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REPORT OF THE 23RD SESSION OF IOTC SCIENTIFIC COMMITTEE DECEMBER 7-11, 2020

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CHAIR OF THE SC

25TH IOTC COMMISSION MEETING, JUNE 7-11, 2021@VIRTUAL

SCIENTIFIC COMMITTEE MEETING IN KARACHI, PAKISTAN

- The 23rd Session of the Indian Ocean Tuna Commission (IOTC) Scientific Committee (SC) was held online from 7-11 December 2020
- A total of 141 delegates and other participants attended the Session
  - 112 delegates from 20 Contracting Parties
  - 29 participants from 13 observer organisations (including the invited experts)
- The meeting was chaired by Dr. Toshihide Kitakado (Japan)
- The reports of Working Parties were smoothly introduced, discussed and endorsed

CONTENTS

- Stock status of species for which a new stock assessment was carried out in 2020
  - Skipjack
  - Swordfish
  - Shortfin mako shark
  - Kawakawa, Longtail tuna, Narrow-barred Spanish mackerel
- Management advice for Yellowfin tuna
- Other issues and general recommendations from SC 2020
- Workplan and draft meeting schedule in 2021-2022

STOCK STATUS

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STRUCTURE OF THE IOTC SCIENTIFIC COMMITTEE

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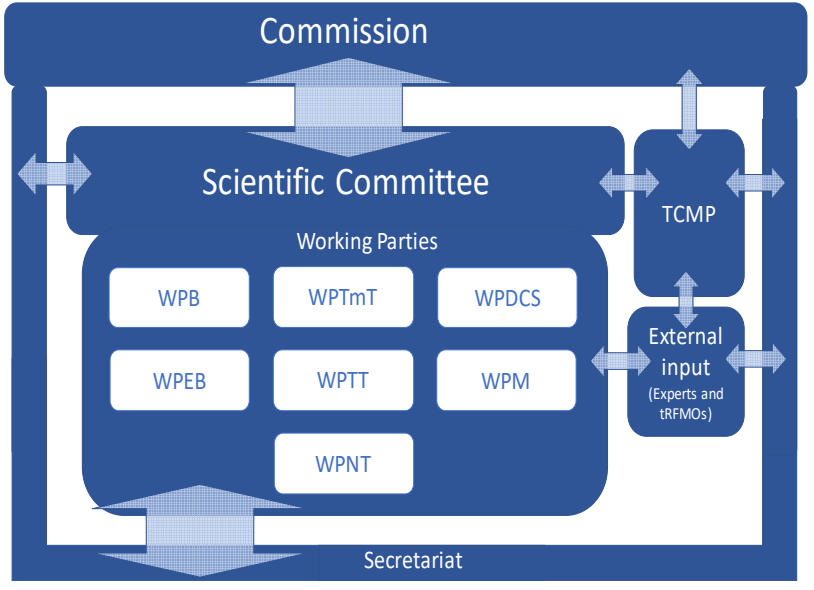
- The Scientific Committee consists of subsidiary Working Parties, where stock assessment is dedicatedly conducted every few years
- The SC then reviews the outcomes and finalize the stock assessment results with management advice



Stock	WP	2015	2016	2017	2018	2019	2020	2021
Albacore	Temperate		SA			SA		
Bigeye tuna			SA			SA		
Skipjack tuna	Tropical			SA			SA	
Yellowfin tuna		SA	SA		SA	SA		SA
Swordfish							SA	
Black marlin			SA		SA			SA
Blue marlin	Billfishs		SA			SA		
Striped marlin		SA			SA			SA
Indo-Pacific Sailfish		SA				SA		
Bullet tuna								SA
Frigate tuna								SA
Kawakawa	Neritics	SA		SA			SA	
Longtail tuna		SA	SA	SA			SA	
Indo-Pacific king mackerel		SA	SA					SA
Narrow-barred Spanish mackerel		SA	SA	SA			SA	
Blue shark				SA				SA
Oceanic whitetip shark								
Scalloped hammerhead shark								
Shortfin mako shark	Bycatch						SA	
Silky shark	(shark)							SA
Bigeye thresher shark								
Pelagic thresher shark								
Seabirds	Bycatch							
Marine mammals	(others)							
Seaturtles								

STOCK ASSESSMENT MODELS

	Data-rich	Data-moderate	Data-poor
	Integrated assessment with age- (and gender-) structured models (SS3, SCAA, ASPM,…)	Age-aggregated models (JABBA, BSPM, ASPIC,..)	Data-limited methods (C-MSY, OCOM)
Catch series	✔	✔	✔
STD-CPUE	✔	✔	
Catch-at-size (or Catch-at-age)	✔		
Biological parameters	✔		
Tag-data	(✔)		

yellowfin, bigeye, skipjack, albacore, swordfish

billfish, marlins, shark

neritic species

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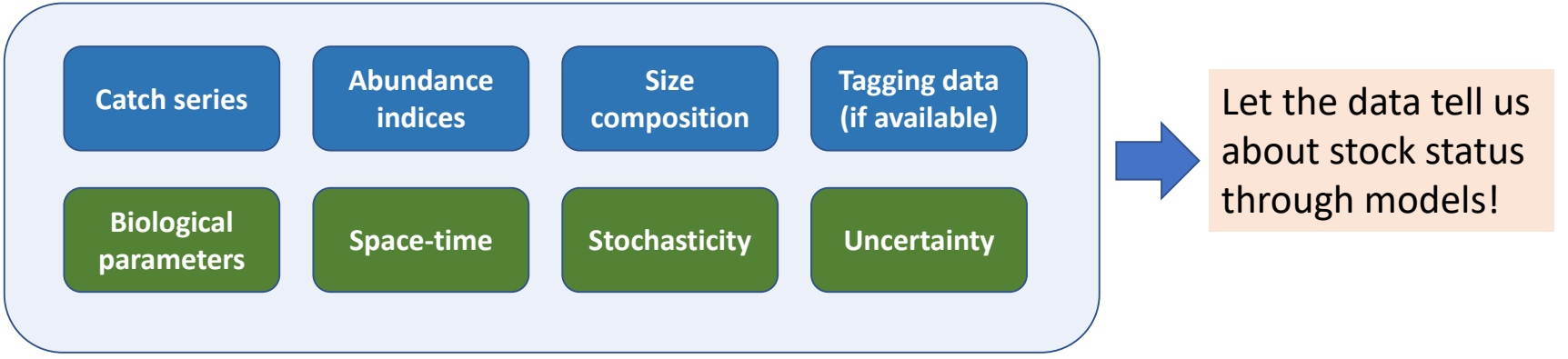
STOCK STATUS AND MANAGEMENT ADVICE (1)

SKIPJACK TUNA

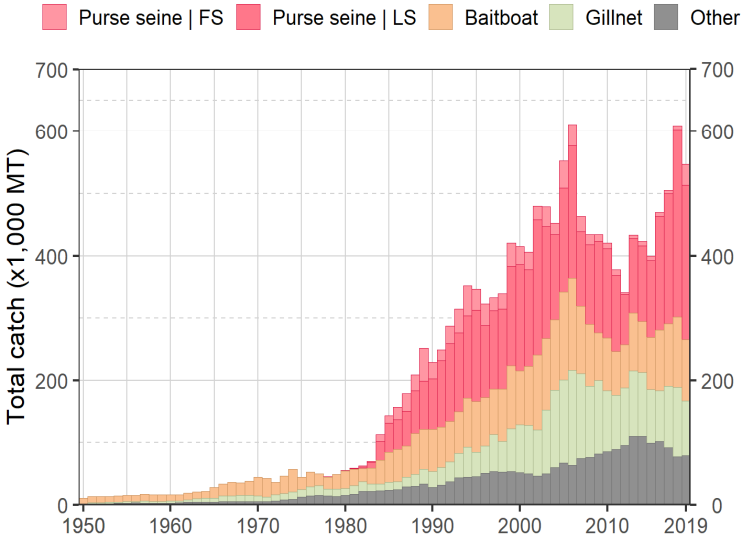
Stock assessment model

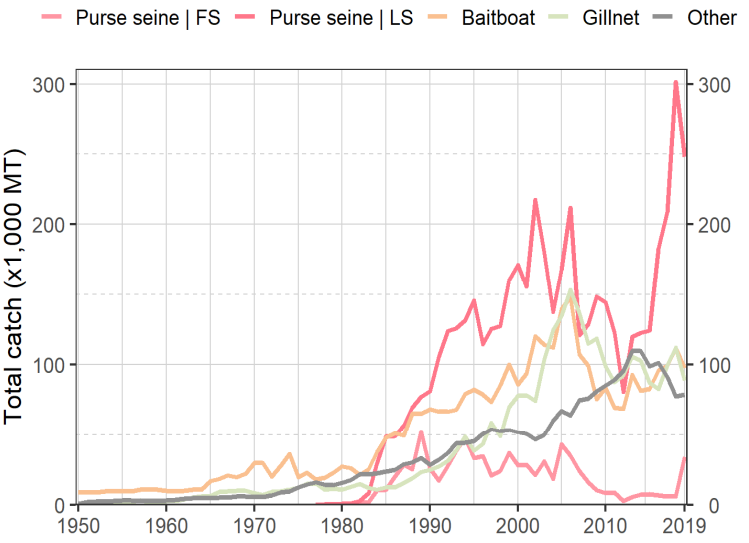
- "Stock Synthesis 3" (SS3), an **integrated** stock assessment model
- Simultaneous use of different sources of data on catch, abundance indices, size and tagging
- Age-structured model with spatial and seasonal components
- High flexibility to account for different fisheries, biological assumptions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



- **Catch series (~ 2019)**
- Abundance indices
- Size frequency data
- Tagging data

Catches in period 2018-2019 are larger than the annual catch limit set for 2018-2020 by the HCR (470,029t)

