WPSAR Panel Review of Benchmark Stock Assessment for the Main Hawaiian Islands Deep 7 Bottomfish Complex in 2024, with Catch Projections Through 2029

Prepared For
Pacific Island Fisheries Science Center, NOAA/NMFS
Pacific Islands Regional Offices, NOAA/NMFS
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Summary

A new benchmark stock assessment for the Deep 7 Hawaiian bottomfish complex aimed to evaluate the overfishing and overfished status in the Main Hawaiian Islands. The public review process was conducted at Pier 32 in Honolulu, HI, from Dec 11-15, 2023. The WPSAR panel, consisting of two CIE reviewers (Dr. Cathy Dichmont and Dr. Yan Jiao) and the SSC Chairperson (Dr. Steve Martell), reviewed a total of seven presentations covering input data, management history, CPUE standardization, and the stock assessment for the Deep 7 bottomfish, presented by NMFS staff.

In response to the review, the panel requested eight additional model runs to explore sensitivity to assumptions. Public participation played a significant role in understanding the local markets and fishery dynamics. There were 3 public comment periods, and many comments provided a clearer understanding of market-demand and the dynamics of fishing the Deep 7 species. The panel expressed gratitude for the valuable local knowledge and expertise shared through public engagement in the WPSAR process.

Following thorough deliberation over alternative model runs, the panel recommended changes to the prior distribution to better capture uncertainty in population growth parameters. The panel concluded that the source of the retrospective bias is due to recent divergent trends between the fishery-dependent CPUE and BFISH survey time series. The review panel suggests that TAC recommendations should consider the additional uncertainty associated with the retrospective bias, especially if these divergent trends persist in future data updates.

Summary findings from the base model indicate that the Deep 7 complex is neither overfished nor experiencing overfishing. The review panel scrutinized methods for reconstructing Deep 7 catch, CPUE standardization, model-based indices of abundance from the BFISH survey, model structure, and statistical criteria for fitting the model. While acknowledging the informativeness of the data for certain parameters, the panel noted that some remain less informed. The model results are contingent on the informative prior distribution for Bmsy/K. Contradictory trends in the BFISH survey and fishery CPUE were observed, and the use of highly informative priors mitigated retrospective bias at the expense of increased certainty in estimates. The panel recommends augmenting the prior variance to better capture uncertainty in the data and addressing retrospective bias when setting ABC and OFL for this complex.

Introduction

A Bayesian state-space surplus production model was employed to analyze time series data on fishery-dependent CPUE spanning from 1948 to 2022, along with model-based information from a fisheries-independent survey, or hearafter BFISH. The reported catch data underwent reconstruction using enhanced data filtering methods, and the ratios of unreported to reported catch were reassessed. The new benchmark utilizes the JABBA software platform for model fitting and uncertainty estimation using a Bayesian approach. Notably, it addresses a previous structural limitation related to the undefined ratio of Bmsy to carrying capacity (Bmsy/K) for values below 0.368. Additionally, the new benchmark re-evaluates prior distributions for model parameters based on updated life-history information. As per the assessment, the Deep 7 complex is currently not overfished, and overfishing is not occurring.

The benchmark assessment also includes a single-species evaluation for Opakapaka within the Deep 7. Both a state-space surplus production model and an age-structured assessment model were applied to specific time series data for Opakapaka. The age-structured model was jointly fitted to size composition data where available. This model was consistent with what one would expect given the Deep 7 model, and thus supports the findings.

Review Panel Findings

The review panel employed the following terms of reference (TOR) as a guide for this review. Questions 1-8 were discussed, and the panel provided a straightforward "yes" or "no" response based on the relevant material in the Benchmark assessment. In instances where specified, detailed caveats for the terms of reference were provided to offer the authors clear direction and clarification. The list of eight additional panel requests for additional model runs is attached to the end of this document.

Terms of Reference

1. **Of the data considered for inclusion in the complex stock assessment, were final decisions on inclusion/exclusion of particular data appropriate, justified, and well-documented?**

Panel Response: YES

Comments:

During the panel review, there were discussions regarding shark depredation and its potential impact on BFISH survey results. While acknowledging the occurrence of shark depredation, the difficulty in quantifying it was highlighted. As a recommendation, the panel suggests recording the suspected presence or absence of shark-depredation events at each survey station as part of the dataset to enhance understanding the magnitude of shark depredation.

Concerns were raised about filtering methods potentially narrowing the dataset to core fishing grounds based on highliners' activity. This raises challenges in detecting any changes in the range contraction of the fishery. The panel emphasizes the importance of addressing this issue for a more comprehensive assessment in the CPUE trends between fishery dependent and independent data.

Unreported catch, particularly in recent years, sparked significant discussion. The panel recommends further research on surveilling unreported catch, taking into account contributions from recreational and commercial fishers who retain a portion of their catch. The fishing community's fear of retribution for reporting catch (e.g., tax avoidance, internet sales of fish) was identified as a potential source of bias of unknown scale. The panel suggests ongoing outreach efforts to underscore the importance of reporting catch to mitigate these concerns and biases.

