Minutes of the Joint Plan Teams for the Groundfish Fisheries of the Gulf of Alaska (GOA) and Bering Sea and Aleutian Islands (BSAI)

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Introduction

Ten members of the BSAI Groundfish Plan Team and five members of the GOA Groundfish Plan Team participated in this WebEx meeting (names in bold above). Others in attendance included: Teresa A'mar, Alison Dauble, Bob Lauth, Krista Milani, Steve Minor, Jan Rumble, Chad See, Janet Smoker, Dave Somerton, Anne Vanderhoeven, and Ernie Weiss. The purpose of the meeting was to recommend models for inclusion in this year's preliminary assessments of Pacific cod in the (Eastern) Bering Sea, Aleutian Islands, and Gulf of Alaska.

Plan Team members were provided with several background documents two weeks prior to the meeting. The background documents are provided as attachments to these minutes, numbered as follows:

1. Comments and proposals related to the 2013 Pacific cod assessments.
2. Full text of relevant Team (November, 2012) and SSC (December, 2012) minutes.
3. Models analyzed in the 2012 Bering Sea Pacific cod assessment.
4. Models analyzed in the 2012 Aleutian Islands Pacific cod assessment.
5. Models analyzed in the 2012 Gulf of Alaska Pacific cod assessment.
6. Comparing Pacific cod catches from survey bottom trawls with a low and a high vertical opening (summary of 2012 pilot field study, by Robert Lauth and Cynthia Yeung).

Grant Thompson, senior author of the EBS and AI Pacific cod assessments, opened the meeting with a brief overview of last year's models and this year's comments and proposals. Grant also described the individual EBS and AI proposals during the discussion. Teresa A'mar, senior author of the GOA Pacific cod assessment, did the same for the individual GOA proposals. Mike Sigler moderated the discussion.

Trawl survey escapement study

For the last few years, the EBS and GOA models have used the results of the archival tagging study by Nichol et al. (2007, *Fisheries Research* 86:129-135) to constrain their respective estimates of survey catchability. Specifically, the average of the product of catchability and selectivity across the 60-81 cm size range has been constrained to a value of 0.47 in the EBS and 0.92 in the GOA. The underlying assumption is that more fish escape over the headrope in the EBS survey than in the GOA survey, because the former has a lower headrope. The Teams received a presentation from Bob Lauth, who led a 2012 pilot field study that compared the Pacific cod CPUE from the two nets by deploying both in the same location (see Attachment 6). The results from this study failed to reject the null hypothesis that the nets used in the EBS and GOA surveys have the same catchability for Pacific cod in the 60-81 cm size range. Because this was just a small pilot study, Dave Somerton, the Program Manager for the Groundfish Assessment Program, felt that the results were inconclusive, and the Teams agreed. Dave Somerton noted that the archival tags used in the paper by Nichol et al. measure depth, not distance off bottom, which is why the number of tags used in the paper (11) was much smaller than the total number of tags returned (286), as it was necessary to exclude all tags not recovered over flat bathymetry (defined in the paper as slope<0.05%). However, a new tag design has recently come on the market which may give more direct information about distance off bottom. Dave has applied for funding to obtain a supply of the new tags. There was some discussion about the possibility of repeating the 2012 field study in deeper water. It was noted that the co-occurrence of pollock in deeper water would complicate the study and that it would require more funding and survey time than was currently available in the survey budget. On a related issue, this summer the EBS trawl survey group will be conducting a small pilot study to examine survey selectivity for larger Pacific cod that may out-swim the survey net. **The Teams commend Bob Lauth, Dave Somerton, and the other RACE Division scientists for their efforts to estimate the catchability and selectivity of the EBS shelf bottom trawl survey gear with respect to Pacific cod, and recommend that such efforts continue to receive high priority.**

Recommended models for this year's preliminary assessments

A total of 45 comments relevant to this year's Pacific cod assessments were received prior to the meeting from the Teams, the SSC, the Freezer Longline Coalition (the two FLC's proposals were identical to their 2012 proposals), and individuals. These were divided into two groups: 28 were classified as "model proposals," which pertained to structural features suggested for this year's models or data; and 17 were classified as "non-model comments," which pertained to other things such as requests for inclusion of additional graphs or analyses based on model results. Of the 28 model proposals, 12 pertained to the EBS assessment, 1 to the AI assessment, and 15 to the GOA assessment. In addition to the 28 model proposals received prior to the meeting, two proposals were developed during the meeting itself, giving a total of 30. The non-model comments were not discussed during the meeting, but will be addressed by the authors in their respective assessments as appropriate, either in the preliminary or final drafts.

The Teams dealt with the 30 model proposals in three ways (Table 1): Some were recommended for inclusion in a set of candidate models, some were recommended to be left up to the authors to investigate at their discretion, and two were recommended to be tabled until after the September meeting. These last two (tabled) proposals pertained to alternative variance estimators for abundance and biomass in the EBS bottom trawl survey. **The Teams recommend that the RACE survey scientists apply the alternative variance estimators to the EBS survey time series for Pacific cod and present the results at the September meeting, after which the BSAI Team will determine whether to recommend their use in the final EBS assessment.**

Jim Ianelli offered to assist the authors with prioritizing the “discretionary” proposals.

For the preliminary AI assessment, the Teams recommend that the author have discretion over any and all models to be included. The Teams noted that no model for this stock has been accepted by the SSC and that a significant amount of development and analysis still needs to occur before a model for this stock can be recommended with confidence. The Teams understand that the SSC will recommend separate EBS and AI harvest specifications for 2014 regardless of whether a model is accepted this year. Although the Teams are not recommending any specific models for the AI stock, one member suggested that the author might consider starting the model in 1977 but omitting survey data prior to 1991, as was done in last year’s AI Model 4.

For the preliminary EBS assessment, the Teams recommend that the following models be included:

1. Last year’s final model (Model 1), which is the same as the 2011 final model
2. Last year’s “exploratory” model (Model 4), but with the logarithm of survey catchability estimated internally, using a non-constraining uniform prior
3. Last year’s “exploratory” model (Model 4), but with the logarithm of survey catchability estimated internally, using a normal prior derived from the archival tagging data used by Nichol et al. (2007), and with asymptotic trawl survey selectivity

Grant reported that he will likely bring forward an EBS model similar to last year’s Model 4 on his own.

Regarding the two proposals that requested inclusion of an EBS model with the age data turned off (BPT2 and FLC1), the Teams noted that models like this have been included in the past, but primarily just as a sensitivity test. In last year’s EBS assessment, the final model (Model 1), which had the age data turned on, gave results very similar to those of the same model with the age data turned off (Model 3), suggesting that there may not be much value in repeating this comparison.

For the preliminary GOA assessment, the Teams recommend that the following models be included:

0. The 2011 final model
1. Last year’s final model (Model 2)
2. Last year’s Model 4, but with all selectivities forced to equal zero at age zero, growth parameters fixed at the values from Model 2, and time-invariant selectivity for the 27-plus survey

The Teams also recommend that catchability for the 27-plus survey in the GOA models not be retuned unless the average of the product of catchability and selectivity across the 60-81 cm size range departs appreciably from the value of 0.92 estimated by Nichol et al. (2007).

Other business

For the last two years, the Teams have reserved the right to request that the author’s preferred model be excluded from the final assessment. Upon further reflection and consideration of the SSC’s June, 2012 minute stating that authors are free to include their own models in both the preliminary and final assessments, the Teams decided to abandon their previous policy. **The Teams recommend that authors feel free to include their own models in both the preliminary and final assessments.**

The Teams also discussed whether they should plan to hold a similar meeting next year. Some of the controversy over the Pacific cod assessments seems to have diminished, and some of the remaining issues are highly technical in nature and so do not lend themselves to discussion by a large group. The authors feel that the meetings have been helpful, given the large number of proposals that continue to be made; however, the meetings are time consuming for those who have to read the background documents and participate. **The Teams recommend that the following alternatives be considered next year:**

1. Perhaps the authors' introductory remarks at the beginning of the meeting could be expanded, so as to bring participants up to speed regarding what was done in the previous year's assessments and what the proposals for the current year's assessments entail, recognizing that some proposals may be ambiguous and require clarification from the proposer(s). (In the past, the Teams have asked the authors to keep their introductory remarks very brief, to maximize the amount of time available for Team discussion. However, as the proposals have become increasingly technical, some Team members have found it difficult to keep track of how everything fits together.)
2. Perhaps the task of prioritizing proposals and developing candidate models could be delegated to a subcommittee comprised of Team members who are especially interested in assessment methodology. This might have the benefit of keeping the discussion more focused, and would free other Team members from having to participate in yet another meeting (note that nearly half of all Team members were absent from this year's meeting).

Table 1. List of paraphrased model proposals (see Attachment 1) and assignment thereof to candidate models, as recommended by the Teams. Column “D”: Proposals to be included at the author’s discretion. Column “T”: Proposals to be tabled until after the September meeting. Legend for other symbols: A = age, G = growth, L = length, M = natural mortality, Q = catchability, R = recruitment, S = selectivity, W = weight.

