Independent peer review of Stock Assessment Update for the Main Hawaiian Islands Deep7 Bottomfish Complex Through 2013 With Projected Annual Catch Limits Through 2016

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Assignment undertaken for:

Center for Independent Experts (CIE)

January 2015

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Executive Summary

The Hawaiian Islands bottomfish panel review meeting took place in Honolulu, Hawaii between December 9th and December 12th, 2014 and reviewed the Update of the 2011 benchmark stock assessments for the Main Hawaiian Islands (MHI) Deep7 bottomfish complex**.** The review panel, which was composed of three appointed reviewers and one chair, all from the Center of Independent Experts (CIE), attended the meetings and discussed the data and methodology with the scientific team and other attendees to assess the quality of assessment and relevant findings. Criteria considered to reach a decision included the adequacy and appropriateness of data and assessment models and whether the science reviewed was considered to be the best scientific information available.

The assessment used a Bayesian statistical framework with a generalised surplus production model and CPUE and catch data to calculate the status of the stock. The results indicated that the current (2013) size of the Deep7 complex was 11,630 million pounds and the harvest rate was equal to 5.1%. The current harvest rate was predicted to be below H_{MSY} while the current biomass although lower than $B_{MSY,}$ was above the biomass benchmark selected and therefore, the assessment concluded that the complex was not currently overexploited and overexploitation was not taking place.

The assessment, although an improvement in comparison to the 2011 one, has met the criteria set in the ToRs only partially. Due to concerns about the reliability of some of the input data, the efficacy of the assessment outcomes in addressing management goals is considered to be low and does not support conclusions on the current status of the stock. Further exploration of data used, as well as incorporation of new knowledge into the analysis, is recommended to improve the robustness of the assessment results.

Background

The stock assessment of the Main Hawaiian Islands Deep7 Bottomfish Complex assesses the status of six deepwater snapper and one grouper species. Those species are pink snapper (opakapaka), longtail snapper (onaga or ula'ula koa'e), squirrelfish snapper (ehu), Hawaiian sea bass (hapu'upu'u), flower snapper (gindai or ukikiki), Von Siebold snapper (kalekale), silverjaw snapper (lehi). All seven species are found in the Hawaiian Archipelago but are currently exploited only in one of the three management zones included in the federal fisheries management regime for that area. That zone is the main Hawaiian Islands zone and this is the area on which the reviewed stock assessment focused.

Management of the bottomfish fisheries falls both on the State and Federal Government with the former covering the inshore waters. Current management measures include an Annual Catch Limit for commercial catches, bag limits for non-commercial catches, bottomfish restricted fishing areas, and restrictions in fishing gears (only hook and line). The Hawaii bottomfish fishery still uses deep handline capture methods for both recreational and commercial fishing that are very similar to those that have been traditionally used by native Hawaiians. Records of catches for the seven bottomfish species are available starting in 1949. Reported catches started increasing in mid 1970s with highest catches in the period 1987-1989 (about 2-3

times higher than catch estimated for years prior to 1975) and have declined after that. Studies on unreported catches suggest that a significant part of catches has not been reported. The 2005 stock assessment indicated that the bottomfish complex was experiencing overfishing and led to the adoption of some of the management measures that are currently used (e.g. catch limits).

The latest stock assessment of the Deep7 bottomfish complex was an update of the previous (2011) stock assessment with just a few changes. The generalised biomass production model and Bayesian statistical framework used were the same as in 2011. Only short-term projections were presented. The analysis used MSY-based indicators and assumptions about natural mortality to assess the status of the stock. Based on the chosen benchmarks, the assessment concluded that the stock was currently not overexploited and overexploitation was not taking place.

Three CIE reviewers and a chair were commissioned to conduct an impartial and independent peer review of the **stock assessment update for the main Hawaiian Islands Deep7 bottomfish complex** in accordance with the SoW and stock assessment ToRs listed in Appendix 2. Each CIE reviewer was also contracted to produce an independent peer review report. This document is my peer review report and presents my comments on Deep7 bottomfish assessment and supporting material. Further details on the reviewer's role and the review request of the Center for Independent Experts are presented below and in Appendix 2.

Description of the Reviewer's Role in the Review Activities

I was contracted to:

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate during the panel review meeting at the Honolulu Service Center, NOAA Fisheries Pier 38, Honolulu Harbor, 1139 N. Nimitz Hwy, Suite 220, Honolulu, HI 96817 during 9-12 December 2014, as specified herein, and conduct an independent peer review in accordance with the ToRs (Appendix 2, Annex 2).
3) No later than 2 January 2015, submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Dr. Manoj Shivlani, CIE Lead Coordinator, via email to mshivlani@ntvifederal.com, and Dr. David Die, CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2 (Appendix 2).

