CANARY ROCKFISH

STAR Panel Report

Alaska Fisheries Science Center
Seattle, Washington
September 26-30, 2005

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STAT Team Members present:
Richard Methot, Northwest Fisheries Science Center

Overview

Canary rockfish are currently managed under a Pacific Fishery Management Council (PFMC) rebuilding plan. A new canary rockfish assessment was prepared in 2005 using new assessment software (SS2) and reviewed by a STAR Panel in August 2005. Assessment results indicated that the stock remains in an overfished state with only a modest amount of rebuilding occurring in recent years. In comparison to the previous assessment, canary rockfish was estimated to be in significantly worse condition (4% of unfished in 2002 compared to 8% of unfished in the previous assessment). Changes in stock status were primarily due to different treatment of selectivity and mortality in the new assessment software rather than continued overfishing or new survey data indicating a more severe decline. Recent management measures have reduced fishing mortality to very low levels. The Panel concurred with the principal assessment conclusions, and endorsed the use of the assessment to support management decisions.

During its September meeting, the PFMC Scientific and Statistical Committee (SSC) reviewed the post-STAR canary assessment document (revised with all STAR Panel recommendations incorporated). Several technical issues were raised during the SSC's review. Given the wide-ranging impact of restrictive canary harvest guidelines across many PFMC-managed groundfish, the SSC recommended that the canary assessment be revisited during the "Mop-Up" STAR Panel meeting (September 26-30 2005 in Seattle). More specifically, the SSC requested that the stock assessment team (STAT) consider the following four issues, report on them, and be prepared to conduct additional runs during the "Mop-Up" Panel meeting.

a) The survey catchability (q) estimated in the canary assessment appears to be considerably larger than the q estimated for other rockfishes. The validity of the q estimate should be investigated.

b) The assumed variability associated with the spawner-recruit relationship (σ_R =0.4) is small relative to that used for other rockfish. The sensitivity of the canary assessment results to larger values of σ_R should be explored.

c) Documentation more complete than that in the draft assessment document should be provided. Minimally, the updated selectivity curves and the SS2 data and control files should be made available.

d) Inclusion of the Santa Cruz juvenile survey data should be considered.

Panel Discussion of the SSC Issues

The STAT carried out preliminary analyses to address the SSC issues, and reported their results to the Panel (Appendix A of the final 2005 canary rockfish assessment). A brief summary of the Panel's discussion of these issues follows.

SSC Issue (a).   The survey catchability (q) estimated in the canary assessment appears to be considerably larger than the q estimated for other rockfishes. The validity of the q estimate should be investigated.

The interpretation of the q estimate from SS2 is not straightforward. The estimate is conditioned on other model parameters -- such as selectivity and natural mortality – making it a difficult to compare across species or even across earlier assessments of the same species. The current canary assessment reports a q value of 0.705, but it also shows low selectivity at age 5 (0.21) then slowly increasing selectivity with age. The average selectivity across ages 5 to 40, weighted by biomass at age in 1992, is 0.617. Thus the effective q is 0.705 x 0.617 = 0.435. This effective q may be a better parameter to compare across species and assessments. Unfortunately, effective q is not reported in other assessment documents, making comparisons impossible.

The canary STAT reviewed other PFMC assessments and suggested that another *q-like* statistic—based on information generally available in the documents – might be useful. Namely, the ratio of average survey biomass to average population biomass over 1995-2004 (B_{ratio}), which has a range of 0.02 to 0.67 for the 2005 assessments. For the 2005 canary assessment, the B_{ratio} is 0.56, which is highest of all shelf rockfish, but lower than the estimated B_{ratio} for dark-blotched rockfish, a rockfish found in deeper water.

The Panel considered it reasonable to expect broad consistency in survey catchability for species with similar depth distributions, habitat preferences and behavioral responses to trawling gear.   It is also reasonable to expect consistent differences between species with different habitat preferences, for example, that pelagic species would tend to have lower catchability than demersal species, or that species found in rocky reefs would tend have lower catchability than a species found in trawlable areas.   A recent paper by Millar and Methot (2002) developed a Bayesian meta-analysis of survey catchability for shelf rockfish that provides a quantitative framework for making these comparisons. Dr. Methot, a co-author of the study, cautioned against using the results of the paper directly for stock assessment, arguing that the paper was intended as a demonstration of a new method, rather than to provide results that would be relevant the canary rockfish assessment.

The qualitative evaluation provided the STAT was sufficient to raise significant concern about the estimate of survey catchability. Nevertheless, the estimate could not be rejected by the Panel as obviously implausible. Although canary rockfish is considered a species that is commonly found in areas of high relief and complex substrates, (which would imply low catchability), too little is known about its relative abundance in trawlable and untrawlable habit to identify a range of plausible values for survey catchability. This issue is clearly important to the assessment, since a lower catchability would imply higher biomass, and further investigation is recommended. Although the Panel chose not to deal explicitly with this concern, it was factor that was considered in the development of an alternative to the base model described below.

