Review of West Coast Groundfish Stock Assessments: Yelloweye rockfish and greenstriped rockfish

STAR Panel, August 3 - 6, 2009
Seattle, Washington

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1 EXECUTIVE SUMMARY

This report presents results of an independent peer review of two west coast groundfish stock assessments (yelloweye rockfish and greenstriped rockfish), conducted for the Center for Independent Experts. The primary activity of the review was active participation in the August 3 - 6, 2009 STAR Panel in Seattle, Washington. A major focus of the review was to ascertain that data, model, and assessment uncertainties were fully explored and that these uncertainties were appropriately carried through to management advice.

The STAR panel review process for yelloweye and greenstriped rockfish was thorough, effective, and resulted in a comprehensive review of the two stock assessments. STAR Panel members agreed all substantive issues that arose, and the STAT teams agreed with suggested changes to *base case* model formulations and presentation of uncertainty about the assessments. Both stock assessments are technically sound, and represent the best science available for the respective resources.

The yelloweye rockfish assessment models the resource from southern California to the U.S. – Canada border as a single stock, with sub-stocks that separate California (CA), Oregon (OR), and Washington (WA). A single (deterministic) stock-recruitment relationship is assumed, with constant proportions recruiting to each of the sub-stocks. Commercial and recreational fisheries are modelled for each sub-stock, and a variety of abundance indices including fishery-independent trawl surveys and recreational fishery CPUE are included in the model fits. Uncertainty in the assessment is captured through alternative historical catch scenarios and uncertainty in stock-recruitment steepness. The alternative catch scenarios affect the magnitude of stock abundance and the alternative steepness parameter values affect rebuilding time lines.

Yelloweye rockfish was declared overfished in 2002 and currently is managed under a rebuilding plan. Although a number of improvements to the data and the analytical methods were incorporated in the current assessment, results are consistent with previous assessments.

Greenstriped rockfish have not previously been assessed, and the current assessment represents a significant effort to compile all available data. The assessment was conducted for a single coast-wide stock (excluding Puget Sound) with fisheries partitioned by trawl gear (WA/OR and CA), other gear, foreign, and recreational. Historical catch estimates, both landings and discards, are highly uncertain which results in uncertainty about the magnitude of the resource. The conclusion that current exploitation levels are low and that the stock is above the target level is robust to uncertainties in the assessment.

2 BACKGROUND

This document reports on an independent peer review of two west coast groundfish stock assessments (yelloweye rockfish and greenstriped rockfish) conducted for the Center for Independent Experts (CIE). The primary review activity was active participation in the August 3-6, 2009 Groundfish Stock Assessment Review (STAR) Panel in Seattle, Washington.

The CIE *Statement of Work* (Appendix 2) defines the scope of this review. In addition to participation in the STAR Panel, the *Statement of Work* requests a review of draft assessment documents and other pertinent background materials prior to the review meeting and preparation of this report summarizing review findings relative to the terms of reference for the review.

3 DESCRIPTION OF REVIEW ACTIVITIES

The activities undertaken for this review include; 1) assimilation of draft assessment documents and other pertinent background materials prior to the STAR Panel meeting, 2) participation in the STAR Panel review meeting and preparation of Summary Reports, 3) review of updated assessment documents to ensure they reflected Panel recommendations, and 4) preparation of this report.

The materials provided to prepare for the STAR Panel meeting included: the draft yelloweye rockfish and greenstriped rockfish stock assessment documents; the 2006 yelloweye rockfish stock assessment document and 2007 assessment update; the 2006 STAR Panel yelloweye rockfish Summary Report; and documentation of the Stock Synthesis model (SS3) (Appendix 1).

The primary focus for the STAR Panel members (Appendix 3) during the August 3-6, 2009, meeting included:

- Understanding the basis and rationale for data usage, model assumptions, and model configurations used in the assessments.
- Requesting runs with alternative model configuration, additional analyses, and additional model outputs to evaluate the reliability of the assessment and aid interpretation of results.
- Working with the stock assessment teams (STAT) (Appendix 3) to determine appropriate axes for expressing uncertainty and approaches for representing that uncertainty in decision tables.

STAR Panel reports, summarizing meeting review activities and Panel recommendations, were prepared during and after the meeting by Panel members.

4 SUMMARY OF FINDINGS

4.1 OVERVIEW

The STAR panel review process for yelloweye and greenstriped rockfish was thorough, effective, and resulted in a comprehensive review of the two stock assessments. STAR Panel members agreed all substantive issues that arose, and the STAT teams agreed with suggested changes to *base case* model formulations and presentation of uncertainty about the assessments. Both stock

assessments are technically sound, and represent the best science available for the respective resources.

