# Stock Assessment Review (STAR) Panel Report
# for Rougheye (and Blackspotted) Rockfish

Northwest Fisheries Science Center Auditorium
Montlake Blvd, Seattle, Washington
8-12 July 2013

**STAR Panel Members**

| | |
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| David Sampson (Chair) | Oregon State University, PFMC Scientific & Statistical Committee |
| Chris Francis | Center for Independent Experts |
| John Field | NMFS, Southwest Fisheries Science Center |
| Yan Jiao | Center for Independent Experts |

**Pacific Fishery Management Council (PFMC) Advisors**

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| John DeVore | PFMC Staff |
| Colby Brady | NMFS Northwest Region, PFMC Groundfish Management Team |
| Gerry Richter | PFMC Groundfish Advisory Subpanel |

**Stock Assessment Team (STAT)**

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| Allan Hicks | NMFS, Northwest Fisheries Science Center (NWFSC) |
| Chantell Wetzel | NMFS, NWFSC |

## Summary of the STAR Panel Meeting

*Overview*

During 8-12 July 2013 a Stock Assessment Review (STAR) Panel met in Seattle, Washington to review a draft stock assessment for rougheye rockfish (Hicks et. al, 2013) that had been prepared by Hicks, Wetzel and Harms of the Northwest Fisheries Science Center. The Panel operated under the Pacific Fishery Management Council's (PFMC) Terms of Reference for the Groundfish and Coastal Pelagic Species Stock Assessment and Review Process for 2013-2014 (PFMC 2012). This same panel also reviewed a draft assessment for aurora rockfish.

Rougheye rockfish (*Sebastes aleutianus*) and blackspotted rockfish (*S. melanostictus*) are two species with very similar appearance that only recently were identified as separate species. Because historic landings and most other sources of information do not distinguish between the species (and even well trained observers have difficulty distinguishing one species from the other), the stock assessment treats these two species as if they were a single species. For simplicity, in the assessment document and in this report references to rougheye rockfish refer to the complex of rougheye rockfish and blackspotted rockfish, unless otherwise noted.

Rougheye rockfish are at the southern extent of their range off the US West Coast and are rarely caught south of Oregon. Despite the fact that two species comprise the rougheye complex the fish of this stock found off the US West Coast are assumed to be a self-sustaining unit. This stock, which has been managed since 2000 as part of the minor slope rockfish complex, has not previously been assessed. Its high score in the Council's productivity and susceptibility analysis (PSA) indicated that it was vulnerable to becoming overfished (Cope et al, 2013).

The draft assessment document and other background materials were made available on the Council's ftp site on 06/25/2013, and the STAR Panelists all had adequate time to review the assessment document in advance of the meeting. The slide presentations prepared by the STAT were also made available from the ftp site, which greatly facilitated the panel's review and subsequent preparation of this STAR Panel report.

Results for the base model developed during the STAR Panel are summarized as follows. The assessment estimates that the spawning stock biomass of rougheye rockfish at the start of 2013 was 2,552 metric tons and was depleted to 47% of its unfished level. There is some small (but non-trivial) chance that the stock's spawning biomass may have dropped below the Council's target level (40% of unfished) around 2000, but there is very little chance that it ever dropped below the minimum stock size threshold (25% of unfished).

The STAR Panel commends the STAT members for their excellent presentations and complete and well-written documentation. Their willingness to respond to STAR Panel requests and to engage in productive discussions greatly contributed to the collegial atmosphere of the STAR meeting. The STAR Panel also extends its thanks to the NWFSC and PFMC staff who provided administrative support and hosted the meeting.

The STAR Panel recommends that the assessment for rougheye rockfish constitutes the best available scientific information on the current status of the stock and that the assessment provides a suitable basis for management decisions.

*Summary of the Assessment Data and Model*

The assessment, which was conducted using the Stock Synthesis software (SS3 version 3.24o), was structured as a single coastwide region with removals taken from 1916 through 2012. The model has three fishing fleets, a bottom-trawl fleet (including the historic foreign bottom-trawl fishery) and a fixed-gear fleet, both of which had discards, and a no-discard fleet that is the combination of the historic foreign and more recent domestic at-sea midwater-trawl fishery for Pacific hake.

In the model the sexes were combined, growth was freely estimated, and the natural mortality rate (constant by age and time) was estimated using a lognormal prior distribution. The steepness parameter for the recruitment versus spawning biomass function was fixed at the mean of its prior distribution (0.779). Fishery selection was length-based and fishery selectivity curves were assumed to be asymptotic. Asymptotic retention curves were estimated for the bottom-trawl and fixed-gear fleets.

The assessment considers biomass indices from four trawl surveys: the Triennial shelf survey, split into an early and late series; the Alaska Fishery Science Center slope survey; the Northwest Fisheries Science Center (NWFSC) slope survey; and the NWFSC shelf-slope survey. Survey length composition data were available for all but NWFSC slope survey. Conditional age-at-length composition data were available for the NWFSC shelf-slope survey.

Fishery length composition data were available for all three fleets but not until relatively recent years. Limited amounts of conditional age-at-length composition data were available from the bottom-trawl and no-discard fleets for two years near the end of the time series. Discard data included observed total discards, length compositions of the discards, and mean body weight observations of the discarded fish.

