WIDOW ROCKFISH
STAR Panel Report

July 11-15, 2011

Hotel Deca
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Overview

A draft assessment of the widow rockfish (*Sebastes entomelas*) off the U.S. west coast was reviewed by the STAR panel during July 11-15, 2011. The stock is assumed to be a single stock with two-area subpopulations due to differences in growth and fecundity schedule. There are no genetic data available that would provide information on population structure. The stock is subject to five major fisheries – four in the northern area and one in the southern area. This assessment used the Stock Synthesis platform version 3.20d and incorporated a variety of fisheries-dependent and -independent data sources into the candidate base model.

The last full assessment of widow rockfish was conducted in 2009. This assessment is similar to the 2009 assessment in model structure and data sources. Changes in this assessment relative to the 2009 assessment include:

1. New SS3 version
2. New data:
    - 2009-10 data: catch, age, and survey
    - New ASP fishery (at-sea whiting processor)
        - Previously lumped to OR mid-water trawl
        - New age and length data
    - OR historical catches
3. Number of age group changed from 30+ to 35+
4. Updated steepness (h) prior
5. Use of double-normal selectivity functions instead of logistic functions

This assessment also documented results from two studies intended to address 2009 STAR concerns and recommendations – ageing errors for fish 30 – 40 cm and area configuration.

The STAR Panel cannot conclude that the proposed base model is the best assessment model to be used for management without additional exploration of model structure and organization of data. Areas of concern include 1) the use of dome-shaped selectivity patterns for all fisheries and surveys without proposed model-independent biological mechanisms, and 2) the sensitivity of model estimates to changes in the form of the selectivity patterns (asymptotic or dome-shaped) and whether selectivity is length-based or age-based.

Dome-shaped selectivity pattern for all fisheries and surveys is a strong assumption. More information on population distributions and fishing locations is needed for justification. Further exploration of alternative selectivity pattern for each fishery and survey is encouraged.

Model sensitivity (large variation in model outputs to changes in model structure) and stability (model runs that do not converge and/or have some parameter estimates at their bound) can potentially be addressed by fixing parameters at reasonable values. However, this step should be taken after evaluation of alternative formulations of model structure and available data that may improve model stability.

Due to data availability and time constrains, exploration of alternative model formulations was not possible during the STAR panel meeting. Additionally, the Panel did not have opportunities

to review other issues (i.e., parameter uncertainty, estimation of discard rates) because of time spent on attempting to stabilize model structure. The Panel notes that several of the concerns regarding model and data structure were also identified in the 2009 STAR Panel report.

The STAR Panel thanks the STAT member for his hard work and responses to panel requests. The Panel encourages the STAT team to conduct further model evaluation and exploration of alternative model configurations such as one-area model and length-based selectivity.

Analyses requested by the STAR Panel

The requested analyses pertained mostly to alternative model runs and are listed in chronological order. Responses for each day are grouped together.

Day 1 requests

1) Conduct model runs, with and without a 2 or 3 year retrospective pattern, with two areas and fixed *M* (as in proposed base model) but with asymptotic selectivity.
Rationale: In the base model, all selectivities are modeled as dome-shaped without biological mechanisms explaining why selectivity and/or availability would decrease at older ages. Asymptotic selectivities appear to be plausible given the pelagic distribution of the stock, and would simplify the model.

2) Conduct model runs with the base model, but with asymptotic selectivity and estimated *M* on older ages.
Rationale: In the proposed base model, the use of dome-shaped selectivities suggests that fish at older ages exist but are not being selected. Alternatively, asymptotic selectivities would suggest that older age fish do not exist, and the estimated natural mortality on these fish may be larger.

3) Two parts in this request:

a. **Conduct a single area run using asymptotic selectivity and the northern area growth and maturity pattern for both areas.**
b. **Conduct a single area run using asymptotic selectivity and the southern area growth and maturity pattern for both areas**

Rationale: Differences in growth, maturity, and fecundity were observed between the northern and southern areas, and motivated the two-area model. The rationale for these two requests is to evaluate the influence of spatial differences in biological characteristics by approximate single-area models using either the northern or southern set of biological parameters.