This document provides the outcome of this review.

Summary of Findings

TOR 1. Review the assessment methods used: determine if they are reliable, properly applied, and adequate and appropriate for the species, fisheries, and available data.

The model used for the assessment was a Bayesian surplus production model with a shape parameter, in addition to the standard intrinsic growth and carrying capacity parameters, and an annual step. The shape parameter adds flexibility in the shape of the surplus production curve relative to carrying capacity so the peak of the curve does not need to be at 0.5 of carrying capacity. The model was the same as the one used in the 2011 stock assessment.

The choice of a surplus production model is appropriate given the data available (CPUE, catches) when the model was adopted (i.e. 2011) and generally, these type of models have been shown to perform well and provide robust estimates for management advice. The use of the shape parameter also allows more flexibility in shaping the production function to be closer to the dynamics of the stock. Such models appear to be less robust for species of low productivity and given that information presented at the review meeting suggests that the productivity of species in the Deep7 complex might be low, it is recommended that caution is used when interpreting the results of the adopted model. The model does not allow for stage-specific dynamic to be captured explicitly in the calculations and that reduces the breadth of fishing behaviors and management approaches that could be tested including accounting for any benefits on certain age-groups that closed areas that exist in the area might offer.

A single population dynamics model was used to represent the dynamics of the Deep7 stocks as a group. However, the information provided before and during the review meeting indicated that key biological processes and also fishing patterns differ among these seven species (e.g. life span, targeting from fishery). So, it would be recommended that further work is done both on new biological information but also on fishery data to allow for single species population dynamics models to be constructed where possible.

The choice of Bayesian framework is also appropriate although the formulation of some priors is of concern; this is covered in the next ToR.

In conclusion, the statistical assessment framework has been used and tested extensively and is reliable and the choice of it for this assessment is acceptable. However, as some species from the complex appear to be less productive than others the assessment of the seven species as a single stock might not be able to highlight overexploitation risks for some of the species.

For that reason, although the choice of model is appropriate given limitations in the fishery data, its reliability for the complex of stocks is less clear and that makes using the results to guide management difficult.

TOR 2. Evaluate the implementation of the assessment model: configuration, assumptions, and input data and parameters (fishery life history); more specifically determine if data are properly used, if choice of input parameters seem reasonable, if models are appropriately specified and configured, assumptions are reasonably satisfied, and primary sources of uncertainty accounted for.

The assessment used catch data for the years from 1949 to 2013. This was the same catch series used in the previous assessment but it was extended to include catch data for the three years since the previous assessment. Similarly, the model was fit to CPUE data for the period from 1949 to 2013 but the series was split into two to reflect the additional information taken into account in the standardisation of the CPUE data for the more recent years (1994 onwards).

a) Catch

Both reported and unreported catches were included in the model; the latter was calculated using studies on unreported catches that were available for a few years and then extended those ratios to the whole period 1949-2013. Specifically, estimates of unreported catches for years 2004, 2005 and 1990 were used to cover the pre-1990 and the more recent recreational catches. The estimates for 2004 and 2005 that were used to characterise the ratio of unreported to reported catches for recent years were based on unpublished data available from the HMRFS which also included taxa specific information. The process followed is logical but it is based only on two points and the report acknowledges that the estimates of unreported catches are probably an underestimate.

More importantly, the analysis used a single point (from 1990) for that ratio and applied it to calculate total catch for the first 40+ years of the catch series when the relevant estimate for 1990 was itself an extrapolation from one part of the fishery. It is not clear what bias/uncertainty this has introduced in the analysis. The model assigns 20% uncertainty in the value of unreported catches to reflect the uncertainty in estimates without a clear explanation why that was appropriate. Such choice also does not reflect the general view expressed by the assessment team and others during the review meeting that catch estimates are less reliable for early years.

Given the importance of this assumption for model results, the current configuration is not adequate and does not account for all sources of uncertainty. Further work is recommended to consider whether alternative sources of information could be used to improve the reliability of the total catch data or fully reflect the uncertainty in the data. Future assessment reports will also benefit from further justification for the ratio of unreported to reported catches and associated level of uncertainty chosen.