Both stock assessments reviewed by the STAR Panel used the age- and length-structured fishery assessment model, Stock Synthesis (SS3). This model, designed specifically for west coast groundfish, can deal with aspects of the data and fisheries that are potentially unique (eg. high and largely unknown discarding rates). The model code is well tested and the common assessment framework allows a body of expertise in its use to develop. Standard analytical approaches for using SS3 assist in ensuring consistency and objectivity across the groundfish stock assessments.

4.2 YELLOWEYE ROCKFISH

The yelloweye rockfish assessment models the resource from southern California to the U.S. – Canada border as a single stock, with sub-stocks that separate California (CA), Oregon (OR), and Washington (WA). A single stock-recruitment relationship is assumed, with constant proportions recruiting to each of the sub-stocks. Deterministic recruitment is assumed for the *base case* model configuration. Commercial and recreational fisheries are modelled for each sub-stock, and a variety of abundance indices including fishery-independent trawl surveys and recreational fishery CPUE are included in the model fits.

Historically managed as part of a *Sebastes* complex, yelloweye rockfish were declared overfished in 2002 and have been managed with a separate OY developed through a rebuilding plan since then.

Findings for each ToR:

Determine if the stock assessment document is sufficiently complete according to the Pacific Fishery Management Council's Terms of Reference for West Coast Groundfish Stock Assessment and STAR Panels.

The yelloweye rockfish assessment document is well-written, clear, and comprehensive. The document covers all components specified in the Pacific Fishery Management Council's Terms of Reference for West Coast Groundfish Stock Assessment and STAR Panels. The revised post-STAR SAFE document addressed all issues that arose during the STAR meeting.

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

Currently, commercial catch (non-retention fisheries, so essentially discards) is well estimated through the West Coast Groundfish Observer Program (WCGOP). Recreational catch is estimated through State-specific programs which appear to be adequate, though a comprehensive database that contains all recreational data would facilitate data compilation.

There are two fisheries-independent surveys that are currently operational and can potentially provide information on yelloweye abundance trends. The NWFSC shelf/slope trawl survey (2003 – 2008, ongoing) is not designed to index a species like yelloweye, which is largely associated with reefs and rocky bottom. Because of the low incidence of tows with positive catches, only

data from OR is used in the GLMM analysis and fitted in the assessment model. Even for OR, the number of positive tows per year is generally 7 or less. This survey has limited value for indexing yelloweye rockfish abundance.

The IPHC survey (1999 – 2008, ongoing) currently generates the most useful index of abundance for yelloweye rockfish and will likely be the primary source of information about abundance trends in the short- to mid-term. For the current assessment, separate indices were developed for WA and CA. Because yelloweye rockfish were caught at few stations during the early IPHC survey, the survey was extended with additional stations beginning in 2006. Different approaches for allocating additional stations were used in WA and OR and it is unclear if one approach is superior to the other. Data from the additional IPHC stations was not included in the current stock assessment because the time-series are still too short and because methods to integrate data from the different sampling approaches need to be developed.

Further work to evaluate the IPHC survey design in WA and OR is required to ensure that the approaches for allocating additional stations ensures the best (precision and accuracy) yelloweye abundance index. Also, analytical methods that integrate data from the additional stations with that from the original stations need to be investigated so that single time-series can be developed (for the next yelloweye assessment). During the STAR, a GLM analysis of the IPHC data including station effects was evaluated and this is one potential approach for including the additional stations since 2006.

Experimental work has been conducted on the use of visual surveys to index yelloweye rockfish abundance. Ultimately, expansion of this approach to develop a coast-wide yelloweye visual survey would likely provide the best and most comprehensive information on abundance trends. Given yelloweye rockfish behaviour (sedentary as adults) it is likely that serial depletion has occurred, and a visual survey would provide the information to assess stock rebuilding at the reef or reef-complex level.

Comment on quality of data used in the assessment.

Estimates of historical catch from both commercial and recreational fisheries are highly uncertain. Historically, catch was reported to general rockfish categories and compositional data to allocate this to species level is limited. Recent efforts to reconstruct the CA commercial and recreational catches has improved the quality (and likely, accuracy) of that data. Also, the post-1973 OR recreational catch has been reconstructed. WA historical catch estimates are likely the most uncertain, and potentially the most biased. Yelloweye rockfish is a sought-after high-value species so discarding is not likely to be an issue. Uncertainly in historical catch is one of the major sources of uncertainty for the yelloweye stock assessment. The approach taken to account for this uncertainty in the assessment, bracketing historical catch (pre-2000) at 75% and 150% of the best estimates, is appropriate.

The value of the two trawl surveys, the NWFSC (2003 – 2008) and the triennial survey (1980 – 2004), is limited for assessing yelloweye rockfish abundance trends because they primarily sample outside yelloweye habitat. The surveys catch few yelloweye rockfish so analytical estimates of abundance index c.v.'s are large, indicating these surveys would only discern very large scale changes in abundance. Although IPHC survey c.v.'s are also large, that survey encompasses more yelloweye habitat and therefore provides a useful abundance index.

