Center for Independent Experts (CIE) Independent Peer Review Report

on

Stock Assessment of the Main Hawaiian Islands

Deep7 Bottomfish Complex Through 2010

Prepared by

Yong Chen
Professor of Fisheries Population Dynamics
School of Marine Sciences
University of Maine
Orono, ME 04469
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I. Executive Summary

The Deep7 bottomfish complex in the Main Hawaii Islands (MHI) fishing zone consists of seven species and supports a traditional deepwater handline fishery in Hawaii. An assessment in 2005 suggested that the MHI bottomfish were not overfished, but overfishing occurred in 2004 with fishing mortality being 24% higher than the overfishing threshold. Subsequently, relevant management regulations were developed to reduce fishing mortality. This stock assessment was updated in 2008 with use of revised CPUE data and Bayesian methods. A review was conducted in 2009 to evaluate the 2008 assessment update. The reviewers made recommendations on: (1) improvement of quality and quantity of input data including both catch/CPUE data and priors; (2) modification of stock assessment models and statistical methods; and (3) improved stock assessment report and supporting documents.

The current stock assessment update was conducted to address the concerns raised in the 2009 review. The major components/tasks and modifications in this assessment include: (1) focusing on the Deep7 bottomfish species considered to have similar life histories; (2) substantially reducing the mean value of priors for the intrinsic growth rate; (3) developing various scenarios to account for unreported catch; (4) developing various scenarios to account for uncertainty in CPUE estimation; (5) considering three scenarios for temporal changes in fishing power; (6) conducting CPUE standardizations and relevant sensitivity analyses; (7) reparameterizing the production model; (8) developing informative priors for key model parameters; (9) evaluating stock assessment results and uncertainty under various configurations of model, data, and priors in modeling the stock dynamics; (10) conducting a short-term risk analysis for different levels of exploitation; (11) conducting sensitivity analyses to evaluate the impacts on stock assessment due to uncertainty associated with various data and parameters; and (12) developing a decision tree analysis to evaluate the performance of different levels of TAC under uncertainty.

As a CIE reviewer, I evaluated this current stock assessment report with respect to a set of predefined Terms of Reference. I conclude that overall this assessment update is scientifically sound and adequately addresses most concerns raised in the 2009 review report. In particular, I would like to commend the efforts of Dr. Brodziak and his co-workers to address uncertainty regarding data quality and quantity in the assessment. However, I also believe some important questions (mostly new and not identified in the 2009 review report) have not received enough attention or have not been addressed in this assessment. These issues include: a general lack of understanding of the surplus production model’s performance in quantifying the Deep7 stock complex; no evaluation of impacts of priors on the assessment and relative contributions between the priors and data; no analysis of possible retrospective errors; and failure to explicitly define target, threshold and limit reference points for stock biomass and fishing mortality.

Accordingly, I recommend that future research be done in the following areas: (1) conducting an extensive simulation study to evaluate the performance of surplus production model in modeling dynamics of the Deep7 stock complex consisting of species with relatively long life spans; (2) evaluating impacts of priors on the assessment and relative contribution of the priors and data to the assessment; (3) conducting a retrospective analysis to evaluate possible
retrospective errors; (4) attempting to develop a fishery-independent monitoring program or an index fishery program with standard fishing methods to yield a more reliable abundance index and to compare with standardized commercial CPUE; (5) improving documentation of various scenarios and quantification of differences in the assessment results among these different scenarios; (6) explicitly evaluating and defining target, threshold and limit references and corresponding harvest control rules; and (7) attempting to conduct stock assessments for individual species using age/size structured population models.
II. Background

The Hawaii bottomfish complex, inhabiting waters of the Hawaiian Archipelago, comprises of several species of snappers and jacks, plus a grouper. The complex historically supported deepwater handline fisheries in three fishing zones, the Main Hawaiian Islands (MHI) zone, the Mau zone, and the Hoomalu zone. However, fishing currently takes place only in the MHI zone with fishing activity prohibited in the other two zones. The Deep7 bottomfish complex includes seven species that are the main targets of this fishery and that have been the focus of fishery management measures since 2005 (Brodziak et al. 2008).

A stock assessment was conducted for the Hawaiian bottomfish complex in 2005 by fitting a surplus production model to fishery data through calendar year 2004 using a nonlinear least squares estimator (Moffitt et al. 2006). The assessment suggests that the MHI bottomfish were not overfished, but that overfishing occurred in 2004 when fishing mortality was 24% higher than the overfishing threshold. Subsequently, relevant management regulations were developed to reduce fishing mortality. This stock assessment was updated in 2008 by fitting the same surplus production model to fishery data through calendar year 2007 using Bayesian methods (Brodziak et al. 2008). In the update stock assessment, catch and effort information was audited to include only those of single day trip in the estimation of CPUE and Bayesian method replaced least squares method to better quantify uncertainty in key population parameters. The stock assessment was done separately for the three Hawaiian fishing zones: the Main Hawaiian Islands zone, the Mau zone, and the Hoomalu zone. Uninformative priors were assumed for all the production model parameters except for intrinsic growth rate for which an informative prior was assumed (Brodziak et al. 2008). The use of revised CPUE data and Bayesian methods was considered an improvement over the 2005 stock assessment.

A review was conducted in 2009 to evaluate the 2008 assessment update. The reviewers suggested that the surplus production model is adequate for assessment of the Hawaiian bottomfish complex but made various recommendations on: (1) improvement of quality and quantity of input data, including both catch/CPUE data and priors; (2) modification of stock assessment models and statistical methods; and (3) preparation of stock assessment reports and supporting documents.

The current stock assessment update was conducted to address the concerns raised in the review. The baseline model structure was similar to the model used in the 2008 update. The assessment focused on the Deep7 bottomfish species that were considered to have similar life history processes. Many scenarios were developed in the current assessment to incorporate uncertainties in assessment data, model assumptions, and statistical methods. The major modifications done in this assessment include: (1) focusing on the Deep7 bottomfish species perceived to have similar life histories; (2) substantially reducing the mean value of priors for the intrinsic growth rate; (3) using fishing year (July 1 – June 30), instead of calendar year; (4) considering four scenarios in estimating catch statistics to account for unreported catch; (5) considering three scenarios in assuming temporal changes in fishing power; (6) considering various scenarios to account for uncertainty in estimating nominal CPUE; (7) conducting CPUE standardization and relevant sensitivity analyses; (8) re-parameterizing the surplus production model; (9) developing various scenarios of priors for key model parameters; (10)
conducting convergence diagnostics; (11) evaluating the performance of various configurations of model, data, and priors in modeling the stock dynamics; (12) conducting a short term risk analysis of different levels of TAC; (13) conducting sensitivity analysis to evaluate the impacts on stock assessment due to uncertainty associated with various data and parameters; and (14) developing a decision tree analysis to evaluate the performance of different TACs under uncertainty.

As a CIE reviewer, I am charged to evaluate this current stock assessment update with respect to the Terms of Reference including whether this stock assessment adequately addresses the comments raised in the 2009 review report (Stokes 2009).

This report includes an executive summary (Section I), background introduction (Section II), description of my role in the review activities (Section III), my comments on each item listed in the Terms of Reference (ToRs, Section IV), summary of my comments and recommendations (Section V), and references (Section VI). The final part of this report (Section VII) includes a collection of appendices including the Statement of Work (SoW).

III. Description of the Individual Reviewer’s Role in the Review Activities

As stated in the SoW, this review is “to conduct a follow-up peer review to determine if the recommendations have been adequately addressed and adequacy of the revised assessment for management purposes”. My role as a CIE independent reviewer is to “conduct an impartial and independent peer review” of the stock assessment of the Hawaiian Deep7 bottomfish complex through 2010, with respect to the pre-defined Terms of Reference.

This is a desk review. Thus, I have no opportunity for face-to-face discussion and questioning. I read the “Stock Assessment of the Main Hawaiian Islands Deep7 Bottomfish Complex Through 2010” by Brodziak et al. (2011), “Report of the Western Pacific Stock Assessment Review 1 Hawaii Deep Slope Bottomfish” by Stokes (2009) and all other background documents that were sent to me (see the list in the Appendix II). I also read references relevant to the topics covered in the reports and the SoW. Based on these readings, I address each topic covered in the ToRs, evaluate the strengths and weaknesses of what was done in this assessment update, and provide recommendations to improve future assessment. Based on these evaluations and analyses, I identify future research priorities for the assessment of the Deep7 bottomfish stock complex.
IV. Summary of Findings

My detailed comments on each item of the ToRs are provided under their respective subtitles from the ToRs (see below).

IV-1. Determine if recommendations from the June 2009 WPSAR/CIE review have been adequately addressed within the assessment update.

_I conclude that recommendations from the June 2009 WPSAR/CIE review with respect to data quality and quantity have been adequately addressed and that recommendations on stock assessment models and documentation have been partially addressed in this stock assessment update._

Recommendations made in the 2009 WPSAR/CIE review (Stokes 2009) can be summarized as follows:

(1) **Improving data quality and quantity**: adjusting unaccounted catch data, developing more representative CPUE data by identifying fishing trips targeting the Deep7 species, considering various sources of uncertainty in the CPUE standardization (e.g., temporal changes in fishing efficiency and models used to standardize the CPUE) and deriving more biologically realistic informative priors for some key parameters based on meta-analysis.

(2) **Improving population dynamic models and statistics**: considering the hierarchical Bayesian approach (Jiao et al. 2009), incorporating uncertainty in input data in CPUE standardization and assessment modeling, and conducting separate assessments for those species most susceptible to overfishing.

(3) **Improving documentation of stock assessment data preparation, model parameterization, and result reporting**: standardizing the format and providing more details on the derivation of key fisheries statistics.

The current stock assessment update has explicitly addressed the issues related to data quality and quantity, and recommendations on models and documentation have been partially addressed. In particular, I believe the documentation can be further improved by streamlining the scenarios tested in this assessment update and by better quantifying differences in the assessment results among different scenarios.

More specifically, this assessment update has adequately addressed the following issues related to the input data for the surplus production model used in assessing the Deep7 bottomfish complex:

- Assessed the Deep7 bottomfish species as a single stock complex to develop population benchmarks and management parameters;
• Conducted a comprehensive evaluation of MHI catch and effort data and relevant qualitative information in collaboration with HDAR and fishermen;

• Developed a criterion to filter catch and effort data to yield improved nominal CPUEs for CPUE standardization;

• Developed plausible scenarios for alternative CPUE indices to account for potential uncertainty associated with CPUE;

• Reconstructed non-commercial catch histories and estimated non-reported catch;

• Conducted a meta-analysis of fish life history data to develop informative priors on population intrinsic growth rate $r$ and carrying capacity $K$.

This assessment update has adequately addressed the following model issues:

• Explored alternative models for the CPUE standardization;

• Evaluated the performance of different CPUE standardization model configurations; and

• Evaluated the performance of a hierarchical Bayesian approach applied to the surplus production model.

However, this assessment has not addressed the following recommendations on modeling:

“• A Bayesian assessment model for the two species (onaga and ehu) most likely being overfished and another assessment model for the remainder of the deep slope bottomfish.
• A Bayesian assessment model for the deep 7 bottomfish and another model to the remainder of the deep slope bottomfish and compare the TAC estimated in comparison to using a ratio of the TAC for the deep slope bottomfish.
• A separate Bayesian assessment model of the fast and slower growing snappers.
• As a potential independent measure of stocks status, undertake length frequency sampling and use past data to calculate SPR or an SPR proxy by species.” (Stokes 2009)

Although the documentation of data and models has been improved in this assessment update, I believe there is room for further improvement. In particular, I recommend a table summarizing all the scenarios considered in this study and a second table summarizing all the priors and their specific values. I also suggest better quantification of the differences in assessment results among different scenarios. I elaborated on these recommendations in my comments on TOR 6.
IV-2. Review the assessment methods used: determine if they are reliable, properly applied, and adequate and appropriate for the species, fisheries, and available data.

The general approach applied in this study is reasonable and perhaps the best one can do, given data limitation. However, I conclude that an extensive simulation study is needed to evaluate whether surplus production model is adequate and appropriate for the Deep7 stock complex.

This assessment follows an assessment for the MHI bottomfish complex conducted in 2005 with data through 2004 (Moffitt et al. 2006) and its 2008 update with data through 2007 (Brodziak et al. 2009). Although some substantial efforts were made in revising catch and CPUE data and defining priors, the assessment method used is similar to that used in the past. A surplus production model was used to quantify dynamics of the Deep7 bottomfish complex. The model incorporates a shape parameter and is re-parameterized by scaling stock biomass with carrying capacity $K$. The model fit to the catch and standardized CPUE data was implemented using a Bayesian approach with distributional assumptions on process and observational errors. Priors for the model parameters were assigned based on the modelers’ understanding of the biology of the Deep7 bottomfish complex. MSY-based biological reference points were estimated and short-term risk analysis was done with respect to different harvest levels for different scenarios of uncertainty in catch and CPUE.

