Impact of replacing Purse seine FAD catches on bigeye tuna MSY

IOTC Secretariat, February 2024

PURPOSE

The purpose of this document is to update the Special Session of the Scientific Committee (SSC01) on an analysis assessing the impact of replacing catches from Purse seine FAD fishery on the Maximum Sustainable Yield (MSY) for bigeye tuna, in response to a request from the Commission. In accordance with Resolution 23/04, we estimated the percentage changes in MSY benchmarks using the Stock Synthesis model for bigeye tuna. This analysis involved scenarios in which a fixed proportion of catches from purse seine FAD fishery was transferred to either the purse seine free school fishery or the longline fishery.

BACKGROUND

During its 26th session, the IOTC Commission adopted Resolution 23/04, which established the Total Allowable Catch (TAC) for bigeye tuna for 2024 and 2025, aligned with the Management Procedure set out in Resolution 22/03. Resolution 23/04included several requests for the Scientific Committee:

> *"(Para 13) The IOTC Scientific Committee shall conduct a comparative analysis of the contribution of all fishing gears to the mortality of bigeye tuna, which shall include both absolute and relative contributions to mortality and stock depletion.*
>
> *(Para 14) The IOTC Scientific Committee shall develop a table as shown in Annex 2 that quantifies the expected impact on maximum sustainable yield (MSY) and SSBmsy for bigeye tuna resulting from replacing fishing mortality/catches of any major fishing gear/fishery (e.g., Longline, DFAD fisheries, AFAD fisheries, Purse seine on free school, other fisheries) for consideration by the Commission at its 2025 Session. The IOTC Scientific Committee shall also provide advice on FAD management options, including on, limits on FADs sets, that may be necessary to achieve a replacement of fishing mortality of FAD fisheries with free school fisheries. This analysis shall be conducted for DFADs and AFADs fleets separately"*

The first request (Para 13) was addressed through a fishery impact analysis conducted by Correa et al. (2023). This analysis showed reductions in spawning biomass associated with fishing from various fisheries (Figure 1). The results were discussed at the 2023 Scientific Committee meeting and reported to the Commission in 2024, contributing to the FAD management proposal considered during the Commission's 28th session.

This document presents an analysis addressing the second request (Paragraph 14). Specifically, the 2022 bigeye tuna stock assessment reference case (Fu et al., 2022) was used to estimate the impact on MSY reference points from replacing catches in the FAD fisheries. Resolution 23/04 called for separate analyses for Drifting FADs (DFADs) and Anchored FADs (AFADs). However, the IOTC Secretariat has not yet received specific catch data for AFADs. The assessment model did not differentiate a fishery or fleet specifically for AFADs. The 'BB1N' fishery defined for region 1N in the assessment includes several fleets/gears primarily fishing on AFADs, such as small purse seiners in Indonesia and the pole and line fishery in the Maldives (the latter fish on both free and associated schools). Therefore, the analysis for AFADs was based on the 'BB' fishery, acknowledging that it also includes components not fishing on AFADs. On the other hand, the DFAD fisheries correspond to purse seine associated sets operating in areas 1N, 1S, and 2, referred to as PSLS1N, PSLS1S, and PSLS2 (Table 1 of Fu et al., 2022).

MSY-based reference points were derived from the reference model using the benchmark calculation routine of the Stock Synthesis platform. Generally, MSY is determined by the biological characteristics of the stock and the fishing selection pattern (selectivity). Biological characteristics include life-history parameters fixed within the assessment (e.g., growth, maturity, natural mortality, steepness) and quantities estimated (e.g., average recruitment or R0). Fishing selectivity (or F-at-age) is determined by selectivity of individual fleet/fishery and the relative catch weight of the fisheries, with the overall selectivity largely influenced by the fishery with the highest catch volumes. Notably, variations in the proportion of catches across the main fishing gears amongst years (PSLS catches in region 1N doubled in 2021, see Table 1) can lead to significant changes in overall selectivity, even if individual selectivity remains constant. For benchmark calculations, it is necessary to specify a reference period to determine F-at-age, with the most recent year(s) typically being the preferred option due to their relevance to likely exploitation patterns. For this analysis, we assumed the last model year (2021) as the reference year to determine F-at-age reflective of the potential transfer or replacement of catches, noting that the choice of reference year can influence estimated MSY benchmarks, though key conclusions are unlikely to change.

