Food and Agriculture Organization of the United Nations

Indian Ocean Tuna Commission
Commission des Thons de l'Ocean Indien
iotc ctoi

APPENDIX 4
EXECUTIVE SUMMARY: YELLOWFIN TUNA (2021)

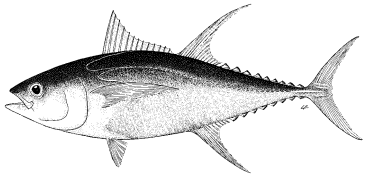

Table 1. Status of yellowfin tuna (*Thunnus albacares*) in the Indian Ocean

Area[1]	Indicator	Value	Status[3]
Indian Ocean	Catch in 2020 (t)[2]	432,624	6~~7~~8%*
	Average catch 2016-2020 (t)	434,569	
	MSY (1,000 t~~T~~) (80% CI)	34994 (~~325~~286-~~463~~412)	
	F_{MSY} (80% CI)	0.18 (0.154-0.21)	
	SB_{MSY} (1,000 t) (80% CI)	1,333~~515~~ (1,~~146~~018-1,~~885~~648)	
	F_{2020} / F_{MSY} (80% CI)	1.3227 (0.684-1.951)	
	SB_{2020} / SB_{MSY} (80% CI)	0.~~7~~87 (0.~~57~~63-~~0.98~~1.10)	
	SB_{2020} / SB_0 (80% CI)	0.3128 (0.241-0.384)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence
[2]Proportion of catch estimated or partially estimated by IOTC Secretariat for catches in 2020: 13.6%
[3]The stock status refers to the most recent years' data used in the assessment conducted in 2021, i.e., 2020

*Estimated probability that the stock is in the respective quadrant of the Kobe Plot (shown below). Median and quantiles calculated from the uncertainty grid taking into account of weighting on models

Colour key	Stock overfished (SB_{2020} / SB_{MSY}<1)	Stock not overfished (SB_{2020} / SB_{MSY}≥ 1)
Stock subject to overfishing (F_{2020} / F_{MSY}≥ 1)	6~~8~~%	~~<1~~2%
Stock not subject to overfishing (F_{2020} / F_{MSY}≤ 1)	1~~2~~3%	1~~9~~%
Not assessed / Uncertain		

The percentages are calculated as the proportion of model terminal values that fall within each quadrant with model weights taken into account

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. A new stock assessment was carried out for yellowfin tuna in 2021. The 2021 stock assessment was carried out using Stock Synthesis III (SS3), a fully integrated model that is currently used to provide scientific advice for the three tropical tunas stocks in the Indian Ocean. The model used in 2021 is based on the model developed in 2018 with a series of revisions that were noted during the WPTT in 2018, 2019 and 2020. The model uses four types of data: catch, size frequency, tagging and CPUE indices. The proposed final assessment model options correspond to a combination of model configurations, including alternative assumptions about the spatial structure (2 options), longline CPUE catchability (2 options on the effect of piracy), weighting of the tagging dataset (lambda =0.1 or 1),

steepness values (0.7, 0.8, and 0.9), natural mortality values (2 options), and growth parameters (2 options). The model ensemble (a total of 96 models) encompasses a range of stock dynamics.

A number of sensitivity runs were conducted to address additional uncertainty , including two new natural mortalities (based on maximum age of 10.9 and 18, respectively), a new growth curve (based on the most recent aging study), an assumed Longline catchability increase (1% per ~~annual~~year), as well as a model that includes only the Japanese size data for the Longline fishery. The results of these models generally indicate a more pessimistic stock status and would lower the estimated median biomass if included in the final grid of models. However, ~~but~~ the results from the sensitivity runs were~~are well~~ within the range of uncertainty estimated by the model grid. ~~However, t~~The sensitivity models still require~~s~~ further exploration to ensure uncertainty is being captured appropriately and models are not mis-specified~~scrutinization~~. Other key uncertainties (for example, catch levels) were not explored

The new model grid represents a marked improvement over the previous results available in 2018 and incorporates a far wider range of uncertainty. According to the information available in 2021, the total catch has remained ~~relatively stable at levels around~~above the estimated MSY since 2012 (i.e., between 399,000 MT and 448,642 MT), with the 2019 catch (448,642 MT) being the largest since 2010~~, and exceeding the MSY range considering the best catch estimate by the Scientific Committee~~ (for details see WPTT23 report).

