Summary of Center for Independent Experts (CIE) Reviewers reports on the 2008 assessment of Alaskan sablefish (*Anoplopoma fimbria*)*

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Prepared for

NOAA Fisheries' Alaska Fisheries Science Center (AFSC)

Review Meeting
Alaska Fisheries Science Center
Auke Bay Laboratories
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**Note: This summary was prepared by the CIE reviewers, but is not an official consensus report reviewed and authorized by the Center for Independent Experts.*

Contents

Executive Summary

Multiple changes have been implemented in the Alaskan sablefish (*Anoplopoma fimbria*) assessment in the period since the last independent review. There are stakeholder concerns over areal apportionment of harvest and depredation of survey catches by whales. Therefore, NOAA Fisheries' Alaska Fisheries Science Center (AFSC) requested a thorough review of the Alaskan sablefish assessment. Accordingly the CIE appointed a panel of independent Experts to undertake a review of the 2008 assessment of Alaskan sablefish. The Panel comprised three CIE reviewers, Michael Armstrong (CEFAS, UK), John Casey (CEFAS, UK) and Neil Klaer (CSIRO, Australia); and the review was Chaired by Jim Ianelli (AFSC, Seattle). The review was held at the AFSC laboratory at Lena Point from Tuesday, 17 March 2009, through Thursday, 19 March 2009.

Review activities
Preparations for the meeting were excellent, and the Review Panel received the assessment report and associated relevant documentation within the prescribed time schedule. The meeting was conducted in comfortable surroundings, with satisfactory facilities and with a spirit of cooperation from all participants. AFSC staff extended a warm and hospitable welcome to all participants.

The review benefited from the presence of scientific expertise from the AFSC and representatives of other stakeholder groups, all of whom made valuable contributions to the review process.

The review was conducted in a series of plenary sessions. AFSC scientists gave a series of presentations covering pertinent topics, including an overview of sablefish biology, fishery, and assessment history; a summary of assessment input data, including fishery dependent data comprising abundance indices, ages, lengths, logbook and observer data; an overview of Alaskan fishery-independent surveys that capture Alaskan sablefish;. and the detailed formulation and results of the current (2008) stock assessment model used for Alaskan sablefish. Panelists and stakeholders had the opportunity to comment and question each of the presenters and to highlight and discuss any arising issues.

The Panel wishes to thank all participants for their valuable input and professionalism throughout the review process.

Panel Conclusions
The Panel's comments on specific aspects of the assessment are documented in the main body of the summary report.

In relation to the Terms of Reference the Panel concluded the following:

1. Evaluation, findings, and recommendations on quality of input data and methods used to process them for inclusion in the assessment.

In general, the Review Panel considered that the input data and methods used to process them for inclusion in the assessment were adequate and appropriate. The fishery and survey data were extensive and well documented. The current treatment of abundance index data affected by whale depredation is unlikely to have affected the overall management advice for the Alaskan sablefish stock, but the Panel notes that alternative approaches should be investigated for dealing with any further increases in whale depredation.

2. Evaluation, findings, and recommendations on the level and adequacy of knowledge and incorporation of life history, ecology and habitat requirements.

Knowledge of stock structure, natural mortality and sex-related maturity and growth parameters are adequately represented in the assessment, although there are some issues regarding the handling of sex ratio in the model that need to be resolved for future assessments.

3. Evaluation, findings, and recommendations of the analytical approach used to assess stock condition and stock status.

Although the assessment showed some retrospective bias up to 2006, the Panel concluded that the analytical approach provides an acceptable basis for assessing stock condition and status and for providing management advice.

4. Evaluation, findings, recommendations of areal apportionment of harvest strategy as related to optimizing spawning stock biomass.

The Panel concludes that the current apportionment scheme is difficult to evaluate given the information presented, particularly since there are unstated socio-economic objectives that play a role. The Panel recommends that a set of objectives be clearly identified. While recognizing that there are uncertainties in regional abundance and productivity, the approach of distributing ABC values taking into account regional biomass levels appears an appropriate way of attaining equivalent fishing mortality in the different regions.

