AGENDA D-1(g, h)
JUNE 2012

MEMORANDUM

TO: Council and SSC Members

FROM: Chris Oliver
Executive Director

ESTIMATED TIME
8 HOURS

DATE: May 31, 2011

SUBJECT: Groundfish Issues (SSC only)

ACTION:

(g) Review Pacific cod assessment models.
(h) Receive report of the Recruitment Workshop.

BACKGROUND

(g) Pacific cod models

Nine members of the BSAI Groundfish Plan Team and eight members of the GOA Groundfish Plan Teams met at a Joint Meeting of the BSAI GOA Groundfish Plan Teams via teleconference and WEBEX on May 1, 2012. The objective of the meeting was to review proposals for GOA and BSAI Pacific cod stock assessment models and recommend models for each area assessment for fall 2012. Seven model proposals were ranked among four models. The background document and joint plan team report are attached as Item D-1(g)(1) and Item D-1(g)(2)).

Table 1. List of proposals and Joint Plan Team recommended models for preliminary assessments.

Model proposals

Topic	Number	Proposal	Proposed area	Priority	Model 1	Model 2	Model 3	Model 4
Ageing	FLC2	Include last year's Model 4 or this year's preferred model without age data	EBS	high				EBS
Aleutians	SSC6	Develop age-structured model	AI	medium	AI			
Base model	new	Include last year's final model without modification	EBS, GOA	high	EBS, GOA			
Growth	FLC1	Include last year's Model 3b with time-varying growth	EBS	low				
Q/selectivity	BPT1	Consider new fishery selectivity period starting in 2008 or 2010	EBS	high			EBS	
Q/selectivity	FLC3	Include last year's Model 3b with re-tuned catchability	EBS, GOA	high (EBS)		EBS		
Q/selectivity	new	Include last year's Model 3 with re-tuned catchability	GOA	high		GOA		

Non-model proposals

Topic	Number	Proposal	Proposed area	Priority
Ageing	GPT1/SSC3	Explore divergent ageing bias trends in EBS and GOA and impacts thereof	EBS, GOA	medium
General	SSC1	Keep no. models small, retain current model for several years	EBS, GOA	n/a
General	SSC5	Apply additional scrutiny to GOA stock	GOA	n/a
Growth	SSC2	Evaluate biological basis for seasonal weight at length	EBS, GOA	medium
Parsimony	SSC4	Reduce number of parameters	GOA	high
Q/selectivity	JPT1	Estimate catchability internally	EBS, GOA	medium

A status report on the Joint Groundfish/Crab Plan Team Working Group on total catch accounting is provided as Item D-1(g)(3).

(h) Receive report of the Recruitment Workgroup (Phase 1)

The Groundfish Plan Teams (GPT) and Crab Plan Team (CPT) have appointed a working group to list and evaluate alternatives for a number of assessment and management issues related to recruitment. To aid the working group in accomplishing its task, a workshop was held at the AFSC Seattle laboratory during the dates of April 4-5, 2012. The workshop was intended to address a long-standing request from the BSAI GPT for analysis of recruitment-related issues such as: which cohorts to include in estimation of reference points, how to estimate parameters related to recruitment (including parameters of a stock-recruitment relationship), and how to determine the reliability of the F_{MSY} probability density function as well as to develop guidelines on how to address environmental changes in the SR relationship into biological reference points and how to model environmental forcing in stock projection models.

A "Phase I" working group report was mailed to you on May 18th and is attached as Item D-1(h)(1). This is being provided prior to completion of the full working group report because four agenda items from the workshop were deemed critical for consideration at the May 2012 meeting of the CPT. These were:

A. Identification of regime shifts, either for an ecosystem or some subunit thereof

1. Current policy on identification of regime shifts
2. Possible improvements to current policy, including consideration of risk

B. Estimation of parameters (average recruitment, stock-recruitment relationships, sigma-r)

1. Establishing criteria for excluding individual within-regime year classes from estimates

C. Forecasting environmental variability

1. (to be addressed later)
2. How knowledge of environmental forcing changes perceptions of reference points.

The Crab Plan Team provided their recommendations on a policy for moving forward to address these items at their May 2012 meeting. An excerpt from the CPT minutes on this topic is provided as Item D-1(h)(2). The full CPT report is included under agenda item C-3(a). SSC input is being sought on both the current draft of the Phase 1 report as well as the resulting recommendations from the CPT.

The full report of the working group will be prepared in time for consideration at the September meetings of the CPT and GPTs. The full report may revisit some or all of the items addressed in this Phase I report, and will address as many of the remaining agenda items as possible within the time available.

1 Pacific cod model structures included in the final 2011 SAFE reports

1.1 Model structures considered in the 2011 EBS assessment (Model 3b was adopted)

The Pacific cod stock assessment models were reviewed in March of 2011 by three scientists contracted by the CIE. A total of 128 unique recommendations were received from the CIE reviewers. Following the review in March, a set of seven models was requested for inclusion in the preliminary assessment by the Plan Teams in May, with subsequent concurrence by the SSC in June. Following review in August and September, four of these models (Models 1, 2b, 3, and 4) were requested by the Plan Teams or SSC to be included in the final assessment. In addition, the SSC requested one new model, which is labeled here as Model 3b.

Model 1 is identical to the model accepted for use by the BSAI Plan Team and SSC in 2010, except for inclusion of new data and corrections to old data.

In the preliminary assessment, the only difference between Model 1 and Model 2b was that the pre-1982 portion of the AFSC bottom trawl time series was omitted from the latter. In the present assessment, the following additional changes were made relative to Model 1:

- The 1977-1979 and 1980-1984 time blocks for the January-April trawl fishery selectivity parameters were combined. This change was made because the selectivity curve for the 1977-1979 time block tended to have a very difficult-to-rationalize shape (almost constant across length, even at very small sizes), which led to very high and also difficult-to-rationalize initial fishing mortality rates.
- The age corresponding to the *L1* parameter in the length-at-age equation was increased from 0 to 1.4167, to correspond to the age of a 1-year-old fish at the time of the survey, which is when the age data are collected. This change was adopted to prevent mean size at age from going negative (as sometimes happened for age 0 fish in previous assessments, and as happened even for age 1 fish in one of the models from the 2010 assessment), and to facilitate comparison of estimated and observed length at age and variability in length at age.
- The parameters governing variability in length at age were re-tuned. This was necessitated by the change in the age corresponding to the *L1* parameter (above).
- A column for age 0 fish was added to the age composition and mean-size-at-age portions of the data file. Even though there are virtually no age 0 fish represented in these two portions of the data file, unless a column for age 0 is included, SS will interpret age 1 fish as being ages 0 and 1 combined, which can bias the estimates of year class strength.

Model 3 is identical to Model 2b, except that ageing bias was estimated internally and the parameters governing variability in length were re-tuned (again).

Model 3b is identical to Model 3, except that the parameters governing variability in length were estimated internally, all size composition records were included in the log-likelihood function, and the fit to the mean-size-at-age data was not included in the log-likelihood function.

Model 4 is identical to Model 3b, except that ageing bias was not estimated internally and the fit to the age composition data was not included in the log-likelihood function.

1.2 Model structures considered in the 2011 GOA assessment (Model 3 was adopted)

The Pacific cod stock assessment models were reviewed in March of 2011 by three scientists contracted by the CIE. A total of 128 unique recommendations were received from the CIE reviewers. Following the review in March, a set of seven models was requested for inclusion in the preliminary assessments (of which only the EBS version was actually completed) by the Plan Teams in May, with subsequent concurrence by the SSC in June. Following review in August and September, GOA versions of three of these models (Models 1, 3, and 4) were requested by the Plan Teams or SSC to be included in the final GOA assessment. In addition, the SSC requested one new model, which is labeled here as Model 3b.

Model 1 is identical to the model accepted for use by the GOA Plan Team and SSC in 2010, except for inclusion of new data and corrections to old data.

Model 3 in the present assessment differs from Model 1 in the following respects:

- The age corresponding to the *L1* parameter in the length-at-age equation was increased from 0 to 1.3333, to correspond to the age of a 1-year-old fish at the time of the survey, which is when the age data are collected. This change was adopted to prevent mean size at age from going negative (as sometimes happened in previous EBS Pacific cod models), and to facilitate comparison of estimated and observed length at age and variability in length at age.
- The parameters governing variability in length at age were re-tuned. This was necessitated by the change in the age corresponding to the *L1* parameter (above).
- A column for age 0 fish was added to the age composition and mean-size-at-age portions of the data file. Even though there are virtually no age 0 fish represented in these two portions of the data file, unless a column for age 0 is included, SS will interpret age 1 fish as being ages 0 and 1 combined, which can bias the estimates of year class strength.
- Ageing bias was estimated internally. To preserve a large value for the strength of the 1977 year class and to keep the mean recruitment from the pre-1977 environmental regime lower than the mean recruitment from the post-1976 environmental regime, ageing bias was constrained to be positive (this constraint was not included in the EBS version of Model 3; here, it ultimately proved to be binding only at the maximum age).

Model 3b is identical to Model 3, except that the parameters governing variability in length were estimated internally, all size composition records were included in the log likelihood function, the fit to the mean-size-at-age data was not included in the log likelihood function, selectivity and catchability in the 27-plus trawl survey were both forced to be constant over time, and catchability deviations in the sub-27 survey were given normal priors with mean = 0 and standard deviation = 0.46. The sigma value of 0.46 for the annual deviations in catchability for the sub-27 survey was chosen on the basis of the variability in age 1 survey selectivity from Model 3b in this year's EBS Pacific cod model. This variability had a CV of 0.49, which corresponds to a sigma of 0.46, assuming a lognormal distribution. As with Model 3, ageing bias was constrained to be positive (this constraint was not included in the EBS version of Model 3b; here, it ultimately proved to be binding only at age 1).

Model 4 is identical to Model 3b, except that variability in survey catchability and selectivity was configured as in Models 1 and 3, ageing bias was not estimated internally, the fit to the age composition data was not included in the log-likelihood function, and mean recruitment in the pre-1977 environmental regime was constrained to be less than mean recruitment in the post-1976 environmental regime (this constraint was not included in the EBS version of Model 4; here, it ultimately proved to be binding).

2 Pacific cod minutes from the November 2011 Plan Team and December 2011 SSC meetings

2.1 Joint Plan Team

Grant Thompson described the candidate models for this year's specifications, which had evolved through a series of meetings and trials including a CIE review in March, a team conference in May and SSC meeting in June that produced an intermediate suite of candidates, and finally the September team meeting and October SSC meeting where the candidates for this meeting were chosen. Last year's model was Model 1 and had these features:

- *M* fixed at 0.34.
- Length-specific commercial selectivities for all fisheries, some forced to be asymptotic, estimated for blocks of years.
- Age-specific survey selectivity with an annually varying left limb.
- Survey catchability fixed at the value obtained in the 2009 assessment (0.77), where it resulted in the product of catchability and selectivity at 60-81 cm equal (on average) to the desired value of 0.47 in the EBS and 0.92 in the GOA. The desired values were based on a small number of archival tags.
- Assumed ageing error bias of +0.4 y at all ages.
- A single growth schedule for all years (cohort-specific in the 2009 assessment).
- Length composition data not used where age data were available (to avoid double fitting).

This year's assessment provided additional candidate models as follows:

- Model 2b in the EBS was the same as Model 1 except that pre-1982 trawl survey data were left out of the fit and Grant made a few minor but helpful housekeeping changes to the model configuration. Model 2b was fitted only in the EBS.
- Model 3 was the same as Model 2b except that ageing error was estimated internally.
- Model 3b for the EBS was the same as Model 3 except that the standard deviation of length at age was estimated internally, the mean length-at-age data were left out of the likelihood, and all length frequency data were used. In Model 3b for the GOA, there were also some constraints on survey catchability, survey selectivity, and ageing error parameters to keep the estimates reasonable and to approximate more closely the amount of survey variability estimated in the EBS.
- Model 4 for the EBS was the same as Model 3b except that all age composition data were left out of the fit (to avoid the whole issue of ageing error). Model 4 for the GOA also had a constraint on pre-1977 recruitment.

In the EBS, all of the models produced similar estimates of historical recruitment and present abundance, and similar fits to the survey biomass estimates. All of them also predicted mean length at age among younger fish in good agreement with the modes in the survey length frequencies. In the GOA, Models 1 and 3 produced similar estimates but Models 3b and 4 produced much higher estimates of abundance and estimates of historical recruitment that differed from each other and from the first two models. The higher abundance estimate by Model 3b resulted mainly from its much lower estimate of survey selectivity at 60-80 cm. In the GOA, Model 3 fitted the age data better than Model 3b, and showed more between-year variation in estimated survey selectivity.

Grant showed some graphs of variation among years in mean length at age 1. This variation adds to the variance of length at age 1 when the model is fitted, so external estimates of the standard deviation of length at age tend to be too low. For that reason Grant felt that the models that estimated the standard deviation internally (3b and 4) were superior in that respect.

Grant also reported jitter tests for all models. Convergence is still weak for some, especially in the GOA. It was questioned whether the jitter tests were meaningful, given that the jitters were scaled to the very wide bounds on the parameters. He suggested that the tests be run with the "Fballpark" penalty, which leads the parameter vector to a realistic neighborhood during the first phase of minimization, avoiding excursions to extreme regions of parameter space.

In the assessment document Grant had set out some criteria for model selection based on CIE, SSC, and other recommendations. These criteria included: (i) the model should continue to be fitted to the age composition data, (ii) the ageing error should be estimated internally, (iii) the model fit should estimate the desired value of the product of survey catchability and selectivity at 60-81 cm (0.47 in the EBS and 0.92 in the GOA), and (iv) the model should estimate the full variance of length at age. By these standards Model 3b was the clear choice in the EBS. In the GOA none of the models had all the desired features and Grant settled on Model 3 on the grounds that it had all of the most important features.

After some discussion the Teams endorsed the author's decision to estimate ageing error internally and continue fitting to the age data. It was noted, however, that the ageing error estimates were troubling. In the EBS, both of the models that estimated ageing error (Models 3 and 3b) produced very similar estimates of the ageing error parameters, but in the GOA, Models 3 and 3b produced parameter estimates that were quite different from each other and from the EBS values. It appears that in the GOA these parameters are not well determined by the data.

The Teams also supported the practice of relying on the target values of survey catchability times selectivity at 60-81 cm to scale the abundance estimates. The empirical support for these values is not strong, but both values are plausible, they are the best external estimates available, and at this point we still need an external estimate to scale the fits. Bob Lauth reported on planned field work using a Didson sonar to investigate the vertical distribution of cod in front of the EBS survey trawl, and paired tows with the EBS and GOA survey trawls to see whether the higher-opening GOA trawl (7 m vs 2.5) catches substantially more cod in the EBS. **The Teams strongly support this research.** We feel that more information on survey catchability is needed to inform the assessment.

