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REFERENCE DOCUMENT FOR THE REVIEW OF CMM 2019-02 AND DEVELOPMENT OF HARVEST STRATEGIES (PACIFIC BLUEFIN TUNA)

WCPFC17-2020-18
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Paper prepared by the Secretariat

A. INTRODUCTION

1. The purpose of this paper is to provide a quick reference guide to the recommendations of the Scientific Committee (SC) and Northern Committee (NC) of relevance to the discussions on stock status and management advice for Pacific bluefin tuna. The proposed amendments to the existing CMM for Pacific bluefin tuna (CMM 2019-02) were taken from the NC16 Summary Report, and the status of developing harvest strategies for Pacific bluefin tuna is briefed in Section D.

B. SCIENTIFIC COMMITTEE RECOMMENDATIONS

2. The ISC Bluefin Tuna Working Group conducted a benchmark stock assessment for Pacific bluefin tuna in March 2020 (SC16-SA-WP-06[1]). Several modifications, such as the spatio-temporal modeling for CPUE standardization, more detailed modeling of fisheries, inclusions of newly available size data and discard information, and bias correction for the projection results, were made to improve the assessment. The ISC plenary considered the 2020 assessment results as the best available scientific information on Pacific bluefin tuna. Detailed discussions are in Paragraphs 150 – 166 of the SC16 Summary Report, and full text of stock status and management advice are in **Attachment A** and highlighted below.

a. Stock Status and trends

3. SC16 noted the stock status from ISC, which is briefly highlighted below:

> The WCPFC and IATTC adopted an initial rebuilding biomass target (median SSB for 1952 – 2014) and a second rebuilding biomass target (20%$SSB_{F=0}$) without specifying a fishing mortality reference level. The 2020 assessment estimated $SSB_{MED1952-2014}$ to be 6.4%$SSB_{F=0}$ and the corresponding fishing mortality expressed as $F_{6.4\%SPR}$. The Kobe plot shows that the point estimate of the SSB_{2018} was 4.5%$SSB_{F=0}$ and the recent (2016-2018) fishing mortality corresponds to $F_{14\%SPR}$. An evaluation of stock status against common reference points shows that the stock is

[1] https://www.wcpfc.int/node/46614

overfished relative to 20%$SSB_{F=0}$ and fishing mortality has declined but not reached the level corresponding to that reference point ($F_{20\%SPR}$).

The Pacific bluefin tuna SSB has gradually increased in the last 8 years (2011-2018), and young fish (age 0-2) shows a more rapid increase in recent years, where these changes in biomass coincide with a decline in fishing mortality over the last decade. Based on these findings, the following information on the status of the Pacific bluefin tuna stock is provided:

1. The latest SSB_{2018} is estimated to be 4.5% of $SSB_{F=0}$ which is increased from 4.0% in 2016. The PBF stock is overfished relative to the potential biomass-based reference points (SSB_{MED} and 20%$SSB_{F=0}$).
2. The recent (2016-2018) $F_{\%SPR}$ is estimated to produce 14%SPR, where recent fishing mortality is above the level producing 20%SPR.

b. Management advice and implications

4. The estimated recruitments for 2017 and 2018 are the lowest since early 1990s, noting that the recruitment in these years is uncertain. The majority of CCMs noted that future recruitments may remain low until there is sufficient recovery in spawning biomass. Therefore, the majority of CCMs reiterate their advice from SC14 and urge the Commission to take a precautionary approach to the management of Pacific Bluefin tuna, especially in relation to the timing of increasing catch levels, until the rebuilding of the stock to higher biomass levels is achieved.

5. SC16 also noted the conservation information from ISC, which is briefly highlighted below:

After the steady decline in SSB from 1995 to the historically low level in 2010, the Pacific bluefin tuna stock has started recovering slowly. The projection results show that, in most of the scenarios, the SSB is projected to recover to the initial rebuilding target ($SSB_{MED1952-2014}$) in April of 2021 with a probability above 60% prescribed in the CMM 2019-02. Because the projections include catch limits, fishing mortality ($F_{x\%SPR}$) is expected to decline, i.e., SPR will increase, as biomass increases. Further stratification of future impacts is possible if the allocation of increased catch limits among fleets/countries is specified.

Based on these findings, the following conservation information is provided:

1) Under all examined scenarios, rebuilding to $SSB_{MED1952-2014}$ by 2024 with at least 60% probability is reached. This projection results assume that bluefin measures are fully implemented with the assumption of no discard mortality.
2) Given the low SSB, uncertainty in future recruitment and the influence of recruitment on stock biomass, monitoring recruitment and SSB should continue so that the recruitment level can be understood in a timely manner.

C. NORTHERN COMMITTEE RECOMMENDATIONS

6. The NC16 recommends that the Commission adopt the revised Conservation and Management Measure for Pacific Bluefin Tuna for one-year roll-over in **Attachment B.** (Paragraph 10, NC16 Summary Report)

D. DEVELOPMENT OF HARVEST STRATEGIES FOR PACIFIC BLUEFIN TUNA

7. In 2017, the Commission adopted the Harvest Strategy for Pacific Bluefin Tuna Fisheries (**Attachment C**) and the first Pacific Bluefin Tuna Management Strategy Evaluation (MSE) Workshop was

convened in Yokohama in May 2018 in preparation for undertaking an MSE process beginning in 2019. The workshop was intended to begin discussions on management objectives and performance indicators.

8. In 2018, NC15 adopted the terms of reference for the Pacific bluefin tuna MSE (**Attachment D**) and candidate reference points and harvest control rules for Pacific bluefin tuna (**Attachment E**).

9. The second Pacific Bluefin Tuna MSE Workshop was convened in San Diego, USA, in May 2019 to begin discussions on management objectives and performance indicators from eastern Pacific Ocean managers and stakeholders. It was noted that governance and management of a Pacific bluefin tuna MSE process will be more challenging than the Albacore MSE because of the diversity of fisheries and interests on both sides of the Pacific Ocean. (Paragraph 6, NC15 Summary Report)

10. In 2020, there was no Pacific Bluefin Tuna MSE Workshop due to COVID-19 pandemic. However, Japan expressed their continued commitment to developing an MSE for PBF by 2024. (Paragraph 20, NC16 Summary Report)

Attachment A
(Paragraphs 159 – 166, SC16 Summary Report)

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean
Scientific Committee
Sixteenth Regular Session
Electronic Meeting
12 – 19 August 2020

PACIFIC BLUEFIN TUNA STOCK ASSESSMENT
(Refer to Paragraphs 150 – 166 of the SC16 Summary Report for the detailed discussions)

Provision of scientific information

1. ISC presented a working paper *Stock assessment of Pacific Bluefin tuna in the Pacific Ocean in 2020* (SC16-SA-WP-06[2]) and full text for the stock status and management advice are annexed below.

a. Stock status and trends

2. **SC16 noted that the ISC provided the following conclusions on the stock status of Pacific bluefin tuna.**

> The base-case model results show that: (1) spawning stock biomass (SSB) fluctuated throughout the assessment period (fishing years 1952-2018); (2) the SSB steadily declined from 1996 to 2010; (3) there has been a slow increase of the stock biomass continues since 2011; (4) total biomass in 2018 exceeded the historical median with an increase in immature fish; and (5) fishing mortality ($F_{\%SPR}$) declined from a level producing about 1% of SPR[3] in 2004-2009 to a level producing 14% of SPR in 2016- 2018 (Table PBF-1). Based on the model diagnostics, the estimated biomass trend for the last 30 years is considered robust although SSB prior to the 1980s is uncertain due to data limitations. The SSB in 2018 was estimated to be around 28,000 mt (Table PBF-1 and Figure PBF-1), which is a 3,000 mt increase from 2016 according to the base-case model. An increase of young fish (0-2 years old) is observed in 2016-2018 (Figure PBF-2), likely resulting from low fishing mortality on those fish (Figure PBF-3) and is expected to accelerate the recovery of SSB in the future.
>
> Historical recruitment estimates have fluctuated since 1952 without an apparent trend. Relatively low recruitment levels estimated in 2010-2014 were of concern in the 2016 assessment. The 2015 recruitment estimate is lower than the historical average while the 2016 recruitment estimate (about 17 million fish) is higher than the historical average (Table PBF-1 and Figure PBF-1). The recruitment estimates for 2017 and 2018, which are based on fewer observations and more uncertain, are below the historical average.

[2] https://www.wcpfc.int/node/46614

[3] SPR (spawning potential ratio) is the ratio of the cumulative spawning biomass that an average recruit is expected to produce over its lifetime when the stock is fished at the current fishing level to the cumulative spawning biomass that could be produced by an average recruit over its lifetime if the stock was unfished. F%SPR: F that produces % of the spawning potential ratio.

Estimated age-specific fishing mortalities (F) on the stock during the periods of 2011-2013 and 2016-2018 compared with 2002-2004 estimates (the reference period for the WCPFC Conservation and Management Measure) are presented in Figure PBF-3. A substantial decrease in estimated F is observed in ages 0-2 in 2016-2018 relative to the previous years. Note that stricter management measures in the WCPFC and IATTC have been in place since 2015.

Figure PBF-5 depicts the historical impacts of the fleets on the PBF stock, showing the estimated biomass when fishing mortality from the respective fleets is zero. Historically, the WPO coastal fisheries group has had the greatest impact on the PBF stock, but since about the early 1990s the WPO purse seine fishery group targeting small fish (ages 0-1) has had a greater impact and the effect of this group in 2018 was greater than any of the other fishery groups. The impact of the EPO fisheries group was large before the mid-1980s, decreasing significantly thereafter. The WPO longline fisheries group has had a limited effect on the stock throughout the analysis period because the impact of a fishery on a stock depends on both the number and size of the fish caught by each fleet; i.e., catching a high number of smaller juvenile fish can have a greater impact on future spawning stock biomass than catching the same weight of larger mature fish. There is greater uncertainty regarding discards than other fishery impacts because the impact of discarding is not based on observed data.

