WESTERN PACIFIC STOCK ASSESSMENT REVIEW

"Stock Assessment of American Samoa Bottomfish, 2023"

Individual Reviewer Report

by

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Executive Summary

This document is an individual peer review from the Western Pacific Stock Assessment Review of the 2023 stock assessments for American Samoa bottomfish. The most recent (2019) assessment used a Bayesian surplus production model of the aggregate bottomfish species complex to conclude that the fishery was overfished and experiencing overfishing. The 2023 benchmark stock assessments of American Samoa bottomfish used integrated statistical catch-at-age models (i.e., Stock Synthesis v3) using time series of catch, CPUE, and length composition data to conclude that all stocks were not overfished, nor experiencing overfishing. Given the results presented in the assessment report and the additional information presented by the assessment team during the review, I recommend that the base case assessments and additional sensitivity runs requested by the panel for the final assessment represent the best scientific information available and can be used for managing this fishery. The assessment should also incorporate a detailed explanation with supporting data of the transition from the prior assessment methodology to the current one. The panel reached a similar consensus recommendation for the assessment. The assessments were over-reliant on the length composition data, relative to the CPUE indices, so there was some concern about the effects of fixed life history parameters but the multitude of sensitivity runs presented in the assessments and during the review showed that the results were robust to potential uncertainties in the data, models, and parameterizations. Given the recent low levels of fishing effort in the fishery, the primary management concern was not overfishing but whether or not the stocks were overfished. The assessments concluded that all stocks were not overfished for the base cases and under numerous sensitivity runs that evaluated a range of input parameters. While these results are encouraging for the status of the stocks, a fair amount of caution is warranted in these conclusions given the various caveats identified in the review that reflect the data-limited foundation of the analyses based on creel surveys, length composition data, and life history parameters. For two species with "unknown" status (i.e., *E. carbunculus* and *P. filametosus*), the use of indicator species is recommended for their assessment and management. As with many fisheries in the US Pacific Islands, the need for higher quality information describing catch and effort is important, but a particular emphasis should be put on generating local life history parameters for the American Samoa BMUS. For the final version of the stock assessment report, several short-term recommendations need to be incorporated.

Background

The bottomfish management unit species (BMUS) of American Samoa consist of a 11 fish species federally managed under the "Fishery Ecosystem Plan for the American Samoa: by the Western Pacific Regional Fishery Management Council (WPRFMC). The most recent stock assessment for the bottomfish of American Samoa as an aggregate stock complex found that they were overfished and experiencing overfishing (Langseth et al. 2019). A more recent benchmark assessment has been performed for American Samoa BMUS to update the status of the fishery (Nadon et al. 2023). This document is an external independent peer review under the Western Pacific Stock Assessment Review (WPSAR) Framework for the benchmark "Stock Assessment of American Samoa Bottomfishes, 2023" by M. Nadon M. Oshima, E. Bohaboy and F. Carvalho. This WPSAR addresses a set of eleven Terms of Reference (TOR) for the review of the benchmark stock assessment, following guidelines established in the WPSAR framework. The WPSAR framework identifies a peer review process for the scientific information used to advise the WPRFMC about the conservation and management of fisheries. This report includes a description of the role and tasks of the WPSAR Chair, general comments on the assessment, and detailed responses to each of the Terms of Reference.

WPSAR Chair Role and Tasks

For the WPSAR panel, I served in the role of WPSAR Chair and completed the following tasks under sections *Pre-review Background Documents*, *Panel Review Meeting*, and *Post Panel Review Tasks* in accordance with the Statement of Work provided by the WPSAR Coordinating Committee.

Pre-review Background Documents

While serving as Chair for this WPSAR panel, I read all the following documents prior to the in-person peer review. Required pre-review documents:

- Langseth B, Syslo J, Yau A, Carvalho F. 2019. Stock assessments of the bottomfish management unit species of Guam, the Commonwealth of the Northern Mariana Islands, and American Samoa, 2019. NOAA Tech Memo. NMFS-PIFSC-86, 177 p. (+ supplement, 165 p.). doi:10.25923/bz8b-ng72.
- Ma, H., Matthews, T., Nadon, M., Carvalho, F. 2022.Shore-based and boat-based fishing surveys in Guam, the CNMI, and American Samoa: survey design, expansion algorithm, and a case study. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-126, 115 p. doi: 10.25923/c9hn-5m88
- Methot Jr, R.D. and Wetzel, C.R., 2013. Stock synthesis: a biological and statistical framework for fish stock assessment and fishery management. Fisheries Research, 142, pp.86-99.

- Nadon, M.O. and Ault, J.S., 2016. A stepwise stochastic simulation approach to estimate life history parameters for data-poor fisheries. Canadian Journal of Fisheries and Aquatic Sciences, 73(12), pp.1874-1884.
- Nadon MO, Bohaboy EC. 2022. Evaluation of the data available for bottomfish stock assessments in American Samoa. U.S. Dept. of Commerce, NOAA Technical Memorandum NMFS-PIFSC-123, 85 p. doi:10.25923/m74z-7d07.
- Nadon MO, Oshima MC, Bohaboy EC, Carvalho F (DRAFT) Stock assessment of American Samoa bottomfishes, 2023. U.S. Dept. of Commerce, NOAA Technical Memorandum NMFS-PIFSC-###, 220 p.
- Rudd, M.B., Cope, J.M., Wetzel, C.R. and Hastie, J., 2021. Catch and length models in the stock synthesis framework: expanded application to data-moderate stocks. Frontiers in Marine Science, 8, p.663554.

Panel Review Meeting

The panel was convened February 17-23, 2023 in the Tradewinds Hotel Conference Room in Pago Pago, American Samoa. I served as chair for the WPSAR panel with other members Joe Powers and Patrick Cordue. A list of meeting participants and a meeting agenda are available in the Appendices. As Chair, I facilitated the review to accomplish the stated goals and objectives articulated in the TORs. I led discussions with the assessment team in seeking clarification and requested additional analyses to address the TORs. The NOAA Pacific Islands Fisheries Science Center (PIFSC) Stock Assessment Program members presented the results of the stock assessments to the panel and provided additional analyses and outputs as requested by the panel. A list of the requests from the panel to the stock assessors is in the Appendices section. At the conclusion of each review day, I conferred with members of the review panel to summarize findings, discussed comments, and attempted to arrive at a consensus relative to each of the TOR elements discussed that day. During the appropriate time, I sought and received public comments. At the conclusion of the review, I produced a draft Consensus Summary Report outlining the consensus recommendations from the three panel members addressing each TOR. I presented this report on the last day of the review to the assessment team, WPSAR principals, and the public.

Post Panel Review Tasks

I completed an independent peer review report (i.e., this document) in accordance with the WPSAR TORs. I also completed a Consensus Summary Report with input from all panel members to describe findings for each TOR. I provided a brief synopsis of my views on the summary findings and conclusions reached by the panel (in this document). I plan to present, in-person, the consensus results of the review to the SSC and Council after finalization of the reviewed assessment document.

General Review Comments

The stock assessment authors are to be commended for an improvement on prior approaches to the assessment of American Samoa BMUS. This work represents a strong progression from the species-complex surplus production modeling approach of the prior assessment (Langseth et al

2019) to an integrated statistical catch-at-age approach that should provide a framework for the future assessment of BMUS throughout the US Western Pacific region.

This was the first WPSAR meeting held outside of Hawaii. There were minor logistical issues that are provided here as suggestions to improve future WPSAR meetings away from the Western Pacific Regional Fishery Management Council (WPRFMC) office. They include:

- minimal guidance from staff was provided for first day logistics to panel
- only a single microphone was available for the panel and stock assessment team which had to be shuttled around to speakers
- large meeting room had poor acoustics and it was difficult for audience to hear speakers and lay out of room was narrow and long with panel and assessors "at the head of the class"
- a number of figures were unreadable in slides with text too small
- translator present for non-English speaking audience members. A number of audience members were more comfortable speaking Samoan than English. Archie Soliai stepped in to serve that role, but if he hadn't, many audience members would have been left out

Otherwise, the facility provided sufficient meeting space and resources for the panel to perform its duties. I greatly appreciated the hospitality and support of the staff at the facility, American Samoa Division of Marine & Wildlife Resources, WPRFMC, and NOAA PIFSC.

