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Implementing the recommendations from the bigeye tuna assessment review

WCPFC-SC11-2015/SA-IP-08

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This paper provides an overview of the progress made in implementing the recommendations from the bigeye tuna assessment review (Ianelli et al., 2012). WCPFC provided additional resources to implement the review recommendations, including relevant developments of the MULTIFAN-CL software routinely used to undertake assessments.

This paper is similar to that provided to SC10 (SA-WP-02), as we describe progress against each recommendation – as grouped by SPC-OFP (2013) into different categories (see Table A1 for further details of those recommendations implemented and associated narrative). It is important to note that in implementing these recommendations, where appropriate the improvements have also been made in the skipjack tuna, yellowfin tuna, and in 2015, the south Pacific albacore tuna assessments.

Best practice: **9 out of 10** recommendations have been implemented; with the one outstanding task being a lower priority MULTIFAN-CL development;

Analysis of data that SPC holds: **all 5** recommendations were implemented, but further work in this area will continue especially for longline CPUE and tagging data. We specifically recognize the analysis of the joint operational longline data set undertaken in 2015 to support the Pacific-wide bigeye modelling exercise.

Analyses of data held by others: **2 out of 3** recommendations have been implemented.

Specifications for the next assessment: **all 4** recommendations were implemented.

Further research activities: **both** activities have continued thanks to the generosity of those funding continued tagging activities.

MULTIFAN-CL developments: **9 out of 13** recommendations have been implemented; given that only one year of funding was provided, the highest priority items have been addressed and further work is scheduled for MULTIFAN-CL developer workshops in November 2015 and March 2016.

The reference list for this paper indicates the key papers that respond to the bigeye review recommendations.

WCPFC-SC may wish to consider the next stages of stock assessment peer review activity. One option would be to continue the approach of conducting a major review of a MULTIFAN-CL assessment, comparable to the style used for the 2011 bigeye assessment review. If this option is chosen, then the the 2015 south Pacific albacore assessment may be an appropriate candidate for review.

As we have seen with the 2011 bigeye assessment review, many of the issues raised in the review had application to other species. Therefore, a second option might be to adopt a more multi-species, thematic approach to reviews, whereby reviews would consider one or more thematic topics that have application to several assessments. Candidate themes for review could include:

- The approaches used to develop the key CPUE inputs to stock assessment models;
- Consideration of the pro's and con's of spatial assessment models, recognizing their greater data requirements and assumptions (e.g. the development of regional weights);
- Consideration of specific spatial structure designs for tropical tuna and south Pacific albacore assessments;
- The use of age-at-length data and tagging data to inform the estimation of growth in assessments;
- The implications of ignoring spatial variability in biological processes (e.g. growth, reproductive maturity) in assessments; and
- Appropriate statistical assumptions for modelling compositional data in assessments.

If SC11 wishes to consider these issues, we suggest that they might be initially discussed in a small group at SC11, before reporting back to the Plenary with a suggested approach.

References

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McKechnie, S. Harley, S., Chang, S-K., Liu, H-I., and Yuan, T-L. 2014b. Analysis of longline catch per unit effort data for bigeye and yellowfin tunas. WCPFC SC10- SA-IP-03, Majuro, Republic of the Marshall Islands, 6 – 14 August 2014.

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Key review recommendations, initial SPC-OFP responses, and 2014 bigeye assessment outcomes

Table A1: The full set of recommendations from the review plus some general comments on each from SPC and an indication of what progress will be made on it prior to the next bigeye assessment in 2014.

CATEGORY 1: Best practice			
Review recommendation	**SPC-OFP initial response**	**2014 bigeye assessment outcome / progress achieved by August 2015**	**Achieved?**
1) When moving from one reference model to a modified one, care should be taken to change only one factor at a time to ensure the impact of changes can be fully understood.	Will be a priority for next assessment, but discernment will be required around updates to data which will be numerous, e.g. it will not be possible to make individual model runs for changes to each fishery.	Stepwise runs and specific one-off runs provided in the Annex – Sections 10.3 and 10.4	✓
2) The way the fisheries are linked should be more fully documented in the assessment report, and the implications of such linkage should be more fully evaluated.	We will include a table like Table E1 of the review report in future assessment reports.	Provided in Table 4	✓
19) Sensitivity analyses should continue to be shown to the assumed value for steepness and an appropriate means (e.g., a decision table) used to summarize the management implications of uncertainty regarding steepness.	We will continue to conduct sensitivity analyses on steepness. Implications around the impact of uncertainty in steepness will best be examined through management strategy evaluation.	Provided in Table 7	✓
20) The size of the stock recruitment penalty should be selected which allows the asymptote of the stock-recruitment relationship to be estimated, but is otherwise uninformative about stock size.	We will use an appropriate penalty weight to achieve this outcome	Done and demonstrated in Figure 39 where the steepness runs are overlaid.	✓
21) Consider fitting the stock-recruitment relationship to the annual rather than seasonal recruitments.	This capability currently exists in MULTIFAN-CL, but has not been fully tested.	This has been implemented in the south Pacific albacore tuna assessment. Some further work is required to ensure that reference point and depletion estimates are consistent.	✓

