9th Joint IATTC–NC Working Group on PBF management

Agenda 7.1 Progress and issues related to developing Management Strategy Evaluation

Updates from ISC PBFWG: MSE and Harvest Strategies

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Acknowledgements

❖ All works to develop and improve the PBF MSE were done by the following members of the ISC PBFWG as a team effort;

- M. Maunder, J. Valero (MSE Analyst) (IATTC)

- S.K. Chang (Chinese Taipei and WG vice chair)

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- H.H. Lee, D. Tommasi (MSE analyst), S. Teo (U.S.A.)

- H. Fukuda, N. Takahashi (MSE analyst), Y. Tsukahara, K. Nishikawa (Japan)

- S. Nakatsuka (WG chair)

Why do a Management Strategy Evaluation for PBF?

○ Currently, the PBF stock is subject to a recovery plan. This includes implementation of strict catch limits for PBF fisheries by the IATTC and WCPFC, with some revisions in accordance with the stock assessment results.

○ The need for a long-term management measure for the fishery after achieving the second rebuilding target has been discussed at the JWG of the WCPFC NC and the IATTC.

○ The JWG agreed to work on an MSE **to evaluate the expected performance of alternative long-term management strategies for PBF fisheries** once the 2nd PBF rebuilding target is reached.

○ The JWG requested to the ISC to complete the technical analyses for the MSE in 2025.

○ According to the latest ISC stock assessment, the 2nd PBF rebuilding target was reached in 2021.
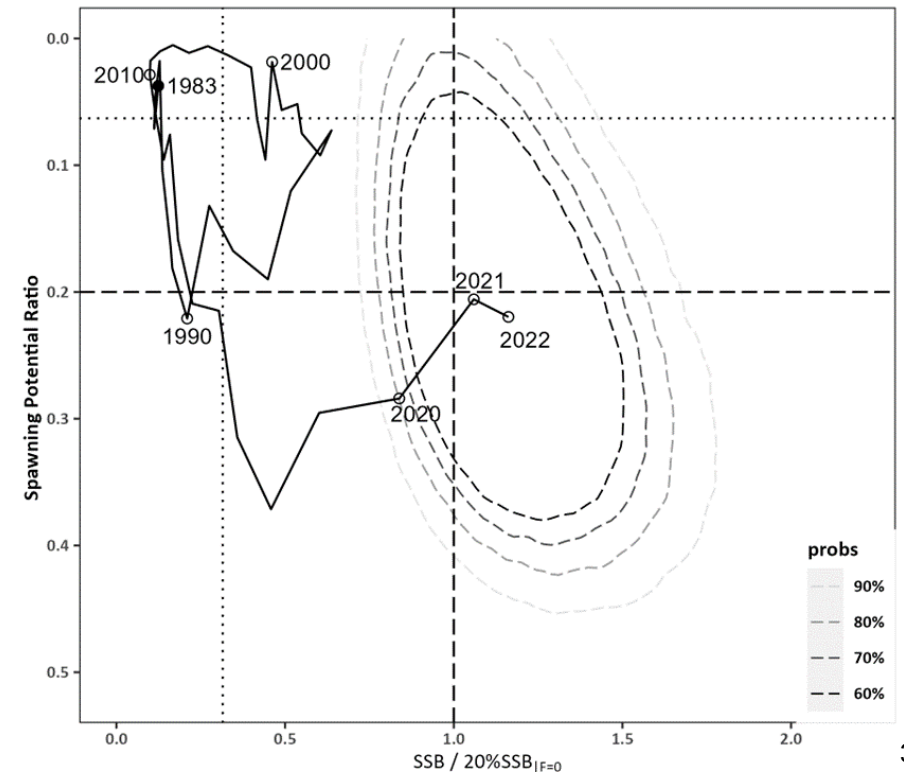
What is Management Strategy Evaluation?

o   MSE is a process to evaluate the **trade offs** and **performance** of **candidate management strategies** under a range of **scenarios** and **uncertainties** using computer simulations

o   Flight simulator for fisheries management but with a lot more uncertainty

o   If a management strategy does not perform adequately in a computer simulation, we should not expect it to work in the real world

o   Difference between forward projections and MSE is that MSE uses a feedback loop

Brief History of PBF MSE Process

1st ISC PBF MSE Workshop (May 2018)
Yokohama, JAPAN

- ✓ **~70 participants**
- ✓ **Purpose:** review the requirements to implement an MSE, define stakeholder roles, review recent progress made by tuna RFMOs towards implementing the MSE process

2nd ISC PBF MSE Workshop (May 2019)
San Diego, USA

- ✓ **~70 participants**
- ✓ **Purpose:** promote understanding of MSE among stakeholders and continue discussion on required elements for PBF MSE

7th Meeting of the IATTC_WCPFC NC JWG on PBF (July 2022)
Virtual

- ✓ Workplan for development of long-term harvest strategy (including MSE) adopted
- ✓ Candidate **operational management objectives** and **harvest control rules (HCRs) for MSE** discussed
- ✓ To be revisited at JWG08 meeting

