Center for Independent Experts (CIE) Independent Peer Review of the 2018 Benchmark Stock Assessment of the Main Hawaiian Islands Kona Crab Fishery

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Contents

1 Executive Summary

This review relates to the draft benchmark stock assessment for the Main Hawaiian Islands Kona crab (*Ranina ranina*) fishery (Kapur *et al*., 2018). Two of the reviewers, Drs Nick Caputi and Malcolm Haddon, both from Australia, were from the Center for Independent Experts (CIE), and the chair of the review panel was Dr Steve Martell, who is a member of the Western Pacific Fisheries Management Council's Science and Statistical Committee. The review meeting was held in Honolulu, Hawaii, over the week of 10th – 14th September 2018. The review consisted of readings the documentation sent to the reviewers prior to the meeting, presentations by the scientists involved during the meeting, two written submissions and one spoken submission from experienced commercial fishers, and subsequent discussions with all persons present at the meeting, as well as within review panel discussions.

The scientists, managers, and fishers present were all open to discussion and a full review of the fishery. In particular, the assessment team were very responsive to requests for further model runs and explorations of data manipulations. All of this facilitated the completion of addressing the eleven terms of reference (TOR). Yes or no answers were requested to the TOR and these, plus explanatory notes are in detail below. All TOR received a YES response, with, in some cases caveats which are addressed in the recommendations (see TOR 10 for the detailed description of all TOR). Four short term recommendations are made along with eight medium term recommendations (some with sub-recommendations).

The greatest weakness in the assessment derives from the CPUE data appearing not to respond appropriately to changes in the catches. In a developed fishery if catches decline, then CPUE would be expected to increase, perhaps after a delay. This does not happen with the Kona crab fishery, particularly since 1980 and then from 2007. However, there have been some influential changes to the fishery regulations, most especially the requirement not to take female crabs imposed at the end of 2006. The solution of using a Bayesian assessment framework with plausible and informative priors has had the effect of enabling the assessment to provide useable management advice.

Briefly, the outputs from the draft stock assessment for the Main Hawaiian Islands Kona crab fishery can be used for management purposes once the recommendations to 1) remove the fixed observation error term relating to the CPUE fit is removed from the likelihood while estimating the remaining observation and process error and 2) the adjustment to the projections to account for female discard mortality are both implemented.

2 Background

This review relates to the draft benchmark stock assessment for the Main Hawaiian Islands Kona crab (*Ranina ranina*) fishery (Kapur *et al.*, 2018) written by scientists from the Pacific Islands Fisheries Science Center. Kona crabs have a significant degree of cultural importance in Hawaii and the assessment aims to provide the basis for the future management of the fishery for this species.

Previous stock assessments for Kona crabs were conducted by non-NOAA scientist 1978 (not seen) and in collaboration with PIFSC scientists in 2010-2011 (Thomas, 2015; Hall, 2015). The new benchmark assessment uses fishery data from 1958 through 2016 which is modelled using a Bayesian state-space production model. The assessment incorporates significant changes to the standardization of the index of relative abundance (commercial CPUE) and the use of a state-space model has different assumptions and so is also novel.

The catch per unit effort (CPUE) data were re-analysed so that records now relate to individual fishers (rather than a minimum of three fishers combined as was done previously) and effort is now represented as single-reporting-days. The new CPUE standardization based on this re-structured data was split into two time series (fishing years 1958-2006 and 2007-2016) to reflect a large change in the fishery dynamics due to passage of an Hawaiian State law at the end of 2006, which prohibited the taking of female Kona crab. This change appears to have been initiated based upon intuition rather than on scientific grounds.

Attempts were made to account for unreported catches (thought sometimes to be large) by evaluating the use of published estimates of non-reporting ratios e fisheries in the Main Hawaiian Islands as well as by incorporating estimates of fishing effort specific to crustaceans from ancillary surveys. In addition, for the second time-series from 2007 – 2016, allowance was made for the female mortality expected from them being returned to the sea after capture (Wiley and Pardee, 2018).

In the new benchmark stock assessment (Kapur *et al.*, 2018), stock status is evaluated against MSY-based reference points defined in the Fishery Ecosystem Plan for the Hawaii Archipelago (WPRFC (2009). The model, once fitted to the available data, was projected under different conditions of constant catch to inform the recommendations for annual catch limits.

A review of the new assessment was conducted in Honolulu, Hawaii, over the week of September 10th – 14th, 2018, with three reviewers (see Appendix 3), two of which were arranged through the Center for Independent Experts (CIE).

2.1 Acknowledgements

I would like to express my appreciation of the support provided by the Western Pacific Regional Fishery Management Council. The use of their conference room for the review greatly simplified the process for the review panel. The assessment team of Maia Kapur, Mark Fitchett, Annie Yau, and Felipe Carvalho are also thanked for their admirable openness and cooperation in the review process. Their rapid responses to the review panels formal requests for more model runs and data examinations was very helpful. Finally, it was both informative and a pleasure talking with the commercial fishers who attended the meeting, thanks to those as well. The whole review was conducted in a friendly and cooperative manner which was greatly appreciated.

3 Description of Review Activities by Reviewer

The review of the Hawaiian Kona Crab fishery was scheduled to occur between September 10–14, 2018 in Honolulu, Hawaii in the offices of the Western Pacific Regional Fishery Management Council (WPRFMC). The background material for the review was received on Thursday, August 23, 2018, which provided ample time to read through the supplied materials. This reviewer travelled to Hawaii on September 8, 2018, contributed to the review process, and travelled back to Hobart in Tasmania, Australia leaving Hawaii on Saturday, September 15, 2018.

During the first day of the review five, PowerPoint presentations were made by Hawaiian local staff. These were entitled:

- Hawaii Kona crab WPSAR benchmark review: objectives and Terms of reference + History of Stock Assessments, presented by Annie Yau
- Federal Management of Kona crab in the Main Hawaiian Islands, presented by Kate Taylor
- Commercial Fisheries Dependent Data 2018 Kona Crab WPSAR September 10, 2018, presented by Reginald Kokubun
- 2018 Benchmark Stock Assessment of the Main Hawaiian Islands Kona Crab Fishery presented by Maia Kapur
- Post Release Mortality in the Hawaiian Kona Crab Fishery presented by John Wiley and Cassie Pardee.