Previous STAR panel reviews have questioned the use of recreational fishery CPUE indices in yelloweye stock assessments because of concerns that these indices may not reflect changes in abundance (due to changes in management, changes in fishery operations, etc.). These are however, the longest abundance index time-series and possibly the only indicator of historical abundance trends available to the model. The approach taken in this assessment to account for influences that could affect the CPUE-biomass relationship was to truncate the time series when management interventions occurred and to allow a non-linear relationship between CPUE and abundance. These two measures adequately deal with the primary issues in assuming a CPUE-abundance relationship.

Length frequency data from commercial and recreational fisheries is not extensive, but is adequate to inform estimation of selectivity functions. The quality and quantity of age-composition data (fitted as conditional length-at-age in the model) is adequate to inform estimation of the growth functions.

A recent meta-analysis of *Sebastes* species fecundity relationships provided an estimate of the fecundity per gram versus female weight relationship, which is an improvement over previous assumptions that fecundity is proportional to weight.

Data from Canadian sources were used to develop a prior for male yelloweye rockfish natural mortality (relative to female natural mortality). The prior developed from these data (mean of 0.11 for male *M*), implied a maximum male age of around 40, which is inconsistent with the maximum age of 147 observed for a male yelloweye rockfish in U.S. waters. This suggests either sampling issues in the collection of the Canadian data, or fundamentally different dynamics for Canadian and U.S. yelloweye. The use of this prior was dropped for the final *base case* assessment.

Evaluate and comment on analytic methodologies

Analytic methods used in the yelloweye rockfish assessment are sound, and represent state-of-the-art approaches. The assessment model used the SS3 software, which has been tested and is commonly used for west coast groundfish assessments. Estimation was essentially maximum likelihood (MLE), although informed priors were used for some model parameters. A Bayesian analysis with posterior integration was not conducted due to some unresolved technical issues.

A few new analytic approaches, not used in previous assessments, represent improvement in the consistency between data collection and model statistical assumptions. First, age-composition data is treated as conditional age-at-length. With this approach the data is not “double counted” (because age samples are generally a sub-set of fish measured for length) and the information in the data can inform estimates of the variability in length-at-age. Although not fitted in the analysis, implied fits to marginal age composition data were presented in the assessment and these can be informative about model misspecification. Second, an ageing precision analysis was conducted using a new analytical approach (Punt et al. 2008) and estimates included in the SS3 analysis.

GLM (INPFC survey) and GLMM (NWFSC and triennial surveys) methods were used to calculated abundance indices from survey data. These methods are appropriate, and consistent with recommendations from the 2006 Bottom Trawl Survey Workshop (Anon 2007).

Iterative reweighting of the primary data sets fitted in the assessment model was conducted to ensure consistency between the assumed uncertainty of the data and the models ability to fit the data. For the compositional data, this results in more extreme Pearson residuals than expected particularly for fits to the conditional age-at-length data. The distribution of residuals appears to be leptokurtic with a higher proportion of very small residuals and a few very extreme residuals. The approach used to re-weight the data sets is based strictly on the variance of the residuals. An approach that also considered the value of the median absolute residual, may allow a better fit between the expected and fitted residual pattern. Also, for abundance index data with very few observations it is not clear if iterative re-weighting is the best data weighting approach.

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.

The assumptions of the *base case* model structure are appropriate and parameter estimates consistent with the data and ancillary information. The assumption of a single stock with sub-population structure makes appropriate use of the limited data while accounting for different exploitation histories in the regions. Implied yelloweye rockfish density estimates, calculated as the ratio of model estimates of stock biomass to available yelloweye habitat in each region, are consistent with density estimates from visual surveys.

Model estimates of natural mortality appear to be well determined, even when an inappropriate prior was assumed for male natural mortality. This may be related to the assumption of asymptotic selectivity for all fishing fleets and the INPFC survey. Model estimates of stock-recruitment steepness also appear to be well determined, likely the result of assuming a deterministic stock-recruitment relationship.

The three major sources of uncertainty in the yelloweye rockfish stock assessment are: uncertainty in the catch history; the assumption of deterministic recruitment; and the estimate of stock-recruitment steepness.

Uncertainty in the catch history is captured through the alternative “states of nature” explored for the assessment’s decision table. The alternative catch histories, 75% and 150% of the best estimates, are appropriately asymmetrical given the likely biases in the data and likelihood profile analysis indicating lower catches are inconsistent with the data. The alternative catch histories do not capture the possibility that there is different error structure and bias in catch estimates among the States.

Recruitment is treated as a deterministic function of stock fecundity, rather than as a stochastic process. As a result asymptotic confidence intervals about the MLE underestimate the true uncertainty in model estimated and derived parameters, in particular the steepness parameter. Also, a stochastic recruitment process at the sub-population level would admit greater uncertainty in the relative abundance of the stock within each State.