2. **Is the CPUE standardization correctly applied and appropriate for this complex, fishery, and available data?**

Panel Response: YES

Comments:

In this assessment, two distinct CPUE datasets were utilized:

1. Fishery-dependent CPUE, derived from catch and effort data spanning from 1949 to 2022.
2. A model-based index based on fishery-independent survey (BFISH) conducted from 2016 to 2022.

For the fishery-dependent CPUE dataset, standardization was performed using a delta-lognormal approach. The best-fit model for standardization incorporated factors such as fisher, fishing year, area, an interaction term for area and year, pounds of uku, and quarter.

The BFISH survey, a stratified-random sampling design-based survey, generated an abundance index based on structured fishing and camera drop events. A spatiotemporal statistical model (VAST) was applied to these data to create a model-based index. The gear calibration coefficient is the key uncertainty in this model-based approach.

Considering this key uncertainty, the panel recommends redesigning the BFISH survey to include more paired stations where both Experimental fishing and the MOUSS Camera system are used simultaneously. This may require additional resources to maintain the current target number of sampling stations. Additionally, the panel suggests updating gear calibration coefficients annually as paired station data become available.

3. **Is the complex stock assessment model used reliable, properly applied, adequate, and appropriate for the complex, fishery, and available data?**

Panel Response: YES

Comments:

The model faces significant constraints due to the prior distributions, primarily because the underlying data lacks sufficient contrast to resolve the confounding between population scale and productivity within the model structure. The data provide insufficient information to estimate the four key parameters related to management variables; however, there is sufficient information to estimate three of the four parameters conditional on the prior specified for the shape parameter (*m*). The overall model scaling is proportionally influenced by changes in unreported catch.

The prior for *r* is grounded in life-history data but only incorporates uncertainty in natural mortality and steepness, neglecting uncertainty in growth, maturity or selectivity parameters and assumed longevity. Recognizing these limitations, the panel recommends increasing the variance in the priors for *r*. This adjustment aims to accommodate unaccounted-for variance terms that were not considered during the construction of the prior distributions. By doing so, the model can better capture uncertainties and enhance its robustness in setting management advice.

4. **Are decision points and input parameters reasonably chosen?**

Panel Response: YES

Comments:
All three models exhibit internal consistency, as demonstrated by the assessment team through extensive sensitivity testing. The initial stock size parameter (*psi*) in the base case model was highly informative. However, the updated posterior distribution, informed by the data and conditional on other prior distributions, indicates that the initial stock size was closer to carrying capacity. Based on this result, the review panel requested a non-informative beta prior on *psi*, which resulted in poor model convergence diagnostics and was abandoned. The net result is that the panel requested increasing the CV for the *psi* parameter by 50%.

5. **Are primary sources of uncertainty documented and presented?**

Panel Response: YES

Comments:
The primary sources of uncertainty in the Deep 7 bottomfish complex stock assessment are well documented and presented in the report. The assessment report provides a comprehensive account of the sources of uncertainty, including process and observation errors, and the impact of various assumptions and data limitations on the assessment results. The report also discusses the sensitivity of the model results to changes in assumed prior distributions for certain parameters. The only source of uncertainty that was not considered was the potential bias associated with shark depredation events in the experimental fishing portion of the BFISH survey and various biological and fishery parameters when calculating the priors for the model.

The review panel also appreciated the oral history shared by the public and how it relates to uncertainty.

6. **Are complex stock assessment model assumptions reasonably satisfied?**

Panel Response: NO for the Base Case, YES for model defined in Request 7.

Comments:
In the base case model, the priors for the initial stock size (*psi*) and the shape parameter (*m*) were deemed overly informative, biasing the uncertainty downwards. The panel recognizes this and provides a caveat, suggesting that the variance terms for the intrinsic rate of increase (*r*), *psi*, and *m* be increased. This adjustment aims to account for additional uncertainty not considered during the construction of the prior distributions. Conditional on these changes, the panel recommends utilizing the model (Request 7) that incorporates more uncertainty in the initial 1949 abundance (*psi* see TOR 5) and the ratio of Bmsy/K (*m*) for providing catch advice.

This recommendation is consistent with the demonstrated internal consistency among the three models, where similar results with increased prior variances were also obtained in the single species models. The complex under assessment is predominantly influenced by two dominant species, opakapaka and onaga, as elaborated in comments within TOR 3, 4, and 5. The panel's emphasis on augmenting variance terms aims to enhance the models' ability to capture the full uncertainty in the system, and not be overly constrained by prior variance.

7. **Are the final results from the complex stock assessment scientifically sound, including estimated stock status in relation to the selected biological reference points and overfishing limits, and can the results be used to address management goals stated in the relevant FEP or other documents provided to the review panel?**

~~Panel Response: NO~~

The review panel finds that uncertainty is underestimated in the Base model. However, subject to the panel recommendation using the caveat outlined in TOR 6, the panel response is Yes.

