2018 Benchmark Stock Assessment of Main Hawaiian Islands Kona Crab

Report Prepared by:

Steve Martell - October 11, 2018

1. Executive Summary

A new benchmark assessment for the Main Hawaiian Island Kona Crab was prepared for the Western Pacific Stock Assessment Review (WPSAR) process, conducted during September 10-14, 2018 in Honolulu HI. The review panel consisted two reviewers contracted through the Center for Independent Experts (CIE): Dr. Malcom Haddon (Australia), Dr. Nick Caputi (Australia), and myself. I am also a member of the Western Pacific Fisheries Management Council (WPFMC) Science and Statistical Committee (SSC). I served as the chair of the review panel, and I have had no previous experience with the Kona crab assessments.

I found all the documentation provided for this review was excellent and very well written. Two major issues with respect to uncertainty were discussed in detail during the course of the review: 1) constructing a time-series of catch and effort data, and 2) the uncertainty in model scaling information and its potential influence on setting ACLs. These are further summarized below. The primary challenge in this assessment stems from a data conflict between long-term decline in landings and declining trends in commercial CPUE. A stationary production model cannot fit to these data because the underlying production model results in increasing biomass during this long period of declining catch. The CPUE data are highly suspect due to the nature of how this fishery is prosecuted and the dwindling number of participants. The overall model scaling was biased by an additional fixed observation error (this error term was intended to reflect changes in catchability associated with the aforementioned problem). I recommend that this additional variance term be removed from the likelihood.

Global scaling of the model results are also directly proportional the errors in the unreported catch. If the unreported catch is over-estimated, then the OFL is over-estimated and vice versa. The costs of over-estimation versus under-estimation are not symmetric; the risk of overfishing increases with a downward bias in the unreported catch. I would recommend looking at potential management tools (and cost/benefit) that would increase the incentive for self-reporting (e.g., weekly draw, restaurant reporting & promoting contracts with local fishermen, or another carrot/stick option).

With respect to each of the terms of reference, I address them in the following bullet points:

1. The data for this assessment relies heavily on fisheries dependent information. The filtering methods developed for this assessment are an improvement over the previous assessments. In particular, the ability to track individuals from year to year. The only major shortcoming with respect to scientific uncertainty was the identification of multi-day trips. A particular challenge for the Kona crab fishery is defining a unit of "effort". Regulation changes in the directed Kona crab fishery have changed the dynamics of fishing effort over time, making it difficult to rely on the assumption of constant catchability over time.

2. CPUE standardization is not my area of expertise. Discussion during the review and input from public testimony all suggested that changes in regulation, changes in how the fishery is prosecuted, and the reduction in the number of participants has a larger influence on the CPUE than abundance.

3. The assessment is based on fitting a biomass production model, conditioned on catch and fitted to CPUE data. The vast majority of the landings for this species comes from Penguin Banks, and any signal that exists in the Catch and Effort data is most likely to reflect the dynamics in this area. At this time I would say that yes, the biomass production model is appropriate for use in setting Annual Catch Limits for Kona Crab. But also note that these catch and CPUE data do not inform an upper bound on the global scaling. That being said, I would also would limit any dramatic increases in catch from what has been observed in the recent 10 years and continue to monitor trends in CPUE.

4. The decision points and input parameters are reasonably chosen. My only concern, however, is the additional error term intending to capture potential variability in catchability. Sensitivity testing during the course of the review clearly showed that the addition of this "subjective" variance term biased the estimates of population scale upwards with no real improvements to any of the residual patterns in the CPUE. Given this demonstrated upward bias, I recommend that the decision points be updated with no additional variance term added to the likelihood.

5. Yes the primary sources of uncertainty are well documented. Unreported catches will continue to plague this problem. It is important to note here that a major source of uncertainty is based on the underlying principle that the proportion of unreported catch is known and/or assumed to be constant over periods or blocks of time.

6. The major underlying assumption is that the fisheries-dependent CPUE index is proportional to abundance. Given the amount of research and effort that has gone into the data filtering process, I think the authors have done the best that can possibly be done to satisfy my curiosities about how much more information can be gleaned from these data. An independent estimate of biomass, or fishing mortality rate, could greatly enhance the available data for this assessment, by providing more information on global scaling.

7. This document is a comprehensive look at the data, assumptions, and sensitivities to those assumption. The additional model runs conducted during the course of the review also assured the reviewers that a thorough look at the parameter space has been conducted. I find the results to be scientifically sound based on the available information and is suitable to address goals of management.

8. The methods used for projection are suitable for projecting population status. The data and priors that inform this assessment are likely appropriate for defining the lower production bound, but not informative about the upper levels of production. Therefore the projections could be considered overly-optimistic and continue to stress continued monitoring of commercial CPUE in response to increases in catch.

9. I would recommend using this model for the provision of catch advice, subject to the removal of the additional variance terms and the other short term recommendations made in the review panel report.

10. My strongest recommendation to improve this assessment is to conduct some sort of field experiment to directly measure catchability in the commercial gear (tagging or depletion experiments, &

underwater video on the traps to measure probability of capture). Having an informative prior on catchability will greatly enhance the existing data that inform this model and likely provide better information on overall population scaling.

