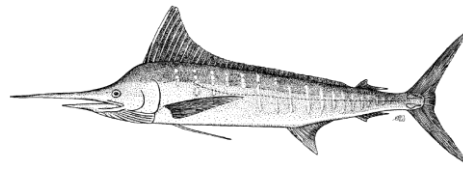## APPENDIX 14
EXECUTIVE SUMMARY: STRIPED MARLIN (2023)

Table 1. Status of striped marlin (*Kajikia audax*) in the Indian Ocean

Area[1]	Indicators		2021 stock status determination[5]
Indian Ocean	Catch 2022[2] (t)	3,431	
	Average catch 2018-2022 (t)	2,898	
	MSY (1,000 t) (JABBA)	4.60 (4.12 - 5.08)[3]	**100%***
	MSY (1,000 t) (SS3)	4.82 (4.48 - 5.16)	
	F_{MSY} (JABBA)	0.26 (0.20–0.33)	
	F_{MSY} (SS3)	0.23 (0.23 - 0.23)	
	F_{2019}/F_{MSY} (JABBA)	2.04 (1.35 - 2.93)	
	F_{2019}/F_{MSY} (SS3)	3.93 (2.30 - 5.31)	
	B_{2019}/B_{MSY} (JABBA)	0.32 (0.22 - 0.51)	
	SB_{2019}/SB_{MSY} (SS3)[4]	0.47 (0.35 - 0.63)	
	B_{2019}/B_0 (JABBA)	0.12 (0.10 – 0.19)	
	SB_{2019}/SB_0 (SS3)	0.06 (0.05 - 0.08)	

[1] Boundaries for the Indian Ocean are defined as IOTC area of competence
[2] Proportion of 2022 catch estimated or partially estimated by IOTC Secretariat: 39.6%
[3] JABBA estimates are the range of central values shown in Fig. 2
[4] SS3 is the only model that used SB/SB_{MSY}, all others used B/B_{MSY}
[5] 2019 is the final year that data were available for this assessment
* Estimated probability that the stock is in the respective quadrant of the Kobe plot (shown below), derived from the confidence intervals associated with the current stock status

Colour key	Stock overfished ($B_{year}/B_{MSY} < 1$)	Stock not overfished ($B_{year}/B_{MSY} \geq 1$)
Stock subject to overfishing ($F_{year}/F_{MSY} > 1$)	**100%**	**0.0%**
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)	**0.0%**	**0.0%**
Not assessed/Uncertain/Unknown		

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

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Stock status. No new stock assessment was carried out for striped marlin in 2023, thus the stock status is determined on the basis of the 2021 assessment based on two different models: JABBA, a Bayesian state-space production model (age-aggregated); and SS3, an integrated model (age-structured) (using data up to 2019). Both models were generally consistent with regards to stock status and confirmed the results from 2012, 2013, 2015, 2017 and 2018 assessments, indicating that the stock is subject to overfishing ($F>F_{MSY}$) and is overfished, with the biomass being below the level which would produce MSY ($B<B_{MSY}$) for

over a decade. On the weight-of-evidence available in 2021, the stock status of striped marlin is determined to be *overfished* and *subject to overfishing* (**Table 1**; **Fig. 3**).

Outlook. Biomass estimates of the Indian Ocean striped marlin stock have likely been below BMSY since the late 90's – the stock has been severely depleted ($B/B_0 = 0.12$; JABBA model). The outlook is pessimistic, and a substantial decrease in fishing mortality is required to ensure a reasonable chance of stock recovery in the foreseeable future (**Table 2**). It should be noted that point estimates from SS3 indicate that F_{curr}/F_{MSY} are higher than those estimated by JABBA.

Management advice. Current or increasing catches have a very high risk of further decline in the stock status. The 2022 catches (3,431 t) are lower than MSY (4,601 t) but are slightly above the limit set by Resolution 18/05 for that year which may be a concern if this trend continues.

The stock has been overfished for more than a decade and is now in a highly depleted state. If the Commission wishes to recover the stock to the green quadrant of the Kobe plot with a probability ranging from 60% to 90% by 2026 as per Resolution 18/05, it needs to provide mechanisms to ensure the maximum annual catches remain between 900 t – 1,500 t (**Table 3**).

