Western and Central Pacific Fisheries Commission

TO ALL COMMISSION MEMBERS, COOPERATING NON-MEMBERS, PARTICIPATING TERRITORIES AND OBSERVERS

Circular No.: 2023/71
Date: 4 September 2023
No. pages: 91

Nineteenth Regular Session of the Scientific Committee (SC19) – Outcomes Document

Dear All,

Pursuant to Rule 33 (2) of the Rules of Procedure of the Commission on the communication of decisions, please find the enclosed **Outcomes Document for SC19**, which lists the agreed decisions and recommendations to the Commission. The draft Summary Report for SC19 is tentatively scheduled to be distributed to all CCMs and Observers for comments on Tuesday 19 September 2023.

For any comments or questions on the Outcomes Document, please reach out to the Science Manager, Dr SungKwon Soh at sungkwon.soh@wcpfc.int, as early as possible but no later than **Monday, 11 September 2023**.

Yours sincerely,

Rhea Moss-Christian
EXECUTIVE DIRECTOR

Western and Central Pacific Fisheries Commission

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

SCIENTIFIC COMMITTEE
NINETEENTH REGULAR SESSION

Koror, Palau
16-24 August 2023

OUTCOMES DOCUMENT

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

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WCPFC20-2023-SC19-01

AGENDA ITEM 1 — OPENING OF THE MEETING

1.1 Welcome address
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1.3 Issues arising from the Commission
1.4 Adoption of agenda
1.5 Reporting arrangements
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AGENDA ITEM 2 — REVIEW OF FISHERIES

2.1 Overview of Western and Central Pacific Ocean (WCPO) fisheries
2.2 Overview of Eastern Pacific Ocean (EPO) fisheries
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AGENDA ITEM 3 — DATA AND STATISTICS THEME

3.1 Data gaps

3.1.1 Data gaps of the Commission

3.1.1.1 Data gaps

1. SC19 noted the availability of the Annual Catch Estimate (ACE) template to facilitate the uploading of information to WCPFC databases and encouraged CCMs to consider using this voluntary template.

3.1.1.2 Updates on data-related projects

2. SC19 noted the progress on Projects 60 (*Improved purse seine species composition*), 90 (*Better data on fish weights and lengths for scientific analysis*), and 114 (*Improving coverage of cannery receipt data*) and supported the proposed workplans in those progress reports.

3.1.1.3 Minimum data reporting requirements

Operational longline data fields

3. SC19 acknowledged the scientific value of the additional longline operational data fields in

Table ST-01 and **recommended that these fields be considered for inclusion in the "Scientific Data to be Provided by the Commission (SciData)".**

4. However, SC19 noted broad implementation concerns of CCMs with respect to the collection of these data, **recommended that TCC and the Regular Session of the Commission take account of these concerns, and suggested a possible option would be to include them as voluntary reporting items.**

Table ST-01. Additional longline operational data fields for CPUE standardization and related analyses

DATA FIELD	Suggested PROTOCOL for data collection
Target species for the set	Record the primary target species, or group of species, for this set.
Number of lightsticks used in set	Record the total number of lightsticks used in the set.
Bait type used in set	Record the FAO code for type of bait used for the set. Example types: • Squid (class Cephalopoda) • Sardine or Pilchard (family Clupeidae) • Mackerel (family Scombridae) • Mixed Mackerel and Sardine …
Mainline length	Record the mainline length (in kilometres) used in the trip or set, as appropriate.
Length of branch line	Record the average length in metres of the branch lines in the trip or set. (The total length from the mainline to the hook).
Length of float line	Record the average length in metres of the float lines in the set. (The total length from the float to the mainline).
Vessel speed during setting	Record the average speed in knots of vessel during line setting.
Speed of the line setter	Record the speed in knots of the line setter (i.e. the line shooter speed).

Additional code for the ACTIVITY field

5. SC19 acknowledged that the proposal for the addition of a new activity code for any day when a "transhipment at sea occurs" would allow the WCPFC's Scientific Services Provider (SSP) to define 'trips' within the operational data submitted to the Commission.

6. SC19 also noted the explanation from the SSP that aggregating the catch by species in the longline operational data at the trip level (when the trip is terminated by an at-sea transhipment) is fundamental for the validation processes using other independent sources of data (e.g. transhipment observers and carrier declarations) to provide more certainty in the data used in assessments and other work of the Commission.

7. **SC19 recommended that this proposal be considered further by TCC and the Regular Session of the Commission**.

Inconsistencies between SciData and CMM operational data reporting requirements

8. SC19 acknowledged the review by the WCPFC SSP of inconsistencies in the data reporting requirements between the Scientific Data to be Provided by the Commission (SciData), and other WCPFC reporting obligations (e.g., in CMMs)

9. This review identified a reporting requirement under CMM 2018-04 (*Conservation and Management of Sea Turtles*) that does not appear to be specifically covered in operational data requirements of the SciData (refer to CMM 2018-04 paragraph 5 (c) and 7(e)).

10. After discussion and consideration, SC19 noted that the reporting requirement under CMM 2018-04 does not explicitly require operational data. **SC19 recommended that TCC19 consider whether it is necessary to clarify the reporting requirements in the CMM 2018-04, while noting the difficulty of logbook-based data collection for sea turtles.**

Inconsistent reporting of Set Start Time

11. The SC19 working paper on the proposed Billfish Research Plan 2023 - 2027 (SC19-SA-WP-16) noted in a review of available operational data for future billfish research that, *"...some fleets record time as ships time, others at UTC and some as country capital time. Clarifying this at a fleet level will be needed before this analysis can be completed with any certainty."*

12. The SciData indicates that *"the date of start of set and time of start of set: The date and start of set time should be GMT/UTC"*. Reporting date/time in the GMT/UTC standard is not a binding SciData requirement, so **SC19 recommended that the WCPFC CCMs, with assistance from the WCPFC SSP where required, indicate:**

(a) the date/time standard used in their historical operational data submissions to the Commission, and

(b) the date/time standard in their operational data, when they are submitted each year in the future.

Information to ensure the date/time standard is linked back to GMT/UTC shall also be provided.

Additional Billfish Species

13. SC19 noted the need for data on short-billed spearfish and sailfish catches, as highlighted in the Billfish Research Plan, and **recommended that TCC19 determine how to best accommodate the inclusion of these two species into the Science Data to be Provided to the Commission.**

FAD Data fields

14. SC19 recognised the scientific value of the PNA's proposal on *"Minimum Data Fields to be Recorded by WCPFC Vessel Operators"* (SC19-ST-WP-05).

15. Noting the current workload of observers, and some FAD data may be more effectively provided by vessel operators, **SC19 agreed on the need for developing a FAD logbook for vessel operators as a priority**.

16. SC19 noted that the PNA has developed the Standard Operating Procedures (SOPs) for the provision of FAD data by vessel operators for licensed vessels from January 2022 and IATTC have also adopted a FAD logbook, currently used for vessels operating in the EPO and in the overlap area. SC19 noted both could be used as the basis for discussion at FADMO-IWG.

17. **SC19 recommended WCPFC20 considers this work be progressed intersessionally within the FADMO-IWG**.

3.1.1.4 Frequent submission of operational catch and effort data

3.1.2 Bycatch estimates of longline fisheries

18. SC19 noted the following in relation to the updated estimates of longline bycatch:

a) Changes to the methodology now allow for uncertainty in the estimated hooks between floats (HBF) to propagate through uncertainty in estimated catches.

b) There continue to be difficulties in robust estimation of longline bycatch resulting in high uncertainty given the low levels and spatially imbalanced nature of observer coverage, and for some years the low coverage of data.

c) Earlier work suggests the *trends* in estimated catch rates are more reliable than the *magnitude* of the estimated catches.

d) Assuming a timely return of observer coverage to pre-COVID levels, that there will probably be sufficient observer data available to revise the catch rates models in the future.

e) A previous analysis (SC16-ST-IP-11) suggested that an observer coverage of at least 10 % of trips would allow for reasonably good estimates of bycatch, and that the increase in precision would be highest for species that are frequently caught, and weakest for rarely caught species, especially sea turtles and cetaceans.

19. SC19 noted that the adopted level of 5% observer coverage, which has been in place for over a decade, has not provided good estimates of longline bycatch. Therefore, **SC19 recommended that the Commission explore options to expand the observer coverage on longline vessels through both human and electronic approaches in the WCPO so that the SC can provide better estimates of bycatch levels and other metrics from these fleets**.

3.2 Regional Observer Programme

3.2.1 Review of observer training project for elasmobranch biological sampling (Project 109)

20. SC19 endorsed a no-cost extension of Project 109 to the end of December 2024.

3.2.2 ROP data issues

3.3 Electronic Reporting and Electronic Monitoring (ER and EM)

21. SC19 noted the report from the research project on EM monitoring transhipment that utilized a digital scale integrated to the onboard EM system to automatically store transmitted weights. SC19 welcomed such developments and **recommended that the trials of EM on at-sea transhipment vessels should be continued**.

3.4 Economic data

3.5 Baseline period or limit of the Indonesian Large Fish Handline Fishery

AGENDA ITEM 4 — STOCK ASSESSMENT THEME

4.1 Independent review of recent WCPO Yellowfin tuna assessment

22. SC19 noted the recommendations in the peer review of the 2020 WCPO yellowfin tuna stock assessment (SC19-SA-WP-01 *Independent review of recent WCPO yellowfin tuna assessment*), and **recommended that, where practical, recommendations therein be considered for future bigeye and**

yellowfin tuna assessments, as well as other assessments as appropriate.

23. SC19 noted that regular and ongoing peer reviews are helpful for improving stock assessments.

4.2 Improvement of MULTIFAN-CL software

24. SC19 supported ongoing development of MULTIFAN-CL by the SSP but noted that the next generation of assessment models for tuna assessments in the WCPFC should be considered. SC19 noted that a TOR for work towards the development of the next generation of tuna assessment models was submitted to SC19.

4.3 WCPO tunas

4.3.1 WCPO yellowfin tuna (*Thunnus albacares*)

4.3.1.1 Research and information

a. Review of 2023 yellowfin tuna stock assessment

25. A. Magnusson (SPC-OFP) presented SC19-SA-WP-04 (*Stock assessment of yellowfin tuna in the western and central Pacific Ocean*), which describes the 2023 stock assessment of yellowfin tuna (*Thunnus albacares*) in the WCPO.

26. SC19 noted that the SSP had made significant improvements to the WCPO yellowfin tuna assessment based upon the recommendations from the 2022 peer review of the 2020 yellowfin tuna assessment, and from several CAPAM (Center for the Advancement of Assessment Modeling) meetings. Some key changes from the 2020 assessment include:

- Estimating natural mortality internally in the model.
- Reducing the spatial complexity from 9 regions to 5 regions.
- Using a Lorenzen functional form of natural mortality.
- Changing to a catch-conditioned model and estimating a likelihood for CPUE
- Revising the treatment of tagging data included in the model.
- Incorporating estimation uncertainty to the structural uncertainty grid.

4.3.1.2 Provision of scientific information

a. Stock status and trends

27. The 2023 WCPO yellowfin tuna assessment provides stock status based upon a 54-model structural uncertainty grid with four axes: steepness with three levels, tag mixing period with two levels, and size and age composition data with three levels each, as illustrated in table YFT-01. **SC19 recommended that the proposed axes of uncertainty be accepted and that all models should be weighted equally. SC19 noted that an important improvement in the characterization of uncertainty was the inclusion of estimation uncertainty for each of the models in the grid.**

28. SC19 noted that the most influential axis of uncertainty in the grid was steepness.

29. The spatial structure used in the 2023 stock assessment is shown in Figure YFT-01. SC19 noted that the simplification of the model from 9 regions to 5 regions improved the convergence of the model.

30. The time series of total annual catch by fishing gear over the full assessment period is shown in Figure YFT-02. The time series of total annual catch by fishing gear and assessment region is shown in Figure YFT-03. Estimated annual average recruitment, spawning potential, and total biomass by model region is shown in Figure YFT-04. Estimated trends in spawning potential depletion ($SB/SB_{F=0}$) for the 54 models in the structural uncertainty grid is shown in Figure YFT-05, and juvenile and adult fishing mortality rates from the diagnostic model is shown in Figure YFT-06. Estimates of the reduction in spawning potential due to fishing by region are shown in Figure YFT-07. Estimated trends in spawning potential for the 54 models are shown in Figure YFT-08. A Majuro and Kobe plot summarizing the results for each of the 54 models in the structural uncertainty grid are shown in Figure YFT-09. A comparison of the dynamic MSY for the diagnostic model compared with annual catch by the main gear types are shown in Figure YFT-10.

31. SC19 noted that the preliminary estimate of total catch of WCPO yellowfin tuna for 2022 was 721,169 mt which was lower than the 2021 level. Longline catch in 2022 (84,232 mt) was higher than the 2021 catch, but lower than the recent 10-year average. Purse-seine catch in 2022 (379,715 mt) was similar to the 2021 catch, and higher than the recent 10-year average (Figure YFT-02).

32. The 2023 WCPO yellowfin tuna stock assessment median depletion from the model grid for the recent period (2018–2021; $SB_{recent}/SB_{F=0}$) was estimated at 0.47 (10^{th} to 90^{th} percentile interval of 0.42 to 0.52, including estimation and structural uncertainty). For all models in the grid $SB_{recent}/SB_{F=0}$ was above the biomass limit reference point. The recent median fishing mortality (2017–2020; F_{recent}/F_{MSY}) was 0.50 (10^{th} to 90^{th} percentile interval of 0.41 to 0.62, including estimation and structural uncertainty, Table YFT-02). For all models in the grid, F/F_{MSY} was less than one.

33. SC19 noted that the spawning potential of the stock has become more depleted across all model regions until around 2010, after which it has become more stable, or shown a slight increase.

34. SC19 also noted that average fishing mortality rates for juvenile and adult age-classes have increased throughout the period of the assessment, although more so for juveniles which have experienced considerably higher fishing mortality than adults. In the recent period (2015-2021), a sharp increase in juvenile fishing mortality was estimated, while adult fishing mortality stabilized.

Table YFT-01: Summary of reference points over the 54 individual models in the structural uncertainty grid, along with results incorporating estimation uncertainty (Table 5 from SC19-SA-WP-04).

	mean	median	min	10%ile	90%ile	max	diagnostic model
C_{latest}	751657	751856	750785	750860	752268	752337	751908
F_{MSY}	0.07	0.07	0.06	0.06	0.09	0.09	0.07
F_{mult}	1.96	2.00	1.47	1.64	2.38	2.50	1.89
F_{recent}/F_{MSY}	0.51	0.50	0.40	0.42	0.61	0.68	0.53
MSY	697874	700400	616800	644320	739560	771600	671600
SB_0	5761796	5729000	4455000	4817200	6640900	7279000	5216000
$SB_{F=0}$	5633743	5603267	4624645	4907798	6280841	6825888	5173954
SB_{latest}/SB_0	0.49	0.50	0.41	0.44	0.54	0.56	0.49
$SB_{latest}/SB_{F=0}$	0.50	0.50	0.41	0.45	0.55	0.58	0.49
SB_{latest}/SB_{MSY}	2.49	2.48	1.78	1.91	3.11	3.16	2.44
SB_{MSY}	1177733	1160500	740400	838260	1538200	1707000	1044000
SB_{MSY}/SB_0	0.20	0.20	0.17	0.17	0.23	0.24	0.20
$SB_{MSY}/SB_{F=0}$	0.21	0.21	0.16	0.17	0.24	0.25	0.20

***SB*recent/*SB*$_{F=0}$**	0.47	0.47	0.38	0.42	0.52	0.54	0.46
***SB*recent/*SB*MSY**	2.31	2.30	1.68	1.77	2.89	2.94	2.27
***Y*$_{F\text{recent}}$**	157188	155300	141400	145150	172270	173300	152500

Including estimation uncertainty:

	mean	**median**	**min**	**10%ile**	**90%ile**	**max**
***SB*recent/*SB*$_{F=0}$**	0.47	0.47	0.36	0.42	0.52	0.59
***F*recent/*F*MSY**	0.51	0.50	0.26	0.41	0.62	0.78
***SB*recent/*SB*MSY**	2.31	2.28	0.93	1.73	2.95	3.59

Table YFT-02: Structural uncertainty grid for the 2023 WCPO yellowfin tuna stock assessment. Bold values indicate settings for the diagnostic model (Table 3 from SC19-SA-WP-04).

Axis	**Levels**	**Option 1**	**Option 2**	**Option 3**
Steepness	3	0.65	**0.8**	0.95
Tag mixing (# quarters)	2	1		**2**
Size data weighting divisor	3	10	**20**	40
Age data weighting	3	0.5	**0.75**	1

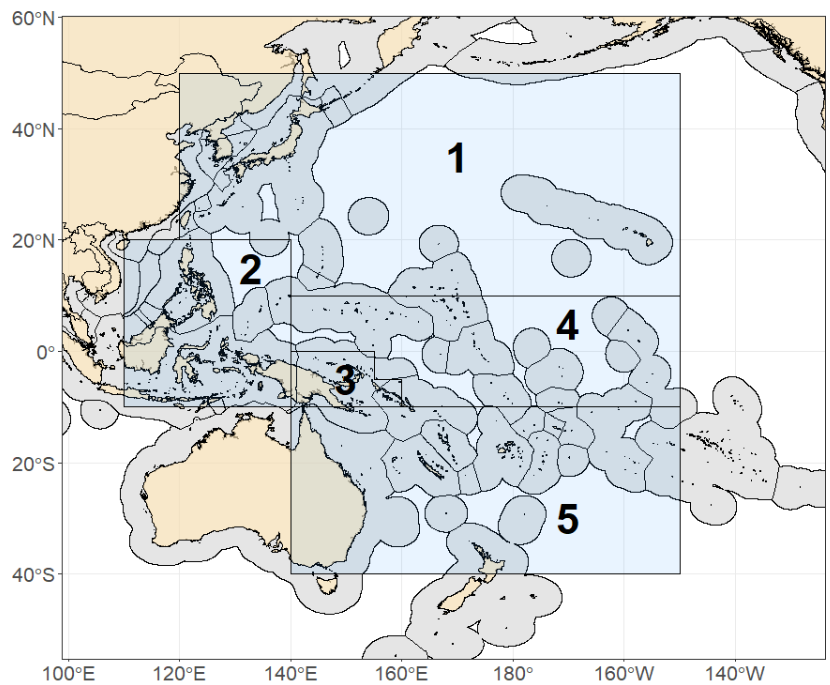


Figure YFT-01: The geographical area covered by the stock assessment and the boundaries of the model regions for the 5-region structure that was used for 2023 WCPO yellowfin tuna assessment (Figure 1a from SC19-SA-SP-04).