8th Meeting of the IATTC_WCPFC NC JWG on PBF (July 2023)
Fukuoka, JAPAN

- ✓ Candidate **operational management objectives** and **harvest control rules for MSE** finalized
- ✓ Reviewed and adopted by WCPFC NC at NC19

2025 - ISC presents **final results** from the **MSE** to JWG10
JWG recommends a final HS to WCPFC and IATTC for adoption

JWG09

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Candidate Operational Management Objectives for PBF

Category	Operational Management Objective	Performance Indicator
Safety	There should be a less than 20% probability of the stock falling below the limit reference point (LRP)	• Probability that SSB<LRP in any given year of the evaluation period
Status	To maintain fishing mortality at or below F_{target} with at least 50% probability	• Probability that F≤ in any given year of the evaluation period F_{target} • Probability that SSB is below the equivalent biomass depletion levels associated with the candidate for F_{target}
Stability	To limit changes in overall catch limits between management periods to no more than 25% unless the ISC has assessed 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 an equitable balance in proportional fishery impact between the WCPO and EPO	• Median fishery impact (in %) on SSB in the terminal year of the evaluation period by fishery and by WCPO fisheries and EPO fisheries
	To maximize yield over medium (5-10 years) and long (10-30 years) terms, as well as average annual 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 yield in any given year of the evaluation period, by fishery
	To increase average annual catch in all fisheries across WCPO and EPO	

Candidate HCRs and Reference Points for PBF MSE
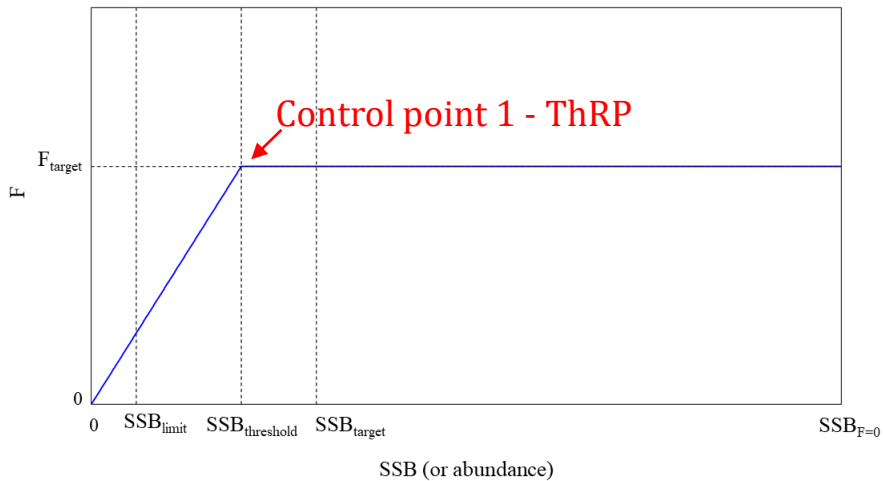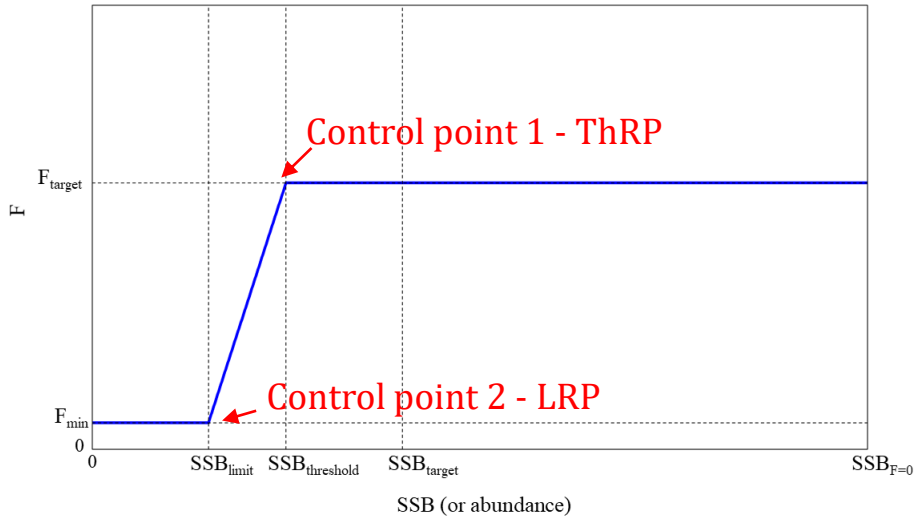
HCR Number	F_{target}	SSB Control Point 1 (ThRP)	SSB Control Point 2 (LRP)	Number of SSB control points	F_{min}
1	FSPR30%	20%SSB$_{F=0}$	15%SSB$_{F=0}$	2	10%F$_{target}$
2	FSPR30%	25%SSB$_{F=0}$	15%SSB$_{F=0}$	2	10%F$_{target}$
3	FSPR40%	20%SSB$_{F=0}$	15%SSB$_{F=0}$	2	10%F$_{target}$
4	FSPR40%	25%SSB$_{F=0}$	15%SSB$_{F=0}$	2	10%F$_{target}$
5	FSPR40%	25%SSB$_{F=0}$	20%SSB$_{F=0}$	2	10%F$_{target}$
6	FSPR30%	20%SSB$_{F=0}$	10%SSB$_{F=0}$	2	FSPR70%
7	FSPR25%	20%SSB$_{F=0}$	10%SSB$_{F=0}$	2	FSPR50%
8	FSPR30%	20%SSB$_{F=0}$	Median SSB 1952-2014	2	CMM limits
9	FSPR20%	20%SSB$_{F=0}$	NA	1	NA
10	FSPR25%	15%SSB$_{F=0}$	NA	1	NA
11	FSPR30%	15%SSB$_{F=0}$	7.7%SSB$_{F=0}$	2	5%F$_{target}$
12	FSPR30%	20%SSB$_{F=0}$	7.7%SSB$_{F=0}$	2	5%F$_{target}$