During each presentation questions were asked by the panel of three reviewers and these questions occasionally led to formal requests for further exploration of alternative analyses or data manipulations.

The rest of the week involved detailed discussions with the authors of the new stock assessment and examination of the results of the formally requested further analyses. The results of the initial formal requests often prompted further explorations and subsequent questions. In this way, a very detailed exploration of the strengths and weaknesses of the available data and the model used was obtained. Collaborative sessions were held among the review panel to facilitate the chair in writing the summary overview of the panel's findings.

Following the requirements listed in the Terms of Reference and the Statement of Work, this report detailing this individual reviewer's evaluation of the 2018 Benchmark Stock Assessment for Main Hawaiian Islands Kona Crab fishery was also written.

On Thursday, September 13, 2018, time was made available to allow for public comments to be made formally to the review panel. Two written submissions from active fishers were read out by WPRFMC staff, and one fisher attended and made a verbal presentation to the review panel. These helpful contributions assisted the panel in understanding some of the changes apparent in the commercial fishery.

In addition, on Friday, September 14, 2018, the review panel prepared and presented a brief and draft overview of their combined findings and comments.

4 Summary of Findings for each TOR

4.1 ToR 1: Input Data

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

YES

The available catch and catch-rate data and how these were manipulated is well described in the stock assessment document. Of particular note and value to the assessment was the data processing that allowed the authors to follow individual fishers through time. This was not previously possible, because prior to 1993 each Commercial Marine Licence (CML) issued to individual fishers each year had different numbers. The 2015 assessment (Thomas *et al*., 2015) could not allow for the effects of individual fishers and this innovation was important and influential on the outcome. In addition, the re-organisation of the measure of effort from “trip” to “single-reporting-day” also improved the resolution possible with the measure of effort. However, there may remain some potential for unintended consequences of those manipulations that would require more explorations to characterize the full range of implications. For example, one of the formal requests made during the review was to examine the proportion of single-day-records with catches greater than 500 lbs landed (**Figure 1**). The reason this may be an issue is that with the prevalence of live wells it is perfectly possible for different vessels to stay out for multiple days catching Kona crabs and returning them in a healthy state. Reporting multiple days of fishing into what appears to be a single-reporting-day would be a simple mistake to make, so characterizing its potential influence would help understand the strengths and weaknesses of the assessment.

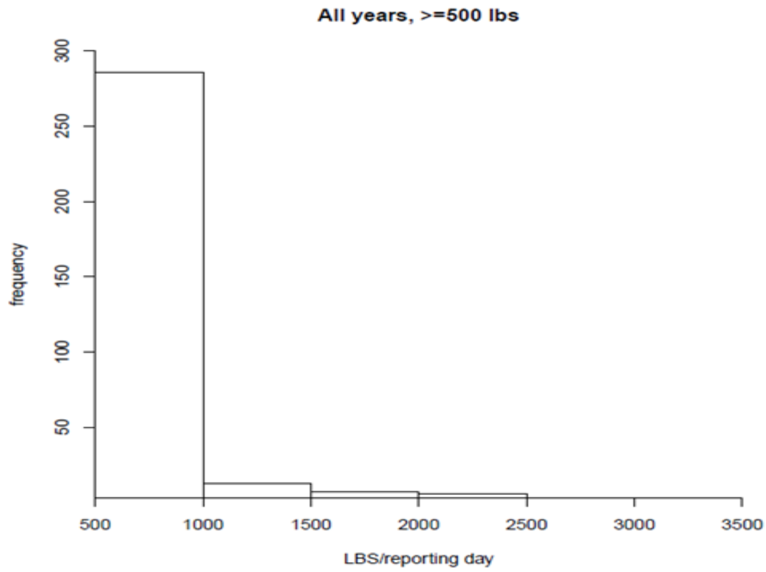

Figure 1. About 21% of 11,015 single-reporting-day records contained > 500lbs. Extracted from a slide in ‘Kona Crab WPSAR Review Day II’ produced by the stock assessment authorship team in response to a formal request within the review.

It is recommended that industry members be surveyed to determine what they would consider to be an unlikely total catch to derive from a single-reporting-day and whether there would be approximately 20% of all single reporting days successfully landing greater than 500lbs.

The data and catches from 2014 – 2016 are minimal and this contraction in commercial fishing is reported to be due to the recent change in regulation which requires no landing of female Kona crabs. The three commercial fishers who commented on the review all agreed that the fishery is no longer economic when they need to return 80% or more of their catches (females plus under-sized crabs). This recent data and possibly the data into the future will continue to be related to only a small subset of the stock taken by the fishery. Such data, in the absence of alternative fishery independent data, could potentially lead to a biased view of the state of the stock. Without a change to this no-take of female crabs it seems likely that future data will become less informative about the stock status.

4.2 ToR 2: CPUE Standardization

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

YES

The use of a Generalized Linear Mixed Model is appropriate with such fisheries data. Treating the Commercial Marine Licence holders as a random effect within the standardization assumes that each year's collection of CML holders are random samples from a set of values that are normally distributed. When there are very many fishers operating in any one year using the same methods, this may be a reasonable assumption. However, given, for example, that while there have been between 25 – 51 fishers active on the commercial Kona crab fishery over the last decade, about 50% - 60% of fishing trips are attributed to only three fishers (Taylor, 2018), this assumption might be called into doubt, especially in the second time-series of data. When the primary fisher numbers are reduced to low numbers having just one leave the fishery can have a marked effect on apparent catch rates.

Within the available data there were a total of 11,015 single-reporting-days across all the known Commercial Marine Licence (CML). However, 1,250 of these records related to CMLs that only reported five or fewer records of Kona crab single-reporting days in the entire time series (termed 'novice' fishers). A formal question asked was for the authors to conduct a different standardization, which removed the records relating to the novice fishers. The outcome exhibited an almost complete overlap of the trends and the 95% confidence intervals for the trends.