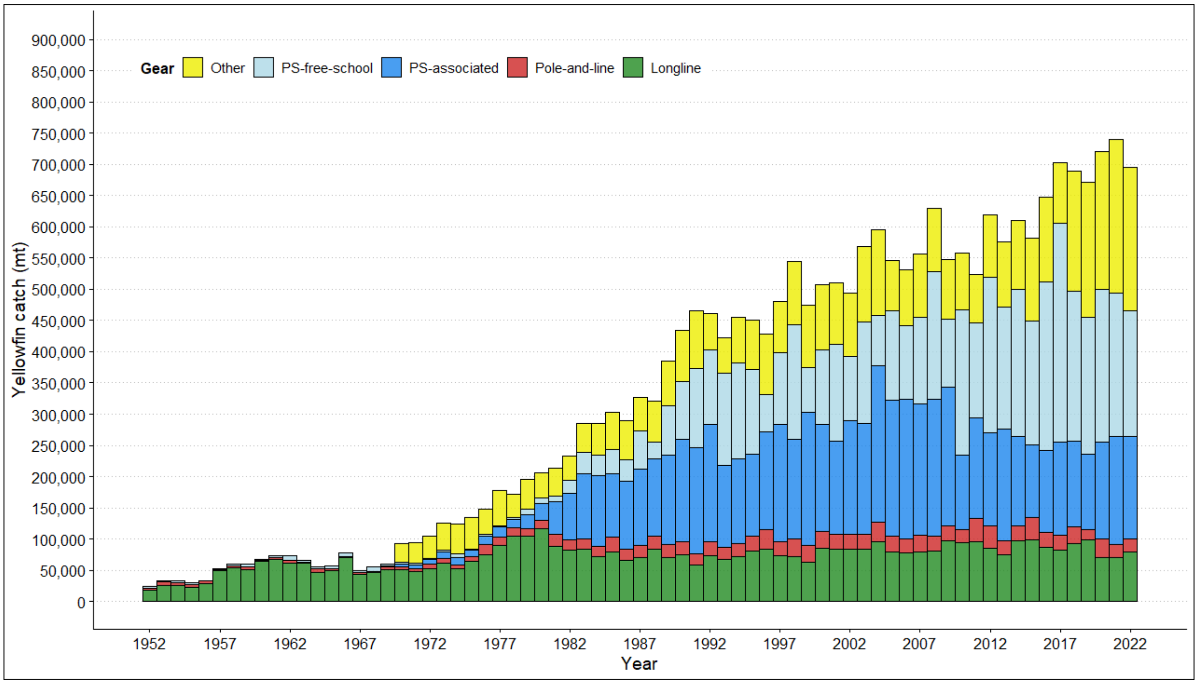


Figure YFT-02: Annual catches of yellowfin by gear type in the WCPO area covered by the assessment (Figure 3 from SC19-SA-WP-04).

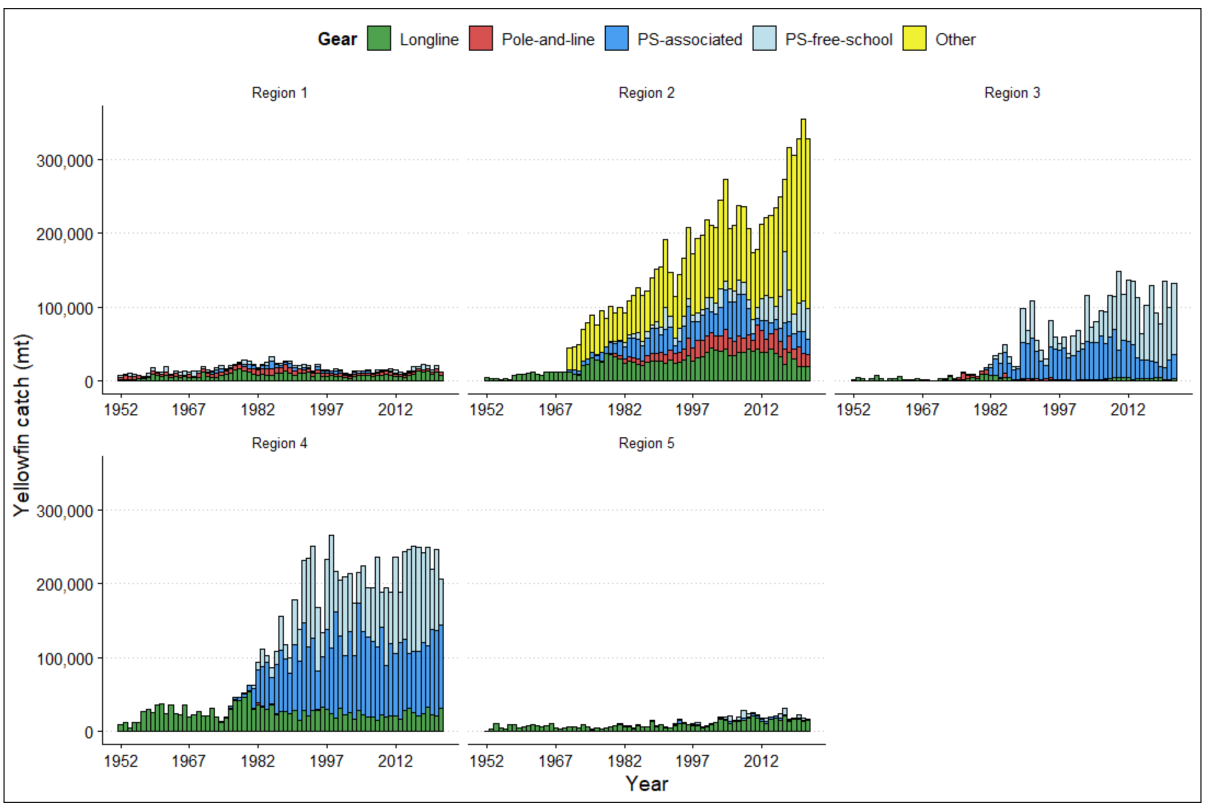


Figure YFT-03: Annual catches of yellowfin by gear type for each of the five model regions (Figure 4 from SC19-SA-WP-04).

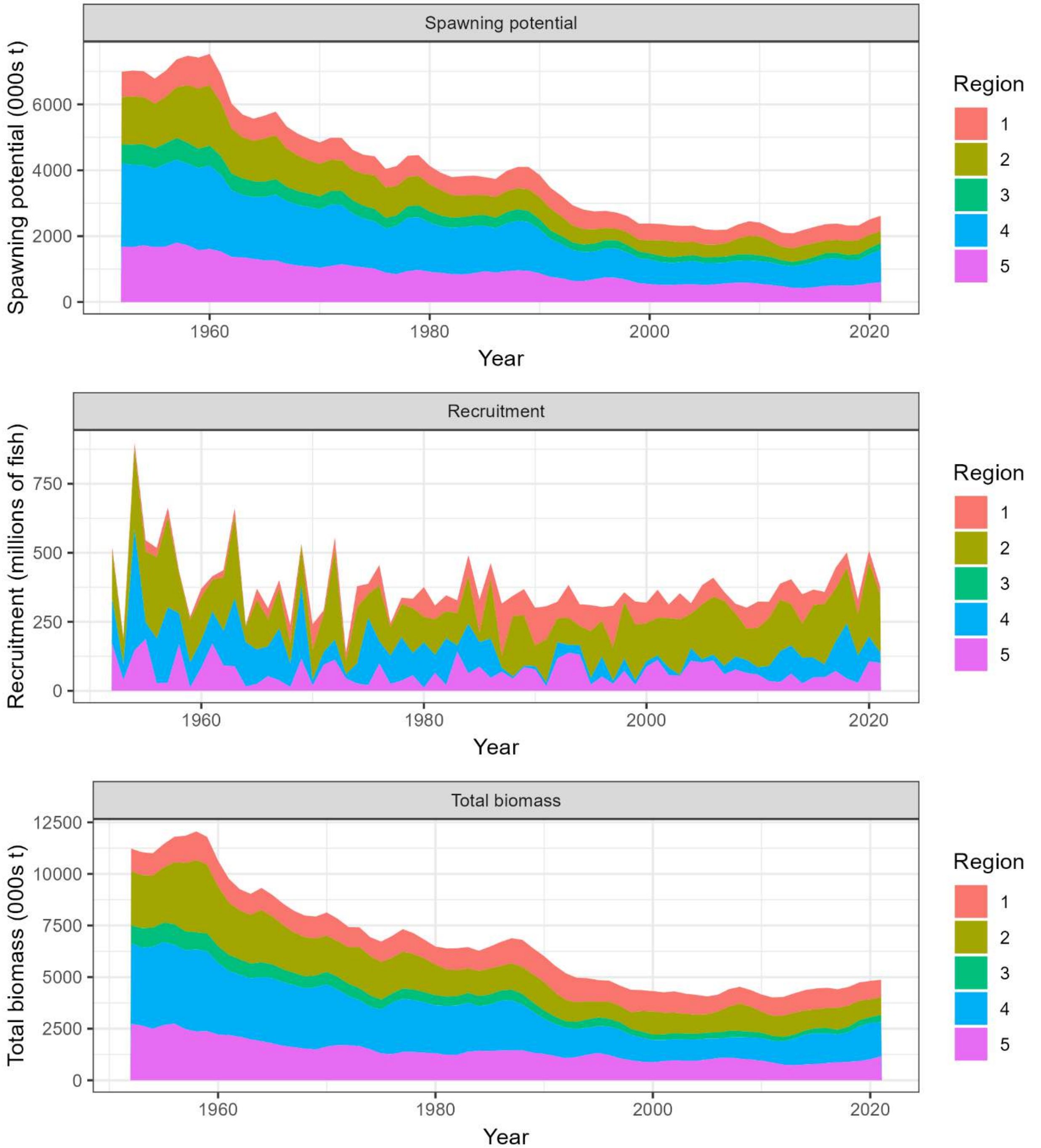


Figure YFT-04: Time series of estimated annual recruitment, spawning potential and total biomass by model region for the diagnostic model, showing the relative proportions among regions (Figure 44 from SC19-SA-WP-04).

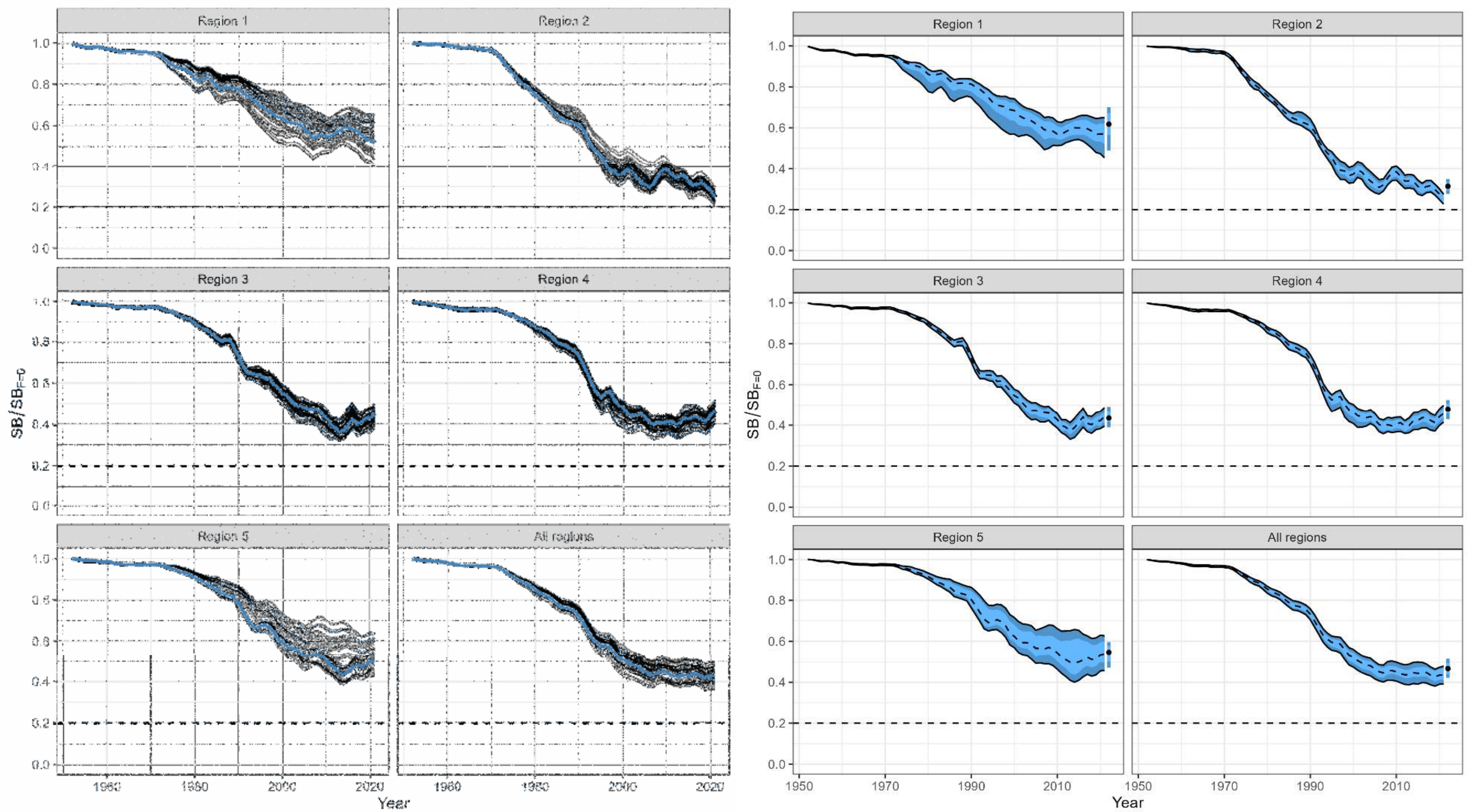


Figure YFT-05: (Left) Trajectories of spawning potential depletion for the individual model runs included in the structural uncertainty grid over the period 1952-2021. (Right) Estimated spawning depletion across all models in the structural uncertainty grid over the period 1952-2021. The dashed line represents the median, the lighter band shows the 25th and 75th percentiles, and the dark band shows the 10^{th} and 90^{th} percentiles of the model estimates. The bar at the right of each ribbon indicates the median (black dots) with the 10^{th} and 90^{th} percentiles for $SB_{recent}/SB_{F=0}$ (Figure 58 from SC19-SA-WP-04).

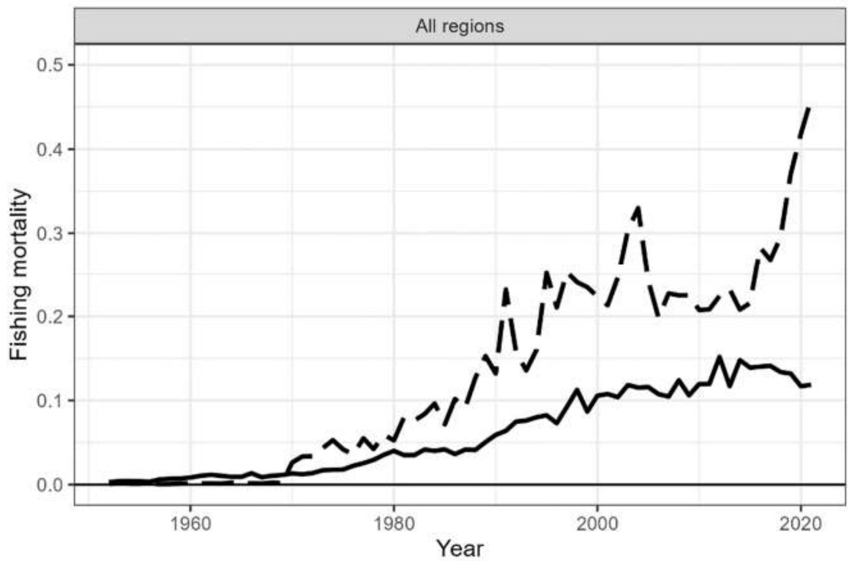


Figure YFT-06: Estimated annual average adult (solid line) and juvenile (dashed line) fishing mortality for the diagnostic model (Figure 49 from SC19-SA-WP-04).

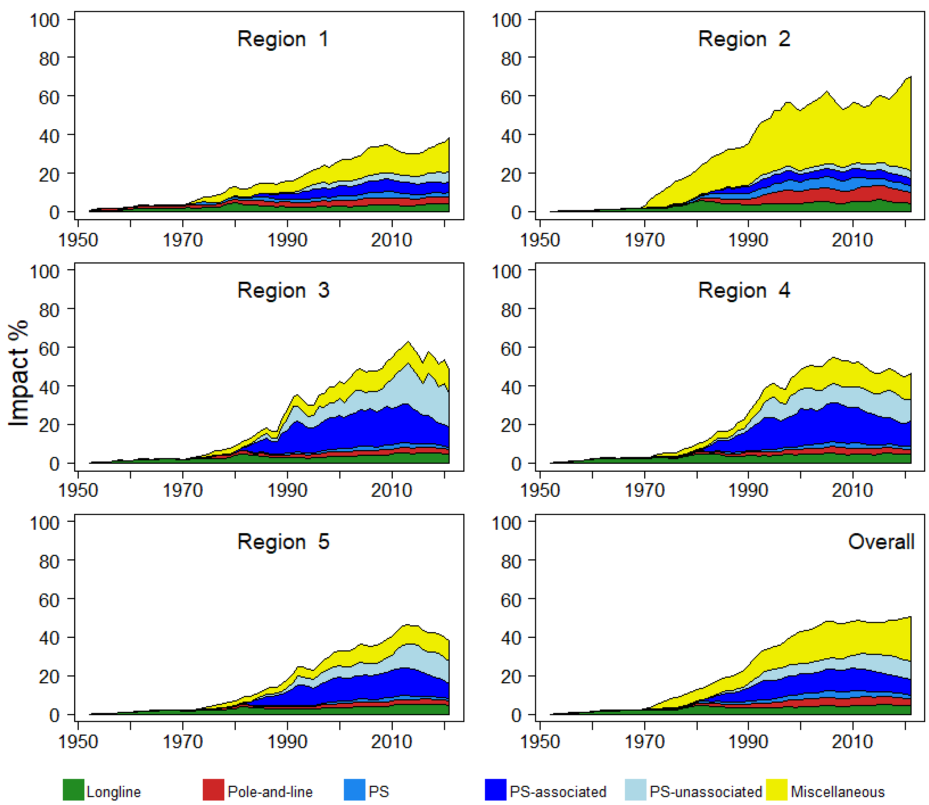


Figure YFT-07: Estimates of reduction in spawning potential due to fishing (Fishery Impact = $1-SB_t/SB_{t,F=0}$) by region, and over all regions (lower right panel), attributed to various fishery groups for the diagnostic model (Figure 65 from SC19-SA-WP-04). (request to overlay MSY for final report in both bigeye and yellowfin tuna – as a separate figure)