At the same time, **the Teams encouraged the author to try estimating survey catchability internally again.** It is possible that with the other improvements made in this assessment, catchability will be estimable, at least in the EBS assessment.

2.2 BSAI Plan Team

2.2.1 Eastern Bering Sea

Grant Thompson presented the Pacific cod assessment. The various candidate models for this year's harvest specifications were discussed by the joint teams (see JPT minutes). In the EBS, Model 3b was the clear choice by the standards adopted by the author and the teams. The BSAI team agrees with the specifications based on Model 3b recommended by the author.

In addition to the joint teams' recommendations, **the BSAI team recommends that the author check for any poor fits to commercial length frequencies that might indicate a change in selectivity**

resulting from the implementation of Amendment 80 in 2008 and the creation of longline cooperatives in 2010.

2.2.2 Aleutian Islands

The team discussed two alternatives for accounting for the Aleutians in the ABC: a Tier 5 calculation based on Kalman filtering of the Aleutian survey biomass estimate, or a simple expansion of the ABC from the EBS assessment by the ratio of AI and EBS survey estimates (presently 9%). The team preferred the second method, which has been the standard. The combined BS/AI specifications were calculated this way.

2.3 GOA Plan Team

Grant Thompson provided an overview of the Pacific cod model considered in this year's assessment in the Joint Plan Team meeting. The various candidate models for this year's harvest specifications were discussed by the joint Teams (see JPT minutes). In the GOA, Model 3 and 3b were chosen for further consideration by the Plan Team based on the criteria adopted by the author. The authors' preferred model was Model 3. Although model Model 3b had better diagnostics for some of the model fits, estimates of the product of survey catchability and selectivity was lower than that observed by Nichol et al.(2007) which resulted in Model 3b having stock size estimates that were much higher than Model 3. The Team noted that retrospective analyses indicated that when data were added the revised abundance estimates in the most recent years tended to be lower. The Team agreed with the author and selected model 3 and also noted that since the retrospective patterns seemed to indicate an upward bias, a more conservative and consistent approach is warranted.

The Team discussed ideas for field work that could help with some of the uncertainties in the stock assessment. The model estimates that age-2 cod have a lower selectivity than age-1 cod. Field work to identify locations of age-2 Pacific cod may help support this model result. Also discussed were studies to directly estimate ageing bias using methods such as samples from known-aged tagged fish similar to what has been done for sablefish.

The Team pointed out that the ageing error bias is estimated to be different between the GOA and Bering Sea. They **encouraged exploration of this phenomenon and in particular, how estimates of ageing bias affect model results.**

The Team discussed the Kalman filter approach for areal apportionment of ABC. Similar to sablefish, the Team reasoned that variations between apportionment schemes are unlikely to have biological consequences in terms of stock conservation. The Kalman filter approach and past methods using unweighted proportions give similar results and both were acceptable to the Team.

2.4 SSC

Since last year's assessment, the Pacific cod models underwent a CIE review and, as in 2010, model proposals from stakeholder were considered. These were reviewed by the Joint Plan Team in May/September and by the SSC in June/October to reduce the numerous recommendations from the CIE review, Plan Teams, SSC, and the public to a more manageable set of five models that were brought forward in this year's assessment.

The SSC appreciates the tremendous work that went into improvements to the Pacific cod model in recent years and thanks the author for clearly laying out the recent history of the assessment models. For next year's assessment cycle in both areas, the SSC supports the current protocol of vetting models through a public process and selecting a limited set of models to bring forward. We agree with a recommendation from the CIE review that the number of explorations and new model configurations for upcoming assessments should be reduced to allow for a thorough evaluation of the performance of the current model over several assessment cycles.

The author proposed seven model evaluation criteria; 1) fitting the age composition data (unanimous CIE recommendation), 2) internal estimation of aging error bias (much more efficient), 3) correspondence between the model-estimated mean size-at-age and the empirical survey mean size-at-age of the first three modes of the average survey size composition, 4) correspondence of the product of survey catchability and survey selectivity (for the 61 to 80 cm size range) from the model and the value of 0.92 estimated by Nichol et al. (2007), 5) accounting for full variability in the observed length-at-age among individuals and years, 6) low temporal variability in survey selectivity and catchability, and 7) reasonable retrospective behavior. The Plan Team endorsed, and **the SSC concurs, with these selection criteria, which are a distillation of past preferences and recommendations from the Plan Teams, CIE reviewers, the public, and the SSC.**

One of the largest sources of uncertainty in both assessments remains the catchability of Pacific cod in the survey. **The SSC strongly supports proposed research on the vertical distribution of Pacific cod relative to the EBS bottom trawl and comparisons between the EBS and GOA trawl gear.**

Other comments that pertain to both areas:

- The SSC notes that weight-at-age in both regions was lowest in May-Aug. or Sept.-Oct. and highest in Jan.-Feb. These patterns seem somewhat counter-intuitive and we encourage the authors to evaluate biological basis for these patterns.
- The recommended models for both regions estimate ageing bias as a linear function of age, but the estimated patterns in bias by age differs by region increasing from approximately 0.34 at the youngest age to 0.85 at the oldest age in the BSAI assessment (model 3b), but decreases from 0.36 to 0 at the oldest age in the GOA assessment (model 3).

2.4.1 BSAI Pacific cod

Public testimony was provided by Kenny Down (Freezer Longline Coalition), who urged the SSC to continue the current protocol of vetting models in a public process. The FLC supports continued work on determining catchability and supports selection of model 3b and the associated ABC for 2012.

For this year's assessment, the 2010 preferred model, as accepted by the SSC in December 2010, was updated with new data and was used as the base model for 2011 as requested by the SSC. Other models were used to explore a number of incremental changes to the base model and their consequences. The author and the Plan Team recommend model 3b, which includes the following features: 1) Natural mortality is fixed at M = 0.34, 2) pre-1982 trawl survey data were are excluded, 3) ageing bias is estimated internally as a linear function of age (previously, bias was fixed at 0.4 across ages), 4) commercial length composition data are fitted with length-specific selectivities by fishery, estimated in blocks of years, 5) Trawl survey age composition data are fitted with age-specific selectivities, 6) catchability is fixed at 0.77 based on limited tagging experiments, 7) standard deviations of length-at-age are estimated internally as a linear function of length-at-age, and 8) mean length-at-age data are not included in the likelihood. In addition, a number of other, sensible changes were made as previously reviewed and recommended by the Plan Team and the SSC.

Survey biomass increased substantially between 2009 and 2010 and showed a moderate increase in 2011. All model-based estimates of total biomass have been increasing for the last three years and are expected to increase further due to above-average recruitment in 2006, 2008, and possibly in 2010, although the 2010 estimate is highly uncertain and has only been observed once in the survey.

Based on the proposed selection criteria, model 3b was the clear choice. Model diagnostics and a comparison of likelihoods suggest that model 3b provides a reasonable fit overall and the best fit to the age composition data. **The SSC agrees with the author and Plan Team to use model 3b for stock status determinations in 2012, and sees no compelling reason to reduce the ABC from the maximum permissible value under Tier 3a as summarized below in metric tons:**

Stock/ Assemblage	Area	2012 OFL	2012 ABC	2013 OFL	2013 ABC
Pacific cod	BSAI	369,000	314,000	374,000	319,000

The SSC requested in its December 2010 minutes that a separate assessment for the AI be brought forward because of concerns over diverging trends in the biomass estimates for the AI and EBS. In response, the author provided a Tier-5 assessment for AI cod as an appendix to the current assessment. The author plans to develop an age-structured model for the Aleutians in 2012. We look forward to reviewing a preliminary model in October 2012.

2.4.2 GOA Pacific cod

No public testimony was provided specific to the GOA assessment, but see the above BSAI cod section above for general testimony on the cod assessments. The current GOA assessment was updated with new survey and commercial data series for CPUE, catch at age, and catch at length. The 2011 bottom trawl survey estimated a 33 % decrease in abundance over the 2009 survey estimate, but this was still a 199% increase from the 2007 estimate.

Models considered for the GOA cod assessment were similar to those for the BSAI assessment. The 2010 preferred model, as accepted by the SSC in December 2010, was updated with new data and was used as the base model for 2011 (model 1). Other models (models 3, 3b, and 4) were similar to the corresponding models for the BSAI and included the following features: 1) model 3 included internal estimation of the aging bias as a linear function of age, a modification of the L1 parameter in the length-at-age equation to correspond to the age of age 1 fish at the time of the survey, and external estimation of the variability in length-at-age, 2) model 3b was similar to model 3 but estimated variability in length at age internally, was not fit to the mean size at age data, fixed the selectivity and catchability for the 27cm-plus size classes in the trawl survey to be constant over time, and used a normal prior distribution for the catchability deviations in the sub-27 cm size class, and 3) model 4 was similar to model 3b but excluded all age composition data and constrained the pre-1977 mean recruitment to be less than the post-1976 mean recruitment. In addition, a number of other sensible changes were made as previously reviewed and recommended by the Plan Teams and the SSC.

Because no model met all of the selection criteria, the criteria were prioritized with the highest priority placed on criteria 1-4. The author recommended model 3 because of the good fit to the age composition data, estimating ageing bias internally, a good match between estimated and observed size modes at ages 1 and 3, and a good fit to the Nichol et al. (2007) estimate of the product of survey catchability and selectivity. The Plan Team agreed with the author's choice and also noted that the retrospective patterns indicate that inclusion of additional data tends to decrease estimates of abundance, which supports models with a higher level of survey catchability, such as models 1 and 3.

Based on these considerations, model diagnostics, and an examination of the likelihood components, **the SSC accepts the Plan Team's and the authors' preferred model (model 3), Tier 3a designation, and the 2012/13 ABC and OFLs shown below in metric tons.** With respect to area apportionments, the SSC requested in December 2010 that the simple Kalman filter approach, which has been used to estimate the proportions of Pacific cod biomass in the EBS and AI since 2004, be applied to the GOA as well. We heard that a special working group intends to review and standardize approaches to area apportionments across stock assessments to improve consistency. Until the group makes its recommendations, the SSC endorses the status quo method for area apportionments based on the three most recent surveys, resulting in area apportionments of 32% Western, 65% Central, and 3% Eastern:

Stock/		2012		2013	
Assemblage	Area	OFL	ABC	OFL	ABC
Pacific Cod	W		28,032		29,120
	C		56,940		59,150
	E		2,628		2,730
	Total	104,000	87,600	108,000	91,000

The SSC raised two concerns about the current model. First, authors' use of jitter runs is intended to ensure that the model converges to a global minimum of the objective function. We note that of the 50 runs included in the final jitter runs (Fig.2.12), no two model runs resulted in same estimates for any of the models except model 3b and that the objective value function (on the log-likelihood scale) differs substantially among runs. This suggests that there is still considerable uncertainty about whether the model has converged to the "best" solution. The SSC suggests that a further reduction in the number of parameters may be warranted to improve convergence. Secondly, based on the preferred model (model 3), the estimated fishing mortalities have exceeded F_{ABC} in the past 5 years (F_{OFL} in 2 years), suggesting that additional scrutiny for this stock may be warranted. However, current stock status indicates an increasing biomass trend supported by several years of above-average recruitment. Therefore the SSC concurs that a reduction from the maximum permissible ABC is not warranted at this time.

3 Bering Sea Pacific Cod Stock Assessment Model Scenarios Requested by FLC/QRA

3.1 Introduction

Requesting model scenarios for the Pacific cod stock assessments without knowledge of the assessment authors preferred model and alternatives greatly complicates the process. Therefore, we request that the assessment author use his best judgment when interpreting our requests and contacts us with any questions about the scenarios. We include our previous commentary of the CIE reviewers' reports that the assessment author, Plan Team, and SSC, can use as a guide in creating their own scenarios or interpreting the scenarios that we request (see Appendix).

3.2 BS Scenarios Requested

1) Model 3b, last year's base case model. We assume that this will automatically be one of the models.
2) Model 3b with survey catchability adjusted so that the product of catchability and selectivity is similar to that estimated by Nichol et al. (2007).
3) Model 3b with temporal variation in growth. We will leave it to the assessment author to decide which growth parameters should vary or if cohort specific growth should be used.
4) Model 4, last year's model and or this year's preferred model that excludes the age data.

3.3 GOA Scenarios Requested

1) Model 3b (which was not the base case) with survey catchability adjusted so that the product of catchability and selectivity is similar to that estimated by Nichol et al. (2007).

3.4 Appendix: Report on the Pacific cod CIE review

3.4.1 Summary

The three reviewers generally agree that the Pacific cod assessment is based on the best available science, but there a few areas that need improving through additional research and data collection. The reviewers did not provide any novel suggestions that would greatly improve the assessment or deal with the remaining issues.

The review process followed a set of questions outlined in the terms of reference. I present my summary below based on these questions. I have also added topics addressed by the reviewers that were not included in the terms of reference. My recommendations are provided at the bottom of each section in italics. I also summarize my recommendations that are relevant to choosing the 2011 model assumptions.

3.4.2 Assumptions for 2011 model

Further investigation is needed to determine the appropriate method to model and estimate the aging error and selectivity parameters.

Include the age composition data and the length composition data (or age conditioned on length and length composition) for all years if an appropriate aging error matrix can be generated, otherwise exclude the age data.

Include the conditional age at length data and the length composition data, rather than the mean-size-at-age data, and estimate the variation in length at age inside the stock assessment model.

Keep the current data partitioning.

Use dynamic binning for composition data

Eliminate the pre 1982 survey data.

Time blocks should be determined by initially modeling selectivity as a random walk.

Fix the catchability at the value estimated by Nichol et al. (2007).

Fix natural mortality at the value from Jensen's (1996) equation.

Use the bootstrap method to estimate the samples sizes, scale them so that the average is 300, then use iterative reweighting to update the samples sizes by fitting the Michaelis–Menton equation to the observed and effective samples sizes.

Model time invariant survey selectivity, but model temporal changes in growth.

Fix the standard deviation of recruitment the annual residuals at 0.6 and test the sensitivity of management parameters to 0.4 and 0.8.

3.4.3 Terms of reference topics

3.4.3.1 Use of age composition data

The reviewers acknowledge that there is aging error/bias. They recommend including the age composition data in the assessment model in conjunction with an aging error matrix. They noted that excluding the aging data caused some undesirable model behavior. The reviewers also recommended continuing the research into the sources of the aging bias.