				September model					
Region	Type	Number(s)	Proposal (model numbers are those from last year's respective final assessment)	0	1	2	3	D	T
AI	base	n/a	Model 3? (used to illustrate results, but not accepted for use in management)					x	
AI	data	WGC1	Start the model in 1991					x	
BS	base	SSC1	Retain final 2011 model for several assessment cycles		x				
BS	base	n/a	Last year's final model (Model 1)		x				
BS	data	RRL1	Adjust survey variance estimators to account for spatial autocorrelation						x
BS	data	RRL2	Adjust survey variance estimators to account for temporal sequence of stations						x
BS	data	BPT2,FLC1	Model 3 (like Model 1, but with ageing bias and agecomp fit both turned off)					x	
BS	biology	FLC2	Like Model 1, but with time-varying G					x	
BS	biology	GGT1	Allow increasing M with age					x	
BS	capture	BPT1	Like Model 4, but with gear-and-block-specific S					x	
BS	capture	SSC2	Like Model 4, but with gear-and-block-specific S and time-varying Q					x	
BS	capture	new	Like Model 4, but with non-constraining uniform prior on ln(Q)			x			
BS	capture	new	Like Model 4, but with normal prior on ln(Q) based on tagging data, and asymptotic survey S				x		
BS	capture	BPT2	Model 2 (like Model 1, but with free Q)					x	
BS	capture	SSC3	Like Model 1, but with Q adjusted to reflect results of 2012 field study					x	
BS	capture	GGT2	Include annually varying S					x	
BS	various	SSC4	Like Model 4, including Richards G, new W-at-L, length-based S, internal estimation of σ_R					x	
GOA	base	SSC1	Retain final 2011 model for several assessment cycles	x					
GOA	base	n/a	Last year's final model (Model 2)		x				
GOA	data	GPT4	Turn off age zeros whenever sub-27 age data are included			x			
GOA	data	GPT1	Evaluate implications of weighting L-at-A data spatially					x	
GOA	data	SSC7	Further explore omitting or downweighting L-at-A data for the 27-plus survey					x	
GOA	data	SSC8	Downweight, rather than omit, the L-at-A data					x	
GOA	biology	SSC12	Use Richards G					x	
GOA	biology	SSC5,JPT2	Use an explicit phenological model to estimate seasonal W-at-L					x	
GOA	biology	SSC6,JPT3	Evaluate implications of using ageing bias parameters as estimated in Bering Sea model					x	
GOA	capture	JPT1	Integrate out random effects before estimating σ parameters for Q and S devs					x	
GOA	capture	GPT3	Use age-based cubic splines for S					x	
GOA	capture	SSC10	Use length-based survey S					x	
GOA	capture	SSC11	Do not use time-varying S for an index that primarily reflects variability due to incoming R					x	
GOA	various	SSC9	Evaluate impacts of S form and interactions between S, G, and L-at-A data					x	
GOA	various	GPT2	Like Model 4, but with G fixed at Model 2 values and constant 27-plus S			x			

1 Comments and proposals related to the 2013 Pacific cod assessments

Comments and proposals are listed in order of assessment, and chronologically within assessment. Comments that do not pertain to a structural feature of an assessment model (e.g., requests for inclusion of additional graphs or analyses based on model results) are not numbered but are instead labeled "non-model comment."

Assessments in general

Please note: This section contains only those comments on assessments in general that have arisen since last year's assessments. Any previous comments on assessments in general that were not addressed fully in last year's assessments are listed in the appropriate assessment-specific section below.

SSC minutes (June, 2012)

Non-model comment: "We note that stock assessment authors are free to develop and bring forward an alternative model or models in both the preliminary and final assessment."

GOA Team minutes (November, 2012)

Non-model comment: "The Team discussed a pollock CIE review comment that the assessment be risk neutral. This comment is relevant to all stock assessments, and led to the specific question of 'at what biomass is there no longer a need for the author's recommended ABC lower than the maximum permissible ABC?'"

Non-model comment: "The Team noted that in general for all stocks where a projection is employed, the catch projection for the current year should be the current ABC or the current technique for estimating in year catches whichever is less."

SSC minutes (December, 2012)

Non-model comment: "The SSC recommends that the authors consider whether it is possible to estimate *M* with at least two significant digits in all future stock assessments to increase validity of the estimated OFL."

Non-model comment: "The SSC requests that all assessment authors of AI species evaluate AI survey information to ensure that the same standardized survey time series is used." (Please note: In a 4/4/2013 e-mail, SSC chair Pat Livingston offered the following clarification of this comment: "I brought this up to the SSC and we are definitely open any time to what the analysts deem to be the best time series to use - it would be particularly important to hear the rationale from each analyst as to why they feel a particular time series is best for their species.")

Bering Sea Pacific cod assessment

Please note:

- This section lists only those comments that have arisen since last year's assessment and any previous comments that were not addressed fully in last year's assessment. See last year's SAFE report for other comments.
- Although no proposals were received regarding use of last year's final model as this year's base model, tradition indicates that this will be the case.

SSC minutes (December, 2011)

SSC1: “Allow for a thorough evaluation of the performance of the current model over several assessment cycles.”

BSAI Plan Team minutes (September, 2012)

BPT1: “There was also a lot of interest in a model intermediate between Model 1 and Model 5, such as a version of Model 5 in which the commercial fishery data are still broken out by gear and season, with selectivity parameters estimated by time block. The Team recommends that the author investigate a model like that and bring it forward on his own if it looks worthwhile.” (Please note: Model 5 from last year’s preliminary assessment was relabeled Model 4 in the final assessment.)

BPT2: “While they are not candidates for the specifications, we think that Models 1.1 and 4 provide a useful check on the candidate models and recommend that they be reported in November (and next September).” (Please note: Models 1.1 and 4 from last year’s preliminary assessment were relabeled Models 2 and 3 in the final assessment, respectively.)

SSC minutes (October, 2012)

SSC2: “The Plan Team recommended the author bring forward a version of Model 5 that incorporates time varying selectivity for the fishery, if time permits and is worthwhile. The SSC supports Plan Team recommendations and encourages the author - if time permits - to bring forward a model that considers time varying survey *Q* to see if that produces better fit to the survey data.” (Please note: Model 5 from last year’s preliminary assessment was relabeled Model 4 in the final assessment.)

BSAI Plan Team minutes (November, 2012)

Non-model comment: “The Team recommends that jitter tests continue to be conducted, but statistics related to jitter tests do not need to be reported in future assessments.”

Non-model comment: “The Team commends the authors for responding to every single Team request, of which (as is customary for Pacific cod) there were a large number during the past year.”

SSC minutes (December, 2012)

SSC3: “The SSC re-iterates continuing concerns over the best value for the catchability coefficient, which by long-standing practice is either tuned to experimental results or fixed at a previously tuned value to keep it close to the experimental results (currently fixed at 0.77 in Model 1). Based on exploratory models estimating *Q*, catchability may be much higher. The SSC expects to receive a report prior to next year's assessment about a comparison of the standard EBS trawl with a high-opening trawl conducted during the 2012 field season.”

SSC4: “The results for Model 4 suggest that several of the new features represent an improvement over the current base model and the SSC recommends bringing forward a similar model next year that retains at least some of these promising features such as the Richards growth curve, newly parameterized seasonal changes in weight-at-length, selectivity modeled as a function of length, and estimating log-scale standard deviations for recruitment internally rather than fixing them.”

Non-model comment: “The SSC would like to see [an] … analysis of retrospective patterns for a model with an alternative estimate for *Q* (internally estimated or updated value from field experiment) in next year's assessment.”

Freezer Longline Coalition (April, 2013)

The following two proposals were originally made in April, 2012, but the FLC has asked that they be resubmitted for this year's assessment cycle.

FLC1: "Last year's final model and/or this year's preferred model with age data excluded."

FLC2: "Last year's final model 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."

Bob Lauth (April, 2013)

RRL1: "Use the variance estimation method of D'Orazio (2003, *J. Agric. Biol. Environ. Stat.* 3:280-295) to account for spatial autocorrelation in the systematic design of the EBS shelf trawl survey."

RRL2: "Use a variance estimation method suggested during the CIE review of the survey programs to account for the temporal sequence of stations in the systematic design of the EBS shelf trawl survey."

Grant Thompson (April, 2013)

The following two proposals were conveyed to the assessment author informally, but emphatically enough that the assessment author felt that it was appropriate to bring them forward on his own. Except for the following, the assessment author has no new proposals to bring forward at present. However, consistent with SSC policy, he reserves the right to bring forward additional models at any time.

GGT1: Allow increasing natural mortality with age.

GGT2: Include annually varying selectivity.

Aleutian Island Pacific cod assessment

Please note:

- This section lists only those comments that have arisen since last year's assessment and any previous comments that were not addressed fully in last year's assessment. See last year's SAFE report for other comments.
- Identification of a base model for this year's assessment is problematic due to the fact that no model was accepted by the SSC last year. One possibility might be to use last year's Model 3 as the base model, as this was the model that was used to illustrate results and possible harvest projections in last year's assessment.
- The assessment author has no new proposals to bring forward at present. However, consistent with SSC policy, he reserves the right to bring forward additional models at any time.

