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 (2025)

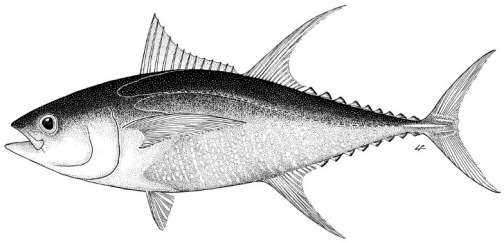


Table 1. Status of yellowfin tuna (*Thunnus albacares*) in the Indian Ocean

Area[1]	Indicators		2024 stock status determination[3]
Indian Ocean	Catch 2025 (t)	518,841[2]	89%*
	Mean annual catch 2021-2025 (t)	457,648	
	MSY_{recent} [4] (1,000 t) (80% CI)	421 (416-430)	
	F_{MSY} (80% CI)	0.2 (0.16-0.26)	
	SB_{MSY_recent} [4] (1,000 t) (80% CI)	1,063 (890-1,361)	
	F_{2023} / F_{MSY} (80% CI)	0.75 (0.58-1.01)	
	SB_{2023} / SB_{MSY_recent} (80% CI)	1.32 (1.00-1.59)	
	SB_{2023} / SB_0 (80% CI)	0.44 (0.40-0.50)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence

[2]Proportion of 2024 catch fully or partially estimated by IOTC Secretariat: 8.3%

[3]2023 is the final year that data were available for this assessment

[4] Recent refers to the most recent 20 years (2003-2022)

Colour key	Stock overfished (SB_{2023} / SB_{MSY}<1)	Stock not overfished (SB_{2023} / SB_{MSY}≥ 1)
Stock subject to overfishing (F_{2023} / F_{MSY}≥ 1)	7.9%	3.3%
Stock not subject to overfishing (F_{2023} / F_{MSY}≤ 1)	0%	88.8%
Not assessed / Uncertain / Unknown		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new stock assessment was conducted in 2025. The stock status for yellowfin tuna was estimated based on the stock assessment carried out in 2024. The 2024 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 grid from this assessment was re-run in 2025 in light of errors identified and subsequent revisions to the standardised CPUE input data. However, none of the figures or tables have been updated, because a full stock assessment with the corrected CPUE has not been conducted.

The model used in 2024 is based on the model developed in 2021 with a series of revisions that were discussed during the WPTT in 2024. The new model represents a marked improvement over the previous model available in 2021, as demonstrated using a number of statistical diagnostic analyses. These revisions addressed many of the recommendations of the independent review of the yellowfin stock assessment carried out in 2023. 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 selectivity of longline fisheries (2 options on size frequency data prior and post 2000), longline catchability (effort creep (0% and 0.5% per year)) and steepness values (0.7, 0.8, and 0.9). The model ensemble (a total of 12 models) encompasses a range of plausible hypotheses about stock and fisheries dynamics.

A number of sensitivity runs were conducted to understand additional uncertainties not captured in the model grid, including two alternative natural mortalities (based on maximum age of 18 years and the natural mortality used in 2021), the CPUE used in 2021, a model that started in 1975, the influence of the tagging data and the revised catch information for Indonesia. In general, the sensitivity runs did not suggest that other parameters should be included in the reference grid and the group decided not to include any additional axes of uncertainty.

The model estimates of current stock status are predominantly informed by the new abundance index derived from the Joint CPUE estimated for longline fleets. It was noted that the new index was significantly different to the index used in 2021 (**Fig. 6**), especially for the Northwestern region of the Indian Ocean for the periods 2005-2015 and 2019-2020 (this is further discussed, below). In addition, the new index suggests a marked increase of abundance for yellowfin in the last three years (2021-2023).

With regards to the differences in the modelling choices, the new SS3 model includes a new growth model, natural mortality and maturity. All these have been updated from recent biological studies, as agreed by the WPTT in the 2024 data preparatory meeting.