One major concern from the panel that arose was that the public presentation of preliminary assessment results may have mislead public attendees about the status of the Bottomfish Management Unit Species (BMUS) stocks prior to completion of the review. Since these meetings are open to the public, I would suggest repeatedly clarifying during any talks that the results are not final and could still change before management action is taken. For audiences without native English speakers, I would suggest having a translator present and handouts in the local language that describe the stock assessment process, the role of the WPSAR process, and when and how final management actions are developed for the fishery under review.

This purpose of this document is to provide responses to a set of Terms of Reference (TOR) for the peer review of the benchmark Stock Assessments for the American Samoa Bottomfish, 2023. The panel was instructed that for TOR questions 1-10 and their subcomponents, reviewers shall provide a "yes" or "no" answer and will not provide an answer of "maybe". Only, 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 National Marine Fisheries Service.

Abbreviations for BMUS used in the document are in the following table:

APRU	*Aphraeus rutilans*	LUKA	*Lutjanus kasmira*
APVI	*Aprion virescens*	PRFI	*Pristipomoides filamentosus*
CALU	*Caranx lugubris*	PRFL	*Pristipomoides flavipinnus*
ETCA	*Etelis carbunculus*	PRZO	*Pristipomodies zonatus*
ETCO	*Etelis coruscans*	VALO	*Variola louti*
LERU	*Lethrinus rubrioperculatus*		

Responses to TORs

Detailed responses to the Term of Reference are given in the following sections. The following summary table provides an overview of the responses. Dashes represent no response for that combination of species and term of reference due to missing information (e.g., no assessments for ETCA and PRFI) or a TOR not being applicable (e.g., indicator species only used for ETCA and PRFI).

	Term of Reference									
	Data	**CPUE**	**Models**	**Decision points**	**Uncertainty**	**Assumptions**	**Scientific Validity**	**Projections**	**Indicator Species**	**Management**
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
APRU	Yes	Yes	Yes	Yes, with caveats	Yes	Yes, with caveats	Yes	Yes, with caveats	-	Yes
APVI	Yes	Yes	Yes	Yes, with caveats	Yes	Yes, with caveats	Yes	Yes, with caveats	-	Yes
CALU	Yes	Yes	Yes	Yes, with caveats	Yes	Yes, with caveats	Yes	Yes, with caveats	-	Yes
ETCA	-	-	-	-	-	-	-	-	Yes	Yes
ETCO	Yes	Yes	Yes	Yes, with caveats	Yes	Yes, with caveats	Yes	Yes, with caveats	-	Yes
LERU	Yes	Yes	Yes	Yes, with caveats	Yes	Yes, with caveats	Yes	Yes, with caveats	-	Yes
LUKA	Yes	Yes	Yes	Yes, with caveats	Yes, with caveats	Yes, with caveats	Yes	Yes, with caveats	-	Yes, with caveats
PRFI	-	-	-	-	-	-	-	-	Yes	Yes
PRFL	Yes	Yes	Yes	Yes, with caveats	Yes	Yes, with caveats	Yes	Yes, with caveats	-	Yes
PRZO	Yes	Yes	Yes	Yes, with caveats	Yes	Yes, with caveats	Yes	Yes, with caveats	-	Yes
VALO	Yes	Yes	Yes	Yes, with caveats	Yes	Yes, with caveats	Yes	Yes, with caveats	-	Yes

TOR 1 Data: Of the data considered for inclusion in the assessment, were final decisions on inclusion/exclusion of particular data appropriate, justified, and well-documented?

General response applicable across all assessments

The assessments included life history parameter values and time series of catch, abundance indices (CPUE), and length composition data for each species. Catch was composed of "historical" catch from three periods: (1) a fishery exploration program (1967-1970), a Dory fishing program (1972-1980), and the Alia program (1980-1985), with the American Samoa Department of Marine and Wildlife Resources managed boat-based and shore-based creel surveys starting in 1986 and continuing until the present (e.g., 2021).

Species-level historical catch reconstructions were derived from the product of estimated total bottomfish catch by year and species proportion in the catch by year. The attempt to reconstruct the historical catch was justified as a means to better characterize the long-term catch history for BMUS in American Samoa. The methods used were described briefly in the assessment but were well-documented in Nadon and Bohaboy (2022). To better understand prior phases of the BMUS fishery, it was appropriate to attempt to reconstruct historical catch which included many of the highest annual catches for all species in the early Dory and Alia program periods which provided valuable data for the assessments. While the accuracy of these historical catch records includes considerable uncertainties, the well-documented steps taken by the assessment team are reasonable and represent a credible approach to incorporate these earlier years in the catch time series.

Data inputs for catch estimation from the creel surveys were intercept interviews with fishermen and counts of the number of boats leaving or out of port and number of trips (for boat-based) or fisher participation (for shore-based). These are the primary data sources for these assessments. Boat-based creel survey data collected prior to 2016 is rife with misidentifications and data errors. In 2016, a staff training in survey methods and taxonomic identification was performed and was assumed to lead to improved survey data accuracy. There is a concern about inconsistency in choices about creel data inputs that arise when including catch records back to the beginning of the surveys but omitting CPUE for all but the most recent period. I understand that SS3 needs the catch record as a data input but sensitivity analyses should explore potential effects of this choice. Additional efforts should be made to see if pre-2016 CPUE data can be incorporated into the assessments, especially since you are using catch data from the same source over that time period. Shore-based creel survey data were not reliable as an index for BMUS due to habitat mismatches (i.e., shore-fishing is typically shallow and the BMUS are primarily deep water species). Surveys in Manua islands ceased in 2009 so a linear model for catch relationships between Tutuila and Manua was used to estimate catch in Manua for 2010-2021. This is a reasonable approach to filling the catch data gaps but underestimates the variability in catch from Manua and artificially introduces a temporal autocorrelation to a component of the catch. Details on the survey expansion methodology are detailed and well-documented (Ma et al. 2022).

Since 1990, a commercial purchase program managed by DMWR has collected fish sales data from local vendors. Although pertinent fields are available on the sales forms, many records were missing information or did not possess sufficient data to be incorporated into the assessment (Nadon and Bohaboy 2022). For example, information relevant for standardizing CPUE was missing from almost half the records and insufficient records were present to generate time series of size frequencies for the BMUS. Insufficient information was available to include the commercial purchase program as an index in the assessment.

Fishery-independent visual diver survey data for coral reef fishes provided some information on relative abundance and size structure for the shallow BMUS (i.e., LUKA, VALO, APVI, LERU, CALU) but probably don't represent a good index for these species given the limited depth range (0-30 m) and infrequency (every few years) of the surveys. Insufficient information was available to include the diver survey data as an index of abundance in the assessment.

Responses species-specific assessments

Species-specific responses to TOR 1 are provided in Table 1. Various data corrections were necessary in the historical catch and creel survey data for particular species (see Section 2.2.1). Total catch by species by area presented in Figure 8.1-7 was an effective visual to summarize the catch time series used in the assessments.

Responses and comments to Terms of Refence 1 for each stock assessment.

