VERMILION ROCKFISH

STAR Panel Report

Southwest Fisheries Regional Office
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STAR Panel members:

Martin Dorn (Chair), Alaska Fisheries Science Center and SSC representative
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STAT Team Members Present:

Alec MacCall, Southwest Fisheries Science Center

Overview

This represents the first assessment of vermilion rockfish and is restricted to the stock in California waters. The stock was broken into two components with the division approximately off Point Conception, and separate assessments were developed for each area. An important consideration in contemplating these results is that recent genetic research indicates that this stock is comprised of two species. However, there are no data to consider this complexity in this assessment.

The assessment was presented by the author, Dr. Alec MacCall. For both north and south components, the author proposed two models, one with a Beverton-Holt stock-recruit relationship with steepness (h) fixed at 1.0, and the other with a Ricker stock-recruit relationship. A draft assessment was distributed before the meeting, but considerable revision and model runs were requested during the STAR meeting.

The STAR panel and the STAT team struggled during the course of the week to arrive at a suitable model or models to describe historical biomass trends and current status. Length frequency and CPUE data suggest strongly episodic recruitment with consequent variation in stock size on decadal scales. Available data sets begin in the late 1970s and early 1980s when the stock was apparently at a low level of abundance, and are consistent with an increasing biomass trend due to strong recruitment events. From a modeling perspective, this pattern presents difficulties, since models typically assume that the stock is initially close to its mean unfished abundance. This difficulty was compounded by the shortage of available data. Different configurations of the model, such as the year in which to start the model, the year to begin estimating annual recruitments, and the form of the stock-recruit curve, resulted in wildly divergent results, with estimates of current stock depletion ranging from over twice unfished biomass to 1% of unfished biomass.

The STAT team observed that a strongly dome-shaped Ricker model was consistent with the pattern of strong recruitment being produced at low stock size, and in some model runs used an estimated Ricker curve to model this pattern. STAR Panel was not averse to using the Ricker curve per se, but considered a strongly dome-shaped stock-recruit relationship to be implausible. This pattern has not been seen in any another rockfish stock, and no biological rationale was suggested for why the stock-recruit relationship for vermilion rockfish would show strong overcompensation. On the other hand, decadal periods of strong and weak recruitment have been seen for other rockfish stocks with longer time series of fishery-independent data, such as Pacific Ocean perch in the Gulf of Alaska. The Panel felt that decadal variability in recruitment should be the main hypothesis for this pattern, and recommended that models used for management advice be based on a Beverton-Holt stock-recruit relationship with assumed values of steepness within the range seen for other rockfish. This approach seemed justified given the shortage of available data on vermilion rockfish.

Paired models were accepted for both the northern and southern components of the stock. These pairs for each stock component are chosen to represent the range of uncertainty in the assessment, and neither should be considered as a base model. The STAR panel and STAT team agreed that this approach was the most appropriate way to characterize the likely lower and upper bounds on the estimate of stock depletion. For the northern component the two bracketing models produced estimates of stock depletion of 41% and 89% of unfished biomass, while for the southern component the two bracketing models produced estimates of stock depletion of 30% and 88% of unfished biomass.

For a perspective on these results, we note that before this assessment was produced it was reasonable to expect that the status of vermilion rockfish would be somewhere between 0% and 100% of unfished biomass. Therefore these results should be viewed as a modest but significant reduction in the uncertainty concerning its status. Importantly, it is reasonable to conclude that vermilion rockfish is probably not overfished according to Pacific Fishery Management Council criteria.

The STAR panel concluded that the vermilion rockfish assessment was based on the best available data, and that this new assessment constitutes the best available information on vermilion rockfish in California waters. The STAR panel thanks the STAT team for their willingness to respond to panel requests and their dedication in attempting to find solutions to difficult assessment problems.

Analyses requested by the STAR Panel

1) Provide a run with a steepness of 0.65 instead of 1.0. A fixed value of steepness equal to the mean value for rockfish was considered appropriate assumption for a data-poor assessment. For the southern area model, this run had slightly poorer likelihoods and higher depletion with a doubling of the biomass. The model increases biomass to find a flatter region of the stock recruitment curve. No detectable difference was seen in northern area model.