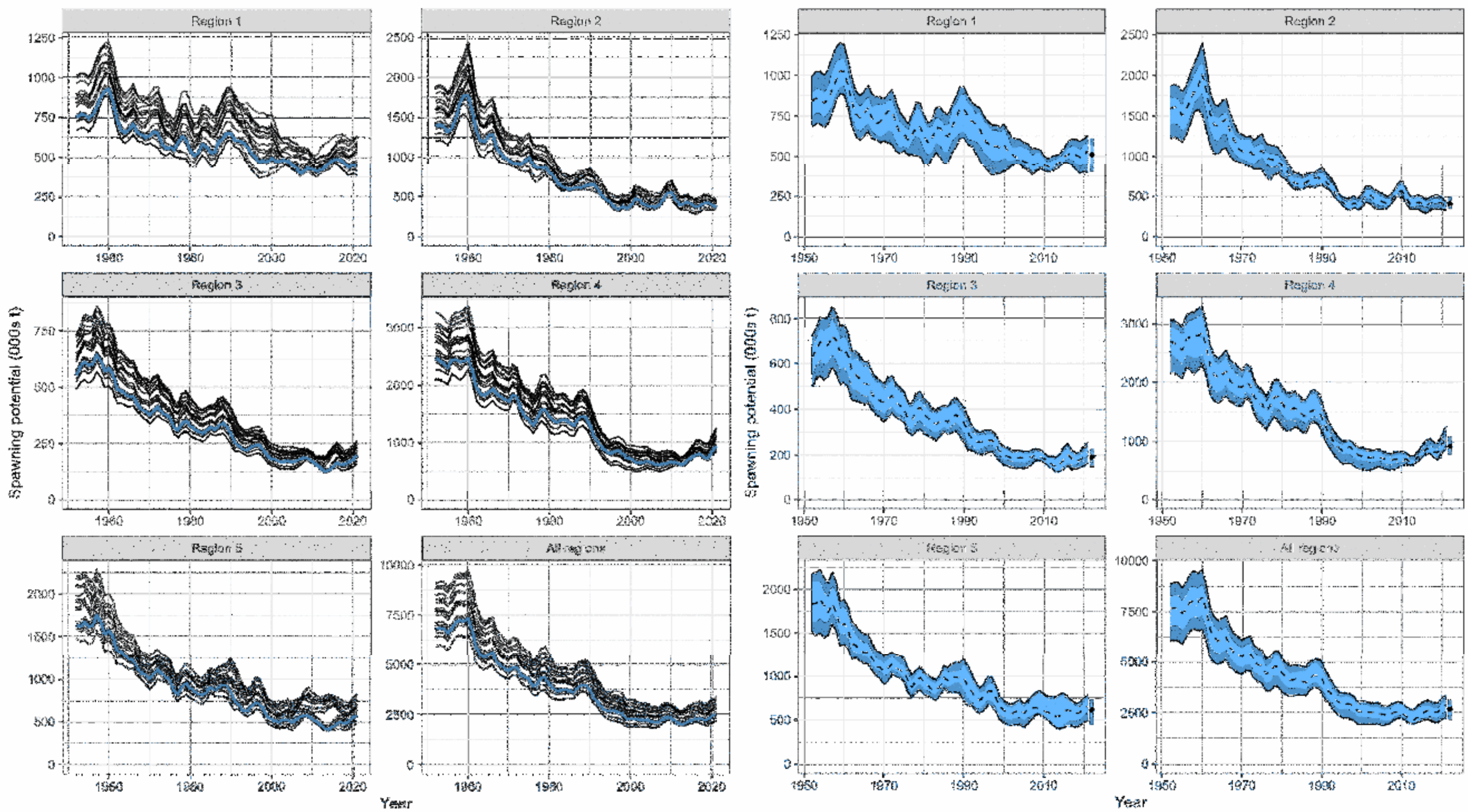
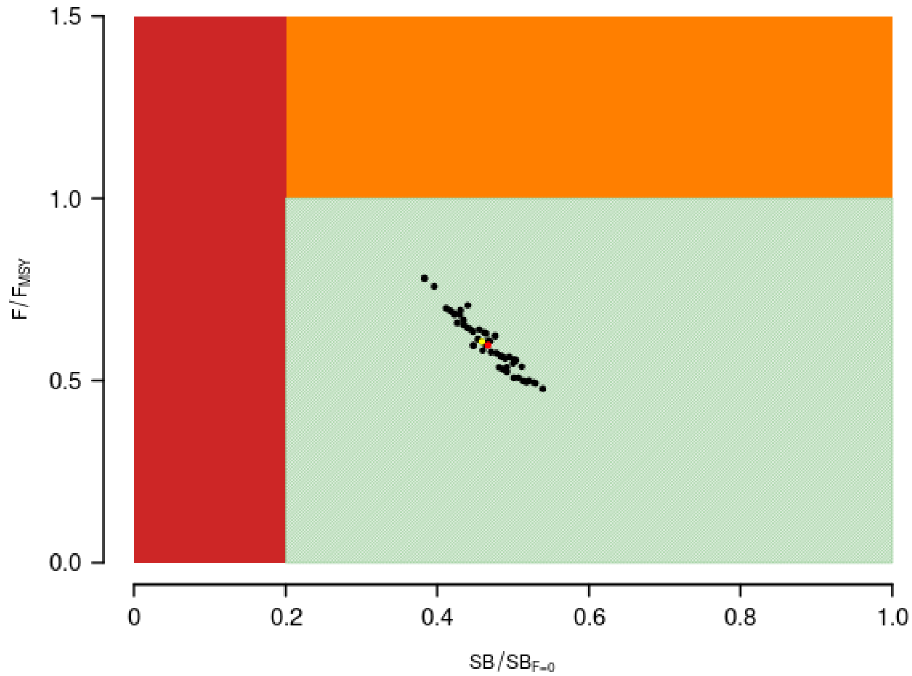


Figure YFT-08: (Left) Trajectories of spawning potential for the individual model runs included in the structural uncertainty grid over the period 1952-2021. (Right) Estimated spawning potential across all models in the structural uncertainty grid over the period 1952-2021. The dashed line represents the median, the lighter band shows the 25th and 75th percentiles, and the dark band shows the 10^{th} and 90^{th} percentiles of the model estimates. The bar at the right of each ribbon indicates the median (black dots) with the 10^{th} and 90^{th} percentiles for SB_{recent} (Figure 59 from SC19-SA-WP-04).



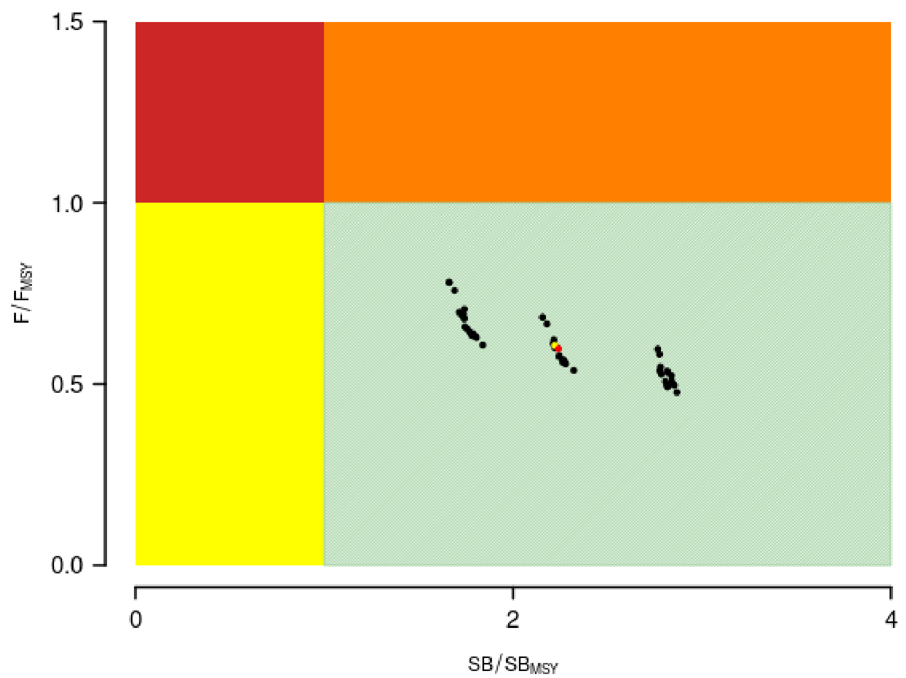


Figure YFT-09: Majuro plot (top) and Kobe plot (bottom) summarising the results for each of the models in the structural uncertainty grid for the recent period (2018-2021). The yellow point is the 2023 diagnostic model and the red point is the median (Figure 63 from SC19-SA-WP-04).

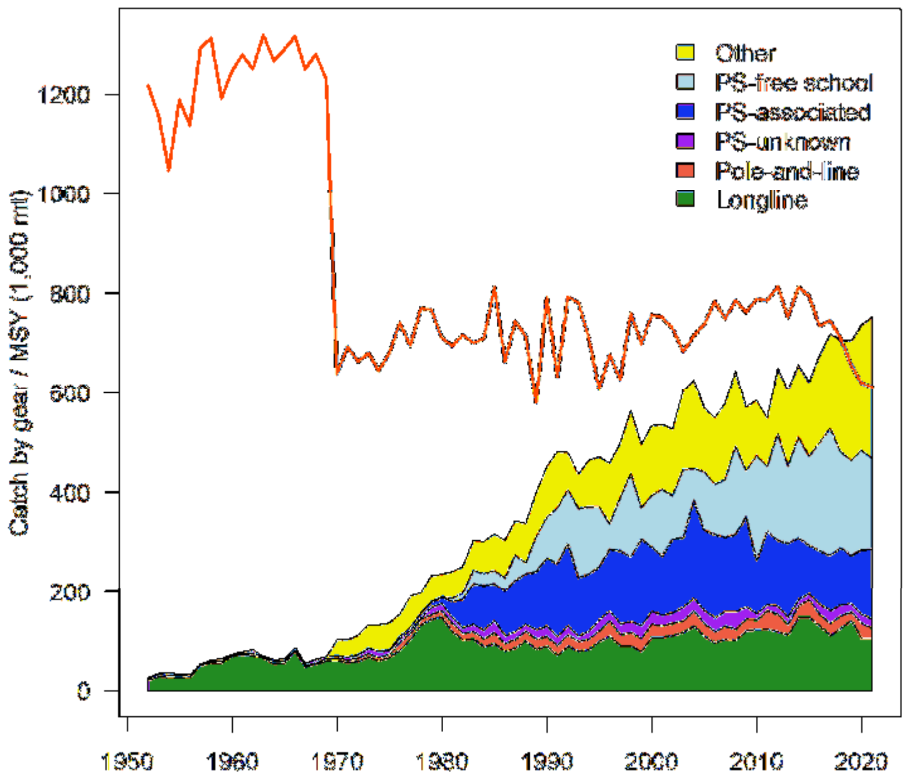


Figure YFT-10: History of the annual estimates of MSY (red line) for the diagnostic model compared with annual catch by the main gear types. Note that this is a 'dynamic' MSY.

b. Management advice and implications

35. The WCPO yellowfin tuna spawning biomass is above the LRP and recent F is below F_{MSY} based on the uncertainty grid, The stock is not experiencing overfishing (100% probability $F<F_{MSY}$) and is not in an overfished condition (0% probability $SB/SB_{F=0}<LRP$).

36. The objective for yellowfin tuna in CMM 2021-01 (the Tropical Tuna Measure) to maintain the spawning biomass depletion ratio at or above the average $SB/SB_{F=0}$ for 2012-2015 is being achieved. $SB_{recent}/SB_{F=0}$ (47%) exceeds the average $SB/SB_{F=0}$ for 2012-2015 (44% calculated across the unweighted grid).

37. SC19 recommends stochastic projections based on the adopted yellowfin tuna grid be undertaken by the SSP and provided to the Commission for their consideration**.**

38. The interim objective of yellowfin tuna stock under CMM 2022-01 is to maintain the depletion level of the stock at or above the average $SB/SB_{F=0}$ for 2012-2015 and the recent depletion level of yellowfin tuna is close to the interim objective. SC19 noted that while the projection results based on the 2023 yellowfin tuna assessment were not available for SC19 to review, this information will be available when for the 4th tropical tuna management workshop and will provide the Commission guidance on future expected levels of fishing mortality and the outcomes relative to the interim or future management objectives.

39. SC19 also noted a continuous downward trend in spawning potential ratio over the recent decade in Region 2 in the westernmost equatorial region, mainly due to the miscellaneous gear fisheries within this

region, whereas other regions have been relatively stable over this period. This is the impact of artisanal (small-scale) fisheries other than longline and purse seine within this region. **SC19 recommends that the Commission note the need for clear limits for these.**

40. SC19 also noted that there is evidence that the overall stock status is buffered with spawning biomass kept at a more elevated level overall by low exploitation in the temperate regions (1 and 5). The assessment model estimates spawning biomass to be divided between the tropical (59%) and temperate (41%) regions, but the vast majority of catch occurred in the tropical (94%) region.

c. Research recommendations

41. SC19 noted several research recommendations for the further development and improvement of the WCPO yellowfin tuna assessment:

a) Exploration into the conflict between the length and weight composition data; if unresolved this conflict should be reflected within future structural uncertainty grids;
b) Exploration of a simplification of the spatial structure by using a single area, with "areas-as-fleets";
c) Exploration of alternative approaches to modeling of tagging data, including consideration of the most appropriate mixing periods for different regions and development of stand-alone tagging (mark-recapture) models;
d) Exploration of which parameters are most sensitive to initial model starting values, and taking steps to reduce the impact of starting values on the results in future assessments; this could include simplification of models and/or systematic use of jittering;
e) Further research to improve estimates of catches (both historical and recent) in the fisheries of Indonesia, the Philippines and Vietnam through the continued funding of the WPEA monitoring project;
f) An exploration of seasonal and regional growth traits for the stock assessment;
g) A study on longline CPUE standardization process considering effort creep; and
h) Developing alternative CPUE scenarios with different implied regional weightings.

4.3.2 WCPO bigeye tuna (*Thunnus obesus*)

4.3.2.1 Research and information

a. Review of 2023 bigeye tuna stock assessment

42. J. Day (SPC-OFP) presented SC19-SA-WP-05 (*Stock assessment of bigeye tuna in* the *western and central Pacific Ocean*), which described the 2023 stock assessment of bigeye tuna *Thunnus obesus* in the WCPO.

43. SC19 thanked the SSP for the thorough work conducted on the WCPO bigeye stock assessment and for the considerable efforts to improve the assessment and to incorporate the recommendations from SC18 and the 2022 yellowfin tuna peer review.

44. SC19 noted that the 2023 bigeye stock assessment applied a more rigorous approach, including randomized initial parameter analyses, i.e., "jittering" and achieving a positive definite Hessians in the diagnostic model, however, model instability appears to remain.

45. SC19 noted that the changes in the modelling of bigeye tuna stock in the WCPO indicate that the assessment results are slightly less optimistic than the 2020 assessment.

46. SC19 accepted the 2023 WCPO bigeye tuna stock assessment with a 9-region spatial structure (Figure BET-01) and adopted the full unweighted grid in Table BET-01 to provide stock status and management advice, however, future projection results were not provided at SC19. **SC19 recommended that those stock projection analyses to be provided for the Commission consideration for management advice prior to the Commission meeting.**

47. Given the similarity in stock status as presented to SC16, some CCMs preferred to re-iterate the advice from SC16 that WCPFC20 could continue to consider measures to reduce fishing mortality from fisheries that take juveniles, with the goal to increase adult bigeye fishery yields and reduce any further impacts on the spawning biomass for this stock. Other CCMs considered that this advice was unclear and had previously been misinterpreted, noting that the SC had previously agreed not to advise the Commission to take measures to reduce mortality in fisheries that take juvenile bigeye tuna. The aforementioned CCMs did not share this observation.

4.3.2.2 Provision of scientific information

a. Stock status and trends

48. The 2023 WCPO bigeye tuna assessment provides stock status based upon a 54-model structural uncertainty grid with four axes: steepness with three levels, tag mixing period with two levels, and size and age composition data with three levels each, as illustrated in Table BET-01. **SC19 recommended that the proposed axes of uncertainty be accepted and that all models should be weighted equally**. The SC19 noted that an important improvement in the structural uncertainty grid was the inclusion of estimation uncertainty for each of the models in the grid.

49. SC19 noted that the most influential axes of uncertainty in the grid were steepness and tag mixing period.

50. The spatial structure used in the 2023 stock assessment is shown in Figure BET-01. Time series of total annual catch by fishing gear over the full assessment period is shown in Figure BET-02. The time series of total annual catch by fishing gear and assessment region is shown in Figure BET-03. Estimated annual spawning potential, average recruitment, and total biomass by model region is shown in Figure BET-04. Estimated trend in spawning biomass depletion ($SB/SB_{F=0}$) for the 54 models in the structural uncertainty grid is shown in Figure BET-05, and juvenile and adult fishing mortality rates from the diagnostic model is shown in Figure BET-06. Estimates of the reduction in spawning potential due to fishing by region are shown in Figure BET-07. A comparison of the dynamic MSY for the diagnostic model compared with annual catch by the main gear types are shown in Figure BET-08, and estimated age specific fishing mortality for the diagnostic model, by region and overall are in Figure BET-09.

51. SC19 noted that the preliminary estimate of total catch of WCPO bigeye tuna for 2022 was 140,664 mt which was similar to the 2021 level. Longline catch in 2022 (54,800 mt) was similar to the 2021 catch and lower than the recent ten-year average and understood to be partly due to the impacts of the COVID-19 pandemic. Purse-seine catch in 2022 (62,811 mt) was also similar to the 2021 catch, and lower than the recent ten-year average (Figure BET-02).

52. The 2023 WCPO bigeye tuna stock assessment median depletion from the model grid for the recent period (2018-2021; $SB_{recent}/SB_{F=0}$) was 0.35 (10^{th} to 90^{th} percentile interval of 0.30 to 0.40, including estimation and structural uncertainty, Table BET-02). For all models in the grid $SB_{recent}/SB_{F=0}$ was above the biomass limit reference point. The recent median fishing mortality (2017-2020; F_{recent}/F_{MSY}) was 0.59 (10^{th} to 90^{th} percentile interval of 0.46 to 0.74, including estimation and structural uncertainty, Table BET-02). For all models in the grid, F/F_{MSY} was less than one.

53. SC19 noted that the results show that the both total and spawning potential has been continuously declining since the late 1950s through until the mid-1970's, followed by a more gradual decline through to the present (Figure BET-04).

54. SC19 noted that the catch in the last year of the assessment (2021) was less than the median MSY (164,640 mt), which is a 17% increase in the estimated MSY for bigeye tuna from the 2020 stock assessment (140,720 mt).

55. Majuro (Figure BET-10) and Kobe (Figure BET-11) plots show that the stock status estimates across the 54 models are all within plot zones that indicate that the stock is not overfished nor undergoing overfishing.

Table BET-01. Description of the updated structural sensitivity grid used to characterize uncertainty in the assessment.

Axis	Value 1	Value 2	Value 3
Steepness	0.65	0.8	0.95
Tag mixing (# quarters)	1	2	
Size data weighting divisor	10	20	40
Age data weighting	0.5	0.75	1

Table BET-02. Summary of reference points over the 54 models in the structural uncertainty grid. Note that "recent" is the average over the period 2018-2021 for SB and fishing mortality, while "latest" is 2021. The values of the upper 90th and lower 10th percentiles of the empirical distributions are also shown. F_{mult} is the multiplier of recent (2018-2021) fishing mortality required to produce MSY.