BSAI Plan Team minutes (November, 2012)

Non-model comment: "The Team commends the authors for responding to the Team's request for inclusion of specific alternative models in this exploratory assessment."

Bill Clark (November, 2012)

WGC1: "The fishery size comps from the 1980s … are … strange, with more small fish and fewer big fish than the model can predict…. One course of action therefore would be to leave out all of the early years (not just the … survey data) when fitting the model."

SSC minutes (December, 2012)

Non-model comment: "The SSC encourages further model development but had no specific suggestions beyond those identified in plan team discussions and the possibility of obtaining additional age composition data from archived otoliths."

Gulf of Alaska Pacific cod assessment

Please note:

- This section lists only those comments that have arisen since last year's assessment and any previous comments that were not addressed fully in last year's assessment. See last year's SAFE report for other comments.
- Although no proposals were received regarding use of last year's final model as this year's base model, tradition indicates that this will be the case.
- The assessment author has no new proposals to bring forward at present. However, consistent with SSC policy, she reserves the right to bring forward additional models at any time.

Joint Plan Team (September, 2011)

JPT1: "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." (Please note: The BSAI Plan Team has since retracted this criticism (September, 2012), but the GOA Plan Team has not.)

SSC minutes (December, 2011)

(See comment SSC1 under "Bering Sea Pacific cod assessment" above, as this comment pertained to the GOA assessment also.)

SSC5: "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 the biological basis for these patterns."

SSC6: "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)."

Non-model comment: "The SSC is pleased to see that many assessment authors have examined retrospective bias in the assessment and encourages the authors and Plan Teams to determine guidelines for how to best evaluate and present retrospective patterns associated with estimates of biomass and recruitment. We recommend that all assessment authors (Tier 3 and higher) bring retrospective analyses forward in next year's assessments."

Joint Plan Team minutes (May, 2012)

JPT2: "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."

JPT3: "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."

GOA Plan Team minutes (September, 2012)

Non-model comment: "The Teams recommend that authors conduct a retrospective analysis back 10 years (thus, back to 2002 for the 2012 assessments), and show the patterns for spawning biomass (both the time series of estimates and the time series of proportional changes relative to the 2012 run). This is consistent with a December 2011 NPFMC SSC request for stock assessment authors to conduct a retrospective analysis. The base model used for the retrospective analysis should be the author's recommended model, even if it differs from the accepted model from the previous year."

Non-model comment: "The Teams recommend that authors continue to include other removals in an appendix for 2012. Authors may apply those removals in estimating ABC and OFL; however, if this is done, results based on the approach used in the previous assessment much also be presented."

GOA Plan Team minutes (November, 2012)

GPT1: "The Team suggested that the spatial aspect of available length-at-age data be evaluated, particularly between years for the older/larger Pacific cod since in some years most of the apparent 'lack-of-fit' arose from the larger fish samples."

GPT2: "The Team suggested considering a model that had the features of Model 4 but with fixed growth (e.g., at Model 2 values), then look at constant selectivity for main survey data."

GPT3: "Examination of the possibility of using cubic splines over age, smoother shape and fewer parameters (in general) was recommended."

GPT4: "The Team suggested that the stock synthesis feature to turn off age zeros whenever sub-27 age data were included should be activated."

Non-model comment: "Retrospective patterns should be evaluated as an additional diagnostic for alternative models (e.g., Model 4 may show an improved retrospective pattern)."

Non-model comment: "For communication purposes, when stock sizes change for the same year from one assessment to the next, it would be useful to evaluate the changes graphically (e.g., biomass at age for last year's model with the accepted model this year)."

Non-model comment: "Since the fishery is comprised of many components, the Team suggested using a general exploitation matrix such as 1-SPR for F implied over time."

SSC minutes (December, 2012)

SSC7: "The Plan Team noted, and the SSC concurs, that Model 4 had much better fits to other data components and encourages the authors to further explore a model that omits or down-weights the mean-length at age data for the 27cm-plus group."

SSC8: "The Plan Team recommended, and the SSC concurs, to consider down-weighting rather than omitting the mean size-at-age data to more appropriately reflect the effective sample sizes associated with the data."

SSC9: "We encourage the authors to carefully evaluate the impact of the chosen form for selectivity curves on model results and to examine how changes in selectivity interact with the treatment of growth and inclusion of mean size-at-age data."

SSC10: “The SSC encourages the author to develop a model with length-based survey selectivity to take advantage of available length data from all survey years.”

SSC11: “While there are legitimate concerns about the high variability of the sub-27 group, omitting the data may not be consistent with using the best available information. However, using time varying catchability with an index that primarily reflects variability due to incoming year classes is clearly not appropriate.”

SSC12: “To improve fits to the size data, the author may also want to consider using the Richards growth curve to parameterize growth as in Model 4 in the EBS Pcod assessment.”

Non-model comment: “It would also be informative to explore how the exclusion of the size-at-age data in models 3 & 4 interacts with other features of the model to result in these apparently inflated biomass estimates.”

2 Full text of relevant Team (November, 2012) and SSC (December, 2012) minutes

BSAI Plan Team minutes (November, 2012)

BS/AI Pacific cod

Grant Thompson presented the assessment. Following suggestions from Team/SSC meetings in May/June and September/October, he had fitted four models. The base model, used for making specifications in 2011 and designated Model 1, had the following features, many of long standing:

- M = 0.34
- Length-specific commercial selectivities for all fisheries, some forced to be asymptotic, estimated for blocks of years (as before).
- Age-specific survey selectivity with 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. The desired value was based on a small number (11) of archival tags.
- A single growth schedule for all years.
- Intercept and slope of age reading bias estimated internally.
- Standard deviation of length at age estimated internally.
- Mean length at age data left out of the fit.
- All length composition data included in fit.

Model 2 was the same as Model 1 but with survey catchability estimated freely. Model 3 was the same as Model 1 except that the age composition data were not used (i.e., left out of the log likelihood). Models 2 and 3 had been requested by the Team as checks on Model 1, not as candidates for setting specifications.

Model 4 was a simplification of the “author’s preferred model” from 2011. It has many fewer parameters than the other models and it differs from Model 1 in many ways, among them:

- Improved modeling of weight at length.
- Initial numbers estimated at 10 ages rather than 3.
- The full Richards growth equation used rather than the von Bertalanffy.
- Survey selectivity estimated as a function of length rather than age.
- Fisheries defined (and selectivities estimated) for each of five seasons with gears combined.
- Age composition sample size multipliers tuned iteratively to make the standard deviation of the normalized residuals equal 1.

The fits of the four models were similar in most respects, including selectivity estimates, fit to age and size compositions, agreement with survey length frequency modes, agreement with survey abundance data, and (except for Model 2) estimates of present abundance. The dissimilarities were:

- Model 2 estimates survey catchability (freely) at about 1 and therefore estimates present abundance to be much less than the other models, where catchability is fixed at 0.77. Model 2 also fits the survey abundance data much better, with RMSE=0.16 compared with around 1 for the other models.
- Model 3 fits the age composition data poorly. (It doesn’t try.)
- Model 4 fits the survey size composition data much better than the others, an indication that length-based survey selectivity (rather than age-based) is appropriate.

Grant reported jitter tests in which a (presumably) global minimum was first located by an exhaustive procedure of perturbing the minimizing parameter vector at a succession of local minima until no further improvement was possible. The final parameter vector was then perturbed and the model refitted to see how often each model fit could relocate the global minimum. All of the models performed more or less poorly, relocating the global minimum only around half the time. On the other hand, all of them except Model 2 produced a present biomass estimate very close to the correct number in almost every trial. The Team had some discussion of the relevance of jitter tests to model selection and eventually concluded that they were not relevant, so long as the author followed a procedure akin to Grant's for locating the global minimum.

The Team recommends that jitter tests continue to be conducted, but statistics related to jitter tests do not need to be reported in future assessments.

Grant stated that he wanted to do more work on Model 4 before proposing its use for setting ABC and OFL. The Team agreed to that, so Model 1 was left as the sole candidate and a solid performer in most ways but not in retrospective performance. In retrospective runs, successive estimates of abundance in a given year have been steadily revised downward as each new year of data is added. At the extreme, the estimate of 2008 spawning biomass from a fit to data through 2007 was 70% higher than the estimate of 2008 spawning biomass from a fit to data through 2012. The Team had a brief discussion of the implications of poor retrospective performance for setting ABC and OFL. Clearly the retrospective differences add to the uncertainty of the biomass estimates, but for the time being we continue to believe that the best estimate of present abundance is the one from the most recent assessment. (The Joint Teams have appointed a retrospective working group that is examining the retrospective behavior of all groundfish assessments.)

