1 Principle 1 Updated Scoring – KT – May 2022

1.1 Principle 1 – Low Trophic Level (LTL) species

None of the target species for this assessment are key Low Trophic Level (LTL) species, as they do not meet the requirements for key LTL species defined in paragraphs SA2.2.8 – SA2.2.10 of the MSC Fisheries Certification Requirements v2.0. The stocks are not involved in large portions of the trophic connections in the ecosystem; large volumes of the energy does not pass through the stocks between lower and higher trophic levels; and there are many other species at their trophic level through which energy can be transmitted from lower to higher trophic levels. They are not one of the species types listed in Box SA1, nor do they feed predominantly on plankton.

1.2 WCPO bigeye tuna background

Stock: Genetic analysis does not suggest significant population differentiation across the tropical Pacific (Grewe and Hampton, 1998), however for management purposes, bigeye is divided into two separate stocks, west and central and eastern. Bigeye grow relatively quickly, attaining a maximum length of ~200 cm. Individuals are considered to be mature between 80 and 120 cm in length. Work on bigeye growth has been the subject of recent research activities by scientists (Farley et al., 2018), leading to a new, more optimistic stock assessment in 2017 (McKechnie et al., 2017) and updated in 2018 (Vincent et al., 2018) compared to the previous assessment in 2014 (Davies et al., 2014).

Stock status: The most recent stock assessment (McKechnie et al., 2017) was later updated in 2018 to incorporate the updated growth curve from 'Project 81' (Vincent et al., 2018). These analyses surmised that all models with the updated new growth function put SB above the limit reference point (LRP) and that with the new growth function, estimated that recruitment has increased spawning potential in the last few years. Table 1 gives the stock assessment output from the Scientific Committee (SC)14 uncertainty grid (WCPFC, 2018a). SC14 concluded that the 'updated new' growth model reflected the best scientific information available, so did not incorporate the outputs with the old growth model into the data used to provide scientific advice to WCPFC.

Despite this, all models also estimated that there had been substantial decline in the abundance of bigeye across the time series. In terms of the probabilities of stock status relative to reference points, using the SC14 grid the SB is estimated to be above the limit reference point with high probability (36 out of 36 models), and F is estimated to be below F_{MSY} with 94% probability (2 out of 36 models) (WCPFC, 2018a). Figure 1 presents a Majuro plot comparing new and old growth models in relation to F and SB.

Table 1. Summary of reference points over the 36 models in the structural uncertainty grid. Note that $SB_{recent}/SB_{F=0}$ is calculated where SB_{recent} is the mean SB over 2012-2015 (WCPFC, 2018a).

Parameter	Min.	10%	Median	90%	Max.
F_{recent} / F_{MSY}	0.59	0.67	0.77	0.93	1.06
SB_{latest} / $SB_{F=0}$	0.30	0.35	0.42	0.48	0.53

SB_{latest} / SB_{MSY}	1.15	1.31	1.62	1.93	2.19
SB_{recent} / $SB_{F=0}$	0.25	0.30	0.36	0.41	0.45
SB_{recent} / SB_{MSY}	0.96	1.12	1.38	1.66	1.88
SB_{MSY} / $SB_{F=0}$	0.26	0.26	0.28	0.30	0.30

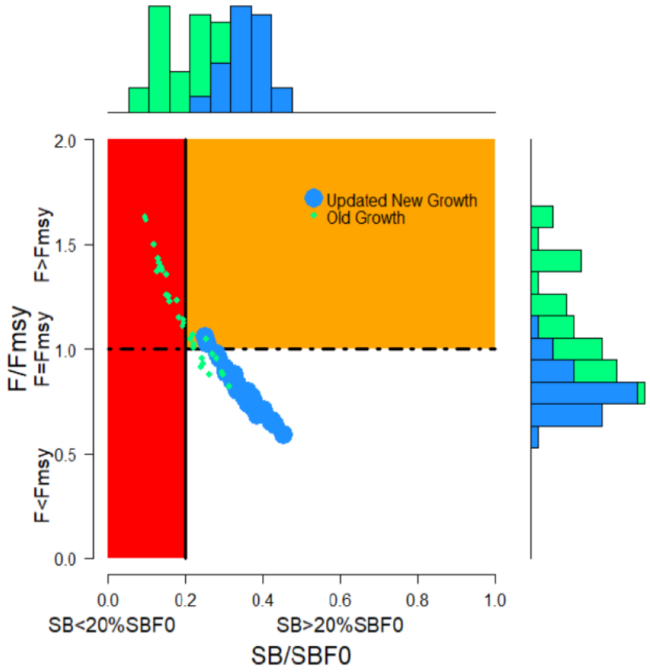

Figure 1. Majuro plot showing the outcome of each of the 72 models in the grid from the assessment update in 2018, with the updated new growth model in blue and the old growth model in green (these results discarded by the Scientific Committee). The red area shows SB below the LRP, while the orange area shows F higher than F_{MSY} (Figure 7 in Vincent et al. (2018)).

Reference points: WCPFC has agreed an explicit limit reference point (LRP) for bigeye (and other stocks) of 20%$_{SBcurrent,F=0}$, where 'current' is defined as the most recent ten-year period for which data are available for the stock assessment. The acceptable level of risk of breaching the limit reference point was agreed at WCPFC13 (in 2016) to be not greater than 20% but is not defined further than that. Pending agreement on a target reference point (TRP) the spawning biomass depletion ratio ($SB/SB_{F=0}$) is to be maintained at or above the average $SB/SB_{F=0}$ for 2012-2015. The harvest strategy workplan (see below) set 2019 as a deadline for defining a TRP for bigeye and yellowfin, but this was not achieved at WCPFC16, and the workplan has been revised to push this deadline back to 2021 (WCPFC16 outcomes report; WCPFC 2019a, Attachment H).

Harvest strategy: CMM 2014-06 commits WCPFC to developing a formal harvest strategy for key stocks, including those considered here (although the terminology was changed in 2019 to 'management procedure'). The Commission agreed a workplan to implement the CMM, which has been revised several times; most recently at WCPFC16 in December 2019. The stock is further

managed through CMM 2018-01, which has the purpose to create 'a bridge to the adoption of a harvest strategy for bigeye, skipjack, and yellowfin stocks and/or fisheries in accordance with the work plan and indicative timeframes set out in the Agreed Work Plan for the Adoption of Harvest Strategies under CMM 2014-06, which includes the development of management objectives and target reference points. The SC determined that although the bigeye stock appears not to be experiencing overfishing and is not in an overfished condition, fishing mortality should not be increased from the current level to maintain current or increased spawning biomass (CMM 2018-01). CMM 2018-01 expires at the end of 2020, and a further 'bridging measure' will have to be agreed at WCPFC17 (December 2020) because the revised harvest strategy workplan does not now foresee a formal management procedure being agreed for bigeye and yellowfin until sometime after 2022 (WCPFC 2019a).

CMM 2018-01 provides a series of management measures in order to restrict effort of tropical tunas, which includes bigeye and particularly for the purse seine fishery, which accounts for 45% of bigeye catch (in 2017; WCPFC 2018)(see Table 2). These include a three-month ban on deploying, maintaining or setting on FADs during July- September, including the high seas and EEZs, in the area 20°N-20°S (with some exemptions for PNA vessels operating under the VDS); a maximum of 350 instrumented FADs to be in use, per vessel, at any one time and zone-based and high seas purse seine effort control. Where limits may be exceeded by a CCM or group of CCMs, CMM 2018-01 further states that they will be deducted from the limits for the following year (Table 2). Longline fisheries catching bigeye are also subject to restrict on catch limits (Table 3).

Table 2. Purse seine effort/catch limits under CMM 2018-01 (* = limits not notified to the Commission, ** = The United States notified the Secretariat of the combined US EEZ and high seas effort limits on 1 July 2016 (1828 fishing days on the high seas and in the U.S. EEZ (combined)).

Coastal CCM or group of CCMs	High Seas purse seine effort limit (days)	Zone-based purse seine effort control/catch limit in tonnes
PNA	N/A	44,033 days
Tokelau	N/A	1000 days
Cook Islands	N/A	1,250 days
Fiji	N/A	300 days
Nuie	N/A	200 days
Samoa	N/A	150 days
Tonga	N/A	250 days
Vanuatu	N/A	200 days
Australia	N/A	30,000 mt SKJ 600 mt BET 600 mt YFT

French Polynesia	N/A	0
Indonesia	0	*
Japan	121	1500 days
Korea	N/A	*
New Zealand	N/A	40,000 mt SKJ; nothing specified for other species
New Caledonia	N/A	20, 000 mt; nothing specified for other species
Philippines	Separate measures for Philippines, see CMM 2018-01	*
Taiwan	95	*
USA**	1270	558 days
Wallis and Futuna	N/A	*
China	26	N/A
EU	403	N/A
Ecuador	Subject to CNM on participatory rights	N/A
El Salvador	Subject to CNM on participatory rights	N/A

Table 3. Longline catch limits imposed for bigeye under CMM 2018-01.

Bigeye catch limits by flag
CCMs Catch Limits CHINA 8,224 INDONESIA 5,889* JAPAN 18,265 KOREA 13,942 CHINESE TAIPEI 10,481 USA 3,554 *Provisional and maybe subject to revision following data analysis and verification
Japan will make an annual one-off transfer of 500 metric tonnes of its bigeye tuna catch limit to China.

With regard to unwanted catch, the fisheries specifically target bigeye, and there are no requirements such as minimum or maximum landing sizes or quotas which could lead to any of this catch being unwanted. Discarding rates for bigeye are presumed to be minimal, although this would have to be shown at full assessment. For the purpose of this pre-assessment, it was assumed that there is no 'unwanted catch'[1] of bigeye in this fishery.

PNA harvest strategy and the VDS: There is some management of bigeye under the PNA vessel day scheme, which limits purse seine effort in the EEZs of the Parties to the Nauru Agreement (PNA) which between them cover >50% of WCPO purse seine effort.

Information and stock assessment: The most recent stock assessment (McKechnie et al., 2017, updated in 2018) is conducted by SPC using MULTIFAN-CL. It includes a wide range of information to make the analysis, collecting data on types of fisheries targeting the stock, catch, effort, CPUE, length/weight frequency and tagging studies, all of which is used to compile a robust and comprehensive evaluation of data ranging from 1952 to 2015.

