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REFERENCE DOCUMENT FOR THE REVIEW OF CMM 2018-02 AND DEVELOPMENT OF HARVEST STRATEGIES (PACIFIC BLUEFIN TUNA)

WCPFC16-2019-22
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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), Northern Committee (NC) and the Technical and Compliance Committee (TCC) of relevance to the discussions on stock status and management advice for Pacific bluefin tuna. The annexed information from the NC15 at Portland meeting, including amendments to the existing CMM for Pacific bluefin tuna (CMM 2018-02) and the development of a harvest strategy framework, were extracted from the DRAFT NC15 Summary Report (https://www.wcpfc.int/node/43895), which is expected to be formalized and adopted by NC15 at its Special Session on 4 December 2019.

B. SCIENTIFIC COMMITTEE RECOMMENDATIONS

2. The following stock status and management advice are from Paragraphs 52 – 56 of the SC15 Outcomes Document. Refer to **Attachment 1** for the details of the latest stock assessment.

a. Stock Status and trends

3. SC15 noted that no stock assessment was conducted for Pacific bluefin tuna in 2019. Therefore, the stock status description from SC14 is still current. For further information on the stock status and trends from SC14, please see https://www.wcpfc.int/node/32155

4. SC15 noted that the total Pacific bluefin tuna catch by ISC members in 2018 was 10,148 mt, a 31% decrease from 2017 and a 25% decrease from the 2013-2017 average. Pacific bluefin tuna is caught by various fishing gears including purse seine, longline, set net, troll, pole-and-line, handline and recreational fisheries. The detailed catch information by fishery is available in the ISC19 Plenary Report (SC15-GN-IP-02).

b. Management advice and implications

5. SC15 advises the Commission to note the current very low level of spawning biomass (3.3% B_0), the current level of overfishing, and that the projections are strongly influenced by the inclusion of a relatively high but uncertain recruitment in 2016. While noting that additional positive signs of Pacific bluefin tuna stock were observed after the last assessment, and while noting that the agreed Harvest Control Rule could allow for catch limit increases, some of CCMs recommended a precautionary approach to the management of Pacific bluefin tuna until the rebuilding of the stock to higher biomass levels is achieved.

6. One CCM recommended that ISC consider a grid approach for taking into account the structural uncertainty for the provision of stock status and management advice.

7. SC15 also noted the following management advice of ISC19:

> "The following requests were made to ISC by the IATTC-WCPFC NC Joint Working Group meeting in September 2018 at NC14 (see Attachment E of NC14 Summary Report (https://www.wcpfc.int/node/31946)). Responses from ISC PBFWG are provided below the requests.
>
> **Request 1**: review the updated abundance indices, including recruitment index, up to 2017 to evaluate the need to change its scientific advice in 2018.
>
> **Response from ISC**
> The WG noted that some positive signs for the PBF stock were observed after the last assessment. In the 2018 assessment, the projections were considered optimistic because they were influenced by a high but uncertain recruitment in the terminal year (2016). The WG notes 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 the EPO, although this information needs to be confirmed for the next stock assessment expected in 2020.
>
> After reviewing the updated CPUE indices as well as the Japanese recruitment monitoring results, the PBFWG recommends maintaining the conservation advice from ISC18 (in 2018) that the projection mimicking the current management measures under the low recruitment scenario resulted in an estimated 98% probability of achieving the initial rebuilding target (6.7%$SSB_{F=0}$) by 2024 and that of achieving the second rebuilding target (20%$SSB_{F=0}$) 10 years after the achievement of the initial rebuilding target or by 2034, whichever is earlier, is 96%.
>
> In the projections reported here, the projected future SSBs are the medians of the 6,000 individual SSB calculated for each 300 bootstrap replicates (i.e. catch, CPUE and size) to capture the uncertainty of parameter estimations followed by 20 stochastic simulations based on the different future recruitment time series. The projection assumes that each harvesting scenario is fully implemented and is based on certain biological or other assumptions of base case assessment model. If conditions change, the projection results would be more uncertain.
>
> **Request 2**: Conduct projections of harvest scenarios shown below based on 2018 assessment and provide probability of achieving initial and 2nd rebuilding targets in accordance with paragraph 2.1 of HS2017-02.

Scenarios for catch increase

West Pacific		East Pacific
Small fish	Large fish	
0	600t	400t
5%	1300t	700t
10%	1300t	700t
5%	1000t	500t
0	1650t	660t
5%		5%
10%		10%
15%		15%

* 250t transfer of catch limit from small fish to large fish by Japan is assumed to continue until 2020.

Response from ISC

PBFWG conducted projections in the same manner as in the 2018 assessment. The recruitment scenario followed paragraph 2.1 of WCPFC Harvest Strategy 2017-02; and was kept at a low level (re-sampling from 1980-1989) until the initial rebuilding target is achieved and then changed to the historical average level.

The projection results are shown in Table PBF-02 and Figure PBF-01. The results show that increasing the catch limit of small PBF (<30 kg) in the WPO has the largest impact on the probability of achieving the interim and 2nd rebuilding targets. In addition, an overall increase in catch from the current limits, particularly a 15% increase, has the largest impact on achieving rebuilding targets.

Table PBF-01. Future projection scenarios for Pacific bluefin tuna (*Thunnus orientalis*).

Scenario #	Fishing mortality	Catch limit					Catch limit Increase		
		WPO		EPO			WPO		EPO
		Small	Large	Small	Large	Sport	Small	Large	
Base case	F2002-2004	4725	6582	3300		-	0%		
Current catch limit	F2002-2004*2	4725	6582	3300		-	0%		
1	F2002-2004*2	4725	7180	3699		-	0%	600	400
2	F2002-2004*2	4960	7880	4000		-	5%	1300	700
3	F2002-2004*2	5196	7880	4000		-	10%	1300	700
4	F2002-2004*2	4960	7580	3800		-	5%	1000	500
5	F2002-2004*2	4725	8231	3960		-	0%	1650	660
6	F2002-2004*2	4960	6909	3465		-	5%		
7	F2002-2004*2	5196	7238	3630		-	10%		
8	F2002-2004*2	5433	7567	3794		-	15%		

Table PBF-02. Probability of achieving targets under projection scenarios for Pacific bluefin tuna. Future projection scenarios for Pacific bluefin tuna and their probability of achieving various target levels by various time schedules based on the 2018 base-case model.

