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TECHNICAL ASPECTS OF A POTENTIAL SOUTH PACIFIC ALBACORE HARVEST STRATEGY

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EXECUTIVE SUMMARY

SC14 requested that this paper be submitted to WCPFC15. A minor modification has been to highlight suggestions and requests of WCPFC15 as raised by members at SC14. These are emphasised in bold in the paper's abstract.

SCIENTIFIC COMMITTEE

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Technical aspects of a potential South Pacific albacore harvest strategy

WCPFC-SC14-2018/ MI-WP-02

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1. Abstract

To support development of a Roadmap for south Pacific albacore management, SC14 was tasked to provide WCPFC15 with 'advice on technical aspects of the south Pacific albacore harvest strategy including (…) scientific elements of candidate harvest control rules and potential components of the management procedure'. This paper: reviews potential elements of a harvest strategy for south Pacific albacore (primarily reference points, the estimation method, and harvest control rule); details available information to inform selection of potential elements; and proposes SC14 recommendations for WCPFC15 to inform development of the Roadmap for improving south Pacific albacore management.

While limit reference points for albacore and other Western and Central Pacific Ocean (WCPO) stocks have been agreed by the WCPFC, a target reference point has only been agreed (on an interim basis) for skipjack tuna. Existing scientific analyses of candidate target reference points for south Pacific albacore are summarised, noting that a new stock assessment has since been agreed by SC14. The current review indicates that a target reference point based upon $\%SB_{F=0}$ would be appropriate for use as a performance indicator within the harvest strategy.

Within the harvest strategy framework, the estimation method provides information on the level or trend in stock status to a harvest control rule (HCR), from which the necessary management action is then determined. The estimation method may be based on either an empirical approach (where the level or trend in CPUE is used to drive future decisions) or a model-based approach (where albacore stock status is proposed at this initial stage to be assessed through a simple model, such as a surplus production model, although more complex approaches may be considered based upon experience with skipjack modelling). We recommend both empirical and model-based approaches be considered for evaluation, at least in the initial phases, with the emphasis on an empirical approach.

For both empirical- and model-based estimation methods, the input CPUE should reflect as far as possible changes in the underlying population biomass. Given the greater spatial and temporal coverage of the longline fleet, and available information suggesting that the limited-range New Zealand troll fleet CPUE does not necessarily reflect true stock biomass, it is suggested that longline CPUE be used as the primary source of information.

A regional combined CPUE index may provide an appropriate signal for the estimation method. However, a localised 'reference' fleet may also be able to provide suitable information from a smaller spatial scale, while also incorporating economic drivers. Further analyses are required to identify the combined or individual fleet that can best inform management. The need for continuity and timeliness in data availability is noted.

The different benefits of using standardised or nominal CPUE series are discussed. Standardised indices take greater account of external drivers that may affect CPUE (hence improving the signal for changes in underlying biomass) whereas nominal CPUE provides a more transparent indicator for the wider stakeholder group. An absolute CPUE value (potentially averaged over a recent period) or the trend in CPUE over time may be used. The period over which a trend or average should be taken will be influenced by the variability in the CPUE series. These issues would be evaluated within the Management Strategy Evaluation (MSE) process to assess their impact on management performance. Whichever data are used and analyses applied, they must be documented to ensure management action is influenced by changes in the data (and hence underlying stock biomass), rather than the way in which those data are processed.

The estimation method will feed information into the HCR, which pre-defines overall management action. Notwithstanding the general focus on the southern longline fishery, two key decisions are needed: 1) do managers wish all fisheries targeting south Pacific albacore to be controlled (e.g. both longline and troll fisheries); and 2) which mechanism (fishing effort or catch) will be used to control the impact of the fishery on the albacore stock? These decisions will reduce the number of alternative forms of the HCR to be evaluated. Additional HCR constraints and settings (e.g. minimum or maximum levels of change in catch or effort between management cycles) can also be tested.

A draft technical work plan for southern longline harvest strategy development, along with recommendations to SC14 after each key section herein. SC14 discussed these issues, and raised the following recommendations for and requests of WCPFC15:

SC14 recommended that WCPFC15 use this working paper to inform development of the Roadmap for improving south Pacific albacore management and requested guidance from WCPFC15 on:

> **1) the south Pacific albacore fisheries to be included in the MSE (e.g. longline and troll); and**
> **2) the potential management control method for the fisheries (e.g. through catch, fishing effort, etc.).**

SC14 also recommended that WCPFC15 note the need for ongoing review of monitoring strategy requirements as the harvest strategy develops, ongoing efforts to gather key economic data on the southern longline fishery, and endorse the proposed work plan for development of scientific aspects of a south Pacific albacore harvest strategy.