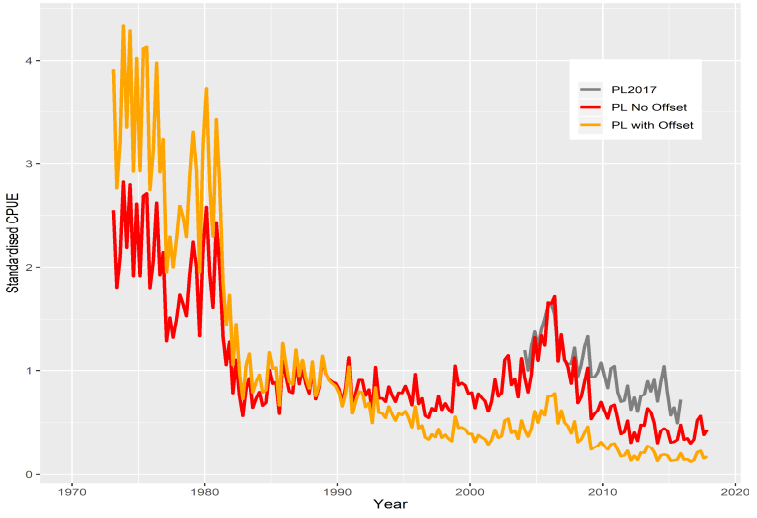




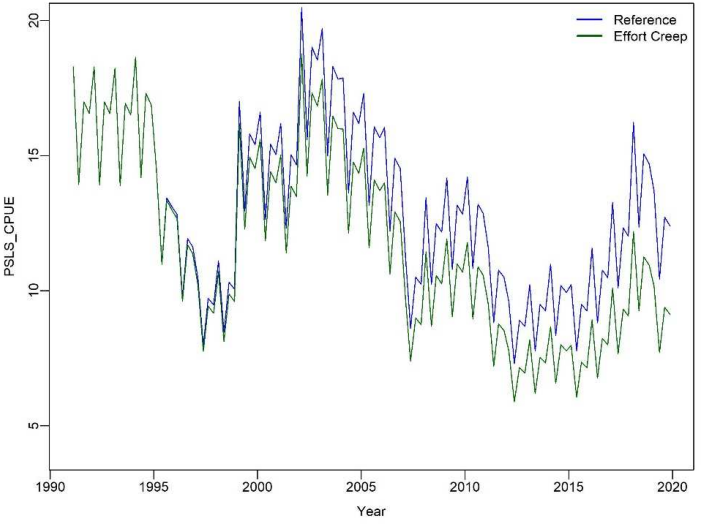
DATA

- Catch series
- **Abundance indices**
- Size frequency data
- Tagging data

Pole and line from Maldives

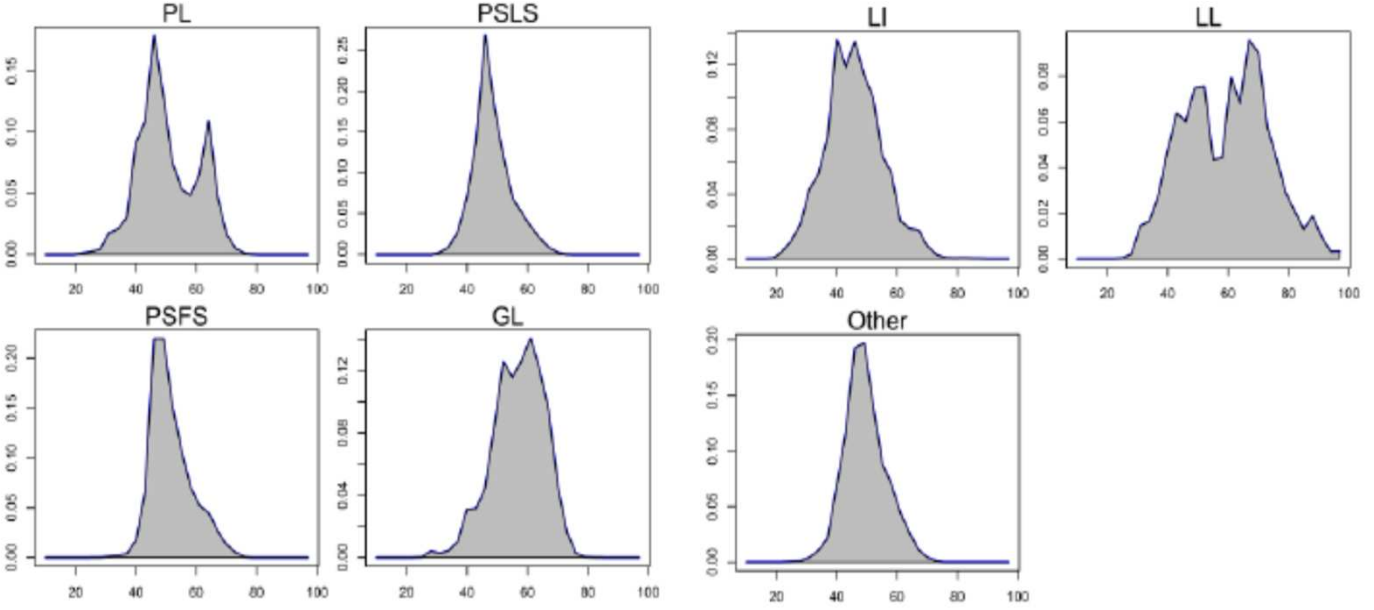


EU purse seine using FADs



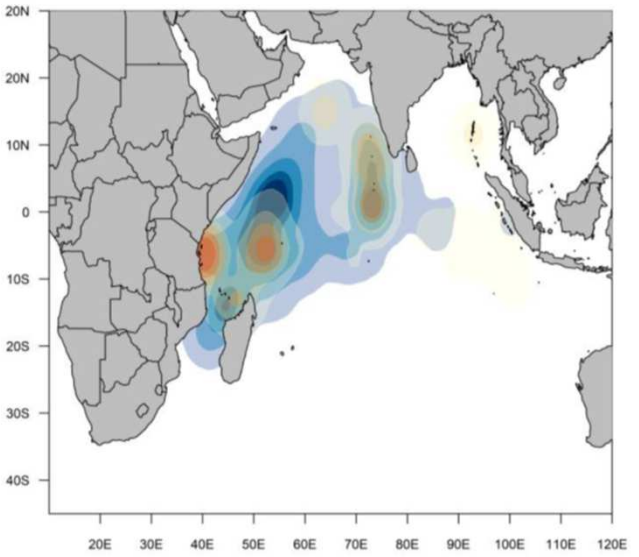
DATA

- Catch series
- Abundance indices
- **Size frequency data**
- Tagging data



DATA

- Catch series
- Abundance index: Joint Longline CPUE
- Size frequency data
- Tagging data: release/recovery from Indian Ocean RTTP used with a tag-release mortality parameter that assumes a higher mortality (≠ 2017)



Location of releases and density of recoveries for the skipjack tuna RTTO-IO and small-scale tag Programs

MODEL SEPECIFICATION

Characterization of uncertainty inherent to skipjack dynamics

- *Structural uncertainty:* SS3, grid of 24 model configurations:
  - (i) stock recruitment relationship (3 levels: steepness h=0.7,0.8,0.9)
  - (ii) the influence of tagging information to likelihood (2 levels: tag lambda =0.1 and 1)
  - (iii) Technological effort creep to PS fleets (2 levels: 0% and 1.25%)
  - (iv) Spatial configuration (2 level: single, two-area)

- *Statistical uncertainty:*
  - The median values are calculated from bootstrapped samples (n=500) of individual models using the Hessian matrix, combined across the model grid, with a total of 24* 500 points

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QUICK SUMMARY OF STOCK ASSESSMENT 2020

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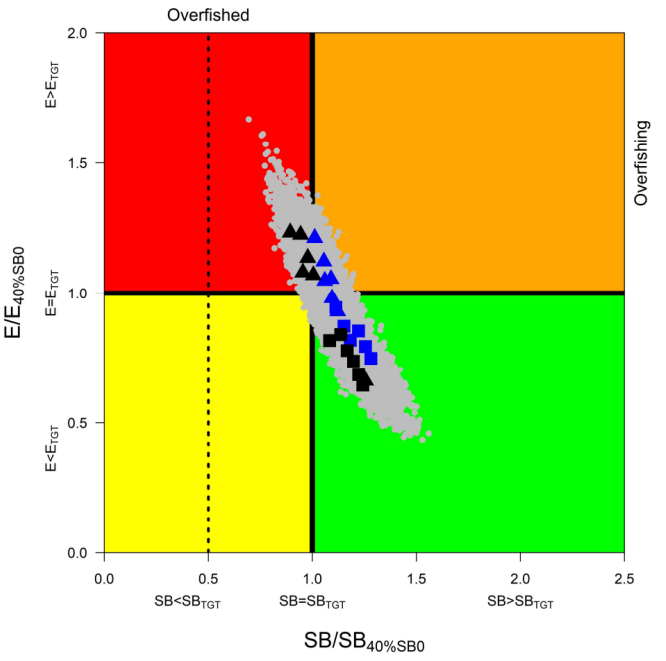
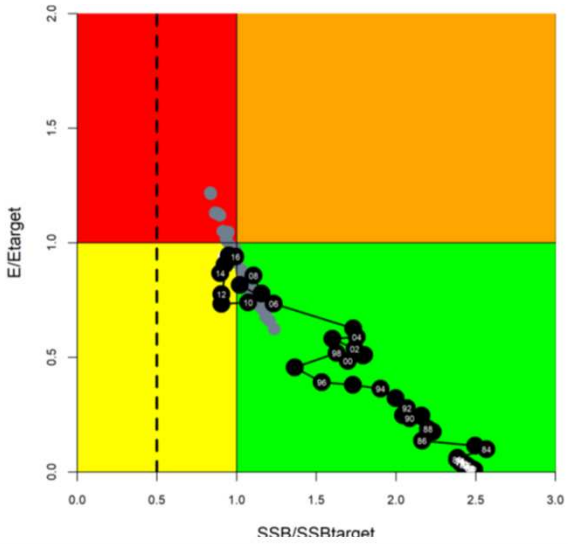
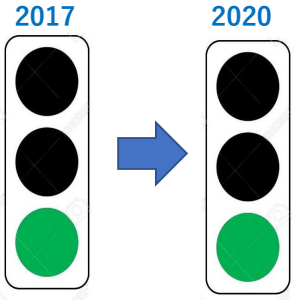
Indicator	Value	Status[2]
Catch in 2019 (MT)	547,248	60.4%*
Average catch 2015-2019 (MT)	506,555	
$C_{40\%SB0}$ (MT) (80% CI)	535,964 (461,995–674,536)	
C_{2019} / $C_{40\%SB0}$ (80% CI)	1.02 (0.81–1.18)	
$E_{40\%SB0}$ [3] (80% CI)	0.59 (0.53–0.66)	
E_{2019} / $E_{40\%SB0}$ (80% CI)	0.92 (0.67-1.21)	
SB_0 (MT) (80% CI)	1,992,089 (1,691,710–2,547,087)	
SB_{2019} (MT) (80% CI)	870,461 (660,411–1,253,181)	
$SB_{40\%SB0}$ (MT) (80% CI)	794,310 (672,825–1,019,056)	
$SB_{20\%SB0}$ (MT) (80% CI)	397,155 (336,412–509,528)	
SB_{2019} / SB_0 (80% CI)	0.45 (0.38-0.5)	
SB_{2019} / $SB_{40\%SB0}$ (80% CI)	1.11 (0.95-1.29)	
SB_{2019} / SB_{MSY} (80% CI)	1.99 (1.47-2.63)	
MSY (MT) (80% CI)	601,088 (500,131–767,012)	
E_{2019} / E_{MSY} (80% CI)	0.48 (0.35-0.81)	

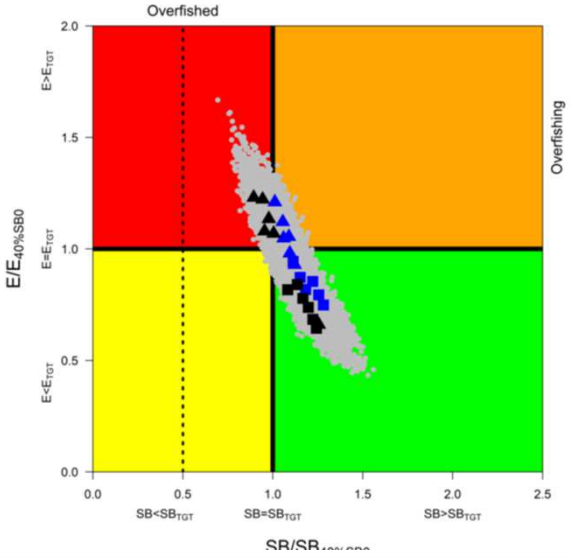


- blue=no effort creep;
- black=additional effort creep;
- triangle=full weighting of tagging data;
- square=downweighted

COMPARISON OF RESULTS







Colour key	Stock overfished ($SB_{year}/SB_{40\%} < 1$)	Stock not overfished ($SB_{year}/SB_{40\%} \geq 1$)
Stock subject to overfishing ($F_{year}/F_{40\%} > 1$)	38%	2%
Stock not subject to overfishing ($F_{year}/F_{40\%} \leq 1$)	13%	47%

Colour key	Stock overfished (SB_{2019} / $SB_{40\%SB0} < 1$)	Stock not overfished (SB_{2019} / $SB_{40\%SB0} \geq 1$)
Stock subject to overfishing (E_{2019} / $E_{40\%SB0} \geq 1$)	19.5%	19.5%
Stock not subject to overfishing (E_{2019} / $E_{40\%SB0} \leq 1$)	0.6%	60.4%

The SC **AGREED** that it is important to explore and understand the underlying ecological and environmental drivers that underpin the stock trend to ensure that the recent overshooting of TAC did not undermine the sustainability of the stock.