Scenario #	Catch limit Increase				Initial rebuilding target			Second rebuilding target		Median SSB (mt) at 2034
	WPO		EPO		The year expected to achieve the target with >60% probability	Probability of achiving the target at 2024	Probability of SSB is below the target at 2024 under the low recruitment	The year expected to achieve the target with >60% probability	Probability of achiving the target at 2034	
	Small	Large	Small	Large						
Base case	0%				2020	99%	0%	2028	96%	262,952
Current catch limit	0%				2021	97%	0%	2028	96%	264,748
1	0%	600	400		2021	95%	0%	2028	95%	256,252
2	5%	1300	700		2021	88%	0%	2029	91%	236,691
3	10%	1300	700		2021	81%	1%	2030	88%	224,144
4	5%	1000	500		2021	89%	0%	2029	92%	240,739
5	0%	1650	660		2021	92%	0%	2029	94%	246,593
6	5%				2021	93%	0%	2029	94%	248,757
7	10%				2021	86%	1%	2029	90%	232,426
8	15%				2021	76%	2%	2030	85%	215,385

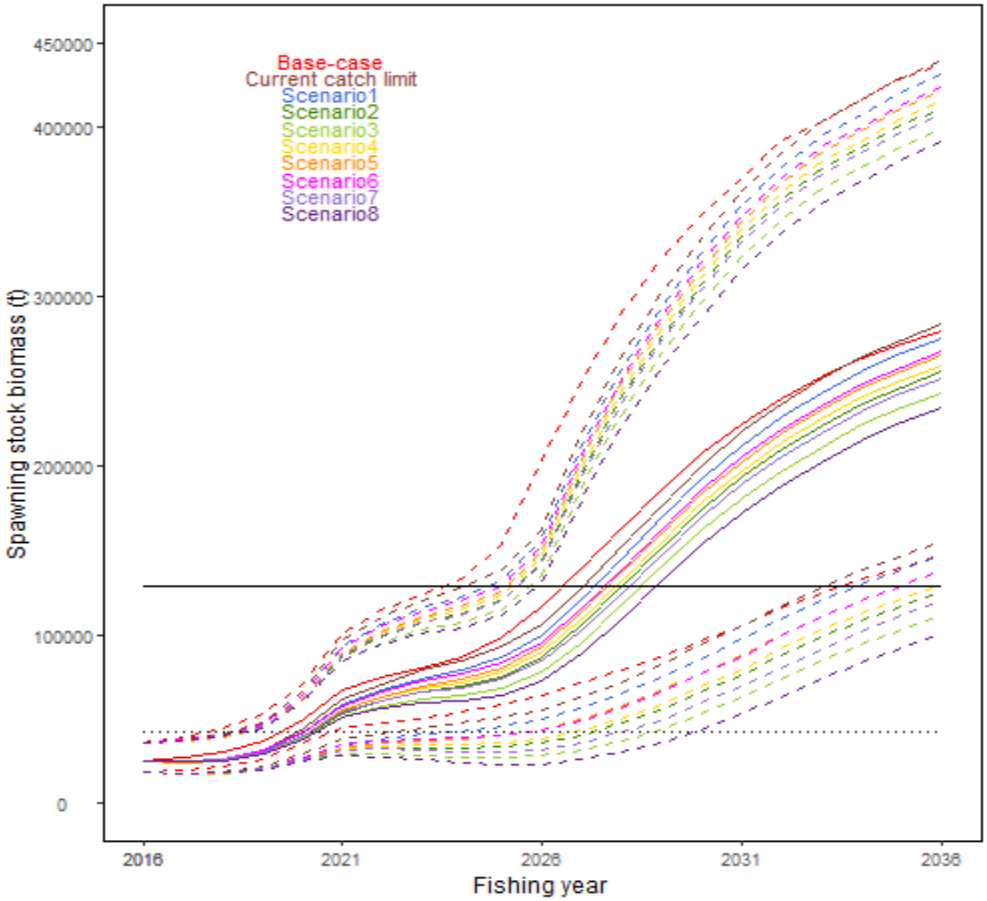

Figure PBF-01. Time series of the projected spawning stock biomass by various harvest scenarios listed on the Table PBF-01. Each colored solid and broken lines indicate the median spawning stock biomass and its 95% confidence intervals, respectively. The black dotted and solid lines are corresponded to the spawning stock biomasses of the initial and second rebuilding targets of Pacific bluefin tuna, respectively.

C. NORTHERN COMMITTEE RECOMMENDATIONS

(Paragraphs 9 – 13, DRAFT NC15 Summary Report)

8. NC15 recommends that the Commission adopt revised Conservation and Management Measure on Pacific Bluefin Tuna in **Attachment 2**.

9. NC15 agreed to request the ISC to conduct projections of the harvest scenarios shown in Table 1 below and the base case (current management regime), based on the 2020 assessment. The outputs should include the probability of reaching the initial and 2nd rebuilding targets by their respective target dates in accordance with paragraph 2.1 of HS 2017-02, the likely date (year) of reaching each of the two targets, the expected fishery impact on spawning stock biomass (SSB) of each of the major eastern Pacific Ocean (EPO) and western and central Pacific Ocean (WCPO) fisheries upon reaching each of the two targets, and any other outputs deemed useful by the ISC.

Table 1. Scenarios for catch increase. (A 250t transfer of catch limit from small fish to large fish by Japan is assumed to continue until 2020 under all scenarios.)

West Pacific		East Pacific
Small fish	Large fish	
0	500t	500t
250t	250t	500t
0	600t	400t
5%	1300t	700t
10%	1300t	700t
5%	1000t	500t
0	1650t	660t
5%		5%
10%		10%
15%		15%
20%		20%
125t	375t	550t

10. NC15 requested that ISC provide fishery impact on the SSB under recent conditions, taking into account the difference in age caught. ISC was also requested to provide a matrix of conversion values across age classes.

11. NC15 adopted the terms of reference for the Pacific bluefin tuna MSE in **Attachment 3**.

12. NC15 adopted candidate reference points and harvest control rules for Pacific bluefin tuna in **Attachment 4**.

D. TECHNICAL AND COMPLIANCE COMMITTEE RECOMMENDATIONS

13. TCC15 noted that there are presently nine quantitative limits where there are limited or no additional data presently available to WCPFC to verify the CCM's report on their implementation against the limit. [CMM 2005-03 02 (NP albacore), CMM 2006-04 01 (SW Striped Marlin), CMM 2009-03 01, 02 (Swordfish), CMM 2010-01 05 (NP striped marlin), CMM 2017-01 45, 47, 48 (Tropical tuna vessel limits), CMM 2017-01 51, CMM 2017-08 (Pacific Bluefin)]. TCC15 recommended that the Commission consider whether additional reporting or revised formulations of quantitative limits should be considered so that WCPFC has more ready access to data that can be used to verify a CCM's implementation of a quantitative limit. *(TCC15 draft summary report, para 125)*

Attachment 1

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

Scientific Committee
Fourteenth Regular Session

Busan, Republic of Korea
8 – 16 August 2018

PACIFIC BLUEFIN TUNA STOCK ASSESSMENT
(Paragraphs 263 – 267, SC14 Summary Report)

Provision of scientific information

Stock status and trends

1. SC14 noted that ISC provided the following conclusions on the stock status of Pacific bluefin tuna.

The base-case model results show that: (1) SSB fluctuated throughout the assessment period, (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). 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. Using the base-case model, the 2016 SSB (terminal year) was estimated to be around 21,000 t in the 2018 assessment, which is an increase from 19,000 t in 2014 (Table PBF-1 and Figure PBF-11).

