Draft proposal of "Statement of Work for the Management Strategy Evaluation of Pacific Bluefin tuna"

Hiromu Fukuda and Norio Takahashi

Highly Migratory Resources Division, Fisheries Resources Institute,

Japan Fisheries Research and Education Agency

2-12-4, Fukuura, Kanazawa-ku, Yokohama, Kanagawa 236-8648, JAPAN

Corresponding author: fukuda_hiromu57@fra.go.jp

November 2022

Working document submitted to the ISC Pacific bluefin tuna Working Group, International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC), from 1-8 November 2022, Webinar.

1 INTRODUCTION

The Joint Inter-American Tropical Tuna Commission (IATTC) and the Northern Committee of Western and Central Pacific Fisheries Commission (WCPFC NC) Working Group (hereafter JWG) developed a Terms of Reference (TOR) for Pacific Bluefin tuna (PBF) Management Strategy Evaluation (MSE) and the commissions of IATTC and WCPFC adopted this TOR in 2019 (IATTC-NC-JWG04-03). In the TOR, the commissions requested the ISC to provide technical guidance on and oversee the development, execution and outputs of the model to be used in the PBF MSE. This document is drafted to provide an entire picture of the PBF MSE with detailed information reference, technical tasks, considerations, and schedules. Also, this kind of document might be useful to allocate tasks and roles among the RFMOs, managers, stakeholders, and the ISC. This could be a living document which is subject to updates as the project going on.

2 PURPOSE and TIMELINE of PBF MSE

The TOR stated that the purpose of PBF MSE is to evaluate the expected performance of alternative long-term management strategies for Pacific bluefin tuna fisheries once the second rebuilding target is reached.

Currently, the management measures of PBF have been developed and introduced in each RFMO to recover the stock level to higher than a 20% of the equilibrium virgin biomass (SSB_0), which is sometimes used as a B_{MSY}-proxy reference point. Given the situation of recent rapid recovery of this stock as well as a relatively low recent fishing intensity on this stock (ISC 2022), the stock is projected to recover to a level higher than the current rebuilding target when the PBF MSE is scheduled to be activated. The PBF MSE might be expected to provide evaluations of alternative management measures, which can maintain the stock level in a somewhere high level with a better yield for a long term with a robustness to the possible uncertainty.

In the 7th JWG meeting held in July 2022, it agreed to prioritize the stock assessment for PBF as a task of ISC in 2024, and allowed some delays to complete the PBF MSE works to 2025. Thus, the ISC is now anticipated to provide a series of final MSE outputs with appropriate guidance to interpret those outputs at 2025 commission meetings. To make all the MSE outputs available for the PBF related forum held in 2025, those should be confirmed by the PBFWG in early spring of 2025 as our usual schedule for the assessment. However, given a possible long calculation time of the full-spec MSE using the SS3, the input data, any model set-ups, format of outputs, and MP(s) need to be determined at the earlier timing than the usual stock assessment, such as the end of 2024. With those technical specification, the modeling group could work on the

calculation during the intersessional period of the WG workshops. The meeting in the early spring of the 2025 will be a meeting to confirm the results and discuss how to present those outputs to the stakeholders. Thus, the schedule might be as below;

Nov 2022 *Discussion* about Grid, EM, performance indicator etc;

Mar 2023 *Continue Discussion* about technical works. *Preparation* for the feed-back to JWG about Management objectives, MP, Management cycle, MSE periods etc;

Nov 2023 *Data prep for the assessment*, *Decisions* for OM and Grids, Data (with its duration) used for the OM conditioning and MP, *Development* of weighting method, MP(s), and performance indicators based on the inputs from JWG;

Mar 2024 *Conduct Stock Assessment*,

Dec 2024 *Data deadline* for the OM/MP, *Decisions* for model specifications, MP(s), and outputs including performance indicators;

Mar 2025 *Confirm* the results of the MSE, *Discussion and decisions* for the report-back to the commissions;

May~Sep 2025 *Presentation* of the PBF MSE outputs to the IATTC SAC, ISC plenary, JWG, WCPFC SC, WCPFC NC.

In addition, results of MSE work need to be regularly updated at JWG as well as IATTC and WCPFC meetings, possibly including informal workshops for stakeholders involvement.