Having accepted Model 1, the Team had a lengthy discussion of whether the ABC/OFL recommendation should be lower than the standard Tier 3a value. The main issue was the survey catchability coefficient and whether it was prudent to discount the high catchability (and low biomass) estimated by Model 2. The low fixed value in the other models is based on data on the vertical distribution of 11 fish obtained from archival tags, which suggests that they were above the survey trawl headrope a good deal of the time. However other studies suggest that cod (and other species) tend to dive to the bottom when a trawl approaches. Bob Lauth reported (as he had in September) that comparative tows made with the low-opening Bering Sea survey trawl and the high-opening GOA survey trawl appeared to catch about the same quantity of cod. (A full report will be available next year.) He also related that the echo sounder showed few fish in midwater during the comparative tows when cod were plentiful on the bottom, and that midwater trawling during acoustic surveys for pollock in the summer encountered few cod. On the other hand, he reported that at least one exploratory tow in shallow water, inshore of the survey area, had brought up a very large catch of cod, so it may be true that in summer a sizable proportion of the stock is near shore and unavailable to the survey. In the end the Team decided to continue to rely on the lower fixed survey catchability both for fitting the model and setting ABC. The Team therefore agreed with the authors' recommended ABC/OFL.

The Team commends the authors for responding to every single Team request, of which (as is customary for Pacific cod) there were a large number during the past year.

GOA Plan Team minutes (November, 2012)

Pollock

<u>Assessment CIE</u>

Assessment authors will continue to improve on methods following CIE review recommendations. This year the author implemented recommendations which could be quickly accomplished without major changes to the model structure (e.g., the age range of the assessment was expanded to ages 1-10 from 2-10). Future assessments will explore CIE recommendations that require methodological development and substantial analysis (e.g., including predation mortality in the assessment). The Team briefly discussed a CIE review comment that the assessment be risk neutral. This comment is relevant to all stock assessments, and led to the specific question of "at what biomass is there no longer a need for the author's recommended ABC lower than the maximum permissible ABC?" The author will examine this issue, but noted that given recent positive trends in the spawning stock biomass this appears to be less of a concern than past years.

Pacific cod

Teresa Amar presented the assessment of GOA Pacific cod. As in past years she refined models based on detailed discussion and presentations given at the September 2012 meeting. At the September meeting the Team requested analysis where q is fixed at 1.0 rather than tuning to a specific size range (there was little difference between these model runs and the extra work required seemed unjustified). They also requested models which dropped the heavily influential growth data components and the "sub-27cm" survey data. The Team discussed that the statistical weights from these likelihood components may be too high given the input sample size for the length-at-age data from NMFS surveys. It may be more appropriate to use the number of hauls instead of the raw numbers of fish. The Team suggested that the spatial aspect of available length-at-age data be evaluated, particular between years for the older/larger Pacific cod since in some years most of the apparent 'lack-of-fit' arose from the larger fish samples.

The Team suggested considering a model that had the features of Model 4 but with fixed growth (e.g., at Model 2 values), then look at constant selectivity for main survey data. Also examination of the possibility of using cubic splines over age, smoother shape and fewer parameters (in general) was recommended. Retrospective patterns should be evaluated as an additional diagnostic for alternative models (e.g., Model 4 may show an improved retrospective pattern. For communication purposes, when stock sizes change for the same year from one assessment to the next, it would be useful to evaluate the changes graphically (e.g., biomass at age for last year's model with the accepted model this year). Since the fishery is comprised of many components, the Team suggested using a general exploitation matrix such as 1-SPR for F implied over time. This provides an indication of the effective exploitation rate relative to the reproductive potential of recruits entering the population.

The quota allocations between GOA regions are provided following two methods: a new approach (Kalman filter) vs status quo (weighted survey average). The Plan Team recommended going forward with the Kalman filter approach since the survey averaging work-group notes that this method is robust. The Team suggested that the stock synthesis feature to turn off age zeros whenever sub-27 age data were included should be activated.

Northern rockfish

Chris Lunsford provided a summary of the northern rockfish executive summary for lead author Pete Hulson. This assessment was updated with catch data in 2012 for projecting 2013 and 2014 ABC. The Team noted that in general for all stocks where a projection is employed, the catch projection for the current year should be the current ABC or the current technique for estimating in year catches whichever is less. The Team approved the recommended ABCs and OFLs for 2013 and 2014.

SSC minutes (December, 2012)

General SAFE Comments

The SSC reviewed the SAFE chapters and 2011 OFLs with respect to status determinations for BSAI and GOA groundfish. The SSC accepts the status determination therein, which indicated that, with the exception of BSAI Octopus, no stocks were subject to overfishing in 2011. Also, in reviewing the status of stocks with reliable biomass reference points (all Tier 3 and above stocks and rex sole), the SSC concurs that these stocks are not overfished or approaching an overfished condition.

The SSC recommends that the authors consider whether it is possible to estimate *M* with at least two significant digits in all future stock assessments to increase validity of the estimated OFL. The SSC encourages assessment authors of stocks managed in Tier 5 to consider the recommendations found in the draft survey averaging workgroup report.

Bering Sea assessment

Public testimony was provided by Dave Fraser on behalf of Adak Development Corporation. He reiterated their long-standing support for an area split for Pacific cod, but questioned model assumptions with respect to survey catchability in the Aleutians. Based on his fishing experience there are times (particularly under low-density conditions) when a low-opening net is most efficient, while at other times, a high-opening trawl is more efficient to target off-bottom concentrations. He recommended that the effectiveness of the survey trawl in the Aleutians under different conditions be closely examined.

Following review of the preliminary assessment by the Plan Team in September and SSC in October, four models were selected for this year's final assessment. Model 1 is last year's accepted model, updated with new information (catch data, fishery and survey size compositions, survey abundances, survey age compositions, and fishery CPUE data); Model 2 is identical to model 1 but estimates the survey catchability coefficient as a free parameter; Model 3 is identical to model 1, but does not include age composition data in the likelihood function; Model 4 is an exploratory model that incorporates a number of author-suggested changes.

The authors, as always, have been very responsive to Plan Team and SSC recommendations and the models brought forward in the final assessment were selected based on Plan Team and SSC recommendations. There was insufficient time to consider some other recommended modifications such as time varying survey catchability (SSC, Oct-12) or selectivity parameters estimated by time block, gear, and season (Plan Team, Sep-12). A retrospective analysis was included as requested by the Plan Team and SSC and 'other' removals were included in an appendix but not incorporated in the assessment.

The authors and Plan Team recommend Model 1, which is last year's accepted model. The SSC concurs with the choice of Model 1 for stock status determinations in 2013 in spite of a good fit for Model 4, which incorporates some desirable features but has not been fully vetted. The data and models suggest a relatively high and increasing biomass in recent years, putting the stock in Tier 3a. The SSC agrees with the current expansion of the biomass estimated for the EBS to the BSAI area based on the updated Kalman filter estimates for biomass distribution between the two areas (93% EBS and 7% AI). In spite of concerns over the status of the stock in the Aleutians as noted below, the SSC agrees with the Plan Team that there is no compelling reason to reduce the ABC from the maximum permissible value under Tier 3a as summarized below in metric tons. The SSC supports the following ABCs and OFLs for 2013 and 2014 (in metric tons):

The SSC re-iterates continuing concerns over the best value for the catchability coefficient, which by long-standing practice is either tuned to experimental results or fixed at a previously tuned value to keep it close to the experimental results (currently fixed at 0.77 in Model 1). Based on exploratory models estimating q, catchability may be much higher. The SSC expects to receive a report prior to next year's assessment about a comparison of the standard EBS trawl with a high-opening trawl conducted during the 2012 field season. Very preliminary results suggest that catchability is higher than the currently used value because catch rates in both trawls were not substantially different.

A second concern is the strong retrospective pattern that suggests consistent over-estimation of biomass in the most-recent year, relative to the current assessment. The SSC would like to see a similar analysis of retrospective patterns for a model with an alternative estimate for q (internally estimated or updated value from field experiment) in next year's assessment.

In combination, the above concerns suggest the possibility that biomass may be substantially lower than the current model suggests. However, biomass has increased in recent years in large part to above-average year classes in 2006, 2008, and 2010 and the possibility of another strong year class in 2011 (based on limited 2012 survey data).

The results for Model 4 suggest that several of the new features represent an improvement over the current base model and the SSC recommends bringing forward a similar model next year that retains at least some of these promising features such as the Richards growth curve, newly parameterized seasonal changes in weight-at-length, selectivity modeled as a function of length, and estimating log-scale standard deviations for recruitment internally rather than fixing them. The appropriate treatment of selectivity remains to be determined but the simplifications introduced in Model 4 (i.e. combining gear types), in combination with the other changes, appears to provide a very reasonable fit to the age composition data and other data components.