APPLICATION OF HCR SPECIFIED IN RESOLUTION 16/02

Indicator	Value	Status[2]
Catch in 2019 (MT)	547,248	60.4%*
Average catch 2015-2019 (MT)	506,555	
$C_{40\%SB0}$ (MT) (80% CI)	535,964 (461,995–674,536)	
C_{2019} / $C_{40\%SB0}$ (80% CI)	1.02 (0.81–1.18)	
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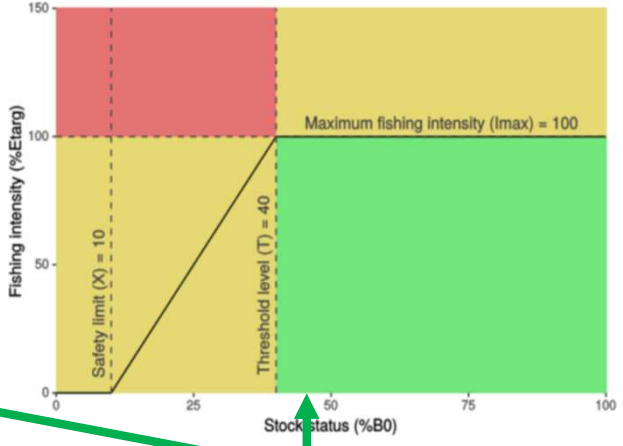
E_{2019} / E_{MSY} (80% CI)	0.48 (0.35-0.81)	

Annual catch limit

= Imax x Etar x Bcurrent

= 1 x 0.59 x 870,461

= 513,572



MANAGEMENT ADVICE

In 2017 SC

Management advice. Based on the results of the stock assessment of skipjack tuna in 2017, the Commission, following Resolution 16/02, adopted an annual catch limit of 470,029 tonnes for the years 2018 to 2020. Total catches in 2018 (607,701 t) were 29% larger than the catch limit generated by the Harvest Control Rule (470,029 t) which applies to the years 2018–2020, and there has been an increasing trend in catches over the past 3 years. The Commission needs to ensure that future catches of skipjack do not exceed the agreed limit for the 2018-2020 period.

In 2020 SC

Management advice. The catch limit calculated applying the HCR specified in Resolution 16/02 is 513,572t for the period 2021 -2023. The SC noted that this catch limit is higher than for the previous period. This is attributed to the new stock assessment which estimates a higher productivity of the stock and a higher stock level relative to the target reference point, possibly due to skipjack life history characteristics and favourable environmental conditions. Thus, it is likely that the recent catches that have exceeded the limits established for the period 2018-2020 have been sustained by favourable environmental conditions. Therefore, the Commission needs to ensure that catches of skipjack tuna during this period do not exceed the agreed limit.

RECOMMENDATION REGARDING SKJ

SC23.11 (para. 78) The SC **NOTED** that the reference points for skipjack tuna are defined with respect to unfished spawning biomass only in resolution 16/02; nonetheless the notation is in terms of B (total exploitable biomass) instead of SB (spawning biomass). Although the resolution also specified Etarg (annual equilibrium exploitation rate associated with the unfished target spawning biomass), it was intended as a control parameter for the harvest control rule, rather than as an explicit target. Meanwhile Resolution 16/02 did not define a limit exploitation rate (Elim). The SC further **NOTED** that resolution 15/10 had specified a default depletion-based target and limit fishing mortality rate but it was discussed whether these are appropriate for skipjack tuna (the default values are defined only when MSY-based reference points can not be estimated robustly according to 15/10). As such the SC **RECOMMENDED** that the skipjack MSE project to revisit these reference points, including to investigate the plausibility of establishing a limit reference point for fishing mortality (or exploitation rate).) and to evaluate the .differences on the catch forecasts by using total biomass instead of spawning biomass in the HCR.

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STOCK STATUS AND MANAGEMENT ADVICE (2)

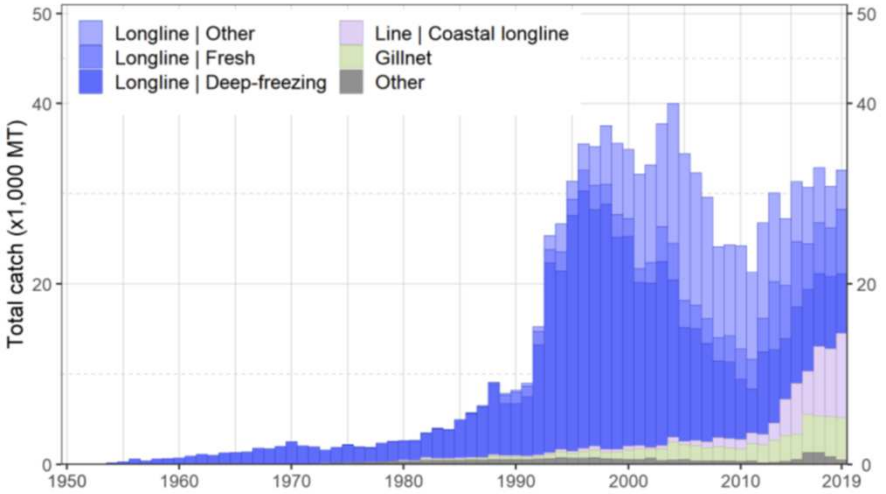
SWORDFISH

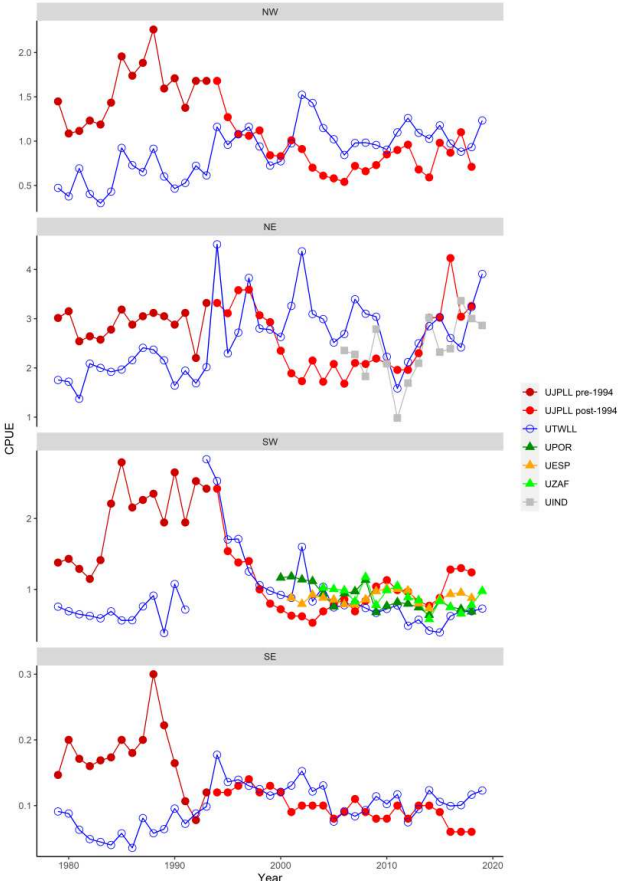
STOCK ASSESSMENT FOR SWORDFISH

Stock assessment used for the management advice

Stock Synthesis 3 (SS3)

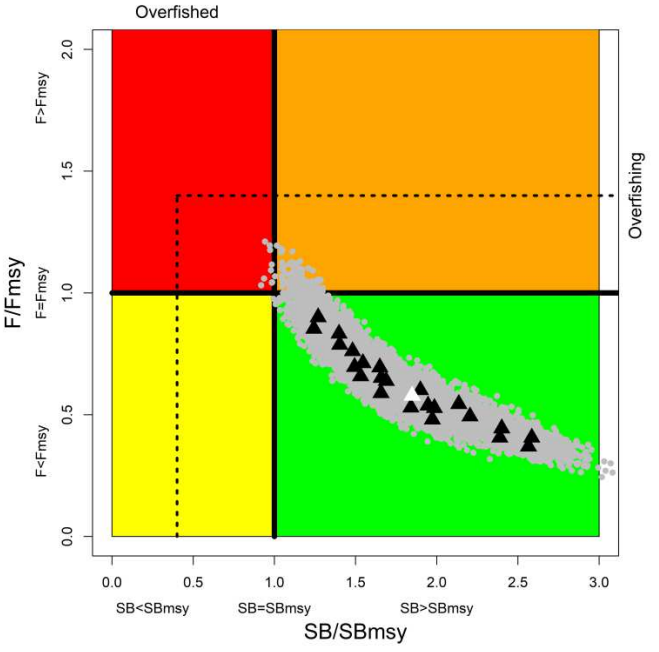
- Spatially disaggregated - 4 areas
- Sex explicit





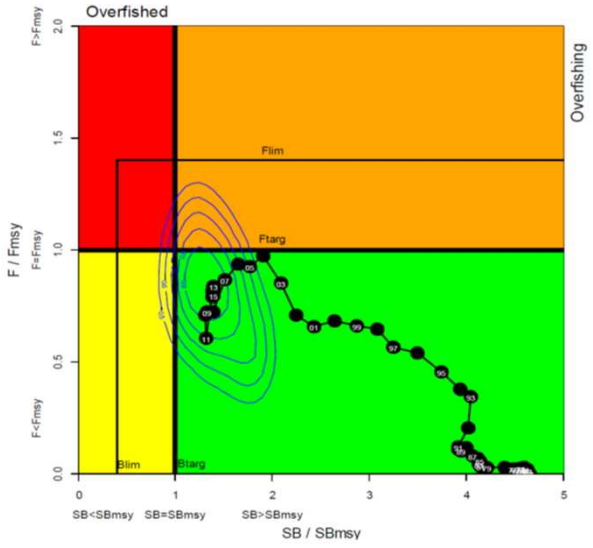
STOCK STATUS

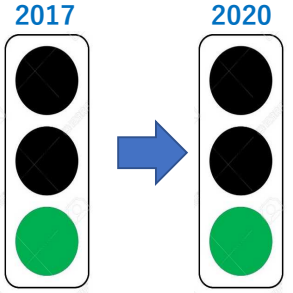
Indicators		2020 stock status determination
Catch 2019[2] (MT)	32,671	98%
Average catch 2015-2019 (MT)	31,712	
MSY (1,000 MT) (80% CI)	33 (27–40)	
F_{MSY} (80% CI)	0.23 (0.15–0.31)	
SB_{MSY} (1,000 MT) (80% CI)	59 (41–77)	
F_{2018}/F_{MSY} (80% CI)	0.60 (0.40–0.83)	
SB_{2018}/SB_{MSY} (80% CI)	1.75 (1.28–2.35)	
SB_{2018}/SB_{1950} (80% CI)	0.42 (0.36–0.47)	