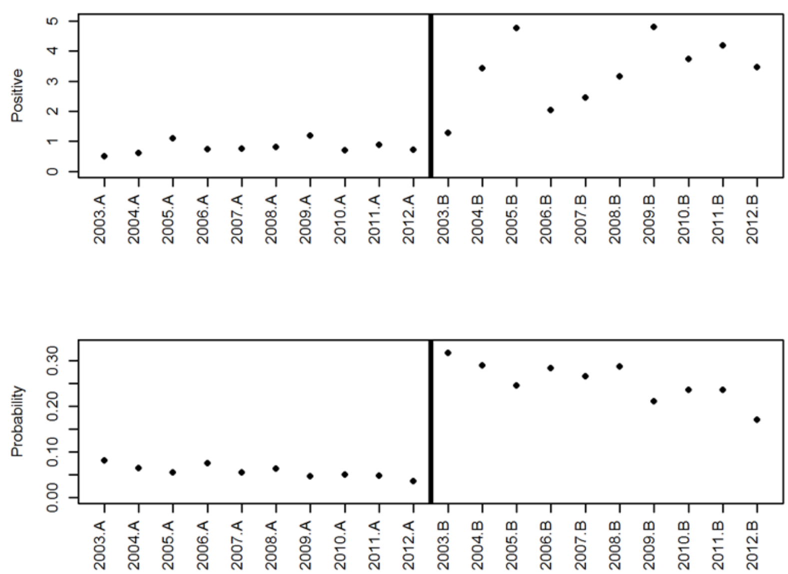
*Analyses Requested by the STAR and the STAT's Responses*

**Request 1:** Report additional diagnostics from the GLMMs, including predictions for model covariates. We would also like to see indices and coefficients of variation from the design and final model outputs in tabular form, as well as summarizing model predictions of the distinct GLM components (positive model and binomial model).

<u>Rationale:</u> Given the potential for trends in the random vessel effects over time, it is important to feel confident that the estimated effects are plausible. Strong effects may also have implications with respect to how length expansions are developed.

<u>Response:</u> Plots were presented of model predictions of stratum-year effects, both combined and separated into components (mean catch of positive tows and probability of a positive tow). These provided useful background information about the surveys. In particular it was of interest that the NWFSC shelf/slope survey showed consistent downward trends in the probability of positive catches and, in the deeper stratum, an upward trend in the mean catch rate from positive catches.

Stratum-Year components for the NWFSC shelf/survey biomass index.



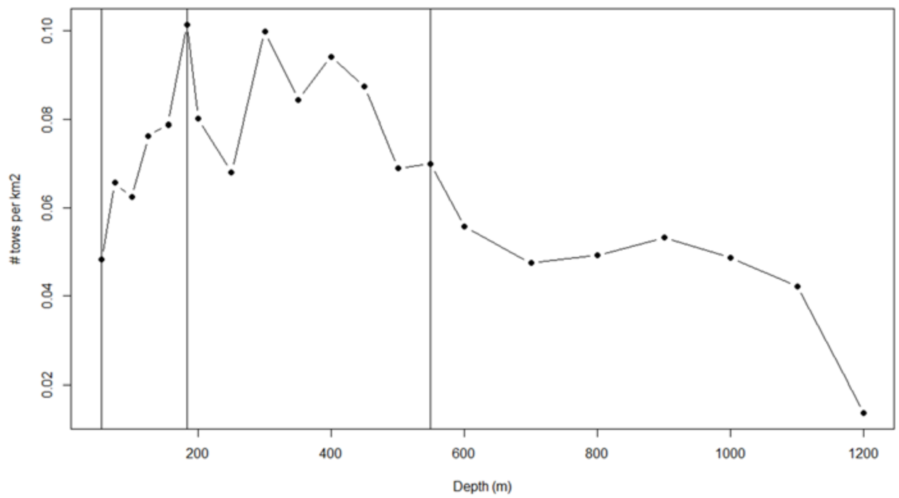

A comparison was presented between the design and model coefficients of variation (CVs) for the survey indices. For the late triennial and NWFSC slope surveys (as well as most years of the AFSC slope survey), the design-based CVs were always lower than the model CVs, whereas in the early Triennial survey they were similar. For the NWFSC shelf/slope survey the average CVs were similar, but the design-based CVs showed much more year-to-year variability.

**Request 2:** If data are available, report the number of tows per square km of habitat (north of 42) in 50 meter depth bins from 100 through 450 meters (include total # tows as well as total habitat area). Provide documentation on survey design (or point to where this exists in the background material).

<u>Rationale:</u> To see if there is an apparent explanation for the paucity of 35-45 cm fish from the combined trawl survey.

<u>Response:</u> The STAT presented a plot (below) of the number of tows per km$^2$ by depth-bin using the NWFSC shelf/slope data. This showed a relatively high density of survey tows in the depth range in which these fish were most likely to occur (250-300 m), and thus did not provide an explanation for the lack of 35-45 cm fish in the survey. However, the plot did show a lower tow density in the deeper bins.

Density of tows by depth in the NWFSC survey north of 42º.



