Assessment author’s response to the Center for Independent Experts (CIE) review of the Gulf of Alaska pollock assessment

Martin Dorn
National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA

The Gulf of Alaska pollock assessment was reviewed by three external reviewers from the Center for Independent Experts (CIE) during July 17-20, 2012. The previous CIE review of the Gulf of Alaska (GOA) pollock assessment was in 2003. The GOA pollock assessment is also subject to annual reviews by the Gulf of Alaska Goundfish Plan Team and the Scientific and Statistical Committee under the North Pacific Fishery Management Council’s stock assessment review process.

This document is a response to the July 2012 CIE review and is organized as follows. First we provide a short summary of the historical context for GOA pollock assessments. Next we summarize and discuss the comments of the reviewers. All the reviewers had good comments on the assessment, and made useful recommendation for improvement. There was some range in the views expressed, and a greater range in the tone in which those views were expressed. Despite this, the reviewers were not strongly dissimilar in the overall direction of their recommendations, and except for a few issues, we generally agreed with their recommendations.

This response is written from the perspective of the lead assessment author, and it is concerned primarily with prioritizing analytical work over the next 3-5 years. A companion document provides a response to the reviews by MACE, the group at AFSC that conducts the acoustic surveys for pollock. Some of the analytical work involves improved treatment of the input data while other work involves assessment modeling. We have attempted to sort tasks into those that are relatively short-term in nature, and those will require additional analytical work that will take longer to accomplish. Those engaged in pollock-related assessment work have competing demands on their time, and perhaps the best that can be expected is a good faith effort to make progress on the identified tasks. A number of the more straightforward recommendations have already been implemented in the 2012 assessment.

Historical context for the GOA pollock stock assessment
Quantitative assessments for GOA pollock began in the early 1980s. Initially, short-term stock projections were made using the estimated numbers at age from the Shelikof Strait acoustic survey, assuming that these estimates were absolute estimate of abundance. GOA pollock was an early application of separable age-structured assessment models, and in 1982 to 1988 results from an early version of the CAGEAN model were also presented in the assessment. In 1989, the first integrated assessment of GOA pollock was done using the stock synthesis model. These early assessments dealt with several challenging issues. The initial acoustic estimate of pollock biomass in Shelikof Strait in 1981 was approximately 3.0 million t, but subsequent surveys indicated a very rapid decline, and by 1988 the biomass was approximately 10% of the initial estimate. Bottom trawl surveys during the same period showed no trend in abundance. There were several hypotheses to explain this discrepancy, but ultimately it could not be resolved with available information. The approach taken was to include both indices in assessment model (with an assumed catchability of one for the bottom trawl index) and to accept that the model would not show an adequate fit to either index. This compromise solution was arrived at after

considering many different approaches, and was adopted only after careful consideration. Subsequent assessments have followed, more or less, the same approach. In 1999, the assessment model was converted to an AD Model Builder application, but the major assumptions were carried forward from the stock synthesis model.

Summary of CIE reviewer comments and findings

A. Data collection procedures and analytical methods used to develop assessment model input

The reviewers noted that survey design and data collection methods for assessment inputs are generally very good but some improvements could be made. The reviewers recommended that more information be provided for each time series of data used in the assessment, and wanted to see a more comprehensive exploratory analysis of all datasets. They recommended that more careful consideration be given to the strengths and weaknesses of each survey in terms of comparability across the whole time series (i.e., changes in design, gear, timing, and protocols). This is a common problem for stock assessments in the North Pacific. Datasets that are introduced receive considerable scrutiny, while those that are used routinely gradually receive less attention in the stock assessment document. We will attempt to provide more information on data inputs in future GOA pollock assessments.

Fishery data

The reviewers were generally satisfied with the fishery monitoring that takes place and relatively comfortable with how the fishery data is used in the assessment. There was concern about adequate sampling on two catcher processors trawlers supposedly fishing for pollock in the GOA. This concern was based on a miscommunication during the presentation by Fisheries Monitoring and Analysis Division staff. Catcher processors are prohibited from fishing for pollock in the GOA.

Bottom trawl survey

The reviewers recommended dropping earlier surveys due to a lack of consistency in survey design. The 1984 and 1987 NMFS trawl surveys were conducted jointly with Japanese commercial vessels that used different gear. The timing of these surveys was much different than subsequent surveys. Considerable effort was expended historically to provide fishing power corrections (FPC) for these surveys. Reviewers also expressed some concern about how the bottom trawl surveys were conducted in the eastern GOA in 1990 and 1993 by the Auke Bay Lab with a higher priority on surveying rockfish. This is a minor issue for GOA pollock because the assessment extends only to 140° W lon. However, the surveys in 1990 and 1993 passed through about a month later than subsequent surveys, and used 30 minute tows rather than 15 minute tows. Therefore an argument could also be made to remove 1990 and 1993 from the time series, or treat them differently. We agree that dropping some of the earlier surveys should be considered, although the utility of an index for stock assessment depends both on its consistency and the length of the time series. The decision to shorten a time series should not be made lightly.