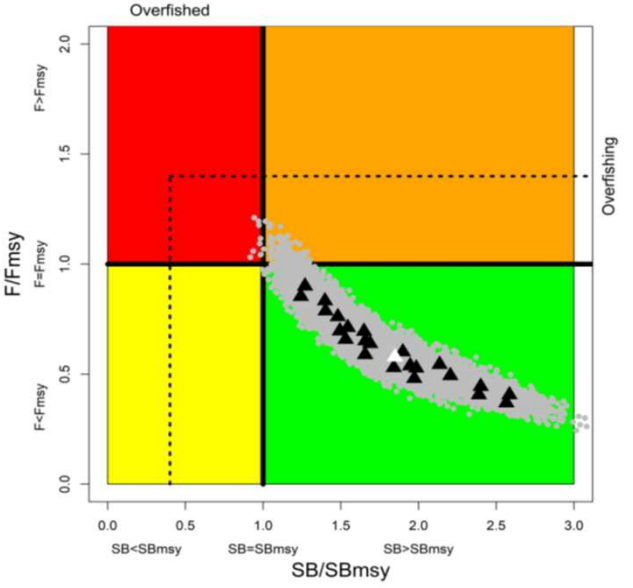


- MSY-based reference points were not exceeded (F2018/FMSY< 1; SB2018/SBMSY> 1).
- Stock is determined to be not overfished and not subject to overfishing

COMPARISON OF RESULTS







FUTURE PROJECTION BASED ON ASSESSMENT

Pr ($SB<SB_{MSY}$)

Catch	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
60%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100%	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02
120%	0.00	0.00	0.01	0.02	0.03	0.06	0.08	0.11	0.13	0.18
140%	0.00	0.01	0.01	0.04	0.10	0.17	0.25	0.32	0.40	0.47

Pr ($F>F_{MSY}$)

Catch	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
60%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100%	0.02	0.03	0.04	0.04	0.04	0.05	0.06	0.07	0.06	0.07
120%	0.10	0.13	0.18	0.21	0.26	0.30	0.32	0.35	0.38	0.42
140%	0.25	0.34	0.44	0.51	0.57	0.62	0.66	0.70	0.73	0.78

MANAGEMENT ADVICE

Management advice. The most recent catches (32,671 MT in 2019) are at approximately the MSY level (33,000 MT). Under the current levels of catches, the spawning biomass is projected to remain relatively stable, with a high probability of maintaining at or above the SB_{MSY} for the longer term. Nevertheless, the Commission should consider limiting the catches so as not to exceed the 2018 catch level (30,847 t) to ensure that the probability of exceeding the SB_{MSY} target reference points in the long term remains minimal (2%). Projections indicate that an increase of 40% or more from 2018 catch levels will likely result in the biomass dropping below the SB_{MSY} level for the longer term (>75% probability). Taking into account the updated information regarding swordfish stock structure (IOTC-2020-WPB18-09), as well as the differential CPUE and biomass trends between regions, the WPB should continue to discuss the swordfish stock assessment model specifications and consider the feasibility of including a multi-stock assessment in 2023. Recognising that there is recurring evidence for localised depletion in the southern regions (particularly the South West) the WPB expresses concern and suggests this should be further monitored.

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STOCK STATUS AND MANAGEMENT ADVICE (3)

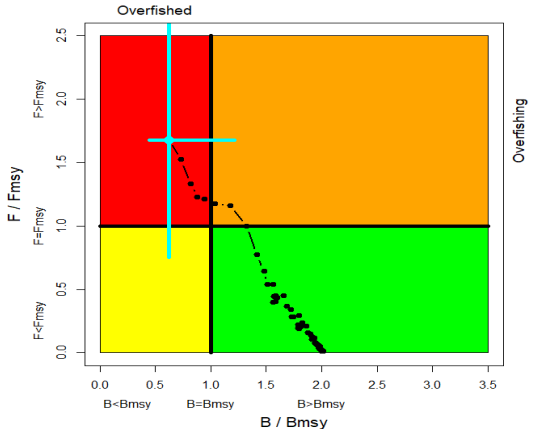
NERITIC TUNA SPECIES

STOCK ASSESSMENT FOR NERITIC TUNA

- This year, we conducted several stock assessments.

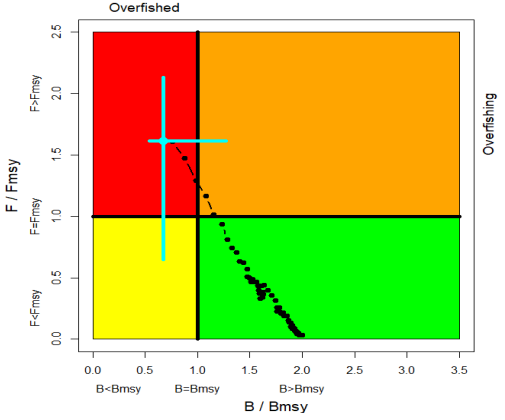
Longtail tuna

Indicators		2020 stock status determination
Catch 2019[2] (MT)	107,088	76%
Average catch 2015–2019 (MT)	133,872	
MSY (MT) (80% CI)	128,750 (99,902 – 151,357)	
F_{MSY} (80% CI)	0.32 (0.15 – 0.66)	
B_{MSY} (MT) (80% CI)	395,460 (129,240 – 751,316)	
$F_{current}/F_{MSY}$ (80% CI)	1.52 (0.751 – 2.87)	
$B_{current}/B_{MSY}$ (80% CI)	0.69 (0.45 – 1.21)	



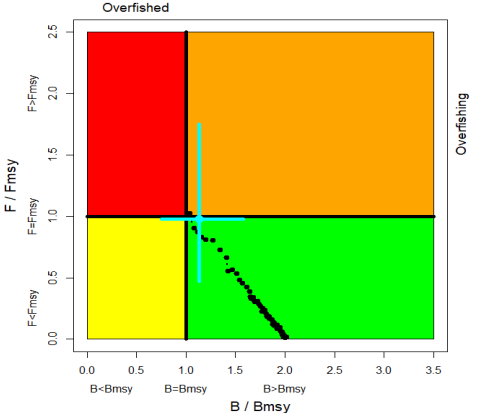
Narrow-barred Spanish mackerel

Indicators		2020 stock status determination[3]
Catch 2019[2] (MT)	152,574	73%
Average catch 2015-2019 (MT)	170,298	
MSY (MT) (80% CI)	157,760 (132,140–187,190)	
F_{MSY} (80% CI)	0.49 (0.25–0.87)	
B_{MSY} (MT) (80% CI)	323,500 (196,260–592,530)	
$F_{current}/F_{MSY}$ (80% CI)	1.24 (0.65–2.13)	
$B_{current}/B_{MSY}$ (80% CI)	0.80 (0.54–1.27)	



Kawakawa

Indicators		2020 stock status determination[3]
Catch 2019[2] (MT)	128,042	50%
Average catch 2015-2019 (MT)	148,084	
MSY (MT) (80% CI)	148,825 (124,114 – 222,505)	
F_{MSY} (80% CI)	0.44 (0.21–0.82)	
B_{MSY} (MT) (80% CI)	355,670 (192,080 – 764,530)	
$F_{current}/F_{MSY}$ (80% CI)	0.98 (0.85–1.11)	
$B_{current}/B_{MSY}$ (80% CI)	1.13 (0.75–1.58)	



STOCK ASSESSMENT MODELS

	Data-rich	Data-moderate	Data-poor
	Integrated assessment with age- (and gender-) structured models (SS3, SCAA, ASPM,…)	Age-aggregated models (JABBA, BSPM, ASPIC,..)	Data-limited methods (C-MSY, OCOM)
Catch series	✔	✔	✔
STD-CPUE	✔	✔	
Catch-at-size (or Catch-at-age)	✔		
Biological parameters	✔		
Tag-data	(✔)		

yellowfin, bigeye, skipjack, albacore, swordfish

billfish, marlins, shark

neritic species

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EXAMPLE (3) LONGTAIL TUNA

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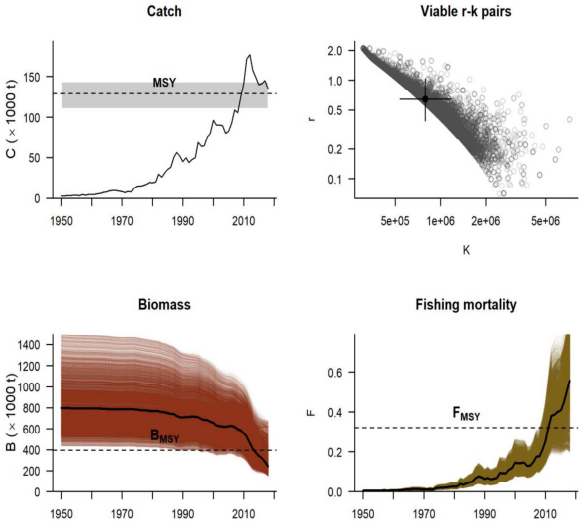
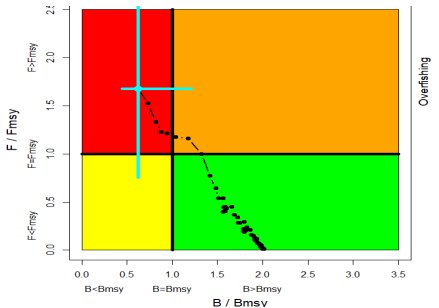
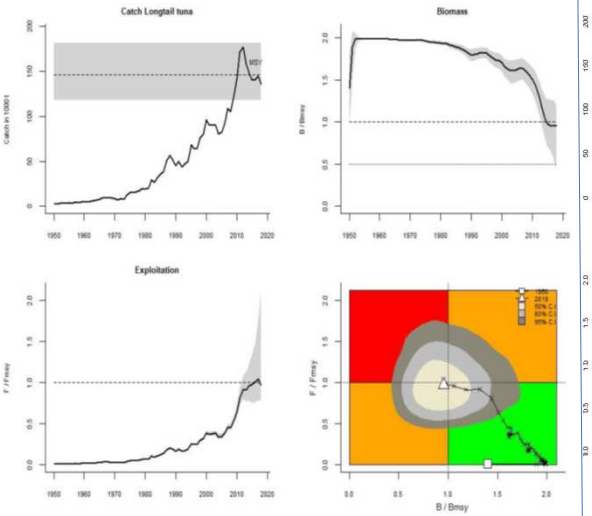
OCOM

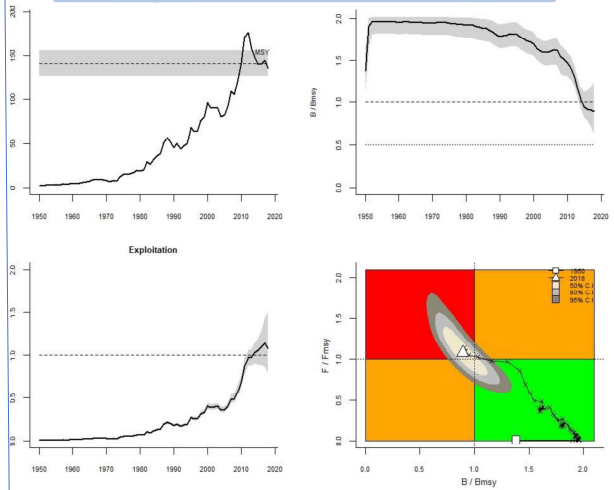




C-MSY



Bayesian Surplus Production (with CPUE)



