Report on the 2009 STAR --- Greenspotted Rockfish and Bronzespotted Rockfish Stock Assessment

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Prepared for

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Contents

Executive Summary

The 2009 stock assessments of greenspotted rockfish (*Sebastes chlorostictus*) and bronzespotted rockfish (*Sebastes gilli*) stocks along the California coast waters were reviewed as a special Stock Assessment Review (STAR) process. Bronzespotted and greenspotted rockfish are two of the species of concern in southern California and neither has been previously assessed.

The assessments of the stocks were presented to the Review Panel and the validity of the data, assessment procedures and results were discussed. A set of proposed data-poor models and methods were presented for bronzespotted rockfish; a set of age-structured stock assessment models fitted to length frequency data with and without abundance indices (implemented in Stock Synthesis version 3 toolbox, SS3) were presented for greenspotted rockfish. An extra simulation study based on chilipepper rockfish (*Sebastes goodei*) fisheries data was presented by the Stock Assessment Team (STAT). The review panel members requested some extra runs and explorations on competing hypotheses in explaining the observation data of greenspotted rockfish and extra analyses of the depletion models and the ASPIC runs on bronzespotted rockfish. The panel members then prepared their individual reviews.

Bronzespotted rockfish stock assessments were executed using multiple models including 2 depletion models (Leslie and Davis 1939; DeLury 1947), depletion-corrected average catch (DCAC, MacCall 2009), a production model (ASPIC534 from the NMFS Fisheries Toolbox; Prager 1994) and an age-structured population model employed in SS3. A fish assemblage analysis using a generalized linear model (Stephens and MacCall 2004) found that cowcod rockfish (*Sebastes levis*) was the strongest predictor of the bronzespotted rockfish presence probability. This conclusion matched their habitat association from the surveys. The STAT team then “borrowed” the F (fishing mortality) estimation of cowcod. Data for cowcod fishery stock assessment are of relatively high quality and the stock assessment of cowcod was done through an age-structured population model employed in SS3. An abundance index of bronzespotted was approximated by using *Catch* of bronzespotted divided by the *Fishing mortality* of cowcod estimated from a SS3 statistical catch-at-age model. This abundance index was used in many of the models, such as depletion models, ASPIC and SS3.

There are very limited data on Bronzespotted rockfish: no direct survey or fishery independent abundance indices, length frequency data of a few years with small sample sizes. It’s a typical data-poor species. The STAT investigated several methods to deal with this data-poor species and employed a series of studies on the influence of uncertainty in the assumed values, which are very valuable, although many of them were not used/written in the presented stock assessment report. All of the models supported the conclusion that this stock is overfished to a very low level.

Greenspotted rockfish stock assessments were executed using an age-structured population model employed in SS3. The data available for this stock are not as limited as that for Bronzespotted rockfish and are considered adequate to perform a credible stock assessment. Available data include landings (commercial and recreational by region and gear), time series of relative abundance, and length frequencies from both the landing samples and the relative abundance surveys. The STAT divided the species into two stocks: northern and southern California stocks based on the length-at-age differences from these two locations. The STAT also developed a "data-rich model" and a "data-poor model". Both models are employed in a statistical catch-at-age modelling framework with data-rich model used all of the data and considered the stochasticity of the Stock Recruitment (SR) relationship in the model fitting, while the data-poor model used only the landing and length frequency data from the landing sampling and assumed a deterministic SR relationship in the model fitting. The stock assessment was based on the "data-rich model". The STAT would like to compare the results from the "data-poor model" with that from the "data-rich model", in order to determine whether it would work for data-poor species to leave fishery-independent survey data out and use a simplified model.

Greenspotted rockfish stock assessments were considered to be preliminary both by the STAT and the review panel. The current support for a two-stock hypothesis needs to be further addressed. The STAT indicated that they would like to investigate temporal variation of fish growth; however the data used to support a two-stock hypothesis were collected from two time periods which may confound the growth heterogeneity of spatial areas and temporal periods. The output of the model fits, such as length frequency, indicated lack of fit in some years. Some of the results, including lack of fit, were not well explored because of the time limitation. An extra simulation study based on chilipepper rockfish fisheries data was presented by the STAT working on greenspotted rockfish. The objectives of this simulation were to investigate the performance of the "data-poor model" framework, provide basis for the stock assessment of data-poor species, and investigate the possibility of using SS3 to assess data-poor species. The current number of simulations is too low; however, these attempts are considered very valuable and are encouraged to continue beyond the current preliminary results.

Some key recommendations are summarised below:

- Bronzespotted: The idea of borrowing information from closely related species based on the fish assemblage analysis may be improved by incorporating more than one species that have relatively high-quality data and closely correlated with bronzespotted rockfish. Some sensitivity analysis on this possibility is valuable to conduct.

- Bronzespotted: The differences of the preference of depth between cowcod and bronzespotted rockfish need to be further investigated. Future assessment may incorporate this difference into the analysis since cowcod

assessment results were borrowed and strongly influenced bronzespotted rockfish stock assessment. It is expected that incorporating more than one correlated species may diminish the influence of the habitat differences between cowcod and bronzespotted rockfish.