Uncertainty in the stock-recruitment steepness parameter is captured through the alternative “states of nature” explored for the assessment’s decision table. While this parameter has only minor affect on the stock reconstruction, it will be a significant source of uncertainty in stock rebuilding projections.

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

The yelloweye rockfish stock assessment makes appropriate use of the best available data and represents the best available science to inform management decisions.

Recommendations for any further improvements

Future yelloweye rockfish stock assessments should include the data from the additional INPFC stations that have been surveyed since 2006. Further work is required to investigate how best to analyze the data from all stations to develop abundance indices.

There is some evidence for region-specific growth at the yelloweye rockfish sub-population level. Future yelloweye stock assessments should consider these differences and possibly regional variation in other biological parameters.

Although many scenarios that explored domed versus asymptotic selectivity for the yelloweye rockfish fisheries and surveys were investigated for the current assessment, further work is warranted to explore the relationship between natural mortality estimates and the assumption of asymptotic selectivity.

The assumption of a stochastic stock-recruitment function would improve future yelloweye stock assessments from the perspective of increasing uncertainty in key model parameters and outputs. Additional work is required to explore the ramp approach for stock-recruitment bias correction that is currently used within the SS3 modelling environment.

Considerable work has gone into reconstructing historical rockfish catches in CA. Similar efforts in OR and WA could substantially improve the quality of this data that is fundamental to any stock assessment.

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

The draft yelloweye rockfish assessment that the panel reviewed was well-developed, thorough and comprehensive. The focus of the panel review was to better understand some aspects of the model behaviour and to ensure that uncertainty in the assessment was fully captured particularly as it would flow into stock rebuilding scenarios.

A few minor changes to the *base case* model formulation were suggested by the panel and agreed by the STAT: a correction to the OR recreational observer program length frequency data; and a change to the natural mortality priors.

Investigation of changes in the way recreational CPUE data was used in the current assessment (truncation of time series and non-linear catchability assumption) showed these had minimal impact on the assessment results. Up-weighting the index data time series relative to compositional data decreased the depletion estimate but had minimal effect on the fits to the compositional data.

Smaller fish are caught in surveys off OR than off WA. Does this result from higher depletion of the OR sub-population, differential growth among the regions, or different gear selectivity? With the correction of the OR recreational length frequency data, a domed selectivity assumption for the OR INPFC fishery provided better fits to the data. Also, the data supports that WA fish are somewhat larger size-at-age than OR fish. The likelihood that the INPFC survey has domed selectivity in OR and asymptotic selectivity in WA was discussed, but it seemed premature to change the model structure without further investigation of the interactions of growth, depletion and selectivity.

Panel discussion focussed on uncertainty in the yelloweye stock assessment and how best to capture this so that it would flow into stock rebuilding analyses. Uncertainty in historical catch levels was clearly the primary axes that captures uncertainty in the absolute magnitude of stock abundance, and bracketing historical catch (pre-2000) at 75% and 150% of the best estimates was selected as appropriately capturing this uncertainty. The value of stock-recruitment steepness will significantly impact rebuilding time lines, and uncertainty in this parameter was selected as a second axis of uncertainty.

4.3 GREENSTRIPED ROCKFISH

The greenstriped rockfish assessment is the first conducted for this stock, and considerable effort went into compiling relevant catch data, survey time series and ancillary biological information. The assessment was conducted for a single coast-wide stock (excluding Puget Sound) with fisheries partitioned by trawl gear (WA/OR and CA), other gear, foreign, and recreational. Abundance indices fitted in the analysis included NWFSC trawl survey (2003 – 2008) and triennial trawl survey (1980 – 2004, split into two series). Length frequency data is available from the surveys and fisheries and conditional age-at-length data from the NWFSC survey.

While there is considerable uncertainty about the current status of the greenstriped rockfish resource, largely the result of uncertainty in historical catches (discards and landings), the conclusion that the stock is above the management target is robust to this uncertainty.

Findings for each ToR:

> *Determine if the stock assessment document is sufficiently complete according to the Pacific Fishery Management Council's Terms of Reference for West Coast Groundfish Stock Assessment and STAR Panels.*

The draft greenstriped rockfish assessment document presented a well-considered, well-written, and thorough assessment of this resource. The revised stock assessment document covered all changes agreed at the STAR panel meeting. The assessment document included all relevant information specified in the PFMC's Terms of Reference for West Coast Groundfish Stock Assessment and STAR Panels thereby presenting all information required by the STAR Panel and Council in conducting their business.

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

Current data collection programs appear to be adequate for ongoing stock monitoring and assessment. The West Coast Groundfish Observer Program (WCGOP) provides accurate information on amount and size distribution of discarded and landed greenstriped rockfish. The number of greenstriped rockfish length-frequency samples from commercial fisheries has decreased in recent years, but this may be the result of reduced landings due to management regulations.