For the 2024 model, a new approach was applied to the derivation of the MSY and associated biomass-based reference point (SB_{MSY}) based on the magnitude of recruitment estimated for the recent 20-year period (see Para 89–100 of IOTC-2024-WPTT26-R for details). The derivation of MSY is in line with the recommendations of the 2023 review. MSY was estimated to be 421,000 t. Catch in 2024 is estimated to be well above the MSY-range (489,742 t). Differences in the estimates of MSY and B_{MSY} using recent and long-term recruitment levels introduce additional uncertainty in the estimates of stock status relative to B_{MSY}. This is highlighted in Tables 2 and 3 which indicate, for example, that while SB/SB_{MSY} is estimated to be higher (1.47) under long-term recruitment assumption, MSY is estimated to be lower (374,000 t). However, fishing mortality-based estimates of stock status are insensitive to those assumptions.

Table 2. Reference points for yellowfin tuna (*Thunnus albacares*) in the Indian Ocean based on long term and 20-year conditions

Long term MSY (t)	Recent 20 yr MSY (t)	Long term SB_{MSY} (t)	Recent 20 yr SB_{MSY} (t)
374,421	420,623	986,599	1,094,844

Table 3. Status of yellowfin tuna (*Thunnus albacares*) in the Indian Ocean using equivalent (i.e. long-term) recruitment trends

Indicators	
Catch 2023 (t)	400,950
Mean annual catch 2019-2023 (t)	423,142
MSY_{eq} (1,000 t) (80% CI)	374 (350-411)
SB_{MSY_eq} (1,000 t) (80% CI)	987 (791-1,247)
SB_{2023} / SB_{MSY_eq} (80% CI)	1.47 (1.21-1.65)

The recent 20-year period was selected for the estimation of recent benchmarks (SB_{MSY} and MSY) on the basis that the period encompassed the most reliable series of catch and size composition data and, as such, provided the best available information regarding the prevailing productivity of the stock.

According to the information available to the 2024 assessment, the total catch has remained within the estimated recent (20-year average) MSY since 2007 (i.e., between 402,000 t and 427,000 t), with the exception of, 2018 (443,252 t) and 2019 catch (450,586 t).

Overall stock biomass declined substantially during the 1980s and 1990s. The stock is estimated to have been in an overfished state from 2007 to 2019 (**Fig. 4**). Spawning biomass increased considerably after 2021 following recent strong recruitment (informed by the recent increase in LL CPUE). Correspondingly, overfishing was occurring from 2003 until 2020. Fishing mortality was estimated to be below the F_{MSY} level in 2021-2023. The recent strong recruitments also contribute to a continued increase in projected biomass in the forthcoming years. The magnitude of the recent annual recruitments (2020-2022) is unprecedented in the time series.

Overall stock status estimates differ substantially from the previous assessment. Spawning biomass in 2023 was estimated to be on average 44% of the initial (1950) levels (**Table 1**). Spawning biomass in 2023 was estimated to be 32% higher than the level that supports the maximum sustainable yield (SB_{2023}/SB_{MSY} = 1.32). Current fishing mortality is estimated to be 25% lower than F_{MSY} (F_{2023}/F_{MSY} = 0.75). The probability of the stock being in the green Kobe quadrant in 2023 is estimated to be 89%.

It is noted that the uncertainties identified in relation to the CPUE standardisation in 2024 were addressed in 2025. The methodology used to standardise the 2024 index underwent review, during which an error was discovered and corrected through a number of methodological adjustments, following feedback from SC and WPTT, to ensure greater consistency with the previously agreed standardisation approach. During WPTT27, the revised CPUE was used to rerun the 2024 stock assessment model grid to assess the likely impact on key management quantities. The estimated median biomass and fishing mortality relative to MSY were SB_{2023}=1.18 $SB_{MSY,recent}$ and F_{2023}=0.83 F_{MSY} respectively; and the probability for being in the green quadrant of the Kobe plot was estimated to be at 76.6%. Therefore, the updated results did not change the 2024 status qualitatively. The median estimated stock depletion level was 0.37. The estimated median MSY (420,000 t) was nearly identical to the value estimated in 2024 (421,000 t). As the revision carried out did not represent a new full stock assessment and that it only aimed at corroborating the advice provided in 2024, the SC considered not to change the summary table (**Table 1**) with the revised values. Based on 2024 evidence and a 2025 review, yellowfin tuna is estimated to be **not-overfished and not-subject to overfishing** (**Table 1** and **Fig. 5**).