2) Provide a run without the last two years of RecFIN CPUE estimates. Because of concerns about the effects of recent changes in management regulations it was suggested that these estimates be omitted. The Ricker model was insensitive to this change, suggesting that the last two years were not important. Ultimately, despite concern about the effect of management regulations on CPUE, the STAR panel concluded that the complete CPUE time series should be used. Without full documentation of all management regulations that could potentially effect CPUE, there did not appear to be objective basis for excluding specific data points.

3) Provide a run of southern area model with combined the CPFV and private boat length frequencies. It was not obvious that the two fisheries were different enough to warrant estimation of separate selectivity patterns. The model failed to work when constraining the two selectivities to one (mirroring).

4) Provide standardized residuals and the standard deviations of the standardized residuals as diagnostics for the various data series. This was completed and reported for subsequent model runs. It was necessary to collapse the zeros from the edges of length frequency data or otherwise histograms of residuals showed false zeroes.

5) Produce plots of the cumulative length frequency distributions of CPFV and private boats for the northern and southern area with all years equally weighted. Time and the relatively low priority of this request did not allow its completion.

6) Provide additional information on the effect of the species association filter: the number of records kept and rejected by year, a plot of the RecFIN CPUE time series with and without the filter, and if time permits a comparison of model runs with the filtered and unfiltered CPUE time series. The first two parts of this request were completed. About 10% of the southern and about 20% of the northern data were kept. The comparison with and without the species association filter showed that it tended to smooth the data and reduce the spike in 1997 in the north. Time did not permit the completion of the final part of this request.

7) Investigate more fully the spike in the RecFIN CPUE in the north in 1997. The 1997 value is the highest in the CPUE time series, and is a seven-fold increase from 1996. Time did not permit a detailed investigation of this year. It was noted that this was the strongest El Niño year of the century and that regulations affecting vermilion fishing came into effect at this time.

8) Provide results for model runs for the northern area with the 1997 RecFIN CPUE point removed and with the entire time series removed. When the entire time series was removed from northern area model the estimate of stock depletion decreased substantially.

9) Provide model runs that start the model in 1915, estimate recruitment deviations in 1970-2001, delete the 2002 and 2003 values from the CPUE index. Three scenarios for the stock-recruit relationship were requested: Beverton-Holt with h = .65, Beverton-Holt with h=1.0 (random around mean) and Ricker.

These runs were proposed in an attempt to define a base model.

There were several more iterations of requests for slightly changed models to search for a suitable base model or models. The alterations to the models were relatively minor and are not reported. In the end, a single base model could not be chosen but rather a pair of models were defined to examine uncertainty. In the northern area, the principal dimension of uncertainty was represented by stock-recruit steepness and the ranging values chosen were 0.65 and 1.0. In the southern area, the principal dimension of uncertainty was represented by the emphasis given to the RecFIN CPUE index and the ranging values chosen were 2 and 5.

Final Model description.

North
Data
Full catch history
RecFIN CPUE (1975 – 2004)
CDFG CPUE (1986-1999)
Recreational length frequencies (1978-2004)

Model
Beverton-Holt stock recruit relationship, h = 0.65 and h = 1.0 for bracketing runs
Begin model in 1916
Estimate recruitment deviations starting in 1970
M = 0.1
Length coefficient of variation (0.08)
Selectivities estimated for private boats, CPFV, set nets and commercial gear.

South
Data
Full catch history
RecFIN CPUE (1975 – 2004, all years used), emphasis = 2 and emphasis = 5 for bracketing runs
Recreational length frequencies (1975-2004)

Model
Beverton-Holt stock recruit relationship 0.65
Begin model in 1916
Estimate recruitment deviations starting in 1970
M = 0.1
Length coefficient of variation (0.08)
Selectivities estimated for private boats, CPFV, set nets and commercial gear.

10) Complete a decision table. Conduct appropriate projections under the 40-10 harvest policy through 2016 under the two bounding scenarios. The decision table is to be completed by STAT team and included in the final assessment document.

Comments on Technical Merits and/or deficiencies in assessments
The assessment used a relatively simple model, with assumed values for steepness, natural mortality, and the length coefficient of variation. Other growth parameters and fully-parameterized selectivity curves for multiple fisheries were estimated. In general, the model structure was appropriate for the amount of reliable data available, though the Panel would have liked to have seen further exploration of simpler models.

A base model could not be defined. This is a reflection on the quality and extent of data rather than the model. The Panel worked with the STAT team to develop an approach to provide useful information to the Council while at the same time emphasizing the uncertainty of the results.

Areas of disagreement

No areas of disagreement remained unresolved.