2. INTRODUCTION

To support development of a Roadmap for south Pacific albacore management, SC14 was tasked with providing WCPFC15 'advice on technical aspects of the south Pacific albacore harvest strategy including, for example, a consideration of scientific elements of candidate harvest control rules, and potential components of the management procedure' (e.g. the use of CPUE (vulnerable biomass) indices to inform on stock status; WCPFC14 report, paragraph 265).

This paper:

- Reviews potential elements of a harvest strategy for south Pacific albacore;
- Details available information that could inform the selection of potential elements; and
- Identifies potential SC14 recommendations for WCPFC15 to inform the development of a Roadmap for improving south Pacific albacore management.

Recommendations to SC14 are developed after each key section, and have been summarised in the Executive Summary.

3. ELEMENTS OF A HARVEST STRATEGY FOR SOUTH PACIFIC ALBACORE AND THE SOUTHERN LONGLINE FISHERY

The elements of a harvest strategy for south Pacific albacore considered here are primarily: the estimation method (the approach used to monitor stock status and provide the signal for management action, which includes the data to be gathered); the harvest control rule (HCR, the pre-agreed overall management action); reference points; and the monitoring strategy. Once options for candidate elements are defined, their collective performance and robustness to uncertainty can be tested using Management Strategy Evaluation (MSE; see Scott et al., 2018b). Elements of the corresponding monitoring strategy are also discussed. Terminology associated with MSE can be found in Scott et al. (2018b).

At the time of writing, results of the latest stock assessment for south Pacific albacore were not available. At present, therefore, we summarise existing information where appropriate, which SC14 can review in the light of the latest assessment results (see Tremblay-Boyer et al., 2018).

We first discuss the estimation method element of the harvest strategy, and then the format of the HCR, into which outputs of that estimation method would feed. We discuss the role of reference points within this framework, and finally comment on the south Pacific albacore monitoring strategy.

3.1. ESTIMATION METHOD

The estimation method provides information on the level or trend in stock status, and hence the need for and extent of management action (defined through a HCR). Two types of estimation method are commonly considered:

- An empirical approach, where the level or trend in an indicator of stock status (e.g. catch per unit effort, fish size) is used to drive future decisions. For south Pacific albacore, given the relationship between fleet CPUE and the noted economic management objectives, an empirical approach has intuitive appeal;
- A model-based approach, where a stock assessment is used to assess stock status or fishing mortality. Ideally, a simple assessment model can be used, e.g. surplus production model. As noted in discussions at the MSE expert consultation workshop (Scott et al., 2016) and

through experience evaluating more complex models for skipjack, there are challenges in implementing integrated assessment models within the harvest strategy framework, even for a skipjack stock with a considerable tagging data set. Simpler models also have the advantage of being faster to run within simulations. However, more complex models may be examined as necessary, building on the experience gained through skipjack MSE modelling.

We suggest that both types of estimation method are evaluated for south Pacific albacore:

- An empirical estimation method based upon the absolute or trend in CPUE as the primary approach for development.
- A model-based approach can also be considered, but with an initial focus on simpler assessment models that include surplus production models, for which CPUE is a key input.

Both approaches are driven by CPUE data, which as noted above is consistent with the focus of recent discussions for the southern longline fishery on catch rates and fleet profitability, as reflected in the economic management objectives that were noted at WCPFC14 (see WCPFC14, Attachment K).

A direct evaluation of vessel profitability, rather than CPUE, to drive the harvest strategy process would most closely align with economic objectives. However, given the external drivers of key costs such as fuel, and the challenges in obtaining economic information across fleets, this is not recommended, but should be considered further under the monitoring strategy (see later in this paper).

Catches of 'non-target' species provide notable economic benefit to the southern longline fishery (e.g. bigeye and yellowfin; see Pilling et al., 2016). At this stage of MSE development, a multispecies approach is not proposed, but will be an important future step in the WCPFC MSE framework, particularly within the calculation of relevant performance indicators. Approaches such as those used by Pilling et al. (2016) may be used.

