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REFERENCE DOCUMENT FOR SOUTH PACIFIC ALBACORE FOR THE REVIEW OF CMM 2015-02 AND DEVELOPMENT OF HARVEST STRATEGIES UNDER CMM 2014-06

WCPFC18-2021-18
5 November 2021

Paper prepared by the Secretariat

A. INTRODUCTION

1. The purpose of this paper is to provide a quick reference guide to the latest recommendations of the SC17 in support of discussions to review CMM 2015-02 and to develop harvest strategies for South Pacific albacore under CMM 2014-06. This paper includes the latest scientific information on the stock status, management advice, and recommendations for the South Pacific albacore stock.

B. SCIENTIFIC COMMITTEE RECOMMENDATIONS

2. The following paragraphs provide a brief summary of stock status and management advice from the results of 2021 stock assessment for South Pacific albacore. For full description, refer to Paragraphs 110 – 138 of the SC17 Summary Report, which is also copied in **Attachment A**.

Stock status and management advice

3. SC17 noted that:
   a) the median value of relative recent (2016-2019) spawning biomass depletion for South Pacific albacore ($SB_{2016-2019}/SB_{F=0}$) was 0.52 with a 10^{th} to 90^{th} percentile interval of 0.41 to 0.57, and there was 0% probability (0 out of 72 models) that the recent (2016-2019) spawning biomass had breached the adopted limit reference point (LRP); and

   b) there has been a long-term increase in fishing mortality for adult South Pacific albacore, with a notable steep increase in fishing mortality since 2000; the median of relative recent (2015-2018) fishing mortality for South Pacific albacore ($F_{2015-2018}/F_{MSY}$) was 0.24 with a 10^{th} to 90^{th} percentile interval of 0.15 to 0.37; and there was 0% probability (0 out of 72 models) that the recent fishing mortality was above F_{MSY};

4. Annual catch estimates for South Pacific albacore peaked at 93,835 mt (all gears) in 2017. Catch by longliners represented 93% of the catch weight in 2020 at 64,963 mt and represented a 21% decrease from 2019 despite a shift of effort from the tropical to the southern longline fishery in 2020. By comparison, the 2020 total albacore catch within the southern part of the WCPFC-CA was 61,778 mt and the longline catch was 57,006 mt.

5. The South Pacific albacore assessment indicates that the decline in the latest estimated $SB_{latest}/SB_{F=0}$ (year 2019; median 0.40; 10^{th} and 90^{th} percentiles 0.27 - 0.45) is notably more pessimistic than those of $SB_{recent}/SB_{F=0}$ (years 2016-2019) indicating that there has been a substantial decline in stock status estimated over the last three years.

6. For the WCPFC-CA region, the 'recent' and 'latest' SB estimates are on average both below the interim TRP of 0.56. In relation to management objectives for the WCPFC-CA longline fishery, the median `latest' (2019) and `recent' (2016-2019) longline vulnerable biomass for the WCPFC-CA are 56% and 76% of the 2013+8% target level that defined the interim TRP.

7. SC17 expressed great concern with the projected status of South Pacific albacore if recent catch or effort levels are maintained. Projections indicated that South Pacific albacore stock has a greater than 20% risk of falling below the LRP in 2021 under both catch and effort scenarios, and in most cases the TRP is not achieved within the 30-year projection period.

8. Recalling its previous advice from SC11, SC12, and SC13, SC17 recommended that longline catch be reduced to avoid further and extended declines in the vulnerable biomass so that economically viable catch rates can be maintained, especially for longline catch of adult albacore.

9. SC17 recommended a recalibration of the interim TRP for review at WCPFC18 in accordance with the process agreed at WCPFC15 (WCPFC15 Summary Report, Para 207[1]). Further, SC17 recommended projections be undertaken to estimate the constant catch levels that would achieve that TRP on average over the long-term. SC17 recommended that these analyses be provided to WCPFC18 to guide its consideration of reductions in longline fishing mortality that will be required to return the vulnerable biomass to the 2013 +8% level as agreed.

C. DEVELOPMENT OF A HARVEST STRATEGY FRAMEWORK

Target Reference Point *(Paragraph 128, SC17 Summary Report)*

10. SC17 recommended a recalibration of the interim TRP for review at WCPFC18 in accordance with the process agreed at WCPFC15 (WCPFC15 Summary Report, para 207). Further, SC17 recommended projections be undertaken to estimate the constant catch levels that would achieve that TRP on average over the long-term. SC17 recommended that these analyses be provided to WCPFC18 to guide its consideration of reductions in longline fishing mortality that will be required to return the vulnerable biomass to the 2013 +8% level as agreed.

Mixed Fisheries *(Paragraph 320, SC17 Summary Report)*

11. SC17 endorsed the work outlined in SC17-MI-WP-05 and noted the next steps to progress this work, including i) building a full suite of OMs for bigeye and yellowfin, ii) developing candidate MPs for bigeye for the tropical longline fishery, iii) the inclusion of South Pacific albacore in the modelling framework, and iv) agreeing multi-species performance indicators.

[1] Refer to **Attachment B**

Attachment A

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean
Scientific Committee
Seventeenth Regular Session
Electronic Meeting
11 – 19 August 2020

SOUTH PACIFIC ALBACORE TUNA STOCK ASSESSMENT

(*SC17 Summary Report, Paragraphs 110 – 138*)

Provision of scientific information

Stock status and trends

1. The median values of relative recent (2016-2019) spawning biomass depletion ($SB_{recent}/ SB_{F=0}$) and relative recent (2015-2018) fishing mortality (F_{recent}/F_{MSY}) over the uncertainty grid of 72 models (Table SPA-01) were used to define South Pacific albacore stock status. The values of the upper 90th and lower 10th percentiles of the empirical distributions of relative spawning biomass and relative fishing mortality from the uncertainty grid were used to characterize the probable range of stock status.

2. A description of the updated structural sensitivity grid used to characterize uncertainty in the assessment is illustrated in Table SPA-01. Tables SPA-02, SPA-03, and SPA-04 show reference points for South Pacific-wide, WCPFC-CA (Convention Area) and IATTC-CA, respectively, including the median values of relative 'recent' (2016-2019) and 'latest' (2019) spawning biomass depletion ($SB_{recent}/SB_{F=0}$) and relative recent (2015-2018) fishing mortality (F_{recent}/F_{MSY}) over the uncertainty grid of 72 models used to define stock status. These values are based on the uncertainty grid with the downweighted SEAPODYM (M2) movement hypothesis. The values of the upper 90th and lower 10th percentiles of the empirical distributions of relative spawning biomass and relative fishing mortality from the uncertainty grid were used to characterize the probable range of stock status.

