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WESTERN PACIFIC STOCK ASSESSMENT REVIEW

"Stock Assessment Update for the Main Hawaiian Islands Deep 7 Bottomfish Complex in 2021, with Catch Projections Through 2025"

Individual Reviewer Report

By

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Summary

A Western Pacific Stock Assessment Review (WPSAR) of the 2021 Main Hawaiian Islands Deep 7 bottomfish fishery update stock assessment was conducted online during December 16-17, 2020. The Deep 7 bottomfish complex consists of six snapper species: *Etelis carbunculus* called commonly "ehu", *Etelis coruscans* called "onaga", *Pristipomoides filamentosus* called"opakapaka", *Pristipomoides sieboldii* called "kalekale", *Pristipomoides zonatus* called "gindai" and *Aphareus rutilans* called "lehi", and a grouper species: *Hyporthodus quernus* called hapu'upu'u. The update assessment (Syslo et al. 2021) incorporated an updated time series of data and used the methods of the preceding benchmark assessment including a Bayesian surplus production model fit to standardized CPUE for the Deep 7 complex and a single species (opakapaka). Some additional minor steps were made in data filtering and CPUE standardization, but the methods did not depart significantly from the benchmark assessment methods. The inclusion of the fishery-independent surveys ("BFISH") is an excellent additional data set to evaluate the status of this fishery but additional work needs to be performed to clarify any possible biases in the data collection methods of these surveys. Another concern regarding the assessment is the accuracy of the non-commercial catch data but this uncertainty was dealt with in appropriate ways in the assessment (i.e., uninformative priors, multiple possible modeled data trends). The assessment also included extensive sensitivity analyses investigating the effects of key inputs and parameters on model results. Results for the Deep 7 complex and opakapaka models indicated that the stocks were not overfished nor were experiencing overfishing for 2018 (the most recent year of data available and assessed). The update assessment also provided projected stock levels to inform setting ACLs through 2025.

As WPSAR Chair for this review, I asked SSC members not serving on the panel for input on the update assessment relative to TOR question 2 about CPUE standardization. I had a written response from an SSC member, Milani Chaloupka, and include his comments in full as an appendix to my report.

In general, the assessment provides an excellent and detailed account of the status of the Main Hawaiian Islands Deep 7 bottomfish fishery and represents the best scientific information available for fishery management decision-making on the stocks. The assessment also provides sufficient guidance and resources to allow the replication of results by an independent, trained scientist. I found that the assessment report sufficiently met the Terms of Reference (TOR) and provide a detailed response to describe how each TOR was satisfied. To improve the final version of the assessment report and guide future scientific activities, I include a list of short, medium, and long-term recommendations.

Responses to TORs

The panel was requested to address eight TOR questions for this assessment review and provide a "yes" or "no" answer, with specific caveats if necessary. If responses to questions 1-6 were "no", it should be noted as to why the answer was "no" and which alternative set of existing stock assessment information/results should be used to inform fishery management. Detailed responses to the TOR questions are given in the following sections. A summary table provides an overview of the responses (Table 1).

Table 1. Summary of responses to Term of Reference 1-9 (TOR). Potential responses were "Yes" or "No" with caveats, as necessary. TOR 9 is this report.

TOR	Response
1: Input data & filtering uncertainty	Yes
2: CPUE standardization	Yes
3: Models and methodology	Yes
4: Uncertainty	Yes
5: Stock status in relation to BRPs	Yes
6: Projections	Yes
7: Reponses to 1-6 or Alternatives	N/A
8: Recommendations	See section

TOR 1 Input data & filtering uncertainty*: Is uncertainty with respect to input data quality and filtering methods well documented, including its potential effect on results?*

Yes, the uncertainty with respect to input data quality and filtering methods is well documented, including its potential effect on results.

