Sablefish STAR Panel Report

National Marine Fisheries Service
Hatfield Marine Science Center
Newport, Oregon
25-29 July 2011

Review Panel Members:

Vidar Wespestad (Chair), SSC representative
Kevin Stokes, Center for Independent Experts
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STAT Team Members Present:

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Advisors:

John DeVore, Pacific Fishery Management Council (PFMC) Staff
Joanna Grebel, PFMC Groundfish Management Team representative
Gerry Richter, PFMC Groundfish Advisory Subpanel representative

Overview

During 25-29 July 2011 a Stock Assessment Review (STAR) Panel met in Newport, Oregon to review draft stock assessment documents for sablefish (Stewart et al. 2011) and Dover sole (Hicks and Wetzel 2011). This report covers only the review of sablefish, but the Panel considered and discussed many issues common to both stock assessments. The Panel operated under the Pacific Fishery Management Council's (PFMC) Terms of Reference for the Groundfish Stock Assessment and Review Process for 2011-2012 (PFMC 2010).

The West Coast sablefish stock assessment was conducted using a recent version of Stock Synthesis 3 (SS3 ver3.21f) applied to data from several sources. Although a draft assessment document was distributed to the Panelists several weeks before the Panel meeting, subsequent to the distribution, but prior to the meeting, the STAT discovered an error in the SS3 code associated with time-varying age-based selectivity curves. Although the corrected code produced only minor changes to the assessment results, many of the results presented in the draft document were erroneous. Prior to the STAR Panel meeting the STAT was able to redo the analyses using the corrected program and for the meeting the STAT provided a partially revised assessment in which results produced by the corrected SS3 program were presented in the Executive Summary. Results presented by the STAT during the STAR Panel meeting were based on the corrected SS3 program. Tables and figures in the body of the assessment document will be corrected for the version of the document that will be reviewed during the September PFMC meeting.

The sablefish assessment assumes a unit stock in the waters off Oregon, Washington, and California. All model configurations included available length, age, and biomass data from four bottom trawl surveys of the slope or shelf, and available length and age data from the trawl, hook

and line, and pot fisheries. The estimated catch history, split into the three gear-types, extended back to 1915. All parameters were freely estimated except for steepness, which was fixed at 0.6.

The STAT lead author (Ian Stewart) presented an overview of the model, including the differences between the original base model presented in the draft assessment document and the results produced by the corrected SS3 code. The new assessment model was developed by making a sequence of changes to the model from the previous assessment, implementing many of the changes requested by the previous STAR Panel. The new model is much simplified compared to previous sablefish assessment models, which generally included complicated structures of time-blocking to accommodate time-varying selection.

The requests to the STAT by the current STAR Panel focused on exploring whether the simplified model structure proposed by the STAT provided an adequate representation of the stock dynamics. In particular there was some evidence in the diagnostic residual plots for the fishery age-compositions of systematic lack of fit to certain cohorts and an apparent tendency to under-estimate strong year-classes. After reviewing results from several exploratory analyses prepared by the STAT the STAR Panelists were satisfied that the proposed base model adequately fit the available data. However, the STAR notes that uncertainty in the model probably could be reduced in future assessments with better maturity data and improvements in age determination. Also, the STAR shares the STAT's concern that the assessment results may have been degraded by uneven port sampling among the states for age and length data.

The STAR recommends the new sablefish stock assessment as the best available science and that it provides a suitable basis for management decisions.

Given that the current model structure appears to result in underestimates of strong year classes, the Panel recommends that the current model would be suitable for producing an update assessment in two years; but, over a longer time horizon, a full assessment should be conducted to explore the need for possible changes in the model structure.

Summary of data and assessment models

The new stock assessment structured the fishery data (landings, and length- and age-compositions) into three major gear-types (hook & line, pot, and trawl) and the fishery data were collapsed across states. Fishery independent data sources included the Northwest Fishery Science Center's (NWFSC) shelf / slope combination survey, which has operated annually since 2003, and three surveys that operated historically but are now discontinued: the NWFSC slope survey, the Alaska Fishery Science Center (AFSC) slope survey, and the AFSC shelf survey.