Aleutian Islands assessment

The author continued to explore an age-structured model for the Aleutian Islands but did not bring forward a full assessment. Model 1 for the AI is similar to Model 1 for EBS Pacific cod, except that it assumes a single season and fishery per year, does not include age data, and the catchability coefficient is tuned to a higher value (because of the difference in survey net configurations between the two areas, Nichol et al. 2007). Model 2 is similar to Model 1, except that it allows temporal variability in two of the growth parameters. Model 3 is identical to Model 1, except that all input sample sizes for length composition data are multiplied by 1/3 in response to a Plan Team request to use a smaller average sample size. Model 4 differs from Model 1 in that it: 1) excludes US-Japanese joint survey data from before 1990 because of concerns over their reliability, 2) allows survey catchability to vary randomly among surveys, 3) forces selectivity to be asymptotic for the survey but not for the fishery, 4) estimates input sample sizes for length composition data iteratively, 5) allows several selectivity parameters to vary randomly, and 6) estimates the standard deviation for log-recruitment internally.

All models except Model 4 overestimate survey abundances substantially and result in relatively poor fits to the fishery size composition data, particularly in early years when sample sizes were low. All of the models achieved a reasonable fit to the survey size composition data. Recruitment deviations differed considerably for Model 4 and, as the authors noted, the recruitment deviations are very different from those in the eastern Bering Sea and Gulf of Alaska models, while recruitment in the latter two regions is highly synchronous. It is unclear whether that reflects a true difference in recruitment dynamics or suggests a problem with the exploratory AI assessment models.

A number of issues and data gaps were identified by the author that may need to be resolved before the present model can be adopted for stock status determinations for AI Pacific cod. In particular, the authors question whether the data to support an age-structured assessment for AI Pacific cod are adequate given large survey CVs and small sample sizes for length composition data. The SSC encourages further model development but had no specific suggestions beyond those identified in plan team discussions and the possibility of obtaining additional age composition data from archived otoliths.

While these models are still exploratory, the range of models examined appears to provide strong evidence for a substantial decline in biomass in the Aleutian Islands since the early 1990s. This decline, unlike in the Eastern Bering Sea, has continued in recent years and is consistent with observed declines in fishery CPUE in the AI for both longline and trawl fisheries (Fig. 2.3b of the assessment). The model estimates of maxABC ranged from 2,990 to 8,690 for the four exploratory models fit to the AI data and were substantially below the actual catches taken in recent years (29,000 t in 2010, 10,862 t in 2011, and 12,991 t through Nov 3). Therefore the current approach of setting a single ABC for the entire BSAI area raises potentially serious conservation concerns for Pacific cod in the AI. As noted in the SAFE introduction, the SSC has put the Council on notice for some time that it expects to adopt an area-specific ABC and OFL for the Aleutians. Given the heightened conservation concern, the SSC intends to set separate ABC/OFL for EBS Pacific cod and AI Pacific cod for the 2014 fishing season based on the best available information at that time, regardless of whether the age-structured model is adequate for stock status determinations. Therefore, the Council should initiate preparation of any background supporting documents such as a supplemental NEPA document that may be required for specification of separate ABCs/OFLs in 2014.

GOA assessment

Public testimony was provided by Julie Bonney (Alaska Groundfish Data Bank) expressing concerns about the significant drop in ABC/OFL due to model changes and about implementing a change in area apportionments prior to adopting the new Kalman filter approach across stocks.

For this assessment cycle the 2011 model (with and without "tail compression") was updated with new data, including catch for 2011, preliminary catch for 2012, catch-at-length for 2011, seasonal and gearspecific catch for 1991-2012, and age composition and mean size-at-age for the 2011 NMFS bottom trawl survey data. In addition, five new models (Models 1-5) were explored to examine the effects of different combinations of the survey '27 cm – plus' and 'sub-27 cm' length groups on model fit. The sub-27 survey data are highly variable and there is considerable uncertainty in the catchability and selectivity of sub-27 cm fish in the trawl survey. In addition, variants of three of the models fixed catchability at 1.04 (2011 value) instead of 1.00.

The SSC agrees with the author's and Plan Team recommendation to use Model 2 for the purposes of specification. This model excludes all of the sub-27cm data, yet estimated a length at age-1 that was more consistent with the observed value than estimates from other models. The biomass estimates were similar to other model configurations. The plan team noted, and the SSC concurs, that Model 4 had much better fits to other data components and encourages the authors to further explore a model that omits or down-weights the mean-length at age data for the 27cm-plus group.

The Pacific cod stock in the Gulf of Alaska has benefitted from relatively strong recruitment from 2005 to 2009, hence stock abundance is expected to be stable or increase in the short term. The projected spawning stock biomass based on Model 2 is 110,000 t in 2013, which is well above the B40% reference point of 93,900 t and puts the stock in Tier 3a. The SSC agrees with the Plan Team that there is no reason to reduce the ABC from maximum permissible and the standard control rule results in the OFL and ABC estimates for the total GOA shown in the table below.

The Plan Team discussed two options for area apportionments using either the established approach or a new Kalman filter approach that has been recommended by a recent working group on the issue. The SSC agrees with using the recommended new approach, resulting in apportionments of 35% in the Western GOA, 61% in the Central GOA, and 4% in the Eastern GOA and the ABC splits shown below (in metric tons):

With respect to further development of the model, the SSC has the following concerns and recommendations:

- Omitting mean size-at-age data for the 27+ group (Models 3 & 4) had a large effect on biomass estimates (estimating substantially higher biomass levels in the 1980s) and a strong impact on model fits. The Plan Team recommended, and the SSC concurs, to consider down-weighting rather than omitting the mean size-at-age data to more appropriately reflect the effective sample sizes associated with the data. It would also be informative to explore how the exclusion of the size-at-age data in models 3 & 4 interacts with other features of the model to result in these apparently inflated biomass estimates.
- The estimated fishery selectivities-at-length are extremely peaked for most fisheries and the resulting low selectivities for larger size classes imply high abundances of “cryptic” large Pacific cod. While similar patterns are seen in the EBS and Aleutians there is continuing large uncertainty about how to appropriately parameterize selectivity. We encourage the authors to carefully evaluate the impact of the chosen form for selectivity curves on model results and to examine how changes in selectivity interact with the treatment of growth and inclusion of mean size-at-age data.
- Of particular concern is the time varying pattern of dome-shaped selectivity with age in the survey based on very little data prior to the 1990s (Fig. 2.11). It is doubtful that age-based selectivity for the early time period can be reliably estimated if only age data from 1990-2011 was used in the model (as indicated in Table 2.7, where data from 1987 were omitted). It was not clear from the documentation if there were any composition data to inform the first time-block of selectivity for the trawl survey. The SSC encourages the author to develop a model with lengthbased survey selectivity to take advantage of available length data from all survey years.
- While there are legitimate concerns about the high variability of the sub-27 group, omitting the data may not be consistent with using the best available information. However, using time varying catchability with an index that primarily reflects variability due to incoming year classes is clearly not appropriate.
- To improve fits to the size data, the author may also want to consider using the Richards growth curve to parameterize growth as in Model 4 in the EBS Pcod assessment.

3 Models analyzed in the 2012 Bering Sea Pacific cod assessment

Models analyzed in the preliminary assessment

Four primary models (1-4 below) and three secondary models (1.1-1.3 below) were requested by the Plan Team and SSC for inclusion in the preliminary 2012 assessment. A fifth primary model and six more secondary models were added by the assessment author. A brief description of each model is shown below:

Model	Description
1	Last year's accepted model (same as last year's Model 3b)
1.1	Same as Model 1, except survey catchability estimated internally
1.2	Same as Model 1, except ageing bias parameters fixed at GOA values
1.3	Same as Model 1, except with revised weight-length representation
2	Same as Model 1, except survey catchability re-tuned to match Nichol et al. (2007)
3	Same as Model 1, except new fishery selectivity period beginning in 2008
4	Same as Model 1, except no age data used (same as last year's Model 4)
Pre5.1	Same as Model 1.3, except for three minor changes to the data file
Pre5.2	Same as Model Pre5.1, except ages 1-10 in the initial vector estimated individually
Pre5.3	Same as Model Pre5.2, except Richards growth curve used
Pre5.4	Same as Model Pre5.3, except σ for recruitment *dev*s estimated internally as a free parameter
Pre5.5	Same as Model Pre5.4, except survey selectivity modeled as a function of length
Pre5.6	Same as Model Pre5.5, except fisheries defined by season only (not season-and-gear)
5	Same as Model Pre5.6, except four quantities estimated iteratively

The purpose of including Models Pre5.1-Pre5.6 was to provide a reasonably smooth transition between Model 1.3 and Model 5. The main differences between primary and secondary models were: 1) full results were presented for primary models, but only a small subset of results were presented for secondary models, and 2) some of the secondary models (specifically, Models Pre5.1-Pre5.6) were subjected to less rigorous tests for convergence than the other models.

Models analyzed in the preliminary assessment

Following review in September and October, four of the models from the preliminary 2012 assessment were requested by the Plan Teams or SSC to be included in the final 2012 assessment:

Model 1 was identical to the model accepted for use by the BSAI Plan Team and SSC last year, except for inclusion of new data.

Model 2 was identical to Model 1, except that the survey catchability coefficient was estimated as a free parameter.