1.3 WCPO yellowfin tuna background

Stock: The WCPO stock of yellowfin is considered to be discrete, although some there is some evidence of longitudinal movement eastwards across the equator. From a management perspective the west-east boundary is 150°W (Tremblay-Boyer et al., 2017). Yellowfin are fast growing, reaching a maximum length of ~180 cm and maturing at ~100 cm. It is thought that growth rates are slower in Indonesia/Philippines waters than in the wider WCPO. This however is not taken into account in the stock assessment model, which uses a single growth schedule across all regions. Tagging recapture data suggests individuals of four years old are common (Tremblay-Boyer et al., 2017).

Stock status: The most recent stock assessment (Tremblay-Boyer et al., 2017) estimates that the stock is not overfished nor is overfishing occurring. The probability that the spawner biomass is below the point of recruitment impairment (PRI) is less than 5%, as is the probability that F is above F_{MSY}. The stock assessment estimates that F has increased continuously since the start of fishing and although recent recruitment has been relatively high, spawner biomass is estimated to have declined across the whole period for all models and for most of the regions.
Table 4 presents the summary of the uncertainty grid in the assessment. Figure 2 presents the Majuro plots for the full grid and key sensitivities.

Table 4. Summary of stock status estimates relative to reference points, across all 72 models in the structural uncertainty grid used to characterise uncertainty; latest = 2015, recent = 2011-14; $SB_{F=0}$ = average spawning potential in the absence of fishing for 2005-14, following the definition of the LRP agreed by the SC. Taken from Table A6 in Tremblay-Boyer et al., 2017.

Parameter	Min.	25%	Median	75%	Max.
F_{recent} / F_{MSY}	0.54	0.66	0.73	0.82	1.13

[1] SA3.1.6: The term 'unwanted catch' shall be interpreted by the team as the part of the catch that a fisher did not intend to catch but could not avoid and did not want or chose not to use.

SB_{latest} / $SB_{F=0}$	0.16	0.30	0.39	0.43	0.50
SB_{latest} / SB_{MSY}	0.80	1.24	1.41	1.62	1.91
SB_{recent} / $SB_{F=0}$	0.15	0.27	0.35	0.39	0.45
SB_{recent} / SB_{MSY}	0.81	1.28	1.43	1.59	1.93
SB_{MSY} / $SB_{F=0}$	0.16	0.25	0.26	0.29	0.35

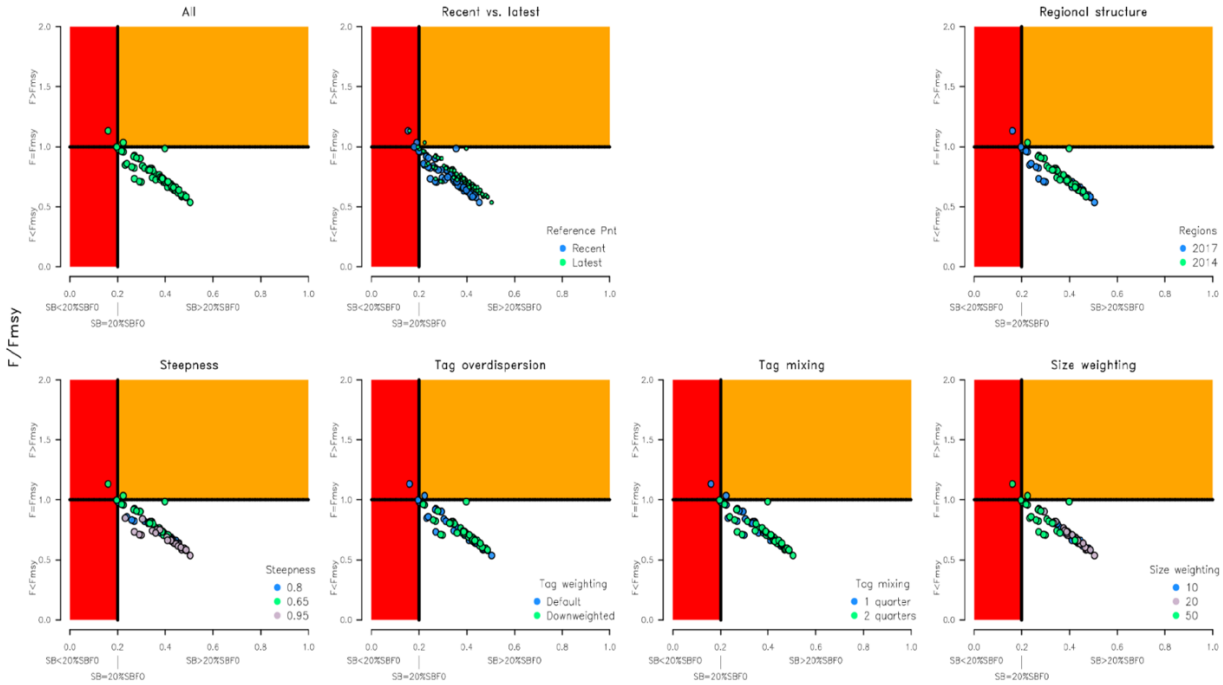

Figure 2. Majuro plots summarising the results for each of the models in the structural uncertainty grid individually; y-axis = F/F_{MSY}; orange zone = $F>F_{MSY}$; x-axis = $SB/SB_{F=0}$ (contrary to how it is labelled in the original figure); red zone = $SB<20\%SB_{F=0}$, i.e., LRP agreed by WCPFC. All figures show SB_{latest}, except where otherwise indicated. Top left: all models for SB_{latest}; top middle: ditto, also including SB_{recent}. Remaining five models show key sensitivity runs, with blue the diagnostic case model in each case: Top right: regional structure; bottom left: steepness; bottom mid-left: tag overdispersion; bottom mid-right: tag mixing; bottom right: size data weighting. Figure A41 in Tremblay-Boyer et al., 2017.

Reference points: See bigeye above in Section 1.2.

Harvest strategy: As per bigeye in Section 1.2.

Information and stock assessment: As for bigeye, the stock assessment is conducted by SPC using MULTIFAN-CL. The most recent stock assessment (Tremblay-Boyer et al., 2017) relies on longline and purse seine CPUE, length-frequency from port sampling and tagging data. Overall, SPC considers the model output to be relatively robust.

1.4 EPO bigeye background

Stock: For general information on bigeye tuna, see Section 1.2 above. The purse-seine catches of bigeye are substantially lower close to the western boundary of the EPO (150°W); the longline catches are more continuous, but relatively low between 160°W and 180°W. Recruitment in EPO bigeye is highly variable. It is hypothesised that recruitment of EPO bigeye is affected by environmental conditions; specifically, being higher during El Nino events and lower in La Nina periods (Xu et al., 2018).

Stock status: The updated stock assessment in 2018 (Xu et al., 2018) estimates that the stock is not overfished, however, according to the base case model, recent F is above F_{MSY}, although recent S remains above the MSY level. At this level of F, and assuming average recruitment, S is predicted to decline to ~0.17, which is below the MSY level. This estimate of F is a substantial change from the previous update assessment in 2017, which estimated that $F<F_{MSY}$.

IATTC scientific staff identified a range of uncertainties and concerns with the stock assessment in 2018 and concluded that it was not sufficiently robust to be used to provide management advice. They have developed and are implementing a workplan (Maunder et al., 2018) to improve the stock assessment, but in the meantime use a range of indicators to evaluate stock status, rather than a formal stock assessment (Xu et al. 2019). Xu et al. (2019) outline the six data-based indicators which have been developed for bigeye. Rather than using reference points based on maximum sustainable yield, the current value of each indicator is compared to its distribution of historical values. The indicators are based on data from all purse-seine vessels that fished during 2000-2018, to avoid the period covering the floating-object fishery expansion in the mid-1990s. All stock status indicators for 2018, except catch, are at, or near, their respective reference levels that indicate high exploitation rates, increasing fishing mortality and reduced abundance over time.

Reference points: The management goal of the Commission is to maintain stocks at MSY. To assess whether a stock is above the point where recruitment is impaired (PRI) a limit reference point is defined for all tuna species harvested in the EPO. The limit reference points for bigeye is set at $0.38*S_{MSY}$ which correspond to a 50% reduction in recruitment from its average unexploited level based on a conservative value of steepness (i.e., h = 0.75) for the Beverton-Holt stock-recruitment relationship. In 2014, this LRP was proposed by the SAC and accepted by the Commission, along with a TRP based on MSY (IATTC 2014a, b). This LRP is below the MSC default level for the PRI ($50\%B_{MSY}$ / $20\%B_0$), so these defaults are used for scoring instead. Since $20\%S_0$ is close to the level of S_{MSY} estimated analytically, this was not considered a suitable proxy for the PRI, so 50% of S_{MSY} is used.

Harvest strategy: IATTC agreed a harvest control rule for tropical tunas in Resolution C-16-02, based on the reference points set out above. The HCR is as follows:

- If the probability that $F>F_{lim}$ is >10% for the most vulnerable stock, management measures shall be established such that there is at least a 50% probability that F will reduce to F_{MSY} or below, and with a probability of <10% of $F>F_{lim}$.

- If the probability that SB<SB_{lim} is >10%, management measures shall be established such that there is at least a 50 % probability that SB will recover to SB_{MSY} or above, and with a probability of <10% that SB will decline to <SB_{lim} within two generations or five years, whichever is greater.

Overall, harvest strategy is relatively simple, i.e., if fishing mortality is higher than the level consistent with producing MSY, then reduce F to F_{MSY}. The harvest strategy is implemented by restricting effort of the entire fishery for yellowfin, bigeye and skipjack, based on the stock with the highest F relative to F_{MSY} (F-ratio; measured in IATTC as the F-multiplier (F-mult) which is F_{MSY}/F – NB: this is the inverse ratio from F/F_{MSY}, habitually used by the other tuna RFMOs including WCPFC). Allowable fishing effort is based on the stock with the lowest estimate of F-mult therefore fishing mortality on the other two stocks must also be below F_{MSY}. The 2018 update assessment for bigeye estimated F-mult to be 0.87 (see above); considerably below the previous estimate and the lowest of the three stocks. According to the HCR, this estimate, plus any changes in fleet capacity, should have been used to adjust the closure period. However, because the assessment was not considered robust, the number of days for 2019 was not changed, pending external review, evaluation and revision of the stock assessment methodology (see below).