Historical recruitment estimates have fluctuated since 1952 without an apparent trend. The low recruitment levels estimated in 2010-2014 were a concern in the 2016 assessment. The 2015 recruitment estimate is lower than the historical average while the 2016 recruitment estimate (15.988 million fish) is higher than the historical average (13.402 million fish) (Figure PBF-4, Table PBF-1). The uncertainty of the 2016 recruitment estimate is higher than in previous years because it occurs in the terminal year of the assessment and is mainly informed by one observation from the troll age-0 CPUE index. The troll CPUE series has been shown to be a good predictor of recruitment, with no apparent retrospective error in the recruitment estimates of the terminal year given the current model construction. As the 2016 recruits grow and are observed by other fleets, the magnitude of this year class will be more precisely estimated in the next stock assessment. The above average recruitment estimated in 2016 had a positive impact on the projection results.

Estimated age-specific fishing mortalities (F) on the stock during the periods 2012-2014 and 2015-2016 compared with 2002-2004 estimates (the base period for the WCPFC Conservation and Management Measure) are presented in Figure PBF-2. A substantial decrease in estimated F is observed in ages 0-2 in 2015-2016 from the previous years. Note that stricter management measures in the WCPFC and IATTC have been in place since 2015.

The WCPFC adopted an initial rebuilding biomass target (the median SSB estimated for the period 1952 through 2014) and a second rebuilding biomass target ($20\%SSB_{F=0}$ under average

recruitment), without specifying a fishing mortality reference level.[1] The 2018 assessment estimated the initial rebuilding biomass target to be 6.7%$SSB_{F=0}$ and the corresponding fishing mortality expressed as SPR of $F_{6.7\%SPR}$ (Table PBF-2). SPR 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 intensity to the cumulative spawning biomass that could be produced by an average recruit over its lifetime if the stock was unfished. Because the projections include catch limits, fishing mortality is expected to decline, i.e., $F_{x\%SPR}$ will increase, as biomass increases. The Kobe plot shows that the point estimate of the SSB_{2016} was 3.3%$SSB_{F=0}$ and the 2016 fishing mortality corresponds to $F_{6.7\%SPR}$ (Figure PBF-3).

Table PBF-3 provides an evaluation of stock status against some common reference points. It shows that the PBF stock is overfished relative to biomass-based limit reference points adopted for other species in WCPFC (20%$SSB_{F=0}$) and is subject to overfishing relative to most of the common fishing intensity-based reference points.

Figure PBF-4 depicts the historical impacts of the fleets on the PBF stock, showing the estimated biomass when fishing mortality from 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 fleets, in particular those targeting small fish (ages 0-1), have had a greater impact, and the effect of these fleets in 2016 was greater than any of the other fishery groups. The impact of the EPO fishery was large before the mid-1980s, decreasing significantly thereafter. The WPO longline fleet 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.

2. SC14 noted the following stock status from ISC:

Based on these findings, the following information on the status of the Pacific bluefin tuna stock is provided:

1) **No biomass-based limit or target reference points have been adopted to evaluate the overfished status for PBF. However, the PBF stock is overfished relative to the potential biomass-based reference points evaluated (SSB_{MED} and 20%$SSB_{F=0}$, Table PBF-3 and Figure PBF-3).**
2) **No fishing intensity-based limit or target reference points have been adopted to evaluate overfishing for PBF. However, the PBF stock is subject to overfishing relative to most of potential fishing intensity-based reference points evaluated (Table PBF-3 and Figure PBF-3).**

3. **SC14 noted that the total PBF catch in 2017 was 14,707 mt, 11% increase from 2016 and 9% increase from the average 2012-2016. PBF is caught by various fishing gears including purse seine, longline, set net, troll, pole-and-line, handline and recreational fisheries. The detailed catch information by fishery is available in ISC 2018 stock assessment (SC14-SA-WP-06).**

Management advice and implications

4. **SC14 advises the Commission to note the current very low level of spawning biomass (3.3% B_0), the current level of overfishing, and that the projections are strongly influenced by the inclusion**

[1] The IATTC has adopted the first rebuilding target, the second target is to be discussed at a future IATTC meeting.

of a relatively high but uncertain recruitment in 2016. The majority of CCMs recommended 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. **SC14 noted the following conservation advice from ISC:**

After the steady decline in SSB from 1995 to the historical low level in 2010, the PBF stock appears to have started recovering slowly. The 2016 stock biomass is below the two biomass rebuilding targets adopted by the WCPFC while the 2015-2016 fishing intensity (spawning potential ratio) is at a level corresponding to the initial rebuilding target.

The 2018 base case assessment results are consistent with the 2016 model results. However, the 2018 projection results are more optimistic than the 2016 projections, mainly due to the inclusion of the relatively good recruitment in 2016, which is above the historical average level (119%) and twice as high as the median of the low recruitment scenario (which occurred 1980-1989).

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

1) **The projection based on the base-case model mimicking the current management measures by the WCPFC (CMM 2017-08) and IATTC (C-16-08) under the low recruitment scenario resulted in an estimated 98% probability of achieving the initial biomass rebuilding target (6.7%SSBF=0) by 2024. This estimated probability is above the threshold (75% or above in 2024) prescribed by the WCPFC Harvest Strategy (Harvest Strategy 2017-02) (scenario 0 of Table PBF-4; see also Figure PBF-5 and Figure PBF-6). The low recruitment scenario is more precautionary than the recent 10 years recruitment scenario.**

2) **The Harvest Strategy specifies that recruitment switches from the low recruitment scenario to the average recruitment scenario beginning in the year after achieving the initial rebuilding target. The estimated probability of achieving the second biomass rebuilding target (20%SSBF=0) 10 years after the achievement of the initial rebuilding target or by 2034, whichever is earlier, is 96% (scenario 1 of Table PBF-3, Table PBF-4, and Table PBF-5; Figure PBF-5 and Figure PBF-6). This estimate is above the threshold (60% or above in 2034) prescribed by the WCPFC Harvest Strategy. However, it should be recognized that these projection results are strongly influenced by the inclusion of the relatively high, but uncertain recruitment estimate for 2016.**

The Harvest Strategy adopted by WCPFC (Harvest Strategy 2017-02) guided projections conducted by ISC to provide catch reduction options if the projection results indicate that the initial rebuilding target will not be achieved or to provide relevant information for potential increase in catch if the probability of achieving the initial rebuilding target exceeds 75%. The projection results showed that the probability of achieving the initial rebuilding target was above the level (75% or above in 2024) prescribed in the WCPFC Harvest Strategy. **Accordingly, the ISC examined some optional scenarios with higher catch limits, which can be found in Appendix 1 of the PBF 2018 stock assessment report (SC14-SA-WP-06).**

Research needs

Given the low SSB, the uncertainty in future recruitment, and the influence of recruitment on stock biomass, monitoring of recruitment and SSB should be strengthened so that the recruitment trends can be understood in a timely manner.