Model 3 was also identical to Model 1, except that ageing bias was not estimated internally and the fit to the age composition data was not included in the log-likelihood function.

Model 4 was an exploratory model that differed from Model 1 in several respects:

1. A new, inter- and intra-annually varying weight-length representation developed in the preliminary assessment was used.

2. "Tail compression" was turned off. This feature aggregates size composition bins with few or zero data on a record-by-record basis, which improves computational speed, but which also makes some of the graphs in the R4SS package difficult to interpret. In Models 1-3, tail compression was turned on.
3. Fishery CPUE data were omitted. In Models 1-3, fishery CPUE data were included for purposes of comparison, but are not used in estimation.
4. A new population length bin was added for fish in the 0-0.5 cm range, which was used for extrapolating the length-at age curve below the first reference age. In Models 1-3, the lower bound of the first population length bin is 0.5 cm.
5. Mean-size-at-age data were eliminated. In Models 1-3, mean-size-at-age data are included, but not used in estimation.
6. The number of estimated year class strengths in the initial numbers-at-age vector was set at 10. In Models 1-3, only 3 elements of the initial numbers-at-age vector were estimated, which causes an automatic warning in SS.
7. The Richards growth equation (Richards 1959, Schnute 1981, Schnute and Richards 1990) was used, which adds one more parameter. In Models 1-3, the von Bertalanffy equation—a special case of the Richards equation—was used.
8. The log-scale standard deviation of recruitment was estimated internally (i.e., as a free parameter estimated by ADMB). In Models 1-3, this parameter was held constant at the value of 0.57 that was estimated in the final 2009 assessment by matching the standard deviation of the recruitment *dev*s, per Plan Team request.
9. Survey selectivity was modeled as a function of length. In Models 1-3, survey selectivity was modeled as a function of age.
10. Fisheries were defined with respect to each of the five seasons, but not with respect to gear. In Models 1-3, fisheries were defined with respect to both season and gear.
11. Fishery selectivity curves were defined for each of the five seasons, but were not stratified by gear type. In Models 1-3, seasons 1-2 and 4-5 were lumped into a pair of "super" seasons for the purpose of defining fishery selectivity curves, and fishery selectivities were also *gear*-specific (3 super-seasons × 3 gears = 9 selectivity curves).
12. The selectivity curve for the fishery that came closest to being asymptotic on its own (in this case, the season 3 fishery) was forced to be asymptotic by fixing both *width_of_peak_region* and *final_selectivity* at a value of 10.0 and *descending_width* at a value of 0.0. In Models 1-3, six of the nine super-season × gear fisheries were forced to exhibit asymptotic selectivity.
13. Survey catchability was tuned iteratively to set the average of the product of catchability and survey selectivity across the 60-81 cm range equal to 0.47, corresponding to the Nichol et al. (2007) estimate. In Models 1-3, *Q* was left at the value of 0.77 estimated by a similar procedure in the final 2009 assessment, per Plan Team request.
14. The age composition sample size multiplier was tuned iteratively to set the mean of the ratio of effective sample size to input sample size equal to 1.0. In Models 1-3, the variance adjustment was fixed at 1.0.
15. The two parameters governing the ascending limb of the survey selectivity schedule were given annual additive *dev*s with each σ_{dev} tuned to match the estimate that would be appropriate for a univariate linear-normal model with random effects integrated out. In Models 1-3, no *dev* vector corresponding to the *initial_selectivity* parameter was used, because it was "tuned out" in the 2009 final assessment; and σ_{dev} for the *ascending_width* parameter was left at the value of 0.07 estimated iteratively in the final 2009 assessment, per Plan Team request.

4 Models analyzed in the 2012 Aleutian Islands Pacific cod assessment

Models analyzed in the preliminary assessment

Two models (labeled Model 1 and Model 2) were presented in the preliminary 2012 assessment, both based largely on the 2011 final model for Pacific cod in the EBS. The natural mortality rate was fixed at 0.34 in both models, borrowing the accepted value in the EBS.

In both models, weight (kg) at length (cm) was assumed to follow the usual form weight=$\alpha \times$length$^{\beta}$ and to be constant across the time series, with α and β estimated at 5.68×10^{-6} and 3.18, respectively, based on 8,126 samples collected between 1974 and 2011.

In both models, length bins (1 cm each) were extended out to 150 cm instead of the limit of 120 cm that is used in the EBS assessment, because of the higher proportion of large fish observed in the AI.

In addition to differences in the data between the AI and EBS, Model 1 differed from the 2011 final EBS model in the following respects:

- Each year consisted of a single season instead of five.
- A single fishery was defined (with forced asymptotic selectivity) instead of nine season-and-gear-specific fisheries (with forced asymptotic selectivity for six of them).
- Fishery selectivity was constant over time instead of variable in multiple time blocks.
- The survey was assumed to sample age 1 fish at true age 1.5 instead of 1.41667.
- Ageing bias was not estimated (no age data) instead of estimated.
- Survey catchability *Q* was tuned to match the value of 0.92 estimated by Nichol et al. (2007) for the AI survey net instead of the value of 0.47 estimated for the EBS survey net.

Model 2 was chosen from a set of seven candidate models, all of which were identical to Model 1 except that they each allowed at least one of the three length-at-age parameters (length at age 1, *L1*; asymptotic length, *Linf*; and Brody's growth coefficient, *K*) to vary annually from 1977-2010, using multiplicative *dev*s with σ = 0.1. The candidate models were structured as follows:

Model	*L1 dev*s	*Linf dev*s	*K dev*s
A	yes	yes	yes
B	yes	yes	no
C	yes	no	yes
D	no	yes	yes
E	yes	no	no
F	no	yes	no
G	no	no	yes

The candidate model with the lowest AIC value was chosen as Model 2.

Models analyzed in the final assessment

Four models were presented in the final 2012 assessment, three of which were based largely on last year's accepted model for Pacific cod in the EBS.

Models 1 and 2 were identical to Models 1 and 2 from the preliminary assessment, with one exception: An additional year of catch data (1976) was included in the data file for Model 2. This change was necessitated when it was discovered that SS was estimating $B_{100\%}$ from the length-at-age parameters corresponding to the first year in the catch data, which would normally be 1977. However, it turned out that 1977 had one of the largest estimated growth *dev*s in the time series. The available options were either to turn off the growth *dev*s for 1977 or to add another year to the start of the time series. Given that 1977 appeared to exhibit one of the most non-typical growth patterns in the time series, the latter option seemed preferable.

Model 3 was the same as Model 1, except that all input sample sizes for length composition data were multiplied by 1/3, in response to a request from the BSAI Groundfish Plan Team.

Model 4 differed from Model 1 in several respects:

1. Survey data from the pre-1991 years (i.e., the years of the U.S.-Japan cooperative survey) were removed from the data file.
2. Survey catchability was allowed to vary randomly around a base value (estimated iteratively, using the same approach as the other three models), with the input standard deviation estimated iteratively by matching the standard deviation of the estimated *dev*s.
3. Survey selectivity was forced to be asymptotic.
4. Fishery selectivity was not forced to be asymptotic.
5. Input sample sizes for length composition data were estimated iteratively by setting the root-mean-squared-standardized-residual of the survey abundance time series equal to unity.
6. All fishery selectivity parameters except *initial_selectivity* and the *ascending_width* survey selectivity were allowed (initially) to vary randomly, with the input standard deviations estimated iteratively by matching the respective standard deviations of the estimated *dev*s.
7. The input standard deviation for log-scale recruitment *dev*s was estimated internally (i.e., as a free parameter).

5 Models analyzed in the 2012 GOA Pacific cod stock assessment

Models analyzed in the preliminary assessment

Model	Description
1	The base model: Model 3 from the 2011 stock assessment
1Q	Model 1 tuned iteratively so that the mean catchability for the 27plus survey is 0.916
A	Model 1 with tail compression turned off
AQ	Model A tuned iteratively so that the mean catchability for the 27plus survey is 0.916
B	Model A with changes to the sub27 survey: changed from 12 to 2 periods for catchability, changed from 1 to 2 periods for selectivity, initial values for some devs changed to 0.0
BQ	Model B tuned iteratively so that the mean catchability for the 27plus survey is 0.916
C	Model B with the initial value for the pre-1977 R0 dev (SR_R1_offset) changed from -0.391537 to 0.0 and the upper bound changed from 0.0 to 5.0
CQ	Model C tuned iteratively so that the mean catchability for the 27plus survey is 0.916
D	Model C with changes to the 27plus survey: changed from 11 to 2 periods for selectivity
E	Model A with q for the 27plus survey estimated (requested by the Plan Team)
1B	Model B with the tail compression value set to the same value as in Model 1 (turned on)
1C	Model C with the tail compression value set to the same value as in Model 1 (turned on)

Models analyzed in the final assessment

Model	Description
2011 model	Model 3 from the 2011 stock assessment with 2012 data
2011 model no tc	Model 3 from the 2011 stock assessment with 2012 data and tail compression turned off
1	q set to 1.0, 2 periods of catchability and selectivity for the sub27 survey, tc off
1Q	Model 1 with q set to 1.04 (the value used in 2011)
2	q set to 1.0, all sub27 survey data is omitted, tc off
2Q	Model 2 with q set to 1.04 (the value used in 2011)
3	q set to 1.0, 2 periods of catchability and selectivity for the sub27 survey, all sub27 and 27plus survey mean length-at-age omitted, tc off
3Q	Model 3 with q set to 1.04 (the value used in 2011)
4	Model 2 with the 27plus mean length-at-age data omitted
5	Model 1 with the sub27 mean length-at-age data omitted

Several additional models were run with weights on the 27plus mean length-at-age data ranging from 0.1 to 0.5; Models 2 and 5 had the value of this weight of 1.0, and Models 3 and 4 had the value of this weight of 0.0.