Species	TOR Response	Comments
APRU	Yes	Methods used to separate/reallocate catch in creel surveys of APRU, PRFL, and PRFI were explicitly documented. The catch reconstruction was justified and appropriate given the input from the fishing community on the historic species misidentifications.
APVI	Yes	Diver surveys are possible abundance index, but needs more consistent sampling across years
CALU	Yes	None
ETCA	No	All data excluded for assessment due to species misidentification in catch records with a newly described species, *E. boweni*.
ETCO	Yes	Historic period reconstructed catch is high relative to recent catches
LERU	Yes	None
LUKA	Yes	Historic period reconstructed catch is high relative to recent catches
PRFI	No	All data excluded for assessment due to data scarcity and inability to perform a single species assessment SS3
PRFL	Yes	Methods used to separate/reallocate catch in creel surveys of APRU, PRFL, and PRFI were explicitly documented. The catch reconstruction was justified and appropriate given the input from the fishing community on the historic species misidentifications.
PRZO	Yes	Historic period reconstructed catch is high relative to recent catches
VALO	Yes	Methods used to separate catch of *V. louti* from *V. albimarginata* were explicitly documented. The catch reconstruction was justified and appropriate given the input from the fishing community on the historic species misidentifications. Diver surveys are possible abundance index, but needs more consistent sampling across years

Questions and Suggestions

- From the review of the stock assessment document or the interaction during the WPSAR panel meeting, the following points were considered or suggested.
- Is the proportional species composition for the historical catch stable? *Assessment team response:* yes, with slight variability
- Is there another jack from catch records that could be confused with CALU? *Assessment team response:* no.
- Recommend better training and incentives for commercial dealers to fully complete purchase records.
- Recommend re-establishment of Manua surveys for updated data and as a means to validate the data correction for the recent time period from historic catch. (Note: American Samoa DAWR will be restarting Manua surveys.)
- For the "summary data sets used" figures for each species, add a legend that provides values for the size of circles for each fishery method used in the figure.
- Add a scale bar and a polygon with the min and max depths of the American Samoa BMUS to Figure 8.1.1.

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

General response applicable across all assessments

The CPUE standardization of boat-based bottomfish creel survey data used delta-lognormal generalized additive models with a set of explanatory variables including Year, Area, Hours Fished, Number of gears, Season, Windspeed, Type of day, and DPC catch composition components (PC1 and PC2). The DPC catch composition method (Winker et al. 2014) assumes that the direction and extent of targeted effort is reflected in the species composition of a trip's catch. The method attempts to minimize the effect of time-varying trends in fishing tactics on nominal CPUE but it is unclear if there was evidence of temporal shifts in targeting for the 2016-2021 time period that would justify its use. Winker et al. (2014) suggests an evaluation of yearly catch compositions for changes as a simple indicator of time-varying targeting trends which would be a useful addition. The delta-lognormal GAM approach is sufficient here given some of the constraints on the data (i.e., short time series, limited geospatial information) but more sophisticated methods are available. The data cleaning and filtering steps (i.e., only "bottomfishing" trips used, incomplete records not used) were documented and appropriate. The cleaning resulted in only 269 surveys available from 2016-2021 which averages to about 45 per year. They recovered 32 additional surveys by reclassifying the *Months* to *Seasons* and fishing grids into three *Areas*. This is quite a low number of surveys and only represents a few per month. Ideally, CPUE would include units of catch and effort that are as descriptive as possible, such as weight per hooks per hour fished. The choice to use *kg/trip* as the unit of CPUE was reasonable given the lack of a direct relationship between *kg/trip* and *number of gear* or *hours fished* but the units of CPUE included in the assessments were inherently variable given the different characteristics of any particular trip. Reasonable to include the effort variables in the standardization model instead of directly in the CPUE units. The suite of model diagnostics employed to evaluate the models were properly applied and appropriate. The plots comparing progressively simpler CPUE models is effective.

Responses for species-specific assessments

Responses and comments to Terms of Refence 2 for each stock assessment (Note that ETCA and PRFI are excluded since they had no CPUE standardizations).

Species	TOR Response	Comments
APRU	Yes	None
APVI	Yes	None
CALU	Yes	Standardized CPUE has inter-annual high variability
ETCO	Yes	Standardized CPUE has inter-annual high variability
LERU	Yes	Increasing recent trend in standardized CPUE
LUKA	Yes	None
PRFL	Yes	None
PRZO	Yes	Declining trend in standardized CPUE
VALO	Yes	Increasing recent trend in standardized CPUE

Questions and Suggestions

- For the "CPUE model diagnostics" figures for each species, add an icon to the legend in the last row of figures for the nominal model (wide, light blue line). Also, correct the text to accurately reflect which diagnostics are in which rows in the figure. Currently, the "first two rows" seem to describe the first four rows of the figure.
- Points in the deviance residual plots for each species are too small. Increase size so they are visible.
- Suggest the inclusion of a figure of the annual proportion of total catch by species to assess time-varying targeting trends and justify the use of the DPC method for CPUE standardization.
- Suggest collection of data on fisher experience as a variable in the CPUE standardization, if possible.
- Recommend correcting the numbering of the Figure labels and in-text references for this section.
- When calculating the weighted average of the annual CPUE estimates across areas, the same weights (0.89 for Tutuila, 0.11 for banks) were used for each species but the species inhabit different depth ranges. The area weights for different depth ranges may differ. Suggest calculating the area weights based on the depth range for each species and use that in the weighted average for the annual CPUE estimates.

TOR 3 Models: Are the assessment models used reliable, properly applied, adequate, and appropriate for the species, fishery, and available data?

General response applicable across all assessments

Stock Synthesis (v 3.30) is an integrated catch-at-age model utilized widely by NOAA for stock assessments. In general, SS3 is a reliable, well-documented, and thoroughly tested software platform for stock assessments. Each of the BMUS assessments used time series of catch, CPUE index, and fish lengths from data sources described in TOR 1. Based on the available data for this fishery, the assessment models were adequate and appropriate for these species so the response is "YES" for all assessments to this TOR 3.

Responses for species-specific assessments

There are no species-specific assessment responses since the comments about the use of SS3 are generic to all assessments.

Questions and Suggestions

- It's unclear why the current assessments find a completely different result to the prior assessment. Is it due to the models, the data, both, or something else? Addressed in TOR 4.
- During the review, some discussion involved the use of a Bayesian modeling framework for future assessments to better capture the uncertainty inherent in many of the inputs that are currently assumed known (i.e., fixed values).

TOR 4 Decision Points and Input Parameters: Are decision points and input parameters reasonably chosen?

General response applicable across all assessments

Given the data-limited nature of these assessments, a number of choices were made regarding the models and information used. A primary concern regards the utilization of SS3 for these assessments which provided different outcomes (i.e., not overfished, no overfishing) compared to the prior assessment results (i.e., overfished with overfishing) using a state-space Bayesian surplus production model for a species complex (Langseth et al. 2019). There is currently an inadequate explanation and testing of why the model results should differ in the assessment documentation. Currently, the document neglects the prior methods and results by not including some connection between the current and former approaches. It leaves one without a clear answer to whether the differences are due to the different models, different use of data, or a combination of the two? This is especially concerning given the choice to omit CPUE data prior to 2016 from the assessments given that the longer-term CPUE data series for the aggregate species complex is what led to the negative stock status conclusions from the prior assessment. This suggests that dropping the earlier years of CPUE data had a strong effect on model results. Given the negative issues with early years (pre-2016) of survey data documented in Nadon and Bohaboy (2022), it was reasonable to exclude that data. A better accounting of the transition from the prior SPM model to the current species-specific needs to be described so that there is a clearer understanding of how the model results can be so different. This will help justify all the decision points used for the models and increase confidence that the results are accurate.

With a shift to species-specific models, the incorporation of accurate life history parameters is important. Unfortunately, only PRFL had local age and growth parameters. With a limited time series for the CPUE indices, these assessments relied strongly on the length composition data but were informed primarily by studies from other areas in the Pacific or the model-based stepwise procedure of Nadon and Ault (2016). The need for locally-derived life history parameters (age, growth, reproduction, mortality, longevity, etc.) cannot be understated as a reliable data input for these assessments which are essentially acting as modified type of length-based assessment without informative input from the brief time-series of CPUE indices.

Finally, a number of input parameters were fixed (not estimated) in the models which limited the exploration of uncertainty in model results. A number of these parameters were explored in the sensitivity analyses identify the effects that a range of parameter value would have on the model results (covered in TOR 5).