In general, the uncertainty and filtering methods for input data included in the assessment were appropriate, justified, and well-documented. At a series of prior workshops between fishery science and management agency staff and members of the fishing community, the guidelines for the data filtering approach for this fishery were outlined (for details, see Yau 2018). These steps included the selection of trips using bottomfish gears and thus targeting bottomfish, better accounting for multiday trips, and selecting representative records. The data filtering process began with approximately 5 million fishing records (from the Hawaii Division of Aquatic Resources) that were filtered to just over 200,000 event-based fishing records that were relevant for the assessment of the bottomfish fishery.

A primary source of uncertainty is the accuracy of the non-commercial catch (termed "unreported" catch) data included in the assessment. To address this concern, the assessment team evaluated model results under multiple possible trends for these data to provide a possible range of effects on model results. While these scenarios adequately provided a range of outcomes for different unreport catch trends, an improvement in the recording and estimation of the actual non-commercial catch data are important.

The data workshops were a critical step in the approvement of the information used for the prior benchmark assessment and this update assessment. A recommendation is the continued interaction of the stock assessment and management teams with the fishing community for future workshops and informal interactions to

TOR 2 CPUE Standardization: *Is the CPUE standardization properly applied and appropriate for this species, fishery, and available data?*

Yes, the CPUE standardization was applied properly and appropriate for this species, fishery, and available data.

In general, the update assessment provided a clear structure and a detailed sequence of actions used to standardize CPUE indices that utilized the same generalized linear and linear-mixed modeling approaches as the benchmark assessment which were previously WPSAR reviewed

(Martell et al. 2017). One change (recommended from prior review) was the incorporation of zero catches in the CPUE standardization dataset. Following prior methods, the CPUE was analyzed using different effort units for two time periods, with fishing days reported for 1948-2002 and fishing hours reported for 2002-2018. While the CPUE standardization methods are sufficient to assess the fishery, there could still be additional improvements made to these models including the effect of gear technology improvements, shark depredation of catch, and additional single species or complex sub-groupings. Several of these improvements were suggested during prior data workshops (Yau 2018) and additional ideas should be solicited from the fishing community during future workshops.

<u>TOR 3 Models*: Are the assessment model and methodology the same as those used in the 2018 benchmark stock assessment?*</u>

Yes, the assessment model and methodology are the same as those used in the 2018 benchmark stock assessment.

The update assessment used the same Bayesian surplus production model to assess the Deep 7 complex and opakapaka in the update as that used in the benchmark 2018 assessment but incorporated additional years of data for the analyses. One minor exception is that the update model was fit to a CPUE time series that had a modified data filtering approach (noted previously). The update model also incorporated the BFISH fishing-independent survey data that used a refined method to estimate the effective radius of the sampled area of the underwater cameras. The approach led to the use of the surveys as an index rather than a scaling factor for total fish abundance.

<u>TOR 4 Uncertainty*: Are primary sources of uncertainty documented and presented?*</u>

Yes, the primary sources of uncertainty were documented and presented.

In general, the sources of uncertainty for the data were adequately documented and described in the assessment. A major source of uncertainty is the accuracy of the non-commerical (i.e., unreported) catch for the fishery. Given that uncertainty, the multiple unreported catch scenarios provided an range of effects that quantified their possible contributions to model results. The explicit nature of distributions for inputs to the Bayesian analysis and retrospective analysis results presented a clear documentation of methods used to address uncertainty and provided standard diagnostics to document the performance of the model and data.

The fisheries independent survey methods had sufficient documentation to describe the methods used to incorporate uncertainty into their estimation process but there remains additional research needed to address potential species-specific biases in the data collection. In particular, the current description of this method as providing “absolute abundance” is misleading and probably inaccurate. In particular, the determination of the true effective area sampled is critical as well as how the Nmax variable is used to count fish. Currently the radius estimation is calculated for opakapaka but applied to all species which do no share the same behavior and life history traits as that species. While the survey sampling design is robust, an improvement to the field methods used to estimate abundance fishery-independent survey data is recommended.

