

Pacific Islands Fisheries Science Center Program
Review of Stock Assessment Process
May 19-23, 2014
Reviewer 5

A. Introduction

The Pacific Island Fisheries Science Center (PIFSC) has a mission to provide timely and high-quality information to support the conservation and management of fisheries, protected species, and habitats in the central and western Pacific Ocean. This is mandated by the US domestic laws including Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, Marine Mammal Protection Act, Coral Reef Conservation Act; international agreements/Regional Fishery Management organizations (RFMOs); and U.S. government administrative and executive orders (e.g., marine national monuments). The PIFSC stock assessment program focuses on the assessment of two groups of fish species: highly migrated pelagic species (HMS) and the insular Hawaii bottomfish complex. The PIFSC has recently been asked to conduct stock assessment for coral reef species. The PIFSC stock assessment program responsibilities include conducting stock assessments, developing and improving monitoring program designs and modeling methods, and providing quantitative expertise to various domestic and international fisheries research and management organizations including the PIFSC, PIRO, WPRFMC, State of HI, WCPFC, ISC, IATTC and other emerging RFMOs.

The HMS covered by the PIFSC stock assessment program mainly include tunas (e.g., albacore) and billfishes (e.g., striped marlin and blue marlin) that are widely distributed in the Pacific Ocean. These species differ greatly in their life histories, and are targeted with multiple gears by multiple fishing fleets from different countries. The fisheries are assessed and managed by various RFMOs including WCPFC, IATTC, and ISC. Input data for the stock assessments are collected and provided by relevant countries and regions. The PIFSC stock assessment scientists take a leading role in developing quantitative approach, conducting the stock assessment, and communicating the stock assessment results to relevant stakeholders.

The Hawaii bottomfish complex inhabits waters of the Hawaiian Archipelago. 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, including six species of snappers and jacks and one species of grouper, are the main targets of this fishery. They have been the focus of the assessment and management since 2005. The 2011 assessment follows an assessment for the MHI bottomfish complex conducted in 2005 with data through 2004 and its 2008 update with data through 2007. 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 fishery 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. 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.

Coral reef fish complex includes more than 100 species targeted by commercial and recreational fishermen. The fishery data are incomplete at the best. However, there is some information on size structures of many fish species/families. Although most coral reef fisheries occur in the state waters, the PIFSC is requested to develop quantitative modeling approaches for their stock assessment.

My role as an independent external reviewer is to conduct an impartial and independent peer review of the Pacific Island Fisheries Research Center (PIFSC) stock assessment process with respect to a set of pre-defined Terms of Reference (TORs).

Two weeks prior to the review in the PIFSC in Honolulu, I was given the access to relevant reports, documents, and presentation slides. The review was held from May 19 to 22, 2014 in a PIFSC facility in Honolulu, HI. The review was chaired by Dr. Steve Murawski (independent reviewer) and attended by the relevant PIFSC scientists, WPRFMC managers and publics, in addition to the other four external reviewers.

A series of presentations were given during the review to provide the review panel with background information on the PIFSC stock assessment process. The review panel was involved in the discussion during the presentation by (1) questioning and asking for clarification; (2) making observations of the process; and (3) making comments and suggestions for alternative approaches. The review panel interacted with the relevant scientists and managers who presented the talks and asked for further clarifications and references during the review. The review panel also discussed relevant issues within themselves.

B. General Observations, Findings and Recommendations

1. High-level scientific/technical approach

The PIFSC has a mission to provide timely and high-quality information to support the conservation and management of fisheries, protected species, and habitats in the central and western Pacific Ocean. Having a strong stock assessment program that can yield high quality estimates of key parameters for fisheries is critical in achieving the mission. The high quality stock assessment can only be achieved when sufficient information is available and suitable analytical methods are developed.

The information available for the three major fish species complexes differs greatly, ranging from data-poor to data-rich, which results in large differences in the approaches to their assessments. The approaches developed for the three groups of fish species cover a good range of stock assessment modeling approaches requiring an extensive amount of information to limited information.

For the pelagic HMS that are assessed and managed by the RFMOs, the PIFSC has taken a leading role in developing, evaluating and implementing stock assessment approaches. The PIFSC has effectively worked with scientists of various countries within various treaty organizations to develop and implement cutting-edge stock assessment approaches for the assessment of the pelagic HMS. This can be clearly shown by a good number of publications mainly on the methodology development co-authored by the PIFSC and international collaborators. The stock assessment program for these species appears to be well-planned, structured, and scientifically and technically sound, and can adequately address needs for management advices and fulfill the international treaty obligations. However, more simulation studies and sensitivity analyses may be needed for a better understanding of potential consequences of violating many assumptions associated with the assessment. Model parameterization may need to be better justified and evaluated for alternatives. Uncertainty associated with modeling needs to be better quantified and evaluated. Such excises provide young stock assessment scientists in the PIFSC with an excellent opportunity for more in-depth analyses of modeling process, and can greatly enhance research capacity building in the PIFSC.