✓ Changes in TAC between consecutive management periods constrained to be no more than 25%.

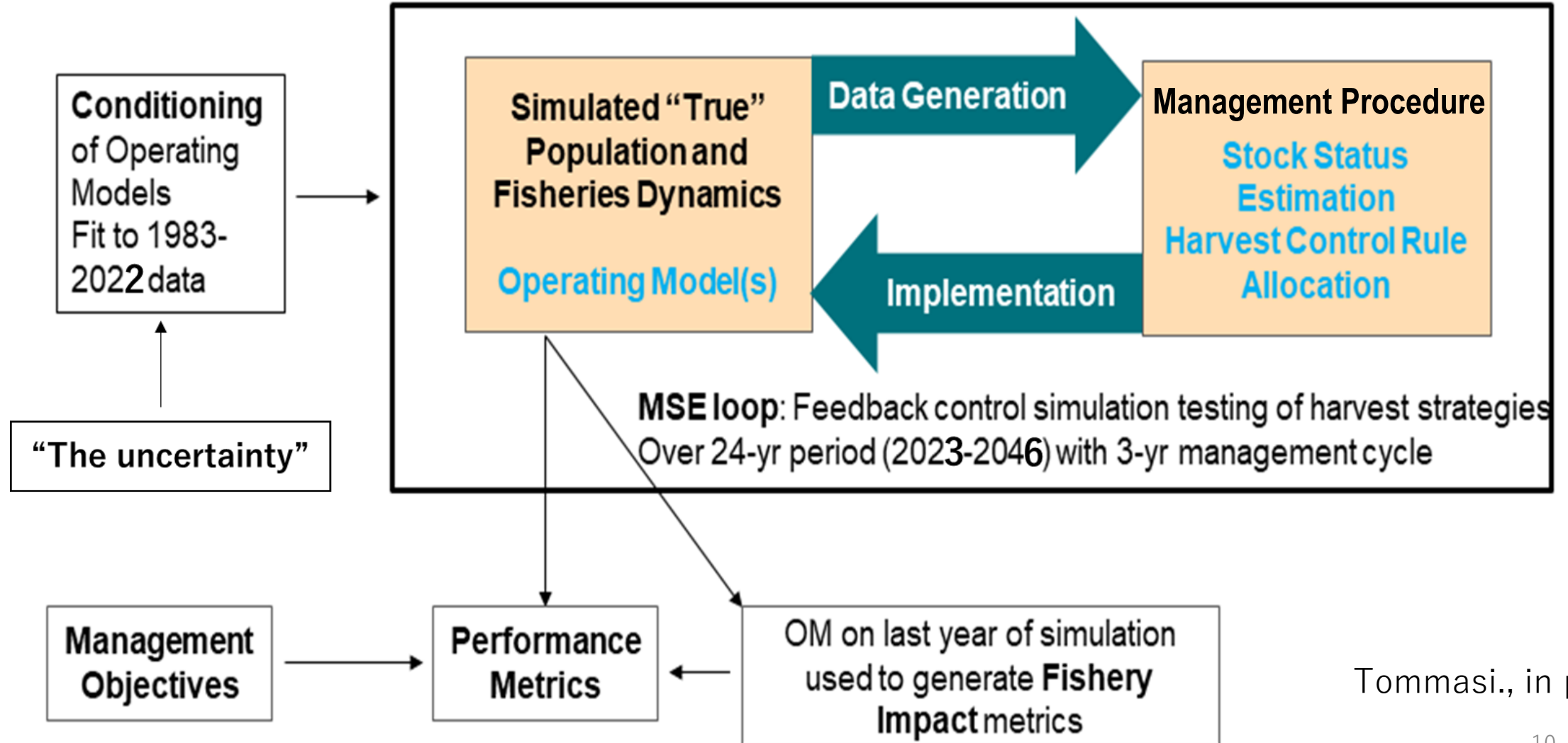✓ Tuned to reach WCPO:EPO fishery impact ratio of 70:30 and 80:20.

Plan for the stock assessment and MSE/MP TAC update

❖ The ISC is requested to provide the results from PBF MSE in 2025.