Separate analyses were carried out to the DFADs (purse seine associated sets, or PSLS) and AFADs fisheries. In each case, two sets of estimates were obtained: one for the scenario where catches from transferred to the purse seine free school fishery (PSFS), and another where the catches were replaced by longline (LL) catches. It was assumed that the catch transfer occurred within the same quarter and area; for instance, catches of PSLS1S in quarter one would be transferred to the PSFS1S fishery in the same quarter. In each scenario, four transfer percentages were considered: 10%, 20%, 50%, and 100%. The resulting MSY and SSBMSY were estimated and expressed as percentage changes compared to the reference model, which assumed 0% catch transfer. These results are given in Tables 2.

As expected, both MSY and SSBMSY increased when catches from fisheries primarily targeting juveniles were replaced with those from fisheries catching larger, adult fish.

RECOMMENDATIONS

That the WPTT

1) **NOTE** paper IOTC–2025–SSC01–04 which summarised an analysis to assess the impact of replacing FAD catches on MSY for bigeye tun in order to satisfy the Commission's requests and **AGREE** to the results to be considered by the Commission in 2025.

REFERENCES

Correa, G., Merino, G., Santiago, J. Urtizberea, A. 2023. Responses of tuna stocks to temporal closures in the Indian Ocean. IOTC-2023-WGFAD05-13

Fu, D., Merio, G., Winker, H. 2022. Preliminary Indian Ocean bigeye tuna stock assessment 1950-2021 (stock synthesis). IOTC–2022–WPTT24–10.

Table 1: Recent bigeye tuna catches (mt) by fishery included in the 2022 stock assessment. The annual catches are presented for 2017- 2021.

Fishery	Year				
	2017	2018	2019	2020	2021
FL2	8 910	7 201	8 172	9 152	8 893
LL1N	3 050	2 488	2 680	5 578	2 653
LL1S	14 002	11 139	13 091	14 328	14 308
LL2	4 354	2 813	3 843	4 155	4 239
LL3	5 008	3 602	2 760	3 107	3 138
PSFS1N	4 376	2 292	2 211	2 117	6 733
PSFS1S	5 807	1 342	5 272	1 969	2 077
PSFS2	65	–	–	–	–
PSLS1N	9 381	13 855	10 601	10 425	21 011
PSLS1S	9 628	9 941	8 166	9 979	6 586
PSLS2	639	5 360	897	60	1 099
BB1N	6 961	5 295	6 293	8 678	7 180
LINE2	10 121	7 177	9 009	12 210	9 784
OT1	4 502	5 001	3 519	2 983	1 604
OT2	4 395	3 574	4 160	5 918	5 717
Total	91 199	81 080	80 674	90 659	95 022

Table 1: The impact on estimates of MSY and SSBMSY (measured as percentage changes) for bigeye tuna resulting from replacing catches DFADs or AFAD fisheries: transferring catches (1) from PSLS (1N 1S, 2) to PSFS (1N, 1S, 2), (2) from PSLS (1N, 1S, 2) to LL (1N, 1S, 2), (3) from BB (1N) to PSFS (1N), (4) from BB (1N) to LL (1N).

