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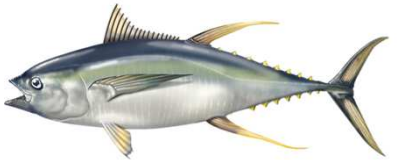

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REPORT OF THE YELLOWFIN STOCK STATUS

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CHAIR OF THE SC

2021 IOTC YFT SPECIAL SESSION, MARCH 8-12, 2021

CONTENTS

- Stock assessment and management advice developed in 2018 SC
- Activities in 2019 and 2020 SC
- Current management advice agreed at 2020 SC

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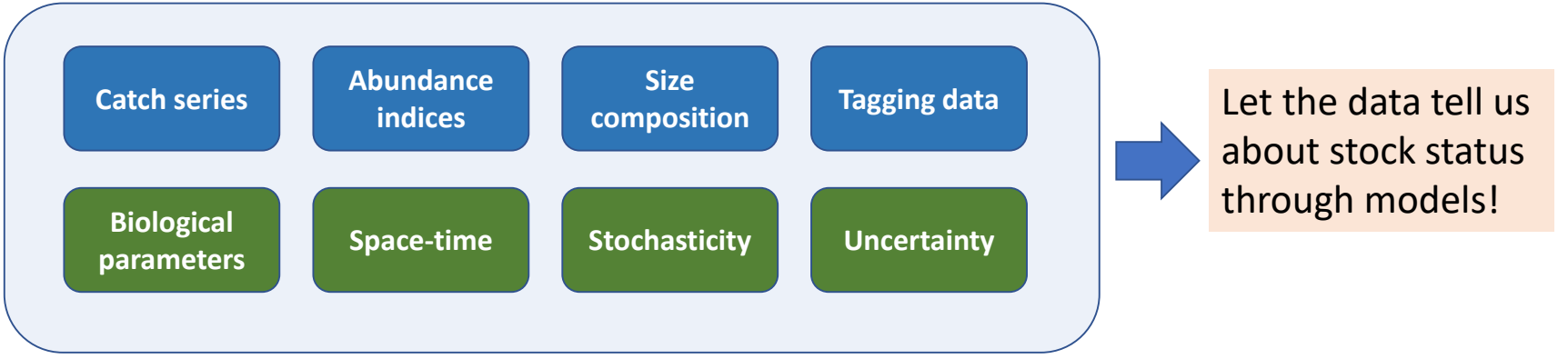
STOCK ASSESSMENT AND MANAGEMENT ADVICE DEVELOPED IN 2018 SC