Overall stock status estimates do not differ substantially from the previous assessment. Spawning biomass in 2020 was estimated to be ~~28~~31~~.0~~% on average of the unfished (1950) levels (**Table 1**). Biomass is estimated to have been declining in recent years, and since the previous assessment. Spawning biomass in 2020 was estimated to be ~~78~~87% of the level that supports the maximum sustainable yield (SB2020/ SBMSY = 0.~~78~~87). Current fishing mortality is estimated to be ~~27~~32% higher than FMSY (F2020/ FMSY = 1.~~27~~32). The probability of the stock being ~~currently~~ in the red Kobe quadrant in 2020 is estimated to be 6~~7~~%. On the weight-of-evidence available since 2018, the yellowfin tuna stock is determined to remain **overfished** and **subject to overfishing** (**Table 1** and **Fig. 1**).

Commented [SEC1]: State which year decline starts?

~~It is noted that the estimated productivity of the stock (MSY) might be unrealistically low for some of the scenarios of the reference grid. Their plausibility and reasons for this low productivity are yet to be fully investigated~~. It is also difficult to explain how the stable reported catch levels and increasing catch trends for some" relevant artisanal fisheries are possible to accommodate from a stock showing a declining population trend as estimated by the stock assessment model. Inconsistencies in the biomass trend by region also remain unresolved and this also deserves further investigation.

Outlook. The increase in catches in recent years has substantially increased the pressure on the Indian Ocean stock, resulting in fishing mortality exceeding the MSY-related levels. The critical errors in the projections and estimations for computing probabilities in the K2SM developed in 2018 have been addressed and the updated projections no longer suffer from the issues previously experienced..

Management advice.

For each catch scenario, the probability of the biomass being below the SB_{MSY} level and the probability of fishing mortality being above F_{MSY} were determined over the projection horizon using the delta-MVLN estimator (Walter & Winker 2019), based on the variance-covariance derived from estimates of SB/SB_{MSY} and F/F_{MSY} across the model grid. According to the K2SM (**Table 2**),

- if catches are reduced to 60% of 2020 levels[1] there is >50% probability of being above Bmsy levels by 2023.
- ~~Catch would need to be reduced to less than~~if catches are reduced to < 80% of 2020 levels there is a >50% probability of being above BMSY in 2030~~in order to recover the stock to levels above Bmsy by 2030 with 50% probability or more~~.
- ~~Catches would need to be reduced~~if catches are reduced to less than 80% of 2020 levels ~~in order to~~there would be a >50% probability of ending overfishing (F<Fmsy) by 2023 and also by 2030~~ with >50% probability, and to achieve this by 2030, catches would need to reduce to 80% of 2020 levels~~.
- The probability of breaching the biological limit reference point (0.4Bmsy) with 2020 catches is 7% by 2023 and 64% by 2030. The probability of breaching the F limit reference point (1.4 Fmsy) with 2020 catch is 52% by 2023 and 78% by 2030.

The Commission should note that, given some of the additional uncertainties described above and not captured in the assessment or projections, additional precaution may be required when interpreting the assessment outcomes. The

[1] 2020 catch levels indicate the nominal catch available to the WPTT at its session in October 2021 (WPTT23).

Commission has an interim plan for the rebuilding the yellowfin stock, with catch limitations based on 2014/2015 levels (Resolution 21/01which superseded 19/01, 18/01 and 17/01). Some of the fisheries subject to catch reductions have achieved a decrease in catches in 2020 in accordance with the levels of reductions specified in the Resolution; however, these reductions were offset by increases in the catches from CPCs exempt from and some CPCs subject to limitations on their catches of yellowfin tuna.

The following key points should also be noted:

- Maximum Sustainable Yield (MSY): estimate for the Indian Ocean stock is 34994,000 MT with a range between 325286,000-463412,000 MT (**Table 1**). The 2016-2020 average catches (434,383 MT) were above the estimated MSY level. The last year (2020), catch has been substantially higher than the median MSY.
- **Interim reference points**: Noting that the Commission in 2015 agreed to Resolution 15/10 on target and limit reference points and a decision framework, the following should be noted:
- **Fishing mortality**: 2020 fishing mortality is considered to be 3227% above the interim target reference point of F_{MSY}, and below the interim limit reference point of 1.4*F_{MSY} (**Fig. 2**).
- **Biomass**: 2020 spawning biomass is considered to be 1322 % below the interim target reference point of SB_{MSY} and above the interim limit reference point of 0.4*SB_{MSY} (**Fig. 2**).
- **Catch data uncertainty** – The overall quality of the nominal catches of yellowfin tuna shows some large variability between 1950 and 2020. In some years, a large portion of the nominal catches of yellowfin tuna had to be estimated , and catches reported using species or gear aggregates had to be further broken down. The data quality was particularly poor between 1994 and 2002 when less than 70% of the nominal catches were fully or partially reported, with most reporting issues coming from coastal fisheries. The reporting rate has generally improved over the last decade however detailed information on data collection procedures, which determines the quality of fishery statistics, is still lackingThe quality has however generally improved over the last decade.
- **Main fishing gears** (average catches 2016-20): Purse seine ~34.3% (FAD associated school ~24%; free swimming school ~8.6%; unclassified ~1.7%); Line: 33.5%; Gillnet ~19.1%; Longline ~8.5%; All other gears ~4.6% (**Fig. 1**).
- **Main fleets** (average catches 2016-20): European Union ~18.2% (EU-Spain ~11%; EU-France ~6.7%, EU-Italy ~5%); I.R. Iran ~12.3%; Maldives ~10.9%; Seychelles ~9.7%; Sri Lanka ~8.9%; All other fleets ~40%.