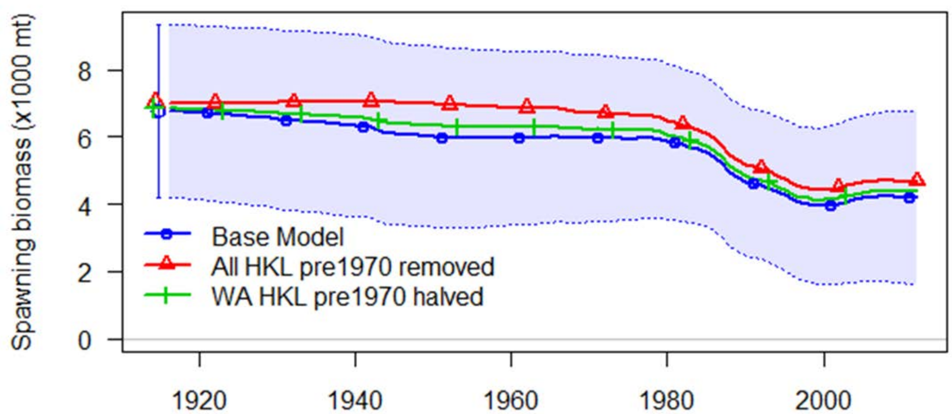

The STAT included a brief but very useful description of the design of each of the four surveys. It would be helpful to provide similar summaries of the survey designs as background information for future STAR Panels.

**Request 3:** Patterns of historical catches are unusual in some parts of the series, particularly where fixed-gear catches drop to nearly zero in the 1960s-70s, then increase again sharply. Two catch scenarios that would be useful would be to 1) remove all hook and line catches prior to 1970, and 2) halve the Washington hook and line catches during the pre-1970 time period (keeping Oregon catches as reported). Summarize the impact on equilibrium yield as well as depletion. If possible, report on trends in hook and line fisheries for other target species (Pacific halibut and sablefish) that may be associated with these trends.

Rationale: To provide a way of evaluating the effect on the assessment of uncertainty in the catch history and to seek an explanation for the reduction in hook and line catches of rougheye rockfish in the 1960s and '70s (see Figure 20 in the draft assessment report).

Response: The STAT presented two new runs with alternative catch histories as described in this request. Neither run produced results that differed substantially from the base run. Both showed slightly higher biomass and depletion trajectories (current depletion increased from 63% to 68% and 65%, respectively, see figure below) and slightly higher estimates of *M* (0.0481 $y^{-1}$ and 0.0465 $y^{-1}$, respectively, compared to 0.0455 $y^{-1}$ for the base run). Estimated SPR yield increased from 284 t to 309 t and 292 t, respectively.

Spawning biomass trajectories for the base model and
two alternative models that have slightly different catch histories.



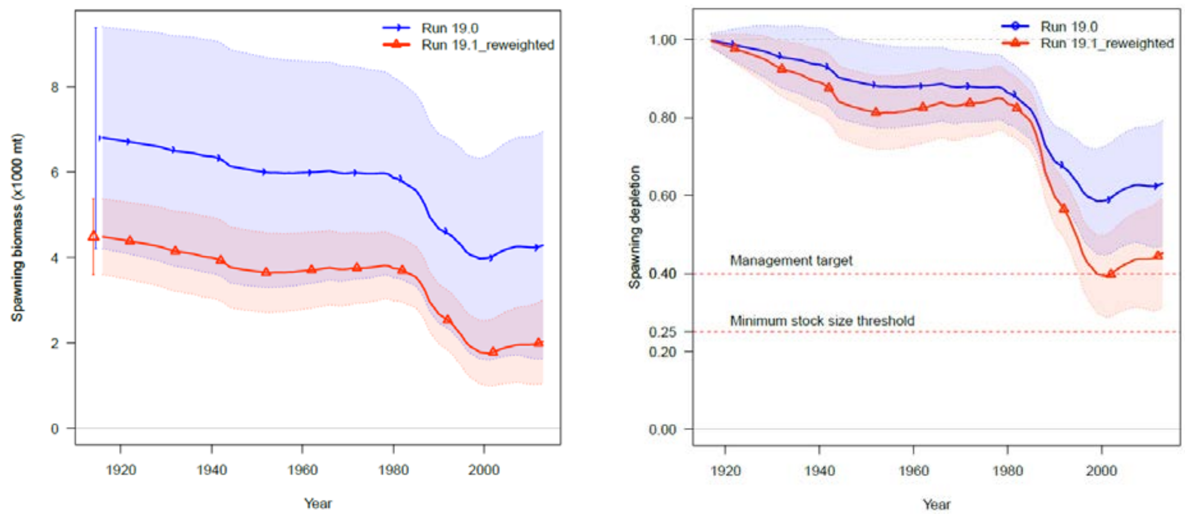

With regard to alternative hook-and-line fisheries, Pacific halibut catches dropped during the 1970s, but there was no substantial change in sablefish catches in this period. Thus fishing effort patterns associated with these two hook-and-line fisheries do not provide an explanation for the near-zero catches of rougheye rockfish during the 1960s and '70s.

**Request 4:** Explore alternative effective sample size iteration methods. Based on the Francis (2011) approach, a new set of effective sample sizes can be jointly developed by the STAR Panel (Francis) and STAT Team. Do new runs with these re-weighted compositional data (as a sensitivity analysis to current base model).

Rationale: The observation that that there is strong autocorrelation in the residuals is an indication of correlations in the data that are not accounted for in estimates of effective sample size. This analysis may need to be done separately for the discard data.

Response: Model 19.0, which used the original data weighting, was compared to run 19.1, in which the composition data were reweighted using method TA1.8 of Francis (2011). This reweighting involved substantial down-weighting of most of the length composition data (e.g., down-weighting factors for the fishery data ranged from 0.07 to 0.30), but much less down-weighting for the conditional age-at-length data. The largest data set – the slope/shelf survey – was not down-weighted, and reweighting factors of 0.55 and 0.71 were applied to the fishery data. The reweighting had a reasonably substantial effect on stock status (see figure below), with current depletion changing from more than 0.6 to less than 0.5 and yield dropping by around 30%.

