Western Pacific Stock Assessment Review of the

Stock Assessment Update for the Main Hawaiian Islands Deep 7 Bottomfish Complex in 2021, with Catch Projections Through 2025[1] (*Draft*)

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[1] **Stock Assessment Update for the Main Hawaiian Islands Deep 7 Bottomfish Complex in 2021, with Catch Projections Through 2025.** ***DRAFT*****. John Syslo, Jon Brodziak, Felipe Carvalho**. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Pacific Islands Fisheries Science Center. ***Draft Report for WPSAR Review.***

Summary

The benchmark stock assessment for the main Hawaiian Islands Deep 7 complex in 2018, with assessment to 2015 and catch projections through 2022 will be replaced with an update assessment for 2021 with assessment to 2018 and catch projections through 2025. The draft 2021 update stock assessment was subjected to a Western Pacific stock assessment review (WPSAR) panel review with this report being one component of the review process.

The 2021 assessment remained within the guidelines of a stock assessment update, applying the same Bayesian generalized surplus production model developed for the 2018 benchmark assessment applied to the Deep 7 complex (Figure 1; onaga (*Etelis coruscans*), ehu (*Etelis carbunculus*), kalekale (*Pristipomoides sieboldii*), opakapaka (*Pristipomoides filamentosus*), gindai (*Pristipomoides zonatus*), lehi (*Aphareus rutilans*), and hapu'upu'u (*Hyporthodus quernus*), and to a single-species assessment for opakapaka.

Additional data filtering and CPUE standardization was applied to the prior dataset plus three years of additional data. Model results characterize the main Hawaiian Island Deep 7 complex and opakapaka stock as not overfished and not experiencing overfishing in 2018. Results for both stock complex and stock were very similar and subjected to thorough sensitivity analyses. Assessment results provided stock status estimates of MSY-based reference points for 2018 and risk of overfishing estimates relative to stock projections through 2025 useful for the setting of ACL management levels.

The assessment is well described and conducted and ample materials for the review were supplied by PIFSC and the stock assessment team. I consider this 2021 stock assessment update to represent best scientific information available on the stock condition and population status of the main Hawaiian Island Deep 7 and opakapaka stock in 2018.

Figure 1. The Hawaii Deep 7 bottomfish complex

1) Background

The federally managed bottomfish complex of Hawaii includes thirteen shallow and deep-water species of snappers and jacks with one endemic grouper species. The 2011 benchmark stock assessment was the first to assess the seven deep-water species separately from the shallow-water species within the complex (Brodziak et al. 2011). The Deep 7 bottomfish species include two eteline snappers; onaga (*Etelis coruscans*) and ehu (*Etelis carbunculus*); four additional snapper species; kalekale (*Pristipomoides sieboldii*), opakapaka (*P. filamentosus*), gindai (*P. zonatus*) and lehi (*Aphareus rutilans*); and the endemic grouper; hapu'upu'u (*Hyporthodus quernus*).

Splitting the 13 species complex by depth distribution represented a significant improvement to the assessment structure while recognizing that the Deep 7 complex still contains species quite different in life history characteristics such as for the only grouper species.

The 2011 assessment was updated in 2014 that included improved information on fisher effects for improved CPUE standardization (Brodziak et al. 2014). The assessment was reviewed by a panel through the Center for Independent Experts who recommended it not be used for management purposes due to issues with the quality of catch and CPUE data inputs despite these data being used in prior stock assessments (Haist 2015). As a result, the PIFSC conducted a specific assessment with data through fishing year 2013 but using the same modeling approach of the 2011 assessment.

To address these and other issues, PIFSC coordinated a series of five data workshops with fishery participants and the bottomfish community to improve assessment efforts (Yau 2018). The 2018 benchmark stock assessment for the Deep 7 complex utilized recommendations from the workshops to develop stock status determinations for 2015 with projections through 2022. The assessment also included the development of a single-species stock assessment for opakapaka, the largest species component of the Deep 7 complex (Langseth 2018). For the first time, the model was able to provide estimates of total biomass using a scalar and incorporating biomass estimates from fishery-independent survey data.

This review examines the draft 2021 assessment update to the 2018 benchmark assessment that incorporates three additional years of data with stock status determinations for 2018 with projections through 2025 (Syslo et al. 2021). This document examines the draft update assessment in relation to six terms of reference provided for this review (Annex I).

2) Addressing the Terms of Reference

The panel members were asked to review the following six TORs specific to this review and provide a "yes" or "no" answer, with specific caveats if necessary. If responses to questions 1-6 are "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.