- The OCOM model has provided more defensible approach in addressing the uncertainty of key parameters

  (e.g. the utilization of species-specific life history parameters)

- Bayesian production model was attempted as a trial and to encouraging to improve standardized CPUE in the future

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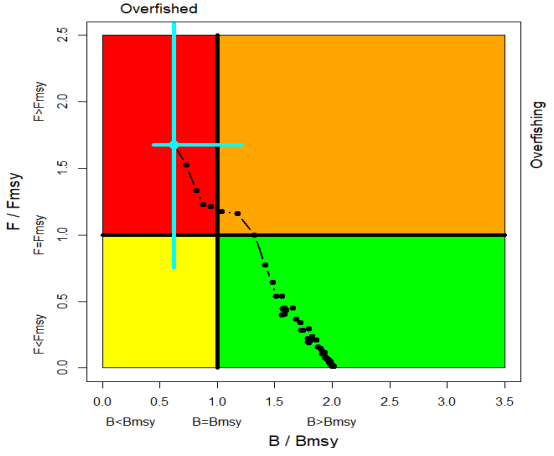
LONGTAIL TUNA

iotc ctoi

Area[1]	Indicators		2020 stock status determination
Indian Ocean	Catch 2019[2] (MT)	107,088	76%
	Average catch 2015–2019 (MT)	133,872	
	MSY (MT) (80% CI)	128,750 (99,902 – 151,357)	
	F_{MSY} (80% CI)	0.32 (0.15 – 0.66)	
	B_{MSY} (MT) (80% CI)	395,460 (129,240 – 751,316)	
	$F_{current}/F_{MSY}$ (80% CI)	1.52 (0.751 – 2.87)	
	$B_{current}/B_{MSY}$ (80% CI)	0.69 (0.45 – 1.21)	

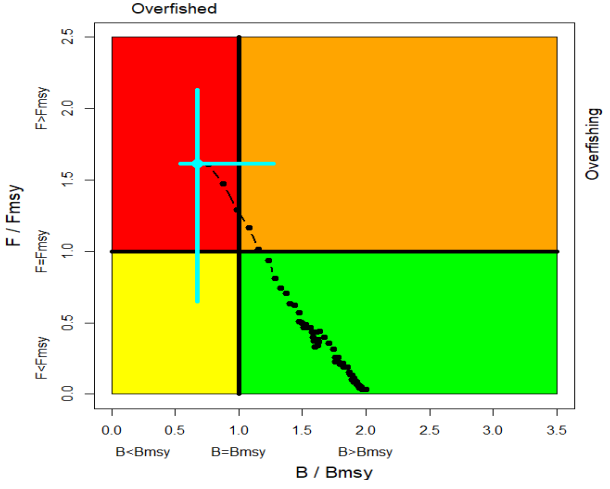


- The **OCOM** model indicated that F was above FMSY (F/FMSY=1.52) and B below BMSY (B/BMSY=0.69), with an estimated probability of 76% for the stock currently being in red quadrant of the Kobe plot.
- The recent catches are close to historical high levels and available gillnet CPUE showed declining catch rates, which is a cause of concern.
- On the weight-of-evidence available in 2020, the stock status is assessed to be both **overfished and subject to overfishing**. However the assessment models rely on catch data, which is considered to be highly uncertain.

- **Management advice.** The catch in 2018 was just below the estimated MSY but the exploitation rate has been increasing over the last few years, as a result of the declining abundance. Despite the substantial uncertainties, this suggests that the stock is very close to being fished at MSY levels and that higher catches may not be sustained. A precautionary approach to management is recommended

NARROW-BARRED SPANISH MACKEREL

Area[1]	Indicators		2020 stock status determination[3]
Indian Ocean	Catch 2019[2] (MT)	152,574	73%
	Average catch 2015-2019 (MT)	170,298	
	MSY (MT) (80% CI)	157,760 (132,140–187,190)	
	F_{MSY} (80% CI)	0.49 (0.25–0.87)	
	B_{MSY} (MT) (80% CI)	323,500 (196,260–592,530)	
	$F_{current}/F_{MSY}$ (80% CI)	1.24 (0.65–2.13)	
	$B_{current}/B_{MSY}$ (80% CI)	0.80 (0.54–1.27)	

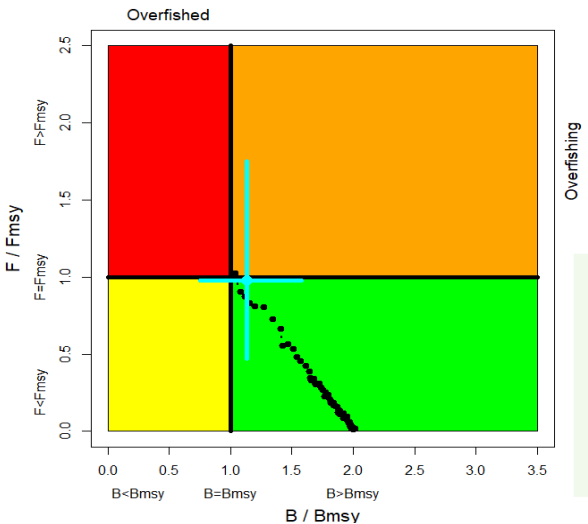


- The **OCOM** model indicated that F was above FMSY (F/FMSY=1.24) and B below BMSY (B/BMSY=0.89).
- The estimated probability of the stock currently being in red quadrant of the Kobe plot is about 73%.
- On the weight-of-evidence available in 2020, the stock status is assessed to be both **overfished and subject to overfishing**. However the assessment models rely on catch data, which is considered to be highly uncertain.

- **Management advice.** The catch in 2018 was just below the estimated MSY and the available Gillnet CPUE show a somewhat increasing trend in recent years although the reliability of the Index as abundance indices remains unknown. Despite the substantial uncertainties, the stock is probably very close to being fished at MSY levels and that higher catches may not be sustained.

KAWAKAWA

Area[1]	Indicators		2020 stock status determination[3]
Indian Ocean	Catch 2019[2] (MT)	128,042	50%
	Average catch 2015-2019 (MT)	148,084	
	MSY (MT) (80% CI)	148,825 (124,114 – 222,505)	
	F_{MSY} (80% CI)	0.44 (0.21–0.82)	
	B_{MSY} (MT) (80% CI)	355,670 (192,080 – 764,530)	
	$F_{current}/F_{MSY}$ (80% CI)	0.98 (0.85–1.11)	
	$B_{current}/B_{MSY}$ (80% CI)	1.13 (0.75–1.58)	



- The **OCOM** model indicated that F was just FMSY (F/FMSY=0.98) and B above BMSY (B/BMSY=1.13).
- The estimated probability of the stock currently being in green quadrant of the Kobe plot is about 50%.
- The available gillnet CPUE showed a somewhat increasing trend.
- On the weight-of-evidence available in 2020, the stock status is assessed to be **not overfished and not subject to overfishing**. However the assessment models rely on catch data, which is considered to be highly uncertain.

- **Management advice.** The catch in 2018 was above the estimated MSY. Despite the substantial uncertainties, the stock is probably very close to being fished at MSY levels and that higher catches may not be sustained in the longer term. A precautionary approach to management is recommended.

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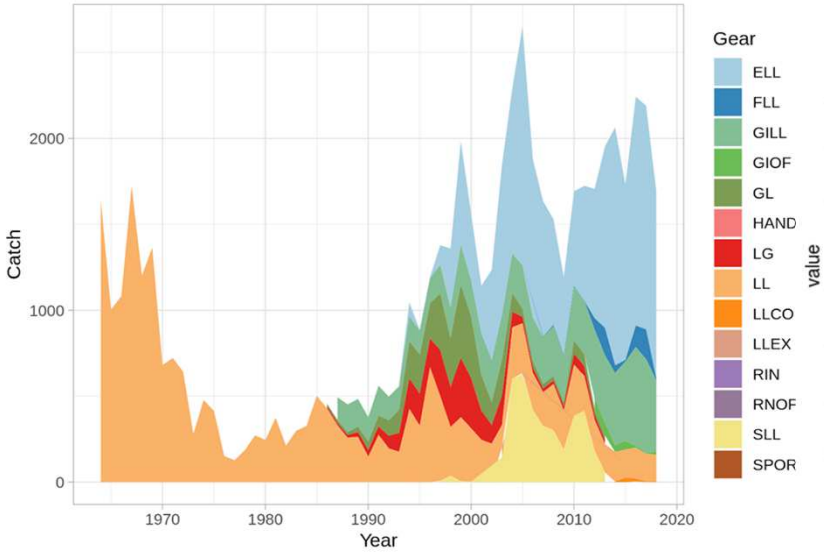
STOCK STATUS AND MANAGEMENT ADVICE (4)

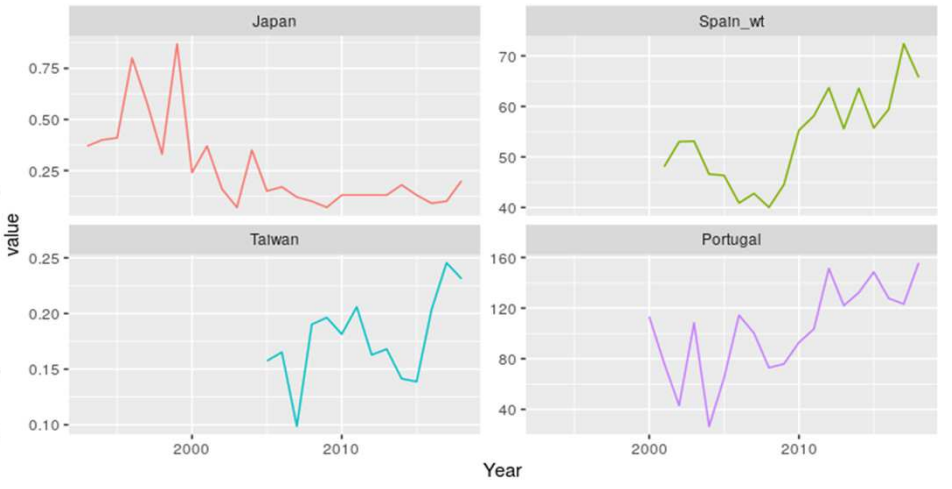
SHORTFIN MAKO SHARK

SHORTFIN MAKO SHARK

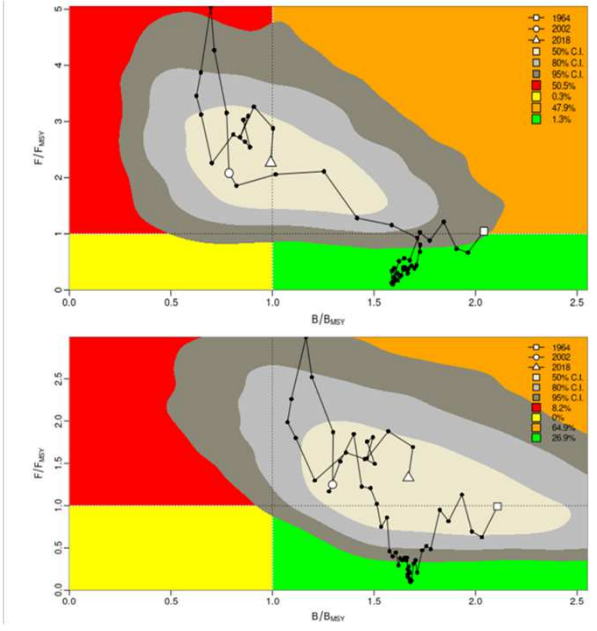
Catch in tonnes of SMA as reported by the CPCs to the IOTC



Standardised CPUE as reported to the IOTC
by Japan, EU,Spain, Taiwan,China, and EU,Portugal.