Recreational catch appears to be estimated reasonably well in recent years through State specific programs. A number of sources need to be queried to compile recreational catch estimates, suggesting a comprehensive data base would have long-term efficiency value, and minimize potential errors through erroneous data processing.

The NWFSC trawl survey (2003 – 2008, ongoing) provides a fairly good fishery-independent index of greenstriped rockfish abundance, with a high proportion of positive tows over the depth range for this species. Greenstriped rockfish sampling during this survey is adequate, and provides useful information on length-frequency and conditional age-at-length.

Comment on quality of data used in the assessment.

Although considerable effort went into reconstructing historical landings for this assessment, due to data limitations estimates are highly uncertain. Market categories for historical greenstriped rockfish landings are by aggregate rockfish groupings, and compositional data to estimate species landings are limited. Detailed catch reconstructions of CA commercial groundfish and recreational fisheries have been completed and the quality of this data is better than that for the other States.

Discarding of greenstriped rockfish in commercial fisheries is common, and potentially only a small fraction of the fish caught is retained. Discard estimates are available from two sources: a 3-year OR program in the mid-1980's (termed the *Pikitch* study) and the WCGOP program (2002 – 2007). Discard rate estimates from the WCGOP program are substantially higher than those from the *Pikitch* study. Also, data from the WCGOP program indicate the full size range of greenstriped rockfish are discarded while the *Pikitch* study suggest only larger greenstriped rockfish are discarded. These discrepancies between the two studies are problematic when deciding which data best reflects the historical period. The STAT team chose not to use the *Pikitch* data on the basis that it was less reliable than the more recent WCGOP data, a decision supported by the STAR Panel. The effect of uncertainty in discard rates was investigated in the assessment.

Abundance time-series for greenstriped rockfish are limited and the decision to split the triennial trawl survey data into two series much reduces the value of the survey. The survey is split into two series because of an abrupt shift in survey timing in 1994. The decision to split the triennial time series is appropriate – the need to do it is unfortunate as it reduces the information value of the data.

Evaluate and comment on analytic methodologies

The primary assessment tool was the statistical catch-age model, SS3. This software is used extensively for west coast groundfish assessments, and as such it has been well tested and standard approaches for using the software developed. Estimation was essentially maximum likelihood (MLE), although informed priors were used for some model parameters.

A few analytic approaches that I've not encountered in previous SS stock assessments represent improvement in the consistency between data collection and model statistical assumptions. First, age-composition data is treated as conditional age-at-length. With this approach the data is not "double counted" (because age samples are generally a sub-set of fish measured for length) and the information in the data can inform estimates of the variability in growth. Although not fitted in the analysis, implied fits to marginal age composition data were presented in the assessment and these can be informative about model misspecification. Second, an ageing precision analysis was conducted and estimates included in the SS3 analysis.

Delta-GLMM analyses were used to develop greenstriped rockfish abundance indices from the NWFSC and Triennial trawl survey data. This approach was endorsed by the 2006 Bottom Trawl Survey Workshop (Anon 2007) and its use here is appropriate.

Iterative reweighting of the primary data sets fitted in the assessment model was conducted to ensure consistency between the assumed uncertainty of the data and the models ability to fit the data. Re-weighting was conducted based on the RMSE, a measure of the variance of the residuals. This approach may overweight the influence of a few large outliers, which are often seen in fisheries data. Additional investigations to explore this approach (and others) are warranted to determine best approaches for data weighting.

A new approach in SS3 for doing stock-recruitment bias correction involves using a ramp-up of the bias correction for the initial years where recruitment residuals are estimated. The rationale for this approach appears to be to account for the variance of the recruitment residual estimates and to ensure that MLE parameter estimates are consistent with the median of parameter marginal posterior distributions (ie. from MCMC simulations). In my experience, this approach is unique to SS3 stock assessments and it is unclear if the objectives of the approach are attainable. Generally, when conducting Bayesian estimation the MLE (generally called the MPD when using Bayesian estimation) is taken as a starting point for the MCMC simulation with no expectation about its relationship to the posterior distribution.

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.

The assumptions of the *base case* model structure are appropriate and parameter estimates consistent with the data and ancillary information. The assumption of a single stock along the U.S. lower west coast (excluding Puget Sound) is appropriate, given data limitations.

The primary and overriding source of uncertainty in the greenstriped rockfish stock assessment results from uncertainty about historical catch. The draft greenstriped assessment addressed this uncertainty through sensitivity analyses that varied historical landings estimates. Given that

historical discard rates are a greater source of uncertainty about total catch, and the model uses discard information as absolute estimates rather than proportions, the Panel suggested uncertainty in discard rates would be a better approach to reflect the uncertainty in total catch.

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

The yelloweye rockfish stock assessment makes appropriate use of the best available data and represents the best available science to inform management decisions.