Table PBF-1. Total biomass, spawning stock biomass and recruitment of Pacific bluefin tuna (*Thunnus orientalis*) estimated by the base-case model, where coefficient of variation (CV) measures relative variability defined as the ratio of the standard deviation to the mean.

Fishing year	Total biomass (t)	Spawning stock biomass (t)	CV for SSB	Recruitment (x1000 fish)	CV for R
1952	150825	114227	0.51	13352	
1953	146228	107201	0.49	21843	0.17
1954	147385	96239	0.49	34556	0.15
1955	152230	83288	0.50	14106	0.19
1956	169501	76742	0.49	34261	0.11
1957	188830	82975	0.46	12574	0.15
1958	208078	108677	0.41	3436	0.30
1959	214898	147004	0.39	7963	0.22
1960	218055	155183	0.39	7745	0.21
1961	211262	168125	0.39	23323	0.10
1962	197361	151993	0.42	10794	0.18
1963	181329	129755	0.45	27615	0.10
1964	169581	114448	0.45	5827	0.32
1965	159109	100628	0.46	11584	0.35
1966	144866	95839	0.44	8645	0.44
1967	121987	89204	0.44	10803	0.38
1968	107216	83374	0.45	13656	0.24
1969	93223	69074	0.47	6413	0.30
1970	81816	57958	0.48	7120	0.40
1971	71900	49980	0.48	12596	0.34
1972	67819	43035	0.46	22742	0.17
1973	65474	37205	0.44	11058	0.27
1974	65059	29896	0.44	13570	0.17
1975	63515	27733	0.38	11011	0.18
1976	66532	30485	0.30	9171	0.32
1977	64320	36220	0.25	25078	0.17
1978	69199	33382	0.25	15057	0.26
1979	69609	28007	0.29	11509	0.20
1980	71313	30757	0.25	7584	0.27
1981	72109	28867	0.21	11703	0.13
1982	53715	25408	0.21	6965	0.21
1983	31185	15086	0.29	10078	0.15
1984	33147	12813	0.31	9231	0.20
1985	36319	12846	0.28	9601	0.19
1986	35877	15358	0.23	7857	0.19
1987	31609	14632	0.25	6224	0.22
1988	33868	15709	0.25	8796	0.14
1989	38189	15519	0.25	4682	0.28
1990	46388	19468	0.23	18462	0.09
1991	61501	25373	0.21	11803	0.11
1992	70077	32022	0.20	4426	0.17
1993	79910	43691	0.18	4365	0.18
1994	90135	51924	0.19	28350	0.04
1995	103322	67152	0.18	17414	0.09
1996	98854	66841	0.18	17564	0.06
1997	99196	61069	0.19	10919	0.10
1998	95373	60293	0.19	15014	0.08
1999	91963	56113	0.20	23450	0.05
2000	87384	53835	0.21	14335	0.06
2001	76182	50222	0.21	15786	0.05
2002	77727	47992	0.20	13509	0.06
2003	74204	47569	0.19	7769	0.09
2004	68407	40707	0.20	26116	0.04
2005	63042	33820	0.21	14659	0.06
2006	50197	27669	0.23	11645	0.06
2007	43558	22044	0.24	21744	0.04
2008	41169	16754	0.27	20371	0.04
2009	35677	13011	0.27	8810	0.07
2010	33831	12188	0.25	15948	0.05
2011	34983	13261	0.23	13043	0.06
2012	37451	15892	0.20	6284	0.09
2013	39113	18107	0.20	11874	0.06
2014	38918	19031	0.19	3561	0.14
2015	38322	19695	0.20	7765	0.13
2016	41191	21331	0.22	15988	0.21
Average (1952-2016)	89579	53722	0.31	13402	0.17
Median (1952-2014)	71900	43035	0.25	11703	0.16

Table PBF-2. Spawning stock biomass and fishing intensity of Pacific bluefin tuna (*Thunnus orientalis*) in 1995 (recent high biomass), 2002-2004 (WCPFC reference year biomass), 2011 (biomass 5 years ago), and 2016 (latest) to those of the adopted WCPFC biomass rebuilding targets. SPR is used as a measure of fishing intensity; the lower the number the higher the fishing intensity that year.

	Initial rebuilding target	**Second rebuilding target**	**1995 (recent high)**	**2002-2004 (reference year)**	**2011 (5 years ago)**	**2016 (latest)**
Biomass (%SSBF=0)	SSB median1952-2014 = 6.7%	20%	10.4%	7.1%	2.1%	3.3%
SPR	6.7%	20%	5.1%	3.4%	4.9%	6.7%

Table PBF-3. Ratios of the estimated fishing intensities mortalities (Fs and 1-SPRs for 2002-04, 2012-14, 2015-16) relative to potential fishing intensity-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*).

	F_{max}	F0.1	Fmed	Floss	(1-SPR)/(1-SPRxx%)				Estimated SSB for terminal year of each reference period	Depletion ratio for terminal year of each reference period
					SPR10%	SPR20%	SPR30%	SPR40%		
2002-2004	1.77	2.47	1.04	0.78	1.07	1.21	1.38	1.61	40,707	6.3%
2012-2014	1.47	2.04	0.86	0.65	1.05	1.19	1.36	1.58	19,031	3.0%
2015-2016	1.32	1.85	0.78	0.58	1.02	1.15	1.32	1.54	21,311	3.3%

Table PBF-4. Future projection scenarios for Pacific bluefin tuna (*Thunnus orientalis*).

Scenario #	WPO					EPO*3		Catch limit Increase			
	Fishing mortality*1	Catch limit				Catch limit					
		Japan*2		Korea		Taiwan	Commercial		Sports	WPO		EPO	
		Small	Large	Small	Large	Large	Small	Large		Small	Large	Small	Large
0*4	F	4,007	4,882	718		1,700	3,300		-	0%		0%	
1	F	4,007	4,882	718		1,700	3,300		-	0%		0%	

*1 F indicates the geometric mean values of quarterly age-specific fishing mortality during 2002-2004.

*2 The Japanese unilateral measure (transferring 250 mt of catch upper limit from that for small PBF to that for large PBF during 2017-2020) would be reflected.

*3 Fishing mortality for the EPO commercial fishery was assumed to be high enough to fulfill its catch upper limit (F multiplied by two). The fishing mortality for the EPO recreational fishery was assumed to be the F2009-11 average level.

*4 In scenario 0, the future recruitment were assumed to be the low recruitment (1980-1989) level forever. In other scenarios, recruitment was switched from low recruitment to average recruitment from the next year of achieving the initial rebuilding target.