- Bronzespotted: Hierarchically structured distributions may be used for modelling uncertainty of natural mortality in the DCAC analysis. Figure 10 indicated that using a "joint" estimate of M is not enough. A hierarchically structured M can be $M \sim N(\bar{M}, \bar{M} \times CV)$, and $\bar{M} \sim U(a1, a2)$ given figure 10 (Clark 2003; Jiao et al. 2009a and 2009b).

- Greenspotted: The stock structure needs to be reconsidered and more evidence is needed.

- Greenspotted: The priors of natural mortality and the parameters in the SR model were collected. I recommend that STAT consider using them comprehensively in the SS3 framework or through a full Bayesian analysis (Punt and Hilborn 1997; Patterson et al. 2001). Current sensitivity analyses shed light on the influence of the parameters on the stock assessment results but have trouble indicating which scenario to believe.

- Greenspotted: If the "data-poor model" is intended to be used for species with only landing data and length frequency sampling of landing, priors on selectivity of the fishing gears are suggested to be collected.

- Greenspotted: Before comparing the results between the "data-poor model" and the "data-rich model", a more comprehensive exploration on the data-rich scenario (incorporating all data) with consideration of different competing hypotheses is suggested. By doing this, we would understand the driving factors that influence the stock assessment of the example fishery. Possible hypotheses that arose during the discussion include: selectivity variation over time, bias in the catch composition, recruitment variation and discarding. When conducting the simulation study to evaluate the "data-poor model", these hypotheses tested should be incorporated when simulating the data to reflect the real fisheries.

1. BACKGROUND

The 2009 STAR assessments of greenspotted rockfish and bronzespotted rockfish stocks along the California coast were reviewed as a special Stock Assessment Review process. The meeting took place at the Southwest Fisheries Science Center, Santa Cruz, California from Sept 22 - Sept 24 2009. Bronzespotted and greenspotted rockfish are two of the species of concern in southern California and neither has been previously assessed.

The review committee was composed of Drs. Mike Prager and Todd Gedamke from SEFSC and Dr. Yan Jiao (Virginia Tech University) affiliated with the Center for Independent Experts, Northern Taiga Ventures, Inc. (NTVI).

The review was assisted by Dr. Stephen Ralston (SEFSC) and his staff (SEFSC). The greenspotted roskfish stock assessment report was prepared and was presented at the meeting by Drs. E.J. Dick, Xi He and Steve Ralston (SWFSC). The bronzespotted rockfish stock assessment report was prepared by Drs. Alec MacCall, John Field and Don Pearson and was presented at the meeting by Drs. Alec MacCall and John Field (SEFSC).

2. REVIEW ACTIVITIES

The 2009 STAR assessments meeting on greenspotted rockfish and bronzespotted rockfish stocks was held at the Southwest Fisheries Science Center (110 Shaffer Road), Santa Cruz, California from Sept 22 – 24, 2009. The meeting followed the “draft agenda” of this review (see appendix 2). The meeting was open to the public, and was attended by observers from University of California and California Department of Fish and Game.

About one to two weeks before the meeting, assessment documents and supporting materials were made available to the review panel via emails. In the morning of Sept 22 before the meeting, the assessment review committee met with Dr. Ralston and the STAT team to discuss the meeting agenda, reporting requirements, and meeting logistics. During the STAR meeting, all documents were made available electronically and in print if requested.

The meeting started on Monday morning, Sept 22, with a welcome and introduction by Dr. Ralston. The greenspotted rockfish assessment was presented that morning and bronzespotted rockfish assessment was presented in the afternoon. Input data, models, parameter estimates and the fishery status determination were evaluated through open discussion. The STAT members were always available when required for further discussion, additional model runs for clarification, and clarification of how the STAR Terms of Reference were addressed. On Tuesday, Sept 23, the greenspotted and bronzespotted assessments were discussed further,

and both STAT teams presented/updated further results on the additional model runs. On Wednesday, Sept 24, a follow-up discussion on both assessments was conducted and the committee asked further questions and then used the remaining time to discuss on the content of the review among the review panel members. The panel members were required to prepare an independent report according to the Term of Reference (appendix 2).

3. ASSESSMENT OF GREENSPOTTED ROCKFISH

Greenspotted rockfish is one species of concern in California and has not been previously assessed. Both the STAT and the review panel consider greenspotted rockfish stock assessments as preliminary. A follow-up data and model validation is needed before it can provide the basis for the management of this fishery off the West Coast of the U.S., including providing scientific basis for setting annual catch levels (ACLs) and acceptable biological catches (ABCs) as mandated by the Magnuson-Stevens Act. The STAT compared the results from the "data-poor model" with that from the "data-rich model" in order to investigate whether leaving fishery-independent survey data out and using a simplified model would work for data-poor species. A further simulation study was performed, but the number of runs was very limited at this stage. However these attempts are potentially very valuable for many rock-fish stock assessment.

TERMS OF REFERENCES

1. Become familiar with the draft greenspotted rockfish stock assessment documents and background materials.

   The assessment documents and supporting materials were made available to the review panel via emails one to two weeks before the meeting. During the STAR meeting, all documents were made available electronically and in print if requested. This TOR was completed successfully.

2. Evaluate relevant data collection operations and survey design and make recommendations for improvement.

   The stock structure hypothesis, two stocks, was not well supported. The only evidence of this hypothesis was the region-specific length-at-age models. However the data collected from two regions were also collected from different years (2001-2004 central California; 2004-2008 Southern California). This can confound both the temporal variation and the fish composition in the samples.