Responses for species-specific assessments

Responses and comments to Terms of Refence 3 for each stock assessment (Note that ETCA and PRFI are excluded since they had no assessment models).

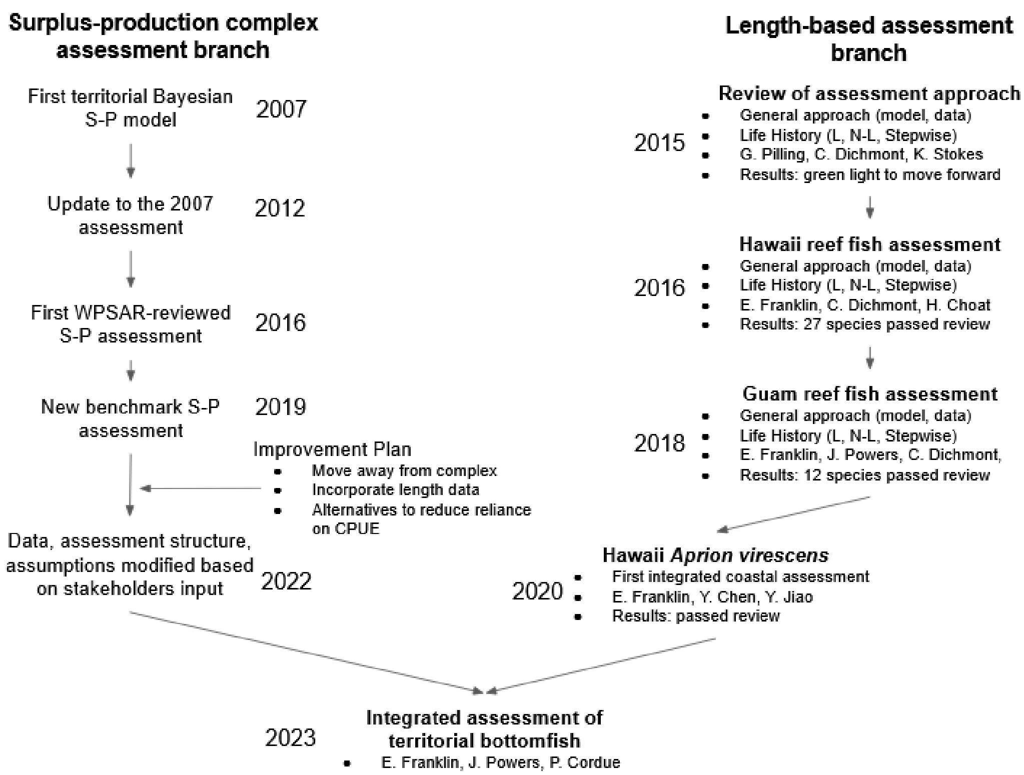
Species	**TOR Response**	**Comments**
APRU	Yes with caveats	Non-local LH data.
APVI	Yes with caveats	Non-local LH data. Compare two-stage VBGF with O'Malley data so methods are similar.
CALU	Yes with caveats	Non-local LH data.
ETCO	Yes with caveats	Non-local LH data.
LERU	Yes with caveats	Non-local LH data.
LUKA	Yes with caveats	Non-local LH data. Is longevity estimate accurate? If not, can strongly influence results.
PRFL	Yes with caveats	None
PRZO	Yes with caveats	Non-local LH data.
VALO	Yes with caveats	Non-local LH data.

Questions and Suggestions

- Compare the APVI growth model using a two-stage VBGF with the O'Malley data (2021) so that the methods are comparable.
- Is the longevity estimate for LUKA low? It is from a New Caledonia study published in 1980. Is this representative of the American Samoa populations? The maximum age has a

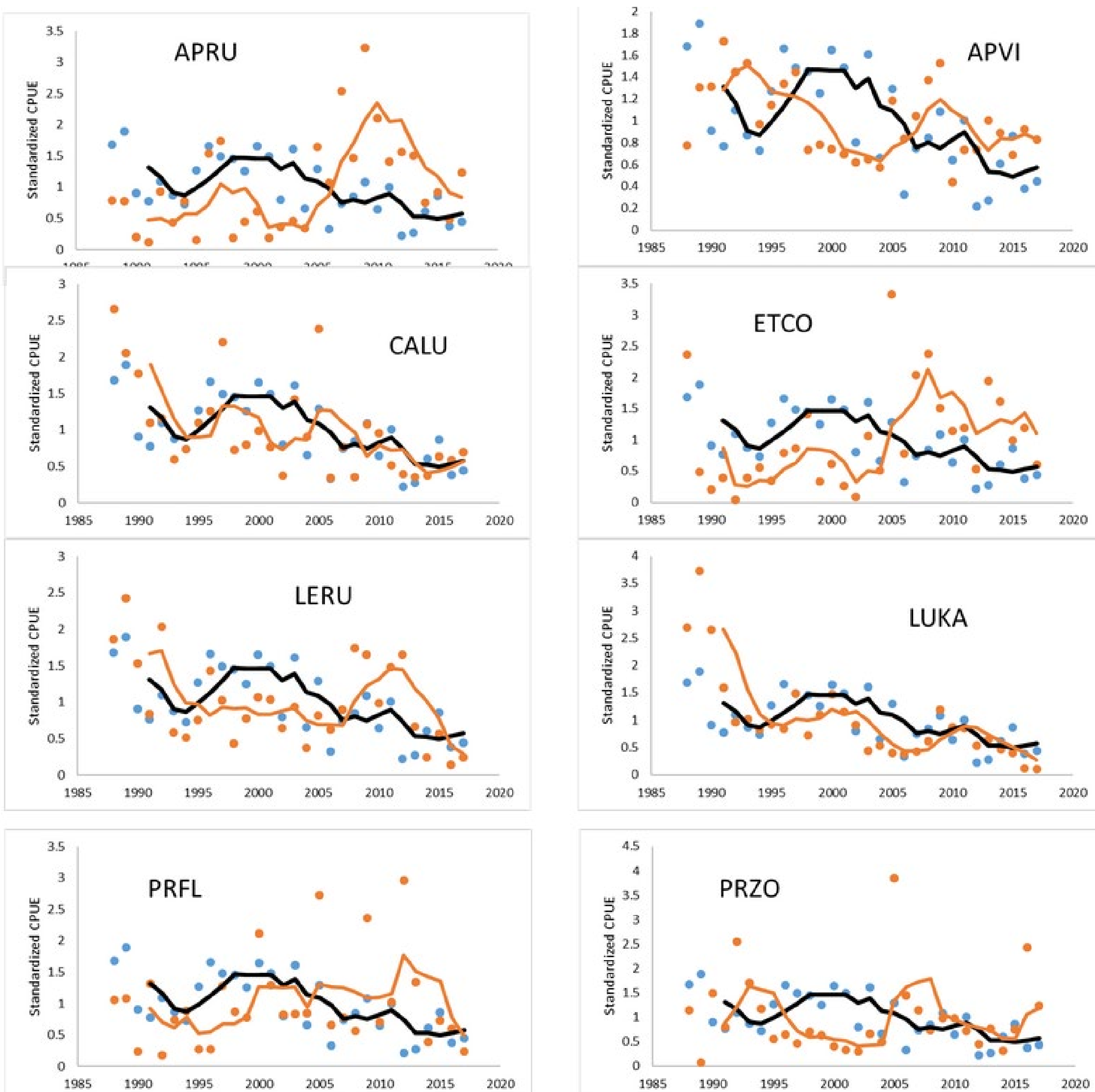
significant influence on the estimate of natural mortality which seems high (0.68) for this snapper. Suggest prioritizing local life history for this species.