There was some concern that the age composition data used the same information as the length composition data so that the data was used twice. This needs to be clarified. However, double weighting of data is not too concerning since the weights are arbitrary in the current model. If the weights are "estimated" inside the model, then the issue of double weighting needs to be addressed.

Include the age composition data and the length composition data (or age conditioned on length and length composition) for all years if an appropriate aging error matrix can be generated (see below), otherwise exclude the age data.

3.4.3.2 Use of mean-size-at-age data

The reviewers recommend excluding the mean-size-at-age data, particularly if temporal variation in growth is not modeled. The mean-size-at-age data is the same data as used in the age composition and length composition data so the data sets are not independent.

Include the conditional age at length data and the length composition data rather than the mean-size-at-age data. This data provides information on variation of length at age, mean length at age, and temporal variation in mean length at age. The appropriate data to include also needs to consider the information required to estimate an aging error matrix.

3.4.3.3 Use of ageing bias as an estimated parameter

The reviewers did not agree on whether estimating the aging bias in the assessment model was the best approach. The models run during the review were not adequate to determine if the aging bias could be estimated appropriately. More research is needed on the form of the aging error and bias and whether it can be estimated within the stock assessment model.

The aging error comes from at least two sources: 1) variability in reading the ages as indicated by double reading and 2) bias due to "false" rings being formed or the edge effect. An appropriate functional form for the aging error needs to be developed that can accommodate these two sources of error. We need to obtain the model files and investigate the appropriate method to model and estimate the aging error.

3.4.3.4 External estimation of between-individual variability in size at age

All three reviewers suggest estimating the variation of length at age outside the stock assessment model. This is partly due to undesirable model behavior when it was estimated inside the model.

The model does not include age conditioned on length data and therefore ignores some of the information available to estimate variation in length at age. Estimating variation in length at age outside the model does not take account of the aging error or selectivity. Variation in length at age should be estimated inside the model while including the age conditioned on length data. The development of a more appropriate growth model should also improve the models estimates of variation in length at age.

3.4.3.5 Catch data partitioned by year, season, and gear

The reviewers consider that the current catch data partitioning is appropriate. One reviewer noted that there is uncertainty in the catch estimates and this should be investigated.

Keep the current catch partitioning. Consider investigating a model that combines all catch into a single fishery for each season (it might be appropriate to reduce or eliminate the number of seasons) and use time varying selectivity for the fishery (the approach used by Ianelli for assessing pollock). The length composition data would need to be raised to the total catch within each fishery and summed across fisheries.

3.4.3.6 Size composition data partitioned by year, season, gear, and 1-cm size intervals

The reviewers consider that the current size composition data partitioning is appropriate. They recommended using dynamic binning to reduce the number of zeros in the likelihood function.

Keep the current size composition partitioning and use dynamic binning.

3.4.3.7 Age composition data partitioned by year, season, and gear

The reviewers consider that the current age composition data partitioning is appropriate. The reviewers were ambivalent about the use of the pre 1982 survey data because it probably does not influence the results.

Keep the current age composition partitioning and eliminate the pre 1982 survey data.

3.4.3.8 Functional form of the length-at-age relationship and estimating the parameters thereof

The reviewers noted the poor performance of the Richards growth curve due to the need to constrain one of the parameters to be positive.

A new growth curve needs to be developed for the Pacific cod assessment and implemented in Stock Synthesis.

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

The reviewers suggested that at least one selectivity curve should be asymptotic. They also suggested that a random walk should be used to model time varying selectivity to identify changes is selectivity and use this to determine where the time blocks should be applied.

The reviewers did not understand the types of selectivity curves available in Stock Synthesis. A selectivity curve can be created as a random walk over age (or length). This would allow a bimodal selectivity curve. The parameter for each age (the age offset) can also be modeled as a random walk over time, as can the parameters for functional forms.

A more robust approach is needed to model selectivity and determine which selectivity curves are asymptotic. Time blocks should be determined by initially modeling selectivity as a random walk.

3.4.4 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 reviewers recommended fixing the catchability at the value estimated by Nichol et al. (2007). They noted that when estimated, the estimate was similar to the Nichol et al. (2007) value. They also recommended collecting more tagging data to improve the estimate.

Fix the catchability at the value estimated by Nichol et al. (2007) and encourage further data collection.

3.4.4.1 Fixing the natural mortality rate at the value corresponding to Jensen's (1996) Equation 7

The reviewers recommended that the value of natural mortality continue to be fixed at the value from Jensen's (1996) equation. They also noted that it should be updated once the aging bias has been addressed and that age-specific natural mortality should be investigated.

Fix natural mortality at the value from Jensen's (1996) equation until the issues in the stock assessment model have been addressed, then estimate natural mortality within the stock assessment model and consider age specific natural mortality.

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

The reviewers recommended that the standard errors used for the survey index of abundance likelihood function should be reevaluated based on the survey design. The reviewers generally agreed with the bootstrap method used to estimate sample sizes, but noted that rescaling the averages to 300 caused the samples sizes to be lower than that suggested by the model fit to the composition data (effective sample sizes).

Use the bootstrap method to estimate the samples sizes, scale them so that the average is 300, then use iterative reweighting to update the samples sizes by fitting the Michaelis–Menton equation to the observed and effective samples sizes.

3.4.4.3 Allowing for annual variability in trawl survey selectivity

The reviewers questioned the need for annual variability in survey selectivity. However, they did recognize that catchability might change over time due to environmental factors such as bottom water temperature.

One reason for allowing the trawl survey selectivity to change over time is to accommodate changes in mean size at age for the young individuals. Temporal changes in catchability could also be due to abundance of different types of prey.

Model time invariant survey selectivity, but model temporal changes in growth.

3.4.4.4 Setting the input standard deviation of log-scale recruitment (σR) equal to the standard deviation of the estimated log-scale recruitment deviations

The reviewers were not conclusive about how to deal with the standard deviation of recruitment residuals. A value of 0.6 is supported by meta-analysis.

Fix the standard deviation of recruitment residuals at 0.6 and test the sensitivity of management parameters to 0.4 and 0.8.

3.4.4.5 Use of survey data and non-use of fishery CPUE data in model fitting

The reviewers recommended continuing to exclude the fishery CPUE data from the estimation of model parameters. One reviewer recommended excluding them completely because they might cause confusion. They recommended that the fishery CPUE data should be standardized.

Standardize the fishery CPUE indices and continue to include them in the assessment model, but not contributing to the estimation of parameters.

3.4.5 <u>Other topics</u>

3.4.5.1 Standardizing the survey

One reviewer suggested that the survey index of abundance be standardized for factors such as vessel, temperature, bottom type, location, and depth using a GLM or GAM. This reviewer also suggested mapping the habitat to improve the survey design.

Standardizing the survey for factors such as vessel, temperature, bottom type, location, and depth is a reasonable approach, but it might be better to post stratify by temperature, bottom type and depth each year rather than simply using a GLM. The habitat mapping could be used in this approach.

3.4.5.2 Jittering

Jittering the initial starting values of the estimated model parameters came up several times in the reviews. Jittering is a method to make sure that parameter estimates are the best values given the data and model assumptions. This is done because several years ago the model put forward had not converged properly and a better set of parameter values was found prior to the SSC meeting. The sensitivity of results to initial parameter values is probably caused by the selectivity curves. The need to jitter the starting values greatly increases the amount of time needed to do the assessment.

The model needs to be made more stable so it does not need jittering. This might be achieved by developing more robust selectivity curves.

3.4.5.3 Year to year changes in the model structure

The reviewers questioned the changes in model assumptions from year to year and suggested that the model structure should be fixed for a few years and the assessment only include updated data. In the years between "benchmark assessments" research could be carried out to improve the model.

Fixing the model structure for a few years is a reasonable approach to deal with several practical issues, but it would require the existence of a reasonable model. Unfortunately, and despite the substantial progress made on the Pacific cod assessment, there are still a few major issues that need to be resolved.

3.4.5.4 Tagging studies

The value of tagging studies came up several times in the reviewers' reports. The obvious need is to determine catchability for the survey using archival tags. However, well designed conventional tagging studies could be used to provide information on selectivity and natural mortality, validate aging, estimate abundance and exploitation rates, and evaluate stock structure.

A well designed and comprehensive tagging study is highly recommended.

3.4.5.5 Alternative modeling environments

The reviewers noted that alternative modeling environments might be useful to either customize model assumptions or double check model results. Developing a completely new customized assessment model for Pacific cod with all the functionality needed for sensitivity test would be a substantial task. It would be much better to request that the Stock Synthesis code be modified into a form that makes customization easy. Stock Synthesis can be configured to replicate either exactly or approximately many other stock assessment models and it would be better to apply simplifications of Stock Synthesis rather than using other models. The main reason to use another model is to identify programming errors in Stock Synthesis.

Request that Stock Synthesis becomes more user customizable.

3.4.5.6 Over parameterization

The reviewers mentioned several times that the models are over parameterized or nearly so. I doubt if this is correct. The issue is more likely related to poor model structure and parameterization (i.e. the selectivity curves).

The models are not over parameterized, but work needs to be carried out to make the model more stable.

3.4.5.7 Management strategy evaluation

The reviewers recommend continuing the management strategy evaluation work.

Management strategy evaluation (MSE) is very useful, but time consuming. Solving some of the issues in the assessment model are higher priority than the MSE work.

3.4.5.8 Diagnostics

The reviewers suggested several diagnostics that should be applied to the stock assessment including retrospective analysis, residual analysis, and evaluation of the correlation matrix to identify parameters that are highly correlated.

These are useful diagnostics and could be used to help select which model assumptions are appropriate. Retrospective analysis should not be used to determine the size or direction of the bias, only that some form of model misspecification exists.

3.4.5.9 Dynamic reference points

One reviewer noted that auto correlated recruitment may cause the abundance to drop below management reference levels even if the fishing mortality is relatively low.

Consider instituting dynamic reference points that take account of variation in recruitment

4 Summary of 2012 Pacific cod model recommendations from the BSAI senior author

4.1 2011 preliminary Model A revisited

At this point, I would like to consider a model similar to Model A from the 2011 preliminary BSAI assessment (Joint Plan Team comments pertaining to Model A are listed at the end of this attachment). A few features of Model A were incorporated into Model 3b in the final assessment (Model 3b was ultimately adopted by the Plan Team and SSC). The features of Model A that I would like to explore further in this year's preliminary assessment (with a couple of highlighted modifications) are listed below.

Relative to Model 3b in the 2011 BSAI SAFE, the following items would be changed in the data file:

- GGT1. Define fisheries with respect to each of the five seasons, but not with respect to gear (in Model 3b, fisheries were defined with respect to both season and gear).
- GGT2. Eliminate fishery CPUE data (in Model 3b, fishery CPUE data were included for purposes of comparison, but were not used in estimation).
- GGT3. Add a new population length bin for fish in the 0-0.5 cm range, which would be used for extrapolating the length-at age curve below the first reference age (in Model 3b, the lower bound of the first population length bin was 0.5 cm).

Relative to Model 3b in the 2011 BSAI SAFE, the following items would be changed in the control file:

- GGT4. Use the Richards growth equation (in Model 3b, the von Bertalanffy equation—a special case of the Richards equation—was used).
- GGT5. Define fishery selectivity curves for each of the five seasons, but not stratified by gear type (in Model 3b, seasons 1-2 and 4-5 were lumped into a pair of "super" seasons, and fisheries were also *gear*-specific).
- GGT6. Choose a single fishery that will be forced to exhibit asymptotic selectivity by determining which fishery comes closest to exhibiting asymptotic selectivity when unconstrained (in Model 3b, the January-April trawl fishery was forced to exhibit asymptotic selectivity).
- GGT7. Model survey selectivity as a function of length (in Model 3b, survey selectivity was modeled as a function of age).
- GGT8. Estimate numbers at age for ages 1-10 in the initial numbers-at-age vector (in Model 3b, only ages 1-3 in the initial numbers-at-age vector were estimated).
- GGT9. Use annual—but not random walk—*devs* for survey catchability (in Model 3b, survey catchability was constant).
- GGT10. *Initially* (see iterative tuning procedure described below), use annual random walk *devs* for all estimated selectivity parameters (in Model 3b, certain fishery selectivity parameters were estimated independently in pre-specified blocks of years; the only time-varying selectivity parameter for the survey was *ascending_width*, which had annual—but not random walk—*devs*)

In addition to the above changes, the following parameters would be tuned iteratively:

- GGT11. Tune the age composition "variance adjustment" (a multiplier applied to the input sample sizes) iteratively such that the mean effective sample size equals the mean input sample size (in Model 3b, this multiplier was fixed at 1.0).
- GGT12. Tune the base value for survey catchability iteratively such that the average of the product of catchability and survey selectivity across the 60-81 cm range equals 0.47, corresponding to the Nichol et al. (2007) estimate (in Model 3b, the base value was left at the value used in the 2009 assessment).

GGT13. Tune σ_{dev} for survey catchability iteratively such that the root-mean-squared-standardized-residual of the survey abundance estimates equals 1.0 (in Model 3b, σ_{dev} for survey catchability did not exist).

GGT14. Tune σ_{dev} for each estimated selectivity parameter iteratively to match the standard deviation of the estimated *devs*, except remove the *devs* for any selectivity parameter with an iteratively tuned σ_{dev} less than 0.005. New proposed change relative to last year's Model A: After following the preceding procedure, adjust σ_{dev} for any remaining *dev* vector to account for the model's inability to integrate out random effects, using the method I described at the February SSC recruitment workshop and the April Plan Team recruitment workshop (in Model 3b, σ_{dev} did not exist for any fishery selectivity parameters; the only survey selectivity parameter with a *dev* vector had σ_{dev} set at the value used in the 2009 assessment).

GGT15. Estimate σ_R internally. New proposed change relative to last year's Model A: After following the preceding procedure, adjust σ_R to account for the model's inability to integrate out random effects, using the method I described at the February SSC recruitment workshop and the April Plan Team recruitment workshop (in Model 3b, σ_R was set at the value used in the 2009 assessment).

4.2 Joint Plan Team (September, 2011)

"In Model A ..., the catchability and selectivity deviations are treated as random effects but they are not properly integrated out. The MLEs are therefore suspect, and the iterative tuning may produce pathological results."

"Allowing survey catchability to vary from year to year, perhaps substantially, achieves a better fit to the data but at the expense of discounting the relative abundance data. Some members felt strongly that this was a mistake. The survey catchability estimates produced by Model A seemed to be missing in the presentation."

"The great variability of survey selectivity estimates from Model A is a clear indication that the model is overfitting the data."