Overall, I believe this is a rather appropriate approach, given the data available to the assessment. In particular, I would like to commend Dr. Brodziak and his co-workers’ efforts to incorporate different sources of uncertainty into the assessment and their openness to the discussion of issues in the assessment that may have given rise to data limitation. Having said so, I do believe the assessment approach leaves room for improvement.

The 2009 review panel concluded that they have “every confidence in the surplus production model used as a way of providing management advice…” (Stokes 2009). Although I agree that the surplus production model might be an obvious candidate given the limited data, I am not convinced that this type of model is suitable for the Deep7 bottomfish complex. An implicit assumption associated with a surplus production model is that population size/age structure does not significantly affect population dynamics. This might be a reasonable assumption for fish with short life span and/or relatively simple age/size structure, but certainly not the case for the Deep7 complex. This complex includes species with long life spans, the most abundant species possesses a life span of 40 years. Addition of a shape parameter to the model may remedy this problem a bit, but performance of this model in quantifying the dynamics of the Deep7 complex is still unknown. I believe a computer simulation study is needed to evaluate if the surplus production model is adequate to quantify the dynamics of the Deep7 bottomfish complex. The simulation study should include the development of a size/age-structured operating model able to generate input data (i.e., catch and CPUE data) for the surplus production model. I provide more details about this research priority in Section IV-6.
IV-3. 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.

*Overall I believe the implementation of this assessment model is scientifically sound.*

Brodziak et al. (2011) modified the surplus production model by adding a shape parameter to better capture the dynamics of the Deep7 complex and re-parameterizing the model to improve the parameter estimation. They also made every effort to audit their database to improve the quality and quantity of catch and CPUE data. Extra analyses were done to justify the setting of priors for some key model parameters. Assumptions regarding process and observational errors in modeling are reasonable and commonly used in assessments of similar nature. Fish life history parameters, although not used explicitly in the model, are used to justify prior probability distributions of some key parameters. Choices of alternative scenarios in the assessment were justified based on the information available and perhaps covered the most likely ranges of uncertainty associated with the CPUE and catch data. I conclude that, overall, this assessment is scientifically sound. My specific comments are described below.

**Is use of the data proper?**

*Given all the limitations and uncertainty, I conclude that the data were used properly in general. I do have some issues which are described below.*

The standardized CPUE data were derived from catch generated by fishing efforts targeting the Deep7 bottomfish species. The data were filtered from the database based on a criterion developed in this study. The criterion used to select a cutoff fraction value was the maximum total bottomfish catch weight and sale value (page 10, Brodziak et al. 2011). This resulted in trips comprising only 17% of bottomfish catch being included in the CPUE standardization. This is quite different from the number used in the past. Although I commend the efforts to develop a relatively objective criterion to filter catch resulting from targeted efforts, I am curious whether this low percentage of data really represent all the efforts targeting the Deep7 complex species. This selection may overlook inefficient/inexperienced fishermen who also target the Deep7 species. Depending on temporal variability in the efforts of such fishermen, this might result in biases in CPUE standardization. I suggest evaluating the potential impacts of using this criterion to filter catch/effort data by comparing its assessment results against those derived from the one used in the 2008 assessment update.

Different scenarios were developed regarding uncertainty associated with temporal changes in catchability. The nominal CPUE data were then adjusted accordingly prior to the CPUE standardization. I commend this effort because temporal change in catchability is critical in stock assessment. However, I am not sure if pre-adjusting CPUE is a good approach. Such an approach may be subjective in determining temporal trend in catchability. If there is
strong evidence pointing to the existence of temporal trends in catchability, a more objective approach is to build a function into the observational model and to estimate function parameters in modeling. The format of the function should depend on how catchability is understood to change with time.

A problem in the assessment of this stock complex is the lack of a fishery-independent abundance index. Future research priorities should include developing a fishery-independent monitoring program to generate a time series of a reliable abundance index which can be used to cross-check with the fishery CPUE. In the event a fishery-independent monitoring program cannot be developed, an index fishery sampling program employing standard gear and method and carried out by volunteer fishermen may be a good choice for yielding a cost-effective, reliable and consistent abundance index.

**Is choice of input parameters reasonable?**

I think this item is not well defined in the ToR. So, I consider the following two possibilities.

1. Assuming that this refers to defining priors for model parameters (because most model parameters are estimated, rather than inputted, but priors are inputted).

*Overall I believe the priors defined are plausible and cover parameter uncertainty reasonably well.* However, I have concerns as to the impacts of prior specifications on the stock assessment results that were not evaluated in this assessment update. The two most important parameters \( r \) (intrinsic growth rate) and \( K \) (carrying capacity) were both given informative priors. These priors were derived based on past stock assessments and some recent analyses of the life history of key species in the Deep7 complex. Priors for \( r \) differ greatly from those used in the 2008 stock update. I am curious how the stock assessment results would differ if priors for \( r \) and \( K \) were the same as those used in 2008. Such a comparison may provide some insights about the impacts of priors on stock assessment, and would partially address my concerns. I commend all the efforts by Dr. Brodziak and his co-workers in attempting to justify their choices of priors, but do believe that it is necessary to evaluate the impacts of priors for key parameters (e.g., \( r \) and \( K \)) on stock assessment (Chen et al. 2008a).

It is also unclear to me if there are upper and lower boundaries for informative priors to avoid biologically unrealistic values drawn from prior distributions. A summary table of all the priors with their upper and lower boundaries and their distributional specifications may be helpful.

Parameters \( r \) and \( K \) are often strongly and negatively correlated (Hilborn and Walters 1992). Such a correlation can be estimated based on previous assessments (e.g., evaluating correlations between posterior distributions of \( r \) and \( K \)). I suggest that such a correlation be considered in developing priors for \( r \) and \( K \) so that priors of these two parameters can be drawn from an \( r-K \) joint prior probability distribution. In any case, I believe it is necessary to evaluate correlations between posterior distributions of \( r \) and \( K \).
I suggest plotting priors and posterior distributions together to show the relative importance of data and priors in determining the dynamics of the Deep7 bottomfish complex. A small difference between the two distributions for key parameters like $r$ and $K$ may suggest that priors play a more important role than the data, while a large difference may suggest that the data used are more important. The former suggests that the data are less informative and calls for attention because priors are more or less subjectively defined.

(2) Assuming that this refers to choice of model parameterization.

*If this is what this specific ToR refers to, I think Dr. Brodziak and his co-authors made an excellent choice.*

They re-parameterized a typical surplus production model to improve the parameter estimation, added a shape parameter to make the surplus production calculation biologically more reasonable to this stock complex, and included both process and observational errors in modeling.

*Are models appropriately specified and configured?*

*Given the data available to this study, the models developed for standardizing CPUE and quantifying Deep7 stock complex dynamics are well specified and configured. However, the model specification and configuration can be further improved with the inclusion of some environmental variables (e.g., depth, distance to fishing ports, and bottom type) in the GLM for CPUE standardization. There is also room for improvement in documenting the model specification and configuration. I also suggest incorporating a time-varied catchability in the surplus production observational model to account for temporal trends in catchability.*

Three model configurations were considered for standardizing CPUE: (1) no change in bottomfish fishing power; (2) decadal increase in fishing power during 1949-2010; and (3) substantial increase in fishing power since the 1950s at an annual rate of 1.2%. All these configurations used the observed Deep7 single-trip handline data re-audited in this assessment. Both spatial and temporal factors were considered in the CPUE standardization. Akaike’s information criterion (AIC) was used to select the most suitable model specification. The updated assessment evaluated the impacts on CPUE standardization attendant to different temporal scales (monthly or quarterly) and different areas, but only with respect to the first CPUE model scenario. Similarly, alternative CPUE model specifications were tested, but again only with regard to the first model scenario. The alternative specifications tested included a delta-GLM model, a quasi-likelihood Poisson-GLM model, or simply having all the data, including the years 1958-1960. Given the subjective nature of defining temporal changes in fishing power, I suggest that nominal CPUE values not be adjusted prior to the CPUE standardization. Instead possible temporal trends in catchability should be considered in surplus production modeling. I also suggest evaluating the possibility of including some environmental variables in the CPUE standardization if these variables can potentially influence fishing power (it seems that some environmental information, such as bottom temperature, distance to fishing port, and bottom
type, can be derived and included in the CPUE standardization if fishing locations are known).

The constant PI (π) value was wrongly defined in WINBUGS coding, although I believe this should not change the AIC ranking among different GLM configurations. WINBUGS usually requires the initial values for all the parameters, and the results may be sensitive to those initials. However, I could not find the relevant source codes in WINBUGS.

The documentation of various models leaves room for improvement. I suggest including a table listing all parameters, along with their explanations and prior distributions, and with upper and lower boundaries defined for these priors. I also suggest streamlining all the scenarios evaluated in the assessment by means of a summary table that would include each scenario along with variables that were analyzed for their uncertainty. The current piece-by-piece descriptions of scenarios are confusing and hard to evaluate while also considering adequate combinations of uncertainties from different sources.

**Are assumptions reasonably satisfied?**

I believe that the statistical assumptions were well dealt with in CPUE standardization modeling and surplus production modeling.

However, I believe some residual plots are necessary to evaluate distributional assumptions in CPUE standardization modeling. I also think it is necessary to evaluate whether size/age structure is important in regulating Deep7 bottomfish stock complex dynamics, as one of the most important assumptions implied in surplus production models is that age/size structure will not influence the dynamics. I understand this may not be possible in this study, but it should be considered as a top priority for future research.

Residual plots were nicely done in surplus production modeling to evaluate whether there is a temporal trend. I suggest adding a Q-Q plot to evaluate the distribution of residuals and the possible existence of outliers. I did not see residual plots and Q-Q plots for CPUE standardization modeling, and suggest that it is necessary to evaluate residual distributions for this modeling.

**Are primary sources of uncertainty accounted for?**

I would like to commend the efforts made to consider various sources of uncertainty in this assessment.

These include uncertainty associated with data quality and quantity (catch and CPUE), process and observational errors, and model parameter priors. Information of different sources was used to justify the scenario choices and probability distributions considered in the assessment. The only source of uncertainty seemingly not considered or even mentioned in the assessment was uncertainty in the models used to quantify stock dynamics. I believe the assessment should at least state the potential problems with using surplus production models to quantify the Deep7 bottomfish stock complex dynamics.
Another potential source of uncertainty that was not evaluated in the assessment stems from how MCMC was run. A thinning interval of 4 runs might not be enough for a population model in this assessment with a relatively low burning-in run. I suggest evaluating possible impacts of different thinning intervals (e.g., 50, 100 or 200) on posterior distributions.

Although it is not commonly done for a surplus production model, I recommend that a retrospective analysis be done to evaluate if there exist retrospective errors in the assessment. This should be done at least for the base case scenario. Given uncertainty in the temporal trend in catchability, such an analysis may be very important (Mohn 1999, Chen et al. 2008b).

**IV-4. 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.**

I think the estimation of management biological reference points and their associated uncertainties is scientifically sound. However, I believe the report did not clearly define the target, threshold, and limit reference points and no harvest control rule was defined for the Deep7 bottomfish stock complex.

I could not find an explicit description of target, threshold and limit reference points for either stock biomass or fishing mortality. I suggest that a harvest control rule plot be included in the report to explicitly describe what target and limit (and threshold) reference points are and how these estimated management parameters are used in determining the status of the fishery and stock complex and developing harvest strategies.

Based on my reading of the report I consider this fishery as being managed with MSY-based reference points. Although MSY is stated as biological objective in the management of many fisheries in the USA, the use of MSY in this fishery should be cautious. This is because the stock complex consists of 7 species with different life history processes and some of these species may be more susceptible to overfishing than others. Thus I suggest considering a fishing mortality rate $f_{0.1}$, equivalent to $F_{0.1}$ (as opposed to $F_{\text{max}}$) derived from yield-per-recruit analysis (Chen and Montgomery 1999), instead of $F_{\text{MSY}}$. Similar to the definition of $F_{0.1}$ (i.e., fishing mortality at which the slope of the yield-per-recruit curve is 10% of its maximum slope), $f_{0.1}$ can be defined and estimated from a surplus production model as

$$0.1 \frac{\partial C(F)}{\partial F} \bigg|_{F=f_{0.1}} = \frac{\partial C(F)}{\partial F} \bigg|_{F=0}$$

where $C(F)$ is catch as a function of fishing mortality $F$ that can be derived from surplus production model with the population being in the equilibrium status (in the same way that $F_{\text{MSY}}$ is estimated as $\frac{\partial C(F)}{\partial F} \bigg|_{F=F_{\text{MSY}}} = 0$; Chen and Montgomery 1999). Corresponding stock
biomass can also be estimated. Such reference points may be more appropriate as management targets for the Deep7 bottomfish complex.