For the Deep 7 stock assessment, a biomass production model has been developed and modified over the last few years. Substantial changes have been made over the time in model parameterization and statistical estimators, which has improved the performance of the production model. Although there are some concerns such as the temporal representation of stock abundance by fishery-dependent CPUEs, given the constraints of data quality and quantity, the biomass production model might be a good choice in the past. However, given a lack of contrast in CPUE data and availability of more biological/life history information on individual Deep 7 species, it might be a good time to consider developing age-structured stock assessment models for species-specific stock assessment for some Deep 7 species. Given the concerns on the quality of fishery-dependent CPUE data, a fishery-independent monitoring program may be necessary for yielding more reliable abundance indices. The PIFSC has been testing multiple fishery-independent sampling methods since 2011, but these programs are still in the early stage of the development. Because of financial constraints, a cost-benefit analysis may be necessary for optimizing the survey designs for identifying one or two survey methods that are most efficient and effective for the development of reliable abundance estimates.

For the coral reef fish complex, because of large number of fish species and a lack of fisheries and life history information, size-based approach recently developed by the PIFSC scientists for the assessment of fish family appears to be appropriate. I would like to comment the PIFSC stock assessment staff for developing some innovative approaches to incorporate uncertainties associated with our understanding of the life history and dynamics of coral reef species. However, more studies may be needed for the evaluation of impacts of various assumptions associated with the size-based approach. Such studies may need to be done separately for fish species/family with different life histories because the performance of a size-based model may vary with life history strategies.

The PIFSC has invested an admirable amount of research efforts in developing and evaluating stock assessment approaches. This has been shown in the modifications/changes in the approaches to assessing the pelagic HMS, Deep 7 and coral reef fish complexes. However, it is

important that if a new model or model parameterization needs to be used, it should be run in parallel to the old model or model parameterization to identify changes in stock assessment results resulting from changes in model configurations. This needs to be applied to all the assessments.

Limited ecological information has been considered in the stock assessment. It appears that a lot of ecosystem dynamic modeling work has been done and some information derived can be readily incorporated into the current stock assessment. There is a need for a close collaboration between the ecosystem and stock assessment groups so that ecosystem information can be incorporated into the stock assessment in a systematic way. Future research emphasis may need to focus on the improvement of our understanding of roles of trophic dynamics and habitats in influencing the spatial and temporal dynamics of fish stocks and developing frameworks to incorporate changes in the ecosystems and habitats in the assessment. Such an approach can greatly improve our understanding of impacts of changes in the ecosystems and habitats on the dynamics of targeted fish species/complexes.

There is a need to develop analytic approaches to formally incorporate the information derived (or to be derived in future) in the diver reef survey and various fishery-independent survey programs into the assessment of coral reef fish and Deep 7 complexes.

2. Assessment process

In general the PIFSC has an effective process for the assessments of the pelagic HMS and Deep 7 species. The TORs used in the assessment of Deep 7 complex are developed by the West Pacific Stock Assessment Review (WPSAR) working group that is represented by relevant constituents (e.g., WPFMC, SSC, and PIFSC) and designed to establish a procedure for peer review for the Deep 7 assessment as referenced in the 2006 Reauthorization of the Magnuson-Stevens Fishery Conservation and management Act (MSA); but the process of developing the TORs seemed not to work well in its first application of the Deep 7 assessment.

The current process of developing TORs for the HMS assessment is not clear. The development process of TORs may need to be better formalized and structured for both Deep 7 and HMS stocks to reduce the uncertainty in the process. There is no evidence of having clearly defined TORs for the formulation of stock assessment reports. If the guideline and procedure can be developed and outlined regarding TORs for the peer review and reporting of the HMS, Deep 7 and potentially coral reef fish stock assessments, responsibilities and expectations of relevant participants will be clarified.

The PIFSC assessment scientists have been actively involved in preliminary data preparation and analysis for the relevant stock assessments. Although this may take the scientists extra time and effort, this involvement is necessary for the stock assessment scientists to better understand the issues related to data quality and quantity, which is important for stock assessments. It is important for the PIFSC stock assessment group to continue working closely with the monitoring and life history groups in the identification of data need gaps, optimization of monitoring programs, and data compilations and preliminary analyses for stock assessments.

It appears that a well-structured protocol has been in place for consistently evaluating

technical issues including alternative assumptions on model error structures, sensitivity analyses for impacts of different model parameterizations on stock assessment, and quantification of uncertainties of various sources in stock assessment modeling. For the pelagic HMS stock assessment, uncertainties in the input data, fisheries and biological processes, and model parameterization appear to be carefully evaluated in the stock assessment and projection. However the performance of biomass production model still needs to be evaluated.

