China Rockfish
Stock Assessment Review (STAR) Panel Report

NMFS, Southwest Fisheries Science Center
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Overview

The STAR Panel reviewed a full assessment of China rockfish (*Sebastes nebulosus*) off the west coast of the United States during a five-day meeting in Santa Cruz, CA. China rockfish were assessed using three separate regional stock assessments to account for differences in growth, length composition, and exploitation history. The northern area model covered Washington marine catch areas 1-4. The central area model extended from the Oregon-Washington border to 40° 10' N latitude. The southern area model extended from 40° 10' N. latitude to the U.S.-Mexico border, though China rockfish are uncommon south of Point Conception. China rockfish were assessed in the last assessment cycle in 2013 using XDB-SRA, an index-only data-moderate assessment method in two areas (north and south of 40° 10' N. latitude). Although the current assessment would still be considered a data-moderate assessment because recruitment deviations are not estimated, age and length data were incorporated into the regional assessments, and growth and fisheries selectivity were estimated.

The STAR Panel recommends that the current assessment for China rockfish constitutes the best available scientific information on the current status of the stock and that the assessment provides a suitable basis for management decisions.

Summary of Data and Assessment Model

The three regional assessments used Stock Synthesis 3 (v3.24u). Model structure and assumptions were similar for each assessment with the exception that commercial fishery discards were explicitly modeled in the southern area assessment. Discards were very low in the central and northern areas and were simply combined with the landed catch. China rockfish is a nearshore species, and consequently the regional assessments rely primarily fishery-dependent data. No fishery-independent trend information is available. The main sources of information in the assessments included:

1) Fishery catch from the start of the fishery. Major fisheries for China rockfish include commercial nearshore fisheries (both live fish and dead fish), and recreational fisheries (both charter fisheries and private boat fisheries).
2) Length composition data.
3) Ageing data.
4) Discard length composition and quantity.
5) Maturity at length, length-weight relationship, fecundity at length.
6) Fishery-dependent relative abundance (CPUE) indices for commercial and recreational fisheries.

The models used for China rockfish are highly simplified versions of stock synthesis, in which many of the features of stock synthesis are not used. Simplifications include not estimating relative year class strength, and use of a simple 2-parameter asymptotic selectivity pattern. The key model features include:

1) Abundance indices used in the assessment were obtained using delta-GLM modeling approaches. For dockside sampling data, the Stephens-MacCall (2004) procedure was used to obtain the subset of relevant records.
2) Fisheries within each regional model were split into geographical components to accommodate local differences in growth and fishing patterns.
3) Growth was estimated within each regional model.
4) A Beverton-Holt stock recruit relationship without recruitment deviations was assumed.
5) Prior distributions for steepness (Thorson pers. com.) and natural mortality (Hamel 2015) were used. Steepness was fixed at the mean of the prior, while natural mortality was estimated using the prior in the southern and northern area models, and then fixed at the average of the north and south estimates for all areas.
6) Length-based selectivity was estimated for all fisheries. In some cases it was necessary to apply constraints to selectivity parameters to ensure that the estimated selectivity pattern was reasonable.
7) Ageing data were, for the most part, modeled as conditional age at length in the assessments.
8) Input data were reweighted using several approaches. Additional variance terms were estimated for index data; length composition data were reweighted using the Francis method; and the harmonic mean of effective sample size was used to reweight the conditional age at length data.

Requests by the STAR Panel and Responses by the STAT

Request No. 1: Explore the utility of using California Recreational Fisheries Survey (CRFS) data from 2004-2007 to partition California catches in the early years based on the proportion of catch in the private and charter modes north and south of 40°10’ N latitude (concerns the southern and central area models).