SHORTFIN MAKO SHARK



*The WPEB **AGREED** not to provide the management advice based on the stock assessment results due to several fundamental issues:*

1) *model misspecification;*
2) *data credibility of nominal catch;*
3) *selection of information utilized (e.g. productivity-r);*
4) *inability of aggregated biomass dynamic model (JABBA) to reconcile significant time delay (approx. 8+ years) between fishing and its effect on the spawning population.*

SHORTFIN MAKO SHARK

Indicators		2020 stock status determination
Reported catch 2019	1,087 t	
Not elsewhere included (nei) sharks[2] 2019	37,773 t	
Average reported catch 2015-19	1,789 t	
Av. not elsewhere included (nei) sharks[2] 2015-19	41,367 t	
MSY (1,000 t) (80% CI)	unknown	
F_{MSY} (80% CI)		
SB_{MSY} (1,000 t) (80% CI)		
$F_{current}/F_{MSY}$ (80% CI)		
$SB_{current}/SB_{MSY}$ (80% CI)		
$SB_{current}/SB_0$ (80% CI)		

10. Shortfin mako shark: IUCN threat status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[3]		
		Global status	WIO	EIO
Shortfin mako shark	*Isurus oxyrinchus*	Endangered	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean

[3]The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

Sources: IUCN Red List 2020, Cailliet 2009

There remains considerable uncertainty about the relationship between abundance, the standardised CPUE series, and total catches over the past decade

Management advice. In the absence of a stock assessment and noting conflicting information, the Commission should take a cautious approach by implementing management actions that reduce fishing mortality on shortfin mako sharks. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission so as to better inform scientific advice.

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STOCK STATUS AND MANAGEMENT ADVICE FOR YELLOWFIN TUNA

Food and Agriculture Organization of the United Nations

YELLOWFIN STOCK ASSESSMENT IN 2018

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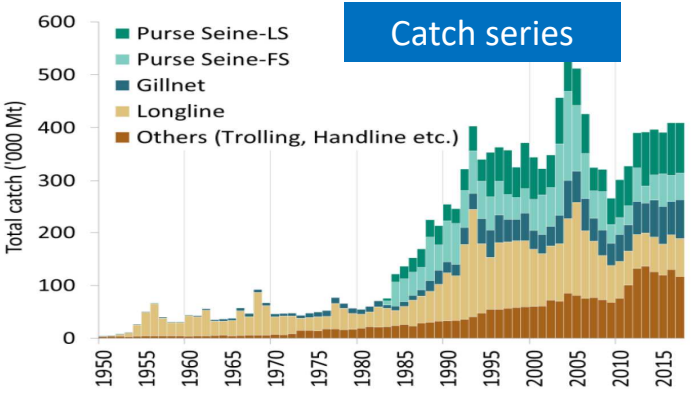
Catch series



Data: tagging data

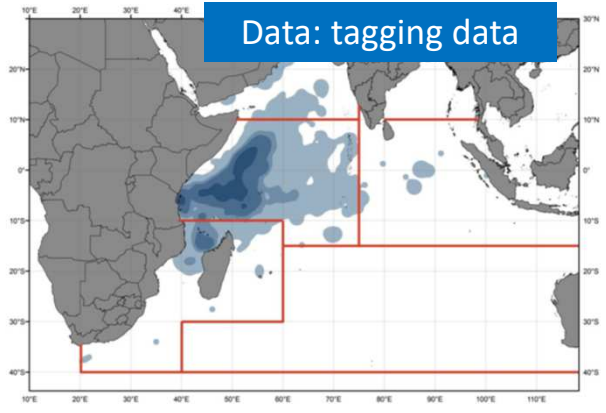
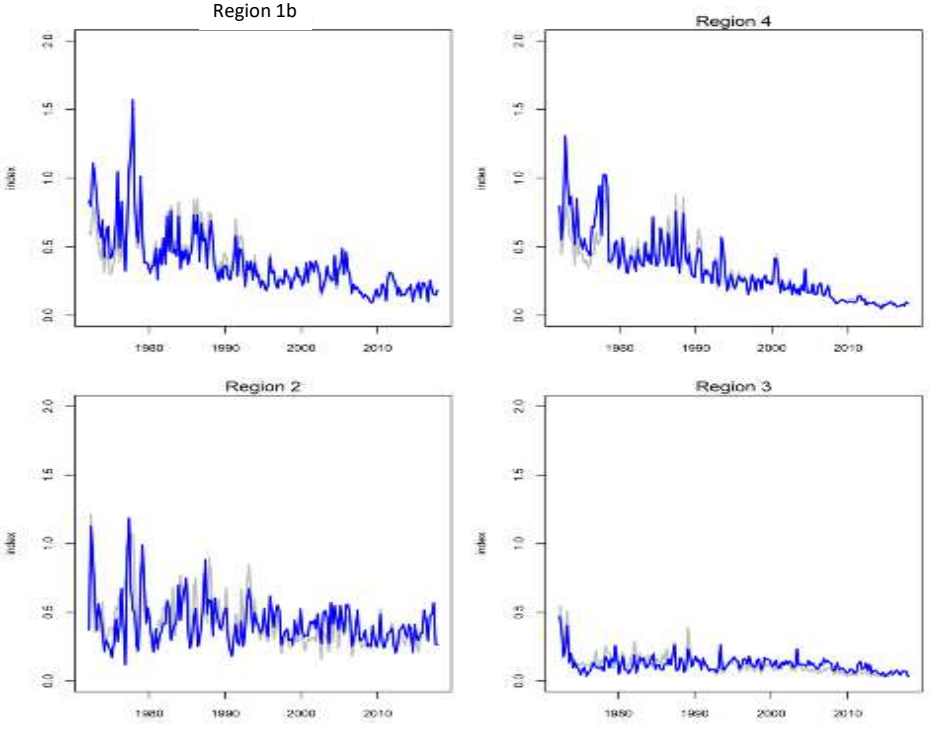
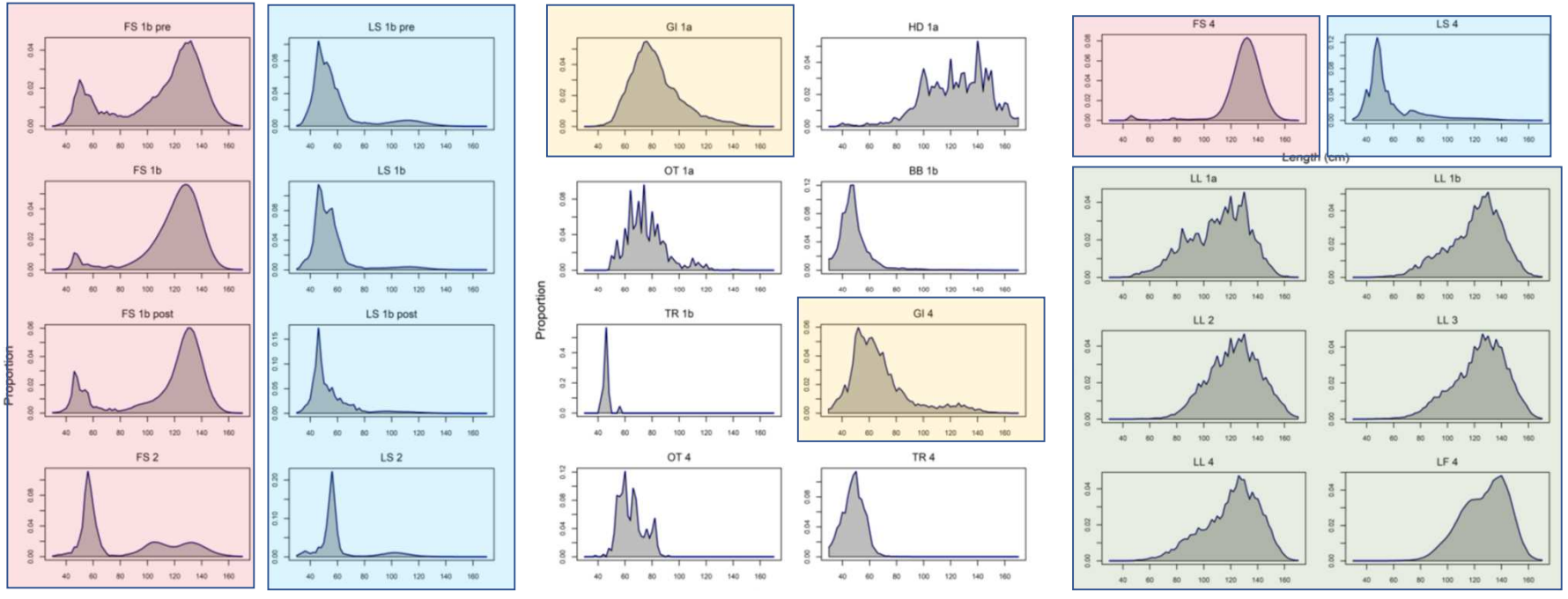


Figure 11: Density of RTTP-IO tag recoveries.

Abundance indices (longline joint CPUE)



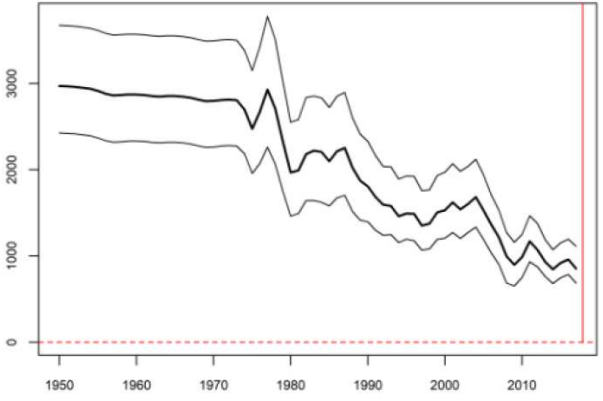
Data: size composition (aggregated over time)



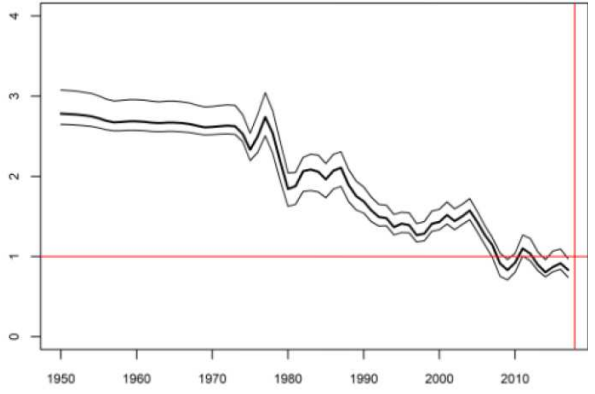
YELLOWFIN STOCK ASSESSMENT IN 2018

- 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]