5. Recommendations for further improvements.

For future assessments of the Alaskan sablefish stock, the Panel made a number of recommendations relating to input data, assessment model, and diagnostics. These included the following topics:

Input data - age and length data, age-length sampling, commercial longline fishery catch rates, and whale depredation.

Assessment model and diagnostics - Size selectivity, spatial structure, diagnostics, weighting of likelihood components, sensitivity analyses, model building/specification, growth parameter estimation, simulation testing, and retrospective pattern.

General Conclusion

The Panel concluded that the input data used for the 2008 Alaskan sablefish assessment have been processed and used appropriately. The Panel further concludes that the results of the assessment represent the best estimate of current stock status and form an appropriate basis on which to take management decisions.

Accordingly and noting that Alaskan sablefish are managed under Tier 3 of NPFMC harvest rules, the Panel agrees with the recommendation in the 2008 assessment that the ABC for 2009 should be 16,080 t.

1 Introduction

1.1 Background

The Sablefish Stock Assessment Review met in Juneau, Alaska, from Tuesday, March 17, through Thursday, March 19, 2009, to review the assessment of Alaska sablefish *Anoplopoma fimbria*.

The Review Panel was composed of three scientists affiliated with the Center for Independent Experts, University of Miami: Dr. Mike Armstrong, Dr. John Casey, and Dr. Neil Klaer. The Review Meeting was chaired by the Gulf of Alaska (GOA) Plan Team Chair, Dr. Jim Ianelli. Staff of the Auke Bay Laboratories, Alaska Fisheries Science Center made presentations and assisted with the meeting proceedings.

On 20 February, assessment documents and supporting materials were made available to the Panel via a secure webserver. During the meeting, all documents were available electronically via the same webserver, and notes and presentations were uploaded as they became available.

The meeting format included presentations mixed with questions and open discussion. The Panel participated in the review of each term of reference. The meeting was open to the public and public comments were also accepted. A list of participants is given in Annex I.

1.2 Review of Activities

After general introductions, the first session on Tuesday morning was an overview of sablefish biology, fishery, and history of assessment by Dr. Jeff Fujioka. Questions were raised about how closed the assessed stock was (reasonably), the nature of spawning (no known spawning concentrations), marketability of post-spawn fish (not as valuable) and sex ratios of catches (variable depending on area and fishing method). The

recruitment pattern through time was discussed, and the possibility of an ecosystem or environmental change since about 1980, leading to lower recruitment in more recent years. The Panel noted that the change may be due to the level of variability being greater in the early period than more recently. Industry concerns were related to how whale depredation affects survey abundance estimates, whether the survey correctly reflects abundance, the weighting of fishery information for apportionment, and the effect of differing age distributions of catches in different areas on the assessment and apportionment.

In the second morning session Cara Rodgveller presented a summary of fishery data including abundance indices, ages, lengths, logbooks and observer data. The Panel asked whether there may be large foreign catches from the stock not accounted for and this was seen as unlikely. It was noted that observer coverage in the fishery is greater for larger vessels, and as vessels using pots in the west are mostly large, there is a differing level of observer coverage of the catch by area. Most of the fishing is in the GoA where the observer coverage is lower. Overall, 25% of the IFQ catch is observed. The Panel noted that statistical procedures such as GLMs were not used for any of the abundance indices.

An overview of Alaskan surveys that capture Alaskan sablefish was presented by Chris Lunsford on Tuesday afternoon. Different procedures were used through time to avoid fishery interaction with the domestic longline survey. The IPHC has conducted studies to determine localized depletion effects on survey results for halibut. These studies were not able to demonstrate a significant effect, but there are no similar studies for Alaskan sablefish. There has been a trend of decreasing interactions through time. The Panel noted that if there was a localized depletion effect, then accounting for fishery interactions would make recent abundances lower compared to earlier years than is shown by the current survey indices. Ecosystem/environmental effects on survey indices were raised as an item that has not been examined. The Panel requested recruitment series from US West Coast and BC sablefish stocks for comparison with Alaskan sablefish.