	Mean	Median	Minimum	10th percentile	90th percentile	Maximum
C_{latest}	139,314	139,199	138,527	138,947	139,939	140,347
$Y_{Frecent}$	37,982	37,805	33,400	34,365	42,369	42,980
F_{MSY}	0.06	0.06	0.04	0.04	0.07	0.08
F_{mult}	1.69	1.67	2.27	2.17	1.35	1.22
MSY	162,248	164,640	137,920	143,112	180,820	184,440
F_{recent}/F_{MSY}	0.59	0.59	0.37	0.46	0.74	0.99
$SB_{F=0}$	1,952,050	1,921,715	1460,378	1,612,630	2,356,598	2,561,690
SB_{MSY}	393,037	376,300	225,100	277,230	534,330	595,900
$SB_{MSY}/SB_{F=0}$	0.20	0.20	0.15	0.17	0.23	0.24
$SB_{latest}/SB_{F=0}$	0.34	0.34	0.27	0.30	0.38	0.40
SB_{latest}/SB_{MSY}	1.76	1.77	1.16	1.28	2.31	2.46
$SB_{recent}/SB_{F=0}$	0.35	0.35	0.28	0.31	0.40	0.41
SB_{recent}/SB_{MSY}	1.82	1.83	1.20	1.32	2.38	2.54
Including estimation uncertainty						
	Mean	median	min	10%ile	90%ile	max
$SB_{recent}/SB_{F=0}$	0.35	0.35	0.25	0.30	0.40	0.46
F_{recent}/F_{MSY}	0.59	0.59	0.37	0.46	0.74	0.99
SB_{recent}/SB_{MSY}	1.82	1.79	0.94	1.32	2.41	2.96

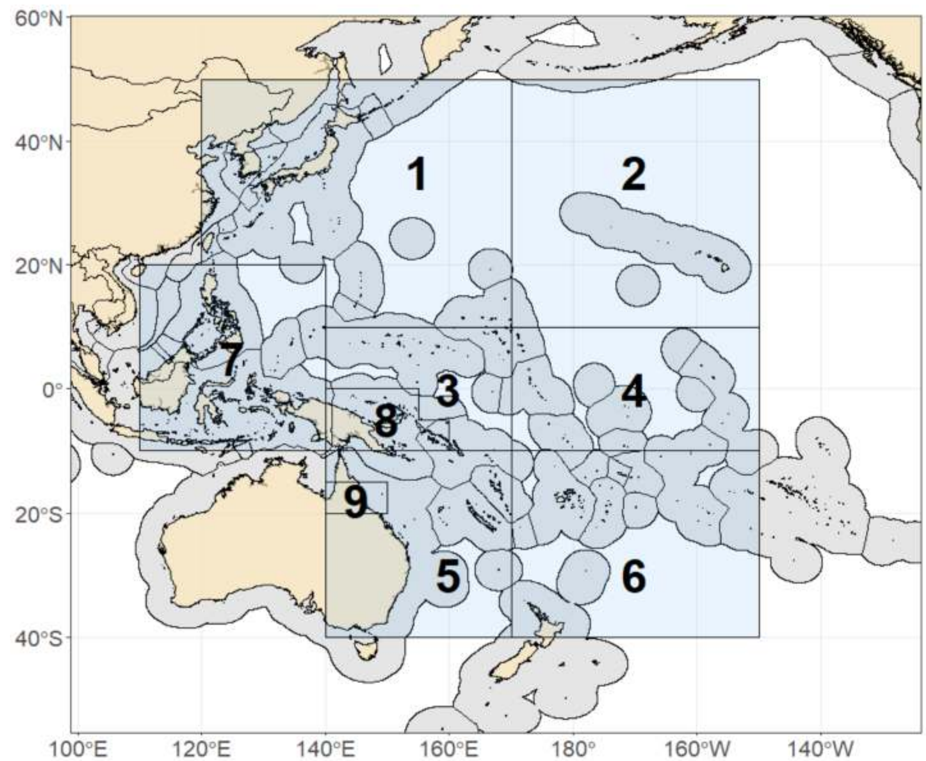


Figure BET-01. Spatial structure for the 2023 bigeye tuna stock assessment.

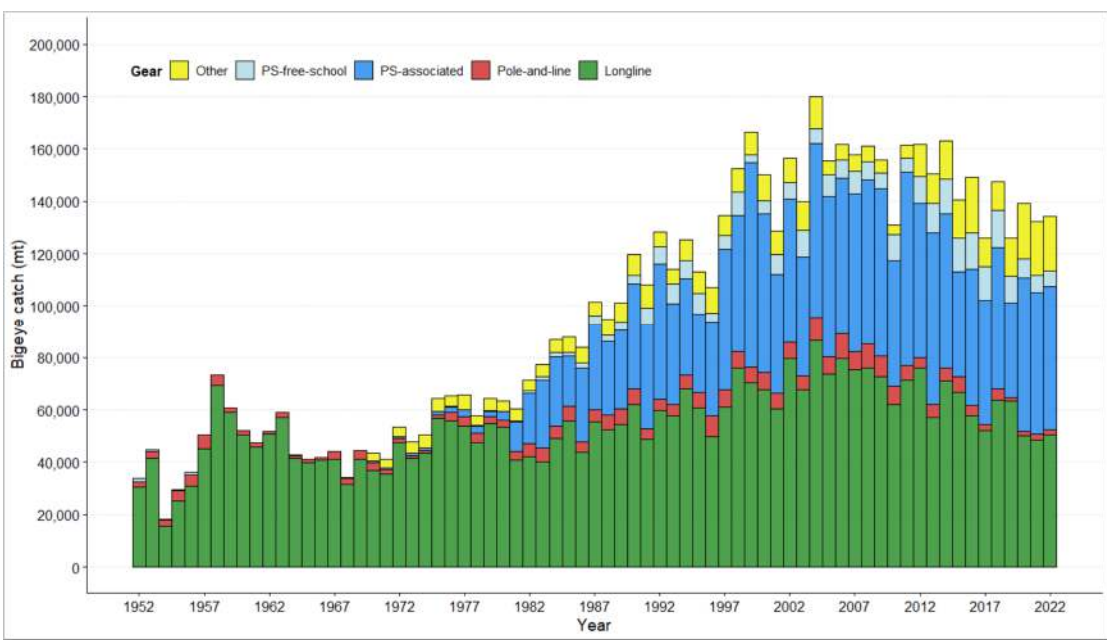


Figure BET-02. Time series of total annual catch (1000s mt) by fishing gear for the diagnostic model over the full assessment period. The different colors refer to longline (green), pole-and-line (red), purse seine (blue), purse seine associated (dark blue), purse seine unassociated (light blue), miscellaneous (yellow), and index (gray). Note that the catch by longline gear has been converted into catch-in-weight from catch-in-numbers and so may differ from the annual catch estimates presented in (Williams et al., 2023), however these catches enter the model as catch-in-numbers.

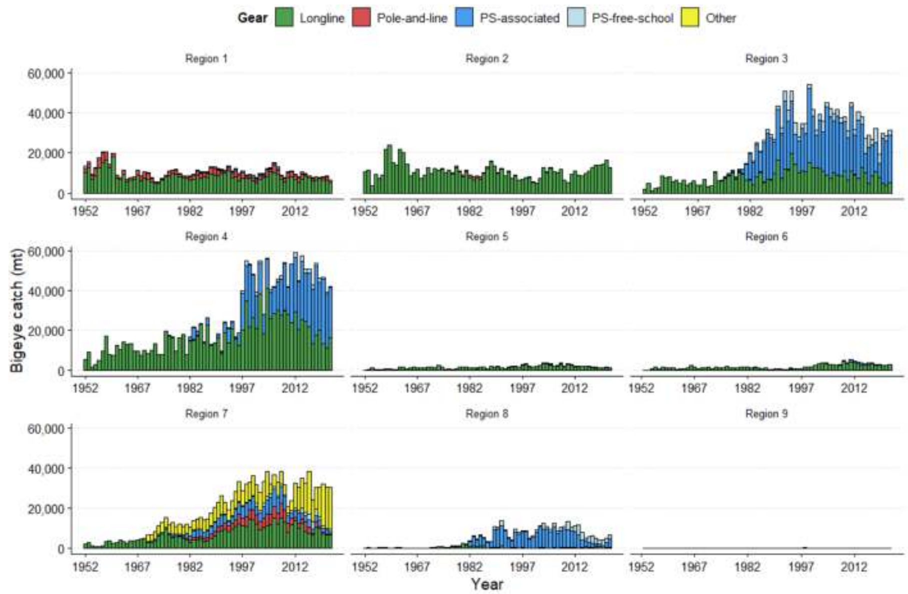


Figure BET-03. Annual catches of bigeye by gear type for each of the nine model regions

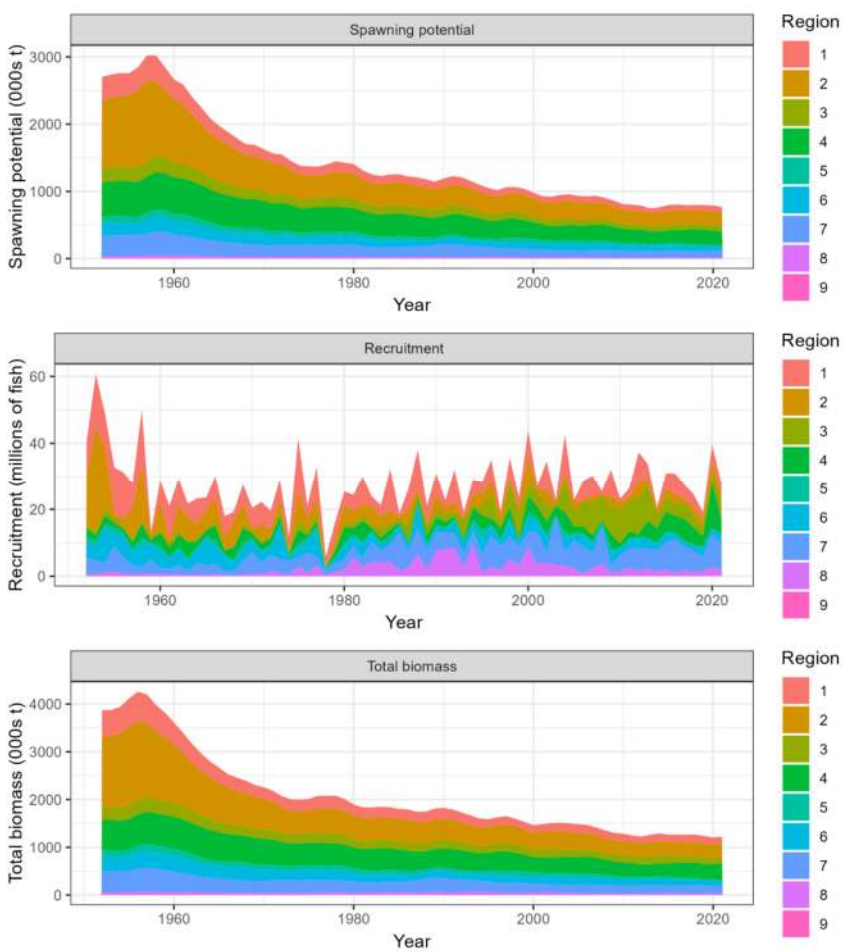


Figure BET-04. Estimated (a) spawning potential, (b) annual average recruitment and (c) total biomass by model region for the diagnostic model, showing the relative sizes among regions.

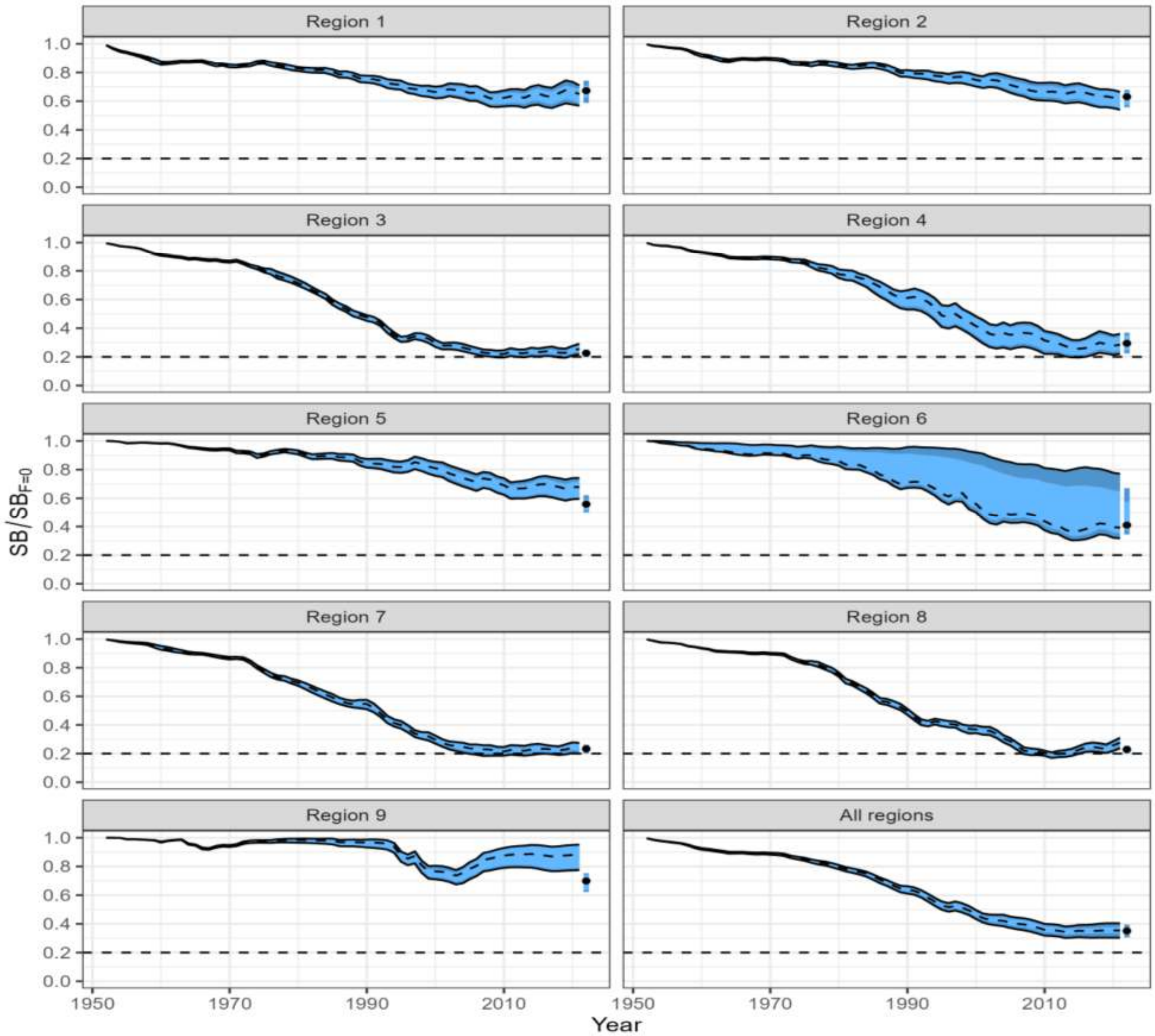


Figure BET-05. Estimated spawning depletion across all models in the structural uncertainty grid over the period 1952-2021. The dashed line represents the median. The lighter band shows the 50th percentile, and the dark band shows the 80th percentile of the model estimates. The bar at the right of each ribbon indicates the median (black dots) and 80th percentile range for $SB_{recent}/SB_{F=0}$.

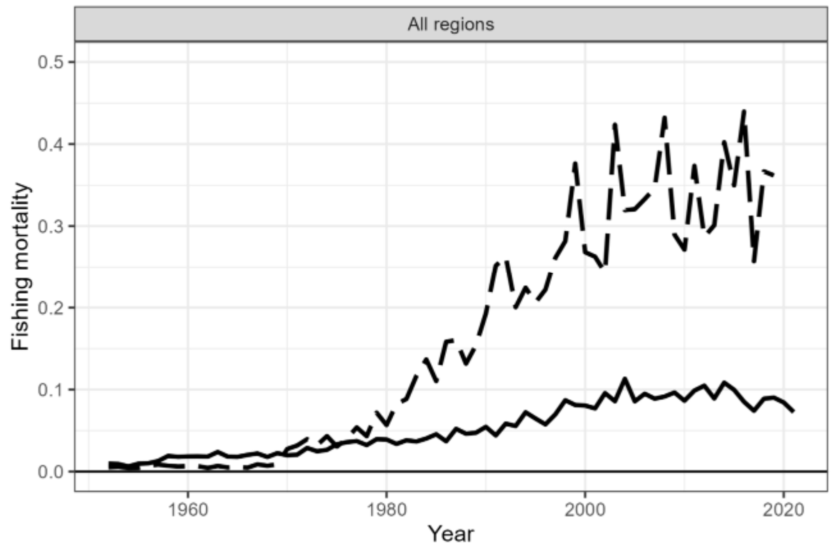


Figure BET-06. Estimated annual average adult (solid line) and juvenile (dashed line) fishing mortality for the 2023 diagnostic model.

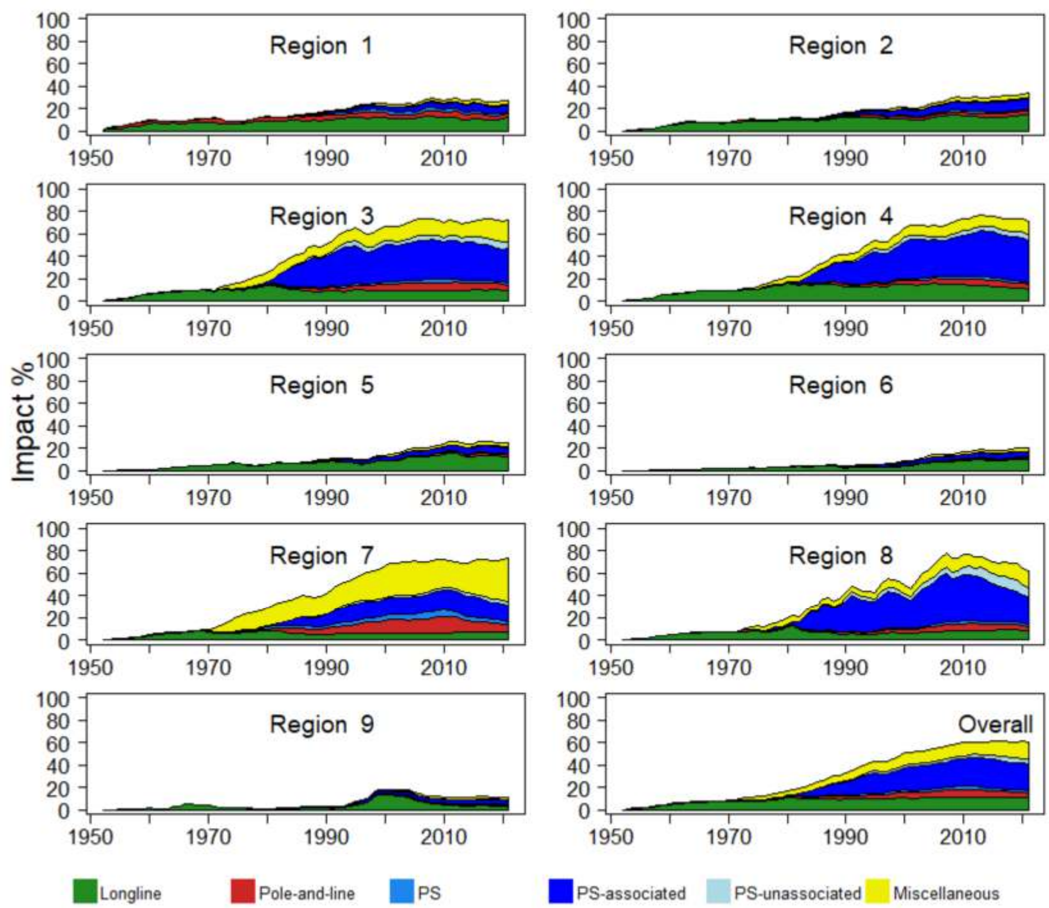


Figure BET-07. Estimates of reduction in spawning potential due to fishing (fishery impact = $(1-SB_t/SB_{t,F=0}) * 100\%$) by region, and over all regions (lower right panel), attributed to various fishery groups for the 2023 diagnostic model.

