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AFSC Rockfish Assessment Review

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Prepared for the Centre of Independent Experts

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1 Executive Summary

The review workshop for the Alaska rockfish assessment took place in Juneau, Alaska, on April 9-11 2013. In attendance were review panel members Drs Dichmont, Klaer and Kupschus, rockfish stock assessment authors and other scientists involved in the stock assessment. The review was undertaken in a very co-operative light with reasonable requests for additional work met, including providing more diagnostic plots and sensitivity tests.

The panel members were presented with a large amount of reading material on a number of key biological rates and how they were derived, the data inputs to the model (especially those related to the survey), additional surveys, genetic stock identity tests and simulations, and the different regional assessments for several of the rockfish species and species assemblages. Given the large volume of information provided, the panel was directed to certain highlighted documents, which narrowed the species scope to Pacific Ocean Perch (POP) and the "Other rockfish" (OR) assemblage, and much of the review discussions and this report concentrates on these. The information provided correlated well with the review Terms of Reference, which is appreciated.

In future, it is recommended that reviews concentrate on a small number of species or issues, as the large volume of documents and issues that needed to be addressed diluted this review. It was difficult in the time provided to make extensive comments on any one specific topic[1].

Although the documentation was comprehensive, some additions are recommended:

a) providing an overview of the fishery, the data, assessment types, spatial allocation, and stock structure across the whole rockfish component;
b) undertaking more comprehensive sensitivity tests as a norm, and
c) providing more diagnostic tests as part of the SAFE documentation.

The BSAI (see Appendix 5 for commonly used acronyms) region is characterised as being data rich by world standards with regular surveys and good biological information – however these surveys often focus on species other than rockfish, which are a bycatch in several fisheries.

The BSAI rockfish component uses a range of different assessment methods to estimate biomass (Table 1 and Table 2). POP and OR are used as an example of a Tier 3 and 5 assessments respectively.

The science is of a very high standard with most aspects of the data, biology and models well thought out and analysed. The previous CIE review recommendations were generally implemented or were underway.

For both the Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) region, the POP assessment is age-based, using data from various sources including survey age and length, fishery age and catch, and a survey relative index of abundance. It is well set up using a high standard and is the best approach to assessing this stock.

In most cases, rockfish is not the focus of either the fishery (it is a bycatch species) or the survey design. This means that key catch rate and survey index data is more difficult to interpret than would be case for target fisheries and a survey directly designed for these species. There is evidence that rockfish distribution is clumped or over-dispersed. This means that standard stratified random survey analysis techniques would more likely be inappropriate. Numerous analytical survey analysis methods apply in this case, for example methods aimed at zero inflated data such as the two-stage

[1] Comments in bold are key recommendations

delta method. Furthermore, linking the survey results with the environmental (including habitat) spatial modelling would be highly recommended.

The likelihood function in the POP models assume that catch is known without error, however there is some evidence that this is unlikely to be true for the early periods of the data. This uncertainty is in both the total catch and in the species composition. Sensitivity tests were undertaken in which a high and low total catch series were tested – this work should be taken further.

One aspect of research that is still underway is the catchability of the trawl survey and how longline survey data could add to the assessment. Although this data is more limited, this work should continue to explore the usefulness of these surveys as indices of rockfish population.

Of some concern are the consistent age residual patterns – especially for the age plus group – of the BSAI POP assessment. These should be further investigated, including whether growth should be estimated within the model.

Tests with regard to the age and length plus group were appropriately undertaken and resolved. As shown, extending length bins was less important given the growth rate of rockfish.

In the BSAI POP assessment, the selectivity parameter deviations over time are more complex than what is indicated by the data and estimates. Methods of simplifying this component of the model include allowing only the age-at-50% selected parameter to change over time, and using a spline to further reduce the number of parameters.

The GOA POP model assumed dome-shaped selectivity for the more recent years. There is good evidence for choosing this selectivity function over the more traditional logistic selectivity. In general, the method that selectivity is changed over time blocks is appropriate. It may be a good sensitivity test to use a gamma-logistic function for the recent time block.

Work that enables a species/complex to move from a Tier 5 to 4 is recommended wherever possible. However, survey index data seems to be an issue for the GOA OR species – the index is highly variable inter-annually considering the biology of the species and most have high CVs. The present method for setting the OFL and ABCs for the GOA OR is not robust and is likely to be more reactive to variance than actual changes in biomass. Research should therefore concentrate on analysing the survey specifically for these species, such as methods for zero inflated data or linking with habitat information.

An improved method to model biomass of the Tier 5 species or assemblages such as a Kalman filter and random walk models were investigated and this work should continue. However, in the GOA OR case modelling the complex together rather than as separate species may be more appropriate given the mean-variance behaviour of the data where low indices have very low CVs and would therefore always be over-emphasised in these analyses. A test within the workshop showed that this approach had merit.

As more information becomes available on species and they move to higher Tiers, the species that remain in the Tier 5 complex become more difficult to model. An alternative approach would be to use a combination of modelling methods with data poor risk assessment (e.g. PSA). Hierarchical models should also be investigated for the complexes in terms of species, for example Punt et al. (2011) or for spatial allocations (Zhou et al., 2009). The former kind of hierarchical model can draw from data rich species with better-known biology and data to extrapolate to data poor species of similar type.

The research on stock structure and its justification is a model for assessments elsewhere in the world. Genetic research that shows that rockfish move relatively small distances in a generation (i.e. isolation-by-distance) is an important finding. Although there is some contrasting information (e.g. depletion studies), the precautionary approach of managing rockfish in reasonably small areas is supported. However, given the complexity of the data, it is appropriate that the Tier 3 assessments are at broader spatial scales with a separate process of further dividing the OFL or ABC (whichever is appropriate). However, the method of allocating the ABC spatially is different between species and Tiers and clear justification for this difference should provided.

Simulation studies that were undertaken to investigate the risk of managing at the incorrect spatial scale relative to the stock boundaries were extremely insightful and valuable. Some of the assumptions in the model were aimed at targeted species, and modifying this procedure to apply to bycatch species such as rockfish would be very valuable and is recommended.

An important initiative of undertaking ecosystem work on habitat mapping and oceanographic conditions (e.g. currents, sediments, topography, and temperature) should continue as it has direct links to the survey index analysis and assessments.

Table 1: Number of species/complexes by Tier against method to obtain biomass and obtaining the area proportion for the BSAI (Source: Paul Hanselman, Jim Ianelli and Thompson presentation during review).

Method for obtaining biomass	Tier					
Biomass estimation method	1	2	3	4	5	6
Number of stocks	3	0	11	0	7	3
NA	3		10			3
average			1		3	
weighted average					1	
Kalman filter			1		1	
most recent					2	

Method for obtaining proportion	Tier					
Proportion estimation method	1	2	3	4	5	6
Number of stocks	3	0	12	0	6	3
NA	3		8		6	3
weighted average			3			
average			1			

Table 2: Number of species/complexes by Tier against method to obtain biomass and obtaining the area proportion for the GOA (Source: Paul Hanselman, Jim Ianelli and Thompson presentation during review).

Method for obtaining biomass	Tier					
Biomass estimation method	1	2	3	4	5	6
Number of stocks	0	0	9	2	11	5
NA			9			5
average				1	7	
most recent				1	3	
mature biomass from assessment model					1	

Method for obtaining proportion	Tier					
Proportion estimation method	1	2	3	4	5	6
Number of stocks	0	0	9	2	11	5
NA				1	3	4
average			2		2	
weighted average			4	1	3	
most recent			3		3	
Proportion of historical catch						1

2 Background

Rockfish in the BSAI and GOA regions are a bycatch of several fisheries, including the trawl and longline fisheries. They consist of two genera, being *Sebastes* and *Sebastolobus* that are ovoviviparous or oviparous. Their early life history is planktonic of variable duration, followed by a pelagic juvenile phase. Adults tend to move deeper with age. Despite this early life history, they seem to be characterised by genetic stock structure with limited dispersal, which flows into a need for spatial management.

Rockfish are caught as bycatch in fisheries targeting several other species using different gear types. Catch shares are not universally allocated within POP and BSAI regions – these occur in Central GOA and most of BSAI. For each species or assemblage, there are some differences to the spatial allocation of the OFL and ABC.

The rockfish assessments consist of a range of assessment types depending on the amount and quality of the data, and the biological knowledge about the species concerned. These range from age-structured assessments to non age-structured assessments on individual species or assemblages (Table 1 and Table 2).

The rockfish harvest control rules fall into the Tier 3, 4 and 5 categories (depending on species/assemblage) of the NPFMC Tier system. The review team concentrated on the POP assessment (Tier 3) and the OR assessment (Tier 5). The Tier 3 control rule is characterised by being able to estimate B, $B_{40\%}$, $F_{35\%}$, $F_{40\%}$, Tier 4 by B, $F_{35\%}$, and $F_{40\%}$ and Tier 5 has an estimate of B and M.

3 Description of the Individual Reviewer's Role in the Review Activities

The review workshop for the Alaska rockfish assessment took place in Juneau Alaska on April 9-11 2013. In attendance were review panel members Drs Dichmont, Klaer and Kupschus, rockfish stock assessment authors and other scientists involved in the stock assessment. The ASFC Office provided the documents on a website for the Review (Appendix 1). The Statement of Work provided to the review panel is provided in Appendix 2. Membership of the review team, the chair and attendees are provided in Appendix 3.

Given the volume of documents provided, the review team were provided with a highlighted shortlist (bold in Appendix 1), concentrating on POP and OR, and other documents directly related to the Terms of References (ToR). During the workshop several additional information and sensitivity tests were requested (Appendix 4). These were provided during the workshop and were of great value to the discussion. The assessment team's contribution to the review team during the workshop was greatly appreciated. The assessment code, input and output files were not provided before the review so tests were not undertaken in that regard. These were provided at the end of the review and therefore were not reviewed or discussed.

The summary review panel document was written on the last day of the review and is a summary of the key points of the discussion and findings during the workshop. This should be read in conjunction with the individual CIE members' reports, as more detail is only possible in these individual documents.

The Terms of Reference (ToR) were:

a) Evaluation of data used in the assessments, specifically trawl and longline survey abundance estimates, and recommendations for processing data before use as assessment inputs.
b) Evaluation of analytical methods used in assessments, particularly in regard to selectivity, selection of age and length bin structures, data weighting assumptions, and assumptions and modelling of trawl and longline catchability.
c) Evaluation, findings, and recommendations on the analytic approach used for "data-poor" rockfish stocks and complexes, including the use of an age-structured model for a two-species complex, and application of state-space production models to stocks and stock complexes.
d) Evaluation, findings, and recommendations on the adequacy of current levels of spatial management, including apportionment strategy.
e) Recommendations for further improvements

Dr Jim Ianelli of AFSC (Seattle), on behalf of the CIE review team, chaired the meeting, but the summary review was the view of the CIE panel members.

Several very insightful presentations were provided during the review. These were well directed towards providing background and input to the ToR. The agenda for the review is provided in Appendix 3.

A summary of findings against each Term of Reference is listed below.

3.1 ToR a: Evaluation of data used in the assessments, specifically trawl and longline survey abundance estimates, and recommendations for processing data before use as assessment inputs.

A summary of the data (below) used or presented for the Tier 3 POP and Tier 5 OR assessments by area is provided. These data highlight that there is a long catch, ageing (in the case of the Tier 3 assessments) and survey data series in both the BSAI and GOA areas. The Tier 3 assessments rely heavily on this data and care should be taken to not discontinue this data, particularly the trawl surveys.

The catch series data in the early history, particularly from the foreign fleets, are likely to be considerably more uncertain than their treatment within the assessments indicates. The early catch records were often recorded in species complexes that had to be separated using observer data. Given these reconstructions and the foreign fleet data, it is unclear whether early catch values by species are higher or lower, and as such, more effort should be directed towards investigating these early catches. Methods such as bootstrapping the uncertainty in the age composition and level of discards, as well as running simple high-low sensitivity tests in the assessments, would be appropriate.

Although greater observer coverage could be obtained for the 60-120 foot vessels and coverage for the <60 foot fleet, there is still an overall high observer coverage for rockfish in the areas, especially BSAI. This is an essential source of a variety of data types – including ageing, species composition – that should be maintained or expanded in GOA. Rockfish are a bycatch species and not generally targeted, thus resulting in reasonably high discard rates (Figure 1).

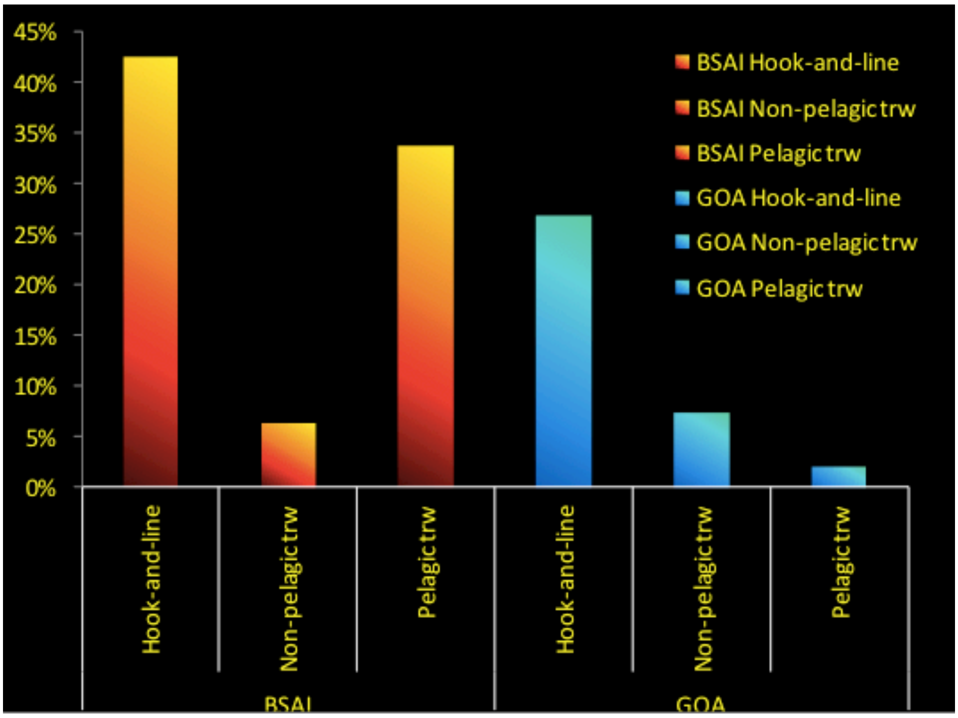

Figure 1: Discard rates by gear (2008-2012) for all rockfish (Source: Presentation by Hanselman during review).

