CIE Independent Peer Review Report

on

BSAI and GOA Pacific Cod Stock Assessment Review

Prepared by

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Contents

SECTION **Page**

I. Executive Summary

The CIE review for the BSAI and GOA Pacific cod stock assessment, held in Seattle, WA from March 14-18, 2011, was aimed to evaluate current model assumptions and make recommendations for improvement. This review is the first CIE review of the BSAI and GOA Pacific cod stock assessment since 2001. The Alaska Fisheries Science Center (AFSC) provided all the necessary logistics support, documentation, data, and background information I requested. The scientists involved in the process were open to suggestions and provided additional information upon request. The review contact, Dr. Grant Thompson, accommodated all the requests I had made for different test runs and extra information. The whole process was very open and constructive and all materials were sent to me in a timely manner. As a CIE reviewer, I am charged to evaluate BSAI and GOA Pacific cod stock assessment with respect to the Terms of Reference.

I would like to commend the great efforts of all the participants in the Pacific cod CIE review for providing necessary background information on Pacific cod life history, fishery-dependent and fishery-independent monitoring programs, genetic work on stock structure, stock assessment history, and management issues. I was impressed by the breadth of expertise and experience of the participants, the amount of effort spent to collect 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. I observed on many occasions constructive interactions and dialogs between scientists/managers and the sole representative of the industry in the review.

Overall, I believe the Pacific cod stock assessment provides rather robust assessment results for the BSAI and GOA stocks 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. Thompson and his co-workers for their efforts and openness in addressing uncertainty in the assessment and in exploring alternative model configurations. However, I believe some important questions still need to be addressed and there is still room for improving the current stock assessment.

My specific recommendations/comments include (1) conducting retrospective analysis for all models considered in stock assessment to evaluate nature (positive or negative) and magnitude of retrospective errors; (2) standardizing survey abundance index using a general linear model (GLM) and/or general additive model (GAM) to remove the impacts of factors (e.g., boat, temperature, bottom type, location, depth etc.) on survey catchability; (3) using a nonlinear random effects model explicitly assuming that an individual's growth parameters are samples from a multivariate distribution to fit back-calculated length-at-age data to estimate between-individual variability; (4) having a better representation of gear and vessel size composition in the fishing fleet by the observer program; (5) comparing and cross-validating catch-reporting data from different sources (which have overlaps) to yield some insights about potential errors in catch estimates from different sources; (6) conducting an extensive computer simulation study based on the data collected in the past to evaluate the effectiveness of the current sampling/reporting system in yielding catch estimates and to evaluate potential error sources for catch estimates; (7) estimating uncertainty associated with catch estimates to develop a plausible range of catch estimates, which can be used to evaluate impacts of uncertainty associated with catch estimates on stock assessment; (8) estimating ageing errors and variations outside the SS3 model; (9) down-weighting (e.g., each assigned a weight of 0.5) age and size composition data from the same survey program if both are used in the assessment, to reflect the fact that age and size composition are derived from the same set of the data; (10) analyzing data collected from a monitoring/survey program using methods consistent with the design of the monitoring/survey program; (11) exploring a dynamic binning approach to reduce the impact of numerous size classes without data; (12) developing standardized fishery CPUE data outside the SS3 to remove factors that may result in temporal variability in fishery catchability and then comparing the standardized CPUE with nominal CPUE and survey abundance index to determine if they can be used in the stock assessment; (13) assuming a random walk over years for selectivity and then examining the temporal trend of selectivity plots to identify whether a temporal pattern exists for determining time block; (14) conducting habitat suitability modeling to identify suitable habitats for Pacific cod, to outline potential habitat maps in the BSAI and GOA, and to help improve survey design; (15) conducting thorough model diagnosis and residual analysis; (16) keeping assessment model structure relatively stable over time; (17) evaluating among-model variations in the assessment for models that were selected in the past assessments; (18) evaluating suitability of current recruitment measure which is defined as number of fish in age 0; and (19) evaluating the cause of retrospective errors seemingly existing for current recruitment estimates in the test runs.

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

II. Background

Pacific cod (*Gadus macrocephalus*) supports important fisheries in the eastern Bering Sea (EBS), Aleutian Islands (AI) area, and the Gulf of Alaska (GOA). The fisheries are currently assessed and managed as Bering Sea Aleutian Islands (BSAI) stock and GOA stock. Previous studies suggest significant migration within and among these areas (Shimada and Kimura 1994). Landscape in the AI may form barriers to fish movement because of current fields. Lengths at age of Pacific cod in the AI tend to be larger than those in the BS and GOA at the same age. Based on a recent study (Ingrid Spies's presentation at the CIE review, Appendix I), BSAI Pacific cod are not considered to be genetically homogeneous. Genetic differentiation increases with distance. There is evidence for more than one stock or population. The Pacific cod may have a metapopulation structure in the BSAI. The spatial structure of this stock may call for separate area management for the BS and AI. In 2006, the Council first considered separate quotas for the BS and AI. The SSC recommended separate quotas in 2008, but their recommendation was not implemented. The SSC requests the Plan Team to develop "a course of action" in 2011.

Limited information is available on early life history of Pacific cod. Larvae are epipelagic, mainly in the upper water column and moving downward as they grow. Pacific cod tend to experience size-dependent inshore-offshore distribution with smaller fish staying inshore and larger fish offshore. Natural mortality was estimated to have values ranging from 0.29 (Thompson and Shimada 1990) to 0.99 (Ketchen 1964), with young cod having higher natural mortality. Age-2 Pacific cod was found to aggregate in areas where trawling efficiency is low, leading to reduced catchability (Ueda et al. 2006).

In 1971, a fishery-independent bottom trawl survey was started in the Eastern Bering Sea (EBS) continental shelf. The first large scale bottom trawl survey of the EBS shelf was in 1975 and was considered as the baseline survey. The first triennial survey of the Norton Sound and the northern Bering Sea was in 1976. In 1979 the first bottom trawl survey was conducted in the EBS upper slope. Prior to 1982, survey gears were not standardized. After 1982, survey gears tended to be consistent in methods and protocol. The EBS survey program follows systematic design with two geographic strata: NW (arctic area) and SE (sub-arctic area) three depth strata (inner shelf < 50 m; mid-shelf between 50 and 200 m; and outer shelf > 200 m). Moreover, the EBS survey program consists of 376 survey stations, with tow duration of 30 mins at a speed of 3 knots. The survey duration could last for two months because of the large area it needs to cover. Subsamples have been taken from these surveys for size measurement and age determination. The nominal survey abundance index is standardized with the swept area. The mean and standard deviation of survey abundance index were estimated under the assumption that the survey followed stratified random design. Factors that may influence survey catchability have not been considered in survey abundance standardization, even though large variability may exist in the form of environmental variables such as temperature, which may affect catchability over the survey's two-month duration. Vertical distribution of the Pacific cod has been studied to evaluate their availability to survey trawl (Nichol et al. 2007).

Fishery-independent bottom trawl surveys for the GOA and AI started in 1981. The GOA and AI have rougher terrain than the EBS, which mandates trawl gear be more rugged. The shelf is broad across most of the GOA, but narrow in the AI, resulting in less trawlable area in the AI than in the GOA. The survey method is as follows; two areas are surveyed on a rotating biennial schedule using the same method with an extra depth stratum in the GOA covering depth from the shelf to 1000 m. Because of limited trawlable area, stations are mostly fixed in the AI. On the other hand, stratified random design is used in GOA. Furthermore, the survey does not target a specific species. There were missed rotations in the AI in 1989 and 2008, and not all sample stations were surveyed in some years, but Pacific cod was not considered to be substantially affected.

Each year, there are 825 stations surveyed by three boats in the GOA, and 420 stations surveyed by two boats in the AI. 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 five 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. Pacific cod were caught in most survey hauls. 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 BS, GOA and AI surveys, there are too many factors varying over time and within a survey season, which may call for a thorough study to evaluate their impacts of survey abundance.