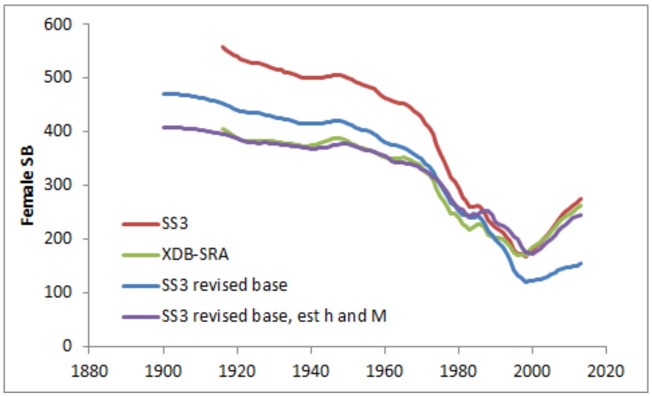
Rationale: This may be a better alternative to the current approach of using logbook data to partition the recreational catches north and south of 40°10’ N latitude.

STAT Response: This request was not completed, and was repeated as request no. 13.

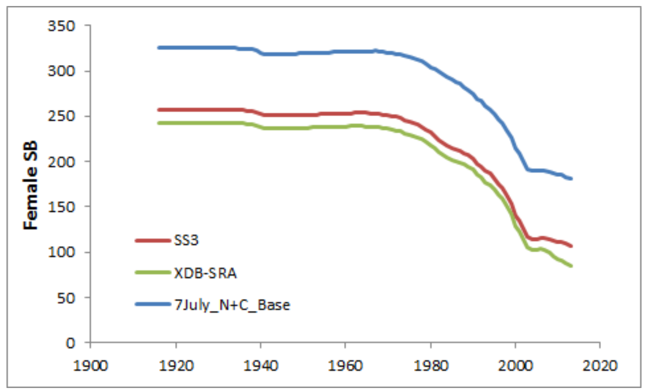
Request No. 2: Add the current assessment biomass trends for current base model to the plot in the draft assessment that compares the XDB-SRA and stock synthesis runs and plot an additional set of runs for all models where steepness and natural mortality are estimated with priors (add results from the northern and central area models). This would be two sets of plots with spawning biomass and depletion.

Rationale: To provide a comparison between the previous assessment results using XDB-SRA and the current assessment. XDB-SRA has more flexible productivity assumptions than stock synthesis, so estimating h and M was regarded as a way to more closely mimic XDB-SRA using stock synthesis.

STAT Response: The plots were provided (below). Since XDB-SRA had knife-edge maturity at age 5, summary biomass for ages 5 and older was used in the plot to provide a common basis for comparison. For the southern area model, the stock synthesis model with estimated h and M and XDB-SRA show similar results in absolute summary biomass and depletion. For the north plus central area models, it was not possible to simultaneously estimate h and M, but again the results were similar.



Southern area model



Northern + central model

Request No. 3: Compare the amount of available habitat for China rockfish in the area covered by northern and central area models with estimates of R_0 for the northern and central area models.

Rationale: Available habitat by region may provide an independent proxy for the relative abundance of the stock in each region.

STAT Response: Available rocky habitat was examined using two methods. The ratios of habitat between areas showed an increase in habitat from the northern area with the least habitat, to the central area, and lastly to southern area with the most habitat. The Panel regarded this as a useful exercise for ranking assessment areas, but it cannot be used for determining relative abundance. There were a number of methodological issues that would need to be addressed to do this more rigorously, and ultimately its application to stock assessment would be indirect given the assumptions required. The Panel will consider making a research recommendation to examine the estimated area of reefs at more finely resolved scales.

Request No. 4: Provide a model run where historical discards for the live-fish fishery are modeled as a separate fleet. For the discard fleet, estimate actual tonnage of catch. Apply the discard fraction for the earliest four years to estimate discards back to 2000 with a ramp from 1990 to 2000 (selectivity for this fleet is the determined from the discard length composition data) (southern area model only).

Rationale: Fits to discard amount for the live-fish fishery by the model since 2000 are poor, and the model structure does not allow flexibility to decrease the discards prior to 2000.

STAT Response: This was done. Fits generally improved and the estimated selectivity pattern for the discard fleet appeared reasonable. The STAR Panel and the STAT agreed that the base model should incorporate this new approach.

Request No. 5: Provide the proportion of trips removed using the Stephens-MacCall filter over time as a diagnostic for all regional models.

Rationale: To evaluate potential bias in the filtering procedure.

