# COWCOD

## STAR Panel Report

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STAR Panel members:

Martin Dorn (Chair), Alaska Fisheries Science Center and SSC representative
Jon Brodziak, Northeast Fisheries Science Center
Patrick Cordue (Rapporteur), Center for Independent Experts
Christopher Legault, Northeast Fisheries Science Center
Robert Mohn, Center for Independent Experts

Deborah Aseline–Neilson, GMT representative
Susan Ashcraft, GMT representative
Gerry Richter, GAP representative

STAT team members present

Kevin Piner, Southwest Fisheries Science Center

## Overview

A draft stock assessment of cowcod (*Sebastes levis*) was considered by a STAR Panel which met from May 9-13, 2005 at the NMFS Southwest Regional Office in Long Beach, California. The first and only previous full assessment of cowcod in 1999 led to cowcod being declared overfished and the development of a rebuilding plan. The new assessment used several data sources and included a biomass estimate from the cowcod conservation area (CCA) derived from a 2002 line-transect submersible survey. Mary Yoklavich gave a presentation on the visual survey. The new assessment was presented by Kevin Piner.

The biomass estimate of cowcod derived from the visual survey was used in all the initial base models presented to the Panel. The presentation on the visual survey covered the motivation for the survey, the design, implementation, results, and the subsequent review of the method and results. The reviewers had seven areas of concern with regard to the original estimate. The researchers investigated each of these areas and found three issues that made a difference to the biomass estimate. They reanalyzed their raw data and produced the revised estimate used in the new cowcod assessment. The estimate pertains only to cowcod in the CCA.

Two methods had been investigated for estimating the proportion of the cowcod stock in the CCA at the time of the visual survey. One method used the CalCOFI larval data but it was clear that the very rare occurrence of cowcod larvae in the CalCOFI tows made this method very tenuous. The second method used CPUE data from commercial passenger fishing vessels (CPFVs) logbooks to obtain relative density estimates inside and outside the CCA. Estimates of cowcod habitat (rough/rocky bottom) were then used to weight the relative abundance estimates inside and outside the CCA, and hence obtain an expansion factor (CCA to whole area). The expansion factor of 1.55 was derived from data covering an extended time frame and was considered to be an overestimate by the Panel. A revised estimate of 1.33 was supplied that only used data from the 1990s. The Panel recommended that the visual survey estimate be used in all runs as a relative abundance estimate with an informative, but relatively diffuse, prior on the proportionality constant q. Sensitivity to both the mean and variance of the prior on q were explored but the assessment results were insensitive to the alternative values used.

The initial base models used all of the data sets from the previous assessment and also included the visual survey estimate and some length frequency samples from the recreational and commercial catches. The Panel and STAT team discussed, at length, the quality of each data set with regard to model assumptions. The Panel recommended the removal of the CalCOFI spawning biomass time series, the outfall time series indexing 3-year-old recruits, and the length frequency data. The CalCOFI and outfall surveys capture very low numbers of cowcod larvae and juveniles respectively. The CalCOFI series is extremely variable and may be strongly influenced by non-random processes unrelated to year specific cowcod spawning biomass (e.g., weather and climate which influence the availability of cowcod larvae to the CalCOFI tows). The outfall trawl surveys cover only a small proportion of the juvenile cowcod habitat and do not sample its preferred habitat. The length frequencies had such low sample sizes that it appeared unlikely that they would be representative of the catch.

The STAT team adopted the Panel's recommendations and produced the final base model using the CPFV CPUE indices and the visual survey estimate (with an informative prior). Sensitivity to natural mortality (M) and Beverton-Holt stock-recruitment steepness (h) were investigated over plausible ranges for rockfish. Results were sensitive to both parameters, but uncertainties were adequately captured by either parameter. Uncertainty in steepness was considered more important for rebuilding so the base model was bracketed by two models with alternative values of h (base model: h = 0.5, alternative values: h = 0.4, 06). The Panel and STAT team assigned subjective probabilities to each model: base = 40%, low h = 30%, high h = 30%.

The Panel concludes that the final model runs are based on the best available data and that the assessment results constitute the best available scientific advice on the status of cowcod. The Panel commends the STAT team for their efforts before and during the meeting and their responsiveness to Panel requests.

**Analyses requested by the STAR Panel**

Requests from the STAR Panel and the response from the STAT team are listed below. There are two categories of analysis requests, those made prior to the meeting, and those made during the meeting.

***Pre-meeting requests (1-8)***

**1) Generate CPUE time series from the RecFIN database using the logistic regression method of Stephens and MacCall (2004). CPFV and private boat data should be analyzed separately using delta-GLM models.** The time series were generated using the requested method. However, there were insufficient data to support the use of the CPUE time series as abundance indices. It was also noted that CPFV data were already incorporated into the existing logbook based CPFV time series.

