REVIEW OF ICCAT BET ASSESSMENT IN 2015

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SUMMARY

Different approaches were examined in the Bigeye Assessment Meeting held 2015; however, conflicting data inputs, primarily CPUE series used provided different conclusions on stock status, and further analysis was warranted. In addition, length frequency data are particular important for the age structured assessments used, and accuracy in these data is crucial to the inference, as large uncertainties still exist in this series. Data weighting issues were not examined extensively, and further work is warranted regarding this subject. Overall, the process was transparent, and issues were briefly discussed relevant to uncertainty in the assessment results. A key limitation was that insufficient time was available to examine both data, and assessment issues at the meeting. If data issues were resolved before the meeting, additional time would be available on discussing further refinements in the assessments. Finally, approaches dealing with uncertainty and projections were not given due importance, but as these are critical for stock status advice, and management advice that would sustain the long-term sustainability of the stock, additional time should be spent on these issues in the future.

RÉSUMÉ

Différentes approches ont été examinées à la réunion d'évaluation du thon obèse qui s'est tenue en 2015 ; cependant, la saisie de données contradictoires, principalement des séries de CPUE utilisées, a fourni des conclusions différentes sur l'état du stock, et une analyse plus poussée s'est imposée. En outre, les données de fréquences de taille sont particulièrement importantes pour les évaluations structurées par âge qui sont utilisées, et l'exactitude de ces données est cruciale pour l'inférence, étant donné que de grandes incertitudes existent toujours dans cette série. Les questions de pondération des données n'ont pas été examinées en profondeur, et il faut poursuivre les travaux à cet égard. Dans l'ensemble, le processus était transparent, et les questions ont été abordées brièvement en ce qui concerne l'incertitude planant dans les résultats de l'évaluation. Une limitation essentielle a été le manque de temps pour examiner les données et les questions liées à l'évaluation lors de la réunion. Si les questions relatives aux données étaient réglées avant la réunion, un délai supplémentaire serait disponible pour discuter des améliorations supplémentaires à apporter aux évaluations. Enfin, les approches traitant de l'incertitude et des projections n'ont pas reçu l'importance qui leur était due, mais comme celles-ci sont essentielles pour formuler un avis sur l'état des stocks et un avis de gestion qui appuierait la durabilité à long terme du stock, il conviendrait d'accorder davantage de temps à ces questions à l'avenir.

RESUMEN

En la reunión de evaluación de patudo celebrada en 2015 se examinaron diferentes enfoques, sin embargo, las entradas de datos contradictorias, principalmente la serie de CPUE utilizada proporcionaba diferentes conclusiones sobre el estado del stock, por lo que son necesarios más análisis. Además, los datos de frecuencia de tallas son especialmente importantes para las evaluaciones estructuradas por edad utilizadas, y la precisión de estos datos es crucial para la deducción, ya que en esta serie continúan existiendo grandes incertidumbres. Los temas relacionados con la ponderación de los datos no se examinaron en profundidad, por lo que se requiere más trabajo en este sentido. En general, el proceso fue transparente, y se discutieron brevemente temas relacionados con la incertidumbre en los resultados de la evaluación. Una limitación clave fue que no se dispuso de tiempo suficiente para examinar los datos y los temas relacionados con la evaluación durante la reunión. Si los temas relacionados con los datos se resolvieran antes de la evaluación, se dispondría de más tiempo para discutir más mejoras de

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las evaluaciones. Por último, no se dio la importancia adecuada a los enfoques que abordaban la incertidumbre y las proyecciones, pero dado que son críticos para el asesoramiento relacionado con el estado del stock y el asesoramiento sobre ordenación que garantizarán la sostenibilidad a largo plazo del stock, en el futuro debería dedicársele más tiempo a estos temas.

KEYWORDS

Integrated assessment, Virtual population analysis, CPUE, Likelihood, Data weighting

Introduction

The second meeting to assess the bigeye stock in the Atlantic Ocean was held in Madrid between 13 and 17 July, 2015. The participation at the meeting included representatives from CPCs involved in the Atlantic bigeye fishery (Chinese Taipei, EU-Spain, EU-France, Japan, Uruguay, USA, Côte D'Ivoire, Ghana, Mauritania and Senegal), though some important countries like Angola were missing.

The primary reviewer is currently the Stock Assessment Expert at IOTC, and has been involved with stock assessment issues since 1998 (17 years) in the US, Asia and Africa. He has worked extensively on issues related to CPUE standardization and assessments of Bigeye, Skipjack, Swordfish, Marlin and neritic tuna in the Indian Ocean. The additional pages address the review as related to the key aspects of the TORs for the reviewer.

1. Evaluate the adequacy, appropriateness, and application of data used in the assessment

i) Three (possibly 4) pieces of information are normally used in the assessment; they are the catch data, the length-composition data, the abundance indices, and possibly tagging data. Catch data had been examined carefully by each CPC (and the Secretariat), and all issues related to them are discussed in the 1st report (**Appendix 1**). Primary issues relate to the large uncertainty in the data, and how this would be propagated in the assessment. Issues with catch reporting from Longline fisheries in the 1990's were not discussed extensively, but knowing coverage was less than 10% in some years for log-book coverage in the Indian ocean, similar issues maybe prevalent in other oceans. In addition, issues with length-composition of the LL fleets (Task II) also need to be examined. Issues with Ghana are problematic as the data that were examined and estimation techniques for Ghana catch estimates in 2012 and 2013 seem problematic as the catch estimates submitted appear to be too low, as there is no documentation on what has been done to estimate this component. The 2012 and 2013 catches are much lower but there is no apparent reason for this. However, the alternative catch series provided was not fully documented and catches may need to be further reviewed. It was recommended that Ghana shall receive additional assistance from ICCAT including full access to the source code of the database that is used (IRD AVDTH Database) and full documentation of the estimation procedure. Otherwise alternative research institutions shall be identified to assist Ghana with this work.

ii) As far as the Abundance index data used in the assessment (see review 1 of the abundance index data used in report on data used meeting of 4-8 May). While the indices presented seem appropriate, the methods used could be fine-tuned or improved as discussed in the previous report prepared by the reviewer (see **Appendix 2**). The primary issues are related to how strata were defined and whether areas were appropriately used in the assessment, whether targeting was appropriately accounted for, and whether fleet effects were incorporated correctly.