Resolution C-16-02 does not specify the tools that should be used to implement the HCR, but Resolution C-17-02 for 2018-2020, applying to purse seine vessels with >182 t carrying capacity, and to longline vessels >24 m LOA.

- 72 days closure for purse seine vessels in 2017, 2018, 2019 and 2020;
- One-month closure in the area shown in Figure 3, which is from 9 October-8 November;
- Active FAD limits per purse seine vessel, from 70-450 according to vessel class (size);
- Bigeye catch limits: for key distant water fleets as shown in Figure 4 (with up to 30% transferable); for other CPCs the greater of 2001 catches or 500 t;
- Measures to be evaluated according to the results of stock assessments in 2018, 2019 and 2020, and adjusted accordingly.

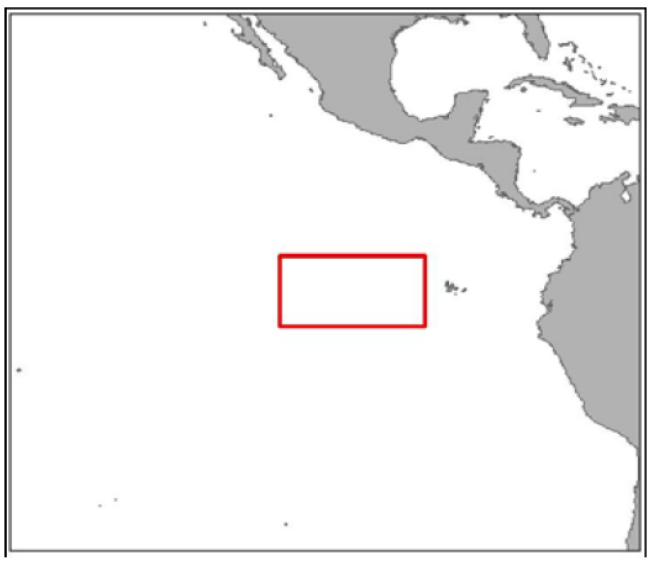

Figure 3. Closed area from 29th September – 29th October under C-17-01 (Figure 1 in Resolution text).

Metric tons	2018-2020
China	2,507
Japan	32,372
Korea	11,947
Chinese Taipei	7,555
United States	750

Figure 4. Bigeye longline catch limits under Resolution C-17-02

There is not a direct link between these measures and the HCR, as there would be, for example, if target reference points were used to establish a TAC, as is done elsewhere. In the past, the number of days of closure have been adjusted according to the F-ratio for the most vulnerable species. The 2018 update assessment for bigeye estimated F-mult to be 0.87, so according to the HCR, this estimate, plus any changes in fleet capacity, should be used to adjust the closure period, as set out in Figure 5 (i.e., to 107 days in 2019).

	Bigeye	Yellowfin
F multiplier from the stock assessment	0.87	0.99
Capacity increase	1.0%	1.0%
F multiplier adjusted for capacity increase	0.86	0.98
Days of closure[3]	107	71

Figure 5. Calculations for closure period for 2019, based on F-mult and adjustments for changes in capacity (from IATTC, 2018)

In fact, however, IATTC scientists advised using F-mult from yellowfin (i.e., no change to the closure), on the following basis (IATTC, 2018):

- The large change in F-mult over one year is implausible.
- The probability of LRPs being exceeded remains <10%, including for the sensitivity analysis.
- The assessment is not considered reliable enough; specifically, it is considered too sensitive to new data and some other issues.
- Capacity in the purse seine fleet has decreased slightly from 2017.
- The current closure is 72 days, while the previous level of 62 days was used in the three-year average for calculating F-mult for each stock.

IATTC scientists have developed a plan to address the issues with the stock assessment (Maunder et al., 2018), in the hope that this can be done before C-17-02 expires in 2020; presumably they consider the 72-day closure sufficiently precautionary for bigeye in the short-term, till then. In the longer term, under the strategic plan it is proposed to conduct a comprehensive Management Strategy Evaluation (MSE) for bigeye tuna and plan MSEs for the other tropical tuna species, including the multi-species fishery for tropical tunas. This based on the same methodology as used for the current stock assessment, i.e., using the Stock Synthesis (SS) modelling platform to develop operating models (assumed to represent the underlying true dynamics) based on current assessments was developed. Simulated data are generated, and modified stock assessments are implemented, often including mis-specified processes and parameters to represent some of the uncertainty and structural errors of real assessments (Maunder et al., 2015).

Information and stock assessment: As with other assessments, catch data is taken from a number of fisheries. For the most recent assessment in 2019 (Xu et al.) new or updated longline catch information were available for China, Japan, Korea, Taiwan, the US, French Polynesia, and Vanuatu, amongst others. Port technicians complement the collection of information and verify the accuracy of the catch recorded by the observers. Tagging, size composition and effort data was also taken into account in the model runs.

1.5 EPO yellowfin background

Stock: For general information on yellowfin tuna, see Section 1.3 above.

Stock status: The most recent formal stock assessment (Xu et al., 2018) suggests that the 5%/95% confidence intervals for spawning stock sit at approximately 50% MSY, which means that there is approximately a 5% probability that the stock is below the MSC default for the PRI. The 2019 assessment (Minte-Vera, 2019a) uses indicators rather than a formal assessment model, because the model was not considered robust. These indicators (catch, average weight per fish, closure-adjusted capacity and three FAD-related indicators) are all at levels set as the outer safe limit, except for catch. Since these limits are well before the point at which recruitment should be impaired.

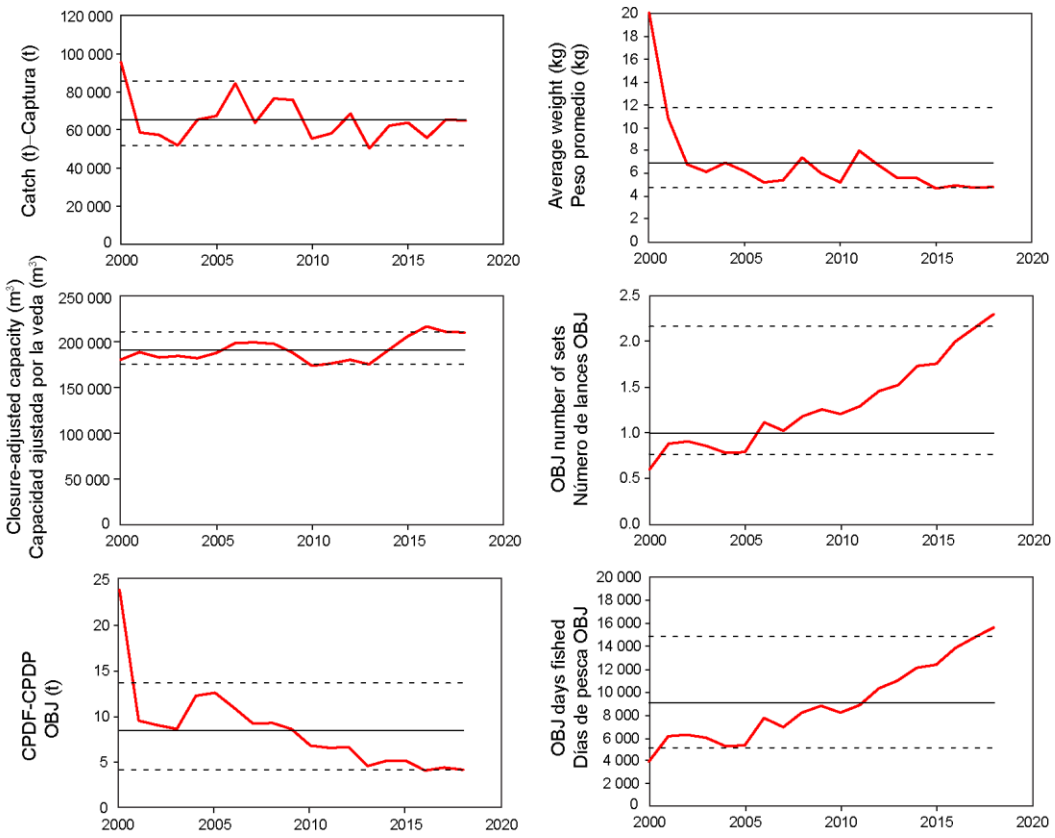

Figure 6. Stock status indicators for bigeye tuna in the EPO, based on purse-seine data, 2000-2018. The dashed horizontal lines are the 5th and 95th percentiles, the solid horizontal line is the median. CPDF: catch per day fishing; OBJ: sets on floating objects.

Reference points: As for bigeye, the management goal of the Commission is to maintain stocks at MSY. This has led to the definition of target and limit reference points such that biomass and fishing mortality rates are maintained at levels that produce MSY, i.e., S (SB) $_{MSY}$ and F_{MSY} respectively. To assess whether a stock is above the point where recruitment is impaired (PRI) a limit reference point is defined for all tuna species harvested in the EPO. The limit reference points for yellowfin is set at $0.28*S_{MSY}$ which correspond to a 50% reduction in recruitment from its average unexploited level based on a conservative value of steepness (i.e., h = 0.75) for the Beverton-Holt stock-recruitment relationship. In 2014, this LRP was proposed by the SAC and accepted by the Commission, along with a TRP based on MSY (IATTC 2014a, b). In practice, as for EPO bigeye, F_{MSY} is used as the management target.

Harvest strategy: See Section 1.4 above. In 2019, the update stock assessment for yellowfin showed F-mult<1, i.e., following the harvest strategy the closure days should be increased. The situation is the same for bigeye in 2018, however, in that IATTC scientific staff had no confidence in the stock assessment (in fact, the external review of the assessment raised issues for the bigeye methodology which also apply to yellowfin). Pending a benchmark assessment in 2020 which will consider all these issues, there is no application of the HCR in 2020 as in 2019 (Minte-Vera et al. 2019b).