The data were fitted using the Stock Synthesis modeling software (SS3 (ver3.22)), which incorporates several new features that were not available when this stock was assessed previously, notably the ability to allow flexible but smooth selectivity curves. The new assessment was configured to estimate major stock parameters such as natural mortality, growth, and unexploited stock size, which past assessments had generally left at fixed values. Consequently the new assessment was much better able to estimate uncertainty in the modeling results.

Requests by the STAR Panel and Responses by the STAT

Request #1: Provide bubble plots of residuals for length and age compositions by sex for all data sets, aligned by year as possible.

Rationale: In the draft assessment document the bubble plots of residuals were laid out in way that made it very difficult to evaluate residual patterns among the different data sources. The Panel wanted to investigate the residual plots for evidence of systematic patterns such as missed year classes or poorly chosen time-block boundaries.

Response: The STAT provided the requested bubble plots (e.g., Fig.1). The bubble plots indicated a pattern of negative residuals associated with the 1999 and some other year-classes, implying that the base-run model was underestimating the strength of the 1999 year-class and other year-classes. There were also some indications of systematic lack of fit during particular time periods (e.g., large negative residuals in age compositions for males from the pot fishery during 1986-1991).

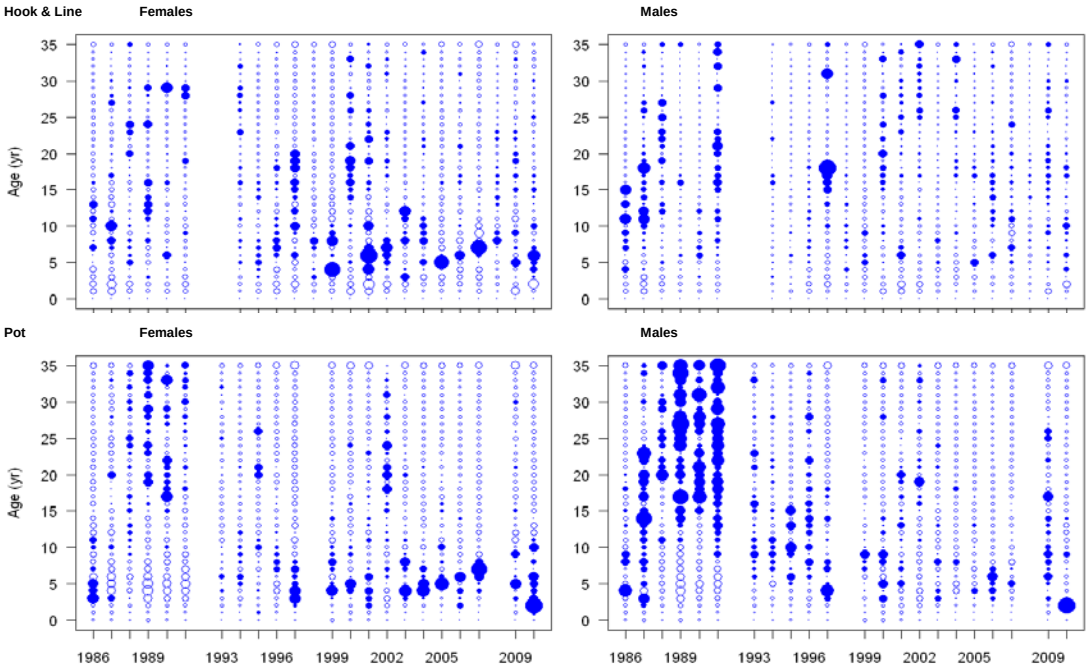

Figure 1. Example of bubble plots produced by the STAT in response to Request #1.