SSC Issue (b).   The assumed variability associated with the spawner-recruit relationship ($\sigma_R = 0.4$) is small relative to that used for other rockfish. The sensitivity of the canary assessment results to larger values of σ_R should be explored.

As with the B_{ratio}, above, the STAT compiled a table of σ_R values from 2005 assessments. The range of σ_R values was (0.35, 1.00). The value for recruitment variability (σ_R) used in this and the previous canary stock assessment is the lowest of any rockfish, although there are other rockfish at or near the value used for canary rockfish (fixed at 0.4). Remarkably, the value of σ_R output by the model (~0.25) is considerably smaller that the input σ_R (0.40). This result is driven largely by the fishery age data, which has showed remarkable stability over time, suggesting very stable recruitment. Furthermore, it was noted that age data are considered more reliable for canary than for most other rockfish.

Such low recruitment variability in a rockfish is unexpected and puzzling. There is nothing in canary rockfish life history or behavior to explain why it would be the lower extreme in the range of recruitment variability for rockfish. It was noted, however, that other shelf rockfish, such as black rockfish and yellowtail rockfish, also tend to have relatively stable recruit. Although the model was not highly sensitive to the assumed level of input σ_R, low recruitment variability has strong implications for achievability of rebuilding targets, since it would make rebuilding probabilities extremely sensitive to relatively minor changes in stock status or the rate of rebuilding.

SSC Issue (c).   Documentation more complete than that in the draft assessment document should be provided. Minimally, the updated selectivity curves and the SS2 data and control files should be made available.

Additional documentation was provided in the final draft of the assessment.

SSC Issue (d).   Inclusion of the Santa Cruz juvenile survey data should be considered.

The panel explored the effect of including the Santa Cruz juvenile survey data and found importance of this survey depended critically how this survey was included in the model. Modeling as in the widow rockfish assessment resulted in higher recent recruitments and higher estimated spawner-recruit steepness, and thus could have an important impact on assessment results and rebuilding analyses. The juvenile index is the only data source that is potentially informative on recent recruitment, which has been strong in several other rockfish stocks.

The widow STAR panel identified general technical issues with including the juvenile index into the assessment that need to be addressed before any approach can be recommended. Additional issues were raised by the canary STAT to justify exclusion of these data. The team also noted that the juvenile survey is at the southern end of the range of canary rockfish and may not provide a consistent index of year-class abundance for the coast-wide stock. After considerable debate, the Panel consensus was that exclusion of the juvenile survey data was not sufficient to reject the assessment.

Analyses requested by the STAR Panel

Request A (September 27, 2005)

(1)   Make a run with near-zero emphasis on all age composition data and with the growth parameters fixed.

The panel wanted to evaluate whether the age composition data were primarily responsible for the low estimates of recruitment variability. Results of this run showed increased recruitment variability and steepness, but recruitment variability was still somewhat low for a rockfish. An adequate assessment of canary rockfish can be conducted without ageing data. Nevertheless, age composition data are reasonably consistent with the length composition data, so consideration of model runs with alternate weighting on length and age composition data was not pursued further.

(2)   Make a run using the Santa Cruz juvenile survey as a recruitment index. The run should be set up to model the survey data in a fashion similar to that done in the recent widow rockfish assessment.

Results from this run indicated that recent recruitments estimates were higher and steepness in the stock-recruit relationship was higher. Iterative re-weighting of input survey variances resulted in successively down-weighting the contribution of the juvenile survey until it was effectively removed from the model.

(3)   Provide a likelihood profile on survey q (and also report the corresponding ratio of average survey biomass to total biomass).

The model did not respond quite as expected when the generating a likelihood profile on q. Although biomass tended to increase with lower values for q, the fit to the survey time series degrades and develops a bias. Based on these runs, the STAT team argued that stock-recruit steepness was a better parameter with which to bracket uncertainty.

The results of these runs were intended to inform the Panel on the general sensitivity of base case results to these three issues, and to aid the Panel in its discussion of whether the assessment should be considered adequate for management purposes. The STAT was not asked to incorporate these runs into its final stock assessment document.

Request B (September 28, 2005)
Using the base case from the post-STAR document as the starting point:

(4)   Compute an approximate 99% CI on steepness from the likelihood profile. Show biomass trends and other model output associated with the lower and upper bounds of the 99% CI. Compare to the base case.

Steepness appears to be relatively precisely estimated, which is to be expected when recruitment variability is very low and there is good contrast in spawning biomass. The Panel considered this apparent precision to be suspect because it depended on the assumption of stationarity in the stock-recruit relationship. The possibility that the recent trend of low recruitment is due to period of unfavorable conditions is not encompassed by the model estimate of uncertainty in steepness. This led the Panel to look for alternatives to using the steepness parameter to bracket uncertainty.

(5)   Create a likelihood profile on the CV of the triennial survey, starting with the CV obtained from the re-weighting used in the base case, and extending to smaller CV's (i.e. giving the triennial survey additional weight in the model). Show biomass trends and other model output associated with the range of CV's used in the profile.