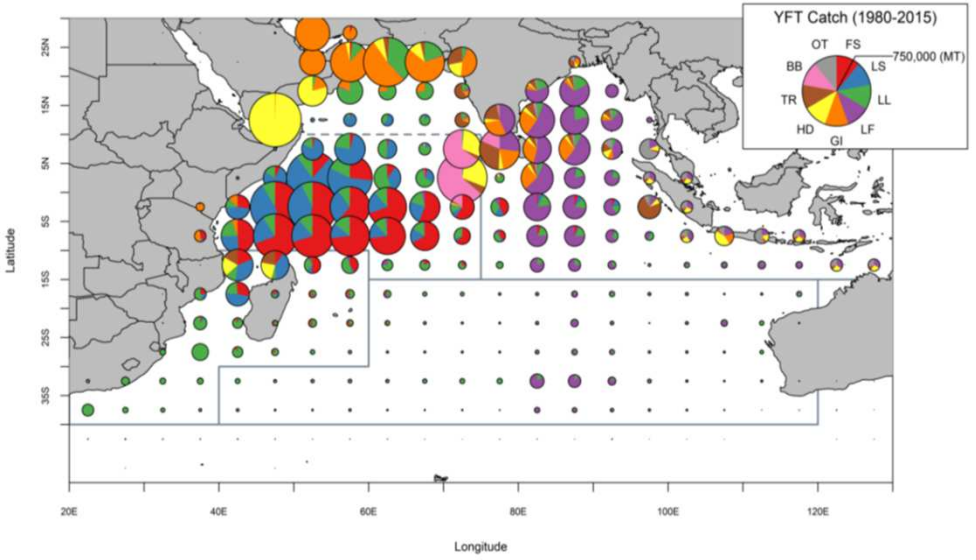
Stock assessment model

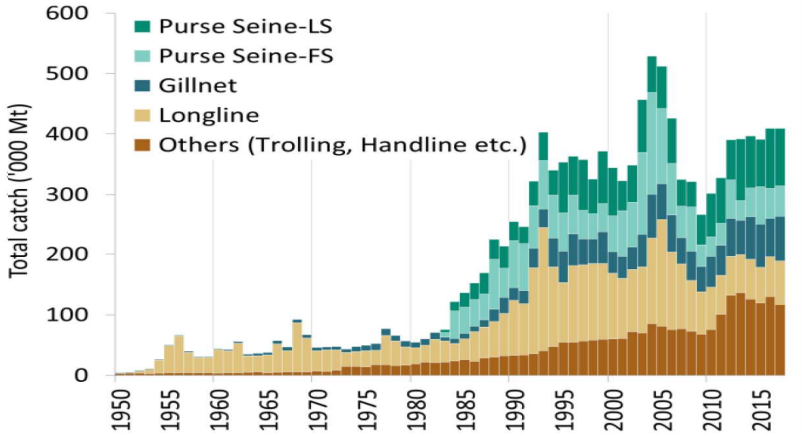
- "Stock Synthesis 3" (SS3), an **integrated** stock assessment model
- Simultaneous use of different sources of data on catch, abundance indices, size and tagging
- Age-structured model with spatial and seasonal components
- High flexibility to account for different fisheries, biological assumptions and stochasticity