**2) Provide results for model runs which omit in turn the CalCOFI and CPFV times series.** These time series were showing contradictory trends from 1984 to 2000. Runs which de-emphasized each time series were already in the draft assessment document. Results were presented for all existing sensitivity runs and the largest effects highlighted. Removal of one or other of the time series had a minor effect for base models 2 & 3 in the draft document, with a larger effect for base model 1 (CalCOFI favoring higher biomass than CPFV).

**3) Present a plot of the time series of ratios used to estimate pre-1980 commercial catches of cowcod.** It appeared that the ratio of state-wide catches of cowcod to state-wide catches of rockfish during 1980-97 had been used to estimate the pre-1980 commercial catch. Given that there were significant commercial catches of cowcod north of the Southern California Bight (SCB), it was unclear how these removals would not be incorrectly attributed to SCB. The time series showed considerable variability but no strong trend. The catches used had not been state wide but just from the SCB. It was agreed that the draft assessment document would be clarified.

**5) Present the time series of ratios used to estimate the pre-1980 recreational catches.** These ratios were formed using CPFV data and LA Times catch and the RecFIN catch estimate. The time series was presented and discussed. It was noted that the assessment results were not sensitive to exact values of the reconstructed recreational catch.

**6) Tabulate the strengths and weaknesses of each data time series used in the assessment, relative to the model assumptions.** Each time series was assigned an acceptability score of 1, 2, or 3 with regard to various characteristics (e.g., spatial coverage, temporal coverage, sample sizes). The average score for each time series was worse than 1.5, with the exception of the CPFV time series, which scored 1.3.

**7) Provide various model diagnostics: plots of standardized residuals for each time series, and the standard deviations of the standardized residuals.** Diagnostics were presented for early runs. The details of the request were clarified during the meeting and a full set of diagnostics were presented for the final runs.

**8) Compare the standard deviation of the estimated recruitment deviations to the assumed standard deviation of recruitment.** Values were presented for initial runs which estimated recruitment deviations. In the final runs recruitment deviations were not estimated.

***Within meeting requests (9-13)***

**9) Provide a number of runs based on two alternative data sets:**

a. **CPFV CPUE and visual estimate**
b. **CPFV CPUE, outfall trawl series, and visual estimate**

The CalCOFI time series and the length frequency data were not used. For each data option a number of runs were requested for alternative values of M (0.04-0.07) and h (0.4-0.7). In all cases selectivity was assumed to equal female maturity. Recruitment deviations were only to be estimated in option b. (for a time frame supported by the outfall data) The updated visual survey estimate was used with a prior on q: mean(q) = 0.65 (from the CPUE-based estimate of the expansion factor), and a c.v. of 50%.

The results were presented for various values of M and h, with and without iterative re-weighting of the time series. The bad residual patterns for the CPFV series persisted in all models, with the model predictions unable to fit the steep downward trend in the time series.

**10) Provide a number of runs using only the CPFV CPUE time series and the visual estimate to investigate the sensitivity of results to changes in the mean and variance of the prior on the visual survey q.** Specifications for the runs were: mean(q) = 0.65, 0.75; c.v.(q) = 0.5, 0.75; h = 0.5, M = 0.055. The assessment results were not sensitive to the changes in the prior investigated. There was much greater sensitivity to the values of M and h (with smaller values of M and h preferred by the model).

**11) Provide a revised expansion factor for the visual survey estimate. Use the CPUE based method with a more recent time frame.** The expansion factor was reduced from 1.55 to 1.33 when data from only 1990 onwards were used. This corresponds to a visual survey q of 0.75 (which had already been used in some new runs).

**12) Provide a run using only CPFV CPUE time series and the visual estimate in which a power term is estimated for the CPFV time series.** Specifications for the run were: mean(q) = 0.75, c.v.(q) = 0.5, h = 0.5, M = 0.055. The power term was estimated larger than one (1.6) denoting hyperdepletion and the fit to the CPFV time series was improved. However, there was still a very bad trend in standardized residuals, indicating that the assumed error and/or model structure was inappropriate.

**13) Participate in an exercise to assign probabilities to the base case and the two bracketing runs.** The value of h had been identified as the primary dimension of uncertainty: h = 0.4, 0.5, 0.6. The Panel and the STAT team discussed the relative likelihood of each value and various rationales that could be used for assigning probabilities to each run. Subjective probabilities were assigned by most members of the Panel and STAT team and then averaged. Probabilities assigned were: 30%, 40%, 30% for h = 0.4, 0.5, 0.6 respectively.