The assessment team was asked to do an additional model run using the same ratio for reported to unreported catches as that used in recent years (i.e. unreported catches in early years were less than in the basecase). Although, the relative trend in stock size over the years did not change much the prediction about the current stock status did change to indicate that overfishing was taking place.

b) CPUE

The first part of the CPUE series, 1949-1993, was standardized following the same approach as in 2011 leading to a standardized series that was almost the same as that used in 2011. The standardization of the second CPUE series (covering 1994 -2013) included information on fishing licenses, which was not available for the earlier period, to account for fisher skill effect. The inclusion of new information and splitting the CPUE into two was a departure and the main change from the 2011 configuration.

The analysis considered different standardization models and showed that the explanatory power of the model increased when the license numbers were included in the calculations as an explanatory variable. However, despite the addition of that new information and increase in the explanatory power of the standardization model, the trend in the CPUE series for the most recent period remained almost the same as that in 2011.

Much more information on the compilation of the catch and effort data used to construct the CPUE was provided during the review meeting. According to that information, the quality of reporting in early years was questionable and possibly highly variable. For example, it was not clear if trip records were submitted for each trip or for a combination of trips. Some records were excluded to reduce that bias by removing records that reported catches of over 1500 pounds per day. That is a reasonable exclusion but it will not fully address the issue of aggregated data since multiple day trips with low catches will not be excluded using that filter. Those records would be treated as a single trip records and will support higher catch rates than the real ones. Information presented suggests that reporting has improved in recent years so, that might have reduced bias/inaccuracies and generally, data for the most recent period are probably more reliable. However, that is not reflected in the CV of the CPUE series with CVs in early years only slightly higher than those in recent years.

The analysis done to calculate CPUE is an improvement relative to the 2011 one but the reliability of the data is still questionable and therefore, further investigation is recommended.

The weight that each CPUE point was given in the likelihood function was expressed relative to the minimum CV in that CPUE series; in this way, the points of a CPUE series that have high CVs could still receive similar weights to those for a CPUE point with smaller CVs if the relative values are the same. This part of the analysis was not well explained and relative CVs for each CPUE series were not presented but material presented in the 2011 stock assessment report indicates that the weight assigned to each CPUE point in the most recent year is similar to those assigned to CPUE points for the first years in the CPUE series. This misrepresents the contribution of early points of the CPUE series to the results. The way in which CPUE points are weighed in the likelihood function needs to be modified to ensure that the weight assigned to each CPUE point is consistent across CPUE series and not only within a CPUE series.

c) Priors

The analysis uses informative priors for model parameters including carrying capacity, K, intrinsic growth rate, r, shape parameter and proportion of the population

relative to the carrying capacity in the first year of the populations (1949). The use of informative priors is an appropriate approach to make best use of any knowledge about the value of those parameters that comes from sources not used in the stock assessment (i.e. indirect data instead of the direct data that are used as input to the stock assessment). However, in this case, the choice of some priors was based on results from model runs from previous stock assessments. Specifically, the mean values of intrinsic growth and another parameter from the previous stock assessment was used to calculate the mean of the prior for the carrying capacity used in the current assessment. Also, the choice of the mean of the prior for relative stock size in the first year of the calculations was based on the results of stock assessment runs essentially, using the model fit to the data to decide which state to give more probability using a prior. That process of constructing priors is inappropriate since, it is using the data that are provided as input to the model to construct priors so, essentially using the data twice.

The analysis also seems to assign priors to the relative size of the stock in each of the years of the calculations; these parameters can be calculated by the model given priors for the relative stock size in the first year of calculations, carrying capacity, intrinsic growth, and shape parameter and using the catch data that are an input to the model. Therefore, the configuration of the model needs to be reconsidered to ensure that the choice/number of priors is appropriate and does not lead to conflicting joint priors (e.g. Borel paradox).

The priors used for key parameters are informative and, at least in some cases, the choice of priors is not justifiable based on prior knowledge. A couple of runs done during the review meeting changing one prior at the time to use less informative distributions did not lead to any significant changes indicating that a single parameter prior did not drive the results but the use of quite narrow priors is still of concern, and it is recommended that future assessments include a more comprehensive examination of the effects of the priors.

In summary, the implementation of the model was not adequate given concerns about the reliability of input data and the way in which the model was configured and given that uncertainty was only partially accounted for in the analysis. Therefore, this ToR has not been met.

TOR 3. Comment on the scientific soundness of the estimated population benchmarks and management parameters (e.g. MSY, Fmsy, Bmsy, MSST, and MFMT) and their potential efficacy in addressing the management goals stated in the relevant FMP or other documents provided to the review panel.

MSY-based benchmarks were used to express the status of the stock; more specifically, the analysis calculated the maximum sustainable yield, MSY, and harvest rate, H_{MSY}, and exploitable stock biomass, B_{MSY}, that corresponds to MSY. Two benchmarks were used for management purposes; H_{MSY} was used to assess whether overexploitation is taking place and $(1-M)*B_{MSY}$ was used to decide whether the stock was overexploited where M is natural mortality and was set equal to $0.25y^{-1}$ for the calculations.