   Length-weight, fecundity-weight relationships and natural mortality are estimated outside of the models and were from the literature. Uncertainty and

prior of steepness of the SR relationship were discussed but were treated as fixed in the model. In general all the biological parameters were treated as fixed.

The commercial and recreational landing data are considered appropriately handled. The method to reconstruct historical landings was previously peer reviewed and was considered appropriate. It was briefly covered in the presentations and I have not reviewed it in any depth. However sensitivity analysis or even model framework with consideration of uncertainty of the constructed historical landings are suggested in the future assessment. Length frequency data from landings were considered to be well handled. There was no discarding/retention analysis reported. The STAT would like to look into the potential reference/data sources on discarding/retention in the near future.

There are three time series of the relative abundance data used in the assessment: the Northwest Fisheries Science Center combined trawl survey, Southern California Hook-and-Line survey and Central California commercial passenger fishing vessel index. Another fishery independent survey, Triennial Survey, was available but was not considered because greenspotted rockfish were rare in this survey. The STAT briefly covered the method used to standardize the relative abundance indices. I considered them appropriate because they were done following commonly recognized methods. The length frequency data from these surveys are considered to be well compiled and used appropriately. The lack of fit of the length frequency data indicated that further model and data validation is needed.

3. Comment on the overall quantity and quality of data used in the assessment.

   In general, the fishery data can provide a suitable basis for exploring a range of catch-at-age models to provide credible fishery management advice.

4. Evaluate and comment on analytic methodologies.

   This stock assessment was executed using an age-structured population model employed in SS3. It is a statistical catch-at-age model with total year specific landings and length frequencies, and year specific relative abundance indices and length frequencies from the surveys. The STAT developed a “data-rich model” and a “data-poor model”. Both models are employed in this statistical catch-at-age modelling framework with the data-rich model using all the data and considering the stochasticity of the SR relationship in the model fitting, whereas the data-poor model uses only the landing and length frequency data from the landing and assuming a deterministic SR relationship in the model fitting. The stock assessment was based on the “data-rich model”. However the STAT would like to compare the results from the “data-poor model” with that

from the “data-rich model”, in order to find out whether leaving the fishery-independent survey data out and using a simplified model would work for a data-poor species.

A more comprehensive exploration on the data-rich scenario (incorporating all data) with consideration of different competing hypotheses is suggested before comparing the results of the “data-poor model” and the “data-rich model”, . By doing this, we would understand the driving factors that influence the stock assessment of the example fishery. Possible hypotheses that arose during the discussion include: selectivity variation, bias in the catch composition, recruitment variation and discarding. When conducting the simulation study to evaluate the ”data-poor model”, these hypotheses tested should be incorporated when simulating the data to reflect the real fisheries.

Although no written report was provided on an extra simulation study based on chilipepper rockfish (*Sebastes goodei*) fisheries data, it was presented by the STAT working on greenspotted rockfish. The objectives of this simulation were to investigate the performance of the “data-poor model” framework, provide basis for stock assessments of data-poor species, and investigate the possibility of using SS3 to assess data-poor species. The current number of simulations was too low; however, these attempts are considered very valuable and are encouraged to continue beyond the current preliminary results. Possible hypotheses suggested in the above paragraph may be considered in the simulation study when searching for an appropriate model for data-poor species.

5. Evaluate model assumptions, estimates, and major sources of uncertainty. Specifically, recommend improvements including alternative model configurations or formulations as appropriate during the panel meeting and comment on the primary sources of uncertainty in the assessment model.

   Assessment model: in the statistical catch-at-age model, all the biological parameters were treated as fixed although priors for M and steepness of the recruitment were discussed. A model framework, such as a Bayesian framework that can incorporate the uncertainty of these parameters is suggested. Appropriate priors for the selectivity parameters and even catchability parameters should be very useful when only length frequency data from the landings are available as assumed in the “data-poor model”. This further requires the flexibility of the model framework to incorporate uncertainty and informative priors for these parameters.

   Estimation method: the estimates are based on a maximum likelihood estimation (MLE) approach penalized by the prior for the recruitment stochasticity assumption. The current assessment results indicated lack of fit in length frequency data which indicated that the estimation algorithm also needs

to be visited. The current method is acceptable but may be improved by using a full Bayesian estimation method which is available and effort on it is worthwhile.

Uncertainties were conducted through sensitivity analysis but were not estimated and reported. More effort may be spent to develop an alternative framework so that uncertainty of the parameters can be incorporated comprehensively instead of only conducting assessments given different possible values of each single parameter. Projection with uncertainty of the parameters was not provided but was suggested in the future stock assessment. The review panel understands that greenspotted rockfish stock assessment is still preliminary.

6. Insert an explicit statement as to whether this stock assessment represents the best available science.

   Both the STAT and the review panel consider greenspotted rockfish stock assessments as preliminary and follow-up data and model validation is needed before it can provide the basis for the management of this fishery. Extra model runs were conducted for both the greenspotted rockfish and the simulation study, which were considered very valuable for future improvement. The assessment is on the right track in general.

7. Recommendations for any further improvements given data limitations.

   Gather more information to further estimate the stock structure which can greatly influence the reliability of the stock assessment. A comparison of the assessment results from the two-stock hypothesis with the one from a single-stock hypothesis is suggested before further evidence is provided. A modelling framework that can incorporate the uncertainties of the parameters and the useful informative priors should improve the stock assessment quality.