No harvest control rule was explicitly defined. No target, threshold or limit biological reference points were explicitly defined for either fishing mortality or stock biomass.

IV-5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status.

_Overall I believe that the approach developed for the short-term (2 years) projection of how the Deep7 bottomfish stock complex may respond to different levels of exploitation is sound. However, if relatively long-term projection (e.g., 10, 20 years) is needed, the approach needs to be modified. A harvest control rule needs to be developed and implementation errors need to be considered in the projection._

The short-term projection was made under different scenarios considered in the assessment. No implementation errors were considered. Risk analysis was done under uncertainty to evaluate the potential risks of overfishing the complex and of the complex itself becoming overfished within the next 1-2 years. However, I found the use of target, threshold or limit reference points in this assessment to be confusing and often not explicit. Estimated stock biomass and fishing mortality were compared with B_{MSY} and F_{MSY}, respectively (e.g., Fig. 20, Brodziak et al. 2011), but 70% F_{MSY} was also mentioned in the assessment report. It was not clear to me how “overfishing” and “overfished stock” were defined in this assessment. I did find limited information in other documents I was given (e.g., Brodziak et al. 2009), but I was not sure if similar rules were used in this assessment. I suggest a clear and explicit definition be included in the stock assessment report.

No long-term projection was done in this assessment.

IV-6. Suggest research priorities to improve our understanding of essential population and fishery dynamics necessary to formulate best management practices. 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.

My biggest concern with this stock assessment is a general lack of consideration of the performance of the surplus production model in quantifying dynamics of the Deep7 bottomfish stock complex. Given implicit model assumptions about the role of size/age structure and relatively long life span of the most abundant species (up to 40 years), use of surplus production models should be questioned. I suggest taking the following steps to evaluate the performance of the surplus production model:

(1) Develop size/age-structured population dynamic models (with exponential survival equation, catch equation and von Bertalanffy growth model; Ricker 1975) for each species, parameterize these models with known (or assumed) life history and fishery
parameters, and use these models as operating models to simulate the dynamics of the Deep7 bottomfish stock complex;
(2) Use the historical fisheries statistics to simulate a fishery using the operating model developed in step (1);
(3) Generate “observed” CPUE and landing data in the simulated fishery with the consideration of different scenarios with respect to process errors in population dynamics and observational errors in catch and effort;
(4) Fit the surplus production model developed in this study to the CPUE and landing data “observed” in the simulated fishery to estimate the dynamics of the simulated Deep7 bottomfish stock complex;
(5) Compare the stock dynamics estimated in Step (4) with the built-in stock dynamics in Steps (1) and (2) to determine the performance of the surplus production model.

The above procedures can also be modified to evaluate the performance of different statistical estimators and to identify key factors (e.g., uncertainty associated with certain data) that may significantly influence the quality of stock assessment. This may lead to efforts to improve quality of key information.

Lack of a fishery-independent survey program also concerns me. Large uncertainty associated with commercial CPUE makes the stock abundance index less reliable. This stock assessment yielded largely similar conclusions about the status of the fishery and the stock under different assumptions regarding uncertainty in the CPUE and catch data. I suspect the following two reasons contributing to such consistent conclusions in the face of large uncertainty in CPUE and catch data: (1) fishery and stock status were indeed healthy; and/or (2) consistent priors given to key model parameters for different scenarios. Clearly this does not mean uncertainty in the data will not be a problem in the future when stock status changes. I recommend the development of a fishery-independent monitoring program to yield a reliable stock abundance index. If this is logistically or financially impossible, I suggest developing an index sampling program with volunteer fishermen fishing in a standard way with good spatial and temporal coverage to develop an abundance index. In either case, these newly derived abundance indices can be compared with those from the commercial fishery.

I also have concerns about seeming lack of consideration of the impacts of priors on the stock assessment. The two most important parameters were assumed to have informative priors, which might lead to underestimation of uncertainty associated with the stock assessment. More studies are needed to evaluate the robustness of the conclusions of this assessment with respect to priors. Relative importance of the priors and observed data (i.e., catch and standardized CPUE) should also be carefully evaluated in the assessment.

Given likely existence of a temporal trend in fishing efficiency, a retrospective analysis is necessary to evaluate possible retrospective error.

An explicit harvest control rule should be developed with target, threshold, and limit references explicitly defined for both stock biomass and fishing mortality. An extensive simulation study may be needed to evaluate the performance of different harvest control
rules/biological reference points in achieving the management objectives of this fishery. The operating model developed for testing the performance of the surplus model can also be used in such a simulation study.

Even though the assessment report suggests that differences in life history are small among the Deep7 bottomfish species, I found such differences were not that small at all with very different life spans, growth, and natural mortality distinguishing these species (Table 2, Brodziak et al. 2011). It seems to me that a single species based stock assessment is the way to go. Given the data available, I believe an age-structured stock assessment model can be developed and used for some species of the Deep7 bottomfish complex. Given the overlapping habitats of these species and the passive gears used in the fishery, differences in catch among these species may reflect differences in their “exploitable” abundances. Ratios of catches of different species aggregated over some space and time may be used to partition fishing efforts in estimating CPUE. This approach can also be evaluated if a fishery-independent monitoring program or an index fishery sampling program can be developed.

V. Conclusions and Recommendations

Overall I believe this assessment update is scientifically sound and adequately addresses most concerns raised in the 2009 review report. In particular, I would like to commend the efforts of Dr. Brodziak and his co-workers to address uncertainty in data quality and quantity in the assessment. However, I believe some important questions (mostly new and not identified in the 2009 review report) have not received enough attention or have not been addressed in this assessment.

In summary, I believe the assessment can be further improved by addressing the following issues:

• Improving documentation of scenarios, priors and quantification of differences in the assessment results among different scenarios;

• Carefully checking WINBUGS codes to avoid errors (constant \( \pi \) is wrongly defined) and including the initial values assigned for all the parameters in WINBUGS source codes so that the sensitivity of stock assessment results can be evaluated regarding to those initial values;

• Evaluating implicit biological assumptions (i.e., roles of size/age structure in regulating population dynamics) associated with the surplus production model with respect to the Deep7 bottomfish life history;

• Evaluating uncertainty in defining priors, considering the impacts of this uncertainty on the assessment, and evaluating the relative importance of priors and data in estimating posterior distributions by comparing prior and posterior distributions for each model parameter;
• Evaluating different thinning intervals in MCMC to determine whether the current thinning interval of 4 runs is sufficient;

• Attempting to incorporate temporal trends in catchability in the observational model so that parameters describing these trends can be estimated through modeling, rather than decided subjectively;

• Fitting the model to the base case data configuration compiled in the 2008 assessment update and comparing the results with those derived for the base case selected in this assessment to quantify differences resulting from changes made in this assessment;

• Explicitly defining target, threshold and limit reference points for stock biomass and fishing mortality;

• Conducting a retrospective analysis to evaluate whether retrospective errors exist in the assessment;

I recommend that future research priorities be focused on the following areas:

• Developing an age/size structured operating model to simulate dynamics of Deep7 stock complex and evaluate the performance of the surplus production model in quantifying these simulated dynamics;

• Developing and evaluating explicit harvest control rules and relevant target, threshold and limit reference points for long-term projection and management of the Deep7 bottomfish complex;

• Developing a fishery-independent monitoring program or an index fishery program to yield a more reliable abundance index and to cross-check standardized CPUE data from the commercial fishery;

• Developing an age/size structured stock assessment framework for individual species.
VI. References


Appendix I: Statement of Work for Dr. Yong Chen

External Independent Peer Review by the Center for Independent Experts

Hawaii Deepslope Bottomfish

Scope of Work and CIE Process: The National Marine Fisheries Service’s (NMFS) Office of Science and Technology coordinates and manages a contract to provide external expertise through the Center for Independent Experts (CIE) to conduct impartial and independent peer reviews of NMFS scientific projects. This Statement of Work (SoW) described herein was established by the NMFS Contracting Officer’s Technical Representative (COTR) and CIE based on the peer review requirements submitted by NMFS Project Contact. CIE reviewers are selected by the CIE Coordination Team and Steering Committee to conduct the peer review of NMFS science with project specific Terms of Reference (ToRs). Each CIE reviewer shall produce a CIE independent peer review report with specific format and content requirements (Annex 1). This SoW describes the work tasks and deliverables of the CIE reviewers for conducting an independent peer review of the following NMFS project.

Project Description: A peer review of the Hawaiian multispecies deepslope bottomfish resource is required using the CIE process. The scientific information and assessment for Hawaiian deepslope bottomfish was peer reviewed in June 2009 providing recommendations to increase the accuracy of the assessment. The objective of this review is to conduct a follow-up peer review to determine if the recommendations have been adequately addressed and adequacy of the revised assessment for management purposes. The assessment has a large potential impact on a valuable fishery important to commercial and recreational fishers in Hawaii and fish consumers in the state. It forms the basis 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.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. Each CIE reviewer’s duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein. The CIE reviewers shall have the expertise, background, and experience to complete an independent peer review in accordance with the SoW and ToRs herein. CIE reviewer expertise shall include fish stock assessment, mathematical modeling, and statistical computing.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Statement of Tasks: The CIE reviewer 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 than 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, and other pertinent information. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

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 reviewers in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

This list of pre-review documents may be updated up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process, including a SoW modification to the schedule of milestones and deliverables. Furthermore, each CIE reviewer is responsible only for the pre-review documents that are delivered to the reviewers in accordance to the SoW scheduled deadlines specified herein.

Desk Review: 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 can not 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. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review 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.

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.

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) Conduct an independent peer review in accordance with the ToRs (Annex 2).
3) No later than 28 January 2011, each CIE reviewer shall submit an independent peer review report addressed to the “Center for Independent Experts,” and sent to Mr. Manoj
Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, 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.

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 January 2011</td>
<td>CIE sends each reviewer contact information to the COTR, who then sends this to the NMFS Project Contact</td>
</tr>
<tr>
<td>7 January 2011</td>
<td>NMFS Project Contact sends the CIE Reviewers the pre-review background documents</td>
</tr>
<tr>
<td>13 January 2011</td>
<td>Project contact provides the CIE reviewers with the report to be peer reviewed</td>
</tr>
<tr>
<td><strong>14-28 January 2011</strong></td>
<td>Each reviewer conducts an independent peer review as a desk review</td>
</tr>
<tr>
<td>28 January 2011</td>
<td>CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator</td>
</tr>
<tr>
<td>11 February 2011</td>
<td>CIE submits CIE independent peer review reports to the COTR</td>
</tr>
<tr>
<td>Feb. 15 2011</td>
<td>The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director</td>
</tr>
</tbody>
</table>

**Modifications to the Statement of Work:** Requests to modify this SoW must be made through the Contracting Officer’s Technical Representative (COTR) who submits the modification for approval to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the CIE within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and Terms of Reference (ToR) of the SoW as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToRs and deliverable schedule are not adversely impacted. The SoW and ToRs cannot be changed once the peer review has begun.

**Acceptance of Deliverables:** Upon review and acceptance of the CIE independent peer review report by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, this report shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (the 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 have 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 report shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

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

**Key Personnel:**

William Michaels, Program Manager, COTR  
NMFS Office of Science and Technology  
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910  
William.Michaels@noaa.gov  
Phone: 301-713-2363 ext 136

Manoj Shivlani, CIE Lead Coordinator  
Northern Taiga Ventures, Inc.  
10600 SW 131st Court, Miami, FL 33186  
shivlanim@bellsouth.net  
Phone: 305-383-4229

**NMFS Project Contact:**

Gerard DiNardo  
Pacific Islands Fisheries Science Center  
2570 Dole Street  
Honolulu, HI 96822-2396  
Robert.Moffitt@noaa.gov  
808-983-5397
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.

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
Annex 2: Terms of Reference for the Peer Review

Hawaii Deepslope Bottomfish

1. Determine if recommendations from the June 2009 WPSAR/CIE review have been adequately addressed within the assessment update.

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

3. 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.

4. 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.

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

6. Suggest research priorities to improve our understanding of essential population and fishery dynamics necessary to formulate best management practices. 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.
Appendix II. List of documents received


Courtney, D. 2011. Review of unreported to reported catch ratios for bottomfish resources in the Main Hawaiian Islands. PIFSC Internal Report, PIFSC, 2570 Dole Street, Honolulu, HI 96822, 10 p.