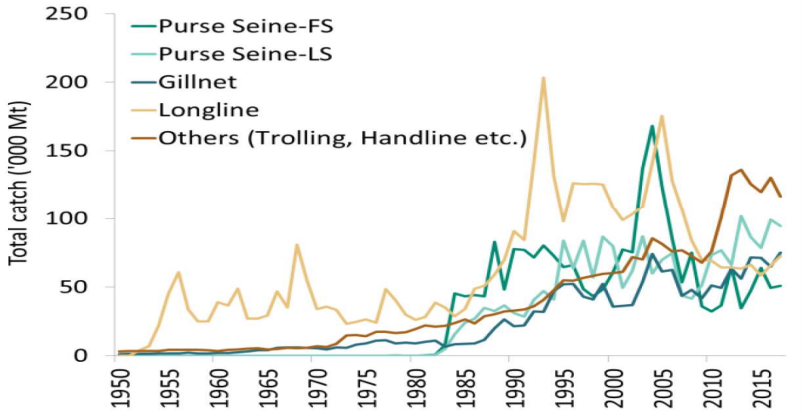


YELLOWFIN STOCK ASSESSMENT IN 2018

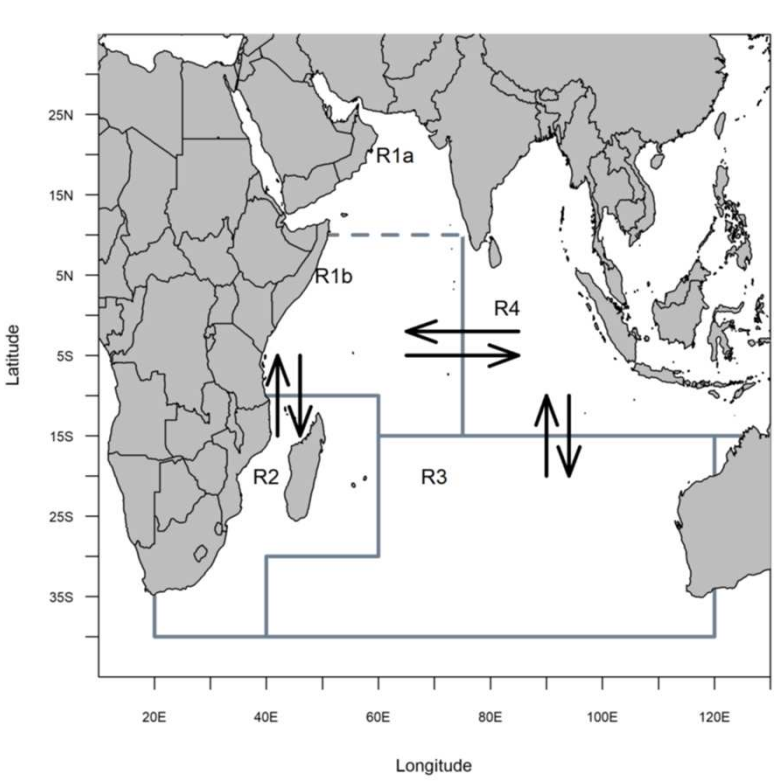
Catch in space & time and by fishery

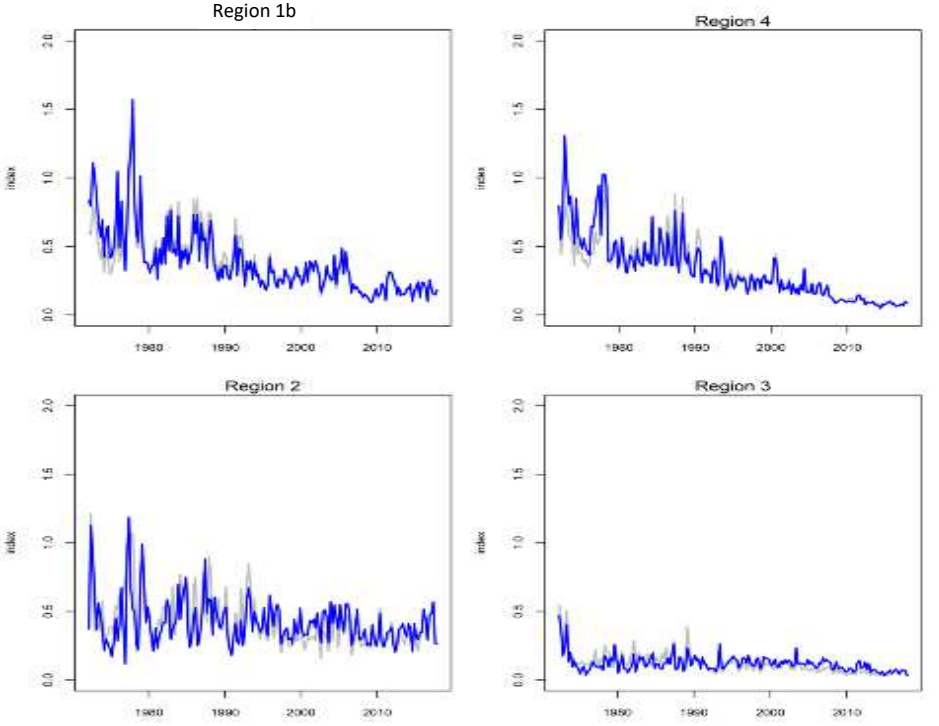




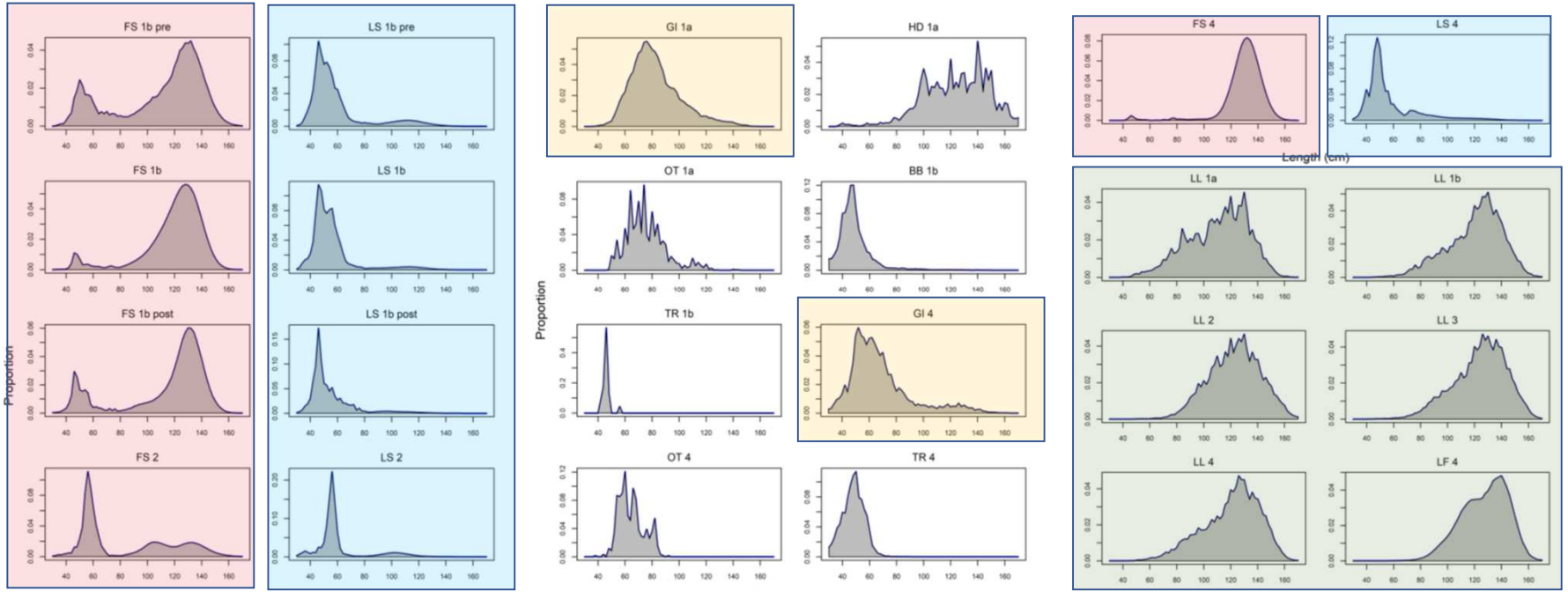


Abundance indices (longline joint CPUE)





Data: size composition (aggregated over time)