Base model (Run 19.0) results with Francis reweighting of composition data (Run 19.1).




**Request 5:** Report on the differences between OR and WA length frequency data over the 1995-2012 time period, including the pre-2004 and post-2004 period. Also look at separation of Astoria (port complex, inclusive of Warrenton) length frequencies, which may reflect WA catches. Other possible explorations of port-specific sample distribution can be conducted at the discretion of the STAT.

Rationale: The differences in available length frequency data between OR and WA may be driving unusual residual patterns in the fits to the length composition data.

Response: Before responding to this request the STAT described an error that they had discovered in the weighting by state of the trawl fishery length compositions, and noted that with the corrected compositions both the estimated spawning biomass and depletion were slightly lower.

The length compositions disaggregated by state showed that big fish appeared to be more common in OR than in WA. This was consistent with the pattern of fish length against latitude (shown in Figure 13 in the draft assessment, using the shelf/slope survey data), which showed that mean lengths were higher around 45ºN (OR) than around 48ºN (WA). The proportion of trawl length samples that came from Astoria was very variable, being more than 40% in 1995 and 1996, and less than 5% in other years.

**Request 6:** Report on how survey length compositional data are expanded.

Rationale: How the data were expanded was not entirely clear to STAR Panel. Also, if there are vessel-specific catchabilities (non-random effects), then it might be appropriate to consider this in making expansions.

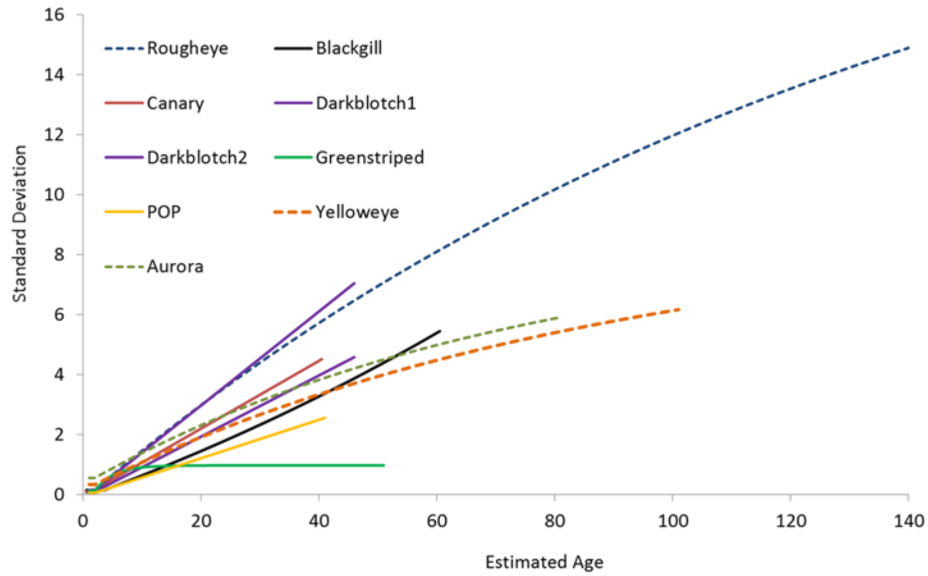
Response: The STAT reported that the survey length compositions were scaled up within strata by number, rather than by weight.

**Request 7:** Look at aging error from other long-lived rockfish species relative to the estimated error for this species.

Rationale: The Panel wanted to know whether the ageing error used in this assessment was consistent with what has been used in assessments of other rockfishes.

Response: A graph of ageing error (standard deviation as a function of age) for nine rockfish species (below) showed that the errors used in the rougheye assessment model were at the upper end of the range of the other species.

Comparison of rockfish ageing error vectors.




**Request 8:** Also report the marginal age composition plots (traditional view), with axes scaled in an easily interpretable manner.

Rationale: The original plot with this information was hard to interpret because of the scaling of the Y-axis.

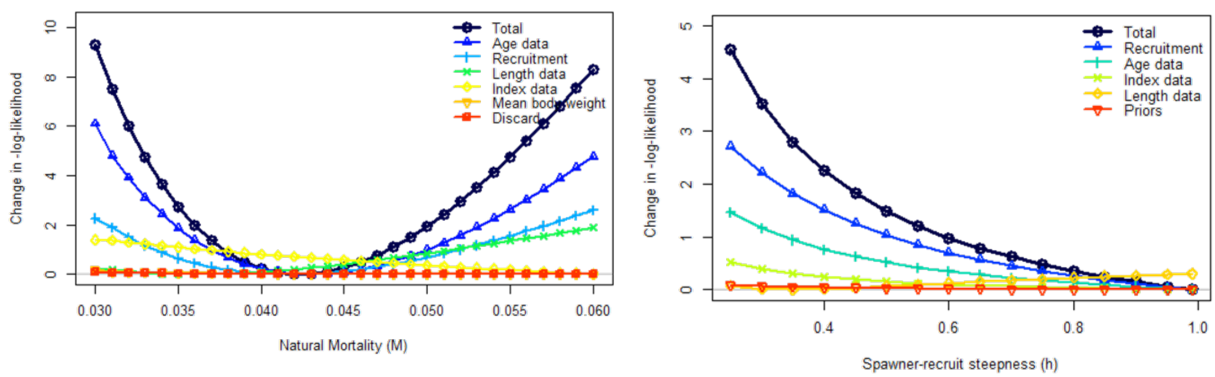
Response: The modified plot was useful, showing much more clearly the relationship between observed and expected ages. In particular, the strong 1999 year class was very evident in both the observed and expected proportions at age.