"In view of the many new features in Model A and several concerns about it, the Teams do not favor including it ... as one of the candidates in November."

5 Summary of 2012 Pacific cod model recommendations from the Plan Teams, SSC, and public

5.1 Joint Plan Team (November, 2011)

JPT1: "The Teams encouraged the author to try estimating survey catchability internally again. It is possible that with the other improvements made in this assessment, catchability will be estimable, at least in the EBS assessment."

5.2 BSAI Plan Team (November, 2011)

BPT1: "The BSAI team recommends that the author check for any poor fits to commercial length frequencies that might indicate a change in selectivity resulting from the implementation of Amendment 80 in 2008 and the creation of longline cooperatives in 2010."

5.3 GOA Plan Team (November, 2011)

GPT1: "The Team pointed out that the ageing error bias is estimated to be different between the GOA and Bering Sea. They encouraged exploration of this phenomenon and in particular, how estimates of ageing bias affect model results." (See also SSC3.)

5.4 SSC (December, 2011)

5.4.1 EBS and GOA

SSC1: "We agree with a recommendation from the CIE review that the number of explorations and new model configurations for upcoming assessments should be reduced to allow for a thorough evaluation of the performance of the current model over several assessment cycles."

SSC2: "The SSC notes that weight-at-age in both regions was lowest in May-Aug. or Sept.-Oct. and highest in Jan.-Feb. These patterns seem somewhat counter-intuitive and we encourage the authors to evaluate biological basis for these patterns."

SSC3: "The recommended models for both regions estimate ageing bias as a linear function of age, but the estimated patterns in bias by age differs by region increasing from approximately 0.34 at the youngest age to 0.85 at the oldest age in the BSAI assessment (model 3b), but decreases from 0.36 to 0 at the oldest age in the GOA assessment (model 3)." (See also GPT1.)

5.4.2 GOA only

The SSC raised two concerns about the current model.

SSC4: "First, authors' use of jitter runs is intended to ensure that the model converges to a global minimum of the objective function. We note that of the 50 runs included in the final jitter runs (Fig. 2.12), no two model runs resulted in same estimates for any of the models except model 3b and that the objective value function (on the log-likelihood scale) differs substantially among runs. This suggests that there is still considerable uncertainty about whether the model has converged to the 'best' solution. The SSC suggests that a further reduction in the number of parameters may be warranted to improve convergence."

SSC5: "Secondly, based on the preferred model (model 3), the estimated fishing mortalities have exceeded F_{ABC} in the past 5 years (F_{OFL} in 2 years), suggesting that additional scrutiny for this stock may be warranted."

5.4.3 AI

SSC6: "The SSC requested in its December 2010 minutes that a separate assessment for the AI be brought forward because of concerns over diverging trends in the biomass estimates for the AI and EBS. In response, the author provided a Tier-5 assessment for AI cod as an appendix to the current assessment. The author plans to develop an age-structured model for the Aleutians in 2012. We look forward to reviewing a preliminary model in October 2012."

5.5 Freezer Longline Coalition (April, 2012)

5.5.1 EBS only

FLC1: "Model 3b with temporal variation in growth. We will leave it to the assessment author to decide which growth parameters should vary or if cohort specific growth should be used."

FLC2: "Model 4, last year's model and or this year's preferred model that excludes the age data."

5.5.2 EBS and GOA

FLC3: "Model 3b ... with survey catchability adjusted so that the product of catchability and selectivity is similar to that estimated by Nichol et al. (2007)."

JOINT MEETING OF THE BSAI AND GOA GROUNDFISH PLAN TEAMS
May 1, 2012

Members of the Plan Teams present for the meeting, which convened via WebEx, included those shown in bold below.

BSAI Team

Grant Thompson	**AFSC REFM (BSAI co-chair)**
Mike Sigler	**AFSC (BSAI co-chair)**
Kerim Aydin	AFSC REFM
Lowell Fritz	AFSC NMML
David Carlile	**ADF&G**
Alan Haynie	**AFSC REFM**
Jane DiCosimo	**NPFMC (Coordinator)**
Henry Cheng	**WDFW**
Brenda Norcross	UAF
Mary Furuness	NMFS AKRO Juneau
Bill Clark	**IPHC**
Dave Barnard	**ADF&G**
Leslie Slater	USFWS
Dana Hanselman	**AFSC ABL**

GOA Team

Jim Ianelli	**AFSC REFM (GOA co-chair)**
Diana Stram	**NPFMC (GOA co-chair)**
Sandra Lowe	**AFSC REFM**
Chris Lunsford	**AFSC ABL**
Jon Heifetz	**AFSC ABL**
Mike Dalton	AFSC REFM
Kristen Green	ADF&G
Henry Cheng	**WDFW**
Nick Sagalkin	ADF&G
Paul Spencer	**AFSC**
Leslie Slater	USFWS
Nancy Friday	AFSC NMML
Tom Pearson	NMFS AKRO Kodiak
Ken Goldman	ADF&G
Steven Hare	IPHC
Craig Faunce	**AFSC FMA**

Others in attendance: Pat Livingston, Anne Hollowed, Farron Wallace, Teresa A'Mar, Kenny Down, Mark Maunder, Pete Hulsen, Buck Stockhausen, Dave Fraser, Charlie Trowbridge, Ernie Weiss.

February 2012 Pacific cod workshop

The Teams agreed to forward, without review,, a summary report of recommendations from a Pacific cod workshop that was held at the NMFS AFSC on February 6, 2012. The Teams will review the report as part of its compilation of recommendations for changes to research priorities for 2014 – 2018; the Teams did not want to delay SSC consideration of any specific recommendation that it might wish to consider for 2013 – 2017, since the Teams are out of synchrony with SSC and Council adoption of research priorities each year.

Last year the Teams identified a critical need for research on the catchability of Pacific cod by the EBS survey trawl. The value of the trawl survey catchability parameter currently used in the assessment model is based on the assumption that roughly half of the Pacific cod in the 60-81 cm range are unavailable to the survey trawl because they can inhabit the water column above the headrope. If Pacific cod are being herded vertically by the survey trawl (i.e., if Pacific cod exhibit a "dive response" to an oncoming vessel or net), or if the catchability value used in the model is otherwise inaccurate (e.g., due to the very small sample size of the archival tagging study by Nichol et al. (2007)), the model would give biased estimates of biomass and other quantities. If the assumptions about vertical availability of Pacific cod used in the BSAI and GOA Pacific cod models are correct, it is expected that higher catch rates would be observed with the poly Nor'Eastern, because its higher vertical opening results in greater catchability, selectivity, or both. Jane DiCosimo reported that Bob Lauth informed her that funds were received from the NOAA Cooperative Research Program to investigate vertical herding behavior of Pacific cod in response to the eastern Bering Sea shelf survey bottom trawl during the first leg of the survey. As noted in the Pacific cod workshop report, the investigation will involve use of the of a Dual frequency IDentification SONar (DIDSON) on the trawl for observing and quantifying movements of Pacific cod in front of the trawl. A second component will be a side-by-side trawl study to compare catch rates of Pacific cod between the standard EBS shelf survey bottom trawl (83-112 Eastern) and the standard GOA survey bottom trawl.

Proposals for the 2012 preliminary Pacific cod assessments

Five background documents were provided to the Teams prior to the meeting, and are included in these minutes as the following set of attachments:

1) Pacific cod model structures included in the final 2011 SAFE reports
2) Pacific cod minutes from the November 2011 Plan Team and December 2011 SSC meetings
3) Bering Sea Pacific Cod Stock Assessment Model Scenarios Requested by Freezer Longline Coalition (FLC) and Quantitative Resource Assessment (QRA), including the same appendix responding to the 2011 CIE review that was provided last year at this time
4) Summary of 2012 Pacific cod model recommendations from the BSAI senior author
5) Summary of 2012 Pacific cod model recommendations from the Plan Teams, SSC, and public (this attachment excerpts *just the recommendations* from Attachments 1, 2, and 3)

The meeting began with an introduction by BSAI senior author Grant Thompson, who summarized very briefly the above attachments and the annual cycle for development of models to be analyzed in the preliminary and final assessments for Pacific cod.

At last year's August/September meeting, the Teams recommended that the authors' preferred model not be included in the final assessment. Grant asked whether this was a standing policy of the Teams and, if so, whether it applied to both the preliminary and final assessments or just the final assessment. **The Teams clarified that the authors are welcome to present their own models during the preliminary assessment, but the Teams reserve the right to request that those models be excluded from the final assessment.** Given this clarification, and in the interest of time, the Teams agreed to forgo a discussion of the authors' own proposals for this year's preliminary assessment (Attachment 4).

Not counting the authors' own proposals, a total of 12 proposals were received prior to the meeting: three from the Teams, six from the SSC, and three from the FLC/QRA (Attachment 5). One of the GOA Team proposals was essentially identical to one of the SSC proposals, which brings the total down to 11 unique proposals. During the course of the meeting, two other proposals were added, bringing the total of unique proposals to 13. The final set of proposals is shown in Table 1.

The Teams made two passes through the final set of proposals: The first pass separated those proposals that were amenable to allocation among a set of requested models ("model proposals") from those that were not ("non-model proposals"), and assigned priority rankings to all proposals (except for two that were deemed too generic to rank); the second pass allocated all medium-priority and high-priority model proposals among a set of requested models (Table 1).

In the first pass, the Teams determined that six of the proposals were not amenable to allocation among a set of requested models, either because they lack specificity, they involve parameters estimated outside of the assessment model, or they can be explored sufficiently without developing and presenting a full set of results for an additional model. Of these six non-model proposals, two were not assigned a priority ranking, three were ranked as medium priority, and one was ranked as high priority. For the non-model proposals, the Teams clarified the meanings of "medium" and "high" priority rankings as follows: "Medium" means that the Teams expect to see an attempt made to address the proposal, while "high" means that the Teams expect this attempt to be successful.

Seven proposals were determined to qualify as true model proposals. One of these (FLC1: include last year's final model with time-varying growth) was ranked as low priority, another (SSC6: develop an age-structured model for the Aleutian Islands) was ranked as medium priority, and the other five were all ranked as high priority for at least one region. The six medium-priority and high-priority model proposals were then allocated among a set of requested models.

Recommendations

- For the EBS, the Teams recommend that the preliminary assessment include the following four models, which are in addition to any models that the authors wish to propose: Model 1 is last year's final model, Model 2 is last year's final model with re-tuned catchability, Model 3 is last year's final model with a new fishery selectivity period beginning in 2008 or 2010, and Model 4 is last year's final model without age data. For Model 3, the Teams acknowledge that estimating a full set of selectivity parameters with only 2-4 years of data may be challenging.
- For the AI, the Teams recommend that a preliminary assessment be developed with a simple, age-structured model configured in Stock Synthesis *if there is enough time to do so*. This initial attempt at age-structured modeling of the AI stock may serve largely to determine whether the lack of age data prohibits meaningful parameter estimation at the present time.
- The Teams recommend that the AFSC begin production ageing of AI Pacific cod.
- For the GOA, the Teams recommend that the preliminary assessment include the following two models, which are in addition to any models that the authors wish to propose: Model 1 is last year's final model, and Model 2 is last year's final model with re-tuned catchability.
- The Teams recommend that Stock Synthesis be modified so that a prior distribution can be placed on the average, across the 60-81 cm size range, of the product of catchability and selectivity at age, where the average is weighted by long-term average numbers at length.
- For both the EBS and GOA, the Teams recommend that the authors attempt to explore the divergent ageing bias trends in the two regions and the impacts thereof.
- For both the EBS and GOA, the Teams recommend that the authors attempt to evaluate the biological basis for estimated patterns of seasonal weight at length.
- For both the EBS and GOA, the Teams recommend that the authors attempt to estimate catchability internally. This can be addressed as an option under Model 1 without developing and presenting a full set of results for an additional model (full results for the base case of Model 1 are requested, however).
- For the GOA only, the Teams recommend that the authors reduce the number of parameters. This can be addressed as an option under Model 1 without developing and presenting a full set of results for an additional model (full results for the base case of Model 1 are requested, however).

Notes

- Teresa A'mar will be the senior author of the GOA assessment this year.
- The BSAI Team may need to consider separate specifications for the AI this year, depending on how much progress is made in developing an age-structured model for the AI stock.
- A member of the public suggested that the process of submitting model proposals would be easier if the authors would commit in advance to a preferred model.

Table 1. List of proposals and Joint Plan Team recommended models for preliminary assessments.

Model proposals

Topic	Number	Proposal	Proposed area	Priority	Model 1	Model 2	Model 3	Model 4
Ageing	FLC2	Include last year's Model 4 or this year's preferred model without age data	EBS	high				EBS
Aleutians	SSC6	Develop age-structured model	AI	medium	AI			
Base model	new	Include last year's final model without modification	EBS, GOA	high	EBS, GOA			
Growth	FLC1	Include last year's Model 3b with time-varying growth	EBS	low				
Q/selectivity	BPT1	Consider new fishery selectivity period starting in 2008 or 2010	EBS	high			EBS	
Q/selectivity	FLC3	Include last year's Model 3b with re-tuned catchability	EBS, GOA	high (EBS)		EBS		
Q/selectivity	new	Include last year's Model 3 with re-tuned catchability	GOA	high		GOA		

Non-model proposals

Topic	Number	Proposal	Proposed area	Priority
Ageing	GPT1/SSC3	Explore divergent ageing bias trends in EBS and GOA and impacts thereof	EBS, GOA	medium
General	SSC1	Keep no. models small, retain current model for several years	EBS, GOA	n/a
General	SSC5	Apply additional scrutiny to GOA stock	GOA	n/a
Growth	SSC2	Evaluate biological basis for seasonal weight at length	EBS, GOA	medium
Parsimony	SSC4	Reduce number of parameters	GOA	high
Q/selectivity	JPT1	Estimate catchability internally	EBS, GOA	medium

Joint Plan Team Total Catch Accounting Working Group

May 22, 2012

Members: Grant Thompson (BSAI Plan Team Co-chair), Sandra Lowe (GOA Plan Team), Chris Lunsford (GOA Plan Team), Mary Furuness (BSAI Plan Team), Jane DiCosimo (BSAI Plan Team Coordinator), and Jason Gasper (Crab Plan Team)

Other participants: Melanie Brown and Jeff Hartman (AKRO)

The objective of the Working Group is to assist the Plan Teams in making recommendations for changes deemed necessary to comply with the Magnuson-Stevens Act (MSA) and the National Standard Guidelines, specifically related to total catch accounting (TCA). The National Standard Guidelines for the MSA require accounting for all removals. The Working Group identified its first priority as providing comments on an advance notice of proposed rulemaking (ANPR) to revise NMFS guidelines for National Standard 1 (NS1), because the deadline for public comments is August 1, which is prior to the next meeting of the joint groundfish plan teams. This report is organized according to the Working Group's agenda (attached).