The current stock assessment model used for Alaskan sablefish was presented by Dr. Dana Hanselman on Wednesday morning. Recent changes to the model included split sexes, changes to selectivity functions, a temporal change in growth, and estimation of catchability priors. The Panel suggested exploring selectivity by length instead of age, accounting for selectivity when fitting growth, and the potential utility of a spatially disaggregated model. Multiple uses of some indices in the objective function and methods to re-weight likelihood components were discussed. The Panel requested model runs that dropped each survey index in turn and a sensitivity analysis for natural mortality. The Panel also requested diagnostic statistics on input and output CVs for survey indices and recruitment deviations, and input compared to effective sample sizes for length and age composition for the base case model.

Assessment model results and apportionment was presented by Dana Hanselman on Wednesday afternoon. Juvenile tagging using archival tags was also presented on Wednesday afternoon.

Tagging data, migration, and movement modeling was presented by Dr. Jon Heifetz on Thursday morning. Tagging data has been used for the assessment of growth rates, availability, ageing error, movement patterns, evaluation of apportionment schemes and population estimation. There have been a large number of tag releases - 326,500 in the years 1972-2007. Movement patterns from the Markov model are not currently used in the stock assessment used for calculating the ABC.

Chris Lunsford presented an overview of depredation by killer and sperm whales on Thursday morning. Depredation by killer whales in western areas has been a continuous problem, and affected sets are removed from the domestic longline survey data before calculation of the abundance index. Sperm whale depredation in the east has been increasing in recent years. Industry was concerned that sperm whale interactions have led to the domestic longline survey becoming less reliable, and favor increased use of fishery data as commercial operators are more adept at avoiding sperm whale depredation.

Dr. Dana Hanselman presented the results of requests by the Panel related to the stock assessment, including a sensitivity analysis for natural mortality, removal of individual and closely associated indices (with fixed base case selectivity), input and effective samples sized for age and size composition data, and raw growth data used to fit the growth model.

Ecosystem considerations for Alaskan sablefish were briefly presented by Dr. Kalei Shotwell in the last of the formal presentations on Thursday. Considerations that may have important influences on the Alaskan sablefish population are both natural and fishery induced environmental change (such as trawling impact on juvenile habitat), competition (juveniles are resident with arrowtooth flounder that have greatly increased in abundance recently), and predation (whales and possibly sharks).

The meeting was formally closed early in the afternoon, and the reviewers and meeting chair used the afternoon to complete a first draft of the summary report.

2 Review of Alaskan sablefish assessment

2.1 Terms of reference

The Panel considered the sablefish assessment in light of the terms of reference (TOR) provided as follows:

1. Evaluation, findings, and recommendations on quality of input data and methods used to process them for inclusion in the assessment.

2. Evaluation, findings, and recommendations on the level and adequacy of knowledge and incorporation of life history, ecology and habitat requirements.

3. Evaluation, findings, and recommendations of the analytical approach used to assess stock condition and stock status.

4. Evaluation, findings, recommendations of areal apportionment of harvest strategy as related to optimizing spawning stock biomass.

5. Recommendations for further improvements.

2.2 Panel findings by term of reference

2.2.1 TOR1 Evaluation, findings, and recommendations on quality of input data and methods used to process them for inclusion in the assessment.

In general, the Review Panel considered that the input data and methods used to process them for inclusion in the assessment were adequate and appropriate. The fishery and survey data were extensive and well documented. As with all assessments, the Panel identified a number of points worthy of discussion including the following:

Alaska Longline survey

The use of the Alaska longline survey data is appropriate for the current assessment configuration. The survey is well designed and appropriately executed and covers a large area of the stock distribution.