Prepared by

Neil Klaer

Prepared for

Center for Independent Experts (CIE)

Desktop Review
January/February 2011
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      2.2.5 TOR5 Evaluate the adequacy, appropriateness, and application of the methods used to project future population status.
      2.2.6 TOR6 Suggest research priorities to improve our understanding of essential population and fishery dynamics necessary to formulate best management practices. 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.

Appendix 1: Bibliography of materials provided for review
Appendix 2: A copy of the CIE Statement of Work
Executive Summary

A Western Pacific Stock Assessment Review (WPSAR) examined the 2008 Hawaii deep slope bottomfish assessment update in June 2009. The review found that the assessment required further work on data filtering, investigation of the cause of change in catchability, alternative CPUE standardization and Bayesian model structure, and improvement to the presentation of model selection, diagnostics and sensitivity tests. As a consequence, the assessment was revised and has now been made available for further independent external review. This desktop review of the revised assessment was carried out during the period 18 January to 7 February 2011.

Findings by term of reference

1. Determine if recommendations from the June 2009 WPSAR/CIE review have been adequately addressed within the assessment update.
   
   • The assessment was significantly revised and attempted to address the primary review recommendations. This was partly successful, but the WPSAR highlighted, in particular, the need to examine questions of technological change and historical catch levels in collaboration with Hawaii Division of Aquatic Resources and fishers. As this collaboration is yet to take place, the choices made in the assessment on base case and sensitivity scenarios were not sufficiently justified to be relied upon for management purposes.
   
   • There were a number of additional review recommendations that remain to be addressed.

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

   • The WPSAR/CIE review found that the Bayesian stock production model is an appropriate assessment method that could provide a sound basis for the provision of management advice. I also agree with this view.

3. 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, if assumptions are reasonably satisfied, and primary sources of uncertainty accounted for.

   • An objective procedure was developed to determine cutoff values in data filtering that requires additional documentation.
   
   • The Bayesian production model implementation was acceptable, but insufficient detail was given to justify the choices made in setting prior values and distributions for a number of parameters.

4. Comment on the scientific soundness of the estimated population benchmarks and management parameters (e.g. MSY, $F_{msy}$, $B_{msy}$, 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.

- The MSY-based methods used for reference point calculations are appropriate, and can provide useful management inputs.
- There is a need for harvest control rules to be specified that are likely to attain the management objectives of the fishery in the long-term. Particular difficulties with the main Hawaiian Islands (MHI) Deep7 bottomfish is that the complex combines multiple species with different distributions and biology, the different regional abundance and exploitation patterns within the MHI, and the existence of various fishery closures. There is also a suggestion that species within the Deep7 complex (onaga and ehu) may be overfished. Under these conditions, the development of specific harvest control rules would benefit from simulation testing to determine those that meet management objectives given these difficulties.

5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status.
   - The projection method appears to be appropriate and adequately applied, but requires further documentation.

6. Suggest research priorities to improve our understanding of essential population and fishery dynamics necessary to formulate best management practices. 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.
   - A number of research priorities have been listed.
1 Introduction

1.1 Background

Hawaii deepslope bottomfish are managed under the Magnuson Stevens Act and stock assessments are examined within the Western Pacific Stock Assessment Review (WPSAR) process. The goal of the WPSAR is to provide independent review of input data and stock assessments to ensure the best available stock assessment advice is available for fishery management – particularly the Western Pacific Regional Fishery Management Council (WPRFMC).

The first review under WPSAR that examined the 2008 Hawaii deep slope bottomfish assessment was held from 15-19 June 2009. That 2008 assessment for the period 1948-2007 (Brodziak et al. 2009) updated a previous 2006 assessment for the period 1948-2004 (Moffitt et al. 2006). The review found that the 2008 assessment required more work on data filtering, investigation of the cause of change in catchability, alternative CPUE standardization and Bayesian model structure, and improvement to the presentation of model selection, diagnostics and sensitivity tests. Reports that summarized the review findings were by the WPSAR (Skillman 2009) and the Center for Independent Experts (CIE) (Stokes 2009).

As a consequence, the assessment has been revised (Brodiak et al. 2011) and has now been made available for further independent external review.

1.2 Review Activities

The statement of work for the current review is given in Appendix 2. My role was to provide an external independent desktop peer review in accordance with the statement of work and the terms of reference (TOR) of the review. The review commenced 10 days later than originally planned and took place during the period 18 January to 7 February 2011.
2 Review of the Hawaii deepslope bottomfish assessment

2.1 Terms of reference

The Review considered the assessments in light of the terms of reference provided as follows:

1. Determine if recommendations from the June 2009 WPSAR/CIE review have been adequately addressed within the assessment update.

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

3. 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.

4. Comment on the scientific soundness of the estimated population benchmarks and management parameters (e.g. MSY, $F_{msy}$, $B_{msy}$, 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.

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

6. Suggest research priorities to improve our understanding of essential population and fishery dynamics necessary to formulate best management practices. 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.

2.2 Findings by term of reference

2.2.1 TOR1 Determine if recommendations from the June 2009 WPSAR/CIE review have been adequately addressed within the assessment update.

The assessment was significantly revised and attempted to address the primary review recommendations. This was partly successful, but the WPSAR/CIE review highlighted in particular the need to examine questions of technological change and historical catch levels in collaboration with Hawaii Division of Aquatic Resources (HDAR) and fishers. As this collaboration is yet to take place, the choices made in the assessment on base case and sensitivity scenarios are not sufficiently justified to be relied upon for management purposes. There were a number of additional review recommendations that remain to be addressed.
There were a large number of recommendations made in the WPSAR and CIE review documents. I do not have information on what level of resources were available to address the recommendations, but I can see that addressing all of them would be a considerable undertaking, and not possible in the time between the last and this review.

The CIE reviewer (Stokes 2009) noted which research priorities could be addressed immediately (within a year), and which were short or medium-term. The assessment team has taken those recommendations deemed as immediate to address in particular in the current assessment, which I agree was a reasonable approach. Specifically, those recommendations were:

1. Comprehensively explore main Hawaiian Islands (MHI) CPUE data and qualitative information in close collaboration with HDAR and fishers throughout the process. Develop credible CPUE standardization, including if appropriate alternative indices.
2. Attempt to reconstruct non-commercial catch histories, possibly in the same collaborative process used for (1).
3. Consider using meta-data to develop informative prior on $R_{\text{max}}$. Develop prior for $B_{\text{init}}$ in collaborative process above (1).
4. Assess MHI as single stock to develop population benchmarks and management parameters. Ensure appropriate sensitivity testing to CPUE uncertainty.

Rather than a comprehensive exploration (including input from fishers), the input data for standardization was subjected to a re-audit. Rules used to filter the data were re-examined, and an objective method for selecting bottomfish trips from the handline data was developed. Development of a credible CPUE standardization was approached primarily through the development of a number of alternative series that accounted for uncertainty in changes in fishing power through time, inclusion of 1958-1960 data, and alternative model structural approaches (delta-GLM, quasi-likelihood Poisson GLM). Interaction between model terms was examined, and a base model chosen that included an area-season interaction. The model with negligible change in fishing power through time was selected as the base model because the WPSAR review panel viewed models with increases as unsupported by data, and ad hoc, and WPRFMC used this model in post hoc modeling of the 2008 assessment. There is still a need to examine alternative scenarios in close collaboration with DAR and industry (including recreational fishers), and I believe this should also include group sign-off on the most appropriate base case, and acceptable alternatives for sensitivity testing. Group sign-off was not specifically recommended by the WPSAR/CIE review, but is a logical outcome of such collaboration, and greatly assists with the provision of justification for a base case and plausible sensitivities, and also with industry acceptance of the assessment and any management consequences.

The second recommendation was examined through the development of four scenarios of unreported catch to characterize that uncertainty, ranging from none to 550,000lb/y in recent years. The catch scenario used for the base case assumed moderate recent unreported catch of 240,000lb/y. A consultative reconstruction was not included in the documents, so I assume has not yet been undertaken, although a new review of alternative scenarios (Courtney) was provided. While it appears that a useful range of scenarios have been constructed, reasons for selection of one of them as the best...
available estimate were not developed. I believe such a decision still needs to be made in a collaboration as above, and the reasons documented.

The third recommendation was addressed through concentration of the assessment on MHI Deep7 bottomfish species only, thereby somewhat reducing the uncertainty in the development of priors for $R$ and initial biomass levels. The value for $R$ for Deep7 bottomfish was revised based on recent information about the longevity of the species that forms the greatest portion of that complex, and mean values for the 1949 biomass as a proportion of carrying capacity were derived from posterior mean values.

The MHI Deep7 complex was assessed following the fourth recommendation. Sensitivity testing to CPUE uncertainty was carried out.

A more detailed examination of recommendations and responses to individual issues follows.

I have extracted recommendations common to the WPSAR and CIE reports, and also recommendations made in each individual report, or where the recommendation on an item differed in the details. In the detailed examination below, specific recommendations from the WPSAR and CIE reports are shown as italicized text, and the response in the most recent assessment as normal text.

**Common recommendations**

**CPUE data set creation**

*Create a data set with catches $>0$ and $<1500$ lbs (as currently filtered).*

This was used previously as an initial filter to handline trips to exclude those that caught no bottomfish, and multi-day trips.

*Compute the ratio $\frac{\text{Catch}_{\text{BMUS}}}{\text{Catch}_{\text{all species}}}$ as a possible index of targeting and add to data set.*

The current standardization examined CPUE of the combined Deep7 species only (and additional zero catches as a sensitivity). Targeting was not examined specifically.

*For the assessment catch, remove ta’ape, kahala, armorhead and any non-BMUS.*

Only Deep7 species were examined, so the above species were excluded.

**CPUE data exploration**

*Explore all data comprehensively using, for example, regression trees to help identify factors that could be included in the data standardization model. Possible factors might include depth (inshore/offshore), targeting, technology changes, spatial variability due to aggregating statistical fishing areas, and environmental effects.*

A specific exploration of additional factors was not reported in the documentation. Factors from the data included in the CPUE standardization were those that were
reported consistently in all years – the HDAR area and month (aggregated in various ways).

**CPUE standardization model**

*Use Fishing Year, Month, and some scientifically defensible definition of fishing area and interactions between those factors.*

Standardization models that included the factors year, month or quarter, and HDAR fishing area or island group were examined under CPUE scenario I and AIC used to select the best model. The structure chosen using that approach included year, HDAR area, quarter and HDAR area x quarter interactions.

*Investigate aggregating the HDAR statistical areas into 4 main MHI island groups.*

The model selection process above concluded that aggregation of HDAR areas 100-128, 300-333, 400-429 and 500-528 into a simplified 4 island grouping was sub-optimal according to the AIC criteria. Uncombined HDAR areas were therefore used for the base model.

*If using the C parameter for technological changes in catchability, use this as an offset in the standardization.*

The change in fishing power was applied directly to the observations in the assessment, which is comparable to using an offset.

*Preferably put factors/variables for fishing power directly in the CPUE standardization model even if applied to all records in a year.*

Change in fishing power was dealt with under three CPUE scenarios. The first assumed that there was no change in fishing power through time (CPUE I), the second with no change 1949-1970, 0.25%/y 1971-1980, 0.5%/y 1981-1990, 0.25%/y 1991-2000 and no change 2001-2010 (CPUE II), and 1.2%/y since the 1950s (CPUE III). Rates for CPUE II were derived from values collected from fishers during interviews and the subsequent CPUE workshop (Moffitt et al. 2008), and CPUE III was similar to the scenario used for the 2006 and 2009 assessments. The annual power factor was multiplied by the CPUE observations and then used as input to the standardization.

*Investigate various environmental factors, for example SST and SSH.*

A separate investigation (Lee and Brodziak) was made of the correlation of MHI deep slope bottomfish CPUE (CPUE I from the assessment report) and the southern oscillation index, Pacific decadal oscillation (PDO), sea surface temperature and sea surface height. The report concluded that the CPUE was significantly negatively correlated with PDO, and that both CPUE and PDO showed autocorrelation. There was also a negative association between the CPUE and 1-year lag PDO. No effort has been made to incorporate environmental variables in the stock assessment at this stage, although it would be difficult to do so based on these initial results. The demonstration of correlation would normally need to be accompanied by some understanding of the
linkage mechanism before it could be incorporated in a base case assessment, although sensitivities could be investigated.

*Flag the years 1958-1960 inclusive as bad due to data errors and treat as outliers (i.e., fit dummy variables [1,0] to identify bad years).*

The specific recommendation was not followed, but sensitivity to the inclusion of the 1958-1960 data was examined using CPUE standardization CPUE 1b, and data from these years were excluded for all other CPUE analyses.