Response to Day 1 requests: Model results from the four requested runs were presented and showed some similar properties. The level of B_0 was relatively similar to the pre-STAR model, but the decline in spawning output and biomass in the 1960s and increase since 2000 were more pronounced than in the pre-STAR model. The more rapid dynamics are possible by increased estimates of steepness, which were at their upper bounds in all of the requested runs. For requested run 1, the model response to asymptotic selectivity is to increase recruitments for several age classes, leading to a rapid increase in recent years; this also results in temporal correlation of recruitment deviations. In general, one might expect an interaction between

selectivity and natural mortality rate. However, in the requested runs where *M* for the older age is estimated, the resulting estimate changed little relative to the dramatic change in steepness. This is likely related to only estimating the *M* for the oldest ages. The fact that steepness changed so dramatically and was at the upper bound in all of the requested runs without dome shaped selectivities suggests some structural instability that is rectified by the parametric freedom of complex dome-shape selectivities. However, this is not viewed as a sufficient justification for these selectivities without a model-independent biological rationale.

Day 2 requests

4) Pre-STAR model selectivity curves, but higher CV in length at age matrix at 0.3.
Rationale: Some of the dome-shaped selectivity curves showed a descending limb at high ages where the abundance would be expected to be minimal. If this is due to the CV in the length at age being constrained to 0.1, then increasing the CV may allow a shift in the descending limb of the selectivity curves.

5) Length-based selectivity on commercial fishery, estimate CV on length at age matrix, logistic selectivity curves.
Rationale: Selectivity may be viewed as a function of the length rather than age. Also, asymptotic selectivities appear to be plausible given the pelagic distribution of the stock, and would simplify the model. Because no commercial length compositions were included in the model and available for exploration at the STAR panel meeting, a higher CV in length at age may enhance the fitting of selectivity of age compositions to length selectivities. The STAR panel wanted to see if these CVs were estimable in this model formulation. Use of length-based, asymptotic selectivity may provide a better overall model fit.

6) Length-based selectivity on commercial fishery, fix CV on length at age matrix at 0.3, logistic selectivity curves.
Rationale: The rationale for this request is similar to that for request # 2 above but fixes the CV in the length at age to 0.3 to allow more flexibility in fitting selectivities.

7) Length-based selectivity on commercial fishery, fix CV on length at age matrix at 0.1, logistic selectivity curves, estimate *M* and do coarse likelihood profile on *h* (0.4, 0.6, 0.8).
Rationale: Previous requested runs have indicated difficultly in estimating steepness, with several runs showing steepness very near or at the upper bound. The rationale for this request is to identify the sensitivity of estimated *M* and other model quantities to steepness when asymptotic length-based selectivities are used.

Response to Day 2 requests: Requested run 4 had a wider coefficient of variation (CV) in the lengths at age, and resulted in slight changes in age-based selectivity. However, the model gave substantial declines in B_0 and increases in depletion relative to the pre-STAR model. Requested run 5 as presented was not able to estimate the CV in the length at age and did not converge. Requested run 6, with length-based asymptotic fishery selectivity curves and the CV in the length at age matrix fixed at 0.3, showed an estimate of steepness of 0.98, very close to the upper bound, and a relatively low B_0. A version of run 6 with the CV in the lengths at age set to 0.1 resulted in a higher level of B_0, but also gave high estimates of depletion and steepness. The

likelihood profile on steepness (run 7) with asymptotic selectivity and estimated *M* showed higher estimates of *M* (~ 0.22) relative to the pre-STAR model. The estimates of depletion were also higher and less sensitive to steepness relative to the pre-STAR model. This suggests that some interaction between *M* and selectivity is having a large influence on the depletion estimation (i.e., the scale of stock size) relative to the steepness parameter.