   a) Note, for the PS Index, Soto *et al.* (2015) approach using the juvenile index is important. Some runs to examine sensitivity to the assessment using this series along with the LL series needs to be examined. However, both the nominal and standardized series follow the same trends (exact), so it doesn't appear to being much for the standardization process. Use of the total number of FADs and how it changes catchability is important (thus the number of FAD sets is proportional to the total number of drifting FADs and catch rates will change dependent on the number of drifting FADs present in the area. In addition issues of assessing proportions positive in BET catches maybe indicator of overall abundances decline. Finally, the contribution of free-schools vs FAD schools is important to account for, as they normally take priority when they are available (skippers will go for large YFT rather than FADs if there is YFT available.

iii) The length frequency data was appropriately categorized and analysed for 15 fleets. Minimum 200 (or 50 fish) seem appropriate for representativeness for the fleet length-frequencies. However, log-scale of number sampled seems fairly arbitrary for data weighting of length-frequency data. PS data on length frequency samples appears low, however, again given magnitude of catch in early years it may not be an issue till the late 2000's. Issues relating to changes in length-frequency data for some of the longline fleets, as they are a large component of the catch and there is a need to examine this as well, and how are changes in length-compositions accounted in the assessment. A recommendation was made to compare the catch and effort datasets (average weights) with length-frequency (average weights) dataset reported from these fisheries to make sure these are consistent or whether there is problem in reporting these data. As such, Chinese Taipei reporting numbers and weights for its CE data (only numbers existing at present are till 1994) need to be updated to conduct this comparison.
iv) Tagging data was limited in the early 2000's and as such were discounted and not used in the assessment.

Overall adequacy of data used in assessment

Note that all assessments depend on the quality of data used. It is important to account for the uncertainty in the data, and examine sensitivity to alternative assumptions. The data used here is as good/bad as any other RFMO, as far as the quality in the assessment. However, of particular concern are the PS catch information, the PS CPUE, and the LL size frequencies. More time needs to be paid to details and examinations made to whether these are real or artefact of errors. A strong recommendation would be to examine the CPUE series used in the LL fleets, and improve it based on similar exercise undertaken in the Indian Ocean (see Hoyle *et al.* 2015). In addition a meeting with CPC's to understand inconsistencies/changes in Length Frequency (LF) samples are important as these have large implications on the assessment.

2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stock and if appropriate recommend alternative approaches to be accomplished in the future

Four possible approaches were examined for the BET assessment in 2015 and these should be sufficient to examine a range of possible options for the assessment; my comments will be addressed to each of them separately:

2.1 Examining simplified methods to assess signals in data

Using simplified catch-curve analysis by fleet, it would be easy to assess whether there are signals in the data suggesting that selectivity is dome shaped or mortality is u-shaped (based on ages of catches by fleet over time). Such examples were useful primarily as there are exploratory analysis and are useful to assess if there is any signal in the data, and appropriate assumptions to be used in assessments. The document SCRS/2015/140, was prepared to document methodology to be used to provide hypotheses for selection pattern for use in SS and trends in F.

2.2 Surplus Production based assessments

Methods presented in data prep meeting were used, where you can test which CPUE is informative, and whether we can use some of CPUE data or something else. Bootstrap is a very important diagnostic as the number of acceptable samples chosen would depend on the quality of the relationship and application of the abundance index series. It could use it to find problems with the model or which index is non-informative. Eleven indices were produced and the bootstrap would be useful in examining which index is informative or important. Other diagnostics that are useful are profile likelihood to show which parameter is most informative based on different data types. The idea is to fit one index at a time and check the profiles to test if we estimate similar values of the parameters in the assessments.

ASPIC as related to the assessment using current LL CPUE data

Using multiple indices in a model run, doesn't make sense. Key indices should be examined separately, and not together in a run. These will cause model convergence problems and may give contrasting signals for the model to converge. Running bootstraps should be on separate index at a time rather than multiple indices. Again, it makes sense to only use one index as these are alternate hypothesis of the states of nature of the stock, and depending on what we are testing we may come up with different conclusions on the stock status. It should be noted that a bias in bootstraps occur when we use multiple indices, which then works as a diagnosis on whether we fit to multiple indices. Thus, fitting to multiple indices does not make sense as it would take an average signal rather than following one index of abundance.

The final set of models that should be used are 3 series fit separately, as we get good fits with Japanese LL, Chinese Taipei late and the US, without any residual patterns or poor diagnostics in the final model fits.

Some suggested recommendations on this approach are:

a) One should fit to an index separately as these are alternative states of nature and alternative hypothesis that you are testing against. As such, we need to evaluate this separately and not combining these indices simultaneously.

b) Thorough examination of why there are contradicting indices needs to be examined (like Hoyle *et al*. 2015). Possibly not accounting for targeting can lead to an index that shows an increase for Chinese Taipei, as supposed to the other indices. As such, equal weighting should probably not been given to the three indices. Reasons, one would not have confidence in the Taiwan, China series are taken from the Hoyle *et al.* (2015) report that shows why these maybe issues that were identified in the Indian ocean and could possibly be issues in the Atlantic as well:

   i) "Coverage of the Taiwanese fleet has been variable, beginning in 1979 at 63%, then declining from 77% in 1980 to 4% in 1992, and increasing again to a high level by 2004. The period of very low coverage in the Taiwanese dataset was due to loss of incentives for the vessels to provide logbooks, linked to changes in the economic environment and in the market. It occurred during a period of transition between different targeting practices, and development of a bigeye fishery. Location validation was also reduced, as vessels stopped reporting their locations by radio. Vessels that submitted logbooks may have fished differently from those that did not report, which would have affected the representativeness of the data. During the coverage decline, vessels targeting bigeye may have had less incentive to report than those targeting albacore, and the mix of targeting changed through time. The low coverage and changing targeting appears likely to have affected standardized catch rates. (Hoyle *et al.* 2015)".