> **Survey-fishery interactions**. The Panel noted that over time the numbers of survey-fishery interactions has declined. It is not known whether interaction between commercial fishing and survey operations is likely to significantly affect survey catchability or catch rate indices, but if this is the case, the decline in the number of interactions over the time series is likely to have affected the survey index. However the Panel noted that the results of experiments conducted by the International Pacific Halibut Commission (IPHC) indicate that this may not be of concern.
>
> **Station locations.** The panel noted that many of the locations for stations used to compute the survey index were originally selected by the Japanese fishing masters using knowledge of the spatial distribution of sablefish to set in areas with the highest possible catch rates whilst spreading them out as much as possible along the coast. This selection of stations could lead to bias in the survey index. The additional stations in gullies, which are not used in the assessment, could provide a useful check on this. An analysis to check for differences in trends between the gully and non-gully stations may be a useful analysis to evaluate possible bias in the survey index.

Age and length data. The Panel noted that survey age and length frequency data sample sizes are quite large. Age data have been collected randomly on the surveys since 1995, growth curves are fitted and these data are used in the assessment directly, without applications of age length keys (ALKs) to length frequency data. The Panel considers that the methods used to process the data for assessment are appropriate. The assessment may benefit from improved age and length sampling of juveniles.

Gear saturation. Number of hooks per station on the longline survey was discussed, especially in relation to the potential for the gear to become saturated by sablefish or other species and the effect on survey indices. The Panel concluded based on presented information, including Sigler (2000), that this is unlikely to be a significant problem in deriving representative abundance indices.

Regional abundance trends. It was noted that the survey provides different regional trends in abundance, although the combined area-weighted index is used in the assessment model.

Whale depredation. The Panel noted that the survey index may have been affected by killer whale depredation, but based on presented information the Panel was satisfied that removal of the affected data appears to have only a minor effect on the index. Sperm whale depredation has not been accounted for in the indices (see further comments in the assessment section below).

Other surveys/indices

GOA bottom trawl survey. The Panel concluded that the inclusion of the GOA bottom trawl survey (to 500m) is potentially useful for indices of abundance for incoming year classes; and although the survey should help estimate recent year class strength, the current assessment does not fit this index as well as the longline survey indices.

Commercial longline fishery catch rates. The Panel concluded that the use of fishery CPUE is appropriate for the current assessment. The practice of post-screening fishing operations to derive target-specific effort may lead to unwanted bias in the CPUE indices, and the Panel suggested that a better approach to evaluating the fishery CPUE would be to undertake a statistical (GLM) analysis.

Fishery data

Accuracy of landings/total catch and stock structure. The Panel considers the current treatment of stock area and total catches as adequate for assessment and associated management. Nevertheless, the following points were noted:

- State catches are not included in the assessment but their exclusion is unlikely to have a significant effect on the assessment results.

- Catches from the western Bering Sea in the earlier part of the time period are unknown, and the overall catch figures for the earlier period when the fishery was open to international fleets is likely to be generally of poorer quality than in later years. The likely effect of underestimated catch on the assessment results is not quantifiable but is unlikely to have any significant effect on the recent stock biomass estimates.
- There is anecdotal information of high-grading during different years. The sensitivity of the assessment to alternative plausible catch history has not been investigated.

Age-length sampling. The Panel noted that the adequacy of length-age sampling has improved in recent years.

- Vessels accounting for 30% of the catch are sampled, which is relatively good coverage and indicates that the effective sample size is high. Trawl fishery data are sparse, but the longline fishery was well sampled. The adequacy of existing sample size in terms of precision should be investigated.
- Observer coverage is biased towards large vessels and the effect of this on age and length sampling is uncertain.
- The age-length conversion matrix appears to be appropriate. It was noted that the change in growth is modeled with a step-change. An improvement may be to have a gradual change over a number of years.
- The Panel agrees with the procedures adopted for evaluating the accuracy of age determination using validated known-age samples, and the compilation of an age error matrix to allow for use in the assessment model.

Voluntary logbook scheme. The voluntary logbook program was seen as helpful to evaluate the under-60' fleet, which is otherwise only monitored based on fish-ticket data. Some concerns were raised that the coverage for this fleet was very low historically. The implications of this low sampling level for this fleet component on the derived abundance index should be investigated.

Data not currently included in current assessment.