22) The statistical weights for each data component (e.g., size composition, tagging, effort deviations) should be re-evaluated and revisited with each subsequent assessment.	We will continue to examine alternative weights as has been done in recent assessments and broadened to also include the tagging likelihood.	Effort deviate penalties were reassessed during model development and a sensitivity analysis was included that examined alternative size data weightings. Further work should be undertaken in future assessments	✓
23) Future assessments should include both standard and historical retrospective analyses.	The SC report includes a summary of previous estimates of the key management parameters and this should continue to be updated. For future assessments we will examine the impact of additional years data on key management quantities as a diagnostic.	Presented in section 10.2. This was very useful.	✓
24) Methods should be developed to provide output which accounts for uncertainty regarding the values for the factors considered in the structural analysis.	These are being developed for other assessments (e.g. shark assessments) and as part of the reference point work and will be applied to the next assessments.	The approach is developed and we can produce stock status summaries that reflect model weightings. A decision on weightings is best made within the SC.	✓
25) Stochastic yield functions should be presented because they may not indicate the same values for management reference points such as *F*MSY and *B*MSY.	Stochastic projections are now possible using MFCL. Some work that may support this area has been undertaken as part of the examination of F-based limit reference points (SC9-MI-WP-03).	Not yet implemented in MULTIFAN-CL	X
26) Projections considering MSY estimates should account for fishery-specific changes (i.e., likely proportional catches by fishery).	This is currently done as a matter of course in projections, and fishery selectivity can be re-computed for each time step of the projection.	This can be done in MULTIFAN-CL as demonstrated in Figure 35. The stochastic projections of Pilling et al. (2014) calculated MSY quantities based on the terminal f-at-age profile.	✓
CATEGORY 2: Analysis of data that SPC holds			
8) Further explore methods for weighting purse seine length frequencies by catch.	This will be examined as part of the review of purse seine species composition.	Presented in Abascal et al. (2014) and used in the assessment	✓
9) Further explore methods for the calculating longline size-composition data by weighting spatial data by long-term average catches.	Further approaches will be considered	Presented in McKechnie (2014) and used in the assessment	✓
12) A more appropriate method should be used to calculate the CVs for the Japanese CPUE indices (e.g. Francis' canonical method or prediction-based methods)	This is an easy recommendation to achieve in a technical sense. SPC holds some operational level data for Japan when they are fishing in some PICT EEZs. This is not	This methodology was applied to the all-flags CPUE indices in McKechnie et al. (2014b) and used in the assessment.	✓

	necessarily representative of the full operational data set used previously to derive the CPUE indices.		
14) Available data on tag shedding should be examined and be used to provide a value for use in the assessment, noting that this may be challenging given the possibility of correlation between tag loss for each tag for double-tagged animals.	To date, modeling of double tagging data has not indicated continuous longer-term shedding to be an issue. Tag shedding is currently included (along with non-reporting, etc) in a general instantaneous tag loss component.	These data were examined by Berger et al. (2014)	✓
16) Future analysis of operational CPUE data should focus on how to identify targeting and investigate year-area interactions and the implications of increasing numbers of year-area cells without data.	This is a high priority area and papers have been submitted SC9. SPC holds some operational level data for Japan when they are fishing in some PICT EEZs. This is not necessarily representative of the full operational data set used previously to derive the CPUE indices.	All-flags operational data was used to achieve these joint goals and the results are described in McKechnie et al. (2014b). Japanese and Korean data were not available for the 2014 analysis. Data for Korea, Japan, Chinese Taipei, China, and the United States was made available for the 2015 Pacific-wide analysis (McKechnie et al., 2015a).	✓
CATEGORY 3: Analysis of data that SPC does not hold			
10) Length-frequency data for the Japanese longline fishery should be omitted from the reference model until these data are better understood and can be shown to be compatible with the associated weight-frequency data. Analysts should gain access to how training vessel trips and any other sampling programs are undertaken, and analyze the available data at the set-by-set level before these length-frequency data are considered for re-inclusion in the assessment.	Agree	An analysis of these data is provided in Okamoto (2014) and was greatly appreciated by SPC. It led to the decision to only use length samples for the later years in region 4.	✓
11) Separate the training vessel length frequency data from the commercial data and create a "survey" length composition series to be included in the model.	We agree that this is a good idea. It is an approach adopted in the skipjack assessment to utilize longline training vessel data.	SPC does not have access to these data	NA
16b) Remove these unidentified vessels from the latter period is advised (Japanese LL		This was done in the bigeye tuna operational longline CPUE analysis in 2015.	✓