Information and stock assessment: As with other assessments, catch data is taken from a number of fisheries. For the most recent assessment in 2019 (Minte-Vera et al.), the indicators used were catch, effort, catch per unit effort (CPUE) and average length of fish in the catch, and are based on data from 1975 – 2018. Research is planned to revise the model and several of its assumptions in preparation for the benchmark assessment in 2020. Meanwhile, data-based indicators have been developed for the yellowfin stock, similar to those for the skipjack and bigeye tuna stocks.

1.6 South Pacific albacore background

Stock: There are considered to be two stocks of albacore tuna in the Pacific Ocean, one in the north hemisphere and the other in the southern hemisphere. This conclusion is based on a number of reasons, including sampling of larval and adult fish, lower catch rates of albacore around the equator, and genetic data showing variations between those fish found in the north and those found in the south (Tremblay-Boyer et al., 2018). Albacore tend to grow to around or just above 80 cm and inhabit tropical and sub-tropical areas of the Pacific between ~10^{o} – 25^{o} during the summer months. They make seasonal migrations between tropical and sub-tropical waters, which are thought to correspond with the seasonal shifts in the 23-28^{o}C sea surface temperature isotherm. Their growth rates vary by sex (males tend to be larger) and longitude, with individuals in the east growing larger than their western counterparts. Fish are commonly caught at ten years old or more, but the level of natural mortality still poses questions within the stock assessment model (Tremblay-Boyer et al., 2018).

Stock status: The stock is estimated to be in good health, with the spawning biomass estimated to be ~52% of the unfished level, which is below the target reference point (TRP; which takes economic considerations into account) but above SB_{MSY}. F is also below F_{MSY} with high probability (>>90%) (Table 5). Current stock status is presented in the form of dynamic Kobe plots and Majuro plots (Figure 7 and Figure 8).

Table 5. Summary of stock status in relation to reference points across the 72 models in the uncertainty grid; C=catch, $YF_{current}$=equilibrium yield at $F_{current}$; F_{mult}=multiplier of current effort required to fish at F_{MSY}; latest=2016; recent=2012-15 (Tremblay-Boyer et al., 2018).

	Mean	Median	Min	10%	90%	Max
C_{latest}	61719	61635	60669	60833	62704	63180
MSY	100074	98080	65040	70856	130220	162000
$YF_{current}$	71579	71780	56680	62480	80432	89000
fmult	6.2	4.96	1.89	2.44	12.05	17.18
F_{MSY}	0.07	0.07	0.05	0.05	0.09	0.1
$F_{recent}/F_{\mathrm{MSY}}$	0.23	0.2	0.06	0.08	0.41	0.53
SB_{MSY}	71407	68650	26760	39872	100773	134000
SB_0	443794	439800	308800	353870	510530	696200
SB_{MSY}/SB_0	0.16	0.17	0.07	0.1	0.21	0.23
$SB_{F=0}$	469004	462633	380092	407792	534040	620000
$SB_{\mathrm{MSY}}/SB_{F=0}$	0.15	0.15	0.06	0.09	0.2	0.22
SB_{latest}/SB_0	0.55	0.56	0.33	0.42	0.69	0.74
$SB_{latest}/SB_{F=0}$	0.53	0.52	0.3	0.37	0.69	0.77
$SB_{latest}/SB_{\mathrm{MSY}}$	4	3.42	1.45	1.96	7.07	10.74
$SB_{recent}/SB_{F=0}$	0.51	0.52	0.32	0.37	0.63	0.72
$SB_{recent}/SB_{\mathrm{MSY}}$	3.88	3.3	1.58	1.96	6.56	9.67

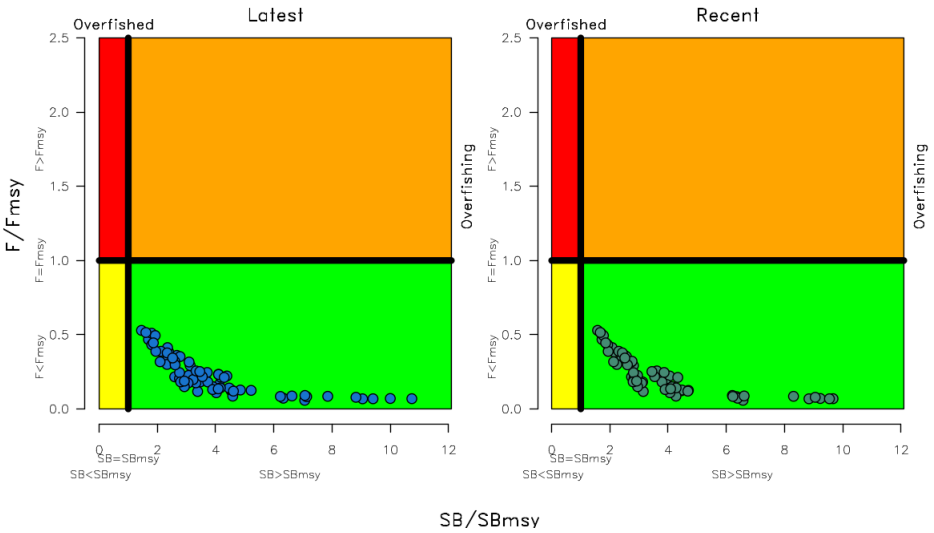

Figure 7. South Pacific albacore: Kobe plots summarising the results for each of the models in the structural uncertainty grid for SB_{latest} (left) and the SB_{recent} (right) relative to MSY reference points. (Tremblay-Boyer et al. 2018).

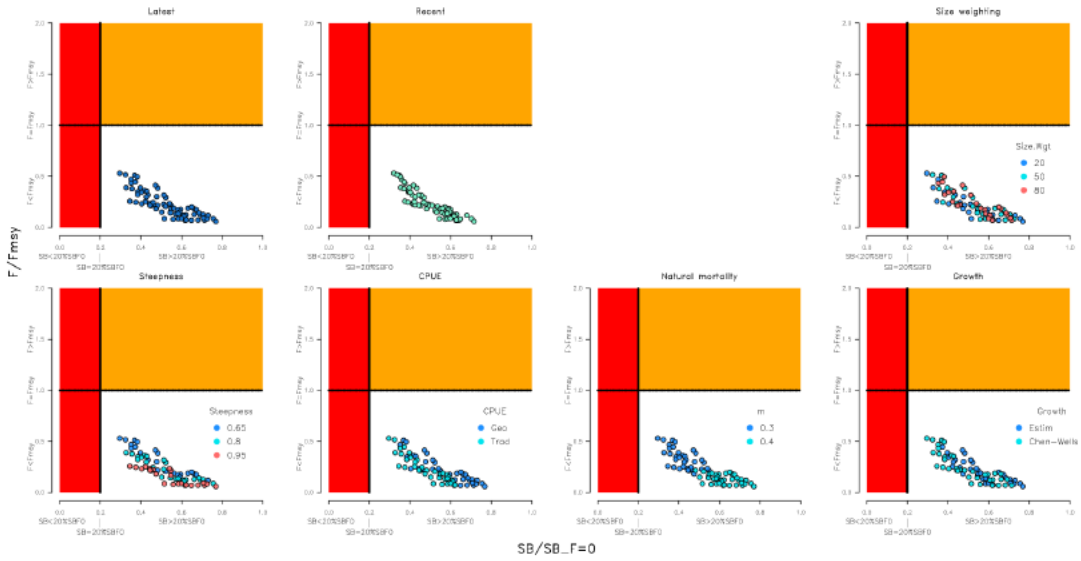

Figure 8. South Pacific albacore: Majuro plots summarising the results for each of the models in the structural uncertainty grid. The plots represent estimates of stock status in terms of spawning potential depletion and fishing mortality. The red zone represents spawning potential levels lower than the agreed limit reference point. The orange region is for fishing mortality greater than F_{MSY}. The points represent SBlatest for each model run except the two second from the left which show SB_{recent}. Otherwise, the different panels and colour-coding represent different sensitivity runs. Tremblay-Boyer et al., 2018.

Reference points: The point of recruitment impairment (PRI) is not currently known, but WCPFC have adopted a limit reference point (LRP) for south Pacific albacore of 20%$SB_{F=0}$. An interim target reference point (TRP) of 56% $SB_{F=0}$ was agreed in December 2018 at the 15th Annual meeting of the WCPFC.

Harvest strategy: South Pacific albacore is de facto managed by WCPFC although the stock extends into the EPO. The harvest strategy is set out in CMM 2015-02. The management objective of 2015-02 is that effort (expressed as the number of active vessels targeting SPA) should not increase over recent historical levels (defined as 2005 or 2002-04) (CMM 2015-02, paragraph 1). The adoption of a TRP (mentioned in the paragraph above) aims to achieve an 8% increase in CPUE relative to 2013 levels for economic reasons, which is estimated by SPC to correspond to a SB level of 56%$SB_{F=0}$. This will be adjusted as necessary based on stock estimates in future assessments. A 20-year timeframe was agreed for achieving this management target. The next stage in the WCPFC workplan under CMM 2014-06, to which all MSC overlapping fisheries' conditions are bound, is for analysis of options for HCRs based on this management target. The revised workplan (WCPFC 2019a, Attachment H) sets a deadline for the adoption of a management procedure for SPA of 2022.

Information and stock assessment: The latest stock assessment was completed in 2018 (Tremblay-Boyer et al.) and like other tuna stocks uses catch, effort and size frequency, tag recapture data and biological information. The stock assessment model used is MCFL, as for bigeye and yellowfin WCPO stocks.

1.7 North Pacific albacore background

Stock: The other of the two Pacific albacore stocks. See above in 1.6 for background.

Stock status: The most recent stock assessment was published in 2017 (Albacore Working Group, 2017). The stock is not overfished, with $F_{2012\text{-}2014}$ estimated to be ~61% of F_{MSY}, with the SB at ~2.5 times the LRP. Current fishing intensity ($F_{2012\text{-}2014}$) was estimated to be below all MSY-proxy reference points except $F_{50\%}$ (Table 6). Figure 9 provides a Kobe plot showing stock status relative to the LRP and equivalent fishing intensity.