Request #2: Prepare summary of proportions of samples and catch by year, state and gear.

Rationale: The assessment structured the data into three broad gear-types (hook & line, pot, trawl) combined across the three states. Some of the apparent patterns in the residuals may be artifacts of uneven sampling by the states or changes in the level of sampling.

Response: The STAT provided plots by gear-type of the annual proportions of sampled trips coming from each state, and companion plots showing the corresponding landings (e.g., Fig.2). The level of sampling is sometimes erratic, with years when landings from a state have no corresponding sample information. In general there were no changes in the pattern of sampling

that matched the unusual patterns evident in the residual plots, which suggests that uneven sampling was not the source of the residual patterns. One possible exception was the data from the pot fishery in early years, which were dominated by sampling data from Oregon even though landings from California were comparable to landings from Oregon. The uneven sampling probably contributed to the problematic residual patterns, but the effect did not appear to be strong.

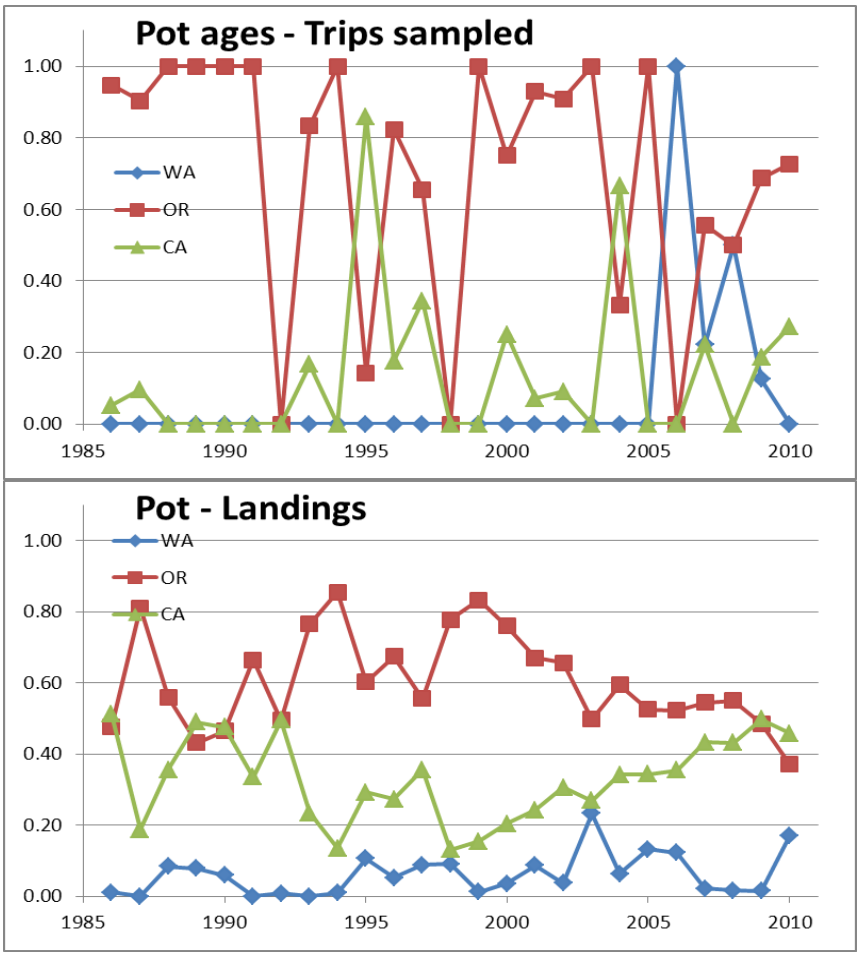

Figure 2. Example of time-series plots of samples and landings produced by the STAT in response to Request #2.

Request #3: Prepare very brief summary of management and other issues that might have affected fishery behaviour.