Data: tagging data

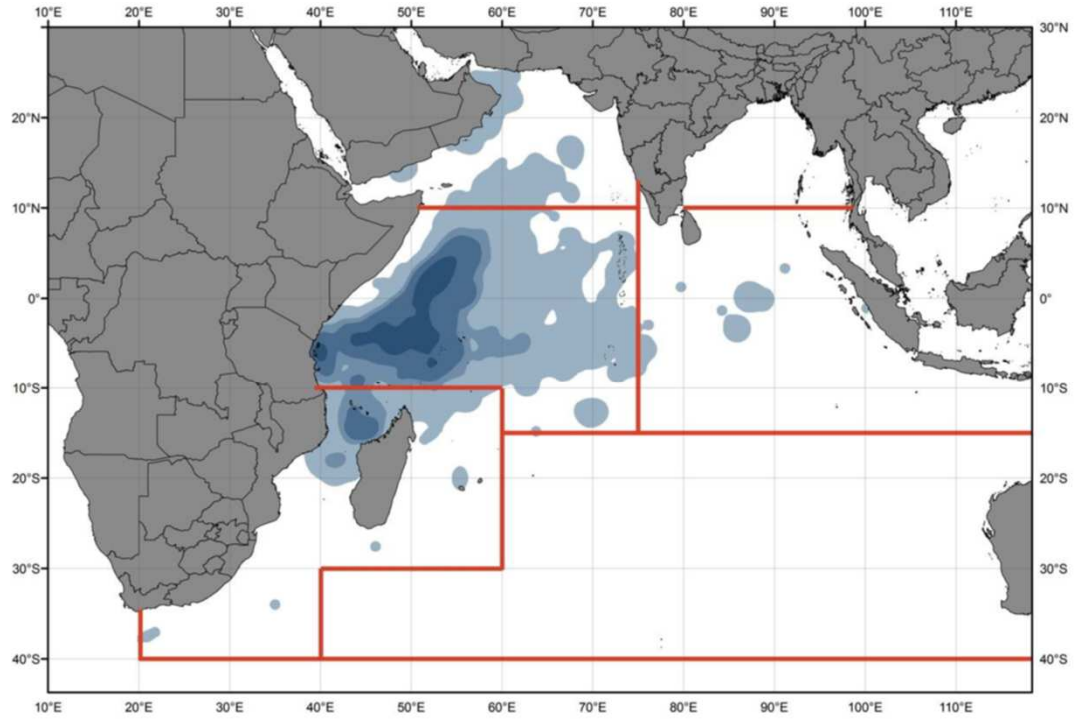


Figure 11: Density of RTTP-IO tag recoveries.

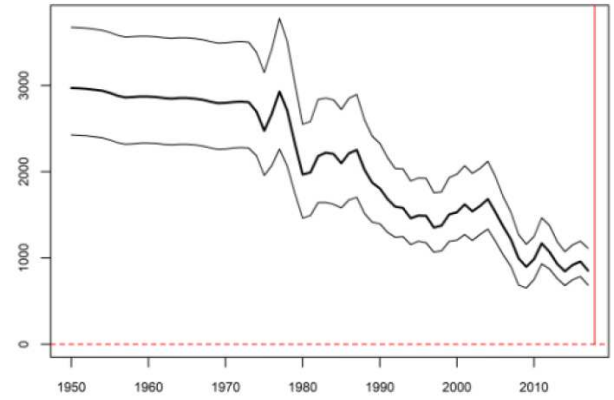
YELLOWFIN STOCK ASSESSMENT IN 2018

- 24 model grids to account for several uncertainty in the biological parameters and model configurations
  - Steepness in stock-recruitment (h=0.7, 0.8, 09) [3]
  - Initial tag mortality (10% and 27.5%) [2]
  - Weight for tag data (Tag lambda = 0.1 and 1) [2]
  - Treatment of piracy effect (down weight CPUE and different catchability) [2]

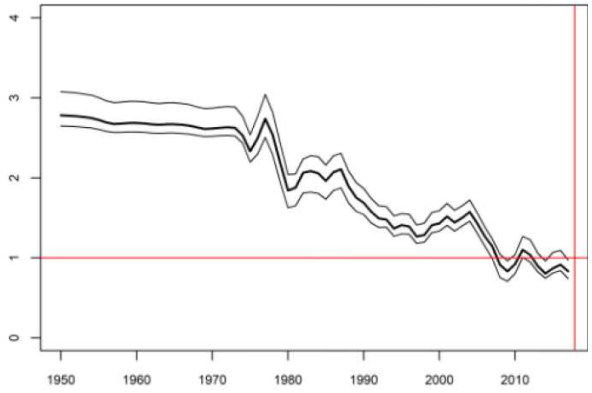
YELLOWFIN STOCK ASSESSMENT IN 2018

- 24 model grids to account for several uncertainty in the biological parameters and model configurations

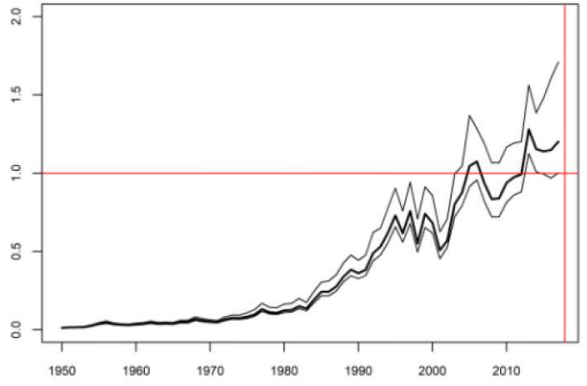
SSB (Spawning Stock Biomass)