   ii) "The way Taiwanese logbooks are managed reduces the availability of data for analysis. Logbooks that arrive after the data have been 'finalized' (currently over a year after the end of the calendar year of the data) are never added to the dataset that is provided to CPUE analysts. It is unclear what proportion of potentially-available logbook data are omitted as a result. "Taiwanese CPUE in southern regions is affected by the rapid recent growth of the oilfish fishery. This is a new fishery with significantly lower catchability for tunas. It is important for CPUE indices to adjust for this change in catchability. We recommend that future tuna CPUE standardizations should use appropriate methods to identify effort targeted at oilfish and either remove it from the dataset, or include a categorical variable for targeting method in the standardization. Some cluster analysis methods successfully identified this type of effort, and using this approach is probably preferable to the identification of oilfish vessels. The analyst should have access to the 'oilfish' variable, which was added to the logbook in 2009 (Hoyle *et al.* 2015). "

   iii) "We recommend that sets with no catches of the main species are not removed by default but based on an understanding of the reasons for their occurrence, and that alternative methods such as cluster analysis to identify targeting may be more effective, depending on the data quality. We also recommend that a consistent approach to outliers should be applied across the whole time series, and that approach should be adjusted according to the requirements of the analysis (Hoyle *et al.* 2015)."

   iv) "In the Indian Ocean Bigeye CPUE trends during the 2002-2004 period were very different for the Japanese and Taiwanese fisheries. Japanese CPUE was generally stable and consistent with surrounding periods, while Taiwanese CPUE rose sharply to peak in 2003, returning to previous levels in 2005. At the same time, the frequency distribution of Taiwanese catches changed considerably with a large increase in average catch per set, while the Japanese and Korean catches did not. This period coincides with what is believed to be a period of misreporting ('laundering') of the origins of bigeye catches, with some catches of Atlantic bigeye (which was subject to a catch limit) reported as being from the Indian Ocean (ICCAT 2005, IOTC 2005). False reporting of bigeye tuna catch during this period by some vessels has been acknowledged by Taiwanese fishery managers (IOTC 2005). We were unable to identify vessels that may have participated in fish laundering, and remove them from further analyses (Hoyle *et al*. 2015)."

c) We should use a hindcasting/retrospective analysis (Kell *et al. in prep*) for deciding on which CPUE index should be used (based on what was presented in the previous meeting).

d) Uncertainty estimation using different approaches (Bootstrap, MCMC, Hessian) showed very similar distributions in a preliminary analysis. The choice of how you estimate uncertainty has a big effect on the assessment especially for projections. Some more description of these approaches and how they are used in projections should be examined in future analysis (this should be made explicitly clear in future reports and analysis).

e) An issue on using LL indices was discussed as the bulk of mortality is coming from the PS index on juveniles. So, it would make sense to examine that as well in the ASPIC analysis at some point.

2.3 Virtual Population Analysis (VPA)

It was noted to examine the diagnostics carefully as it appears to fit some data well and other indices not that well. Age 10+ F's are not estimated well, and can create problems for the VPA. Quite a large difference in the two fits exists over pre 2003 and post 2003. Given the magnitude of the catch in Chinese, Taipei fleet and the possible bias in the length frequency reported, creates substantial problems in the fitting of these with the estimated F's that are quite high.

There are big sampling issues on age structure in Chinese Taipei, and this will change the overall dynamics of the assessment giving a factor of F. Split index 2005/2006 seems to correct the problems seen in the fishery. There is strong evidence that selectivity has changed. This is probably not true, and can create problems with the assessment, by giving more weight to the length composition changes to suggest that these are representative of what is happening in the fishery.

Three candidate runs were examined. The retrospective patterns were still present in all the runs (suggesting there maybe some problems with model convergence), but converge at the end points. Thus, there are no good starting values, but the models appear to come to the same concluding points. There was severe sensitivity to UR LL index, so it would make sense to probably drop this. Finally, the Taiwanese data needs to be examined carefully as a lot is being attributed to selectivity on changes in age structure in catch, but some analysts believe it maybe sampling errors.

Recommendation on VPA: Use the results with caution as it is likely that CAA (Catch at Age) could be problematic, implicitly estimating a very high F is recent years. While these seem to mirror some of the results, from the statistical catch at age analysis, the results maybe misleading as to the actual effects of fishing in recent years. In addition the recruitment signal seems auto-correlated and that no information is really seen in the catch at age matrix used in the analysis in the later years.

Further examination showed the model was extremely sensitive to starting conditions and gave quite different results depending on assumptions used on incomplete cohorts, and terminal F values used. This implicitly indicated that the model was highly unstable, and even though some runs gave reasonable estimates compared to the Surplus production or integrated models, the fact that it is highly unstable suggests that this model not be used further until these issues are resolved. Finally, the catch at age matrix was provided very late to the analysis here, and if such approaches are to be used in the future all such data should be prepared and provided to the analysts well in advance of the meetings.

2.4 Integrated Assessments (SS3, Mutifan-CL)

Background Material/Model Specifications: Stock resolution indicates that 15 fleets tailored after Miyabe *et al.* (2005) were used. They were primarily related to the Purse Seine (PS), Longline (LL) and Baitboat fleets operating in different areas. The largest catches observed were in Area 2. Model Biological parameters like growth were captured/based on variation from 11 growth models of proposed in a paper by Craig Brown (personal communication) and make sense to use the Hallier growth in the base model, as the growth is considerably different in the Atlantic as compared to the Indian Ocean. It was noted that BET fish in Atlantic make big migrations and feed in northern latitudes, which is highly productive giving a larger size fish and faster growth rates. For natural mortality, the Lorenzen curve was used that matches the growth of Hallier. In terms of Indices of Abundance (AI) the CPUE from LL fleets was primarily used, not BB nor PS. The length composition data was computed for most fisheries, however considerable uncertainty exists on the quality of this information. Finally, movement was estimated by CPUE and Length compositions, as tagging data was discounted as it indicated no movement across Region 2.

A recommendation was made that it didn't make much sense to estimate movement when we don't have any information on that. Given that, it was suggested to use only one area with fishery stratification across the three areas as identified.

An issue was brought up on model weighting so as to balancing the data on the length composition, based on model estimates of Effective Sample Size (ESS). The model was adjusted so that the ESS matches the observed sample size. The approach used iterative reweighting. If you don't do reweighting, you are over-fitting to Length Frequency (LF) and not CPUE. It was noted that larger problems possibly exist in that LC data from Taiwan may not be representative of length frequencies (Geehan *et al*. 2013). As such, a recommendation was made to further down-weight the ESS after iterative reweighting. This is a critical piece that is recommended and follows approaches suggested by Francis (2011).