3. **SC16 noted the following stock status from ISC:**

The WCPFC and IATTC adopted an initial rebuilding biomass target (the median SSB estimated for the period from 1952 through 2014) and a second rebuilding biomass target (20%$SSB_{F=0}$ under average recruitment), without specifying a fishing mortality reference level. The 2020 assessment estimated the initial rebuilding biomass target ($SSB_{MED1952-2014}$) to be 6.4%$SSB_{F=0}$ and the corresponding fishing mortality expressed as $F_{6.4\%SPR}$. The Kobe plot shows that the point estimate of the SSB_{2018} was 4.5%$SSB_{F=0}$ and the recent (2016-2018) fishing mortality corresponds to $F_{14\%SPR}$ (Table PBF-1 and Figure PBF-4). Although no reference points have been adopted to evaluate the status of PBF, an evaluation of stock status against some common reference points (Table PBF-2) shows that the stock is overfished relative to biomass-based limit reference points adopted for other species in WCPFC (20%$SSB_{F=0}$) and fishing mortality has declined but not reached the level corresponding to that reference point ($F_{20\%SPR}$).

The PBF spawning stock biomass (SSB) has gradually increased in the last 8 years (2011-2018). Young fish (age 0-2) shows a more rapid increase in recent years (Figure PBF-1 and PBF-2). These changes in biomass coincide with a decline in fishing mortality over the last decade (Figure PBF-3). Based on these findings, the following information on the status of the Pacific bluefin tuna stock is provided:

1. **The latest (2018) SSB is estimated to be 4.5% of $SSB_{F=0}$ which is increased from 4.0% in 2016 (Figure PBF-4 and Table PBF-1). No biomass-based limit or target reference points have been adopted for PBF. However, the PBF stock is overfished relative to the potential biomass-based reference points (SSB_{MED} and 20%$SSB_{F=0}$) adopted for other tuna species by the IATTC and WCPFC.**
2. **The recent (2016-2018) $F_{\%SPR}$ is estimated to produce 14%SPR (Figure PBF-4 and Table PBF-2). Although no fishing mortality-based limit or target reference points have been adopted for PBF by the IATTC and WCPFC, recent fishing mortality is above the level producing 20%SPR. However, the stock is subject to rebuilding measures including catch limits and the capacity of the stock to rebuild is not compromised, as shown by the projection results.**

4. **In addition, SC16 noted that, although the WCPFC has not established any reference points for PBF, recent fishing mortality is above the level producing 20%SPR, which is the second rebuilding target established by the WCPFC indicating that overfishing is taking place relative to the possible reference point of 20%SPR and some of the other commonly used F-related reference points. SC16 also noted that the projection results, while projected from a single base case model, estimate that the stock may continue to rebuild.**

5. **SC16 noted that regarding the probability of meeting the rebuilding targets, the approach taken in this assessment is not based on the structural uncertainty grid approach used to characterize uncertainty in the assessment of other stocks in the WCPO. The majority of CCMs recommend that such an approach is adopted in future, especially when using these models to drive management action.**

6. **However, ISC currently does not see the need for structural uncertainty grid because of internally consistency of the assessment model of PBF.**

b. Management advice and implications

7. **SC16 noted that the improved recruitment in 2016, relative to recent years, noted by SC14 in the previous assessment has now been followed by two much lower recruitments. Apart from the low recruitment in 2014 these estimated recruitments for 2017 and 2018 are the lowest since the early 1990s, while noting that the recruitment in these years is uncertain. The majority of CCMs noted that, given ongoing uncertainty in the stock-recruitment relationship and the very low levels of current spawning biomass estimated by this assessment (4.5%), future recruitments may remain low until there is sufficient recovery in spawning biomass. Indeed, the increase seen in young fish in recent years may be transient unless followed up with a series of higher recruitments.**

8. **While SC16 recognized the existence of an interim Harvest Strategy for this stock, noting ongoing concerns of low stock size, the current level of overfishing relative to the possible reference point of 20%SPR and some of the other commonly used F-related reference points, and uncertain future recruitments, the majority of CCMs reiterate their advice from SC14 and urge the Commission to take a precautionary approach to the management of Pacific Bluefin tuna, especially in relation to the timing of increasing catch levels, until the rebuilding of the stock to higher biomass levels is achieved.**

9. **SC16 also noted the following conservation information from ISC:**

> After the steady decline in SSB from 1995 to the historically low level in 2010, the PBF stock has started recovering slowly, consistent with the management measures implemented in 2014-2015. The spawning stock biomass in 2018 was below the two biomass rebuilding targets adopted by the WCPFC while the 2016-18 fishing mortality ($F_{\%SPR}$) has reduced to a level producing 14%SPR.
> The projection results based on the base-case model under several harvest and recruitment scenarios and time schedules requested by the RFMOs are shown in Tables PBF3 and PBF4. The projection results show that PBF SSB recovers to the biomass-based rebuilding targets due to reduced fishing mortality by applying catch limits as the stock increases (Figure PBF-6). In most of the scenarios, the SSB biomass is projected to recover to the initial rebuilding target (SSB_{MED}) in the fishing year 2020 (April of 2021) with a probability above the 60% level prescribed in the WCPFC CMM 2019-02 (Table PBF-4).
> A Kobe chart and impacts by fleets estimated from future projections under the current management scheme are provided for information, (Figures PBF6 and PBF7, respectively).

Because the projections include catch limits, fishing mortality ($F_{x\%SPR}$) is expected to decline, i.e., SPR will increase, as biomass increases. Further stratification of future impacts is possible if the allocation of increased catch limits among fleets/countries is specified.

Based on these findings, the following conservation information is provided:

1. **Under all examined scenarios the initial goal of WCPFC and IATTC, rebuilding to SSB_{MED} by 2024 with at least 60% probability, is reached and the risk of SSB falling below historical lowest observed SSB at least once in 10 years is negligible.**
2. **The projection results assume that the CMMs are fully implemented and are based on certain biological and other assumptions. For example, these future projection results do not contain assumptions about discard mortality. Although the impact of discards on SSB is small compared to other fisheries (Figure PBF-7), discards should be considered in the harvest scenarios.**
3. **Given the low SSB, the uncertainty in future recruitment, and the influence of recruitment has on stock biomass, monitoring recruitment and SSB should continue so that the recruitment level can be understood in a timely manner.**

Table PBF-1. Total biomass, spawning stock biomass, recruitment, and spawning potential ratio of Pacific bluefin tuna (*Thunnus orientalis*) estimated by the base-case model, 1952-2018.

Fishing Year	Total Biomass (t)	Spawning Stock Biomass (t)	Recruitment (1,000 fish)	Spawning Potential Ratio
1952	134,751	103,502	4,857	0.11
1953	136,428	97,941	20,954	0.13
1954	146,741	87,974	34,813	0.08
1955	156,398	75,360	13,442	0.11
1956	175,824	67,700	33,582	0.16
1957	193,597	76,817	11,690	0.11
1958	201,937	100,683	3,195	0.19
1959	209,300	136,430	7,758	0.23
1960	202,121	144,411	7,731	0.17
1961	193,546	156,302	23,339	0.03
1962	176,618	141,277	10,737	0.11
1963	165,892	120,244	28,112	0.07
1964	154,192	105,870	5,696	0.07
1965	142,548	93,222	10,710	0.03
1966	119,683	89,236	8,680	0.00
1967	105,084	83,208	10,897	0.01
1968	91,408	77,466	14,535	0.01
1969	80,523	64,299	6,484	0.09
1970	74,222	53,961	7,027	0.03
1971	66,114	46,839	12,420	0.01
1972	64,114	40,447	23,552	0.00
1973	63,023	35,273	10,968	0.06
1974	64,885	28,502	13,322	0.06
1975	65,074	26,410	11,252	0.08
1976	64,512	29,274	9,253	0.03
1977	74,670	35,105	25,601	0.04
1978	76,601	32,219	14,037	0.06
1979	73,615	27,093	12,650	0.08
1980	72,809	29,657	6,910	0.05
1981	57,482	27,928	13,340	0.00
1982	40,398	24,240	6,512	0.00
1983	33,210	14,456	10,133	0.06
1984	37,464	12,651	9,184	0.05
1985	39,591	12,817	9,676	0.03
1986	34,349	15,147	8,181	0.01
1987	32,008	13,958	6,026	0.08
1988	38,086	14,931	9,304	0.11
1989	41,849	14,839	4,409	0.14
1990	58,122	18,953	18,096	0.18
1991	69,351	25,294	10,392	0.10
1992	76,228	32,252	3,958	0.15
1993	83,624	43,639	4,450	0.16
1994	97,731	50,277	29,314	0.14
1995	94,279	62,784	16,533	0.05
1996	96,463	61,826	17,787	0.09
1997	90,349	56,393	11,259	0.06
1998	95,977	55,888	16,018	0.04
1999	92,232	51,705	22,842	0.04
2000	76,795	48,936	14,383	0.02
2001	78,052	46,408	17,384	0.10
2002	76,110	44,492	13,761	0.06
2003	68,707	43,806	7,110	0.02
2004	66,433	36,701	27,930	0.01
2005	55,778	30,004	15,256	0.01
2006	43,912	24,089	13,660	0.01
2007	43,765	19,061	23,146	0.00
2008	39,646	14,805	21,265	0.01
2009	35,135	11,422	8,002	0.01
2010	38,053	10,837	18,230	0.02
2011	38,901	12,096	12,574	0.05
2012	41,058	14,578	6,845	0.07
2013	49,383	16,703	12,798	0.05
2014	47,864	18,503	3,783	0.09
2015	52,725	21,014	8,778	0.10
2016	62,069	25,009	16,504	0.10
2017	71,228	25,632	6,663	0.17
2018	82,212	28,228	4,658	0.15
Median (1952-2018)	73,615	35,273	11,259	0.06
Average(1952-2018)	86,908	49,388	13,199	0.07