- ○ The PBFWG plans to finalize the MSE package in 2024 and evaluate MPs in early 2025.
  - ✓ There is some available time to have a science-management dialogue in Jan.-Feb. 2025.
- ○ The results from the MSE will be provided to the IATTC-WCPFC JWG in 2025 (June-Sept.?).
- ○ 3-year management cycle is currently considered.
  - ✓ SA (2024) -> 1st MSE with multiple MPs (2025) -> Research (2026) -> SA (2027) -> MP TAC update
  - ✓ The MP selected in 2025 will be updated every 3 years to calculate the TAC for the next 3 years.
  - ✓ SA focused on detailing what is going on the stock, and whether anything unexpected happens.

	2024	2025	2026	2027	2028	2029
Stock assessment	○			○		
CMM@ interim HCR		→				
MSE/MP		1st formal MSE			MP TAC update	
CMM@ MSE			→		→	→

Work Progress on MSE development

Framework of the PBF MSE

Conditioning of Operating Models Fit to 1983-2022 data

"The uncertainty"

Simulated "True" Population and Fisheries Dynamics

Operating Model(s)

Data Generation

Management Procedure
Stock Status Estimation
Harvest Control Rule
Allocation

Implementation

MSE loop: Feedback control simulation testing of harvest strategies Over 24-yr period (2023-2046) with 3-yr management cycle

Management Objectives

Performance Metrics

OM on last year of simulation used to generate **Fishery Impact** metrics

Tommasi., in prep.

Framework of the PBF MSE

○ The ISC PBFWG decided to apply the MSE framework developed for the NP ALB stock for PBF MSE.

○ This allows for simulation testing of the performance of a management procedure (MP, including a HCR) in a feedback manner with the operating model developed for PBF.

○ Framework is coded in R, with Operating Models (OMs) and Estimation Models (EMs) developed in Stock Synthesis 3.3.

JWG09
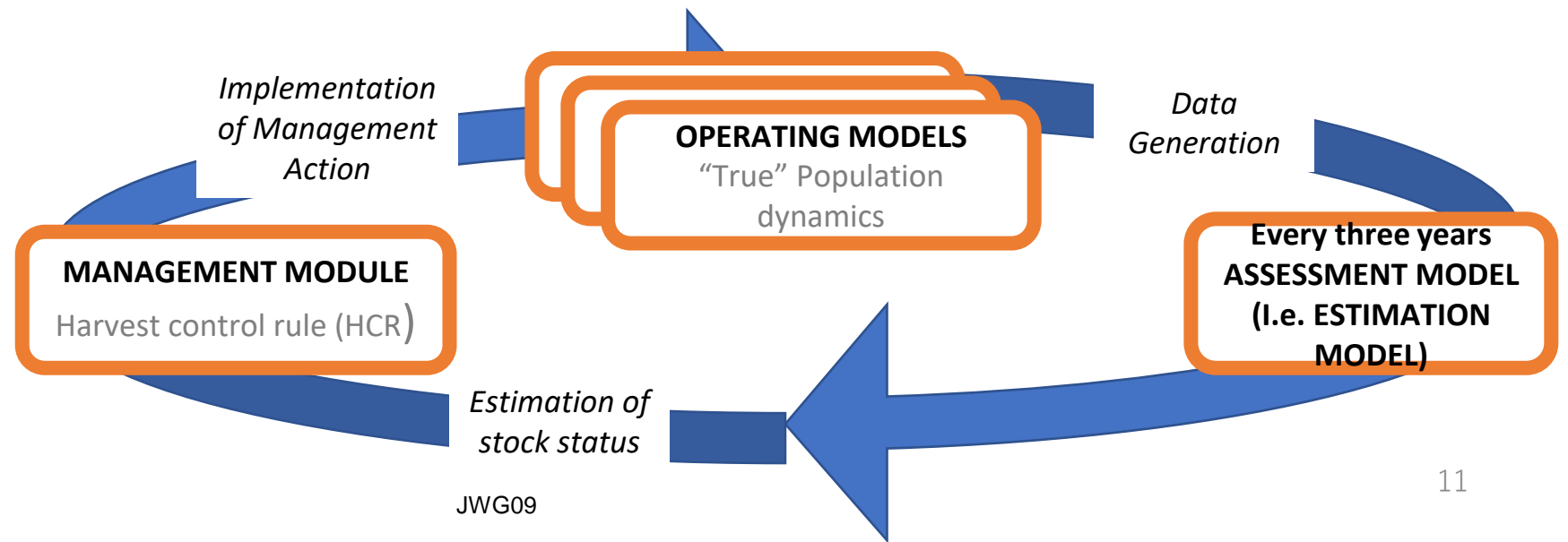
Operating Model(s) – Reference set

❖ The OM reference set captures the most likely plausible range of stock and fishery dynamics

❖ Base case OM is ISC PBF 2024 assessment

❖ ISC PBFWG developed methodology to select final reference OM set based on model diagnostics (Lee and Tommasi 2024)

❖ Use of reference set allows for consideration of *parameter uncertainty* in PBF steepness, natural mortality, and growth

❖ PBF MSE framework also considers

  ○ *Process uncertainty* in recruitment by using multiple iterations with different random recruitment deviations

  ○ *Observation uncertainty* by generating data with error to be input into the EM

  ○ *Estimation uncertainty* by simulating an assessment model (EM)