STAT Response: This was done for the northern area, and proportion of trips retained showed a temporal pattern of a slight increase followed by a decline in number of trips retained. The STAT asked that this request be considered a low priority for the other areas because it was not clear what patterns in proportion of trips retained would indicate, and the northern area model was not sensitive to index treatment. The Panel agreed. Further investigation is needed and this will be added to the list of research recommendations. Examination of the characteristics of trips retained/removed using the Stephens-MacCall method should be a routine part of index standardization.

Request No. 6: For the central area model, provide a run where the northern California length composition data are added to the model, estimate two selectivity parameters (i.e., the simpler selectivity function), and estimate M to understand how this affects fits to the length composition data. Provide residual plots.

Rationale: This may produce a selectivity pattern that has a more realistic peak (full selection of a reasonable portion of observed lengths).

STAT Response: The selectivity pattern improved, but the model estimates a very high M (0.12) and produces an implausible estimate of biomass (>1000 times the base model). This was not supportable as a new base model.

Request No. 7: Exclude the Marine Recreational Fisheries Statistics Survey (MRFSS) index in Oregon to define a new base case for the central area model.

Rationale: It was learned that multiple intercept interviews were done for a single trip, so the index was not constructed from trip level data, as was intended. This only affects the MRFSS index for Oregon.

STAT Response: Excluding this index had a minor effect on model results. This problem should be correctable so the STAR Panel will list this as a research recommendation.

Request No. 8: Add in the northern California length composition data to central area model. The selectivity pattern for this fishery should mirror the southern Oregon selectivity pattern. Re-tune the length composition data.

Rationale: These data were inadvertently left out of the model.

STAT Response: This was done. Adding these data had a minor effect on model results.

Request No. 9: For the central area model, attempt to estimate the selectivity patterns for each fishery and determine which of the selectivity patterns provides plausible estimates. Take the mean of those estimates (peak and/or spread parameters) and use the mean as a prior for the poorly estimated selectivity curves. Also consider using the mode of the observed length distribution as a prior for the peak parameter.

Rationale: To provide a more objective means to obtain selectivity parameters for fleets where those parameters cannot be reliably estimated.

STAT Response: Alternative procedures resulted in models with a small difference in the estimated depletion compared to the base case, though scale is dependent on the value of peak selectivity used for parameters that needed to be fixed (defined in the base model as largest estimated value that didn't hit the bound of 45 cm). The Panel agreed that the original procedure used for the base model was simple and more defensible from a methodological point of view.

Request No. 10: For the central area model, repeat request #9 using a two parameter ascending logistic curve for selectivity.

Rationale: To examine the effect on model results of using a different functional form for asymptotic selectivity.

STAT Response: Logistic curves did not improve model results, and all the same issues remained.

Request No. 11: Turn on estimation of recruitment deviations for all models, and iteratively increase σ_R from a low value until the residual pattern stabilizes.

Rationale: To determine whether estimating recruitment deviations can be supported by any of the models.

STAT Response: All models estimated extremely large recruitments in the 1980s and early 1990s that are implausible and are not obvious in length composition data. For the southern area model, the standard error of recruitment deviation is larger than σ_R for many early estimates, which is a nonsensical result. The likelihood components show slightly worse fit to indices, an improved fit for age composition data, and the most improvement for length composition data. This suggests that the estimated recruitment deviations are chasing relatively subtle signals in the length composition data rather than improving the ability to fit the trends in the indices. The Panel concluded that there was insufficient information to estimate recruitment deviations for all models.

Therefore no changes were made to the base model. One potential area of research for data-moderate stocks would be evaluate the effect of assuming different levels autocorrelation in the stock-recruit relationship. This might help curb the tendency to estimate extreme recruitment with sparse datasets.

Request No. 12: For all models, explore alternative methods of reweighting the conditional age-at-length data, but do not increase the weight on any data set. Alternatives to evaluate are: the unmodified sample size (the method used for the base case), and Francis weighting method A and B (report the values of A and B).

Rationale: Methods for weighting conditional age-at-length data are a current active area of research with no generally agreed procedures, so model sensitivity to each method requires examination.

STAT Response: For the southern area model the weights for both the Francis A and B methods were above one, so no reweighting was applied. For both the central and the northern area models, Francis method A for the most part strongly downweights the conditional age-at-length data. The situation is most extreme for the northern area model, where iterative application of Frances method A appeared to be leading to a zero weight being given to conditional age-at-length data. Weighting is highly influential on both absolute biomass and relative depletion.