3. Peer review

Peer review process is a critical part of fisheries management process, which is designed to ensure high quality stock assessment work. The MSA mandate requires a peer review process to be independent and transparent. The WPSAR process is developed to address the mandate for the Deep 7 stock assessment. The WPSAR is structured to involve the Center, regional management agencies, Council, SSC, and CIE in different stages of review process. However, the WPSAR process still in its early stage of development. The responsibility and expectation of relevant participants need to be better defined in the review process. The review process for the internationally managed HMS stocks has not been clearly defined.

The CIE reviews for the HMS and Deep 7 stocks are mainly desk review with no face-to-face interactions as a result of financial and logistic constraints. The current review is mainly focused on the end product of a stock assessment, which may be too late if major problems in the assessment are identified during the review. It is necessary to develop a review protocol/framework allowing for the examination of stock assessment modeling work during the stages of model development and parameterization, which can provide some early guidance and quality control for the process of stock assessment to ensure that major issues can be identified and resolved in the early stages of stock assessment.

There is a need to find the balance between the local reviewers who are likely to have better knowledge about the fisheries versus outside reviewers who may provide some fresh thoughts about the stock assessment. Both groups of reviewers can provide very useful insights on the quality of a stock assessment and possible improvements.

A protocol needs to be developed to allow stock assessment scientists to have an opportunity to rebut the reviews. These reviews should be made available online.

4. Organization and priorities

There are two forms of stock assessment in the PIFSC, benchmark and updates, which differ in time and efforts. A stock assessment is usually planned 2-3 years ahead with a targeted frequency of benchmark assessment every 3 years and update stock assessment every 1-2 years for a fish stock. A stock assessment scientist is normally engaged in both types of stock assessments, which include conducting regular stock assessment and research activity focusing on the exploration and evaluation of new approaches for stock assessment. Although both the assessment and research are active in the PIFSC stock assessment program, there appears a lack of formalized protocol to prioritize the efforts.

Given the financial and logistic constraints and number of species needed to be assessed,

assessment priority needs to be identified for domestic stocks (i.e., Deep 7 and coral reef stocks) and international stocks (i.e., pelagic HMS stocks). Formalized prioritization of stock assessment program can help identify critical issues that need to be addressed in the assessment and research to optimize the assessment and research efforts. The issues identified in the stock assessment work can be potentially used for identifying needs for research and the results derived from the research activities can be used to support and improve various components of stock assessments (e.g., data collection, survey design, model and statistical method development).

One important aspect of the PIFSC stock assessment program is research capacity building. With an unusually large proportion of young stock assessment scientists, this is very important. These young scientists may need to be mentored more closely by senior scientists in stock assessment.

5. Accomplishments relative to mandates

The number of stock assessments done per year is around 2-3 per years prior to 2014. This is not a lot given the number of stock assessment scientists in the Center. The relatively small number of stock assessments that were done prior to 2014 might result from a lack of senior stock assessment scientist, needs to develop new modeling methods, and/or efforts for compiling the data in initial stock assessments. The number of stock assessment that will be done in 2014 increases to 5. The fish stocks covered in these stock assessments are HMS species and bottomfish complex including MHI Deep 7, North Pacific (NP) swordfish, Pacific bluefin tuna, NP albacore, NP striped marlin, NP blue shark, and NP blue marlin. Referred publications are close to 2 papers per person per year on average in the recent years. This is a pretty good output for young scientists.

6. Communication of assessment results and data needs

Although data collection and stock assessment are responsibilities of three different branches (monitoring branch, life history branch, and stock assessment branch) in the PIFSC, there appears to have a good communication among these branches regarding the stock assessment needs of input information and quality of the information. The PIFSC is fully aware of potential problems associated with a lack of fishery-independent data in the stock assessment. Fishery-dependent CPUE data are all standardized before they are used in the assessment. Efforts have been steadily increased recently for the collection of life history data. Multiple approaches, including those using state-of-the-art equipments and technologies, have been explored for the development of fishery-independent survey programs. Although these efforts just started recently, some of them have shown to be promising for developing a more reliable set of abundance index and biological data for the Deep 7 and coral reef fishes, which can greatly improve the Deep 7 and coral reef fish stock assessments.

The Deep 7 and pelagic HMS assessment process and results have been communicated to various stakeholders through public meetings of the Western Pacific Fishery Management Council and Western and Central Pacific Fisheries Commission (northern committee ISC-related stocks), regular reports to WPFMC and its SSC (quarterly report), professional journals, RFMO reports, PIFSC internal reports, and some public events. Input data have been identified for their sources. Most stock assessment reports and aggregated data are available online. However, there seems a

lack of public attentions to and interests in fisheries in the region, perhaps as a result of a lack of crisis in fishery management (a good thing to have) and/or relatively small fishery outputs.