Panel Response: YES

Given the model specified in Request 7, the review panel is satisfied that inflated uncertainty in the prior distributions better reflects the true uncertainty in the underlying data and that the model is scientifically sound to address management goals. There is a recognition of retrospective bias associated with recent divergent trends between the 2 CPUE datasets, and this uncertainty is better captured using the less informative priors.

8. **Are the methods used to project future population status for the complex adequate, including the characterization of uncertainty, and appropriately applied for meeting management goals as stated in the relevant FEP?**

Panel Response: YES

Comments:

The panel acknowledges the adequacy of the method for future projections. However, it highlights that the base case model falls short in fully capturing uncertainty. Consequently, the panel recommends basing projections on the increased variance in the prior distributions, as suggested in TOR 6.

Additionally, the panel recognizes an improvement in the new model structure, which now enables the propagation of uncertainty in future projections. This marks a notable advancement over the previous limitation encountered with the OpenBugs software package.

9. **If any results of the complex stock assessment model should not be applied for management purposes with or without minor short-term further analyses (in other words, if any responses to any parts of questions 1-8 are "no"), indicate**
    - **Which results should not be applied and describe why, and**
    - **Which alternative set of existing stock assessment results should be used to inform setting fishery catch limits instead, and describe why.**

The panel expresses that model from request 7 is the best available scientific advice for providing management advice in the TAC setting process. The preference is for the increased variance terms, accepting the retrospective bias linked to the differences in trends between the BFISH survey and the fishery-dependent CPUE. This decision reflects a considered approach to balance the advantages of increased uncertainty accommodation with the acknowledged challenges posed by the retrospective bias.

10. **Given the limitations associated with using a surplus-production model on a multi-species complex, is the supplementary single species, age-structured opakapaka model useful in supporting the general conclusions from the surplus-production model (biomass and mortality trends and stock status)?**

Panel Response: YES

Comments:
The report discusses the agreement between the estimates from the single-species production model and the age-structured model, indicating that the supplementary model supports the general conclusions regarding biomass and mortality trends and stock status derived from the surplus-production model. The review panel also appreciates the model comparison and found that the general model results were consistent with the model for the Deep 7 aggregated fish complex.

11. **As needed, suggest recommendations for future improvements and research priorities. Indicate whether each recommendation should be addressed in the short/immediate term (2 months), mid-term (3-5 years), and long-term (5-10 years). Also indicate whether each recommendation is a high priority (likely most affecting results and/or interpretation), mid priority, or low priority.**

Comments:
The panel puts forth the following recommendations:

Short-term:

Update the JABBA assessment model for the Deep 7 bottomfish complex based on request 7, i.e.,

1. Increase the variance on the priors for the initial population size (psi) to 50%.
2. Increase the prior for the shape parameter (m) to 20%.
3. Increase the coefficient of variation (CV) for the prior on r to 66%.

Medium-term:

1. Implement additional paired stations on the survey to enhance information on gear calibration.

Long-term:

1. Continue to collect missing life-history data for Deep 7 species.
2. Explore deeper camera and lighting options for improved survey accuracy.
3. In the long term, consider development of single species stock assessment for Opakapaka and Onaga species. These two are the primary target species in the Deep 7, while the remaining species are not targeted and constitute a minor component of the catch.

Acknowledgements

The review panel acknowledges the authors for an outstanding document and well-organized meeting, with excellent materials presented logically. Appreciation is also extended to industry and public participants. This collaborative effort in fisheries stock assessment stands out as a prime example of industry-science collaboration, showcasing remarkable improvements in data and scientific information over the past two decades.

Closing Note:

The Hawaiian bottomfish fishery, characterized as a fresh market fishery, and strictly adheres to the philosophy of "Sell-it or smell-it" – Layne Nakagawa.

List of Panel Requests

1) For the model based BFISH estimates, run the model without the Spatial effects in the VAST model.

2) Using the VAST mode, run the stepwise regression plot again using the delta lognormal error structure and show the influence plots.

3) Provide plots of the selectivity curves that were used to develop the R-prior from the LBSPR model and compare with the estimates used in the single species opakapaka model from Stock Synthesis.

4) Run the Jabba model with larger CVs on the priors for 'r', 'psi', and 'm' jointly. We are interested in comparing the management quantities between the informative and less informative priors.

5) Change the lognormal prior for the initial proportion of the carrying capacity ('psi') to a non informative beta distribution rescaled between 0 and 1.2.
6) Re-run the Jabba surplus production model for the single species opakapaka data with the same uniform prior between 0.01 and 1.2. Compare the marginal posterior distribution for psi for both the single species model and the deep 7 model.
7) The panel would like to see a model run with the prior for 'r' with the CV doubled (66%). For 'psi', increase the CV to 50% and set the CV for the M prior two 20%.
8) Perform the same changes to the single species opakapaka model with the same priors for R and Phi doubled. And the CV for M = .2. Same as model 6.