The values for those parameters based on the basecase model were as follows: H_{MSY}=6.6%, B_{MSY}= 13.460 million pounds, MSY = 415, 000 pounds and (1-M)* B_{MSY}=10.095 million pounds. The current (2013) size of the stock was 11,630 million pounds and the harvest rate was equal to 5.1%. The current harvest rate was predicted to be below H_{MSY} while current biomass is greater than (1-M)*B_{MSY} and therefore, the assessment showed that the stock was not overexploited and overexploitation was not taking place in 2013.

The choice of MSY-based benchmarks is appropriate, but given serious flaws in the input data and configuration of the stock assessment (see previous ToR), the efficacy of the estimated values in addressing the management goals is considered to be low.

For management purposes, a stock is considered overfished when its size is less than (1-M)*B_{MSY}. This requires knowledge of the value of natural mortality which, based on information presented at the review meeting, is not well defined for the Deep7 complex. The value of M was set equal to 0.3 y^{-1} for the previous stock assessment and that was reduced to 0.25 y^{-1} for the current stock assessment. However, that choice was based on general perception of the natural mortality that would represent the biology of those stocks and not on scientific studies on natural mortality. Additional information on maximum age from recent studies as well as length frequency data could be used to inform the decision on the value of natural mortality and preliminary discussions during the review meeting supported lower values for M.

This is of particular relevance for this assessment given that the estimates of the stock size are below B_{MSY} and that means that the value of M chosen could change the stock status from not been overfished to overfished.

Given greater concerns about the results of the stock assessment, this issue was not explored much at the review meeting (but see relevant text about an additional model run in the next ToR) but it is important to undertake further work on this making use of all relevant information to better determine the value of M either at species-specific level (if possible) or for a group of species.

Given serious issues with input data and the parameter values used to determine the stock status, conclusions based on the adopted benchmarks should be treated with caution. However, they do provide some insight into the possible state of the stock. That in conjunction with the CPUE data from recent years that do not show a decline provide some reassurance that the population might be stable or the changes in the population size are small even though it is not clear whether the population is overexploited or not.

In summary, this ToR has only partially been met and the status of the stock cannot be determined with confidence based on the estimated benchmarks.

TOR 4. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status.

A surplus production model similar to that used for the stock assessment was also used to run short term projections (to 2016) and 41,000 MCMC samples of the values of the uncertain parameters were used to calculate the risk that the Deep7 complex will experience overfishing or become overfished in the near future. The risk was tested for a range of possible catch limits for the commercial fishery while the ratio of unreported to reported catches was the same as that used for recent years (1.08).

The approach used is appropriate and propagates well the uncertainty captured in the stock assessment. Only one management approach is considered (i.e. setting catch limits) but there is not enough information about fishery or stock behavior to allow conclusions on whether more elaborate management measures should have been tested (e.g. closed area to protect nursery grounds, targeting of certain fish sizes, etc.).

With that in mind and given limitations in the robustness of the stock assessment, the set of projections chosen is acceptable. The parameters calculated were also appropriate to support management discussions.

Given concerns about the value chosen for natural mortality, the assessment team was asked to rerun the projections using M =0.1 instead on 0.25. As expected, the risk for the stock to become overexploited exceeded 50% under all catch limits tested because the stock size below which the stock was considered overexploited increased and became greater than the mean value of the current (2013) stock size. This highlights the importance of increasing the confidence in the value of M used in the stock assessment.

Generally, although the overall approach followed is appropriate, the robustness of the outcomes is compromised because of the problems with input data and hence, with the results of the stock assessment, as described in previous ToRs.

TOR 5. Determine whether the science reviewed is considered to be the best scientific information available.

The assessment approach used was selected as part of the 2011 benchmark stock assessment and as a result, I expect that it reflects the information available then. New research on relevant topics and findings were presented at the review meeting but a lot of that knowledge has not been incorporated into the science that guided the latest stock assessment. The assessment team explained that the current stock assessment was an update stock assessment and, for that reason, only minor changes in the general approach had been done.

New information presented at the review meeting included studies on species-specific longevity and growth, size frequency data from catches, changes in reporting requirement and different sources of information on fishing activity (state and federal reports, dealer reports, etc.), differences in gear design even for the same type of gear

(e.g. different catchability), population surveys in small closed areas, and knowledge about the species from the Deep7 complex that the fishery targets.