Recommendation:

- Focus primarily on empirical-based estimation methods for south Pacific albacore, using CPUE as the biomass signal;
- Retain a secondary focus on a model-based approach, with initial trials using a simple assessment approach such as a surplus production model.

For the proposed empirical and model-based approaches, the chosen CPUE index should reflect, as far as possible, changes in the underlying population biomass. We discuss the potential sources and analyses of CPUE data and the decisions that will need to be taken for south Pacific albacore below.

Which fishery?

The two main fishing gears currently catching south Pacific albacore in the Western and Central Pacific Ocean (WCPO) select different components of the south Pacific albacore stock: troll gear; and the southern longline fleet. These gears are, in general terms, spatially distinct.

Troll gear has a relatively small estimated impact on the population (taking ~3% of the total catch; Brouwer et al., 2017), operates in southerly waters of the south Pacific (e.g. Williams and Reid, 2018) and tends to catch smaller (juvenile) individuals. The New Zealand troll fishery data have been evaluated as a potential index of abundance. Kendrick and Bentley (2010) concluded that the CPUE of troll-caught albacore in New Zealand waters was unlikely to be a useful index of abundance, but rather represented an index of availability of juvenile fish to New Zealand. This suggests that the troll fishery is unlikely to offer a reliable stand-alone index for an estimation method.

Longline fleets operating in the southern WCPFC-CA catch 97% of the south Pacific albacore in the WCPO (Brouwer et al., 2017), and tend to catch larger (adult) fish. For stock assessment, the longline fishery CPUE time series is the primary source of a regional index of abundance, with data being relatively extensive in space and time.

Multiple indices, for example capturing the longline (adult) and troll (juvenile) fisheries might allow the monitoring and evaluation of trends and impacts on different segments of the stock. This could provide benefits for management, in a similar fashion to the integrated approach used within other harvest strategies (e.g. Hillary et al., 2012). However, given that the NZ troll fishery index does not appear to offer information on recruitment to the stock or fluctuations in biomass, there appears to be little benefit for considering this approach for south Pacific albacore. At this stage, therefore, southern longline CPUE is considered as the primary source of information for the estimation method.

Recommendation:

- Longline CPUE be used as the primary source of information for the estimation method.

Which longline fleet(s)?

Two longline fleets groupings are considered here, based upon the available data, being: distant water fishing nations (DWFNs) and Pacific Island Countries and Territories (PICTs).

DWFNs are currently supplying time series of operational data to the SPC to support development of abundance indices for regional stock assessments. These data span almost 60 years of fishing over a wide geographic range. PICT fleets tend to have shorter, and frequently more localised (sometimes constrained to EEZs or areas within EEZs) operational data sets.

As noted, the information to drive the HCR should reflect the underlying population biomass. A regional (southern WCPFC-CA wide) abundance index may provide an appropriate signal for overall south Pacific albacore stock biomass. However, a more localised time series from a specific fleet, or combined fleets that can act as a 'reference' fleet in the estimation method, might also provide both indicative trends that can drive the decision-making process, as well as direct information on fleet profitability. The 'reference' fleet must provide information indicative of regional, rather than local, stock biomass. We note there may be advantages in using information from multiple spatially-separated longline fleets, one in the main catching region (Region 2 in the assessment) and one to the south (Region 3) where smaller fish tend to be caught. Further analyses are required to identify the combined or individual fleet that can best inform the HCR.

A key feature of any CPUE series to be used is that the data must have a high probability of remaining available for the foreseeable future. DWFNs are providing recent operational data to the WCPFC (Williams, 2017), with improving fleet coverage. Access to the historical time series for DWFN fleets is currently the subject of specific agreements for stock assessment purposes only. If data for a longer time period are necessary for development of harvest strategies, future access to those data would require modification of existing agreements. The continued availability of the time series of PICT fleet (and in-zone DWFN fleet) operational data appears more certain.

Timeliness of data availability should also be considered. Those from PICT fleets may be more readily available when compared to DWFN fleets where vessels may be at sea for extended periods. The use of electronic reporting, which should accelerate the availability of data for all fleets, may be an additional benefit when considering 'reference' fleets.