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: estimates for the Indian Ocean stock are highly uncertain and estimates range between 4,120 - 5,160 t. However, the current biomass is well below the B_{MSY} reference point and fishing mortality is in excess of F_{MSY} at recent catch levels.
- **Provisional reference points**: although the Commission adopted reference points for swordfish in [Resolution 15/10](#) *on target and limit reference points and a decision framework*, no such interim reference points have been established for striped marlin.
- **Main fisheries (mean annual catch 2018-2022)**: striped marlin are caught using gillnet (66.5%), followed by longline (20%) and line (11.9%). The remaining catches taken with other gears contributed to 1.6% of the total catches in recent years (**Fig. 1**).
- **Main fleets (mean annual catch 2018-2022)**: the majority of striped marlin catches are attributed to vessels flagged to I. R. Iran (36%) followed by Pakistan (26.2%) and Indonesia (16.9%). The 24 other fleets catching striped marlin contributed to 20.8% of the total catch in recent years (**Fig. 2**).
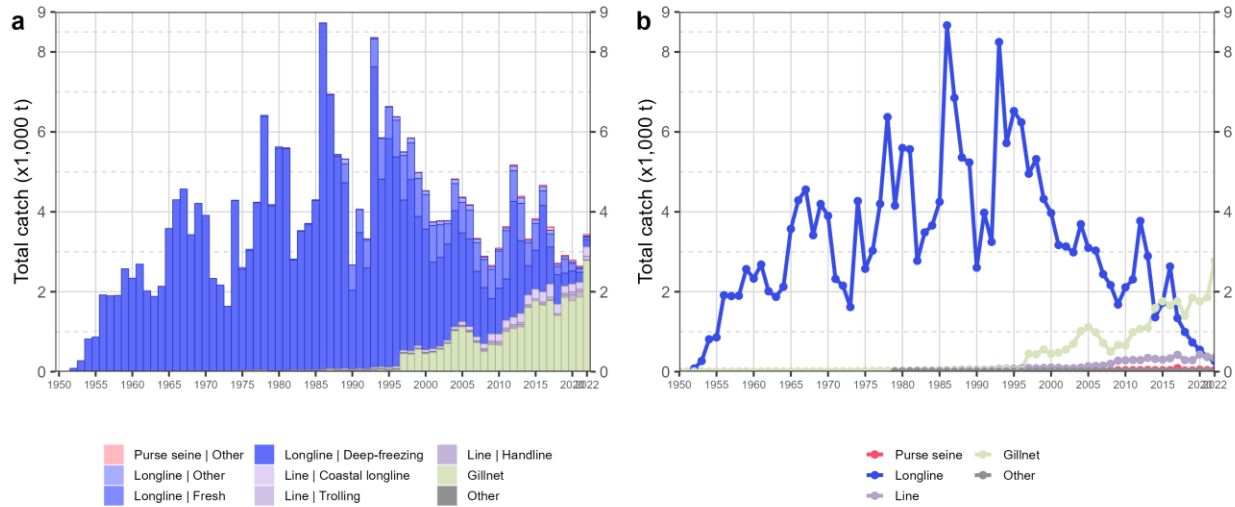
Fig. 1. Annual time series of (a) cumulative nominal catches (metric tons; t) by fishery and (b) individual nominal catches (metric tons; t) by fishery group for striped marlin during 1950-2022. <u>Longline | Other</u>: swordfish and sharks-targeted longlines; <u>Other</u>: all remaining fishing gears
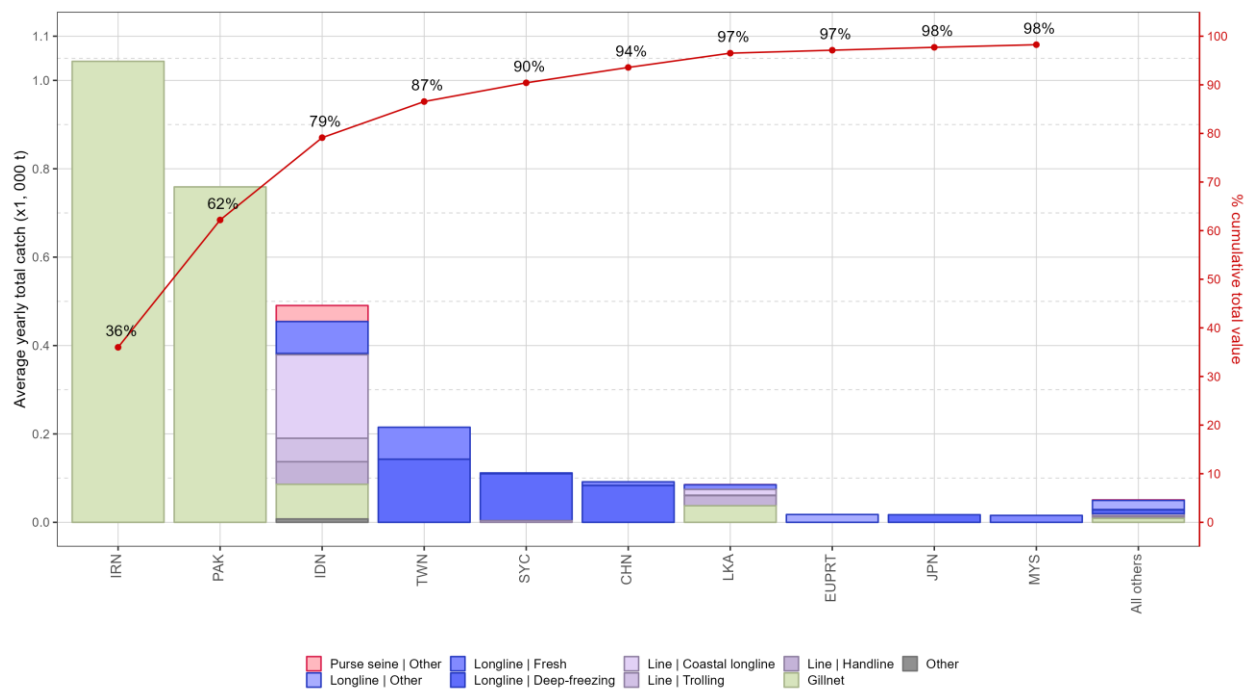
Fig. 2. Mean annual catches (metric tons; t) of striped marlin by fleet and fishery between 2018 and 2022, with indication of cumulative catches by fleet. <u>Longline | Other</u>: swordfish and sharks-targeted longlines; <u>Other</u>: all remaining fishing gears
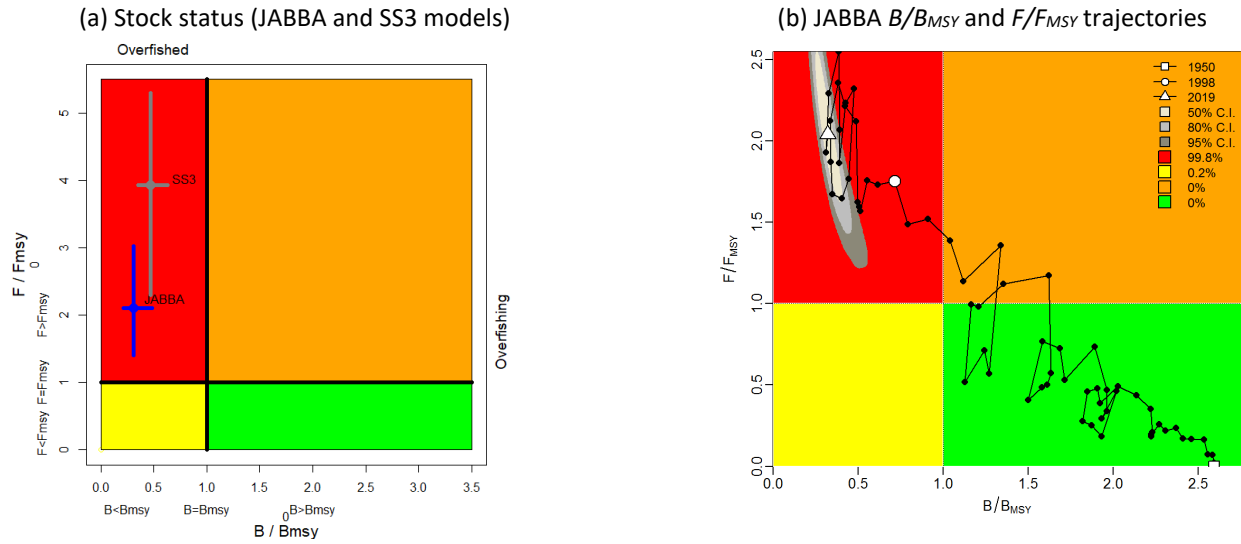
Fig. 3. (a) Striped marlin: Stock status from the Indian Ocean assessment JABBA (Bayesian State Space Surplus Production Model) and SS3 models with the confidence intervals (left); (b) Trajectories (1950-2019) of B/B_{MSY} and F/F_{MSY} from the JABBA model. NB: SS3 refers to SB/SB_{MSY} while the JABBA model's output refers to B/B_{MSY}