Rationale: Some of the patterns evident in the bubble plots may reflect changes in the fishery that are not adequately accounted for by the current structure of the assessment model. The panel wanted to explore whether there is any correspondence between patterns in the residuals and an important change in management or other aspect of the fishery.

Response: The STAT produced the requested list of important changes in the fishery and its management. This informed further discussion between the Panel, STAT and industry advisors regarding potential blocking structure.

Request #4: Perform model run with three selectivity time blocks (to 1983, 1984-1995, 1996-present); provide standard outputs and if possible comparison as for Request 1.

Rationale: The base model had two time blocks, with a break in fishery selectivity curves between 2002 and 2003, coinciding with the implementation of the Rockfish Conservation Area. The Panel was concerned that the assumption of constant selectivity might be causing distortion and the non-random residual patterns observed in the young ages. Based on consideration of the response to Request 3, the Panel identified a scenario with three time blocks.

Response: The STAT produced the requested model run and results. Comparative bubble plots of residuals did not indicate any appreciable improvement in the residual patterns associated with the 1999 and other strong year classes (e.g., Fig.3). The trajectories of spawning biomass and recruitment were not greatly affected either.

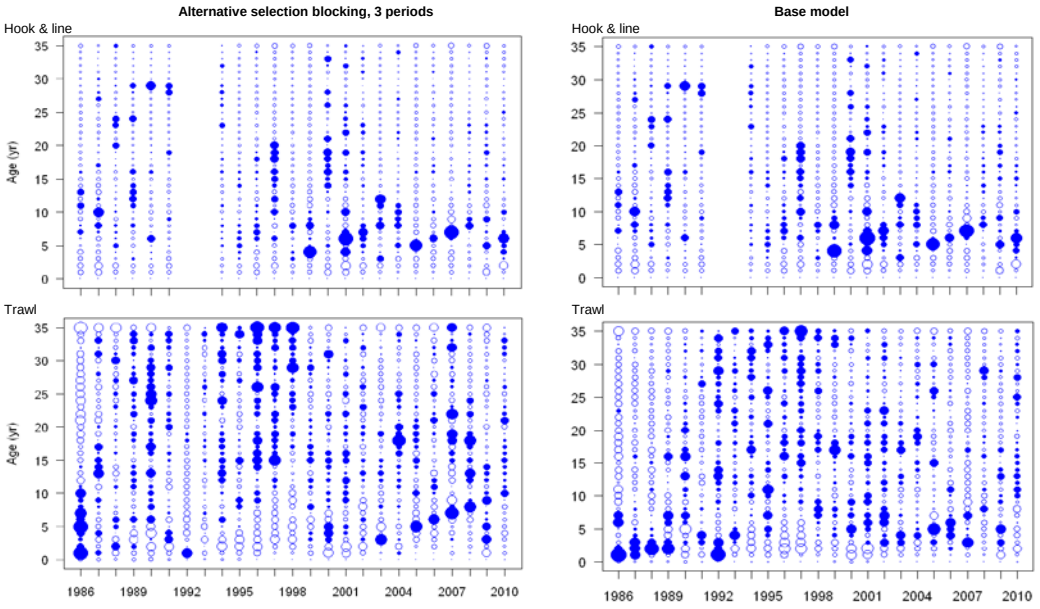

Figure 3. Example residual bubble plots produced by the STAT in response to Request #4, comparing a model having three periods of fishery selection with the base model, which had two periods of fishery selection. Female age-composition residuals are shown.

Request #5: Run base case with plus group set to 15 years.

Rationale: Given the large number of age-classes in the base model, the Panel was concerned that the model may have been achieving a reasonable fit to older age-classes at the expense of degraded fits to younger age-classes.

Response: Fulfilling this request required the STAT first to collapse age-composition data that were input to Stock Synthesis. The STAT was able to accomplish this task and produced a

set of plots to illustrate fits to the restructured data and their effects on model outputs. The bubble plots of the age-composition residuals did not indicate any appreciable improvement in the residual patterns associated with the 1999 and other strong year classes (e.g., Fig.4). The trajectories of spawning biomass and recruitment were affected, however, because the restructuring of the data removed signals of early recruitment events that were previously evident in the compositional data for older age-classes (Fig.5). The overall declining trend in spawning biomass remained and there were only minor changes in the estimates of current depletion.