8. Brief description on panel review proceedings, highlighting pertinent discussions, issues, effectiveness, and recommendations

   The greenspotted rockfish assessment was presented in the morning of Sept 22. Input data, models, parameter estimates and fishery status determination were evaluated through open discussion. The STAT members were always available when required for further discussion, additional model runs for clarification, and clarification of how the STAR Terms of Reference were addressed. On Tuesday, Sept 23, the greenspotted assessments were discussed further, and the STAT teams presented/updated further results on the additional model runs. On Wednesday, Sept 24, a follow-up presentation on requested model runs and further discussion on this assessment were

conducted and the committee asked further questions and then used the remaining time to discuss the content of the review among the review penal members. The panel members then prepared an independent report according to the Term of Reference (appendix 2).

The requested further model runs and possible output were attached in appendix 4. The discussions on the possible competing hypotheses in assessing this species, and the possible model runs and the hypothesis/flexibility on the model structures of the "data-poor model" went very well. The STAT did extra runs and would like to update them with more runs and scenarios in the future. The panel also suggested that effort to dive into the retention rate or discarding information was valuable and should be able to help explain the differences in the observed length frequency variation.

I consider the review proceeding and discussions effective and I believe that they will improve the stock assessment in the future. A suggestion from this review is that it may be possible to conduct a follow-up review in the reasonable future, so that the review and discussion are actually implemented effectively.

4. ASSESSMENT OF BRONZESPOTTED ROCKFISH

Bronzespotted rockfish is also a species of high concern in California and has not been previously assessed. There are very limited data on bronzespotted rockfish: no direct survey or fishery independent abundance indices, length frequency data of a few years with small sample sizes. It's a typical data-poor species. A fish assemblage analysis using a generalized linear model (Stephens and MacCall 2004) found that cowcod rockfish was the strongest predictor of bronzespotted rockfish presence probability. This conclusion matched their habitat association from the surveys. The STAT team then "borrowed" the F (fishing mortality) estimation of cowcod to approximate an abundance index of bronzespotted by using *Catch* of bronzespotted divided by the *Fishing mortality* of cowcod estimated from a SS3 statistical catch-at-age model. This abundance index was used in many of the models, such as depletion models, ASPIC and SS3. Bronzespotted rockfish stock assessments were executed using multiple models including 2 depletion models, DCAC, ASPIC and an age-structured population model employed in SS3. The conclusion on the fishery status from all the models was that the fishery was overfished to a very low level. The STAT also employed a series of studies on the influence of uncertainty and assumptions in the assumed values during the review process, which are very valuable, though many of them were not used/written in the presented stock assessment report.

TERMS OF REFERENCES

1. Become familiar with the draft bronzespotted rockfish stock assessment documents and background materials.

The assessment documents and supporting materials were made available to the review panel via emails two weeks before the meeting. During the STAR meeting, all documents were made available electronically and in print if requested. This TOR was completed successfully.

2. Evaluate relevant data collection operations and survey design and make recommendations for improvement.

   A fish assemblage analysis using a generalized linear model (Stephens and MacCall 2004) found that cowcod rockfish was the strongest predictor of bronzespotted rockfish presence probability. This conclusion matched their habitat association from the surveys. The STAT team then "borrowed" the F estimation of cowcod. An abundance index of bronzespotted was approximated by using Catch of bronzespotted divided by the Fishing mortality of cowcod estimated from a SS3 statistical catch-at-age model. This work was considered valuable and effective. It provided further opportunities to perform stock assessments for this data-poor species. The analysis may be improved by incorporating a couple of other species, e.g., pink rockfish, with relatively high-quality data and closely correlated with bronzespotted rockfish. Some sensitivity analysis on this possibility is valuable to conduct.

   There is very limited biological sampling on age and length and considerable ageing error was observed. However the STAT did use a measurement error model that considered the measurement error of ageing.

   Natural mortality uncertainty was considered by estimating uncertainty from each possible approach including Hoenig (1983), Pauly (1980) and Beverton (1992), and then a "joint" probability density function was develop. Figure 10 indicates that using a "joint" estimate of M is not enough to cover the possible uncertainties of natural mortality. Hierarchically structured distributions may be used for modelling uncertainty of natural mortality in the DCAC analysis (Clark 2003; Jiao et al. 2009a, 2009b).

   The vulnerability assessment based on the life history parameters was considered efficient and worked as side evidence in determining fishery status although management strategy was not discussed.

   The commercial and recreational landing data are considered appropriately handled given the data limitation. The sensitivity analysis conducted in the report and during the review meeting further helped the STAT and the review panel to understand the influence of the uncertainty of constructed historical catch. The method to reconstruct historical landings was peer reviewed previously and is considered appropriate. It was briefly covered in the presentations and I have not reviewed it in any depth.

There is one fishery independent survey although this was not designed for bronzespotted rockfish. Bronzespotted rockfish were observed during submersible surveys for cowcod in the Cowcod Conservation Area (CCA) of the Southern California Bight conducted in 2002. The observed ratio of bronzespotted rockfish to cowcod was used to estimate bronzespotted rockfish biomass. This 2002 biomass value was used in the depletion model analysis and one ASPIC run and is considered valuable information to be used in the SS3 model and even future stock assessment given the data limitation of this species.