Technical merits of the assessment

Questions concerning the data (and omissions thereof) and model structure were unanswerable with the pre-STAR model formulations and data available to the STAR Panel. These questions, such as sharply-peaked selectivity patterns, age or size based selectivity, one or two area model, mirrored those from the review of the 2009 assessment. The pre-STAR model was itself reasonably investigated by the STAT, but major alternative hypotheses to model specification were not. Data omissions, particularly length compositions, were notable, making model exploration difficult. The one-area model, requested by the 2009 Panel, was also not available for exploration. Concerns about the pre-STAR model included 1) large sensitivities to small changes in natural mortality and steepness, both highly uncertain parameters, and 2) differential sensitivity to derived quantities depending on assumptions affecting the fits to the descending limb of the much dome-shaped selectivity. Attempts to fit length or age based asymptotic selectivity during the meeting were unsuccessful, though they did reveal that different combinations of selectivity, steepness and natural mortality than those used in the pre-STAR model resulted in divergent estimates of derived quantities. Given the lack of data, especially length data, available to the model to differentiate between asymptotic and dome-shaped selectivity, or the shape of the descending limb (if domed), the STAR Panel considered it necessary to undertake more exploration before a credible base case can be determined. The STAT was willing to discuss all of these issues and considerations, but noted the requested explorations were all untenable during the review meeting.

Explanation of areas of disagreement regarding STAR panel recommendations

A. Among STAR panel members (including concerns raised by GAP and GMT representatives)

There were no areas of disagreement among STAR panel members.

B. Between the STAR panel and the STAT team.

The STAT conducted a simulation analysis that compared one- and two-area models (Appendix D – Comparisons of three widow assessment models: area configuration and CPUE data). Given the similarity in ending biomass and depletion estimates the STAT elected to maintain a two area model in order to avoid blending together real geographic differences in growth and fecundity. Nonetheless, the STAT is willing to conduct further analysis of this issue.

Unresolved problems and major sources uncertainty

There were several unresolved problems and sources of uncertainty, as detailed in the "Technical merits" section above. In addition to the uncertainty of whether a one-model formulation and the uses of length-based selectivities would increase model stability, there is also uncertainty regarding the parameter estimates of steepness and natural mortality. The Panel also notes that the current overfished status, combined with the relatively low occurrence in current surveys, has limited the collection of recent age and length composition data that would provide information on current stock status.

Management, data, or fishery issues raised by the GAP and the GMT representatives

There are no special issues raised by the GAP and GMT representatives.

Prioritized recommendations for future research and data collection

1) A thorough review of model structure and available data should be conducted, including but not limited to evaluation of one-area vs two areas models, the use of age- or length-based selectivities, evaluation of fixed model parameters (i.e. natural mortality), the use of dome-shaped or asymptotic selectivity curves, and the spatial definition of fisheries. Some of these items are discussed in detail below

2) Provide data and/or maps on spatial patterns of fishing harvest and/or effort, particularly as it relates to the split between the northern and southern areas, in order to assess whether the division at 43° N corresponds to a natural break in the fishery or whether it divides a continuous pattern.

3) Consider the theoretical basis of selectivity with regard to whether the mechanistic process is age-based or size-based, and the types of data which would provide information on this topic.

4) Obtain all length composition from the fisheries and surveys, and evaluate whether the inclusion of these data in the model improves model performance.

5) Consider multiple model-independent estimates of natural mortality in order to assess potential variation, with the possibility of developing a prior distribution for *M*.

6) Future estimates of steepness should be accompanied by comparisons to other west coast rockfish stocks, with proposed biological explanations for any large discrepancies from other rockfish stocks.

7) Apply other assessment methodologies, potentially including catch curves, surplus production models, stock reduction analysis, etc., to evaluate whether the information obtained on stock status, vital rates, and productivity are consistent with the assessment model.

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