3 Status of technical works for PBF MSE development

3.1 Modeling platform

The PBFWG agreed to use the stock synthesis 3.3 (Methot and Wetzel, 2013) as a platform of the operating model (OM) (ISC PBFWG, 2021). The WG also developed a shorter time series model specification, which could replicate compatible stock dynamics with the current assessment model when those two models were overlapped. The WG recognized that this shorter time series model is more flexible to the alternative assumptions in the population dynamics or observation models than the current stock assessment base case model (Fukuda, 2021).

3.2 Uncertainty Grid

Although the PBFWG conducted several sensitivity analyses using the short time series model in the 2022 stock assessment, an uncertainty grid corresponding to the full range of uncertainty of this stock needs to be

developed. In this regard, the WG would consider candidates of uncertainties for both the population dynamics model and observation model, as well as the method for weighting in each OM.

Regarding the observation model, the WG recognized that the observed retained catch likely does not account for the total amount of removals by fishing activity, as there is certain amount of unseen removal due to the post release mortality and unreported discards. In the PBF stock assessment, the WG incorporated unseen mortality by estimating or assuming those removals based on the surveys or expert judgement. Since the amount of the unseen removals and its selectivity are uncertain, the level of the unseen mortality should be an axis of the uncertainty grid in the MSE. However, to treat this axis only in the future process or in both of conditioning and future processes would be subject of discussion by the WG. Those unseen mortality is assumed to have increased only in recent years when the strict catch upper limit were introduced, and the amounts of the unseen mortality did not affect to the estimation of the unfished population scale so far. It may affect the fishing mortality and biomass at the terminal year of the operating model which could impact to the Total Allowable Catch (TAC) determination in short term. The WG may want to discuss if they need to include the unseen mortality uncertainty in the conditioning process too or only in the future process. .

Also, the performance of a recent recruitment abundance index, which has a short time series (i.e. Japanese Recruitment Monitoring Survey index), was a part of uncertainty in the last assessment since its performance could not be evaluated due to the lack of information to validate it in the model. Thus, this could also be an axis of the uncertainty, but it also relates to what data is going to be used in the OM/MP.

As for the population dynamics model, the natural mortality and stock-recruitment relationship (SRR) are major uncertainties in the PBF assessment. The growth is another trait, which is often treated as a source of uncertainty in many fish species. However, in the case of PBF MSE, the growth was estimated outside the model based on the relatively well sampled otoliths and the model fit to the size composition data is basically good. If the WG prioritize the source of uncertainty to include in the OM, the priority of growth might be less than that of the natural mortality and SRR.

3.3 Observation and process errors in the data and implementation error

One of the major differences between a general future projection in assessment and evaluation of Management Procedure (MP) in MSE is the adaptive management, which control the TAC or Total allowable effort (TAE) in MP according to the abundance index or results of the estimation model. To depict a MP with adaptive management in MSE with appropriate process, observation, and implementation errors, a sophisticated feedback loop to iterate a harvest, data curation (generation), stock assessment, and TAC determination (Management model) would be essentially important. The WG agreed on borrowing the feedback loop developed for the North Pacific Albacore MSE (ISC ALBWG 2020), though the WG still needs to consider the evaluation model, data generation with appropriate process and observation errors, and implementation error when the harvest is occurring in the OM. Those technical matter will be discussed and solved in current and future WG meetings and its intersessional works.

3.4 Exceptional circumstances

Although the process to check whether the stock is at the exceptional circumstances of the MSE might be more conceptual matter comparing with the OM/MP development, this is also an important task for the scientist to develop. In the case of the PBF stock, stock assessment work would play a main role of the evaluation. Also, since there is a high uncertainty in the future recruitment, checking the indices in timely manner tells us whether there is something unexpected.

About the fishery, because the ages for vulnerable biomass of PBF ranged from age 0 to 20+, the selectivity, which is always unknown for future period, could impact the stock dynamics. In this regard, checking the size composition data would also be important.

The PBFWG are welcomed for further discussions on this topic.

4 Matters related to Status of Management for PBF MSE development

Besides above-mentioned technical issues, the WG need to develop performance indicators and harvest control rule(s) based on the requests and management objectives raised from managers and stakeholders.