It is recommended that further exploration is made of treating the CML, especially of the major fishers that contribute the most to the fishery, as categorical variables in the CPUE standardization. In that way the relative fishing 'power' of the different fishers could be investigated. It seems likely that any fisher/CML factor would be confounded with 'area' fished, but nevertheless might be a fruitful longer-term research program.

CPUE standardization has an enormous literature, both formal and 'grey', and an associated enormous number of options that are possible. In practice, the path adopted is often associated with the amount of time available to trial different approaches. Because the outcomes from the surplus production model are so influenced by the CPUE series used, this is a serious consideration and alternatives should continue to be investigated. The current time-series appears relatively robust, but continued exploration of options may generate a rather different time-series, which would influence the assessment outcome.

The previous assessment (Thomas *et al*., 2015) differed markedly from the current assessment and this appears to have been due to both the different catch time-series used (which was not adjusted for the under-reported catch ratio) and, possibly more importantly, to the different CPUE time series used in the earlier report, which was based on lbs-per-trip (**Figure 2**).

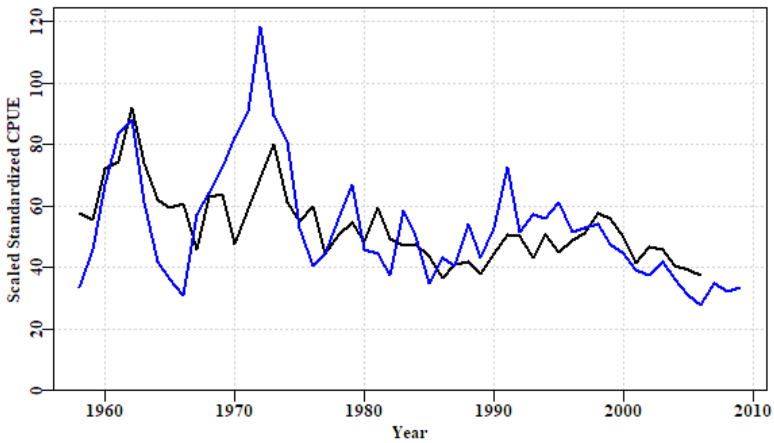

Figure 2. A comparison of the current standardized CPUE (black line) and the CPUE series (blue line) from Thomas *et al*., (2015) assessment re-scaled to the same mean CPUE from 1958 - 2006 as the current CPUE. The estimates for the Thomas *et al*., (2015) series were taken from the plot in their document, and so are only approximate but suffice for a visual comparison.

It is recommended that a helpful addition to the current Kona crab assessment would be to include a plot and table of the number of single-reporting-days of effort occurred in each day (Figure 3).

One of the formal requests fulfilled during the review was related to the influence of reporting other species landed during the same single-reporting-day and that provided a first look at the relative effort through time. By comparing the effort expended with the estimated harvest rate through time (Figure 3), the expected correlation between the two trends becomes apparent and lends support for internal coherency to the analysis. Had the correlation not been strong, this would have been diagnostic of some imbalance or bias within the assessment.

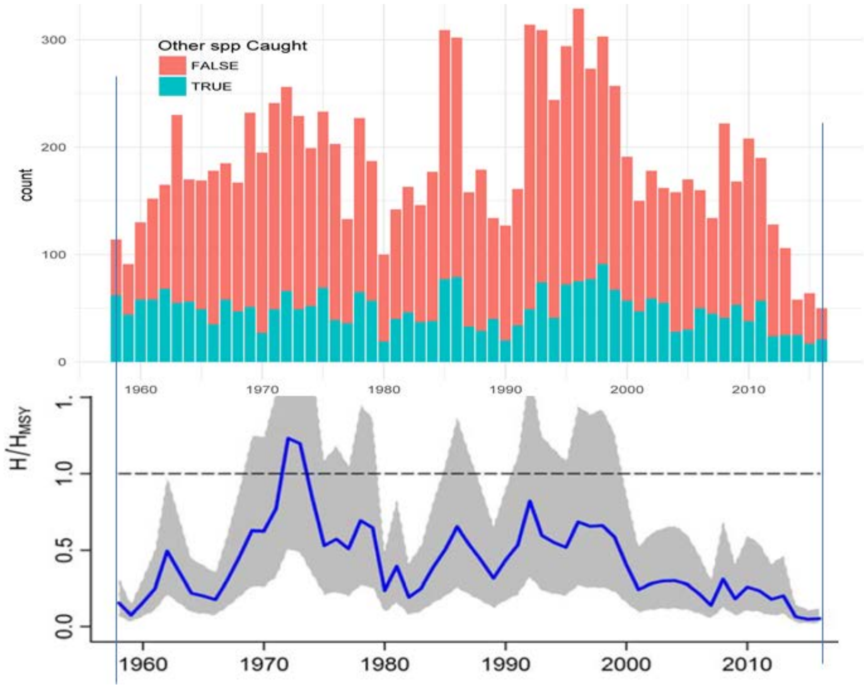

Figure 3. A comparison of the total effort (top plot; obtained following a formal request during the review) and the base-case harvest rate to H_{MSY} illustrating the expected strong correlation between the two. The harvest rate ratio confidence range is truncated to facilitate the visual comparison of the central trends.

Apart from the management changes that have occurred in the Kona Crab fishery there appear to be three different phases to the catches and CPUE (Figure 4).