The differences of the observed preference of depth between cowcod and bronzespotted rockfish need to be further investigated. The review panel understands that STAT will look into some historical records and literatures to better explain it. Future assessments may incorporate this difference into the analysis since cowcod assessment results were borrowed and strongly influence bronzespotted rockfish stock assessment.

3. Comment on the overall quantity and quality of data used in the assessment.

   In general, both quality and quantity of the data available for bronzespotted rockfish are poor, but they can provide a suitable basis for exploring a range of data-poor approaches to provide credible fishery management advice. This multi-model approach is appreciated and suggested for future similar data-poor species stock assessment.

4. Evaluate and comment on analytic methodologies.

   This stock was executed using multiple models/approaches including two depletion models, DCAC , population reconstruction using biomass VPA, production model and an age-structured population model. Although none of the modelling approaches would be considered operational and optimal in the current and near future stock assessment, the combined results from all the approaches are considered convincing and enough to provide credible fishery management advice.

5. Evaluate model assumptions, estimates, and major sources of uncertainty. Specifically, recommend improvements including alternative model configurations or formulations as appropriate during the panel meeting and comment on the primary sources of uncertainty in the assessment model.

   All of the models used in bronzespotted rockfish stock assessment made assumptions and simplified the models in different ways. None of them should be used as an independent stock assessment model for this species given the

data limitation and the assumptions in the model. The overall multi-model approach is considered efficient for management advising. The STAT conducted extra runs to investigate the uncertainty brought by assumptions. For example, the assumption that population growth equalled harvest used in the depletion models, was verified through a sensitivity analysis by assuming different ratios of population growth to harvest. A further modelling analysis may be conducted by assuming it to be a random factor following a prior distribution. This allows the variation of the ratio among years to be modelled.

6. Insert an explicit statement as to whether this stock assessment represents the best available science.

   Both the STAT and the review panel consider the bronzespotted rockfish stock assessments are sufficient to provide the basis for the management of this fishery.

7. Recommendations for any further improvements given data limitations.

   The fish assemblage analysis was the basis for the assessment of this species. The analysis may be improved when borrowing information from closely related species by incorporating some other species, e.g., pink rockfish, which have relatively high-quality data and are also closely correlated with bronzespotted rockfish. Some sensitivity analysis on this possibility is valuable to conduct. The differences of the preference of depth between cowcod and bronzespotted rockfish need to be further explored. Future assessment may incorporate this difference into the analysis since cowcod assessment results were borrowed and strongly influence bronzespotted rockfish stock assessment. The differences may be explained by incorporating information of more than one species that are closely related to bronzespotted rockfish.

8. Brief description on panel review proceedings, highlighting pertinent discussions, issues, effectiveness, and recommendations

   The bronzespotted rockfish assessment was presented in the afternoon of Sept 22. Input data, models, parameter estimates and fishery status determination were evaluated through open discussion and the STAT members were always available when required, for further discussion and additional model runs for clarification. On Tuesday, Sept 23, the bronzespotted rockfish assessments were discussed further, and the STAT teams presented/updated further results on the additional model runs. On Wednesday, Sept 24, a follow-up presentation on requested model runs and further discussion on this assessment were conducted and the committee asked further questions and then used the remaining time to discuss the content of the review among the review penal

members. The panel members then prepared an independent report according to the Terms of Reference (appendix 2).

The requested additional model runs and possible output were attached in appendix 5. The discussions on the possible alternative in model structure to incorporate population growth to harvest ratios (named as production adjusted Leslie model), and the alternative runs with different assumptions of reconstructed historical catch went very well.

I consider the review proceeding and discussions effective and I believe that they are useful for the bronzespotted rockfish stock assessment in the future.

5. Conclusions and Recommendations in accordance with the ToRs

Greenspotted rockfish

1. Become familiar with the draft greenspotted rockfish stock assessment documents and background materials.

    - No further recommendations.

2. Evaluate relevant data collection operations and survey design and make recommendations for improvement.

    - The stock structure hypothesis needs to be reconsidered and more evidence is needed.

    - Steepness and natural mortality uncertainty should be considered and informative priors should be developed and used. Uncertainty of the biological parameters should be reviewed and considered.

    - Uncertainty of the constructed historical landings should be considered.

    - Discarding/retention may be reviewed, if possible, given the data availability.

    - A modelling framework with consideration of possible uncertainties of both parameters and landings are suggested to be considered in future assessments.

3. Comment on the overall quantity and quality of data used in the assessment.

In general, the fishery data are adequate to provide a suitable basis for exploring a range of catch-at-age models to provide credible fishery management advice.

- No further recommendations.

4. Evaluate and comment on analytic methodologies.

    - A more comprehensive exploration on the data-rich scenario (incorporating all data) with consideration of different competing hypotheses is suggested. Possible hypotheses that desire consideration include selectivity variation, bias in the catch composition, recruitment variation and discarding.

    - When conducting the simulation study to evaluate the ”data-poor model”, the hypotheses tested above should be incorporated when simulating the data to reflect the real fisheries.

    - The lack of fit of the length frequency data indicated that further model and data validation is needed.