**Technical merits and deficiencies**

Technically the base model is sound. The model structure is very simple with estimation of only three parameters, two of which are nuisance parameters (CPFV and visual survey qs). This is appropriate given the very limited reliable data available. Parameter estimates of uncertainty were not calculated during the meeting as there was insufficient time to perform a full Bayesian assessment (MCMC runs).

**Reasons for excluding previously used and newly proposed data**

The current assessment directly uses only two data sources, the CPFV time series and the visual survey estimate. The previous assessment (Butler et al. 1999) and the initial base models presented to the STAR Panel used additional data sources. During the course of the meeting, three data sets were removed from the initial base models. In the opinion of the STAR Panel and the STAT team, the data sets were of insufficient quality to be used in an assessment. The specific reasons for the exclusion of each data series is given below.

The Panel recommended that the abundance indices based on the percentage of CalCOFI tows containing cowcod larvae not be used for assessment purposes for several reasons. The index is extremely variable most likely due a range of effects unrelated to the year specific abundance of cowcod spawning biomass (e.g., weather, climate, El Nino). This is not a problem if the cumulative effects are without trend, but decadal patterns in environmental conditions have been well documented in SCA. The extremely rare occurrence of cowcod larvae in the CalCOFI tows (3.8% of tows prior to 1970 and 1.3% of tows since 1970) is, by itself, of concern. There are 16 years, out of 43, in which no cowcod larvae are captured. Changes of survey implementation, in1969 and 1978, including the type and size of net is also of concern, particularly due to the unknown effect of these changes on the probability of positive records. Finally, the assumed lognormal error structure would appear to be inappropriate for an index based on a percentage of successful tows.

The Panel shared the concerns of the STAT team with regard to the outfall indices of age-3 cowcod recruitment from the Sanitation Department trawl surveys. Such an index provides a sound basis for estimating recruitment deviations if it is an unbiased index of recruitment to the stock. Unfortunately, the trawl surveys cover only a small proportion of the stocks distribution and necessarily avoids the preferred habitat of cowcod (which have an affinity for rough/rocky bottom). As with the CalCOFI time series, the indices are based on the percentage of tows which capture cowcod, and the average percentage of successful tows is very low (4.6%). There is also the same concern, as with the CalCOFI time series, that an index based on the percentage of successful tows will not have the assumed lognormal error structure.

A new data set of length frequency samples was proposed for use by the STAT team in the assessment. Sample sizes were very low except for the recreational fishery in 1975-78. These data may contain some useful information on the recreational selectivity pattern of the time. However, there are concerns about the representativeness of the samples given the modest sample sizes (usually less than 100 fish per year). The Panel recommended, and the STAT team agreed, that the data be omitted and that the fishery selectivity patterns be set equal to the female maturity pattern.

**Areas of disagreement**

There are no areas of disagreement between the STAR Panel and the STAT team, or within the STAR Panel.

**Unresolved problems and major uncertainties**

It is uncertain whether the CPFV time series is an adequate index of abundance for stock assessment purposes. It was not possible, during the meeting, to find an adequate fit to the time series. The strong residual patterns indicate an inconsistency with model assumptions.

The visual survey method has undergone a full review and the original estimate was revised in response to issues raised by the review. However, the method does not yet have demonstrable repeatability. A consistent time series of estimates is needed before full confidence can be placed in this method for cowcod biomass estimation.

The available assessment data are inadequate to allow reliable estimation of the stock recruitment relationship, natural mortality, and recruitment patterns.

## Research recommendations

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

### *Cowcod recommendations*

It is not clear how cowcod stock abundance will be monitored in the future. This is a planning issue which needs to be urgently addressed. Line-transect submersible surveys such as the survey in the CCA in 2002 are a promising approach for monitoring cowcod and other species of groundfish associated with rocky habitats, and are used routinely for assessment of similar rockfish species in Southeast Alaska. However, as noted above, a consistent time series of estimates is needed before full confidence can be placed in this method.

Future monitoring plans for cowcod should involve surveying both inside and outside the CCA. This obvious point seems to have been ignored when additional research efforts were devoted to cowcod following their designation as an overfished stock.

There is the possibility that the CPFV time series may have declined more rapidly than cowcod abundance (hyperdepletion). To explore this possibility, there needs to be research on cowcod spatial pattern and the behavior of the CPFV fleet in response to changes in the relative abundance of different target species.

### *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 valuable contribution to the stock 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 historic 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.

## References

Butler, J.L., L.D. Jacobson, J.T. Barnes, H.G. Moser and R. Collins. 1999. Stock assessment of cowcod. In Pacific Fisheries Management Council. Status of the Pacific Coast Groundfish Fishery through 1998 and recommended biological catches for 1999: Stock Assessment and Fishery Evaluation.

Stephens, A. and A. MacCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fisheries Research, 70: 299-310.