To summarise, key necessary features of fleet data time series include:

- The data represent a key fleet or combined fleets whose catch rates reflect regional, rather than local or seasonal, abundance.
- Fleet composition should be relatively stable, with reasonable consistency in targeting over time/within the year (or a consistent pattern of seasonal targeting).
- The existing time series should cover a sufficient (recent) period to allow analysis.
- Data are readily available for the historical period and into the future.
- To reduce time lags, data should be available soon after fishing is completed (e.g. be subject to electronic reporting).
- High coverage operational level data should be available, verifiable through consistent and representative observer coverage (and e.g. electronic monitoring), and catch verifiable through unloading data.

Recommendation:

- SC discusses candidate 'reference' fleets that might meet the above criteria.

Pre-analysis of CPUE data

The empirical model may operate based upon 'raw' (nominal) CPUE information, with absolute CPUE data from the selected fishery/'reference' fleet informing the HCR. However, the estimation method/harvest control rule may be better informed if the CPUE data are subject to a level of pre-analysis.

Standardising CPUE

Catch per unit effort will be influenced by factors such as vessel targeting behaviour, vessel performance (e.g. 'effort creep'), environmental factors, market prices, and recent average catch rate (e.g. Tremblay-Boyer and McKechnie, 2018; Brouwer et al., 2015).

CPUE time series inputs for stock assessment are standardised to try to remove these influences and better reflect underlying stock biomass. Different statistical approaches have been used in WCPO stock assessments, from clustering/GLM analyses (e.g. Tremblay-Boyer et al., 2015) to geo-statistical analyses (e.g. Tremblay-Boyer et al., 2017). For the 2018 south Pacific albacore assessment, CPUE indices have been developed using both approaches and applied to an 'index' longline fishery for each of the five model regions. This standardised series was calculated for the overall longline fleet CPUE developed from the database of DWFN and PICT combined operational data (Tremblay-Boyer et al., 2018, Tremblay-Boyer and McKechnie, 2018).

If a standardised CPUE time series is to be used as the estimation method, details of the input data and the settings used within the standardisation approach <u>must</u> be sufficiently documented to ensure the approach can be repeated consistently in subsequent years. This will ensure that changes in the CPUE result from changes in the underlying biomass, rather than the way in which those data are processed.

A disadvantage of using standardised CPUE is that a level of transparency is lost. There are potential benefits in trying to identify a suitable nominal CPUE series that provides the necessary signal of underlying biomass to the HCR. By providing a direct link between the CPUE experienced and the management action, this would potentially improve the transparency of the approach for the wider stakeholder group, and may more closely link to CPUE-related TRPs.

Recommendations:

- Note the need to document the data inputs and standardisation settings (if needed) for any CPUE index used to inform the estimation method.
- Note the potential to examine both standardised and nominal CPUE time series as potential inputs into the estimation method.
- Assess model performance using standardised vs nominal CPUE.

Absolute CPUE values or trends in CPUE

An empirical-based HCR could be based on:

- the absolute CPUE level (the nominal or standardised CPUE at a given time, or averaged over a specified period). An absolute CPUE value might translate more directly to economic management objectives, and hence into a 'target' CPUE or target 'range' of CPUE that achieves those objectives; and/or
- the trend in CPUE over time (i.e., is the relative change in CPUE over some recent period increasing, stable, or declining?). In this case, the variable being considered could be the slope of a regression against annual average CPUE over the most recent years.

The absolute CPUE value can be taken from a specific year, or averaged over a recent period. The most recent year of catch and effort data is frequently the most uncertain for longline fisheries, given the issues with logsheet return lag times (noting that electronic reporting should reduce this somewhat in the future), and the most recent year may need to be excluded from the calculation. Use of a slightly more historical period will mean the approach is functioning with a time lag.

The period to be used will be influenced by the level of inter-annual variability in the CPUE data set. A time series with significant variability (noise) may have a reduced signal of underlying stock biomass and will affect performance. An average CPUE over a recent period may be appropriate, if that average provides a sufficiently reliable signal to inform the HCR. These issues would be evaluated within the MSE along with the robustness to data uncertainties and biases that will affect the CPUE information (Hillary et al., 2012). The period of data to be used must, once finalised, be specified to ensure the approach can be repeated consistently in subsequent years.

Recommendations:

- Note the potential to use an absolute CPUE value and/or trend in CPUE to inform the harvest control rule.
- Note the need to document the approach used to calculate the values input to the harvest control rule (e.g. single value, average or trend, and over a specified period).