**Stock assessment**

Stock assessment documents should follow a standard format (such as the recently developed for the Bering Sea and Aleutian Islands Crab SAFE Report).

The assessment generally followed the structure of the previous report. I agree that a standard such as the Crab Safe (2009) is a good one, and that there is still a need to adopt such a standard for the assessment documentation.

*Combined plots of priors and posteriors for model parameters should be provided, as well as posterior plots of management indicators (e.g. $B_{\text{current}}/B_{\text{msy}}$, $F_{\text{current}}/F_{\text{msy}}$). MCMC evidence of model convergence should be given.*

These plots were not provided. It would have been useful if they were, especially for the baseline model from Table 19 of the assessment report. The posterior plots of management indicators, or at least indicators of the error range should be provided (e.g. in Table 13). The errors for parameters directly estimated are given, but it is the derived quantities that are important for management.

Model convergence was investigated using the Geweke convergence diagnostic, the Gelman and Rubin diagnostic and the Heidelberger and Welch stationarity and half-width tests for key model parameters. Overall, these diagnostic tests supported the convergence of the base case and all of the sensitivities. These results were discussed in the text of the assessment report, but it would have been useful to provide the values for the diagnostic results (particularly the Geweke) in a table. No diagnostic MCMC plots were produced.

*As a potentially independent measure of stock status, undertake length frequency sampling and use past data to calculate SPR or an SPR proxy by species.*

This has not been investigated.

*Investigate the use of a hierarchical Bayesian stock production model, with a multilevel $R_{\text{max}}$ to account for different biological characteristics of species in the complex, and time-varying $R_{\text{max}}$ to account for changing species composition through time (worthy of investigation but not the highest priority).*

The Deep7 complex was dealt with as a single group, so species-specific $R$ values were not investigated at this stage. A model that estimated $R$ values using a multi-level prior for annual and overall mean values was examined. However, that model was rejected.
using Bayesian information criteria (over a range of sensitivity tests) in favor of the simple model with a single R value.

New information from bomb radiocarbon analysis for the most abundant Deep7 species opakapaka (A. Andrews, PIFSC, unpublished data) suggested a maximum age in the order of 40 years, and a corresponding natural mortality rate of about 0.1. This new information was used to revise the $R_{\text{max}}$ estimate used in the 2008 assessment downwards from 0.45 to a range 0.05-0.15 for the Deep7 complex.

There is a need to improve documentation and especially explanations as to how and why decisions have been made in the past (e.g. values for the technology change parameter C).

Changes in fishing power was dealt with as a number of alternative scenarios (CPUE I – III). It remains difficult to judge the relative plausibility of those scenarios because of a lack of documentation of the procedures used to convert observations of methods used through time (as in Moffitt et al. 2008) to annual indices of fishing power.

Include sensitivity analyses of the technology coefficient, habitat ratios and initial biomass. Show key management indicators such as $B_{2007}/B_{\text{msy}}$, $F_{2007}/F_{\text{msy}}$ in the sensitivity analysis table.

Sensitivity analysis results were given for alternative CPUE (accounting for different technology changes) and catch history (accounting for various levels of unreported catch) scenarios. Habitat ratios were not relevant to the analysis as it was MHI only. For the CPUE x catch scenario sensitivities (Table 13 – 14.3), management indicators rel$H_{2010}$ and rel$B_{2010}$ were given.

As the fishery will shortly cease in the NWHI region, the assessment should now focus on the MHI as a single stock.

The 2010 assessment update applies to the MHI region only.

In the medium term, a model that spatially resolves island-specific population structure may be developed. Further research is required to parameterize the spatial aspects of such a model.

An island-specific model has not yet been investigated.

WPSAR

Generalized Linear Mixed Models (GLMM) and Generalized Additive Models (GAM) that are formulated to include spatial and temporal effects, technological changes and other factors affecting catchability are recommended in preference to Generalized Linear Models (GLM). Investigate including a vessel size effect, and alternative spatial schemes.

Log-linear models were the primary standardization method used for the assessment. Alternative CPUE standardization models were examined as a sensitivity analysis using the observed Deep7 single-trip handline data under CPUE Scenario I (no change in
fishing power through time). The first included data from 1958-1960 in the analysis (CPUE 1b), the second applied a two-stage delta model to data that included zero catches for Deep7 species (CPUE IV), and the third used a quasi-likelihood Poisson-GLM approach (CPUE V). GLMMs or GAMs were not examined.

Given the biological differences in the bottomfish species, separate Bayesian assessments should be carried out for (a) the two species most likely to be overfished (onaga and ehu) and the remaining deep slope bottomfish, (b) combined Deep7 bottomfish, and remaining deep slope bottomfish (c) fast growing snappers and slow growing snappers.

The assessment only considers combined Deep7 species.

Account for potentially significant levels of unreported catch.

Four scenarios of unreported catch were developed using published estimates and other sources, which were assumed to characterize the uncertainty. Catch scenarios I-IV were in order of decreasing levels of non-reporting, from 550,000lb/y to 0lb/y recently. Catch scenario II was used by the assessment team for the base case.

Use distributions rather than point priors for habitat ratios (MHI, Mau and Ho’omalu), undertake a meta-analysis for priors for R, K and the habitat ratios. Investigate other possible data sources such as oral histories or auction data for priors on initial biomass.

Only the MHI region was used in the analysis. Additional biological information for opakapaka was used to develop a prior distribution for R for that species, which was then used for the Deep7 complex. The assessment states that there is limited quantitative information on life history parameters for the Deep7 bottomfish. A meta-analysis is still justified however – if only to look at related species, and for information on initial biomass.

The Council and SSC should provide guidance to the assessment team on control rules and therefore assessment outputs.

Additional documentation on specific guidance from the Council or SSC was not available. There is considerable scope for the testing and development of specific harvest control rules for the conversion of MHI Deep7 assessment advice into catch recommendations.

CIE

A credible CPUE model is likely to require either Generalized Linear Mixed Models (GLMMs) or Generalized Additive Mixed Models (GAMMs) formulated to include spatial and temporal effects, technological changes, and other quantitative and qualitative factors affecting catchability. This is because a mixed model will allow investigation of correlation structure in the year effects as well as interactions, not just main effects of Year, Month, and Area. Some concern was noted in the review that attempts to include interactions, especially with area, would lead to unbalanced models. The simple way to deal with this issue, if it is important, is to bin data differently by area or, for example, to bin by quarter instead of month. Exploration is required.
GLMMs or GAMs have not yet been examined.

*Future workshops should include more commercial and non-commercial fishers to link qualitative information and quantitative models to better understand the catch rates and catch history.*

There does not appear to have been any workshops on catch rates or catch history with fisher participation since the last assessment.

*Fully explain the rationale and limitations of the species complex selected for assessment.*

The assessment now concentrates on the MHI Deep7 complex alone. Assessment documentation describes the lack of comprehensive biological information for all 7 species, and the reasoning for the use of a low $R$ for the complex.

*Consideration should be given to whether it is feasible to undertake separate assessments (including relevant CPUE analyses) of species most likely to be overfished (onaga and ehu). Alternatively, or possibly in addition, an assessment of the Deep7 complex could be attempted to set a Deep7 total allowable catch (TAC) directly, rather than by taking a multiplier from the BMUS assessment derived catch limit. It is not at all clear that working directly to derive a Deep7 TAC would result in a higher or lower TAC. Alternative assessment splits might also be explored based on life history and fishery characteristics as well as data availability.*

The assessment now concentrates on Deep7 species. The problem of having species that may be overfished that form a minor part of the Deep7 complex is a difficult one. There needs to be clear management objectives for species or groups of species within the Deep7 complex, and either the ability to carry out more species-specific assessments, or a demonstration that the current management procedure for the complex should achieve management objectives for the component species or groups.

*Both in the assessment documents and presentations, only limited diagnostics were provided on CPUE standardization or the stock assessment. For the future, it is essential to see good diagnostics of both the CPUE standardization and the Bayesian stock assessment. For the assessment, it is important to see how the likelihood components are affected by model assumptions and parameterisation; to compare directly posterior and prior distributions (graphically on the same plots); and convergence performance, graphically as multiple traces and as standard convergence statistics. It is always useful to see the convergence diagnostics not just for main parameters but also for the derived parameters ($F_{status}$ and $B_{status}$).*

Most of these recommendations still apply, and there is a need to provide additional diagnostic information – particularly for the selected base case, and evidence of convergence at least as tables for all cases including sensitivities.

*While analyzing data to develop a credible CPUE index, it would be worthwhile exploring in detail whether it is possible to disaggregate data by area sufficient to*
develop area specific CPUE and assessments. Although this would be a useful exploration, the priority should be on development of a credible single area MHI.

Area specific CPUE indices within the MHI area have not been examined at this stage, although HDAR area and island groupings of them were included as factors in the standardization.

2.2.2 TOR2 Review the assessment methods used: determine if they are reliable, properly applied, and adequate and appropriate for the species, fisheries, and available data.

The WPSAR and CIE review reports both agree that the Bayesian stock production model is an appropriate assessment method that could provide a sound basis for the provision of management advice. I also agree with this view.

2.2.3 TOR3 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.

Implementation of the assessment methods can be divided into data preparation, CPUE standardization and Bayesian stock production model for discussion on each of these components separately.

Data preparation

An aspect of data filtering that did not attract specific review recommendations previously was the cutoff fraction used to determine which handline trips were bottomfish ones. Earlier values for this fraction were 90% in the 2005 assessment and 50% in the assessment update. An objective procedure was developed for the current assessment that maximized total catch weight and value captured by filtered records, while minimizing catch and value variation. The new cutoff values obtained were 29% for bottomfish and 17% for Deep7 species. The development of such a procedure is acceptable, but the documentation of it requires further work. To me it is unclear how the catch value was calculated (e.g. were historical sales records used, or recent values assumed to apply for all years?), and whether an objective function that treats proportions of total catch/value and CV ratios as equally important can be justified (and what alternatives may also be appropriate). The importance of change to the cutoff value is one that needs to be included as a sensitivity analysis of the assessment results.

CPUE standardization

An issue in the standardization was the necessary removal of zero catches because it was recognized that reporting practices had changed through time. Both the WPSAR and CIE reviews agreed that this was not optimal, but the approach was appropriate. Additional work was carried out to examine the effect of zero catches (Piner and Lee) using a two-stage delta standardization procedure. It was noted that 98% of the MHI
observations from 1948-2011 used in the analysis were non-zero for the Deep7 species, so the effect of non-zero catches was small.

Until further investigation of factors other than year, month or quarter, and HDAR fishing area or island group (e.g. depth, factors affecting technological change and catchability) take place, the simple log-linear model and the model selection process used in the assessment is appropriate. I agree with the previous review that a more rigorous investigation of additional factors that affect the catch rate is required and that it should also take place in consultation with HDAR and industry. I am unable to predict whether additional useful factors that apply to all/most of the data would result from such a process, and how the analysis would be improved by the implementation using GLMM or GAM. I believe that it is uncertain whether this issue can be resolved in the short-term, but should be attempted if resources are available.

**Bayesian stock production model**

The 2008 update assessment was found to be unsatisfactory primarily because of poor quality of input data – particularly the standardized CPUE and total catch series and limited stock assessment diagnostics and sensitivity testing.

The current assessment update was limited to the MHI Deep7 complex alone, which addresses a number of difficult issues in examining the wider management regions, and additional species. The remaining major difficulties of estimation of unreported catch, and accounting for technological change affecting catchability have been dealt with as sensitivity scenarios.

A number of additional changes have been made to the production model structure, some of which were possible or necessary because the assessment concentrated on the Deep7 species complex:

- The assessment method included a production shape parameter $M$ (and an associated prior), where values other than 1 move the surplus production peak away from $0.5K$.

- Previously the prior for $K$ was essentially uninformative, but the most recent assessment imposed a mean value of 18.0 million pounds and CV of 50% for high catch scenarios and a mean of 9.0 million pounds and CV of 25% for low catch scenarios.

- A different distribution was used for the prior for $R$ (now lognormal rather than beta). The mean value for $R$ was set to 0.1 based on previously published recommendations about the low productivity of Deep7 species, and new information about the expected life span of opakapaka, and the CV set to 25% - changes that essentially restricted $R$ to the range of 0.05 to 0.15. The previous assessment used a mean value of 0.46 and a CV of 26%.

- The prior distribution for catchability was changed, but remained essentially uninformative as previously.
• The prior for process error variance was increased substantially compared to that used previously, and observation error was set to 10 times process error rather than +40% previously.