1. NS1

Jeff Hartman provided background on an early opportunity for NMFS AKRO staff to provide comment to NOAA Fisheries HQ on its plans to publish an ANPR for NS1. The Working Group discussed whether the uncertainty caused by the ANPR should postpone the Plan Teams' attempts to comply with the 2009 National Standard 1 Guidelines. *The Working Group recommended no changes to current practices for total catch accounting (TCA) during the 2012 stock assessment cycle* because the NS1 Guidelines are being evaluated and may be revised (see next item also).

2. AKRO paper on research removals

Jeff Hartman and Melanie Brown reported on a planned discussion paper on total catch accounting for research removals of groundfishes. The paper, originally planned for June SSC review, is now planned for September Plan Team review and October SSC review. The authors plan to incorporate SSC and Council comments on the ANPR from June 2012 into the September draft. Resolution of TCA issues could be delayed as a result of the ANPR.

3. Data
   a) What are the official "catch" data? In August 2011 the Groundfish Plan Teams recommended that total catch should, in principle, be taken into account in the stock assessment determinations of OFL and ABC so that downward adjustments of the TAC are not necessary. However, the Plan Teams also felt that existing estimates of removals other than those taken in the groundfish fisheries were too preliminary to be used for determining OFLs and ABCs in November 2011 for the 2012/2013 assessment cycle. In addition, the Teams felt that the Council should not make allocative decisions between research removals and commercial catch. As of 2011, NMFS (through AKFIN) provides estimates of total catch available to authors for incorporation into the stock assessments for the groundfish fisheries by October 1 each year, although it should be noted that these estimates do not currently include all sources of removal; for example, Pacific cod catches in the BSAI crab fishery are not included.

   The Working Group considered a June 2011 discussion paper prepared by Grant Thompson (reference topic #3 in that paper). When considering incorporation of "other" catches in the SAFE reports, the Working Group noted the importance of distinguishing between:

   - listing other catches but not using them for anything,
   - using other catches to estimate reference fishing mortality rates (F40%, F35%, etc.),

- using other catches to estimate reference harvest amounts (maxABC, OFL, etc.) given the reference fishing mortality rates, and
- including other catches in the total against which harvest specifications are compared.

If "other" catches are to be used to estimate maxABC, OFL, etc., how should this be done? One idea proposed by the GOA Plan Team at its November 2011 meeting is to subtract "other" catches from the begin-year biomass. This approach would not be consistent with how most other harvest calculations are made, but it would be simple to apply for stocks managed under Tiers 5 or 6. The Working Group, however, did not identify a method for applying this approach to stocks with age-structured models.

b) Time series of research, subsistence, personal use, recreational, and exempted fishing permit removals – Jason Gasper confirmed that AKRO (through AKFIN) would complete the accounting of 2010 and 2011 "other" catch removals and have it available on AKFIN October 1. An accurate time series for these data is currently unavailable because data prior to 2010 are incomplete for some historical surveys (e.g., State of Alaska and RACE). An outstanding issue is what to do about years in which surveys occurred but no data have been entered into the AKRO database. Prior to the 2014 stock assessment cycle, AKRO will query providers for missing data to help establish a times series of removals.

c) Other data sets – The Working Group reviewed the history of Halibut Fisheries Incidental Catch Estimation (HFICE) data. In August 2011 the Teams recommended that all authors provide the 2001-2010 HFICE and a dataset including 2010 research, subsistence, personal use, recreational, and exempted fishing permit removals as an appendix to each assessment chapter in November 2011, but the Teams did not use these data for determining OFLs and ABCs in November 2011 for the 2012/2013 assessment cycle. Since these estimates are preliminary and the Teams have not reviewed the complete database or assessed the potential effects on determination of OFL and ABC for each stock, further analysis is needed before the Teams can recommend incorporation of these estimates in their OFL/ABC recommendations. The Teams raised some issues regarding how authors should use the databases in the future: 1) how to use catch estimates with no size/age composition information in the models (similar issues occur in the Pacific halibut stock assessment), 2) how the AKRO could or would incorporate these estimates into in-season management (to avoid overharvesting), and 3) development of a single catch estimation time series incorporating all data components. The Teams recommended that they investigate the implications of estimated removals from sources other than the groundfish fisheries on ABC estimation in September 2012. The Teams would then consider whether and how such estimates would be used in stock assessments in November 2012 for the 2013/2014 assessment cycle. The Working Group however noted that this would be a huge undertaking and recommended taking no action until issues surrounding the ANPR for NS1 Guidelines are clarified.

The Working Group considered the HFICE as a partial time series and an indicator of groundfish catch in the directed IFQ halibut fishery, but not a complete estimate that should necessarily be added to existing Catch Accounting System (CAS) estimates. Removals generated by major non-groundfish fisheries (BSAI crab and Pacific halibut) are generally incomplete. Reporting non-compliance is still a management and enforcement issue for past years, even if resolved for current years. The Working Group concluded that HFICE would not be included in the CAS and that extending it beyond 2011 was not necessary due to data from the observer restructuring being incorporated into the CAS in 2013. Further, programming and maintenance of HFICE requires significant staff and budgetary resources from both the AKRO and the AFSC that, given the priority of observer restructuring, is not feasible.

The Working Group recommended that the 2001-2011 HFICE appendix continue to be included in each assessment chapter until these interim indicators of groundfish catch in the halibut fishery are replaced by data collected under the restructured observer program. The Working Group recommended no further action on HFICE.

The Working Group discussed total accounting of Pacific cod caught for bait purposes in the crab fishery. Pacific cod catch in crab fisheries was first required to be reported on crab tickets in 2011. Compliance appears to be low and reported catches are likely underestimates. Fish ticket reports of Pacific cod caught for bait in the BSAI crab fishery will be included in the "other" catch data set available to stock assessment authors.

4. Stock assessment use
   a) Mary Furuness compiled a table (attached) listing which annual harvest specifications accommodate state removals and the approach adopted (e.g., PWS pollock, GOA Pacific cod, BSAI Pacific cod, BS and AI sablefish).
   b) and c) For all SAFE chapters, the Working Group recommended that authors continue to report "other" removals in an appendix but not apply those removals in the models.
   d) The Working Group recommends that further Plan Team discussion of how "other" removals would affect determination of OFL and ABC be tabled, pending potentially revised NS1 guidance.
   e) The Working Group discussed whether it would be beneficial to schedule a CIE review of how best to incorporate these data sets into stock assessments. Because CIE reviewers are often unfamiliar with the MSFCMA, the NS1 guidelines, or management of BSAI and GOA groundfish, the Working Group instead recommended a joint SSC/GPT workshop, perhaps in February 2013 or some other time outside the August – December assessment cycle. The Working Group noted that one cannot address how to incorporate the databases into the stock assessment without also discussing how the fishery is managed. Further interpretation of NS1 guidelines is necessary for incorporation of "other" catch data into stock assessments and harvest specifications.
   f) The Working Group recommended no new Instructions to Authors, but did recommend continued inclusion of appendices from 2011.

5. Next Steps. The Working Group will discuss/decide whether to convene again after it reviews the SSC recommendations on this topic from its June 2012 meeting. When it is appropriate to resume the TCA discussion, the following outstanding issues will need to be resolved (these are identified above, but are repeated here for convenience):
   - When considering use of "other" catches (i.e., catches other than those taken in the groundfish fishery) in assessment and management, it will be necessary to distinguish between:
     i. listing those catches but not using them for determination of catch limits,
     ii. using those catches to estimate reference fishing mortality rates (F40%, F35%, etc.),
     iii. using those catches to estimate reference harvest amounts (maxABC, OFL, etc.) given the reference fishing mortality rates, and
     iv. including those catches in the total against which harvest specifications are compared.
   - It will also be necessary to determine whether the use of "other" catches should differ depending on the source of the removals (e.g., should research catches be treated differently from catches taken in non-groundfish fisheries?).

- In the event that "other" catches will be used to estimate either reference fishing mortality rates or reference harvest amounts, methods will need to be devised for doing so, noting that these methods will need to address all tiers.
- What, if anything, to do with the HFICE time series (2001-2011).
- What to do about *years* for which "other" catches were known to have occurred, but for which no direct estimate of magnitude is available (e.g., years in which surveys occurred but no data have been entered into the AKRO database).
- What to do about *sources* for which "other" catches were known to have occurred, but for which no direct estimate of magnitude is available (e.g., catches taken in non-groundfish fisheries).

BSAI		
BSAI stock assessments	**Federal TAC**	**State GHL**
Eastern Bering Sea Pollock	<=ABC	none
Aleutian Islands Pollock	<=ABC	none
Bogoslof Island Pollock	<=ABC, set for incidental catch amounts	none
BSAI Pacific cod	<= 97% of ABC	3% of ABC
AK Sablefish[1]	<=ABC	5% of BS and AI TAC
BSAI Yellowfin Sole	<=ABC	none
BSAI Greenland turbot	<=ABC	none
BSAI Arrowtooth flounder	<=ABC	none
BSAI Kamchatka flounder	<=ABC	none
BSAI Northern Rock Sole	<=ABC	none
BSAI Flathead Sole	<=ABC	none
BSAI Alaska Plaice	<=ABC	none
BSAI Other Flatfish	<=ABC	none
BSAI Pacific Ocean Perch	<=ABC	none
BSAI Northern Rockfish	<=ABC	none
BSAI Blackspotted and Rougheye rockfi	<=ABC	none
BSAI Shortraker rockfish	<=ABC	none
BSAI Other Rockfish	<=ABC	none
BSAI Atka Mackerel	<=ABC	none
BSAI Skates	<=ABC	none
BSAI Sculpin	<=ABC	none
BSAI Sharks	<=ABC	none
BSAI Squids	<=ABC	none
BSAI Octopus	<=ABC	none

[1]Sablefish State GHL is set by the State as 5% of the Federal BS and AI TAC. However, this amount is not deducted from the Federal TACs.

GOA		
GOA stock assements	**Federal TAC**	**State GHL**
GOA Pollock	<=ABC	set prior to Federal AB(
GOA Pacific cod	<=75% of ABC	25% of Federal ABC
AK Sablefish	<=ABC	none
GOA Shallow-water Flatfish	<=ABC	none
GOA Deep-water Flatfish	<=ABC	none
GOA Rex Sole	<=ABC	none
GOA Arrowtooth Flounder	<=ABC	none
GOA Flathead Sole	<=ABC	none
GOA Pacific Ocean Perch	<=ABC	none
GOA Northern Rockfish	<=ABC	none
GOA Shortraker rockfish	<=ABC	none
GOA Dusky Rockfish (PSR)	<=ABC	none
GOA Rougheye and Blackspotted rockfi	<=ABC	none
GOA Demersal Shelf Rockfish	<=ABC	none
GOA Thornyheads	<=ABC	none
GOA Other Rockfish (other slope)	<=ABC	none
GOA Atka Mackerel	<=ABC	none
GOA Skates	<=ABC	none
GOA Sculpin	<=ABC	none
GOA Sharks	<=ABC	none
GOA Squids	<=ABC	none
GOA Octopus	<=ABC	none

1. National Standard 1
   a. Headquarters recommendation/guidance to Alaska and Council
   b. Is there or will there be ACL interpretation in writing (does ABC = ACL)
2. AKRO discussion paper for October SSC meeting
   a. Jeff/Melanie authors
   b. Examines consistency of AK accounting of SRP and EFP with NS1?
3. Data Interpretations
   a. What is official "catch" data
      i. AKRO CAS estimates?
      ii. Or "proxy" data sets generated independently?
   b. Time series of research catches –
      i. Yearly updates
      ii. 2010 gathered in 2011, AKFIN is developing database
      iii. Stock assessment authors need time series to effectively work with data. Is it possible to build up or can we at least capture the majority of it through a compilation of available data?
      iv. Years
      v. Data ownership – AKRO catch accounting branch annually provides to AKFIN.
      vi. Access – AKFIN
   c. Other data sets
      i. Halibut Fishery Incidental Catch Estimates (HFICE) - The Plan Teams recommended that the authors consider issues for sablefish where there is overlap between the data sources in these HFICE estimates. In general, for all species, it would be good to understand the unaccounted-for catches and the degree of overlap between the CAS and HFICE estimates and to discuss this at the September 2012 Plan Team in.
         1. Who will generate HFICE estimates and take ownership
            a. Currently working group is planning to compute 2011 estimates and then writing up time series (2001-2011) as a Tech Memo
            b. If not incorporated in CAS then what are the recommendations to authors
            c. Is/was HFICE a one-time analysis
      ii. Removals generated by other fisheries(e.g., Pacific cod taken for use as bait in the crab fisheries)
4. Stock assessment use
   a. Should we survey all current assessments that may already make concessions of ABC/TAC – ex. GOA Pollock?
   b. Need to clarify that this must be incorporated in all assessments including non-modeled assessments (esp Tier 6 – avg catch = ABC)
   c. Potential options for incorporating these estimates
      i. Include in the model as part of catch history
         1. What are the effects
      ii. Run projections of ABC with research catches included and compare to current projections (no research catches included)
      iii. Develop a risk assessment outside of model but included in assessment – somehow evaluates model derived ABC recommendations in relation to magnitude of "other catches"
      iv. Appendix – not in the model
   d. Interaction with OFL and ABC, TAC for the Council/Secretary of Commerce.

e. Is there potential to have a CIE review of how to incorporate these data sets in stock assessments?
f. Instructions to Authors

5. September 2012 Plan Team discussion
    a. Presenter?
    b. Format?
        i. Needs to inform Teams of issue
        ii. How do we recommend anything under heading 4 without guidance from heading 1?

"Phase I" Report of the Joint Plan Team Working Group on Assessment/Management Issues Related to Recruitment

May 2012

Introduction

The Groundfish Plan Teams and Crab Plan Team ("GPTs" and "CPT," respectively) have appointed a working group (Robert Foy, James Ianelli, Diana Stram, and Grant Thompson) to list and evaluate alternatives for a number of assessment and management issues related to recruitment. To aid the working group in accomplishing its task, a workshop was held at the AFSC Seattle laboratory during the dates of April 4-5, 2012. The workshop was intended to address a long-standing request from the BSAI GPT for analysis of recruitment-related issues such as: which cohorts to include in estimation of reference points, how to estimate parameters related to recruitment (including parameters of a stock-recruitment relationship), and how to determine the reliability of the F_{MSY} probability density function. The workshop was also intended to satisfy the following SSC request (from the February 2012 minutes):

> *"The SSC supports the previous recommendation of the Groundfish PT ... to hold a workshop to develop guidelines on how to address environmental changes in the SR relationship into biological reference points and how to model environmental forcing in stock projection models.... The SSC believes it would be useful to have members from both the Groundfish and Crab Plan Teams present, because the issues are common to both groups."*

The workshop agenda, a list of modifications to the agenda that occurred during the workshop itself, a list of references, and a list of participants are attached in Appendix A. The workshop initiated discussion of existing and proposed approaches and provided ideas for further analysis.