The assessment team used fishing license numbers to update the CPUE series used in the 2011 assessment and information about the natural mortality of opakapaka to change the value of natural mortality used in the calculations. Those changes are an improvement in comparison to the 2011 assessment but there is still new information that has not been used to inform the assessment approach both in terms of improving the robustness of input data and guiding the selection of assessment methodology. For that reason, the science included in the assessment was not the best available.

If the nature of the current assessment did not allow for more changes in the approach I would strongly recommend that the necessary work is done to ensure that new information is used in the next stock assessment. That includes ensuring that there is coordination among different teams that undertake relating research or have access to relevant data to maximize the information available.

TOR 6. Suggest research priorities to improve our understanding of essential population and fishery dynamics necessary to formulate best management practices. Comment on alternative data sources and modeling, including any potential fishery independent data sources that could be used to supplement fisheries data. Include guidance on single species models, and whether this is possible given the current nature of this multispecies fishery, and difficulties in partitioning fishing effort between species

- Given concerns about the robustness of CPUE data especially for early years, it is recommended that further filtering of the data is done to ensure that data from multi-day trips are correctly captured or excluded. For example, month catch records that record just a single trip should be revisited to decide whether to exclude them from the data series. Further, a subset of data from certain fishing licenses or skippers with good reporting record could be used to construct a CPUE.

- On CPUE standardization and level of uncertainty, further exploration of the catch and effort data will also help assess whether uncertainty in CPUE values especially in early years is appropriately reflected. Similarly, technological changes and their effect on CPUE values needs to be better explained and captured in the standardization process.

- The level of unreported catches is an important factor that affects the robustness of the assessment results. It is recognized that finding information about unreported catches is a challenge; if additional knowledge on this cannot be gained from local knowledge or other resources (e.g. buyers' receipts), at least, further work is recommended to assign the appropriate level of uncertainty to those values.

- Going forward, accurate reporting of catches and effort remains a priority and given that a significant proportion of catches appears to be taken by recreational fishermen or for non-commercial use, better catch reporting for all segments of

the fishery is highly recommended to ensure that information on type of gear, effort and species caught are recorded for each management area.

- Presentations at the review meeting referred to possible reporting options for non-commercial fishermen and that is encouraging but until those are in place, it is recommended that other arrangements are made to record unreported catches.

- New knowledge on species growth and longevity lends support to species-specific assessment models. Given differences in biology among the Deep7 species and in the interest of the fishery in each of them, I would recommend that further work is done to construct single species models for as many of the seven species as possible but at least for those that are targeted or show the biggest differences in biology (e.g. grouper).

- As the ToR notes, partitioning fishing effort between species is a challenge but given catch information at species level and knowledge about species that the fishery targets further analysis of the catch and effort data to develop species-specific CPUE series, especially for more recent records for which the level of detail in the reporting appeared to have increased, is recommended.

- I also recommend using this new information to construct updated priors/estimates for intrinsic growth and natural mortality. Metapopulation analysis could also support construction of priors for these values as well as for the shape value (if a generalized surplus production model is still used).

- Length frequency data from a catch sampling program presented at the review meeting could also be used to get an idea of mortality levels. So, their analysis is also recommended but it is noted that the sampling was not following a scientific design and that will limit the robustness of the results.

- Fishery independent data on exploitation or trends on stock size will, of course, be useful and should be considered for this fisheries given the level of unreported catches. I will also recommend that such work consider development of indicators that could inform about possible changes in the stock status without using a stock assessment (e.g. changes in recruitment levels, extend of habitats populated)

- Limited information about important biological areas and appropriate habitats for those species was presented at the meeting but indicated that there are some data that could be used to identify spawning or nursery grounds or other areas of importance. I would recommend analysis of those data since they could inform assessment scenarios and management discussions in the future.

Provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

As part of this review I was asked to provide a critique of the review process.

The background information and assessment report were sent to the reviewers promptly and according to schedule. The assessment team had put together a series of presentations for the review meeting all of which provided useful information. They also provided additional information and runs quickly when asked and that was highly appreciated.

The assessment report would have benefited from a more comprehensive description of all the assumptions and calculations that underlined the input data and configuration of the model. A section on management and management changes over the years would also be very useful. As it was, the reviewers relied heavily on the 2011 assessment report and presentations given at the review meeting to compile all the information needed.

The additional runs and calculations requested during the review meeting were not included in the assessment report (updated report), which also makes compiling and referring to all relevant information difficult.

The reports of the reviewers from the review of the 2011 assessment were not included in the background material; that information should have been part of the package of information sent to the reviewers especially given that the reviews of the 2008 assessment were part of the background information.