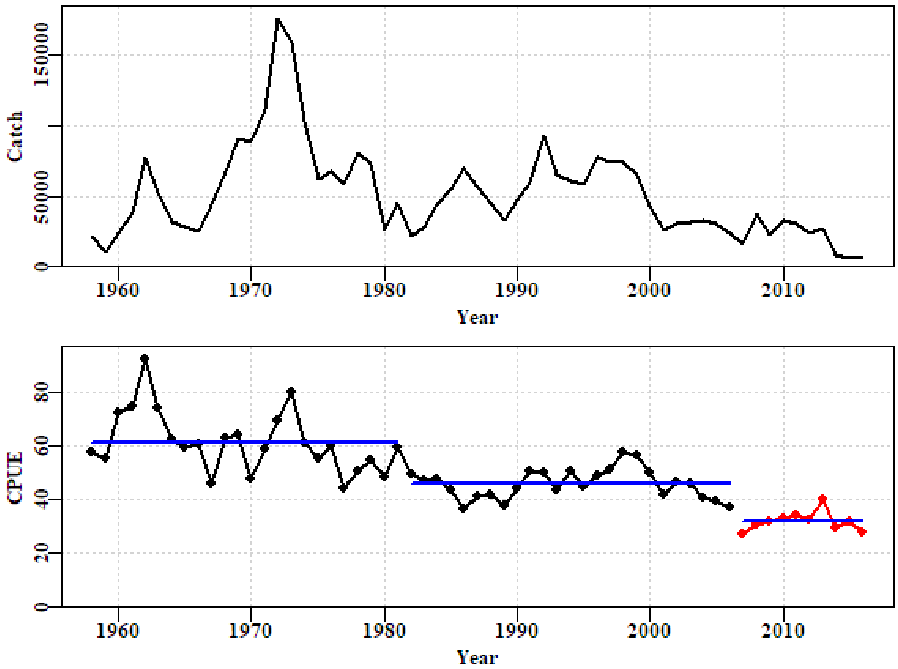

Figure 4. The catch time-series used in the base-case Kona Crab assessment compared to the base-case CPUE time-series. Three periods can be recognized, although other arrangements are possible: 1958 – 1981 with an average catch of 61.3 lbs per single-reporting-day, 1982 – 2006 with an average catch of about 45.8 lbs per SRD, and finally from 2007 – 2016 at an average catch rate of 31.7 lbs per SRD.

Whether the interpretation that there were three periods or the process of CPUE reducing was more continuous than stepped is not really important. The key issue is that for a surplus production model to perform well, the CPUE data need to illustrate contrast in how the fishery has responded to catches going up and coming down. Evidence for such contrast in the Kona crab fishery is not immediately apparent.

4.3 ToR 3: Assessment Model Selection

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

YES

Surplus production models are one of the simplest formal models available that attempt to model the stock dynamics by conditioning on catch data (or effort data) and by being fitted to indices of relative abundance (Prager, 1994, Haddon 2011). As one of the simplest stock assessment models available, they only require catches and an index of relative abundance; hence they are certainly appropriate for this species and fishery. Without other classes of data (e.g. age- or size-composition data) other more complex models could not be used. The data available lacks contrast (see later), which, in this case, was enough to prevent the characterization of the production curve. Nevertheless, the assessment has succeeded in providing a plausible solution because of the auxiliary information provided by the priors used in the Bayesian model. The Bayesian state-space surplus production model was implemented within the R package 'Jabba' (Winker *et al*., 2018), which has been formally published and reviewed, and used for other fisheries. This was certainly properly applied, with the advantage that two of the authors of the R package were authors of the Kona crab assessment.

The available data represent the one place where this assessment may have issues. In this case the indices of relative abundance are two time-series of commercial CPUE. Surplus production models are most reliable when the data to which they are applied have what is termed 'contrast'. The term 'contrast' refers to the prediction that when catches in a fishery increase then CPUE is expected subsequently to decline, and conversely if catches reduce then CPUE is expected to increase. Such changes in the time-series provide information concerning how the stock responds to fishing mortality. In this case, however, the negative correlation expected between CPUE and catches is not particularly pronounced (**Figure 5**). The correlation at a lag of 0 is significant, which implies that as catches increase so does CPUE and vice versa, which suggests poor contrast in this data set. The strong correlation at lag 0 suggests that fishers appear to be fishing more intensely when availability improves, and reduce effort when availability reduces. The model is still modelling availability, but its dynamics expect biomass to increase once catches reduce; so given the recent relatively low catches, the model will predict stock increases in any projections that also imply relatively low catches. Such model driven increases may or may not be real and ideally auxiliary data supporting such predicted increases should be obtained before they can be believed.

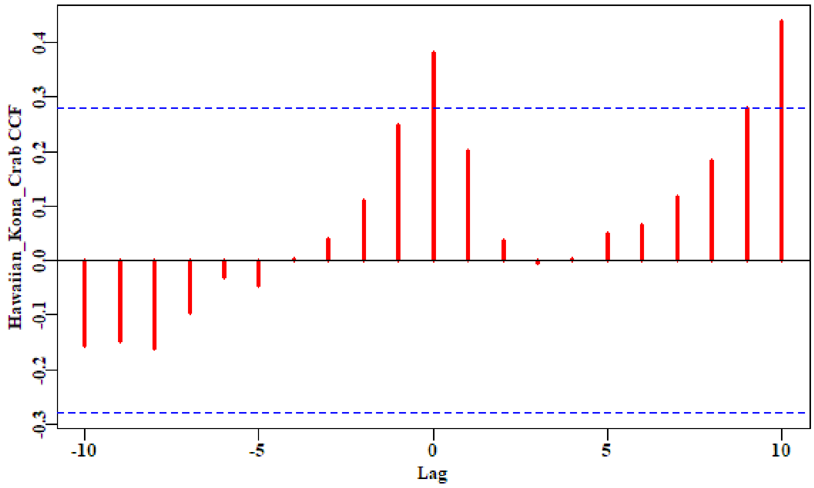

Figure 5. A cross-correlation between CPUE and catch using the Hawaiian Kona Crab fishery base case data from Kapur *et al*. (2018). There is a strong and significant correlation at a lag of 0 and +10. While there are negative correlations they are not significant.

4.4 ToR 4: Decision Points and Input Parameters

4. Are decision points and input parameters reasonably chosen?

YES

No specific reference points had been selected explicitly for Kona Crabs prior to this assessment. The reference points selected relating to the determination of whether the stock was over-fished or over-fishing was occurring derived from the Fishery Ecosystem Plan for the Hawaiian Archipelago WPRFMC (2009; see Table 20 page 144). This selection appears to be consistent with the many other fisheries in Hawaii, and as such constitutes a reasonable choice.