	Source fishery	Target fishery	Catch replacement	Percent change MSY	Percent change SSBMSY
(1)	PSLS (1N, 1S, 2)	PSFS (1N, 1S, 2)	10% (2 870 t)	+4%	+5%
	PSLS (1N, 1S, 2)	PSFS (1N, 1S, 2)	20% (5 739 t)	+8%	+8%
	PSLS (1N, 1S, 2)	PSFS (1N, 1S, 2)	50% (14 348 t)	+22%	+17%
	PSLS (1N, 1S, 2)	PSFS (1N, 1S, 2)	100% (22 957 t)	+53%	+21%
(2)	PSLS (1N, 1S, 2)	LL (1N, 1S, 2)	10% (2 870 t)	+4%	+5%
	PSLS (1N, 1S, 2)	LL (1N, 1S, 2)	20% (5 739 t)	+9%	+10%
	PSLS (1N, 1S, 2)	LL (1N, 1S, 2)	50% (14 348 t)	+27%	+19%
	PSLS (1N, 1S, 2)	LL (1N, 1S, 2)	100% (22 957 t)	+75%	+16%
(3)	BB (1N)	PSFS (1N)	10% (718 t)	+1%	+1%
	BB (1N)	PSFS (1N)	20% (1 436 t)	+2%	+1%
	BB(1N)	PSFS (1N)	30% (3 590 t)	+5%	+2%
	BB (1N)	PSFS (1N)	100% (7 180 t)	+11%	+1%
(4)	BB (1N)	LL (1N)	10% (718 t)	+1%	+1%
	BB (1N)	LL (1N)	20% (1 436 t)	+2%	+1%
	BB (1N)	LL (1N)	30% (3 590 t)	+5%	+3%
	BB (1N)	LL (1N)	100% (7 180 t)	+11%	+3%

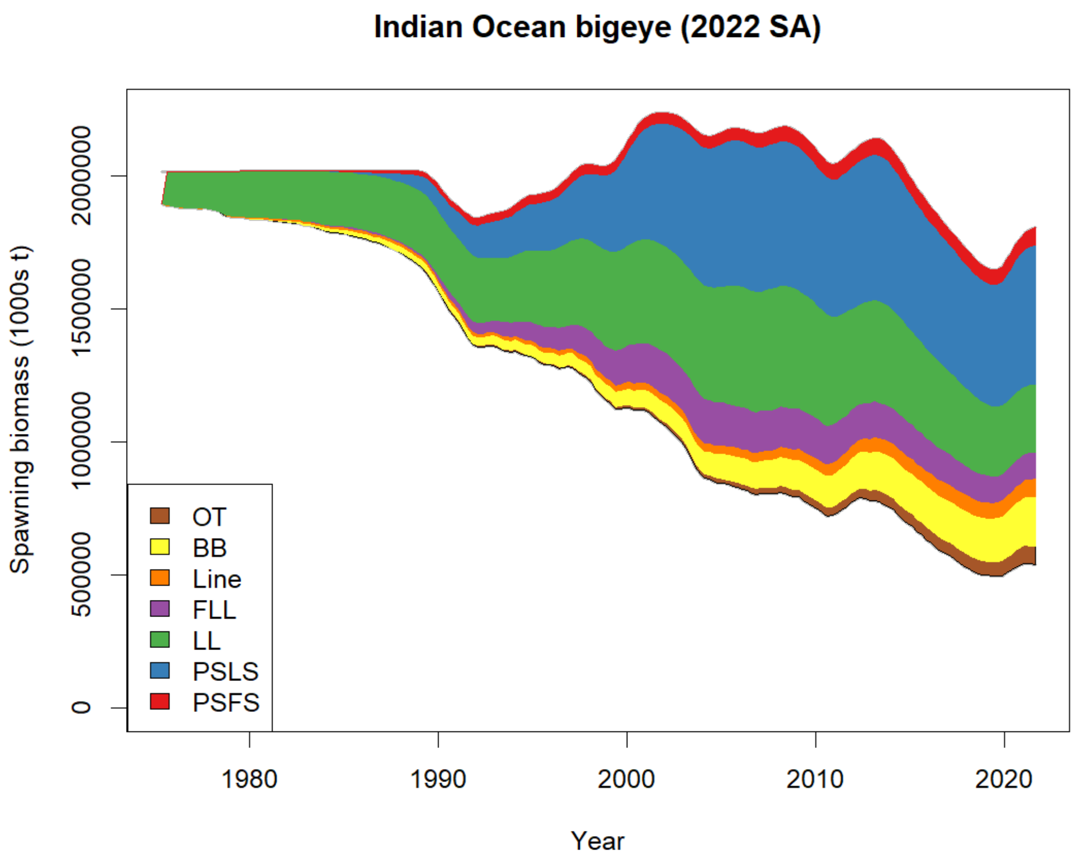

Figure 2. Impact plot for bigeye from Correa et al. 2023. This plot shows the change in spawning biomass if a specific fleet is removed from the stock assessment model.