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

Response: Yes

The uncertainty with respect to input data quality and data filtering methods are well documented though the individual effect of some specific data filtering actions to the assessment are not always stated. The key data uncertainty in the assessment centers on uncertainty in unreported catch that likely exceeds reported

commercial catch data. This uncertainty was examined through logical and well documented sensitivity analyses.

The long history of the fishery with evolving data protocols and standards applied to a diverse species complex makes data filtering and standardization challenging. A great deal of effort has been devoted to data filtering to produce catch and effort data specific to the commercial harvest of Deep 7 species within the main Hawaiian Islands represented by similar effort characteristics. The considerable efforts of the PIFSC stock assessment team to sort the available commercial dataset for analysis are to be commended.

In order to address previous WPSAR recommendations and to improve data quality, PIFSC held five data workshops with experienced fishery participants or persons familiar with the Deep 7 (D7) fishery. Workshop participants identified several factors that can influence D7 catch rates for consideration in the assessment and data filtering (Yau 2018). A key factor for data standardization is the ability to track individual fishers over time which was first introduced with the 2018 benchmark assessment.

In the update assessment, commercial fisher reported data for use in CPUE analyses were filtered in four ways:

- selecting for records targeting Deep 7 species,
- sorting records to identify and account for multi-day trips,
- selecting records representative of the fishery,
    - to filter out records from fishers who never reported catching a Deep 7 bottomfish,
    - to filter out data reporting effort records from fishers on days where they were participating in the fishery-independent bottomfish survey activities.

A total of 904,559 records credited to the deepsea handline gear from 1948-2018 were initially considered for analysis as with previous stock assessments. These records accounted for 95% of the D7 data records and 98% of D7 records by weight. These data were carefully filtered, often on the basis of information resulting from the data workshops to concentrate on Deep 7 targeted trips within the main Hawaiian Island area for data corresponding to a unique commercial marine license (CML) having associated effort. Records from periods when the deep bottomfishery was closed due to regulatory action or resulting from research fishing were also removed from the analysis. Previous assessments identified multiple day trips using an upper limit of 1500 pounds of D7 species as a cutoff point for a single day catch. This system failed to identify and remove multiple day trips that caught less than 1500 pounds of D7 with negative impact to CPUE estimates. Again, based on input from the data workshops, effort in days was adjusted based on distance travelled between port and the fishing area with 0-30 nm considered representative of a single reporting for one day of effort.

The value of holding data workshops during the development of a benchmark stock assessment is clear and fully recognized by the review panel. A High Priority recommendation to supporting the data workshop process to stock assessment is included in section 3 of this report.

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

Response: Yes

The 2021 update assessment used the same generalized linear and liner mixed model to standardize Deep 7 CPUE data as was used in the 2018 benchmark assessment. This approach used in the benchmark 2018 assessment was subject to a WPSAR process and determined to be BSIA (Martell et al. 2017).

An improvement to the 2021 update assessment recognized information from participants noted during data workshops indicating that it is possible to have zero Deep 7 catch while actually targeting D7 species. Therefore, zero catch data were included in the dataset for CPUE standardization. In addition, CPUE was calculated for two time periods based on single reporting days (1948 – September 30, 2002) and by hours (October 1, 2002 – 2018) due to a change in data reporting procedures beginning in October 2002.

Participants to the data workshops identified several factors believed to affect CPUE of Deep 7 species. Fisher skill and wind speed/direction were listed as the most influential factors, supporting their inclusion in the current analysis. Although not specifically identified on this list, catch of shallow-water uku (*Aprion virescens*) was also included due to competition with Deep 7 effort when uku becomes seasonally abundant and highly vulnerable to the fishery.

Data workshop participants have identified several additional factors that may have an impact on bottomfish CPUE that have not yet been addressed in the D7 stock assessment process (from Table 9 of Yau 2018). A partial list of these factors includes:

- BRFAs and Kahoolawe – impact of closed fishery zones
- Technology creep – GPS chart plotters, improved echo sounders, electric reels, spectra line, etc.
- Influence of depredation or catch competition – sharks, amberjack (*Seriola spp*.)
- Loss of experienced, ageing fishers
- Oceanographic conditions and productivity
- Targeting of certain D7 species
- Marketing and ex-vessel price
- Consider sub-grouping of some D7 species or assessing others for single-species assessment

Consideration of these factors in future benchmark assessments should be addressed. A High Priority recommendation supporting the identification of additional factors that may influence Deep 7 CPUE and their prioritization for consideration in future benchmark assessments is included in section 3 of this report.

- **TOR 3: Are the assessment model and methodology the same as those used in the 2018 benchmark stock assessment?**

Response: Yes

The stock assessment team followed the guidelines for an update assessment in utilizing the same Bayesian generalized surplus production assessment model as applied in the 2018 benchmark stock assessment. However, the model was fit to a standardized CPUE time series with modified data filtering and updated with three additional years of data to provide stock status determinations for 2018 with projections assessing risk of overfishing through 2025.

