

**Blackgill Rockfish
STAR Panel Report**

Pacific Fishery Management Council
Southwest Fisheries Science Center
Santa Cruz Laboratory
110 Shaffer Road
Santa Cruz, CA 95060
August 8-12, 2011

Review Panel Members

Vladlena Gertseva, NMFS NWFSC, Panel Chair, SSC
Mike Armstrong, CIE
Kevin Stokes, CIE
Louis Botsford, UC Davis, SSC

Stock Assessment Team (STAT) Member present

John Field, NMFS SWFSC

STAR Panel Advisors

Sean Matson, NMFS NWR, GMT
Gerry Richter, PCGFA, GAP
John DeVore, PFMC

Overview

A draft assessment of blackgill rockfish (*Sebastes melanostomus*) in the Conception and Monterey International North Pacific Fisheries Commission (INPFC) areas was reviewed by the STAR Panel that met at the Southwest Fisheries Science Center (SWFSC) in Santa Cruz, CA, during August 8-12, 2011. Blackgill rockfish is a slope species that has been subjected to a targeted fishery since the late 1970s. Although the distribution of blackgill extends to Canadian waters in the north and Mexican waters in the south, the assessment is limited to the Conception and Monterey areas, since the species becomes exceedingly rare north of Cape Mendocino, CA, and data from Mexican waters are unavailable. The assessment models the species as a single stock since there is currently no genetic information to suggest the presence of multiple stocks in the assessed area, and there is some evidence for other rockfish species that multiple stock structuring is more likely for shelf rather than slope species.

The Panel operated under the Pacific Fishery Management Council's (PFMC) Terms of Reference for the Groundfish Stock Assessment and Review Process for 2011-2012. The assessment model estimated that the stock of blackgill rockfish in Conception and Monterey INPFC areas is currently at 30% of its unexploited level, which is above the overfished level of SB_{25%} but below management target of SB_{40%} and, therefore, is in the precautionary zone.

The STAR Panel agreed that the blackgill rockfish assessment constitutes the best available scientific information on the status of the species in the assessed area and recommends it to be used for status determination and management decision in the Council process.

Summary of data and assessment models

This assessment uses the Stock Synthesis (SS) modeling framework (version 3.21f) and incorporates a variety of fisheries-dependent and fishery-independent data sources. The stock assessment structures the fishery-dependent data into three fisheries, including Southern California fixed gear, Central California fixed gear, and Central California trawl. Fishery-independent data sources include the Northwest Fishery Science Center's (NWFSC) shelf-slope bottom trawl survey, which has operated annually since 2003, and two trawl surveys that operated historically but are now discontinued: the NWFSC slope survey, and the Alaska Fishery Science Center (AFSC) triennial survey.

The last full assessment of blackgill rockfish was conducted in 2005. Major changes made in this assessment, compared with the previous one include:

- Use of SS3 modeling framework instead of previously employed SS2.
- Use of revised catch history based on the catch reconstruction by Ralston et al. (2010).
- Use of revised fleet structure (fixed gear removals north and south of Point Conception are treated as separate fisheries, instead of dividing fixed gear into two (hook-and-line and gillnet) coastwide fleets, as was done in 2005 assessment).
- Use of updated female maturity-at-length parameters (derived from an ongoing histological study).
- Use of updated female weight specific fecundity parameters.
- Use of an updated value of stock-recruitment steepness based on the most recent meta-analysis by Dorn (Martin Dorn, pers. com.).

- Use of gender specific natural mortality values (0.063 for females, 0.065 for males) based on the prior developed by Hamel (Owen Hamel, pers. com.), in contrast with the natural mortality of 0.05 used for both genders in 2005 assessment.
- Recruitment estimated as deterministic values from a Beverton-Holt model with fixed input steepness and estimated R_0 (instead of estimated recruitment deviations as was done in 2005 assessment).

The pre-STAR document as well as the STAT presentation at the STAR Panel provided extensive information on ecosystem considerations for blackgill rockfish, which (although not explicitly included in the assessment model) provided valuable background information and outlined potential areas of research to pursue in the future while moving toward ecosystem-based management.