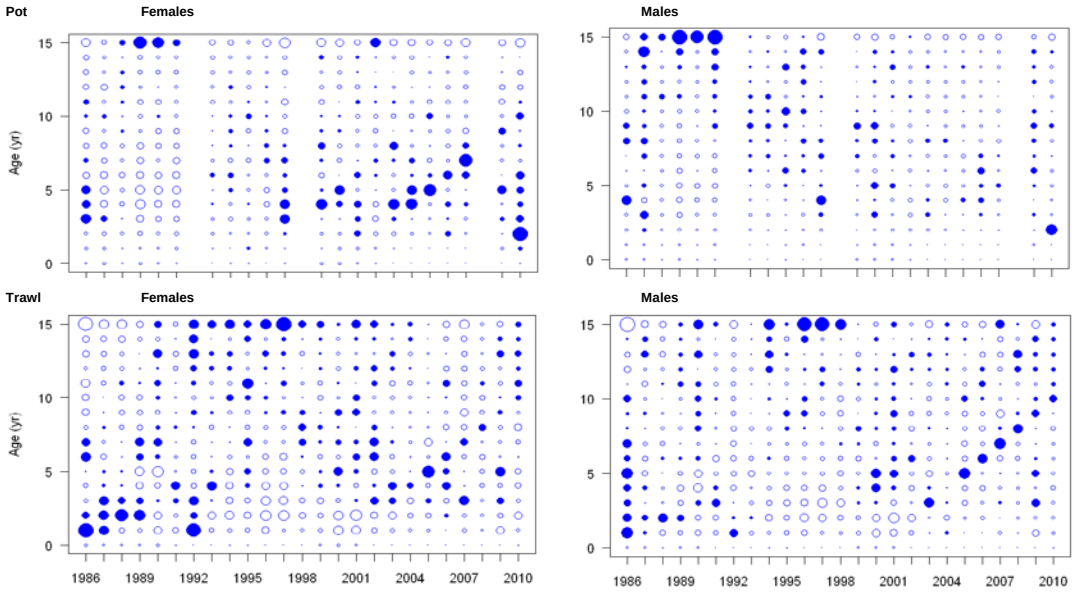

Figure 4. Example residual bubble plots produced by the STAT in response to Request #5, from a model with age-composition data structured into ages 1 to 15+.

The STAT also produced a sensitivity run using a new Stock Synthesis feature for age-dependent natural mortality based on the Lorenzen model, which links natural mortality with growth, such that fish suffer higher rates of natural mortality when they are small. This alternative model formulation produced a slightly degraded fit to the data and did not have any appreciable effect on the problematic residual patterns produced by the base model.

The Panel did not have any additional data or modeling requests for the STAT and collectively agreed that the base model, as proposed and presented by the STAT was suitable for use in formulating a decision table and management advice.