Communications and interactions among the Centers in stock assessment have been increasing. The PIFSC stock assessment scientists have been active on various regional, national and international working groups (e.g., assessment method working group). More interactions, communications, and collaborations with other Centers can be cost effective in helping address some of the stock assessment problems shared by various Centers.

7. Opportunities and Needs

The diversities and complexities of stock assessment conducted by the PIFSC provide an opportunity for research in developing new stock assessment approaches for data-limited stock assessment, integrated stock assessment, meta-population model, estimation of protected species bycatch, and multi-model inference. Although these are all challenging issues, they provide great opportunities for research capacity building and for collaborations with scientists outside the PIFSC stock assessment program.

The PIFSC stock assessment program has many very talent and motivated young scientists. Their career development and Center's research capacity building call for them to be mentored by senior scientists in the Center and be provided opportunities to collaborate with scientists both inside and outside the Center. The high turn-over rate of young scientists and a high proportion of foreign young scientists are a concern. However, the PIFSC may not be able to resolve this problem alone. The PIFSC may need to work with other agencies to develop a strategic plan to recruit and maintain a stable, high quality, capable and experienced team of stock assessment scientists. The collaborations with various universities to have graduate students work at various projects related to the stock assessment program is certainly a cost-effective way to conduct the research under the constraints of budget and increased public/outside requests for high quality stock assessment.

The Center has been taking advantages of new and state-of-the-art survey technologies. The initial evaluation of various approaches is necessary in the process of identifying most suitable survey technology for the region. However, such a use of multiple survey methods is not financially and logistically sustainable. Some analyses including simulations based on the data that have been collected need to be done for identifying 1-2 approaches for the fishery-independent survey. The Center needs to work with the Ecosystems and Oceanography Division and local universities and state agency in the collection of biological information of targeted fish species.

The Center has made a good progress in developing innovative approach for coral reef fish stock assessment modeling. However, the modeling approach needs to incorporate the data collected in the fishery-independent program.

The Center can continue developing new stock assessment models, expanding and promoting intra- and inter-agency partnerships; and developing a framework allowing for programmatic feedback. A cost-benefit analysis may need to be done for prioritization of the stock assessment program to find the balance between demands for the quantitative skills and payoffs of

staff time/effort.

More social and economic analysis needs to be done to better understand fleet dynamics, fishermen's fishing behavior and possible responses to the changes in regulations, which can provide critical information for a better understanding and interpretation of fishery-dependent data for the stock assessment. This provides an opportunity to work with social scientists and to develop new research arenas considering fisheries as a coupled natural-human system in the assessment and management.

C. Conclusions

Large geographic areas, relatively small values, diversity of fish species, relatively large subsistence fisheries, difficulty (if not impossible) to run a traditional bottom trawl survey program, and unusually high proportion of young stock assessment scientists in the PIFSC make the stock assessment challenging in the Pacific Island region. These challenges, however, have provided great opportunities and incentives for the PIFSC scientists to develop new sampling programs and new analytical approaches for the stock assessment.

Overall the stock assessments done in the PIFSC are well-planned and structured, and scientifically and technically sound. Uncertainties in the input data, fisheries and biological processes, and model parameterization appear to be carefully evaluated in the stock assessment. Sensitivity analyses have been commonly used to evaluate possible consequences of violating model and data assumptions. Innovative approaches have been developed to cope with the issues related to data quality and quantity. However, there is a need to develop a cost-effective and sustainable fishery-independent survey program to provide a set of more reliable abundance index for the Deep 7 complex. A size/age-structured model needs to be developed to assess some of the Deep 7 species. The stock assessment research program is rather productive, but needs to be more structured and planned to tail the needs of the stock assessment.

The Center may need to formalize and streamline the process for prioritizing the stock assessment program. The research activity may need to be centered at addressing technical and scientific challenges identified in the stock assessment.

The current review process is focused on the end product of a stock assessment, which may be too late if major problems in the assessment are identified during the review. It is necessary to develop a review protocol/framework allowing for the examination of stock assessment modeling work during the stages of model development and parameterization. The protocols for the development of TORs for a stock assessment, peer review, and report writing may need to be formalized to ensure a clear definition of responsibilities and expectations of relevant participants.

A strategic plan and relevant strategies/actions may need to be developed for recruiting and maintaining a stable, high quality, capable and experienced team of stock assessment scientists. The Center can continue enhancing ongoing collaborations with various universities to involve faculty and graduate students in the stock assessment program, which is a cost-effective way for conducting the research under the constraints of budget and increased public/outside requests for high quality stock assessment.