3. The spatial structure used in the 2021 stock assessment is shown in Figure SPA-01. Time series of total annual catch by fishing gear over the full assessment period and by region are shown in Figure SPA-02. Estimated annual average recruitment, spawning potential, and total biomass by model region for the diagnostic case model are shown in Figure SPA-03. Estimated trends in spawning potential by region for the diagnostic case are shown in Figure SPA-04, and juvenile and adult fishing mortality rates from the diagnostic model are shown in Figure SPA-05. Time series of estimated spawning potential for the 72 models are shown in Figure SPA-06. Time-dynamic percentiles of depletion ($SB_t/SB_{t,F=0}$) for the 72 models are shown in Figure SPA-07. Majuro and Kobe plots summarizing the results for each of the 72 models in the weighted structural uncertainty grid are shown in Figures SPA-08 and SPA-09 for the 'recent' and 'latest' periods, respectively.

4. The most influential axis of uncertainty with respect to estimated stock status was movement, where assuming SEAPODYM-derived movement resulted in more pessimistic outcomes.

5. SC17 noted that the median value of relative recent (2016-2019) spawning biomass depletion for South Pacific albacore ($SB_{2016-2019}/SB_{F=0}$) was 0.52 with a 10th to 90th percentile interval of 0.41 to 0.57.

6. SC17 further noted that there was 0% probability (0 out of 72 models) that the recent (2016-2019) spawning biomass had breached the adopted limit reference point (LRP).

7. SC17 noted that there has been a long-term increase in fishing mortality for adult South Pacific albacore, with a notable steep increase in fishing mortality since 2000.

8. SC17 noted that the median of relative recent fishing mortality for South Pacific albacore ($F_{2015-2018}/F_{MSY}$) was 0.24 with a 10th to 90th percentile interval of 0.15 to 0.37.

9. SC17 further noted that there was 0% probability (0 out of 72 models) that the recent (2015-2018) fishing mortality was above F_{MSY}.

10. SC17 noted the results of stochastic projections (based on the weighted grid, SC17-SA-WP-02a, Figures 1 and 2) from the 2021 assessment, which indicated the potential stock consequences of fishing at "status quo" conditions (2017–2019 or 2020 average catch or, separately, fishing effort) using the uncertainty framework approach endorsed by SC17. These results are provided for both South Pacific-wide and for the WCPFC Convention area only. All projections show a steep and rapid decline in biomass towards the LRP in the year 2021 followed by an increase in biomass thereafter.

Table SPA-01. Description of the structural uncertainty grid used to characterize uncertainty in the management quantities derived from this assessment. Note that the M2-SEAPODYM hypothesis was downweighted by 50% by the SC17.

Axis	1	2	3
Steepness (S)	0.65	**0.80**	0.95
Movement (M)	**M1-Estimated, age-dependent**	M2-SEAPODYM	
Size data weight (D)	Low (50)	**Medium (25)**	High (10)
Recruitment distribution (R)	**R1-SEAPODYM**	R2-Regions 3 and 4	
Growth/M (G/M)	**Fixed otolith, Nat-M1**	Estimated from length frequency, Nat-M2	

Table SPA-02. South Pacific-wide (all regions) reference point estimates from the assessment based on the weighted grid.

	Mean	Median	Min	10%	90%	Max
C_{latest}	87,184	86,827	83,519	85,092	87,633	130,936
F_{MSY}	0.06	0.06	0.05	0.05	0.07	0.08
f_{mult}	4.37	4.25	2.11	2.69	6.62	7.84
F_{recent} / F_{MSY}	0.25	0.24	0.13	0.15	0.37	0.47
MSY	115,661	120,020	68,200	75,584	158,600	166,240
SB_0	623,542	660,200	361,800	392,590	845,100	929,300
$SB_{F=0}$	675,861	678,345	524,886	537,740	824,855	873,278
SB_{latest} / SB_0	0.41	0.41	0.34	0.37	0.46	0.48
$SB_{latest} / SB_{F=0}$	0.37	0.40	0.25	0.27	0.45	0.46
SB_{latest} / SB_{MSY}	2.50	2.33	1.45	1.69	3.921	4.28
SB_{MSY}	109,710	104,100	48,040	61,497	157,500	190,000
SB_{MSY} / SB_0	0.18	0.18	0.11	0.11	0.22	0.23
$SB_{MSY} / SB_{F=0}$	0.16	0.16	0.09	0.11	0.22	0.23
$SB_{recent} / SB_{F=0}$	0.50	0.52	0.37	0.41	0.57	0.59
SB_{recent} / SB_{MSY}	3.34	3.22	2.07	2.24	5.18	5.33
$Y F_{recent}$	81,998	85,020	58,440	63,656	94,720	101,400

Table SPA-03. WCPFC-CA reference point estimates from the assessment based on the weighted grid.

	Mean	Median	Min	10%	90%	Max
C_{latest}	78,788	78,455	75,673	76,959	79,126	118,706
$SB_{F=0}$	459,648	463,424	415,746	431,617	491,092	501,602
$SB_{latest} / SB_{F=0}$	0.37	0.39	0.26	0.28	0.43	0.45
$SB_{recent} / SB_{F=0}$	0.51	0.52	0.39	0.42	0.58	0.61

Table SPA-04. IATTC-CA reference point estimates from the assessment based on the weighted grid.

	Mean	Median	Min	10%	90%	Max
C_{latest}	8,396	8,242	7,845	8,074	8,760	12,229
$SB_{F=0}$	216,213	233,755	92,190	98,063	356,491	379,718
$SB_{latest} / SB_{F=0}$	0.38	0.42	0.22	0.25	0.46	0.48
$SB_{recent} / SB_{F=0}$	0.47	0.52	0.28	0.32	0.56	0.57

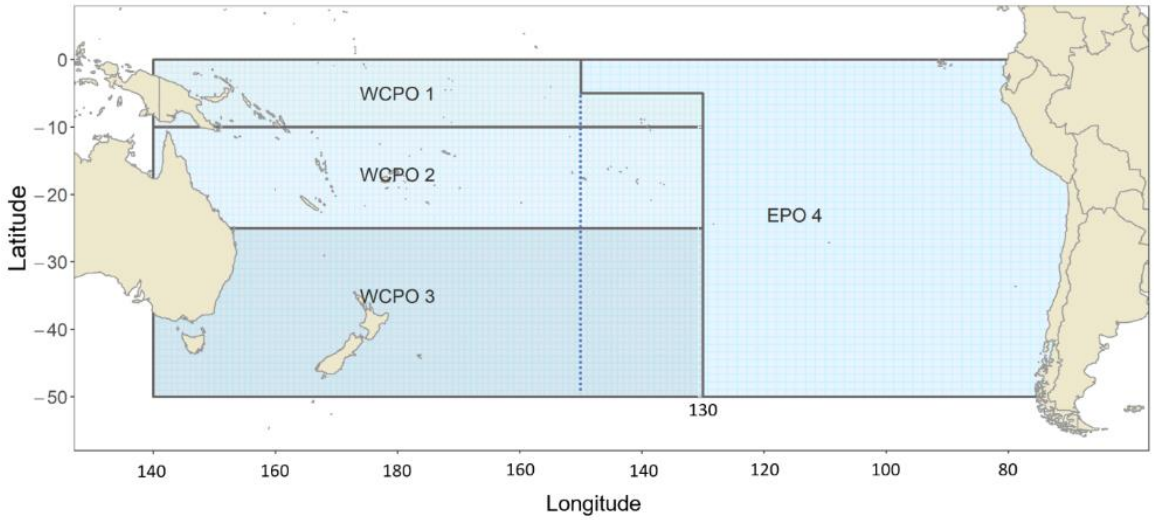

Figure SPA-01. The geographical area covered by the stock assessment and the boundaries of the four model regions used for South Pacific-wide 2021 albacore assessment. The overlap region between the WCPFC and IATTC convention areas is the area between 130º - 150º west demarcated by the dashed line. The catch from the 'overlap' area is included within the WCPFC-CA for this assessment.