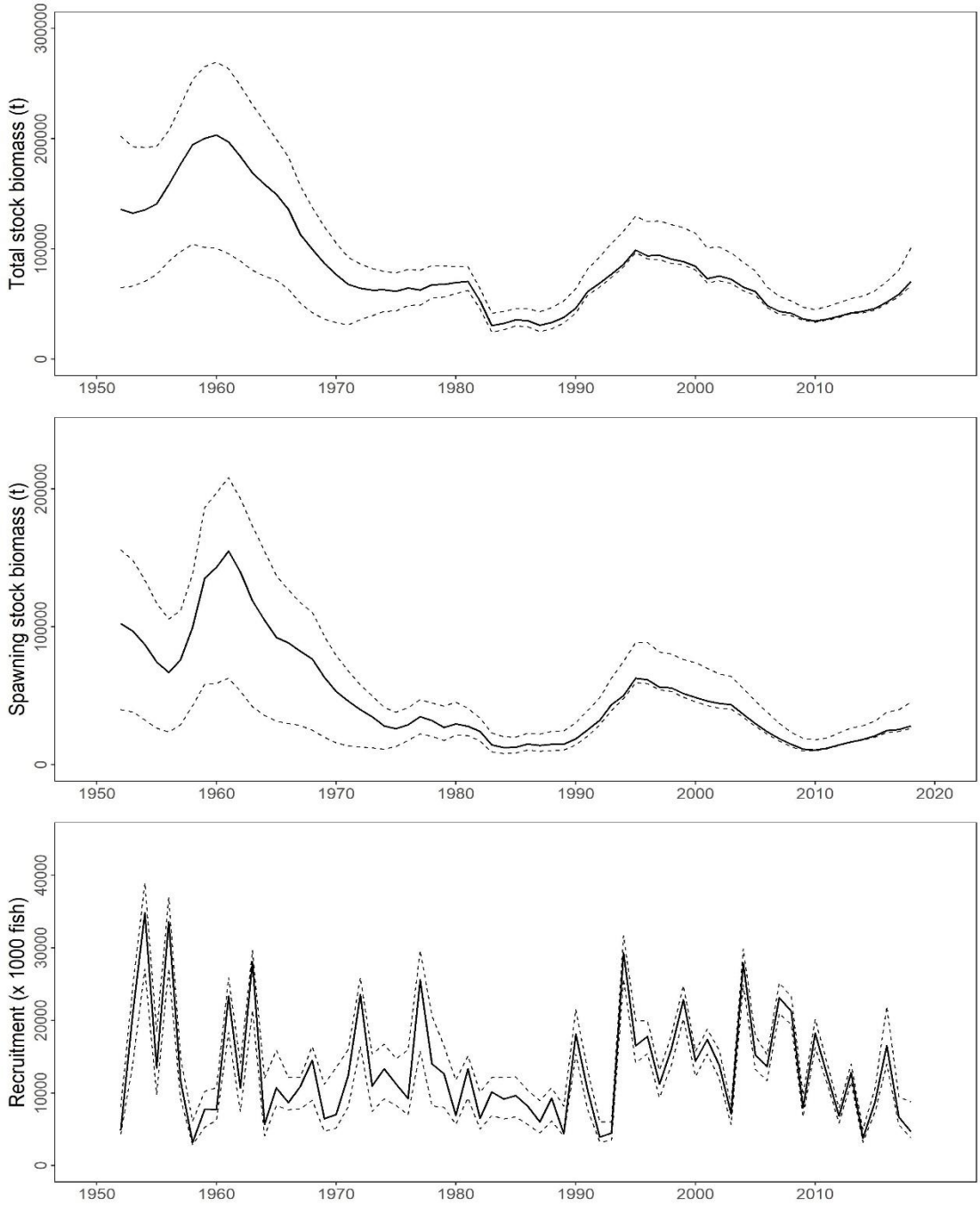

Figure PBF-1. Total stock biomass (top), spawning stock biomass (middle), and recruitment (bottom) of Pacific bluefin tuna (*Thunnus orientalis*) (1952-2018) estimated from the base-case model. The solid line is the point estimate and dashed lines delineate the 90% confidence interval.

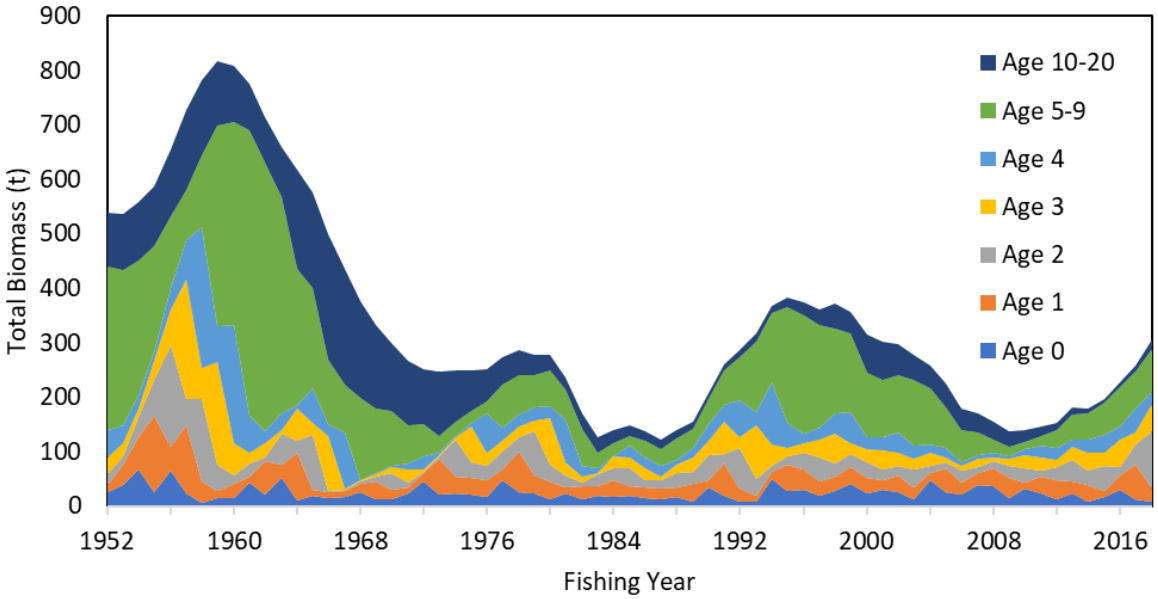

Figure PBF-2. Total biomass (tonnes) by age of Pacific bluefin tuna (*Thunnus orientalis*) estimated from the base-case model (1952-2018).

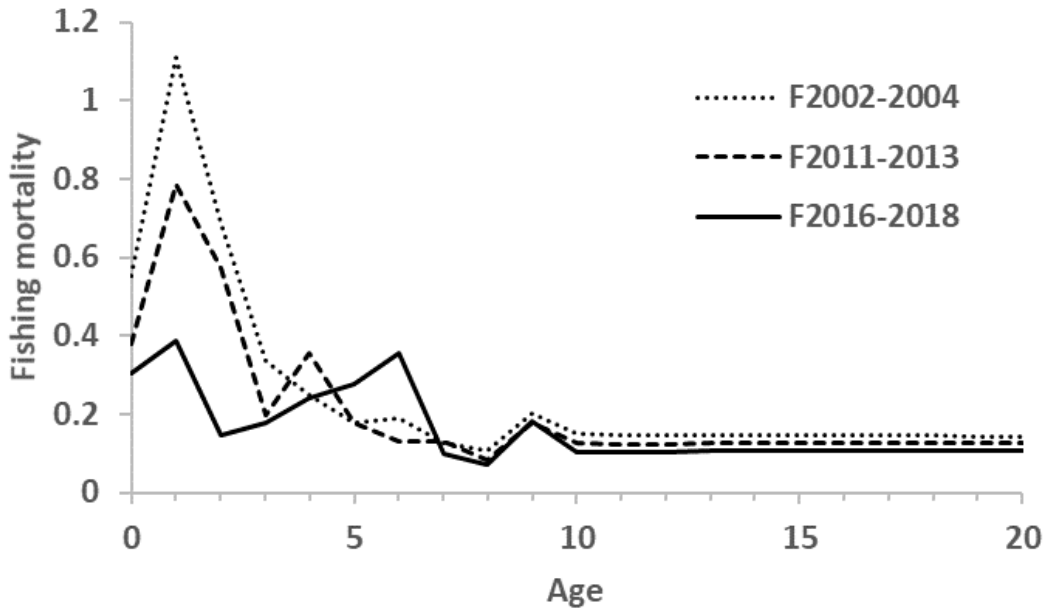

Figure PBF-3. Geometric means of annual age-specific fishing mortalities (F) of Pacific bluefin tuna (*Thunnus orientalis*) for 2002-2004 (dotted line), 2011-2013 (broken line) and 2016-2018 (solid line).

Table PBF-2. Ratios of the estimated fishing mortalities (Fs and 1-SPRs for 2002-04, 2011-13, 2016-18) relative to potential fishing mortality-based reference points, and terminal year SSB (t) for each reference period, and depletion ratios for the terminal year of the reference period for Pacific bluefin tuna (*Thunnus orientalis*) from the base-case model**.** F_{max}: Fishing mortality (F) that maximizes equilibrium yield per recruit (Y/R). $F_{0.1}$: F at which the slope of the Y/R curve is 10% of the value at its origin. F_{med}: F corresponding to the inverse of the median of the observed R/SSB ratio. $F_{xx\%SPR}$: F that produces given % of the unfished spawning potential (biomass) under equilibrium condition.

Reference period	F_{max}	$F_{0.1}$	F_{med}	(1-SPR)/(1-SPRxx%)				Estimated SSB for terminal year of each period (ton)	Depletion rate for terminal year of each period (%)
				SPR10%	SPR20%	SPR30%	SPR40%		
2002-2004	1.92	2.84	1.14	1.08	1.21	1.38	1.61	36,701	5.80
2011-2013	1.54	2.26	0.89	1.05	1.18	1.35	1.57	16,703	2.64
2016-2018	1.14	1.65	0.57	0.95	1.07	1.23	1.43	28,228	4.46

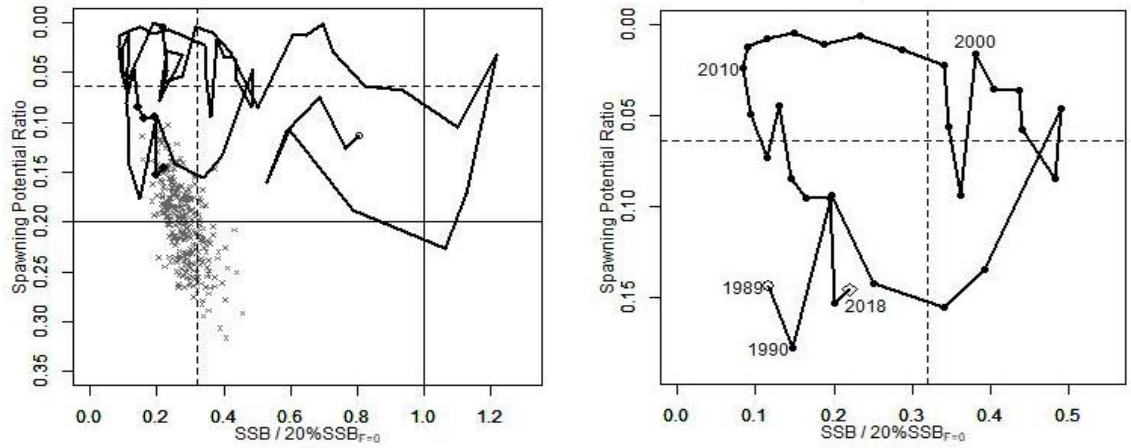

Figure PBF-4. Kobe plots for Pacific bluefin tuna (*Thunnus orientalis*) estimated from the base-case model. The X-axis shows the annual SSB relative to 20%$SSB_{F=0}$ and the Y-axis shows the spawning potential ratio (SPR) as a measure of fishing mortality. Vertical and horizontal solid lines in the left figure show 20%$SSB_{F=0}$ (which corresponds to the second biomass rebuilding target) and the corresponding fishing mortality that produces SPR, respectively. Vertical and horizontal broken lines in both figures show the initial biomass rebuilding target (SSB_{MED} = 6.4%$SSB_{F=0}$) and the corresponding fishing mortality that produces SPR, respectively. SSB_{MED} is calculated as the median of estimated SSB over 1952-2014. The left figure shows the historical trajectory, where the open circle indicates the first year of the assessment (1952), solid circles indicate the last five years of the assessment (2014-2018), and grey crosses indicate the uncertainty of the terminal year estimated by bootstrapping. The right figure shows the trajectory of the last 30 years.