While all of these changes seem acceptable, the assessment documentation needs to include convincing reasons for making those choices rather than alternative ones – particularly where the choice has a significant effect on the results. For example, the discussion about the rejection of a multi-level R value had a sufficient reason and detail to be convincing.

Tables 13 – 14.3 generally indicate that $M$ was very poorly estimated which suggests that a fixed value for this parameter is probably required (and sensitivity investigated if values other than 1 are used).

The sensitivity of the new cutoff fraction was not investigated.

Overall, the Bayesian production model implementation was acceptable, but insufficient detail was given to justify the choices made in setting prior values and distributions for a number of parameters.

2.2.4 TOR4 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.

The management objectives of the WPRFMC bottomfish fishery management plan are to (from Ralston et al. 2004):

• maintain opportunities for fishing experiences by small-scale commercial, recreational, and subsistence fishermen, including native Pacific islanders
• protect stocks from environmentally destructive fishing practices
• improve quality and quantity of data available for fisheries management
• maintain year-round supply of fresh fish in Hawaii
• maintain a balance between harvest capacity and harvestable fishery stocks to prevent over-capitalization

The WPRFMC has relied on a two main assessment approaches previously to provide information on stock status and to assist in setting catch limits for Hawaiian bottomfish – CPUE based SPR, and dynamic production models. The current assessment does not examine SPR, and provides management advice in the form of MSY-based reference points. Specifically these are $B_{\text{current}}/B_{\text{MSY}}$, $H_{\text{current}}/H_{\text{MSY}}$, and short-term probability of the exploitable biomass exceeding the limit of 0.7$B_{\text{MSY}}$, and probability of the harvest rate exceeding $H_{\text{MSY}}$ under different future catch scenarios. The methods used for the stock assessment and reference point calculations are appropriate, and can provide useful management inputs. However, as the current assessment requires further work, it can not currently be used for management advice.

I could not find specific control rules used by management to convert the reference point information from the current assessment method (e.g. short-term probability of being overfished) into a TAC (recognizing that these are guided by legislation such as
the Magnuson-Stevens Act Overfishing Provisions, and the WPRFMC Bottomfish Fishery Management Plan. There is a need for harvest control rules to be specified that are likely to attain the management objectives of the fishery in the long-term. Particular difficulties with the MHI Deep7 bottomfish is that the complex combines multiple species with different distributions and biology, the different regional abundance and exploitation patterns within the MHI, and the existence of various fishery closures. Of note also is the suggestion that species within the Deep7 complex (onaga and ehu) may be overfished. Under these conditions, the development of specific harvest control rules would benefit from simulation testing to determine those that meet management objectives given these difficulties. An often used framework for such testing is management strategy evaluation.

2.2.5 TOR5 Evaluate the adequacy, appropriateness, and application of the methods used to project future population status.

The analytical approach was closely tied to the assessment procedure, and involves the forward application of the production model with known catches. This procedure is adequate for projection purposes. However, the assessment documentation does not describe the projection method in detail, and does not describe how the various underreporting scenarios are implemented within the projections.

2.2.6 TOR6 Suggest research priorities to improve our understanding of essential population and fishery dynamics necessary to formulate best management practices. 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.

I have compiled a set of research priorities, some of which reiterate those made by the previous review. I have also categorized them into those that could be undertaken in the short-term to produce an assessment that could be used to make management recommendations, and more medium-term recommendations.

Short-term

1. Form a data advisory group that consists of HDAR personnel, fishers with knowledge of the fishery history, other relevant government MHI Deep7 data and CPUE experts and the assessment team or representatives. Whether formally constructed or not (from formal meetings/workshops to an email group), this group should have the capacity to sign off on the best available scenario to be used for a base case stock assessment, and also a plausible range of alternatives to be used for sensitivity testing. Such decisions should include the participation of fishers especially, both to give credibility to assessment inputs, and to assist in acceptance of assessment results and any subsequent management actions.

2. Use the data advisory group to review in particular the methods used to filter data going into the CPUE analysis, the scenarios of technological improvement, and the scenarios for underreporting. Such a group is best placed to decide which of these are the best estimates currently available and should be used for a base case assessment. The group should also consider whether the alternative
scenarios developed by the assessment team reasonably characterize the uncertainty.

3. The assessment documentation should be improved to better justify the choices made in setting model priors, to better demonstrate model convergence particularly for the base case, to document the projection procedure, to show errors values for quantities of interest to management in the results, and to show the effect on management quantities of all sensitivities investigated. A summary table of sensitivity results should include for the base case and all sensitivities, as columns: principal direct estimates ($K$, $R$, $M$, $Q$), principal derived quantities (e.g. $B_{MSY}$, TAC 25%OF2012, TAC 50%OF2012, $B_{2013}/B_{MSY}$) and individual objective function components (perhaps as a separate table if getting too wide). A comprehensive sensitivity table should include CPUE and catch scenarios as well as alternative model assumptions about model formulations, parameter means and priors. Developing national standards in stock assessment documentation should be implemented.

Medium-term

4. Investigate additional factors that affect the catch rate in consultation with HDAR and industry, and consider standardization using GLMM or GAM.

5. Develop specific harvest control rules for the conversion of MHI Deep7 assessment advice into TACs. Simulation-test the control rules for robustness to uncertainty, and achievement of management goals, particularly given the multispecies nature and spatial heterogeneity of the assessed stock.

6. The problem of having species that may be overfished that form a minor part of the Deep7 complex requires addressing. There needs to be clear management objectives for species or groups of species within the Deep7 complex, and either the ability to carry out more species-specific assessments, or a demonstration that the current management procedure for the complex should achieve management objectives for the component species or groups.

7. Develop systems to improve the collection of non-commercial catch information.

8. Continue research to develop informative priors for $R$, $K$ and 1949 proportions of $K$.

9. Consider length frequency sampling for the development of species-specific stock indicators, or movement of the assessment to length/age based approaches.

10. Investigate the utility of a metapopulation assessment model, with a spatially resolved island-specific structure (Hawaii, Maui complex, Oahu, Kauai), to better address island-specific fisheries risk as well as local and regional management options.
11. If the management measures are shown to be sensitive to dispersal rate, then get better species dispersal information to support the potential use of metapopulation assessment model.

References

# Appendix 1: Bibliography of materials provided for review

## Hawaii Deepslope Bottomfish

### Review Document List

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<td>CPUE Standardization Workshop Proceedings August 4-6, 2008</td>
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Appendix 2: A copy of the CIE Statement of Work

Statement of Work for Dr. Neil Klaer

External Independent Peer Review by the Center for Independent Experts

Hawaii Deepslope Bottomfish

Scope of Work and CIE Process: The National Marine Fisheries Service’s (NMFS) Office of Science and Technology coordinates and manages a contract to provide external expertise through the Center for Independent Experts (CIE) to conduct impartial and independent peer reviews of NMFS scientific projects. This Statement of Work (SoW) described herein was established by the NMFS Contracting Officer’s Technical Representative (COTR) and CIE based on the peer review requirements submitted by NMFS Project Contact. CIE reviewers are selected by the CIE Coordination Team and Steering Committee to conduct the peer review of NMFS science with project specific Terms of Reference (ToRs). Each CIE reviewer shall produce a CIE independent peer review report with specific format and content requirements (Annex 1). This SoW describes the work tasks and deliverables of the CIE reviewers for conducting an independent peer review of the following NMFS project.

Project Description: A peer review of the Hawaiian multispecies deepslope bottomfish resource is required using the CIE process. The scientific information and assessment for Hawaiian deepslope bottomfish was peer reviewed in June 2009 providing recommendations to increase the accuracy of the assessment. The objective of this review is to conduct a follow-up peer review to determine if the recommendations have been adequacy addressed and adequacy of the revised assessment for management purposes. The assessment has a large potential impact on a valuable fishery important to commercial and recreational fishers in Hawaii and fish consumers in the state. It forms the basis 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.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. Each CIE reviewer’s duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein. The CIE reviewers shall have the expertise, background, and experience to complete an independent peer review in accordance with the SoW and ToRs herein. CIE reviewer expertise shall include fish stock assessment, mathematical modeling, and statistical computing.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Statement of Tasks: The CIE reviewer 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, and other pertinent information. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

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 reviewers in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

This list of pre-review documents may be updated up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process, including a SoW modification to the schedule of milestones and deliverables. Furthermore, each CIE reviewer is responsible only for the pre-review documents that are delivered to the reviewers in accordance to the SoW scheduled deadlines specified herein.

Desk Review: 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 can not 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. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review 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.

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.

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) Conduct an independent peer review in accordance with the ToRs (Annex 2).
3) No later than 28 January 2011, each CIE reviewer shall submit an independent peer review report addressed to the “Center for Independent Experts,” and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, 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.
CIE sends each reviewer contact information to the COTR, who then sends this to the NMFS Project Contact

NMFS Project Contact sends the CIE Reviewers the pre-review background documents

Project contact provides the CIE reviewers with the report to be peer reviewed

Each reviewer conducts an independent peer review as a desk review

CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator

CIE submits CIE independent peer review reports to the COTR

The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

**Modifications to the Statement of Work:** Requests to modify this SoW must be made through the Contracting Officer’s Technical Representative (COTR) who submits the modification for approval to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the CIE within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and Terms of Reference (ToR) of the SoW as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToRs and deliverable schedule are not adversely impacted. The SoW and ToRs cannot be changed once the peer review has begun.

**Acceptance of Deliverables:** Upon review and acceptance of the CIE independent peer review report by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, this report shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (the 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 have 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 report shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

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

William Michaels, Program Manager, COTR  
NMFS Office of Science and Technology  
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910  
William.Michaels@noaa.gov  
Phone: 301-713-2363 ext 136

Manoj Shivlani, CIE Lead Coordinator  
Northern Taiga Ventures, Inc.  
10600 SW 131st Court, Miami, FL 33186  
shivlanim@bellsouth.net  
Phone: 305-383-4229

NMFS Project Contact:

Gerard DiNardo  
Pacific Islands Fisheries Science Center  
2570 Dole Street  
Honolulu, HI 96822-2396  
Robert.Moffitt@noaa.gov  
808-983-5397
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.

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
Annex 2: Terms of Reference for the Peer Review

Hawaii Deepslope Bottomfish

1. Determine if recommendations from the June 2009 WPSAR/CIE review have been adequately addressed within the assessment update.

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

3. 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.

4. 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.

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

6. Suggest research priorities to improve our understanding of essential population and fishery dynamics necessary to formulate best management practices. 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.
Report on Hawaii Deepslope Bottomfish

Prepared for the Center for Independent Experts
By

Stephen J. Smith
383 Portland Hills Drive
Dartmouth, Nova Scotia
Canada B2W 6R4
smithsj@eastlink.ca
EXECUTIVE SUMMARY

A Center of Independent Experts (CIE) review panel was convened to conduct a desk review of a stock assessment of the Hawaiian multispecies deepslope bottomfish resource. The current assessment provided an update to the previous analysis which had been reviewed in 2009 within the Western Pacific Stock Assessment Review (WPSAR) process. The previous review had identified a number of issues concerning data, analysis methods and model assumptions that limited the usefulness of the assessment to support management of the resource.

The current stock assessment has made some improvements over the version reviewed in 2009. However, there continue to be a number of issues that need to be addressed before the assessment should be accepted as support for management. The first recommendation from the previous panel on providing a credible CPUE standardization was not adequately dealt with here. A re-analysis of the CPUE data taking into account the issues raised above will be required. A number of serious issues concerning the Bayesian surplus production model were identified here. Further work is required here to clean up the modeling as was presented here. The assessment needs to properly deal with the previous recommendations plus the additional issues identified here before any evaluation is conducted of the use of these data for monitoring the population dynamics of the species in the Deep 7 bottomfish group.

BACKGROUND

In 2009, a stock assessment of the Hawaiian multispecies deepslope bottomfish resource was peer reviewed within the Western Pacific Stock Assessment Review (WPSAR) process. This process is a collaborative initiative of the NOAA Pacific Islands Fisheries Science Center (PIFSC), the Western Pacific Fishery Management Council (WPFMC), and the NOAA Pacific Islands Regional Office (PIRO). As a result of this review a number of recommendations were made with respect to improving the analysis of the data and improving the models used in the assessment. The objective of the current review was to conduct a follow-up peer review to determine if the recommendations have been adequately addressed and adequacy of the revised assessment for management purposes. Unlike the first review in which participants met in Hawaii to conduct the review, this review was conducted independently by three CIE reviewers within their individual home locales.