This model differed significantly from the 2011 and prior assessments with the model being fit to fishery-independent biomass estimators and the splitting of the data into two CPUE time periods that capture changes in reporting of fishing effort in 2002 (to hours versus single days). Both CPUE time periods in the 2018 benchmark and the 2021 update were fit separately with different fishery catchabilities and new information on priors and error in unreported catches.

The authors of the 2021 update stock assessment noted that the main difference between the 2021 update and 2018 benchmark assessments involved methods related to inclusion of the fishery-independent survey. Additional data and refinements in methodology increased the effective radius of the sampled area. The mean value of the radius increased from 20.2 m in the 2018 benchmark assessment to 27.6 m in the 2021 update. The upper bound of estimates increased from 41.6m to 60m. This resulted in an effective down weighting of the survey data to serve more as an index than a scaling factor for total abundance.

- **TOR 4: Are primary sources of uncertainty documented and presented?**

Response: Yes

The largest potential source of uncertainty in the assessment relates to the estimate of unreported catch (recreational/non-commercial) and to a lesser extent any under-reporting of CML effort. Levels of unreported catch are explored in detail through sensitivity analyses to different catch scenarios and model runs. The magnitude of unreported catch likely exceeds reported catch, highlighting the importance of continued efforts to reduce uncertainty in unreported catch estimates in future benchmark assessments.

Another area of uncertainty that could be further explored relates to the integration of fishery independent survey data to the assessment process. Visual survey data collected with the Modular Optical Underwater Survey System (MOUSS) stereo video system is important to the estimation of relative abundance and expansion to total biomass. However, a key uncertainty remains as to the effective area that is being sampled by the stereo-video system and how well the system is observing each species in the complex.

The deployed MOUSS system as described by Amin et al. (2017) and Ault et al. (2018) has the following characteristics:

- Can identify species to a depth of 250 m in Hawaiian waters using ambient light
- No artificial lighting is used during surveys, therefor no sampling at night or below 250m
- Stereo-video cameras are calibrated to provide size data
- Unit is anchored ~4m above the seafloor
- Unit is oriented down current and records at a downward angle of 15° in viewing a quadrant of 84°
- Unit is baited
- Unit is deployed for 15 minutes per station
- Standardized test fishing takes place in selected grids but not concurrent with MOUSS surveys

Due to the deployment protocol of the video camera system, the effective sampling area can be impacted by survey limitations due to ambient light (daytime sampling only), demersal orientation, influence of baiting and species-specific differences in diurnal schooling, feeding and vertical behavior.

During initial field experiments and during the 2016 survey, the test fishers and video analysts observed Deep 7 species schooling higher in the water column and likely out of range of the bottom-oriented cameras (Ault et al. 2018). Fishers have noted this issue may be particularly relevant for observing daytime onaga and large opakapaka that are known to school and feed both on the bottom and significantly higher in the

water column. Additional limitations to survey efficiency may be caused by the limited field of view of the camera system.

The assessment update includes refined estimates of the effective area sampled, but further improvements may be possible. Currently, radius estimation is based on opakapaka for which the most complete life history data is available and then extrapolated to the other Deep 7 species.

Considering the importance of the camera surveys on estimation of total biomass, the uncertainty regarding effective area and species sampling should be further examined and reduced in future benchmark assessments. Species specific issues should be investigated regarding diurnal schooling characteristics and vertical behavior in relation to the orientation and field of view of the MOUSS camera system. Efforts to gain additional life history and behavioral data are needed to improve future Deep 7 stock assessments.

A Medium Priority recommendation to reducing uncertainty in visual estimates of relative abundance of Deep 7 species for stock assessment is included in section 3 of this report.

- **TOR 5: Do results include 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?**

Response: Yes

The 2021 update stock assessment provided stock status estimates of MSY-based reference points for 2018, including additional results needed to advise the SSC and Council relevant to management responsibilities.

The draft update assessment provided a mean estimate of maximum sustainable yield of 473 thousand pounds (± 225 thousand pounds); a harvest rate to produce MSY equal to 6.8% (± 2.6%); and an exploitable biomass to produce MSY of 15.5 million pounds (± 5.0 million pounds) (Syslo et al. 2021). This represented a slightly lower MSY and H_{MSY} with a slight increase in B_{MSY} compared to the 2018 benchmark stock assessment (Langseth et al. 2018).