Recommendations for any further improvements

The greenstriped rockfish assessment is most limited by the uncertainty in historical catch levels. While more effort on landings reconstructions may improve that component of the historical catch, uncertainty in historical discards which are potentially much larger than landings are unlikely to be improved through recovery of historical information. Alternative methods to deal with historical catch could potentially be developed through alternative approaches. For example, co-occurrence of greenstriped rockfish with other species in fishery-independent trawl survey catches may provide a basis for estimating relative fishing effort trends.

The necessity to split the triennial trawl survey time series due to a shift in survey timing greatly reduces the value of this relatively long-term data series. Exploration of GLMM approaches with a calendar date covariates may allow the triennial survey time series to be used as a single index. A species assemblage meta-analysis approach could potentially be used to develop priors for the ratios of catchability among the early triennial, the late triennial and the NWFSC surveys.

A blind re-read of ageing structures from the strong 1993 year-class would ascertain if there is ageing bias resulting from the expectation of a strong year-class.

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

Analyses conducted for this assessment and presented in the draft assessment report were thorough, and Panel discussions focussed on only two issues: 1) how best to capture uncertainty about historical catches, and 2) the lack of fit to the strong 1993 year-class observed in the NWFSC trawl survey marginal age-composition data, which led to investigation of ageing precision, recruitment variability and their influence on bias adjustment and depletion estimates.

Minor changes to the *base case* model formulation were suggested by the Panel and agreed by the STAT team: remove the 1980 triennial survey length frequency data; re-run the ageing precision analysis assuming no bias; and use a recruitment bias correction ramp for 1970 – 1986.

Investigations to determine why the strong 1993 year-class observed in the NWFSC trawl survey marginal age-composition data was poorly fitted in the model showed that the ageing precision assumption was primarily responsible. When no ageing imprecision was assumed, the model fit the strong 1993 year-class observations well. Co-incidentally, the "tuned" estimate of recruitment variation (*sigmaR*) was reduced (to 0.60) and the depletion estimate increased. The Panel felt the assumption of no ageing error was inappropriate, and it was possible that ageing the

1993 cohort was biased due to an expectation of a strong year-class. Thus the Panel suggested that the ageing imprecision assumptions be retained in the assessment and *sigmaR* fixed at 0.60.

The Panel investigated alternative approaches for estimating the historical discard pattern and for capturing uncertainty in the assessment related to historical discards. The Panel agreed the estimated size distribution of retained greenstriped rockfish from the *Pikitch* survey was suspect (all fish greater than 30 cm retained), and therefore the data shouldn't be used. The *Pikitch* data was used to inform the lower bound for the historical discard rate for the alternative scenarios developed to capture uncertainty in the assessment.

The Panel and STAT team agreed a second axis for presenting assessment uncertainty in decision table results. The natural mortality rate is not well determined in the model, and depletion estimates are highly correlated with this parameter. The base model value (0.08) was bounded at 0.10 based on high values predicted from life history characteristics and at 0.06 based upon values of natural mortality estimated from the data included in the assessment.

5 CONCLUSIONS AND RECOMMENDATIONS

The two stock assessments reviewed, yelloweye rockfish and greenstriped rockfish, are based on theoretically sound analyses and the major axes of uncertainty were fully explored. As such they provide a solid basis to inform management decisions.

Yelloweye rockfish was declared overfished in 2002 and currently is managed under a rebuilding plan. Although a number of improvements to the data and the analytical methods were incorporated in the current assessment, results are consistent with previous assessments.

Greenstriped rockfish have not previously been assessed, and the current assessment represents a significant effort to compile all available data. Historical catch estimates, both landings and discards, are highly uncertain which results in uncertainty about the magnitude of the resource. The conclusion that current exploitation levels are low and that the stock is above the target level is robust to uncertainties in the assessment.

The STAR process is comprehensive and allows for thorough stock assessment reviews. Preparation of draft assessment documents prior to review meetings and limiting reviews to two assessments per week ensures there is adequate time to become familiar with the assessment data and methods and to thoroughly investigate implications of modelling assumptions. The terms of reference for the review process are clear and explicit, and the guideline for the content of stock assessment reports ensures the documents provide a complete description of all aspects of the assessments.

An overriding issue for the two assessments reviewed here, and one that will certainly be an issue for other west coast rockfish stock assessments, is the uncertainty in historical catch estimates. Major effort has gone into reconstruction of California historical catches. Similar effort is required to reconstruct Oregon and Washington historical catches. In addition to reconstructing the "best" catch time series, alternative catch scenarios should be developed that reflect potential "low" catch and "high" catch scenarios. Such alternative catch scenarios are best developed in conjunction with the full catch reconstruction.

Having participated in previous groundfish STAR panels, I have seen improvements in the quality of assessments and development of consistent analytical approaches. The use of a

common statistical catch-age model, SS3, for most west coast groundfish stock assessments has facilitated these developments. In general the analytical approaches have a solid statistical foundation, but there are a few areas that warrant further research.