  ○ *Implementation uncertainty* due to discards

Lee and Tommasi 2024
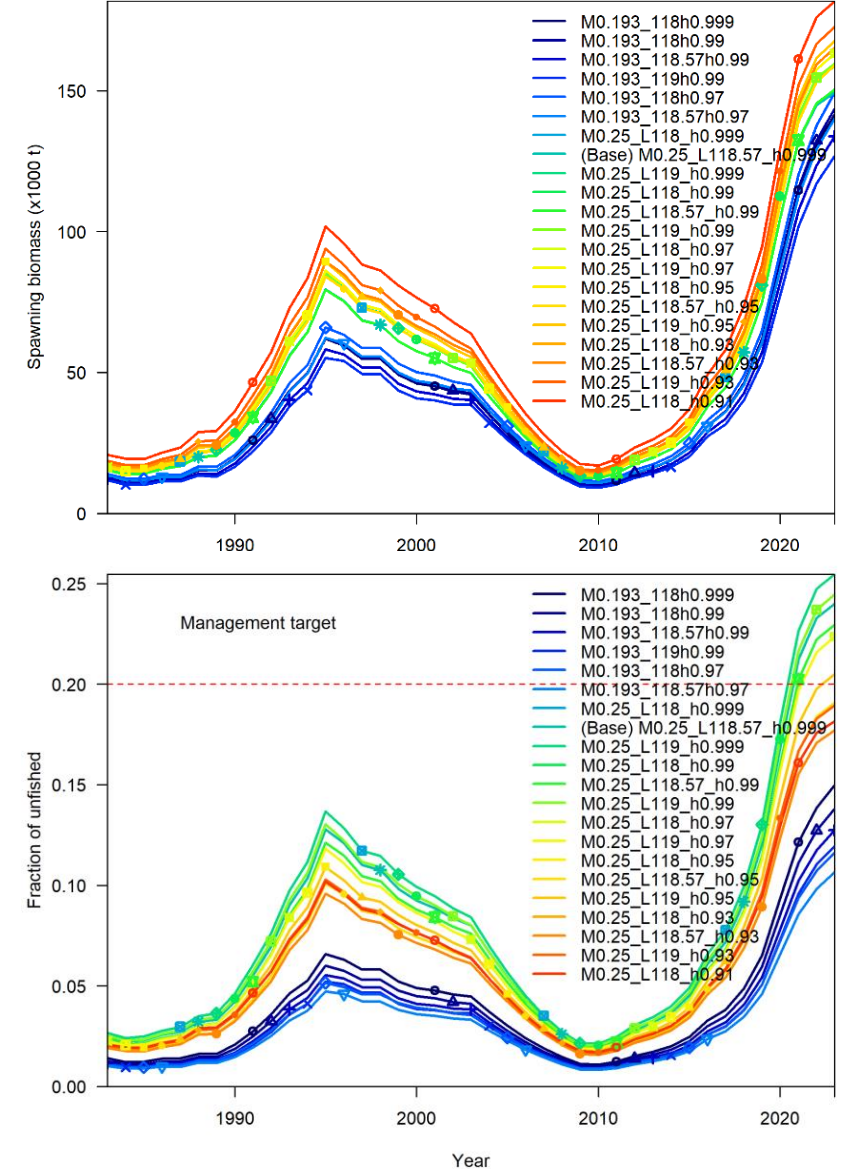
Operating Model(s) – Robustness Set

❖Robustness OMs are still plausible but unlikely

❖The robustness set allows for a check that the management procedure still behave as intended even in an unlikely, but still plausible, scenario

❖ISC PBFWG considers the following scenarios as high priority for inclusion in the robustness set:

- No adult longline index

- Catchability change in the Taiwanese longline index

- Recruitment drop (10-yr long drop as in the 1980's)

- Implementation error reflecting higher discards than the currently considered 5% (WPO catch) and 6% (EPO release)

Tommasi and Lee 2024, ISC PBF WG meeting report, spring 2024

Estimation model (EM) in MP

❖ EM is a module to estimate the stock status for the harvest control rule.

- ○ For the last decade (in the real world), the management measure has been decided based on the stock assessment using the fully integrated model (SS3 model).

- ○ The base-case SS3 model of the 2024 assessment could be used as the default EM in the MSE.

- ○ Due to the high computational burden to run the full SS3 model in each MP, simpler assessment models (e.g. ASPM-R) are currently under consideration to optimize the tradeoff between calculation time and actualism.

- ○ Preliminary evaluation showed that use of ASPM-R reduced computation time to ¼ and produced future TAC and SSB trajectories similar to those of a full SS3 EM (Takahashi et al. 2024).

Management Module

❖ All the candidate harvest control rules proposed by the JWG08 have been implemented in the MSE (Tommasi et al. 2023), with the 25% limit on TAC changes between management periods (Tommasi and Lee 2024a).