5. Evaluate model assumptions, estimates, and major sources of uncertainty. Specifically, recommend improvements including alternative model configurations or formulations as appropriate during the panel meeting and comment on the primary sources of uncertainty in the assessment model.

    - A model framework that can incorporate the uncertainty of these parameters is suggested. A Bayesian framework seems more appropriate.

    - Appropriate priors for the selectivity parameters should be very useful when only length frequency data from the landings are available as assumed in the “data-poor model”. This further requires the flexibility of the model framework to incorporate uncertainty and informative priors for these parameters.

    - The current method is acceptable but may be improved by using a full Bayesian estimation method which is available and effort on it is worthwhile.

    - Projection with uncertainty of the parameters was not provided but was suggested in future stock assessments.

6. Insert an explicit statement as to whether this stock assessment represents the best available science.

    Both the STAT and the review panel consider greenspotted rockfish stock assessments as preliminary and follow-up data and model validation is needed before it can provide the basis for the management of this fishery.

- No further recommendations.

7. Recommendations for any further improvements given data limitations.

    - Gather more information to further analyze the stock structure, which can greatly influence the reliability of the stock assessment.

    - A comparison of the assessment results from the two-stock hypothesis with the one from a single-stock hypothesis is suggested before further evidence is provided.

    - A modelling framework that can incorporate the uncertainties of the parameters and the useful informative priors should improve the stock assessment quality.

8. Brief description on panel review proceedings, highlighting pertinent discussions, issues, effectiveness, and recommendations

    - A suggestion from the review is that it may be possible to conduct a follow-up review in the reasonable future, so that the review and discussion are actually implemented effectively.

Bronzespotted rockfish

1. Become familiar with the draft bronzespotted rockfish stock assessment documents and background materials.

    - No further recommendations.

2. Evaluate relevant data collection operations and survey design and make recommendations for improvement.

    - The idea of borrowing information from the cowcod fishery based on a fish assemblage analysis may be improved by incorporating other species, e.g., pink rockfish, with relatively high-quality data and closely correlated with bronzespotted rockfish. Some sensitivity analysis on this possibility is valuable to conduct.

    - Natural mortality uncertainty was considered by estimating uncertainty from each possible approach. Hierarchically structured distributions may be used for modelling uncertainty of natural mortality in the DCAC analysis (Clark, 2001; Jiao et al. 2009a, 2009b).

    - The differences of the preference of depth between cowcod and bronzespotted rockfish need to be further investigated. Future assessments may incorporate this difference into the analysis since cowcod assessment results were borrowed and strongly influence

bronzespotted rockfish stock assessment.

3. Comment on the overall quantity and quality of data used in the assessment.

   In general, both quality and quantity of the data available for bronzespotted rockfish are poor, but they can provide a suitable basis for exploring a range of data-poor approaches to provide credible fishery management advice. This multi-model approach is appreciated and suggested for future similar data-poor species stock assessment.

   - No further recommendations.

4. Evaluate and comment on analytic methodologies.

   - No further recommendations.

5. Evaluate model assumptions, estimates, and major sources of uncertainty. Specifically, recommend improvements including alternative model configurations or formulations as appropriate during the panel meeting and comment on the primary sources of uncertainty in the assessment model.

   - Complexity of the depletion models can be increased by adding more fisheries realities even though the data are limited. The suggested production adjusted model can be conducted by assuming the ratio of population growth to catch as a random factor following a prior distribution. This allows the variation of the ratio among years to be modelled.

   - The alternative runs with different assumptions of reconstructed historical catch are suggested to be incorporated in future stock assessments.

   Suggestions on the uncertainty from the fish assemblage analysis, fish habitat preference differences and the uncertainty of M are listed in TOR 1.

6. Insert an explicit statement as to whether this stock assessment represents the best available science.

   - No further recommendations.

7. Recommendations for any further improvements given data limitations.

   - The fish assemblage analysis was the basis for the assessment of this species. The idea of borrowing strength from closely related species may be improved by incorporating some other species that have relatively high-quality data and are closely correlated with bronzespotted rockfish. Some sensitivity analysis on this possibility is valuable to conduct.

- The differences of the preference of depth between cowcod and bronzespotted rockfish need to be further explored. Future assessment may incorporate this difference into the analysis since cowcod assessment results were borrowed and strongly influence bronzespotted rockfish stock assessment. The differences may be explained by incorporating information of some other species that are closely related to bronzespotted rockfish.

8. Brief description on panel review proceedings, highlighting pertinent discussions, issues, effectiveness, and recommendations

    - No further recommendations.

6. References

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7. Suggestions for improvements of NMFS review process

The current review process looks well designed. It should be further improved if a follow-up review can be conducted in the reasonable future for stocks that needs improvement before the stock assessment is credible enough to provide management advice. The STAR review and discussion should be implemented more effectively by this extra follow-up review.

8. Acknowledgement

I would like thank all the STAT members contributing to the meeting for their informative presentations on the stock assessments of greenspotted and bronzespotted rockfish and for providing helpful responses to the review panel's questions. Many thanks also to the scientists at the Santa Cruz Laboratory for their hospitality and help throughout the meeting. Special thanks also to the other members of review panel for productive discussions on the assessments.