operational data)		(McKechnie et al., 2015b).	
CATEGORY 4: Assessment specifications for the next assessment			
6) High volume small-fish fisheries (e.g., Philippines and Indonesia) should be retained in the model to ensure their catches are removed from the population correctly with respect to length. However, the model should be formulated so that the data for such fisheries do not have a large impact on estimates of population trend and size.	We agree, but we note that the reviewers have not provided any specific advice on how to achieve this, and we note that this is more difficult if the fish are mixing across other regions of the model. We also note that these data are improving slowly over time and less certain aspects of these catches should become less important over time.	A new region (7) was added to the model	✓
7) To better address the assumption of homogeneity in tag recapture data, split region 3 into two regions and examine whether region 5 should be split into two regions for tagging off eastern Australia.	We agree with the general conclusion that alternative spatial structuring may be necessary to better utilize these tagging data. Such changes might not be limited to regions 3 and 5 and may well include region four. Assumptions regarding tag mixing periods will also be important.	Region 3 was split into three regions and region 5 into two regions to address this recommendation (Figure 1)	✓
10) Length-frequency data for the Japanese longline fishery should be omitted from the reference model until these data are better understood and can be shown to be compatible with the associated weight-frequency data.		After the analysis of Okamoto (2014) these data were only included for the later part of the time for region 4.	✓
13) Drop the region 5 tagging data unless the model can be re-structured to make the area where the Australian tagging took place in region 5 a separate region.	Agree. We also plan to carefully examine tagging data and model fits for both recent and historical tagging to determine if other issues exist. This will be complimented with analyses of mixing rates to determine the best way to model tagging data.	A new region was added to region 5 (Figure 1) and a key sensitivity run was undertaken where the mixing rate was greatly extended to greatly reduce the impact of these data on the overall model (Table 7). The results fits were much improved.	✓
CATEGORY 5: Further data collection / research activities			
5) Continue tagging programs to allow estimates of movement rates to be obtained for a wide range of environmental conditions	Agree, and we note that this is also important to yellowfin and skipjack tuna which are predominantly taken in surface fisheries. It has been shown that assessments using integrated statistical models for WCPO skipjack in particular are at best unreliable and at worst impossible without good quality and high	Through funding from the NZ Science and Information Services project we have been able to continue through 2013 and 2014 the central Pacific bigeye-focused tagging. Further tagging is planned under EU	✓

	volume tagging data. This will have considerable budgetary implications. The costs (including tag recovery, database and analytical support) of an annual three month pole-and-line based tagging cruise in the western WCPO and an annual 4-6 week tagging crews in the central Pacific Ocean (targeting BET) are around USD1.5 million.	funding in 2015. Further funding will be required to continue this work or undertake tagging across the equatorial WCPO.	
18) Continue seeding experiments due to the impact that reporting rates have on the present model configuration and estimation.	Agree, and this is being done with the cooperation of national observer programmes across the region. These costs will be included within existing tagging programs while the funds are available.	Tag seeding has been continuing through 2014	✓
CATEGORY 6: Assessments to undertake			
3) A Pacific-wide assessment should be conducted soon to evaluate whether the past conclusion that the results from a WCPO-only assessment are consistent with expectations from a Pacific-wide assessment remains true.	Agree	Undertaken in 2015 and documented in McKechnie et al. (2015a)	✓
4) Pacific-wide assessments should be conducted regularly (~every five years) to confirm the assumption that a WCPO-only assessment will provide robust estimates of stock status.	Agree	See above	SC decision
CATEGORY 7: MULTIFAN-CL developments (misplaced items that should be in the following section)			
6b) Spatial variation in biological parameters should form a focus for future model development	This is possible, but it is important to examine the theoretical basis for spatial variation – especially in models that estimate movement across sub-regions.	Multi-stock capability has been implemented to MULTIFAN-CL which enables region-specific growth to be modelled. A suitable example stock may now be selected for application of this feature.	X
15) Tag loss and tagging-induced mortality should be modeled separately	Agree, although we note that specific estimates of tagging-induced mortality are not available.	No work initiated yet	X