During the review of the revised model grid outputs, a number of uncertainties were considered by the SC, including a) CPUE index data in the late 1970s and the impact of these on the model's ability to derive plausible population dynamics over time; and b) uncertainty related to whether estimated higher recent recruitment will be maintained. Further consideration of these issues to resolve associated uncertainties should be undertaken as part of the next assessment

It is noted that there is also considerable uncertainty in the reported catches by some fisheries. In particular, catch estimates for several artisanal fisheries have increased substantially in recent years, the implication of which should also be further investigated.

Outlook. Assumptions on recent productivity were used to make 10-year projections and evaluate the impact of alternative catch levels. The results of these projections are shown in **Fig. 7** and summarized in the K2SM (**Table 3**). 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 2020), based on the variance-covariance derived from estimates of SB/SB_{MSY} and F/F_{MSY} across the model grid.

The revised model was projected with the advice provided in 2024 (421,000 t) and it was estimated that with that level of catch, the stock would be above SB_{MSY_recent} with 89.7% of probability by 2026 and 83% probability by 2033.

Management advice

The review of the 2024 assessment grid in 2025 was deemed sufficient to extend the management advice provided in 2024.. As such, the following advice was recommended:

- If catches are maintained within the estimated MSY range (416,000-430,000 tons) there is more than a 50% probability that the stock will remain above SB_{MSY} in 2033.
- Higher levels of catch are predicted to lead the stock to an overfished state in the long term.
- The probability of breaching the biological limit reference point ($0.4SB_{MSY}$) with recent catches is 0% by 2033. The probability of breaching the F limit reference point ($1.4\ F_{MSY}$) with recent catch is 0% by 2033However, in order to account for the uncertainty of the projections (e.g., relating to whether estimated high recruitment will be maintained) and uncertainty not captured in the assessment grid (e.g. relating to the new CPUE indices), the Commission should set a TAC that does not exceed the median recent MSY estimate.
- Results of the K2SM generated from the 2024 assessment (**Table 3**) is not used as catch advice

Noting these points, it is recommended that the Commission sets a TAC for the period 2026, 2027 and 2028 that does not exceed the median recent MSY estimate (421,000 t). The SC noted the catch level in 2024 (489, 742 t), and urged the Commission to ensure that the recommended TAC is not exceeded.

The SC does not consider the need to advance the next yellowfin stock assessment, scheduled for 2027.

The following key points should also be noted:

- Maximum Sustainable Yield (MSY): estimate for the Indian Ocean stock is 421,000 t with a range between 416,000 and 430,000 t (**Table 1**). The catch in in 2024 (489,742 t) was above the estimated MSY level.
- **Interim reference points**: Noting that the Commission in 2015 adopted Resolution 15/10 on target and limit reference points and a decision framework, the following should be noted:
- **Fishing mortality**: 2023 fishing mortality is considered to be 25% below the interim target reference point of F_{MSY} and below the interim limit reference point of $1.4*F_{MSY}$ (**Fig. 4**).
- **Biomass**: 2023 spawning biomass is considered to be 32% above the interim target reference point of SB_{MSY} and above the interim limit reference point of $0.4*SB_{MSY}$ (**Fig. 4**).
- **Catch data uncertainty:** the overall quality of the nominal catches of yellowfin tuna shows some large variability between 1950 and 2024. 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 lacking**.**
- **Main fisheries (mean annual catch 2021-2025)**: yellowfin tuna are caught using line (42.2%), followed by purse seine (29.9%) and gillnet (15.3%). The remaining catches taken with other gears contributed to 12.5% of the total catches in recent years **Fig. 8**.
- **Main fleets (mean annual catch 2021-2025)**: the majority of yellowfin tuna catches are attributed to vessels flagged to Sultanate of Oman (17.1%) followed by Indonesia (11.3%) and I. R. Iran (9.3%). The 34 other fleets catching yellowfin tuna contributed to 62.1% of the total catch in recent years (**Fig.** 2).