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Appendix 2: Statement of Work for Dr. Yan Jiao

External Independent Peer Review by the Center for Independent Experts

Stock Assessment Review Panel for Greenspotted Rockfish and Bronzespotted Rockfish

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract to provide external expertise through the Center for Independent Experts (CIE) to conduct impartial and independent peer reviews of NMFS scientific projects. This Statement of Work (SoW) described herein was established by the NMFS Contracting Officer's Technical Representative (COTR) and CIE based on the peer review requirements submitted by NMFS Project Contact. CIE reviewers are selected by the CIE Coordination Team and Steering Committee to conduct the peer review of NMFS science with project specific Terms of Reference (ToRs). Each CIE reviewer shall produce a CIE independent peer review report with specific format and content requirements (**Annex 1**). This SoW describes the work tasks and deliverables of the CIE reviewers for conducting an independent peer review of the following NMFS project.

Project Description: Bronzespotted and greenspotted rockfish are species of concern in southern California and neither has been previously assessed. These two benchmark stock assessments will provide the basis for the management of the groundfish fisheries off the West Coast of the U.S. including providing scientific basis for setting annual catch levels (ACLs) and acceptable biological catches (ABCs) as mandated by the Magnuson-Stevens Act. The technical review will take place during a formal, public, multiple-day meeting of fishery stock assessment experts. Participation of an external, independent reviewer is an essential part of the review process

The Terms of Reference (ToRs) for the CIE review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: One CIE reviewer shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. The CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein. The CIE reviewer shall have the expertise, background, and experience to complete an independent peer review in accordance with the SoW and ToRs herein. The CIE reviewer shall have expertise and work experience in fish population dynamics, with particular experience in the integrated analysis modeling approach using likelihood based age-and size-structured models in data-limited applications. Knowledge of Generalized Linear Models in the development of standardized abundance statistics is desirable.

Location of Peer Review: The CIE reviewer shall conduct an independent peer review during a 3-day panel review meeting tentatively scheduled in Santa Cruz, CA on September 22-24, 2009.

Statement of Tasks: The CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering committee, the CIE shall provide the CIE reviewer information (name, affiliation, and contact details) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and information concerning other pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., name, contact information, birth date, passport number, travel dates, and country of origin) to the NMFS Project Clearance for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations (available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/sponsor.html).

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send by electronic mail or make available at an FTP site to the CIE reviewer all necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE on where to send documents. The CIE reviewers shall read all documents in preparation for the peer review.

Documents to be provided to the CIE reviewers prior to the STAR Panel meeting include:

- The current draft stock assessment reports;
- The Pacific Fishery Management Council's Scientific and Statistical Committee's Terms of Reference for Stock Assessments and STAR Panel Reviews;
- Stock Synthesis (SS) Documentation
- Additional supporting documents as available.

- An electronic copy of the data, the parameters, and the model used for the assessments (if requested by reviewer).

This list of pre-review documents may be updated up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process, including a SoW modification to the schedule of milestones and deliverables. Furthermore, the CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein.

Panel Review Meeting: The CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs. **Modifications to the SoW and ToRs can not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** The CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified in the contract SoW. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

The CIE reviewer's role includes being an active panel participant and participants are strongly encouraged to voice all comments regarding the assessment data, model configurations, and uncertainty during the stock assessment review panel so the assessment teams can address the comments during the Panel meeting and incorporate changes when appropriate. The assessments are finalized by the end of the Panel meeting and comments made after the fact will not be able to be included in the final assessment document.

The review panel will operate as closely as possible under the Pacific Fishery Management Council's Terms of Reference for West Coast Groundfish Stock Assessments and Stock Assessment Review Panels. However, this review will occur outside of the Council process and therefore the process may be modified from the Council's ToRs. Moreover, the review will focus on novel assessment methods for "data poor" species and, as a consequence, inferences concerning stock status may be more limited in scope than is typical for assessments presented to the PFMC.

Contract Deliverables - Independent CIE Peer Review Reports: The CIE reviewer shall complete an independent peer review report in accordance with the SoW. The CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. The CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Other Tasks – Contribution to Summary Report: There will be no consensus report and each reviewer should write an individual review report. Of particular concern will be providing advice concerning the strength of the analyses presented and the usefulness of the assessments in developing management recommendations for these two species.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review;
2) Participate during the panel review meeting in Santa Cruz, California, Sept. 22-24, 2009 as called for in the SoW, and conduct an independent peer review in accordance with the ToRs (Annex 2);
3) No later than October 8, 2009, the CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to David Die at ddie@rsmas.miami.edu. The CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2;
4) CIE reviewers shall address changes as required by the CIE review in accordance with the schedule of milestones and deliverables.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

17 August 2009	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
8 September 2009	NMFS Project Contact sends the CIE Reviewers the pre-review documents
22-24 September 2009	The reviewer participates and conducts an independent peer review during the panel review meeting
8 October 2009	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
22 October 2009	CIE submits CIE independent peer review reports to the COTR
29 October 2009	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be made through the Contracting Officer's Technical Representative (COTR) who submits the modification for approval to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the CIE within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and Terms of Reference (ToR) of the SoW as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToRs and deliverable schedule are not adversely impacted. The SoW and ToRs cannot be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review report by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, the report shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (the CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards: (1) the CIE report shall have the format and content in accordance with Annex 1, (2) the CIE report shall address each ToR as specified in Annex 2, (3) the CIE report shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon notification of acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the approved CIE reports to the NMFS Project Contact and regional Center Director.