DESCRIPTION OF THE INDIVIDUAL REVIEWER'S ROLE IN THE REVIEW ACTIVITIES

This review was established to be a desk review (Appendix) and therefore solely dependent upon the background and assessment documentation as supplied. Originally, all background documents were to be sent by January 7 with the assessment document to follow on January 13. We were notified that there was going to be a delay in providing the material and the background information began arriving on January 17 with the assessment document actually arriving by email on January 21. The work schedule was adjusted so that the review report would be due on February 7.
SUMMARY OF FINDINGS BY TERM OF REFERENCE

1. Determine if recommendations from the June 2009 WPSAR/CIE review have been adequately addressed within the assessment update.

   The assessment document (Brodziak et al. 2010) lists the following as the recommendations to be addressed in the assessment update. These correspond to those determined as needed to be done in the immediate term in the previous CIE review (Stokes, 2009). The short and medium term recommendations were not explicitly addressed in the assessment document.

1.1. Comprehensively explore MHI CPUE data and qualitative information in close collaboration with HDAR and fishers throughout the process. Develop credible CPUE standardization, including if appropriate alternative indices.

   The issue of what constitutes a bottomfish trip was discussed in the 2009 WPSAR/CIE review. The 2008 stock assessment had used the condition that 50% or more of the total catch of trip had to be bottomfish. This approach was not criticised per se by the panel but justification was sought based on the differences in results when all of the data was used. In the current document a new rule was developed using an objective function comprised of functions of variability of the catch and bottomfish sale value per trip, as well as the proportion of the total bottomfish catch and value of the bottomfish catch. It is difficult to determine whether this was a sensible approach because few details were given. It is not clear if all of the data over all years are used or if this was done year by year. Would area or quarter/seasonal differences be important here? It is difficult to know if there are time trends in the variability of bottomfish sale value that could complicate this measure. In addition it is unknown what the maxCV measures are calculated from, i.e., by area, quarter or year or over the whole data series.

   The final base level model for the CPUE data was determined to include fishing year, area, quarter, and area by quarter interaction terms in the linear predictor (Table 8, Brodziak et al. 2010).\footnote{The text on page 13 Brodziak et al. (2010) refers to Single-R and multilevel R models which are out of place when discussing to the CPUE models; probably a cut-and-paste error. Text also states that \( \Delta AIC > 200 \) for all models but this was not true as \( \Delta AIC=133.5 \) for the \( Y+A+Q+Y*Q \) model.} The text does not explain how the interaction term was used in the construction of the standardized CPUE series. Main effects standardizations are straightforward to interpret because the annual trend would be parallel for the different areas and quarters when treated as main effects only. However, the implication of an interaction term is that these annual trends are no longer parallel and there will be different trends for different combinations of area and quarter. No information was presented in the documents about how different the trends were by area/quarter so it is impossible to assess the impact of the interaction terms on the annual trend.

   Note that the “delta-glm” model of Piner and Lee (2010) did not include interaction terms. I do not know if the Poisson model referred to on page 14 of Brodziak et al.
Pine and Lee (2010) used all of the single-trip Deep7 bottomfish handline gear dataset while Brodziak et al. (2010) used their 17% cutoff rule. Although not stated, the entire single trip data set was probably used for the Poisson model as zero records were included. Brodziak et al. (2010) stated that separate Poisson models were fit to the series pre- and post-1990, although 1989 was the breakpoint for the change in recording zero catches.

Piner and Lee (2010) refer to Lo et al. (1992) as their source for their binomial/lognormal “delta” model. Lo et al. (1992, eqn. 6) did not use a binomial model for the proportion of non-zero records, \( P_k \) and instead used an additional lognormal model for \( \log(P_k+1) \). It was not clear how the jackknife method for estimating variances worked here but the authors may want to consult Candy (2004) on the application of Tweedie models to these kinds of data. Tweedie models augment positive valued distributions with zeroes in a generalized linear model approach allowing for model based estimates of variances. There is an R package available at http://www.r-project.org/package=tweedie.

The current stock assessment developed two CPUE scenarios (II and III) where fishing power was set as increasing functions over time. In the text on page 12, the authors state that “the annual incremental changes in fishing power (\( \delta_T \)) were applied to adjust observed CPUE prior to fitting a CPUE standardization model as recommended by the WPSAR panel (Stokes, 2009).” Adjustments to the observed CPUE were made as follows.

\[
CPUE_{ADJ,T} = CPUE_{OBS,T}/(1 + \sum_{i=1}^{T} \delta_i).
\]

In fact, Stokes (2009) recommended that changes in power be modeled as an offset term which is not the same as dividing by the adjustment above. The above procedure will result in the CPUE\(_{ADJ}\) series having a smaller variance than the original series, that is

\[
Var(CPUE_{ADJ,T}) = (1 + \sum_{i=1}^{T} \delta_i)^{-2} Var(CPUE_{OBS,T}).
\]

This decrease in variance will become more pronounced in the more recent years as the correction term gets larger. Using the offset approach does not alter the variance of the observed CPUE. The offset term should be included in the predict function when extracting the Year effect, but it should be set to one value for the whole series, i.e., set equal to 1.0 (\( \log(1)=0 \), so the same as not including it) or to the maximum of \( (1 + \sum_{t=1}^{T} \delta_t) \) if the Year effect is to be expressed in terms of current conditions for fishing power.

The models proposed here for the effect of technological change on catch rate appear to be ad hoc with little obvious connection to the changes listed in Table 2 of Moffitt et al. (2008). The report of the CPUE workshop (Moffitt et al. 2008) supplied to this
reviewer appeared to be incomplete (file name given as CPUE Workshop Proceedings - Short Version) and did not discuss how technological change could be included in the model. There is no evidence in the current stock assessment document that MHI CPUE data and qualitative information in the current assessment were explored in “close collaboration” with HDAR and fishers throughout the process as recommended. This may have been done but the process was not documented.

Given the issues listed identified above about the cutoff rule, interaction terms, fishing power formulation and questions concerning the alternative models, I do not believe that a credible CPUE standardization has been presented here.

1.2. Attempt to reconstruct non-commercial catch histories, possibly in the same collaborative process used for (1).

Four scenarios were considered for accounting for non-commercial catch into estimates of total removals. These scenarios ranged from having the non-commercial catch exceed the commercial catch through assuming minimal amounts to assuming no non-commercial catch. The estimates for non-commercial catch for each of the relevant scenarios were based upon published studies as discussed by Courtney (2010). The data are sparse and require many assumptions to be used. At present, these data seem to be the best available for meeting this recommendation.

1.3. Consider using meta-data to develop informative prior on Rmax. Develop prior for Binit in collaborative process above (1).

The current document has defined the prior for $R$ based upon the recommendations of Musick (1999) and Musick et al. (2000) and the new information on the expected life span of the primary Deep7 species, opakapaka.

The prior means for the carrying capacity parameter $K(B_{init})$ were set to amounts thought necessary to support the fish catches reported for the low and high catch scenarios evaluated as a result of options for including non-commercial catch.

There were no details given on whether or not a collaborative process was followed when developing the prior for $K$.

1.4. Assess MHI as single stock to develop population benchmarks and management parameters. Ensure appropriate sensitivity testing to CPUE uncertainty.

The current stock assessment was limited to the “Deep 7” bottomfish species in the MHI area and therefore this recommendation was adequately addressed. I am not clear what was actually required of the authors to test the sensitivity to CPUE uncertainty in this context.

2. Review the assessment methods used: determine if they are reliable, properly applied, and adequate and appropriate for the species, fisheries, and available data.
Please refer to my discussion concerning the treatment of the CPUE data, catch data, etc., above in items 1.1, 1.2.

3. 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.²

There are a number of issues that need to be addressed with the WinBugs code given in Appendix 1. Firstly, \( \pi \) has been incorrectly set to 1.1415926 in Table A4 and A5 in the appendix; it should be set to 3.1415926. Since this is a constant term in the likelihoods defined on pages 7 and 10, this misspecification should have no effect on the results of the likelihood comparisons. However, there is another error in the log likelihoods that will need to be corrected. The log likelihood for a lognormal random variable, \( x_i \) is defined as:

\[
\frac{1}{2} \log(\sigma_i^2) - \frac{1}{2} \log(2\pi) - \log(x_i) - \frac{1}{2} (\sigma_i^{-2}) (\log(x_i) - \mu)^2
\]

The variance term \( \sigma_i^2 \) has been indexed with \( i \) to correspond to the model for the CPUE data in the surplus production model used in this assessment. The authors have used the precision, i.e., \( \sigma_i^{-2} \) instead of the variance for the first term in the likelihood in the equations in the WinBUGS code on pages 7 and 10. That is,

\[
\text{LOG.LIKE}[i] <- 0.5*(\log(\text{Precision_CPUE}[i])) - 0.5*\log(2*\pi) - \log(\text{CPUE}[i]) + - 0.5*\text{Precision_CPUE}[i]*\text{pow}((\log(\text{CPUE}[i]) - \text{CPUE_mean}[i]),2).
\]

The use of AIC to compare model fits is not appropriate here. AIC requires calculating the deviance and knowing the exact number of parameters — NPARI in the WinBUGS code. The surplus production model used here is a state-space model and the state variables contribute to the parameter count. The value for NPARI is not given in the code nor in the paper (Brodziak et al., 2010), but the actual total number of parameters cannot be counted directly. Also, calculating the deviance for the CPUE observation model ignores the contribution of the process part of the model to the total deviance. A logical node called "deviance" is created automatically by WinBUGS: this stores \(-2 \times \log(\text{likelihood})\), where 'likelihood' is the conditional probability of all data nodes given their stochastic parent nodes. While the authors could access this deviance calculation directly, they should consider using DIC where the effective number of parameters is estimated, for comparing models; see Spiegelhalter et al., (2002) and pages 182–184 in

² Note that the section on the surplus production model contained material from previous documents, including the senior author’s swordfish assessment from 2009. The word swordfish appears on pages 17 and 18.
Gelman et al. (2004). When using WinBUGS directly (i.e., not through R2WinBUGS), the DIC option on the Inference menu is greyed out but this condition only lasts until the model has finished “adapting” as indicated on the Update tool. DIC can be chosen and calculated by running the model for an additional number of runs once the model has converged.

Use of the BIC measure to evaluate the different formulations for $R$ is akin to using Bayes Factors where it is assumed that there is one True model amongst the candidate models being compared (page 21 of Brodziak et al. (2010)). In addition, the actual number of parameters is required similar to AIC. Do the authors assume that there is one true model here amongst those considered or are they just evaluating goodness-of-fit similar to their investigations of the different CPUE models? If the latter is true then the DIC measure should the choice here as well. The authors should consult the references above and the DIC notes on the WinBUGS website to understand the differences between AIC, BIC and DIC, and the implications of using each.

The authors have used inverse gamma distributions as priors for the variance terms for the process error ($\sigma^2_i$) and observation error ($\tau^2_i$). There seems to be some confusion in the text on expected values and CVs given the parameters chosen for the inverse gamma distributions in the bottom paragraph on page 20 of Brodziak et al. (2010). Note that if a random variable $y$ has a gamma distribution with shape parameter $\alpha$ and scale parameter $\beta$, then $1/y$ has an inverse gamma division with shape parameter $\alpha$ and scale parameter $\beta$. The expected value for $y$ is $\alpha/\beta$, while the expected value for $1/y$ is $\beta/(\alpha-1)$ and is therefore undefined when $\alpha \leq 1$ (page 575, Gelman et al. 2004). Brodziak et al. (2010) set the shape parameter to be 0.2 for both observation and process error. Since this value is less than one, the mean for prior variances cannot be 0.5 and 5 as given on page 20. Further, the CVs for inverse gamma cannot be calculated in this case as the mean is undefined as shown above and the variance is undefined when $\alpha \leq 2$.

The inverse gamma has been recommended in the past as the conjugate prior distribution for the normal variance by a number of reputable researchers with the non-informative distribution obtained as $\alpha, \beta \rightarrow 0$. Recently, Gelman (2006) has pointed out that the inverse gamma even with small parameter values may actually be a very informative prior. Consider the following probability density curve for the inverse gamma prior distribution for process errors using the authors’ parameter values of $\alpha=0.2$ and $\beta=0.1$. 
As Gelman (2006) points out, the inverse gamma can become very informative when estimating variances close to zero. However, Brodziak et al. (2010) did not report what the process and observations errors were so I cannot evaluate how serious the issue will be. Gelman (2006) recommends using a uniform prior (e.g., unif(0,100)) for the standard error instead. Also see the Seeds example in the WinBUGS package for a comparison of using the uniform and the inverse gamma for variance terms.

The model diagnostics concentrate on the fit to the CPUE data (time trends for observed/expected and residual plots). Other informative diagnostics not included here would be comparisons of the prior and posterior distributions for the variance terms, and R, M and K. As noted above the inverse gamma prior may be quite informative for the variance estimates and it would be useful to evaluate the impact of the prior for these parameters. The influence of the priors on the other parameters including derived values (e.g., B_{msy}), should be investigated as well. Note that the previous CIE review asked for prior/posterior plots to be included in the next assessment.