Table 6. North Pacific albacore: Estimates of MSY, female spawning biomass (SSB) and F-based reference-point ratios for the base case assessment and important sensitivity analyses. Note that in this case, F is not instantaneous fishing mortality, but is calculated as 1-SPR (SPR is the equilibrium SSB per recruit that would result from the current year's fishing mortality). Current fishing intensity is defined as the average fishing intensity during 2012-2014 ($F_{2012\text{-}2014}$). (Albacore Working Group, 2017).

Quantity	Base Case	M = 0.3 y^{-1}	Growth CV = 0.06 for L_{inf}
MSY (t) [A]	132,072	92,027	118,836
SSB_{MSY} (t) [B]	24,770	42,098	22,351
SSB_0 (t) [B]	171,869	270,879	156,336
SSB_{2015} (t) [B]	80,618	68,169	63,719
$SSB_{2015}/20\%SSB_{current,\ F=0}$ [B]	2.47	1.31	2.15
$F_{2012\text{-}2014}$	0.51	0.74	0.57
$F_{2012\text{-}2014}/F_{MSY}$	0.61	0.89	0.68
$F_{2012\text{-}2014}/F_{0.1}$	0.58	0.90	0.65
$F_{2012\text{-}2014}/F_{10\%}$	0.56	0.81	0.63
$F_{2012\text{-}2014}/F_{20\%}$	0.63	0.91	0.71
$F_{2012\text{-}2014}/F_{30\%}$	0.72	1.04	0.81
$F_{2012\text{-}2014}/F_{40\%}$	0.85	1.21	0.96
$F_{2012\text{-}2014}/F_{50\%}$	1.01	1.47	1.16

A – MSY includes male and female juvenile and adult fish
B – Spawning stock biomass (SSB) in this assessment refers to mature female biomass only.

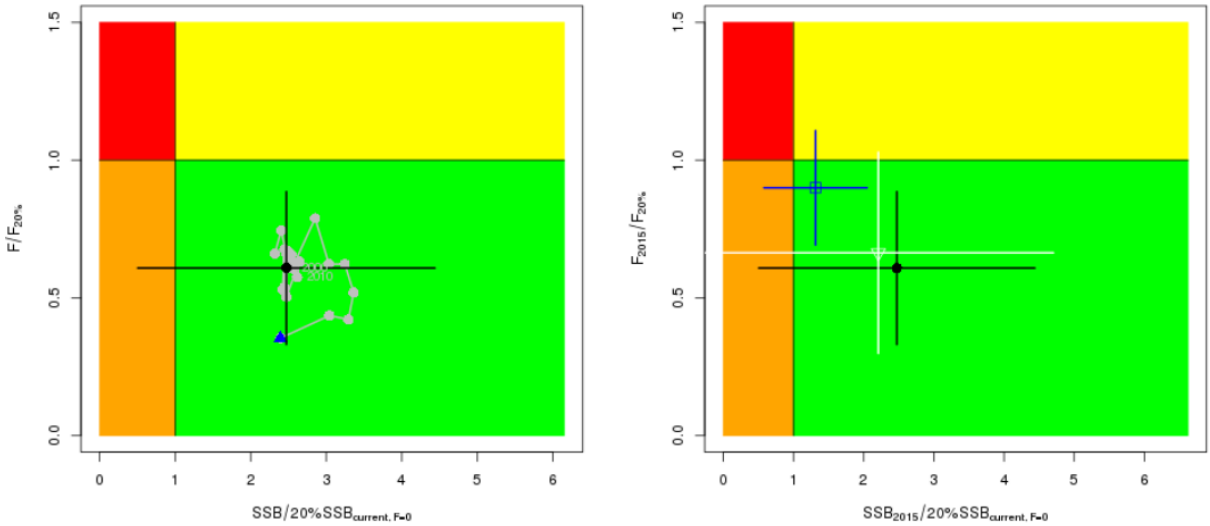

Figure 9. North Pacific albacore: Left: Kobe plot showing stock status relative to the LRP (20%$SSB_{F=0}$) and equivalent fishing intensity ($F_{20\%}$; calculated as 1-$SPR_{20\%}$) over the base case modelling period (1993-2015). The blue triangle indicates the start year (1993) and the black circle with 95% confidence intervals the terminal year (2015). Right: Kobe plot showing stock status and 95% confidence intervals in the terminal year (2015), for the base case model (black; closed circle) and important sensitivity runs: M = 0.3 y-1 (blue); CV = 0.06 for Linf in the growth model (white). Albacore Working Group, 2017.

Reference points: As with the south Pacific stock, PRI is not known, so the WCPFC agreed LRP of 20%$SB_{F=0}$ is again used. A TRP in not yet in place for this stock.

Harvest strategy: Management of NPA is shared jointly between WCPFC and IATTC, who each have a harmonised management measure in place (WCFPC: CMM 2005-03, soon to be replaced by CMM 2019-03; IATTC: Resolutions C-05-02 and C-18-03). The management objective fixed in these measures is that F should not increase beyond 'current levels' (i.e., levels which were current in 2005 – defined as $F_{2002\text{-}4}$).

In 2017, the WCPFC Northern Committee agreed an 'interim harvest strategy' for North Pacific albacore (see WCPFC (2017c); Attachment H); this was endorsed by the WCPFC plenary ((WCPFC 2017b); paragraph 206). This incorporates the LRP of 20%$SB_{F=0}$. It does not fix a TRP but notes that this should be determined as part of a MSE included under the Northern Committee's future work. The Albacore Working Group (ALBWG) of ISC have held five MSE workshops covering NP albacore.

The interim harvest strategy incorporates a management objective and a decision rule relating to the LRP, as follows:

- Management objective (para. 1): *The management objective for the North Pacific albacore fishery is to maintain the biomass, with reasonable variability, around its current level in order to allow recent exploitation levels to continue and with a low risk of breaching the limit reference point.*
- Decision rule (para. 3): *In the event that, based on information from ISC, the spawning stock size decreases below the LRP at any time, NC will, at its next regular session or intersessionally if warranted, adopt a reasonable timeline, but no longer than 10 years, for rebuilding the spawning stock to at least the LRP and recommend a CMM that can be expected to achieve such rebuilding within that timeline*.

It is worth noting that the decision rule contradicts the management objective, in that the objective is to maintain the stock at a level which has a low risk of breaching the LRP, while the decision rule does not require any action until the stock has actually breached the LRP. It likewise contradicts a statement in the same section of the Northern Committee report: '*NC recommends a management strategy for the stock that ensures that the risk of the biomass decreasing below the LRP is low*' (WCPFC, (2017c), p. 50), as well as WCPFC's decision (WCPFC 2016) that harvest strategies should ensure that the risk of falling below the LRP is not higher than 20%.

WCPFC's CMM 2014-06, committing WCPFC to the development of formal harvest strategies and harvest control rules, applies to NP albacore as well as skipjack and the other tropical stocks. The work to develop the harvest strategy has, however, been delegated to the Northern Committee. The Northern Committee have, like WCPFC, agreed a harvest strategy workplan for NP albacore in 2018. The previous 2017 workplan proposed that the MSE work should end in 2020, but the 2018 version makes no such promise for either 2020 or 2021. There was no change in 2019 (Northern-Committee 2019) (see Attachment G). In the meantime, the Northern Committee is tasked with reviewing the requirements and the implementation of CMM 2005-03 and recommend changes where necessary. The US is providing funding to support the MSE process for NP albacore, with an expert based at IATTC (Tony Beeching, WCPFC, pers. comm.).

Information and stock assessment: Similar to the other target stocks mentioned here, sources of information for the stock assessment includes catch data, abundance and size information, as well as tagging studies and information from the main fisheries catching north Pacific albacore. Resolution C-13- 03 of IATTC strengthens the data requirements from C-05-02 / CMM 2005-03, with templates for both catch and effort data.

2 Pre-assessment results

2.1 Principle 1

Table 7. Summary of Principle 1 Performance Indicator level scores – WCPO bigeye tuna

Performance Indicator	Draft scoring range	Data deficient?
1.1.1 – Stock status	**≥80**	**No**
Rationale or key points		
Based on the most recent stock assessment in 2017 (McKechnie et al., 2017) and its update (Vincent et al., 2018), there is a high degree of certainty that the stock is above the point of recruitment impairment (PRI). The LRP is 20%$SB_{F=0}$, with SB_{recent} = 36%$SB_{F=0}$ =1.8LRP; SB_{latest} = 42%$SB_{F=0}$ = 2.1LRP (median of SC uncertainty grid). The stock has been fluctuating around a level consistent with MSY (SB_{MSY} is the default target in the absence of a formal Target Reference Point). SB_{recent} = 1.38SB_{MSY}; SB_{latest} = 1.62 SB_{MSY} (median of SC uncertainty grid).		
1.1.2 – Stock rebuilding	**N/A**	**N/A**
Rationale or key points		
As PI 1.1.1 scored at least SG80, this PI does not need to be scored (as FCP SA2.3.1).		
1.2.1 – Harvest Strategy	**60 – 79**	**No**
Rationale or key points		
At present, a formal harvest strategy is not in place for the stock, although WCPFC have committed to deliver one through its harvest strategy workplan (most recently updated at WCPFC16 (WCPFC, 2019a). Status quo projections provide a basis on which to evaluate the extent to which the harvest strategy is expected to achieve stock management objectives but as, yet it cannot be said that all the elements of the harvest strategy work together towards achieving stock management objectives reflected in PI 1.1.1 SG80.		
1.2.2 – Harvest control rules and tools	**60 – 79**	**No**
Rationale or key points		
WCPFC have an agreed, legally binding framework in place to establish formal harvest strategies and control rules for their main stocks, including WCPO bigeye. A HCR can be considered to be 'available' for this stock. SG60 is met. Since the harvest strategy is not 'in place', it cannot be said that the HCRs are robust to the main uncertainties, nor do they include well-defined target exploitation levels. SG80 is not met.		
1.2.3 – Information and monitoring	**≥80**	**No**

Rationale or key points		
It is considered that a comprehensive range of information on stock structure, stock productivity, abundance, UoA removals fleet composition etc. is available. There is regular monitoring of stock removals from this UoA and other fisheries, allowing for regular stock assessments and which are sufficient to support the HCR. SG80 is met.		
1.2.4 – Assessment of stock status	**≥80**	**No**
Rationale or key points		
The assessment is conducted using an integrated assessment model Multifan-CL (MFCL) that is able to combine a range of datasets and to model several components. The stock assessment estimates stock status relative to a range of reference points, including SB and F reference points and depletion and MSY-based reference points. The stock assessment has been tested and shown to be robust. It has been both internally and externally peer reviewed.		