Requests by the STAR Panel and Responses by the STAT

The STAT presented an overview of the model described in the pre-STAR assessment report. The STAT also presented a few modifications, which were evaluated and accepted as improvements. These modifications included the use of additional age data points (that became available only after the pre-STAR report was submitted) and incorporation of gender specific natural mortality values base on Hamel priors. The model with those modifications was considered a “new” base, and all the requests used that “new” base model as a starting point.

Request №1: Provide plots of lower and upper 10%iles in length composition data by fleet and year.

Rationale: To investigate whether lower 10%ile supports blocking of selectivity used in the assessment and whether upper 10%ile indicates the size truncation expected from fishing history.

STAT Response: The STAT provided the requested plots.

Southern California fixed gear in the model has two time blocks with a break in selectivity between 1999 and 2000 to reflect implementation of the Cowcod Conservation Area (CCA): An overall reduction in mean length of over 10cm is observed since 1980s, which is substantial. The 10%ile declines progressively over the time series and the 90%ile declines until around 1992 and then is flat, a direct evidence of shift in fishing patterns associated with implementation of the CCA. Panel concludes that there is no evidence to change existing blocks or to add additional blocks.

Central CA fixed gear: no clear trend in percentiles (no blocks are used in model).

Central CA trawl: decline is observed in 10%ile and 90%ile until mid-1990s, then flat (no blocks used in model).

Request №2: If possible, plot the best estimates of historic proportions of blackgill rockfish catch inside and outside CCA

Rationale: To help evaluate the potential utility of the NWFSC combined shelf-slope trawl survey in the assessment.

STAT Response: A very rough approximation was carried out. Between 1950-1970, about 5% of total blackgill and unspecified rockfish landings occurred in the CCA. The percentage increased to over 40% by mid 1980s coincident with an increase in total blackgill and unspecified landings, and declined to around 20% by 2000 as total catches declined. The STAT proposed that a more accurate estimation would be done in the future.

Request №3: Provide plots of catch time series (total and by gear) used in pre-STAR sensitivity runs and in 2005 assessment.

Rationale: To evaluate alternative catch scenarios and help formulate sensitivity runs on historical catch time series.

STAT Response: Catches used in the 2005 assessment are almost identical to data in the 2011 assessment up to 1968 and from 1984 onwards. Catch amounts used in 2005 assessment in the interim period are around half the 2011 assessment values. Tabulated data in Appendix of 2005 assessment show much higher landings up to the 1980s, but are not the actual values used in the assessment. The Panel decided that options for catch streams for sensitivity runs should be applied to the period prior to 1978 (in 1978 species composition sampling began, and uncertainty in landings significantly decreased).

Request №4: Re-run model with double normal selectivity for surveys, but with length bins added in the model. Compare likelihoods and selectivity patterns with logistic model presented on day 1.

Rationale: To determine if a problem with double normal selectivity (peak parameter hitting the upper bound) persists with new length binning, in order to decide on likely post-STAR base case.

STAT Response: Double normal (with 3 parameters estimated) for NWSFC combo survey no longer goes all the way to the bounds with new length bins added. The 50% selection (30-35cm) was however shifted to the right of simple logistic (2-parameter) (<30cm). For the triennial survey, there was little difference between double normal and logistic up to around 80% selection, then there was a slight difference. There was a slight improvement in fit (~11 points) with double normal applied to NWSFC combo over logistic; applying additionally to triennial adds ~4 points. The changes make negligible difference to depletion estimates. The Panel's preference is to retain the new bin structure and apply the logistic model.

Request № 5: Provide recruitment series from model run with recruitment deviations estimated.

Rationale: To see if there are features suggesting changes in productivity over time.

STAT Response: Recruitment estimation was freed up from 1970 in place of deterministic estimates from fixed Beverton-Holt stock-recruit steepness and estimated R_0 . The recruitment estimates were strongly serially correlated with peak in 1980, large trough in 1990s, and subsequent increase. The run resulted in more optimistic depletion (though depletion level remained between minimum threshold and target). The Panel noted that the selectivity blocking was still in place to help explain changes in length compositions and requested a further run without the selectivity blocking (Request № 7).

Request №6: If time allows, re-run assessment using 60+ plus group.

Rationale: To evaluate sensitivity of assessment to plus group, given small numbers of older fish in age data sets.