The procedure for calculating residuals in the log scale seems a little convoluted. The following should be appropriate to the task.

\[(\log(\text{CPUE}[i]) - \text{CPUE\_mean}[i]) \times \sqrt{\text{Precision\_CPUE}[i]}\]

A very useful diagnostic for evaluating whether the model is consistent with the data (in the original scale of measurement) is posterior predictive checking as discussed in Gelman et al. (2004, pages 159–177). This approach usually provides more insight into
goodness of fit than calculating the CPUE residuals in the original scale as was done in the WinBUGS script.

I could not find any discussion about the results for the estimates of the production shape parameter \( M \) in the text, although estimates for the different options were given in Tables 13 and 14\(^3\). On page 16 of Brodziak et al. (2010) there was the general statement that “In practice, estimates of the shape parameter \( M \) for Deep 7 biomass production in the MHI tended to be greater than unity”. Given the standard errors associated with these estimates, it is likely that there is no evidence against assuming \( M=1 \). Having the credible limits of the posterior distribution for \( M \) at the 90 or 95% level would help to assess whether this parameter is actually needed.

4. 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.

No FMP or other management documents were provided to the review panel. Brodziak et al. (2010) did provide estimates for \( F_{msy} \), \( B_{msy} \) and \( H_{msy} \) based on the surplus production model. These reference points were used in the standard way for stocks under NMFS jurisdiction to determine whether the stocks were overfished or if overfishing was occurring. Given the issues identified here with the CPUE series, the code used to fit the model and the other model related issues, it is premature to comment on whether these estimates are appropriate given the data and what is known about these species.

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

I assume that the code at the bottom of page 11 and top of page 12 of Appendix I was used to help generate Tables 17.1 to 18.3 and that \( proj\_C1[1:NTAC] \) and \( proj\_C2[1:NTAC] \) were supplied to the program as potential catches for 2012 and 2013, respectively. In turn, \( proj\_pH1 \) and \( proj\_pH2 \) returned by WinBUGS for each potential catch were used outside of WinBUGS to interpolate catches corresponding to the 5% intervals for the probabilities in the tables. If so, then this is a reasonable approach to evaluate the range of potential TACs. More explanation in the text would be helpful to the reader when assessing how the projections were evaluated.

Again, assuming the projection code in table A5 was used here, there is an inconsistency that could affect the validity of the results. Note that in fitting the model, the mean log biomass (scaled by the estimate of \( K \)) for year \( i \) was generated by the surplus production model,

\[
\begin{align*}
\text{Pmean}[i] & \leftarrow \log(\max(P[i-1] + r*P[i-1]*(1-\text{pow}(P[i-1],M)) - \text{Catch}[i-1]/K, 0.0001))
\end{align*}
\]

\(^3\) Note \( M \) also used to designate natural mortality on page 6 of Brodziak et al. (2010).
The biomass estimate for year $i$ was estimated by $B[i] = P[i] * K$, where the $P[i]$ was a draw from the lognormal distribution with variance $\sigma^2$,

$$P[i] \sim \text{dlnorm}(Pmean[i], \text{isigma}^2) \text{I}(0.0001, 10000).$$

The projected biomasses for 2011, 2012 and 2013 were estimated only using the first of the above two steps, e.g.,

$$\text{proj}_P[1] \leftarrow \max(P[T] + r*P[T] \times (1 - \text{pow}(P[T], M)) - \text{Catch}[T]/K, 0.0001)$$

$$B[T+1] \leftarrow \text{proj}_P[1] * K$$

This will likely result in the biomass projections being more precise than what was expected for the annual biomass estimates within the model. Generally, one would expect the opposite to hold. It would be informative to see a comparison of the distribution of projections using this current method with that from adding the additional step of sampling from the lognormal to see what the impact is of skipping this step.

There is another approach that can help evaluate how well the model performs when projecting forward in time. That is, fit the model up to year $t$ (e.g., 2000) and project forward for year $t+1$ using the actual catch. Compare the biomass estimate for 2001 for the model fit to the year 2000 with that estimated when fitting the model to the data including 2001. Repeat this process up the present time. This analysis can offer insight into the stability of the process for projecting ahead to 2011 and beyond.

6. Suggest research priorities to improve our understanding of essential population and fishery dynamics necessary to formulate best management practices. 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.

The current stock assessment has made some improvements over the version reviewed in 2009. However, there remain a number of issues that need to be addressed before the assessment should be accepted as support for management. The first recommendation from the previous panel on providing a credible CPUE standardization was not adequately dealt with here. A re-analysis of the CPUE data taking into account the issues raised above will be required.

A number of serious issues concerning the Bayesian surplus production model were identified here. Further work is required here to clean up the modeling as was presented here.

The final paragraph of the Summary section in Brodziak et al. (2010) suggests that single species models may be possible in the future if the data currently being collected were augmented with more species specific information including the initiation of a multispecies fishery-independent survey. While all of this will be useful for going forward with single-species models, it is not obvious how this will help disentangle single species information from the data available to date. There is an extensive literature on
partitioning fishing effort by species in a multispecies fishery (e.g., Tascheri et al. (2010) for a recent paper) as well as literature on whether it is appropriate to use species-specific reference points in managing multispecies fisheries (e.g., Walters et al. 2005). I really cannot judge what the next steps would be for this fishery given only the information presented for this review.

CONCLUSIONS and RECOMMENDATIONS

This stock assessment is completely dependent upon the information contained in the CPUE series. The previous review (Skillman 2009, Stokes 2009) identified many problems with the analysis of the CPUE data in the 2008 assessment and recommended that priority be given to developing a credible CPUE standardization. The re-analysis of the CPUE data presented in the current assessment falls short of developing this standardization. The new analysis included interaction terms which would result in different annual trends for different combinations of area and quarter but the paper reports only one annual trend for the model. Alternative models were introduced to account for the zero observations but few details were given and no interaction terms were included making it difficult to evaluate or compare with the first model used.

The previous review had recommended using the offset approach in the CPUE model to include temporal changes in the relationship between CPUE and population(s) biomass as formulated in the assessment, but the authors appear to have ignored this recommendation. The corrections proposed to account for these changes do not appear to be directly related to information gathered on what technological changes have occurred in this fishery.

The other three recommendations from the previous review were addressed within the limitations of available data however, there were no details on the collaborative process that was supposed to have been pursued.

A number of issues with the modeling approach were raised here including errors in the WinBUGS code, errors in the text concerning the expected mean and CV for inverse gamma random variables, problems with using AIC and BIC to screen Bayesian models and the potential of the inverse gamma priors used for the variance terms being informative. In addition, lack of model diagnostics such as prior/posterior plots and posterior predictive plots make it difficult to fully evaluate how well the model fits the data. Finally the impact of ignoring the process variance, $\sigma^2$ in the projections needs to be evaluated.

The current assessment did not adequately address the recommendations from the previous panel on the analysis of the CPUE data. The assessment needs to properly deal with the previous recommendations plus the additional issues identified here before any evaluation is conducted of the use of these data for monitoring the population dynamics of the species in the Deep 7 bottomfish group. Further, the modeling issues identified here need to be addressed before evaluating how useful the Bayesian surplus production model could be for supporting management of these species.
Respectfully submitted on 6 February 2011,

Stephen J. Smith
383 Portland Hills Drive
Dartmouth, Nova Scotia
Canada, B2W 6R4
902-446-4404 (residence)
902-426-3317 (office)
smithsj@eastlink.ca

REFERENCES


Appendix 1: Bibliography of materials provided for review


Courtney, D. 2011. Review of unreported to reported catch ratios for bottomfish resources in the Main Hawaiian Islands. PIFSC Internal Report, PIFSC, 2570 Dole Street, Honolulu, HI 96822, 10 p.


Appendix 2: Statement of Work for Stephen Smith

External Independent Peer Review by the Center for Independent Experts

Hawaii Deepslope Bottomfish

Scope of Work and CIE Process: The National Marine Fisheries Service’s (NMFS) Office of Science and Technology coordinates and manages a contract to provide external expertise through the Center for Independent Experts (CIE) to conduct impartial and independent peer reviews of NMFS scientific projects. This Statement of Work (SoW) described herein was established by the NMFS Contracting Officer’s Technical Representative (COTR) and CIE based on the peer review requirements submitted by NMFS Project Contact. CIE reviewers are selected by the CIE Coordination Team and Steering Committee to conduct the peer review of NMFS science with project specific Terms of Reference (ToRs). Each CIE reviewer shall produce a CIE independent peer review report with specific format and content requirements (Annex 1). This SoW describes the work tasks and deliverables of the CIE reviewers for conducting an independent peer review of the following NMFS project.

Project Description: A peer review of the Hawaiian multispecies deepslope bottomfish resource is required using the CIE process. The scientific information and assessment for Hawaiian deepslope bottomfish was peer reviewed in June 2009 providing recommendations to increase the accuracy of the assessment. The objective of this review is to conduct a follow-up peer review to determine if the recommendations have been adequately addressed and adequacy of the revised assessment for management purposes. The assessment has a large potential impact on a valuable fishery important to commercial and recreational fishers in Hawaii and fish consumers in the state. It forms the basis 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.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. Each CIE reviewer’s duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein. The CIE reviewers shall have the expertise, background, and experience to complete an independent peer review in accordance with the SoW and ToRs herein. CIE reviewer expertise shall include fish stock assessment, mathematical modeling, and statistical computing.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Statement of Tasks: The CIE reviewer 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, and other pertinent information. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

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 reviewers in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

This list of pre-review documents may be updated up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process, including a SoW modification to the schedule of milestones and deliverables. Furthermore, each CIE reviewer is responsible only for the pre-review documents that are delivered to the reviewers in accordance to the SoW scheduled deadlines specified herein.

Desk Review: 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 can not 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. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review 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.

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.

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) Conduct an independent peer review in accordance with the ToRs (Annex 2).
3) No later than 28 January 2011, each CIE reviewer shall submit an independent peer review report addressed to the “Center for Independent Experts,” and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, 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.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4 January 2011</strong></td>
<td>CIE sends each reviewer contact information to the COTR, who then sends this to the NMFS Project Contact</td>
</tr>
<tr>
<td><strong>7 January 2011</strong></td>
<td>NMFS Project Contact sends the CIE Reviewers the pre-review background documents</td>
</tr>
<tr>
<td><strong>13 January 2011</strong></td>
<td>Project contact provides the CIE reviewers with the report to be peer reviewed</td>
</tr>
<tr>
<td><strong>14-28 January 2011</strong></td>
<td>Each reviewer conducts an independent peer review as a desk review</td>
</tr>
<tr>
<td><strong>28 January 2011</strong></td>
<td>CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator</td>
</tr>
<tr>
<td><strong>11 February 2011</strong></td>
<td>CIE submits CIE independent peer review reports to the COTR</td>
</tr>
<tr>
<td><strong>Feb. 15 2011</strong></td>
<td>The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director</td>
</tr>
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</table>

**Modifications to the Statement of Work:** Requests to modify this SoW must be made through the Contracting Officer’s Technical Representative (COTR) who submits the modification for approval to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the CIE within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and Terms of Reference (ToR) of the SoW as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToRs and deliverable schedule are not adversely impacted. The SoW and ToRs cannot be changed once the peer review has begun.

**Acceptance of Deliverables:** Upon review and acceptance of the CIE independent peer review report by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, this report shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (the 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 have 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 report shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

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

**Key Personnel:**

William Michaels, Program Manager, COTR  
NMFS Office of Science and Technology  
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910  
[William.Michaels@noaa.gov](mailto:William.Michaels@noaa.gov) Phone: 301-713-2363 ext 136

Manoj Shivlani, CIE Lead Coordinator  
Northern Taiga Ventures, Inc.  
10600 SW 131st Court, Miami, FL 33186  
[shivlanim@bellsouth.net](mailto:shivlanim@bellsouth.net) Phone: 305-383-4229

**NMFS Project Contact:**

Gerard DiNardo  
Pacific Islands Fisheries Science Center  
2570 Dole Street  
Honolulu, HI 96822-2396  
Robert.Moffitt@noaa.gov  
808-983-5397
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.

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
Annex 2: Terms of Reference for the Peer Review

Hawaii Deepslope Bottomfish

1. Determine if recommendations from the June 2009 WPSAR/CIE review have been adequately addressed within the assessment update.

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

3. 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.

4. 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.

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

6. Suggest research priorities to improve our understanding of essential population and fishery dynamics necessary to formulate best management practices. 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.