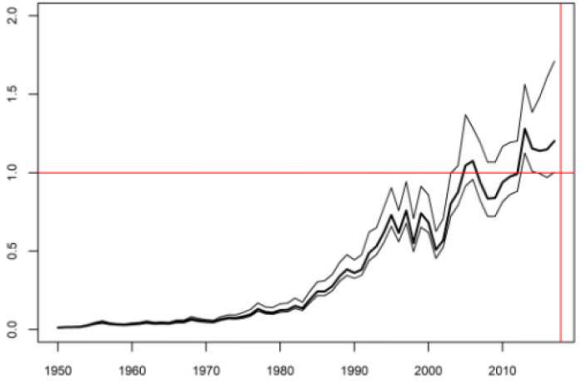
SSB (Spawning Stock Biomass)



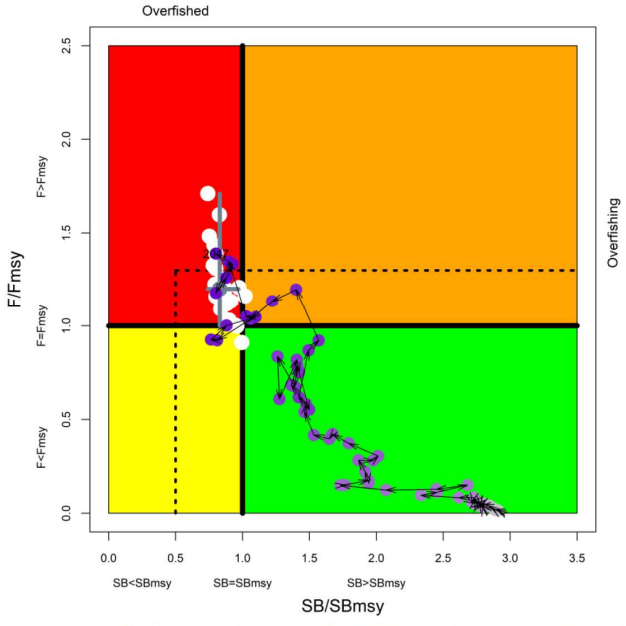
B-ratio (SSB/SSBMSY)



F-ratio (F/FMSY)



YELLOWFIN STOCK ASSESSMENT IN 2018



Area[1]	Indicators		2018 stock status[3] determination
Indian Ocean	Catch 2017[2]:	409,567t	
	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		

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 AND MANAGEMENT ADVIE 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. 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 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 means existing K2SM is no loner valid (the same problems for K2SM of 2016 assessment)

SC CHAIR'S STATEMENT IN 2020 COM

In COM in Nov 2020

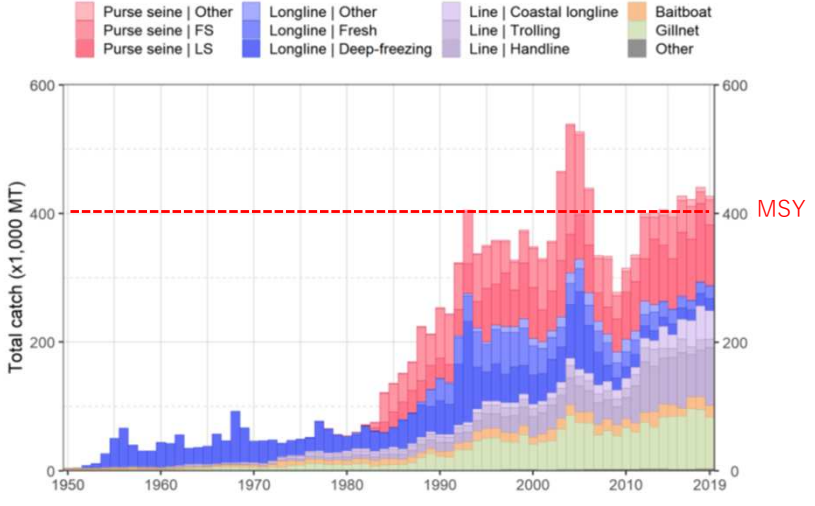
93. The Commission **NOTED** the need to agree on what scientific benchmarks will be used to inform any new CMMs relating to yellowfin tuna. The Commission further **NOTED** the 2019 advice from the Scientific Committee that the Kobe II Strategy Matrix developed in 2018 does not adequately reflect known 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.

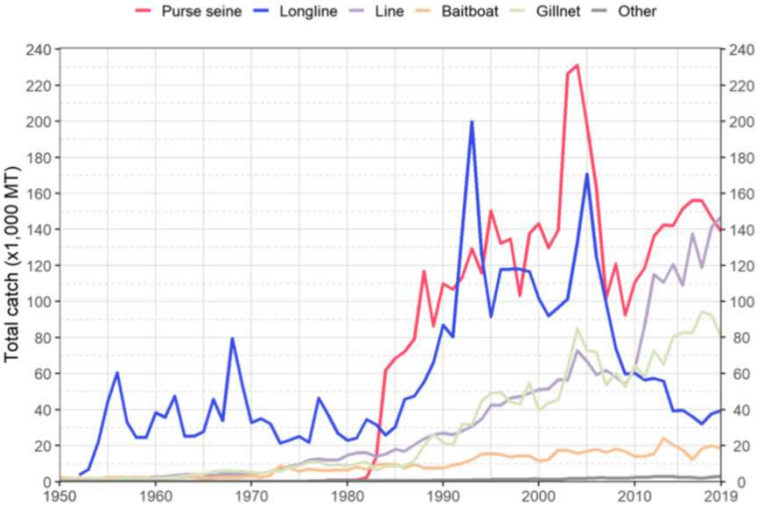
In SC in Dec 2020…..

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 (successfully finished)**
- **Stock assessment meeting in October 2021**

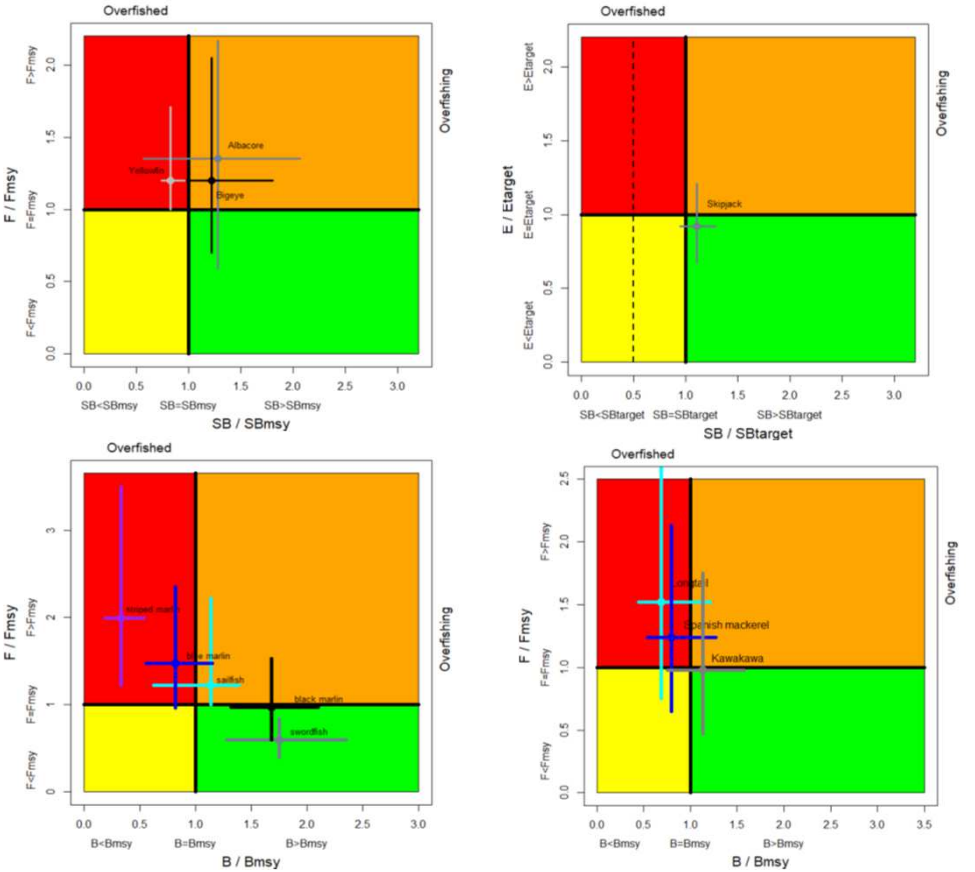
  - Transformation of the stock assessment model into an annual model using the latest version of SS3
  - Develop roadmap to select a new final grid using diagnostics of fit
  - Continue analyzing problems with projections and solutions
  - Changes in SS3 software (by developer)
  - Longline size frequency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

RECOMMENDATIONS TO THE COMMISSION

RECOMMENDATIONS TO THE COMMISSION (1)

SC23.01 – SC23.03

The SC **RECOMMENDED** that the Commission note the management advice developed for each species under the IOTC mandate (tropical, temperate, billfish, neritic tuna and mackerel), as provided in the Executive Summary for each species, and combined Kobe plots.



RECOMMENDATIONS TO THE COMMISSION (2)

Sharks

SC23.04 (para. 134) The SC **RECOMMENDED** that the Commission note the management advice developed for a subset of shark species commonly caught in IOTC fisheries for tuna and tuna-like species:

- Blue shark (*Prionace glauca*) – Appendix 23
- Oceanic whitetip shark (*Carcharhinus longimanus*) – Appendix 24
- Scalloped hammerhead shark (*Sphyrna lewini*) – Appendix 25
- Shortfin mako shark (*Isurus oxyrinchus*) – Appendix 26
- Silky shark (*Carcharhinus falciformis*) – Appendix 27
- Bigeye thresher shark (*Alopias superciliosus*) – Appendix 28
- Pelagic thresher shark (*Alopias pelagicus*) – Appendix 29

Marine turtles

SC23.05 (para. 135) The SC **RECOMMENDED** that the Commission note the management advice developed for marine turtles, as provided in the Executive Summary encompassing all six species found in the Indian Ocean:

- Marine turtles – Appendix 30

RECOMMENDATIONS TO THE COMMISSION (3)

Seabirds

SC23.06 (para. 136) The SC **RECOMMENDED** that the Commission note the management advice developed for seabirds, as provided in the Executive Summary encompassing all species commonly interacting with IOTC fisheries for tuna and tuna-like species:

- Seabirds – Appendix 31

Marine Mammals

SC23.07 (para. 137) The SC **RECOMMENDED** that the Commission note the management advice developed for cetaceans, as provided in the newly developed Executive Summary encompassing all species commonly interacting with IOTC fisheries for tuna and tuna-like species:

- Cetaceans – Appendix 32

RECOMMENDATIONS TO THE COMMISSION (4)

NATIONAL REPORTS FROM CPCS

SC23.08 (para. 31) **NOTING** that the Commission, at its 15th Session (in 2011), expressed concern regarding the limited submission of National Reports to the SC, and stressed the importance of providing the reports by all CPCs, the SC **RECOMMENDED** that the Commission note that in 2020, 25 reports were provided by CPCs (23 in 2019, 26 in 2018, 23 in 2017, 23 in 2016, 26 in 2015) (Table 2).