A number of data sources not currently used in the assessment were identified as candidates for inclusion in future assessments and their utility should be investigated:

- Combined sex data from early fishery size composition data
- Sex ratio data can potentially be used in the fitting the model
- The time-series of sablefish CPUE from IPHC surveys
- EBS slope surveys (although there are concerns regarding the sex ratio and a predominance of large males need to be investigated)
- State surveys (recognizing potential issues with applicability to the AK-wide stock)

Other issues.

The Panel considered that a more specific presentation on data quality would have been useful, given the wide variety of data sets included in the assessment. This presentation could have included assurance that observer protocols and representativeness of sampling has not changed over time.

2.2.2 TOR2 Evaluation, findings, and recommendations on the level and adequacy of knowledge and incorporation of life history, ecology and habitat requirements.

Basic stock structure, distribution and migrations. Based on the available survey and fishery information the Panel considers that the stock assessment data are probably representative of the bulk of the stock extending from Alaska to northern British Columbia.

Growth and age structure. The Panel concluded that the revised bias-corrected data and updated growth curves for 1981-1993, and the new growth curve from random otolith collections in subsequent years, represent an improved use of age data in the assessment. There is evidence for a change in growth rates over time. The Panel recommends an investigation of year and year-class effects on length-at-age as a potential alternative to the simple step change in growth parameters presently used in the model. If significant year and/or year-class effects can be demonstrated, then it may be possible to generate more accurate length compositions from model-based age compositions for use in the fitting of observed length compositions. The Panel notes the difficulties in ageing sablefish, particularly fish over 8 years of age, and the potential effects of age errors on an assessment fitting a model out to 30 years of age. The use of an ageing error matrix appears appropriate for a statistical assessment model, but the smearing of age compositions across year classes will remain a source of error in the assessment particularly for individual large year classes.

Maturity. The use of separate maturity ogives for female and male sablefish represents the most appropriate use of maturity data for computing spawning biomass rather than the use of a combined-sex maturity ogive. The Panel notes that the ogives currently used are from data collected prior to the mid-1980s, and that more recently collected and histologically verified maturity data are available and will be used for future assessments. The new data indicate a slightly higher age at 50% maturity in females. Temporal trends in maturity should be monitored. However, given the observed changes in growth, it would be valuable to quantify the age and length dependence of maturation.

Sex-ratio. The Panel was presented with data indicating a predominance of males in trawl catches and a predominance of females in the longline catches. There appeared to be temporal trends in the data for both fisheries, and the assessment model also generates a trend in proportion of males, increasing to just under 0.55 by the early 1990s followed by a decline close to 0.50 in more recent years. It is not clear if this represents a true picture of changing sex ratios in the population or is an artifact of

allowing the model to estimate population numbers separately for males and females without explicitly considering sex ratio in the fitting process. Depending on any prior knowledge of sex ratio at age in the population, it may be preferred to include the sex-ratio explicitly in the model (e.g., as part of the compositional information that is available by gear type).

Natural mortality. The assumed value for natural mortality (M=0.1) appears appropriate for this stock and is supported by data on longevity of sablefish as well as the results of sensitivity analysis of the results of the assessment model to different values of M, requested by the Panel.

Ecosystem aspects and competition/predation levels that potentially impact sablefish stocks. The Panel supports efforts to quantify ecosystem effects on sablefish dynamics. In particular, studies on factors affecting conditions for pre-recruits would be useful to provide insights on medium-term future trends. Such studies would benefit from reliable data on abundance trends for young sablefish from suitable surveys. Large changes in predator/competitor species (e.g. the recent substantial increase in arrowtooth flounder abundance) may affect population trends of sablefish.

2.2.3 TOR3 Evaluation, findings, and recommendations of the analytical approach used to assess stock condition and stock status.

The Panel concludes that the analytical approach was appropriate and provides an acceptable basis for management advice. There was some double-use of longline relative indices (i.e. both RPNs and RPWs). Sensitivity analyses and diagnostics were requested and examined during the review.

Abundance indices. It was recommended that the RPN versions of the Japanese and domestic longline indices should be used and RPW values should be omitted since these indices are highly correlated. Use of both number and weight effectively doubles the weight given to these data in model fitting.