Generating CPUE from the operating models (OMs)

The suite of Operating Models (OMs) define the alternative underlying stock and fishery dynamics against which the performance of the estimation method and HCR will be tested through MSE. The uncertainty grid for the 2018 south Pacific albacore stock assessment will provide a starting point for determining the suite of operating models to use in the MSE evaluations. This is comparable to the approach proposed for skipjack (Scott et al., 2018a). Expansion of the suite of OMs beyond the 2018 south Pacific albacore assessment grid presented to SC14 will be the subject of further discussion.

Fishery catch and effort data will be simulated from each OM for the required future period to test the proposed approach. The ability of the OM to produce CPUE with realistic levels of variability, consistent with those seen historically, must first be examined.

If a ‘reference’ fleet, or a finer scale division of fleets than that used within the 2018 assessment is to be used, this fleet(s) would need to be separated out from the grouped fleets currently present within the assessment models. The suite of OMs would need to be re-developed accordingly, allowing the catch and effort of that fleet to be modelled into the future.

Existing MULTIFAN-CL functionality allows future fleet catch and effort to be modelled as ‘pseudo-data’ (e.g. Scott et al., 2018c; Davies et al., 2018). The catch and effort data would include some ‘observation error’ (e.g. Polacheck et al., 1999). The appropriate level of ‘error’ to best capture that seen in the actual CPUE to be used would need to be identified as part of the OM ‘conditioning’ exercise. Scott et al. (2018a) provides further discussion on these aspects.

CPUE data generation from the OMs will be driven by the underlying assumption of the relationship between stock biomass and CPUE. Within MULTIFAN-CL, this can be modelled as a linear relationship with underlying stock biomass, or as a non-linear relationship (e.g. Scott et al., 2015). Given the proposed focus on CPUE time series for the estimation method, the robustness of any harvest strategy to uncertainty in this relationship for albacore must be examined.

Recommendations:

- Note the potential need to tailor OMs to provide the required information from proposed individual/grouped fleets providing CPUE information, where those fleets are not part of the 2018 assessment model grid.
- Note the proposal to test the robustness of management to uncertainty in the south Pacific albacore biomass/CPUE relationship.

3.2. Harvest Control Rules (HCRs)

Two key decision are to be made by managers for the development of HCRs:

1. Which fisheries are to be controlled? Noting that troll fisheries only take around 3% of the overall south Pacific albacore catch, these fisheries have previously been kept at ‘status quo’ levels in analyses, but managers should confirm this assumption. This would also help define the level of total catch/effort allowable within HCRs if the stock (CPUE) were at very low levels.
2. What is the mechanism through which the fishery impact on the stock will be controlled by management? That control (for example via management of overall catch or effort) is yet to be defined for the southern longline fleet/south Pacific albacore. The pros and cons of catch or effort controls have been well documented, particularly for multispecies longline fisheries, and is a discussion outside the scope of this paper. However, it will be important for managers to discuss the desired fishery control mechanism in order to provide guidance for the MSE modelling.

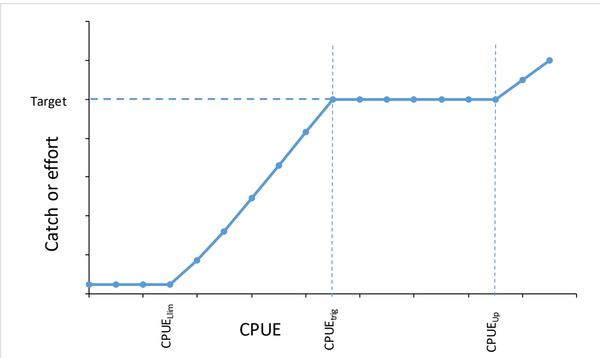
The type of estimation method (model-based or empirical-based, as discussed above) will influence the HCR. While model-based HCRs have been presented to WCPFC SC for both the purse seine and southern longline fisheries (e.g. SPC, 2015b; McKechnie et al., 2016), empirical HCRs have not. We therefore describe this form of HCR in more detail here. Two examples are provided in Figure 1:

- One comparable to the ‘hockey stick’ form often used for model-based HCRs (e.g. Breen, 2009).
- A threshold CPUE where fishing (catch or effort) is controlled if outside a given range of values. This may be more suited to absolute CPUE inputs rather than CPUE trend-based inputs.

These two examples would operate in the same way – the effort or catch in the subsequent time period would be pre-defined by the CPUE information in the current period. The performance of many different forms of HCR for the southern longline fishery would be tested within the MSE process, with for example the HCR parameters (e.g. $CPUE_{lim}$, $CPUE_{trig}$, $CPUE_{Up}$; Figure 1) adjusted ('tuned') to values that best achieve management objectives (e.g. Kell et al., 2015).