Iterative reweighting of the primary data sets is a common procedure used in tuning model fits with the SS3 software. The objective is to ensure consistency between the assumed uncertainty of the data and the models ability to fit the data. Re-weighting is conducted based on the RMSE, a measure of the variance of the residuals. Generally standardized model residuals for compositional data do not conform well to standard normal curves. Distributions are generally leptokurtic. Using the RMSE for reweighting may overweight the influence of a small number of large residuals. Use of other statistics summarizing the residual distributions (eg. median absolute residual) may be more robust to non-normality. Also, for abundance index data with very few observations it is not clear if iterative re-weighting is the best data weighting approach. Investigation of alternative approaches for data weighting is warranted to determine the best approach.

A new approach in SS3 for stock-recruitment bias correction involves using a ramp-up of the bias correction for the initial years where recruitment residuals are estimated. The rationale for this approach appears to be to account for the variance of the recruitment residual estimates and to ensure that MLE parameter estimates are consistent with the median of parameter marginal posterior distributions (ie. from MCMC simulations). In my experience, this approach is unique to SS3 stock assessments and it is unclear if the objectives of the approach are attainable. Additional work to explore this approach and ensure it is statistically sound is required.

On a final note, a technical manual documenting Stock Synthesis and recommended approaches for using the software would facilitate the review process, and would be appreciated by the growing community of SS users.

APPENDIX 1. BIBLIOGRAPHY

The following review materials were provided prior to the STAR Panel meeting:

I. Current Draft Stock Assessments

Stewart, I.J., J.R. Wallace, and C. McGilliard. Status of the U.S. yelloweye rockfish resource in 2009.

Hicks, A.C., M. A. Haltuch, and C. Wetzel. Status of greenstriped rockfish (*Sebastes elongaus*) along the outer coast of California, Oregon, and Washington.

II. Background Materials

Anon. 2006. Yelloweye rockfish STAR Panel Report.

Wallace, F.R., T. Tsou, T. Jagielo, and Y.W. Cheng. 2006. Status of yelloweye rockfish (*Sebastes ruberrimus*) off the U.S. west coast in 2006.

Wallace, J. R. 2007. Update to the status of yelloweye rockfish (*Sebastes ruberrimus*) off the U.S. west coast in 2007.

III. Computer programs and data files:

Computer program: ss3.tpl, ss3.exe, and associated data files

Methot, R.D., Jr. 2009. User Manual for Stock Synthesis Model Version 3.03a (updated May 11,2009)

IV. Additional References (documents available at STAR Panel meeting or used in this review):

Anon. 2007. Summary Report from the NWFSC Bottom Trawl Survey Workshop held October 31 – November 2, 2006 in Seattle, Washington. NOAA Fisheries, NWFSC, FRAM Division.

Hoenig, J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fishery Bulletin 82(1): 898-902.

Punt, A.E., D.C. Smith, K. KrusieGolub, and S.Robertson. 2008. Quantifying age-reading error for use in fisheries stock assessments, with application to species in Australia's southern and eastern scalefish and shark fisheries. Canadian Journal of Fisheries and Aquatic Sciences 65: 1991-2005.

APPENDIX 2. CIE STATEMENT OF WORK

Statement of Work for Vivian Haist

External Independent Peer Review by the Center for Independent Experts

Stock Assessment Review Panel for Yelloweye Rockfish and Greenstriped 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: Yelloweye rockfish has been declared overfish, is subject to a rebuilding plan, and is highly constraining on several west coast fisheries. The last benchmark assessment for yelloweye rockfish was completed in 2006. However, the 2007 update identified numerous data issues which could only be partially addressed under update protocols. Greenstriped rockfish has never been assessed and is viewed as a potentially indicator species for other unassessed shelf rockfish species. 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 OFLs and 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 external, independent reviewer is an essential part of the review process. Participation of external, independent reviewer is an essential part of the review process.

The STAR panel is part of the Pacific Fishery Management Council's process to provide peer review as referenced in the 2006 Reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act, which states that " the Secretary and each Regional Fishery Management Council may establish a peer review process for that Regional Fishery Management Council for scientific information used to advise the Regional Fishery Management Council about the conservation and management of the fishery (see Magnuson-Stevens Act section 302(g)(1)(E)). If a peer review process is established, it should investigate the technical merits of stock assessments and other scientific

information used by the Council's Scientific and Statistical Committee (SSC). The peer review process is not a substitute for the SSC and should work in conjunction with the SSC."