Having an independent chair was useful and strengthened the role and contribution of the CIE team.

Conclusions/Recommendations

- The review meeting of the 2014 assessment of the Hawaii Deep7 bottomfish complex took place in Honolulu, Hawaii between December 9th and December 12th, 2014
- A benchmark stock assessment was conducted in 2011 and the current stock assessment was an update with only small changes in the input data and configuration of the analysis.
- The Hawaii Deep7 bottomfish complex has been the focus of fishery management measures since it was determined to experience overfishing in 2005.
- The current assessment concluded that the complex was not overfished and overfishing was not taking place.
- The assessment method used Bayesian generalised surplus production model, which is appropriate and acceptable for the data available.
- CPUE and catch data were used to estimate the status of the stock together with prior knowledge about key biological parameters. Given low confidence in the raw data or approaches used to construct the input data the current configuration is not considered adequate and does not account for all sources of uncertainty.
- Nevertheless, the additional analysis undertaken to update the CPUE series is an improvement in comparison to the 2011 assessment.

- The MSY-based benchmarks used to express the status of the stock were appropriate, but given flaws in the stock assessment, conclusions based on the adopted benchmarks should be treated with caution, and it is not possible to say with confidence whether the population is overexploited or not,
- CPUE data from recent years that do not show a decline provide some reassurance that the population might be stable or changes in the population size are small.
- Although new information has become available in the recent past, the 2011 assessment model and configuration was used in the 2014 assessment with only small changes because the 2014 assessment was an update assessment.
- A number of suggestions for further filtering or analysis of existing data and use of new knowledge are recommended to increase the robustness of the assessment.

The recommendations included in the previous section (Summary of Findings) are also listed below:

Recommendation 1: Given differences in biology among the species in the Deep7 complex it is recommended that single species population dynamics models are constructed where possible.

Recommendation 2: Work on new biological information but also further analysis of fishery data is also encouraged to support the construction of single species population dynamics models.

Recommendation 3: Further work is recommended to consider whether alternative sources of information (official and other catch records) could be used to improve the reliability of the estimates of unreported catches and characterisation of uncertainty.

Recommendation 4: Further work is needed to explain the process by which uncertainty in unreported catches was calculated and incorporated into the model and ensure that the uncertainty is fully captured in the calculations.

Recommendation 5: It is recommended that further filtering of the CPUE data is done to ensure that data from multi-day trips are correctly captured or excluded.

Recommendation 6: The way in which CPUE points are weighed in the likelihood function needs to be modified to ensure that the weight assigned to each CPUE point is consistent across CPUE series as well as within a CPUE series.

Recommendation 7: The construction process for priors such as the prior for carrying capacity needs to be revised to use external knowledge and not data used as input to the model.

Recommendation 8: The configuration of the model needs to be revised to ensure that the choice/number of priors (i.e. priors for stock size in each year of calculations) is appropriate and does not lead to conflicting joint priors (e.g. Borel paradox).

Recommendation 9: It is recommended that future assessments include a more comprehensive examination of the effects of priors.

Recommendation 10: Further work making use of all relevant information to better determine the value of M (natural mortality) either at species-specific level (if possible) or for a group of species is recommended.

Recommendation 11: I would strongly recommend that the necessary work is done to ensure that new knowledge on biology, other sources of data or additional filtering of data is used in the next stock assessment. That includes ensuring that there is coordination among different teams that undertake relating research or have access to relevant data to maximize the information available.

Recommendation 12: It is not clear whether technological changes and all sources of uncertainty were incorporated into the CPUE standardisation process and therefore, further work is recommended to better explain the process followed and ensure that uncertainty in data and processes is properly captured.

Recommendation 13: Given problems with estimating catch in the past, work to improve catch reporting for all segments of the fishery in the future is highly recommended.

Recommendation 14: Further analysis of the catch and effort data to develop species-specific CPUE series, especially for more recent records for which the level of detail in the reporting appeared to have increased, is recommended.

Recommendation 15: Metapopulation analysis is also recommended to inform the choice of priors and values for model parameters especially at single-species level (e.g. shape parameter, fecundity, intrinsic growth, natural mortality).

Recommendation 16: Analysis of length frequency data from a catch sampling program is also recommended but further sampling should follow a scientific design to reduce potential errors/bias.

Recommendation 17: Collection of fishery independent data on exploitation could be a way to address problems with misreporting and should be considered.

Recommendation 18: Work to consider indicators that could highlight changes in the stock status without using a quantitative stock assessment is also recommended.