Ageing Pacific cod using otolith started in 1978 for the EBS and in 1988 for GOA. Nine age readers have been involved in the last 25 years. Ageing precision is calculated from comparing 20% of a randomly selected sample read by two of the readers. A large inconsistency of size at age 2, estimated from 1988 to 1992, raised questions about ageing accuracy. However, this resulted from mistakenly counting check as annuli in early ages (Roberson 2001). On-going and future research efforts include employing various methods to validate annulus.

The annual process for conducting the Pacific cod stock assessments includes calls for new model proposals and two fully reviewed drafts of the stock assessment report. The review is usually done by the stock assessment plan team and SSC. The last time when Pacific cod stock assessments had a CIE review was in 2001.

Pacific cod in the BSAI are managed on a combined BS and AI basis, but the stock assessment model is only used for the BS. BSAI catch and biomass values are computed by “inflating” values from the BS model, with inflation factor being calculated based on the ratio of endpoints from smoothed survey biomass estimates in the BS and the AI. GOA stock assessment is conducted separately.

For the BS stock, a simple projection of current survey abundance at age was done prior to 1985. The projection was based on 1979-1985 survey abundance at age in 1985. A separable age-structured model was used for the assessment in 1986-1991. Stock Synthesis (SS) 1 with age-based data was used for the assessment, which made for strong 1989 cohort "disappearances". This raised the possibility ageing errors, resulting in ceased ageing production and use of SS1with length-based data only during 1993-2003. Both length- and age-based data were used in SS1 in 2004 after new age data based on revised ageing protocol became available.

For the GOA stock, MSY was set as 0.5 x M x current survey biomass prior to 1988. Stock reduction analysis (Kimura et al. 1984) was used from 1988 – 1993. SS1 was used with length-based data from 1994 to 2004.

Very little change was made from 1993 to 2004 to both the BS and GOA stocks. M was set constant at 0.37 and q was assumed to be constant at 1 for both the BS and GOA stocks. Efforts to estimate M and q internally failed. The stock assessment yielded much higher biomass estimates than those from surveys (using a swept area method). Post-2000 yearly classes were predicted to be weak, and stock biomass was predicted to decline in these assessments.

The SS2 was first used in 2005 for both BS and GOA. The results confirmed the 2004 stock assessment: total biomass was still higher than swept area estimate; post-2000 yearly classes were weak, and stock biomass was declining. A tagging study suggested that escapement over survey trawl headrope might explain biomass differences (Nichol et al. 2007). Longline CPUE showed opposite direction from the temporal trend in stock biomass estimated in stock assessments. An external review of the BS model was conducted in 2006. The 2006 stock assessment confirmed results from previous stock assessments. A technical workshop conducted in 2007 calling for public inputs to stock assessment resulted in the development of many models and scenarios to be tested, resulting in large changes having been made to model configuration and parameterization since 2007 (Thompson et al. 2009a,b, 2010a,b).

In the 2010 assessment, various model configurations were considered and evaluated. Three models were eventually developed and presented in the stock assessment report (Thompson 2010):

"Model A which is the same as 2009 model; Model B which is the same as Model A, except fishery age composition and size-at-age data removed, only one record each (2008 Jan-May longline fishery), IPHC longline survey data removed (BSAI only), new 1-cm length bins, replacing old 3-or-5-cm bins, 5 new seasons replacing 3 old seasons, constant growth replacing cohort-specific growth rates; Model C, which is the same as Model B, except: survey age composition and size-at-age data removed, and all size composition records turned "on". "

Model B was eventually selected for the final stock assessment model (Thompson et al. 2010).

No formal Management strategy evaluation (MSE) has been done for the BSAI and GOA cod stocks. Relevant MSE methods including operating models and computer programs are in the process of development.

This review is the first CIE review on the stock assessment since 2001. The AFSC provided all the necessary logistics support, documentation, data, and background information I requested. The scientists involved in the process were open for suggestions and provided additional information upon request. Dr. Grant Thompson, who is the review contact, worked extremely hard to accommodate all the requests the CIE reviewers made for different test runs and extra information. The whole process was very open and constructive.

As a CIE reviewer, I am charged to evaluate BSAI and GOA Pacific cod stock assessment with respect to the Terms of Reference. This report includes an executive summary (Section I), a background introduction (Section II), a description of my role in the review activities (Section III), my comments on each item listed in the 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 BSAI and GOA stock assessment with respect to the pre-defined Terms of Reference.

Two weeks prior to the review workshop in the Alaska Fisheries Science Center in Seattle, I received the BSAI and GOA Pacific cod stock assessment reports done in 2009 and 2010 and relevant information including comments from the Plan Team and the SSC. I also received SS3 input data file compilations for Models A, B and C, instructions for SS3, an executable SS3 program, and a technical report about SS3 model structure.

I read the two stock assessment reports by Thompson et al. (2009a, 2010a) for the BSAI stock, two stock assessment reports by Thompson et al. (2009b, 2010b) for the GOA stock, and all other relevant documents that were sent to me (see the list in the 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 ASFC.

The CIE review workshop was held from March 14 to March 18, 2011in the AFSC in Seattle, WA (see Appendix II for the schedule). The first two days of review were attended by scientists and mangers from various organizations (see the List of Participant in Appendix III), and the last three days of the review were attended by the three CIE reviewers, Dr. Grant Thompson (CIE review contact), Dr. Anne Hollowed (CIE review Chairperson), and Dr. Teresa A'mar (AFSC stock assessment scientist).

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 program, Pacific cod ageing methods, Pacific cod management issues, stock structure, 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 more 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 would like to discuss the questions I raised at their presentations in greater details.

After all the presentations and discussions over the first two days had ended, the CIE reviewers worked with Dr. Thompson to develop a series of scenarios to evaluate impacts of various model configurations on the performance of the model. The scenario design follows the following principle: changing one variable at a time so that we can ensure that changes observed in modeling can be solely attributed to the change we made. The following test runs were conducted for the BS stock:

- Retrospective error testing (retro for four years);
- CIE0 is the baseline (Model B in the 2010 stock assessment);
- CIE1 evaluates impacts of change in growth model;
- New_CIE1 evaluates possible changes of parameter estimation with the addition of jitter, using the same settings as CIE1;
- CIE2 evaluates impact of value setting for L0 with initial value of L0 being set slightly positive and a lower bound of 0 on L0;
- CIE3 evaluates impacts of time blocks for selectivity (i.e., no annual variation in selectivity, but seasonal differences are still available);
- CIE4 has no time block (i.e. similar to CIE3) with fisheries catch size composition being down-weighed to a very low level to assess impacts of fisheries catch size composition data on stock assessment;
- CIE5 has the Richards growth function and evaluates impact of estimating ageing errors internally;
- CIE6 has a time block (i.e., similar to CIE0) with fisheries catch size composition being down-weighed to a very low level to assess impacts of fisheries catch size composition data on stock assessment;
- CIE7 has all catchability q freely estimated;
- CIE8 is informative prior to M (CV=30%, with lower and upper boundaries of 0 and 1, respectively);
- CIE9 uses dynamic binning in choosing size composition data in likelihood functions;
- CIE10 has size-at-age data turned off in modeling;
- CIE11 has size-at-age data turned off, fishery = season (i.e., 5 fisheries), random walk selectivity at age through age 8, fishery CPUE data removed, no time block, survey size composition tuned on in all years, aging bias estimated internally, and Richards growth turned on;
- CIE12: two re-weighing iterations with sample sizes (effective sample sizes) removed from CIE11.

Four test runs were done for the GOA stock with the following settings to evaluate impacts of dynamic binning, different growth model, and time blocks on the assessment:

- GOAmodel0 = GOA0.ctl + GOA0.dat (base run)
- GOAmodel1 = GOA1.ctl + GOA0.dat (Richards growth with positive L0)
- GOAmodel3 = GOA3.ctl + GOA0.dat (no blocks, except survey)
- GOAmodel9 = GOA9.ctl (same as GOA0.ctl) + GOA1.dat (dynamic binning)

However, because of the time limit at the review meeting, jitters were only added to New_CIE1. Dr. Thompson ran the rest of the simulations with the addition of jitters after the review meeting, but the number of jitters was much smaller than 100, which was normally run for a model in the assessment. The relevant files were sent to the CIE reviewers on March 25, 2011. Detailed description of these test runs can be found in Appendix IV.