The main issues identified in the original runs presented were:

1. Weight to CPUE rather than LF. This could be done by further downweighting the ESS on the LF samples.
2. Reconfigure the 3 area model to a one area model as we have no information on movement. Modelling movement based on CPUE and LC data maybe misleading as it is maybe an artefact of sampling and fishery behaviour (rather than stock behaviour).
3. It was recommended to keep steepness (h) fixed rather than estimated.
4. Profile likelihood should be shown on R0 as this is the driving the assessment and it would be clear whether this was being influenced by the LF, or the CPUE. If the latter, (see Francis 2011) one should fit to indices of abundance rather than LF.
5. Length frequency samples collected could be an artefact of sampling in some fleets in the latter years. As such, it may make sense to probably keep selectivity fixed over time rather than have it change over time.
6. Natural Mortality/Growth/Selectivity interactions need to be examined more carefully in these assessments as they have a large effect on the outcome of the assessment.
7. Uncertainty needs to be accounted for accurately. Possible approaches are to use grid based versus MCMC based approaches. I would recommend using main effects analysis on GRID to assess how things may change over time, and also use in projections, as it would save time. A more comprehensive examination of uncertainty using MCMC at a later point was recommended.

Other issues identified were:

1. The issues of how do we deal with recruitment (continuous) or recruitment at a particular time?
2. The issues addressing correlated parameters over time? How do these effect the assessment?

It is recommended to down-weight LF information and fit more to the AI. The R0 was affected by length-comp indices in opposite directions. It was recommended to switch it to an Age structure Production Model (ASPM). This would possibly bridge the gap between LF and CPUE series. Further, additional analysis were made to estimate changes to keep selectivity as based on the LF data, but only fit this to the CPUE series.

Other critical issues that were not addressed:

a) *Alternative CPUE's:* In essence, we can't believe both indices at the same time. Either we believe the Japanese index or the Taiwanese index (but not both in the same area). Hence, it would be recommended to use one index for any given area. My recommendation would be to fit to the Japanese index in Area 1, 2 and 3 and nothing else. Alternatively, fit to one index in each area, and then redo the model.

b) *Data weighting and conflicting sources of information for assessments:* Based on the conflicts in length frequency and index of abundance in the datasets, using some down-weighting of the LF data would be recommended. Although, the AI was increasing in the mid 1970's, capturing the overall trend is more important than fitting to these increases, as that is probably attributed to targeting changes (Matsumoto 2015). As Francis states in his paper (2011) to use 3 principles in fitting models to data: "Principle 1: Do not let other data stop the model from fitting abundance data well; Principle 2: When weighting composition data, allow for correlations; and Principle 3: Do not down-weight abundance data because they may be unrepresentative." These are recommended guidelines to be used. Final runs presented did address the discrepancy with the series by changing q's in earlier and later periods when it was assumed targeting changes in the mid 1970's explains the in increases observed in the Japanese CPUE's.

c) *Dealing with Uncertainty:* Structural uncertainty was not examined extensively, nor was the data-weighting or area examinations. In addition, when using forecasts, using either structural uncertainty grids with deterministic catch or MCMC based projections were not examined. These are important analyses that need to be addressed in these assessments which were not accounted for at this meeting.

3. Evaluate the methods used to estimate population benchmarks and stock status (e.g., MSY, FMSY, BMSY, or their proxies)

Reference points estimated are a function of the information used in the assessments (i.e. length frequency data, the AI data (CPUE) and the catch data). For integrated assessments and the VPA, the selectivity estimated and the values used are critical in estimating the key reference points. Most models have similar values, and as such using some assumed selectivity (estimated from the data) are used to estimate these from closed form solutions and are robust to the model specifications. However, some of the selectivity in recent years were predicated on the length-composition data, and these may not be known well (Geehan et. al. 2013). As such, some of the absolute measures may be inaccurate, but the relative reference points (B_{curr}/B_{MSY}& F_{curr}/F_{MSY}) should still be a good indicator of stock status. The estimates as such from SS or from VPA are probably more reliable than ASPIC as they deal with selectivity across fleets and surplus production models cannot explicitly do so. However, given the problems with the data, the Surplus production based approaches maybe more appropriate. Note, the use of Virgin Biomass (K) as a reference point shown at the meeting is useful to use as a reference point, as it remains independent of selectivity and its effect on MSY estimates. WCPFC use this since it is both independent of steepness and selection pattern. SPR0 is multiplied by the recruitment each year to give a changing biomass reference point.

4. Evaluate the adequacy, appropriateness, and application of the methods used to evaluate future population status, given the commissions objectives

Methods used incorporated 20 year projections were examined based on selectivity seen in the last 3 years of the data, 2011, 2012, and 2013. Recruitment based on last 3 years for the incomplete cohorts, catch quotas of 2016-2035 using ranges between 60-120K T with 5K increments. Recruitment (process error) was based on long-term average recruitment, and random with auto-correlation. Bootstrap and MCMC projections are useful to assess future population status in the ASPIC runs. This was done adequately for the Surplus Production models (using Biodyn as ASPIC can't do this), and will be examined in Synthesis and VPA over the next few months.

Projections on Surplus Production models using constant catch projections did not make much sense as the current stock status indicates the stock is overfished and is likely being overfished. At these levels, the F estimated is likely high and increasing this would indicate that the stock should show a declining trend. However, as the catch estimates currently are 60% -75% of the MSY levels, then catch levels could be increased by 40% and the stock would still be doing fine in the future, but results did not conform to what was assumed to be stable trajectories. Fishing mortality based projections should be used rather than catch based projections, as these make more sense in Surplus production based models. However, this was only proposed at the last minute and it was not possible to present to the group fully.