The reviewers also suggested that a GLMM analysis be considered to provide an index of abundance that could take into account vessel effects, rather than the design-based estimators that have been used up to now. It is unclear whether the surveys have been conducted in way that would make possible to estimate a vessel effect. Nevertheless we agree that it there are potential benefits to a model-based approach to deriving abundance indices, and will attempt to bring models forward for comparison.

The reviewers requested an analysis of the effect of the change in tow time from 30 to 15 minutes, which occurred in 1996. We agree to look into this, but there may be no information collected with which to make comparisons. Under reasonable assumptions, a change in tow time of this magnitude should not have a large influence on catch per unit effort.

Egg production surveys
The reviewers suggested reconsidering whether to include the egg production survey in the assessment model, given that it is somewhat redundant with the Shelikof Strait acoustic survey, and that the last survey was conducted in 1992. We agree, and in the 2012 assessment this index was dropped from the model after determining that it had a relatively minor effect on estimated abundance trends.

Historical (pre-1977) surveys
The reviewers questioned whether the historical trawl survey indices contribute much to the assessment. We agree, and in 2012 assessment, the historical trawl survey time series was removed. To ensure a stable initialization of the model, we made the following changes: 1) the model begins in 1964 rather than 1961; 2) an accumulator age was added to initial age composition; and 3) stronger equilibrium assumptions were used for the initial age composition.

ADFG survey
The reviewers questioned whether the ADFG trawl survey provides much information to the assessment, and thought that it could potentially be dropped from the model. If it is to be included, they wanted to see additional documentation so that its merits can be evaluated. Sensitivity analyses in the 2004 assessment indicated that the ADFG survey did influence the result, and acted as a counterbalance to the declining trend in the Shelikof Strait acoustic survey. The fit to this survey is better than either the NMFS bottom trawl or the acoustic survey, despite being given less weight in model fitting. We agree that additional documentation should be provided, including variance estimates, and plan to do a comparison of surveyed area between this survey and the NMFS bottom trawl survey.

Winter acoustic surveys
It was acknowledged by the reviewers that the acoustic surveys in the GOA generally follow best practice. Reviewers noted that the presence of multiple length modes of pollock in Shelikof Strait is a challenge for applying acoustic methods to estimate abundance. They had different views on the severity of this issue, ranging from the opinion that it was irresolvable problem to more a more tempered perspective that improvements in sampling procedures and analytical approaches would better address the issue. We tend to agree with the more moderate view, and plan to enhance our sampling procedures and analytical approaches to improve allocation of backscatter to length modes. An increased number of identification tows, at least over recent levels, is likely to be needed. During the 2013 acoustic survey, over 30 identification tows were conducted, compared to mean of 12 for the previous five acoustic surveys. Routine use of the

CamTrawl system will also allow improved discrimination of spatial and depth differences in pollock size composition.

Information presented at the review meeting indicated that escapement of juvenile pollock though the mesh of the sampling net is significant enough to effect estimates of size composition and biomass. The net selectivity experiments suggest that trawl selectivity may be highly variable and that data collection and analysis will be required before correcting the estimates. Comprehensive sampling with pocket nets during the 2013 survey provided a much more extensive data set for analysis and will reduce the uncertainty in estimates of juvenile escapement. We intend to develop a revised time series of biomass estimates and size composition for use in the assessment model that take into account juvenile escapement.

The reviewers suggested that a focus on producing indices of spawning biomass and juvenile abundance (age-1 and age-2) would be a better approach than estimating total biomass and overall size composition, as is current practice. We do not see how this resolves the problem, since it would still be necessary to estimate the relative abundance of different size modes of fish that are mixed together in different layers of backscatter. Pollock in Shelikof Strait do not always form pure aggregations of pre-spawning pollock that are distinguishable from other types of backscatter. We agree that there are potential advantages to parsing out estimates of juvenile abundance and adult biomass in the data sets provided to the assessment model, and will be considering such models in future assessments.

There were recommendations on number of additional issues related to the acoustic survey. These included the length-target strength relationship for pollock, potential eulachon contribution to acoustic back-scatter, increasing survey efforts to cover all major spawning grounds during winter, and better characterization of uncertainty in acoustic biomass estimates. These are dealt with in the companion document by the MACE group.

Life history Information
The reviewers noted that maturity at age estimates are based on samples collected during the Shelikof Strait acoustic surveys. Since Shelikof Strait is a major spawning area for pollock, there is a concern that higher prevalence of mature pollock may bias the maturity at age estimates. However juvenile pollock are also abundant in Shelikof Strait during the winter, so it not clear that the potential bias due to non-representative sampling is likely to be large. There is limited data available to address this concern. A NPRB-funded project is underway to improve estimates of pollock maturity and fecundity, and to evaluate their spatial and temporal variability.