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).

IV-1. Use of age data, including:

<u>IV-1a. Use of age composition data</u>

The SS3 model allows for the incorporation of age composition data of both commercial and survey catches as part of input data. Age composition data were only derived for the survey catch and used in the assessment of the BSAI stock. However, mean size at age 2 is found to be inconsistent with the mode of length frequency distribution of the survey catch, suggesting errors in ageing and/or low catchability of the age-2 cod.

To rectify these problems, I recommend the following separate approaches: (1) continue exploring various methods (see descriptions below) to reduce the likelihood of having ageing errors before ageing data are used in stock assessment; (2) estimate age error probability either outside or inside the SS3 (personally I prefer it is estimated outside of the model to reduce confounding of different components in the parameter estimation); and (3) evaluate hypotheses of low catchability of age 2 fish in the survey.

Ageing Pacific cod started in 1978 for the BSAI stock and 1988 for the GOA stock. From 1986 onwards, there have been 9 age readers involved in the ageing of Pacific cod in the BSAI and GOA. From a survey catch, ageing precision is estimated by randomly selecting 20% of the catch and determining the degree of agreement from the readings of two readers. The tester who reads the randomly selected sample is the same. A study done by Roberson (2001) suggested ageing errors might result from two sources: (1) checks were mistakenly considered as annulus in young ages; and (2) edge criteria used might be wrong, which might result in fish being assigned 1 extra year in ageing. The on-going and proposed future research includes (1) improving understanding of edge type chronology; (2) exploring use of stable isotopes (O-18, C-

13) and bomb-produced C-14 to validate annulus; and (3) conducting otolith trace element analysis. The AFSC researchers have clearly realized the importance of age validation and verification in ageing and have developed research efforts and plans to address issues related to age validation and verification.

I believe the age verification process currently employed by the AFSC is scientifically sound and can yield results that can be directly incorporated into stock assessment modeling. However, the on-going and proposed research efforts in validating annulus may be complicated by fish migrations and large temporal/spatial temperature stratifications in the stock areas, resulting in inconclusive results. Other approaches such as using Pacific cod held in aquaculture facilities, evaluating back-calculated size at age for annulus, and conducting more extensive tagging studies should be explored for annuli validation.

Because age composition data were derived from subsamples of length composition data, using both in the same survey is essentially equivalent to up-weighting size composition data. If both sets of data are used in the SS3, they should be down-weighted accordingly so that this set of size (both age and length) composition data has the same weight as other size composition data (e.g., having a weighting factor of 0.5 for both age and length composition data in the survey if they are both used in the SS3).

IV-1b. Use of mean-size-at-age data

Use of mean-size-at-age data in the model partially repeats the size composition information already implied in length composition data and age composition data (if both used) in the model. This may subjectively put extra weight on size composition data. If between-individual variability in growth can be estimated outside the model (see my comments below), use of mean-size-at-age data in modeling is not necessary.

IV-1c. Use of ageing bias as an estimated parameter

Given the complexity of the SS3 model, I believe it is difficult to interpret the estimation results for ageing bias and variation in modeling. Because parameters are, to varying degrees, correlated, ageing bias and variation may not be estimated independently of other parameters. These estimates may not reflect real ageing errors and variations. Rather, they may reflect combined effects of errors and variations of all data sources. An external estimate of aging errors and variations may be a better way to incorporate the uncertainty of this information in the stock assessment.

IV-1d. External estimation of between-individual variability in size at age

Between-individual variability in size at age can strongly influence the accuracy of population parameter estimates. For example, variability can result in large biases in estimates of growth parameters in length-based population modeling (Rosenberg and Beddington 1987) and can thus subsequently affect the quality of stock assessment and management. Incorporating knowledge on between-individual variability in growth may improve assessments (Wang and Thomas 1995; Wang and Ellis 1998).

I suggest back-calculating length-at-age data using otoliths to derive length at each age for each fish with its corresponding otolith sample. A nonlinear random effects model explicitly assumes that an individual's growth parameters are samples taken from a multivariate distribution, which can then be applied to the back-calculated length at age data (Hart 2001; Pilling et al. 2002) to estimate between-individual variability.

IV-2. Data partitioning/binning, including:

IV-2a. Catch data partitioned by year, season, and gear

Given the strong seasonality in fishing activity and large differences in catchability/selectivity among different gears, I believe the current partition of catch by year, season, and gear is a reasonable and logic approach. However, the variability of catch quality among years, seasons and gears needs to be carefully evaluated.

Catch data, including both landed catch and at-sea discards, are estimated from different sources (e.g., observers, industry logbook reports, processer reports). The Observer program is considered to provide the most reliable information on catch and discards and has >100% coverage for vessels larger than 125 ft, but only 30% non-random coverage for vessels between 60 and 125ft and no coverage for vessels below 60ft. Catches reported by processers are often processed and need to be converted to whole body weights. Although various efforts have been made to yield a high quality of total catch estimates, it is clear that the catch estimates are still subject to errors. Catch data quality before 2002 may be lower than that after 2002 when the observer program was implemented. The composition of vessels of different sizes may vary from season to season, resulting in varied overall observer coverage of the whole fishing fleet and subsequently varied data quality in catch estimates. Different gears tend to have the composition of different sizes of boats, which may also contribute to the different quality of catch estimates between fishing gears. Thus, the level of the errors in catch estimates may vary by year, season and gear. Other sources of fishing mortality that are currently not included in the cod catch estimates also need to be evaluated. These include baits used in crab fisheries, recreational fishing, substance fishing, and research surveys. Part of Pacific cod mortality in the halibut fishery is also not included in the cod catch because of lack of observer coverage. These fishing mortalities are likely to differ among years, seasons and gears. Because catch is considered as an exact estimate having no errors in modeling, different levels of errors in catch by year, season, and gear may affect the stock assessment.

No systematic study has been done to evaluate and quantify errors associated with catch estimates and potential impacts of errors in catch on the stock assessment. No uncertainty (bias and/or variation) estimate is available for catch estimates.

I suggest that observer coverage should not be determined by vessel size. Rather, it should be determined by data needs, and should have a good representation of gear and vessel size composition in the fishing fleet. Because the current program has some overlaps in catch reporting from different sources, data from different sources can be compared and cross-validated. Such a study can yield some insights about potential errors in catch estimates from different sources. Given the importance of the catch 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 sampling/reporting system in yielding catch estimates, to evaluate potential error sources and levels of catch estimates, and to identify alternative sampling/reporting program designs. A study was done in 2003 to evaluate and analyze field sampling in North Pacific groundfish fisheries, but that work was mainly focused on evaluating biological sampling protocols (MRAG 2003). A similar study can be done for evaluating quality-of-catch estimates.

I suggest estimating uncertainty associated with catch estimates to develop a plausible range of catch estimates, which can be used to evaluate impacts of uncertainty associated with catch estimates on stock assessment.

IV-2b. Size composition data partitioned by year, season, gear, and 1-cm size intervals

Given the strong seasonality of fisheries and large differences in selectivity/catchability and fishing seasons among gears, I believe the current partition of fisheries catch size composition by season and gear is necessary and reasonable. The current seasonal partition also yields the best model in the most recent assessment. However, it seems that a year block for size composition data may not be necessary for some fishing fleets. More study is needed to evaluate annual variability in quality of fisheries catch size composition data. Possible differences in gear selectivity among years also need to be evaluated for a given fishing gear to justify the year block currently used in modeling.

Size composition data for fisheries catch are derived from various sources and are likely subject to various errors. However, I did not see the quantification of uncertainty associated with size composition estimates for fisheries data. In-depth analyses should be conducted to evaluate if the quality of size composition data for fisheries catch vary with year, season and gear. Variation or confidence intervals can be estimated for each size bin as indicators for uncertainty associated with size composition data.