Table PBF-5. 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 #	Catch limit Increase				Initial rebuilding target			Second rebuilding target		Median SSB (mt) at 2034
	WPO		EPO		The year expected to achieve the target with >60% probability	Probability of achiving the target at 2024	Probability of SSB is below the target at 2024 under the low recruitment	The year expected to achieve the target with >60% probability	Probability of achiving the target at 2034	
	Small	Large	Small	Large						
0*1	0%		0%		2020	98%	2%	N/A	3%	74,789
1	0%		0%		2020	99%	2%	2028	96%	263,465

*1 In scenario 0, the future recruitment were assumed to be the low recruitment (1980-1989) level forever. In other scenarios, recruitment was switched from low recruitment to average recruitment from the next year of achieving the initial rebuilding target.

Table PBF-6. Expected yield for Pacific bluefin tuna (*Thunnus orientalis*) under various harvesting scenarios based on the base-case model.

Scenario #	Catch limit Increase				Expected annual yield in 2019, by area and size category (mt)				Expected annual yield in 2024, by area and size category (mt)				Expected annual yield in 2034, by area and size category (mt)			
	WPO		EPO		WPO		EPO		WPO		EPO		WPO		EPO	
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
0	0%	0%	0%		4,477	4,384	3,530		4,704	6,133	3,457		4,704	6,211	3,451	
1	0%	0%	0%		4,477	4,384	3,530		4,745	6,202	3,665		4,747	6,640	3,703	

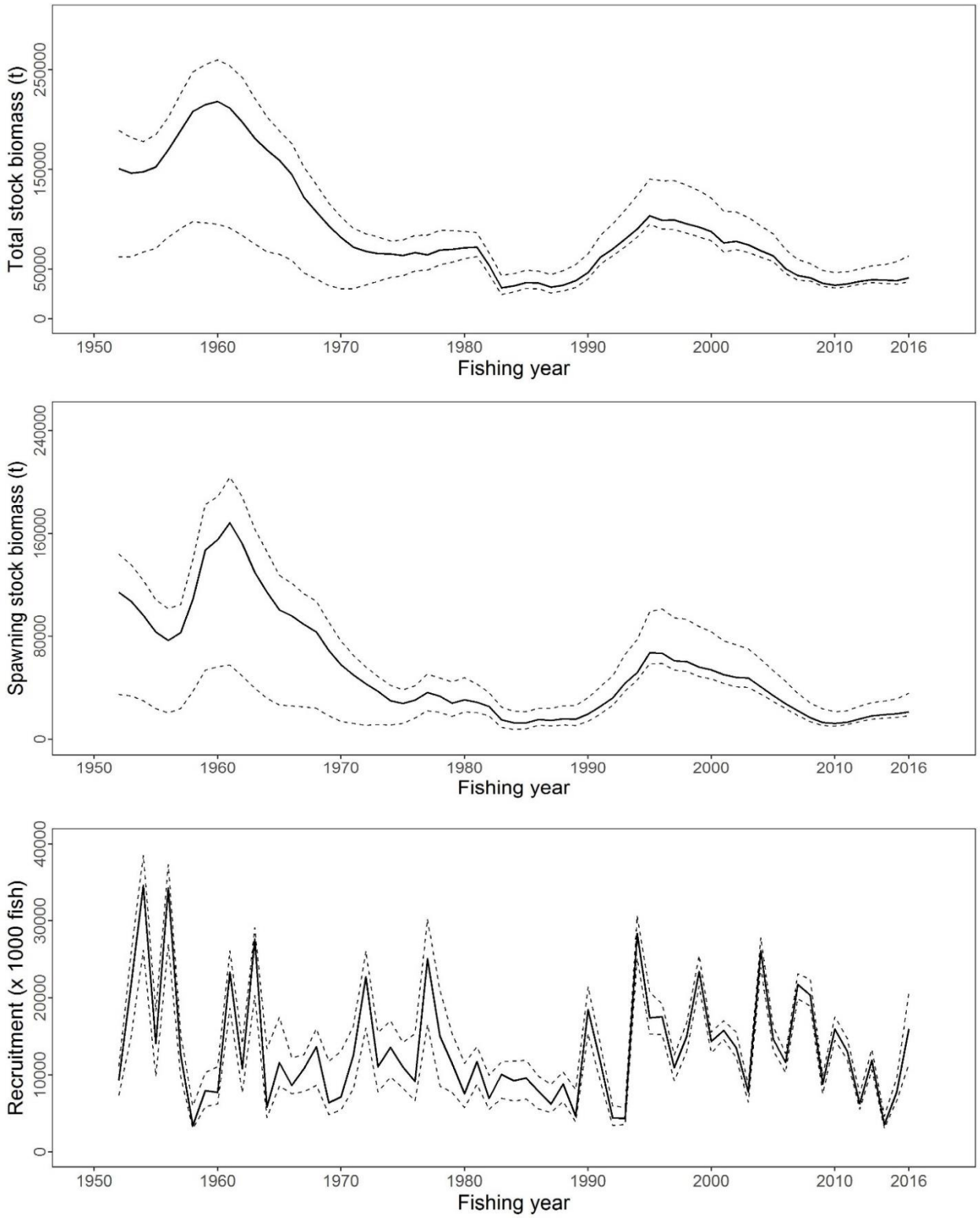

Figure PBF-1. Total stock biomass (top), spawning stock biomass (middle) and recruitment (bottom) of Pacific bluefin tuna (*Thunnus orientalis*) from the base-case model. The solid lines indicate point estimates and the dashed lines indicate the 90% confidence intervals.

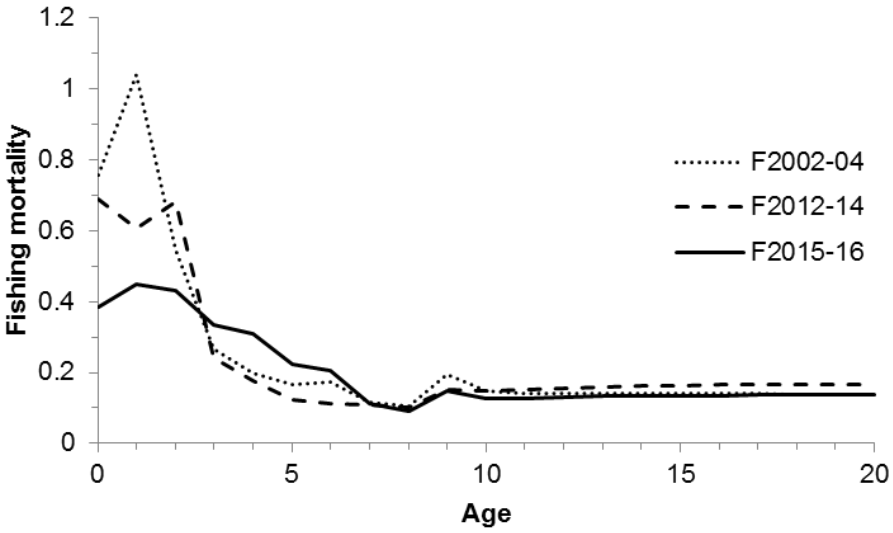

Figure PBF-2. Geometric means of annual age-specific fishing mortalities of Pacific bluefin tuna (*Thunnus orientalis*) in 2002-2004 (dotted line), 2012-2014 (dashed line), and 2015-2016 (solid line).