STAT Response: This made very little difference to stock trends. At 60+ the A_{max} value is now the plus group. Depletion was altered from 0.289 to 0.296. Also, there were slight changes to 2011 SPR, females L_{max} and K . The maximum age in the data is 64 years. This change was retained for the post-STAR base model.

Request №7: Repeat the model run for request (5) (to provide recruitment series from a run with recruitment deviations estimated), but removing the time blocking of selectivity that was introduced to allow a better fit to the trends in length composition and implementation of CCA.

Rationale: To see if there are features suggesting changes in productivity over time, without any possible confounding effect of estimating a change in fishery selectivity.

STAT Response: This gave quite different recruitment trends than the run with selectivity block. Recruitment remained serially correlated. Increased recruitment in 1990s was presumed to explain part of the trend of declining mean length over time in the fishery (the rest was due to truncation at large size from fishing). The depletion patterns for this run compared to the base run are fairly similar. There is an *a-priori* basis for assuming some change in selectivity, but selectivity will be confounded with recruitment in explaining changes in length. Recruitment is still fixed up to 1970; the model estimates a very sharp dip in recruitment in 1971 followed by progressive increase, possibly to compensate for strong year classes in late 1960s not reflected in the fixed values (note Moser et al. 2000 paper shows large larval abundance indices from CalCOFI surveys for some rockfish in late 1960s). The Panel agreed it was important to provide these results in final SAFE to show that the effect of fixing recruitments was investigated, even if it was not appropriate to estimate recruitment (as was done in 2005 assessment) in the base model due to data limitations.

Request №8: Repeat model run for request (6) (use of 60+ plus group) while: (i) setting length at Amax to 55, (ii) setting maximum age in population to 65.

Rationale: To determine the effect on estimation of growth parameters of having the maximum population age and the data plus group the same.

STAT Response: The runs resulted in very minor differences in depletion level and other derived quantities. Some degradation of likelihoods occurs when age bins are set out to 65. The Panel decided not to include this adjustment in the base case.

Request №9: Carry out runs of the base model with: (i) pre-1978 catch time series increased by 25% and (ii) pre-1978 catch time series reduced by 50%.

Rationale: To investigate sensitivity of management variables to uncertainties in historical catches.

STAT Response: Catches of all gears pre-1978 were adjusted +25% and -50% (i.e. foreign catches were adjusted as well). Total 1950-77 catch in the base model is 3562 mt, 1781 mt in low catch scenario, and 4851 mt in high catch scenario. Initial spawning output is adjusted accordingly, but final depletion estimates of 0.292 and 0.324 for high and low catch respectively are similar to base run value of 0.296. The high catch stream scenario leads to a slight increase in likelihoods, although the STAT suggested and the Panel considered the low catch stream scenario more plausible (as advised by GAP representative).

Request №10: Profile likelihoods over range of stock-recruit steepness parameter $h = 0.6 - 0.95$.

Rationale: Investigate sensitivity to steepness.

STAT Response: A lower steepness implies larger rate of reduction in recruitment over the period of depletion of spawning stock. The likelihoods for age decline linearly as steepness is reduced. The opposite pattern is observed for length, indicating the tension between length and age data in the model. Survey likelihoods decline as steepness increases. The overall likelihood

was lowest for smaller steepness values, but the range of likelihoods is relatively small. The Panel concluded there was no value in attempting to estimate steepness in the model.

Request №11: Profile likelihoods over range of natural mortality values 0.04 – 1.0.

Rationale: To investigate sensitivity to natural mortality.

STAT Response: Depletion was very sensitive to natural mortality (M). Total likelihood and age likelihood favors higher M values. Different fleet length compositions give different trends in likelihood over M profile. Overall, a larger fraction of length and age data favors higher M . However, the Central California trawl fleet, which is the longest and best sampled fleet, has smallest likelihood values at low M . Central California fixed gear has domed profile with lowest values at low and high M . Larger M values give lower growth rate (K). The previous assessment had $M=0.04$. Current assessment choice of $M=0.065$ for the base model is from the Hamel prior. Given conflicting indications, and information from Central California trawl, the Panel prefers $M = 0.065$ for males as most objective choice.