The base model estimated a 13% probability of the stock being overfished ($B/B_{MSY}<0.844$) and an 11% chance that the stock complex was experiencing overfishing ($H2018/H_{MSY}=0.37$). As a result, the Deep 7 complex was characterized as not overfished and not experiencing overfishing for 2018. The same conclusion was determined for the main Hawaiian Island opakapaka stock in 2018 (Figure 2).

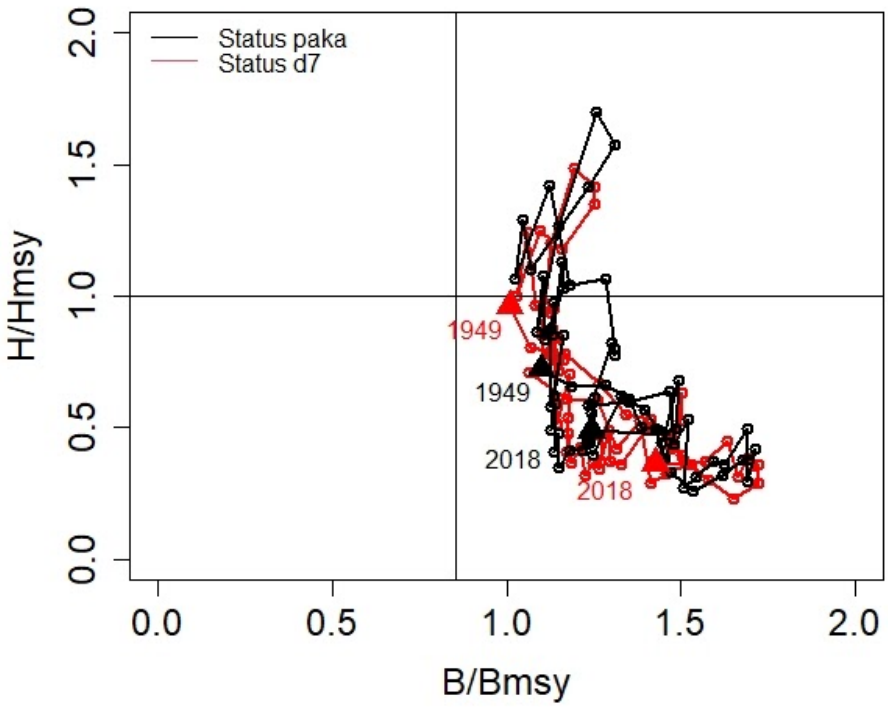

Figure 2. The status of the Deep 7 bottomfish complex (red line) compared to the status of opakapaka (black line) with terminal points to 2018 (Figure 55(rev) from Syslo et al. 2021 draft)

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

Answer: Yes

The methods as described to produce catch projections in the 2021 update are the same as those used in the 2018 benchmark stock assessment. Three years of additional data to 2018 were included to estimate probable stock status to extend catch projections to 2025 using the same stock projection methodology.

- **TOR 7: If responses to questions 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?**

Answer: NA. None of the responses to questions 1-6 were "no" so no alternatives are provided.

- **TOR 8: 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 on importance to interpretation of this and future assessment results.**

3) Recommendations

High Priority

Conduct data preparation workshops with fishery participants during the development of benchmark stock assessments.

High Priority

Explore the inclusion of the impact of additional factors that may impact Deep 7 CPUE identified at previous and additional data workshops on data standardization in future benchmark stock assessments. Where data is lacking to include potentially important factors, make recommendations to appropriate agencies to collect these data.

Medium Priority

Considering the importance of the video surveys on estimation of total biomass, the uncertainty regarding effective sampling area and species sampled should be further examined and reduced where possible in future benchmark assessments. 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.

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4) References

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Annex 1: Terms of Reference for the Peer Review

2020 Stock assessment update for the main Hawaiian Islands Deep 7 bottomfish complex

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

For questions 1-6 and their subcomponents, reviewers shall provide only a "yes" or "no" answer. If necessary, caveats may be provided to these yes or no answers, but when provided they must be as specific as possible to provide direction and clarification to NMFS. Question 7 also asks for additional details when answers to earlier questions were "no". Each panel member will provide a report based on their answers to these questions, and the Chair will provide a report summarizing the answers to these questions across the review panel.

1. Is uncertainty with respect to input data quality and filtering methods well documented, including its potential effect on results?

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

3. Are the assessment model and methodology the same as those used in the 2018 benchmark stock assessment?

4. Are primary sources of uncertainty documented and presented?

5. Do results include 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?

6. Are methods used to project future population state the same as those used in the 2018 benchmark stock assessment?

7. If responses to questions 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?

8. 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 on importance to interpretation of this and future assessment results.

9. Draft a report (individual reports from each of the panel members and an additional Summary Report from Chair) addressing the above TOR questions.