The surveys in GOA and BSAI used in the Tier 3, 4 and 5 rockfish assessments use trawl gear, which mean that they apply mostly to species that are within the trawlable grounds or are found as a consistent proportion over time on these grounds. However for many of the rockfish species, especially the OR assemblage, the surveys are less reliable as the GOA and BSAI surveys are designed for the more valuable and higher biomass species. Indications of the difficulty with respect to the survey data for OR species are that for many of the species there is a mean-variance relationship in GOA, and also high sub-area variability in both GOA (Figure 2) and BSAI (Figure 3). There is therefore evidence that the distribution of some rockfish species are clumped or over-dispersed. The survey data may also be zero inflated, although time did not permit this to be tested during the review. **In these cases, standard statistical survey analyses usually are not appropriate and statistical methods using more appropriate distributions that model habitat in combination with species biomass from the survey data would be much more appropriate. A two-stage delta procedure or another zero-inflated method would also be useful, especially for better survey precision. This work should concentrate on GOA OR complex, but would be useful for most of the rockfish species.**

Adding additional surveys (e.g. longline surveys) especially on untrawlable grounds are of great value and further work in this area is recommended. Combined with the ecosystem work on topographic and sediment mapping, and linking these with oceanography (e.g. currents, temperature) would be extremely useful in the (habitat) mapping of these species (for risk assessments, survey analysis and stock assessments). These may also be able to provide indications of whether the species' distributions on trawlable and untrawlable grounds, change relative to each other over time. This is an important aspect of the interpretation and, in some cases, the legitimate use of these survey indices.

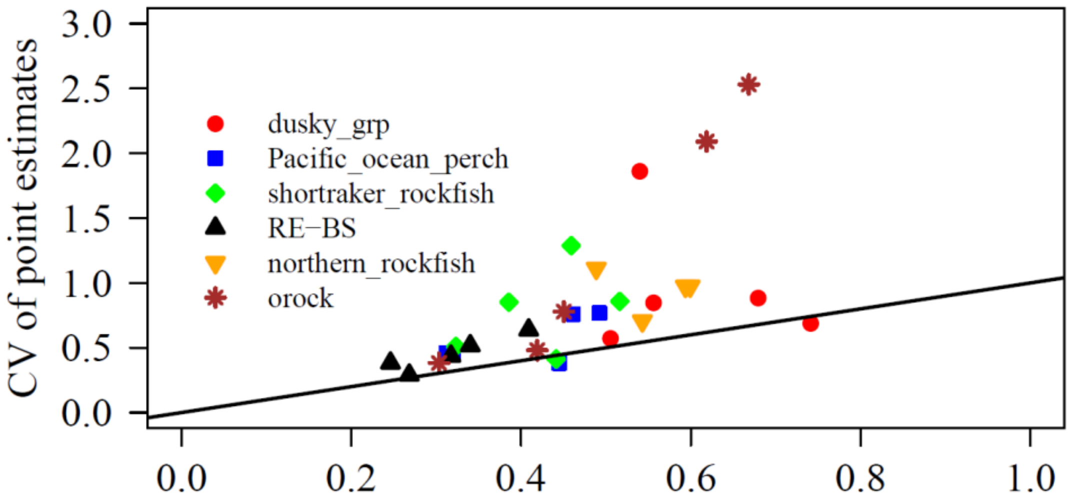

Figure 2: Subarea variability for the main GOA "other rockfish" species (Source: Paul Hanselman, Jim Ianelli and Thompson presentation during review).

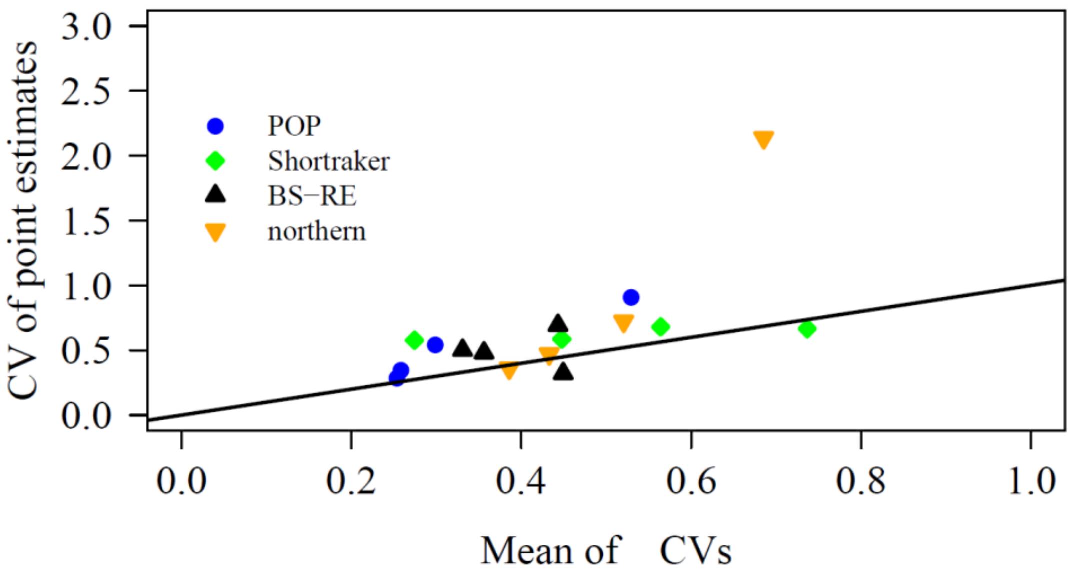

Figure 3: Subarea variability for the main BSAI "other rockfish" species (Source: Paul Hanselman, Jim Ianelli and Thompson presentation during review).

The BSAI trawl surveys changed from 30-minute to 15-minute tows in the mid-1990s. There is some indication that this influence may not have been properly adjusted for in the index, as there seems to be a transition in the index over this period. Some further work on the effect of this transition would be useful to provide more confidence in the continuity of the index.

In the longline survey, the effect of gear saturation was discussed. This issue seemed important to pursue further given some preliminary results provided during the review, although work has been undertaken in this regard.

Since there are benefits from moving species from a Tier 5 to, at least, a Tier 4 assessment, further research on ageing fish to obtain maturity and growth parameters should be carried out. This research should concentrate on species where there is the possibility of using appropriate ageing techniques.

The review team stated that thornyheads showed most promise with respect to tagging methods, as they did not have a swim bladder. During the review, tagging data for thornyheads were investigated and showed that most of the initial tags were on larger individuals. Many of these would have been at, or near, their maximum size and many of these individuals that were tagged had shrunk. There would, however, be some value in obtaining tagging data from smaller thornyheads that are well below maximum age. Nevertheless, post workshop, data were provided that showed that smaller thornyheads were also tagged but were not well represented in the recaptures.

3.2 ToR b: Evaluation of analytical methods used in assessments, particularly in regard to selectivity, selection of age and length bin structures, data weighting assumptions, and assumptions and modelling of trawl and longline catchability.

Comments associated with this ToR will concentrate on the Tier 3 POP assessments, but could in most circumstances be extended to the other Tier 3 assessments.

A comparison of the input data, assumptions, input values, data weighting and likelihood formulations across the assessment revealed inconsistencies between the different regional assessments even for the same species. **It is recommended that an outline of these differences and their reasons be provided in future SAFE assessments and reviews. Although many of these seem to be sound, some of the differences appear more related to the fact that different people undertook the assessment. The latter should be more standardised.**

Most of the Tier 3 assessments provided either few or no sensitivity tests, whereas when these were provided during the review (Table 8), the discussion was more complete and informed. **It is recommended that sensitivity tests should be the norm for SAFE reports** - those tests for the GOA and BSAI POP assessments requested by the review panel would be an appropriate starting point for Tier 3 assessment tests. These tests concentrated on key input data, parameters and the likelihood weighting. **The sensitivity tests should include outputs relevant to management advice, such as ABCs or biomass.**

3.2.1 BSAI POP TIER 3 ASSESSMENT

The BSAI POP assessment is a Tier 3 age-based model programmed in *ADMB* (http://admb-project.org/). The data used in this assessment are listed in Table 3. The model is conditioned to catch with the key index of abundance being from trawl surveys indices. Age and length data are also an input to the data and nominal fishery CPUE of a standard set of vessels are provided for the early period. This model is a sound approach and uses the data appropriately.

There is some concern about the trends in the age residuals, especially that the plus group is always underestimated (Figure 4 **and** Figure 5**). The residuals also often show a series over ages of positive or negative residuals. However, generally these residuals are not excessive for a model with several data inputs that contain some contradictory information. Of concern is that the sensitivity tests undertaken during the review (from preliminary analysis) did not correct this residual pattern as seen by the likelihood plots of the sensitivity tests . As a result it is likely that some input parameters need to be estimated within the model. In most age-based assessments, growth is in actual estimated within the model and this appropach is recommended.**

Table 3: Some of the data used in the Tier 3 POP assessments and presented for the Tier 4 and 5 assessments.

Fishery catch from all commercial fleets	1960-2012	2004-2012	1961-2011	1991-2011
Fishery species composition from observers				1992-2011
Fishery age composition (from observer sampling and on-shore processing)	1981-82, 1990, 1998, 2000-2009, 2011	DR: 2002 (small sample of 108 fish) used for growth analyses, No ageing for SST due to lack of method	1990,1998-2002, 2004, 2005, 2006, 2008, 2010	
Fishery length composition (from observer sampling and onshore processing)	1964-72, 1983-1984, 1987-1989, 1991-1997, 1999, 2010	2002-2012 (DR, SST	1963-1977, 1991-1997	
Fishery (nominal) CPUE	1968-79			
Survey age composition	1980, 83, 86, 91, 94, 97, 2000, 2002, 2004, 2006,2010	1997, 2000, 2002, 2004, 2006, 2010,2012 (DR); 91, 94, 97, 2000, 2002, 2004, 2006, 2010,2012 (SST)	1984, 1987, 1990, 1993, 1996, 1999, 2003, 2005, 2007, 2009	1996 (sharpchin, redstripe, harlequin), 1993, 1996,1999, 2005 (silvergray)
Survey length composition	2012			1990, 1993,1996, 1999,2003,2005,2007,2009,2011
Survey biomass estimates	1980, 83, 86, 91, 94, 97, 2000, 2002, 2004, 2006, 2010,2012	1980, 83, 86, 91, 94, 97, 2000, 2002, 2004, 2006, 2010,2012 (for other rockfish including SST; and SST separately); 1997, 2000, 2002, 2004, 2006, 2010, 2012 (for DR). The SST and non-SST values are used for OFL and ABC calculations	1984-1999 (triennial), 2001-2011 (biennial)	1984-1999 (triennial), 2001-2011 (biennial). 1984 and 1987 – different survey design (1984), Japanese-US surveys 2001- did not sample eastern Gulf of Alaska, used average of 3 previous surveys

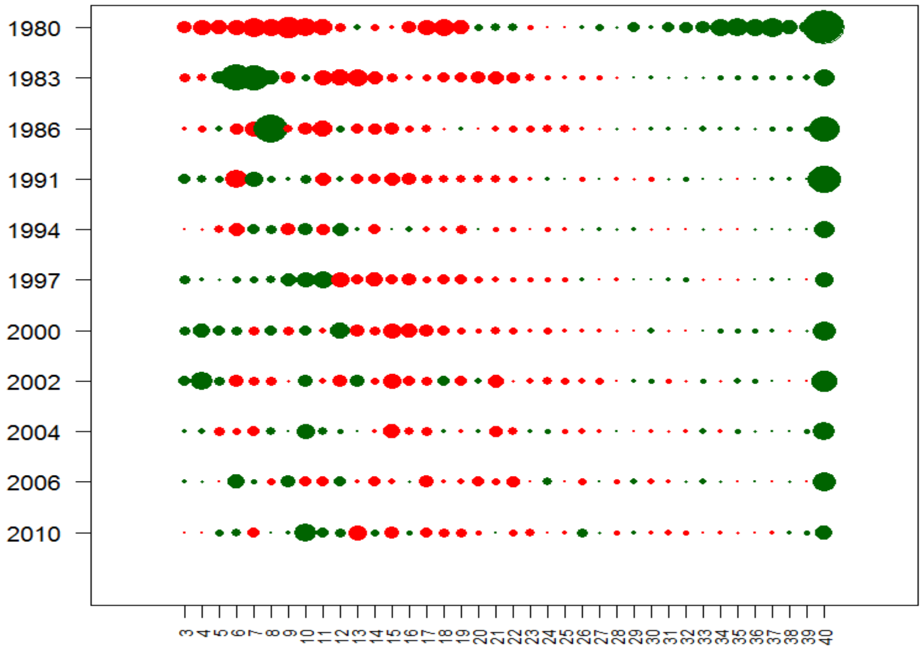

Figure 4: Survey age composition residual plot of the BSAI POP Tier 3 assessment over time and age.