Description of the base model and alternative models used to bracket uncertainty

Start year of the model =1950; one area; two genders; discard incorporated with landings into total removals for the period from 2002 through 2010 (no discards assumed prior to 2002);

M fixed at 0.063yr^{-1} for females and at 0.065yr^{-1} for males (Hamel's prior);

Von Bertalanffy growth model, length at Amin fixed for both genders, all other growth parameters estimated for females and males separately;

Beverton-Holt stock-recruitment model, h fixed at 0.76 (Dorn's prior), R_0 estimated but no recruitments deviations estimated;

Asymptotic length-based selectivity for all fleets, Southern California fixed gear selectivity is blocked between 1999 and 2000 to account for implementation of the CCA.

Fisheries:

- Southern California fixed gear
- Central California fixed gear
- Central California trawl

Abundance indices:

- NWFSC shelf-slope bottom trawl survey (2003-2010)
- NWFSC slope bottom trawl survey (1999-2002)
- AFSC triennial trawl survey (1995-2004)

Length frequencies:

- Southern California fixed gear
- Central California fixed gear
- Central California trawl
- AFSC/NWFSC triennial trawl survey
- NWFSC shelf-slope bottom trawl survey

Age frequencies:

- Southern California fixed gear
- Central California fixed gear
- Central California trawl
- NWFSC shelf-slope bottom trawl survey

The STAT and the STAR Panel discussed various alternatives for capturing the major axes of uncertainty for this assessment. There was widespread agreement that natural mortality (which

strongly covaries with growth parameters and depletion) is the single greatest source of parameter uncertainty in the model. Consequently, the decision was made to bracket model uncertainty with alternative values for natural mortality. Since the point estimates for M used in the assessment (0.063 for females, 0.065 for males) were based on the Hamel prior, the standard deviation for the Hamel prior was used to define the bounds for the uncertainty in M , leading to a high (0.086 females, 0.089 males) and low (0.046 for females, 0.048 for males) natural mortality rates used for alternative states of nature.

Although the scenarios with plus or minus one standard deviation should theoretically encompass more than 50% of the uncertainty in the model, it was recognized that there are additional sources of uncertainty in the model besides M , thus to add or subtract one standard deviation from M was considered reasonable.

Catch streams for the decision table were developed by forecasting the SPR 50% harvest for each state of nature beginning in the year 2013, with catches for the years 2011 and 2012 based on the existing 2011-2012 accumulated catch limits (ACLs).

Technical merits

The current assessment addresses most of the comments from the last STAR Panel held in 2005. As recommended, the STAT explored alternative ageing methods (break and burn, thin sectioning, hand cutting with a diamond saw), developed new ageing criteria and generated additional age data for the assessment (over ten times more age observations were included in the current assessment than previously used). Also, a comprehensive effort was undertaken to better describe maturity (using data from an ongoing histological study) and fecundity of blackgill rockfish.

The assessment also carefully considered biological and fishery information to redefine fishery fleets for the assessment. Fixed gear removals north and south of Point Conception are treated as separate fleets, instead of dividing fixed gear into two (hook-and-line and gillnet) coastwide fisheries as in the 2005 assessment. The change (from the last assessment) was made to reflect both greater similarity in length composition data between two fixed gear fisheries (hook-and-line and gillnet) within areas (rather than between), and the development of the targeted blackgill fishery using fixed gear in the southern California Bight.

This is a relatively simple model within SS, with a number of essential parameters (such as M , h and recruitment deviations) which are fixed due to the limited amount of data available. The assessment, however, uses the most up-to-date external information to inform these parameters in the model, including the most recent Dorn's prior on the stock-recruitment curve steepness and Hamel prior on M .

Technical deficiencies

The data are too limited to allow estimation of important parameters such as M , h and recruitment deviations, which limits the extent of uncertainty estimated within the model. The model therefore, requires careful and extensive sensitivity testing and profiling.

Areas of disagreement regarding STAR Panel recommendations

There were no disagreements among STAR Panel members (including GAP, GMT, and PFMC representatives). There were also no disagreements between the STAR Panel and the STAT.

Management, data, or fishery issues raised by the GMT or GAP representatives during the STAR Panel Meeting

There were no management issues noted by GMT and GAP to be impacting the assessment.