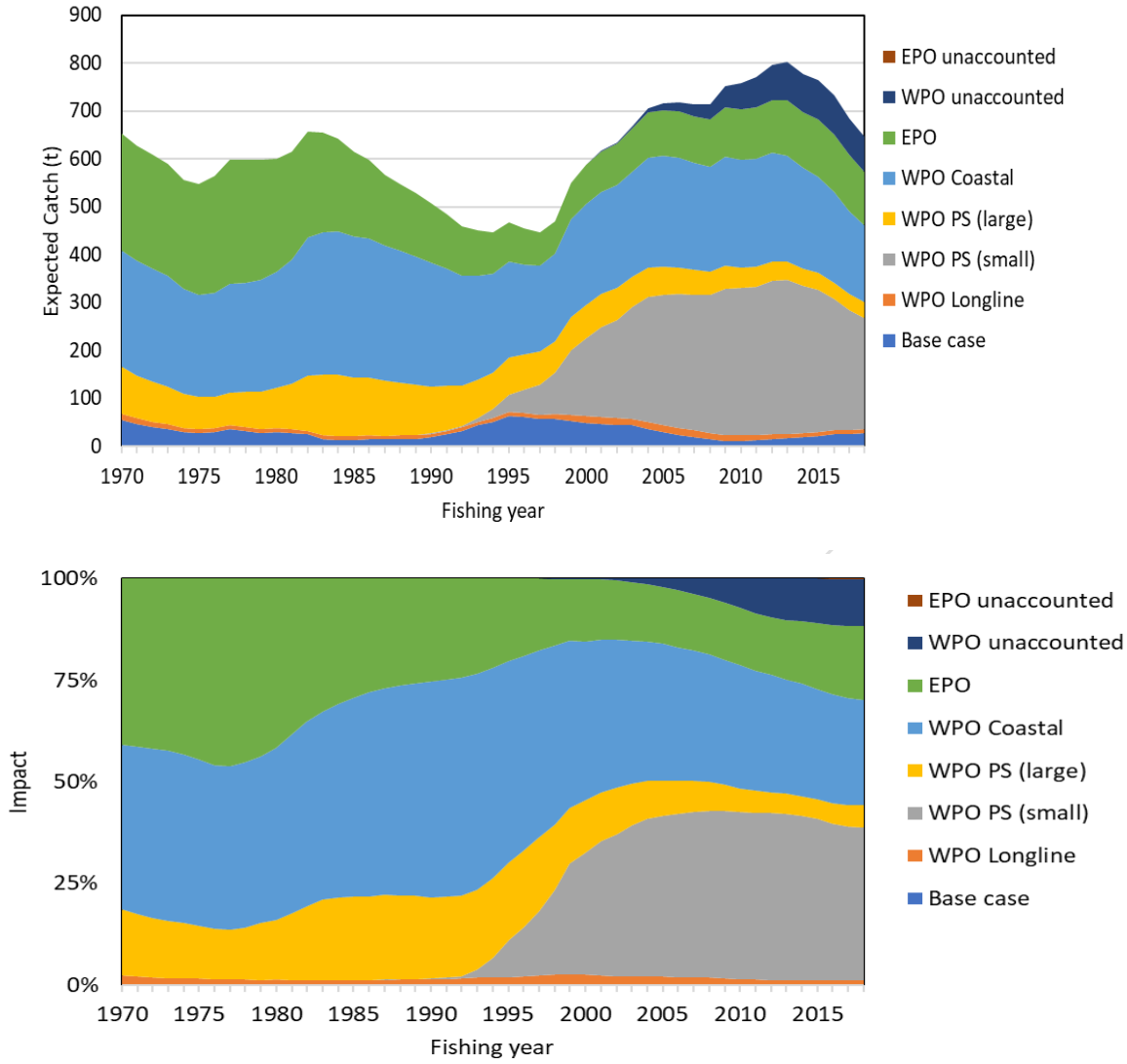

Figure PBF-5. The trajectory of the spawning stock biomass of a simulated population of Pacific bluefin tuna (*Thunnus orientalis*) when zero fishing mortality is assumed, estimated by the base-case model. (top: absolute SSB, bottom: relative SSB). Fisheries group definition; WPO longline fisheries: F1, F12, F17, 23. WPO purse seine fisheries for small fish: F2, F3, F18, F20. WPO purse seine fisheries for large fish: F4, F5. WPO coastal fisheries: F6-11, F16, F19. EPO fisheries: F13, F14, F15, F24. WPO unaccounted fisheries: F21, 22. EPO unaccounted fisheries: F25. For exact fleet definitions, please see the 2020 PBF stock assessment report on the ISC website.

Table PBF-3. Future projection scenarios for Pacific bluefin tuna (*Thunnus orientalis*) and their probability of achieving various target levels by various time schedules based on the base-case model.

scenario #	Upper Limit increase				Probability of SSB is below the Initial rebuilding target at 2024 in case the low recruitment continue	The fishing year expected to achieve the initial rebuilding target with >60% probability	The fishing year expected to achieve the 2nd rebuilding target with >60% probability	Probability of achiving the initial rebuilding target at 2024	Probability of achiving the second rebuilding target at 2034	Probability of SSB falling below the historical lowest at any time during the projection period.	Probability of Catch falling below the historical lowest at any time during the projection period.	Median SSB at 2024	Median SSB at 2034
	WCPO		EPO										
	Small	Large	Small	Large									
1	0%				0%	2020	2026	100%	99%	0%	100%	107,098	286,958
2	0%				0%	2020	2026	100%	99%	0%	100%	104,973	287,020
3	5%				0%	2020	2027	100%	98%	0%	100%	99,968	272,814
4	10%				0%	2020	2027	100%	96%	0%	100%	95,096	258,850
5	15%				0%	2020	2028	99%	94%	0%	100%	90,293	244,959
6	20%				0%	2020	2028	99%	91%	0%	100%	85,618	231,003
7	0%	500	500		0%	2020	2027	100%	98%	0%	100%	99,903	277,396
8	250	250	500		0%	2020	2027	100%	97%	0%	100%	98,164	268,473
9	0	600	400		0%	2020	2027	100%	98%	0%	100%	100,035	278,004
10	5%	1300	700		0%	2020	2027	99%	96%	0%	100%	92,504	259,802
11	10%	1300	700		0%	2020	2027	99%	95%	0%	100%	89,951	249,996
12	5%	1000	500		0%	2020	2027	100%	97%	0%	100%	94,952	264,218
13	0	1650	660		0%	2020	2027	99%	97%	0%	100%	93,897	267,976
14	125	375	550		0%	2020	2027	100%	98%	0%	100%	98,729	272,323
15	0	0	0		0%	2019	2022	100%	100%	0%	100%	221,391	560,259

* The numbering of Scenarios is different from those given by the IATTC-WCPFC NC Joint WG meeting and same as Table 3.

* Recruitment is switched from low recruitment during 1980-1989 to average recruitment over the whole assessment period in the following year of achieving the initial rebuilding target.

Table PBF-4. Expected yield for Pacific bluefin tuna (*Thunnus orientalis*) under various harvesting scenarios based on the base-case model.

scenario #	Upper Limit increase				Median SSB at 2024	Median SSB at 2034	Expected annual yield in 2019, by area and size category (t)				Expected annual yield in 2024, by area and size category (t)				Expected annual yield in 2034, by area and size category (t)			
	WPO		EPO				WPO		EPO		WPO		EPO		WPO		EPO	
	Small	Large	Small	Large			Small	Large	Commercial	Sport	Small	Large	Commercial	Sport	Small	Large	Commercial	Sport
1	0%				107,098	286,958	4,396	5,444	3,310	508	4,583	6,739	3,315	800	4,499	6,871	3,321	1,167
2	0%				104,973	287,020	4,396	6,924	3,541	504	4,580	6,771	3,724	799	4,495	6,851	3,746	1,168
3	5%				99,968	272,814	4,614	7,260	3,468	501	4,809	7,101	3,468	767	4,720	7,187	3,465	1,130
4	10%				95,096	258,850	4,833	7,590	3,633	499	5,038	7,433	3,634	737	4,945	7,523	3,630	1,091
5	15%				90,293	244,959	5,052	7,914	3,797	496	5,267	7,764	3,798	708	5,171	7,859	3,794	1,053
6	20%				85,618	231,003	5,269	8,223	3,964	494	5,493	8,093	3,963	680	5,394	8,195	3,960	1,014
7	0%	500	500		99,903	277,396	4,396	7,411	3,802	500	4,583	7,269	3,803	781	4,497	7,349	3,800	1,150
8	250	250	500		98,164	268,473	4,640	7,172	3,802	499	4,824	7,017	3,802	756	4,734	7,105	3,800	1,118
9	0	600	400		100,035	278,004	4,396	7,506	3,701	501	4,583	7,370	3,703	783	4,496	7,449	3,699	1,152
10	5%	1300	700		92,504	259,802	4,627	8,153	4,003	497	4,814	8,073	4,005	745	4,723	8,156	4,000	1,107
11	10%	1300	700		89,951	249,996	4,858	8,157	4,003	495	5,042	8,074	4,004	721	4,947	8,163	4,000	1,076
12	5%	1000	500		94,952	264,218	4,627	7,881	3,803	498	4,813	7,773	3,805	753	4,722	7,857	3,800	1,115
13	0	1650	660		93,897	267,976	4,396	8,444	3,963	498	4,587	8,426	3,967	769	4,498	8,501	3,960	1,138
14	125	375	550		98,729	272,323	4,517	7,291	3,852	499	4,703	7,142	3,853	767	4,614	7,226	3,850	1,132
15	0%	0%	0		221,391	560,259	0	0	0	0	0	0	0	0	0	0	0	0

* Catch limits for EPO commercial fisheries are applied for the catch of both small and large fish made by the fleets.