The NMFS AFSC contracted MRAG Americas, Inc to conduct a study to evaluate biological sampling protocol in North Pacific groundfish fisheries (MRAG 2003). The objectives of that study include

" (1) To design standardized, practical sampling strategies for at sea observers in North Pacific trawl, longline, and port fisheries to collect size, age, and other biological data from multiple species in a single catch, while maintaining adequate levels of sampling for current economic target species;
(2) to design sampling strategies for shore-based plant observers to collect biological data from multiple species in a single delivery, while maintaining adequate levels of sampling for current economic target species;
(3) to recommend specific changes to current observer program sampling instructions, equipment, data forms, and database necessary to implement multiple-species sampling strategies and make the data available to users; and
(4) to evaluate tradeoffs between the current sampling system and the proposed multi-species sampling strategies in terms of observer workload, impacts on other observer duties, types and amount of data collected, potential improvements in stock assessment and cost. "

It seems that this study is useful to improve quality of the size composition data collected in the fishery. Methods developed in the study can also be used to evaluate the quality of the data. However, there is no explicit indication that the recommendations of this study were considered or implemented during the review and in the materials I have received. The empirical and computer simulation approaches developed in the study (MRAG 2003) can be used to quantify variability associated with size composition data for Pacific cod.

Changes in many factors may influence selectivity/catchability in fisheries, which may affect catch size compositions. For example, changes in baits used in longline and pot fisheries among years and seasons may result in annual variations in catchability/selectivity. Squid, which were used in the past as bait, tend to have high catchability, but haven't been used on a large scale in current years because of high prices. Such changes from year to year may influence size composition data and should be considered in determining year block. More in-depth analyses should be conducted to identify factors that may affect selectivity/catchability and evaluate how these factors vary among years and seasons to justify the partitions of catch size composition by year and season.

Because of large differences in selectivity/catchability among fishing gears, partition of catch by gear is necessary and reasonable.

For a given model configuration, data of different fleets can be deleted one at a time to identify which fleet has had the largest impact on the assessment. Those that have had limited impact can be removed to improve model convergence.

Size composition data partitioned by year, season, and gear were grouped into 1-cm size bins in the most recent assessment. Although a factorial experiment was done to evaluate impacts of different bin widths, only a relatively small difference in SSB was found. Fine size bin can yield more accurate representations of length distributions of fisheries and survey catches. However, fine binning can also result in a large number of bins without observation, in particular for large and small sizes of fish, forcing the model to fit these 0 observations on both sides of the tails of size distribution. This may be done at the cost of other size classes, resulting in a lack of fitting of other size classes which tend to have more reliable and informative information.

A dynamic binning approach seems to be a reasonable approach to remove excessive bins with 0 observations. A test run was conducted at the review to evaluate this approach. However, because of the time limit, the test run was not checked for its convergence and no jitter runs were done to ensure the resultant estimates in the run we did at the review were the "best". No conclusive result can be derived. I suggest that more study be done in the future to explore the dynamic binning approach.

It also should be noted that the size interval of 1 cm used to group length data implies that measurement errors for fish length should be smaller than 1 cm. This is probably a reasonable assumption, but should be explicitly evaluated and clearly defined to ensure that quality of data collected is adequate for such fine binning.

Area closure for Pacific cod fishing in the major Stellar sea lion habitats in 2011 may affect effective cod stock areas included in the stock assessment. Because of spatial variability in cod size composition, lack of size composition data in major sea lion habitats from 2011 may introduce extra variations in size composition data. Possible impacts of this closure on size composition data should be evaluated and considered when partitioning size composition data by year.

For survey catch-size composition data, errors should be relatively small, compared with fisheries catch-size composition data. However, survey stations in EBS and AI are fixed, and more study is needed to evaluate potential impacts of such a design on the quality of size composition data. Uncertainty associated with size composition data should be estimated.

Because the survey was only done biennially for both BSAI and GOA stocks, there is no partition by season. Bin widths of 1 cm seem to be reasonable, although an evaluation should be done to ensure that measurement errors in the field should be smaller than 1 cm.

IV-2c. Age composition data partitioned by year, season, and gear

My understanding is that age composition data are only available for the surveys. Because the survey was only done biennially using the same gear for both BSAI and GOA stocks, age-composition data were not partitioned by season and gear.

IV-3. Functional form of the length-at-age relationship and estimating the parameters thereof

The Richards model, even though more general, provides no better fitting than the von Bertalanffy growth function (VBGF) in one of the test runs conducted during the review. Thus, VBGF is sufficient to describe the length-at-age relationship.

Forcing VBGF to have a positive size at age 0 introduces an extra parameter. It also makes the growth curve not smooth in early ages. Fitting length-at-age data outside the SS3 model to estimate t_0 (age at size of 0) may be an option. Because of the availability of small/young fish in surveys, it is likely that t_0 should have a negative value if this approach is taken. This negative t_0 value can be fixed with the other two parameters being estimated for VBGF in the SS3 model to ensure that the size at age 0 is positive.

Estimating VBGF parameters inside the SS3, although allowing for flexibility in adjusting growth parameters to better fit size composition and data, may create unnecessary correlations between growth and other life history and fishing processes. For a converged run, a close evaluation should be done for the variance-covariance matrix to evaluate possible correlations between growth parameters and other model parameters. High correlations should be biologically justified. If not, spurious correlations may result from tradeoffs of different life history and fisheries processes in model fitting, and the estimates of growth parameters (and other parameters, for this matter) should be questioned. Alternatively, estimating growth parameters outside the SS3 may also be a choice, although this may result in poor fitting of size composition data. It will be interesting to compare differences in the VBGF parameter estimates inside and outside the SS3. The differences reflect impacts of other life history and fishing processes included in the SS3 model on growth parameter estimation.

IV-4. Number and functional form of selectivity curves estimated, including assumptions regarding which selectivity curves should be forced to exhibit asymptotic behavior

Various selectivity functions are available in the SS3. These provide a flexible framework to assign different selectivity functions for different gears. Choice of the selectivity functions and subsequent shape of the selectivity curve with length/age can greatly influence the stock assessment results. Current choice of selectivity function tends to have large flexibility to let model fitting decide the selectivity curves, although in some cases selectivity is forced to follow the curves. In many cases, there is lack of justification for the choice of a particular selectivity function for a fishery. I believe relevant hypotheses should be developed to explain the derived selectivity curves. This has not been done explicitly, giving me an impression that the choice of selectivity function was rather ad hoc and even arbitrary.

Forcing a selectivity curve to exhibit asymptotic behavior implies that fish in large sizes/ages are 100% available to and selected by fishing gear. Clearly, this may not be true for longline and pot because they are passive fishing gears and more size selective. Because selectivity here also includes fish availability to fishing gear, it is also hard to imagine that 100% of fish of any size class become available to trawls. However, if fish of certain size classes become unavailable to fishing gears, they are not part of exploitable stock biomass. In this case forcing selectivity to exhibit asymptotic behavior yields the estimates of exploitable stock biomass. This should be considered in interpreting stock assessment results.

Seasonal selectivity is biologically justified because fishing activity is likely to vary greatly among seasons and fish distribution and availability to fishing gears tend to have seasonal patterns. Thus, I believe current seasonal selectivity is reasonable.

The choice of time block for selectivity is rather arbitrary (BSAI). I believe that a random walk over years may be a better choice. Once a model is run with random-walk selectivity over years, the temporal trend of selectivity plots needs to be examined closely to identify any temporal pattern. The identified temporal pattern can be used in the future to decide the time block for selectivity. For multiple fleets, I believe we need to evaluate one fleet at a time for their temporal trend while holding others constant.

IV-5. Fixing the trawl survey catchability coefficient for the recent portion of the time series such that the average product of catchability and selectivity across the 60-81 cm size range equals the point estimate obtained by Nichol et al. (2007)

The trawl-survey catchability coefficient for recent years was constrained so that the average product of q and S over the 60-81 cm size range equals the point estimate in Nichol et al. (2007). Given the limitation, this may be the best approach one can take. However, the study by Nichol et al. (2007) was effectively based on 11 fish mainly from the GOA, and the estimate is associated with a large variation. This creates large uncertainty associated with the current approach. More studies (e.g., tagging, acoustic survey to identify Pacific cod vertical distribution, and comparing catch from varying headlines) are needed to improve our understanding of survey catchability.