5. Evaluate the adequacy, appropriateness, and application of methods used to characterize the uncertainty in estimated parameters. Comment on whether the implications of uncertainty in technical conclusions are clearly stated

Initial runs showed some profile likelihood analysis for some parameters like steepness (h). However, these should have probably been done on other parameters (R_0, and MSY for e.g.) Structural uncertainty was not examined extensively, nor was the data-weighting or alternative area examinations (one versus three areas in the integrated assessment for e.g.). In addition, when using forecasts, using either structural uncertainty grids with deterministic catch or MCMC based projections were not examined due to time constraints and only examined for the ASPIC (Surplus production based models). These are important analyses that need to be examined in these assessments which were not addressed extensively at this meeting.

6. Comment on whether the stock assessment results are clearly and accurately presented in the detailed report of the Stock Assessment

While some documents were made available before the meeting (SS3 assessment, Schirripa 2015), other approaches were not available (VPA). This makes the analysis conducted difficult to understand as to what exactly was done. All assessment documents should be made available at least two weeks before the meeting so adequate time could be spent examining this, as that is the focus of the assessment meetings.

The presentations did cover most of these results adequately, but having written documentation along with this as well as an archived script for the model runs would help reviewers and participants if made available a few weeks before the meeting. Again, clear explicit requirements for assessments should be specified well in advance of the meetings, and deadlines for all assessment documents made available on the sharepoint server at least a week before the meetings. However, some papers such as SCRS/2105/73 and 140 were both written in markdown, so that all analyses are transparent and replicable, and such methods would be useful to use as a basis in future years.

7. Comment on potential improvements on the stock assessment SCRS process (CPC participation, transparency, objectivity, documentation, uncertainty characterization, etc.) as applied to the reviewed assessments

While a lot of time was spent discussing alternative model runs and approaches, as well as the data at the meeting, I found it a little frustrating that the data issues were not already cleaned before this meeting (almost 2 full days were spent on data issues initially). I suggest the following steps to streamline the process:

a) All datasets are made available to the modellers 2 months before the meeting.
b) Clear write-ups are made available on all approaches used in the assessments at least 2 weeks before the assessment meeting is made.
c) All approaches are discussed on the 1st day, with all additional runs (grids set up for the analysts on the second day)
d) All new results/approaches are presented on the 3rd day as 2nd day used by analysis (other business covered in day 2). Recommendations on stock status and projections completed by 3rd/4th day after the final set of runs agreed to on the second day.

CPC participation was limited primarily to the developed nations (EU, US, Japan and Taiwan). More time spent at the data meetings clearing the data issues of developing coastal countries that have important fisheries on the species that is the target of the assessment would substantially improve this process. Reports available were limited and while some runs were archived on the share-point site, some additional readme documentation should go with this so people are aware of the approaches and possibly could run them if needed.

This is not an overly critical review of the approach, but just ideas to make it more efficient. Given the timelines the modellers were given, the job and approach presented was more than adequate (under the time constraints). However, given the value of the stock and importance of the species in the Atlantic, more time should be given to the analysis, which means more time should be spent understanding and preparing the data so analysts could complete most of the runs before the meetings, and examine only a few hypotheses at the meetings.

Finally, while, a base model is good for advice, numerous alternative models should be examined, and possible a grid of models should be presented to show uncertainty in the assessment and for projections. This was not done (other than for ASPIC models), again possibly due to time constraints, but needs to be addressed in the future. Note, a set of 12 runs with uncertainty were examined for Stock Synthesis, but the projections were not discussed at the meeting and will be addressed at the SCRS meeting later in the year.

8. Comment on the adequacy of the workplan for the assessment and whether it was adequately addressed by the Data or Assessment Working groups

The workplan used was adequate. However, there were serious delays in preparing the datasets for use, and this was detrimental to the process. In future, more time needs to also be paid to quality control on datasets provided by CPC's as these can have a large impact on the assessment and sufficient time examining these data is warranted in the future. As it currently stands, CPC data are used without much proofing (other than Ghana) and

there are obvious short-comings in the datasets being used (e.g. Length frequencies should not be used blindly). I think there should be at least 3-4 months between the data prep meeting and the analysis, if such delays are normal so everything is available and finalized 45 days or so before the assessment meetings, so the data can be analysed adequately by the assessment scientists and reports describing the approaches are made available at least 2 weeks before the meeting to discuss the assessment.

9. Consider the research recommendations provided by the working group and suggest any additional recommendations or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments. Recommend an appropriate interval for the next assessment considering control rules or management strategy in effect

Some of the key recommendations were on biology and growth of the species. Further work needs to be conducted on cross-validation to assess which is the most informative series by using a hind-casting approach (Kell *et al. in prep*). In addition, examination of uncertainty using MCMC/bootstrap approach on all models is important to examine on all assessment approaches. Further work is required to understand the data discrepancies on both the CPUE and LF data across similar fleets operating in similar areas. The main recommendations are the following:

1. To examine the LL CPUE series used, and improve it based on similar exercise undertaken in the Indian Ocean (see Hoyle *et al.* 2015). In addition a meeting with CPC's to understand inconsistencies/changes in LF samples as these have large implications on the assessment.
2. We should use a hindcasting/retrospective analysis (Kell et. al. *in prep*) for deciding on which CPUE should be used in any assessment approach.
3. One should fit to an index separately as these are alternative states of nature and alternative hypothesis that you are testing against. As such, we need to evaluate this separately and not combining these indices simultaneously. This is true especially for surplus production model approaches and models using one area.
4. As far as integrated analysis are concerned further examination should be conducted on the following items:
   i) Weight the model fits to CPUE series rather than LF observed in the fleets.
   ii) To develop a one area rather than three areas as we have no information on movement.
   iii) To examine Natural Mortality/Growth/Selectivity interactions more extensively as these are critical to the assessment.
   iv) To make sure that uncertainty is accounted for accurately. Grid based versus MCMC based. One run versus many runs and grids. I would recommend using main effects analysis on GRID to assess how things may change over time for time limitations. However, for a later period a more thorough examination using MCMC should be examined.

Given the stock status indicators from the alternative assessments, the stock is probably overfished and is likely still experiencing overfishing. As such, it would make sense to redo this analysis before another 5 year period passes (last one done was in 2010). I would recommend visiting this in 2-3 years given the .importance of the stock and the value of the fishery in the Atlantic Ocean.