❖ Work is underway to apply the method to tune the impact ratio (Tommasi and Lee 2024b) to obtain the requested EPO:WCPO impact ratios of 70:30 or 80:20 (Tommasi and Lee 2024) using the new OM based on the 2024 assessment. Note this is dependent on the assumed selectivity and exploitation patter across fleets.
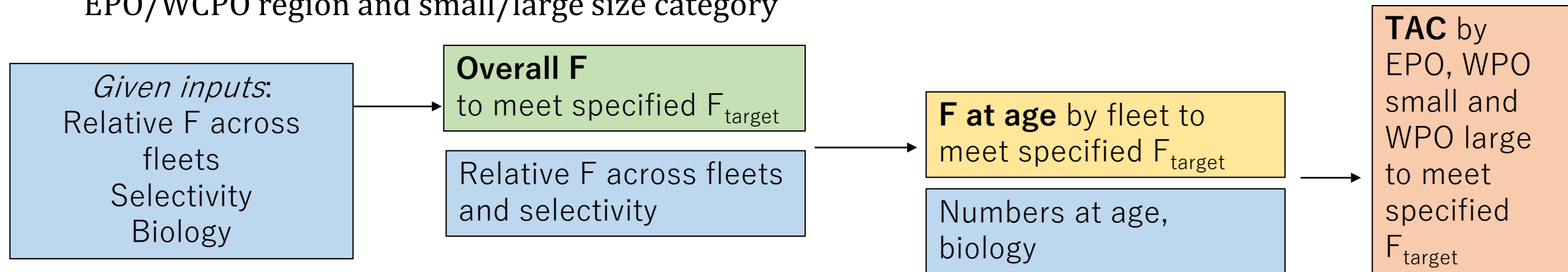

Tommasi et al., 2023
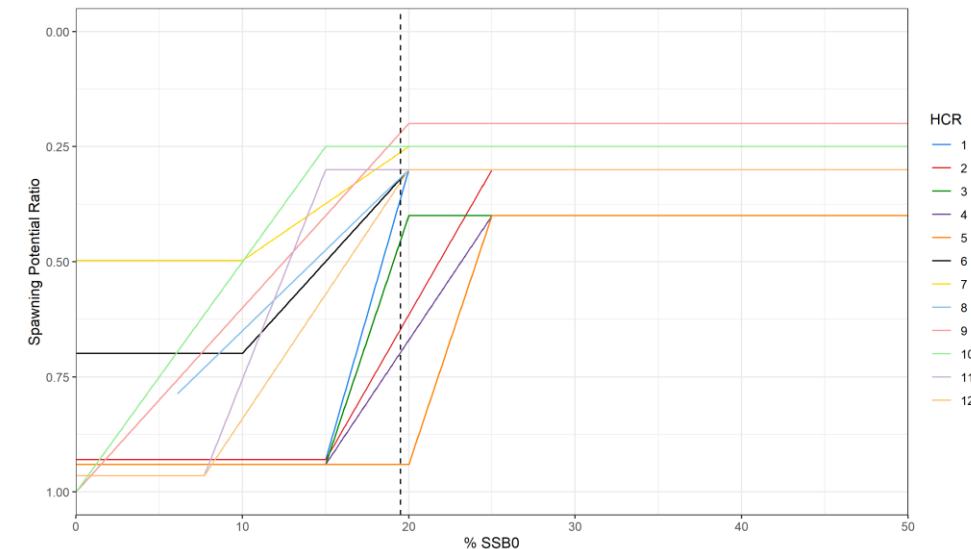
MP question for JWG:

❖ How do you expect the output of the MP-derived TAC (s) (i.e. catch upper limit(s)) to be subdivided?

- ○ E.g. by WPO/EPO regions and large/small categories? Or by member-country? (MSE will internally calculate fleet specific TAC anyway.)

- ○ **Unless requested otherwise the PBFWG will produce a TAC by region and size category.**

- ○ Note that the MP-derived TAC includes both commercial and recreational catches but not catches to account for unseen mortality.

- ○ Unseen mortality will be handled as implementation error, which is one of the uncertainty axes being considered in the MSE.

# How the TAC to meet F_{target} is found in MSE management module

❖ First, the overall F (fully selected fishing mortality) to meet SPR F_{target} is found. It depends on:

    ○ Current numbers at age

    ○ Selectivity of each fleet

    ○ *Exploitation pattern across fleets (relative F)*

❖ The final TAC by fleet is then determined by the current biomass, selectivity for that fleet (including commercial as well as recreational, but not discard), and fleet specific F. It is then aggregated by EPO/WCPO region and small/large size category


Given inputs:
Relative F across fleets
Selectivity
Biology

→

Overall F to meet specified F_{target}

Relative F across fleets and selectivity

→

F at age by fleet to meet specified F_{target}

Numbers at age, biology

→

TAC by EPO, WPO small and WPO large to meet specified F_{target}

❖ *Relative F* and *selectivity* is what determines *how the fishing mortality is allocated across regions and size categories* and hence determines the final allocation across regions and size categories

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How TAC to meet F_{target} is found in MSE management module

❖ The ISC PBFWG is currently testing current selectivity and relative F defined as the average over the past 8 years (i.e. 2015-2022)

❖ The relative F is then tuned to meet the 70:30 or 80:20 (status quo) impact ratio as specified