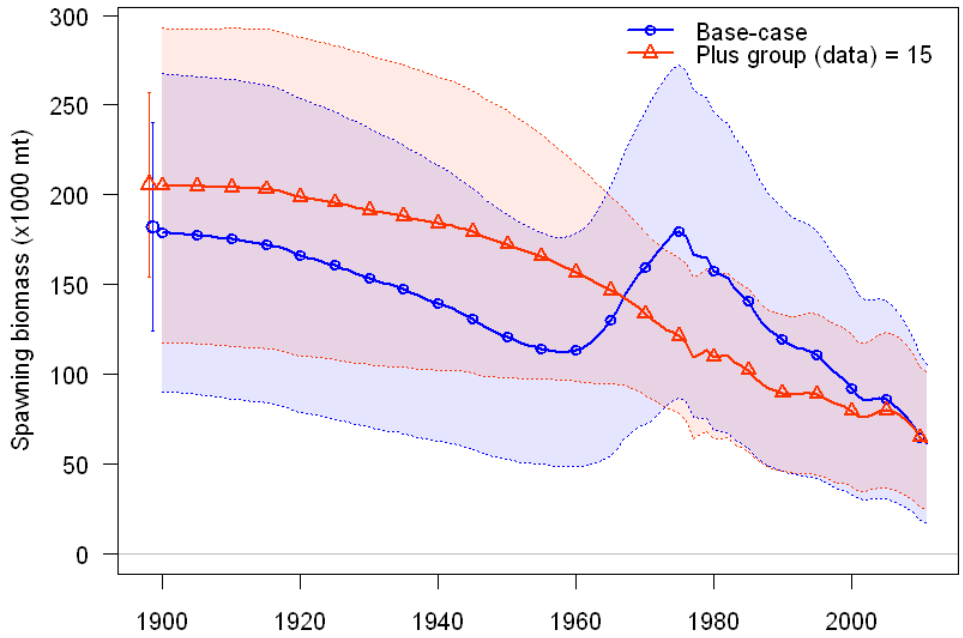

Figure 5. Spawning biomass trajectories from a model with age-composition data structured into ages 1 to 15+ versus the base model.

Description of base model and alternative models used to bracket uncertainty

The final base model was identical to the base model proposed by the STAT. Key aspects of the model were structuring the fishery data into three gear groups with two time-blocks to allow changes in fishery selectivity between 2002 and 2003 and three time-blocks to accommodate changes in retention and discarding practices. Fishery selectivity curves were age-based and fitted using cubic spline functions and included gender-based offsets. Survey selectivity curves were also age-based but were fitted using double-normal selectivity curves with no gender-based offsets. No biological parameters were modeled as time-varying. Natural mortality was estimated using informative priors developed by Owen Hamel (NOAA/NMFS/NWFSC) from information on maximum age, growth and average water temperatures. Recruitment was assumed to conform to a Beverton-Holt stock-recruit relationship with steepness fixed at 0.6. The complete time-series of recruitment deviations were estimated (1900 to 2010).

Because the base model included all major sources of uncertainty other than uncertainty associated with steepness (which was fixed at 0.6), the decision table was based on the hessian matrix from the base model rather than using alternative model runs.

Comments on the assessment

The STAT prepared a very thorough draft assessment document and presentations for the Panel, which anticipated and provided answers to many questions before they were even asked. This greatly facilitated the review process. The STAT made effective use of time during the STAR Meeting and was thorough in responding to the STAR Panelists requests. The STAT are

commended for producing an assessment that makes effective use of technical innovations in the Stock Synthesis software and presenting the results in a clear and concise manner.

Technical merits:

- Significant simplification of model structure and reduction in estimated parameters compared to previous assessments for this stock. A simplified model structure, as used in the new assessment, is unlikely to be able to mimic complex stock dynamics. However, the panel saw no diagnostic evidence that the new assessment was being unduly influenced by structural deformities that could be supported by data or theory.
- Incorporated many more sources of uncertainty into the model results than in previous assessments.

Technical deficiencies:

The Panel found no technical deficiencies in the stock assessment model or in the STAT's application of the model.

Explanation of areas of disagreement regarding STAR Panel recommendations

Among STAR Panel members (including GAP and GMT representatives)

There were no major disagreements among STAR Panel members and there was no public comment to the STAR on the assessments under review.

Between the STAR Panel and STAT Team

There were no major disagreements.

Unresolved problems and major uncertainties

The steepness parameter was fixed, rather than estimated, so this important source of uncertainty was not included in the model's estimates of uncertainty. The STAT used the likelihood profile approach to explore the influence of steepness but that analysis clearly indicated that the current data are not sufficient to inform the model on the value of steepness, which is most likely to influence the estimate of MSY rather than current status. The uncertainty in MSY does not influence short-term management advice but would be important if the stock was overfished. The Panel has no suggestions on how to rectify this deficiency.