Retrospective pattern. The current assessment has a retrospective bias where successive assessments revise the entire biomass series downwards, with the largest bias occurring in the recent period up to 2006. The bias appears much reduced over the last two years of the assessment. The causes of this bias require further investigation, particularly in relation to the appropriateness of the current model configuration. The impact of the bias on ABC estimates is uncertain and also warrants further investigation.

Diagnostics and sensitivity analysis. The Panel requested some standard assessment diagnostics and sensitivity analyses:

- A comparison of input and output CV for abundance indices. The base model configuration tended to produce larger output CVs than input CVs. Results suggest that the CVs for all indices in the base model should be doubled.

- A comparison of input and effective sample sizes for compositional data. These indicate that the input N may be overestimated for the cooperative and domestic longline survey age data, and underestimated for other compositional data.
- A sensitivity analysis for plausible alternative natural mortality values was conducted. The likelihood profile is relatively flat for values of *M* between 0.08 and 0.12. Values of $B_{40\%}$ and ABCs associated with *M* values in this range vary considerably, but the likelihood profile indicates that for the base model configuration, a value of $M = 0.1$ appears the most appropriate.
- A sensitivity analysis for the removal of each abundance index individually. When selectivity was held constant at base case estimates, the biomass trend was most sensitive to the removal of both domestic longline indices (biomass lower recently) and the RPW index (biomass higher historically). There was little sensitivity to removal of other indices.

Projections. The biomass is currently 36% of B_0, slightly below the target of 40%, so under the Tier 3b harvest strategy the ABC was derived from $F_{40\%}$ reduced to account for the current biomass being below the target. This form of harvest control rule is similar to that used for other fisheries, and is appropriate. Projections indicate that the stock will decline until about 2012 and then increase. Also indicated is that the stock may fall below the B_{MSY} level of $B_{35\%}$ in the near term. If the stock evolves as projected, and taking into account the uncertainty around the projection, there is a high probability that ABC estimates will be reduced in the next few years.

2.2.4 TOR4 Evaluation, findings, recommendations of areal apportionment of harvest strategy as related to optimizing spawning stock biomass.

The current apportionment scheme is difficult to evaluate given the information presented, particularly since there are unstated socio-economic objectives that play a role. The Panel recommends that a set of objectives be clearly identified. While recognizing that there are uncertainties in regional abundance and productivity, the approach of distributing ABC values taking into account regional biomass levels appears an appropriate way of attaining equivalent fishing mortality in the different regions.

Use of survey indices and fishery CPUE data. The apportionment scheme provides more weight to the longline survey data for regional abundance than to the fishery CPUE data. The Panel agrees that, given the data available, this is appropriate, even given factors such as trends in fishery interaction and whale depredation with the survey. Although the longline survey covers only part of the fishing season, whilst the fishery CPUE data arises from information over the full 8-month season, the survey has the advantage of using a standardized design over the full area. Variation between areas and times in the fishery CPUE data may not fully reflect the pattern of abundance of sablefish due to targeting and differences in fishing gears. The Panel recommends the use of region-specific selectivity/availability estimates be explored as a possible modification to the apportionment scheme. This may lead to better use of the fishery

and survey data for apportionment. Projections taking such selectivity factors into account could be used to evaluate the performance of different apportionment strategies.

Tagging model. The Panel noted that movement estimates using results from the updated tagging model should be used for evaluating the impact of different apportionment schemes.

Whale depredation. The various impacts of whale depredation were examined. This was identified as potentially affecting the abundance index and as also affecting regional apportionments. The removal of killer whale depredated sections of sets from the longline survey index does not appear to create a bias but is likely to add to the uncertainty (i.e., higher variance due to smaller sampling effort). Killer whale depredation appears to be relatively stable over time. Despite these observations there may be merit in evaluating methods of "in-filling" the removed skates using a GLM or spatial modeling techniques, rather than just leaving them out. Simply leaving out the skates will only be unbiased if they are a random selection of all skates in a stratum.