B. Model structure and assumptions
Precautionary assessment
The reviewers expressed concern about the “precautionary” assumptions in the stock assessment, and specifically mentioned the assumption that catchability equals one for the bottom trawl survey. Reviewers thought that catchability should be estimated and that prior for catchability should be used, rather than fixing catchability at one. Reviewers emphasized that the purpose of stock assessment should be to obtain a “risk-neutral” or “unbiased” assessment of the status of

the stock. Informed by the “best available information” managers can then take appropriate management actions.

We have routinely provided results for models in which catchability is estimated in addition to models where trawl survey catchability is fixed at one. We have recommended that models with estimated catchability not be used for management due to our concerns about the reliability of the catchability estimate. These recommendations have been repeatedly reviewed and endorsed the GOA plan team and the SSC. Characterizing this as precautionary assumption in the assessment is perhaps inaccurate. We believe that the assumption that catchability is one is justifiable based on scientific criteria. Nevertheless, we do agree to focus additional effort on estimating trawl catchability, and on developing quantitative prior for catchability.

Model structure

There was discussion during the review about the benefits of expanding the modeled ages from the current 2-10 age range. Generally reviewers did not see any great advantage to increasing the age range, since there are very few fish above age 10 in the population. In the 2012 assessment, we included age-1s in the model, since allows more straightforward use of age-1 indices from the acoustic and bottom trawl surveys. There was little impact on assessment results.

Reviewers noted that modeling recruitment as log mean plus an annual deviate is the same as assuming steepness equals one, which may lead to biased recruitment estimates if there is sufficient contrast in stock levels. Using deviations from a Beverton-Holt stock-recruit relationship would be a way to deal with this issue. We agree with this recommendation but are doubtful that it will make much of a difference in the assessment results.

Reviewers suggested that alternative different ways to initialize the model be evaluated. Examples included assuming that the age structure is in equilibrium with Bzero, assuming that age structure is in equilibrium with some other level, and freely estimating initial age structure. We considered several of these alternatives in the 2012 assessment, and used a model where age structure is assumed to be in equilibrium at some level different than Bzero.

The reviewers recommended an evaluation of whether natural mortality can be estimated in the model. The use of asymptotic selectivity for surveys and/or the fishery may enable a reliable estimate to be made. There is a concern when using maximum age for a historical period that the value may be unrepresentative of the current period when predation is higher. We agree that this should be evaluated, but are dubious that the data available for the GOA pollock assessment is of sufficient quality to produce a reliable estimate.

Selectivity and Catchability

Reviewers recommended that bottom trawl catchability be estimated rather than fixed at one. There is a general sense that catchability is likely to be lower than one for a bottom trawl sampling pollock, which are found near bottom but also in the pelagic zone. There has been very little experimental work on the elements of catchability for pollock with the high-opening net used for the bottom trawl in the GOA. The experimental work is considered inadequate to provide a quantitative prior for catchability. We have routinely provided results for models in which catchability is estimated, but have recommended that these models not be used for management due to our concerns about the reliability of the catchability estimate. Because some of the data using for the GOA pollock assessment are contradictory, there is a concern that results would be determined more by the attempt to achieve adequate fits to contrasting trends rather than whatever signal there may be in data about catchability. We recognize that at some point there should be sufficient data to support an estimate of catchability for GOA pollock. We are willing to put additional effort into evaluating models with estimated trawl survey catchability, including the use of a prior for catchability, but cannot say now that we would be in favor of using these models for management advice.

Reviewers thought that greater consideration should given to asymptotic selectivity in the model, both for the fishery and NMFS bottom trawl survey. Since the fishery is conducted primarily using mid-water trawls and older fish may be more demersal, there are considerations besides model fit for preferring a dome-shaped selectivity. The situation is less clear for the bottom trawl survey, since there is no obvious reason to expect that the bottom trawl survey would be dome-shaped. Nevertheless, when given the flexibility, the model fits are better with dome-shaped selectivity given the other assumptions in the model. We agree that additional evaluation is needed of fishery and bottom trawl selectivity patterns.

Reviewers noted that in some cases the random walk fishery selectivity appears to be fitting noise rather than a signal. They indicated a preference for modeling selectivity changes using blocks. Based on this recommendation, the 2012 assessment used six selectivity blocks rather than random walk. Model evaluations showed sensitivity to the choice of years when selectivity changes, which adds an element of subjectivity to assessment model. Recent simulation modeling suggests advantages to modeling selectivity with a random walk (Steve Martell, pers. comm. March 2013). We plan to continue exploring methods for modeling changes in fishery selectivity.

Reviewers recommended evaluation of alternative ways to use the acoustic survey data in the assessment model, such as a recruitment index and a spawning biomass index. They also thought unlinking the survey composition data from the survey biomass should be tried. Previous assessments used the age-1 estimate from the acoustic survey as a recruitment index, but this idea could be extended to older but still immature age classes. These are useful suggestions that we will evaluate in future assessments.

