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.

Terms of Reference for the Peer Review

1. Evaluation of the ability of the stock assessment model, with the available data, to provide parameter estimates to assess the current status of pollock in the Gulf of Alaska.
2. Evaluation of the strengths and weaknesses in the stock assessment model for GOA pollock.
3. Review of the use of indices from spatial delta-GLMM models rather than area-swept estimates as abundance indices for the bottom trawl survey.
4. Review of the use of biomass and size composition estimates from the acoustic survey that have been corrected for net selectivity.
5. Potential evaluation of an equivalent walleye pollock assessment model in Stock Synthesis

Review Panel Meeting on Gulf of Alaska Pollock Stock Assessment
Draft Agenda

May 22-25, 2017
Room 2039
Alaska Fisheries Science Center
7600 Sand Point Way NE, Seattle, WA 98112

<u>Monday, May 22, 2015</u>

9:00 a.m.	Welcome and Introductions, Adopt Agenda	Jim Ianelli
9:15 a.m.	Overview of biology, surveys, fishery, management system	Martin Dorn
10:00 a.m.	Gulf of Alaska bottom trawl survey	Wayne Palsson 1 hr
11:00 a.m.	Acoustic surveys in the Gulf of Alaska	Chris Wilson 1 hr
12:00 p.m.	Lunch	
1:30 p.m.	Acoustic survey research projects	Kresimir Williams and Alex DeRobertis 1 hr
2:30 p.m.	Fishery monitoring of the GOA pollock fishery	Craig Faunce and Jennifer Cahalan 1 hr
3:30 p.m.	Age reading	Delsa Anderl 1 hr
4:30 p.m.	Role of pollock in the GOA ecosystem	Kerim Aydin or designee 1 hr
5:30 p.m.	Meeting adjourns for the day	

<u>Tuesday, May 23, 2017</u>

9:00 a.m.	Morning welcome and announcements	
9:15 a.m.	Pollock stock assessment model	Martin Dorn 3 hrs
12:00 p.m.	Lunch	
1:30 p.m.	Pollock stock assessment model (continued)	
3:30 p.m.	Discussion of proposed assessment model changes	
5:00 p.m.	Meeting adjourns for the day	

<u>Wednesday, May 24, 2017</u>

9:00 a.m.	Morning welcome and announcements	
9:15 a.m.	Evaluation of alternative model configurations	
12:00 p.m.	Lunch	
1:30 p.m.	Continued evaluation of alternative model configurations	

Thursday, May 25, 2017

9:00 a.m. Report writing. AFSC analysts will be available to respond to requests and to answer questions

12:00 p.m. Meeting adjourns

VII-3. Appendix III: List of Participants

	First	Last	E-mail	Organization
1	Martin	Dorn	Martin.Dorn@noaa.gov	AFSC
2	Jim	Ianelli	Jim.Ianelli@noaa.gov	AFSC
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5	Kresimir	Williams	Kresimir.Williams@noaa.gov	AFSC
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13	Kerim	Aydin	Kerim.Aydin@noaa.gov	AFSC
14	Ernie	Weiss		AEB
15	Austin	Estabrook		ASPA
16	Jim	Armstrong		NPFMC
17	Katy	McGauley		AGDB
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19	Kurtis	Trzcinski	trzcinskikurt@gmail.com	CIE
20	Yong	Chen	ychen@maine.edu	CIE

AFSC = Alaska Fisheries Science Center, AEB = Aleutians East Borough ASPA = At-Sea Processors Association, NPFMC = North Pacific Fishery Management Council, and AGDB = Alaska Groundfish Data Bank