Appendix 1: Bibliography

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Appendix 2. Statement of Work for Dr Panagiota Apostolaki

External Independent Peer Review by the Center for Independent Experts

Stock Assessment Update for the Main Hawaiian Islands Deep7 Bottomfish Complex Through 2013 With Projected Annual Catch Limits Through 2016

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: A stock assessment update of the Main Hawaiian Islands (MHI) Deep7 bottomfish complex was conducted through fishing year 2013. This update used the previous benchmark assessment data analysis, modeling, and stock projection approaches with one minor improvement in CPUE standardization. This update was conducted using up-to-date re-audited bottomfish catch and effort data from Hawaii state commercial catch reports for the years 1948-2013. Unreported catch was estimated and included in the model using catch and effort data from the deep-water bottomfish handline fishery. Model selection techniques were applied to select the best structural form to standardize CPUE. An important improvement to this stock assessment model is the inclusion of information on individual fishermen's skill, or license effect, to standardize CPUE from 1994-2013; this resulted in a significant increase in the explanatory power of the CPUE standardization model but did not have a substantial effect on the estimated trend in CPUE. CPUE in the model was split into two time series (1949-1993, and 1994-2013) in order to accommodate the inclusion of license effect, which could only be tracked starting in 1994 when licenses became uniquely assigned to a fisher/vessel through time. A Bayesian production model was used to estimate time series of Deep7 bottomfish exploitable biomasses and harvest rates and was also used to conduct stochastic short-term projections of future catches, stock status conditions, and associated risks of overfishing in 2015-2016. These projections explicitly included uncertainty in the distribution of estimated bottomfish biomass in 2014 and population dynamics parameters. Results of the catch and CPUE analyses, production modeling, and stock projections are summarized and are used to characterize uncertainty of Deep7 ACLs for fishing years 2015-2016 assuming alternative commercial catch amounts in 2014. Overall, the Deep7 complex in the Main Hawaiian Islands is not currently

experiencing overfishing and is not currently depleted relative to the best available information on biological reference points.

The scientific information and assessment to be reviewed have not undergone independent peer review and there is a need to evaluate the data and assessment methods to improve the scientific basis for management. Further, the scientific information to be reviewed has a large potential impact on a valuable fishery important to commercial and recreational fishers in Hawaii and fish consumers in the state. It will be the foundation of bottomfish management decisions by the Western Pacific Regional Fishery Management Council (WPFMC), NMFS, and the State of Hawaii.

The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review as part of a panel review under the auspices of the Western Pacific Stock Assessment Review (WPSAR) process, and in accordance with the SoW and ToRs herein. CIE reviewers shall have excellent oral and written communication skills in addition to working knowledge in fish population dynamics, with experience in the application of stock assessment models in data poor situations sufficient to complete the primary task of providing peer-review advice in compliance with the workshop Terms of Reference.

Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in Honolulu, Hawaii during 9-12 December 2014.

Statement of Tasks: Each CIE reviewers shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested

information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/
http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review, including:

Andrews, A. H., R. L. Humphreys, E. E. DeMartini, R. S. Nichols, and J. Brodziak. 2011. Bomb radiocarbon and lead-radium dating of opakapaka (Pristipomoides filamentosus). Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822- 2396. Pacific Islands Fish. Sci. Cent. Admin. Rep. H-11-07, 58 p. + Appendices.

Andrews, A. H., R. L. Humphreys, E. E. DeMartini, R. S. Nichols, and J. Brodziak. 2012. Comprehensive validation of a long-lived life history for a deep-water snapper (Pristipomoides filamentosus) using bomb radiocarbon and lead-radium dating, with daily increment data. Can. J. Fish. Aquat. Sci. 69:1-20. doi:10.1139/f2012-109.

Brodziak, J., D. Courtney, L. Wagatsuma, J. O'Malley, H. Lee, W. Walsh, A. Andrews, R. Humphreys, and G. DiNardo. 2011. Stock assessment of the Main Hawaiian Islands Deep7 bottomfish complex through 2010. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM- NMFS-PIFSC-29, 176 p. + Appendix.

Brodziak, J., A. Yau, J. O'Malley, A. Andrews, R. Humphreys, E. DeMartini, M. Pan, M. Parke, and E. Fletcher. 2014. Stock Assessment Update for the Main Hawaiian Islands Deep7 Bottomfish Complex Through 2013 With Projected Annual Catch Limits Through 2016. 59p.

Courtney, D. and J. Brodziak. 2011. Review of unreported to reported catch ratios for bottomfish resources in the Main Hawaiian Islands. Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Ser., NOAA, Honolulu, HI 96822-2396. Pacific Islands Fish. Sci. Cent. Internal Rep. IR-11-017, 45 p.