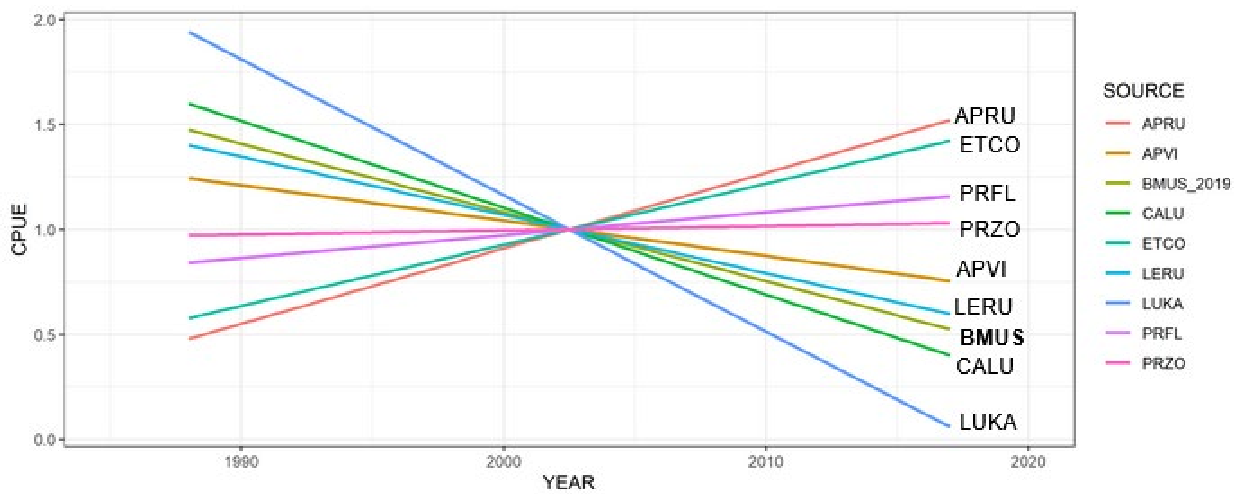
- Does SSB correlate directly with reproductive output for these species? Recommend adding reproductive fecundity at size studies to the local life history studies.
- Future BMUS assessments should include the expanded timeline of CPUE survey data from 2016 onwards to increase confidence in the dataset as an index of relative abundance. Restarting surveys in the Manua Islands will also support this goal.
- Provide a timeline of assessment model development to better document the transition from the Bayesian SPM to the current use of SS3 for the BMUS species.
  Response from Assessment team: they provided a timeline of assessment model development (below) within their group to describe the evolution toward the current modeling approach.



- Identify and compare trends in CPUE for the species complex from the 2019 assessment and individual CPUE trends over the same long-term timeline.
  Response from Assessment team: provided plots (below) of the species complex CPUE trends from the 2019 assessment (black line and blue dots) with CPUE trends for each species from these assessments (orange line and dots) over the same time-period using boat-based creel survey data. Prior assessment results were influenced by declines in CPUE of LUKA, LERU, and APVI that provided a strong influence on the decline in the species complex CPUE given the relatively high catch for those species in the complex. The data cleaning and filtering activities that were influenced by the fisher workshops resulted in changes to positive CPUE trends for some of the deeper species (APRU, ETCO, PRFL). The final plot illustrates linear CPUE trends for all species and the 2019

species complex over the longer time series. The species complex trend is negative, as well as a negative trend in LUKA, which had a strong influence on the overall stock complex CPUE. These results suggest that the decisions made for data inputs to the current assessment models led to changes in the trends of some species CPUE. Based on efforts made to clean and filter input information, it seems reasonable that the current assessment incorporates the most accurate description of the data available.





TOR 5 Uncertainty: Are primary sources of uncertainty documented and presented?

General response applicable across all assessments

The assessments include a variety of methods to evaluate the uncertainty inherent in the models, data, and inputs. The effects of uncertainty in the catch estimates were evaluated using a delta-multivariate lognormal estimator on 30 sets of bootstrapped catch data to generate joint posterior distributions of overfishing and overfished status for each species. The number ("30") seems a bit arbitrary. Might be more informative to explore high, "typical", and low catch scenarios instead. Given the low current fishing effort, there is little concern of overfishing. The focus for this assessment should be on accurately characterizing stock status relative to the overfished threshold. The time series of annual spawning biomass, recruitment, and fishing mortality is presented with error (i.e., coefficient of variation) for each species. The assessment presented the methods used to evaluate uncertainty around model performance used a suite of diagnostics for model convergence (i.e., Hessian inversion, maxim gradient component, jittering starting points for solution search), data fit (i.e., residual analysis), and model consistency (i.e., likelihood profiling, Mohn's Rho). The current range of jitter staring values could be increased to better explore the solution space to identify global minimum. The non-local and model-estimated life history parameters were a documented source of uncertainty. Sensitivity runs on natural mortality, steepness (h), recruitment deviation, omission of historical catches, and an alternative life history profile were performed and presented for each species.

Responses for species-specific assessments

Responses and comments to Terms of Refence 5 for each stock assessment (Note that ETCA and PRFI are excluded since they had no assessment models).

Species	TOR Response	Comments

APRU	Yes	Additional sensitivity runs on M and Linf provide document reasonable range of outcomes. Failed runs test for length composition time series
APVI	Yes	Additional sensitivity runs on M and Linf provide document reasonable range of outcomes.
CALU	Yes	Additional sensitivity runs on M and Linf provide document reasonable range of outcomes.
ETCO	Yes	Additional sensitivity runs on M and Linf provide document reasonable range of outcomes.
LERU	Yes	Additional sensitivity runs on M and Linf provide document reasonable range of outcomes.
LUKA	Yes with caveats	Additional sensitivity runs on M and Linf provide document reasonable range of outcomes. Non-local LH data. Is longevity estimate accurate? If not, can strongly influence results. **Results suggest that this species can't be overfished**.
PRFL	Yes	Additional sensitivity runs on M and Linf provide document reasonable range of outcomes.
PRZO	Yes	Additional sensitivity runs on M and Linf provide document reasonable range of outcomes.
VALO	Yes	Additional sensitivity runs on M and Linf provide document reasonable range of outcomes.

Questions and Suggestions

- Recent fleet fishing effort is relatively low so overfishing is not a strong concern in this assessment. Suggest incorporating additional evidence that the stocks are not overfished as a primary focus of the assessment.
- Some of the ranges around the parameters were relatively small (e.g., natural mortality ± 10%). What is the effect of a larger range of uncertainty around *M* (e.g., 20-30%)? Reinforces importance of accurate local life history information, especially max age/longevity that informs *M*.
- Additional sensitivity runs on *M* (i.e., max age) and *Linf* need to be performed. *Response from Assessment Team*: Exploration of Linf values from literature (local or other locations), stepwise method, or estimated by SS3 on overfished level (SSB/SSBmsst).

Comparison of values of Linf and resulting overfished levels. Note that all values indicate that the stocks are not overfished for every species.

Species	Source	Linf	N	SSB/SSBmsst
APRU	**Stepwise**	**83.3**		3.1
APRU	Fry (2006) - New Guinea	87.2	14	2.1
APRU	SS estimated	85.7		2.4
APVI	**O'Malley (2021) - All regions**	**76.9**	450	1.7
APVI	O'Malley (2021) - NW Hawaiian I.	74.1	248	1.4
APVI	O'Malley (2021) - Main Hawaiian I.	77.7	139	1.2
APVI	O'Malley (2021) - E. Indian Ocean	81.1	63	1.9

APVI	SS estimated	74.8		2.0
APVI	Stepwise	72.1		2.8
CALU	**Stepwise**	**68.8**		4.0
CALU	SS estimated	66.6		4.4
CALU	Fry (2006) - New Guinea	57.5	12	7.0
ETCO	**Andrews (2021) - Hawaii pooled**	**86.8**	187	1.8
ETCO	Uehara (2020) - Japan Pooled	82.1	760	3.5
ETCO	SS	83.5		3.5
ETCO	Stepwise	86.2		2.1
LERU	**Loubens (1980) - New Caledonia**	**33.9**	29	3.4
LERU	Trianni (2011) - Mariana	31.5	275	4.2
LERU	Ebisawa (2009) - Japan	38.3	635	3.0
LERU	SS estimated	33.3		3.8
LERU	Stepwise	33.9		3.4
LUKA	**Loubens (1980) - New Caledonia**	**24.6**	29	7.6
LUKA	Morales-Nin (1990) - Hawaii	32.9	171	5.7
LUKA	SS estimated	24.0		7.7
LUKA	Stepwise	24.7		7.7
PRFL	**O'Malley (2019) - American Samoa**	**41.2**	373	3.3
PRFL	SS estimated	43.8		2.2
PRFL	Stepwise	45.3		1.7
PRZO	**Schemmel (2021) - Guam pooled**	**36.9**	316	3.5
PRZO	Andrews (2021) - Hawaii	42.5	39	2.3
PRZO	SS estimated	36.9		3.4
PRZO	Stepwise	37.0		3.3
VALO	**Stepwise**	**46.1**		4.2
VALO	Schemmel (2023) - Guam	43.8	287	4.6
VALO	SS estimated	52.2		3.8

Comparison of values of natural mortality (M) proxy max age (Amax) and resulting overfished levels. Note that all values indicate that the stocks are not overfished for every species.