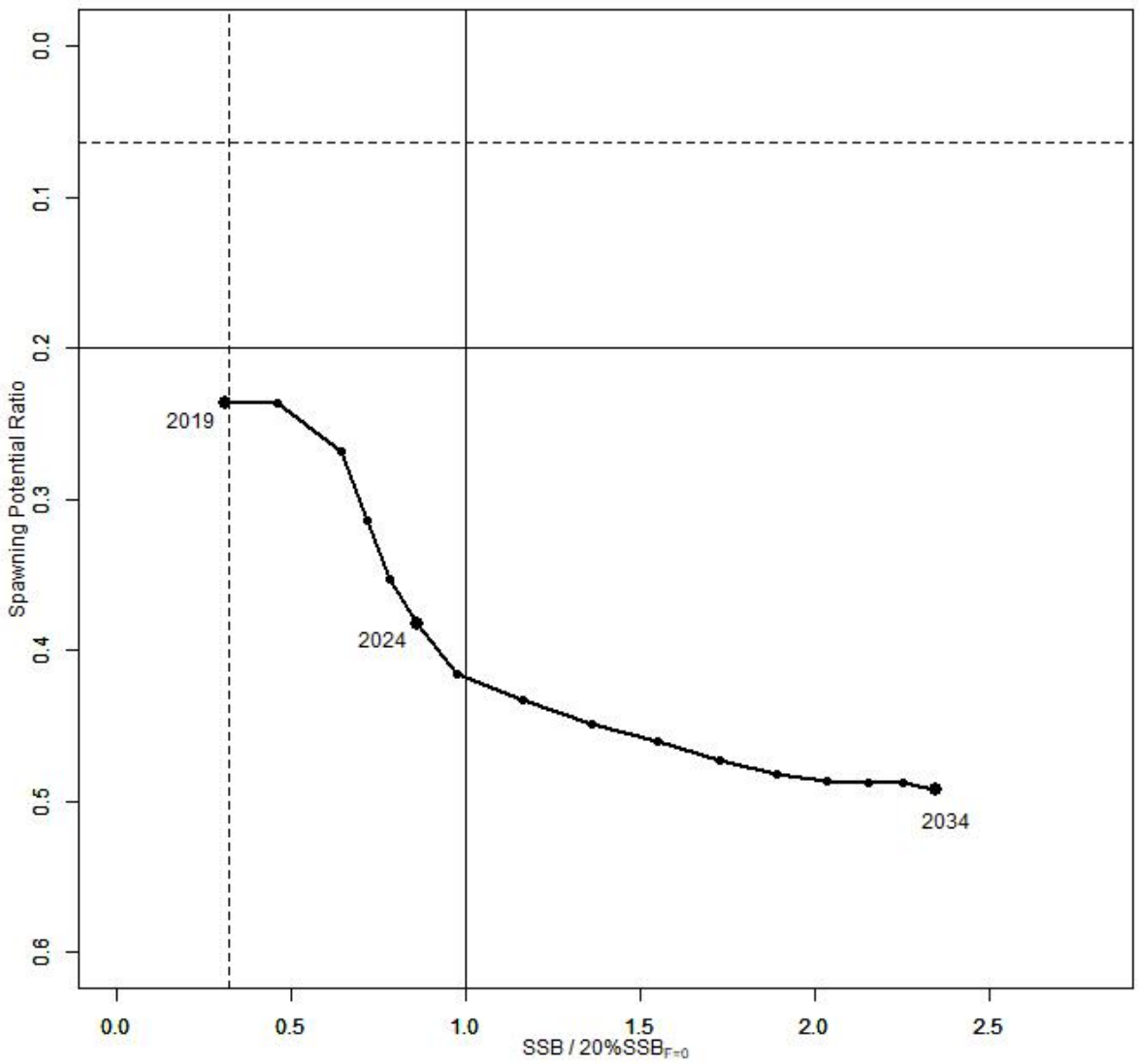

Figure PBF-6. "Future Kobe Plot" of projection results for Pacific bluefin tuna (*Thunnus orientalis*) from Scenario 1 from Table PBF-3.

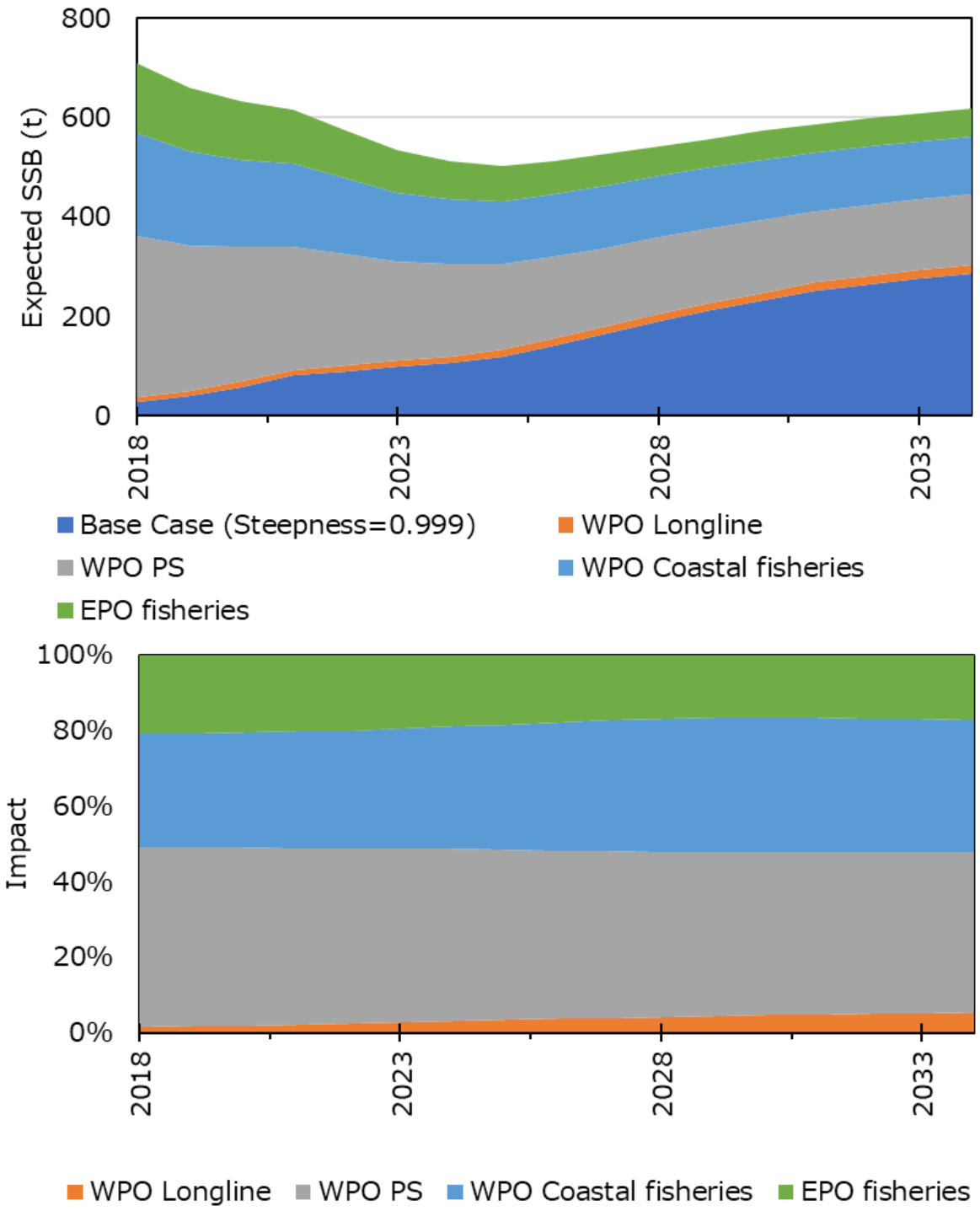

Figure PBF-7. "Future impact plot" from projection results for Pacific bluefin tuna (*Thunnus orientalis*) from Scenario 1 of Table S-3. The impact is calculated based on the expected increase of SSB in the absence of the respective group of fisheries.