Reviewers noted that the selectivity pattern estimated for the acoustic survey is counter-intuitive, since it indicates juvenile fish have higher selectivity than adults. We agree. The high selectivity of the younger fish could simply be a result of using too low a value for juvenile natural mortality, which would have little impact on model results. While juvenile fish can be effectively surveyed using acoustic methods, there is a concern that there is model misspecification or conflicts in the data that are causing this result, and we agree that there should be more evaluation.

Reviewers questioned the need to make a catchability break in the acoustic time series for the change from the Biosonics system to the EK500. The different noise thresholds for the two system would not matter if most of the biomass is in high density aggregations. There was also some question about the need for a catchability break for the change from the Miller Freeman to the Dyson. Although the vessel comparison experiment did not show a strong difference between the two vessels, it was significant, and the experiment was carefully done. We are inclined to retain the catchability break for Freeman-Dyson switch, but will consider models with and without Biosonics-EK500 catchability break. There are larger issues concerning the earlier acoustic biomass estimates.

C. Model estimation procedures (including likelihood functions, and weighting of various data inputs)

The reviewers suggested the use of mean unbiased likelihoods rather than median unbiased likelihoods when fitting indices. This was implemented in the 2012 assessment (it had nil impact on assessment results).

The reviewers recommended that the relative weighting of data sets needs to be more fully explored. This is a good recommendation, and we will work to develop better procedures for data weighting in upcoming stock assessments.

D. Reporting of assessment results and characterization of uncertainty

The reviewers thought that the assessment document should include a more comprehensive presentation of model diagnostics, such as residual bubble plots and retrospective plots where data are sequentially removed from the model. Reviewers also wanted to see a full set of sensitivity runs to show that biomass estimates and projections are relatively stable under alternate reasonable model parameterizations. A systematic exploration of model results by alternately dropping (or down weighting) various data inputs could help determine the main sources of information, and could be done with both survey indices and composition data. In the view of the reviewers, the priority should be to achieve an adequate fit to the surveys (rather than the composition data). Reviewers also wanted to see a plot of an appropriate summary of annual F as part of the assessment results.

Many of these plots and analyses were included in previous pollock assessments, including residual bubble plots, sensitivity analyses down weighting various data inputs, and evaluation of alternative parameterizations. However after having conducting analysis and drawing conclusions from the results, we did not see a need to continue reproducing the analysis in each assessment. This caused problems for the CIE reviewers, since they were not familiar with all the analyses that had been done in previous assessments. We are willing to provide a more expanded set of model diagnostics and sensitivity analyses in the assessment. In the 2012 assessment, a retrospective analysis was provided. Rather than annual fishing mortality estimates, exploitation ratio estimates (catch/starting year 3+ biomass) are provided in every assessment, which do not depend on the selectivity pattern.

We agree with the reviewer comments that the model presented in annual GOA pollock assessment document understates the uncertainty of the assessment. A useful distinction can be made between benchmark assessments, in which all input data and model assumptions are evaluated, and more routine assessment updates where there are limited changes, and we abide by the decisions made during benchmark assessments. The distinction between benchmark assessments and updates is not as clear cut in the North Pacific, and the assessments that are reviewed annually by the Plan Teams and the SSC are somewhere between benchmark assessments and updates. Nevertheless, we have deliberately adopted a conservative approach for the GOA pollock assessment by not revisiting major assumptions and keeping the model structure relatively stable. Since most uncertainty in the GOA pollock assessment is structural rather than estimation uncertainty, assessment updates will not show all of the uncertainty that is present in the assessment.

D. Future model development and assessment-related research

The reviewers recommended that a model that incorporates trends in predation mortality be developed. We agree with this recommendation, but note that this is a significant undertaking. Due to the difficulty in obtaining robust and reliable results, there are very few assessments used to provide management advice that include trends in predation mortality. The reviewers made a number of good suggestions on how to proceed with such a model.

The reviewers suggested that there would be advantages to moving the current assessment to a flexible model package, such as Stock Synthesis or CASAL. There are, of course, advantages and disadvantages to using modeling package, but on balance we agree that it is worthwhile to move forward with a comparison between the current assessment model and comparable model developed using Stock Synthesis, the modeling package that we are most familiar with.

Finally the reviewers recommended that work continue on the MSE for GOA pollock, but with an operating model that does not resemble so closely the assumptions of the current pollock assessment model. We agree that additional MSE work for GOA pollock could potentially be useful, but we would first like to scope out the particular assessment and management issues that would be addressed by further MSE work. There is no reason to do additional MSE work unless MSE is the appropriate tool to address the issues.