References

Walter, J., Winker, H., 2019. Projections to create Kobe 2 Strategy Matrices using the multivariate log-normal approximation for Atlantic yellowfin tuna. ICCAT-SCRS/2019/145 1–12

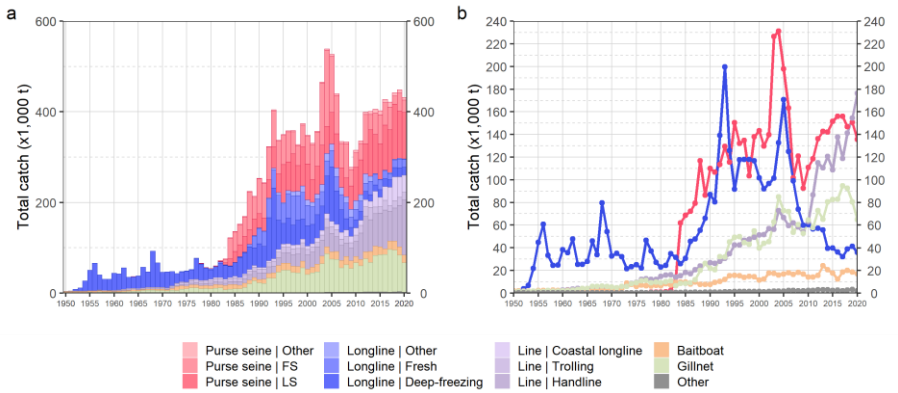

Fig. 1a-b. Annual time series of (a) cumulative nominal catches (MT) by fishery and (b) individual nominal catches (t) by fishery group for yellowfin tuna during 1950–2020. FS = free-swimming school; LS = drifting log or FAD-associated school . Purse seine other: coastal purse seine, purse seine, ring net; Longline: deep-freezing and fresh longlines, swordfish and sharks-targeted longlines; Line: coastal longline, trolling and handline; Baitboat: coastal and offshore baitboats; Gillnet: coastal and offshore gillnets, driftnet; Other: all remaining fishing gears