The Panel was concerned that iterative re-weighting gave more weight to fishery data and less to the triennial survey. Since survey data are collected using a random statistical design, on first principles they should be considered more reliable than fishery data. Estimates of steepness and stock depletion were weakly dependent on the assumed CV for the triennial survey over a plausible range of values. The Panel found no justification for putting an extremely high weight (low CV) on the triennial survey. However, Panel and the STAT agreed that runs that do not re-weight the triennial survey trend should be considered further.

In summary, the Panel concluded that variability around a single base model underestimated the overall uncertainty. This was a particular concern because none of sensitivity runs showed significantly lower stock size than the base model. After considerable deliberation, the STAR panel and STAT team agreed to explore alternative model run(s) to expand the range of uncertainty

Request C (September 29, 2005)
   Using the base case from the post-STAR document as the starting point:

*(6)   Make a run (**Run 6**) that is re-weighted (as is the base case) but does not re-weight the triennial survey trend. The purpose of this run is to effectively give more weight to the survey because from first principles, it should provide the most reliable stock-wide information on biomass trend.*

*(7)   Make a run (**Run 7**) that differs from the base case as follows:*
   a.   assume that length-based selectivity for males and females is the same (the base model allowed for sex-specific selectivity); and
   b.   as in Run 6, above, do not re-weight the triennial survey trend.

   The results of Runs 6 and 7 are intended to provide the Panel with two alternative states of nature that may be used in the management process generally, and for the canary rebuilding plan in particular.

The STAT completed Runs 6 and 7 successfully and presented them to the Panel. In addition, the STAT suggested an algorithm for merging the results from the two runs in a manner that captures the model uncertainty and most of the statistical uncertainty. The Panel did not have any difficulties with the new runs and suggested that these runs could serve as the basis for management. No additional major runs were requested from the STAT – although carrying out the agreed algorithm for merging the Run 6 and Run 7 results will require the STAT to make additional runs after the Panel meeting.

Final model results and quantification of uncertainty

Uncertainty in the assessment results has two components: (1) uncertainty regarding the proper model and (2) statistical uncertainty (variance) in the results from any given model. Initially, there were divergent opinions among Panel members regarding the "best" model and how to adequately quantify the uncertainty. However, after evaluation of many model runs provided by the STAT, the Panel reached a consensus that for management purposes (including rebuilding), model uncertainty could be adequately quantified by considering Run 6 and Run 7 to be equally probable and the likelihood profiles (on S-R steepness) from these runs could be used to quantify the statistical uncertainty. The STAT agreed to characterize the assessment results and the uncertainty in this manner and to structure the canary rebuilding analysis in a parallel fashion.

Technical merits and/or deficiencies in assessments

The use of two alternate models and a likelihood profile of different spawner-recruitment steepness levels within each model allows more realistic evaluation of overall assessment uncertainty.

The assessment uses length composition data, age composition data and length at age data from the same samples. The approach used in the assessment to weighting these data is *ad hoc*. A stronger rationale for assigned weights needs to be developed.

Areas of disagreement regarding STAR Panel recommendations

Although there was vigorous discussion on many of the issues, a consensus was reached on all major issues by the end of the meeting.

Unresolved problems and major uncertainties

It has long been recognized that bottom trawl surveys may not provide an adequate index of abundance for shelf rockfish. For canary rockfish, the particular concern is that the level of stock depletion in trawlable habitat may not be reflective of overall population status. Field studies of relative abundance of canary rockfish in different habitats using alternative gears such as hook-and-line gear and submersible line transects should be continued. Careful thought is needed to design studies that augment traditional bottom trawl surveys and can be integrated into the assessment.

Assessment results for canary rockfish depend on distinguishing between relatively subtle processes such as increasing natural mortality for females and domed-shaped sex-specific fishery selectivity. The selection of one model configuration over another may depend more on the parametric form used to model the process rather than the underlying process itself. There needs to be more testing of stock assessment models using simulated data to get a better sense of how well these processes can be estimated.

The approach of modeling the fisheries of each state separately as competing fisheries operating on a unit stock is needs to be investigated more fully. Differences between state fisheries could be due to different historical patterns of exploitation in each state or simply an artifact of different sampling methods.

Recommendations

Whenever the SSC conducts a detailed review of an assessment, arrangements should be made in advance to have a member of the STAT present at the review. The PFMC terms of reference for the STAR process should be amended accordingly.

The canary rockfish assessment states: "Several of the issues raised here: meta-analysis for survey q, meta-analysis for recruitment variability, and alternative procedures for inclusion of recruitment indexes are not unique to the canary rockfish assessment. Work on these issues during the 2006 off-cycle year would improve consistency in approach among all the assessments." The Panel strongly supports this recommendation.

Reference

Millar, R.B. and R.D. Methot. 2002. Age-structured meta-analysis of U.S. West Coast rockfish populations and hierarchical modeling of trawl survey catchabilities. Can. J. Fish. Aquat. Sci. 59:383-392.