E. Evaluate and provide recommendations on F35% spawning biomass per recruit as an appropriate proxy for FMSY for GOA pollock

A simple simulation model was developed by one of the reviewers to evaluate whether F35% is a good FMSY proxy. Results suggested that an SPR-based fishing mortality of the order of F35% or F40%, when derived from a single species constant-M model, may be a poor proxy for FMSY for stocks where natural mortality is highly dependent on the abundance of predators. Depending on the steepness of the stock-recruitment relationship and the effectiveness of the predators when pollock abundance is low, the use of such fishing mortalities could result in average levels of spawning biomass below what is generally considered desirable or safe.

We share the concern that F35% may not be a good proxy for FMSY if natural mortality is highly dependent on predation. There were few suggestions by the reviewers on what might be more appropriate other than to extend the MSE work to test further the performance of different ways of defining FMSY and BMSY proxies in the context of the changing GOA ecosystem.

F. General comments on review process

There was a general sense that the NPFMC/AFSC review process was a good one, consisting of periodic strategic reviews, rather than more intense short-term reviews such as STAR panels, or accept/reject reviews such as SARC. Reviews conducted by the Plan Teams and the NPFMC

SSC are a way to evaluate the changes implemented in the assessment model as a result of the strategic review, prior to being used to provide management advice to NPFMC . The reviewers wanted to see a more formal process of responding to the review, which did not happen after the GOA pollock review in 2003. This document is an attempt to provide a response to the CIE review.

G. Changes in 2012 assessment implemented as a result of the CIE review
The goal in the 2012 assessment was to implement recommendations that could be relatively easily accommodated within the existing model framework, and to postpone to future assessments those recommendations that require methodological development and substantial analysis. The following changes were implemented: 1) the model includes ages 1-10 rather than ages 2-10 as in previous assessments; 2) an accumulator age was added to initial age composition and stronger equilibrium assumptions were used to initialize the model; 3) mean unbiased log-normal likelihoods are used for survey biomass indices; 4) the historical trawl data (pre-1984) was removed from the model; 5) the egg production index (1981-1992) was removed from the model; 6) six selectivity blocks were used for fishery selectivity rather than allowing selectivity parameters to vary annually with a random walk; 7) reduced weights (input sample sizes) were used for the fishery age composition data; and finally, 8) the model begins in 1964 rather than 1961. A model that incorporates these changes was selected as the base model for this assessment, however a model with last year's configuration, and a model where NMFS trawl survey catchability is estimated using a prior are also provided for comparison.

H. Prospective research to support GOA pollock assessment
We expect that the general direction of assessment research for GOA pollock will be as follows:

- Reduce data sets to those that are informative about current status by removing earlier and more questionable data sets, and reducing the influence of the inconsistent data earlier in the time series.
- Improve relative weightings given to different data sets.
- Consider alternative modeling platforms.
- Conduct research to develop informative priors on acoustic and trawl survey selectivity and catchability, and consider different ways to model selectivity.
- Develop an informative prior for the bottom trawl survey catchability.
- Consider models with asymptotic selectivity for the fishery and the bottom trawl survey
- Explore implications of non-constant natural mortality on pollock assessment and management.

List of specific tasks identified in the response to the CIE review:

1. Provide more information on data inputs used in GOA pollock assessment.
2. Consider dropping some of the earlier bottom trawl surveys.
3. Develop a GLM index of abundance from the NMFS bottom trawl survey.
4. If data are available, evaluate the change in 1996 from 15 to 30 minute tows in the bottom trawl survey.
5. Provided additional information for the ADFG survey, including variance estimates, and make a comparison of surveyed area between this survey and the NMFS bottom trawl survey.
6. Enhance sampling procedures and analytical approaches to improve allocation of backscatter to length modes for the Shelikof Strait acoustic survey.
7. Develop a revised time series of biomass estimates and size composition for the Shelikof Strait acoustic survey use in the assessment model that take into account juvenile escapement.
8. Consider models that parse out estimates of juvenile abundance and adult biomass for the Shelikof Strait acoustic survey
9. Complete the NPRB-funded project to improve estimates of pollock maturity and fecundity, and to evaluate their spatial and temporal variability.
10. Consider models where recruitment is modeled as using deviations from a Beverton-Holt stock-recruit relationship.
11. Consider models with estimated natural mortality.
12. Estimate bottom trawl catchability, potentially using a prior.
13. Evaluate fishery and bottom trawl selectivity patterns (asymptotic vs domed-shaped).
14. Explore methods for modeling changes in fishery selectivity.
15. Evaluate whether the catchability break in the acoustic time series for the change from the Biosonics system to the EK500 is needed.
16. Improve the relative weighting of data sets in the assessment model.
17. Provide a more expanded set of model diagnostics and sensitivity analyses in the assessment.
18. Provide scenarios to better characterize the range of uncertainty in the assessment
19. Develop a model that incorporates trends in predation mortality.
20. Compare the current assessment model with a comparable model developed using Stock Synthesis.
21. Extend the MSE research to test the performance of different ways of defining FMSY and BMSY proxies in the context of the changing GOA ecosystem.