The quality of historical data will affect the trend or absolute HCRs developed; provision of improved historical data could change the history of the CPUE series. HCRs based a relative trend rule, for example, would need to take that into account.

a) Example HCR defining future catch based upon CPUE levels



b) 'Indicator' style approach (upper) where action is taken where CPUE is outside specified bounds, and corresponding example HCR (lower)

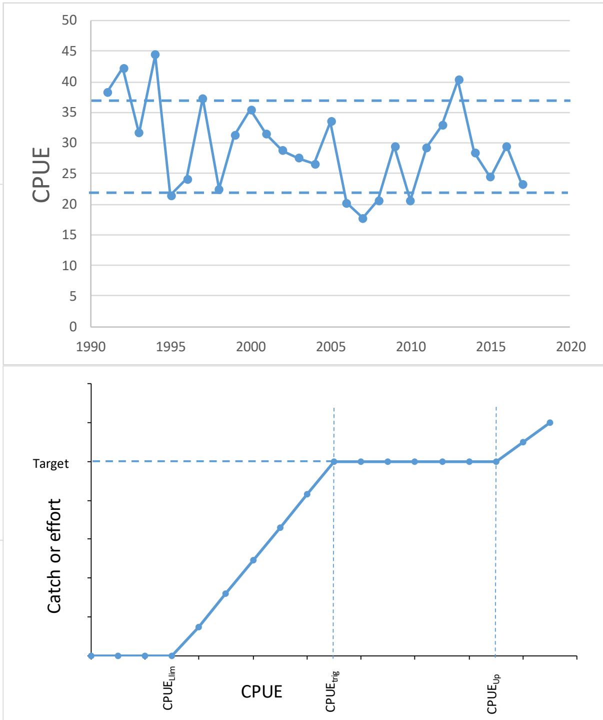


Figure 1. Example empirical HCR forms that could be examined for south Pacific albacore, where $CPUE_{lim}$ defines the CPUE level (or decreasing trend) below which catch or effort is minimal/zero; $CPUE_{trig}$ = the level where management action to decrease catch/effort is triggered; and $CPUE_{Up}$ = the CPUE level above which catch or effort could increase.

Recommendations:

- SC14 request guidance from WCPFC15 on:
  - Fisheries for south Pacific albacore to be controlled within the harvest strategy;
  - the potential management control for the fishery (e.g. through south Pacific albacore catch, fishing effort, etc.)

Other HCR features for consideration

The change in catch or effort between management periods defined by a HCR can be affected by further meta-rules, such as:

- a maximum limit of change, reflecting what may be feasible from a management and industry perspective in terms of the level of change in effort or catch from one management period to the next;

- a minimum level of change below which no action is taken (e.g. where a relatively small change in fishing is considered not to be worthwhile);
- unequal (asymmetric) changes in fishing level, where for example a larger decrease in fishing is allowed to arrest stock declines, but a smaller increase in fishing is allowed when the stock is increasing, as a precautionary measure ('slow up, fast down').

Definition of these additional controls will be developed through the iterative process of harvest strategy development, and will particularly benefit from wider stakeholder input. Whether these additions improve performance of the HCR would need to be tested within the MSE.

3.3. Reference points

Two key reference points are discussed here: the limit reference point (LRP) which defines minimum stock levels below which there is concern for the resource; and the target reference point (TRP) which defines stock levels that achieve the desired trade-offs between differing management objectives for the fishery.

WCPFC9 adopted the use of the biomass-based LRP of 20%$SB_{F=0}$[2] for WCPO target tuna stocks. This has subsequently been used in management advice for WCPO tuna stocks, including south Pacific albacore.

The candidate management objectives for the southern longline fishery noted by the Commission (see Attachment K of the WCPFC14 summary report) provide guidance for discussions around a proposed TRP for south Pacific albacore. Analyses have focussed upon stock levels that provide different levels of vessel profitability (e.g. Pilling et al., 2015; SPC, 2015a), as influenced by the albacore catch rates those vessels would achieve. Given recent fishing levels, which implied continued on-average declines in biomass and hence catch rates, maintaining or increasing vessel profitability required reductions in fishing effort (Brouwer et al., 2017; based upon projections from the 2015 assessment; Harley et al., 2015).