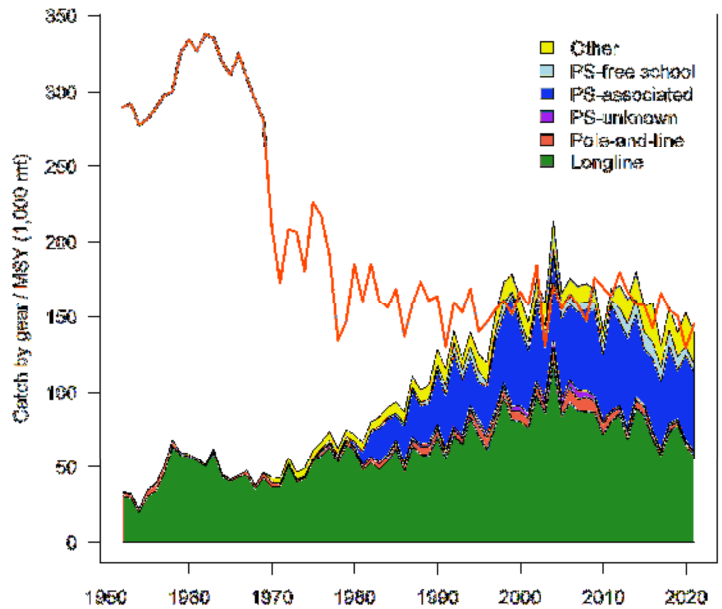


Figure BET-08. History of the annual estimates of MSY (red line) for the diagnostic model compared with annual catch by the main gear types. Note that this is a 'dynamic' MSY.

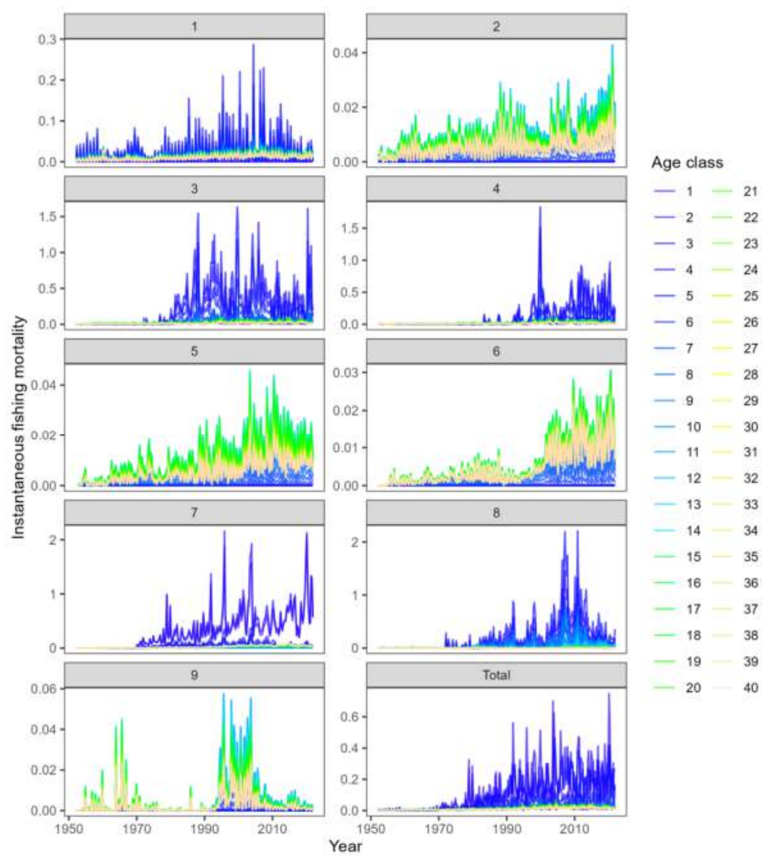


Figure BET-09 Estimated age specific fishing mortality for the diagnostic model, by region and overall.

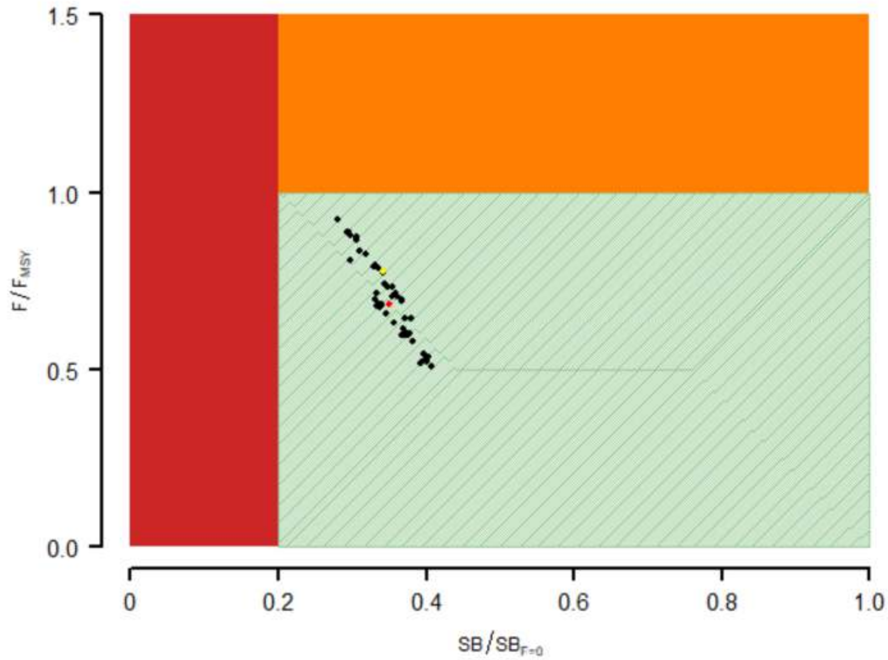


Figure BET-10. Majuro plot for the recent spawning potential (2018–2021) summarizing the results for each of the models in the structural uncertainty grid. The plots represent estimates of stock status in terms of spawning biomass depletion and fishing mortality. The yellow point is the 2023 diagnostic model and red point is the median.

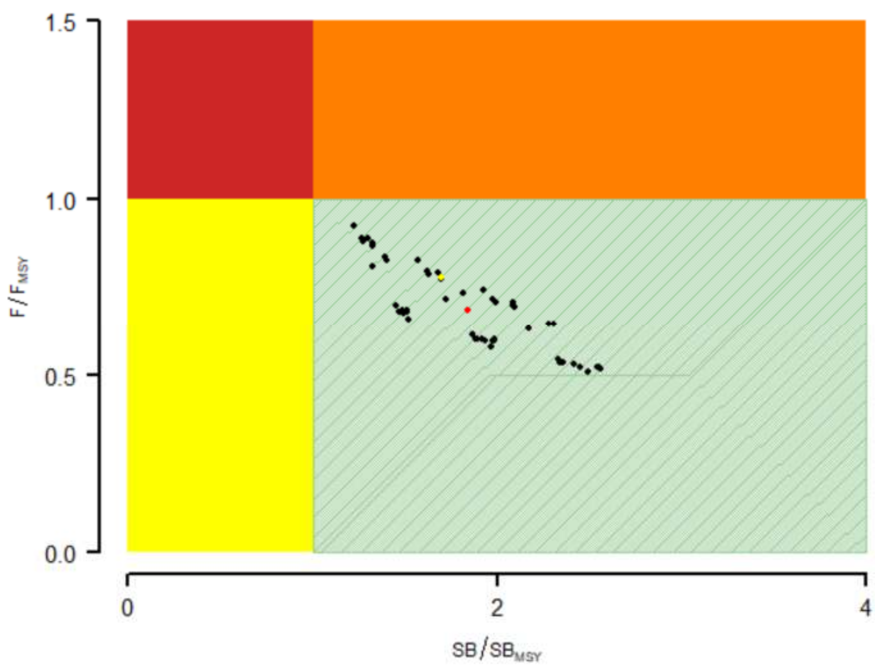


Figure BET-11. Kobe plot for the recent spawning potential (2018–2021) summarizing the results for each of the models in the structural uncertainty grid. The plots represent estimates of stock status in terms of spawning biomass depletion and fishing mortality. The yellow point is the 2023 diagnostic model and red point is the median.

b. Management advice and implications

56. The objective for bigeye tuna in CMM 2021-01 (the Tropical Tuna Measure) – to maintain the spawning biomass depletion ratio at or above the average $SB/SB_{F=0}$ for 2012-2015 – is being achieved. $SB_{recent}/SB_{F=0}$ (35%) is very close to the average $SB/SB_{F=0}$ for 2012-2015 (34%) calculated across the unweighted grid.

57. The WCPO bigeye tuna spawning biomass is above the biomass LRP, and recent F is below F_{MSY} based on the uncertainty grid. The stock is very likely not experiencing overfishing (100% probability $F<F_{MSY}$) and is not in an overfished condition (0% probability $SB/SB_{F=0}<LRP$).

58. SC19 also noted that average fishing mortality rates for juvenile and adult age-classes have increased throughout the period of the assessment (Figure BET-8), although more so for juvenile which have experienced considerably higher annual fishing mortality than adults (Figure BET-6). The purse-seine associated fishery has the most impact, with that of the miscellaneous and longline fisheries also notable (Figure BET-7). Higher fishing mortality rates on juvenile bigeye tuna reduces the realized yield per recruit for the bigeye fishery.

59. SC19 noted that levels of fishing mortality and depletion differ among regions, and that fishery impact was higher in the tropical regions (Regions 3, 4, 7 and 8 in the stock assessment model), with particularly high fishing mortality on juvenile bigeye tuna in these regions.

60. There is also evidence that the overall stock status is buffered with biomass and low exploitation in the temperate region (1, 2, 6 and 9) and most of the predicted movement is within the equatorial region. Exchange rates between temperate and tropical regions are estimated to be low.

61. SC19 noted that the reduction of fishing mortality on fisheries that take juveniles could increase bigeye fishery yields and reduce any further impacts on spawning biomass of this stock. SC19 also noted that this could require considering the impact to other fisheries and stocks.

62. The interim objective of bigeye tuna stock under CMM 2021-01 is to maintain the depletion level of the stock at or above the average $SB/SB_{F=0}$ for 2012-2015. The recent depletion level of bigeye tuna is close to this interim objective. SC19 noted that while the projection results based on the 2023 bigeye tuna assessment were not available for SC19 to review, this information will be available when for the 4th tropical tuna management workshop and will provide the Commission guidance on future expected levels of fishing mortality and the outcomes relative to the interim or future management objectives.

c. Research Recommendations

63. SC19 adopted several research recommendations for the further development and improvement of the WCPO bigeye tuna stock assessment, and suggested these be considered for potential inclusion in the Tuna Assessment Research Plan (TARP):

1) Continued collection of more representative biological data (e.g., age) and tagging data.
2) Develop additional CPUE index series testing key uncertainties about the analysis (e.g., regional vs. global model, classification of catchability vs. abundance covariates, etc.) and explore those as one-off sensitivities to the stock assessment.
3) Consideration of options to account for effort creep in CPUE standardization and/or the assessment model.
4) Simulation study to explore appropriate spatial structure of the stock assessment with a focus on simplifying the spatial structure (e.g., areas-as-fleets and/or 6 region structure) given the estimates of limited movement rates among regions.

5) Investigation of the 2023 model specifications leading to the exacerbated increase in unfished SSB over time for the tropical regions (3, 4, 7 and 8) compared to the 2020 stock assessment.
6) Yield per recruit analyses comparing fishery sectors with different selectivity patterns.
7) Evaluation of the variability and plausibility of estimated growth and mortality-at-age relationship across the structural uncertainty grid.
8) Additional one-off sensitivities exploring key uncertainties in biological assumptions, model specification, and data inputs (e.g., tag mixing, data weighting, and growth).
9) Identification of key parameters that are either highly correlated or highly sensitive to the jittering procedure to inform possible changes in model specification with the aim to decrease model complexity and/or sensitivity to starting conditions.
10) Exploration of seasonal and regional growth traits for the stock assessment.
11) Comprehensive review of the representativeness of the size composition data given conflicts identified in the likelihood profiles.
12) Investigation of the 2023 model specifications that lead to the inversion of the effect of the weight vs. tagging data signal on the total biomass, as shown in the likelihood profile.
13) Further exploration of the advantages and disadvantages of strategies to decrease model sensitivity to starting conditions, including but not limited to multi-start approaches.
14) Pursue development of tag mixing diagnostics and approaches, and investigate the impacts of tag mixing assumptions.

4.3.3 WCPO skipjack tuna (*Katsuwonus pelamis*)

4.3.3.1 Research and information

a. Indicator analysis

64. S. Hare (SPC) presented SC19-SA-WP-06, "A compendium of fisheries indicators for target tuna stocks in the WCPFC Convention Area" providing empirical information on recent patterns in skipjack fisheries.

65. SC19 thanked the SSP for conducting an indicator analysis providing empirical information on recent patterns in skipjack fisheries.

b. Update of skipjack tuna stock assessment information

66. C. Castillo-Jordan presented SC19-SA-WP-07 (*Follow up work on 2022 skipjack assessment recommendations*).

67. SC19 thanked the SSP for their efforts on improving the skipjack diagnostic model and achieving a positive definite Hessian. The follow up work on the model provides a sound basis for future assessments.

68. SC19 noted the results of SPC's work investigating technical issues highlighted by SC18 regarding the 2022 skipjack diagnostic model.

69. SC19 noted that the resulting updates to the diagnostic model for the WCPO skipjack assessment had negligible effect on the stock status and management advice from 2022.

70. SC19 emphasized that while the updates had not resulted in changes to stock status, some estimated quantities differed between the 2022 and 2023 version, most notably the growth curve, the mortality-at-age and the selectivity-at-age, noting these relationships are interrelated. SC19 encouraged further investigation to understand these changes.

71. SC19 noted that this process for allowing staff resources to conduct follow-up is useful one that could be conducted for other WCPFC assessments, with continued dialogue between the SSP assessment team and SC in the intervening years between assessments to address concerns and lay the groundwork for the subsequent assessment. The SSP noted that this was possible this year because staff resources were available. This is not the case every year due to changes in experience and availability of staff resources. Follow-up work suggested by SC should be prioritised under the TARP process.

72. SC19 encouraged that this process become standard practice for WCPO tuna stock assessments. Noting that follow-up work is subject to available staff resources and should be prioritised as part of the TARP process.

73. SC19 noted the following issues for further improvements:
  a) Improve fits to the length composition data.
  b) Estimation of tag reporting rates.
  c) Alternative spatial structure.
  d) Unrealistic recruitment estimates particularly in temperate regions.
  e) Model jittering diagnostic to confirm convergence stability.

4.3.4 South Pacific albacore tuna (*Thunnus alalunga*)

4.3.4.1 Research and information

a. Indicator analysis

74. S. Hare (SPC-OFP) presented SC19-SA-WP-06 (*A compendium of fisheries indicators for target tuna stocks in the WCPFC Convention Area*).

75. SC19 thanked the SSP for the indicator analysis providing empirical information on recent patterns South Pacific albacore fisheries.

76. SC19 noted that the South Pacific albacore catch in the WCPFC-CA was 68,975t in 2022, a 39% increase from 2021 and a 4% increase from the 2017-2021 average.

77. Some CCMs recommended to keep the current catch levels in mind when discussing the South Pacific albacore TRP.

78. **SC19 recommended that the 2024 assessment of South Pacific albacore be South Pacific-**wide. Noting the need to provide management advice specifically for the WCPFC-CA and the ongoing developments relating to the Harvest Strategy process, **if a fleets-as-areas approach is considered for the 2024 assessment, SC19 recommends retaining a separate area for the IATTC**. SC19 noted that a WCFPC-CA only model might also be considered as a one-off sensitivity analysis. **If results from the one-off sensitivity analysis for the WCPFC-CA-only model are different from the WCPFC-CA results from the Pacific-wide model, additional analyses should be conducted with a view to understanding which spatial structure is more reliable when considering future assessment development.**

4.4 Northern stocks

4.4.1 North Pacific albacore (*Thunnus alalunga*)

4.4.1.1 Research and Information

a. North Pacific albacore stock assessment

79. S. Teo (ISC) presented SC19-SA-WP-08 (*Stock assessment of albacore tuna in* the *North Pacific Ocean*), which detailed the data, biological parameters, model, model diagnostics and sensitivities, and results of the North Pacific albacore stock assessment conducted by ISC's Albacore Working Group (ISC ALBWG) in 2023.

80. SC19 thanked ISC ALBWG for their work conducted on the albacore tuna stock assessment in the North Pacific Ocean.

4.4.1.2 Provision of scientific information

a. Stock status and trends

81. SC19 noted that the ISC provided the following conclusions on the stock status of North Pacific albacore:

1) Estimated summary biomass (males and females at age-1+) declined at the beginning of the time series until 2004 (Figure NPALB-1A). Subsequently, the summary biomass fluctuated without a trend until 2018, after which the biomass rapidly increased to historically high levels. It should be noted that the high summary biomass estimates during 2018 – 2021 were highly uncertain and should be treated with caution (Figure NPALB-1A). These high summary biomass estimates were due to historically high recruitment estimates in 2017 (~433 million fish; 95% CI: 194 – 671 million fish) (Figure NPALB-1C). However, it should be noted that the recruitment estimates in the last 5 years (2017- 2021) were highly uncertain and should be treated with caution. Estimated female SSB exhibited a similar population trend to the summary biomass, albeit with a lag of several years, and showed an initial decline until 2007 followed by fluctuations without a clear trend through 2021 (Figure NPALB-1B).
2) The average fishing intensity during 2018 – 2020 was estimated to be $F59_{\%SPR}$ (95% CI: $F72_{\%SPR}$ – $F46_{\%SPR}$), which was relatively moderate and resulted in a population with an SPR of approximately 59%. Instantaneous fishing mortality at age (F-at-age) was similar in both sexes through age-5, peaking at age-4 and declining to a low at age-6, after which males experienced higher F-at-age than females up to age 12 (Figure NPALB-2). Juvenile albacore aged 2 to 4 years comprised approximately 64% of the annual catch-at-age in numbers between 1994 and 2021 (Figure NPALB-3) due to the larger fishery impact of surface fisheries (primarily troll, pole-and-line), which remove juvenile fish, relative to longline fisheries, which primarily remove adult fish (Figure NPALB-4).
3) Stock status is depicted in relation to the target ($F45_{\%SPR}$,), threshold ($30\%SSB_{current,\ F=0}$), and limit ($14\%SSB_{current,\ F=0}$) reference points (Figure NPALB-5A; Table NPALB-1). The estimated female SSB has never fallen below the threshold and limit reference points since 1994, albeit with large uncertainty in the terminal year (2021) estimates. However, the estimated fishing intensity for five years (1999, 2002, 2003, 2004, and 2007) have exceeded the target reference point. Even when alternative hypotheses about key model uncertainties such as growth were evaluated, the point estimate of female SSB in 2021 (SSB_{2021}) did not fall below the threshold and limit reference points, although the risk increases with this more extreme assumption (Figure NPALB-5B). However, estimated average fishing intensity during 2018-2020 ($F_{2018-2020}$) did exceed the target reference point under one of these alternative hypotheses but did not exceed the average fishing intensity during 2002 – 2004 (Figure NPALB-5B; Table NPALB-1).
4) The SSB_{2021} was estimated to be approximately 54% (95% CI: 40 – 68%) of $SSB_{current,\ F=0}$ and

1.8 (95% CI: 1.3 – 2.3) times greater than the estimated threshold reference point (Figure NPALB-6A and Table NPALB-1). The estimated current fishing intensity ($F_{2018-2020}$) was estimated to be $F59_{\%SPR}$ (95% CI: $F72_{\%SPR}$ – $F46_{\%SPR}$) and was lower than both the $F45_{\%SPR}$ target reference point and the average fishing intensity during 2002 – 2004 (Figure NPALB-6B and Table NPALB-1).