Appendix 1. Terms of Reference for the CIE review of Gulf of Alaska pollock

1. Evaluate and provide recommendations on data collection procedures and analytical methods used to develop assessment model input.
2. Evaluate and provide recommendations on model structure, assumptions, and estimation procedures.
3. Evaluate and provide recommendations for the reporting of assessment results and characterization of uncertainty.
4. Evaluate and provide recommendations on F35% spawning biomass per recruit as an appropriate proxy for FMSY under non-stationarity in vital rates. Also evaluate and provide recommendations on the B35% biomass reference point as a proxy for BMSY.
5. Recommendations for further improvements.
6. Brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations.

Appendix 2. Review Panel Meeting on Gulf of Alaska Pollock Stock Assessment Draft Agenda

July 17-20, 2012

Alaska Fisheries Science Center

7600 Sand Point Way NE, Seattle, WA 98112

Tuesday, July 17, 2012

9:00 a.m.	Welcome and Introductions, Adopt Agenda	Anne Hollowed
9:15 a.m.	Overview of biology, surveys, fishery, management system	Martin Dorn
10:00 p.m.	Gulf of Alaska bottom trawl survey	Michael Martin 1 hr
11:00 p.m.	Acoustic surveys in the Gulf of Alaska	Mike Guttormsen/Chris Wilson 1 hr
12:00 p.m.	Lunch	
1:30 p.m.	Evaluation of net selectivity in acoustic surveys	Kresimir Williams 1 hr
2:30 p.m.	Fishery monitoring of the GOA pollock fishery	Lisa Thompson 1 hr
3:30 p.m.	Role of pollock in the GOA ecosystem	Kerim Aydin 1 hr
5:00 p.m.	Meeting adjourns for the day	

Wednesday, July 18, 2012

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.	Management Strategy Evaluation of GOA pollock assessment	Teresa A'mar 2 hr
3:30 p.m.	Discussion of proposed assessment model changes	Martin Dorn 2 hr
5:00 p.m.	Meeting adjourns for the day	

Thursday, July 19, 2012

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

Friday, July 20, 2012

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

Appendix 3. MACE Response to Acoustic Survey Issues Raised during July 2012 CIE GOA Pollock Review

Introduction. The MACE Program participated in the 2012 CIE review of the stock assessment for walleye pollock in the Gulf of Alaska. Two presentations were given by MACE staff. One provided a brief overview of the acoustic-trawl survey methods used to assess walleye pollock in the GOA and eastern Bering Sea (EBS), as well as highlights of research conducted by the acoustics group in support of the surveys. The other presentation described results of a midwater trawl selectivity study, with an emphasis on the impacts of selectivity to acoustic-trawl survey estimates of abundance.

The three reviewers' comments regarding acoustic survey were uneven. One reviewer stated that there, "was no technically defensible method to produce an unbiased estimate of proportion-at-age" in spite of the fact that methods followed by the MACE program were widely accepted as best practice for acoustic surveys (Simmonds and MacLennan 2005) . Example calculations using arbitrary, and in our view extreme, parameter values were provided by the reviewer to illustrate his concern for biased proportion-at-age estimates. Another reviewer stated, however, that current length frequency distributions and numbers-at-age estimates from the acoustic survey did not seem too bad at tracking cohorts through time, particularly up to about age 7, which suggested that the "problems with the way the survey is currently used are possibly not too severe." The third reviewer also commented that he was "less convinced that such a strong alteration is necessary…" when referring to the first reviewer's recommendation to drop, "the age composition data and age2+ biomass index in favor of a spawning biomass index and an age1 recruitment index." Below we respond to the recommendations and concerns raised by all reviewers. Overall, we agree that size biases introduced from the trawl gear and analysis methods are an important concern for acoustic surveys used for stock assessment, including the Shelikof Strait acoustic-trawl survey. However, we do not agree that there is sufficient evidence to conclude that the abundance-at-age estimates from the Shelikof Strait survey are biased to the point of invalidating the survey results. The reviewers raised some valid concerns and suggestions, and we will take actions to incorporate those suggestions in our survey operations, our interpretation of survey results, and our survey-related research to improve survey methods.

Reviewers' Major Concerns & Recommendations, and MACE Responses:

I) **Concern:** Acoustic backscatter in Shelikof Strait is from a heterogenous mix of species and fish sizes, which are inadequately sampled with traditional midwater trawls or other towed samplers because of: mesh selectivity, vertical availability, horizontal availability, and vulnerability. This leads to unacceptably biased proportion-at-age estimates for pollock in Shelikof Strait. More trawling and the use of different types of towed samplers are needed.

   i) **Response:**

      1. We disagree with the reviewer's contention that it is not possible to adequately describe (i.e., classify) the backscatter in Shelikof Strait using trawls and other towed samplers. We do agree that more trawl hauls as well as different towed samplers (e.g., CamTrawl, Multiple Open and Closing Device; MOCC) are needed to improve the species and size classification of pollock during the Shelikof pre-spawning survey. Development of innovative towed samplers to achieve this goal is an active area of research within the Program. Some of these tools were described during the formal review presentation and in publications given to the reviewers. More hauls, including those with our new sampling tools (i.e., CamTrawl, MOCC) will be conducted beginning with the 2013 survey.