4.1 Harvest Control Rule

In the 4th session of the JWG in 2019, the JWG agreed several candidate Reference Points (RPs) as well as schemas of F-based Harvest Control Rule (HCR) (JWG, 2019) (Fig. 1-2). With those, although those could be a myriad of combinations, the WG can create MPs and compare the performance of them using some general performance indicators such as the average future catch or biomass levels. However, in addition to those, 7th session of JWG in 2022 (JWG-07) considered candidate operational management objectives and performance indicators (JWG07-DP-12, 2022) (Table 1). In that document, they suggested some biomass based tuning targets with certain probabilities as well as limits to change in overall catch limit between management periods. Those tuning targets and probability would conflict with F-based HCR and those are not compatible. The WG will need to have a dialogue with managers on this point. In case of the other tuna species, NPALB MP was developed by applying a F-based HCR (ISC, 2021), on the other hand, Atlantic Bluefin tuna (ABF) MP and Southern Bluefin tuna (SBT) MPs were developed based on the tuning targets with certain probability for tuning (CCSBT, 2019).

As for the HCR in the MP, the NPALB MP was mimicking the combination of catch and effort control to depict the suitable management style for different fisheries, which were specified by the stakeholders. There was no such a request for PBF so far.

4.2 Estimation model

As for the management procedure, because the suggested HCRs and RPs by the JWG were based on the biomass and F-based reference points, a model-based MP seems like anticipated implicitly. Given the recent consistent results of the PBF stock assessment as well as some difficulties in the CPUE based abundance index in terms of their continuity, the choice of model based MP could be reasonable. However, the MP based on the fully integrated model, such as the NPALB MP, usually requires long calculation time, the WG may want to have a simpler model for the estimation model such as the Age Structured Production Model with Recruitment variability (ASPM-R). It is worth to note that the ASPM-R and the base case model (fully integrated model) showed similar results in the case of the PBF stock assessment (ISC PBFWG, 2022), so use of ASPM-R could be advantageous in terms of the calculation time.

In the candidate HCRs (JWG04-2019-rev01), the JWG noted an idea to combine both the assessment model and recruitment index to determine the TAC for large PBF (based on the assessment results) and small PBF (based on the recruitment index). There would be a desire to control the catch limit for small PBF depend on the recruitment strength in more timely manner to allow survival for weak cohort as well as some high catch when a strong cohort coming in. This could be desirable for fisheries which caught small PBF, however, it should be noted that a reliable recruitment index and annual TAC determination would be necessary to enable this kind of HCR.

4.3 Performance Indicator and Management Objective

The performance indicator needs to be consistent with the management objectives. Although it has been discussed for a long time among the stakeholders, there is still no consensus about the management objectives. The JWG-07 created a list of candidate operational management objectives, which were categorized into 4 categories, (namely Safety, Status, Stability of catch, and Yield). This categorized list seems like to be developed using the management objectives agreed upon at the ICCAT as a straw-man list. A concern was a potential incompatibility between the tuning target and F-based HCR as mentioned in 4.1. Among the listed candidate objectives, all of them except an objective regarding the fishery impact ratio between WCPO and EPO were commonly used ones and shouldn't be difficult to calculate.

As for the candidate objective regarding the fishery impact, since the fishery impact ratio (Wang et al., 2009) itself is not determined by only the yield, but also the size (age) of fish caught and the balance of those among parties, the category could be "Equitability" instead of "Yield". In addition, as this objective directly related to the allocation of TAC, it must be difficult for managers to reach consensus for a single proportion as the best desirable proportion of fishery impact. It should be noted that all of the MSEs, which became as the basis of the management advise for other tuna species, does not evaluated the best balance of the allocation by their MSE. Rather, those were treated their allocation as constant to be similar with recent years. Taking into account possible difficulty for managers to make consensus on a desirable fishery impact ratio as a management objective, the authors suggested to have an alternative management objective to fulfill a desire of each fishing party in equitable manner such as to maximize the proportion of catch to their

historical maximum in each fishing party. The PBFWG may want to discuss this topic for the feed-back to the commissions.

In a technical matter to be discussed by the WG would be how to calculate the fishery impact in the OM and MP when this objective is formally adopted. In the usual PBF assessment, the WG has conducted several model-runs to calculate fishery impact separate from the assessment base case run, but this procedure is not practical to conduct in the OM and MP due to its complexity. An alternative index, which can be outputted from a single model run would be desirable such as fleet specific $F_{\%SPR}$.

4.4 Period of PBF MSE and management cycle

In the list of candidate operational management objectives, some suggested performance indicators implied that the PBF MSE can calculate the outputs for 30 years onwards. However, because of the intensive requirement of the machine power for the MSE using SS3, a shorter MSE duration is beneficial to allow wider range of uncertainty or MPs or other choices. The authors suggested 15 years as a candidate of MSE period starting from July 1st of 2024 to June 30th of 2039.