The Francis method A appears to produce unrealistically small weights for conditional age-at-length data in some cases. Apparently Francis method A is the recommended approach in preference to method B (C. Francis, pers. comm.), but the Panel was unable to find clear rationale for this recommendation. The harmonic mean method has a history of use and theoretical basis in the multinomial distribution, and generally provided weights that were intermediate between no weighting (unmodified initial otolith counts) and the Frances method A. The Panel recommended that the harmonic mean should be used for now as it provides a compromise between no weighting and Francis A, while noting that a workshop with a focus on these methods later this year may result in the general recommendation of one of the existing methods or a new procedure.

Request No. 13: Explore the utility of using California Recreational Fisheries Survey (CRFS) data from 2004-2007 to partition California catches in the early years based on the proportion of catch in the private recreational and charter modes north and south of 40°10’ N latitude (this concerns the southern and central area models). This is a repeat of Request No. 1.

Rationale: This may be a better alternative to the current approach of using logbook data to partition the recreational catches north and south of 40°10’ N latitude.

STAT Response: This analysis was completed. South of 40°10’ N latitude, the difference in model results between using CRFS data and logbook data for the apportioning catches is small. North of 40°10’ N latitude there is a greater difference, primarily a change in initial stock size. The logbook method was based on data collected over a long period of time, while the CRFS method is based only on recent data. The logbook method better captures temporal changes in fishery, while CRFS method provides better information on relative catches between private and charter boats. In Oregon, recreational fishing for nearshore rockfish began around 1970, and this should be indicative of northern California. The STAR Panel and STAT agreed that the logbook method should be used because the reconstructed catches are more consistent with what is known about the gradual development of the recreational fishery in northern California. Nevertheless, the Panel flagged improved methods for reconstructing recreational catches as a research recommendation.

Request No. 14: A set of revised base models should be brought forward with the following recommended changes:

- Use weight specific fecundity relationships from Dick (2009) for all models.
- Update 2011 and 2012 data in the onboard observer CPUE index (southern area model).
- Change the years in the Abrams dataset to 2010-2011; remove observations N of 40°10' N latitude (southern area model).
- Model discards as a separate fleet (southern area model).
- Remove Oregon MRFSS index (central area model).
- Add northern California length composition data (central area model).
- Fix any selectivity parameters hitting upper bounds (central area model).

Rationale: All of these changes have been identified and agreed to as changes that need to be made to the base models.

STAT Response: The changes were implemented to establish a new set of base models for China rockfish.

Request No. 15: Tune all models using the harmonic mean method for the conditional age-at-length composition and marginal age composition data.

Rationale: The Panel recommended that the harmonic mean method be used to re-weight the conditional age-at-length composition data, because it is a well-understood and frequently applied method that provided intermediate results compared to other alternatives.

STAT Response: This was done and considered appropriate as a new base model.

Request No. 16: Estimate M in the revised base models for southern and northern area models, and use the average of those estimates as a fixed value for all models.

Rationale: The northern and southern area models (but not the central area model) provide some objective basis for the selection of an appropriate value for M.

STAT Response: Although the estimates of M for the northern and southern area models are reasonable, the estimate for the central area M (0.116) is difficult to support. The age composition data are noisy, but fits suggest that more young fish are observed than would be expected for lower values of M, outweighing the effect of older fish on the fits, which results in the preference towards a higher M in this model. There are a good number of observations of older fish that arguably are more important in terms of stock status that should be fitted by the model, and only the lower M values provide a reasonable fit to the oldest age observations. Values of M of 0.09 and above lead to unrealistically high biomass and minimal effect of fishing, which are results that appear to conflict with the habitat-based relative biomass among models. The median of the prior for M is 0.05 for this stock, and it is unclear why the data are so informative about the value of M. The central area model is relatively data rich, but the abundance indices for the central area do not show contrast compared to the northern and southern areas, providing additional justification for not accepting the M estimate from central area model. The Panel's proposed approach is to use the average of the estimated M values for the southern and northern area models (0.07) as a fixed value for all assessments.