Table 8. Summary of Principle 1 Performance Indicator level scores – WCPO yellowfin tuna

Performance Indicator	Draft scoring range	Data deficient?
1.1.1 – Stock status	**≥80**	**No**
Rationale or key points		
Based on the most recent stock assessment in 2017 (Tremblay-Boyer et al., 2017), there is a high degree of certainty that the stock is above the point of recruitment impairment (PRI). The LRP is 20%$SB_{F=0}$, with SB_{recent} = 32%$SB_{F=0}$ =1.6LRP; SB_{latest} = 35%$SB_{F=0}$ = 1.75LRP (median of final grid). The stock is fluctuating around a level consistent with MSY (SB_{MSY} is the default target in the absence of a formal TRP). SB_{recent} = 1.39SB_{MSY}; SB_{latest} = 1.39 SB_{MSY} (median of SC uncertainty grid), meaning that SG80 is at least met.		
1.1.2 – Stock rebuilding	**N/A**	**N/A**
Rationale or key points		
As PI 1.1.1 scored at least SG80, this PI does not need to be scored (as FCP SA2.3.1).		
1.2.1 – Harvest Strategy	**60 – 79**	**No**
Rationale or key points		
As per bigeye, yellowfin is part of the WCPFC workplan (WCPFC, 2019a) and WCPFC are committed to implementing a formal harvest strategy. Without one in place, SG80 cannot be met. The stated objective of the WCPFC harvest strategy as defined in CMM 2018-01 is to maintain status quo		

biomass, pending agreement on a formal target reference point, due this year according to the latest version of the harvest strategy workplan. This fishery targets yellowfin specifically, and there are no requirements such as minimum or maximum landing sizes or quotas which could lead to any of this catch being unwanted. Discarding rates for yellowfin are minimal. Hence there is no 'unwanted catch'[2] of yellowfin in this fishery. C-2018-01, paragraph 24 states all bigeye, skipjack and yellowfin brought on board is required to be landed, except that unfit for human consumption. SG60 is met.		
1.2.2 – Harvest control rules and tools	**60 – 79**	**No**
Rationale or key points		
As with bigeye, as a formal harvest strategy is not in place for this stock, SG80 cannot be met for HCRs. WCPFC have an agreed, legally binding framework in place to establish place formal harvest strategies and control rules for their main stocks, including WCPO yellowfin (see CMM 2014-06).		
1.2.3 – Information and monitoring	**≥80**	**No**
Rationale or key points		
It is considered that a comprehensive range of information on stock structure, stock productivity, abundance, UoA removals fleet composition etc. is available. There is regular monitoring of stock removals from this UoA and other fisheries, allowing for regular stock assessments and which are sufficient to support the HCR.		
1.2.4 – Assessment of stock status	**≥80**	**No**
Rationale or key points		
As per bigeye, comprehensive stock assessments are completed for this stock using MFCL. The assessments are tested and shown to be robust. The assessment takes into account uncertainty and evaluates stock status relative to reference points in a probabilistic way. It has also been subject to peer review.		

Table 9. Summary of Principle 1 Performance Indicator level scores – EPO bigeye tuna

Performance Indicator	Draft scoring range	Data deficient?
1.1.1 – Stock status	**60 - 79**	**No**
Rationale or key points		

[2] * SA3.1.6: The term 'unwanted catch' shall be interpreted by the team as the part of the catch that a fisher did not intend to catch but could not avoid and did not want or chose not to use.

For SIa, to achieve SG60 it has to be likely (≥ 70th %ile), for SG80 is has to be highly likely (≥ 80th %ile) and for SG100 there has to be a high degree of certainty (≥ 95th %ile) that current stock status is above the PRI, i.e., above 50%S_{MSY} or 20%$S_{0.}$ The most recent formal stock assessment (Xu et al., 2018) suggests that the 5%/95% confidence intervals for spawning stock sit at approximately 50% MSY, which means that there is approximately a 5% probability that the stock is below the MSC default for the PRI. The 2019 assessment uses indicators rather than a formal assessment model, because the model was not considered robust. These indicators (catch, average weight per fish, closure-adjusted capacity and three FAD-related indicators) (Figure 6) are all at levels set as the outer safe limit, except for catch. Since these limits are well before the point at which recruitment should be impaired, SG80 is met for SIa.

The management goal of the Commission is to maintain stocks at MSY. In order to score SG80, the stock must be fluctuating at or around a level consistent with MSY. The 2018 stock assessment was not considered robust and pending re-evaluation there was no estimate of S/S_{MSY} in 2019. Overall given the conclusions of the 2019 indicator analysis, there is not sufficient evidence that the stock is fluctuating around a level consistent with MSY. SG80 is not met for SIb.

1.1.2 – Stock rebuilding	**60 – 79**	**N/A**

Rationale or key points

As the score for PI 1.1.1 for bigeye was less than SG80, PI 1.1.2 “stock rebuilding” must be addressed, in lieu of a condition, which is required for all other PIs failing to meet SG80. The decline in stock status to below MSY level is not well understood due to various uncertainties. As a precautionary measure, the Commission should ensure that catches are reduced to end overfishing and allow the SSB to recover to SSB_{MSY} levels. At this stage, no catch limits are specified for the bigeye stock. The current management measure for bigeye and the other target species in this assessment is C-17-02 (conservation measures for tropical tunas in the eastern Pacific Ocean during 2018 – 2020 and amendment to Resolution C-17-01.

A workplan has been developed to address the issues identified in the assessment review, aimed at increasing the Committee’s ability to provide more concrete and robust advice by the 2019 meeting of the Scientific Committee. An external review was part of the workplan and that was done in March 2019 and is available online, and there is evidence that the work is on schedule. Therefore, monitoring is in place to determine whether the rebuilding strategies are effective in rebuilding the stock within the specified timeframe. SG60 is met. As yet, there is no evidence the rebuilding strategies are rebuilding stocks. SG80 is not met.

1.2.1 – Harvest Strategy	**60 – 79**	**No**

Rationale or key points

In 2016, IATTC adopted a HCR for tropical tunas based on the interim target and limit reference points adopted in 2014 (Resolution C-16-02). If the estimated fishing mortality is higher than F_{MSY} for either stock, then fishing mortality should be reduced to F_{MSY}. To achieve this there are currently two management tools used by the IATTC that are agreed among fishing nations and passed as IATTC

Resolutions. The first is in the form of season closures, while the second is limits on fishing capacity. Currently, this harvest strategy is set out in C-17-02, which is due to operate for 2018-2020, with a review of the strategy due before 2021. C-17-02 stipulates that the Commission scientists should review stock status (the F-mult) each year for bigeye (yellowfin and skipjack) and adjust the length of the closure according to the stock with the lowest F-mult (see under 1.2.2). The harvest strategy would be expected to achieve stock management objectives, i.e., MSY and SG60 is met for SIa.

This fishery targets bigeye specifically, and there are no requirements such as minimum or maximum landing sizes or quotas which could lead to any of this catch being unwanted. Discarding rates for bigeye are minimal. Hence there is no 'unwanted catch'[3] of bigeye in this fishery. C-17-02, paragraph 24 states all bigeye, skipjack and yellowfin brought on board is required to be landed, except that unfit for human consumption.

1.2.2 – Harvest control rules and tools	**60 – 79**	**No**

Rationale or key points

The HCR for EPO tropical tunas is set out in Res. C-16-02 (see Section 1.4 for details). The HCR is well-defined, reducing the exploitation rate if F>F_{MSY} and so is likely to reduce F as the point of recruitment impairment (PRI) is approached.
There is some current concern about the stock assessment model used to estimate F-mult for bigeye, but an extensive review is underway, and since the stock is not close to the LRP, the HCR should be robust to this uncertainty in the short term (until 2021).

The tools to implement the HCR are set out in Res. C-17-02; the key tool is the seasonal closure. The HCR has not been implemented (i.e., the closure has not been adjusted according to F-mult) for 2019 and 2020, pending review of the stock assessment methodology. A full review of the HCR is due in 2021. The seasonal closure of 72 days is likely to be sufficient to control the exploitation rate to ensure that the PRI is not crossed, meeting SG60 for SIc. However, it cannot be argued to be likely to achieve the exploitation rates set out in the HCR (i.e., the reference points); in their review of indicators for bigeye, IATTC scientists expressed the view that additional measures are likely to be required to maintain the stock within safe limits in the medium term. If there is a stock recruitment relationship, which is a common assumption in many other tuna stock assessments, then effort would have to be reduced significantly. SG80 is not met.

1.2.3 – Information and monitoring	**≥80**	**No**

Rationale or key points

Sufficient information (on stock structure, stock productivity, fleet composition), is available to monitor and assess stock status including reporting and size-frequency sampling by each fleet and catch-per-unit-effort data from these fleets. Biology and life history is relatively well understood and sufficient for stock assessment. Overall, these data are sufficient for stock assessments to monitor

[3] * SA3.1.6: The term 'unwanted catch' shall be interpreted by the team as the part of the catch that a fisher did not intend to catch but could not avoid and did not want or chose not to use.

status and mortality rates to support a harvest strategy, despite the current problems with the assessment. Stock abundance and fishery removals are regularly monitored at a level of accuracy and coverage consistent with the HCR, and indicators of catch and effort are available and monitored with sufficient frequency to support the HCR, including annual updates of the stock assessment (better practice than other tRFMOs). Catches are reasonably well monitored and are sufficient for stock assessment. There has been an IATTC observer program since 1993 for larger vessels, and the United States has had an observer program from the 1970s. Observer coverage has allowed discards of tuna to be estimated, as well as estimates of bycatch of other species. The level of monitoring is sufficient for the harvest strategy. Overall, this meets SG80.