This "Phase I" working group report is being provided prior to completion of the full working group report because four agenda items from the workshop were deemed critical for consideration at the May 2012 meeting of the CPT. These were:

A. Identification of regime shifts, either for an ecosystem or some subunit thereof
    1. Current policy on identification of regime shifts
    2. Possible improvements to current policy, including consideration of risk
B. Estimation of parameters (average recruitment, stock-recruitment relationships, σ_R)
    1. Establishing criteria for excluding individual within-regime year classes from estimates
C. Forecasting environmental variability
2.
    1.
    2. How knowledge of environmental forcing changes perceptions of reference points

The full report of the working group will be prepared in time for consideration at the September meetings of the CPT and GPTs. The full report may revisit some or all of the items addressed in this Phase I report, and will address as many of the remaining agenda items as possible within the time available.

Alternatives for items A1, A2, B1, and C2

As noted above, the following description of alternatives, evaluations thereof, and preliminary recommendations (items A2, B1, and C2 only) were developed under extreme time pressure dictated by the needs of the CPT for its May 2012 meeting. All recommendations made here are strictly *provisional*, and are constrained by the fact that any policy that the CPT or SSC might mandate for use in this year's crab stock assessments must, by definition, be implementable by this September.

The material contained in this Phase I report will be re-evaluated during preparation of the final working group report. In this re-evaluation, the working group will consider feedback obtained from the May CPT meeting, the June SSC meeting, individual Team and SSC members, and members of the public.

In the following, "SRR" stands for "stock-recruitment relationship."

A1: Current policy on identification of regime shifts

Alternative A1.1 (status quo):

For groundfish, the status quo approach is contained in a 1999 memorandum from James Balsiger (who was at that time AFSC Director) to the AFSC groundfish stock assessment authors, and consists of the following two sentences: *"Projections of future stock sizes and estimation of reference points should be based only on year classes spawned in 1977 or later, unless a compelling case can be made to begin the time series in some other year. The fact that earlier estimates are available does not in itself constitute a compelling case."*

For crab, the status quo approach is described in various parts of the policy listed in Appendix B. Briefly, this approach calls for identification of potential mechanisms to support regime shifts. Such identification should consider evidence of a change in magnitude and direction of life-history characteristics. Candidate life-history characteristics include natural mortality, growth, maturity, fecundity, recruitment, and recruits per unit of spawning. Candidate ecosystem characteristics include the "Overland method" of regime shift detection, change in production of benthic species in the Eastern Bering Sea, and consumption (from ecosystem model outputs). If stock-recruitment data are available, they are to be examined for evidence of multiple SRRs that are consistent with a proposed regime shift.

Because item A1 is restricted to the status quo by definition, no other alternatives are presented for this item. Also, because the status quo is a matter of fact, no recommendation is made for this item.

A2: Possible improvements to current policy, including consideration of risk

Alternative A2.1: Do not consider effects of regime shifts.

Pro: 1) Extremely easy to implement. 2) Minimizes chance of a "false positive" regime shift identification. 3) If the regimes that occurred during the period spanned by the full time series of data constitute a random sample from the distribution of regimes that will occur in the long-term future, this method would give an unbiased estimate of future conditions over the long term.

Con: 1) Maximizes chance of a "false negative" regime shift (non)identification. 2) Given that regimes (almost by definition) persist for a period of at least several years, this method is likely to give a biased estimate of future conditions over the short term. 3) Because environmental regimes typically appear to persist over approximately decadal time scales and because most datasets for BSAI and GOA groundfish and crab typically extend back only a few decades, it is unlikely that the set of regimes that occurred during the period spanned by the data constitutes a random sample from the distribution of regimes that will occur in the long-term future; in which case this method is also likely to give a biased estimate of future conditions over the long term.

Alternative A2.2: Estimate breakpoints in the time series of recruits using an appropriate statistical test such as AIC or likelihood ratio, and possibly employing additional constraints such as a minimum length for the current regime or a maximum permissible CV for parameter estimates.

Pro: 1) Basing the analysis on the time series of recruits, without considering recruits per unit of spawning or a curvilinear SRR, is similar to existing practice for Tier 3 groundfish. 2) If the true SRR is of Beverton-Holt (or similar, asymptotic) form and spawning biomass has been sufficiently high throughout the time series (such that the recruitment predicted by the curve is almost independent of spawning biomass), this method will likely produce results similar to those that would be produced by the more complicated alternative of considering a fully parameterized SRR.

Con: 1) If spawning biomass has been sufficiently low for the most recent part of the time series, low recruitments from those recent years will be mistaken for a new regime even though the true SRR has not changed. 2) Because this method implicitly assumes that the true SRR is approximately horizontal across the observed range of spawning biomasses, productivity will be overestimated if the assumption is extrapolated all the way down to the origin.

Alternative A2.3: Estimate breakpoints in the time series of recruits per unit of spawning using an appropriate statistical test such as AIC or likelihood ratio, and possibly employing additional constraints such as a minimum length for the current regime or a maximum permissible CV for parameter estimates.

Pro: 1) Avoids the problem identified under "Con" for Alternative A2.2. 2) If spawning biomass has been severely depleted throughout the time series (such that spawning biomass is always close to zero), this method will likely produce results similar to those that would be produced by the more complicated alternative of considering a fully parameterized SRR.

Con: 1) If the true SRR is of Beverton-Holt (or similar, asymptotic) form and spawning biomass has been sufficiently high throughout the time series (such that the recruitment predicted by the curve is almost independent of spawning biomass) but spawning biomass has declined significantly during the most recent part of the time series, recent decreases in recruits per unit of spawning will be mistaken for a new regime even though the true SRR has not changed. 2) Because this method implicitly assumes that the true relationship between recruits and spawning is proportional across the observed range of spawning biomasses, productivity will be underestimated if the assumption is extrapolated far beyond the range of the data.

Alternative A2.4: Estimate breakpoints in the time series of an environmental time series such as the Pacific Decadal Oscillation (PDO) using an appropriate statistical test such as AIC or likelihood ratio, and possibly employing additional constraints such as a minimum length for the current regime or a maximum permissible CV for parameter estimates.

Pro: 1) The necessary data may be available even when recruitment data are not. 2) Breakpoints in environmental time series such as the PDO have already been well studied and shown to be significant predictors of many things. 3) This approach would eliminate the need to conduct a separate analysis for every stock.

Con: 1) If the productivity of a particular stock is not linked, directly or indirectly, to the environmental variable(s) used in the analysis, a "false positive" regime shift identification will result. 2) If the productivity of a stock changes only in response to some variable *not* used in the analysis, a "false negative" regime shift (non)identification will result.

Alternative A2.5: Estimate both parameters of a two-parameter SRR for every age- or length-structured stock assessment, with breakpoints estimated using an appropriate statistical test such as AIC or likelihood ratio, and possibly employing additional constraints such as a minimum length for the current regime or a maximum permissible CV for parameter estimates.

Pro: 1) Eliminates the need to use proxy reference points. 2) Does not imply functional forms for the SRR (e.g., horizontal or linear through the origin) that are almost certain to be implausible if extrapolated across the entire range of possible spawning biomasses.

Con: 1) Reliably estimating both parameters of a two-parameter SRR has proven to be very difficult for the vast majority of BSAI and GOA groundfish and crab stocks.

Alternative A2.6 (*provisional recommendation*): Condition the productivity parameter of a two-parameter SRR on one or more F_{MSY} proxies specified or implied by the harvest control rules in the respective FMP, then estimate the scale parameter of the SRR for every age- or length-structured stock assessment, with breakpoints estimated using an appropriate statistical test such as AIC or likelihood ratio, and possibly employing additional constraints such as a minimum length for the current regime or a maximum permissible CV for parameter estimates.

Pro: 1) Results in management recommendations that are consistent with existing F_{MSY} proxies. 2) Does not imply functional forms for the SRR (e.g., horizontal or linear through the origin) that are almost certain to be implausible if extrapolated across the entire range of possible spawning biomasses. 3) Eliminates the need to estimate the more difficult-to-estimate of the two SRR parameters, instead requiring estimation of only the scale parameter, which is analogous to the "average recruitment" currently estimated in all Tier 3 groundfish assessments. 4) This approach has been tested on 11 BSAI and GOA groundfish stocks using a very simple model, and the results appear to be reasonable wherever the assumptions are not violated too severely (6 of the 11 stocks were shown to have breakpoints that passed five statistical tests of significance, with the starting years of the current regimes for these 6 stocks ranging from 1968 to 1990).

Con: 1) Requires use of F_{MSY} proxies. 2) Estimates of derived quantities such as B_{MSY} can be implausible if the F_{MSY} proxies are inconsistent with the data (however, this approach is intended only to estimate the *breakpoints*; estimates of other quantities obtained in the process of determining the breakpoints do not have to be used for management purposes).

Option for any of the above except A2.1: Use a decision-theoretic approach to compute the optimal breakpoints, possibly employing additional constraints such as a minimum length for the current regime or a maximum permissible CV for parameter estimates.

Pro: 1) Costs of mis-estimating a breakpoint are weighted appropriately.

Con: 1) Requires specification of a loss (cost) function. 2) More complicated than an approach that does not weight the costs of mis-estimating a breakpoint appropriately.

B1: Establishing criteria for excluding individual within-regime year classes from estimates

A simple but quantitative evaluation of the alternatives listed here is contained in Appendix C.

Alternative B1.1: Do not exclude any individual within-regime year classes from estimates.

Pro: 1) Eliminates the need to specify quantitative criteria for excluding individual year classes.

Con: 1) May include poorly estimated year classes (e.g., will stock assessment authors be required to estimate strengths of *all* year classes in the current regime, even age 0 in the current year?).

Alternative B1.2 (*provisional recommendation*): Exclude all year classes within the last X years (*provisional recommendation*: X=3, where year 1 is defined as the first age with a survey selectivity of at least 10%).

Pro: 1) Extremely easy to implement. 2) Always feasible, unless X is set higher than the largest age in the model.

Con: 2) No necessary relationship to precision of estimated year class strengths.

Alternative B1.3: Exclude all year classes with model-estimated CVs greater than X.

Pro: 1) Very easy to implement, where feasible. 2) Clear relationship to precision of estimated year class strengths.

Con: 1) May not be feasible, because model-estimated CVs vary greatly across assessments (for example, looking at the CVs of estimated year class strengths from 1977-2009 in the sablefish and EBS Pacific cod assessments, sablefish had only 3 year classes with a CV of less than 10% compared to 25 year classes for Pacific cod, while sablefish had 25 year classes with a CV of greater than 20% compared to 1 year class for Pacific cod).

Alternative B1.4: Exclude all year classes with model-estimated CVs greater than a fraction X (<1) of the CV at the first age included in the model.

Pro: 1) Very easy to implement, where feasible. 2) Clear relationship to precision of estimated year class strengths. 3) May be more feasible than B1.3, because the *relative* CV (rather than the ***absolute*** CV) is the criterion.

Con: 1) May still be infeasible (i.e., if X is set too low).

Alternative B1.5: Exclude all year classes with model-estimated CVs greater than a fraction X (>1) of the asymptotic CV (i.e., the limiting CV that is approached as the number of times a year class is observed becomes large).

Pro: 1) Clear relationship to precision of estimated year class strengths. 2) Where feasible, may be more intuitive than the other approaches, because this approach explicitly focuses on using only those year classes where the estimates have truly stabilized.

Con: 1) May be infeasible, because an asymptotic CV does not always exist. 2) The most difficult alternative to implement, because the asymptotic CV may vary from year class to year class.

C2: How knowledge of environmental forcing changes perceptions of reference points

Alternative C2.1 *(provisional recommendation)*: Acknowledge that current knowledge of environmental forcing is insufficient to alter perceptions of reference points quantitatively.

Pro: 1) Extremely easy to implement. 2) Probably an accurate description of the current state of knowledge for the vast majority (if not all) BSAI and GOA groundfish and crab stocks.

Con: 1) Does not advance the state of the art.

Alternative C2.2: Use knowledge of environmental forcing to compare past, present, and projected stock sizes with past, present, and future values of environmentally forced reference points.

Pro: 1) Keeps BSAI and GOA groundfish and crab on the cutting edge of fishery science and management. 2) Avoids comparing apples and oranges in terms of stock status and reference points (i.e., for any year, stock size would be compared to the reference point applicable to that year, as determined by the relevant past, present, or future values of the relevant environmental variables).

Con: 1) Extremely difficult to implement anytime in the near future, and almost certainly impossible to implement for the crab assessments that are due this September. 2) Criteria used to make status determinations and to measure rebuilding will be moving targets, even for a fixed set of biological data.