Survey catchability is supposed to be constant (with random variation) over time, which forms the base for the survey abundance index to be used as a reliable stock abundance index. This assumption is likely to be violated because of long survey durations, changes in charted vessels, differences in capacity of the three vessels used in a given year, large areas covered by the survey programs, and systematic design of the survey (BS). This calls for standardizing survey abundance index to remove factors influencing survey catchability.

I recommend that a general linear model (GLM) and/or general additive model (GAM) be 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. Such indices can remove annual variations in catchability, thus improving the quality of the input data and reducing the complexity of stock assessment model configuration.

IV-6. Fixing the natural mortality rate at the value corresponding to Jensen's (1996) Equation 7

Natural mortality rate is commonly fixed in most stock assessments because it is almost inseparable from fishing mortality and stock biomass estimates. The current M of 0.34/yr was estimated from equation 7 in Jensen (1996). The point estimate was used. A test run was conducted at the review meeting (i.e., CIE8), which assumes that M has an informative prior (normal distribution) with CV=30% and the lower and upper boundaries of 0 and 1, respectively. This change in M resulted in almost no changes in stock assessment perhaps because the same initial values were used. At this point, M, estimated based on Jensen's method, is perhaps the most reasonable choice. However, I believe age at maturity used to estimate M should be corrected if any ageing errors were defined either inside or outside the model.

In the future, if a Bayesian approach is used in the assessment, I recommend that informative priors be derived for M using M values estimated with different methods.

IV-7. Input sample sizes for size composition and age composition data, and input log-scale standard deviations for survey abundance data

The current stock assessment re-scaled sample size for size composition so that the average sample size in a year is approximately 300. For almost all test runs for both BSAI and GOA stocks, effective sample sizes estimated from the model tend to be much higher than the input sample sizes, suggesting that the model believes that the size-composition data have much higher quality than that suggested by the input sample sizes. Manual iterative adjustment was tried in the past outside parameter estimation, resulting in reduced differences between input sample size and estimated effective sample size. However, no information was available to evaluate differences in stock biomass estimates. Because of time limit, no test run was done at the review to evaluate the difference between input sample size and effective sample size and its implication to the stock biomass estimates. Although dynamic binning was tried at the review meeting, which should potentially reduce the effective sample size, we are not sure if SS3 actually reduces effective sample sizes accordingly.

Log-scale standard deviations for survey abundance data were inputted in the model. However, the variation calculated from the BS survey may not be correct because the current calculation of standard error implicitly assumes that the survey follows a stratified random design, while the actual survey follows systematic survey design. The standard deviation for the BS survey should be re-calculated using the method consistent with the survey design.

IV-8. Allowing for annual variability in trawl survey selectivity

This TOR is not precisely defined because trawl selectivity here may imply three different meanings: simple gear selectivity resulting from the survey trawl codend mesh size, selectivity including both gear selectivity and catchability, and selectivity including gear selectivity, catchability and fish availability.

Ideally, a fishery-independent survey program should not have a temporal trend in selectivity, catchability and availability. This allows 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 availability might differ from year to year because of long survey durations, large areas covered by survey programs, systematic survey design (for BS), and large variations in environmental variables over the survey area and duration. Although SS3 has a built-in capacity to accommodate potential temporal trends in selectivity/catchability/availability, I suggest standardizing survey abundance index outside the SS3 to remove the temporal trend in selectivity/catchability/availability. The temporal trend in selectivity/catchability/availability identified in the standardization can also be compared with the temporal trend derived in the SS3 to identify possible differences. This can improve our understanding of parameter estimation in the SS3.

IV-9. Setting the input standard deviation of log-scale recruitment (σ_R) equal to the standard deviation of the estimated log-scale recruitment deviations

Based on the SSB and recruitment data compiled by Dr. Ram Myers and his colleagues at Dalhousie University, variability in log recruitment was estimated at around 0.6 for Gadus species. However, these data sets might be subject to large errors, raising issues of their reliability. Pacific cod is known in history to vary greatly in their abundance, implying that they tend have a large value of σ_R. However, the time period covered in the assessment may not be long enough to allow us to evaluate a possible range of σ_R values. Thus, fixing the σ_R value in the input data from Myers' database or the standard deviation of log recruitment derived in previous assessments may not be appropriate. In a given assessment year, I believe adjusting the input standard deviation of log-scale recruitment (σ_R) equal to the standard deviation of the estimated log-scale recruitment deviations reflects the current recruitment dynamics and is reasonable.

IV-10. Use of survey data and non-use of fishery CPUE data in model fitting

Fishery CPUE data are often considered not to be representative of population abundance and are unreliable abundance index (Hilborn and Walters 1992) because of reasons such as nonrandomness of fishing process, temporal changes in catchability, and limited spatial coverage. Three fishing gears (trawl, longline, and pot) landed the most catch in the BSAI and GOA Pacific cod fisheries. Trawl mainly targets spawning aggregations, and longlne and pot are set in areas perceived by fishermen to have high density of cod. The fishery covers a limited partition of the Pacific cod stock area in the BSAI and GOA. Fishery CPUE data are not a reliable abundance index for the Pacific cod stock.

A fishery-independent survey program usually follows a standard sampling protocol, which is kept the same over time. This ensures that survey catchability has no temporal trend, yielding reliable abundance index. However, for the bottom trawl survey in the BSAI and GOA, because of long survey duration in a given year and use of chartered survey vessels, many factors may influence survey abundance index. This calls for the standardization of the survey abundance data before they are used in the SS3.

Five seasons are defined for the fishery in the recent stock assessment. Stock abundance index data are only available in one of the five seasons. This single survey program provides the information on temporal changes in stock biomass. Thus, the reliability of the survey abundance index is critical.

I suggest developing standardized fishery CPUE data (Stephens and McCall 2004) outside the SS3 to remove factors that may result in temporal variability in fishery catchability (Punt and Walker 2000; Maunder and Punt 2004). The standardized fishery CPUE for each gear can then be compared to that of each other gear and with the standardized survey abundance index outside the SS3 model to evaluate differences in their temporal trends and develop hypotheses to explain possible differences. Such an analysis outside the stock assessment model can cross check the data that play critical roles in quantifying temporal trends of stock biomass and identify factors that may influence survey catchability and fishery CPUE. Attentions should be paid to those factors identified as important in influencing survey catchability so that caution can be taken in future surveys to minimize impacts of these factors on survey catchability.

Current fishery CPUE data are not used in model fitting. However, these data are still included in the model, which may create confusion. I recommend that the fishery CPUE data that are not used in model fitting be removed from the model. If any analysis needs to be done between predicted stock biomass and CPUE of a fishery, they can be done outside the model to avoid confusion.

V. Conclusions and Recommendations

I would like to commend the great efforts of all the participants in the Pacific cod CIE review for providing necessary background information on Pacific cod life history, fishery-dependent and fishery-independent monitoring programs, genetic work on stock structure, stock assessment history, and management issues. I was impressed by the breadth of expertise and experience of the participants, the amount of effort spent to collect 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. I observed on many occasions constructive interactions and dialogs between scientists/managers and the sole representative of the industry in the review. All materials were sent to me in a timely manner and almost all my requests for extra information and extra runs were addressed promptly.

Overall I believe the Pacific cod stock assessment provides rather robust assessment results, in particular on temporal trends, for the BSAI and GOA stocks 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. Thompson and his co-workers for their efforts and openness in addressing uncertainty in the assessment and in exploring alternative model configurations. 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

In-depth analysis should be conducted to identify possible sources of uncertainty for a given set of data and relevant analysis should be done to reduce the uncertainty and improve data quality BEFORE the data are used in the stock assessment model. Trying to resolve all uncertainties within the SS3 model may complicate parameter estimation, resulting in difficulty in the model converging.

Given the flexibility and many choices that SS3 provides for functions quantifying life history and fishery processes, one needs to use background information of the collection of fishery and survey data, fish life history theory and local ecosystem to develop hypotheses to explain choices and resultant estimates. If a result cannot be justified in a reasonable way, the assessment should be evaluated. I understand that a similar approach was successfully used, which resulted in a better understanding of the model behavior (e.g., mismatching of size at age 2 versus size composition of survey data).