References

Walter, J., Winker, H., 2020. Projections to create Kobe 2 Strategy Matrices using the multivariate log-normal approximation for Atlantic yellowfin tuna. Collect. Vol. Sci. Pap. ICCAT, 76(6): 725-739

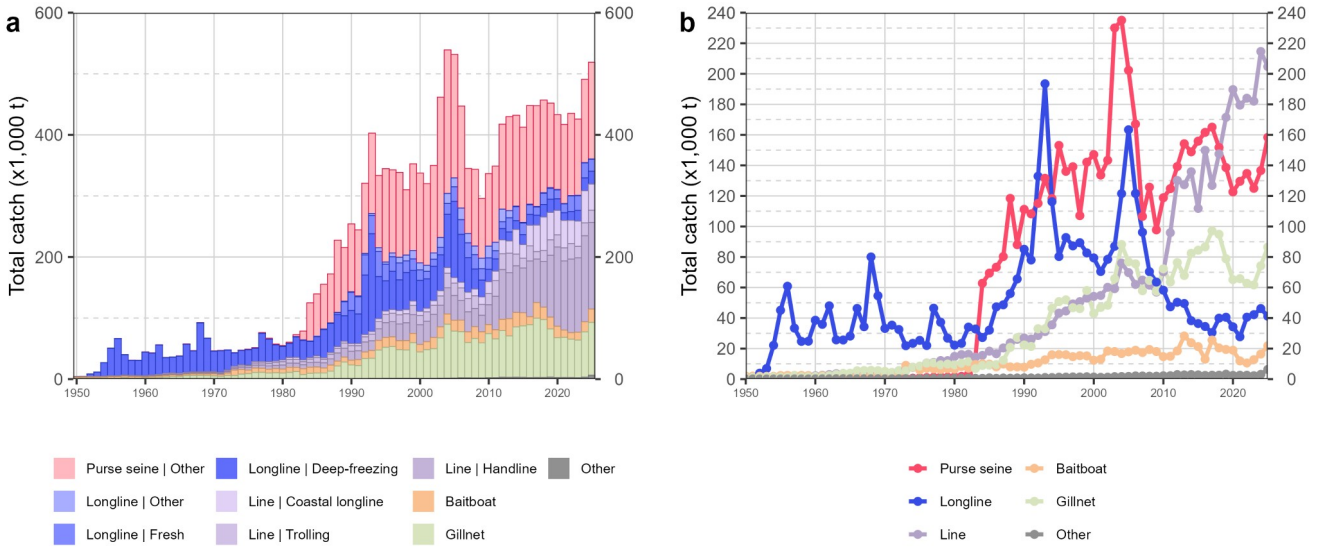


Fig. 1. Annual time series of (a) cumulative retained catches (metric tonnes; t) by fishery and (b) individual retained catches (metric tonnes; t) by fishery group for yellowfin tuna during 1950-2025. Purse seine | Other: coastal purse seine, large-scale purse seine, and ring net; Longline | Other: swordfish and sharks-targeted longlines; Other: all remaining fishing gears