Appendix A: The April 2012 Workshop on Assessment/Management Issues Related to Recruitment

Agenda

Wednesday, April 4		Speakers
0900	Welcome, purpose of workshop, introductions, appointment of rapporteurs	
A. Identification of regime shifts, either for an ecosystem or some subunit thereof		
1. Current policy on identification of regime shifts*		
0920	Estimating B_{MSY} for Tier 4 crab stocks and recruitment for Tier 3 crab stocks: Which years are representative?	B. Foy, D. Stram
0945	Jim Balsiger's memo of September 1999	Grant Thompson
0950	Discussion	
1010	- Break -	
2. Possible improvements to current policy, including consideration of risk*		
1020	A null hypothesis to explain regime-like transitions in ecosystem time series	Emanuele Di Lorenzo
1045	Considerations of biological factors affecting potential crab production regimes	L. Rugolo, J. Turnoc
1110	Identification and management of stocks with regime-based recruitment	Cody Szuwalski
1135	Risk-based selection of regime boundaries for a stock managed under a sloping, SPR-based control rule	Grant Thompson
1200	Discussion	
1220	- Lunch -	
B. Estimation of parameters (average recruitment, stock-recruitment relationships, σ_R)		
1. Establishing criteria for excluding individual within-regime year classes from estimates*		
1320	Criteria for excluding individual within-regime year classes from estimates: current practice for EBS pollock	Jim Ianelli
1345	Accounting for uncertainty in estimated recruitment when computing stock status reference points: an example from the 2010 BSAI blackspotted/rougheye rockfish assessment	Paul Spencer
1410	Choice of recruitment periods for OFL determination and its impacts on Bristol Bay red king crab	Jie Zheng
1435	Discussion	
1455	Break	
2. Use of "conditioned" stock-recruitment parameters (e.g., FMSY=F35%, BMSY=B35%)		
1505	Deriving steepness from F_{MSY} or F_{spr}	Steve Martell
1530	Discussion	
3. Specification of priors, including hierarchical Bayes and other meta-analytic approaches		
1550	Use of stock-recruit steepness priors based on meta-analysis in West Coast rockfish assessments	Martin Dorn
1615	Preliminary results for developing Bayesian priors for relative cohort strength of groundfishes off the U.S. West Coast using multi-species Stock Synthesis models	Jim Thorson
1640	Discussion	
1700	- Adjourn for the day -	

* Critical items for May 2012 Crab Plan Team meeting

	Thursday April 5th	
B. Estimation of parameters, continued		
	4. Alternatives for setting/estimating σ_R	
0900	Problems associated with estimating recruitment and σ_R in a random effects model	G. Thompson
0925	Discussion	
	5. Determining "reliability" of the F_{MSY} pdf	
0945	Environmental factors affecting EBS pollock S-R relationships	Jim Ianelli
1010	Discussion	
1030	- Break -	
	6. Other issues involving the stock-recruitment relationship	
1040	Improving ecological validity and linkage among spawner recruitment, mortality, age structure, and harvesting models: An example from western rock lobster fishery neutrality harvesting model	Yuk W. Cheng
1105	Comprehensive analysis of the stock-recruitment relationship and reference points	Mark Maunder
1130	A new paradigm for stock-recruitment relationships: Viewing the stock-recruitment relationship as density dependent survival invalidates the Beverton-Holt and Ricker models	Mark Maunder
1155	Discussion	
1215	- Lunch -	
C. Forecasting environmental variability		
	1. Best practices for incorporating environmental forcing in stock assessments	
1315	Advice for estimating fishery management reference points given low frequency between-year environmental variability	Melissa Haltuch
1340	Multispecies modeling, including projections and effects of temperature variability and predators on mortality estimates	Kirstin Holsman
1405	Environmental forcing of recruitment in the Bering Sea and Gulf of Alaska and its use in stock assessments and stock projections	Franz Mueter
1430	Recruitment products and indices from FOCI and BASIS – new proposed products for the Plan Teams and SSC	Jeff Napp
1455	Discussion	
1515	- Break -	
	2. How knowledge of environmental forcing changes perceptions of reference points*	
1525	F_{msy} and B_{msy} proxies by regime	Jim Ianelli
1550	Discussion	
1610	Wrap-up	
1630	- Adjourn -	

* Critical items for May 2012 Crab Plan Team meeting

Modifications to the Agenda

1. Lou Rugulo and Jack Turnock's presentation under item A2 was withdrawn.
2. Unscheduled presentation by Andre Punt on use of surplus production models to estimate B_{MSY} in crab stocks was added in place of Rugulo and Turnock's presentation under A2.
3. Martin Dorn's presentation under item B3 was withdrawn.
4. Unscheduled presentation by Kerim Aydin on a multispecies model with an "emergent" stock-recruitment relationship was added under item C1.
5. Jim Ianelli's presentation under item C2 was withdrawn.

References

A'mar, T. Z., A. E. Punt, and M. W. Dorn. 2009. The impact of regime shifts on the performance of management strategies for the Gulf of Alaska walleye pollock (Theragra chalcogramma) fishery. Canadian Journal of Fisheries and Aquatic Sciences 66:2222-2242.

Arregui, I., H. Arrizabalaga, D. S. Kirby, and J. M. Martin-Gonzalez. 2006. Stock–environment–recruitment models for North Atlantic albacore (*Thunnus alalunga*). Fish. Oceanogr. 15:5, 402–412.

Borja, A., Uriarte, A., Egana, J., Motos, L., and Valencia, V. 1998. Relationship between anchovy (Engraulis encrasicolus) recruitment and environment in the Bay of Biscay (1967-1996).

Brander, K. M. 2005. Cod recruitment is strongly affected by climate when stock biomass is low. ICES Journal of Marine Science, 62: 339-343.

Brooks, E. N., and J. E. Powers. 2007. Generalized compensation in stock-recruit functions: properties and implications for management. ICES Journal of Marine Science: Journal du Conseil 64(3):413-424.

Brooks, E. N., J. E. Powers, and E. Cortés. 2010. Analytical reference points for age-structured models: application to data-poor fisheries. ICES Journal of Marine Science: Journal du Conseil 67(1):165-175.

Chen, D. G.. 2001. Detecting environmental regimes in fish stock– recruitment relationships by fuzzy logic. Can. J. Fish. Aquat. Sci. 58: 2139–2148.

Chen, D. G., and D. M. Ware. 1999. A neural network model for forecasting fish stock recruitment. Can. J. Fish. Aquat. Sci. 56: 2385–2396.

Conn, P. B., E. H. Williams, and K. W. Shertzer. 2010. When can we reliably estimate the productivity of fish stocks? Canadian Journal of Fisheries and Aquatic Sciences 67(3):511-523.

Deriso, R.B., M. N. Maunder, and W. H. Pearson. 2008. Incorporating covariates into fisheries stock assessment models with application to Pacific herring of Prince William Sound, Alaska. Ecological Applications 18(5): 1270-1286.

Deriso, R.B., M. N. Maunder, and J. R. Skalski. 2007. Variance estimation in integrated assessment models and its importance for hypothesis testing. Can. J. Fish. Aquat. Sci. 64: 187-197.

Dorn, M. W. 1995. The effects of age composition and oceanographic conditions on the annual migration of Pacific whiting, *Merluccius productus*. CalCOFI Rep., Vol. 36, 1995.

Forrest, R. E., M. K. McAllister, M. W. Dorn, S. J. D. Martell, and R. D. Stanley. 2010. Hierarchical Bayesian estimation of recruitment parameters and reference points for Pacific rockfishes (Sebastes spp.) under alternative assumptions about the stockrecruit function. Canadian Journal of Fisheries and Aquatic Sciences 67(10):1611-1634.

Francis, R. I. C. C. 2006. Measuring the strength of environment–recruitment relationships: the importance of including predictor screening within cross-validations. ICES Journal of Marine Science: Journal du Conseil 63(4):594-599.

Haltuch, M. A., A. E. Punt, M. W. Dorn. 2009. Evaluating the estimation of fishery management reference points in a variable environment. Fisheries Research 100(42-56).

Haltuch, M. A., and A. E. Punt. 2011. The promises and pitfalls of including decadal-scale climate forcing of recruitment in groundfish stock assessment. Canadian Journal of Fisheries and Aquatic Sciences 68(5):912-926.

Haltuch, M. A., A. E. Punt, and M. W. Dorn. 2008. Evaluating alternative estimators of fishery management reference points. Fisheries Research 94(3):290-303.

Holt, C. A., and A. E. Punt. 2009. Incorporating climate information into rebuilding plans for overfished groundfish species of the U.S. west coast. Fisheries Research 100:57-67.

Humston, R., J. S. Ault, M. Lutcavage, and D. B. Olson. 2000. Schooling and migration of large pelagic fishes relative to environmental cues. Fish. Oceanogr. 9:2, 136-146.

Lee, H-H., Maunder, M.N., Piner, K.R., and Methot, R.D. (in press) Can steepness of the stock-recruitment relationship be estimated in fishery stock assessment models? Fisheries Research. (http://www.sciencedirect.com/science/article/pii/S0165783612001099?v=s5)

Litzow, M. A. 2006. Climate regime shifts and community reorganization in the Gulf of Alaska: how do recent shifts compare with 1976/1977? ICES Journal of Marine Science, 63:1386-1396.

Maunder, M.N. 1998. Problems with using an environmental based recruitment index: examples from a New Zealand snapper (*Pagrus auratus*) assessment. In fishery stock assessment models, edited by F. Funk, T.J. Quinn II, J. Heifetz, J.N. Ianelli, J.E. Powers, J.J. Schweigert, P.J. Sullivan, and C.I. Zhang, Alaska Sea Grant College Program Report No. AK-SG-98-01, University of Alaska Fairbanks, pp. 679-692.

Maunder, M.N. 2004. Population Viability Analysis, Based on Combining Integrated, Bayesian, and Hierarchical Analyses. Acta Oecologica 26: 85-94. Special issue for the Extinction Working Group of the National Center for Ecological Synthesis and Analysis.

Maunder, M.N. 2012. Evaluating the stock-recruitment relationship and management reference points: Application to summer flounder (Paralichthys dentatus) in the U.S. mid-Atlantic. Fisheries Research 125-126: 20-26. (http://www.sciencedirect.com/science/article/pii/S0165783612000811)

Maunder, M. N., and R. B. Deriso. 2003. Estimation of recruitment in catch-at-age models. Canadian Journal of Fisheries and Aquatic Sciences 60:1204-1216.

Maunder, M. N. and R. B. Deriso. 2010. Dealing with missing covariate data in fishery stock assessment models. Fisheries Research 101: 80-86.

Maunder, M. N. and R. B. Deriso. 2011. A state–space multistage life cycle model to evaluate population impacts in the presence of density dependence: illustrated with application to delta smelt (*Hyposmesus transpacificus*). Can. J. Fish. Aquat. Sci. 68: 1285–1306.

Maunder, M. N., S. J. Harley, and J. Hampton. 2006. Including parameter uncertainty in forward projections of computationally intensive statistical population dynamic models. ICES Journal of Marine Science, 63:969-979.

Maunder, M.N. and Starr, P.J. 1998. Validating the Hauraki Gulf snapper pre-recruit trawl surveys and temperature recruitment relationship using catch at age analysis with auxiliary information. New Zealand Fisheries Assessment Research Document 98/15 23p.

Maunder, M. N., and G. M. Watters. 2003. A general framework for integrating environmental time series into stock assessment models: model description, simulation testing, and example. Fishery Bulletin 101: 89-99.

Methot, R. D., and I. G. Taylor. 2011. Adjusting for bias due to variability of estimated recruitments in fishery assessment models. Canadian Journal of Fisheries and Aquatic Sciences 68:1744-1760.

Myers, R.A. 1998. When do environment–recruitment correlations work? Rev. Fish Biol. Fish. 8(3): 285–305. doi:10.1023/ A:1008828730759.

Punt, A. E. 2011. The impact of climate change on the performance of rebuilding strategies for overfished groundfish species on the U.S. west coast. Fish and Fisheries 109(2-3):320-329.

Schirripa, M. J., C. P. Goodyear, and R. D. Methot. 2009. Testing different methods of incorporating climate data into the assessment of US West Coast sablefish. ICES Journal of Marine Science 66:1605-1613.

Sinclair, F., and W. R. Crawford. 2005. Incorporating an environmental stock–recruitment relationship in the assessment of Pacific cod (Gadus macrocephalus) Fish. Oceanogr. 14:2, 138–150.

Walters, C. J., R. Hilborn, and V. Christensen. 2008. Surplus production dynamics in declining and recovering fish populations. Canadian Journal of Fisheries and Aquatic Sciences 65(11):2536-2551.

Williams, E. H., and K. W. Shertzer. 2003. Implications of life-history invariants for biological reference points used in fishery management. Canadian Journal of Fisheries and Aquatic Sciences 60(6):710-720.

Zhu, J-F, Chen, Y., Dai, X.J., Harley, S.J., Hoyle, S.D., Maunder, M.N., Aires-da-Silva, A. 2012. Implications of uncertainty in the spawner-recruitment relationship for fisheries management: an illustration using bigeye tuna (Thunnus obesus) in the eastern Pacific Ocean. Fisheries Research 119–120:89–93. (http://www.sciencedirect.com/science/article/pii/S0165783611003869)

Participants

Teresa A'Mar	AFSC
Kerim Aydin	AFSC
Matt Baker	AFSC
Steve Barbeaux	AFSC
Bill Bechtol	UAF
Yuk Cheng	WDFW
Bob Clark	ADFG
Jane DiCosimo	NPFMC
Martin Dorn	AFSC
Bob Foy	AFSC
Scott Goodman	NRC/BSFRF
Melissa Haltuch	NWFSC
Toshida Hamazaki	ADFG
Dana Hanselman	AFSC
Jim Hastie	NWFSC
Alan Haynie	AFSC
Jon Heifetz	AFSC
Anne Hollowed	AFSC
Kirstin Holsman	AFSC/JISAO, UW
Pete Hulson	AFSC
Jim Ianelli	AFSC
Patricia Livingston	AFSC
Sandra Lowe	AFSC
Steve Martell	UBC
Franz Mueter	UAF
Jeffrey Napp	AFSC
Ivonne Ortiz	AFSC
Tom Pearson	AKRO
Andre Punt	UW
Terry Quinn	UAF
Lou Rugulo	AFSC
Kalei Shotwell	AFSC
Shareef Siddeek	ADF&G
Dave Somerton	AFSC
Paul Spencer	AFSC
Gary Stauffer	BSFRF
Diana Stram	NPFMC
Cody Szuwaski	UW
Ian Taylor	NWFSC
Grant Thompson	AFSC
James Thorson	UW
Jack Turnock	AFSC
Tadeyasu Uchiyama	UAF
Juan Valero	IPHC
Tom Wilderbuer	AFSC
Stephani Zador	AFSC
Jie Zheng	ADF&G

Appendix B: Establishing Criteria in Estimating B_{MSY}

CPT (May 2011) with SSC revision (June 2011)

These criteria to select the time period to represent B_{MSY} or $B_{MSYproxy}$ should be included in the analysis in each SAFE.

The time period should be representative of the stock fluctuating around B_{MSY}. The time period should be representative of the stock being fished at an average rate near F_{MSY}. For Tier 3 we are looking for an average recruitment and not an average biomass ($B_{MSYproxy}$ formally only applies to Tier 4).

1. Provide an estimate of the production potential of the stock over the full time period of the assessment.
    a. Identify if the stock below a threshold for responding to increase production.
    b. For Tier-3 stocks, provide the time series of ln(R/S) and recruitment (R). For crab stocks, S is mature male biomass at the time of mating, and R is model estimate of recruitment.
    c. For Tier-4 stocks, provide a surplus production analysis using biomass and catch to evaluate the production potential over time. Give the formula for surplus production (units of MMB). Annual surplus production (ASP_t) is equivalent to the amount of yield that could have been taken in a given year that would have left the stock at equilibrium,

        $ASP_t = B_{t+1} - B_t + C_t$
        B_{t+1} = biomass in year t+1
        B_t = biomass in year t
        C_t = catch in year t

        Also, evaluate the time series of survey recruiting size class as a recruitment index. If it looks consistent look at time series of survey R/S.
    d. Identify potential mechanisms that should be considered to support production changes (i.e. Regime Shifts) based on a. and b. above. Consider evidence of a change in magnitude and direction of life-history characteristics that support a proposed change in production.