6 Comparing Pacific cod catches from survey bottom trawl with a low and a high vertical opening

Robert Lauth and Cynthia Yeung

Introduction

A field experiment was conducted from 17-18 June 2012 aboard the AFSC chartered fishing vessels *Aldebaran* (vessel code=89) and *Alaska Knight* (vessel code=162) comparing catch rates of Pacific cod between the low-opening (~2.5 m) eastern Bering Sea (EBS) shelf standard 83-112 Eastern survey trawl and the high-opening (~7 m) Gulf of Alaska (GOA) standard Poly Nor'eastern survey trawl (Stauffer 2004). Nichol et al. (2007) used archival tag data from Pacific cod to investigate distance off bottom and determined that about 47% of Pacific cod are available to the low-opening EBS 83-112 Eastern survey trawl and that 92% are available to the high-opening GOA Poly Nor'eastern survey trawl. The BSAI assessment model uses the point estimate 0.47 (Thompson and Lauth 2012) and the GOA assessment model uses the point estimate 0.92 (A'Mar et al. 2012) from Nichol et al. (2007) to constrain the product of catchability and selectivity for the 60-81 cm size range of Pacific cod. The objective of the gear comparison experiment was to test the validity of the 0.47 and 0.92 point estimates by determining if there was a difference in catch rates of Pacific cod in the 60-81 cm size range between the low- and high-opening survey trawls used in standard Alaska Fisheries Science Center (AFSC) bottom trawl surveys in the EBS and GOA.

Seventeen side-by-side trawl tows were successfully completed in the vicinity of the EBS shelf survey stations L-07 and L-09 (Fig. 1). The location was chosen during the first leg of the annual EBS shelf survey in an area where there was a relatively high density of Pacific cod over a large area (Fig. 2). The experiment was conducted with the AFSC chartered survey vessels one week after survey sampling was completed in the area. Samples aboard the *Aldebaran* were taken using the standard 83-112 Eastern survey trawl net and samples aboard the *Alaska Knight* were taken using the standard Poly Nor'eastern survey trawl net. Trawl tows were 30 minutes in duration and vessels maintained a minimum distance of 0.1 nm during each tow. Average bottom depths for the comparison tows ranged from 25 to 38 m, and average bottom temperatures from 3.4°C to 5.9°C. Pacific cod were sorted from each trawl catch sample and weighed in aggregate. In trawl catches with ≤ 400 Pacific cod, fork length measurements were taken on all specimens to the nearest centimeter, and in trawl catches with >400 specimens, fork length measurements were taken on a representative sample of about 400 Pacific cod. Mean catch per unit effort (CPUE) values for each haul and gear type were calculated by dividing the catch weight or number by the trawl area swept, which was calculated by multiplying the horizontal distance the trawl was towed by the mean horizontal trawl spread during the time period when the trawl first touched bottom until it lifted off the bottom.

Figure 1. -- Red dots show area where side-by-side comparison tows were made to compare catch rates between the two different trawls.

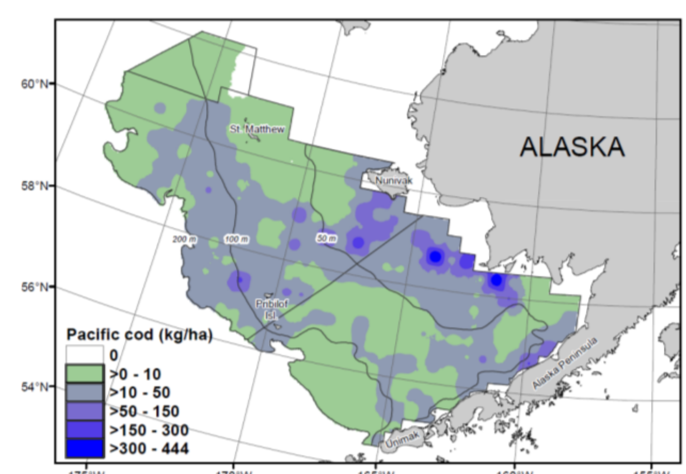


Figure 2. -- Spatial distribution and abundance (kg/ha) of **Pacific cod** (*Gadus macrocephalus*) for the 2012 eastern Bering Sea shelf bottom trawl survey.

CONCLUSIONS

- Cannot reject H_0: Total cpue of pcod 60-81 cm length class EBS trawl = GOA trawl
- Cannot reject H_0: No difference in mean CPUE of pcod 60-81 cm between nets (normal distribution or non-parametric)
- Cannot reject H_0: Equal variance/median in cpue of pcod 60-81 cm between nets = 1 (normal distribution or non-parametric)
- Proportional catch of 60-81 cm pcod EBS trawl/GOA trawl > 1 – EBS trawl catches more 60-81 cm pcod than GOA trawl
- Proportional catch of 60-81 cm pcod is different - EBS trawl/GOA trawl can be 1.27±0.18 x, ~ 9-45% more
- Almost no chance with this sampling distribution that EBS trawl catches any less or 0.5 x less than GOA trawl
- Catch of 60-81 cm pcod, at best EBS trawl = GOA trawl, at worse EBS trawl ~1.25x > GOA trawl

ANALYSIS

TOTAL CPUE (number per km^2) PCOD length class 60-81 cm

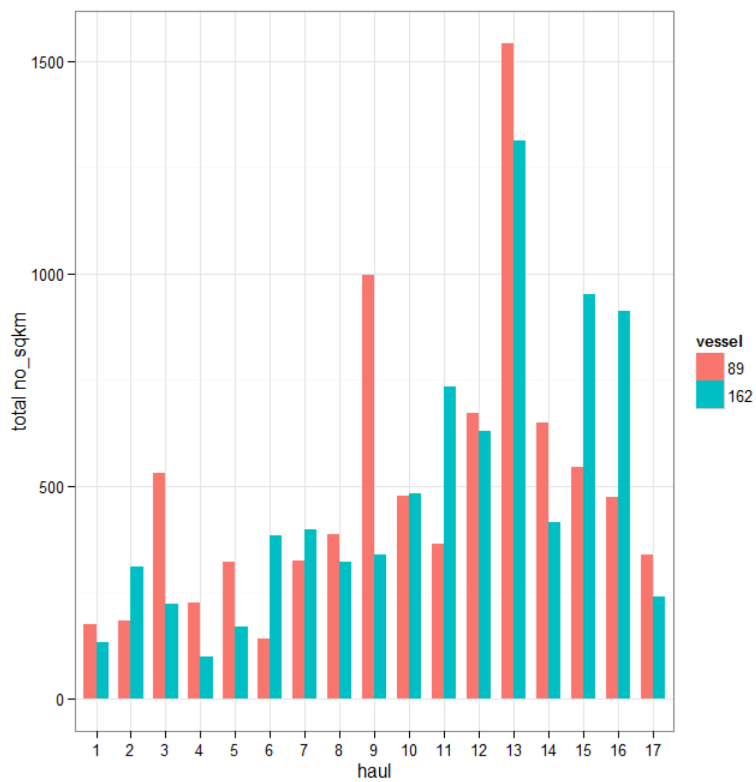


Figure 1. Comparison of paired trawl haul CPUE (no/km^2) for Pcod within the 60-81 cm size class (vessel 89 = EBS trawl, vessel 162 = GOA trawl).