1.2.4 – Assessment of stock status	**60 - 79**	**No**
Rationale or key points		
The assessment was benchmarked in 2016 and updated in 2017 and 2018. The 2018 assessment suggested a large drop in F-mult. relative to the previous update and was not considered by its authors to be realistic. A subsequent external review revealed a series of critical uncertainties. For this reason, the stock assessment was not considered sufficient to provide management advice or to apply the HCR for 2019 or 2020, and the assessment instead relied on estimating a series of indicators. A workplan for the improvement of the stock assessment is in place and in implementation and the assessment will be benchmarked (along with the yellowfin assessment) during 2020, taking into account the external review and in time for the revision of the HCR in 2021. SG60 is met but SG80 is not met.		

Table 10. Summary of Principle 1 Performance Indicator level scores – EPO yellowfin tuna

Performance Indicator	Draft scoring range	Data deficient?
1.1.1 – Stock status	**60 – 79**	**No**
Rationale or key points		
An updated assessment was conducted in 2019. The limit reference points for EPO yellowfin is set at $0.28*S_{MSY}$. As with bigeye, the IATTC LRP for yellowfin is below the MSC default level for PRI ($50\%B_{MSY}$ / $20\%B_0$), so these defaults are used for scoring instead. Since $20\%S_0$ is close to the level of S_{MSY} estimated analytically ($27\%S_0$); this was not considered a suitable proxy for the PRI, so 50% of S_{MSY} is used. To achieve SG60 for SIa, it has to be likely (≥ 70^{th} %ile), for SG80 is has to be highly likely (≥ 80^{th} %ile) and for SG100 there has to be a high degree of certainty (≥ 95^{th} %ile) that current stock status is above the PRI, i.e., above $50\%S_{MSY}$ or $14\%S_0$). According to the approximate 5%/95% CIs the lower		

bound estimate of S is well above this level. This means that there is <5% probability that the stock is below the PRI.

Since 2011, when the SBR fell as a result of the series of low recruitments that coincided with a series of strong La Niña events, it has been estimated to be at, or slightly below, the MSY level. At the start of 2019 it was estimated to be 0.21, below the MSY level (0.27). Fishing mortality rates for yellowfin tuna are now above maximum sustainable yield (MSY) levels (F multiplier = 0.89), a substantial change from the last assessment. Yellowfin tuna in the eastern Pacific Ocean is now overfished and undergoing overfishing (Minte-Vera et al. 2019). Current stock status relative to the MSY reference point (S_{MSY}=3,638 t) is S_{recent} /S_{MSY} = 0.76 (base case model). For SIb, the stock is no longer at or fluctuating around a level consistent with MSY. Given uncertainty on the stock status, it is probable that fishing mortality needs to be reduced to achieve MSY and therefore SG80 is not met. A condition would not be raised for this PI, instead dealt with under PI 1.1.2 – stock rebuilding.

1.1.2 – Stock rebuilding	**60 – 79**	**No**

Rationale or key points

As the score for PI 1.1.1 for yellowfin was less than SG80, PI 1.1.2 “stock rebuilding” must be addressed, in lieu of a condition, which is required for all other PIs failing to meet SG80. The decline in stock status to below MSY level is not well understood due to various uncertainties. As a precautionary measure, the Commission should ensure that catches are reduced to end overfishing and allow the SSB to recover to SSB_{MSY} levels. At this stage, no catch limits are specified for the yellowfin stock. The current management measure for yellowfin and the other target species in this assessment is C-17-02 (conservation measures for tropical tunas in the eastern Pacific Ocean during 2018 – 2020 and amendment to Resolution C-17-01.

A workplan has been developed to address the issues identified in the assessment review, aimed at increasing the Committee’s ability to provide more concrete and robust advice by the 2019 meeting of the Scientific Committee. An external review was part of the workplan and that was done in March 2019 and is available online, and there is evidence that the work is on schedule. Therefore, monitoring is in place to determine whether the rebuilding strategies are effective in rebuilding the stock within the specified timeframe. SG60 is met. As yet, there is no evidence the rebuilding strategies are rebuilding stocks. SG80 is not met.

1.2.1 – Harvest Strategy	**60 – 79**	**No**

Rationale or key points

See rationale for bigeye above.

1.2.2 – Harvest control rules and tools	**60 – 79**	**No**

Rationale or key points

See rationale for bigeye above.

1.2.3 – Information and monitoring	**≥80**	**No**
Rationale or key points		
See rationale for bigeye above.		
1.2.4 – Assessment of stock status	**60 -79**	**No**
Rationale or key points		
See rationale for bigeye above.		

Table 11. Summary of Principle 1 Performance Indicator level scores – South Pacific albacore tuna

Performance Indicator	Draft scoring range	Data deficient?
1.1.1 – Stock status	**≥80**	**No**
Rationale or key points		
The PRI for this stock is not known. WCPFC has adopted 20%$SB_{F=0}$ as a limit reference point (LRP) for the stock, where $SB_{F=0}$ is calculated as the average over the period 2006–2015. This LRP was used as the PRI and stock status was referenced against 20%$SB_{F=0}$ by calculating SB_{recent} /$SB_{F=0.}$ According to the latest stock assessment (Tremblay-Boyer et al., 2018), the reference points and the minimum value of $SB_{recent}/SB_{F=0}$ and $SB_{latest}/SB_{F=0}$ are all above 0.20. This means there is a high degree of certainty that the stock is above the PRI. In relation to the stock fluctuating around a level consistent with MSY, in no case for either 'recent' or 'latest', is stock biomass estimated to be below SB_{MSY}. Stock trajectories suggest that stock biomass has fluctuated without trend since ~1990, therefore the stock has been at a level above SB_{MSY} in recent years. Stock assessments estimates of catch relative to MSY suggest that catch has only exceeded MSY in a very few years (2009 and 2010 in the time series from 1960). The minimum value of SB_{recent}/SB_{MSY} is 1.58 and so SB_{recent} is greater than SB_{MSY}.		
1.1.2 – Stock rebuilding	**N/A**	**N/A**
Rationale or key points		
As PI 1.1.1 scored at least SG80, this PI does not need to be scored (as FCP SA2.3.1).		
1.2.1 – Harvest Strategy	**60 – 79**	**No**
Rationale or key points		

CMM 2014-06 sets out the roadmap to establishing a harvest strategy for key stocks managed by WCPFC. Under CMM 2014-06 WCPFC have also agreed a workplan with indicative timeframes to adopt or refine harvest strategies for south Pacific albacore, which is reviewed annually. At WCPFC15 (December 2018), the Commission adopted an interim TRP for SPA with the objective of an 8% increase in longline CPUE (estimated by SPC to be achieved at 56%$SB_{F=0}$). According to the most recent iteration of the workplan (WCPFC16, Dec. 2019), a management procedure is due to be agreed for SPA in 2022. In relation to SG60 for SIa, the stock is estimated to be well above MSY and the current harvest strategy is likely to keep the stock above LRP. In relation to SG80, the harvest strategy is required to be 'responsive to the state of the stock'. While some progress has been made (e.g., agreement of an interim TRP), the existing harvest strategy currently in place (i.e., CMM 2015-02) simply requires that effort is not increased above recent historical levels and makes no reference to the agreed reference points nor to changes to be made according to the stock status. Furthermore, it has a range of problems (SIDS exemption, nothing north of 20°S, defining vessels 'actively targeting' SPA) which makes its impact on the stock difficult to predict (although in practice it seems to be working). On this basis, SG80 is not met.

Currently the stock is above PRI with a high degree of certainty and F is and has always been below F_{MSY}. Therefore, it appears that the harvest strategy is working and is achieving its objectives. Its performance has not, however, been 'fully evaluated', hence SG80 is met for SIb.

All the major fisheries report both catch and effort data (operational or aggregated; mainly the former) to SPC. CCMs are required to report annual to WCPFC the details of their fisheries (Part 1 reports) and compliance with the CMMs (Part 2 reports). There is therefore monitoring in place, sufficient to meet SG60 for SIc.

This fishery targets albacore specifically, and there are no requirements such as minimum or maximum landing sizes or quotas which could lead to any of this catch being unwanted. Discarding rates for albacore are minimal, according to the stock assessment report. Hence there is no 'unwanted catch' of albacore in this fishery.

1.2.2 – Harvest control rules and tools	**60 – 79**	**No**

Rationale or key points

A HCR may be considered to be 'available' and 'expected to reduce the exploitation rate as the PRI is approached' at SG60 if i) 'stock biomass has not previously been reduced below B_{MSY} or has been maintained at that level for a recent period of time' (SA2.5.2a of FCR v2.0) and ii) 'there is an agreement or framework in place that requires the management body to adopt HCRs before the stock declines below B_{MSY}' (SA2.5.3b of FCR v2.0). The stock is above B_{MSY} with high probability and under CMM 2014-06 there is an established a workplan and agreed timetable for the adoption of well-defined harvest control rules, with an agreement to adopt a HCR in 2021. The process is therefore underway although some delays have been evident in the past. A TRP was finally agreed at WCPFC15 (2018), putting the revised workplan back on track. Overall, at present although a generally understood HCR is in place no well-defined HCRs are in place and so only SG60 is met for SIa.

As there is no formal HCR so it cannot be robust to the main uncertainties. The SG80 requirements are not met for SIb.

Recent average fishing mortality is estimated to be well below F_{MSY} (median F_{recent} /F_{MSY} =0.20, 80 percentile range 0.08-0.41), which level is likely to maintain the stock above the LRP. Pilling et al. (2015) shows that fishing the stock at MSY level would require a massive increase in effort from current levels. A well-defined HCR is being developed under CMM 2014-06. An interim limit and target reference point has been agreed, and HCRs will be evaluated for the main sources of uncertainty using Management Strategy Evaluation (MSE) (Pilling et al., 2018). Overall, therefore, under the MSC requirements and guidance for 'available' HCRs, SG60 is met. SG80 is not met for SIc.

1.2.3 – Information and monitoring	**≥80**	**No**

Rationale or key points

It is considered that a comprehensive range of information on stock structure, stock productivity, abundance, UoA removals fleet composition etc. is available. There is uncertainty around natural mortality growth rates, with more information on age and growth highlighted as a priority requirement. There are also no tagging data available for albacore. However, there is regular monitoring of stock removals from this UoA and other fisheries, allowing for regular stock assessments and which are sufficient to support the HCR.