❖ However, *the small:large allocation within the WPO* has not been specified and thus stays the *same as* that in the *current period*
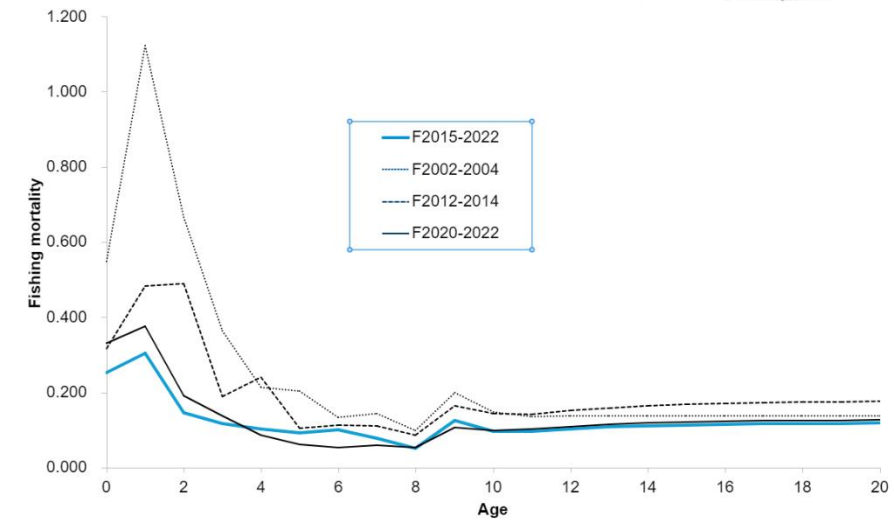
Results from a preliminary simulation with HCR 1 with no estimation error (i.e. perfect assessment, no implementation error) and no EPO:WCPO allocation tuning showing the catch by age within the WPO and by fleet type.
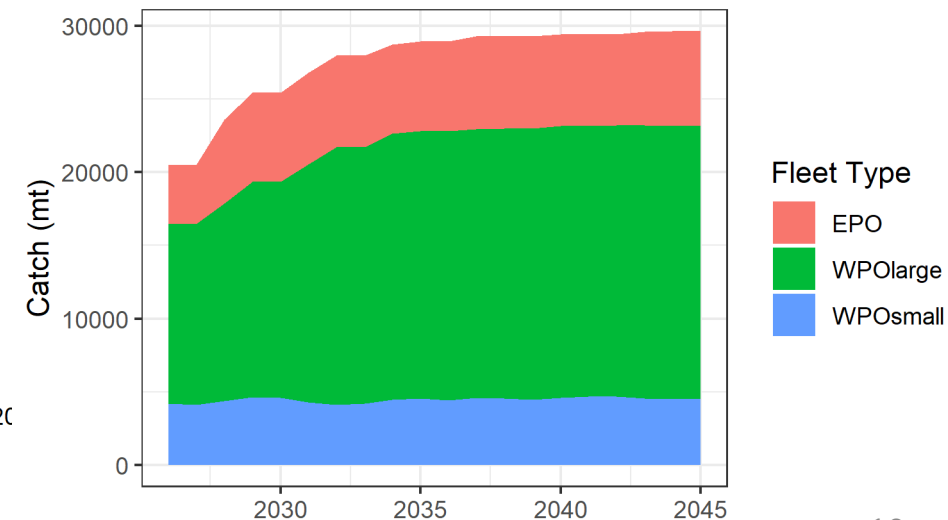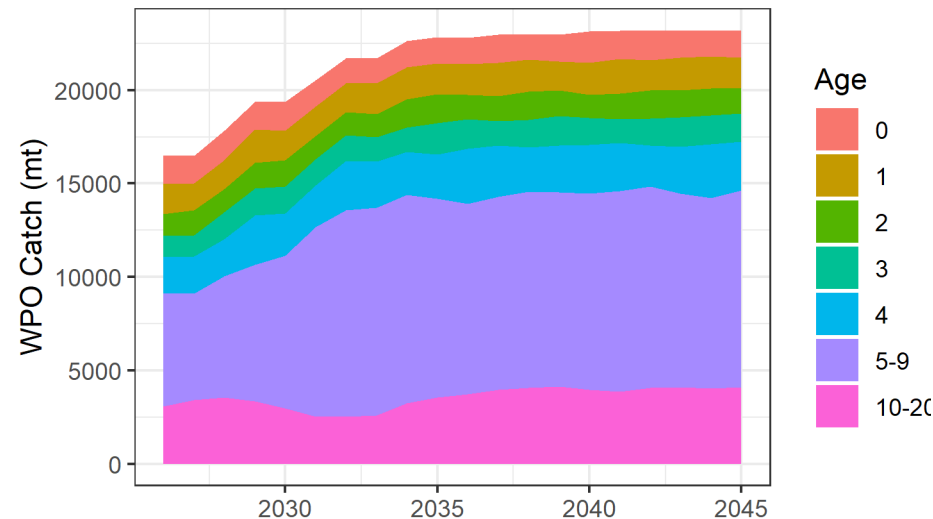
How TAC to meet F_{target} is found in MSE management module

❖ While the choice of selectivity and relative F won't impact performance of HCRs relative to each other, actual performance metric, particularly for yield objectives, are contingent upon the assumed relative F and selectivity.