Previous efforts were focused on accommodating many different requests for model configurations. I believe more effort should be spent on model diagnoses to identify if the model assumptions, implicit and explicit, have been violated. This involves evaluating residual patterns for distributional assumptions, CVs of each estimated parameters to identify if an estimated parameter is significant, and the variance-covariance matrix to identify possible correlations between different parameters (and then to see if such a correlation can be justified biologically).

Retrospective errors tend to result in large errors in estimates of current stock biomass. However, previous assessment has not evaluated retrospective errors associated with the key estimates. In a test run conducted during the review, retrospective errors were found to be small for stock biomass estimate. However, large positive retrospective errors were found for the estimated recruitment, suggesting that current recruitment may be over-estimated by more than 50%; but because extensive jitters were not done, I am not sure if this pattern will be held when a better run is identified from jitters. We only tried the retrospective analysis on the base run (Model B in the 2010 stock assessment). In any case, the retrospective errors should be carefully evaluated for the estimates of stock biomass, fishing mortality, and recruitment.

The recruitment is currently measured as the number of age 0 fish in the Pacific cod stock assessment. I understand the number of age 0 fish is simply a reflection (discounted for natural mortality) of the number of fish in older ages (say 3) because there is no fishing mortality. However, given that age 0 implies larval stage and that there are no observations in survey and fishery, the biological meaning of the so-called recruitment is inappropriate and not well-defined. As it is defined, the current recruitment is neither representative of fishery recruitment nor the number of fish larvae. Rather, it is an index of the recruitment. Although this may not be an issue to fisheries stock assessment scientists, such a measure of recruitment may be mis-used by others who are not familiar with the stock assessment. I believe it is more appropriate to measure the fishery recruitment as the number of fish at an age group at which fish are subject to fishing mortality (e.g., number of fish at age 3).

We conducted many test runs during the review. However, because of time constraints, we were not able to conduct jitters and evaluate if the run was actually converged. As a result we were not sure if the single run yielded the best fit. For all the runs, we did not check whether the model showed convergence. This left great uncertainty in interpreting the results derived in the test runs during the review. Limited jitters were run for some scenarios after the review, but the number of jitters is still far less than normal runs in stock assessment. Although most results remained the same in the jitters, there were scenarios for which results changed. This makes it difficult to make conclusive results in evaluating the test runs. For this reason, I am trying to avoid specifically referring to a particular test run in my review.

Many model configurations were tested in the Pacific cod stock assessment in 2009 and 2010. Calls for public inputs and comments from the Plan Team and SSC resulted in large changes in the final choice of model in the stock assessment. Such changes may create inconsistency in stock assessment, making it hard to evaluate effectiveness of a selected management plan. Once a model is replaced by another model, their consistency should be evaluated. That is the model used in the previous year's assessment model should be included automatically in the next's year assessment as a background check for the model consistency. Future assessment should try to keep the stock assessment model relatively stable to avoid among-model variability over years.

Four criteria were used to select the final model in the last stock assessment:

Does the model makes 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 need to discuss and recommend a set of criteria that are well defined and measureable for choosing the stock assessment model.

Based on recent studies (Ingrid Spies's presentation at the CIE review, Appendix I), the BSAI Pacific cod is not considered to be genetically homogeneous. Genetic differentiation increases with distance. Moreover, there is evidence for more than one stock or population. The Pacific cod may have a metapopulation structure in the BSAI. This stock spatial structure may call for separate area management for the BS and AI. A separate stock assessment for BS and AI seems to be a logical way to start this process.

A habitat suitability modeling approach (e.g., Chang et al. 2010) can be used to identify suitable habitats for the Pacific cod, based on substrate map and ocean observatory data (or model data), to outline potential habitat maps in the BSAI and GOA and evaluate whether survey sampling stations cover the all effective habitat for cod in different age groups. Such an approach can also be used to project possible changes in cod spatial distribution if key habitat variables (e.g., temperature) change. The estimated spatial distribution from such a study can help 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 (Chen et al. 2003).

Although SS3 is very flexible and has been tested and used in the assessment of many fisheries stocks, the results derived still need to be cross-validated to enhance the confidence in the assessment. In the previous assessment, the estimated stock biomass was compared with stock biomass estimated from surveys using swept area methods. I believe some competitive models at different complexities should be developed for comparison with the SS3. Dr. Teresa A'mar of AFSC is currently developing an operating model for management strategy evaluation (MSE). With some modifications, this model has the potential to be used as a stock assessment model. A comparative study of stock assessment, begot from different models, can help improve understanding of fish population dynamics modeled by the SS3.

Although the SS3 has projection capacity, it has no built-in component for MSE. I believe on-going research efforts to develop an MSE framework for the Pacific cod can provide an important analytical tool to evaluate alternative management strategies and their associated risks.

A Bayesian approach has not been fully incorporated in the BASI and GOA Pacific cod stock assessment. Thus, uncertainty in the assessment has not been fully incorporated in the assessment and stock projection under different harvest strategies. I would encourage future assessment to fully utilize this function in the SS3.

Specific recommendations

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

- I recommend that retrospective analysis be conducted for all models considered in the stock assessment to evaluate nature (positive or negative) and magnitude of retrospective errors.

- I suggest standardizing survey abundance index using a general linear model (GLM) and/or general additive model (GAM) including variables that are considered to be important in influencing survey catchability (e.g., boat, temperature, bottom type, location, depth etc.).

- I recommend that fishery CPUE data that are not used in model fitting be removed from the model. If any analysis needs to be done between predicted stock biomass and CPUE of a fishery, they can be done outside the model to avoid confusion.

- I suggest back-calculating length-at-age data using otoliths to derive length at each age for each fish with its respective otolith sample. A nonlinear random effects model explicitly assuming that an individual's growth parameters are samples from a multivariate distribution can then be applied to the back-calculated length at age data (Hart 2001; Pilling et al. 2002) to estimate between-individual variability.

- I suggest that observer coverage should not be determined by vessel size. Rather, it should be determined by data needs, and should have a good representation of gear and vessel size composition in the fishing fleet.

- Because the current program has some overlaps in catch reporting from different sources, data from different sources can be compared and cross-validated. Such a study can yield some insights about potential errors in catch estimates from different sources.

- Given the importance of the catch 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 sampling/reporting system in yielding catch estimates, to evaluate potential error sources and levels of catch estimates, and to identify alternative sampling/reporting program designs.

- I suggest estimating uncertainty associated with catch estimates to develop a plausible range of catch estimates, which can then be used to evaluate impact of uncertainty associated with catch estimates on stock assessment.

- Ageing errors and variations should be estimated outside the SS3 model.

- If both length composition and age composition data from the same survey program are used in the assessment, I suggest that they be down-weighted (e.g., each assigned a weight of 0.5) in model fitting to reflect dependency of length on age or vice versa.

- Data collected from a monitoring/survey program should be analyzed using methods consistent with the design of the monitoring/survey program.

- More study needs to be done to explore the dynamic binning approach.

- I suggest developing standardized fishery CPUE data outside the SS3 to remove factors that may result in temporal variability in fishery catchability, and comparing the standardized CPUE with nominal CPUE and survey abundance index to determine if they can be used in the stock assessment.

- The choice of time block for selectivity is rather arbitrary (BSAI). I believe that a random walk over a defined set of years may be a better choice. Once a model is run with random-walk selectivity over a defined set of years, the temporal trend of selectivity plots needs to be examined closely to identify any temporal pattern. The identified temporal pattern can be used in the future to decide the time block for selectivity. For multiple fleets, I suggest evaluating one fleet at a time for its temporal trend while holding others constant

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

- I suggest that more effort be put towards model diagnosis and residual analysis.

- Many model configurations were used over the time. I recommend analyzing among-model variations (for all the final models used different years) to improve understanding of 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 resulting from changes in model configurations.