As for the management cycle, in Atlantic Bluefin tuna MSE, there are lengthy discussion to determine the management cycle as 2 or 3 years. The ICCAT SCRS showed a trade-off in yield and its stability by changing the management cycle. However, in a practical sense, the management cycle affects to the manpower of the scientist, and shorter management cycle require much more efforts of scientist to run through the MSE and reduce a potential effort to maintain or improve the performance of assessment and MSE by their research works. Even after the MP became available as a management tool, the ISC PBFWG needs to conduct the stock assessment to check the trajectories of stock and fishery in meantime of MP updates. This work also could be a process to check if there is exceptional circumstance. In the case of two-years management cycle, the year of assessment and MP update will alternate each other, and there will be no year for the WG to concentrate the research work for further understanding of the stock. This could be a potential loss for the management which could not be assessed through MSE since there is no concept of "improvement of science" within the common MSE framework. Thus, the authors recommended 3-years management cycle such as a cycle of the MSE year (2025; MP update), the

Research year (2026), and the Assessment year (2027).

5 Discussion

The authors appreciate the PBFWG for their updates and refinements of this draft document through the discussion during the meeting. We just tried to describe the topics required to be done by the PBFWG or JWG in this moment. The descriptions should be changing as this MSE project going on.

6 Literature cited

CCSBT. 2019. Report of the twenty fourth meeting of the Scientific Committee, 7 September 2019. CCSBT, Cape Town, South Africa. 121 pp.

Fukuda H. 2021. How to improve a flexibility of the Stock Synthesis model for Pacific bluefin stock to the alternative assumptions with keeping its performance. ISC/21/PBFWG-02/12.

ISC. 2021. Report of the North Pacific Albacore tuna Management Strategy Evaluation.

ISC. 2022. Stock assessment of Bluefin tuna in the Pacific Ocean in 2022.

Methot Jr., R.D. and Wetzel C.R. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fisheries Research 142, 86-99.

Wang S.-P., Maunder M. N., Aires-da-Silva A. and Bayliff W. H. 2009. Evaluating fishery impacts: application to bigeye tuna (Thunnus obesus) in the eastern Pacific Ocean. Fish. Res. 99(2): 106-111.

WCPFC NC. 2019. Northern Committee Fifteen Regular Session Summary Report.

WCPFC NC. 2022. Northern Committee Eighteen Regular Session Summary Report.

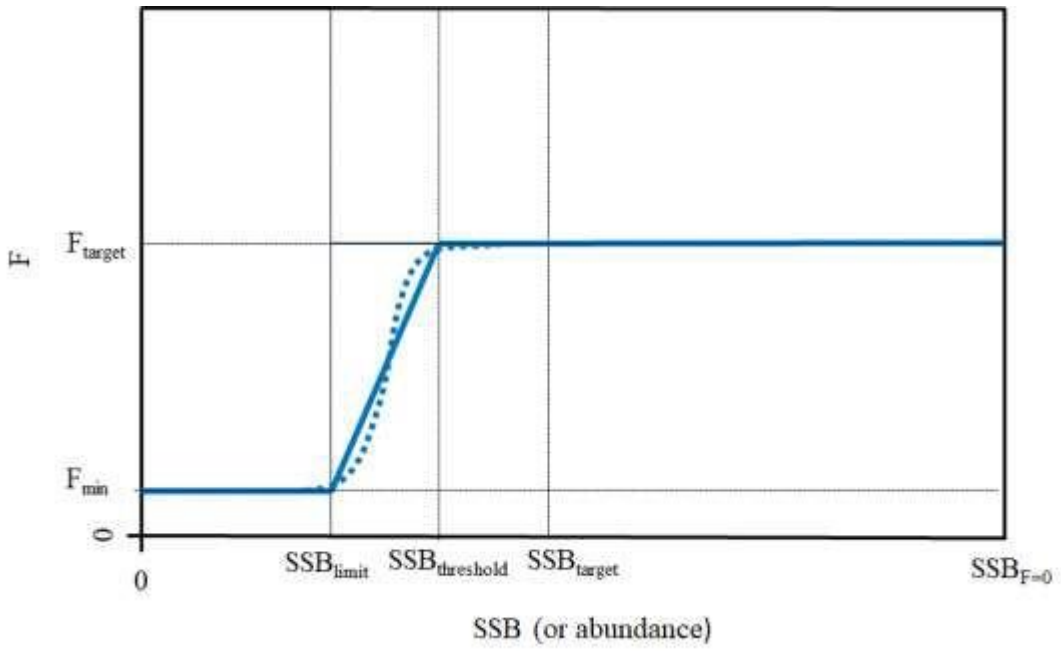

Figure 1. Candidate HCRs 1a (solid line) and 1b (dashed line) adopted by NC15.