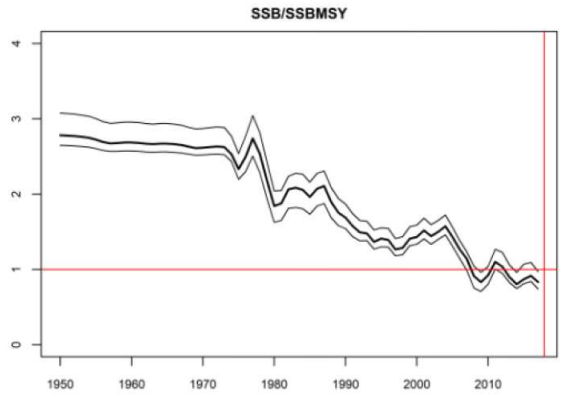
B-ratio (SSB/SSBMSY)

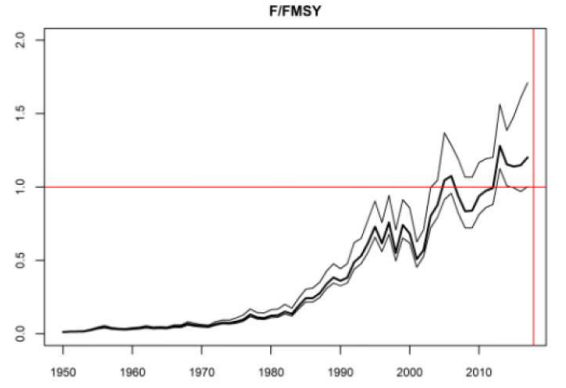


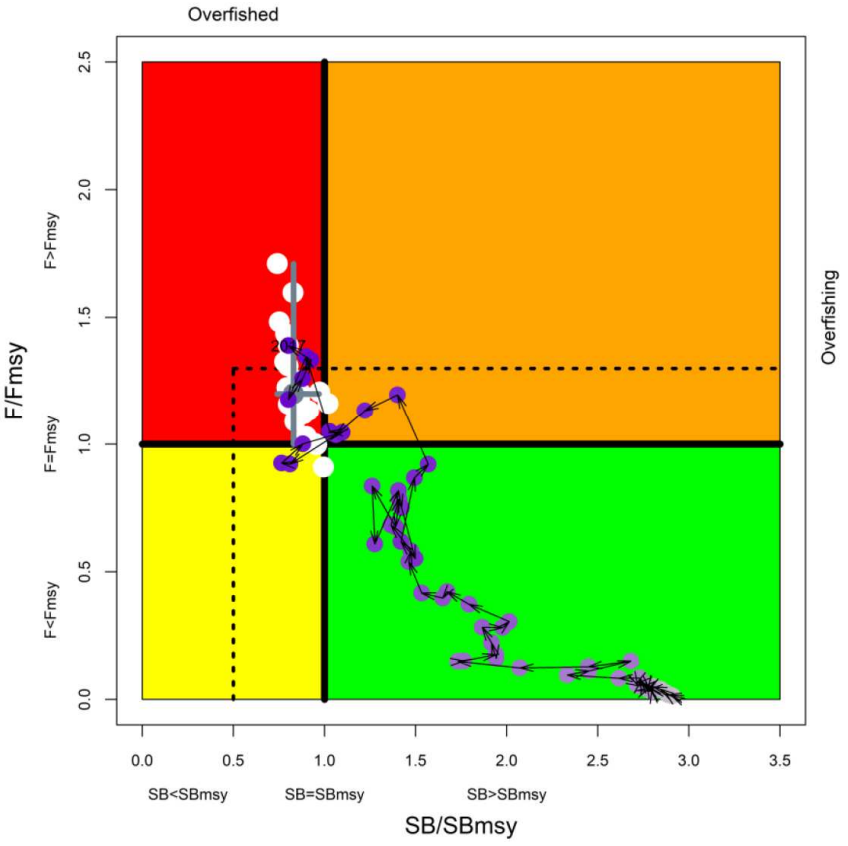
F-ratio (F/FMSY)



YELLOWFIN STOCK ASSESSMENT IN 2018







YELLOWFIN STOCK ASSESSMENT IN 2018

TABLE 1. Yellowfin tuna: Status of yellowfin tuna (*Thunnus albacares*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status[3] determination
Indian Ocean	Catch 2017[2]:	409,567t	94%
	Average catch 2013–2017:	399,830 t	
	MSY (1000 t) (80% CI)[3]:	403 (339–436)	
	F_{MSY} (80% CI):	0.15 (0.13–0.17)	
	SB_{MSY} (1,000 t) (80% CI):	1069 (789–1387)	
	F_{2017}/F_{MSY} (80% CI):	1.20 (1.00–1.71)	
	SB_{2017}/SB_{MSY} (80% CI):	0.83 (0.74–0.97)	
	SB_{2017}/SB_0 (80% CI):	0.30 (0.27 – 0.33)	