Overall Conclusions

The use of multiple approaches is important when assessing stock status. While different approaches were examined, enough time was not spent on diagnostics, nor was there enough time spent on understanding why indices were showing different signals for the same areas. Length frequency data are particular important for both VPA and SS, and as such examining if these data are accurate is critical in the assessment. Currently, it has been pointed out that there are some critical uncertainties in both the CPUE data used in the assessment and the length-frequency datasets, and as such needs further examination. This will have a large effect on the assessment. In addition, for integrated assessments, it is critical to examine the data weighting issues and what drives the assessment. Francis (2011) points out that 3 principles are important when conducting an assessment, and these are: "Principle 1: Do not let other data stop the model from fitting abundance data well; Principle 2: When weighting composition data, allow for correlations; and Principle 3: Do not down-weight abundance data because they may be unrepresentative." This was attempted to some extent, however more substantial analysis should be conducted on this issue.

Overall, the process was transparent, and issues were discussed (although maybe not extensively). A key limitation was that datasets need to be examined and finalized with more lead time, so actual papers and analysis are available at least 2 weeks in advance of the meeting. If this were done, efficient use of time would be spent on discussing further refinements in the assessments rather than spending time reviewing data. Finally, approaches dealing with uncertainty and projections were not given due importance, but as these are critical for stock status advice, and management advice that would sustain the long-term sustainability of the stock, additional time should be spent on these issues in the future (possibly intersessional papers should be circulated before the meetings so these items are discussed extensively at the meetings).

Acknowledgements

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Appendix 1: Review of Data Meeting (4-9 May)

Rishi Sharma, IOTC Stock Assessment Scientist
Date: 22 May 2015.
Re: Review of data to use in Bigeye Tuna Assessment in the Atlantic Ocean in 2015

The meeting was held to collate and review the data inputs for the forthcoming assessments of Atlantic Bigeye Tuna. The meeting was hosted by the ICCAT Secretariat and was very well organized. The capable chairmanship of the meeting by Dr. Hilario Murua (AZTI) and the collegial relationship among the participants enabled most of the key items of the agenda to be addressed in sufficient detail.

Participation at the meeting included representatives from the main CPCs involved in the Atlantic Bigeye fishery (Chinese Taipei, Spain, France, Japan, Uruguay and USA). Smaller NW African CPC's like Cote Devore and Senegal were also represented, though some important countries like Ghana and Angola were missing. CPCs were requested to provide catch, size and abundance indices two weeks before the start of the meeting. The data were reviewed at the ICCAT meeting between 4 May and 8 May.

Unfortunately, I was only able to attend the 1st two days of the meeting, and thus my comments are related to the papers and presentations made the on the 1st two days (Appendix I shows a list of the papers reviewed, and my primary focus was on the CPUE papers and approaches being possibly pursued for the assessments).

Review of the Catch Data (Task 1)

Some problems were identified with catch series from Angola and Ghana. The acknowledgement of uncertainties in data series need to be accounted for in the assessments. The magnitude of uncertainties with respect to overall catch, need to be accounted for in the assessment, as this would have a large effect on the assessment. Note, that a large component of the catches come from smaller CPC's (around 35% are from fleets other than LL, and EU fleets). However, some of the small CPC's may have flagged vessels from EU that operate and report catches from these countries (e.g. Belize has Spanish flagged vessels), and should be fairly reliable. Issues on logbook coverage for fleets and countries need to be documented to understand how reliable the data maybe. Issues with catch reporting from Longline fisheries in the 1990's were not discussed extensively, but knowing coverage was less than 10% in some years for log-book coverage in the Indian ocean, similar issues maybe prevalent in other oceans. In addition, issues with length-composition of the LL fleets (Task II) also need to be examined.

An issue for the assessments is the time-lag of the data reporting and how it effects the assessments as it maybe 2 years out, so data maybe used only from 2013 for this years assessment (it was later clarified that 2014 would also be used though the CPUE data for certain quarters maybe incomplete for that period). Transhipment and exports of catches versus domestic consumption would be useful to put in the section.

Task II (Catch and Effort)

Size samples needs to be consistent with fishery resolution and consistency in how we use the data in the assessment models. First defining fishery and area stratification is important, and then examining if you have the data adequately covered. Data is missing for a number of years.

Length frequency data in general agreed with what is reported as overall catch in biomass. So, both LF and catch data are in coherence to a large extent. Overall coverage of length comp data is about 5% for Japanese fleets, and similar for other LL fleets in the Atlantic.

Issues with Ghana (Both task I and II)

Approaches to estimate catches from Ghana as well as length composition were presented making assumptions of how close the fisheries may look compared to other PS fisheries. Recommend using the correct area and fishery stratification to estimate this. 2012/2013 had decent sampling on Ghanaian fisheries. Closer examination of this needs to be examined to be used in the assessment. Note, that for assessment use, this length-comp should be down-weighted if the fishery is being modelled separately.

The plan to examine this issue in later years was agreed to, and come with an approach to deal with estimation of the total catch data and length-composition data for an assessment in 2015. The re-estimated data will be completed in by mid-June so people can use the re-estimated values for the assessment in July, 2015. It would be good to talk to the scientists from Ghana so its collaboratively done. A call to address this issue was made, but I was unfortunately not present for that, and I am hoping most of these issues were resolved.

Length-Weight Relationship

The data used on L-W is from a study in 1982. The data could/should use the new relationship, and could be used for a new series.

Japan Length Comp Data

Issues with length-composition data were made at the meeting with the Japanese data. This stems from the fact that raised data was not useful when converting catch at size to weight. The way they measured data by lengths appears that rounding errors maybe occurring when trying to estimate overall biomass. This is probably occurring because the coverage is 5% and not randomly distributed with where the fishery is occurring. However, other than that the data was kept at the resolution required for the assessment models and could be stratified by area, and gear type, which is useful for the assessment.

CPUE Series

Catch Effort Series (CPUE standardization issues)

There needs to be some effort made to examine the catch effort series for looking at fishery interaction in tropical areas and temperate areas (3 regions). The approach to use 3 areas would probably make sense in the integrated model being pursued, like Synthesis. However, many things like fishery targeting, use of effort data to determine movement can be confounded with these results, and lot further examination needs to be conducted on these series presented at the meeting.