The input parameters to the model relates primarily to the priors selected for the model fitting process. Generally, these were again reasonable choices, although the assessment report sometimes referred to them as ‘uninformative’ whereas they are clearly informative (except for those relating to the catchability coefficients for the two time-series of CPUE). Some of the formal requests for extra work related to examining the effects of changing the mean and/or spread of some of the more informative priors. By omitting the influence of the CPUE time-series, it became clear that the model with only the catches and priors predicted that there was no possibility of the stock becoming over-fished. When the priors were adjusted to force the productivity of the stock to be reduced, this only succeeded in changing the early dynamics from 1958 – about 1980. Following 1980, the recently reduced catches led to the model continuing to predict for the final year that there was no chance of the stock becoming over-fished.

4.5 ToR 5: Uncertainty

5. Are primary sources of uncertainty documented and presented?

YES

All major sources of uncertainty were documented and adequately presented in the assessment report. Uncertainty in the initial parameter estimated was captured in the priors used. During the review there was discussion of how best to include uncertainty when fitting the model to the commercial CPUE data. The assessment team conducted some requested explorations of the outcome of removing the fixed observation error term from the likelihood calculation (which led to an expansion of the other two terms: both the estimated observation error and the process error relating to the CPUE). After these explorations, the formal recommendation was made to remove the fixed observation error term, which was agreed to. Once this was done, all the priors were deemed defensible. In addition to using the Bayesian analysis framework embedded in the 'Jabba' software (Winker *et al*. 2018), the assessment team implemented a wide range of sensitivity analyses which were all consistent with the interpretation given to the assessment model outcomes. Only a surplus production model was applied to the available data, so it could be argued that model uncertainty was omitted, but such surplus production models are appropriate for the limited data available and possible data-poor alternatives would be less appropriate.

4.6 ToR 6: Model Assumptions

6. Are model assumptions reasonably satisfied?

YES

The primary assumption underlying the valid use of surplus production models to generate predictions of productivity, is that changes in the index of relative abundance used (in this case CPUE) are proportional to changes in the stock biomass of the species being assessed. This translates to an assumption that the catchability within the model is a constant through time. I have answered 'yes' to this ToR despite what appears to be a large deviation from this assumption of all surplus production models. Following the introduction of a regulation that forbade the taking of female crabs, the CPUE dropped as expected, but following a major drop in catches the CPUE has not risen since. One way of determining whether there is an appropriate relationship between catches and consequent CPUE is to conduct a cross-correlation between catches and CPUE. If there is a proportional relationship between stock biomass and subsequent CPUE, then the expectation in a developed fishery is that if catches increase then CPUE will eventually decline, and if catches decrease then eventually CPUE will increase. This should lead to significant negative correlations between CPUE and catches at some negative lag (**Figure 5**; **Figure 6**).

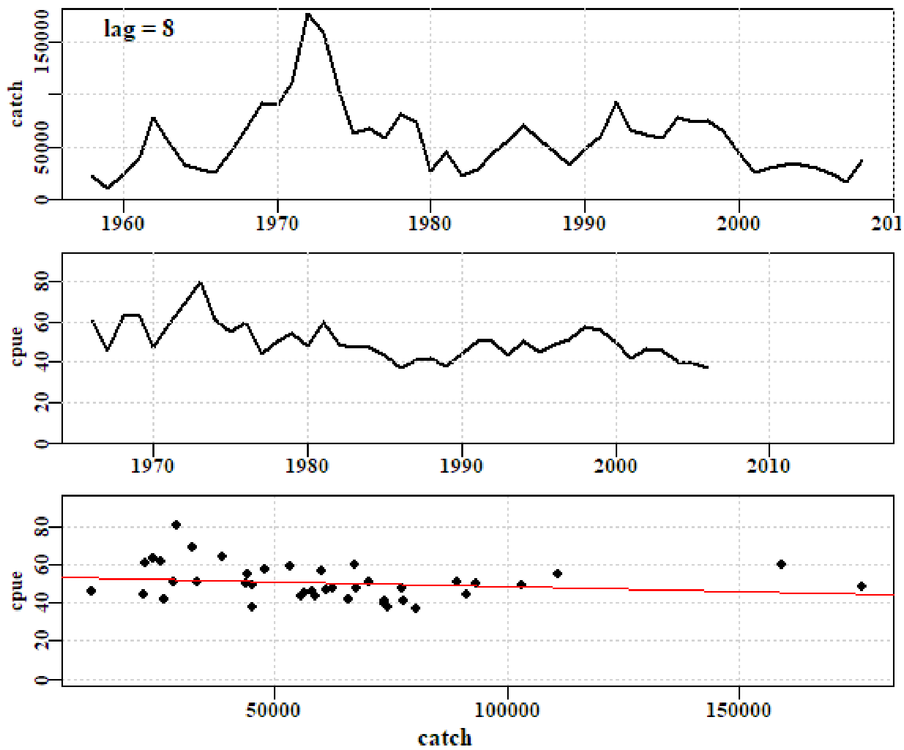

Figure 6. The optimum negative lag (8 years) from the cross-correlation analysis (**Figure 5**). The regression accounts for only 1.5% of the variation in the scatter of data and was not significantly different from a flat line (P = 0.212). When all catch and CPUE data are included out to 2016, the relationship becomes worse.

Despite this assumption failure, the model achieved stable outputs because of the relatively informative and plausible priors on r, K, and m. These imply that the lower end of plausible production is reasonably estimated. However, the model fitting would have trouble eliminating a wide range of upper levels of productivity, because of the failure of the CPUE to reflect the changing circumstances (catches) in the fishery. The time-blocking of catchability around the major change in management (no-take of females at the end of 2006) was the only workable option available.