Species	Source	Amax	N	SSB/SSBmsst
APRU	**Stepwise**	**30**		3.1
	Fry (2006) - New Guinea	16	14	3.7
APVI	**O'Malley (2021) - All regions**	**32**	450	1.7
	O'Malley (2021) - NW Hawaiian I.	32	248	1.7
	O'Malley (2021) - Main Hawaiian I.	27	139	2.5
	O'Malley (2021) - E. Indian Ocean	32	63	1.7
	Loubens (1980) - New Caledonia	26	22	3.3

	Stepwise	24		3.4
CALU	**Fry (2006) - New Guinea**	**12**	12	4.0
	Stepwise	10		5.7
ETCO	**Andrews (2021) - Hawaii pooled**	**55**	187	1.8
	Uehara (2020) - Japan Pooled	55	760	1.8
	Stepwise	30		4.0
LERU	**Loubens (1980) - New Caledonia**	**15**	532	3.4
	Trianni (2011) - Mariana	8	275	6.3
	Ebisawa (2009) - Japan	13	635	4.1
	Stepwise	15		3.4
LUKA	**Loubens (1980) - New Caledonia**	**8**	29	7.6
	Morales-Nin (1990) - Hawaii	6	171	8.3
	Stepwise	13		7.6
PRFL	**O'Malley (2019) - American Samoa**	**28**	373	3.3
	Stepwise	21		4.7
PRZO	**Schemmel (2021) - Guam pooled**	**30**	316	3.5
	Andrews (2021) - Hawaii	30	39	3.5
	Stepwise	19		4.5
VALO	**Grandcourt (2005) - Seychelles**	**15**	101	4.2
	Schemmel (2023) - Guam	14	287	4.6
	Stepwise	18		3.5

- Pstar process should consider the uncertainty retained by assuming fixed life history parameters and a lack of local life history studies to influence the final selection of catch limits used in projections.

TOR 6 Assumptions: Are model assumptions reasonably satisfied?

General response applicable across all assessments

For all assessments, “Yes, with caveats” to model assumptions being reasonably satisfied. A table provided in the stock assessment is a useful starting point to understanding the assumptions of the models. A few of the assumptions that presented issues to merit the “with caveats” are discussed below.

The length composition data were not collected using an unbiased sampling design but relied instead on fishery-dependent catches through the creel survey and bio-sampling programs. These data were most likely biased by fisher behavior, gear selectivity, and other issues. The assumption that the length composition data is representative of the population is weakly satisfied. A fishery independent sampling program would be necessary to provide an unbiased, representative sample of the length structure of the fish populations and is a future goal for data collection.

Several life history parameters are time invariant. Uncertainty around this assumption was explored satisfactorily for natural mortality and Linf in the sensitivity analysis in the stock assessment document and during the panel meeting (see TOR 5 section for more details).

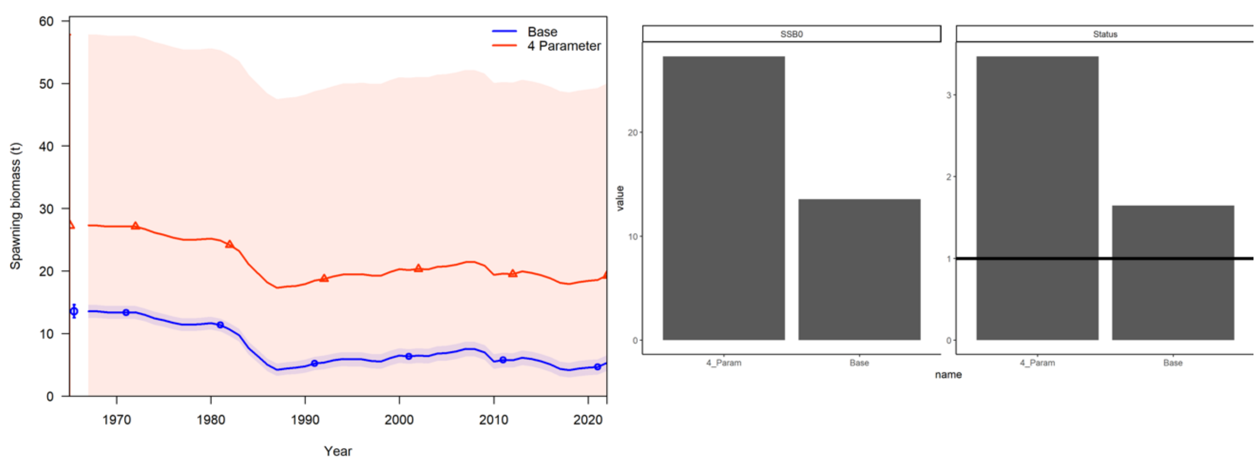
Time-invariant selectivity may not be accurate. Historically, the bottomfish fishery experience higher effort and a broader geographic distribution of fishing as the fishery was in the early development and expansion phase. During this period, it would be reasonable to assume flat-topped gear selectivity since the fishery was active across the region with a larger fleet (than currently operates) that would be sampling the larger, older ages classes in the population. Recent fishing effort is considerably lower than historic periods and is concentrated primarily around Tutuila with rare trips to other areas. This suggests that the population may not be fished by the current fleet at the same effort levels as in the past resulting in a lack of the largest size and age classes from the catch which would result in dome-shaped selectivity.

Responses for species-specific assessments

There are no species-specific assessment responses since the comments about the use of SS3 are generic to all assessments.

Questions and Suggestions

- Explore dome-shaped selectivity effects on model outputs. *Response from Assessment Team:* As test run for ETCO, 4-parameter dome-shaped selectivity resulted in increased SSB estimates and higher error and population status was not overfished.



**TOR 7 Scientific Validity: Are the final results scientifically sound, including but not limited to estimated stock status in relation to the estimated overfishing and overfished status determination
criteria (SDC)?**

General response applicable across all assessments

Yes, for all assessments, the results are scientifically sound for status determination criteria of the American Samoa BMUS. The stock assessment document included a thorough description of the data inputs, CPUE standardization, decision points, input parameters, sources of uncertainty, assumptions, and results to inform on the overfished and overfishing status of each stock. A primary reason for the improvement in the benchmark assessment was the data workshops conducted with the fishing community that led directly to data cleaning and filtering activities that improved legacy datasets that had previously been rife with issues. By incorporating the updated data inputs, these assessments include the best available science to characterize the status of these fisheries. Furthermore, the additional sensitivity runs performed during the review should be added to the assessment to better inform managers of the uncertainty in the results. Overall, this approach is an improvement from the prior assessment and the assessment team should be commended for their efforts.

TOR 8 Projections: Are the methods used to project future population state adequate, including the characterization of uncertainty, and appropriately applied for implementation of overfishing limits (OFL)?