Request No. 17: Provide likelihood profiles for M in all revised base models; consider providing a combined likelihood profile in one graphic for all models.

Rationale: Since the estimated values for M may be used as fixed value in all assessments, the Panel would like the STAT to examine the likelihood profiles as a useful diagnostic.

STAT Response: Likelihood profiles for both the southern and northern area models appear quite reasonable, particularly the northern area model where both the index data and the age data support the estimated M value. It should be noted that since these models are not estimating recruitment deviations, they are highly constrained, and may provide misleadingly precise estimates compared to models with greater flexibility.

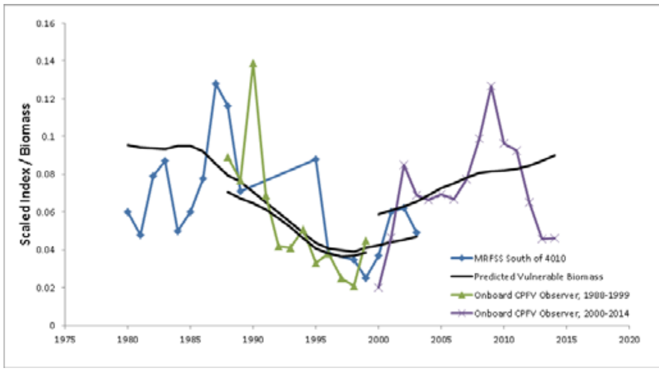
Request No. 18: Normalize all indices and provide time series plots in which groups of comparable indices are plotted together (southern and central area models). Provide time series plots in which groups of comparable index residuals are plotted together.

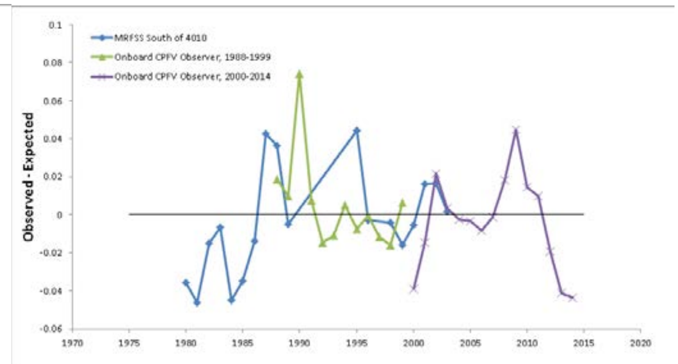
Rationale: To assess the comparability of indices prior to incorporation in the assessment model.
STAT Response: In the southern area model, overall trends are broadly consistent with the model biomass and show a decline to the late 1990s, followed by an increase. The model has the ability to scale the periods before and after 2000 due a lack of overlap of indices in this period. The observer CPFV index shows a sustained decline after 2005 that the model is unable to match, even when recruitment deviations are turned on. Because China rockfish is a very long-lived species, age-structured population dynamics prevents rapid changes in abundance from occurring when fishing is relatively stable, suggesting that there must be some other cause for this recent trend. Indices for the central area show similar pattern from 2000 to 2014 across three indices that are also difficult to account for with China rockfish population dynamics. The Panel discussed

potential interactions with other species (e.g. black rockfish) due to hook competition, and regulatory changes as factors that could affect CPUE indices derived from a multi-species recreational fishery. Panel will add a research recommendation that these factors be investigated.

Normalized indices for southern area *Residuals for indices for southern area model*

Request No. 19: Provide likelihood profiles on M for all base models, which now are using a fixed value of M of 0.07. Plot predicted spawning output on the M profile plots.





Rationale: To evaluate whether the profiles for M for the base models for the northern and southern area are well determined as a justification using a single fixed value across all models, and to also demonstrate the inadequacy of the central area model for estimating M.

STAT Response: This was done. The new base models behaved as expected (except for spawning output declining at very high M for southern area model).

Request No. 20: Provide bracketing model runs varying M for potential decision tables. The low and the high Ms should be equidistant from the base M; low M = 0.05 (set to median of the prior); base M = 0.07; high M =0.09. Assume projected ACL removals for a category 2 stock (P* = 0.45, σ = 0.72, 40-10 adjustment as needed) applied to high and low M scenarios. Also provide projected ACL removals under base case, and recent year catches (if different than base case ACLs).