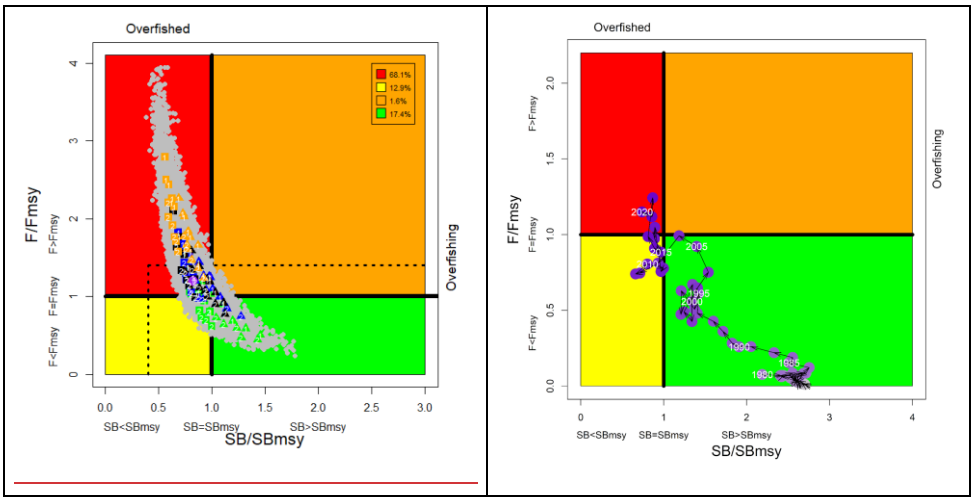

Fig. 2. Yellowfin tuna: SS3 Indian Ocean assessment Kobe plot: (Left): current stock status, relative to SBMSY (x-axis) and FMSY (y-axis) reference points for the final model options. Coloured symbols represent Maximum posterior density (MPD) estimates from individual models: square and Triangles and represents LL CPUE catchability options q1 and q2 respectively; green, blue, black, and orange represents growth and natural mortality option combination Gbase_Mbase, GDortel_Mbase, Gbase_Mlow, and GDortel_Mlow respectively; 1,2, represents spatial structure option io and sp respectively. The purple dot represents the base~~ie~~ model. Grey dots represent uncertainty from individual models. The dashed lines represent limit reference points for IO yellowfin tuna (SBlim = 0.4 SBMSY and Flim = 1.4 FMSY); (right) stock trajectory from the base~~ie~~ model.

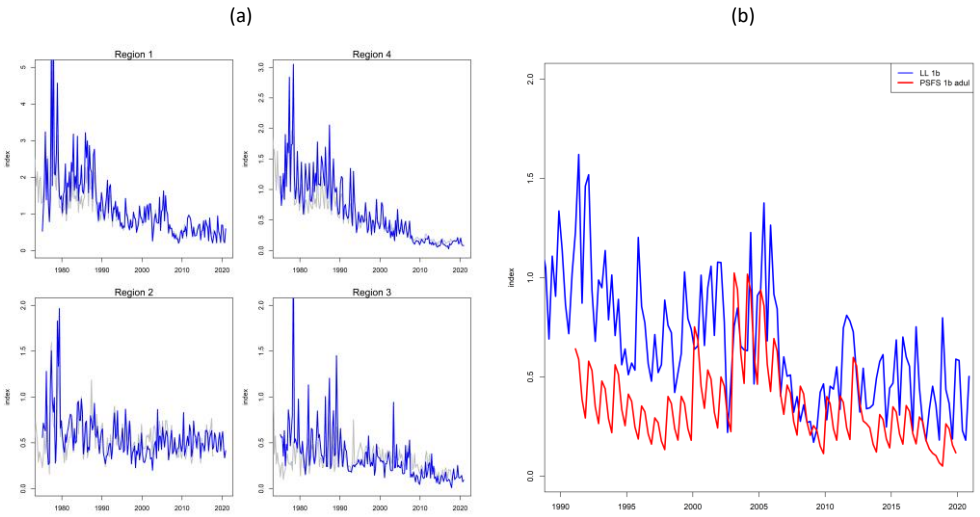

Fig 3: Standardised CPUE indices used in the final assessment models: (a) Joint longline CPUE indices by region 1975-2020 (The grey lines are indices used in 2018 assessment 1972 – 2017), and (b) EU Purse seine free school CPUE on adults (≥10 kg) (overlaid with the longline CPUE in region 1

TABLE 2. Yellowfin tuna: Stock synthesis assessment Kobe II Strategy Matrix. Probability of violating the MSY-based target (top) and limit (bottom) reference points for constant catch projections (relative to the catch level from 2020 -40%, - 30%, -20%, -10%, 0%, +10%, +20%) projected for 3 and 10 years.

Alternative catch projections (relative to the catch level from 2020) and probability of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)							
Reference point and projection timeframe	60%	70%	80%	90%	100%	110%	120%
$SB_{2023} < SB_{MSY}$	0.45	0.56	0.68	0.74	0.76	0.82	0.88
$F_{2023} > F_{MSY}$	0.13	0.30	0.53	0.63	0.72	0.82	0.91
$SB_{2030} < SB_{MSY}$	0.1	0.33	0.54	0.76	0.93	0.99	1
$F_{2030} > F_{MSY}$	0.07	0.31	0.49	0.69	0.84	0.97	0.99
Alternative catch projections (relative to the catch level from 2020) and probability ~~(%)~~ of violating MSY-based limit reference points ($SB_{lim} = 0.4\ SB_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)							
Reference point and projection timeframe	60%	70%	80%	90%	100%	110%	120%
$SB_{2023} < SB_{Lim}$	0	0	0	0.05	0.07	0.1	0.16
$F_{2023} > F_{Lim}$	0.03	0.11	0.25	0.43	0.52	0.63	0.78

$SB_{2030} < SB_{Lim}$	0	0	0.01	0.18	0.64	1	1
$F_{2030} > F_{Lim}$	0.02	0.19	0.33	0.60	0.78	0.98	0.98