82. SC19 noted the following stock status from ISC:
1) The stock is likely not overfished relative to the threshold ($30\%SSB_{current,\ F=0}$) and limit ($14\%SSB_{current,\ F=0}$) reference points adopted by the WCPFC and IATTC, and
2) The stock is likely not experiencing overfishing relative to the adopted target reference point ($F45_{\%SPR}$).
3) Current fishing intensity (F2018-2020) is lower than the fishing intensity from the 2002-2004 period (the reference level for IATTC Resolution C-05-02 and WCPFC CMM 2019-03).

b. Management advice and implications

83. SC19 noted the following conservation information from the ISC:
1) Two harvest scenarios were projected to evaluate impacts on the management objectives of IATTC and WCPFC for this stock: 1) maintain SSB above the limit reference point, with a probability of at least 80% over the next 10 years; 2) maintain depletion of total biomass around historical (2006—2015) average depletion over the next 10 years; and 3) maintain fishing intensity at or below the target reference point with a probability of at least 50% over the next 10 years (WCPFC HS 2022-01; IATTC Resolution C-22-04).
2) The constant fishing intensity scenario showed that the current fishing intensity ($F_{2018-2020}$) is expected to result in female SSB increasing to 90,098 t (95% CI: 23,218—156,978t) and an $SSB/SSB_{current,F=0}$ ratio of 0.54 by 2031. Over the next 10 years, there was: 1) a 97.7% probability of the female SSB remaining above the $14\%SSB_{current,\ F=0}$ LRP for all 10 years; 2) a 72.0% probability of the total biomass (age-1+) being above the average of 2006 – 2015 for any year; and 3) a 95.5% probability of the fishing intensity remaining at or below the $F45_{\%SPR}$ TRP for any year (Figure NPALB-7).
3) The randomly resampled fishing intensity scenario showed that if future fishing intensity is similar to the 2005 – 2019 period, it is expected to result in female SSB increasing to 87,669 t (95% CI: 22,219 – 153,119 t) and a $SSB/SSB_{current,\ F=0}$ ratio of 0.52 by 2031. Over the next 10 years, there was: 1) a 98.1 % probability of the female SSB remaining above the $14\%SSB_{current,\ F=0}$ LRP for all 10 years; 2) a 69.5 % probability of the total biomass (age-1+) being above the average of 2006 – 2015 for any year; and 3) a 79.6 % probability of the fishing intensity remaining at or below the $F45_{\%SPR}$ TRP for any year (Figure NPALB-8).

84. Based on these findings, the following conservation information was provided by ISC:
1) If fishing intensity over the next ten years is maintained at the current fishing intensity ($F_{2018-2020}$), then female SSB is expected to remain around $54\%SSB_{current,\ F=0}$ (90,098 t), with a 97.7% probability of the female SSB remaining above the 14% $SSB_{current,\ F=0}$ LRP for all ten years, and the management objectives of IATTC and WCPFC will likely be met.
2) If fishing intensity over the next ten years is similar to the 2005-2019 period, then female SSB is expected to decrease to $52\%SSB_{current,\ F=0}$ (87,669 t), with a 98.1% probability of the female SSB remaining above the 14% $SSB_{current,\ F=0}$ LRP for all ten years, and the management objectives of IATTC and WCPFC will likely be met.

Table NPALB-1. Estimates of maximum sustainable yield (MSY), female spawning stock biomass (SSB), fishing intensity (F), and reference point ratios for north Pacific albacore tuna for: 1) the base case model; 2) two important sensitivity models due to uncertainty in growth parameters; and 3) a model representing an update of the 2020 base case model to 2023 data. SSB0, $SSB_{current,\ F=0}$ and SSB_{MSY} are the expected female SSB of a population in the equilibrium, unfished state; in the current, dynamic, unfished state; and at MSY, respectively. The Fs in this table are indicators of fishing intensity based on spawning potential ratio (SPR) and calculated as %SPR. SPR is the ratio of the equilibrium SSB per recruit that would result from the estimated F-at-age relative to that of an unfished population. Depletion is calculated as the proportion of the age-1+ biomass during the specified period relative to an unfished age-1+ equilibrium biomass. The model representing an update of the 2020 base case model is similar to but not identical to the 2020 base case model due to changes in data preparation and model structure.

* Model may not have converged and uncertainty estimates were unreliable because of the lack of a positive, definite Hessian matrix.

† A value of >1 for the depletion ratio indicates higher age-1+ biomass in 2021 relative to the 2006 –2015 period.

§ Higher %SPR values indicate lower fishing intensity levels.

¶ Values of >1 for ratios of $F_{\%SPR}$ to $F_{\%SPR}$-based reference points indicate fishing intensity levels lower than the reference points.

Quantity	Base Case	Growth CV = 0.06 for L_{inf}	Growth All parameters estimated	Update of 2020 base case model to 2023 data*
MSY (t)	121,880	93,167	144,792	97,777
SSB_{MSY} (t)	23,154	18,133	30,435	18,756
SSB_0 (t)	165,567	128,155	198,913	132,570
$SSB_{current,\ F=0}$ (2021 estimate)	129,581	97,368	155,542	93,808
$SSB_{2021}/SSB_{current,\ F=0}$	0.54	0.36	0.65	0.39
$SSB_{2021}/30\%SSB_{current,\ F=0}$	1.81	1.21	2.17	1.31
$SSB_{2021}/14\%SSB_{current,\ F=0}$	3.87	2.6	4.65	2.81
†$Depletion_{2021}/Depletion_{2006\text{-}2015}$	1.34	1.33	1.37	1.3
§ $F_{\%SPR,\ 2018\text{-}2020}$ (%SPR)	59.0	41.4	70.4	43.2
§ $F_{\%SPR,\ 2011\text{-}2020}$ (%SPR)	55.0	36.6	63.8	37.9
¶ $F_{\%SPR,\ 2018\text{-}2020}/F_{\%SPR,\ MSY}$	2.04	1.42	2.78	1.47
¶ $F_{\%SPR,\ 2011\text{-}2020}/F45_{\%SPR}$	1.22	0.81	1.42	0.84
¶ $F_{\%SPR,\ 2018\text{-}2020}/F45_{\%SPR}$	1.31	0.92	1.56	0.96
¶ $F_{\%SPR,\ 2018\text{-}2020}/F_{\%SPR,\ 2002\text{-}2004}$	1.48	1.63	1.40	1.25

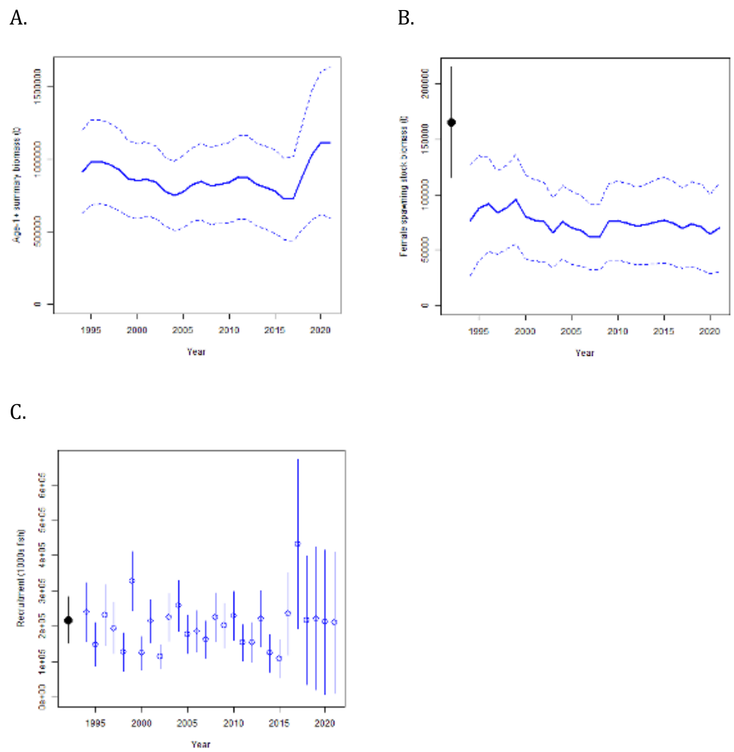


Figure NPALB-1. Maximum likelihood estimates of (A) age-1+ biomass (B), female spawning biomass (SSB), and (C) age-0 recruitment of north Pacific albacore tuna (Thunnus alalunga). Dashed lines (A and B) and vertical bars (C) indicate 95% confidence intervals. Closed black circle and error bars in (B) and (C) are the maximum likelihood estimate and 95% confidence intervals of unfished female spawning biomass, SSB0, and unfished recruitment, respectively, at equilibrium.

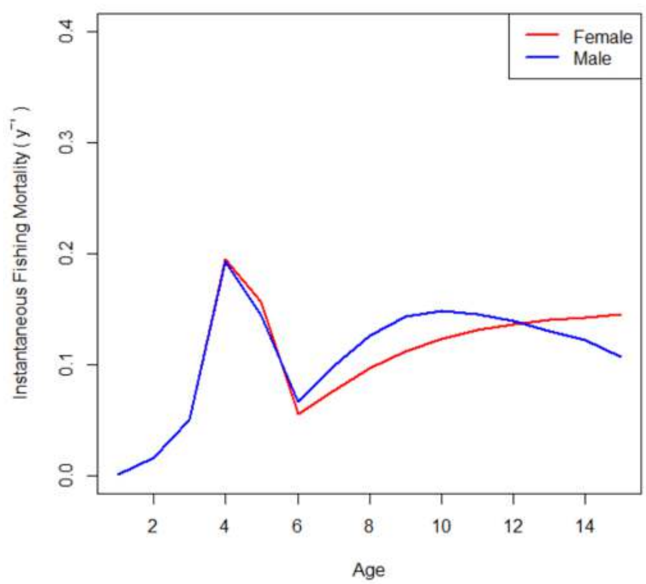


Figure NPALB-2. Estimated sex-specific instantaneous fishing mortality-at-age (F-at-age) for the 2023 base case model, averaged across 2018-2020.

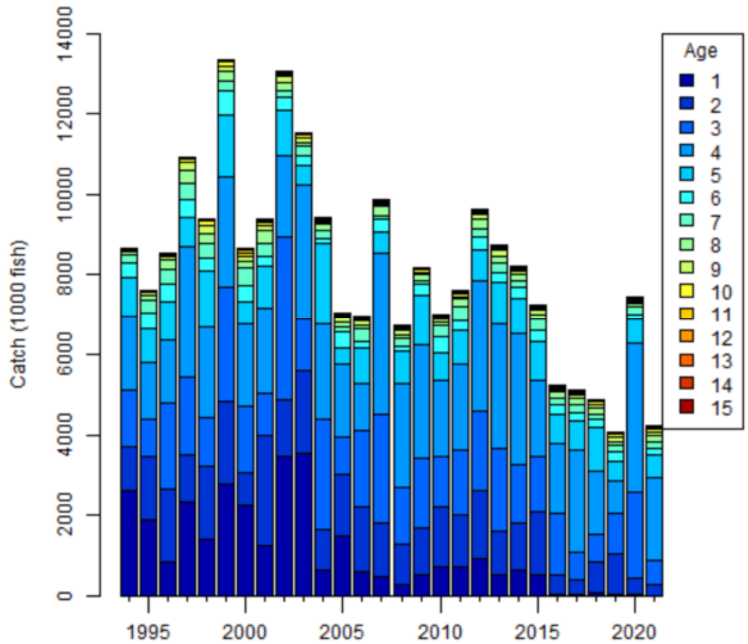


Figure NPALB-3. Historical catch-at-age of north Pacific albacore (*Thunnus alalunga*) estimated by the 2023 base case model.

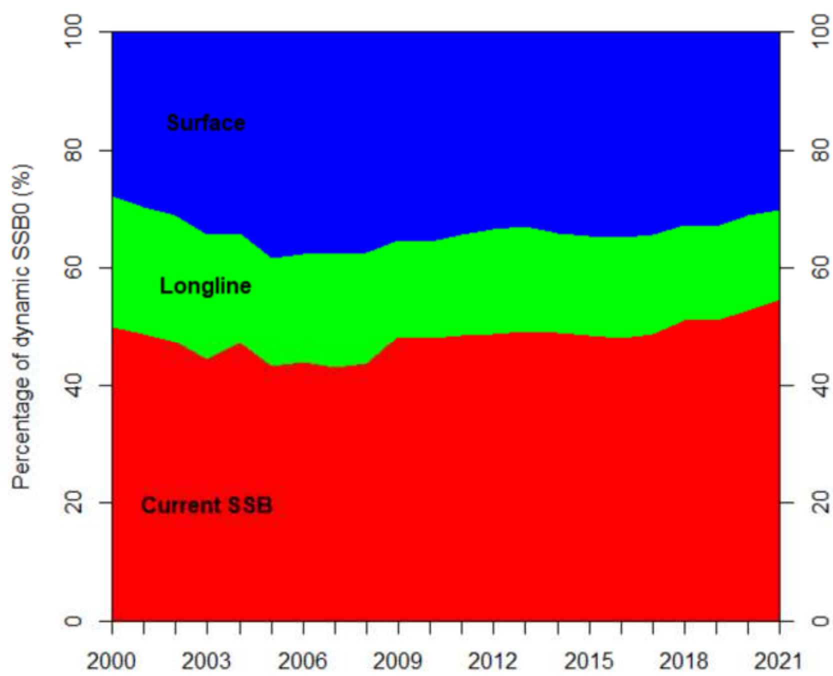


Figure NPALB-4. Fishery impact analysis on north Pacific albacore (*Thunnus alalunga*) showing female spawning biomass (SSB) (red) estimated by the 2023 base case model as a percentage of dynamic, unfished female SSB ($SSB_{current,\ F=0}$). Colored areas show the relative proportion of fishing impact attributed to longline (green) and surface (blue) fisheries (primarily troll and pole-and-line gear but including all other gears except longline).

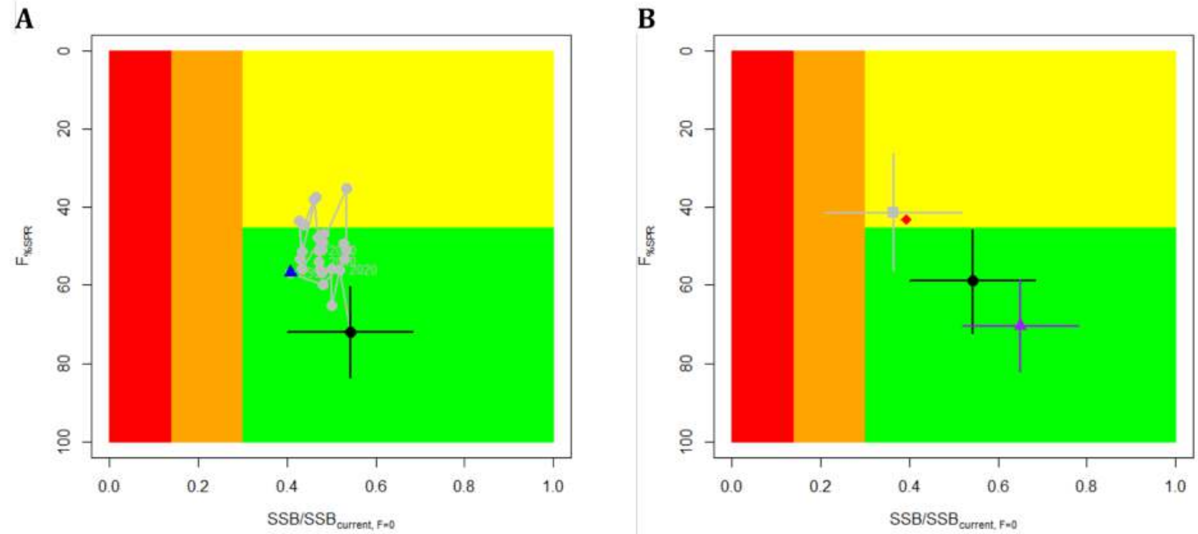


Figure NPALB-5. Stock status phase plot showing the status of the north Pacific albacore (Thunnus alalunga) stock relative to the biomass-based threshold (30%$SSB_{current,\ F=0}$) and limit (14%$SSB_{current,\ F=0}$) reference points, and fishing intensity-based target reference point (F45$_{\%SPR}$) over the modeling period (1994 – 2021). Blue triangle indicates the start year (1994) and black circle with 95% confidence intervals indicates the terminal year (2021). (B) Stock status plot showing current stock status and 95% confidence intervals of the base case model (black circle), an important sensitivity run of CV = 0.06 for Linf in the growth model (gray square), an important sensitivity run with an estimated growth model (purple triangle), and a model representing an update of the 2020 base case model to 2023 data (red diamond). 95% confidence intervals are not shown for the update of the 2020 base case model (red diamond) because the model did not have a positive definite Hessian matrix and uncertainty estimates were unreliable. Red zones in both panels indicate female SSBs falling below the limit reference point while the orange zones indicate female SSBs between the threshold and limit reference points. Green zones indicate female SSBs above the threshold reference point and fishing intensity levels below the target reference point. Yellow areas indicate female SSBs above the threshold reference point and fishing intensity levels above the target reference point. The Fs in this figure are indicators of fishing intensity based on spawning potential ratio (SPR) and calculated as %SPR. SPR is the ratio of the equilibrium SSB per recruit that would result from the estimated F-at-age relative to that of an unfished population. A higher %SPR indicates lower fishing intensity. Current fishing intensity values and SSB/$SSB_{current,F=0}$ ratios in (B) were calculated as the average during 2018- 2020 ($F_{\%SPR}$, 2018-2020) and 2021 (SSB2021/$SSB_{current,\ F=0}$), respectively. The model representing an update of the 2020 base case model is similar to but not identical to the 2020 base case model due to changes in data preparation and model structure.

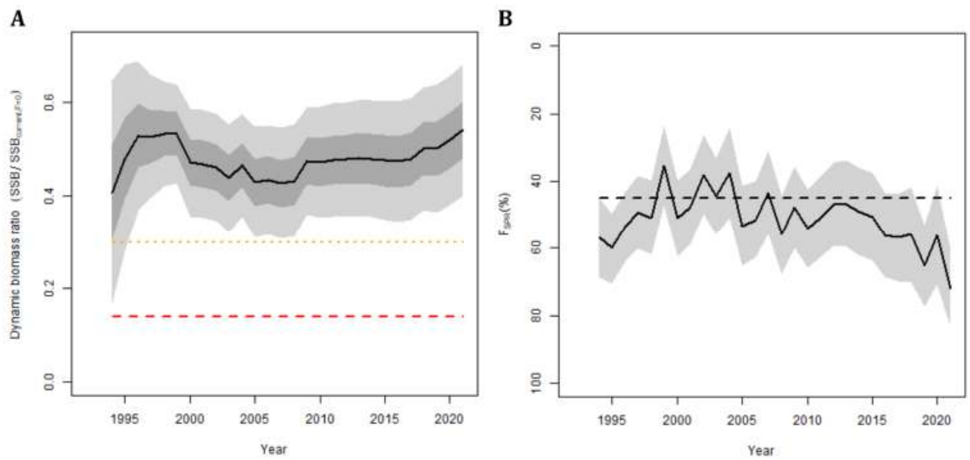


Figure NPALB-6. (A) Estimated dynamic biomass ratio ($SSB/SSB_{current,\ F=0}$) of north Pacific albacore relative to biomass-based threshold ($30\%SSB_{current,\ F=0}$) (orange dotted line) and limit ($14\%SSB_{current,\ F=0}$) reference points (red dashed line) over the modeling period (1994 – 2021); and (B) estimated fishing intensity relative to the fishing intensity-based target reference point ($F45_{\%SPR}$) over the modeling period (1994 – 2021). Light and dark gray areas indicate 95% and 60% confidence intervals respectively. The limit reference point is considered to be breached if the lower bound of the 60% confidence intervals overlaps the limit reference point.