Japan CPUE series

Issues on Japanese CPUE can be broadly categorized into the following:

1) Area effects could be incorporated at larger scales (5 degree squares) like Hoyle and Okamoto (2011). In addition vessel effects could be incorporated to account for efficiency.
2) Using SST can be misleading unless it has an effect on catchability. Careful treatment for that needs to be accounted for.
3) Accounting for factors are important, and need to see what factors are important to use, and how much of the total variance is explained by these factors. Use deviance reduction factor for selecting factors.
4) How do we account for area-based weightings in the analysis?
5) Accounting for zeroes is important. How is this done?
6) Polynomial factors don't make sense. Better to use areas as blocks.

US CPUE

American LL data was examined in this paper. Again, issues regarding time-area stratification need to be paid attention to, primarily issues relating to area based weighting. Approach pursued using the Ichinokawa and Brodziak (2010) was a useful way to choose strata. In addition the presentation of results with major changes in deviance by factors is one of the key approaches for standardizations that is missing from the other papers on this subject. In addition showing the estimate and its effect on the standardization is important for understanding how the main effects influence the standardization (either in a positive or negative manner). All in all, the way results were presented in this paper are the way to proceed in future standardization papers in the secretariat, as it described the methods clearly, and also the results were presented in an effective manner. Also, differences in results based on numbers or biomass had marginal effects, and it probably is better to use numbers rather than biomass to be consistent with the models used in the assessments. The only criticism was that the random-effects approach was not pursued (presented), as in general these should provide as good if not better an approach on standardization for the LL index of abundance.

MOROCCO CPUE

This was too simple a model, with finer small-scale area used in the analysis. I am not sure how representative it is for the Atlantic on the assessment. This approach maybe useful for some areas close to NW Africa in the Atlantic, if the model is doing fine area fishery aggregations.

TAIWAN CPUE

Issues on TWN CPUE can be broadly categorized into the following:

1) CV on log-book standardized on Table 8 is 0.05 every year. This needs to be investigated.
2) The use of ratios problematic, BET data is used in both the dependent and independent variables
3) There are substantial issues on coverage between 1987-1995 for this fishery. The authors need to check whether this is representative of the fishery and done correctly, as it will have a large influence on the assessment.
4) There is no operational level data missing prior to 1981. While some scientists at the meeting suggested breaking this up into smaller periods, I think there maybe issues breaking up series into smaller periods and using them in the analysis, especially if there are no fine scale operational data for use in the standardization.
5) Taiwanese data needs to be examined carefully as targeting not clear for this fleet, and use some other method than proportions to identify sets.
6) Area effects could be incorporated at larger scales (5 degree squares) like Hoyle and Okamoto (2011). In addition vessel effects could be incorporated to account for efficiency.
7) Points 5 & 6 have been examined extensively for the Indian Ocean and several issues have been found for the Taiwanese fleet (Hoyle *et al.* 2015 *in progress)* that will also be relevant for the fleet in the Indian Ocean.

URUGUAY CPUE

The representativeness of this fleet was the largest issue, and there appears to be a divergence from this series as compared to the others.

Modelling Approaches

Laurie Kell (ICCAT Population Modelling Expert): CPUE and effects on assessments

The presentation showed us that it was useful to identify informative series, and point to issues on estimation failure, also use for developing and looking at retrospective analysis, and how it effects an assessment in terms of predictive power. The technique had some key features like the use of profile likelihood informative to see what data drives the assessment, and how informative are the indices used in the assessment for estimating certain parameters in the ASPIC based (or surplus production based) approaches.

This is done primarily by examining through a simulation/hindcatsing exercise and cross-validation to look at performance over time using the actual catch history to see what the model index would say vs what is shown through the standardization process. These exercises will help guide which series is more informative to use. The approach used is quite simple and all it requires is a retrospective fit and a projection. It can be done for any model, from ASPIC to SS, or Seapodym. It can also be used to compare models where AIC can´t be used. The intention in the future is to run the approach for all models to evaluate the consequences of alternative model structures and the benefits of including alternative datasets. This may take some time to run, but will narrow the suite of indices to examine, and will essentially be driven by the model dynamics (and process error, which is really unknown in the future, so assumptions made about that may not be representative of the what is happening with the stock in projections, however this is a failing of stock assessment models in general and not attributable to the approach shown here). In addition, stratification and separate indices could be used for area stratified models which simple models can't do that easily.

Taking the Synthesis Approach

Michael Schirripa Talk: SS-III Structure (Fishery structure and more complexity vs simpler)

The talk helped identify the need to think about data weightings, and how to weigh different sources of data. In addition use of time varying selectivity and M's are important issues to address in the assessment. The use of Lorenzon function is possible for M, and maybe the approach pursued by Schirripa. The Indian Ocean results are useful to help guide the assessment approach in the Atlantic, and could possibly be used for initial values of M. One needs to examine the use of different steepness as well and its interactions with M, growth and the way the data are weighted in the assessment (it would be best to fix it in the assessment and examine a grid based approach on multiple parameter values, e.g. Kolody *et al*. 2010).

As far as CPUE's are concerned, one should think of only using them after 1970's, as there seems to be huge shift in targeting before and after that year. In addition selection of CPUE by area and fleet need to be examined. I personally do not think the CPUE's should be averaged using some GLM based approach as it will tend to smooth the abundance signal over time, and essentially averages all series being analysed. If one were to really look at a common index, all operational data would need to be used, and vessel effects incorporated in the analysis with other covariates (like the paper presented by Walter and Lauretta, SCRS-2015-082).Finally, another possible option would be to change catchability over time in the model specifications to account for targeting effects, and if one thinks the CPUE data is not accounting for all changes in the standardization.

Lastly, examining a large scale one area (parsimony) fishery approach versus fine scale multiple fisheries (complexity) is important to consider.

Final Note/Conclusions of the reviewer

The process as a whole was very collegiate. Approaches were openly discussed, and datasets refined for the final assessment. Such review of data is critical to any assessment, and having multiple people review this (while it maybe a tad bit excessive) is necessary for a better product to use in the assessment. The final model will incorporate uncertainties in the data, and the approach used, and different models will eventually be used in the assessment in July. It is hoped that most assessments have similar results on trends and stock status trajectories, and it is hoped that the same CPUE series from the most important fleets (LL) are used for this assessment. One issue was not thoroughly examined was the age-length keys, and approaches used to either do this outside the model (ASPM, VPA) or inside the model (SS-III, MultiFan-CL).