Attachment B
(Attachment D, NC16 Summary Report)

The Commission for the Conservation and Management of
Highly Migratory Fish Stocks in the Western and Central Pacific Ocean
Northern Committee
Sixteenth Regular Session
Electronic Meeting
8 October 2020

CONSERVATION AND MANAGEMENT MEASURE FOR PACIFIC BLUEFIN TUNA

Conservation and Management Measure 20~~19~~20-~~02~~XX

The Western and Central Pacific Fisheries Commission (WCPFC):

Recognizing that WCPFC6 adopted Conservation and Management Measure for Pacific bluefin tuna (CMM 2009-07) and the measure was revised ~~eight~~nine times since then (CMM 2010- 04, CMM 2012-06, CMM 2013-09, CMM 2014-04, CMM 2015-04, CMM 2016-04, CMM2017-08, ~~and~~ CMM 2018-02 and CMM 2019-02) based on the conservation advice from the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) on this stock;

Noting with concern the latest stock assessment provided by ISC Plenary Meeting in July 2018, indicating the following:

- (1) SSB fluctuated throughout the assessment period (1952–2016), (2) SSB steadily declined from 1996 to 2010, and (3) the slow increase of the stock continues since 2011 including the most recent two years (2015-2016);
- The 2015 recruitment estimate is low and similar to estimates of previous years while the 2016 recruitment estimate is higher than the historical average, and the uncertainty of the 2016 recruitment estimate is higher than in previous years because it occurs in the terminal year of the assessment model and is mainly informed by one observation from troll age-0 CPUE index;
- The fishery exploitation rate in 2015-2016 exceeded all biological reference points evaluated by the ISC except FMED and FLOSS.
- Since the early 1990s, the WCPO purse seine fisheries, in particular those targeting small fish (age 0-1) have had an increasing impact on the spawning stock biomass, and in 2016 had a greater impact than any other fishery group.
- The projection results indicate that: the current management measures by the WCPFC (CMM 2018-02) and IATTC Resolution (C-18-01) under the low recruitment scenario resulted in an estimated 97% probability of achieving the initial biomass rebuilding target (6.7% of SSBF=0) by 2024;
- The estimated probability of achieving the second biomass rebuilding target (20% of SSBF=0) 10 years after the achievement of the initial rebuilding target or by 2034, whichever is earlier, is 96%; and
- Catching a high number of smaller juvenile fish can have a greater impact on future spawning stock biomass than catching the same weight of larger fish;

Noting also that in its response to requests from IATTC-WCPFC NC Joint Working Group, ISC Plenary Meeting in July 2019:

- Noted that the Japanese troll recruitment index value estimated for 2017 is similar to its historical average (1980-2017), that Japanese recruitment monitoring indices in 2017 and 2018 are higher than the 2016 value and that there is anecdotal evidence that larger fish are becoming more abundant in EPO, although this information needs to be confirmed for the next stock assessment expected in 2020;
- Recommended maintaining the conservation advice from ISC in 2018; and,
- Conducted projections of scenarios for catch increase in the same manner as in the 2018 assessment.

Further recalling that paragraph (4), Article 22 of the WCPFC Convention, which requires cooperation between the Commission and the IATTC to reach agreement to harmonize CMMs for fish stocks such as Pacific bluefin tuna that occur in the convention areas of both organizations;

Recognizing that due to the pandemic caused by COVID-19, it is not possible to hold a physical meeting of the Northern Committee in 2020, which makes it difficult for the members of the Northern Committee to engage in substantive discussion to change the existing CMM on Pacific bluefin tuna;

Further recognizing that under such circumstances, a simple roll-over of the 2020-specific measures for one year could be a realistic approach;

Adopts, in accordance with Article 10 of the WCPFC Convention that:

General Provision

1 This conservation and management measure has been prepared to implement the Harvest Strategy for Pacific Bluefin Tuna Fisheries (Harvest Strategy 2017-02), and the Northern Committee shall periodically review and recommend revisions to this measure as needed to implement the Harvest Strategy.

Management measures

2 CCMs shall take measures necessary to ensure that:

(1) Total fishing effort by their vessel fishing for Pacific bluefin tuna in the area north of the 20° N shall stay below the 2002–2004 annual average levels.

(2) All catches of Pacific bluefin tuna less than 30 kg shall be reduced to 50% of the 2002– 2004 annual average levels. Any overage or underage of the catch limit shall be deducted from or may be added to the catch limit for the following year. The maximum underage that a CCM may carry over in any given year shall not exceed 5% of its annual initial catch limit.[4]

3 CCMs shall take measures necessary to ensure that all catches of Pacific Bluefin tuna 30kg or larger shall not be increased from the 2002-2004 annual average levels[5,6].Any overage or underage of

[4] Notwithstanding paragraph 2 and 3, a CCM may carry over up to 17% of its initial 201920 catch limits, which remain uncaught, to 202001.

[5] CCMs with a base line catch of 10 t or less may increase its catch as long as it does not exceed 10 t.

[6] 300 tons of the catch limit of Pacific bluefin tuna 30kg or larger of Chinese Taipei may be transferred to Japan in 2020, subject to a notification by Chinese Taipei to the Secretariat. This transfer may apply for 2020 only. Adoption

the catch limit shall be deducted from or may be added to the catch limit for the following year. The maximum underage that a CCM may carry over in any given year shall not exceed 5% of its annual initial catch limit[1]. However, in ~~2018, 2019, and 2020~~2021 CCMs may use part of the catch limit for Pacific bluefin tuna smaller than 30 kg stipulated in paragraph 2 (2) above to catch Pacific bluefin tuna 30 kg or larger in the same year. In this case, the amount of catch 30 kg or larger shall be counted against the catch limit for Pacific bluefin tuna smaller than 30 kg. CCMs shall not use the catch limit for Pacific bluefin tuna 30 kg or larger to catch Pacific bluefin tuna smaller than 30 kg. The ISC is requested to review, in its work referred to in Section 5 of Harvest Strategy, the implications of this special provision in terms of PBF mortality and stock rebuilding probabilities in 202~~0~~1. Based on that review, in 202~~0~~1 the Northern Committee will determine whether it should be continued past 202~~0~~1, and if so, recommend changes to the CMM as appropriate.

4 All CCMs except Japan shall implement the limits in paragraph 2 and 3 on a calendar-year basis. Japan shall implement the limits using a management year other than the calendar year for some of its fisheries and have its implementation assessed with respect to its management year. To facilitate the assessment, Japan shall:

a. Use the following management years:
   1. For its fisheries licensed by the Ministry of Agriculture, Forestry and Fisheries, use the calendar year as the management year.
   2. For its other fisheries, use 1 April – 31 March as the management year~~7~~[3].

b. In its annual reports for PBF, for each category described in a.1 and a.2 above, complete the required reporting template for both the management year and calendar year clearly identifying fisheries for each management year.

5 CCMs shall report to the Executive Director by 31 July each year their fishing effort and <30 kg and >=30 kg catch levels, by fishery, for the previous 3 year, accounting for all catches, including discards. The Executive Director will compile this information each year into an appropriate format for the use of the Northern Committee.

6. CCMs shall intensify cooperation for effective implementation of this CMM, including juvenile catch reduction.

7. CCMs, in particular those catching juvenile Pacific bluefin tuna, shall take measures to monitor and obtain prompt results of recruitment of juveniles each year.

8. Consistent with their rights and obligations under international law, and in accordance with domestic laws and regulations, CCMs shall, to the extent possible, take measures necessary to prevent commercial transaction of Pacific bluefin tuna and its products that undermine the effectiveness of this CMM, especially measures prescribed in the paragraph 2 and 3 above. CCMs shall cooperate for this purpose.

9. CCMs shall cooperate to establish a catch documentation scheme (CDS) to be applied to Pacific bluefin tuna in accordance with the **Attachment** of this CMM.

~~of this transfer does not confer the allocation of a right, and does not prejudice any future decision of the Commission.~~

~~7~~[3] For the category described a.2, the TCC shall assess in year 20XX its implementation during the management year that starts 1 April 20XX-1 (e.g., in the 2020 compliance review, the TCC will assess Japan's implementation for its fisheries licensed by the Ministry of Agriculture, Forestry and Fisheries during calendar-year 2019 and for its other fisheries during 1 April 2019 through 31 March 2020).

10. CCMs shall also take measures necessary to strengthen monitoring and data collecting system for Pacific bluefin tuna fisheries and farming in order to improve the data quality and timeliness of all the data reporting;

11. CCMs shall report to Executive Director by 31 July annually measures they used to implement paragraphs 2, 3, 4, 5, 7, 8, 10 and 13 of this CMM. CCMs shall also monitor the international trade of the products derived from Pacific bluefin tuna and report the results to Executive Director by 31 July annually. The Northern Committee shall annually review those reports CCMs submit pursuant to this paragraph and if necessary, advise a CCM to take an action for enhancing its compliance with this CMM.

12. The WCPFC Executive Director shall communicate this CMM to the IATTC Secretariat and its contracting parties whose fishing vessels engage in fishing for Pacific bluefin tuna in EPO and request them to take equivalent measures in conformity with this CMM.

13. To enhance effectiveness of this measure, CCMs are encouraged to communicate with and, if appropriate, work with the concerned IATTC contracting parties bilaterally.

14. The provisions of paragraphs 2 and 3 shall not prejudice the legitimate rights and obligations under international law of those small island developing State Members and participating territories in the Convention Area whose current fishing activity for Pacific bluefin tuna is limited, but that have a real interest in fishing for the species, that may wish to develop their own fisheries for Pacific bluefin tuna in the future.

15. The provisions of paragraph 14 shall not provide a basis for an increase in fishing effort by fishing vessels owned or operated by interests outside such developing coastal State, particularly Small Island Developing State Members or participating territories, unless such fishing is conducted in support of efforts by such Members and territories to develop their own domestic fisheries.

16. This CMM replaces CMM 2018~~89~~-02. On the basis of stock assessment conducted by ISC ~~and reported to NC~~ in 2020, and other pertinent information, this CMM shall be reviewed and may be amended as appropriate in 2021.

Attachment

Development of a Catch Document Scheme for Pacific Bluefin Tuna

Background

At the 1st joint working group meeting between NC and IATTC, held in Fukuoka, Japan from August 29 to September 1, 2016, participants supported to advance the work on the Catch Documentation Scheme (CDS) in the next joint working group meeting, in line with the development of overarching CDS framework by WCPFC and taking into account of the existing CDS by other RFMOs.

1. Objective of the Catch Document Scheme

The objective of CDS is to combat IUU fishing for Pacific Bluefin Tuna (PBF) by providing a means of preventing PBF and its products identified as caught by or originating from IUU fishing activities from moving through the commodity chain and ultimately entering markets.

2. Use of electronic scheme

Whether CDS will be a paper based scheme, an electronic scheme or a gradual transition from a paper based one to an electronic one should be first decided since the requirement of each scheme would be quite different.

3. Basic elements to be included in the draft conservation and management measure (CMM)

It is considered that at least the following elements should be considered in drafting CMM.

(1) Objective
(2) General provision
(3) Definition of terms
(4) Validation authorities and validating process of catch documents and re-export certificates
(5) Verification authorities and verifying process for import and re-import
(6) How to handle PBF caught by artisanal fisheries
(7) How to handle PBF caught by recreational or sport fisheries
(8) Use of tagging as a condition for exemption of validation
(9) Communication between exporting members and importing members
(10) Communication between members and the Secretariat
(11) Role of the Secretariat
(12) Relationship with non-members
(13) Relationship with other CDSs and similar programs
(14) Consideration to developing members
(15) Schedule for introduction
(16) Attachment
    (i) Catch document forms
    (ii) Re-export certificate forms
    (iii) Instruction sheets for how to fill out forms
    (iv) List of data to be extracted and compiled by the Secretariat

4. Work plan

The following schedule may need to be modified, depending on the progress on the WCPFC CDS for tropical tunas.