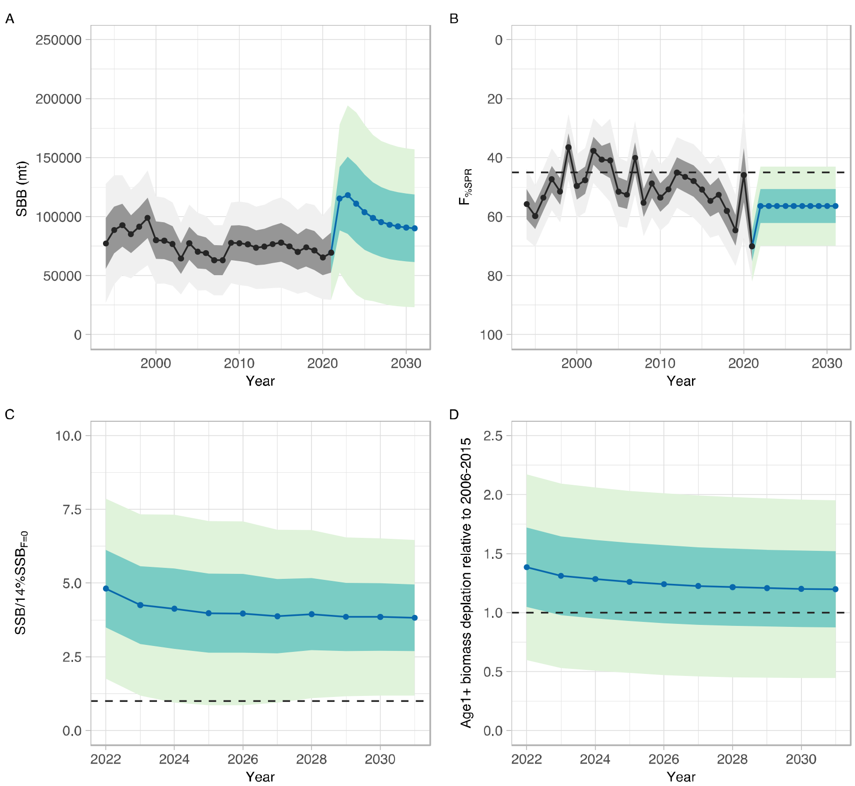


Figure NPALB-7. Future projection results under a constant fishing intensity ($F_{2018\text{-}2020}$) harvest scenario. Solid lines indicate mean values, uncertainty ranges indicate 60% and 95% confidence intervals, and the dashed line is the reference point, respectively. (A) Annual changes in spawning biomass; (B) Interannual changes in fishing mortality ($F_{\%SPR}$); (C) Projected ratios to the limit reference point thresholds; and (D) Projected ratios to management targets for the total biomass.

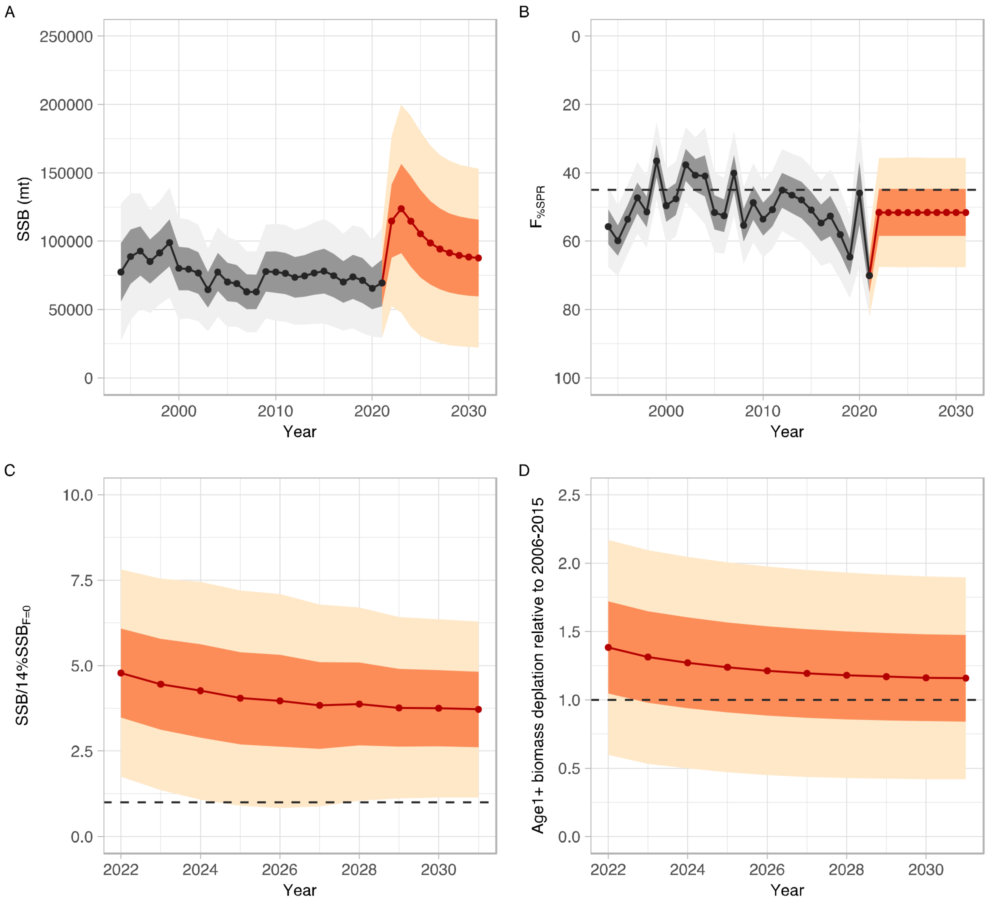


Figure NPALB-8. Future projection results under a randomly F (2005-2019) scenario. Solid lines indicate mean values, and uncertainty ranges indicate 60% and 95% confidence intervals, and the dashed line is the reference point, respectively. (A) Annual changes in spawning biomass; (B) Interannual changes in fishing mortality ($F_{\%SPR}$); (C) Projected ratios to the limit reference point thresholds; and (D) Projected ratios to management targets for the total biomass.

4.4.2 Pacific bluefin tuna (*Thunnus orientalis*)

4.4.2.1 Research and Information

a. Update of Pacific bluefin tuna stock assessment information

85. SC19 noted that no stock assessments were conducted for Pacific bluefin tuna in 2023 and no updated information was presented on the status of Pacific bluefin tuna. Therefore, the stock status descriptions from SC18 are still current for Pacific bluefin tuna.

86. Concern was expressed that no scientific evaluation was provided to SC19 related to the increase in converting part of the small fish catch limit to the large fish catch limit in CMM 2021-02 as recommended by NC19. However, it was clarified that assessment results provided to SC18 showed that the projection under which part of the small fish catch limit was converted to the large fish catch limit using the current conversion factor provides benefit to stock recovery.

87. It was noted that there are some WCPFC members, including New Zealand, who have a strong

interest in PBF but are not involved in the ISC. And they encouraged the ISC to ensure that there are sufficient opportunities for all parties with an interest to be involved in the stock assessment and MP processes.

4.4.3 North Pacific swordfish (*Xiphias gladius*)

4.4.3.1 Research and Information

a. North Pacific swordfish stock assessment

88. M. Sculley (ISC) presented SC19-SA-WP-09 (*Stock assessment of swordfish in* the *North Pacific Ocean through 2021*), which detailed the data, biological parameters, model, model diagnostics and sensitivities, and results of the North Pacific swordfish stock assessment conducted by ISC's Billfish Working Group (ISC BILLWG) in 2023.

89. SC19 thanked ISC BILLWG for their work conducted on the swordfish stock assessment in the North Pacific Ocean.

4.4.3.2 Provision of scientific information

Stock Identification and Distribution

90. The North Pacific swordfish (*Xiphias gladius,* NP SWO) stock area was defined to be the waters of the North Pacific Ocean contained in the Western and Central Pacific Fisheries Commission (WCPFC) Convention Area bounded by the equator and the waters of the Inter-American Tropical Tuna Commission (IATTC) Convention Area north of 10°N (Figure NPSWO-1). All available fishery data from the stock area were used for the stock assessment. For the purpose of modelling observations of catch-per-unit effort (CPUE) and size composition data, it was assumed that there was an instantaneous mixing of fish throughout the stock area on a quarterly basis. The stock was modelled using a fleets-as-areas approach with separate catch and index fleets for the Western and Central North Pacific Ocean (WCNPO) and Eastern Pacific Ocean (EPO) region delineated in (Figure NPSWO-1).

Catches

91. The NP SWO catches were high from the 1970's to the 1980's averaging about 14,000 mt per year during 1975-1990, peaked with unusually high catches in 1998-2000, and then generally declined to the current levels around 11,000mt. Catches by most fleets have generally declined, while minor catches by other WCPFC CCMs have generally increased, except in in the last three years (Figure NPSWO-2). Overall, longline fishing gear has accounted for the vast majority of NP SWO catch.

Data and Assessment

92. Catch and size composition data were collected from International Scientific Committee for tuna and tuna-like species in the North Pacific Ocean (ISC) countries (Chinese Taipei, Japan, and USA) and the WCPFC and IATTC. Standardized CPUE data used to measure trends in relative abundance were provided by Chinese Taipei, Japan, and USA. The NP SWO stock was assessed using an age- and length-structured assessment Stock Synthesis (SS3) model fit to time series of standardized CPUE and size composition data. Life history parameters for growth and maturity were updated for this benchmark stock assessment. The value for stock-recruitment steepness used for the base case model was $h = 0.9$. The assessment model was fit to relative abundance indices and size composition data in a likelihood-based statistical framework.

Maximum likelihood estimates of model parameters, derived outputs, and their variances were used to characterize stock status and to develop stock projections. Several sensitivity analyses were conducted to evaluate the effects of changes in model parameters, including natural mortality rate at age, stock-recruitment steepness, growth curve parameters, and female length at 50% maturity, as well as uncertainty in the input data and model structure.

Biological Reference Points

93. MSY-based biological reference points were computed for the base case model with SS (Table NPSWO-2). The point estimate of annual catch at F_{MSY} was calculated to be 14924 mt. The point estimate of the spawning biomass to produce MSY (adult female biomass) was 16,388 mt. The point estimate of F_{MSY}, the fishing mortality rate to produce SSB_{MSY} (average fishing mortality on ages 1 – 10) was 0.18 and the corresponding equilibrium value of spawning potential ratio at SSB_{MSY} was 19%.

Projections

94. Stock projections for NP SWO were conducted using SS3. No recruitment deviations nor log-bias adjustment were applied to the future projections. Projections are reported as the mean and standard deviation around 100 bootstrapped model runs for each scenario. Projections started in 2022 and continued through 2031 under 5 levels of fishing mortality. The five fishing mortality stock projection scenarios were: (1) F at $20\%SSB_{(F=0)}$ which was calculated from the mean dynamic SSB in the five years, (2) $F_{(2008\text{-}2010)}$ which is the reference years for the proposed CMM for NP SWO, (3) F_{Low} at $F_{30\%SPR}$, (4) F_{MSY}, and (5) F status quo (average F during 2019-2021). Results show the projected female spawning stock biomass and the catch biomass under each of the scenarios (Table NPSWO-3 and Figure NPSWO-5-6).

a. Stock status and trends

95. SC19 noted that the ISC provided the following conclusions on the stock status of North Pacific Swordfish:

1) Estimates of population biomass fluctuated around an average of 80,800 mt during 1975-2021 and was estimated to be 88,800 mt in 2021 (Figure NPSWO-3a and Table NPSWO-1). Initial estimates of female spawning stock biomass (SSB) averaged around 27,600 mt in the late 1970s. SSB was at its highest level of 35,778 metric tons in 2021, and was at its minimum of 22,415 mt in 1981. Overall, spawning stock biomass has been relatively stable for the entirety of the assessment period (Figure NPSWO-3b). Estimated F (arithmetic average of F for ages 1 – 10) decreased from 0.17 year-1 in 1978 to a minimum of 0.09 $year^{-1}$ in 2021 (Figure NPSWO-3c). It averaged roughly F=0.09 during 2019-2021 or about 51% of FMSY with a relative fishing mortality of F/F_{MSY} = 0.49 in 2021. Fishing mortality has been below FMSY since the beginning of the assessment time period and has had a declining trend with the exception of a high peak in 1998 coinciding with high catch by the US LL fleet. Recruitment (age-0 fish) estimates averaged approximately 838,000 individuals during 1975-2021. While the overall pattern of recruitment varied, there was no apparent trend in recruitment strength over time (Figure NPSWO-3d). Overall, total annual catch is declining, CPUE is increasing, and recruitment is relatively stable. When the status of NP SWO is evaluated relative to MSY-based reference points, the 2021 SSB of 35,778 mt is 220% above SSBMSY (16,000 mt) and the 2019-2021 F is about 49% below F_{MSY}. Therefore, relative to MSY-based reference points, overfishing is very likely not occurring (>99% probability) and the NP SWO stock is very likely not overfished (>99% probability, Figure NPSWO-4).
2) WCPFC16 established a limit reference point for the exploitation rate of NP SWO of F_{MSY}. $SSB_{F=0}$, set to equal the average of the last 5 years dynamic B_0 assuming no fishing during those

years. NP SWO reference points will be provided with reference to MSY and with reference to $20\%SSB_{F=0}$.

96. SC19 noted the following stock status from ISC:
1) Female spawning stock biomass was estimated to be 35,778mt in 2021, with a relative SSB ratio of SSB/SSB_{MSY} = 2.18 in 2021;
2) Estimated F (arithmetic average of F for ages 1 – 10) averaged roughly F=0.09 yr^{-1} during 2019-2021 with a relative fishing mortality of F/F_{MSY} = 0.49 in 2021; and
3) Relative to MSY-based reference points, overfishing is very likely not occurring (>99% probability) and the NP SWO stock is very likely not overfished (>99% probability, Figure NPSWO-4).

b. Management advice and implications

97. SC19 noted the following conservation information from the ISC:
1) Projections started in 2022 and continued through 2031 under five levels of fishing mortality. The five fishing mortality stock projection scenarios were: (1) F at 20%SSB(F=0) which was calculated from the mean dynamic SSB in the most recent five years, (2) F(2008-2010) which are the reference years for the proposed CMM for NPO SWO, (3) FLow at F30%SPR, (4) F_{MSY}, and (5) F status quo (average F during 2019-2021). Results show the projected female spawning stock biomass and the catch biomass under each of the scenarios (Table NPSWO-3; Figure NPSWO-5, Figure NPSWO-6).

98. Based on these findings, the following conservation information was provided:
1) The NP SWO stock has produced annual yields of around 11,500 mt per year since 2016, or about 2/3 of the MSY catch amount.
2) NP SWO stock status is positive with no evidence of excess F above F_{MSY} or substantial depletion of spawning potential.
3) It was also noted that retrospective analyses show that the assessment model appears to underestimate spawning potential in recent years.

Special Comments

99. The lack of sex-specific size data and the simplified treatment of the spatial structure of swordfish population dynamics remained as two important sources of uncertainty for improving future assessments.

Table NPSWO-1. Reported catch (mt) used in the stock assessment along with annual estimates of population biomass (age-1 and older, mt), female spawning biomass (mt), relative female spawning biomass (SSB/SSB_{MSY}), recruitment (thousands of age-0 fish), fishing mortality (average F, ages 1–10), relative fishing mortality (F/F_{MSY}), and spawning potential ratio of North Pacific swordfish (*Xiphias gladius*).

Year	2016	2017	2018	2019	2020	2021	Mean[1]	Min[1]	Max[1]
Reported Catch	12,648	11,831	12,730	11,093	10,731	10,136	12,876	9,539	19,230
Population Biomass	83,200	86,835	89,418	89,617	89,992	88,755	80,762	65,722	89,992
Spawning Biomass	28,205	29,785	31,661	33,761	35,159	35,778	28,777	22,415	35,778
Relative Spawning Biomass	1.72	1.82	1.93	2.06	2.15	2.18	1.76	1.37	2.18
Recruitment (age 0)	964,401	746,962	783,354	739,400	624,962	633,046	838,473	595,771	1,430,430
Fishing Mortality	0.1	0.09	0.1	0.09	0.09	0.09	0.12	0.09	0.19
Relative Fishing Mortality	0.55	0.52	0.57	0.49	0.5	0.49	0.68	0.49	1.09
Spawning Potential Ratio	0.34	0.37	0.37	0.42	0.43	0.44	0.33	0.24	0.44

[1] During 1975-2021

Table NPSWO-2. Estimated biological reference points derived from the Stock Synthesis base case model for North Pacific swordfish where F is the instantaneous annual fishing mortality rate, SPR is the annual spawning potential ratio, SSB is spawning stock biomass, and $SSB_{(F=0)}$ indicates the average 5-year SSB_0 estimate, $20\%SSB_{(F=0)}$ is the associated reference point, and MSY is the maximum sustainable yield reference point.

Reference Point	Estimate
$F_{20\%SSB(F=0)}$ (age 1-10)	0.16
F_{MSY} (age 1-10)	0.18
F_{2021}	0.09
$F_{2019-2021}$	0.09
$SSB_{F=0}$	95,732
$20\%SSB_{F=0}$	19,146
SSB_{MSY}	16,388
SSB_{2021}	35,778
$SSB_{2019-2021}$	34,899
$C_{20\%SSB(F=0)}$	14,815
C_{MSY}	14,924
$C_{2019-2021}$	10,653
$SPR_{20\%SSB(F=0)}$	22%
SPR_{MSY}	19%
SPR_{2021}	44%
$SPR_{2019-2021}$	43%

Table NPSWO-3. Projected median values of Western and Central North Pacific striped marlin spawning stock biomass (SSB, mt) and catch (mt) under five constant fishing mortality rate (F) and two recruitment scenarios during 2021-2040. For scenarios which have a 50% probability of reaching the target of $20\%SSB_{F=0}$, the year in which this occurs is provided; NA indicates projections that did not meet this criterion.