The age-length matrix needs to be examined carefully with some external data sources, and as such other oceans and approaches may be useful to examined in this exercise. In addition, examining alternative sources of CPUE in the assessment would be important to contrast results from one source of data versus the other, especially in considering stock-status advice.

I could unfortunately stay only for the 1st two days, so whatever I say here relates to status at the end of the day on 5 May.

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Annex 1. Papers at the ICCAT meeting regarding Data preparation for the Bigeye Assessment

SCRS/2015/023	An Evaluation of the Impact on Uncertainty in Data Processing on Stock Assessment and Management Advice	Carruthers T. R. , Kell L. and Palma C.	laurie <laurie@kell.es>	TROP		BET_Data_Prep
SCRS/2015/060	Bigeye (Thunnus obesus) bycatch estimates from the albacore Spanish surface fishery in the North East Atlantic, 2014	Ortiz de Zárate V. and Perez B.	Victoria Ortiz de Zarate <victoria.zarate@st.ieo.es>	BET		BET_Data_Prep
SCRS/2015/061	Update of standardized CPUE of bigeye tuna, Thunnus obesus, caught by uruguayan longliners in the Southwestern Atlantic Ocean	Forselledo R.	Rodrigo Forselledo <rforselledo@gmail.com>	BET		BET_Data_Prep
SCRS/2015/062	Estimations of non-retained capture of bigeye tuna, Thunnus obesus, in the Southwestern Atlanitc Ocean.	Forselledo R.	Rodrigo Forselledo <rforselledo@gmail.com>	BET		BET_Data_Prep
SCRS/2015/070	Review of bigeye tuna catch including fish size by Japanese longline fishery in the Atlantic ocean	Matsumoto T.		BET		BET_Data_Prep
SCRS/2015/071	Standardized CPUE for bigeye tuna caught by the Japanese tuna longline fisheries operated in the Atlantic Ocean up to 2014	Ashida H., Matsumoto T. and Satoh K.	hashida@affrc.go.jp	BET		BET_Data_Prep
SCRS/2015/072	Tuna fisheries catch landed in Abidjan (Côte d'Ivoire) and sold on local fish market for the period 1982-2014	Chavance P., Dewals P., Amandè M. J., Delgado de Molina A., Cauquil P. and Irié D.	Pierre CHAVANCE <pierre.chavance@ird.fr>	TROP		BET_Data_Prep
SCRS/2015/073	Diagnostics for a biomass dynamic stock assessment of Atlantic bigeye tuna (Thunnus obesus).	Merino G. and Kell L.		BET		BET_Data_Prep
SCRS/2015/074	A post-assessment examination of model diagnostics for the 2010 Stock Synthesis model for bigeye tuna	Schirripa M.	Michael Schirripa - NOAA Federal <michael.schirripa@noaa.gov>	BET		BET_Data_Prep
SCRS/2015/075	Updated standardized catch rate of the bigeye tuna (Thunnus obesus) from the Mmoroccan longline fihery operating in the Atlantic	Abid N., Baibbat S. and M'hamed A.	Noureddine Abid <noureddine.abid65@gmail.com>	BET		BET_Data_Prep
SCRS/2015/082	Standardized catch rates for bigeye tuna (thunnus obesus) from the United States pelagic longline fishery	Walter J. and Lauretta M.	Craig Brown - NOAA Federal <craig.brown@noaa.gov>	BET		BET_Data_Prep
SCRS/2015/083	Statistiques de la pêche et les activités de recherche menees au Cap-Vert sur le thon, les requins et les poissons à rostre	Monteiro V. and Monteiro C.	INDP / Vanda Marques Monteiro - Bióloga Grandes Pelágicos <Vanda.Monteiro@indp.gov.cv>	STAT		BET_Data/SCRS
SCRS/2015/091	Standardized CPUE of bigeye tuna (Thunnus obesus) of the Taiwanese longline fisheries operated in the Atlantic Ocean	Huang H.and Chang F.	Julia Hsiang-wen Huang <julia@ntou.edu.tw>	BET		BET_Data_Prep
SCRS/2015/092	Historical review: 50 years of tropical tuna fishing by Senegalese fisheries	Ngom F. and Fonteneau A.	Fambaye Ngom <famngom@yahoo.com>	TROP		BET_Data_Prep
SCRS/2015/093	Identifying priorities for bigeye tuna electronic tagging in the western Atlantic ocean	Lam C., Galuardi B. and Lutcavage M.E.	Molly Lutcavage <mlutcavage@eco.umass.edu>	BET		BET_Data_Prep
SCRS/2015/094	Inferring seasonal movements of tropical tunas between regions in the eastern Atlantic ocean from catch per unit effort	Sculley M. and Die D.	Michelle Johnston <mjohnston@rsmas.miami.edu>	TROP		BET_Data_Prep
SCRS/2015/095	Bigeye tuna: update on task ii size sampling based on Japanese tuna fleet operating in Uruguayan EEZ (2009-2011)	Mas F., Domingo A. and Forselledo R.	Rodrigo Forselledo <rforselledo@gmail.com>	BET		BET_Data_Prep
SCRS/2015/096	Length-length and length-weight relationships for bigeye tuna (Thunnus obesus) in the southwestern Atlantic ocean	Forselledo R., Mas F. and Domingo A.	Rodrigo Forselledo <rforselledo@gmail.com>	BET		BET_Data_Prep
SCRS/2015/097	Historical data recovery based on port sampling for bigeye tuna (Thunnus obesus) caught by Uruguayan longline fleet	Domingo A. and Forselledo R.	Rodrigo Forselledo <rforselledo@gmail.com>	BET		BET_Data_Prep
SCRS/2015/098	Update of standardized CPUE of bigeye tuna, Thunnus obesus, caught by Uruguayan longliners in the southwestern	Forselledo R., Mas F. Pons M. and Domingo A.	Rodrigo Forselledo <rforselledo@gmail.com>	BET		BET_Data_Prep
SCRS/2015/102	Bigeye catches estimated for EU purse seiners : a need to apply a new post stratification in the TASK2 data processing of recent years	Fonteneau A.		TROP		BET_Dara_Prep