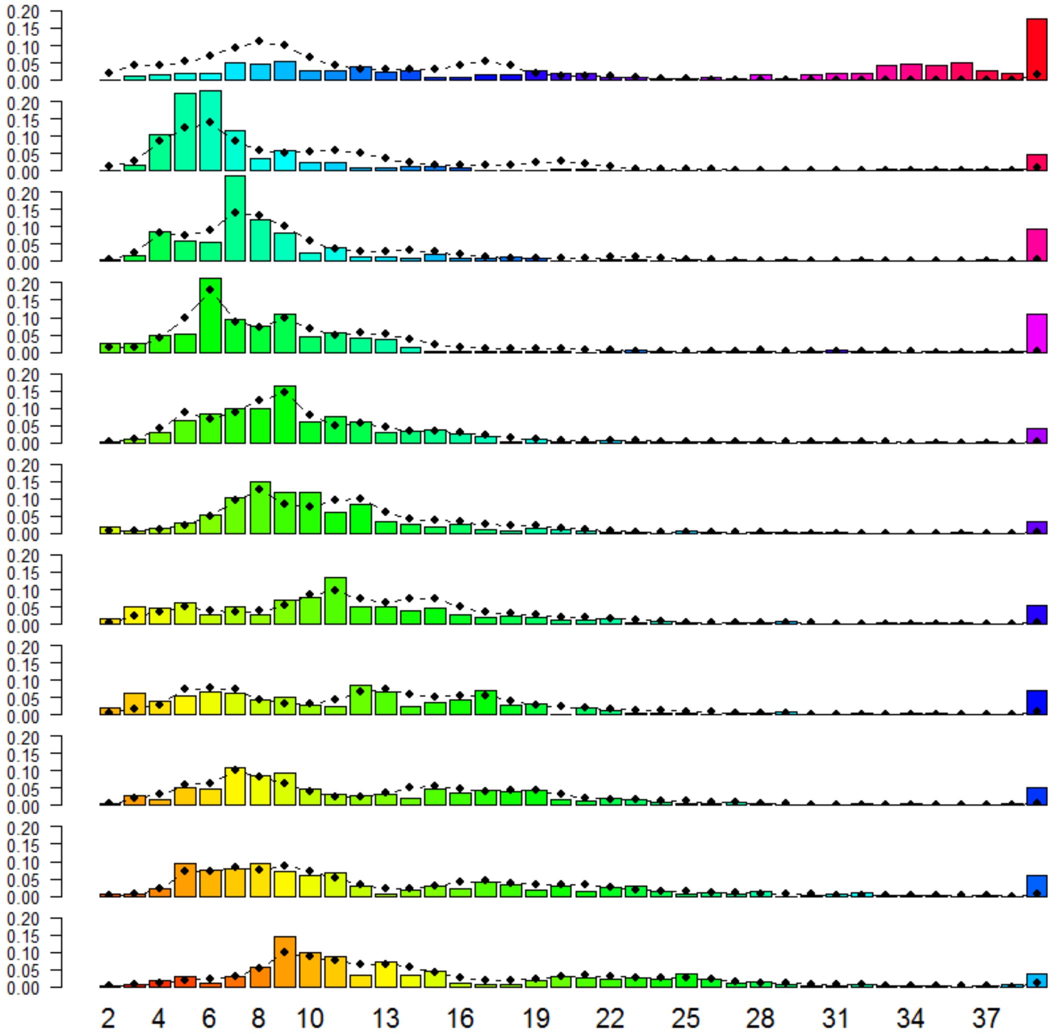

Figure 5: Observed (columns) and predicted BSAI POP assessment survey age composition over years (every 3 years from 1980-2010). Colour bands follow age cohorts.

The survey biomass index residuals are provided in Figure 6. These show that the fit to the survey index is reasonable given the complexity of the model and data types.

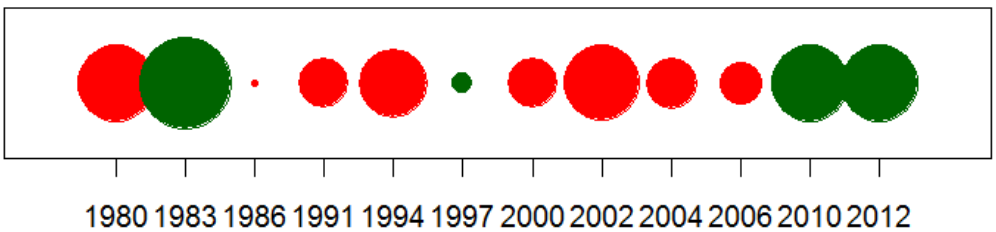

Figure 6: Survey biomass index residuals of the BSAI POP Tier 3 assessment.

The negative log-likelihood values for the different sensitivity tests are provided in Figure 8, key parameters in Figure 8 and management measures in Figure 9. The abbreviations used in these figures are explained in Table 8 in Appendix 4. These tests highlight some of the potential concerns with regard to the assessment assumptions, settings or set-up.

1. The likelihood function assumed that the catch was known exactly since there was no observation error or penalty term included in its formulation. This is unlikely to be the case

given the history of the data. Of particular concern were the early data series – see comments in ToR a. Given the uncertainty is likely to be higher during the early periods, a test of setting the early catches double or half of the present series was included. Another option was to decrease the likelihood weight on the catch in the likelihood term. This showed that the model and management advice is reasonably robust to these tests. **It is recommended that these tests on the early catch data series be further developed.**

2. The Base Case showed that, despite using an informative prior, the posterior M shows a much higher estimated M with the posterior distribution having little overlap with the prior distribution. This indicates the data is tending towards much higher M values than those expected for POP. The tests in this case were to increase the prior variance on M thereby allowing the model to estimate potentially higher M values and a test using a fixed M. For the higher variance test, the M value increased to 0.098 yr^{-1}. As expected in this case, the management measures are affected. **It is therefore recommended that this test should be further developed to understand why these high M values are expected and whether this is a correlation with another parameter. An option of including the estimation of growth within the model may also affect this result.**
3. Sensitivity tests on the likelihood weights – usually regarded as standard in assessments – were also requested. The model was robust to these tests.

All together, the tests show that the model is reasonably robust.

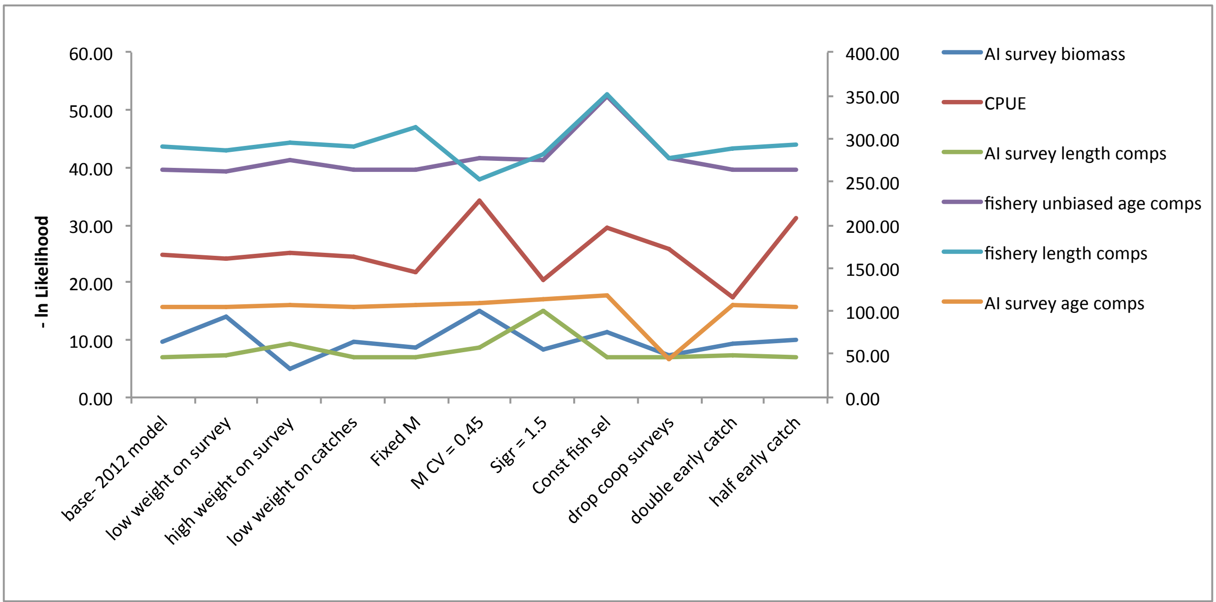

Figure 7: BSAI POP model sensitivity for the different likelihood components. The "AI survey length comps" and the "fishery length comps" negative log-likelihoods are plotted on the second y-axis.

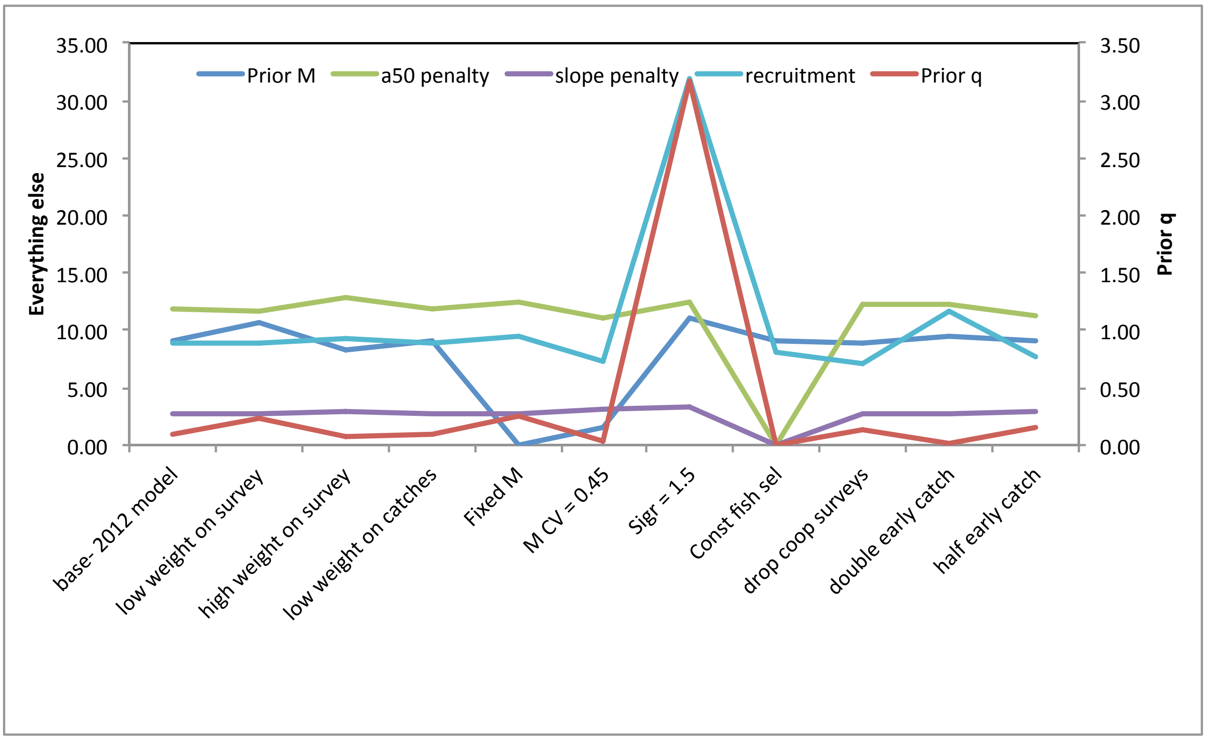

Figure 8: Comparison of output values of sensitivity tests for the BSAI POP Tier 3 assessment undertaken during the review.