Based upon the 2015 stock assessment, SPC (2015a) also indicated that the commonly suggested target level SB_{MSY} equated to adult stock sizes below the LRP ('reference case' assessment SB_{MSY} = 0.14 $SB_{F=0}$) and achieving that level would result in CPUE falling by nearly 65%. A common economic objective of maximum economic yield (MEY) would, in contrast, require considerable reductions in effort (by over 75% relative to 2013 fishing levels).

At present, a candidate interim TRP has been put forward by FFA members of 45%$SB_{F=0}$ (FFA members, 2016), on the basis that this stock level would restore a level of profitability on average to longline fleets in the fishery. However, no agreement on an interim TRP for south Pacific albacore has yet been reached.

The TRP provides a summary indicator of the stock (or fishery) level that meets the trade off in different management objectives. Maintaining the stock around the TRP level indicates that the harvest strategy is achieving key management objectives on average. Given the proposal to use MULTIFAN-CL as the basis for operating models, a TRP defined relative to $SB_{F=0}$ would be appropriate for use as a performance indicator within the harvest strategy for south Pacific albacore/the southern longline fishery.

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[2] See para 269 of the WCPFC9 report, while WCPFC10 adopted the calculation of $SB_{F=0}$ as the average of estimated unfished spawning biomass over the years $t_1=y_{last}-10$ to $t_2=y_{last}-1$ where y_{last} is the last year used in the assessment (WCPFC10 report, paragraph 181).

3.4. Monitoring strategy

Management objectives for the southern longline fishery, as noted by WCPFC14, should be monitored in the real world to ensure objectives are being achieved under an adopted harvest strategy, that results are consistent with outputs of the MSE, and that unexpected 'exceptional' circumstances are not occurring.

The current availability of data that allow objectives to be monitored needs to be considered by WCPFC bodies to ensure all the elements of the monitoring strategy are in place. Much of the information detailed in WCPFC14 Summary Report Attachment K is available through regular fishery data collection and, where available, observer information. However, longline observer coverage (potentially supplemented by electronic monitoring) and the collection of trip-specific catch unloading data may need to be increased to support harvest strategy monitoring. For many of the social indicators, in-country fishery monitoring by CCM governments and other organisations may be required.

One area that would benefit from further consideration is the monitoring of fleet economic performance. Economic objectives will need to be monitored for the overall fishery and/or for the particular 'reference' fleets selected. Efforts to gather economic information within the WCPFC were detailed in Reid and Skirtun (2017) and understanding the economic dynamics of key components of the southern longline fishery will be key to the harvest strategy.

Recommendation:

- Note the need for ongoing review of monitoring strategy requirements as the harvest strategy develops, and for ongoing efforts to gather key economic data on the southern longline fishery.

4. Technical work plan for southern longline harvest strategy development

The following work plan highlights key technical areas to be investigated for south Pacific albacore/southern longline fishery harvest strategy development. Timescales are dependent upon decisions made by WCPFC15:

2018

- Identify candidate longline fleets or fleet groupings as the basis for empirical estimation method inputs;
- As necessary, tailor OMs to provide the required information from individual/grouped fleets, where those fleets are not part of the 2018 stock assessment model grid;
- Examine the use of both standardised and nominal CPUE time series as potential inputs.

2019 onwards

- At SC15, agree an initial range of OMs for HCR evaluation;
- At SC15, agree approach to evaluating preliminary performance indicators;
- For HCR development:
    - Evaluate the potential use of absolute CPUE values or recent CPUE trends;
    - Dependent upon the results, examine the time period over which an average absolute value, or relative trend, could be calculated;

  - Based upon WCPFC15 decisions on TRPs and the fishery control mechanism (catch, effort) and a basic range of OMs, examine a range of HCRs to inform initial discussions at SC15.
- Following SC15 feedback, investigate candidate HCRs, and consult on other elements of the HCR process, such as a maximum/minimum limit of change, unequal (asymmetric) changes in fishing level under e.g. stock depletion or recovery scenarios;
- Evaluate the potential impact on estimated CPUE of uncertainty in the form of the biomass/CPUE relationship;
- Consideration of mixed fishery and multi-species issues:
  - Discuss how best to account for targeting of different species in longline fisheries;
  - Refine fishery economics based on multi-species catches;
- Develop the monitoring strategy for the fishery/stock.

5. References

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