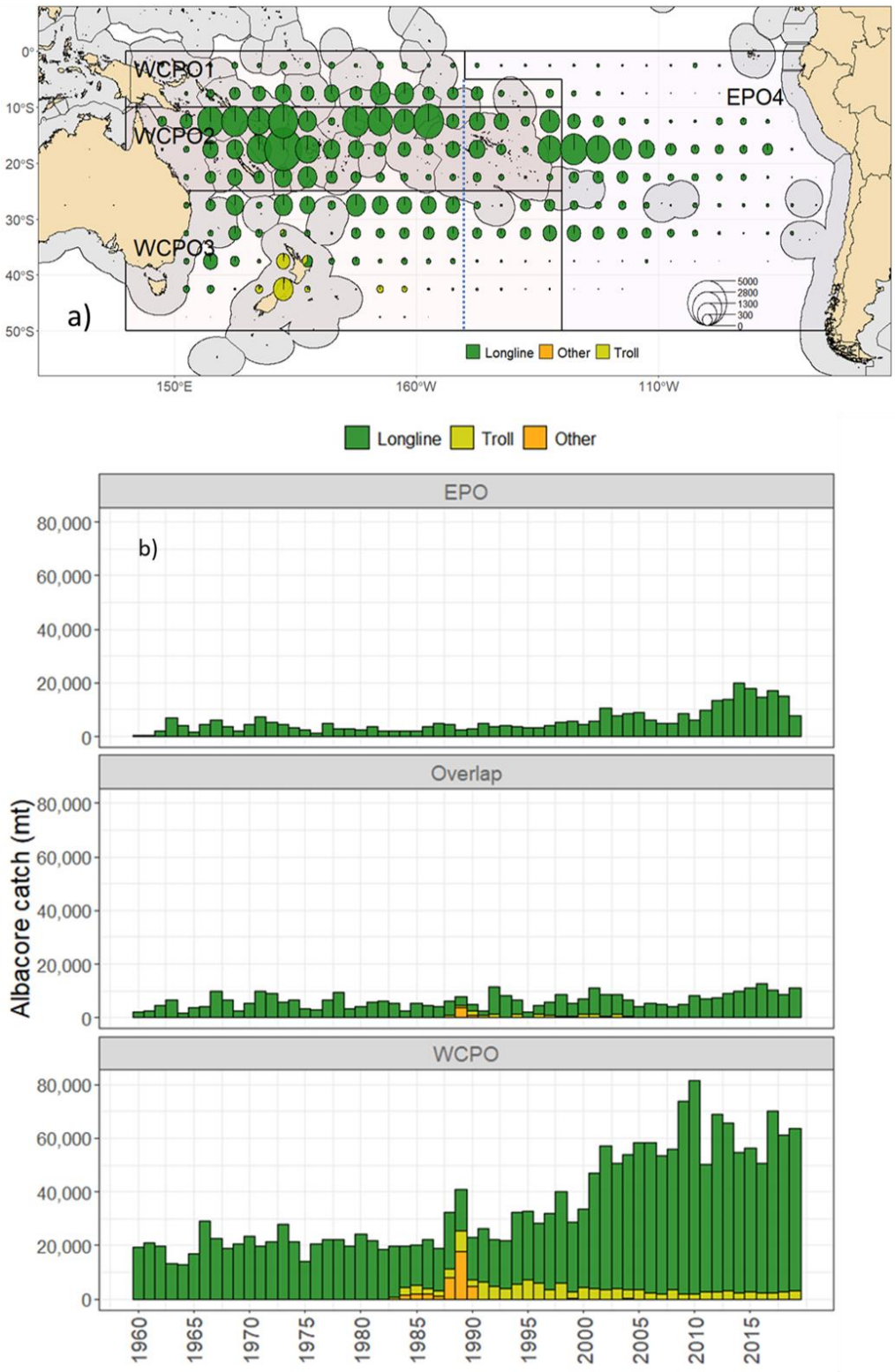

Figure SPA-02. a) Spatial pattern of albacore catch by gear type over the last decade, and b) historical catches of albacore across the model region from 1952-2019 by gear type.