General response applicable across all assessments

The risk of overfishing for 2022-2028 was estimated using different fixed catch scenarios using SS3. For all assessments, yes, with caveats, the methods within SS3 for projections are adequate and appropriately applied. The caveat is that uncertainty is underestimated. In particular, the assumption that recruitment occurred without deviations from the stock-recruitment curve doesn't allow an exploration of variability in year-to-year recruitment on future catches. Given the expected changes to environmental conditions due to climate change, one way to evaluate potential climate effects would be to fluctuate recruitment in the projections. One of the shortcomings of the projections driven primarily by statistical trends in CPUE, is that there is a lack of mechanistic understanding for what may drive changes in biological processes from environmental effects.

Responses for species-specific assessments

There are no species-specific assessment responses since the comments about the use of SS3 are generic to all assessments.

Questions and Suggestions

- Time-variant biological parameters are happening. By ignoring them, what are we missing?

TOR 9 Indicator Species: If applied, is the choice of indicator species to evaluate more poorly known species that are in a stock complex appropriate?

General response applicable across all assessments

Yes, the application of indicator species is appropriate for ETCA and PRFI but "no" for other species. Stock assessments for ETCA and PRFI were not performed due to identification issues with a recently described species (*E. boweni* and ETCA) or a lack of sufficient data (for PRFI). The assessment document describes the status of these two species as unknown. The Magnuson-Stevens Fishery Conservation and Management Act provides guidance on the management of fishery species with unknown status using indicator species (50 CFR 600.310(d)(2)(ii)) by considering an indicator species as one with a similar vulnerability and life history, ecological, and fishery characteristics to the species with unknown status.

Responses for species-specific assessments

Using available information, the recommendations for an indicator species for ETCA is ETCO and an indicator species for PRFI is PRFL. The following is a comparison of available information prepared by the stock assessment team to compare the indicator and unknown species life histories. Each indicator species is a congener that occupies similar depth ranges and is typically caught with the unknown status species. The life history traits of longevity and size demonstrate differences but the indicator species probably represent fish with similar vulnerability to the fishery and comparable biological characteristics.

***Etelis carbunculus* (ETCA)**

- Indicator species *Etelis coruscans*.
- Same genus.
- Max ages:
  - ETCO=55 years (Andrews 2021 - Hawaii)
  - ETCA=39 years (Andrews 2011 - Hawaii). Note only 4 individuals, bomb-radio carbon dating.
- Similar depth range: 200 - 400 m
- Size range:
  - ETCO Linf= 82 - 87cm (Uehara (2020) - Japan, Andrews 2021 - Hawaii)
  - ETCA Lmax= 57 cm (DeMartini 2017 - Hawaii)
- ETCO and ETCA cluster together (Ahrens 2022 - Figure 9)

***Pristipomoides filamentosus* (PRFI)**

- Indicator species: *Pristipomoides flavipinnis*
- Same genus.
- Max ages:
  - PRFL: 28 years (O'Malley 2019 - Samoa)
  - PRFI: 40-45 years (Andrews 2012 - Hawaii, Bomb radio-carbon)
- Similar depth range: 100-400 m
- Size range:

    - PRFL Linf=41.2 cm (O'Malley 2019 - Samoa)
    - PRFI Linf=70 cm (Uehara 2020 - Japan)
- PRFL and PRFI cluster together (Ahrens 2022 - Figure 9)

Questions and Suggestions

- This report uses an ad-hoc set of traits to make a recommendation on an indicator species. Recommend that NOAA PIFSC develop a set of criteria used to identify and justify the choice of indicator species for their region.

TOR 10 Management: Can the results be used to address management goals stated in the relevant FEP or other documents provided to the review panel? If any results of these models 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 1-9 are "no"), indicate which alternative option should be used to inform setting stock status and fishery catch limits between 1) using the previous assessment, 2) using an indicator species, or 3) designing the stock status as "unknown".

General response applicable across all assessments

The results can be used to address FEP management goals. The caveats have been identified explicitly in TORs 1-9. Current fishing effort for the American Samoa BMUS is relatively low so overfishing is not a concern for these assessments. There are concerns about the accuracy of the life history parameters of LUKA which imply that the stock can be fished without limit. The stock status and fishery catch limits for ETCA should be based on those of the indicator species ETCO. The stock status and fishery catch limits for PRFI should be based on those of the indicator species PRFL. Response for each species follow.

Responses for species-specific assessments

Responses and comments to Terms of Refence 10 for each stock assessment.

Species	**TOR Response**	**Comments**
APRU	Yes	None
APVI	Yes	None
CALU	Yes	None
ETCA	No	Use ETCO as an indicator species
ETCO	Yes	None
LERU	Yes	None
LUKA	Yes, with caveats	Is longevity estimate accurate? If not, can strongly influence results. **Results suggest that this species can't be overfished**.
PRFI	No	Use PRFL as an indicator species
PRFL	Yes	None
PRZO	Yes	None
VALO	Yes	None

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

Short/immediate term recommendations

- Incorporate a text section, model runs, and analyses to bridge between prior and current assessment data, model, and results. Include linear and loess CPUE (long time series) plots. (high)
- Update *Aprion virescens* growth parameters for two-stage von Bertalanffy model for three regions from O'Malley paper. (mid)
- For LUKA, have a stock assessment run with the historical catch series is required to be taken using an alternate run with low CV on catch. (high)
- Incorporate life history sensitivity runs and analysis (high)
- Add section on indicator species. Present standardized criteria and justification for indicator species chosen. (high)
- Add to report a summary table of biological reference points for each species (mid)

Mid-term recommendations

- Perform local life history studies for BMUS species and utilize those parameters for base case assessments, with LUKA as a priority (high)
- Ensure standardized methods of creel survey provide reliable and representative catch, CPUE, and length composition data (high)
- Incorporate the additional sensitivity runs (L_∞, M, selectivity) prepared for this assessment as a standard part of model evaluation (high)

Long-term recommendations

- Continue to perform local life history studies for BMUS species and utilize those parameters for base case assessments (high)
- Perform a fishery-independent survey to estimate BMUS density, abundance, biomass, and length composition. (mid)

TOR 12. Report: Draft a report (individual reports from each of the panel members and an additional summary report from Chair) addressing the above TOR questions

This document represents my individual reviewer report which addresses all the above TOR questions. Following the TORs, I also drafted a summary panel report with assistance from the panel members and presented those results to stakeholders on the last day of the review.

APPENDICES

Appendix 1. Panel Membership and List of Participants

WPSAR Panel
Erik Franklin (SSC, WPSAR Chair), Joseph Powers (Center for Independent Experts), Patrick Cordue (Center for Independent Experts)

NMFS - Pacific Islands Fisheries Science Center (PIFSC)-Stock Assessment Team
Marc Nadon, Megumi Oshima, Felipe Carvalho

NMFS - PIFSC
Robert Ahrens, Marlowe Sabater

NMFS - Pacific Islands Regional Office
Brett Schumacher

Western Pacific Fishery Management Council
Mark Daniel Fitchett, Nonu Tuisamoa (Advisory Panel)

Territorial Agency
Taotasi Archie Soliai (Director - DMWR), Domingo Ochavillo (DMWR), Warren Sevaaetasi (DMWR), Christina Samau (DMWR), Tepora Lavatai (DMWR), Yvonne Mika (DMWR) Selaina Vaitautolu (DMWR), Mareko Milo (DMWR), Letisha Fala (DMWR), Shaun Laolagi (DMWR), Auvaa Soonaolo (DMWR), Herbie Umi (DMWR), Tony Langkilde (DOC)

Fishing Community (Public)
Omar Shalhout, Keith Ahsoon, Leuma Sue, Fereti Lemoa, Punipuao Lemoa, Ropeti Misa, Howard Dunham, Calvin Ilaoa, Muamalae Tata Aga, Maselino Ioane, Ogesefolo Tuala, Paepae Simi, Manaima V, Brian Peck