**Request 9:** With respect to effective sample size reweighting, the STAT is encouraged to consider the results and subsequent discussion of the round 1 request (related to alternative means of sample size reweighting), and provide a model run that incorporates a reasonable approach to conducting the reweighting (for example, doing reweighting in one encompassing round, rather than dataset by dataset). If time allows, include likelihood profiles and residual patterns (and other appropriate diagnostics). Additionally, if possible, investigate why the reweighting appears to result in an effective reduction in model uncertainty.

Rationale: The model is very sensitive to how effective sample sizes are reweighted, and the diagnostic plots of mean length (with error bars) suggest that the effective sample sizes are inconsistent with year to year variation in mean length.

Response: Outputs from the new reweighted model (19.2) were similar to those in the initial reweighted model (see Request 4). Profiles from this model appeared more satisfactory than those from a run with the original data weighting. For example (see figure below), the new profile on natural mortality was dominated by the age-at-length data, rather than the length data (which were dominant in the original profile), and the profile on steepness was much flatter than before reweighting (which is consistent with the view that the data contain very little information about this parameter). The reduction in uncertainty in the new model seemed to be because the reweighting effectively reduced the conflict between the length and age-at-length data sets.

Log-likelihood profiles for *M* and *h* from the base model with Francis reweighting (Run 19.2).




**Request 10:** Prepare a plot of the ratio of effective N versus input N by year from the original base model.

Rationale: This will indicate whether the calculation of the input N's is consistent over time.

Response: The requested plot showed no evidence of inconsistency over time in the calculation of input N values.

**Request 11:** With respect to plots of vessel effects in the GLMM, a secondary request is to identify which symbols correspond with which vessels (or confirm that the symbols correspond with the same vessels over time). Additionally, provide the *Vessel* effects in arithmetic (or other interpretable) scale.

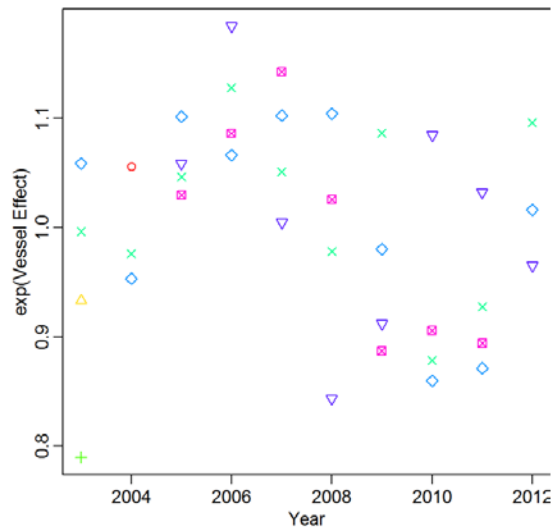
Rationale: There is confusion regarding what the symbols correspond to, including some concern that the GLMM may be aliasing *Year* effects with *Vessel* effects.

Response: A table of vessels used each year in the slope/shelf survey showed that there had been very little variation, with two vessels participating in all ten surveys, and another two in seven of the ten. The revised *Vessel* effects plot from the GLMM for this survey showed no indication that any vessel produced consistently higher (or lower) catch rates than the others, but this did not remove the Panel's concern about aliasing of *Vessel* and *Year* effects (but see response to Request 12).

There was considerable discussion regarding the fact that the *Vessel* x *Year* effects were all positive in some years (e.g., 2005 and 2006 in the figure below). It was unclear why these positive deviations from the average had not become absorbed in the *Year* effect and hence the survey biomass index values. Dr. Jim Thorson (NWFSC), who had helped develop the GLMM software, explained that with random *Vessel* x *Year* effects one should expect that by chance alone all of the vessels could produce positive deviations from the average in any given year.

Discussion of this issue continued after the STAR Panel meeting by email correspondence, with the STAR Panel eventually reaching consensus that in general in the GLMM analyses of survey biomass there should be no issue of aliasing of the *Year* effects with the *Vessel* x *Year* effects.

GLMM *Vessel* x *Year* effects (positive hauls) from the NWFSC slope survey.
(Because the effects are exponentiated, positive effects are those greater than 1 in the plot.)

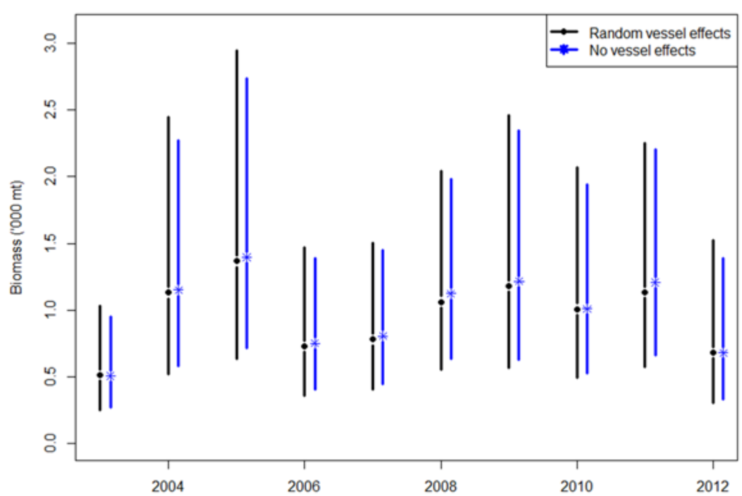



**Request 12:** Run the GLMM without vessel effects.

<u>Rationale:</u> The Panel wants to evaluate the relative influence of vessel effects in the index.