If some means of determining the actual harvest rate or biomass level in a given year was used (perhaps a tagging program aimed at estimating either, or both harvest rate and biomass, in at least the more important areas of the current fishery), then the upper bound on productivity should be able to be determined with greater certainty. A medium-term recommendation is made accordingly.

4.7 ToR 7: Management Conclusions

7. Are the final results scientifically sound, including estimated stock status in relation to the estimated biological reference points, and can the results be used to address management goals stated in the relevant FEP or other documents provided to the review panel?

YES

As a minimum, the surplus production modelling was informative about the lower bounds of biomass required to be consistent with the historical catches. This alone would permit the generation of an estimate of an Over-Fishing Limit, and consequently an Annual Catch Limit (though these may be conservative).

The usual procedure is to re-visit such an assessment at relatively long intervals (perhaps five years). However, given the associated uncertainty in the relationship between CPUE and stock size, it is recommended that annual monitoring of catch and effort be continued if only to ensure that CPUE does not decline further than current levels. This would be especially necessary if catches were to begin to increase again.

4.8 ToR 8: Projections

8. Are the methods used to project future population status adequate and appropriately applied for meeting management goals as stated in the relevant FEP?

YES

The methods used to conduct the projections are standard and have been appropriately applied to meet the objective of identifying management goals. It was pointed out to the review panel by the assessment team during the presentations that the draft report did not include a correction for female discard mortality in its final projection values, but this inclusion was to be undertaken for the final report.

4.9 ToR 9: Utility for Management

9. If any results of these models should not be applied for management purposes with or without minor short -term further analyse
   any parts of questions 1 -8 are “no”), indicate:
   Which results should not be applied and describe why, and
   Which alternative set of existing stock assessment results should be used to inform setting fishery catch limits instead and describe why.

YES

The results from the model described can all be used for management purposes once the recommendations to remove the fixed observation error term relating to the CPUE fit is removed from the likelihood, while estimating the remaining observation and process error and the adjustment to the projections to account for female discard mortality are both implemented.

The only other stock assessment results available are those from Thomas *et al*. (2015). These differ markedly from the current report’s results in that the current model suggests the stock is in a healthy state while the 2015 report suggests the stock to be depleted. Normally, one would conduct a bridging analysis where one would migrate the model from one version to the final base case in steps to illustrate what changes to either the data of the model structure led to the change in stock status (which in this case is relatively dramatic). This has remained difficult to implement through the 2015 report not including summary tables of the data used in their analysis (which is usually standard practice). The assessment team reported not being able to recover this data set, and so no bridging analysis was possible.

It is recommended that to facilitate the construction of a bridging analysis between the two assessments, the 2015 report data be measured from plots in that report. The intent is not to criticize the earlier work, but rather to understand the full range of differences between the assessments and discover exactly what led to the major change in stock status deriving from the two assessments.

4.10 ToR 10: Future Improvements and Research Priorities

10. As needed, suggest recommendations for future improvements and research priorities. Indicate whether each recommendation should be addressed in the short/immediate term (2 months), mid -term (3- 5 years) ar years). Also indicate whether each recommendation is high priority (likely most affecting results and/or interpretation), mid priority, or low priority.

The recommendations collated as a review team are given below with some additional recommendations made since the review meeting in Hawaii:

Short-Term Recommendations

- Remove the fixed observation variance term relating to fitting the CPUE in the likelihood.
- Add a figure with the effort time series, displaying the proportion of trips with multiple species caught.
- Construct a time-series of mean weight (based on records with both numbers and pounds) to act as a potential fishery performance measure.
- Survey industry members to determine what they would consider to be an unlikely total catch to derive from a single-reporting-day, so as to better characterize and understand effort as single-reporting days.

Medium-term Recommendations

- Attempt to extract the data used in the 2015 assessment report (Thomas et al., 2015) to provide an attempt at a bridging analysis between the old assessment and the new (this is intended to aid understanding why the two assessments came to such different conclusions, not as a critique of the 2015 report; it seems possible that the use of priors in the state-space model has led to the improvements).

Team Agreed Recommendations

- Condition the model on fishing effort and fit to catch. The current implementation is conditioned on catch and fit to catch/effort, which assumes the catch is known without error (incl. the addition of unreported catch estimates).

- Implement a tagging program to estimate harvest rates, along with movement, and other aspects of the stock dynamics, in an attempt to anchor the dynamics of the stock and improve the estimation of an upper bound on productivity.
- Continue with the CPUE standardization efforts including any new information.
  - Have a closer look at the year-area interactions in the CPUE data (e.g., contraction and expansion of the fishery), or other possible factors (e.g., wind, currents, mean size of the catch).
  - Develop a time series of catch and effort data just for Penguin bank, where most of the Kona crab harvest comes from. It would be useful to compare the trend from the other 22 of 23 blocks with the trend observed from the Penguin bank to determine their relative influence on the final combined time-series.
  - Further exploration should be made of treating the CML as categorical variables in the CPUE standardization. In that way, the relative fishing 'power' of the different fishers could be investigated, especially of the major fishers that contribute the most to the fishery.
- Conduct a scientific investigation if a male only fishery is appropriate given the sex ratio of the catch is now 49% male:51% female, and a minimum size limit of 4". Under such circumstances and accounting for the discarding of undersized crabs, more than double the effort is required to achieve the same desired harvest rate; potentially doubling the amount of discarding, doubling the mortality rate on males for the same catch, and lowering the overall profitability of the fishery. This could also lead to some females not being mated if the sex ratio becomes skewed to females. Furthermore, if the fishery is restricted by an annual catch limit, retention of both sexes has the potential to reduce overall total mortality on all sizes of Kona crab.
- Explore other management tools for this stock. For example, SPR-based metrics for monitoring Kona crab mortality. This may also provide insights into the upper bound on productivity for the stock.
- Explore the establishment of a cost-effective fishery-independent survey of key fishing areas (e.g. Penguin Bank) with the collaboration of the 3-4 key fishers that take most of the catch and fish in the areas designated for surveys.
- Examine if there are any environmental drivers affecting the recruitment that led to spikes in catches in the early 1960s, early 1970s, and 1990s. Also, examine if there are any shared co-variation with other stocks that show similar trends in productivity during these same time periods.