Formal stock assessments have taken place every few years (2012, 2015, 2018). In between formal stock assessments, SPC provide some information on trends in fishery indicators (total catch, nominal CPUE, catch at length and at weight), to guide management (e.g., Brouwer et al., 2018b).

The assessment method used (MFCL) requires all catch and effort to be allocated to fisheries, where ideally the fisheries are defined to have selectivity and catchability characteristics that do not vary greatly over time. The assessment does not include the albacore fishery (catch or CPUE) east of 130°W, but this does not appear to be an issue related to availability of data and is considered under 1.2.4. SG80 is met for this PI.

1.2.4 – Assessment of stock status	**≥80**	**No**

Rationale or key points

The assessment is conducted using the integrated assessment model Multifan-CL (MFCL). MFCL is able to take into account features of the fisheries (catchability, selectivity) and the biology of the stock (in a population model). The assessment takes into account the major features relevant to the biology of the species and the nature of the UoA. At least SG80 is met for SIa.

A target and limit reference point have been defined, with the TRP estimated in terms of SB directly from the stock assessment. The stock assessment model is able to estimate a range of reference points according to various different methodologies. SG80 is met for SIb.

Numerous sensitivity runs were undertaken during the assessment, allowing a set of axes of uncertainty to be developed which were then used in to construct the uncertainty grid of model runs on which the advice is based. SG80 is met for SIc.

The assessment has been tested and shown to be robust. Alternative hypotheses and assessment approaches have been rigorously explored, for example, externally to the stock assessment, there is consideration each year of how to improve the input data (e.g., addition of new Japanese data in the most recent assessment; new methods of standardisation via geo-statistics). At least SG80 is met SId and overall, for this PI.

Table 12. Summary of Principle 1 Performance Indicator level scores – North Pacific albacore tuna

Performance Indicator	Draft scoring range	Data deficient?
1.1.1 – Stock status	**≥80**	**No**
Rationale or key points		
The PRI for the stock is not known. The default PRI is taken here to be the LRP agreed by WCPFC, i.e., 20%$SB_{F=0}$. The most recent stock assessment by the Albacore Working Group of ISC was in 2017. The assessment estimated SB (base case model) to be ~2.5 times above the LRP. Wide Confidence Intervals (CIs) because of significant uncertainties in the assessment mean that that lower 5% CI for SB has marginally overlapped the LRP throughout the time series, as estimated by the stock assessment. On this basis, SG80 is met for SIa. In respect to SIb, the stock assessment estimates SSB_{MSY} to be lower than the WCPFC LRP (~15%$SSB_{2015,\ F=0}$). In this circumstance, MSC proposes that 2xPRI / 40%$SB_{F=0}$ could be used as a suitable proxy for SSB_{MSY} in the sense intended by MSC. The Albacore Working Group set out three different model scenarios in the report: the base case and the two key one-off sensitivities, i.e., an alternative with M=0.3/yr instead of a sex- and age-specific M ogive, and an alternative with a different growth model. For the base case and the alternative growth model, point estimates of SB_{2015} are estimated to be >2 times higher than the LRP (2.47 times higher for the base case model, 2.15 times higher for the alternative growth model) i.e., above 40%$SB_{F=0}$ (taken as a proxy for SSB_{MSY} for the purposes of this scoring). For the M=0.3 model, however, SSB_{2015} is estimated to be 1.31 x LRP or 0.26 x $SB_{F=0}$; i.e., below the proxy reference point. On this basis, we can reasonably say that it is highly likely that SB is at or above a level consistent with MSY, as defined in a precautionary way by MSC, but there may not be a 'high degree of certainty' that the stock is above that level. SG80 is met.		
1.1.2 – Stock rebuilding	**N/A**	**N/A**
Rationale or key points		
As PI 1.1.1 scored at least SG80, this PI does not need to be scored (as FCP SA2.3.1).		

1.2.1 – Harvest Strategy	≥80	No
Rationale or key points		
The harvest strategy is in two parts: i) the interim harvest strategy as proposed by the NC and accepted by WCPFC in 2017 and ii) CMM 2005-03 / Resolution C-05-02, which are both still in force, although 2005-03 is due to be replaced in the WCPO by CMM 2019-03 which is similar. All have essentially the same management objective, which is to maintain the stock at 'current' levels ('current' being a different time period between the two, i.e., 2015 for the interim harvest strategy and 2002-4 for 2005-03/C-05-02, but similar levels of SB and F (AWG, 2017) (see also PI 1.1.1). This level is perceived to have a low risk of the biomass declining below the LRP. SG80 requires that the harvest strategy be responsive to the status of the stock. The stock status has varied very little over the stock assessment time series (see PI 1.1.1) making this difficult to judge (no response has been required). The conclusions of the MSC harmonisation workshop (MSC, 2016) in relation to this PI were that since there is a regular review of 2005-03 / C-05-02 by the Northern Committee in relation to the most recent stock assessment and status quo projections, the framework is available to respond to the stock status, and the various elements of the harvest strategy (i.e., monitoring, stock assessment, management targets) work together to ensure that this happens. On this basis, it was agreed that SG80 is met for SIa in relation to the regional harvest strategy. Since the harvest strategy has not changed in substance, this analysis still applies. Fishing mortality is below $F_{MSY,}$ and the stock is above SSB MSY (P1.1.1a) and the stock is highly likely to be above the PRI (P1.1.1b) The SG80 level is therefore met for SIb. Monitoring is in place that is expected to determine whether the harvest strategy is working. This is through the recording of all catch and effort data for all fleets targeting the stocks (through logbooks) and through the collection of biological data, such as size composition, length or weight frequencies and sex information). SG60 is met for SIc. The harvest strategy (i.e., 2005-03/2019-03/C-05-02) is reviewed annually by the Northern Committee; most recently via status quo projections, as well as by IATTC and WCPFC who review management measures and the advice of their scientific bodies during their annual meetings. SG100 is met for SId. This fishery targets albacore specifically, and there are no requirements such as minimum or maximum landing sizes or quotas which could lead to any of this catch being unwanted. Discarding rates for albacore are minimal, according to the stock assessment report. Hence there is no 'unwanted catch' of albacore in this fishery.		
1.2.2 – Harvest control rules and tools	**60 – 79**	**No**
Rationale or key points		

WCPFC have an agreed, legally binding framework in place to establish place formal harvest strategies and control rules for their main stocks, including NP albacore (see CMM 2014-06) although for implementation purposes, responsibility for NP albacore has been passed to the Northern Committee. For this purpose, a MSE process is underway which is based at IATTC. SA2.5.3b is therefore met for both RFMOs. On this basis, for a HCR can be considered to be 'available' for this stock. SG60 is met. Since the harvest strategy is not 'in place', SG80 is not met for SIa.

As the HCR is still under development, SG80 cannot be met for SIb, which requires HCRs to be robust to the main uncertainties.

Since the HCR is only considered to be 'available' (see 1.2.2a), only SG60 can be met for SIc, which at least requires Available evidence indicates that the tools in use are appropriate and effective in achieving the exploitation levels required under the HCRs.

1.2.3 – Information and monitoring	**≥80**	**No**

Rationale or key points

At a minimum, sufficient relevant information related to stock structure, stock productivity, fleet composition and other data is available to support the harvest strategy. This includes stock productivity, fleet composition for those vessels targeting the stock, stock abundance, CPUE and fishery removals.

Standardised abundance indices based on CPUE for the main fisheries are available to the ALBWG for stock assessment, which takes place every ~three years. Catch data is provided to ISC and the provision of data is reviewed annual by the Northern Committee. Member states must report total annual catch and annual effort and submit catch logbooks for each trip completed.

ISC Members are required to report the following data for fishery monitoring: total annual catch (live weight by species), total annual effort (active vessels by fishery), summary logbook data and biological data if available. These data are sufficient to support the harvest strategy (via stock assessments and status quo projections which are used in management decision-making). SG80 is met for SIc.

There is adequate information on all other fishery removals from the stock. SId is met at SG80.

1.2.4 – Assessment of stock status	**≥80**	**No**

Rationale or key points

The assessment for albacore tuna is carried out with Stock synthesis (SS3). SS3 is a statistical age-structured population modeling framework that has been applied in a wide variety of fish assessments globally. The 2017 stock assessment model (AWG, 2017) is a sex-specific, length-base, age-structured, forward-simulating, fully integrated statistical model. The model takes into account spatial and temporal extent of fisheries, biology of the stock, such as growth and recruitment, natural mortality, total catch, abundance, size composition and historical fishing operations. On this basis, the assessment is able to take into account all the main features of the biology of the species and the operation of the fisheries. At least SG80 is met for SIa.

The 2017 assessment (AWG, 2017) provides estimates north Pacific albacore stock status relative to a range of reference points which are also estimated within the stock assessment (F, B and SSB; MSY-based, and depletion-based). SG80 is met for SIb.

The stock assessment takes uncertainties into account, so that at least SG80 is met for SIc. The model conducts sensitivity analysis to evaluate changes in data series and attempts to evaluate stock status relative to reference points.

The stock assessment has been tested and shown to be robust. AWG conducted extensive sensitivity analyses to evaluate alternative assumptions on the assessment results. These included sensitivity to biological assumptions (growth, CV of L inf, M, h) and sensitivity to data inputs (alternative CPUE indices, size composition weighting). It was concluded that the assessment has been tested using a systematic exploration of the interactions among different sets of assumptions. SG100 is met for SId.

The albacore assessments are internally reviewed by the ALBWG. The results are reviewed by the ISC Plenary, the WCPFC Scientific Committee, and the staff of the IATTC. SG80 is at least met for SIe.

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Table of Scores for each MSC PI

Table 13. Principle 1 list of scoring for WCPO and EPO longline fisheries for albacore, bigeye and yellowfin tuna

Component	PI	Performance Indicator	WCPO BET	WCPO YFT	EPO BET	EPO YFT	SP ALB	NP ALB
Outcome	1.1.1	Stock Status						
	1.1.2	Stock Rebuilding	N/A	N/A			N/A	N/A
Management	1.2.1	Harvest Strategy						
	1.2.2	HCR and Tools						
	1.2.3	Information and Monitoring						
	1.2.4	Assessment of Stock Status						

Key

Pass without conditions	
Pass with conditions	
Fail	

N/A – Not Applicable