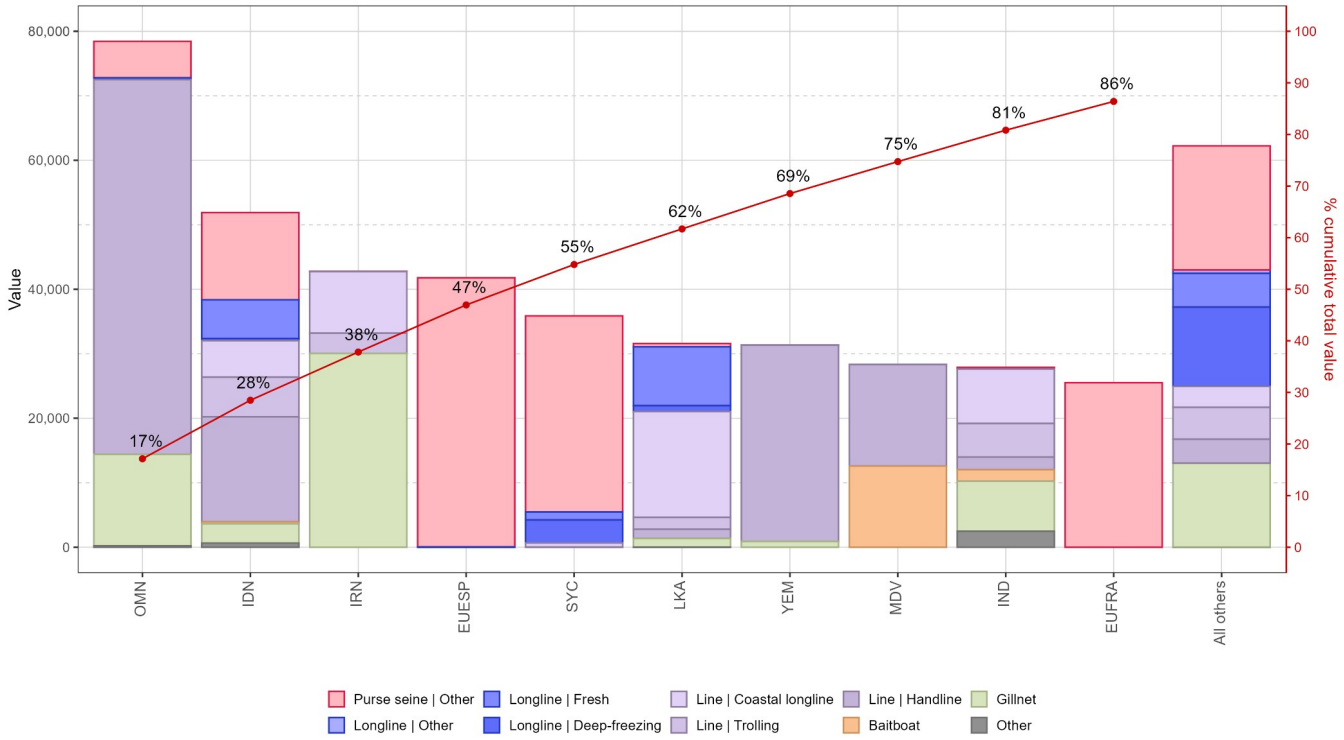


Fig. 2. Mean annual catches (metric tonnes; t) of yellowfin tuna by fleet and fishery between 2021 and 2025, with indication of cumulative catches by fleet. Purse seine | Other: coastal purse seine, large-scale purse seine, and ring net; Longline | Other: swordfish and sharks-targeted longlines; Other: all remaining fishing gears