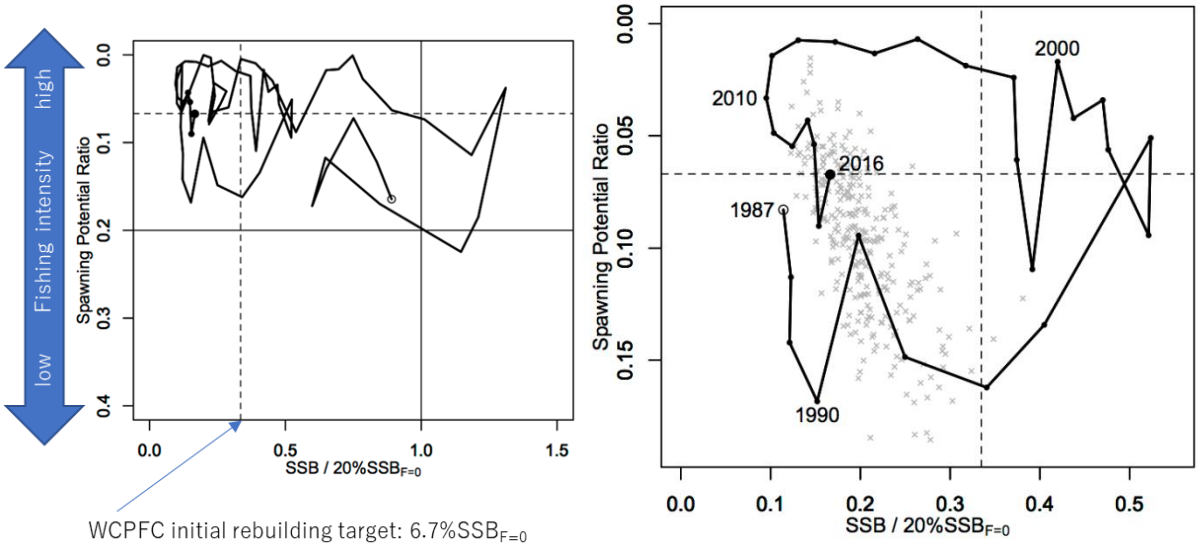

Figure PBF-3. Kobe plots for Pacific bluefin tuna (*Thunnus orientalis*). X axis shows the annual SSB relative to 20%SSB$_{F=0}$ and the Y axis shows the spawning potential ratio as a measure of fishing intensity. Solid vertical and horizontal lines in the left figure show 20%SSB$_{F=0}$ (which corresponds to the second biomass rebuilding target) and the corresponding fishing intensity, respectively. Dashed vertical and horizontal lines in both figures show the initial biomass rebuilding target (SSB$_{MED}$ = 6.7%SSB$_{F=0}$) and the corresponding fishing intensity, 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) while solid circles indicate the last five years of the assessment (2012-2016). The right figure shows the trajectory of the last 30 years, where grey dots indicate the uncertainty of the terminal year.

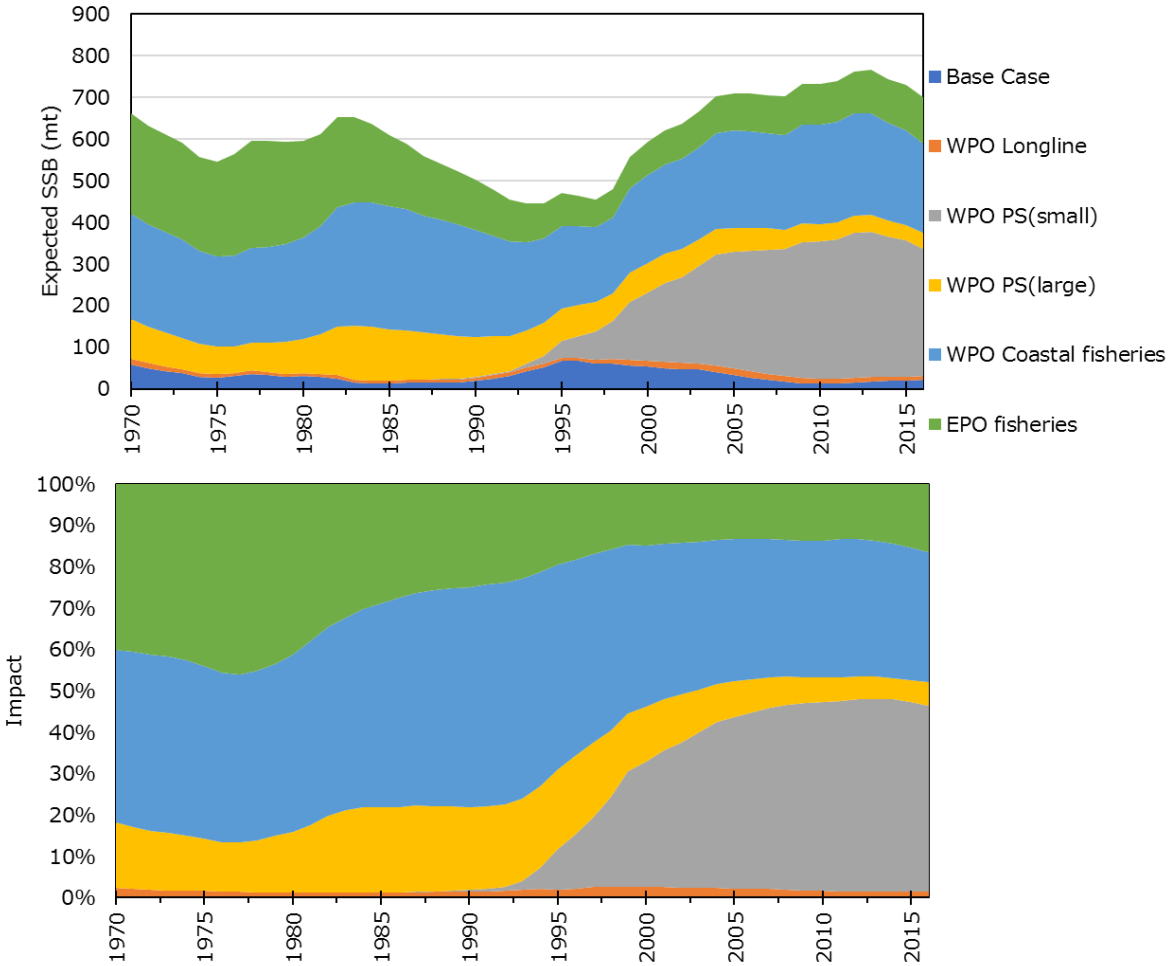

Figure PBF-4. Trajectory of the spawning stock biomass of a simulated population of Pacific bluefin tuna (*Thunnus orientalis*) when zero fishing mortality is assumed, estimated by the base-case model. (top: absolute impact, bottom: relative impact). Fleet definition; WPO longline: F1, F12, F17. WPO purse seine for small fish: F2, F3, F18. WPO purse seine: F4, F5. WPO coastal fisheries: F6-11, F16, F19. EPO fisheries: F13, F14, F15.