4.11 ToR 11: Report Draft

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

This current report.

5 Appendix 1: Bibliography of Review Materials

Brown, I.W. (1985) *The Hawaiian Kona Crab Fishery* Study Tour Report QS85005. Queensland Department of Primary Industries, Brisbane. 18 p.

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5.1 Other References

Haddon, M. (2011) *Modelling and Quantitative Methods in Fisheries.* CRC Press. Chapman & Hall. 2^{nd} Ed. 449 p.

Kapur, M.R., Fitchett, M.D., Yau, A.J. and Carvalho, F. (2018) *2018 Benchmark Stock Assessment of Main Hawaiian Islands Kona Crab.* WPSAR Review: Sep 10 - 14, 2018 Honolulu, Hawaii, USA PowerPoint presentation during review.. 88 slides.

Kokubun, R. (2018) *Commercial Fisheries Dependent Data. 2018 Kona Crab WPSAR September 10, 2018.* PowerPoint presentation during review. DLNR-DAR, State of Hawaii. 29 slides.

Prager, M. (1994) Prager, M.H., 1994. A suite of extensions to a nonequilibrium surplus-production model. *Fishery Bulletin* **92**: 374–389.

Taylor, K. (2018) *Federal Management of Kona Crab in the Main Hawaiian Islands. WPSAR Review of the Main Hawaiian Islands Kona Crab Stock Assessment. Sustainable Fisheries Division September 2018.* PowerPoint presentation during review. 30 slides.

Wiley, J. and C. Pardee (2018) *Post Release Mortality in the Hawaiian Kona Crab Fishery* August 30 2018. PowerPoint presentation during review. 21 slides.

6 Appendix 2: Statement of Work

Performance Work Statement (PWS)
National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service (NMFS)
Center for Independent Experts (CIE) Program
External Independent Peer Review

2018 Benchmark Stock Assessment for the Main Hawaiian Islands Kona Crab

Background

The National Marine Fisheries Service (NMFS) is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards. (http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf).
Further information on the CIE program may be obtained from www.ciereviews.org.

Scope

A benchmark stock assessment for Main Hawaiian Islands Kona crab (Ranina ranina) was conducted by scientists at the Pacific Islands Fisheries Science Center and will provide the basis for management of this culturally important species. Previous stock assessments for Kona crab were conducted by non-NOAA scientists i collaboration with PIFSC scientists in 2010-2011. The benchmark ass incorporates data from 1948 through 2016 and uses a production model, incorporating improvements to data standardization and model assumptions. Specifically, catch per unit effort (CPUE) in the model includes new standardization coefficients and was split into two time series (fishing year 1948-2005 and 2006-2016) Hawaii state law prohibiting the taking of female Kona crab in 2006. The assessment model accounts for unreported catch by evaluating the use of published estimates of non-reporting ratios e

as by incorporating estimates of fishing effort specific to crustaceans from ancillary surveys. Stock status is evaluated against MSY-based reference points s
Fishery Ecosystem Plan. Projections are provided to inform management setting of annual catch limits. The specified format and contents of the individual peer review reports are found in Annex 1. The Terms of Reference (TORs) of the peer review are listed in Annex 2. Lastly, the tentative agenda of the panel review meeting is attached in Annex 3.

Requirements

NMFS requires two reviewers who are external to PIFSC, Pacific Islands Regional Office (PIRO), and the Western Pacific Regional Fishery Management Council and its affiliated bodies to conduct an impartial and independent peer review in accordance with this PWS, OMB Guidelines, and the TORs in Annex 2.

CIE reviewers shall have:

- Working knowledge and recent experience in the application of stock assessment models, including production models, sufficient to complete a thorough review;
- Knowledge of data limited assessment methods;
- Expertise with measures of model fit, identification, uncertainty, forecasting, and biological reference points;
- Familiarity with federal fisheries science requirements under the Magnuson-Stevens Fishery Conservation and Management Act;
- Familiarity with local Pacific Islands fisheries as well as artisanal fisheries and fishing practices;
- Familiarity with crustacean fisheries and assessment models;
- Excellent oral and written communication skills to facilitate the discussion and communication of results.

Tasks for Reviewers

Each of the CIE reviewers shall complete the following tasks in accordance with the PWS and Schedule of Milestones and Deliverables.

Pre-review Background Documents: No later than two weeks before the peer review, the NMFS Project Contact will provide reviewers the necessary background information and reports for the peer review. The reviewers shall read all documents prior to the peer review in accordance with the PWS scheduled deadlines.

Required pre-review documents:

- DRAFT 2018 Kona crab stock assessment: Fitchett et al. Title. NOAA Tech Memo.
- Previous Kona crab stock assessment: Thomas, L., H. Lee, and K. Piner. 2015. Characterization and assessment of the Main Hawaiian Island Kona Crab (Ranina ranina) fishery. A report prepared for the Western Pacific Regional Fishery Council. 35p.

- Independent peer review report for Thomas et al. 2015 stock assessment: Hall, N.G. 2015. Center for Independent Experts (CIE) Report on the Independent Peer Review of the Kona Crab Benchmark Assessment. Western Australia 6008, Australia, 34 p.
- Hawaii Fishery Ecosystem Plan: Western Pacific Regional Fishery Management Council. 2009. Fishery Ecosystem Plan for the Hawaii Archipelago. (only section 4.3 (pp 104 -113) and section 5.4 (pp 149- 157).
- Winker, H., Carvalho, F., Kapur, M. JABBA: Just Another Bayesian Biomass Assessment. (In press at Fisheries Research).
- Pardee, C.B and J. Wiley. 2018. On -board and in- water c release mortality of Kona crab. WPRFMC Contract No. 17 -Coral- 03.
- Brown, I.W., 1985. The Hawaiian Kona Crab Fishery. Queensland Department of Primary Industries, Brisbane. 18 p.
- Onizuka, E.W., 1972. Management and Development Investigations of the Kona Crab, Ranina ranina (Linnaeus). Department of Land and Natural Resources, Honolulu, HI. 29 p.