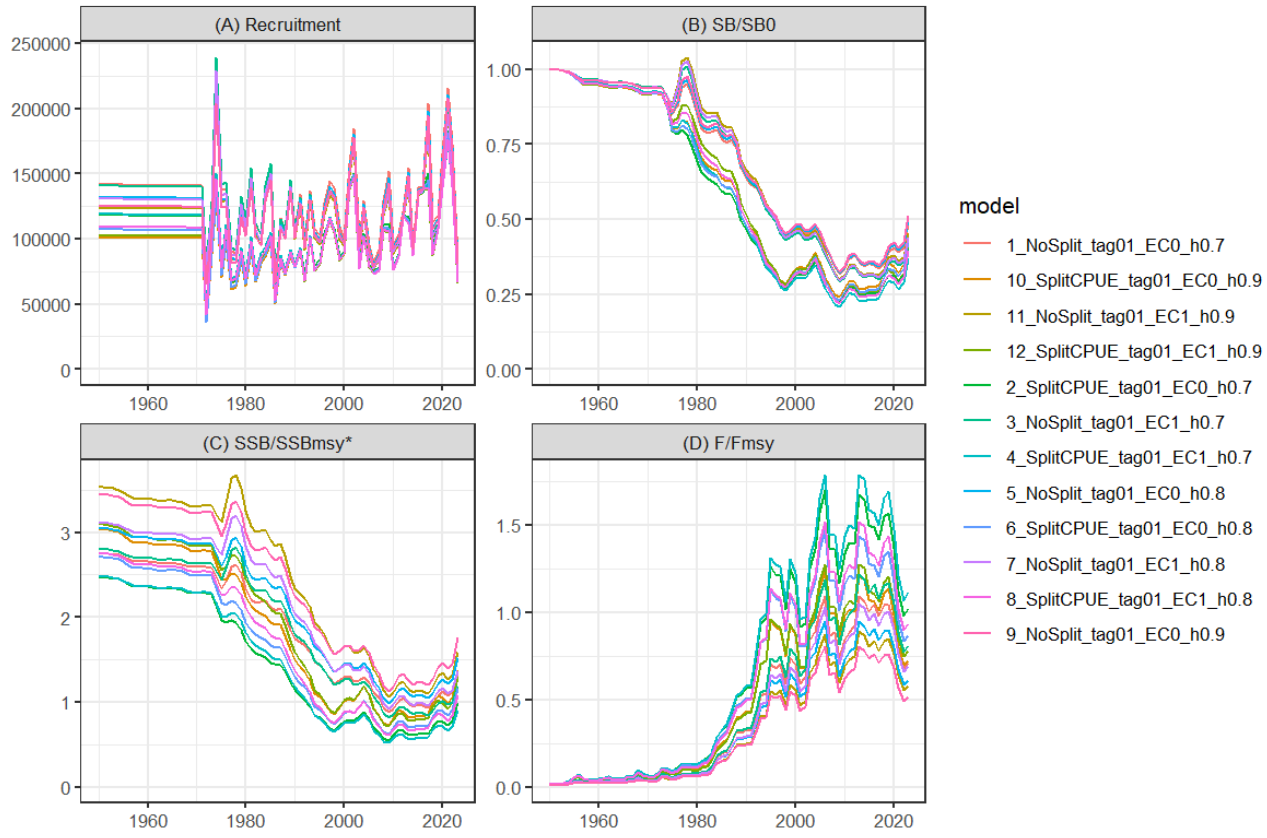


Fig 3. Estimated time series (1950-2023) of recruitment, spawning stock biomass relative to virgin biomass and to spawning stock biomass at MSY and fishing mortality relative to fishing mortality at MSY of yellowfin tuna from the reference models of the 2024 assessment

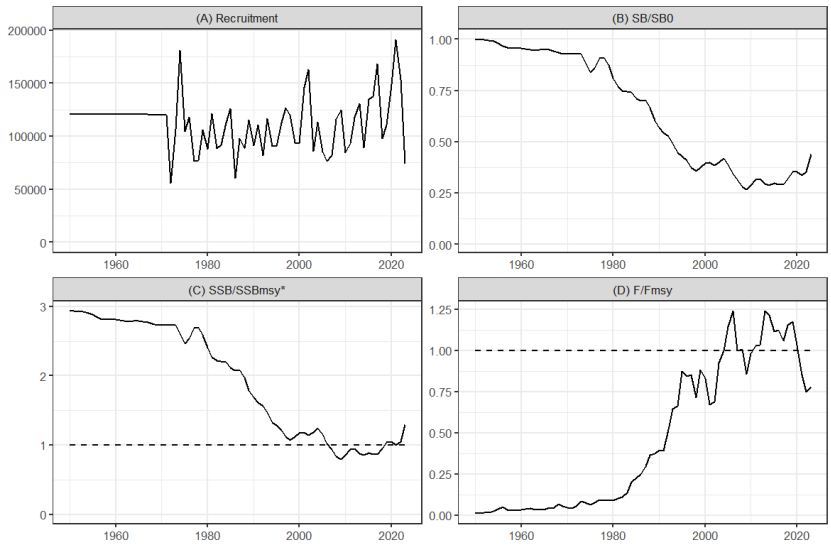


Fig 4. Estimated time series (1950-2023) of recruitment, spawning stock biomass and fishing mortality of yellowfin tuna from the reference model of the 2024 assessment.