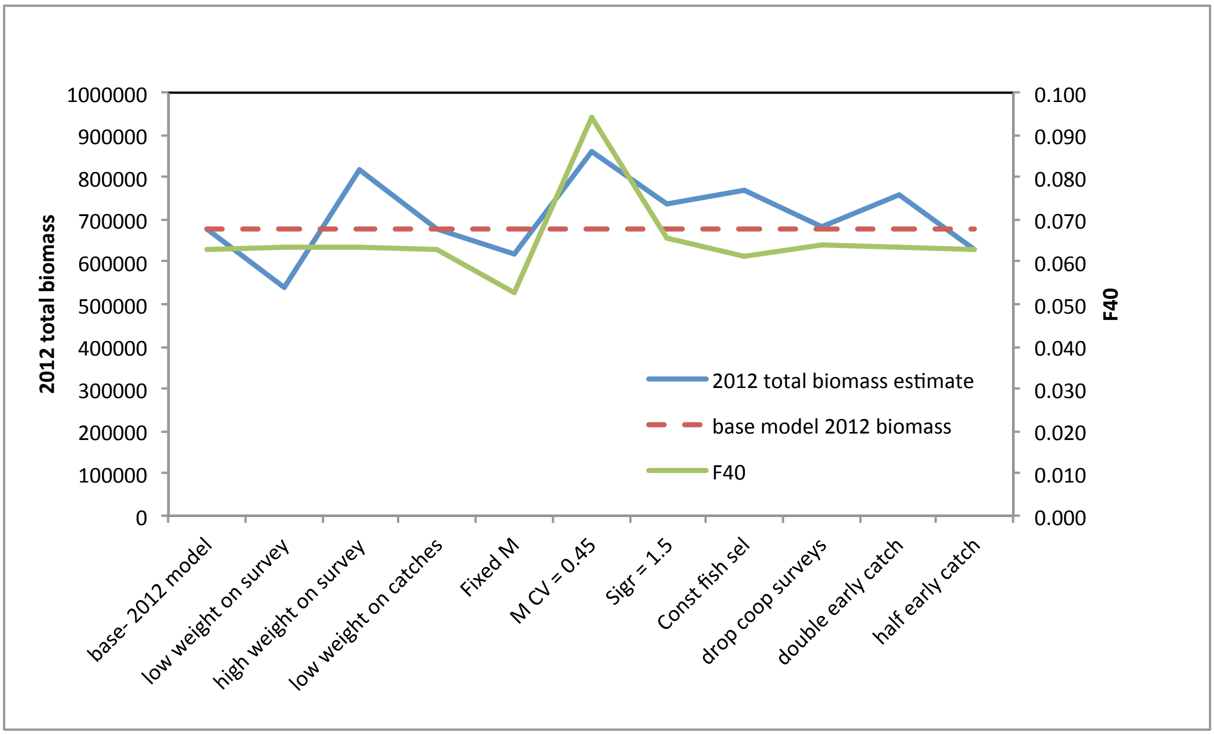

Figure 9: Comparison of the 2012 total biomass and $F_{40\%}$ of sensitivity tests for the BSAI POP Tier 3 assessment undertaken during the review.

3.2.2 GOA POP TIER 3 ASSESSMENT

As per the BSAI POP assessment, the GOA POP assessment is a Tier 3 age-based model programmed in *ADMB* (http://admb-project.org/). The data used in this assessment are listed in Table 3. The model is conditioned to catch with the key index of abundance being from trawl survey indices. In addition are age and length data. This model is a reasonable approach and uses the data appropriately. This model differs to the BSAI POP in that it has 3 distinct fishery age selectivity functions that apply over 3 time blocks – from logistic, logistic-gamma to a gamma function. This change in fishery selectivity is supported by the data. For example, the mean catch-at-age of the fishery has declined whereas that for the survey has increased. Given the evidence provided this selectivity change from previous assessments are supported. However, it is **recommended that a sensitivity test is undertaken to set the final selectivity function as a logistic-gamma function allowing the data to provide the lower selectivity on the older age classes.**

Retrospective analyses provided in a presentation during the review show that many of the changes over succesive assessments are due to the introduction of a new spawner biomass index.

Survey age composition residuals were also provided for the GOA POP Tier 3 assessment (Figure 10) which do not show the consistent underprediction of the plus group residual. These residuals are appropriate for a model of this type with multiple data sources.

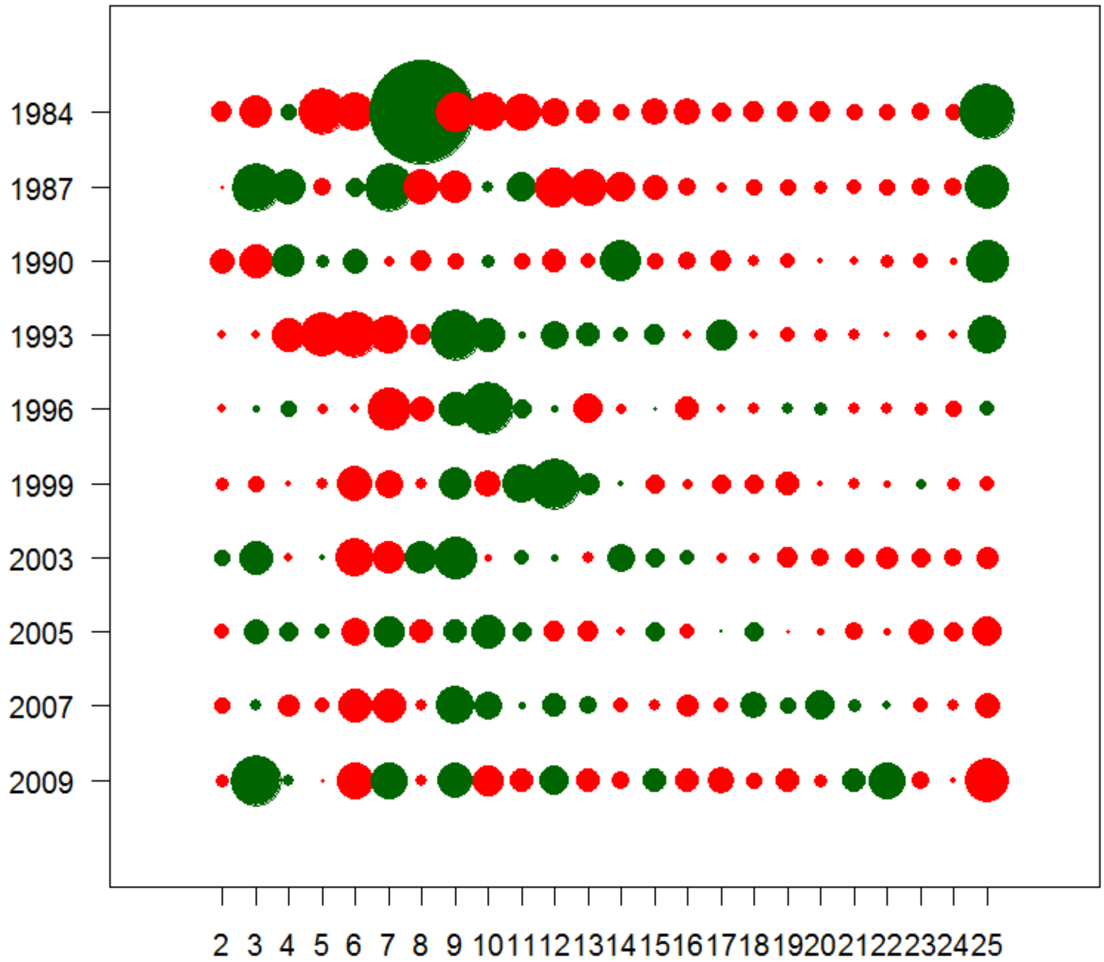

Figure 10: Survey age composition residuals of the GOA POP assessment.

The survey age composition residuals are provided in Figure 11, where generally the model under-predicts the survey index in a reasonably consistent manner, i.e. non-randomly. This issue should be further investigated.

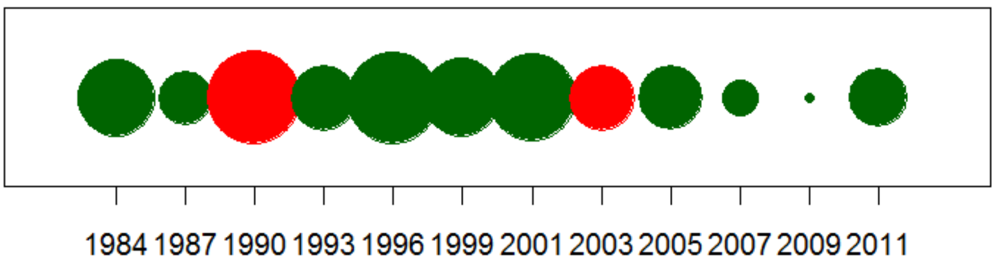

Figure 11: Survey biomass residuals of the GOA POP assessment.

As per the BSAI POP assessment, selectivity tests were undertaken because this was a potential source of concern:

1. Uncertainty in the early catch series: – changing the early catch history does affect the ABC without changing to the likelihoods much. As per BSAI POP, **it is recommended that these tests on the early catch series be further developed.**

2. Difference between prior M and posterior M – in this assessment, this issue is of less concern. Despite this, the ABCs are most sensitive to the test of increasing the M variance as the model estimates a higher posterior M than the Base Case. As expected, these tests provided better fits to the data. **It is recommended that further investigation into the appropriate value for M or POP is carried out. The inclusion of growth as a variable being estimated within the assessment – as per standard age-based assessments – should be investigated.**
3. Likelihood weights – these show that the model output ABCs are generally robust.

Table 4: Likelihoods for the GOA POP Tier 3 sensitivity tests.

	Fish_Age	Fish_Size	SSQ_Catch	SurveyAge	Trawl Abunda
BASE	24.69	55.48	0.11	45.85	7.29
1/5surveybio	24.79	55.39	0.10	45.81	1.73
5*surveybio	24.32	54.99	0.32	48.03	28.78
M=0.05	23.58	51.84	0.04	40.78	6.73
M=100%CV	25.31	50.79	0.03	47.73	8.06
Lowearlycatch	24.62	59.72	0.18	45.40	7.39
Highearlycatch	24.81	54.14	0.12	46.63	7.40
Big-sigr-2	25.06	56.52	0.15	47.39	7.51
1/5Fmortreg	24.78	55.55	0.11	46.16	7.39
5*Fmortreg	25.51	58.59	0.23	44.74	7.04
No8487	24.85	97.84	0.04	23.40	6.52
1/5 catch	24.70	55.23	0.54	45.83	7.22
5*catch	24.69	55.54	0.01	45.86	7.31
1/5*surveyage	24.44	54.97	0.11	10.72	7.01
5*surveyage	25.42	61.57	0.15	189.71	7.35
1/5*fisheryage	5.94	54.02	0.11	45.75	7.52
5*fisheryage	112.38	58.33	0.12	47.89	6.98
1/5*fisherylength	24.50	16.76	0.09	45.01	7.51
5*fisherylength	29.92	238.33	0.37	48.12	7.88

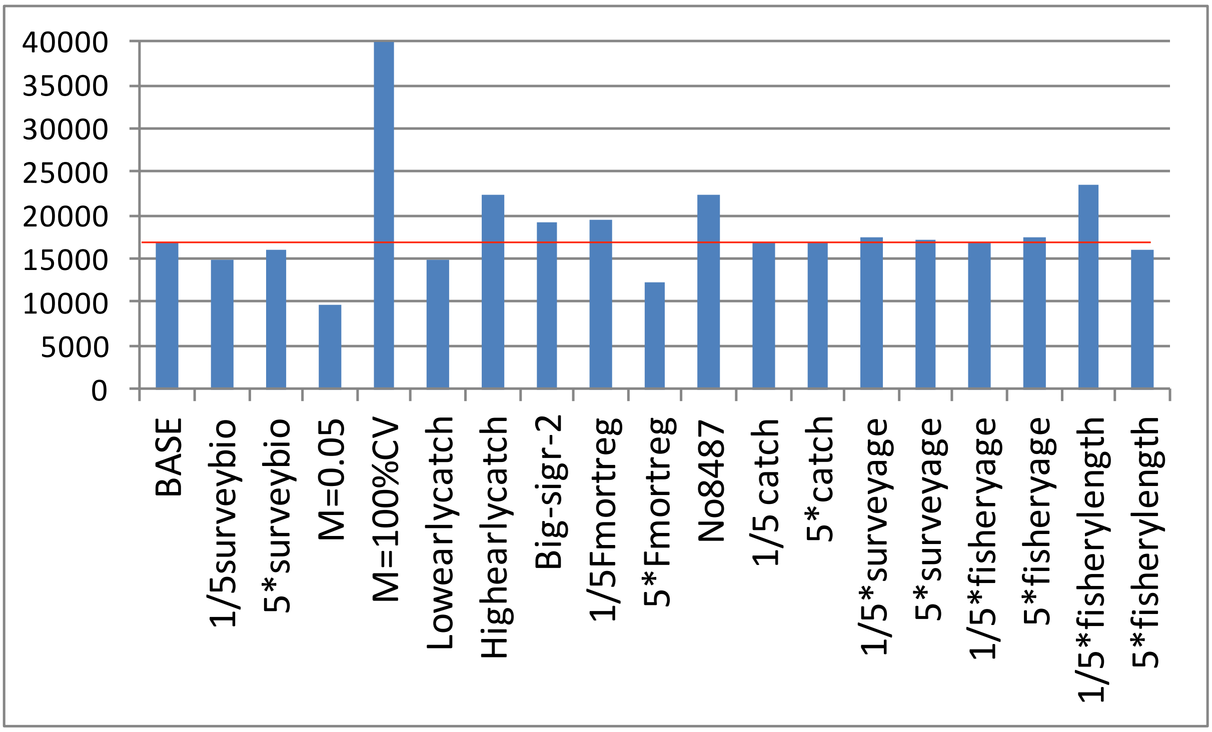

Figure 12: Sensitivity of the ABC for each of the sensitivity tests for the GOA POP Tier 3 assessment.

3.2.3 SELECTIVITY

Comments are provided in detail above but are summarised:

- BSAI POP: The fishery selectivity ogive is computed in a relatively unusual fashion for traditional age-based assessments, but reflects the changes in the fleet structure, management and range over the history of the data series, and is appropriate. For this assessment, a time-varying selectivity is modelled as a logistic equation in which deviations are allowed between 4-year blocks of the age at 50% (a50%) selection and slope. However, the output results show that the a50% changes most and that the slope is reasonably stable over time. Thus, it is **recommended that the time varying component of the selectivity ogive should be simplified by fixing the slope.** One further avenue is to use a spline for the a50% parameter, therefore reducing the number of parameters.
- GOA POP: The fishery selectivity is divided into three time blocks that follow changes to the fishery. Selectivity from old to recent years is modelled using logistic, logistic-gamma and gamma functions. There is strong evidence for choosing this selectivity function over the more traditional logistic selectivity. In general, the method that selectivity is changed over time blocks is appropriate. **It may, however, be a good sensitivity test to use a gamma-logistic function for the recent time block.**

3.2.4 AGE AND LENGTH BIN STRUCTURES

- Comprehensive tests were undertaken to test the appropriate length and age plus groups. For example; for BSAI POP, the standard deviation of the normalised residuals (SDNR) for the survey age compositions increased to a plus group age of 38 years and then decreased for larger aged plus groups. However, the opposite pattern was shown for the fishery age composition, which decreased to an age 42 plus group and then increased thereafter. On the other hand, as expected given the growth rates of these fish species, the SDNR was insensitive to length plus group age. Given this evidence, the choice of a plus group age of 40 years seemed appropriate. **Of concern is that the model did not converge with a plus age**

group of 50 but did for 49 and below and 51 and above. This seems strange and should be investigated.