Key Personnel:

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a detailed summary of findings, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   d. The CIE independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting. The CIE independent report shall be an independent peer review of each ToRs.,

3. The reviewer report shall include as separate appendices as follows:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work
   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

Review Panel for Assessments of Greenspotted and Bronzespotted Rockfish

1. Become familiar with the draft greenspotted rockfish and bronzespotted rockfish stock assessment documents and background materials.
2. Evaluate relevant data collection operations and survey design and make recommendations for improvement.
3. Comment on the overall quantity and quality of data used in the assessment.
4. Evaluate and comment on analytic methodologies.
5. Evaluate model assumptions, estimates, and major sources of uncertainty. Specifically, recommend improvements including alternative model configurations or formulations as appropriate during the panel meeting and comment on the primary sources of uncertainty in the assessment model.
6. Insert an explicit statement as to whether this stock assessment represents the best available science.
7. Recommendations for any further improvements given data limitations.
8. Brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations

Annex 3: Agenda

Review Panel for Assessments of Greenspotted Rockfish and Bronzespotted Rockfish

Southwest Fisheries Science Center

110 Shaffer Road,

Santa Cruz, CA

September 22-24 2009

Point of contact for reviewer security & check-in: Dr. Stephen Ralston

Tuesday, September 22

0830	Introductions, lunch arrangements, agenda revision, etc.
0845-1200	Greenspotted rockfish presentation
1200-1300	Lunch
1300-1330	Review Panel requests re greenspotted rockfish
1330-1600	Bronzespotted rockfish presentation
1600-1700	Review Panel requests re bronzespotted rockfish
1700	Adjourn

Wednesday, September 23 (agenda may be modified as needed)

0830	Greenspotted rockfish discussion
1030	Bronzespotted rockfish discussion
1200	Lunch
1300	Greenspotted rockfish discussion
1500	Bronzespotted rockfish discussion

Thursday, September 24 (agenda may be modified as needed)

0830	Greenspotted rockfish discussion
1030	Bronzespotted rockfish discussion
1200	Lunch
1300	Concluding discussions as needed (open)
1400	Concluding discussions as needed (closed)
1500	Final requests for clarification, and begin writing reports

Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Reviewers other than the CIE reviewer: Drs. Michael Prager and Todd Gedamke, NMFS, SEFSC.

Appendix 4: Review panel requests to greenspotted rockfish (recorded by STAT)

Day 1

1. Conduct two model runs to help the panel understand factors that contribute to differences in estimated selectivity curves between data-rich and data-poor models
    a. data-rich model without indices
    b. b. data-rich model without indices and without survey length compositions
2. Provide plots of observed proportions at length by year and fishery, with predicted proportions from four models (data-rich, data-poor, data-rich minus indices, and data-rich minus indices and survey length compositions). This request is an attempt to understand the reasons for the shifts in selectivity between data-rich and data-poor approaches.
3. Conduct model run with freely estimated recruitment deviations (no S-R relationship); fix steepness=1 and down-weight likelihood component for recruitment deviations
4. Generate *5* additional simulation runs to evaluate effects of recruitment variability (sigma-R) on data-poor approach that assumes deterministic recruitment.
5. Growth may differ between northern and southern California. Available age and growth data are from central/northern CA and the Southern California Bight. Look for otoliths from intermediate regions to see if latitudinal changes in growth are abrupt or gradual.
6. Plot estimates of effective sample size from the data-rich and data-poor models against each other on the same figure with a 1:1 line.
7. Apply depletion-corrected average catch (DCAC) analysis for greenspotted rockfish and compare estimated yield with MSY from age-structured model.

Day 2

8. Resolve issue with previous simulation request (#4) and present results
9. Complete request #2.
10. Plot selectivity curves from four model runs (described in request #2) on the same figure
11. Investigate time-varying selectivity hypothesis to explain absence of small fish in early years of commercial fisheries. Use the data-rich model to fit separate selectivity curves within time blocks.
12. If time allows, begin investigation of two remaining alternative hypotheses from STAT presentation (time-varying retention and time-varying growth)

Review Panel Requests to the Greenspotted Rockfish Analytical Team

1. Determine the availability of S. *chiorostictus* otoliths from sites intermediate between Monterey Bay and the Southern California Bight.

   Rationale: The decision to model the Southern California Bight separately from the Central/Northern California region was based on differences in growth of fish sampled in Monterey Bay and sites south of Point Conception. However, no fish were aged from intermediates sites (e.g., Port San Luis or Morro Bay) and so the stock could show a clinal pattern of growth variability, which may lead to a different structure for the assessment model.

   Response: The Fisheries Ecology Division database of archived otoliths was queried.

Appendix 5: Review panel requests to bronzespotted rockfish (recorded by STAT)

1. Put “plausible” SS3 model from presentation into report
2. Change “depletion” to “rel_B”
3. Scatterplot of results (ASPIC and SS3 together)
4. Alternatives to 10% of reconstructed catch for early catch history- range 1%, 2%, 5%, 10%, 20%, 50% and 100%, for DCAC/VPA, ASPIC and SS3
5. Try Monte Carlo routine in ASPIC
6. Look at the descending limb of catch curve
7. Explore a production-adjusted Leslie Model