[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 2017: 24%
[3] Median and quantiles calculated from the uncertainty grid taking into account of weighting on models

Colour key	Stock overfished ($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)	**94**	**2**
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)	**4**	**0**
Not assessed/Uncertain		

STOCK STATUS IN 2018 SC

Stock status. In 2018 a new stock assessment was carried out for yellowfin tuna in the IOTC area of competence to update the stock status undertaken in 2016. The 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 2018 is based on the model developed in 2016 with a series of revisions that were noted during the WPTT. The model uses four types of data: catch, size frequency, tagging and joint longline CPUE indices. The SS3 stock assessment gave overall similar results to the 2015/2016 assessment but is somewhat more pessimistic than the stock assessment undertaken in 2016 (but similar to the one done in 2015) due to the steeper declining trend of the composite longline CPUE series and sustained large catches in the most recent years. The assessment results were only based on a grid of 24 SS3 model runs which are recognized as insufficient to explore the spectrum of uncertainties and scenarios, noting the large uncertainty associated with data quality (e.g., spatial representativeness of CPUE coverage, estimation of catch and inconsistency in length-frequency) and lack of considering model statistical uncertainty. Spawning stock biomass in 2017 was estimated to be 30.0% of the unfished levels (Table 1). According to the information available for the stock assessment, the total catch has remained relatively stable at levels around the estimated MSY since 2012 (i.e., between 390,000 t and 410,000 t). The 2018 stock assessment estimates SB_{2017}/SB_{MSY} at 0.83 (0.74-0.97) and F_{2017}/F_{MSY} at 1.20 (1.00 -1.71). However, it is noted that the quantified uncertainty in stock status is likely underestimating the underlying uncertainty of the assessment. On the weight-of-evidence available in 2018, the yellowfin tuna stock is determined to remain **overfished** and subject to **overfishing** (Table 1 and Fig. 1).

OUTLOOK IN 2018 SC

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 results of projections of the Stock Synthesis are provided in the form of K2SM (Table 2). There is a high risk of continuing to violate the MSY-based reference points if catches remain at around current levels (≈409,000 t in 2017) (Table 2). However, the projections shown in K2SM results do not adequately reflect known sources of uncertainty due to a series of issues with data and model performance, and should be taken with caution given the issues identified by the Committee.

Reference point and projection timeframe	**Alternative catch projections (relative to the catch level from 2017) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	65% (266,218t)	70% (286,697t)	75% (307,175t)	80% (327,654t)	85% (348,132t)	90% (368,610t)	95% (389,089t)	100% (409,567t)	110% (450,523t)
$B_{2020} < B_{MSY}$	0.48	0.48	0.73	0.85	0.85	0.96	0.98	0.98	1.00
$F_{2020} > F_{MSY}$	0.08	0.23	0.25	0.48	0.56	0.79	0.96	0.98	1.00
$B_{2027} < B_{MSY}$	0.08	0.08	0.25	0.42	0.56	0.79	0.98	1.00	1.00*
$F_{2027} > F_{MSY}$	0.06	0.08	0.23	0.42	0.63	0.85	1.00	1.00	1.00*

MANAGEMENT ADVICE IN 2018 SC

Management advice. The decline in stock status to below MSY reference level is not well understood due to various uncertainties. As a precautionary measure, the Commission should ensure that catches are reduced to end overfishing and allow the SSB to recover to SSB_{MSY} levels. At this stage, specific catch limits are not provided.

A workplan has been developed to address the issues identified in the assessment review, aimed at increasing the Committee's ability to provide more concrete and robust advice by the 2019 meeting of the Scientific Committee. The workplan is scheduled to start in January 2019 and aims at addressing the issues identified by the WPTT and the external reviewer. The draft workplan is attached as Appendix 38 of the 2018 Scientific Committee Report (IOTC-2018-SC21-R). The Commission should ensure that this workplan is budgeted appropriately.

The Commission has an interim plan for the rebuilding the yellowfin stock, with catch limitations based on 2014/2015 levels (Resolution 18/01). Some of the fisheries subject to catch reductions had fully achieved a decrease in catches in 2017 in accordance with the levels of reductions specified in the Resolution; however, these reductions were offset by increases in the catches from CPCs exempt and some CPCs subject to limitations on their catches of yellowfin tuna (see table 3 in IOTC-2018-SC21-R). Thus, the total catches of yellowfin in 2017 increased by around 3% from 2014/2015 levels. The Commission should ensure that any revision of the management measure can effectively achieve any prescribed catch reduction to ensure the effectiveness of the management measure.