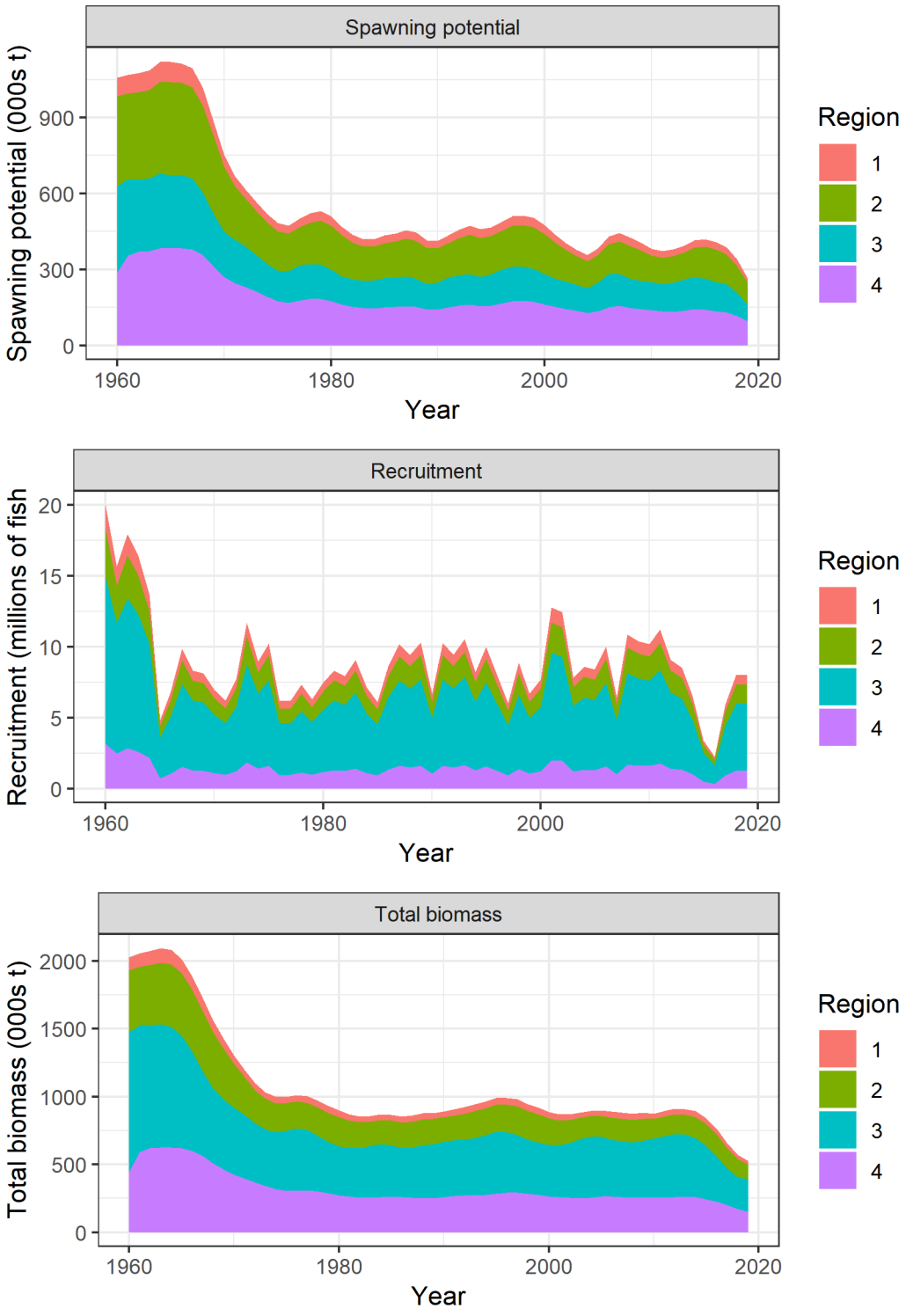

Figure SPA-03. Estimated annual average a) spawning potential, b) recruitment, and c) total biomass by model region for the diagnostic case model, showing the relative levels among regions.

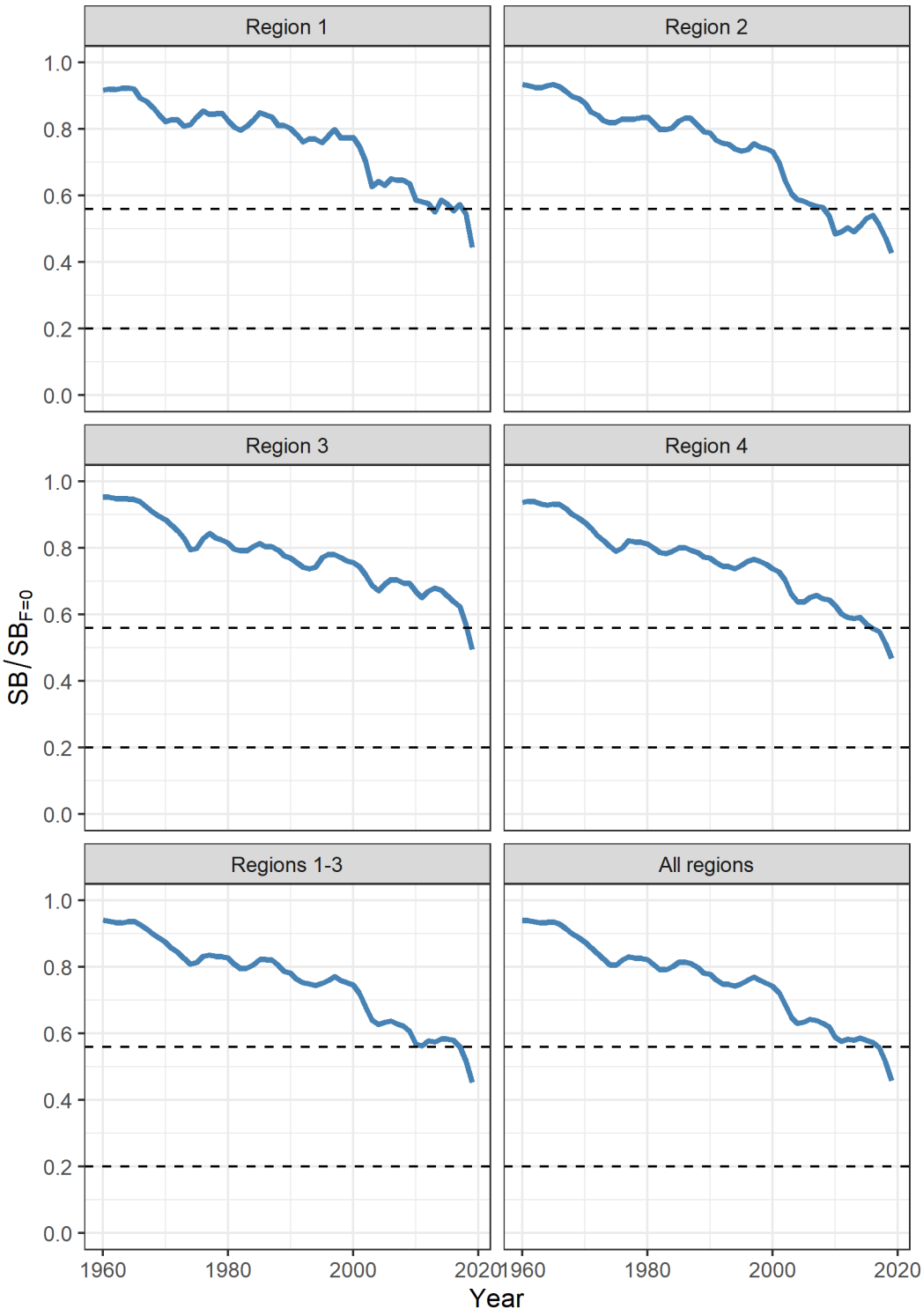

Figure SPA-04. Estimated temporal spawning potential by model region, grouped by region (WCPFC-CA, EPO) and South Pacific as a whole for the diagnostic case model. The dotted lines are included to indicate the $SB/SB_{F=0}$ interim target reference point (iTRP)=0.56 and the LRP=0.2 for the WCPFC-CA albacore fishery. Regions 1-3 represent the WCPFC-CA (including the "overlap"), Region 4 is the IATTC-CA.