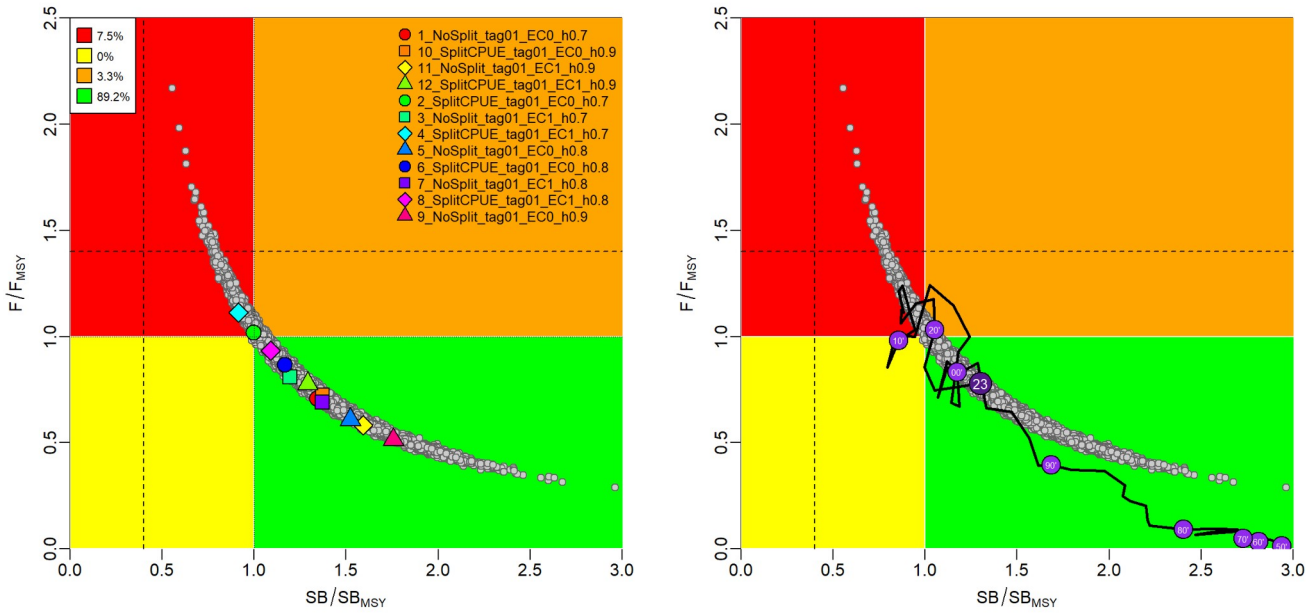


Fig. 5. Yellowfin tuna: SS3 Indian Ocean assessment Kobe plot: (left): current (2023) stock status, relative to SB_{MSY} (x-axis) and F_{MSY} (y-axis) reference points for the final model options. Coloured symbols represent Maximum posterior density (MPD) estimates from individual models. Grey dots represent the statistical uncertainty from individual models (20,000 replicates from each). The dashed lines represent limit reference points for IO yellowfin tuna (SBlim = 0.4 SB_{MSY} and Flim = 1.4 F_{MSY}); (right) mean stock trajectory from the model grid



Fig 6. Standardised Catch Per Unit Effort (CPUE) indices used in the final assessment models: Joint longline CPUE indices by region 1975-2023 (the red lines are indices used in 2021 assessment 1975 – 2020)

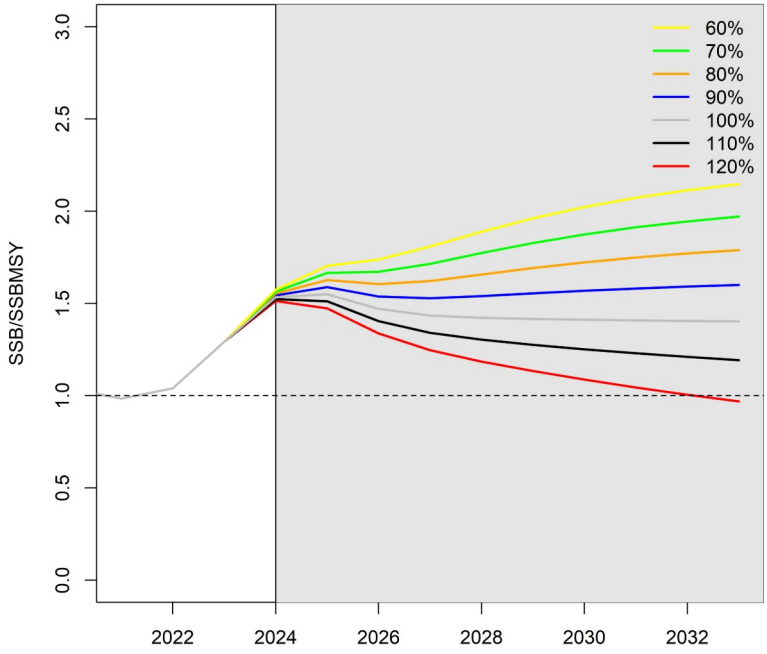


Fig 7. Trajectory showing the impact of alternative catch levels on spawning stock biomass (SSB or SB) relative to spawning stock biomass at MSY relative to the catch level from 2023