        Candidate life-history characteristics (empirical data) include:
        i. Natural Mortality (M)
        ii. Growth
        iii. Maturity (maturity schedule)

iv. Fecundity
v. Recruitment & recruits/spawner
vi. Candidate ecosystem characteristics (empirical data) include:
   1. Overland method of Regime Shift detection
   2. Change in production of benthic spp. in EBS.
   3. Consumption (ecosystem model output).

2. Provide a plot of the history of the exploitation rate on MMB at the time of the fishery relative to F_{MSY} (Tier-3) or relative to the F_{MSY}=M proxy (Tier-4).
3. Provide a plot of the history of the exploitation rate on MMB at the time of the fishery relative to ln(R/S) (Tier-3) or relative to ln(R_{OBS}/MMB_{OBS}) (Tier-4) where R_{OBS} is observed survey recruitment and MMB_{OBS} is observed survey MMB at the time of mating.
4. Examine the stock-recruitment relationship (SRR) for evidence of:
   a. Depensation in the SRR.
   b. Multiple SRRs consistent with a proposed regime shift paradigm.

The following methods were discussed by the CPT and SSC but considered not to be viable (see June 2011 SSC minutes). They are left in this version so that authors may comment on/ or consider their use.

5. For many crab stocks, historical rates of exploitation were higher or lower than current estimates of maximum rates fishing at F_{MSY}. The resultant B_{MSY} would be a biased (low or high) measure of reproductive potential since MMB at mating is tabulated after the extraction of the catch. If recruitment was maintained despite the difference, the extent of this bias is proportional to the magnitude of the catch above or below fishing at F_{MSY}. The recalculated B_{MSY} should be a better reference biomass estimate regardless of whether catches were larger or smaller than F_{MSY} catch.

6. For Tier-4 stocks, an alternative $B_{MSYproxy}$ can be estimated that adjusts for stock losses in excess of F_{MSY}. The analyst should estimate $B_{MSYproxy}$ based on the following approach:
   a. Using observed survey mature male biomass, estimate mature male biomass at the time of the fishery.
   b. Using the F_{MSY} proxy, estimate the catch using the biomass from (a).
   c. In years where exploitation rates exceeded those at F_{MSY}, replace the observed catch with that from (b) and recalculate MMB at mating.

d. Produce a new time series of MMB at mating replacing those years where MMB was recalculated in (c).
e. Recalculate B_{MSYproxy} over the reference time period with the new time series of MMB at mating derived in (d).

Appendix C: A simple analysis of the B1 alternatives

Assumptions common to all examples discussed here:

A. The observational data consist of a survey time series (of length *n*) of numbers at age, which, when log-transformed, are distributed normally about the true log numbers at age.
B. The time series of *Q*, selectivity at age, and *Z* at age are known.

   Given the above assumptions, after *n* observations, the CV of a cohort's estimated initial abundance (i.e., the abundance at some age prior to the age at the first observation) is equal to sqrt(*h*(*n*)/*n*), where *h*(*n*) is the harmonic mean of the time series of the log-scale observation error variances. To make things even simpler, an additional assumption will be used:

C. The log-scale observation error variance is equal to the following constant function of age (*t*): sigma^2 = exp(*a* + *b***t* + *c***t*^2).
   a. In the special case where *b*=*c*=0, the CV of the estimated initial abundance after *n* years is CV(n)=sqrt(exp(*a*)/*n*). Note that this value equals zero in the limit as *n* approaches infinity.
   b. In the special case where *b*≠0 and *c*=0, the CV of the estimated initial abundance after *n* years is CV(*n*)=sqrt(exp(*a*)*(exp(*b*)-1)/(1-exp(-*b***n*))). Note that this value equals zero in the limit as *n* approaches infinity, as in the *b*=*c*=0 case.
   c. In the general case where *b*≠0 and *c*≠0, there is no short-hand formula for the CV of the estimated initial abundance after *n* years . In contrast to the two previous cases, CV(*n*) reaches a positive asymptote (the "asymptotic CV") in the limit as *n* approaches infinity.

Alternatives for criteria pertaining to exclusion of the most recent within-regime year classes:

1. Exclude no year classes.
2. Exclude all year classes within the last *X* years.
   a. In the special case where *b*=*c*=0, the *proportional reduction* in CV relative to CV(1) will depend only on *X*, but the *absolute* CV will also depend on *a*.
   b. In the special case where *b*≠0 and *c*=0, the *proportional reduction* in CV relative to CV(1) will depend only on *X* and *b*, but the *absolute* CV will also depend on *a*.
   c. In the case where *b*≠0 and *c*≠0, both the *proportional reduction* in CV relative to CV(1) will depend only on *X*, *b*, and *c*; but the *absolute* CV will also depend on *a*.
3. Exclude all year classes with model-estimated CVs greater than *X*.
   a. In the special case where *b*=*c*=0, the number of years needed to achieve CV(*n*)=*X* and the *proportional reduction* in CV relative to CV(1) will both depend on *X* and *a*.
   b. In the special case where *b*≠0 and *c*=0, the number of years needed to achieve CV(*n*)=*X* and the *proportional reduction* in CV relative to CV(1) will both depend on *X*, *a*, and *b*.
   c. In the case where *b*≠0 and *c*≠0, it will be impossible to achieve CV(*n*)=*X* if *X* is set too low. If *X* is set sufficiently high, the number of years needed to achieve CV(*n*)=*X* and the *proportional reduction* in CV relative to CV(1) will both depend on *X*, *a*, *b*, and *c*.
4. Exclude all year classes with model-estimated CVs greater than a fraction *X* (<1) of the CV at the first age included in the model.

a. In the special case where b=c=0, the number of years needed to achieve CV(n)=X*CV(1) will depend only on X, but the *absolute* CV will also depend on a.
b. In the special case where b≠0 and c=0, the number of years needed to achieve CV(n)=X*CV(1) will depend only on X and b, but the *absolute* CV will also depend on a.
c. In the case where b≠0 and c≠0, it will be impossible to achieve CV(n)=X*CV(1) if X is set too low. If X is set sufficiently high, the number of years needed to achieve CV(n)=X*CV(1) will depend only on X, b, and c; but the *absolute* CV will also depend on a.

5. Exclude all year classes with model-estimated CVs greater than a fraction X (>1) of the asymptotic CV.
   a. In the special case where b=c=0, the asymptotic CV is zero, so the number of years needed to achieve CV(n)=X*CV(∞) will always be infinite.
   b. In the special case where b≠0 and c=0, the asymptotic CV is zero, so the number of years needed to achieve CV(n)=X*CV(∞) will always be infinite.
   c. In the case where b≠0 and c≠0, the number of years needed to achieve CV(n)=X*CV(∞) will depend only on X, b, and c; but the *absolute* CV will also depend on a.

Note that Alternative #1 is the only one that works regardless of the values of the parameters. However, this begs the question of what to count as the "first observation." Here are some alternatives:

I. The first observation is the first age in the model. This definition could be problematic, because some models start at an age prior to the first age with data (e.g., SS always starts at age zero); conversely, an author might start the model well past the first age with data.

II. The first observation is the first age with relative abundance data for the cohort in question. This definition could be problematic if only a trivial amount of abundance data exist at the first age thus defined.

III. The first observation is the first age with *significant* relative abundance data for the cohort in question. This begs the question of what constitutes "significant." Some sub-alternatives:
   i. "Significant" means an observation error CV of less than X. This definition could be problematic if X is set so low that the definition cannot be satisfied at any reasonably low age (or, worse, not at all).
   ii. "Significant" means estimated survey selectivity greater than X in the respective age and year.

Excerpt from May Crab Plan Team report on the Recruitment Workgroup

D. Plan Team workgroup report on Recruitment

Bob Foy provided an overview of the "'Phase 1' Report of the Joint Plan Team Working Group on Assessment/Management Issues Related to Recruitment". This paper is still in draft form and was distributed to the CPT at this time to facilitate discussion of how to select the timeframes for recruitment when defining management reference points, and to address the possible impacts of environmental effects on the productivity of crab stocks. The CPT discussed the issues raised under sections A-Identification of regime shifts; B-1 Establishing criteria for excluding individual within-regime year classes from estimates; and C-Forecasting environmental variability. The CPT intent was to provide some recommendations for information to be brought forward in the final stock assessments for the fall.

A-Identification of regime shifts (A2 Possible improvements to current policy)

André presented some results of a study to test the provisional recommendation for A2.6 "Condition the productivity parameter of a two-parameter SRR on one or more F_{MSY} proxies specified or implied by the harvest control rules in the respective FMP, then estimate the scale parameter of the SRR for every age- or length-structured stock assessment, with breakpoints estimated using an appropriate statistical test such as AIC or likelihood ratio, and possibly employing additional constraints such as a minimum length for the current regime or a maximum permissible CV for parameter estimates." His analysis assumes that F_{MSY} equals $F_{35\%}$, then fits the stock-recruitment relationship to the stock and recruitment data points to estimate R_0. The output from the analysis is the fitted stock-recruitment relationship and the inferred 95% prediction intervals for recruitment given mature male biomass. This differs slightly from the current forecasting practice of selecting values for steepness and R_0 where the model-predicted values for B_{MSY} and F_{MSY} match those for $B_{35\%}$ and $F_{35\%}$. The team discussed the pros and cons of this approach and to what extent this is changing which tiers stocks are placed in (i.e., Tier 3 vs. *de facto* Tier 1). The team noted that within this framework one could fit two stock-recruitment relationships and try to find the breakpoints in R_0. One suggestion in this regard was to consider a moving window for R_0 and test each possible change in sequence.

Steve showed a plot of log of recruits-per-spawner vs MMB, noting that the slope of the line would be the juvenile survival rate, and that it is possible to test for changes over time in juvenile survival rates. Non-stationarity in juvenile survival rate would imply that whole time-series of recruitments could not be used to define management reference points. Jack noted that we still need to consider the history of a stock and the level of biomass over that timeframe. Others questioned why fitting the stock-recruitment curve would not effectively take this into account, i.e., if one stock-recruitment relationship adequately fits the data, then the major impact of stock size on recruitment was accounted for. Andre noted that one could treat fishing mortality as a covariate when fitting the stock-recruitment relationship if it was postulated that fishing-related effects could be disrupting spawning, independent of the size of the reproductive component of the population.

The CPT recommended that the default assumption for recruitment is to start with the full time series and use the alternatives listed in A2.2 – A2.6 (or other) to recommend a modification to the default timeframe. The team noted the necessity of consistency across stocks in how the set of recruitments is evaluated, and that all authors should look at several ways to detect breakpoints in productivity. Once a breakpoint has been identified, some plausible biological explanation or rationale should also be provided to support the identified change in productivity. The team stressed the need for transparency in how the breakpoint years are selected when defining reference point, and that the same software should be employed by all authors. The software would include all of the main approaches raised in the report and discussed by the team. André and Steve will pursue software for use by authors prior to the September assessments. The software will include the core methods to be used across all assessments.

Additional suggestions included looking at covariates of temperature, predation, etc., to explain some of the variation about the stock-recruitment relationship. This would help identify mechanisms for change, albeit the first step is to identify the breakpoints.

B-1 Establishing criteria for excluding individual within-regime year classes from estimates
The CPT noted that B1 only addresses whether the most recent recruitment estimates should be used when defining reference points (the team has, in the past excluded points from the middle of the time-series when defining B_{MSY} proxies owing to concerns about fishing-induced effects). Under the provisional recommendation of the workgroup, points would be excluded if their precision is low. Alternative approaches are: (a) ignore points based on whether the year-class concerned has entered the fishery and to what extent discards and surveys are monitoring the incoming recruits; (b) ignore points until the CVs for the estimates of year-class strength stabilize; and (c) ignore points until estimates based on retrospective analyses stabilize. The most recent reliable estimate of recruitment may also depend on the choice of the minimum length bin the model. For example, one might base reference points on almost all of the recruitment estimates for St. Matthews blue king crab because the first size-class includes relatively large animals, whereas there will be several cohorts between the first size-class and the size-at-recruitment to the fishery for EBS Tanner crab.

The team did not have an extensive discussion of C2: How knowledge of environmental forcing changes perceptions of reference points.

The CPT will review the full report from the workgroup at their September 2012 meeting and thanks the workgroup members (and in particular Grant Thompson) for their work on this thus far. The team looks forward to seeing the results of A2 in each of the assessments in the fall.

AGENDA D-1(g)
Supplemental
JUNE 2012

Freezer Longline COALITION

ph: 206.284.2522
fax: 206.284.2902
2303 West Commodore Way, Suite 202, Seattle, WA 98199

D-1(g) Groundfish Issues (SSC only)
Review Pacific cod assessment models

May 29th, 2012

Freezer Longline Coalition, Comments on the model scenarios recommended for the Pacific cod preliminary assessments

Dear Chairperson Pat Livingston:
First, we would like to congratulate the Assessment Authors and Plan Team for the substantial progress that has been made in the Pacific cod assessments in the past few years. We would also like to thank the Plan Team for the opportunity to have input into the assessment processes. Unfortunately, there are still several issues that need to be resolved in the assessments and these provide the basis for the alternate models we request. The alternative models provide insight into the stock assessments and can be used to make informed decisions about the best configuration of the final model.

The FLC supports all the recommended model scenarios from the Joint Meeting of the BSAI and GOA Groundfish Plan Teams held on May 1, 2012. The authors preferred model from last year was in alignment with areas we have commented on in the past and we would like to ensure the continued encouragement for the assessment authors to investigate their own preferred models. We also support all the additional all the additional BS and GOA recommendations. We are encouraged to see the additional recommendations for further research on catchability and aging bias, which are two important issues that need addressing. We would also like to encourage research into modeling time varying growth and how that influences the assessment.

In conclusion, the FLC requests the SSC continue to support the yearly "Spring Cod Modeling" meeting of the BSAI and GOA Groundfish Plan Teams. With the advent of a new modeler in the GOA and upcoming certainty of a separate AI model from our vantage point it is more important than ever that the process continue for the next few years. While the process is time consuming and tasks responsibilities on a group that currently has high demands on its time the process of suggesting models and the yearly meeting have become much less laborious each year.

Thank you again for you time and Consideration,

Kenny Down
Executive Director