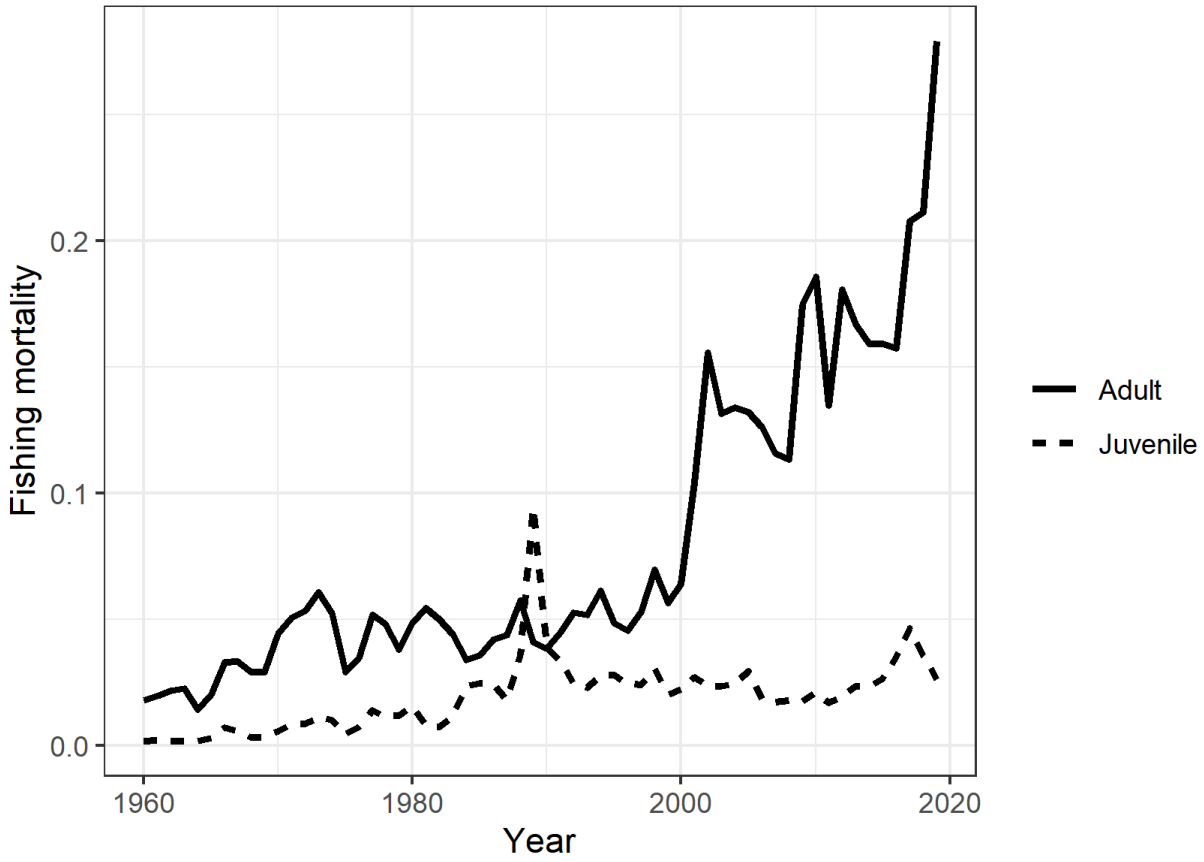

Figure SPA-05. Estimated annual average juvenile and adult fishing mortality for the diagnostic case model.

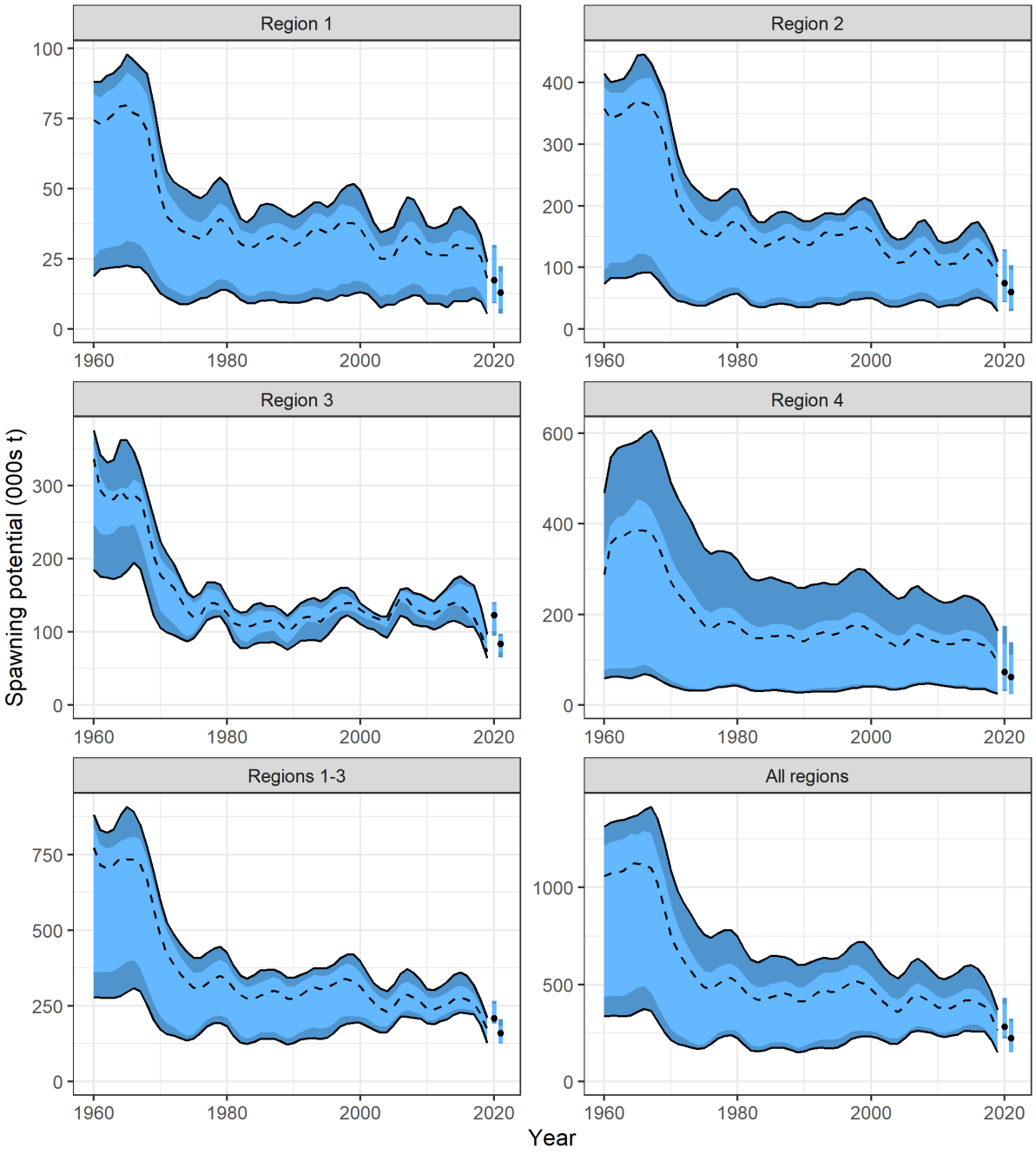

Figure SPA-06. Estimated spawning potential across all models in the structural uncertainty grid over the period 1960-2019. The dashed line represents the median. The darker band shows the 10th-90th percentile, and the lighter band shows the 25th-75th percentile of the model estimates. Regions 1-3 represent the WCPFC-CA (including the "overlap"), Region 4 is the IATTC-CA. The bars at right in each plot are the median values (points) and percentiles for recent (left) and latest (right) spawning potential.