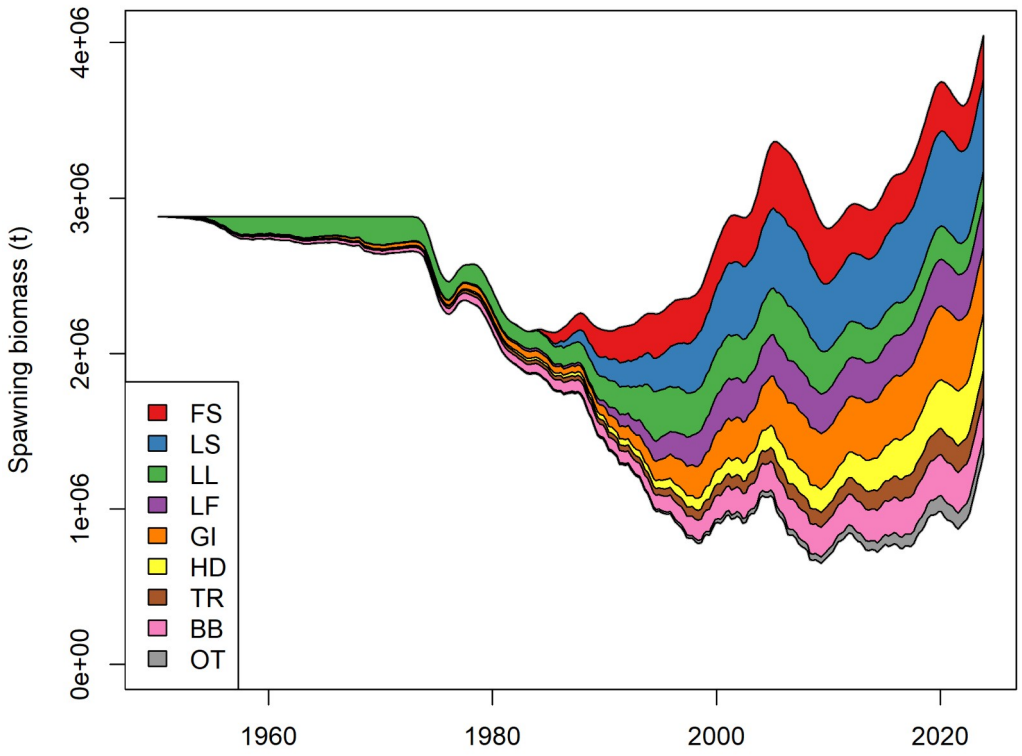


Fig 8. Fishery Impact Plot: Estimates of reduction in spawning biomass due to fishing over all regions attributed to various fishery groups for the assessment model. Fishery group definition: FS, Purse seine free school; LS, Purse seine associated school; LL, longline; LF, fresh tuna longline; GI, gillnet; HD, handline; TR, trolling; BB, Bait boat; OT, others.

TABLE 4. 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 2023 -40%, - 30%, -20%, -10%, 0%, +10%, +20%) projected for 3 and 10 years

Alternative catch projections (relative to the catch level from 2023) 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%
$SB_{2026} < SB_{MSY}$	0	0	0.1	0.1	0.6	1.3	4
$F_{2026} > F_{MSY}$	0	0	0	0	2.5	11.2	30.9
$SB_{2033} < SB_{MSY}$	0	0	0	0	0.1	13.1	66.7
$F_{2033} > F_{MSY}$	0	0	0	0	1.3	31.6	84.9
Alternative catch projections (relative to the catch level from 2023) 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%
$SB_{2026} < SB_{Lim}$	0	0	0	0	0	0	0
$F_{2026} > F_{Lim}$	0	0	0	0	0	0.1	0.9

$SB_{2033} < SB_{Lim}$	0	0	0	0	0	0	0
$F_{2033} > F_{Lim}$	0	0	0	0	0	0.3	24.1