      2. There is little evidence for a strong size-dependent pollock diving response to midwater trawls, such as that described for orange roughy during the formal review. Large variation in species-specific behavioral responses to disturbance is well

documented in the scientific literature. Thus, one must be cautious about presupposing that the behavioral response of one species accurately represents the response of another species, or even the response of a particular species in all situations. The review by De Robertis and Handegard (2012), for example, illustrates the diversity of fish species avoidance behaviors to underwater vessel noise as well as the complicating role that environmental factors may have in mediating the response. De Robertis and Wilson (2006) did, however, report that pollock backscatter declined significantly for vessels involved in trawling versus free-running operations, although they did not detect a significant difference in pollock vertical distribution between the two vessel operations. The Shelikof acoustic survey employs a large commercial midwater trawl designed for catching large walleye pollock. Typically, the depth targeted by the trawl is no different than the observed backscatter depth from the vessel scientific sounder. That is, there are no obvious changes in depth distribution when the pollock are observed with the headrope sonar unit, which is not consistent with the idea of strong vertical herding of pollock (strong herding behavior is observed in this manner for other GOA species such as rockfishes). Also, a paired trawl experiment (n = 21 pairs) was conducted in 2012 in the eastern Bering Sea to determine pollock size selectivity to a small (68 m^2 mouth area) bottom trawl fished in midwater and the large MACE midwater trawl (884 m^2). Preliminary results indicate similar pollock size compositions between the two trawls, which demonstrate that pollock exhibit very little diving response to the smaller trawl, and by inference to the larger trawl.

II) **Recommendation:** Estimate spawning biomass and abundance of 1-2 year olds, not total abundance as proportion-at-age.

i) **Response**:

1. The reviewer assumes that pre-spawning pollock aggregate in a localized area (i.e., length stratum) within the Shelikof Strait survey area. Under this scenario, the pre-spawners would have a narrower size range than fish taken throughout the Strait, and the lengths would be located on the flatter portion of the target strength-to-length (TS-L) curve. The restricted size range of large fish within the "spawning area" would mean that trawl-based length frequency errors would have less influence on the abundance estimate.

   If pre-spawning pollock actually did clearly segregate from other pollock in restricted areas of Shelikof Strait, it would be sensible to estimate the biomass directly for the pre-spawning fish in this spawning location as proposed. However, the pre-spawning pollock do not form clearly identifiable aggregations within a well-defined region of the survey area each year. Although pre-spawners have traditionally concentrated along the west side of the Strait proper, there are years when this has not been evident. Thus, substantial numbers of pre-spawners have sometimes been detected in the southern Strait area (south of Cape Ikolik). Additionally, juvenile and sub-adult pollock often co-occur with pre-spawners in the W. Strait area.

2. A disadvantage of surveying a localized "spawning" location within Shelikof Strait area (e.g., west Strait proper) is that survey timing becomes more critical. That is, fish would likely be moving into the localized "spawning" area until the time of peak spawning. If the survey occurs outside this narrow window of peak spawning, the abundance estimate would be biased low. With a larger survey area, timing is

not as critical as pre-spawning fish are within the survey area (and surveyed) even though they may not be within the more localized "spawning area" at the time of the survey. Previous repeated surveys (e.g., 1981) reveal that pollock distributions in the Strait can change substantially over the course of a 2 week window, which suggests that a localized survey will be more susceptible to biases related to timing of spawning. Additionally, it is not certain that all pre-spawning pollock within the Shelikof Strait survey area do indeed ultimately spawn along the west side of the Strait proper and not within other areas of the surveyed area.

III) **Recommendation.** Investigate feasibility of conducting GOA-wide pollock pre-spawning survey.

i) **Response:**

1. This is an important issue. MACE has been expanding the winter pre-spawning survey coverage in GOA beginning with surveys in the Shumagin Islands area since 1994, the Chirikof shelf break area since 2002, and the Kenai Peninsula/Prince William Sound since 2010. Plans are to continue this increased winter survey effort as funding allows. In addition, MACE recently met with fishing industry representatives to discuss the possibility of establishing collaborative winter acoustic survey efforts to increase coverage spatially and/or temporally. The first step in this potential partnership is to conduct a vessel comparison experiment tentatively planned for winter 2013 between the NOAA research survey ship, *Oscar Dyson* and several commercial fishing vessels, which may be considered for future acoustic-trawl survey work.