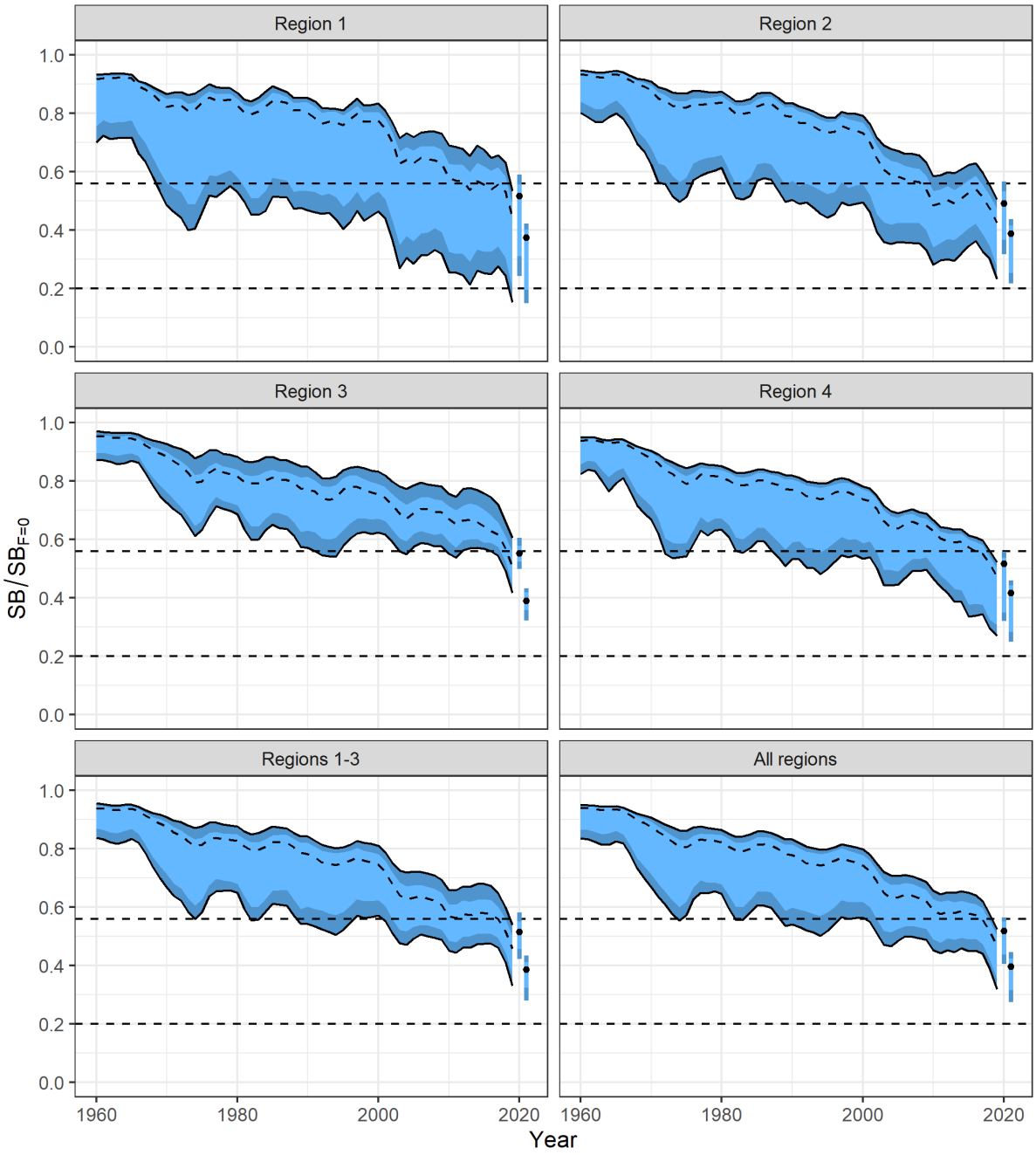

Figure SPA-07. Estimated spawning depletion across all models in the structural uncertainty grid over the period 1960-2019. The dashed line represents the median. The darker band shows the 10th-90th percentile, and the lighter band shows the 25th-75th percentile of the model estimates. Regions 1-3 represent the WCPFC-CA (including the "overlap"), Region 4 is the IATTC-CA. The dashed horizontal lines indicate the depletion LRP (0.2) and the WCPFC-CA TRP for SB/SB$_{F=0}$ (0.56). The bars at right in each plot are the median values (points) and percentiles for SB$_{recent}$/SB$_{F=0}$ (left) and SB$_{latest}$/SB$_{F=0}$ (right).

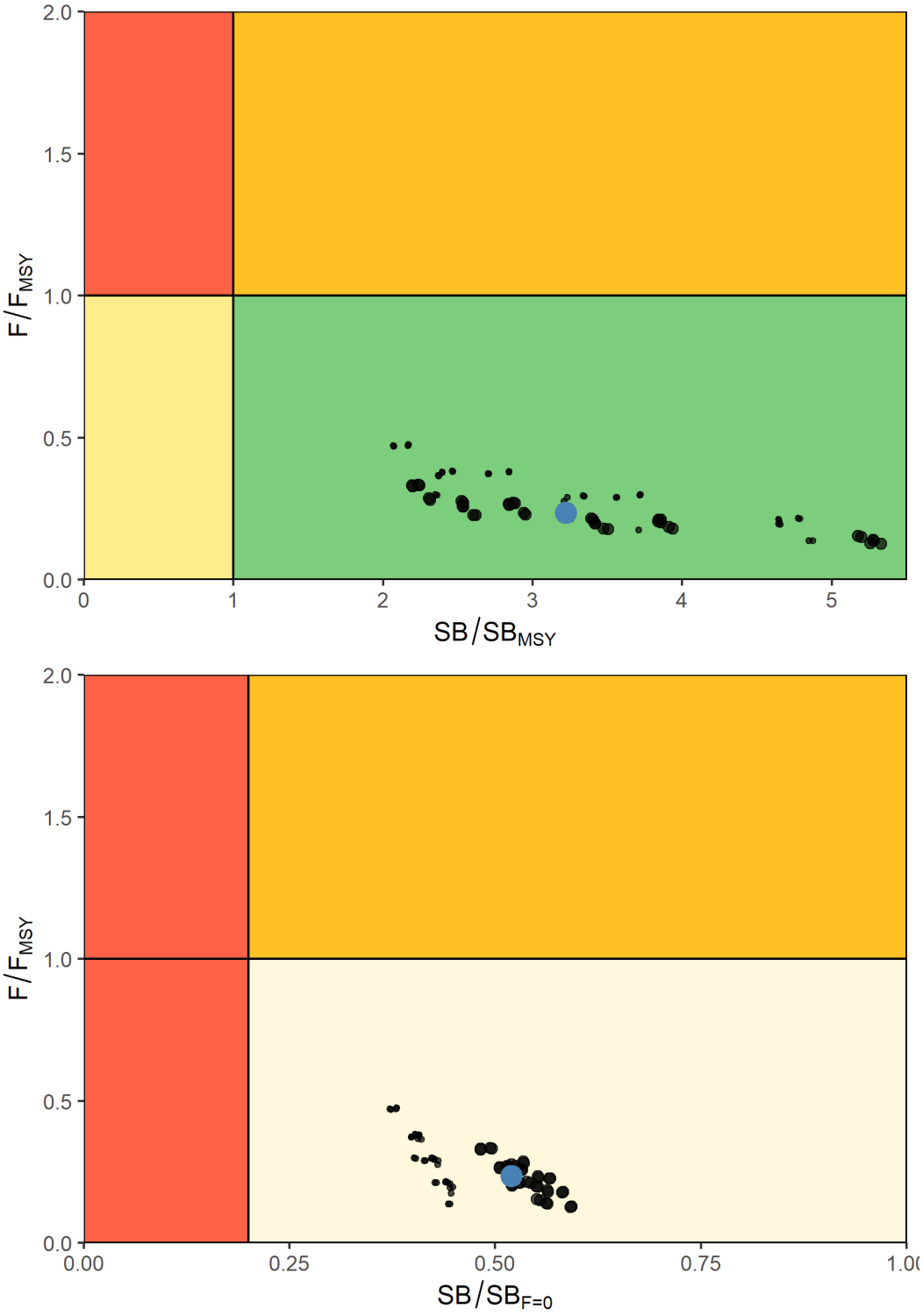

Figure SPA-08. Majuro (bottom) and Kobe (top) plots summarizing the Pacific-wide results for each of the models in the structural uncertainty grid for the 'recent' (2016-2019) period. The blue point is the median value based on the weighted grid models, with the more heavily weight models indicated by the larger black dots.