- GOA POP: – the plus group was not changed for this assessment.
- RE/BS Complex – given the large proportion of the age and length data that still fall within the plus group, it is recommended that older and larger age groups are tested.

3.2.5 DATA WEIGHTING ASSUMPTIONS

These are discussed above within the paragraphs on the sensitivity tests. Key points are:

- Sensitivity tests of the weighting assumptions should be standard;
- Some consistency between assessments and regions should be obtained unless required otherwise (and reasons for these should be explained);
- The POP models are reasonably robust to these weightings from a likelihood and control rule perspective.

3.2.6 ASSUMPTIONS AND MODELLING OF TRAWL AND LONGLINE CATCHABILITY

Several studies have been undertaken using different gear and submersables to study the selectivity and catchability of the different species. This data set is extensive by international standards. These studies confirm that the catchability of most rockfish is >1, especially for POP. A catchability value that is much greater than two would be of some concern and therefore that for POP should be monitored and further tests undertaken, but presently is not a serious cause of concern.

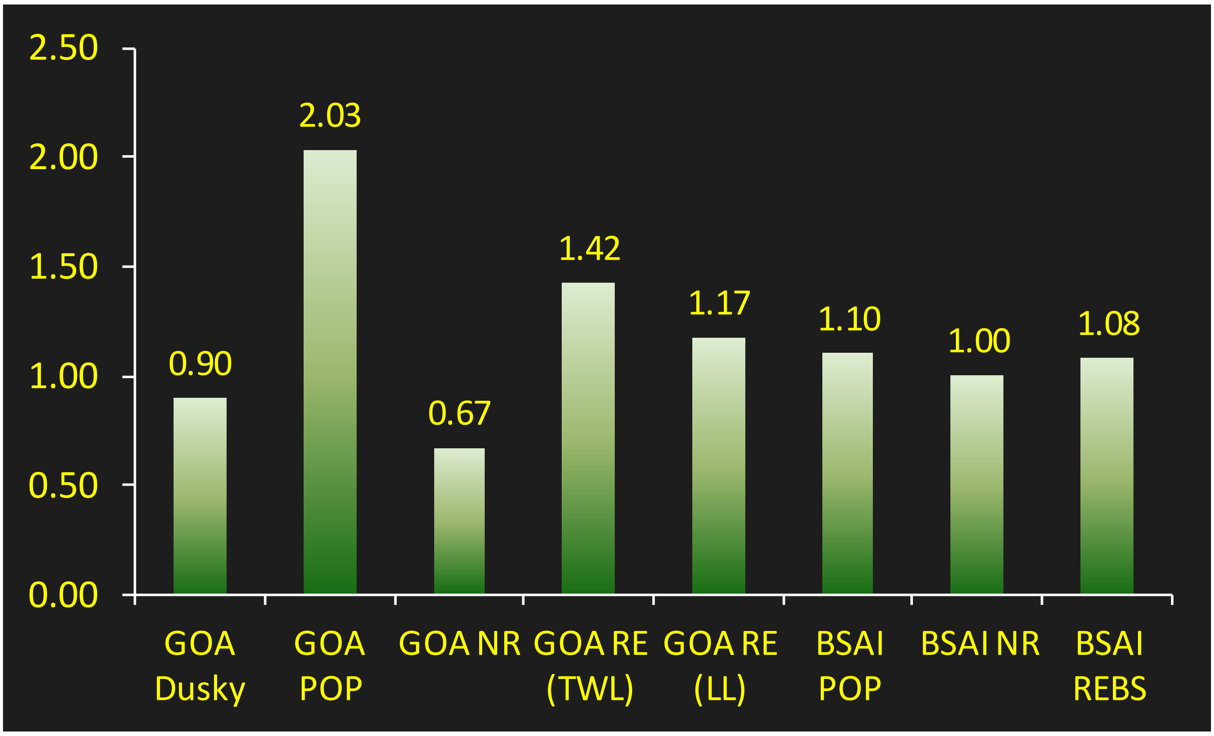

Figure 13: Catchability estimates for the different rockfish species.

3.3 ToR c: Evaluation, findings, and recommendations on the analytic approach used for "data-poor" rockfish stocks and complexes, including the use of an age-structured model for a two-species complex, and

application of state-space production models to stocks and stock complexes.

The Tier 5 “Other rockfish” (OR) is managed as a species complex, trading off individual species protection and a having a unit that is practical to manage. The key information for this Tier 5 group is the trawl survey indices and natural mortality. The survey indices are generally not designed for the species in this complex and many live in rough habitat. Discussing the GOA and BSAI OR separately best highlights the difficulty with this complex. Most of the issues apply (but not exclusively) to the GOA complex.

3.3.1 BSAI OTHER ROCKFISH

Although the OR component consists of a cluster of species, the dominant species are Shortspine thornyhead (SST), followed by dusky rockfish (DR) (Figure 14). There is some spatial difference to this dominance between EBS and AI (Figure 15 and Figure 16).

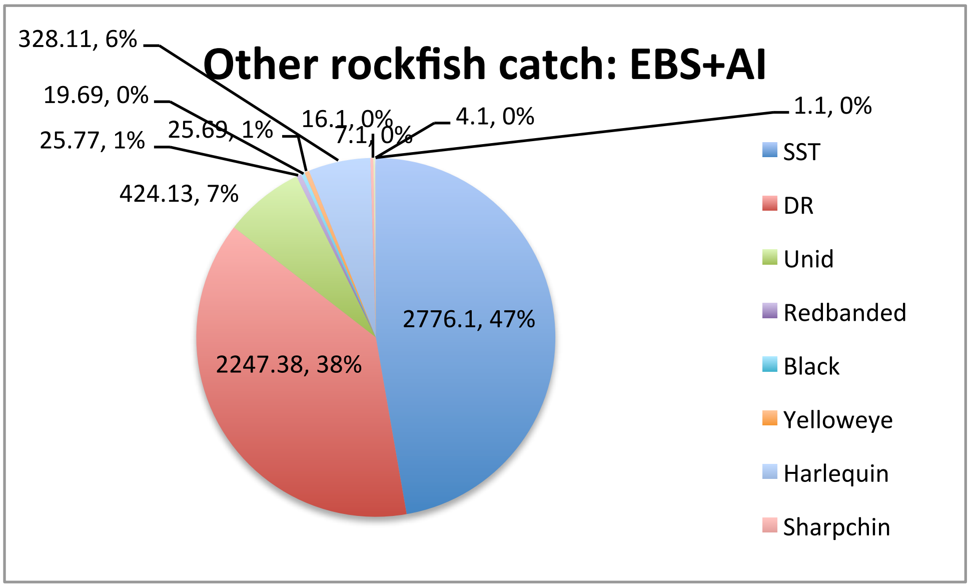

Figure 14: Fishery catch of the seven OR species in the BSAI from 1977 to 2102 (Spies and Spencer 2012).

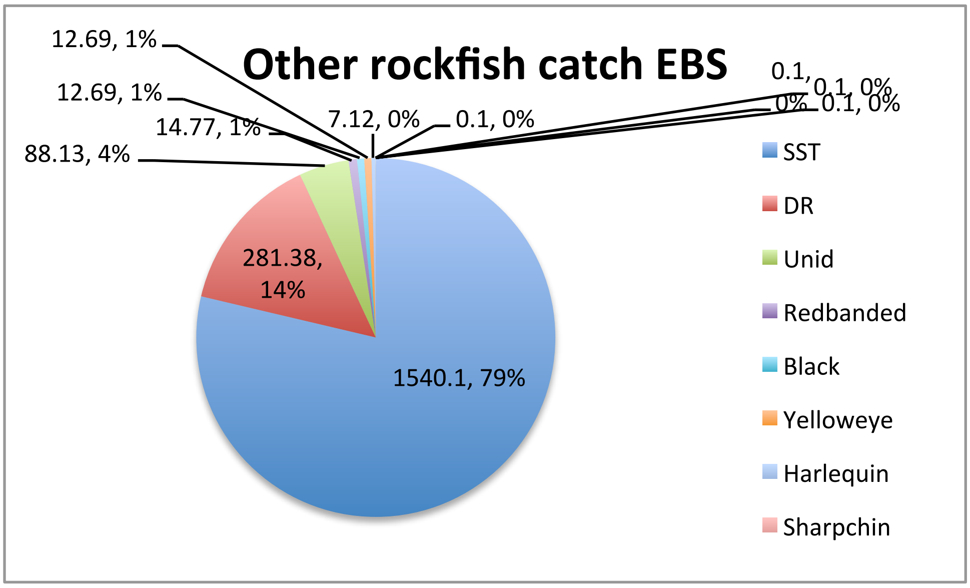

Figure 15: Fishery catch of the seven OR species in the EBS from 1977 to 2102 (Spies and Spencer 2012).

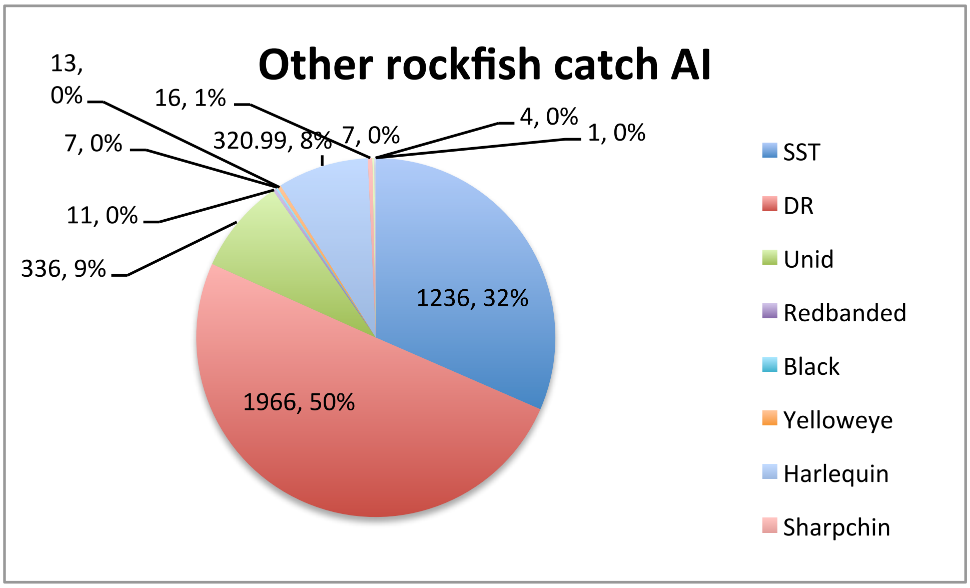

Figure 16: Fishery catch of the seven OR species in the AI from 1977 to 2102 (Spies and Spencer 2012).

The survey index CV of SST is reasonably low compared to the other OR species and does not demonstrate a clear mean-variance relationship (Figure 17). If it was to have such a relationship, the power to statistically demonstrate a decline or increase in the biomass index is substantially reduced – this is a key assumption; that the survey index is proportional to biomass. Usually a survey is designed to reduce this commonly found phenomenon by placing more survey effort in high-density sites. However, the species in the rockfish component are bycatch to the fishery and the OR are generally not the target of the survey design.

The survey CVs of DR are high (Figure 18). Interestingly, if one compares these results with the broad type of gear (especially concentrating on the proportion of the bottom trawl gear which is used by the survey) the above result is not necessarily clearly related to DR occurring more on bottom trawl ground than the SST – assuming commercial gear type gives some indication of their catchability by trawl gear (Figure 19).

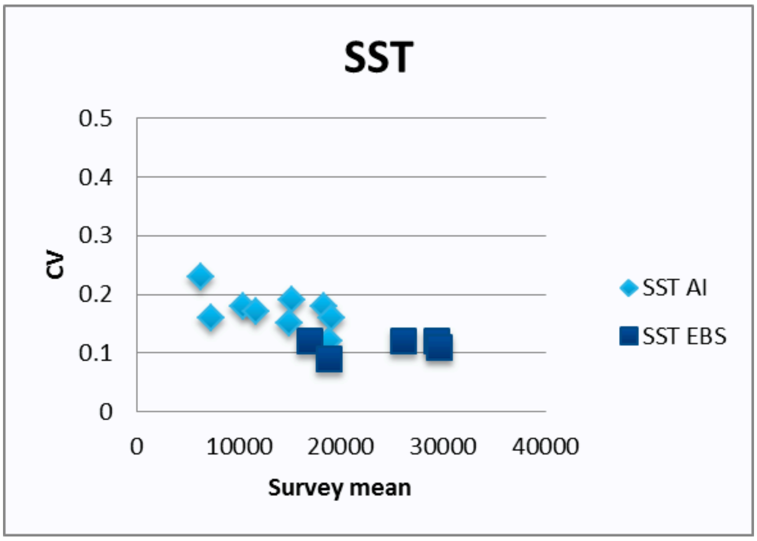

Figure 17: SST survey mean against survey CV for 1991 to 2012 surveys (Spies and Spencer 2012).