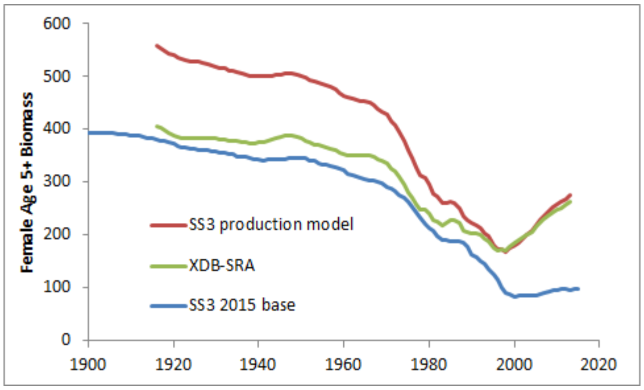
Rationale: Development of a potential axis of uncertainty based on M.

STAT Response: This was done.

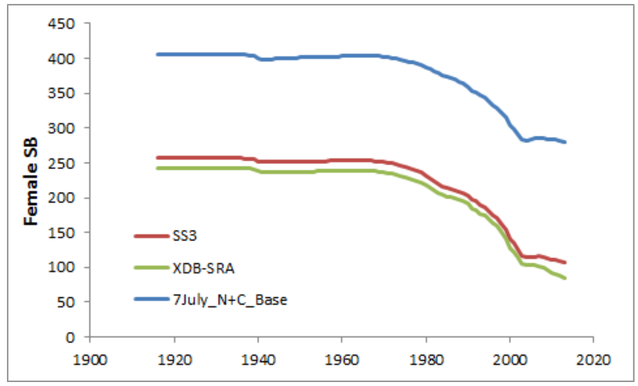
Request No. 21: Update the figures from Request No. 2 with the new base models, show summary biomass.

Rationale: To provide a comparison between the previous assessment results using XDB-SRA and the current assessment.

STAT Response: This was done. The current base models deviate more strongly from the results using XDB-SRA than the pre-STAR models, but results remain broadly consistent (i.e., biomass estimates differ by no more than a factor of two).



Southern area model



Northern + central area model

Request No. 22: Provide runs for the central area model treating all age compositions as marginal (fix growth parameters, and alternatively fix and estimate M).

Rationale: This may provide improved fits to composition data, and may also provide further evidence that large values for M above 0.1 for the central area model are implausible.

STAT Response: Results were only slightly different compared to the base model, so no additional information was provided for the assessment.

Request No. 23: Provide two runs for the base model for the southern area that bracket uncertainty in steepness. Use values of 0.6 and 0.9 which are close to the 12.5 and 87.5 percentiles from the Thorson prior. Provide projected biomass to compare with current bracketing models with M.

Rationale: To determine whether uncertainty in M sufficiently captures uncertainty for decision tables for the southern area model.

STAT Response: This was done. The bracketing model runs for steepness and M produced remarkably similar results, allowing the Panel to agree to use only M to bracket uncertainty for management advice for the southern area model, and to do the same for the northern and central area models.

Request No. 24: The STAR Panel requested a detailed justification be provided for the decisions regarding stock structure assumed in the assessment(s) (i.e., growth differences, length composition, fishery discard rates, evidence of low larval drift, and management history and jurisdiction).

Rationale: This information was not provided in detail in the draft assessment document. This is a bookkeeping request as the Panel had discussed with the STAT the importance of providing supporting information on stock structure decisions, but no formal request was forwarded to the STAT.

STAT Response: This information will be included in the final assessment document.

Description of the Base Model and Alternative Models used to Bracket Uncertainty

The base models developed during the STAR Panel were revised in comparison the pre-STAR models as follows:

Northern area model: Instead of fixing M at the median of the prior, M is estimated then fixed at the average of the northern and southern area models (0.07); conditional age-at-length data were reweighted using the harmonic mean method instead of using input sample sizes; and a weight-specific fecundity relationship from Dick (2009) was used.