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

(1) <u>Documents received prior to the review</u>

DRAFT REPORT of the SCIENTIFIC AND STATISTICAL COMMITTEE to the NORTH PACIFIC FISHERY MANAGEMENT COUNCIL, January 31st –February 2nd, 2011

DRAFT REPORT of the SCIENTIFIC AND STATISTICAL COMMITTEE to the NORTH PACIFIC FISHERY MANAGEMENT COUNCIL, December 6-8, 2010

Minutes of the Bering Sea and Aleutian Islands Groundfish, Plan Team November 16-19, 2010, North Pacific Fishery Management Council, 605 W 4th Avenue, Suite 306, Anchorage, AK 99501

Minutes of the Gulf of Alaska Groundfish Plan Team, November 16-19, 2010. North Pacific Fishery Management Council, 605 W 4th Avenue, Suite 306, Anchorage, AK 99501

Minutes of the Joint Plan Teams for the Groundfish Fisheries of the Gulf of Alaska and Bering Sea Aleutian Islands, November 15-16, 2010, North Pacific Fishery Management Council, 605 W 4th Avenue, Suite 306, Anchorage, AK 99501

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(2) Documents received during the review

Barbeaux, S. J., S. Gaichas, J. N. Ianelli, M. W. Dorn. 2005. Evaluation of biological sampling protocols for at-sea groundfish observers in Alaska. Alaska Fishery Research Bulletin Vol. 11. No. 2

Cahalan, J., J. Mondragon, and J. Gasper. 2010. Catch Sampling and Estimation in the Federal Groundfish Fisheries off Alaska U.S. DEPARTMENT OF COMMERCE, National Oceanic and Atmospheric Administration National Marine Fisheries Service Alaska Fisheries Science Center

Kastelle1, C. R., Thomas E. Helser1, Dan G. Nichol1, Delsa M. Anderl1, and Jennifer McKay. 2010. A Preliminary Age Validation of Pacific Cod (Gadus macrocephalus) Using Stable Oxygen Isotopes (δ 18O). 1Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA, 7600 Sand Point Way, Seattle, WA 98115

Lauth, R. R. 2010. Results of the 2009 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources U.S. DEPARTMENT OF COMMERCE, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center

Ormseth, O. A., Mike Canino, Liz Conners, Sandi Neidetcher, Peter Munro, Sarah Gaichas and Kerim Aydin; Doug Kinzey. 2008. Summary of biological information regarding differences between Pacific cod in the eastern Bering Sea and Aleutian Islands. Alaska Fisheries Science Center

(3) Presentations at the review

- Catch data by Jennifer Mondragon (Alaska Fisheries Science Center)
- History of the EBS and GOA Pacific cod stock assessments History of the EBS and GOA Pacific cod stock assessments by Grant Thompson, Kerim Aydin, Richard Bakkala, Martin Dorn, Sarah Gaichas, Jim Ianelli, Bob Lauth, Mark Wilkins, Dan Nichol, Al Shimada, Skip Zenger (Alaska Fisheries Science Center)

- Overview of the final 2010 BSAI and GOA Pacific cod stock assessments and recent research by Grant Thompson, James Ianelli, Robert Lauth, and Mark Wilkins (Alaska Fisheries Science Center)

- Eastern Bering Sea shelf bottom trawl survey of groundfish and invertebrate resources by Lyle Britt, Jason Conner, Gerald Hoff, Stan Kotwicki, Bob Lauth, Gary Mundell, Dan Nichol, Dave Somerton, Duane Stevenson, Ken Weinberg (Groundfish Assessment Program RACE Division, Alaska Fisheries Science Center)

- Pacific Cod: What Bottom Trawl Surveys of the Gulf of Alaska and Aleutian Islands Tell Us by Mark Wilkins (NMFS, AFSC, RACE Groundfish Assessment Program)

- Description of the Pacific cod fisheries by Grant Thompson

- Management strategy evaluation of the GOA Pacific cod fishery by Teresa A'mar (Alaska Fisheries Science Center)

- Age Determination of Pacific Cod (Gadus macrocephalus) at the Alaska Fisheries Science Center By Delsa M. Anderl (Alaska Fisheries Science Center)

- Some Management Considerations Regarding Pacific Cod Stock Assessments by Jane DiCosimo (North Pacific Fishery Management Council, Anchorage, Alaska)

- Landscape genetics of Pacific cod in the Aleutian Islands and Bering Sea by Spies, I (Alaska Fisheries Science Center and University of Washington).

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

External Independent Peer Review by the Center for Independent Experts

BSAI and GOA Pacific Cod Stock Assessment Review

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance with the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: The Alaska Fisheries Science Center (AFSC) requests a Center of Independent Experts (CIE) review of stock assessments for the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) Pacific cod stock assessments. The Pacific cod fisheries are large and Pacific cod is a key component of the BSAI and GOA ecosystems. The Pacific cod stock assessments routinely undergo thorough review by the AFSC, the North Pacific Fisheries Management Council's Groundfish Plan Teams and Scientific and Statistical Committee, and members of the public. The annual process for producing the Pacific cod stock assessments includes calls for new model proposals and two fully reviewed drafts of the stock assessment report. However, the Pacific cod stock assessments have not had the benefit of a CIE review since 2001. Therefore, a CIE review in 2011 would be timely. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have expertise and working knowledge in the application of current stock assessment, including population dynamics, survey methodology, estimation of parameters in complex nonlinear models, and the Stock Synthesis assessment program in particular. CIE reviewers shall have recent experience conducting stock assessments for fisheries management. Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled at Alaska Fisheries Science Center in Seattle, Washington during the tentative dates of March 14-18, 2011.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later than the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE 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 CIE reviewers who are non-US citizens. For this reason, the CIE 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/sponsor.html).

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs can not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

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

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate during the panel review meeting at the Alaska Fisheries Science Center in Seattle, Washington during the tentative dates of March 14-18, 2011.
3) Conduct an independent peer review in accordance with the ToRs (**Annex 2**), during the tentative dates of March 14-18, 2011 at the Alaska Fisheries Science Center in Seattle, Washington, as specified herein.
4) No later than 1 April 2011, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and Dr. David Die, CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

7 February 2011	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
28 February 2011	NMFS Project Contact sends the CIE Reviewers the pre-review documents
14-18 March 2011	Each reviewer participates and conducts an independent peer review during the panel review meeting
1 April 2011	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
15 April 2011	CIE submits CIE independent peer review reports to the COTR
22 April 2011	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) each CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) each CIE report shall address each ToR as specified in **Annex 2**,
(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Contracting Officer's Technical Representative (COTR)
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-713-2363 ext 136

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Key Personnel:

NMFS Project Contact:

Grant Thompson
7600 Sand Point Way NE., Seattle, WA 98115-6349
Grant.Thompson@noaa.gov Phone: 541-737-9318

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing 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, and especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the Summary Report that they feel 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 CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

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

Annex 2: Tentative Terms of Reference for the Peer Review

BSAI and GOA Pacific Cod Stock Assessment Review

Annex 2: Terms of Reference

For both the EBS and GOA Pacific cod assessments, CIE reviewers shall evaluate current model assumptions and make recommendations for improvements thereof, including:

1. Use of age data, including:
    a. Use of age composition data
    b. Use of mean-size-at-age data
    c. Use of ageing bias as an estimated parameter
    d. External estimation of between-individual variability in size at age
2. Data partitioning/binning, including:
    a. Catch data partitioned by year, season, and gear
    b. Size composition data partitioned by year, season, gear, and 1-cm size intervals
    c. Age composition data partitioned by year, season, and gear
3. Functional form of the length-at-age relationship and estimating the parameters thereof
4. Number and functional form of selectivity curves estimated, including assumptions regarding which selectivity curves should be forced to exhibit asymptotic behavior
5. Fixing the trawl survey catchability coefficient for the recent portion of the time series such that the average product of catchability and selectivity across the 60-81 cm size range equals the point estimate obtained by Nichol et al. (2007)
6. Fixing the natural mortality rate at the value corresponding to Jensen's (1996) Equation 7
7. Input sample sizes for size composition and age composition data, and input log-scale standard deviations for survey abundance data
8. Allowing for annual variability in trawl survey selectivity
9. Setting the input standard deviation of log-scale recruitment (σ_R) equal to the standard deviation of the estimated log-scale recruitment deviations
10. Use of survey data and non-use of fishery CPUE data in model fitting

References:

Jensen, A. L. 1996. Beverton and Holt life history invariants result from optimal trade-off of reproduction and survival. *Can. J. Fish. Aquat. Sci.* 53:820-822.