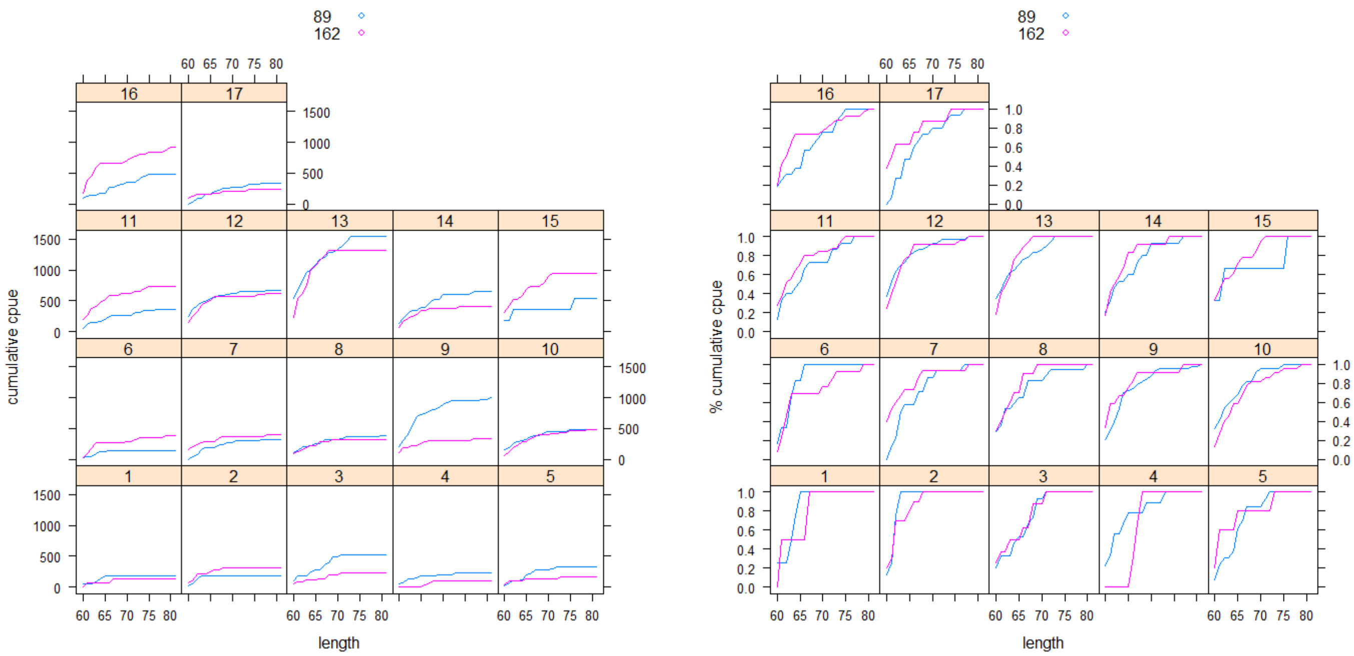


Figure 4. Comparison of length selection (within 60-81 cm, 5 cm bin intervals) of pcod between paired hauls (vessel 89 = EBS trawl, vessel 162 = GOA trawl).

H_0: Total cpue of pcod 60-81 cm length class, EBS = GOA (i.e. Pr(EBS > GOA) = 0.5) √
Two-tailed probability of exact binomial p-value = 0.3036 – cannot reject H_0.

H_1: Ratio of catchability of EBS:GOA is 0.47:0.92, or catch proportion is ~0.5
Compare only retained population; true population availability and avoidance unknown; trawl selectivity unknown.
Catch of cod >81 cm ~ 0; few >70 cm

Define: Total cpues in the 60-81 cm length group are different between nets if GOA > EBS by ±10% (89 = EBS and 162 = GOA).

Total cpue: 60-81 cm length class

	haul.no																
vessel	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
EBS	174	183	529	224	320	141	325	385	996	478	362	671	1541	648	545	475	339
GOA	130	310	223	97	168	382	398	321	337	483	732	628	1311	414	952	912	240
%diff	-25	70	-58	-57	-48	171	23	-17	-66	1	102	-6	-15	-36	75	92	-29

Difference range between -66% to +171%

15/17 hauls with difference of ±10%

H_0: Total cpue of EBS > GOA (-ve difference) in s = 9 of n = 15 paired hauls (haul#1,3,4,5,8,9,13,14,17) √

Two-tailed probability of exact binomial p-value = 0.3036 – cannot reject H_0.
Sample estimate: Pr(EBS > GOA) = 0.6
or
H_0: Total cpue of EBS > GOA in s = 10 of n = 17 paired hauls (haul#1,3,4,5,8,9,12,13,14,17) √
Two-tailed probability of exact binomial p-value = 0.3145 – cannot reject H_0.
Sample estimate: Pr(EBS > GOA) = 0.58

For n = 17 and a chosen significance level of α = 0.05, the threshold for rejecting H_0 is s ≤ 3 or s ≥13.

Descriptive Statistics, total pcod 60-81 cm cpue

vessel	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
EBS	17	490	346	385	444	237	141	1541	1400	1.65	2.44	84
GOA	17	473	333	382	442	235	97	1311	1214	1.03	0.07	81

H_0: Total cpue difference in means between nets = 0 (assume normal distribution) √
Paired t-test t = 0.257, df = 16, p-value = 0.8 – cannot reject H_0.
95% confidence interval -127, 162
Sample estimates: mean of the differences 17.5

H_0: Ratio of variance in cpue between nets = 1 (equal variance; assume normal distribution) √
F-test F = 1.083, num df = 16, denom df = 16, p-value = 0.8753 - cannot reject H_0
95% confidence interval: 0.39, 2.99
sample estimates: ratio of variances 1.083

H_0: Total cpue, difference in location parameter (median) between nets = 0 (non-parametric t-test)
Wilcoxon signed rank test V = 82, p-value = 0.8176 – cannot reject H_0.

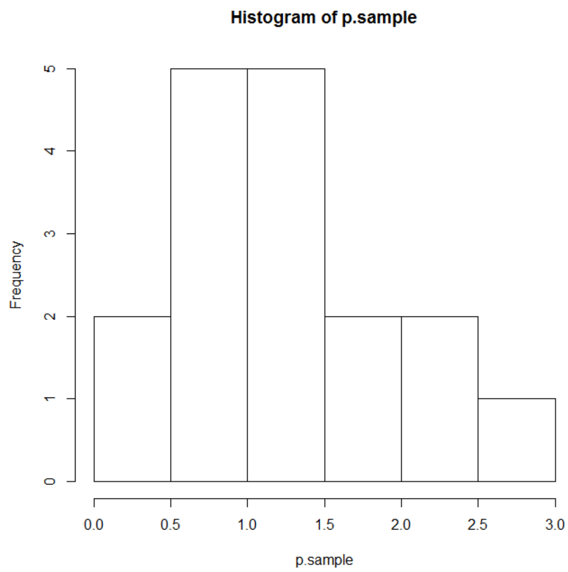
Proportional catch of 60-81 cm pcod, EBS/GOA > 1 – EBS trawl catches more 60-81 cm pcod than GOA trawl

haul.no

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.3	0.59	2.4	2.3	1.9	0.4	0.8	1.2	3	1	0.5	1.07	1.18	1.6	0.6	0.5	1.4

Descriptive statistics, catch proportion EBS/GOA

n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
17	1.27	0.75	1.18	1.22	0.87	0.37	2.96	2.59	0.71	-0.6	0.18



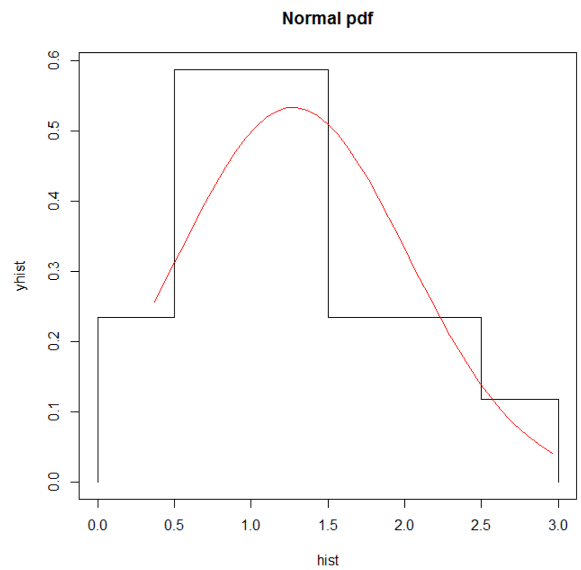


Figure 2 Sampling distribution of the catch proportion (EBS/GOA) of 60-81 cm pcod (left) and a PDF curve fitting for the sampling distribution of catch proportions (right)

Problem: Small sample size (n<40, with <10 failures and <10 success); too? small for χ^2 approximation
normal: mean = 1.27, sd = 0.72
χ^2_{6-2-1} , p = 0.506
df = k bins – p parameters - 1
cannot reject H_0, that sampling distribution is normal

Assume: Normal distribution
mean of sample catch proportions $\bar{x}$ = 1.27
std error of the mean $s_{\bar{x}}$= 0.18
H_0 True population proportion $X = \bar{x}$ √ i.e. EBS > GOA catch in 60-81 cm pcod, EBS/GOA = 1.27, ~ 25% more
H_1 True population proportion $X \leq 1$ (no difference in catch of target length class between nets) X
$Pr(H_1) = 0.07$
H_2 True population proportion $X \leq 0.5$ (EBS catch is ≤0.5 of GOA) X
$Pr(H_2) \approx 0$ i.e. no chance with this sampling distribution that EBS catches less than GOA

Z score 1 sample test of proportions
H_0 True population proportion $X \leq 0.5$ (1-tail)
$\sigma \approx \sqrt{\frac{X(1-X)}{n}}$ = 0.12
$z = \frac{\bar{x}-X}{\sigma}$ = 6.42
Pr(z > 6.42) ≈ 0 => reject H_0