2017	The joint working group will submit this concept paper to the NC and IATTC for endorsement. NC will send the WCPFC annual meeting the recommendation to endorse the paper.
2018	The joint working group will hold a technical meeting, preferably around its meeting, to materialize the concept paper into a draft CMM. The joint working group will report the progress to the WCPFC via NC and the IATTC, respectively.
2019	The joint working group will hold a second technical meeting to improve the draft CMM. The joint working group will report the progress to the WCPFC via NC and the IATTC, respectively.
20~~20~~ XX	The joint working group will hold a third technical meeting to finalize the draft CMM. Once it is finalized, the joint working group will submit it to the NC and the IATTC for adoption. The NC will send the WCPFC the recommendation to adopt it.

Attachment C
(Attachment J, WCPFC14 Summary Report)

COMMISSION
FOURTEENTH REGULAR SESSION
Manila, Philippines
3 – 7 December 2017

HARVEST STRATEGY FOR PACIFIC BLUEFIN TUNA FISHERIES

Harvest Strategy 2017-02

Introduction and scope

This harvest strategy has been prepared in accordance with the Commission's Conservation and Management Measure on Establishing a Harvest Strategy for Key Fisheries and Stocks in the Western and Central Pacific Ocean.

Although the provisions of this harvest strategy are expressed in terms of a single stock, they may be applied to multiple stocks as appropriate and as determined by the Northern Committee.

1. Management objectives

The management objectives are, first, to support thriving Pacific bluefin tuna fisheries across the Pacific Ocean while recognizing that the management objectives of the WCPFC are to maintain or restore the stock at levels capable of producing maximum sustainable yield, second, to maintain an equitable balance of fishing privileges among CCMs and, third, to seek cooperation with IATTC to find an equitable balance between the fisheries in the western and central Pacific Ocean (WCPO) and those in the eastern Pacific Ocean (EPO).

2. Reference points

Because steepness in the stock-recruitment relationship is not well known but the key biological and fishery variables are reasonably well estimated,[8] the stock of PBF is to be treated as a Level 2 stock under the Commission's hierarchical approach for setting biological limit reference points.

2.1 Rebuilding targets

Initial rebuilding target: The initial rebuilding target for the PBF stock size is the median SSB estimated for the period 1952 through 2014, to be reached by 2024 with at least 60% probability.

[8] See the information provided by the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (WCPFC-NC9-2013/IP-03) in response to a request made by the Northern Committee at its Eighth Regular Session (Attachment F of the report of NC8).

Recruitment scenario during initial rebuilding period: The low recruitment scenario (resampling from the relatively low recruitment period (1980-1989)) or the recent recruitment scenario (resampling from the last 10 years), whichever is lower, will be used for the ISC's SSB projections until 2024 or until the SSB reaches the initial rebuilding target, whichever is earlier.
The ISC is requested to periodically evaluate whether the recruitment scenario used during the initial rebuilding period is reasonable given current conditions, and to make recommendations on whether a different scenario should be used. If ISC recommends a different scenario, this will be considered by the NC.
Second rebuilding target: The second rebuilding target for the PBF stock size is $20\%SSB_{F=0}$[9], to be reached by 2034, or 10 years after reaching the initial rebuilding target, whichever is earlier, with at least 60% probability.

However, if: (1) the SSB reaches the initial rebuilding target earlier than 2024; (2) ISC recommends a recruitment scenario lower than the average recruitment scenario; and (3) the SSB projections indicate that the second rebuilding target will not be achieved on this schedule, the deadline for rebuilding may be extended to 2034 at the latest.

Also, if there is a recommendation from the Northern Committee that $20\%SSB_{F=0}$ is not appropriate as the second rebuilding target, taking into account consideration from IATTC, scientific advice from ISC, IATTC or WCPFC SC, and socioeconomic factors, another objective may be established.

Recruitment scenario during second rebuilding period: After the initial rebuilding target is reached and until the second rebuilding target is reached, the recruitment scenario to be used for the SSB projections will tentatively be the average recruitment scenario (resampling from the entire recruitment period).

The ISC is requested to periodically evaluate whether the recruitment scenario used during the second rebuilding period is reasonable given current conditions, and to make recommendations on whether a different scenario should be used. If ISC recommends a different scenario, this will be considered by the NC.

2.2 Development of reference points

The Northern Committee will develop more refined management objectives as well as limit reference point(s) and target reference point(s) through MSE process specified in Section 6.

3. Acceptable levels of risk

Until the stock is rebuilt, the Northern Committee will recommend conservation and management measures as needed to ensure rebuilding in accordance with the probabilities specified in sections 2.1 and 5 for each of the two rebuilding targets.

Once the stock is rebuilt, in accordance with Article 6.1(a) of the Convention, the Northern Committee will recommend conservation and management measures as needed to ensure that any target reference point(s) (once adopted) are achieved on average in the long term, and ensure that the risk of the stock size declining below the B-limit (once adopted) is very low.[10]

[9] $SSB_{F=0}$ is the expected spawning stock biomass under average recruitment conditions without fishing.
[10] WCPFC13 agreed that any risk level greater than 20 percent to be inconsistent with the limit reference point related principles in UNFSA (as references in Article 6 of the Convention) including that the risk of breaching limit reference points be very low.

4. Monitoring strategy

The ISC will periodically evaluate the stock size and exploitation rate with respect to the established reference points and the report will be presented to the Scientific Committee. Until 2024, while the MSE is being developed (see section 6), the ISC is requested to conduct stock assessments in 2018, 2020 and 2022.

In order to cope with the adverse effects on the rebuilding of the stock due to drastic drops of recruitment: (1) all the available data and information will be reviewed annually, including recruitment data provided by the ISC and in National Reports; and (2) the ISC is requested to conduct in 2019, and periodically thereafter as resources permit and if drops in recruitment are detected, projections to see if any additional measure is necessary to achieve the initial rebuilding target by 2024 with at least 60% probability.

5. Decision rules

Harvest controls rules during initial rebuilding period: The interim harvest control rules below will be applied based on the results of stock assessments and SSB projections to be conducted by ISC.

(a) If the SSB projection indicates that the probability of achieving the initial rebuilding target by 2024 is less than 60%, management measures will be modified to increase it to at least 60%. Modification of management measures may be (1) a reduction (in %) in the catch limit for fish smaller than 30 kg (hereinafter called "small fish") or (2) a transfer of part of the catch limit for small fish to the catch limit for fish 30 kg or larger (hereinafter called "large fish"). For this purpose, ISC will be requested, if necessary, to provide different combinations of these two measures so as to achieve 60% probability.

(b) If the SSB projection indicates that the probability of achieving the initial rebuilding target by 2024 is at 75% or larger, the WCPFC may increase their catch limits as long as the probability is maintained at 70% or larger, and the probability of reaching the second rebuilding target by the agreed deadline remains at least 60%. For this purpose, ISC will be requested, if necessary, to provide relevant information on potential catch limit increases.

Harvest controls rules during second rebuilding period: Harvest control rules to be applied during the second rebuilding period will be decided, taking into account the implementation of the interim harvest control rules applied during the initial rebuilding period.

The Northern Committee will, through MSE development process, develop decision rules related to the limit reference points once adopted including for the case of their being breached.

6. Performance evaluation

Until the stock is rebuilt, the Northern Committee will work with the ISC and the Scientific Committee and consult with the IATTC to identify and evaluate the performance of candidate rebuilding strategies with respect to the rebuilding targets, schedules, and probabilities.

The ISC is requested to start the work to develop a management strategy evaluation (MSE) for Pacific bluefin tuna fisheries in 2019 and have a goal of completing it by 2024.

To support development of the MSE, ISC is encouraged to identify at least two experts and NC members are encouraged to provide additional funds for the ISC's work on the MSE.

The Joint WG will start to discuss in 2018, and aim to finalize no later than 2019, guidelines for the MSE, including at least one candidate long-term target reference point (TRP), two candidate limit reference points (LRPs) and candidate harvest control rules (HCRs), which will be provided to the ISC. Those candidate TRPs, LRPs and HCRs will be tested and changed if appropriate during the MSE development process.

In preparation for the Joint WG meeting in 2019, the ISC is requested to organize workshops in early 2018 and 2019 to support the identification of specific management objectives, including level of risks and timelines. The workshops will include managers, scientists and stakeholders, taking into account any recommendations of the Joint WG, and the number of representatives should be relatively small, as it was for the MSE workshop for North Pacific albacore.

In evaluating the performance of candidate target reference points, limit reference points, and harvest control rules, the Northern Committee, in consultation with the ISC and the Scientific Committee, should consider the following criteria:

1. Probability of achieving each of the rebuilding targets within each of the rebuilding periods (if applicable).
2. Time expected to achieve each of the rebuilding targets (if applicable).
3. Expected annual yield, by fishery.
4. Expected annual fishing effort, by PBF-directed fishery.
5. Inter-annual variability in yield and fishing effort, by fishery.
6. Probabilities of SSB falling below the B-limit and the historical lowest level.
7. Probability of fishing mortality exceeding F_{MSY} or an appropriate proxy, and other relevant benchmarks.
8. Expected proportional fishery impact on SSB, by fishery and by WCPO fisheries and EPO fisheries.

Recognizing that developing the operating model and other aspects of the MSE will take time and additional resources, and might require further dialogue between the Northern Committee, the ISC, and the IATTC, while the MSE is in development the ISC is requested to perform this work using the best means at its disposal.

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Attachment D
(Attachment F, NC15 Summary Report)

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Northern Committee
Fifteenth Regular Session

Portland, Oregon, United States of America
3 – 6 September 2019

TERMS OF REFERENCE FOR PACIFIC BLUEFIN TUNA MANAGEMENT STRATEGY EVALUATION

The Northern Committee (NC) of the Western and Central Pacific Fisheries Commission (WCPFC) in consultation with the Inter-American Tropical Tuna Commission (IATTC), requested the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) to begin work on a management strategy evaluation (MSE) for Pacific bluefin tuna (PBF) in 2019 with a goal of completing the first iteration of the MSE by 2024. As requested in the WCPFC harvest strategy for PBF fisheries, the ISC organized two MSE workshops, one in 2018 in Yokohama, Japan, and one in 2019 in San Diego, California, USA, to support the identification of specific management objectives, including level of risks and timelines. These terms of reference will guide the MSE.