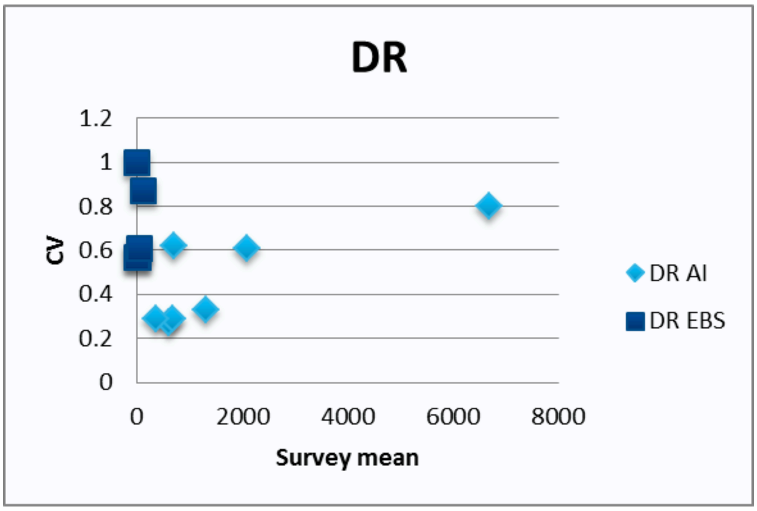

Figure 18: SST survey mean against survey CV for 1991 to 2012 surveys (Spies and Spencer 2012).

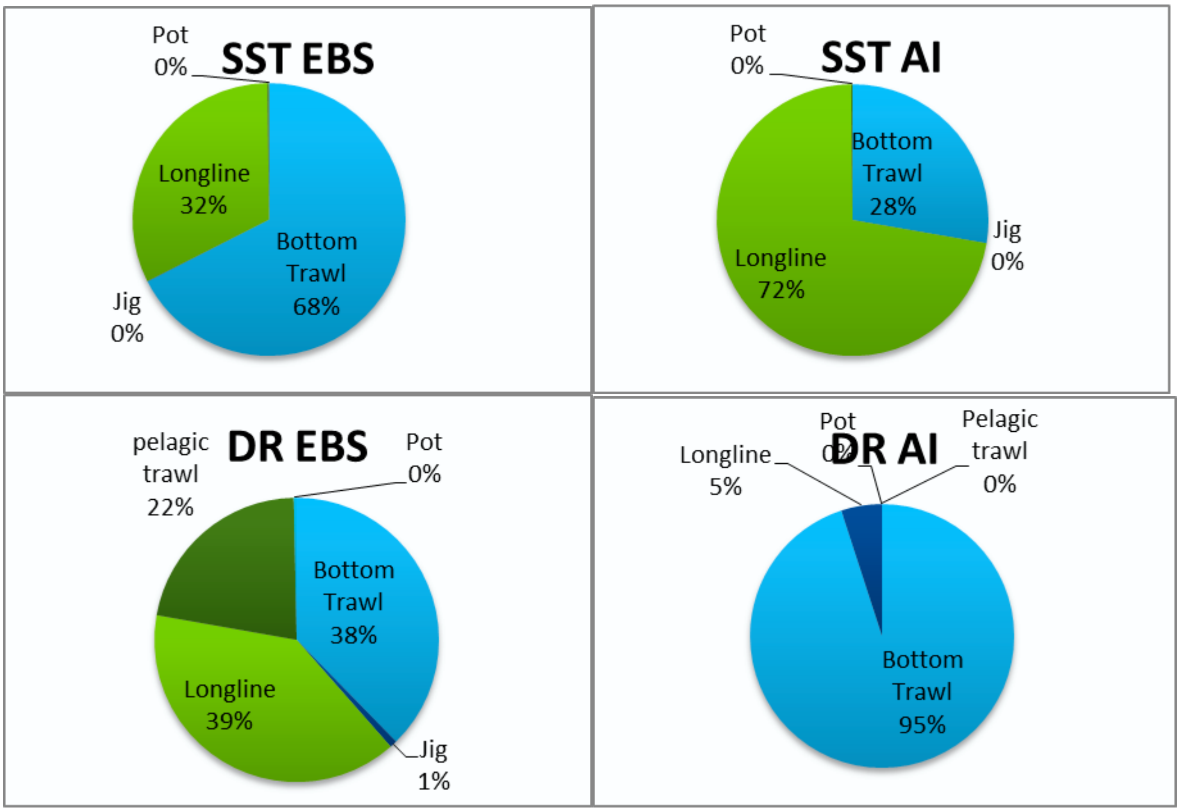

Figure 19: Breakdown by broad gear category for the SST and DR EBS and AI commercial catch (Spies and Spenser 2012).

For the BSAI OR component, the OFL and ABC are calculated using the 3 most recent surveys in two components - SST and the remainder, which included DR. Given the results above, this combination seems appropriate and the key points are summarised in Table 5. The ABC is further divided into the EBS and AI regions.

The natural mortality of the remainder OR component is that for DR. Since this is the dominant species in that component, this also seems appropriate. As a result, the method for setting the OFL and ABC for the BSAI OR seems reasonable, but note comments below on other methods of estimating biomass.

Table 5: Summary of BSAI OR key points.

SST	~80% of EBS catch CV's of <23% No mean-variance relationship Reasonably smooth inter-annual index 62% from EBS and 61% from AI of the survey catch whereas 43% EBS and 34% AI of the commercial catch Dominant species of rockfish in most recent catch years >75% of catch since 2004 EBS ~65% from bottom trawl gear, whereas AI only 28% from bottom trawl gear (ignoring target)
Non-SST (incl. DR)	Mainly DR - 18% from EBS and 22% from AI of the survey catch whereas 39% EBS and 45% AI of the commercial catch DR EBS survey indices have high CVs >57%, so not good for individual analysis

3.3.2 GOA OTHER ROCKFISH

The calculation of the OFL for the GOA Other rockfish is different to that undertaken in the BSAI Other rockfish. The OFL and ABC are calculated for six species and a minor species complex at the whole GOA level, and then the ABC is further split into regions Western, Central and Eastern. Their proportion in the fishery catch is provided in Figure 20, where harlequin, sharpchin and redstripe rockfish are a dominant part of the catch. It is unclear why the silvergray, redbanded and yellowmouth rockfish component is separate from the minor group, especially since they have reasonably similar M values.

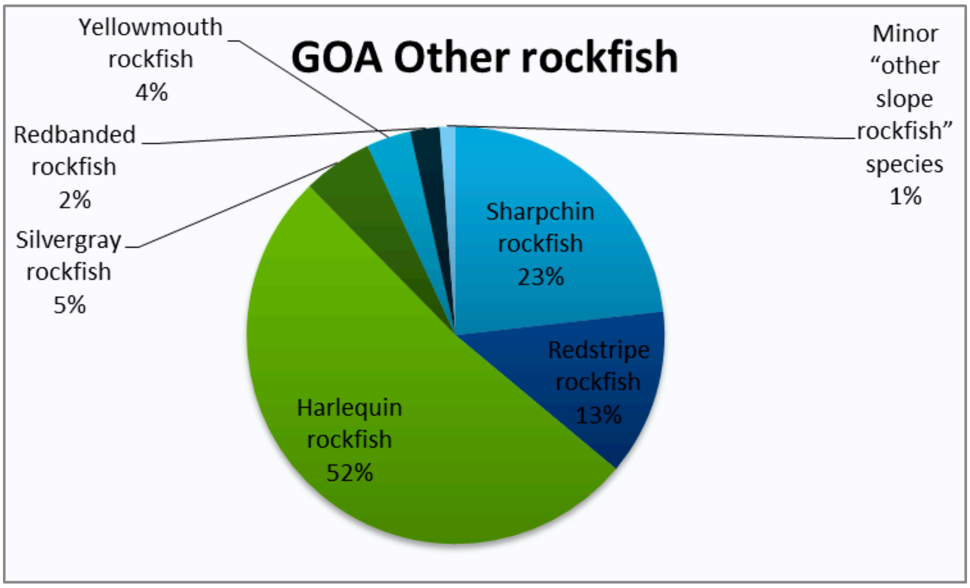

Figure 20: Proportion of species of the GOA OR in the commercial fishery from 1992-2010, excluding yellowtail and widow rockfish (Clausen and Echave 2011).

For most of the GOA OR, the survey CVs of the individual species used in the calculation of the OFL and ABCs are large to extremely large. Importantly, this statement applies to the dominant species of this complex as well. As a result, the use of the survey as an index of abundance is questionable, especially without any smoothing or further modelling.

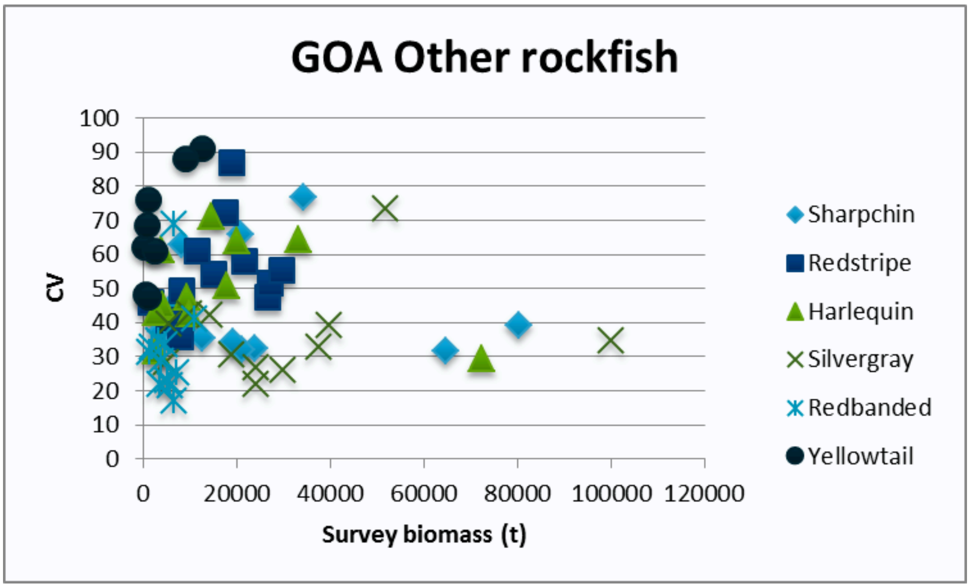

Figure 21: Survey mean versus variance for the 6 key species in the GOA OR complex (Clausen and Echave 2011).

Further sign of issues with the survey are provided in Figure 22, which shows that the inter-annual variability of the index exceeds that expected for a long-lived species. Even by averaging over the past 3 years is still unlikely to reflect biomass as there are signs that the survey fundamentally needs further analysis before being applied. **It is thus noted that work has been undertaken on developing methods such as Kalman filters to analyse this data, and this work is highly recommended.**

It would be very informative to investigate whether this data is zero inflated, as therefore the standard survey analysis would not be appropriate.

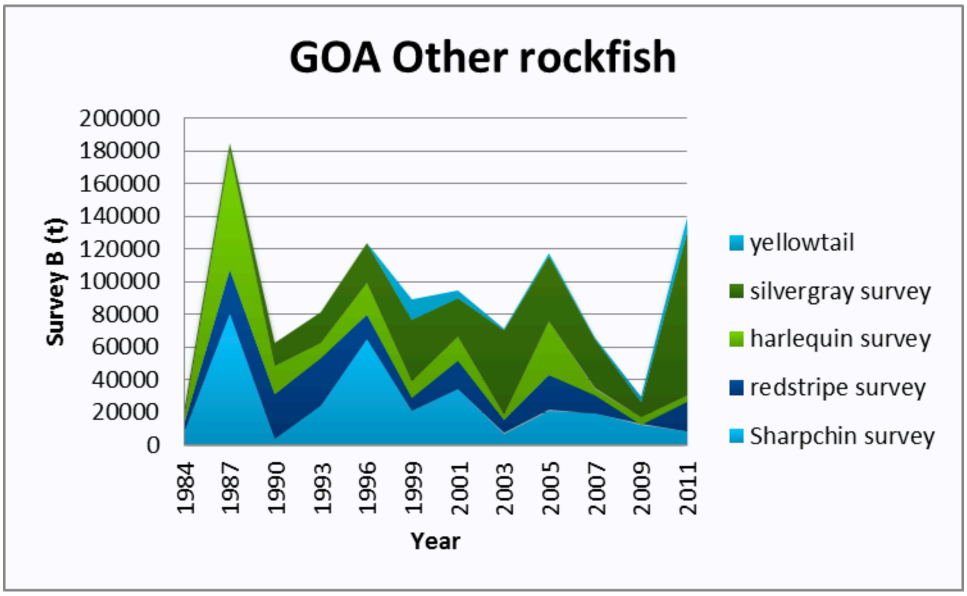

Figure 22: Survey index over time of the key species in the GOA OR complex (Clausen and Echave 2011).

The way forward is to undertake more detailed analyses of the survey data and to use a model-based approach to estimating the biomass. For the former, it is recommended that the survey is re-analysed to produce a survey index with lower CVs by using zero inflated methods, such as the two-stage delta methods or analysing the data in combination with habitat using mixed or additive modelling. The latter component is to further apply Kalman filter or random walk models.