Nichol, D. G., T. Honkalehto, and G. G. Thompson. 2007. Proximity of Pacific cod to the sea floor: Using archival tags to estimate fish availability to research bottom trawls. *Fisheries Research* 86:129-135.

Annex 3: AGENDA

CIE Review of the EBS and GOA Pacific cod stock assessment models

Alaska Fisheries Science Center
7600 Sand Point Way NE, Seattle, WA 98115
March 14-18, 2011
Building 4; Room 2076 (March 14-15), Room 2143 (March 16-18)

Review panel chair: Anne Hollowed, Anne.Hollowed@noaa.gov
Senior assessment author: Grant Thompson, Grant.Thompson@noaa.gov
Security and check-in: Julie Pearce, Julie.Pearce@noaa.gov (206)526-6547

Sessions will run from 9 a.m. to 5 p.m. each day, with time for lunch and morning and afternoon breaks.Discussion will be open to everyone, with priority given to the panel and senior assessment author.

Monday, March 14th

Preliminaries:
- 9:00 Introductions—Anne
- 9:10 Adopt agenda—Anne
- 9:20 Description of the Pacific cod fisheries—Grant

Data:
- 9:40 Catch data—Jennifer Mondragon (via WebEx)
- 10:20 Fishery-dependent length composition data—Patti Nelson

10:50 Break

Data, continued:
- 11:10 EBS trawl survey—Bob Lauth
- 11:40 GOA trawl survey—Mark Wilkins

12:10 Lunch

Data, continued:
- 1:10 Age composition and mean-length-at-age data—Delsa Anderl and Craig Kastelle

2:10 Assessment history—Grant

3:10 Break

3:30 Management issues related to the stock assessments—Jane DiCosimo

Possible considerations for future assessments:
- 4:00 Genetic and spatial considerations—Ingrid Spies
- 4:30 Management strategy evaluation of the GOA stock—Teresa A'mar

Tuesday, March 15th

Details of last year's assessments and pre-meeting model runs—Grant
Discussion, real-time model runs—Everyone
Assignments for models to be presented on Wednesday—Panel

Wednesday-Thursday, March 16th-17th

Review of models assigned the previous day—Grant
Discussion, real-time model runs—Everyone
Assignments for models to be presented the following day—Panel

Friday, March 18th

Review of models assigned on Thursday—Grant
Discussion, real-time model runs—Everyone
Report writing—Panel

VII-3. Appendix III: List of Participants

	First	Last	E-mail	Organization
1	Teresa	A'mar	Teresa.Amar@noaa.gov	AFSC
2	Delsa	Anderl	Delsa.Anderl@noaa.gov	AFSC
3	Ruth	Christiansen	Ruth.Christiansen@Alaska.Gov	ADFG
4	Marlon	Concepcion	Marlon.Concepcion@noaa.gov	AFSC
5	Elizabeth	Conners	Liz.Conners@noaa.gov	AFSC
6	Jane	DiCosimo	Jane.Dicosimo@noaa.gov	NPFMC
7	Kenny	Down	Kenny.Down@comcast.net	FLC
8	Thomas	Helser	Thomas.Helser@noaa.gov	AFSC
9	Anne	Hollowed	Anne.Hollowed@noaa.gov	AFSC
10	Craig	Kastelle	Craig.Kastelle@noaa.gov	AFSC
11	Robert	Lauth	Bob.Lauth@noaa.gov	AFSC
12	Pat	Livingston	Pat.Livingston@noaa.gov	AFSC
13	Sandra	Lowe	Sandra.Lowe@noaa.gov	AFSC
14	Brian	Mason	Brian.Mason@noaa.gov	AFSC
15	Susanne	McDermott	Susanne.McDermott@noaa.gov	AFSC
15	Peter	Munro	Peter.Munro@noaa.gov	AFSC
16	Sandra	Neidetcher	Sandi.Neidetcher@noaa.gov	AFSC
17	Patti	Nelson	Pattie.Nelson@noaa.gov	AFSC
18	Ingrid	Spies	Ingrid.Spies@noaa.gov	AFSC
19	Grant	Thompson	Grant.Thompson@noaa.gov	AFSC
20	Ken	Weinberg	Ken.Weinberg@noaa.gov	AFSC
21	Mark	Wilkins	Mark.Wilkins@noaa.gov	AFSC
22	Jose	De Oliveira	jose.deoliveira@cefas.co.uk	CIE
23	Chris	Darby	chris.darby@cefas.co.uk	CIE
24	Yong	Chen	ychen@maine.edu	CIE

ADFG = Alaska Department of Fish and Game, AFSC = Alaska Fisheries Science Center, FLC = Freezer Longline Coalition, and NPFMC = North Pacific Fishery Management Council.

VII-4. Appendix IV: Design of the test runs at the CIE review meeting from March 14-18, 2011 (documentation was done by Dr. Grant Thompson)

Tuesday (March 15) night model runs

Data file CIE0.dat is the same as last year's final BS model, reformatted to be usable under V3.20b, and with corrected seasons in the size-at-age data.

Control file CIE0.ctl is the same as last year's final BS model, reformatted to be usable under V3.20b. Starting from last year's converged parameter file, this control file gives –lnL=5402.55.

Estimation of the extra parameter in the Richards growth function appears to require that L0 be positive (in last year's final BS model, the estimate was negative).

Control file CIE2.ctl is the same as last year's final BS model, but with the initial value of L0 slightly positive, and a lower bound of 0 on L0. Starting from the converged parameter file for CIE0.ctl (with L0 adjusted), this control file gives –lnL=8611.85.

Control file CIE1.ctl is the same as CIE2.ctl, but with the Richards growth coefficient freed (initial value = 1). Starting from the converged parameter file for CIE0.ctl (with L0 adjusted and an extra line added for the Richards growth coefficient), this control file gives –lnL=6048.38.

Control file CIE3.ctl is the same as CIE0.ctl, but with all time blocks removed, all selectivity parameters except fishery Smin freed, and all other selectivity parameters initialized at the midpoints of their respective ranges. Starting from the values listed in the control file, this gives –lnL=7832.28.

Wednesday (March 16) night model runs

CIE4 sets lambda on fishery sizecomps equal to 0.001, with no blocks (i.e., one step removed from CIE3). R4ss plots available. –lnL=1449.91

CIE5 has Richards growth plus internally estimated ageing bias (ramp from 2 to 20). R4ss did not run completely; only partial set of plots available. –lnL=5723.77

We wanted jitters for models 1, 3, and 5, but things went slowly and we only got 12+ jitters for CIE1 (none for the others)

CIE6 will be like CIE4, but with blocks (i.e., one step removed from CIE0).

Thursday (March 17) daytime

CIE7: Q free.

CIE8: Informative prior for M.

CIE9: Dynamic binning

Thursday (March 17) night assignments

More runs for the GOA? (requires modifying control and data files to work with V3.20b)
Not CIE4 or CIE6 ; yes CIE3 and CIE9 and CIE1 and retro (top priority). Right to left.

“Retro” worked only for the “-1” case in the GOA model.

GOAmodel0 = GOA0.ctl + GOA0.dat (base run)
GOAmodel1 = GOA1.ctl + GOA0.dat (Richards growth with positive L0)
GOAmodel3 = GOA3.ctl + GOA0.dat (no blocks, except survey)
GOAmodel9 = GOA9.ctl (same as GOA0.ctl) + GOA1.dat (dynamic binning)

CIE10: Size-at-age turned off.

Friday (March 18) runs

CIE11: Size-at-age turned off, fishery=season (i.e., 5 fisheries), random walk selectivity at age through age 8, fishery CPUE data removed; no blocks; survey sizecomps turned on in all years; ageing bias estimated internally; Richards growth turned on

CIE12: Two re-weighting (except survey CPUE) iterations removed from CIE11 (note: ageing bias estimated internally).