2. Background

The Kona crab fishery has been managed by the State of Hawaii since 1938. Several notable regulations have changed the dynamics of this fishery, and in recent years the reported landings are less than 5% of what they were 3 decades ago. The number of participants in this fishery has also declined. Some of these new regulations have effectively increased the operating cost where it now requires twice the effort to land the same amount of legal crab (defined as male only 4 inch minimum size limit). Discarding amounts are high, and discarding mortality reduces the yield per recruit in this fishery.

Stock assessment data consist of commercial catch and effort data. There are a number of assumptions involved in defining a unit of effort for this fishery given the historical changes in regulations. However, a key new piece of information has emerged that has allowed this historical catch and effort data be traced to individuals from year to year. For the first time, individual fisher effects can now be included in the CPUE standardizations. Why this may, or may not, improve the overall assumptions of CPUE being proportional to biomass, it does improve confidence that these data were better vetted than in previous assessments. The last key element of the data was the reconstruction of total catch based on recent studies in unreported catch.

A modern state-space biomass surplus production model was fitted to the standardized CPUE data, where the primary assumptions are that catch is known without error and that biomass is proportional to CPUE. The software has been described in the primary literature and has been used in other applications.

There were a number of contradictions that stood out to me as being problematic. There were strong residual patterns in the fits to the CPUE data that seem to correspond to events. The time series was split to reflect the major impacts on catch rates of the male-only regulation in 2007. Prior to this regulation, other patterns in the CPUE were not explained, despite having flexibility with annual process error deviations in the form of random effects. Perhaps the single largest contradiction is the trends in catch and trends in CPUE. Total catch peaked in 1972 at roughly 175,000 lbs and has continued to decline steadily to about 27,000 lbs in 2013. Between 2014-16 total catch each year was less than 10,000 lbs per year. This decline is largely due to the decreased in the number of participants.

3. Reviewers Role

I am a member of the Western Pacific Fisheries Management Councils' (WPFMC) Scientific and Statistical Committee (SSC). My role in this review is 3 fold: 1) to serve as the Chair for the benchmark review process, 2) provide an independent report addressing the Terms of Reference, and 3) to present the review panel summary report to the SSC at the subsequent WPFMC council meeting in 2018.

Prior to this review, I have had no previous involvement with this assessment. I have no financial ties or conflict of interest with the commercial or recreational fisheries for Kona crab.

4. Review Activities

This was a peer review of a new benchmark assessment for Kona Crab. The review panel reviewed a series of presentations by staff on the data, assessment, projections, and an *in situ* study to examine discard mortality rates in the Kona crab commercial fishery. Presentations from the State of Hawaii were key to understanding how the dynamics of this fishery have changed in response to management measures. The previous assessment using another surplus production model (conducted in 2010-11 using ASPIC) for this species relied only on data 2006 due to the change in regulations requiring retention of male only, and no data prior to 1970. This assessment had very different conclusions about the stock status than the present assessment under review.

The review panel also received presentations on the data collection streams, and a new recent field study on the post-release mortality by John Wiley and Cassie Pardee. The results of the recent field research were then used to estimate discard mortality associated with the release of females and undersize crabs. As much as 80% of the catch is released due to regulations. The highest mortality rates were associated with the removal of a periopod. The results of this study set the new discard mortality rate at 10.8%.

The review panel requested a number of model runs to further understand the sensitivities of the model to the various assumptions made during the CPUE standardization process. None of the result from any of these model runs indicated any significant deviations in management advice with the exception of removing the fixed minimum standard deviation for additional observation error. Estimates of model biomass were found to be sensitive to this additional variance term, where biomass would increase proportional to the assumed value of the variance term.

I also enjoyed the Kona crab at dinner, Mahalo!

5. Critique on the NMFS review process

I would like to complement all staff and participants who helped prepare materials and provide answers to the many questions from the review panel. Also thanks to the WPFMC for hosting this review and providing technology and fuel required to support this process. I'd like to reiterate comments I've made in recent reviews. Again this review stands out for:

- Excellent preparations.
- Non-hostile environment. Its a pleasure to see even the last few remaining individuals who participate in this fishery come to the room and share their knowledge through this process.

6. Recommendations

Use the demographic methods described by McAllister et. al. (2001) to develop an informative prior for the intrinsic rate of growth, *r*. A more informative prior might be possible.

The challenge with this data set is that there is no contrasting information to resolve the over all model scaling. Some other external information is required. The sensitivity tests conducted clearly show that the

upper bound on this population is determined by the joint influence of the priors on the model parameters. What is needed is a second piece of information that would help define the upper bound. Direct measures of exploitation through tagging studies is one avenue, but fraught with assumptions and problems in a small scale fishery. Another alternative would be to used small scale depletion experiments to directly measure the catchability of a "unit of effort". This could then be used to inform catchability in the model.

7. References

McAllister, M. K., Pikitch, E. K., and Babcock, E. A. 2001.Using demographic methods to construct Bayesian priors for the intrinsic rate of increase in the Schaefer model and implications for stock rebuilding. Can. J. Fish. Aquat. Sci. 58 1871-1890