3.3.3 USE OF AN AGE-STRUCTURED MODEL FOR A TWO-SPECIES COMPLEX

The following conditions would need to be met for an assessment of combined species group would be appropriate:

a) if the species distribution overlap,
b) the population dynamics are similar,
c) the species are found in similar habitats,
d) have similar productivity, and
e) one of the species are not conservation dependent

In the case of the blackspotted and rougheye rockfish complex (RE/BS), the species are sympatric with only small differences to their distribution. Based on several studies on both of these species, they are slow growing, long lived, late maturing and have a low M. Field studies, including those from submersables, have shown that both species are found in similar habitats when they are juveniles and as adults. Diet studies have shown they consume similar food types. Therefore the above conditions are met.

The risk of misidentification means that separating these two species for separate assessments would produce assessments of high uncertainty, especially with regard to their catch history to which the assessment would be conditioned. For these reasons, assessing these species as a complex is appropriate.

However, comments on the POP assessments regarding, for example, sensitivity tests apply. Of specific interest would be a high and low catch series test. Furthermore, the high CVs of some of the survey indices should be further investigated as per the OR comments above. Although tests with regard to the age at which the plus group occurs was undertaken, the results show that a large component of the fishery age and length data fall within the plus group, which is not ideal. Further work on the optimal plus group for both age and length is recommended.

In addition, it is recommended that different selectivity options be tested.

3.3.4 APPLICATION OF STATE-SPACE PRODUCTION MODELS TO STOCK AND STOCK COMPLEXES

An improved method to model biomass of the Tier 4 and 5 species or complexes such a Kalman filter and random walk models were investigated and this work should continue. However, in the GOA OR case, modelling the complex together rather than by species may be more appropriate given the mean-variance behaviour of the data where low indices have very low CVs and would therefore always be over-emphasised in the models. A test within the workshop showed that this approach had merit.

As more information becomes available on species and they move to higher Tiers, the species that remain in the complex become more difficult to model. An alternative approach of using a combination of modelling approaches with data poor risk assessment (e.g. PSA or Zhou and Griffiths (2008)) techniques should be investigated.

More importantly, hierarchical models should be investigated for the complexes in terms of species, for example Punt et al. (2011), or for spatial allocations (Zhou et al., 2009). The former kind of hierarchical model can draw information from data rich species with better-known biology and data to infer to data poor species of similar type.

3.4 ToR d: Evaluation, findings, and recommendations on the adequacy of current levels of spatial management, including apportionment strategy.

The documentation on the evaluation of stock structure for rockfish are holistic and a model for other fisheries. It covers a wide range of information, such as genetic, oceanographic and biological. An overall summary of the different points was provided in a presentation during the review (Table 6).

Table 6: Summary of Stock Structure Information for Alaska rockfish (+ is presence, - is absence, NA is not available).

	GOA			BSAI	
Data type	**POP**	**Dusky**	**Rougheye/Blackspotted**	**Rougheye/Blackspotted**	**Northern**
Spatial concentration of catch	-	-	-	+	+ (varies)
Spatial differences in population trends			+	+	-
Physical barriers	Mentioned	Mentioned	Mentioned	Mentioned	Mentioned
Growth	-	-	+	+	+
Age/size structure	-	-	-	+	-
Parastic loads	NA	NA	+	NA	NA
Isolation by distance	+	NA	- (Gharrett et al 2007)	+	+
Dispersal distance << management areas	+	NA	NA	+	+
Pairwise differences between populations	+	NA	+	+	+
Author recommendation	Subarea ABCs	Subarea ABCs	Subarea ABCs	Subarea ABCs	Subarea ABCs

Taken as a whole, there is evidence that there is a fine-scale stock structure for rockfish. For example, in the case of POP there are several genetic stock structure studies that are relevant to the issue of ABC apportionment. Ocean currents show there is potential for long-distance larval dispersal. However, documents provided before the review workshop and presentations during the workshop showed that there is genetic isolation-by-distance for POP and potentially most of the rockfish species. This is despite the fact that genetic stock studies often under-estimate the degree of stock isolation. In AI, there are some deep canyons that could limit adult movement. In contrast, depletion studies did not show that localised depletion was a big risk. Although there may be some uncertainty as to the degree of isolation, it seems sufficiently precautionary to keep the management units reasonably small.

The method of dividing the OFL and ABC by region is inconsistent across species and region (see Table 1 and Table 2). These Tables highlight that there is not a consistent area apportionment strategy or not one that clearly explains the reason for this difference. A consistent approach to area apportionment would always be recommended and a change should only occur for a well-specified reason.

Concentrating on POP and OR (Table 7), the area apportionment of the OFL is usually for the larger region, except for GOA POP where the area apportionment was western, central and eastern GOA. For POP, the ABC is divided into smaller sub-regions than the OFL. The ABC for POP and OR is apportioned using a weighted average of the three most recent survey indices – weights of 3:6:9. This emphasises the most recent survey, while it also attempts to smooth between the surveys. Given that the most recent surveys are often several years apart, this presently seems a reasonable method. **However, there is an issue that some of these surveys, e.g. GOA OR, are providing greater inter-annual variability than can be explained by the biology of the species and that therefore other area-based modelling that smooths the series (e.g. a loess smoother, random and mixed effects models linked with habitat models, Kalman filter, hierarchical modelling etc.), but**

maintains the recent trends may be more appropriate. These are already being undertaken and this work should be a priority.

Table 7: Spatial allocation of OFL and ABC for POP and OR.

[redacted]				
OFL	BSAI	BSAI	West, Central, East	GOA
ABC	Westen AI, Central AI, Eastern AI, EBS	EBS; AI	West, Central, East (East further divided into W. Yakutat and E. Yakutat/Southeast)	West, Central, East (W. Yakutat and E. Yakutat/Southeast)

Some accommodation should be made for the fact that the area allocation by survey index may follow the history of exploitation and management rather than being commensurate with the productivity of the species within that region – both being important. However, it is unclear beyond being precautionary how this would be addressed.

Genetic modelling by Spies, Punt and Spencer showed great insight into the issues to consider when managing isolation-by-distance. This study modelled a chain of adjacent stocks similar to that found in the AI region. It assumed the starting biomass in each stock was the same, but modelled the effort distribution by stock over time to be based on a combination of the distance from port (which was assumed to be at one of the ends of the spatial distribution) and the population density in each stock. Dispersal rates used in the modelling were likely to be conservative. It showed that the position of the management boundary was important to the genetic diversity and stock biomass. This work has high merit. **Some changes are recommended for greater applicability to rockfish. The first is to undertake a sensitivity test using higher dispersal rates. A more important change is to model the effort to reflect the target species density and distance from port. This is because the species within the rockfish group are not targeted fish as is assumed in the model.**

4 ToR e: Conclusions, recommendations and further improvements

- Continuing additional surveys (e.g. longline surveys) especially on untrawlable grounds are of great value and further work in this area is recommended.
- The highest priority recommendation is to undertake more detailed analyses of the survey data and to use a model-based approach to estimate the biomass for the Tier 4 and 5 harvest control rule.
    - The survey should be re-analysed to produce a survey index with lower CVs by using:
        - zero inflated methods, such as the two-stage delta methods, or
        - generalised mixed or additive models to combine the ecosystem work on topographic and sediment mapping, the oceanography data (e.g. currents, temperature) with the survey data to produce a modelled survey index. These may also be able to provide indications of whether the species' distributions on trawlable and untrawlable grounds change relative to each other over time. This is an important aspect of the interpretation and, in some cases, the legitimate use of these survey indices.
    - Further work on estimating the biomass for the Tier 4 and 5 control rule using Kalman filter or random walk models.
    - Further options for modelling species with little information or areas with highly uncertain data are hierarchical models that can be applied to complexes in terms of species, for example Punt et al. (2011), or for spatial allocations (Zhou et al., 2009). The former kind of hierarchical model can draw information from data rich species with better-known biology and data to infer to data poor species of similar type.
- It is recommended that sensitivity tests should be the norm for SAFE reports - those tests for the GOA and BSAI POP assessments requested by the review panel would be an appropriate starting point for Tier 3 assessment tests that should routinely be provided in the future. These tests concentrated on key input data, parameters and the likelihood weighting. These sensitivity tests should include outputs relevant to management advice, such as ABCs or biomass estimates.
- There is some concern about the trends in the BSAI POP age residuals, especially that the plus group is consistently underestimated. The residuals also often show a series of positive or negative residuals over age bins. However, generally these residuals are not excessive for a model with several data inputs that show some contradictory information. Of concern is that the sensitivity tests undertaken during the review (from preliminary analysis) did not correct this residual pattern as seen by the likelihood plots of the sensitivity tests. As a result, it is likely that some input parameters need to be estimated within the model. In most age-based assessments, growth is estimated within the model and this approach is recommended.
- Both the POP assessments assumed that the catch was known exactly since there was no observation error or penalty term included in the likelihood formulation. This is unlikely to be the case given the history of the data. Of particular concern were the early data series. Given the uncertainty is likely to be higher during the early periods, a test of setting the early catches double or half of the present series was conducted during the review. Another option was to decrease the likelihood weight on the catch in the likelihood. This showed that the model and management advice is reasonably robust to these tests. It is recommended that these tests on the early catch series be further developed.
- The BSAI POP Base Case showed that, despite using an informative prior, the posterior M shows a much higher estimated M with the posterior having overlap to the prior distribution.

These tests were designed to increase the prior variance on M thereby allowing the model to estimate potentially higher M values and using a fixed M. For the higher variance test, the M value increases to 0.098 yr^{-1}. As expected in this case, the management measures are affected. It is therefore recommended that this test should be further developed to understand why these high M values are expected and whether this is a correlation with another parameter. Including the estimation of growth within the model may also affect this result.

- For BSAI POP, it is recommended that the time varying component of the selectivity ogive be simplified. One possible solution would be to use a spline, therefore having fewer parameters. A sensitivity test using DIC should also be undertaken to ascertain whether a spline or even a time invariant selectivity pattern improves the model compared to the present approach. This test may also include dome-shaped selectivity.
- For the GOA POP assessment, it is recommended that a sensitivity test is undertaken to set the final selectivity function as a logistic-gamma allowing the data to provide the lower selectivity of the older age classes.
- For the GOA POP assessment, a good sensitivity test would be to include a gamma-logistic function for the recent time block.
- As more information becomes available on species and they move to higher Tiers, the species that remain in the complex become more difficult to model. An alternative approach of using a combination of modelling approaches with data poor risk assessment techniques (e.g. PSA or Zhou and Griffiths (2008)) should be investigated.
- Genetic modelling by Spies, Punt and Spencer showed great insight into the issues to consider when managing isolation-by-distance. This study modelled a chain of adjacent stocks into a chain similar to that found in the AI region. It assumed the starting biomass in each area was the same, but modelled the effort distribution to be based on a combination of distance from port (which was assumed to be lowest from the one stock and further as one moves along the chain from this stock) and population density. Dispersal rates used in the modelling were likely to be conservative. It showed that the position of the management boundary was important to the genetic diversity and stock biomass. This work has high merit although some changes are recommended for greater applicability to rockfish. The first is to undertake a sensitivity test using higher dispersal rates. The second (and more important) change is to model the effort to reflect the target species and distance from port, rather than the bycatch biomass and distance from port. This is because the species within the rockfish group are not targeting fish as is assumed in the model.
- For the RE/BS complex assessment, comments on the POP assessments regarding, for example, sensitivity tests apply. Of specific interest would be a high and low catch series test. Furthermore, the high CV in some of the survey data should be further investigated as per the data poor comments in ToR e. Although tests with regard to the age at which the plus group occurs was undertaken, the results show that a large component of the fishery age and length data fall within the plus group, which is not ideal. Further work on the optimal plus group for both age and length is recommended. In addition, it is recommended that different selectivity options be tested.
- In future, it is recommended that reviews concentrate on a small number of species or issues, as the large volume of documents and issues that needed to be addressed diluted this review. It was difficult in the time provided to make extensive comments on any one specific topic.

5 References

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Appendix 1 Bibliography of materials provided for review

All documents were available for download at:
ftp://ftp.afsc.noaa.gov/afsc/public/CIE_Rockfish/rfwg.html

- CIE Statement of work
- CIE Draft Agenda
- 2011/12 Stock assessment (SAFE) reports
  - BSAI Pacific ocean perch
  - BSAI Northern Rockfish
  - BSAI Other Rockfish
  - BSAI Blackspotted/Rougheye Rockfish
  - BSAI Shortraker
  - BSAI Groundfish Plan Team Summary
  - GOA Groundfish Plan Team Summary
  - GOA Pacific Ocean Perch
  - GOA Northern Rockfish
  - GOA Shortraker
  - GOA Rougheye/Blackspotted Rockfish
  - GOA Dusky rockfish
  - GOA Other rockfish
  - GOA Demersal Shelf Rockfish
  - GOA Thornyheads
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  - Stock structure analyses. 2010-2012. Application of stock structure template to GOA POP, dusky, and rougheye/blackspotted rockfish.
  - BSAI Northern rockfish stock structure. 2012. Application of stock structure template to BSAI northern rockfish.
  - BSAI blackspotted and rougheye areal exploitation rates. 2012. Application Update to 2010 stock structure report.
  - BSAI blackspotted and rougheye stock structure. 2010. Application of stock structure template to the BS/RE complex.
  - Northern rockfish genetics. 2012. Genetic analysis suggests limited lifetime dispersal.
  - Geographic structure in POP. 2011. Genetic analysis suggests limited lifetime dispersal.
  - Naming of blackspotted rockfish from rougheye complex. 2008. One of the papers leading to split of rougheye into rougheye and blackspotted rockfish.
  - Localized depletion 2007. Analyzes possibility of short and long-term localized depletion for three species of rockfish.
  - Evidence for sibling species of rougheye rockfish. 2007. One of the papers leading to split of rougheye into rougheye and blackspotted rockfish.
  - Genetic variation of rougheye and shortraker . 2005. Allozyme study for two species of rockfish.
  - Separation of dusky rockfishes. 2004. Formerly one species informally called light and dark rockfish are now S. variabilis and S. ciliatus.
  - Population structure of shortraker rockfish. 2004. DNA microsatellite variation shows some large-scale structure in shortraker rockfish.
- Modeling and data:
  - Effective sample sizes on age comps 2. 2012. Using the GOA POP model to look at iterative reweighting and sampling theory to weight age and length compositions.