❖ Ex) Compare preliminary results from a baseline simulation with 2015-2022 relative F and selectivity (SCN 1) and the same simulation with a 5% increase in WCPO small fleets relative F (SCN 2). SCN 2 showed a lower total catch.
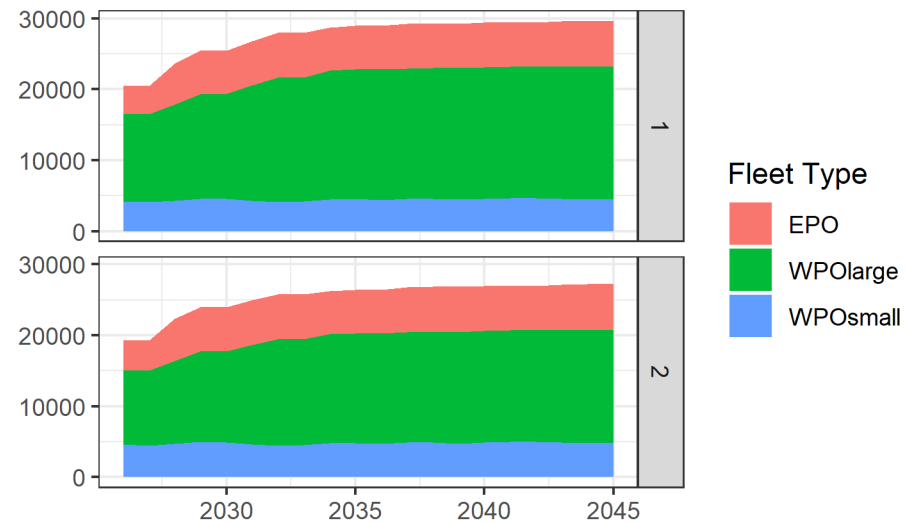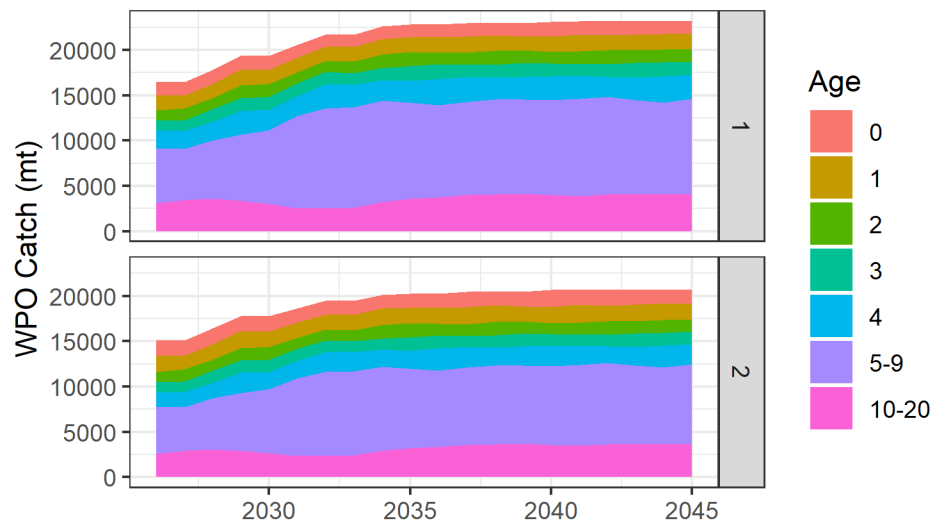
	SCN1 2015-2022 baseline	SCN2 +5% WPOsmall
Total catch	27504 mt	25377 mt
WPO small catch	4454 mt	4783 mt
WPO large catch	17035 mt	14515 mt
EPO catch	6015	6079
EPO:WPO impact	17:83	17:83

❖ The ISC PBFWG encourages the JWG to consider if this small:large baseline within the WPO needs to be tweaked. Unless otherwise instructed the PBFWG will use the 2015-2022 relative F for the MSE calculation for the time being.

Summary for the PBF MSE

❖ The ISC PBFWG has been developing the PBF MSE package, with final report and results to be available in 2025 (JWG 10).

- The ISC PBFWG obtained all required inputs from the IATTC-WCPFC JWG.
- The technical work is proceeding according to the timeline.
  - ✓ General PBF MSE simulation framework developed and candidate harvest control rules implemented.
  - ✓ OM based on 2024 stock assessment developed and reference and robustness sets identified.
  - ✓ Preliminary comparison of alternative EM formats carried out.
  - ✓ Fishery Impact performance metric implemented.
  - ✓ Method to tune relative F to obtain desired impact developed, needs to be tested with updated OM.
- The JWG should consider if MP-derived TAC should be further subdivided, e.g. by country or fleet.
- The JWG should consider if the small:large allocation baseline within the WCPO currently used in the MSE needs to be tweaked.
- The JWG could consider holding an intersessional meeting in early 2025 to review progress of MSE, preliminary results, and further discuss the above questions.

Questions?