A study using data from 1998-2004 suggests that the impact of sperm whale interactions on catch rates is small (~2% for sets with observed depredation). However, there are concerns that the depredation extent is increasing in recent years (in particular, for 8 stations in the W and E Yakutat slope area). The depredation rate is similar to that observed in other fisheries in other parts of the world. Industry views were expressed that the depredation rate is higher than these estimates. Significant changes in the depredation rate will impact both the index of abundance and apportionment schemes. The Panel supports the proposals to develop better ways to quantify impacts including acoustic techniques, hook monitoring, deterrents, set/skate classification (depredated or not), masking vessel noise, and innovative ways to compare between indices (e.g., parallel pot sets).

Whale depredation is an issue for fishery CPUE data, as encounters typically lead to vessels leaving an area or in some areas changing to pot gear as they have in the Bering Sea. Quantifying the effect may however be difficult, because the recording of whale depredation incidences in logbooks is incomplete and may not provide a reliable indicator of the true incidence of depredation and its consequences for vessel activity.

2.2.5 TOR5 Recommendations for further improvements.

The Panel recommends that in future assessments, the following points are addressed.

Age and length data. The Panel recommends that comparisons between the length frequency distribution of the age-samples with the overall length frequency be undertaken as an internal consistency check for sampling bias. Furthermore, it would be desirable to develop ALKs and apply these to the observed length frequency distributions to compare the resulting raised age composition estimates with the randomly sampled age compositions.

Commercial longline fishery catch rates. The Panel recommends that fishery catch and effort data be screened using a statistical modelling (GLM) approach to evaluate and where possible correct for factors other than sablefish abundance affecting CPUE.

Fishery age-length sampling. The adequacy of existing sample sizes in terms of precision should be investigated.

Data sources not currently used in the assessment. The utility of a number of additional sources of data for the assessment should be investigated including combined sex data from early fishery size composition data, sex ratio information from various sources, CPUE from IPHC surveys, EBS slope surveys, and Aleutian Island trawl surveys.

Stock Assessment

- **Size selectivity**. Selectivity is currently modeled by age separately by sex, and the difference in the fitted selectivity curves appear to be largely due to growth differences by sex. The Panel recommends that size-based selectivity be implemented in future assessments, and that single combined-sex selectivity curves be tested for each fishery. This will potentially reduce the number of selectivity parameters used by the model.
- **Spatial structure**. An area-disaggregated assessment approach should ideally be developed and may lead to improved management advice. Abundance trends and size/age composition vary by area, and spatially separable index and composition data and movement data from tagging are available. Such a model can also provide better insight on the impact of apportionment policies. Area-disaggregation options include:
    - Treating areas as separate fisheries, fitting area-specific selectivity.
    - Modeling movement between areas using tagging information.
- **Diagnostics**. Standard assessment diagnostics should include plots of input and output CV for abundance indices, input and effective sample size for age and length composition, and input and output CV for recruitment deviations.
- **Weighting of likelihood components**. Iterative reweighting using input and output CVs, and input and effective sample size should provide default weightings for likelihood components in the assessment model.
- **Sensitivity analyses**. Sensitivity of estimated depletion and recommended ABC to important fixed parameters should be part of the assessment documentation.
- **Model building/specification.** It would be useful to have a more formal examination of the basis for decision making when building towards the final model configuration and adding individual data sets. Also, the impact of “smoothing” factors. (e.g., annual fishing mortality and recruitment) should be evaluated and avoided if unnecessary.
- **Growth parameter estimation**. Growth parameters should be estimated within the assessment model so that the impact of size-based selectivity is properly

accounted for. The sablefish growth parameters have high t_0 values that may be symptomatic of not accounting for selectivity when fitting growth models.

- **Simulation testing**. The current model should be validated by simulation testing using simulated data to ensure that biomass and recruitment trends are reasonably reproduced.
- **Retrospective pattern**. The source of the retrospective pattern shown by the assessment requires further investigation, particularly if such a pattern continues as the assessment evolves from year to year.

Annex 1 Participants

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