Unresolved problems and major uncertainties

The assessment focuses on the portion of the blackgill rockfish population found in the Conception and Monterey INPFC areas, even though the range of the species extends into Mexican waters (to central Baja California). The relationship between blackgill found and harvested in the U.S. and in Mexico is unclear. It is not known whether blackgill in both areas are part of the same stock. It is also not known what portion of blackgill population resides in Mexican waters and what their biological and life history characteristics are.

As with most of the west coast rockfish species, catch history is one of the major sources of uncertainty. Even with the California rockfish catch reconstruction effort reported in Ralston et al. (2010), uncertainty in historical landings remains due to fact that fishing effort exhibited a gradual shift towards deeper waters. Species composition sampling in Southern California began only in the late 1970s, and these compositions were applied to historical landings of multi-species market categories. Therefore, there is the potential to overestimate the historical contribution of slope species (including blackgill) to overall landings of the mixed-species market category (i.e. unspecified rockfish), and underestimate the contribution of shelf species.

Also, reliable fishery-independent information is essential for any stock assessment. Survey efforts on the U.S. west coast are currently closed in the CCA, which is likely to include large areas of very good blackgill habitat (based on fishermen's knowledge and the observation that the highest survey catch rates often occur at similar habitats along the boundaries of the CCA). This produces limitations to effectively utilize survey data and reduces the ability to accurately describe dynamic of the species.

Recommendations for future research and data collection (not prioritized)

To address uncertainty regarding the portion of blackfish population residing in Mexico, the Panel follows the suggestions of the 2005 STAR Panel to attempt to document catches in Mexican waters by both U.S. and Mexican fishers and consider the implications of blackgill being a shared stock. The Panel also suggests exploring alternative sources of information (i.e. to investigate whether there are relevant studies conducted at Universities in Mexico), that could yield information on biology, life history and exploitation of the blackgill that could be used in the next assessment.

The Panel recommends devoting additional efforts to reconstructing historical landings. This recommendation applies to most groundfish species on the U.S. West Coast (and not only blackgill rockfish). In addition to providing the best reconstructed catch histories by species, this effort should develop alternative catch streams that would reflect differences in data quantity and quality available for different time periods. Such (more realistic) alternative catch streams would

be very useful while exploring model sensitivity to uncertainty in catch history (rather than applying a simple multiplier to entire catch time-series, which is currently the case for most groundfish assessments). Also, taking into account a spatial shift in fishing efforts to deeper waters would be a significant improvement to catch reconstruction of blackgill rockfish and other species landed in mixed-species categories.

Both the STAR Panel and the STAT agreed that alternative means of exploring relative or absolute abundance in the CCA is a key research priority. Submersible or other non-invasive survey methods could potentially provide additional information on habitat and abundance for this species. Also, it is important to develop alternative methods to monitor length and age compositions of fish inside CCA.

The STAT emphasized that blackgill rockfish has proven to be very difficult to age, and age estimates are highly uncertain. Improving age data quality (through validation studies, otolith exchange between labs) and greater exploration of possible differences in age and growth throughout the range of this stock using the data from otoliths that have not yet been processed is desirable. The STAR Panel agreed, but noted that careful consideration should be devoted to producing exactly the age data which would be of most direct benefit to the assessment, based on representative sampling, since expertise, time and funds are all limited.

Given that no changes in assessment model structure were suggested, the Panel recommends that the next blackgill rockfish assessment be an update assessment.

Acknowledgements

The STAR panel thanks the STAT for their hard work and willingness to respond to panel requests. The Panel also thanks staff at the SWFSC Santa Cruz laboratory for their exceptional support and provisioning during the STAR meeting.

References

- Moser, H. G., Charter, R. L., Watson, W., Ambrose, D. A., Butler, J. L., Charter, S. R., Sandknop, E. M. 2000. Abundance and distribution of rockfish (*Sebastes*) larvae in the Southern California Bight in relation to environmental conditions and fishery exploitation. CalCOFI Reports 41: 132-147.
- Ralston, S., Pearson, D., Field, J., M. Key, M. 2010. Documentation of the California commercial catch reconstruction project. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-461.