American Samoa Fono (legislature)
Samuel Meleisea

Appendix 2. WPSAR Meeting Agenda

Location:
Tradewinds Hotel Conference Room
Pago Pago, American Samoa

Day 1, Friday February 17, 2023 (10:00 am - 5:00 pm)

- Welcome and Introductions
- Objectives and Terms of Reference
- Overview of Previous Stock Assessments and Management Framework
- Data sources utilized in American Samoa Bottomfish Assessment
- Public Comment

Day 2, Saturday February 18, 2023 (9:00 am - 5:00 pm)

- Presentation and Review of Stock Assessment Methods and Results
- WPSAR Review Panel Discussion and Model Run Requests
- Public Comment

Day 3 Sunday February 19, 2023 (9:00 am - 5:00 pm)

- WPSAR Review Panel Discussion with Presenters

Day 4, Monday February 20, 2023 (9:00 am - 5:00 pm)

- WPSAR Review Panel Discussion with Presenters

Day 5, Tuesday February 21, 2023 (9:00 am - 5:00 pm)

- WPSAR Review Panel Discussions with Presenters

Day 6, Wednesday February 22, 2023 (9:00 am - 5:00 pm)

- WPSAR Review Panel Discussions with Presenters
- WPSAR Review Panel Discussions (closed, afternoon)

Day 7, Thursday February 23, 2023 (9:00 am - 5:00 pm)

- WPSAR Review Panel Discussions
- Public Comment
- WPSAR Panel Report on Review Outcomes and Recommendations
- Adjourn

Appendix 3. List of Requests from Stock Assessors

During the WPSAR, the panel requested a number of data and model requests to explore the effects of the inputs, methods, and outputs on the assessments. These requests were provided to the stock assessment team responded with analysis, figures, and tables to the requests (file names are in bold). The rationale for requests was also provided.

<u>Data requests</u>

1. Linear model to explain individual fish lengths with available covariates for two species with the most available data (BBS). Provide results and plots, as needed.

   1.1 Rerun analysis with data filter for lengths used for assessment. Example: filter LUKA lengths were above the assessment filter length. (ROB)

   01_Length and Catch exploration (all slides)

   Rationale: explore variation of length in time (SEASON) and space (AREA). Explore different scales of SEASON (dry vs wet) and AREA (sub-island quadrants).

2. Describe monthly and area trends in catch for three species with most available data. *Rationale*: Determine month and area of catch. Provide descriptive results and plots.

   01_Length and Catch exploration (page 4)

3. Plot the species-specific CPUE indices (1986-2017/8) on a linear scale on the same graph as the aggregate CPUE time series from the 2019 assessment.

   3.1 Plot the LOESS trends with broader smoother and visible line width (=3 or larger).

   06_CPUE comparisons (page 1-2)

   3.2 Plot of linear fits to CPUE for individual species and 2019 assessment.

   06_CPUE comparisons (page 2)

   Rationale: Compare trends between CPUE indices for prior and current assessments.

4. Plot time series of # of vessels, # of trips, and # of fishers (if available) for all years. (related question: when were large diesel vessels active in fishery).

   01_Length and Catch exploration (page 5)

5. Select indicator species for *P. filamentosus* and *E. carbunculus* and provide justification for your selections.

   08_Indicator species

6. Run two-stage von Bertalanffy models for APVI using data from O'Malley 2021 three growth studies (EIO, MHI, NWHI)

   Rationale: Explore the variability in Linf between the three areas.

7. Prepare a 1-hour presentation describing the outcome of requests from the WPSAR panel and present during Thursday session. Include the following:

   - Provide overview of catch and effort trends in fishery

- Reasons for change in stock status between 2019 and 2023 assessments.
- Changes in the methods are in response to prior recommendation to move to single species stock assessment
- Downward trend in CPUE of the species complex was driven by only a few species (LUKA etc.)
- Describe the steps taken to explore uncertainty in the assessment results (e.g., Linf, M, etc.)
- Describe indicator species suggested for PRFI and ETCA and their justification.

8. Update and complete the table for the Linf and M sensitivity runs for all species. For the Linf runs also include assessment results such as SSB0, % unfished, etc.

<u>Model requests</u>

NOTE: Whenever a result is produced for a time series of SSB, provide a table of the median values and CVs

1. Explore the sensitivity of the stock assessment to uncertainty in Linf for two species (ETCO and APRU). Produce results and plots.
   a. Run a range of fixed Linf values sufficient to observe large changes in SSB0. Plot estimated SSB0 vs Linf for a range of fixed and assumed values.
   b. Estimate Linf in the model and produce a likelihood profile for Linf
   c. Estimate Linf in the model and produce a likelihood profile for SSB0

   1.1 Perform all above steps for LUKA
   Rationale: concern that the estimates of SSB0 can be sensitive to Linf.
   03_Linf and M estimation (slide 24-29)
2. Explore the sensitivity of the stock assessment to uncertainty in M for two species (ETCO and APRU). Produce results and plots.
   a. Run a range of fixed M values. Plot estimated SSB0 vs M for a range of fixed and assumed values.
   b. Estimate M in the model and produce a likelihood profile for M
   c. Estimate M in the model and produce a likelihood profile for SSB0

   2.1 Perform all above steps for LUKA
   Rationale: concern that the estimates of SSB0 can be sensitive to M.
   03_Linf and M estimation (slide 24-29)

   Perform assessment runs including the CPUE time series (1986-2017) for two species (ETCO and APRU). Produce results and plots.
   d. Compare the results of these model runs with the base models.
   Rationale: Explore the sensitivity of assessment results to the longer time series of CPUE.
3. Perform assessment runs with recruitment deviation sigmaR of 0.4 for two species (ETCO and LUKA). Produce results and plots. Present the results to determine the variability of SSB and stock status.
   Rationale: Evaluate the effects of recruitment deviation estimation on uncertainty.

4. Perform assessment runs with CPUE time series from (1988-2015) and (2016-2021) as separate indices for as many species as possible. Do not include length composition data in the likelihood (include ghosted fits to the LFs). Produce results and plots.
   Rationale: Provide analysis that serves as a bridge between the 2019 assessment and current assessments.

   08_Model with no comp data on likelihood
5. For each species, estimate the possible B0 from the product of species-specific densities from BFISH Hawaii bottomfish survey and area of bottomfish habitat in American Samoa. Provide a best guess and a lower and upper limit.
   Rationale: These estimates could be used to form a prior on logR0 for use in sensitivity runs

   10_B0 priors

6. Explore sensitivity analyses of Linf on all species. Perform the estimation of Linf in stock assessment runs for each species (using the prior from point 6). Determine the value **of Linf that identifies the overfished SSB in 2021** (and calculate the **probability of being overfished**). Take that Linf and use it with the uncertainty associated with the stepwise method to estimate the probability of being overfished.

   Rationale: These analyses can provide an understanding of the probability of being overfished due to uncertainty in Linf.

   10_B0 priors

7. Explore sensitivity analyses of M on all species. Perform the estimation of M in stock assessment runs for each species using a broad prior (e.g., the mode of the prior is from the base model and the CV is consistent with variation in the stepwise estimate of M). Use the B0 prior from point 6. Determine the value of M that identifies the overfished SSB (and calculate the probability of being overfished). Take that M and use it with the uncertainty associated with the stepwise method to estimate the probability of being overfished.

   Rationale: These analyses can provide an understanding of the probability of being overfished due to uncertainty in M.

   10_B0 priors

8. Explore the sensitivity of the stock assessment to dome-shaped selectivity for APVI. Produce results and plots.
   a. Run a range of fixed selectivity parameter values sufficient to observe large changes in SSB0. Plot estimated SSB0 vs selectivity parameter values for a range of fixed and assumed values.

   Rationale: concern that the estimates of SSB0 can be sensitive to dome-shaped selectivity.

   09_Dome Shape Sel/ex
9. Produce plots of vulnerable biomass and exploitation rate for LUKA and LERU from the base models.

10. For LUKA, have a stock assessment run with the historical catch series is required to be taken. alternate run with low CV on catch.