TOR 5 Stock Status in Relation to BRPs*: Do results include estimate stock status in relation to the estimated biological reference points, and other results required to address management goals stated in the relevant FEP or other documents provided to the review panel?*

Yes, the results included estimated stock status in relation to the estimated biological reference points, and other results required to address management goals stated in the relevant FEP or other documents provided to the review panel.

The 2021 update stock assessment for Main Hawaiian Islands Deep 7 complex estimated and MSY of 473,000 lbs., H_{MSY} of 6.8%, and an exploitable biomass of 15.5 million pounds. These estimates were a small decrease in MSY and H_{MSY} compared to the prior benchmark stock assessment. The assessment estimated a 13% probability of the Deep 7 complex being overfished and an 11% probability that it was experiencing overfishing. Thus, the assessment finds that the MHI Deep 7 complex was not overfished and not experiencing overfishing for 2018, with similar conclusions for the single species assessment for opakapaka.

TOR 6 Projection Methods*: Are the methods used to project future population state the same as those used in the 2018 benchmark stock assessment?*

Yes, the methods used to project future population state are the same as those used in the 2018 benchmark stock assessment.

The same methods from the benchmark assessment were used to project future population state for 2021-2025 and presented various catch levels that correspond to a range of overfishing probabilities.

TOR 7 Responses to 1-6 or Alternatives: *If responses to question 1-6 are "no", indicate for each: Why was the answer "no"; Which alternative set of existing stock assessment information/results should be used to inform fishery management in this case and why?*

N/A, none of the responses to questions 1-6 were "no", thus no alternatives are provided.

TOR 8 Recommendations: *For consideration in future benchmark assessments, suggest and prioritize recommendations for improvements and research. For each recommendation prioritize to three categories (high, medium, low) dependent upon the importance to interpretation of this and future assessment results.*

High Priority

Data workshops and stakeholder connections: Maintain direct communications with fishers about stock assessment activities. Conduct data workshops with the fishing community to develop collaborative contributions to the data and methods included in the next benchmark stock assessment.

Unreported catch: Unreported catch is a significant source of uncertainty. Continued collaborative efforts between NOAA, the Council and the fishing community should be pursued to improve the collection of data describing non-commercial catch. These activities could include improvements to MRIP, the federal non-commercial license program, and pilot programs to directly collect catch and effort data from non-commercial fishermen.

Medium Priority

Complex and single-species assessments: Continue to present both the Deep 7 complex and single-species assessments for important species with sufficient information (e.g., opakapaka) in next benchmark assessment. We recommend further data collection and life history studies for other species in the complex to facilitate stock assessments.

Fishery independent survey methods: Perform research activities to provide improved empirical estimates of the survey area for the stereo-video method used in the fishery independent survey. Species specific issues should be investigated regarding diurnal schooling characteristics and vertical behavior in relation to the orientation and field of view of the camera system. The collection of life history and behavior data from Deep 7 species useful for improving fishery-independent survey data should be strongly promoted.

CPUE standardization: Explore the inclusion of additional factors that may impact Deep 7 CPUE identified at previous and future workshops on data standardization in future benchmark stock assessments. Interact with fishers and the scientific community for additional ideas to improve the standardization process. Where data is lacking to include potentially important factors, make recommendations to appropriate agencies to conduct research and collect these data.

References

Syslo J, Brodziak J, Carvalho F. 2021. Stock Assessment Update for the Main Hawaiian Islands Deep 7 Bottomfish Complex in 2021, with Catch Projections through 2025. DRAFT. NOAA Tech. Memo. NMFS-PIFSC - ###, ## p.

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Appendix: Comments from SSC member Milani Chaloupka regarding the update assessment and TOR question 2.

Peer Review under the Western Pacific Stock Assessment Review framework: *2020 Stock assessment update for the main Hawaiian Islands Deep 7 bottomfish complex*

TOR 2: Is the CPUE standardization properly applied and appropriate for this species, fishery, and available data?

Data

Significant effort has been made on the data filter procedures including accounting for multi-day trips. And that is a major achievement.