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ACTIVITIES IN 2019 AND 2020 SC

IN 2019 AND 2020

Progress in 2019 SC

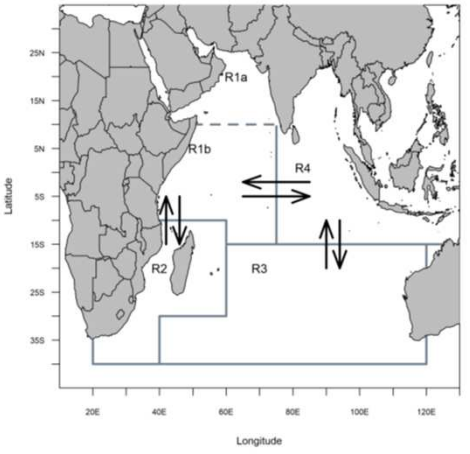
- The SC established a workplan to reduce uncertainties and increase the SC ability to provide concrete and robust advice by the 2019 meeting
- Although a considerable amount effort was made in 2019 to reduce structural and data uncertainty, the 2019 SC **NOTED** that there was no strong evidence indicating a qualitative difference on the advice provided in 2018

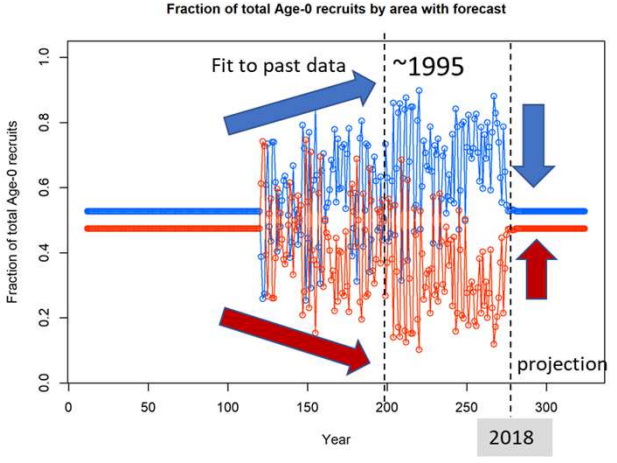
Progress in 2020 SC

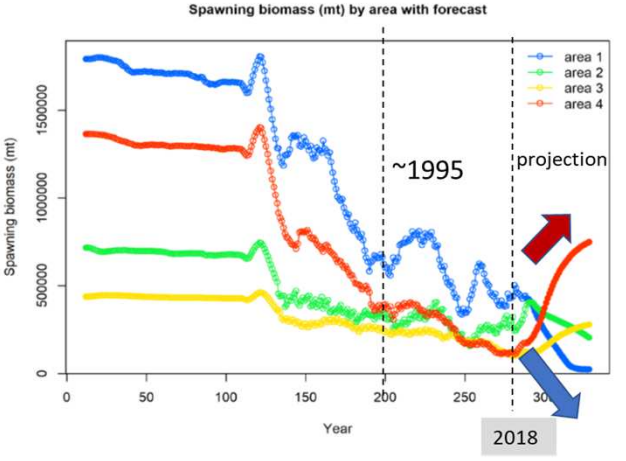
- The SC reviewed all data sources and development of model configuration and objective model evaluation methods.
- The SC also spent time for the improvement of projection methods and **found an error in the projection** conducted in 2018 assessment, which gave a big implication to the K2SM (the same problems might have happened in K2SM of 2016 assessment)

PROBLEMS IN THE PROJECTION

The proportion of recruits was assumed to be distributed between Regions 1 and 4.







Extract from the WPTT report slide prepared by the Chair, Dr. Merino

CURRENT MANAGEMENT ADVICE AGREED IN 2020 SC

SC CHAIR'S STATEMENT IN 2020 COM

Management advice in 2018&2019 SC

Management advice. The decline in stock status to below MSY reference level is not well understood due to various uncertainties. As a precautionary measure, the Commission should ensure that catches are reduced to end overfishing and allow the SSB to recover to SSB_{MSY} levels. At this stage, specific catch limits are not provided.

In COM in Nov 2020

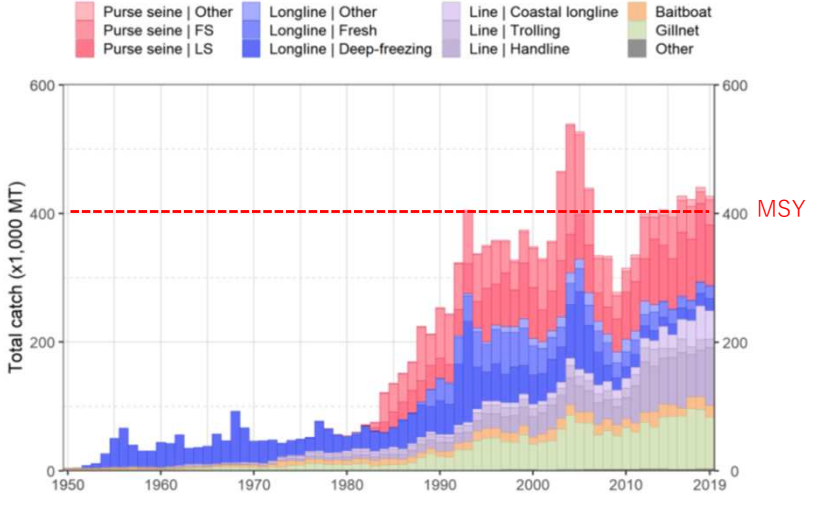
93. The Commission **NOTED** the need to agree on what scientific benchmarks will be used to inform any new CMMs relating to yellowfin tuna. The Commission further **NOTED** the 2019 advice from the Scientific Committee that the Kobe II Strategy Matrix developed in 2018 does not adequately reflect known sources of uncertainty due to a series of issues with data and model performance, and should be taken with caution given the issues identified by the Committee. The Commission was informed by the Scientific Committee Chairperson that no new advice on yellowfin tuna will be available until after the Scientific Committee meeting in December 2021.