Management, data, or fishery issues raised by the GMT or GAP representatives during the STAR Panel.

There were no management issues noted to be impacting the assessment, but GMT and GAP members noted that changes due to adoption of individual vessel quotas may lead to potential changes in harvest patterns. Also, the GAP member expressed concern regarding the timing of

the next assessment. Given the model's apparent difficulty estimating strong year classes and the potential for strong incoming strong year classes in the near term, a full assessment should be conducted if survey and fisheries data indicate that strong year classes are expected to enter the exploitable population.

Recommendations for future research and data collection.

The following recommendations are listed in priority order.

General recommendations affecting more than one assessment.

- Complete and review the Washington catch reconstruction and review the California and Oregon catch reconstructions. The accuracy and wide availability of consistent basic information is essential to the development of Pacific coast assessments. In addition to the raw data, the reliability and availability of more spatially dis-aggregated forms of the data should be investigated to determine if they could be used to develop more spatially or temporally explicit models without causing sacrifices in accuracy.
- Include in future versions of Stock Synthesis the capability to explore alternative error distribution assumptions for compositional data. Currently the multinomial distribution is the only type of error distribution available in Stock Synthesis for length or age information. It appears that this may have some impact with respect to underestimating strong year-classes. It would be helpful to be able to explore alternative error assumptions in order to analyse composition information, in particular where the effective sample size estimates (which control the variance in the composition data) may be related to perceived stock abundance.
- Develop guidelines for use of the Lorenzen model for age-dependent natural mortality. The panel investigated the use of age dependent M in both the Dover sole and sablefish assessments. In each case one of the reasons for exploring different mortality schedules was the potential imbalance between the genders in the age- and length composition information, either in the sex ratio at older ages (Dover sole) or in the ratio of young to old fish (Sablefish). The use of the Lorenzen M model, which is based on a decline in M with age by the inverse of the growth rate, implies a link with size-based predation. However, with likely wider use of this model feature there should be development of some guidance on the appropriateness of the implementation in other stock assessments.
- Conduct new studies of maturity by length and age based on more comprehensive coastwide and depth-based sampling and using histological techniques for determining maturity stage. Given that there is uncertainty regarding the temporal stability of maturity schedules, there should be periodic monitoring to explore for changes in maturity
- Modify the Stock Synthesis code to allow changes to the plus-group age. The Panel found it very helpful to be able to modify the plus-group in the age-composition data to investigate the influence of old versus young age composition data. This feature could also be used to explore the influence of ageing errors. The current version of SS requires restructuring of the input data if the plus-group is changed.

Recommendations specific to sablefish.

- Further investigate potential inaccuracy in using maximum likelihood estimates and the normal distribution to approximate confidence limits for estimates of spawning biomass. The current assessment's measures of uncertainty in spawning biomass are based on the assumption that the errors can be adequately approximated by normal distributions. The current model for sablefish is sufficiently simple that it may be feasible to conduct a full Bayesian analysis of uncertainty. There is concern that asymmetries in the error distributions, which the normal distribution cannot account for, may be creating a biased view of stock status.
- Conduct new studies on maturity and age-reading error. A major uncertainty in the sablefish assessment relates to the maturity schedule and in age determination. Better maturity and age-at-length data could reduce uncertainty and help resolve issues of cohort size.

Acknowledgements

The Panel commends the STAT member for demonstrating a productive, collaborative relationship in responding to the Panel's requests and for his stellar performance at the meeting. The STAR Panel also thanks Dr. Jim Hastie and Ms. Stacey Miller of the NWFSC for providing logistical support for the meeting.

References

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Stewart, I.J., Thorson, J.T., and Wetzel, C. 2011. Status of the U.S. Sablefish resource in 2011.