<u>Response:</u> There was virtually no change in the biomass indices from the NWFSC shelf/slope survey when vessel effects were removed from the GLMM. Thus, for this survey at least, there was no evidence of the aliasing mentioned in Request 11.

Biomass indices from the NWFSC slope survey, with and without random *Vessel* effects.



**Request 13:** Plot the mean number of rougheye caught per positive tow in the deep stratum.

Rationale: The Panel wants to better understand trends observed in the different components of GLMM.

Response: This plot (for the slope/shelf survey) showed no trend, which supported the hypothesis that the increasing trend in the mean catch rate from positive tows in the deep stratum (shown in the plot for Request 1 above) was an indication that fish were increasing in size (and thus weight), rather than numbers over the period of this survey (possibly because of growth of the strong 1999 cohort).

**Request 14:** If feasible, find or develop simple plots of length composition by depth (similar to Figure 13 in the draft assessment) for other (ideally northern slope) species.

Rationale: The Panel wants to understand the apparent lack of positive catches in 250-300 meter depths in the NWFSC shelf/slope survey.

Response: These plots were presented for six species (Dover sole, splitnose and darkblotched rockfish, Pacific ocean perch, sablefish and shortspine thornyhead). None showed a lack of positive catches in the 250-300 m depth range. Thus there is no evidence to support the notion that the lack of rougheye rockfish in the 250-300 meter depth range was due to poor performance of the survey gear.

**Request 15:** If feasible, plot the percent positive and average positive biomass by depth, stratum and pass, including the plot of length versus depth by pass (and any other diagnostics the STAT finds informative).

Rationale: The Panel wants to evaluate whether there are seasonal issues related to the vulnerability of rougheye rockfish to the survey gear.

Response: These plots of mean percentage positive tows and of individual catch rates showed no evidence of seasonal effects.

### Description of the Base Model

Although the STAR Panelists were swayed by the evidence from the original base model of residual patterns in the plots of mean length and mean age-at-length and generally supported using the Francis approach for reweighting the composition data, the STAT expressed some reservations about using this approach until they had been able to thoroughly examine all the results of the model run with Francis reweighting. On the last day of the Review the STAT indicated that they had carefully reviewed the results from the run with Francis reweighting and were in agreement with the STAR panelists that this would provide a suitable revised base model for the assessment. Also, after discussion the STAT and STAR agreed that the natural mortality rate (*M*) should form the major axis of uncertainty for constructing the decision table.

The base model has the following structural characteristics.

- The stock is contained in one area, has no seasonality, and is modeled with the sexes combined.
- The stock is unfished in 1915 (but not forced to be at equilibrium) and recruitment deviations start in 1916.

- The rate of natural mortality (*M*) is estimated, based on an assumed lognormal prior distribution having a median value of 0.03365 $y^{-1}$ and log-scale standard deviation of 0.5424.
- The steepness parameter (*h*) for the stock-recruitment function is fixed at the mean value (0.779) of the most recent version of the steepness prior probability distribution for rockfish. The recruitment variability parameter (*sigma-R*) is assumed to be 0.4.
- All parameters for the von Bertalanffy growth model are estimated freely, including the parameters controlling variability in length-at-age.
- There are three fishing fleets operating coastwide. One is conducted with bottom-trawl gear and includes the historic foreign bottom-trawl fishery. A second fixed-gear fleet is conducted primarily with longline gear. These two fleets are modeled as having discards. The third fleet is a combination of the foreign and domestic at-sea midwater trawl fishery that targets Pacific hake.
- Selectivity for all fishing fleets is length-based and has a simple asymptotic form. For the at-sea fleet selectivity is assumed to be time-invariant, but is permitted to vary in time-blocks for the other two fleets (bottom-trawl: 1916-2001 and 2002-2012; fixed-gear: 1916-2002 and 2003-2012).
- The bottom-trawl and fixed-gear fleets each have a length-based logistic retention function that is estimated in time-blocks. For the bottom-trawl fleet there were four time-blocks (1916-1999, 2000-2006, 2007-2010, and 2011-2012) and minimal discards during the first and last blocks, for which the retention functions were linked. For the fixed-gear fleet there were two time-blocks (1916-1999 and 2000-2012) and no discards during the first block.
- There are four fishery-independent trawl surveys: (1) the Triennial shelf survey, split into an early and late series, with separate catchability coefficients and selection curves for each series; (2) the Alaska Fishery Science Center (AFSC) slope survey; (3) the Northwest Fisheries Science Center (NWFSC) slope survey; and (4) the NWFSC shelf-slope survey. The surveys differ slightly from each other in survey design, survey gear, seasonal timing and geographic coverage.
- Selectivity for the surveys is length-based. It is assumed to be asymptotic for all surveys except the Triennial shelf survey, for which selectivity was allowed to be dome-shaped (using the double-normal function). The survey selection curves are independent of one another except for the NWFSC slope survey and the AFSC slope survey, which are assumed to have the same selectivity because no length composition data are available from the NWFSC slope survey to inform a separate selectivity.
- The Francis method is used for reweighting the composition data from the different sources.
- Additional variability added to the year-specific variances of the surveys is estimated to account for inter-annual variability (process error).