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the PWS and TORs, and shall not serve in any other role. Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the TORs. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). NMFS will provide a Chair for this in -person panel review. Th Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers.

Contract Deliverables - Independent Peer Review Reports: Each reviewer shall complete an independent peer review report in accordance with the PWS. Each reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each reviewer shall complete the independent peer review addressing each TOR as described in Annex 2. Reviewers are not required to reach a consensus.

Other Tasks – Contribution to Summary Report: This Benchmark Review consists of two CIE reviewers and one review Chair–not provided by the CIE. Each CIE reviewer will assist the Chair with contributions to the Summary Report, based on the TORs of the review. Each CIE reviewer is not required to report a consensus finding. Reviewers should provide a brief synopsis of their own views on the summary findings and conclusions reached by the review panel in accordance with the TORs.

Foreign National Security Clearance

When reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for reviewers who are non -US citizens. For this rea reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS

Project Contact for the purpose of their security clearance, and this information shall be submitted at least 50 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207 -12 regulations a
Deemed Exports NAO website: http://deemedexports.noaa.gov/ and http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa -foreign- national l- registration-system.html. The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance
Each reviewer shall conduct an independent peer review during the panel review meeting scheduled in Honolulu, Hawaii at the Finance Factors Building, 164 Bishop St #140, Honolulu, HI 96813, during **September 10– 14, 2018**.

Period of Performance
The period of performance shall be from the time of award through November 2018. Each reviewer's duties shall not exceed 14 days to complete all required tasks.

Schedule of Milestones and Deliverables: The contractor shall complete the tasks and deliverables in accordance with the following schedule.

within two weeks of award	Contractor selects and confirms reviewers
No later than two weeks prior	Contractor provides the pre -review c
September 10 - 14, 2	Panel review meeting
Within three weeks of the	Contractor receives draft reports
Within 2 weeks of receiving	Contractor submits final reports to the Government

Applicable Performance Standards
The acceptance of the contract deliverables shall be based on three performance standards:
(1) The reports shall be completed in accordance with the required formatting and content; (2) The reports shall address each TOR as specified; and (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel
All travel expenses shall be reimbursable in accordance with Federal Travel Regulations (http://www.gsa.gov/portal/content/104790). International travel is authorized for this contract. Travel is not to exceed $7,500.

Restricted or Limited Use of Data
The contractors may be required to sign and adhere to a non disclosure agreement

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Annex 1: Peer Review Report Requirements

1. The report must be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether or not the science reviewed is the best scientific information available.

2. The report must contain a background section, description of the individual reviewers' roles 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. Reviewers must describe in their own words the review activities completed during the panel review meeting, including a brief summary of findings, of the science, conclusions, and recommendations.

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

5. Reviewers should elaborate on any points raised in the summary report that they believe might require further clarification.

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

7. The report shall be a stand -alone document
and strengths of the science reviewed, regardless of whether or not they read the summary report. The report shall represent the peer review of each TOR, and shall not simply repeat the contents of the summary report.

8. The report shall include the following appendices:

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

Annex 2: Terms of Reference for the Peer Review
2018 Benchmark Stock Assessment for the Main Hawaiian Islands Kona Crab

External Independent Peer Review under the Western Pacific Stock Assessment Review framework: 2018 Benchmark Stock Assessment for the Main Hawaiian Islands Kona Crab

For questions 1 -8 and their subcomp
answer and will not provide an answer of "maybe". Only if necessary, caveats may be provided to these yes or no answers, but when provided they must be as specific as possible to provide direction and clarification to NMFS.

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

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

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

4. Are decision points and input parameters reasonably chosen?

5. Are primary sources of uncertainty documented and presented?

6. Are model assumptions reasonably satisfied?

7. Are the final results scientifically sound, including estimated stock status in relation to the estimated biological reference points, and can the results be used to address management goals stated in the relevant FEP or other documents provided to the review panel?

8. Are the methods used to project future population status adequate and appropriately applied for meeting management goals as stated in the relevant FEP?

9. If any results of these models should not be applied for management purposes with or without minor short -term further analys any parts of questions 1 -8 are “no”), indicate:
   a. Which results should not be applied and describe why, and
   b. Which alternative set of existing stock assessment results should be used to inform setting fishery catch limits instead and describe why.

10. As needed, suggest recommendations for future improvements and research priorities. Indicate whether each recommendation should be addressed in the short/immediate term (2 months), mid -term (3- 5 years) an years). Also indicate whether each recommendation is high priority (likely most affecting results and/or interpretation), mid priority, or low priority.

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

Annex 3: Tentative Agenda

2018 Benchmark Stock Assessment for the Main Hawaiian Islands Kona Crab

Western Pacific Regional Fishery Management Council Office 1164 Bishop St., Suite 1400; Honolulu, HI 96813

September 10 - 14, 2018, 9am - 5pm

Day 1, Monday September 10

1. Welcome and Introductions
2. Background information – Objectives and Terms of Reference
   a. Fishery Operation & Management
3. History of stock assessments and reviews
4. Data
   a. State of Hawaii Fisher Reporting System
   b. Unreported catch estimates
   c. Life history information
   d. Other

Day 2, Tuesday September 11

5. Presentation and review of stock assessment

Day 3, Wednesday September 12

6. Continue review of stock assessment

Day 4, Thursday September 13

7. Continue review of stock assessment
8. Public comment period
9. Panel discussions (closed)

Day 5, Friday September 14

10. Continue panel discussions (closed, morning)
11. Present panel results (afternoon)
12. Adjourn

7 Appendix 3: Panel Membership

Dr Steve Martell (Chair), Independent consultant, U.S.A.

Dr Nick Caputi, Western Australian Fisheries and Marine Research Laboratories, Department of Primary Industries and Regional Development, Western Australia, Australia

Dr Malcolm Haddon, Independent consultant, Tasmania, Australia