The Pacific Fishery Management Council's Terms of Reference for the West Coast Groundfish Stock Assessments and STAR Process for 2009-2010 requires that some reviewers be appointed from the Center for Independent Experts (CIE). The Council's terms of reference document will be included as background material. The Terms of Reference (ToRs) specific to the CIE are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Two CIE reviewers are required with one of the reviewers participating in all 2009 STAR panels (other than hake) to provide a level of consistency between the panels. The CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein. CIE reviewers shall have the expertise, background, and experience to complete an independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have expertise and work experience in fish population dynamics, with experience in the integrated analysis modeling approach, using age-and size-structured models, use of MCMC to develop confidence intervals, and use of Generalized Linear Models in stock assessment models.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in Seattle, Washington on August 3-7, 2009.

Statement of Tasks: Each CIE reviewers 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 the CIE reviewers 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 most recent previous yelloweye rockfish stock assessments and STAR Panel 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: Each CIE reviewers 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.** Each 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.

In most circumstances a STAR Panel will include a chair appointed from the SSC's Groundfish Subcommittee and three other experienced stock assessment analysts. The STAR panel chair is responsible for: 1) developing an agenda for the STAR panel meeting, 2) ensuring that STAR panel members and STAT teams follow the Terms of Reference, 3) participating in the review of the assessment, 4) guiding the STAR panel and STAT team to mutually agreeable solutions, and 5) coordinating review of final assessment documents.

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 STAR 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 CIE reviewer should also contribute to the final STAR Panel Review Report. Additional details regarding the STAR Panel reviewer's responsibilities will be included in the Pacific Fishery Management Council's final Terms of Reference for Groundfish Stock Assessments and STAR Panel meetings.

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

Other Tasks – Contribution to Summary Report: Each CIE reviewer will assist the Chair of the panel review meeting with contributions to the Summary Report. CIE reviewers are not required to reach a consensus, and should instead provide a brief summary of their views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

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 Seattle, Washington during August 3-7, 2009, as called for in the SoW, and conduct an independent peer review in accordance with the ToRs (Annex 2);
3) No later than August 21, 2009, each 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. Each 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.

6 July 2009	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
20 July 2009	NMFS Project Contact sends the CIE Reviewers the pre-review documents
3-7 August 2009	Each reviewer participates and conducts an independent peer review during the panel review meeting in Seattle, Washington.
21 August 2009	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
4 September 2009	CIE submits CIE independent peer review reports to the COTR
11 September 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 reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports 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) each CIE report shall have the format and content in accordance with Annex 1, (2) each CIE report shall address each ToR as specified in Annex 2, (3) the CIE reports 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:

William Michaels, Contracting Officer's Technical Representative (COTR)
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-713-2363 ext 136

Manoj Shivlani, CIE Lead Coordinator
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shivlanim@bellsouth.net Phone: 305-383-4229

NMFS Project Contact:

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Stacey.Miller@noaa.gov Phone: 206-437-5670

Elizabeth Clarke
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2725 Montlake Blvd. E, Seattle WA 98112
Elizabeth.Clarke@noaa.gov Phone: 206-860-5616

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 should elaborate on any points raised in the Summary Report that they feel might require further clarification.

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

   e. The CIE independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

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

Stock Assessment Review Panel for Yelloweye and Greenstriped Rockfish

1. *Become familiar with the draft yelloweye rockfish and greenstriped rockfish stock assessments and background materials. Along with other members of the Panel,* determine if the stock assessment document is sufficiently complete according to the Pacific Fishery Management Council's Terms of Reference for West Coast Groundfish Stock Assessment and STAR Panels (to be included once finalized).
2. *Evaluate, data collection operations and survey design and make recommendations for improvement*
3. *Comment on 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*
8. *Brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations*

Note – CIE reviewers typically address scientific subjects, hence ToRs usually do not involve CIE reviewers with regulatory and management issues unless this expertise is specifically requested in the SoW.

APPENDIX 3. PARTICIPANTS IN AUGUST 3-6, 2009 STAR PANEL.

Panel Reviewers

Stephen Ralston	Panel Chair, Scientific and Statistical Committee (SSC) Representative
Richard Methot	NMFS, Northwest Fisheries Science Center (NWFSC)
Vivian Haist	Center for Independent Experts (CIE)
J. J. Maguire	Center for Independent Experts (CIE)

Panel Advisors

John DeVore	Pacific Fishery Management Council
Robert Alverson	Groundfish Advisory Subpanel (GAP) Representative
Rob Jones	Groundfish Management Team (GMT) Representative

Greenstriped Rockfish Stock Assessment (STAT) Team members

Allan C. Hicks	NMFS, Northwest Fisheries Science Center (NWFSC)
Melissa A. Haltuch	NMFS, Northwest Fisheries Science Center (NWFSC)
Chantel Wetzel	University of Washington, School of Aquatic & Fishery Resources

Yelloweye Rockfish Stock Assessment (STAT) Team members

Ian Stewart	NMFS, Northwest Fisheries Science Center (NWFSC)
John Wallace	NMFS, Northwest Fisheries Science Center (NWFSC)
Carey McGilliard	University of Washington, School of Aquatic & Fishery Resources