Unresolved problems and major uncertainties

Recent genetic research indicates that vermilion rockfish is comprised of two species. The estimate of stock decline and increase could potentially be a decrease in one of species and an increase in the other.

Recruitment of vermilion rockfish is likely strongly influenced by unknown environmental factors. The increase in vermilion rockfish occurred while most other California rockfish were decreasing. This is coupled with an the inability to resolve divergent stock-recruit models with currently available data.

The Stephens and MacCall (2004) method for filtering RecFIN CPUE data and the fitting of GLM models are the best available methods for minimizing potential biases from a CPUE index. Nevertheless, changes in fishing practice and resource distribution still have the potential to affect the CPUE index in ways that cannot be fully evaluated.

Research recommendations

There are two categories of research recommendations, those specific to vermilion rockfish, and those applicable to all rockfish.

Vermilion rockfish recommendations

Investigation into the species composition of nominal vermilion rockfish is needed.

It is not clear that separate assessments for the northern and southern areas are warranted for vermilion rockfish. Although there were differences in the estimated magnitude and timing of recruitment events, the estimated stock trends were similar in both areas. Pooling of data from northern and southern areas may permit a more robust assessment model to be obtained.

Generic rockfish recommendations

The historical catch is an important input into any stock assessment. Although efforts have been made to construct catch time series for California rockfish, a more sustained effort is needed to do this for all rockfish species. It should not be left to individual analysts to do this for a species as stock assessments arise. It should be done by a specialist team for all species simultaneously, so that consistent times series can be established.

Management changes affect fisher behaviour and alter the correct interpretation of CPUE time series. As for catch histories, it is important that a specialist team consider and document all management changes and how they may have impacted on catch rates for all species. Again, this should not be left to individual assessment authors as the issues are generic and patterns might not be obvious without a multi-species perspective.

Improved documentation of input data and output for GLM analyses of CPFV and RecFIN CPUE data is recommended. In general, GLM analyses should provide analysis of deviance tables, estimated coefficients, and their standard errors to document these calculations. Information on amount of RecFIN records filtered by species association also needs to be presented to show the effect of the species association analysis. Although this method is an objective approach to filtering records, it is unknown how well works in practice to reduce the potential biases of CPUE data. A paper describing a comprehensive application of GLM methods to CPFV and RecFIN CPUE data on California rockfish would be a important contribution to the assessment process and the primary literature.

Many rockfish assessments use CPUE data from the CPFV fishery as an index of population abundance. The CPFV fishery is focused primarily on marketing a successful "fishing experience" that is related to the desirability of the species caught, quantity, body size, and fighting characteristics. The default assumption of proportionality between CPUE and abundance has not been evaluated for a fishery with these characteristics. Simulation modeling of fleet dynamics in a multi-species context is one possible way to address these issues.

A more complete understanding of the multi-species aspects of rockfish population dynamics is needed. Although some rockfish stocks have declined in recent decades under heavy fishing pressure and environmental change, other rockfish species have apparently increased. Are these species adapted to different environmental conditions, or are these increases due to the indirect effects of reduced competition and/or predation?

Conducting additional assessments of the many relatively uncommon rockfish in California is a difficult but worthwhile objective. To facilitate this process, the Panel has a number suggestions:

1. Keep the models simple.
2. Make reasonable assumptions based on life history and better studied species for parameters that cannot be reliably estimated, such as natural mortality, stock-recruit steepness, selectivity.
3. Think meta-analytically. For example, similar species that are often caught together are likely to have experienced similar fishing mortality rates and trends. There are also more rigorous methods for sharing information between related stocks that could be considered.
4. Make the most of CPUE data:
    - For several assessments, indices from GLM analyses of site-specific CPFV data apparently tracked population trends better than indices from RecFIN data, even when a subset of records had been selected using the Stevens and MacCall (2004) procedure. Greater priority should be given to collecting site-specific CPUE data. Given the ubiquity of GPS systems and hand-held data recorders, obstacles to

collecting site-specific information from fisheries are now logistic rather than technological.

- Location information for the historical groundfish catch data of all species is currently available, in hard copy form only, from the California Department of Fish and Game. Putting this information into electronic format would greatly improve the ability to assign catches of all species to specific stocks on a trip-by-trip basis.

5. Do not put too much trust in model results. Models are no better that their input data and assumptions, and for many rockfish species, the data are sparse and potentially misleading.