SC23.09 (para. 32) The SC **RECOMMENDED** that the Compliance Committee and Commission note the lack of compliance by 6 Contracting Parties (Members) and 2 Cooperating Non-Contracting Party (CNCPs) that did not submit a National Report to the Scientific Committee in 2020, noting that the Commission agreed that the submission of the annual reports to the Scientific Committee is mandatory

CPC	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Contracting Parties (Members)											
Australia											19 Nov
Bangladesh	n.a.	n.a.	n.a.	n.a.	n.a.						24 Nov
China											23 Nov
Comoros											1 Dec
Eritrea											
European Union											22 Nov
France (OT)											10 Nov
India											20 Nov
Indonesia											20 Nov
Iran, Islamic Rep. of											29 Nov
Japan											20 Nov
Kenya											1 Dec
Korea, Republic of											22 Nov
Madagascar											23 Nov
Malaysia											22 Nov
Maldives, Rep. of											22 Nov
Mauritius											22 Nov
Mozambique	n.a.										

CPC	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Contracting Parties (Members)											
Oman, Sultanate of											20 Nov
Pakistan											23 Nov
Philippines											22 Nov
Seychelles, Rep. of											20 Nov
Sierra Leone											
Somalia	n.a.	n.a.	n.a.	n.a.							30 Nov
Sri Lanka											19 Nov
South Africa, Rep. of											19 Nov
Sudan											
Tanzania, United Republic of											
Thailand											20 Nov
United Kingdom ("BIOT")											22 Nov
Yemen	n.a.	n.a.									
Cooperating Non-Contracting Parties											
Liberia	n.a.	n.a.	n.a.	n.a.	n.a.						
Senegal											

RECOMMENDATIONS TO THE COMMISSION (5)

REPORT OF THE 15TH SESSION OF THE WORKING PARTY ON ECOSYSTEMS AND BYCATCH (WPEB15)

Status of development and implementation of national plans of action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations

SC23.10 (para. 59) The SC **RECOMMENDED** that the Commission note the current status of development and implementation of National Plans of Action (NPOAs) for sharks and seabirds, and the implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations, by each CPC as provided in Appendix 5, recalling that the IPOA-Seabirds and IPOA-Sharks were adopted by the FAO in 1999 and 2000, respectively, and recommended the development of NPOAs.

RECOMMENDATIONS TO THE COMMISSION (6)

REPORT OF THE 2ND SESSION OF THE WORKING PARTY ON TROPICAL TUNAS (WPTT22)

Skipjack tuna Stock Assessment

SC23.11 (para. 78) The SC **NOTED** that the reference points for skipjack tuna are defined with respect to unfished spawning biomass only in resolution 16/02; nonetheless the notation is in terms of B (total exploitable biomass) instead of SB (spawning biomass). Although the resolution also specified Etarg (annual equilibrium exploitation rate associated with the unfished target spawning biomass), it was intended as a control parameter for the harvest control rule, rather than as an explicit target. Meanwhile Resolution 16/02 did not define a limit exploitation rate (Elim). The SC further **NOTED** that resolution 15/10 had specified a default depletion-based target and limit fishing mortality rate but it was discussed whether these are appropriate for skipjack tuna (the default values are defined only when MSY-based reference points can not be estimated robustly according to 15/10). As such the SC **RECOMMENDED** that the skipjack MSE project to revisit these reference points, including to investigate the plausibility of establishing a limit reference point for fishing mortality (or exploitation rate).) and to evaluate the .differences on the catch forecasts by using total biomass instead of spawning biomass in the HCR.

RECOMMENDATIONS TO THE COMMISSION (7)

REPORT OF THE 16TH SESSION OF THE WORKING PARTY ON DATA COLLECTION AND STATISTICS (WPDCS16)

SC23.12 (para. 107) Furthermore, the SC **RECOMMENDED** the Commission to consider how to best take into account the confidentiality aspects inherent to such a dataset (e.g. through updates to Res. 12/02) while at the same time ensuring proper attribution of its ownership (Refer to paras. 104 and 106 for qualifying details on this Recommendation)

SC23.13 (para. 109) **ACKNOWLEDGING** a potential lack of clarity in the current definition of "For reporting (Optional)" data elements in the context of the ROS minimum standard data fields, the SC **RECOMMENDED** that the Commission require CPCs to report such fields to the IOTC Secretariat (as part of their regular ROS data submissions) when these are available to the national observer programmes.

SC23.14 (para. 111) For this reason, the SC **RECOMMENDED** that an ad-hoc, intersessional Working Group on the development of EM Programme Standard be constituted and physical or virtual workshops (depending on the circumstances) be held to further progress with the definition of EMS minimum standards.

RECOMMENDATIONS TO THE COMMISSION (8)

SUMMARY DISCUSSION OF MATTERS COMMON TO WORKING PARTIES (CAPACITY BUILDING ACTIVITIES – STOCK ASSESSMENT COURSE; CONNECTING SCIENCE AND MANAGEMENT, ETC.)

Invited Expert(s) at the WP meetings

SC23.15 (para. 114) Given the importance of external independent review for working party meetings, the SC **RECOMMENDED** the Commission continues to allocate sufficient budget for invited scientific experts to be regularly invited to scientific working party meetings.

Meeting participation fund

SC23.16 (para. 116) The SC reiterated its **RECOMMENDATION** that the IOTC Rules of Procedure (2014), for the administration of the Meeting Participation Fund be modified so that applications are due not later than 60 days, and that the full Draft paper be submitted no later than 45 days before the start of the relevant meeting. The aim is to allow the Selection Panel to review the full paper rather than just the abstract, and provide guidance on areas for improvement, as well as the suitability of the application to receive funding using the IOTC MPF. The earlier submission dates would also assist with visa application procedures for candidates.

RECOMMENDATIONS TO THE COMMISSION (9)

IOTC species identification guides: Tuna and tuna-like species

SC23.17 (para. 117) The SC reiterated its **RECOMMENDATION** that the Commission allocates budget towards continuing the translation and printing of the IOTC species ID guides so that hard copies of the identification cards can continue to be printed as many CPCs scientific observers, both on board and at port, need to have hard copies.

SC23.18 (para. 118) The SC **RECOMMENDED** that the Commission note and endorse the Chairpersons and Vice-Chairpersons for the SC and its subsidiary bodies for the coming years, as provided in Appendix 7.

PROGRAM OF WORK AND SCHEDULE OF WORKING PARTY AND SCIENTIFIC COMMITTEE MEETINGS

Consultants

SC23.19 (para. 163) Noting the highly beneficial and relevant work done by IOTC stock assessment consultants in previous years, the SC **RECOMMENDED** that the engagement of consultants be continued for each coming year based on the Program of Work. Consultants will be hired to supplement the skill set available within the IOTC Secretariat and CPCs.

ASSESSMENT SCHEDULE

Working Party on Tropical Tunas					
Species	**2021**	**2022**	**2023**	**2024**	**2025**
Bigeye tuna	Indicators	**Data preparatory meeting** **Full assessment**	Indicators	Indicators	**Data preparatory meeting** **Full assessment**
Skipjack tuna	Indicators	Indicators	**Data preparatory meeting** **Full assessment**	Indicators	Indicators
Yellowfin tuna	**Data preparatory meeting** **Full assessment**	Indicators	Indicators	**Data preparatory meeting** **Full assessment**	Indicators

Working Party on Temperate Tunas					
Species	**2020**	**2021**	**2022**	**2023**	**2024**
Albacore		Review of previous assessment and preparation for next assessment	**Data preparatory meeting** **Full assessment**	–	–

ASSESSMENT SCHEDULE

Working Party on Neritic Tunas					
Species	**2021***	**2022****	**2023***	**2024****	**2025***
Bullet tuna	**Assessment**	Data preparation	Data preparation	**Assessment**	Data preparation
Frigate tuna	**Assessment**	Data preparation	Data preparation	**Assessment**	Data preparation
Indo-Pacific king mackerel	**Assessment**	Data preparation	Data preparation	**Assessment**	Data preparation
Kawakawa	Data preparation	Data preparation	**Assessment**	Data preparation	Data preparation
Longtail tuna	Data preparation	Data preparation	**Assessment**	Data preparation	Data preparation
Narrow-barred Spanish mackerel	Data preparation	Data preparation	**Assessment**	Data preparation	Data preparation

Working Party on Billfish					
Species	**2021**	**2022**	**2023**	**2024**	**2025**
Black marlin	**Full assessment**			**Full assessment**	
Blue marlin		**Full assessment**			**Full assessment**
Striped marlin	**Full assessment**			**Full assessment**	
Swordfish		**Indicators****	**Full assessment**		**Indicators****
Indo-Pacific sailfish		**Full assessment***			**Full assessment***

ASSESSMENT SCHEDULE

Working Party on Ecosystems and Bycatch					
Species	**2021**	**2022**	**2023**	**2024**	**2025**
Blue shark	Data preparatory meeting	-	–	–	Data preparatory meeting
Oceanic whitetip shark	–	Indicator analysis	–	Data preparation	Indicator analysis
Scalloped hammerhead shark	–	Assessment*	–	–	–
Shortfin mako shark	–	–		Data preparation Full assessment	–
Silky shark	Data preparatory meeting Assessment*;	-	–	Assessment*;	–
Bigeye thresher shark	–	Assessment*		–	–
Pelagic thresher shark	–	Assessment*		–	–
Porbeagle shark	–	–	Assessment*	–	–
Mobulid Rays				Interactions/ Indicators	–
Marine turtles	–	–	Indicators	–	–
Seabirds	–	Review of mitigation measures in Res. 12/06	–	–	–
Marine Mammals	Review of mitigation measures in Res. 12/13/04	–	–	–	Review of mitigation measures
Ecosystem Based Fisheries Management (EBFM) approaches	ongoing	ongoing	ongoing	ongoing	ongoing

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SCHEDULE OF MEETINGS IN 2021 AND 2022

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Meeting	2021 No.	2021 Date	2021 *Location	2022 No.	2022 Date	2022 *Location
Working Party on **Ecosystems and Bycatch** (WPEB) BSH Data Preparatory Meeting	17th	12-14 April	TBC	18th	NA	NA
Working Party on **Temperate Tunas**	08th	8 - 10 November (TBC)	TBC	9th	TBC	TBC
Working Party on **Tropical Tunas (Data Preparatory meeting)**	23rd	10-14 May	TBC	24th	TBC	TBC
Working Party on **Neritic Tunas**	11th	5-9 July	TBC	12th	TBC	TBC
Working Party on **Ecosystems and Bycatch** (WPEB)	17th	6-10 September (5d)	TBC	18th	TBC	TBC
Working Party on **Billfish** (WPB)	19th	13-16 September (4d)	TBC	20th	TBC	TBC
Ad hoc Working Group on FADs (WGFAD)	2nd	4-6 October	TBC	3rd	TBC	TBC
Working Party on **Methods**	12th	18-20 October (3d)	TBC	13th	October (3d)	TBC
Working Party on **Tropical Tunas** (Assessment meeting)	23rd	21-26 October (6d)	TBC	24th	October (6d)	TBC
Working Party on **Data Collection and Statistics**	17th	1-3 December (3d)	TBC	18th	November (3d)	TBC
Scientific Committee	24th	6-10 December (5d)	TBC	25th	December (5d)	TBC

- Data preparatory meetings are useful and important
- Due to the Covid-19 crisis and the cancellation of physical meetings for the foreseeable future, offers to host meetings in 2021 were not requested or accepted.

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RECOMMENDATIONS TO THE COMMISSION (10)

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REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE 23RD SESSION OF THE SCIENTIFIC COMMITTEE

SC23.20 (para. 168) The SC **RECOMMENDED** that the Commission consider the consolidated set of recommendations arising from SC23, provided at Appendix 38.

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THANK YOU SO MUCH FOR KIND ATTENTION