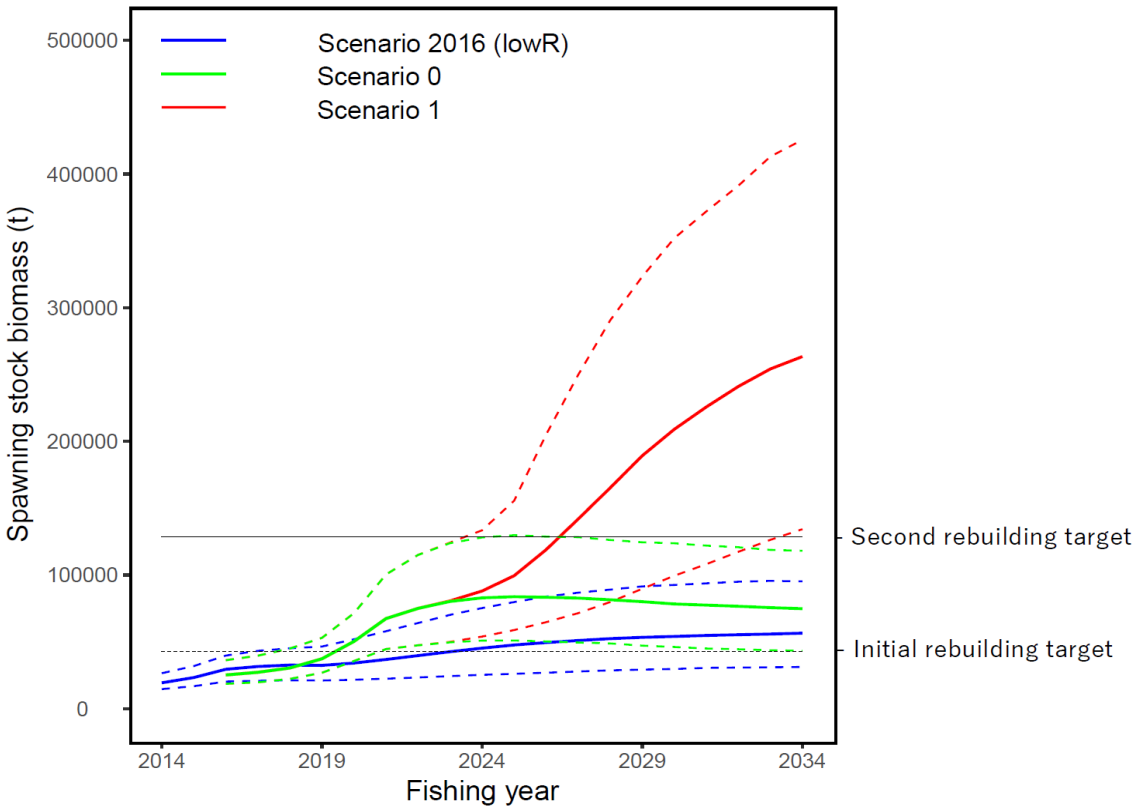

Figure PBF-5. Comparison of future SSB of Pacific bluefin tuna (*Thunnus orientalis*) under the current management measures assuming low recruitement using the 2016 assessment (scenario 2016 lowR), assuming low recruitment using the 2018 assessment (scenario 0), and assuming a shift of the recruitment scenario from low to average after achieving the initial rebuilding target using the 2018 assessment (scenario 1).

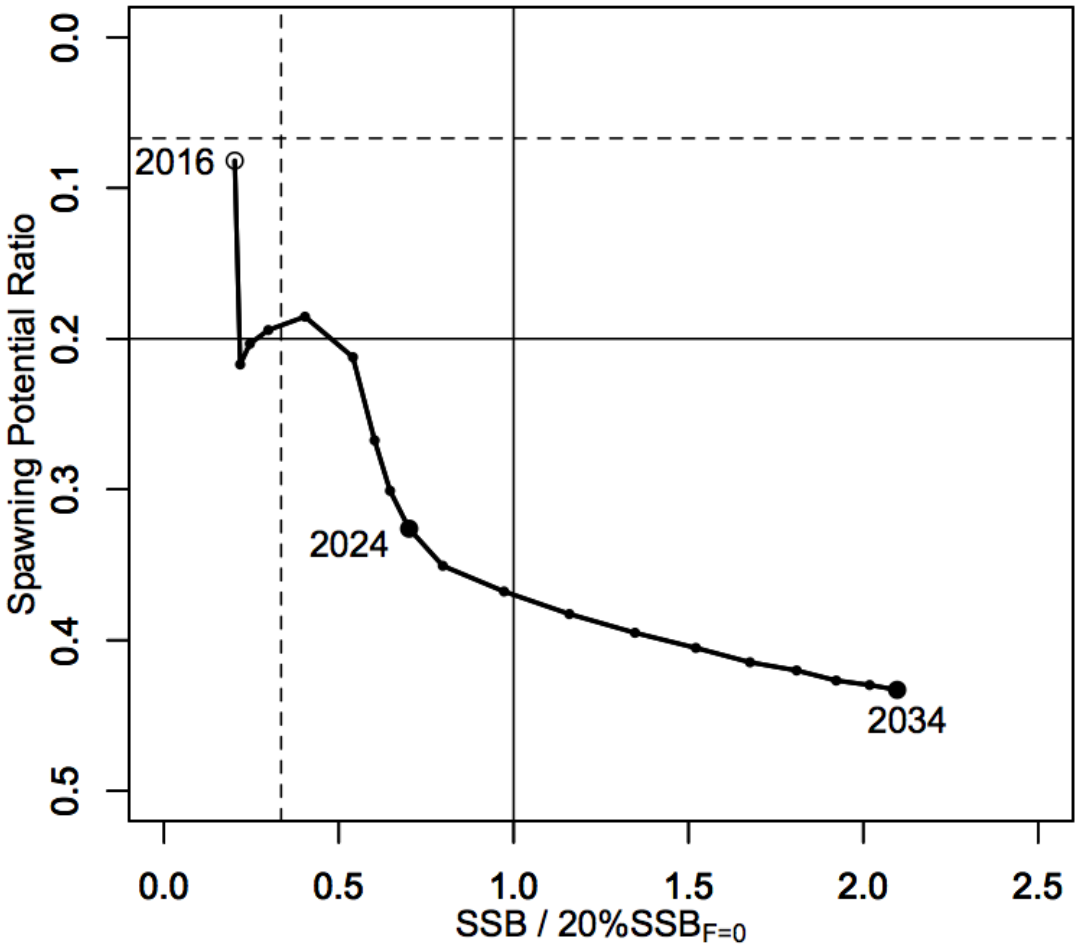

Figure PBF-6. A projection result (scenario 1 from Table PBF-4) for Pacific bluefin tuna (*Thunnus orientalis*) in a form of Kobe plot. The X axis shows the SSB value relative to 20%$SSB_{F=0}$ (second rebuilding target) and the Y axis shows the spawning potential ratio as a measure of fishing intensity. Vertical and horizontal solid lines indicate the second rebuilding target (20%$SSB_{F=0}$) and the corresponding fishing intensity, respectively, while vertical and horizontal dashed lines indicate the initial rebuilding target (SSB_{MED} = 6.7%$SSB_{F=0}$) and the corresponding fishing intensity, respectively.