Central area model: M is fixed at the average of the northern and southern area models (0.07); conditional age-at-length data were reweighted using the harmonic mean method instead of using input sample sizes; a weight-specific fecundity relationship from Dick (2009) was used; the Oregon MRFSS index was removed because the data are not at the trip level; the northern California length composition data, which had been inadvertently omitted, were added to the model; and any selectivity peak parameters hitting the upper bound were fixed at the highest estimated value.

Southern area model: Instead of fixing M at the median of the prior, M is estimated then fixed at the average of the northern and southern area models (0.07); conditional age-at-length data were reweighted using the harmonic mean method instead of using input sample sizes; a weight-specific fecundity relationship from Dick (2009) was used, discards were modeled as a separate fleet, 2011 and 2012 data in the onboard observer CPUE index were updated; and the years in the Abrams (2014) dataset were changed to 2010-2011 and observations N of 40°10’ N latitude were removed.

The impact of the data revisions were all minor, and were identified by the STAT during their presentations to Panel.

Alternative Models for Bracketing Uncertainty

Uncertainty was bracketed by considering uncertainty in natural mortality. The low biomass scenario was defined by low M (median of Hamel (2015) prior M = 0.05) and the high biomass scenario was defined by high M (= 0.9), such that the high and low values are equidistant from the base M. Steepness was fixed at the mean of the prior in all scenarios (h =0.773).

Technical Merits of the Assessment

Overall the assessment models struck a good balance between parsimony and complexity given the available information. New data sources included age-at-length data, age and length compositions of landed and discarded catch. Good use has been made of research on developing priors for natural mortality (Hamel, 2015) and steepness (J. Thorson, NWFSC; pers. comm.). Recent work on spatially-referenced habitat-based revision of abundance indices for recreational CPUE, two new recreational dockside CPUE indices for northern Washington and Oregon, a new commercial logbook CPUE index for the southern Oregon nearshore fishery have been incorporated. Recommendations from previous STAR Panels have been carefully considered.

With the expectation that next assessment of China rockfish will not be done for several assessment cycles, the Panel recommends that the next assessment be a full assessment. Methods of assessing nearshore species are undergoing rapid development, and new techniques and datasets are likely to be available by the time that China rockfish are next assessed.

Technical Deficiencies of the Assessment

Models were applied in a technically sound manner given the limitations of available data. There are opportunities for further development of the assessment model – perhaps as a single integrated three-stock assessment model rather than separate models by area to accommodate sharing of common parameters. It is unclear whether the spatial options in stock synthesis are sufficiently flexible to allow this kind of linked assessment to be developed.

Areas of Disagreement Regarding STAR Panel Recommendations

Between the STAR Panel and STAT

There were no areas of disagreement between the STAT and the STAR Panel regarding the technical aspects or results of the assessment.

Among STAR Panel Members

There were no disagreements among the members of the STAR Panel regarding the technical aspects or results of the assessment.

Management, Data, or Fishery Issues raised by the GMT or GAP Representatives During the STAR Panel Meeting

Requests no. 1 and 13 regarding alternative methods of allocating California recreational catch north and south of 40°10' N latitude were resolved adequately in the view of the GMT representative. The GMT and GAP representatives did not raise any additional data or management issues regarding the China rockfish assessment.

Unresolved Problems and Major Uncertainties

As in most stock assessments, stock-recruit steepness remains as a major uncertainty. In this assessment a prior value was available from a meta-analysis, allowing bracketing of the uncertainty. Exploration of the southern model area established that uncertainty in steepness had similar impacts on assessment results as uncertainty in natural mortality, allowing uncertainty to be indexed by natural mortality alone for management advice.

While the northern and the southern area models are able to estimate a plausible value of natural mortality with an apparently good level of precision, this was not possible with the central area model.

The fishery-dependent abundance indices used in the assessment are short and relatively noisy. There is no fishery-independent index. The assessments assume that trends in CPUE indices are representative of population trends

Assessment results for the central and the northern area models are dependent on the method used for weighting the conditional age-at-length data. This is an area of active research and there is a lack of consensus on an agreed approach. A workshop is planned for later this year that might provide guidance. For this assessment, the Panel recommended use of harmonic mean method, because it is a well-understood and frequently applied method that provided intermediate results compared to other alternatives.