Hospital, J., and C. Beavers. 2013. Catch shares and the Main Hawaiian Islands bottomfish fishery: Linking fishery conditions and fisher perceptions. Marine Policy http://dx.doi.org/10.1016/j.marpol.2013.08.006.

Stokes, K. 2009. Report on the Western Pacific stock assessment review 1 Hawaii deep slope bottomfish. Center for Independent Experts, stokes.net.nz Ltd., Wellington 6035, New Zealand, 27 p.

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs cannot be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Other Tasks – Contribution to Summary Report: Each CIE reviewer may assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. Each CIE reviewer is not required to reach a consensus, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

4) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
5) Participate during the panel review meeting at the Honolulu Service Center, NOAA Fisheries Pier 38, Honolulu Harbor, 1139 N. Nimitz Hwy, Suite 220, Honolulu, HI 96817 during 9-12 December 2014, as specified herein, and conduct an independent peer review in accordance with the ToRs (**Annex 2**).
6) No later than 2 January 2015, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Dr. Manoj Shivlani, CIE Lead Coordinator, via email to mshivlani@ntvifederal.com, and Dr. David Die, CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

1 November 2014	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
21 November 2014	NMFS Project Contact sends the CIE Reviewers the pre-review documents
9-12 December 2014	Each reviewer participates and conducts an independent peer review during the panel review meeting
2 January 2015	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
12 January 2015	CIE submits CIE independent peer review reports to the COTR
16 January 2015	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on changes. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) The CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) The CIE report shall address each ToR as specified in **Annex 2**,
(3) The CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

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Key Personnel:

NMFS Project Contact:

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.

   d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work
   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

Stock Assessment Update for the Main Hawaiian Islands Deep7 Bottomfish Complex Through 2013 With Projected Annual Catch Limits Through 2016

1. Review the assessment methods used: determine if they are reliable, properly applied, and adequate and appropriate for the species, fisheries, and available data.

2. Evaluate the implementation of the assessment model: configuration, assumptions, and input data and parameters (fishery life history); more specifically determine if data are properly used, if choice of input parameters seem reasonable, if models are appropriately specified and configured, assumptions are reasonably satisfied, and primary sources of uncertainty accounted for.

3. Comment on the scientific soundness of the estimated population benchmarks and management parameters (e.g. MSY, Fmsy, Bmsy, MSST, and MFMT) and their potential efficacy in addressing the management goals stated in the relevant FMP or other documents provided to the review panel.

4. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status.

5. Determine whether the science reviewed is considered to be the best scientific information available.

6. Suggest research priorities to improve our understanding of essential population and fishery dynamics necessary to formulate best management practices. Comment on alternative data sources and modeling, including any potential fishery independent data sources that could be used to supplement fisheries data. Include guidance on single species models, and whether this is possible given the current nature of this multispecies fishery, and difficulties in partitioning fishing effort between species.

7. Draft a report of the WPSAR Panel conclusions and findings, addressing each Term of Reference.

Annex 3: Agenda

Stock Assessment Update for the Main Hawaiian Islands Deep7 Bottomfish Complex Through 2013 With Projected Annual Catch Limits Through 2016

Honolulu Service Center, NOAA Fisheries Pier 38, Honolulu Harbor, 1139 N. Nimitz Hwy, Suite 220,

9-10 December 2014

University of Hawaii at Manoa, Hemenway Hall, Room 204

11-12 December 2014

Tuesday December 9 (9:00 am – 4:00 pm)

1. Introduction (DiNardo)
2. Objectives and Terms of Reference (DiNardo; Neilson)
3. Fishery (Alton Miyasaka, HI DAR)
4. Data
    - State of Hawaii System (Miller, HI DAR
    - Biological data
        - Age & Growth (Andrews, PIFSC)
        - Biosampling (Sundberg)
        - F-I Survey (Richards)
5. Management - implementation of assessment results (Makaiau /Sabater)
    - Historical Perspective - NMHI/MHI
    - Recent Management Objectives – MHI Focus
    - P* Process

Wednesday December 10 (9:00 am – 4:00 pm)

6. Review of Stock Assessment (Brodziak/Yau)

Thursday December 11 (9:00 am – 4:00 pm)

7. Continue Assessment Review (1/2 day)
8. Panel discussions (Closed)

Friday December 12 (9:00 am – 4:00 pm)

9. Panel Discussions (1/2 day)
10. Present Results (afternoon)
11. Adjourn

Appendix 3: Panel Membership

In alphabetical order

Panayiota Apostolaki
Noel Cadigan
Vivian Haist
John Neilson (Chair)