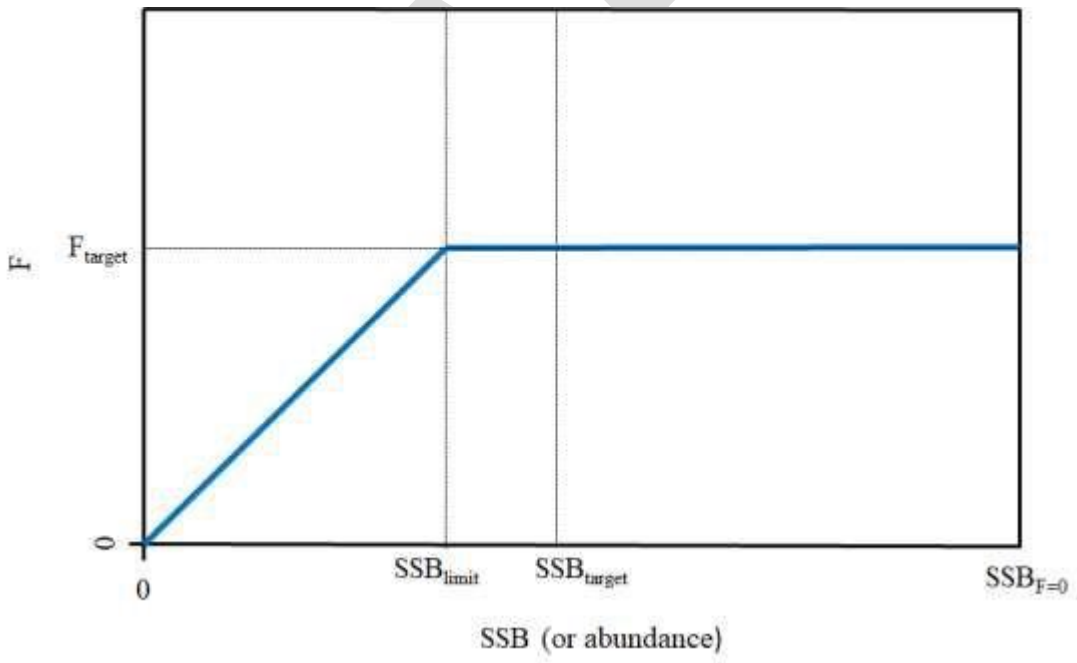

Figure 2. Candidate HCR 2 adopted by NC15.

Table 1. Candidate list of Management objective and Performance indicator reviewed by JWG-07.

Note: JWG07 reviewed JWG07-DP-12, produced this Annex, and agreed to revisit this at JWG08.

Category	Operational Management Objective	Performance Indicator
Safety	There should be a less than [5-20%][1] probability of the stock falling below the LRP	• Probability that SSB< LRP in any given year of the evaluation period ([10-30] years subject to the number of scenarios; NPA use 30 years; can be confirmed in 2023)
Status	To maintain fishing mortality at or below FTarget with at least [50-75]% probability	• Probability that F≤FTARGET in any given year of the evaluation period
Stability	To limit changes in overall catch limits between management periods to no more than [15%] downwards[, unless the ISC has assessed that there is a greater than 50% chance the stock is below the LRP]	• Percent change upwards in catches between management periods excluding periods when SSB<LRP • Percent change downwards in catches between management periods excluding periods when SSB<LRP
Yield	[Maintain a proportional fishery impact between the WCPO and EPO [similar to the average proportional fishery impact from 1971-1994]]	• Median fishery impact (in %) on SSB in any given year of the evaluation period by fishery and by WCPO fisheries and EPO fisheries • The probability that the proportional EPO fishery impact is at least the 1971-1994 average in any given year
	To maximize yield over the medium (5-10 years) and long (10-30 years) terms, as well as average annual ~~catch~~yield from the fishery.	• Expected annual yield over years 5-10 of the evaluation period, by fishery. • Expected annual yield over years 10-30 of the evaluation period, by fishery. • Expected annual ~~catch~~yield in any given year of the evaluation period, by fishery.
	[To increase average annual catch in all fisheries across WCPO and EPO]	

[1] The acceptable levels of risk may vary depending on the LRP selected, but should be no greater than 20%.