Table 2. Striped marlin: JABBA Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections relative to the 2019 catch level (3,001 t)*, ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	Alternative catch projections (relative to the 2019 catch of 3,001 t) and probability (%) of violating MSY-based target reference points (Btarg = B_{MSY}; Ftarg = F_{MSY})								
	60% (1,801 t)	70% (2,101 t)	80% (2,401 t)	90% (2,701 t)	100% (3,001 t)	110% (3,301 t)	120% (3,602 t)	130% (3,902 t)	140% (4,202 t)
$B_{2022} < B_{MSY}$	100	100	100	100	100	100	100	100	100
$F_{2022} > F_{MSY}$	21	49	75	90	97	99	100	100	100
$B_{2029} < B_{MSY}$	6	18	39	62	82	93	98	100	100
$F_{2029} > F_{MSY}$	0	2	9	29	57	81	94	99	100

Table 3. Striped marlin: Probability (percentage) of achieving the KOBE green quadrat from 2022-2029 for a range of constant catch projections (JABBA).

TAC (t) | Year	2022	2023	2024	2025	2026	2027	2028	2029
300	4	31	75	95	99	100	100	100
600	2	22	62	89	98	100	100	100
900	1	15	48	79	94	98	100	100
1201	1	9	33	65	87	96	99	100
1501	1	6	22	49	73	89	96	98
1801	0	3	13	42	55	75	87	94
2101	0	2	7	19	37	55	71	82
2401	0	1	3	10	21	35	49	61
2701	0	0	2	5	10	18	28	38
3001	0	0	1	2	4	8	13	18