2. MACE staff submitted a pre-proposal (which was accepted) in 2012 to use upward-looking moored echosounders to develop an abundance index of pre-spawning pollock abundance in Shelikof Strait, based on a retrospective study we completed using Shelikof survey data. This application of moored echosounders will likely prove to be an important method to increase knowledge on the timing of pollock spawning behavior as well as to help to develop a GOA-wide pre-spawning pollock abundance index in the future.

IV) **Recommendation.** Proportionally allocate acoustic backscatter to eulachon, based on results of recapture net experiment.

i) **Response:**

1. This is a good idea**.** The target strength of a eulachon is about 17.3 dB or ~50 times lower than that of a pollock of the same length (Gauthier and Horne, 2004). This means that the abundance of eulachon must be dominant to contribute appreciably to estimates of pollock biomass. For example, a 1:1 ratio of eulachon to pollock would overestimate pollock abundance by 2%. However, this reasoning does not consider trawl selectivity of eulachon. We have eulachon data from recapture net experiments conducted in 2007, 2008 (Williams et al. 2010). We will use these data to determine the trawl selectivity of eulachon and use the resulting abundance estimates to explicitly compute the relative contribution of eulachon to the observed acoustic backscatter.

V) **Recommendation.** Increase efforts to determine whether the pollock target strength to length (TS-L) model is appropriate under different survey conditions.

i) **Response:**

1. This is an important idea and an active area of MACE research. MACE staff collaborated with other NOAA researchers to design and build a lowered acoustic

system (DropTS device) to increase opportunities for collection of *in situ* target strength (TS) measurements of pollock and other species commonly encountered during our acoustic surveys. The system can be lowered overboard to shorten the range between the transducer and target species to reduce the incidence of multiple targets and range bias towards larger targets. Thus, good TS measurements can often be taken from fish in relatively dense aggregations (e.g. pre-spawning fish in Shelikof Strait). A primary purpose of the DropTS device is to determine whether our traditional TS-L model for pollock is appropriate for pre-spawning fish, and in other situations where the fish occur in dense aggregations (e.g., feeding aggregations).

2. We are optimistic that we will be able to combine our information on trawl selectivity for pollock (Williams et al. 2010) with new statistical methods for TS analysis to relax the conditions (unimodal size distributions) needed for TS measurements. This will allow us to greatly increase our sample size by extracting TS measurements from existing data to assess the validity of and potentially refine our current TS-L model.

3. A reviewer stated that a slope of 20 for the TS regression is an approximation, and that in some species such as orange roughy, the actual slope can be dramatically different. For the TS measurements reported in Traynor (1996) for pollock, the fitted slope of the TS-L relationship is 19.4, which results in target strengths within 0.2 dB (5% in linear units) of those based on a slope forced to 20 for pollock in the 10-70 cm size range.

VI) **Concern.** Transducer motion might negatively bias abundance estimates.

i) **Response:**

1. Earlier investigations using the method of Dunford (2005) along with measurements of vessel motion collected during the Shelikof Strait survey have shown that the impact of transducer motion (a negative bias) was negligible (< 0.5 to 1% of biomass) for both NOAA ships, *Oscar Dyson* and *Miller Freeman*.

MACE current and planned survey-related work. During the CIE Review, MACE presented an overview of the survey-related activities that were currently underway or planned for the near future along with publications describing some of the work. These activities serve to develop new tools for conducting acoustic-trawl surveys and/or test some of the assumptions that are commonly made when conducting these surveys. A list of the activities that are particularly relevant to GOA survey work is provided below and more information (e.g., scientific publications) is available upon request. Discussions during and following the CIE Review were helpful in reminding us of some of the challenges faced when conducting assessment surveys with both trawls and acoustics.

MACE research activities for GOA: current and near-term

- Use of multiple acoustic frequencies to improve species classification of backscatter.
- Use of lowered acoustic device to improve *in situ* TS measurements for pollock (e.g., pre-spawners) and other species commonly encountered during surveys.
- Underwater radiated vessel noise issues: how to measure it and potential influence on estimates of abundance.
- Impact of the acoustic dead zone on pollock (e.g., pre-spawning) abundance estimates.

- Improvement of pollock maturity composition estimates by weighting with acoustic backscatter.
- Development of innovative towed samplers (e.g., CamTrawl, ruggedized CamTrawl, MOCC) to improve species classification of backscatter.
- Development of smaller, less selective, and more efficient towed sampler to replace the standard MACE acoustic survey midwater trawl.
- Evaluation of trawl selectivity (species, size) impacts on acoustic survey estimates.
- Use of trawl-resistant bottom-mounted upward-looking echosounders to estimate timing of peak spawning and provide indices of pre-spawning pollock abundance.
- Development of software to facilitate comparison (i.e., sensitivity analysis) of different trawl length weighting schemes that could be used to generate survey estimates of abundance by size and age.
- Development of a total uncertainty budget for acoustic-trawl surveys (currently uncertainty estimates incorporate only sampling variability) to provide more comprehensive estimates of variance.

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