Purpose of MSE
To evaluate the expected performance of alternative long-term management strategies for Pacific bluefin tuna fisheries once the second rebuilding target is reached. This does not prevent the earlier use of the MSE if the JWG agrees.

Role of the ISC
To provide technical guidance on and oversee the development, execution and outputs of the model to be used in the PBF MSE.

Role of the IATTC-WCPFC NC Joint Working Group (JWG)
The JWG will provide overall guidance on the MSE. Depending on the availability of necessary funds, the JWG will convene workshops to solicit input from managers, scientists, and stakeholders. In providing guidance on the MSE, the JWG will take into account views expressed in stakeholder workshops. The guidance on the MSE may include, but is not limited to, specification of management objectives, performance indicators, timelines, candidate reference points, and candidate harvest control rules. The JWG will provide progress reports on the MSE to the IATTC and WCPFC NC, as appropriate.

Attachment E
(Attachment G, NC15 Summary Report)

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Northern Committee
Fifteenth Regular Session

Portland, Oregon, United States of America
3 – 6 September 2019

CANDIDATE REFERENCE POINTS AND HARVEST CONTROL RULES FOR PACIFIC BLUEFIN TUNA

The Western and Central Pacific Fisheries Commission (WCPFC) harvest strategy for Pacific bluefin tuna fisheries states that "The Joint WG will start to discuss in 2018, and aim to finalize no later than 2019, guidelines for the MSE, including at least one candidate long-term target reference point (TRP), two candidate limit reference points (LRPs) and candidate harvest control rules (HCRs), which will be provided to the ISC."

The following candidate HCRs and reference points will be considered in the management strategy evaluation (MSE) for Pacific bluefin tuna fisheries. Additional HCRs and reference points may be submitted and considered.

Harvest Control Rules

Candidate HCRs 1a and **1b** are illustrated in Figure 1 where fishing mortality is controlled depending on stock status relative to the defined reference points. The F_{target} rate applies when the stock is larger than $SSB_{threshold}$, while F_{min} rate applies when the stock is smaller than SSB_{limit}, and there is either a linear or sigmoidal transition in F for stock sizes between SSB_{limit} and $SSB_{threshold}$. F_{min} would be defined as an F rate that is less than the F rate corresponding to the SSB_{limit}. **Candidate HCR 1a** has a linear transition between SSB_{limit} and $SSB_{threshold}$ whereas **Candidate HCR 1b** has a sigmoidal transition between SSB_{limit} and $SSB_{threshold}$ and could be viewed as more conservative with respect to uncertainty in underlying biomass/abundance estimates when approaching SSB_{limit}, as well as avoiding abrupt management breakpoints.

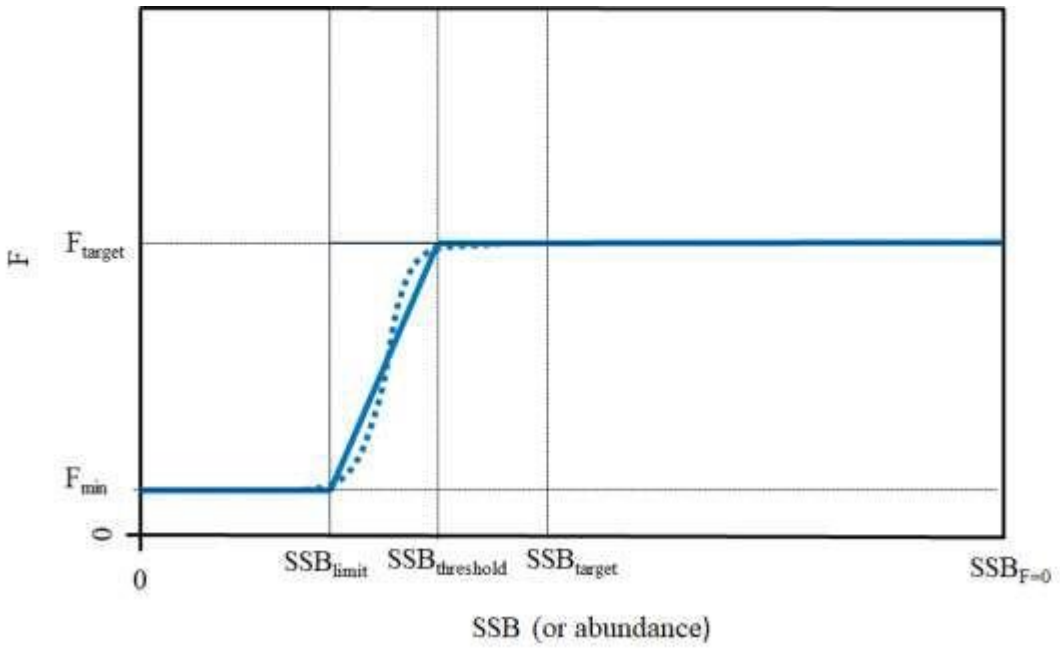

Figure 1. Candidate HCRs 1a (solid line) and 1b (dashed line)

Candidate HCR 2 is illustrated in Figure 2 and is similar to Candidate HCRs 1a and 1b in that F declines once the SSB_{limit} is breached, but unlike Candidate HCRs 1a and 1b, there is no $SSB_{threshold}$ between SSB_{limit} and SSB_{target}.

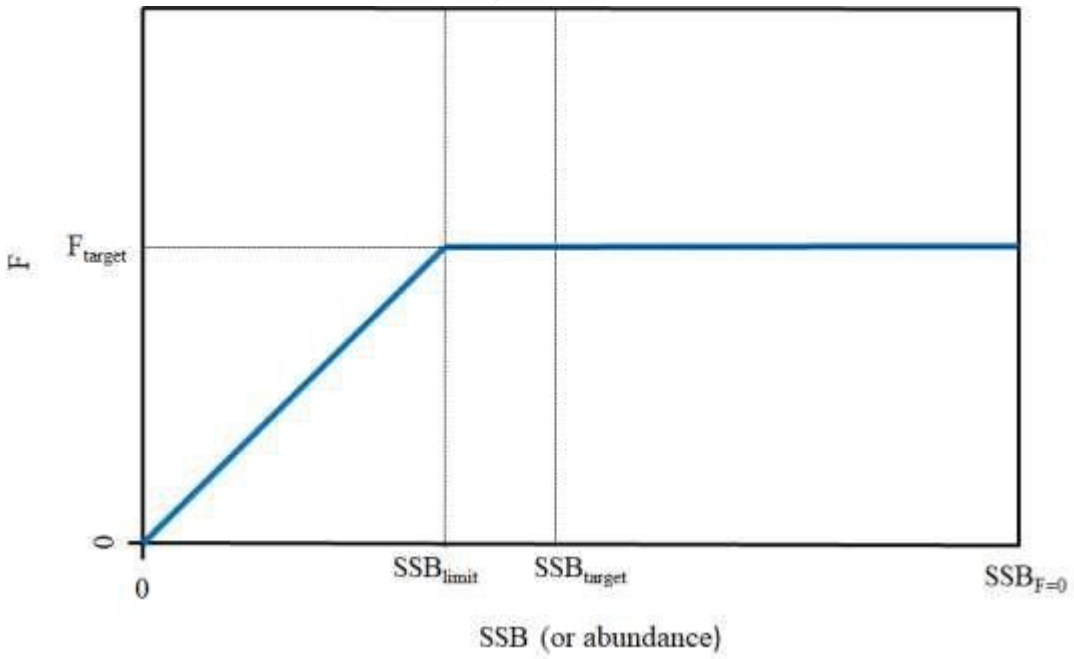

Figure 2. Candidate HCR 2

Candidate HCR 3 specifies two HCRs, one for old-fish fisheries and one for young-fish fisheries. For fisheries that harvest primarily mature Pacific bluefin tuna (e.g., longline fisheries), the HCR could be either Candidate HCRs 1a, 1b or 2 (i.e., fishing mortality is controlled as a function of the size of the spawning stock), and for fisheries harvest primarily immature Pacific bluefin tuna, the HCR would control fishing mortality as a function of recruitment, such as using an index of recruitment based on CPUE in age 0 or 1 fisheries. This approach is similar to that used in Maunder 2014[11].

All of the above candidate HCRs are general in concept and require further work to address issues such as regional distribution, fishery selectivity and fleet allocation.

Candidate Reference Points

The following candidate reference points for the Pacific bluefin tuna MSE are based in part on the hierarchical approach that the WCPFC adopted for identifying limit reference points for key target species as well as the approach taken by the IATTC in identifying interim LRPs for tropical tunas. Under the hierarchical approach adopted by the WCPFC, and as indicated in the harvest strategy for Pacific bluefin tuna fisheries, Pacific bluefin tuna is a Level 2 stock, as the stock recruitment relationship for Pacific bluefin tuna is not well known, but key biological and fishery variables are reasonably well estimated. LRPs for Level 2 stocks are identified as either $FX\%SPR_O$ and either $X\%SB_O$ or $X\%SB_{current,F=0}$. In the IATTC, the interim LRP for tropical tuna stocks is the SSB associated with 50% of the unfished recruitment with assuming a stock-recruitment relationship steepness of 0.75. In addition to an LRP and a TRP, each of Candidate HCRs 1a and 1b require identification of a threshold reference point ($SSB_{threshold}$) and an F_{min}. The combinations of LRPs, threshold reference points and TRPs will depend on which of the Candidate HCRs are evaluated. Further consideration is needed for the reference points associated with the recruitment-based HCR in HCR 3.

Candidate Limit Reference Points: $5\%SSB_{F=0}$, $7.7\%SSB_{F=0}$, $15\%SSB_{F=0}$, $20\%SSB_{F=0}$

Candidate Threshold Reference Points (for candidate HCRs 1a and 1b): $15\%SSB_{F=0}$, $20\%SSB_{F=0}$, $25\%SSB_{F=0}$

Candidate Target Reference Points: $F_{SPR10\%}$, $F_{SPR15\%}$, $F_{SPR20\%}$, $F_{SPR30\%}$, $F_{SPR40\%}$

Candidate F_{min}: 5% F_{target}], $10\%F_{target}$

[11] Maunder, Mark. (2014). Management Strategy Evaluation (MSE) Implementation in Stock Synthesis: Application to Pacific Bluefin Tuna. IATTC Stock Assessment Report. 15. 100-117.