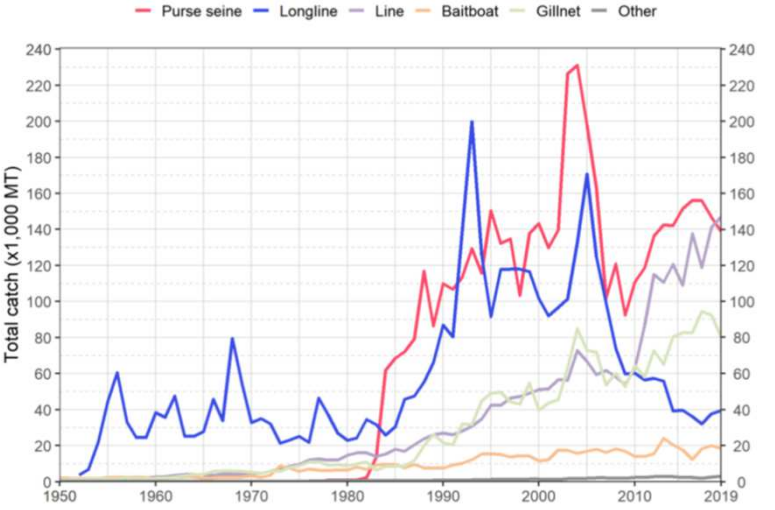
In SC in Dec 2020…..

we discussed ways to clarify the previous management advice as well as provide some additional insight based on the previous assessment model.

MANAGEMENT ADVICE FROM 2020 SC

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 results of projections of the Stock Synthesis are no longer provided in the form of K2SM because subsequent investigation has shown some critical errors in the projections and estimations for computing probabilities in the K2SM developed in 2018. As such the K2SM is not suitable for use to provide management advice. Nonetheless, there is a high risk of continuing to exceed the MSY-based reference points if catches remain at or above 2017 levels (~409,000 MT in 2017 as used in the assessment). In order to provide more updated information with respect to the 2018 assessment Fig.3 reports the trend(s) of the relevant fishery-based indicator(s) updated up to 2019.





MANAGEMENT ADVICE FROM 2020 SC

Management advice. The decline in stock status to below MSY reference level is not well understood due to various uncertainties. As a precautionary measure, the Commission should ensure that catches are reduced to end overfishing and allow the SSB to recover to SSB_{MSY} levels. At this stage, specific catch limits are not provided.

Management advice. The decline in stock status to below MSY reference level is not well understood due to various uncertainties. As a precautionary measure, the Commission should ensure that CPCs take all necessary action to achieve the catch reductions in their fleets, as per Res 19/01, to reduce overfishing. It is recommended that catches be reduced to a level at least below the C_{MSY} estimate (403, 000 MT) from the 2018 assessment until new information based on the 2021 stock assessment and its associated projections are carried out. It is reminded that F_{2017} was 20% above the target reference point.

In the 2018 Scientific Committee a Workplan was developed to address the issues identified in the assessment review, aimed at increasing the Committee's ability to provide more concrete and robust advice by the 2019 meeting of the Scientific Committee. The workplan started in January 2019 which aimed at addressing the issues identified by the WPTT and the external reviewer in 2018. The draft workplan is attached as Appendix 38 of the 2018 Scientific Committee Report (IOTC-2018-SC21-R). The Commission should ensure that this workplan is budgeted appropriately. Despite the progress made to reduce the uncertainties inherent to this assessment, the WPTT agreed that no new K2SM could be provided in 2019 and 2020.

Toward the next regular stock assessment in 2021:

- **Data preparatory meeting in May 2021**
- **Stock assessment meeting in October 2021**

- Transformation of the stock assessment model into an annual model using the latest version of SS3
- Develop roadmap to select a new final grid using diagnostics of fit
- Continue analyzing problems with projections and solutions
- Changes in SS3 software (by developer)
- Longline size frequency data review
- Fishery independent indices of abundance
- Spatial configuration
- Analysis of tagging data

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THANK YOU SO MUCH FOR KIND ATTENTION