The base model is informed by the following data sources.

- Annual landings data from the three fishing fleets (bottom-trawl, fixed-gear, and an at-sea, no-discard fleet) for the period 1916-2012.

- Annual length composition data from the bottom-trawl and fixed-gear fleets starting in 1995, and from the at-sea hake (no-discard) fleet starting in 2003.
- Conditional age-at-length composition data from the bottom-trawl and at-sea hake (no-discard) fleets for two years (2008 and 2011).
- Annual discard biomass amounts for the bottom-trawl and fixed-gear fleets for 2002-2011.
- Annual mean weights of discarded fish for the bottom-trawl fleet for 2002-2011.
- Annual length compositions of discarded fish from the bottom-trawl fleet for 2002-2011, and for the fixed-gear fleet for 2003-2011.
- Annual biomass indices from the early (1980, 1986, 1989, and 1992) and late (1995, 1998, 2001, and 2004) Triennial survey, the AFSC slope survey (1996, 1997, 1999, 2000, and 2001), the NWFSC slope survey (1999, 2000, 2001, and 2002), and the NWFSC shelf-slope survey (2003-2012).
- Annual length composition data from all surveys except the NWFSC slope survey and the AFSC slope survey in 1996.
- Annual conditional age-at-length composition data from the NWFSC shelf-slope survey (2003-2012).

*Alternative Models for Bracketing Uncertainty*

The STAT, in the draft assessment document and in their statements to the STAR, indicated that the results for this assessment were extremely sensitive to the natural mortality coefficient ($M$). The STAR agreed that $M$ was the major axis of uncertainty. However, the best approach for quantifying the uncertainty associated with different values of $M$ was not clear. The topic generated much discussion among all the STAR and STAT members. The STAT proposed the following method for selecting $M$ values to characterize the low and high states of nature. The STAR endorsed this approach.

- Using the base model determine the 12.5 and 87.5 percentiles of spawning biomass in 2013 ($SB_{2013}$), based on the assumption that spawning biomass is lognormally distributed and using the SS3 estimated standard error for the estimate of $SB_{2013}$ (coefficient of variation = 30.6%).
- Determine the fixed $M$ values that produce these low ($M$ = 0.037 y$^{-1}$) and high ($M$ = 0.047 y$^{-1}$) estimates of $SB_{2013}$.

One problem with this approach is that it only incorporates the uncertainty associated with the data measurement errors in the base model; the approach does not consider any of the uncertainties associated with the assumed model structure (e.g., the assumptions that steepness $h$ = 0.779 and that the data weightings are correct).

## Comments on Technical Merits and/or Deficiencies

*Technical Merits*

This is the first assessment for this stock and as such it provides a significant improvement on the previous data-poor view of the stock's potential productivity and current status. The preliminary concerns, based on the Council's productivity and susceptibility analysis, that the stock might be in poor condition proved to be unfounded.

The STAT produced a good quality assessment document, presented it clearly to the STAR, and was very responsive at addressing the questions and points raised by the STAR.

*Technical Deficiencies*

Because there were relatively limited age-composition data available and because the stock had not previously been assessed, our state of knowledge regarding this stock is not fully mature. While the natural mortality rate remains the major source of uncertainty regarding this stock, there are several other potential sources of uncertainty that have not yet been fully explored or accounted for (e.g., steepness, the catch history, and the assumption that fishery selectivity is time-invariant). The current assessment almost certainly underestimates the uncertainty of the stock's status and its ability to support harvest.

**Areas of Disagreement**

*Between the STAR Panel and STAT*

There were no areas of disagreement between the STAT and the STAR Panel regarding the technical aspects or results of the assessment.

*Among STAR Panel Members*

There were no disagreements among the members of the STAR Panel regarding the technical aspects or results of the assessment.

<u>Concerns Raised by the GMT.</u>

The GMT did not raise any concerns regarding the technical aspects of the assessment.

<u>Concerns Raised by the GAP.</u>

The GAP did not raise any concerns regarding the technical aspects of the assessment.

**Unresolved Problems and Major Uncertainties**

The issue of the relative productivity of rougheye rockfish versus blackspotted rockfish remains a very important source of uncertainty with regard to the management of these two stocks. If these two species differ in their biological traits and productivity, then treating them as a single stock could result in great harm to the less productive species. The combined assessment might imply rates of harvest that could not be sustained by the weaker species.

Numerous results presented by the STAT in the draft assessment document and during the review illustrated that the assessment results for rougheye rockfish are very sensitive to the values chosen for the natural mortality coefficient. Natural mortality is always a very problematic parameter for stock assessments, but with very long-lived species such as rougheye rockfish, the presence of very old individuals in composition data can provide strong information regarding the implausibility of large values for $M$. Future assessments of this stock would greatly benefit from an increased number of conditional age-at-length observations and a validation of the ageing method.

Both draft assessments reviewed by the STAR Panel had used the SS3 estimates of effective sample size to iteratively reweight the different sources of composition data. Although this reweighting approach has become a standard feature of most US West Coast assessments, Francis (2011, and in person at the review) provided compelling evidence that this standard approach resulted in implausible residual patterns for the rougheye rockfish assessment and for the aurora rockfish assessment. The Francis approach to reweighting, in contrast, for the most part eliminated these "bad" residual patterns. The Panel endorsed the use of the Francis approach for both assessments. However, it remains to be determined whether the Francis approach is the "best" general approach for deriving reweighting factors. The STAR Panel recommends that a scientific workshop be sponsored to review the state of the art for reweighting stock assessment data, with the aim of preparing a guide to good practices for future assessments.