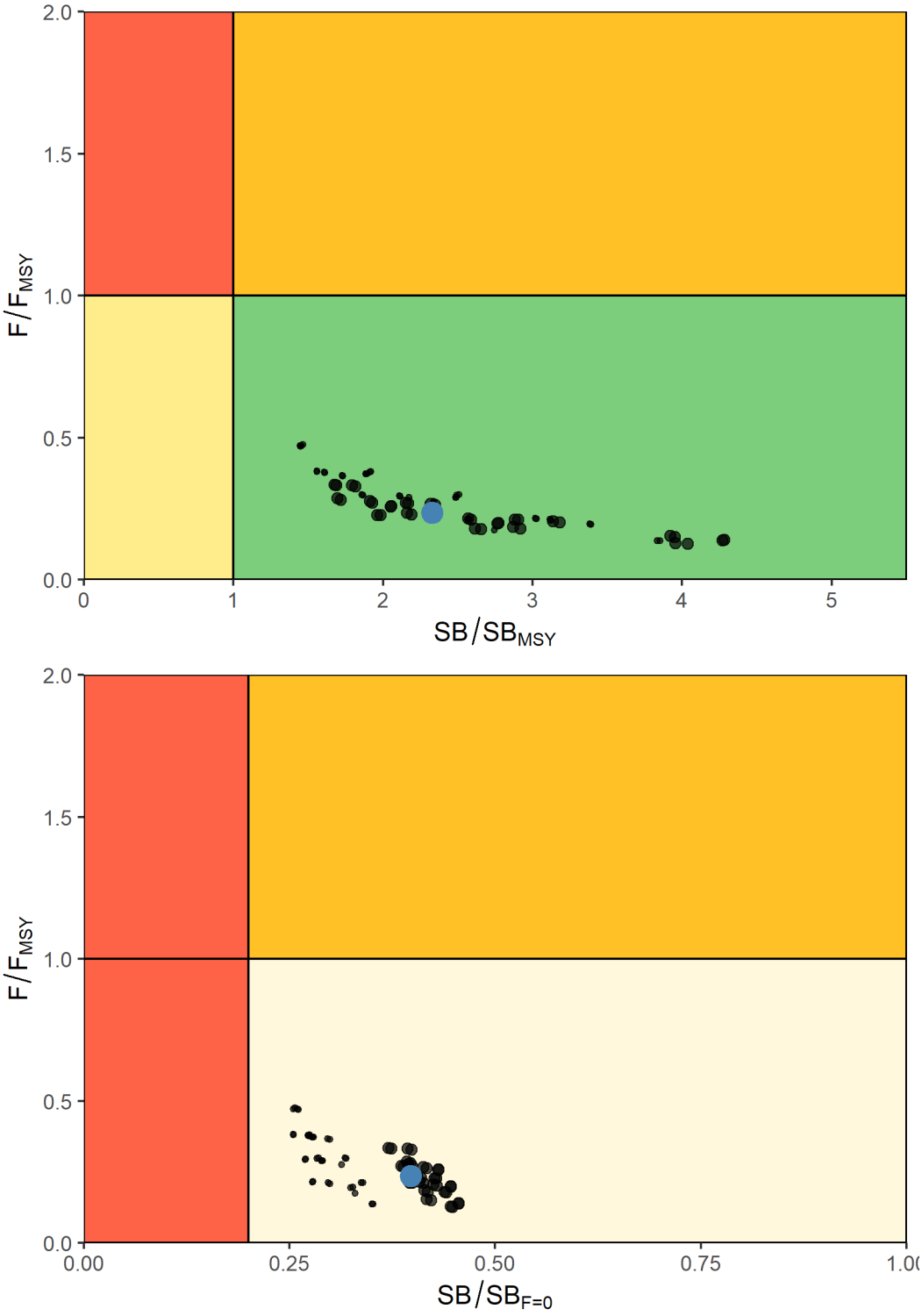

Figure SPA-09. Majuro (bottom) and Kobe (top) plots summarizing the Pacific-wide results for each of the models in the structural uncertainty grid for the 'latest' (2019) period. The blue point is the median value based on the weighted grid models, with the more heavily weighted models indicated by the larger black dots.

Management advice and implications

11. Annual catch estimates for albacore in the South Pacific peaked at 93,835 mt (all gears) in 2017 (SC17-SA-IP-04). Catch by longliners represented 93% of the catch weight in 2020 at 64,963 mt and represented a 21% decrease from 2019 despite a shift of effort from the tropical to the southern longline fishery in 2020. By comparison, the 2020 total albacore catch within the southern part of the WCPFC-CA was 61,778 mt and the longline catch was 57,006 mt.

12. The 2021 South Pacific albacore stock assessment provided results consistent with the 2018 assessment. The addition of the EPO region into the current entire South Pacific assessment did not notably alter the main assessment outcomes, and similar trajectories and terminal depletion were estimated in both RFMO regions.

13. The spawning stock biomass has become more depleted across the model period (1960-2019), with a notable increase in depletion in the most recent years. Based on the set of models in the SC endorsed structural uncertainty grid, the South Pacific albacore assessment indicates the stock is not overfished, and there was zero estimated risk of the stock being below the Limit Reference Point of $20\%SB_{F=0}$. However, the decline in the latest estimated $SB_{latest}/SB_{F=0}$ (year 2019; median 0.40; 10^{th} and 90^{th} percentiles 0.27 - 0.45) is notably more pessimistic than those of $SB_{recent}/SB_{F=0}$ (years 2016-2019; median 0.52; 10^{th} and 90^{th} percentiles 0.41 - 0.57) indicating that there has been a substantial decline in stock status estimated over the last three years. The general trends are consistent for estimates across all regions of the South Pacific stock, and for the WCPFC-CA only.

14. For the WCPFC-CA region, the 'recent' and 'latest' SB estimates are on average both below the interim TRP of 0.56. Further, 86% of models (62 out of 72 models) in the structural uncertainty grid endorsed by SC17 estimated that $SB_{recent}/SB_{F=0}$ was below the interim TRP. In relation to management objectives for the WCPFC-CA longline fishery, this assessment estimated that the median `latest' (2019) and `recent' (2016-2019) longline vulnerable biomass for the WCPFC-CA are 56% and 76% of the 2013+8% target level that defined the interim TRP.