The current term of reference for stock assessment require development of a single decision table with states of nature ranging along a dominant axis of uncertainty. This presumes that uncertainty is consequential only for a single variable or estimated quantity, such as natural mortality, steepness, or ending biomass. This approach may fail to capture important elements of uncertainty that should be communicated to the Council and its advisory bodies. Additional flexibility in the development of decision tables is needed.

Recommendations for Future Research and Data Collection

A coastwide evaluation of genetic structure of China rockfish is a research priority. Genetic samples should be collected at sites spaced regularly along the coast throughout the range of the species to estimate genetic differences at multiple spatial scales (i.e., isolation by distance).

Difficulties were encountered when attempting to reconstruct historical recreational catches at smaller spatial scales, and in distinguishing between landings from the private and charter vessels. Improved methods are needed to allocate reconstructed recreational catches to sub-state regions within each fishing mode.

There was insufficient time during the STAR Panel review to fully review the abundance indices used in the China rockfish assessments. Consideration should be given to scheduling a data workshop prior to STAR Panel review for review of assessment input data and standardization procedures for indices, potentially for all species scheduled for assessment. The nearshore data workshop, held earlier this year, was a step in this direction, but that meeting did not deal with the modeling part of index development.

The Marine Recreational Fisheries Statistics Survey (MRFSS) index in Oregon was excluded because it was learned that multiple intercept interviews were done for a single trip. Evaluate whether database manipulations or some other approach can resolve this issue and allow these data to be used in the assessment.

Many of the indices used in the China rockfish assessment model used the Stephens and MacCall (2004) approach to subset the CPUE data. Research is need to evaluate the performance of the method when there are changes in management restrictions and in relative abundance of different species. Examination of the characteristics of trips retained/removed should be a routine part of index standardization, such as an evaluation of whether there are time trends in the proportion of discarded trips.

Fishery-dependent CPUE indices are likely to be the only trend information for many nearshore species for the foreseeable future. Indices from a multi-species hook and line fishery may be influenced by regulatory changes, such as bag limits, and by interactions with other species (e.g. black rockfish) due to hook competition. It may be possible to address many of these concerns if a multi-species approach is used to develop the indices, allowing potential interactions and common forcing to be evaluated.

Consider the development of a fishery-independent survey for nearshore stocks. As the current base model structure has no direct fishery-independent measure of stock trends, any work to commence collection of such a measure for nearshore rockfish, or use of existing data to derive such an index would greatly assist with this assessment.

Basic life history research may help to resolve assessment uncertainties regarding appropriate values for natural mortality and steepness.

Ageing data were influential in the China rockfish stock assessments. Collection and ageing of China rockfish otoliths should continue. Samples from younger fish not typically selected by the fishery are needed to better define the growth curve.

Consider evaluating depletion estimators of abundance using within season CPUE indices. This approach would require information on total removals on a reef-by-reef basis.

The extensive use of habitat information in index development is a strength of the China rockfish assessment. Consideration should be given to how to further incorporate habitat data into the assessment of nearshore species. The most immediate need seems to be to increase the resolution of habitat maps for waters off Oregon and Washington, and standardization of habitat data format among states.

Although all the current models for China rockfish estimated implausibly large recruitment deviations when allowed to do so, particularly early in the modeled time period, further exploration of available options in stock synthesis could produce acceptable results. In addition, this work may provide guidance on any additional options that could be added to stock synthesis to better handle this situation. For example, assuming different levels autocorrelation in the stock-recruit relationship for data-moderate stocks may help curb the tendency to estimate extreme recruitment with sparse datasets.

The China rockfish models made a number of simplifying assumptions, such as asymptotic fishery selectivity, and no deviations from the stock-recruit curve. It would be worthwhile to conduct a simulation-estimation exercise to evaluate potential errors associated with the assumptions commonly made for data-moderate assessments that use length and age data.

Research is needed on data-weighting methods in stock assessments. In particular, a standard approach for conditional age-at-length data is needed. The Center for the Advancement of Population Assessment Methodology (CAPAM) data weighting workshop, scheduled for later this year, should make important progress on this research need.

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