16c) Further developments of this useful tool – the MULTIFAN-CL viewer. The additional outputs provided in R (e.g. graphs of mean weight and variation in length and weight composition over time) were also very useful	We continue to develop the MULTIFAN-CL viewer and the R4MFCL library	A new version of the MULTIFAN-CL viewer has been developed that runs on JDK 1.8.0_05 32bits and JavaFX 1.8.0_05. The new suite of R-related functions will be released before the end of 2015	✓
17) Use methods that simultaneously use both age-length and growth increment data, ideally within MFCL (linked to MFCL (3))	Agree, and note that this is important for other assessments, notably South Pacific albacore.	Implemented within the development version of MULTIFAN-CL and was used in the south Pacific albacore tuna assessment	✓
21) Consider fitting the stock-recruitment relationship to the annual rather than seasonal recruitments.	This capability currently exists in MULTIFAN-CL, but has not been fully tested.	Implemented within the development version of MULTIFAN-CL and was used in the south Pacific albacore tuna assessment (Harley et al., 2015).	✓
25) Stochastic yield functions should be presented because they may not indicate the same values for management reference points such as *F*MSY and *B*MSY.	Stochastic projections are now possible using MFCL. Some work that may support this area has been undertaken as part of the examination of F-based limit reference points (SC9-MI-WP-03).	No work yet initiated	X

Review comment	**SPC-OFP response**	**Consequences for next assessment**	**Achieved?**
a. Test the options for time-varying selectivity – allowing for time-varying selectivity may address some of the issues related to the sometimes poor fits to the length- and weight-frequency data.	This is currently possible by specifying time breaks in fisheries, but we agree a more elegant solution using time blocks as in Stock Synthesis would be better.	Implemented within the development version of MULTIFAN-CL and was considered in the south Pacific albacore tuna assessment (Harley et al., 2015).	✓
b. Allow the length bins to be of different widths. One might, for example, want many narrow length bins for the smaller lengths, but fewer but wider length bins for the larger lengths. Allowing for a more flexible length bin structure should also reduce computational times as well	Agree this would be useful.	Scheduled for 2015-16, subject to resources	X

as better reflect the available data.			
c. Allow for long-term and initial tag-loss. Currently initial tag-loss is implemented by reducing the number of animals tagged when inputting data to the model and no account can be taken of long-term tag-loss.	Initial tag loss is also allowed through the reporting rate parameter. But agree that the addition of long-term tag loss, while it is not seen to be significant in the double tagging data available, would be useful.	Scheduled for 2015-16.	X
d. Include an option which allows the tagging data to inform movement only rather than movement and mortality.	A tag likelihood conditional on tag recapture exists in MFCL but has not been used for WCPO tuna assessments.	On track – testing needed scheduled for 2015-16	X
e. Allow conditional age-at-length data to be included in the likelihood function. This will allow the ageing data from current sampling (e.g. WCPFC-SC6-2010/GN IP-04) to be formally included in the assessment.	Agree that this is a priority. Likewise for tag length-increment data.	Done	✓
f. Extend MFCL to allow gender to be explicitly represented. This will allow the impacts of differences in growth and natural mortality between the sexes to be represented. The current approach to modeling, for example, length-specific natural mortality (e.g. WCPFC-SC4-2008/ ME-WP-1) seems unnecessarily complicated given the lack of gender-structure in the model.	This development is close to completion in MFCL, but it is unlikely that sufficient data will exist to use it to implement the 2014 bigeye tuna assessment	Development implemented, but not yet applied for bigeye or albacore	✓
g. Create an output table which lists all of the likelihood components by fleet and automates the process of computing effective samples sizes (and other summary statistics related to model fit).	Agree	Done	✓
h. Allow for more general selectivity options, including selectivity patterns where the first age for which selectivity is	Agree	Done	✓

non-zero is pre-specified. This should help to avoid selectivity being non-zero owing to the functional form for selectivity rather than data.			
i. Include a "tail compression" option, which would pool all length- and weight-data for large and small sizes based on a specified percentage (e.g. all lengths would be pooled so that the "plus" length-class contained 0.1% of the length-frequency).	We probably need to discuss the merits of this further with the reviewers.	Development of the implementation is completed with further testing scheduled for 2015-16.	X
j. Add an option which allows the analyst to assume a multinomial likelihood for the compositional data in the first phases and only transition to the robust normal likelihood in the later phases.	Agree	Recent work by Francis (2014), suggested that this might not have been the best idea. However, development of the implementation is completed with further testing in 2015-16. We are also currently investigating better approaches to modelling size composition data, e.g., self-scaling multinomial with random effects.	✓
k. When maturity data are based on length, converting to ages should be done within the model. Presently, the maturity-at-age is based on a fixed age-length relationship.	Agree	2015-16 subject to resources	X
l. An option to add a likelihood weight to the tagging data component should be added.	Agree, although to an extent this exists through the over-dispersion parameter of the negative binomial.	Done	✓