15. SC17 noted CPUE declines in many domestic longline fisheries in the southern portion of the WCPFC-CA.

16. SC17 noted that depletion is greatest in regions north of 25ºS, specifically in assessment Regions 1 and 2 where most domestic Pacific Island Countries and Territories (PICTs) fleets operate, including Small Island Developing States (SIDS) and Participating Territories that may have no high seas access. These are areas mostly unaffected by current management measure for South Pacific albacore (CMM 2015-02), which prescribe effort controls and reporting provisions south of 20ºS.

17. SC17 expressed great concern with the projected status of South Pacific albacore if recent catch or effort levels are maintained (SC17-SA-WP-02a REV2). Projections indicated that South Pacific albacore stock has a greater than 20% risk of falling below the LRP in 2021 under both catch and effort scenarios. These projections indicate an extended period where biomass is below the current interim TRP and in most cases the TRP is not achieved within the 30-year projection period.

18. Recalling its previous advice from SC11, SC12, and SC13, SC17 recommended that longline catch be reduced to avoid further and extended declines in the vulnerable biomass so that economically viable catch rates can be maintained, especially for longline catch of adult albacore.

19. SC17 recommended a recalibration of the interim TRP for review at WCPFC18 in accordance with the process agreed at WCPFC15 (WCPFC15 Summary Report, para 207). Further, SC17 recommended

projections be undertaken to estimate the constant catch levels that would achieve that TRP on average over the long-term. SC17 recommended that these analyses be provided to WCPFC18 to guide its consideration of reductions in longline fishing mortality that will be required to return the vulnerable biomass to the 2013 +8% level as agreed.

Future research recommendations

20. SC17 noted with concern that the standardized CPUE indices do not show linear contrast with catches over the past 20 years when the catch has increased by 2 to 3-fold and also that the fit to the indices show a residual pattern over time. SC17 supported the assessment scientist's suggestion to consider split indices in future assessments, which might allow for the incorporation of more informative catchability and density covariates during the contemporary period, which is more important for estimates of recent status.

21. SC17 noted a possible nonlinear relationship between catch and effort or a time-varying relationship with changing fishing power and catchability. The next assessment could investigate such nonlinear relationships and explore alternative effort metrics.

22. SC17 noted with concern that the standardized CPUE model with hooks between floats (HBF) did not converge. The time-series is almost 70 years with substantial shifts to deploy more HBF though time. These gear changes have probably altered South Pacific albacore catchability and require additional research. HBF is one characteristic of longline gear that could affect catchability; operational longline data are largely absent of detailed vessel and gear characteristics that could be valuable in a standardization model. Reliably collecting additional gear characteristics will better inform these models on variability in catchability among vessels and fleets and over time and these data enhancements could be achieved by revisiting the minimum logsheet data standards, increasing observer coverage, or expanding electronic monitoring applications. Without this additional information the large uncertainties associated with the use of standardised-CPUE in assessments will remain unresolved and continue to impact on future assessments.

23. SC17 noted the need to both recalibrate the interim TRP according to the procedure agreed at WCPFC15 (WCPFC15 Summary Report, para 207) and estimate the constant catch levels that would achieve that TRP on average over the long-term. Specifically, based upon the SC-agreed 2021 South Pacific albacore stock assessment:

a) re-calibrate the WCPFC interim TRP (the median depletion in the WCPFC-CA, $SB/SB_{F=0}$) that would on average achieve the agreed objective of an 8 % increase in vulnerable biomass (CPUE proxy) for the southern longline fishery as compared to 2013 levels.
b) undertake projections to estimate the constant catch levels that would achieve the recalibrated TRP, on average, over the long-term.
c) within that projection-based analysis, WCPFC-CA longline and troll fisheries should be modelled based upon catch, and fishing levels within the EPO should be adjusted in the same way as the WCPO for one scenario and fixed at recent catch levels for another scenario. Future recruitment should be sampled from the long-term recruitment pattern.

24. A number of key research needs were identified in undertaking the assessment that should be investigated either internally or through directed research.

25. As with the previous South Pacific albacore assessment, the fishery dependent CPUE-based indices of abundance lacked contrast to inform population responses to increased fishing pressure. This continues to be a significant concern for the reliability of estimates of population size. The CPUE analysis has been a major focus of preparatory work for this and previous assessments, and despite the attempts of various scientists, application of new approaches including attempts at splitting time series and testing various covariates, the CPUE continues to lack contrast. It is recommended that alternative fishery independent

estimates of population size be explored, especially the genetic method of Close-Kin Mark-Recapture (CKMR).

26. The implications of uncertainty in movement were clearly evident in this year's assessment, with this being the most influential uncertainty for management advice. In the absence of strong empirical data to inform decisions on alternative movement hypotheses and based on the quality of fits to the data, the SC decided to downweight one of the two movement hypothesis for provision of management advice. This is an unsatisfactory situation and there is a clear need to improve understanding of connectivity among albacore populations across the South Pacific, and, in particular, the fishery regions in the WCPFC and IATTC convention areas. This is particularly critical if South Pacific-wide assessments are to continue. The CKMR method as a by-product can also address this uncertainty.

27. Despite applying the new growth data to this assessment, the modal structure in the New Zealand troll fishery size composition was still not fit adequately. Further work on growth modelling is required. It should also be noted that otolith-based growth data being used is mostly derived for otolith samples collected in 2009 -2010. Further, to update the growth information for albacore, samples from the IATTC-CA are needed. Again, samples required to address this issue could be collected as part of a CKMR project that would also include a component to develop (tissue-based) epigenetic ageing methods and sex determination. This would be a major advance in including more contemporary growth information in tuna assessments.

28. Follow-up studies to assess the reliability of size composition data for providing information on recruitment and population trends, and if necessary, develop better stratification methods to improve the representativeness of size composition data should be considered.

29. Finally, the current model is highly parameterized, and reducing model parameters and complexity should be considered to improve model fits and diagnostics. One key advancement would be the application of the "catch conditioned" approach that will be available in MULTIFAN-CL for the next assessment.

Attachment B

WCPFC15 Summary Report, Paragraph 207

207. WCPFC15 agreed on an interim target reference point (TRP) for south Pacific albacore at 56 percent of spawning stock biomass in the absence of fishing (0.56 SBF=0)[2] with the objective of achieving an 8 percent increase in catch per unit of effort (CPUE) for the southern longline fishery as compared to 2013 levels.[3] If a future stock assessment indicates that this interim TRP will not result in the desired longline CPUE, then the interim TRP will be revised in order to meet this objective. The TRP shall be reviewed every 3 years, consistent with the SP albacore assessment schedule.

[2] The method to be used in estimating the recent average spawning biomass in the absence of fishing shall be the same as that adopted by the Commission for the limit reference point, as described in paragraph 3 of CMM 2015-06.
[3] The proxy for CPUE will be the southern longline vulnerable biomass as estimated within the stock assessment.