        - Effective sample sizes on age comps 1. 2011. Using the GOA POP model to test various likelihoods and sample size weightings.
        - Modeling thornyhead abundance with a two-stage model. 2009. Gulf of Alaska survey data is modeled with environmental data for thornyhead rockfish.
        - Kalman filter method for rockfish. 2005. Application of a Kalman filter method to a multi-species complex of Tier 5 stocks.
        - Catch composition. 2011. Study comparing industry and observer reported catch compositions in the rockfish fishery.
        - Publication describing generalized rockfish model. 2007. The paper also compares some sensitivities of the model between different GOA species.
    - Other regions' rockfish assessments
        - West Coast U.S. POP. 2011.
        - Canadian POP. 2001.
- 2006 Rockfish CIE review
    - CIE Agenda
    - Reviewer reports: Summary, Mohn, Cordue, Jones
    - AFSC Response
- Other documents
    - Report of the 1997 rockfish assessment review
    - NPFMC TAC/ABC Recommendations
    - All Alaska groundfish assessments

Appendix 2 Copy of the CIE Statement of Work

Statement of Work for Dr. Cathy Dichmont (CSIRO)

External Independent Peer Review by the Center for Independent Experts

Review of Alaska Rockfish Assessments

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

Project Description: The Alaska Fisheries Science Center (AFSC) is responsible for stock assessments for 13 rockfish stocks and stock complexes. Collectively these rockfish stocks support valuable commercial fisheries. The last time rockfish stocks were independently reviewed by the CIE was in 2006. Several changes have occurred since that time. New assessments have been developed, several existing assessments have been modified to include new life history information, and the fisheries in the Gulf of Alaska have been rationalized allowing more stocks to be fully utilized. Some assessments have implemented or explored modeling changes such as time-varying selectivity or iterative reweighting of data sources to achieve better variance specification. New information has become available on the spatial population structure of rockfish, which has affected the assessment and management of these species and raised questions if the current spatial management is adequate. In addition, fish formerly identified as rougheye rockfish (*Sebastes aleutianus*) are now known to comprise two species which are assessed together in one age-structured stock assessment model because of misidentification problems. These issues underscore the need for an independent review of rockfish resources in the Gulf of Alaska and Bering Sea/Aleutian Islands.

In addition, there are several stocks that are commercially valuable, but are currently only assessed using survey biomass estimates with reference points based on natural mortality. These stocks often have other demographic and life history data available such as length compositions or maturity estimates, but lack reliable age data. The AFSC would benefit with a review of the current methods for "data-poor" rockfish stocks and recommendations for improved methods.

Alaska rockfish assessments rely strongly on trawl survey biomass estimates, and the previous CIE review identified the need for focused research on the fraction of the stock that resides in untrawlable grounds in order to characterize any potential bias and/or imprecision resulting from expansion of fish densities from trawlable areas to untrawlable areas. Since 2006, scientists at the AFSC have conducted experiments to assess the fraction of the rockfish stocks that reside in untrawlable substrate. A review of this research and recommendations for how to incorporate the results into stock assessments is needed.

Finally, the AFSC longline survey provides a relative population index for several species of Alaska rockfish (~1990-present). This index is currently used in the Gulf of Alaska rougheye rockfish population model, but has potential to be incorporated into other rockfish assessments such as shortraker rockfish (Sebastes borealis). The AFSC would benefit from a review of the current methods for incorporating this index into stock assessments and recommendations for new or improved methods.

The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein. CIE reviewers shall have the expertise, background, and experience to complete an independent peer review in accordance with the SoW and ToRs herein. CIE reviewer expertise shall have expertise and work experience in analytical stock assessment, including population dynamics, age/length based stock assessment models, data-poor stocks, survey design, and population structure and spatial management. In order to help ensure an independent review, we request three reviewers who did not serve as reviewers in the 2006 Alaska rockfish CIE review.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled during April 9-11, 2013 at the Alaska Fisheries Science Center in Juneau, Alaska.

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

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

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website:

http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html

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

AFSC will provide copies of the statement of work, stock assessment documents, prior CIE review documents, and other background materials to include both primary and grey literature.

This list of pre-review documents may be updated up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process, including a SoW modification to the schedule of milestones and deliverables. Furthermore, the CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein.

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

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

Other Tasks – Contribution to Summary Report: Each CIE reviewer may assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. Each CIE reviewer is not required to reach a consensus, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

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

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review;
2) Participate during the panel review meeting at the Alaska Fisheries Science Center in Juneau, Alaska during 9-11 April 2013 as called for in the SoW, and conduct an independent peer review in accordance with the ToRs (Annex 2);

3) In Juneau, Alaska during 9-11 April 2013 as specified herein, conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than 26 April 2013, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to David Die ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2;

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

March 1, 2013	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
March 25, 2013	NMFS Project Contact sends the CIE Reviewers the pre-review documents
April 9-11, 2013	Each reviewer participates and conducts an independent peer review during the panel review meeting
April 26, 2013	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
May 10, 2013	CIE submits CIE independent peer review reports to the COR
May 17, 2013	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be made through the COR who submits the modification for approval to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the CIE within 10 working days after receipt of all required information of the decision on substitutions. The COR can approve changes to the milestone dates, list of pre-review documents, and Terms of Reference (ToR) of the SoW as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToRs and deliverable schedule are not adversely impacted. The SoW and ToRs cannot be changed once the peer review has begun.

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

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

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

Support Personnel:

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

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations.
2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR, and Cons and Recommendations in accordance with the ToRs.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a detailed summary of findings, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.

   d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The CIE independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include as separate appendices as follows:

   Appendix 1: Bibliography of materials provided for review

   Appendix 2: A copy of the CIE Statement of Work

   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

Review of Alaska Rockfish Assessments

CIE reviewers shall address the following Terms of Reference during the peer review and in the CIE reports.

a. Evaluation of data used in the assessments, specifically trawl and longline survey abundance estimates, and recommendations for processing data before use as assessment inputs.
b. Evaluation of analytical methods used in assessments, particularly in regard to selectivity, selection of age and length bin structures, data weighting assumptions, and assumptions and modeling of trawl and longline catchability.
c. Evaluation, findings, and recommendations on the analytic approach used for "data-poor" rockfish stocks and complexes, including the use of an age-structured model for a two-species complex, and application of state-space production models to stocks and stock complexes.
d. Evaluation, findings, and recommendations on the adequacy of current levels of spatial management, including apportionment strategy.
e. Recommendations for further improvements

Annex 3: Tentative Agenda

Review of Alaska Rockfish Stock Assessment

Alaska Fisheries Science Center, Juneau, AK

April 9-11, 2013

Contact for security and check-in: Phil Rigby

Contacts for additional documents: Paul Spencer/Dana Hanselman

Tuesday, April 9:

9:00 AM – 10:30 AM: **Introduction**

Topics:

Introductions and the agenda, overview of rockfish biology, fishery, and history of assessment.

10:30 AM – Break

10:45 AM – Discussions

12:00 PM – Lunch

1:00 PM -3:00 PM: **Input data**

Topics:

Survey data – Abundance indices, ages, lengths, growth

Fishery data – Catch, ages, lengths, and observer data

3:00 PM – Break

3:15 PM – **Discussions**

5:00 PM – Adjourn for day

Wednesday, April 10:

9:00 AM – 10:30 AM: **Assessment model**

Topics:

Model structure, likelihood formulations, data weighting

10:30 AM – Break

10:45 AM – **Discussions**

12:00 PM – Lunch

1:00 PM -3:00 PM: **Parameters, priors, and ages**

Topics:

Catchabilities, selectivities, natural mortalities, recruitment variability

3:00 PM – Break

3:15 PM – Discussions

5:00 PM – Adjourn for day

Thursday, April 11:

9:00 AM – 10:30 AM: **Current issues**

Topics:

Spatial management, areal apportionment of catch, overfishing limits

10:30 AM – Break

10:45 AM – Discussions

12:00 PM – Lunch

1:00 PM -3:00 PM: **Alternative model runs, further discussion as needed**

Topics:

TBA

3:00 PM – Break

3:15 PM – Further discussions and summarize

5:00 PM – Adjourn meeting

Appendix 3 Panel membership or meeting attendees

Chair Dr Jim Ianelli, AFSC, Seattle

Members Dr Catherine Dichmont, CSIRO (Australia)

Dr Neil Klaer, CSIRO (Australia)

Dr Sven Kupschus, CEFAS (The United Kingdom)

Attendees

Dana Hanselman	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Kalei Shotwell	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Chris Lunsford	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Jon Heifetz	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Phil Rigby	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Pete Hulson	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Cindy Tribuzio	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Katy Echave	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Paul Spencer	Resource Ecology and Fisheries Management	Alaska Fisheries Science Center	NOAA
Ingrid Spies	Resource Ecology and Fisheries Management	Alaska Fisheries Science Center	NOAA
Jim Ianelli	Resource Ecology and Fisheries Management	Alaska Fisheries Science Center	NOAA
Chris Rooper	Resource Assessment and Conservation Engineering	Alaska Fisheries Science Center	NOAA
Jane DiCosimo	Plan Coordinator		North Pacific Fishery Management Council
Tony Gharrett	Fisheries Division	School of Fisheries and Ocean Sciences	University of Alaska Fairbanks

Appendix 4 Sensitivity tests and other information provided requested during the review

The following diagnostics were requested and provided:

- residual plots of the survey, cpue, length and age data of both BSAI and GOA POP assessments (where relevant)
- Retrospective plots for F and recruitments
- All age composition plots of both GOA and BSAI POP scaled to Numbers

The assessment results for the POP assessments.

The following sensitivity tests of BSAI and GOA POP assessment were requested and undertaken:

Table 8: BSAI and GOA POP Sensitivity tests where results were provided during the review with their respective abbreviations.

Sensitivity test class	Sensitivity test	Setting	BSAI POP abbreviation	GOA POP abbreviation
Base Case	Base Case		Base-2012 model	BASE
Likelihood weights	Survey biomass index weight	Reduced by 1/5th	Low weight on survey	1/5surveybio
		Increase by 5	High weight on survey	5*surveybio
	Fishing mortality regularity	Reduced by 1/5th	-	1/5Fmortreg
		Increase by 5	-	5*Fmortreg
	Catch penalty	Reduced by 1/5th	Low weight on catches	1/5 catch
		Increase by 5	-	5*catch
	Survey age composition	Reduced by 1/5th	-	1/5*surveyage
		Increase by 5	-	5*surveyage
	Fishery age composition	Reduced by 1/5th	-	1/5*fisheryage
		Increase by 5	-	5*fisheryage
	Fishery length composition	Reduced by 1/5th	-	1/5*fisherylength
		Increase by 5	-	5*fisherylength
Input parameters/data	Fix M to 0.05		Fixed M	M=0.05
	Set a higher CV on the M prior		M CV=0.45	M-100%CV
	Lower early catch series		Half early catch	Lowearlycatch
	Upper early catch series		Double early catch	Highearlycatch
	Increase deviance factor for the recruitment vector		Sigr=1.5	Big-sigr-2

Appendix 5 Major acronyms

AFSC = Alaska Fisheries Science Center
ABL = Auke Bay Labs (here)
GOA = Gulf of Alaska
BSAI or BS/AI = Bering Sea/Aleutian Islands
ABC = Acceptable Biological Catch (Target quota recommendation)
TAC = Total Allowable Catch (usually ABC)
OFL = OverFishing Level (Limit)
SSB = Female spawning stock biomass
$B/F_{35/40\%}$ = Spawners per recruit reference points/rates
M = Natural mortality
q = Catchability
OR=Other Rockfish

Species

Common name	Acronym	Scientific name
Pacific ocean perch	POP	*Sebastes alutus*
Northern rockfish	NR	*S. polyspinis*
Dusky rockfish	DR	*S. variabilis*
Rougheye & Blackspotted rockfish	REBS	*S. aleutianus & melanostictus*
Shortraker rockfish	SR	*S. borealis*
Shortspine thornyhead	SST	*Sebastolobus alascanus*
Blackgill rockfish	BG	*Sebastes melanostomus*
Bocaccio	BO	*S. paucispinis*
Chilipepper	CP	*S. goodei*
Darkblotched rockfish	DB	*S. crameri*
Greenstriped rockfish	GS	*S. elongatus*
Harlequin rockfish	HQ	*S. variegatus*
Pygmy rockfish	PY	*S. wilsoni*
Redbanded rockfish	RB	*S. babcocki*
Redstripe rockfish	RS	*S. proriger*
Sharpchin rockfish	SC	*S. zacentrus*
Silvergray rockfish	SG	*S. brevispinis*
Splitnose rockfish	SN	*S. diploproa*
Stripetail rockfish	ST	*S. saxicola*
Vermilion rockfish	VM	*S. miniatus*
Widow rockfish	WD	*S. entomelas*
Yelloweye rockfish	YE	*S. ruberrimus*
Yellowmouth rockfish	YM	*S. reedi*
Yellowtail rockfish	YT	*S. flavidus*

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