Zero catches now included in CPUE-type standardization, with zeroes accounting for ca. 17% of the catch data series.

Now the data used comprised catch and effort data for 70 fishing years (July 1 to June 30) where prior to Oct 2002 effort = "number of days" but then effort = "number of hours" ever-since.

Hence modeling was required for each of these 2 periods separately: (1) fishing years 1948-2003 and (2) then fishing years 2003-2018. This resulted in 2 separate standardized annual abundance indices with 55 years in the first series and 26 in the second (with overlap of the 2003 fishing year).

Is it really correct that it is not possible to splice these two series into one series using a conversion from "hours fished" to "days fished"?

Afterall, catch was based on reported catch plus the unreported catch that was based on a contrived unreported catch ratio. So, a ratio converter was used to derive the catch — so why not effort?

But if not because it is too hard (and fair enough), then why not just use the second series from 2003 onwards for the data standardization and stock assessment model? What benefit is there in the 1948-2003 when apparently there are few informative covariates affecting catch rates in either series?

For instance, no wind speed data could be used as a catch rate predictor for the first period but could and was used for the second time series.

Regression modelling approach for standardization

Once again, a so-called delta-lognormal regression model was used to standardize the catch time series given some potentially informative covariates, which is just a simple form of hurdle model with 2 components: (1) a component with Bernoulli likelihood to model the presence-absence data (or 0 = zero fish caught and 1 = at least 1 fish caught) and (2) a continuous likelihood to account for the positive catch caught (> 0 fish caught) that was called lognormal in this update analysis.

In fact, it isn't really a lognormal likelihood at all because the update just log transformed the positive catch and then used a Gaussian likelihood (and that is not a log-normal likelihood).

Lognormal likelihood was not used because of the limitation of the lme4 package used. So, a make-shift transform Gaussian approach was used. No other hurdle-type likelihoods were explored due presumably to the same limitations of the lme4 package.

Yet again, the two components (Bernoulli, apparent log-normal) then have to be recombined in a make-shift manner to derive some measure of uncertainty.

Given the significant ongoing convergence and memory management problems with the lme4 package for R for this data set then why not use either of the following R packages for a frequentist inference framework instead that are less likely to have such issues: GLMMadaptive (Rizopoulos 2020) or TMB (Kristensen et al 2016) via the lme4-like glmmTMB interface (Brooks et al 2017).

This is especially the case with the large number of random-intercept effects in this data set ("individual fisher ID"). In fact, no random effects could be fitted for the Bernoulli process of the hurdle model for the first period due to convergence issues — and then the same problem for the second period.

Quite frankly, the so-called delta-lognormal regression modelling approach to catch series standardization is just not adequate. Schaefer et al (2021) used a far more informative Bayesian geoadditive GAMM modelling approach with hurdle lognormal likelihood to model tuna catch rates around drifting FADs.

Conclusion

The catch effort data series are challenging and some of the ongoing issues may never be resolved. So why not just focus on the data from 2003 onwards? Far more robust regression model-based standardization approaches need to be explored in future assessment.

References

Brooks M, Kristensen K, van Benthem K, ArniMagnusson A, Berg C, Nielsen A, Skaug H, Maechler M, Bolker B (2017) glmmTMB balances speed and flexibility among packages for zero-inflated generalized linear mixed modeling. The R Journal 9(2): 378-400

Kristensen K, Nielsen A, Berg C, Skaug H, Bell B (2016) TMB: Automatic Differentiation and Laplace Approximation. Journal of Statistical Software 70(5): 1-21

Rizopoulos D (2020) Generalized linear mixed models using adaptive Gaussian quadrature. R package version 0.7-0. https://CRAN.R-project.org/package=GLMMadaptive

Schaefer K, Fuller D, Chaloupka M (2021) Performance evaluation of a shallow prototype versus a standard depth traditional design drifting fish-aggregating device in the equatorial eastern Pacific tuna purse-seine fishery. Fisheries Research 233: 105763