One issue with the base model for this assessment is its poor ability to fit the length composition data for the NWFSC shelf/slope survey. The model was unable to match the bimodal pattern that was apparent in the length distributions in all years except at the end of the series. The model generally estimated more fish in the 30 to 44 cm length bins than were evident in the data. In this length range the fish would range in age from roughly 10 to 19 years. The absence of these fish may be related to the gap in the fish taken by this survey from the 250 to 300 m depth range. The STAR Panel and STAT attempted to explore the issue of these missing fish in Requests 2 and 14, but were unsuccessful at solving the puzzle.

Another issue that generated considerable discussion amongst the STAR and STAT was how to adequately quantify and balance uncertainty when constructing the decision table. An initial attempt by the STAT, which used the lognormal prior distribution for *M*, resulted in low and high states of nature that seemed implausibly asymmetric with respect to spawning biomass and projected catches. Future stock assessments and STAR Panels would likely benefit if they were provided with more detailed technical guidance on how to construct decision tables, including a summary of lessons learned from a review of approaches applied in past stock assessments.

## Issues Raised by the GMT or GAP Representatives

The GMT and GAP did not raise any data or management issues regarding this assessment.

## Prioritized Recommendations for Future Research and Data Collection

*General (affecting more than one assessment)*

1. A workshop should be held to evaluate (a) methods for the iterative reweighting of composition data (e.g., current approach based on SS3 calculation of effective N versus the Francis approach) and (b) methods for developing initial weightings (the initial input N values).
2. A workshop should be held to evaluate methods for constructing survey GLMM estimates. Topics that should be explored include: (a) the effect of treating vessels as random when in fact the vessels hardly vary from one year to the next; (b) possible aliasing of the index values with the *Vessel* x *Year* interactions; and (c) the using information from the GLMM for combining length composition data collected by different vessels. One goal for the workshop should be to provide adequate documentation of the GLMM methods that will be used to produce survey biomass

indices for future assessments and guidelines on how the analyses, including diagnostics, should be presented in stock assessment reports.

3. Port sampling programs should continue their routine collection of otoliths of slope rockfish species. A catalog of historical collections that have not been aged should be developed.

4. The series of historical catches of individual rockfish species, which are important sources of uncertainty in stock assessments of rockfish, should be explored in more detail. The STAR Panel agrees with the statement in the draft assessment document that "*A thorough look at historical landings, species compositions, and discarding practices would reduce the potential uncertainty that is not entirely accounted for*".

   Furthermore, catch reconstructions should not just develop best estimates of rockfish catch by species, but should also characterize the uncertainty of historical catch estimates by identifying periods of greater and lesser uncertainty. For example, rockfish species compositions taken during early years when there limited slope fisheries should be very different from species compositions taken during later years when fisheries on the slope were more prevalent.

5. The SSC should develop detailed technical guidance on how to construct decision tables, including a summary of lessons learned from a review of approaches applied in past stock assessments.

6. Investigate better fishery-independent data collection methods for slope rockfish and other species living in untrawlable habitats (e.g., surveys using submersibles or remotely operated vehicles).

*Specific to rougheye rockfish*

1. The STAR Panel agrees with the STAT regarding the importance of collecting additional age data and other information that will improve our understanding of the life-history characteristics of rougheye and blackspotted rockfish, with the aim of reducing the uncertainty regarding natural mortality.

2. The survey and port sampling efforts should collect genetic material in association with otolith sampling to provide a clear basis for distinguishing between rougheye and blackspotted rockfish. Also, researchers in the PFMC arena should collaborate with ongoing AFSC and Department of Fisheries and Oceans Canada genetic studies of rougheye and blackspotted rockfish.

3. Prior to the next assessment of either rougheye or blackspotted rockfish (or their complex), there should be targeted studies or analyses to investigate what caused the lack 30-44 cm fish caught in the 250-300 m depth zone by the NWFSC shelf/slope survey.

4. The STAR Panel agrees with the STAT regarding the importance of additional studies of the maturity and fecundity of rougheye and blackspotted rockfish. Further, any fish used for maturity and fecundity studies should be subjected to genetic analysis to definitively identify what species it is.

5. The STAR Panel agrees with the STAT regarding the importance of validating the ageing method for rougheye and blackspotted rockfish. Further, any fish used for age-validation studies should be subjected to genetic analysis to definitively identify what species it is.

6. The STAR Panel agrees with the STAT regarding the importance of "*understanding the stock structure and biology of rougheye and blackspotted rockfishes*" and their recommendation for "*… additional research that will provide insight into the distribution, life history, biological characteristics, and catch and discard profiles of the two species*".
7. The STAR Panel agrees with the STAT regarding the importance of "*basin-wide understanding of stock structure, connectivity, and distribution*" for rougheye and blackspotted rockfish, with the aim of defining "*the connectivity between rougheye* [and blackspotted] *rockfish north of the U.S.-Canada border*".

*Suitability for an Update Assessment*

Given that this stock had not been previously assessed, given the sensitivity of the assessment results to small structural changes, and given the uncertainty regarding the mix of rougheye and blackspotted rockfish in the historical data, the Panel recommends that the next assessment of this stock be a conducted as a full assessment.

## References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