Attachment 2
(Attachment D, DRAFT 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

CONSERVATION AND MANAGEMENT MEASURE FOR PACIFIC BLUEFIN TUNA

Conservation and Management Measure 2020-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 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) 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 F_{MED} and F_{LOSS}.
- 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;

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.[2]

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[3,4].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[1]. However, in 2018, 2019, and 2020 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

[2] Notwithstanding paragraph 2 and 3, a CCM may carry over up to 17% of its initial 2019 catch limits, which remain uncaught, to 2020.
[3] CCMs with a base line catch of 10 t or less may increase its catch as long as it does not exceed 10 t.
[4] 300 tons of the catch limit of Pacific bluefin tuna 30kg or larger of Chinese Taipei will be transferred to Japan in 2020.

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 2020. Based on that review, in 2020 the Northern Committee will determine whether it should be continued past 2020, 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[5].

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.

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

[5] 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).

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 2018-02. 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.

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

Attachment 3
(Attachment E, DRAFT 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 4
(Attachment F, DRAFT 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.

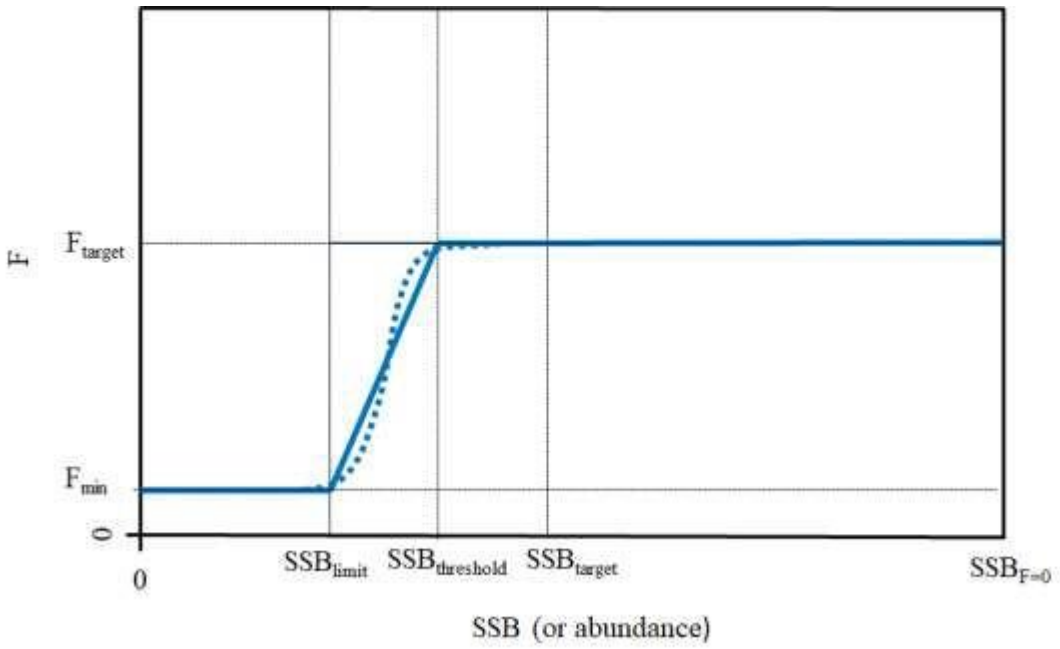

Figure 1. Candidate HCRs 1a (solid line) and 1b (dashed line)

Candidate HCR 2 is illustrated in Figure 2 and is similar to Candidate HCRs 1a and 1b in that F declines once the SSBlimit is breached, but unlike Candidate HCRs 1a and 1b, there is no SSBthreshold between SSBlimit and SSBtarget.

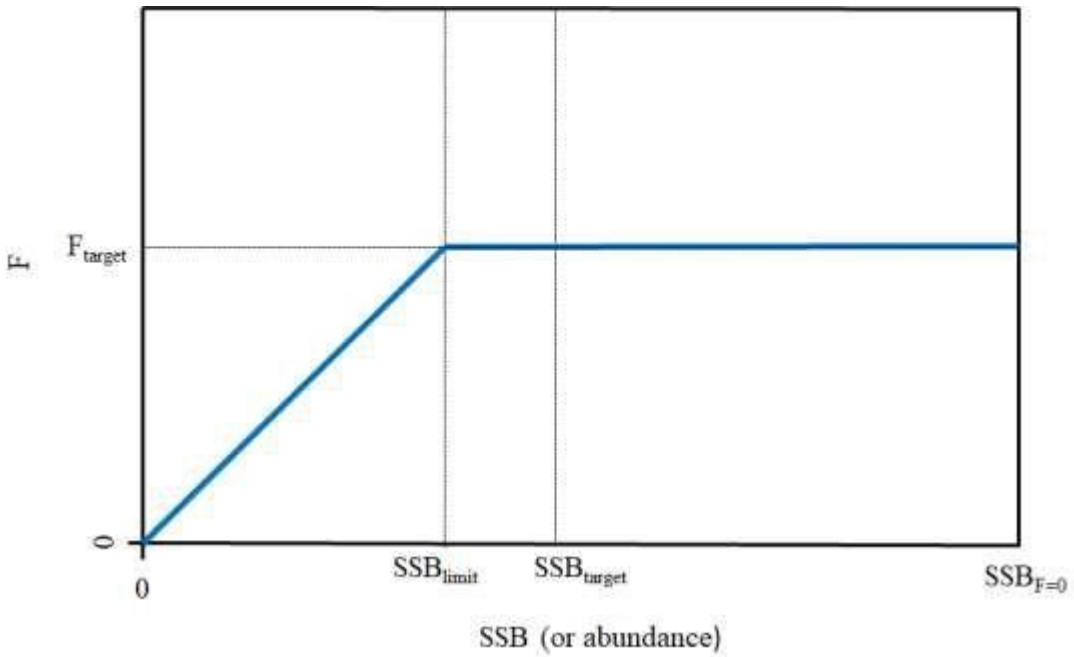

Figure 2. Candidate HCR 2

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[6].

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}], $10\%F_{target}$

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