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Scenario 1: $F_{20\%SSB(F=0)}$										
SSB	40,457	38,288	36,295	35,452	35,425	35,611	36,064	36,387	36,264	36,478
Catch	16,906	14,986	13,531	13,120	13,298	13,612	13,875	14,053	14,161	14,220
Scenario 2: $F_{1998-2000}$										
SSB	41,567	40,422	38,952	38,309	38,371	38,565	39,133	39,534	39,336	39,625
Catch	14,302	13,389	12,608	12,428	12,656	12,967	13,224	13,399	13,509	13,572
Scenario 3: Low F ($F_{SPR30\%}$)										
SSB	42,268	42,368	41,811	41,756	42,235	42,712	43,610	44,300	44,162	44,705
Catch	11,370	11,249	11,096	11,255	11,623	11,990	12,263	12,445	12,557	12,631
Scenario 4: F_{MSY}										
SSB	38,291	34,051	31,164	29,979	29,800	29,894	30,225	30,452	30,322	30,473
Catch	23,395	17,817	14,992	14,169	14,264	14,565	14,812	14,966	15,052	15,095
Scenario 5: $F_{Status\ Quo}$ (Average $F_{2019-2021}$)										
SSB	38,828	35,056	32,339	31,201	31,036	31,138	31,489	31,733	31,602	31,765
Catch	21,803	17,218	14,723	13,981	14,082	14,379	14,627	14,785	14,875	14,921

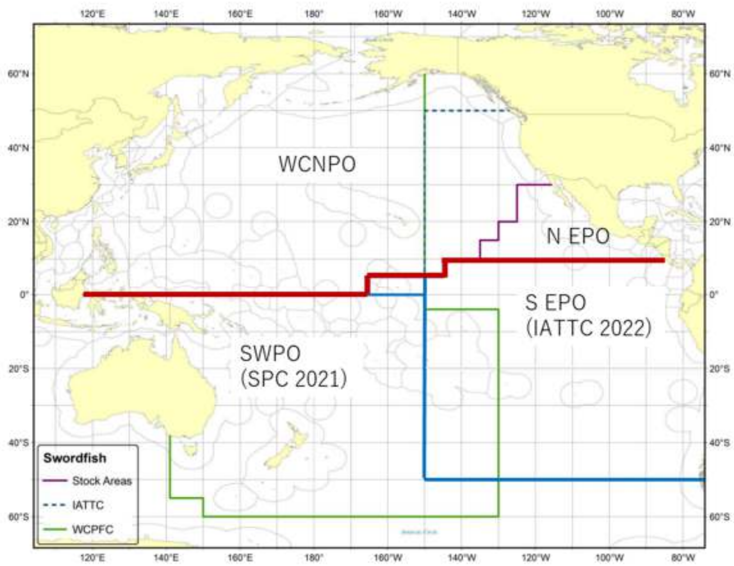


Figure NPSWO-1. Western and Central North Pacific Ocean and North Eastern Pacific Ocean swordfish stock boundaries for the 2023 North Pacific swordfish assessment. Spatial structure is treated implicitly using fleets as areas.

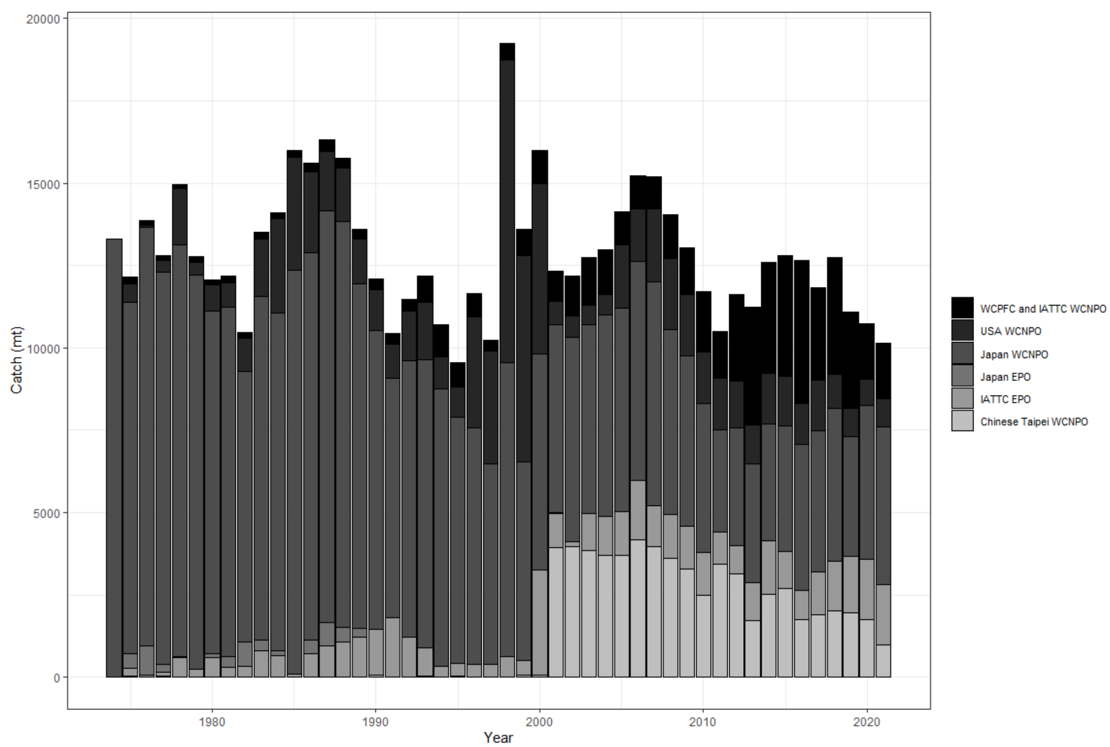


Figure NPSWO-2. Annual catch of NP swordfish by country or commission and area.

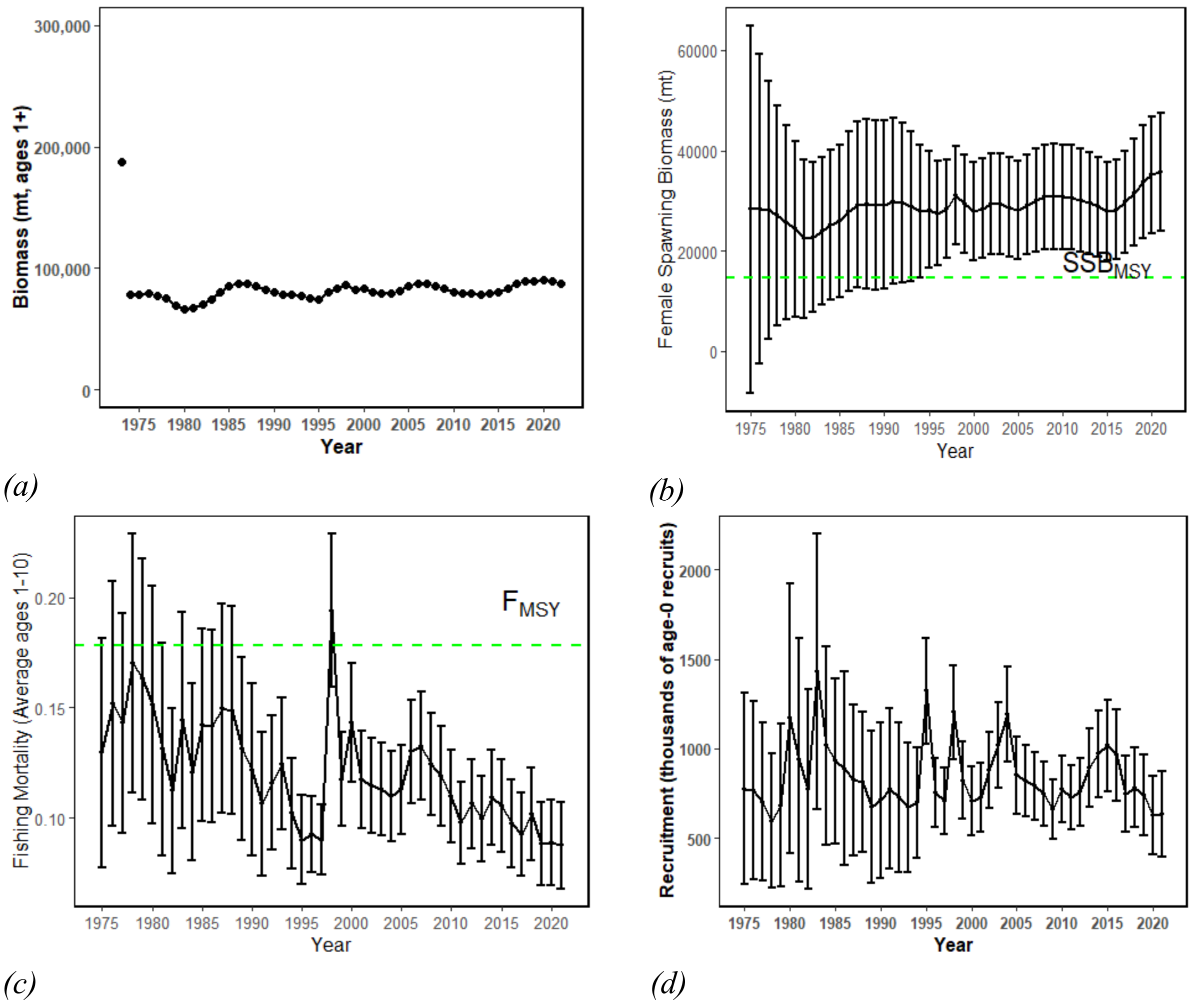


Figure NPSWO-3. Time series of estimates of (a) population biomass (age 1+), (b) spawning biomass, (c) instantaneous fishing mortality (average for age 1-10, year^{-1}), and (d) recruitment (age-0 fish) for North Pacific swordfish (*Xiphias gladius*) derived from the 2023 stock assessment. The circles represents the maximum likelihood estimates by year for each quantity and the error bars represent the uncertainty of the estimates (95% confidence intervals), green dashed lines indicate the dynamic SSB_{MSY} and F_{MSY} reference points.

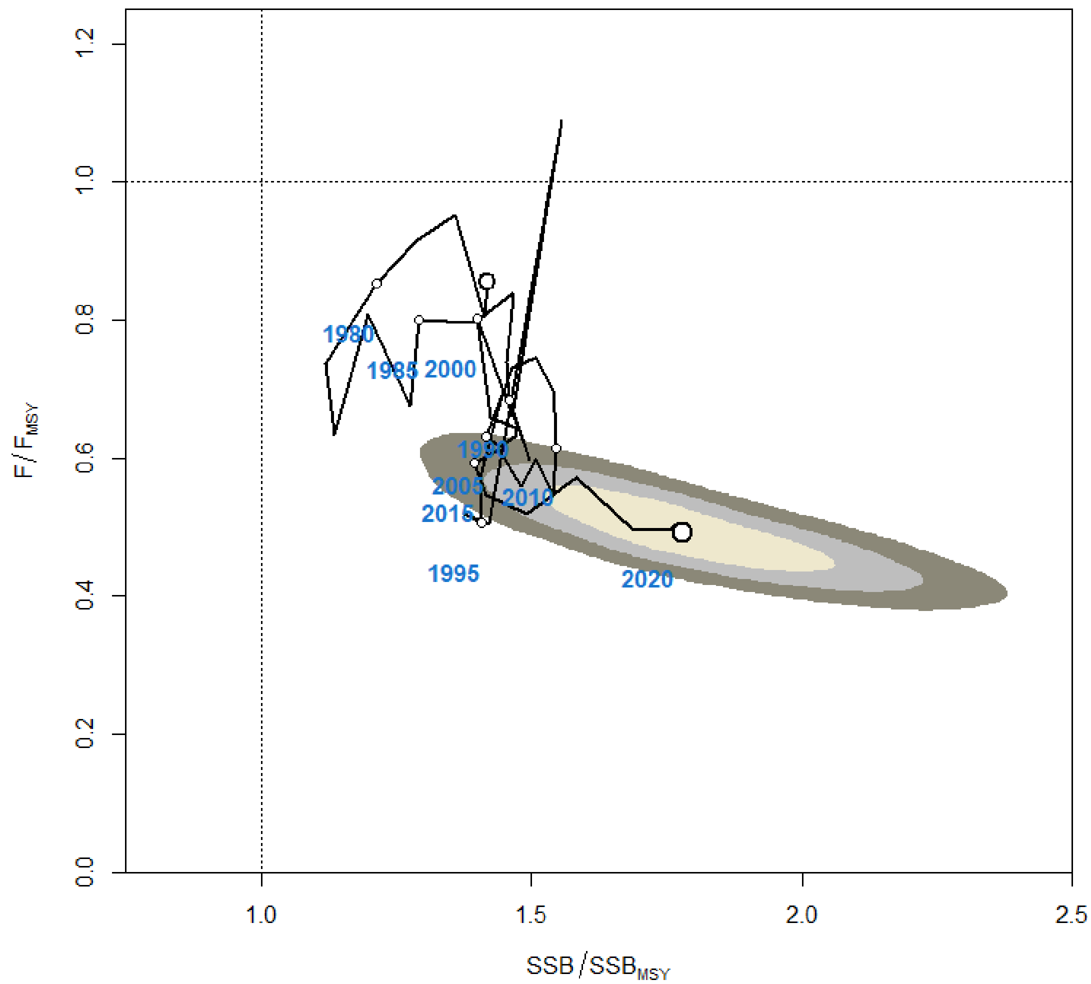


Figure NPSWO-4. Kobe plot of the time series of estimates of relative fishing mortality (average of age 1-10) and relative spawning stock biomass of North Pacific swordfish (*Xiphias gladius*) during 1977-2020. The first white dot indicates 1975, subsequent dots are in 5-year increments. Shading indicates 50%, 80%, and 95% confidence intervals, respectively.

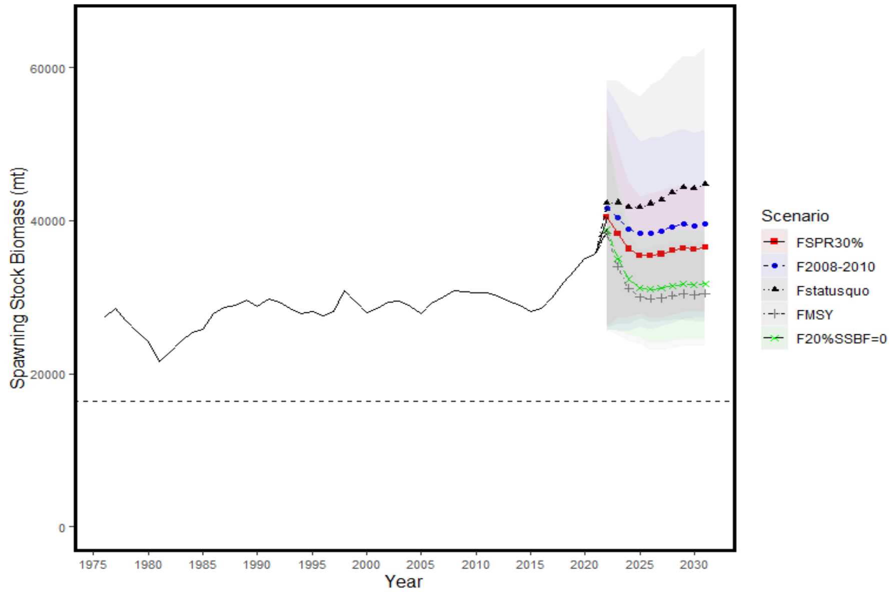


Figure NPSWO-5. Historical and projected trajectories of spawning biomass from the North Pacific swordfish base case model based upon F scenarios. Dashed line indicates the spawning stock biomass at SSB_{MSY}. The list of projection scenarios can be found in Table S3.

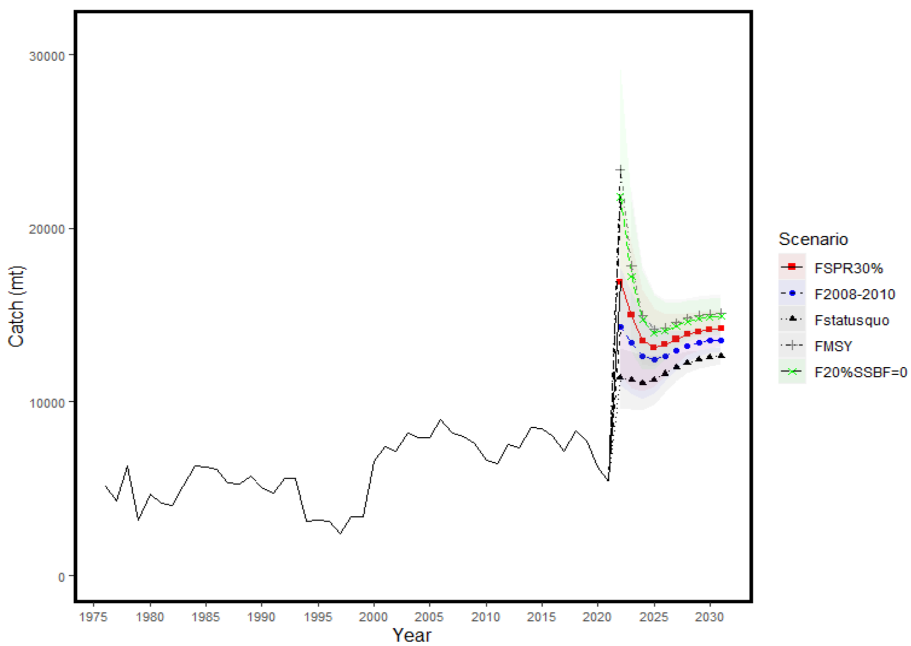


Figure NPSWO-6. Historical and projected trajectories of catch from the North Pacific swordfish base case model based upon F scenarios. The list of projection scenarios can be found in Table S3.

4.5 WCPO sharks

4.5.1 Silky shark (*Carcharhinus falciformis*)

4.5.1.1 Research and information

a. **Silky shark stock assessment in the WCPO (Project 108)**

100. **SC19 recommended that an integrated assessment for silky shark be attempted and that alternative assessment methods such as data-limited methods or a risk analysis be developed concurrently**.

4.6 WCPO billfishes

4.6.1 North Pacific striped marlin (*Kajikia audax*)

4.6.1.1 Research and Information

a. **North Pacific striped marlin stock assessment**

101. H. Ijima presented SC19-SA-WP-11 (*Stock assessment report for North Pacific striped* marlin (*Kajikia audax*) *through 2020*), which detailed the data, biological parameters, model, model diagnostics and sensitivities, and results of the North Pacific striped marlin stock assessment conducted by ISC's Billfish Working Group (BILLWG) in 2023.

102. SC19 thanked ISC BILLWG for their work and welcomed the progress made on the North Pacific striped marlin stock assessment.

103. **SC19 recommended having more consistency in the stock assessment metrics used between assessments across the WCPO stocks**, as recommended in SC19-SA-WP-12.

4.6.1.2 Provision of scientific information

Stock Identification and Distribution

104. The WCNPO MLS (*Kajikia audax*) stock area was defined to be the waters of the North Pacific Ocean contained in the Western and Central Pacific Fisheries Commission Convention Area bounded by the equator and 150°W. All available fishery data from the stock area were used for the stock assessment. For the purpose of modeling observations of CPUE and size composition data, it was assumed that there was an instantaneous mixing of fish throughout the stock area on a quarterly basis.

Catches

105. The WCNPO MLS catches were high from the 1970's to the 1990's averaging about 7,200 mt per year during 1977-1999 and have decreased to an annual average of 2,500 mt during 2018-2020. Catches by Japanese fleets have decreased and catches from the US and Chinese Taipei have varied without trend, while minor catches by other WCPFC countries have generally increased (Figure WCNPOMLS-1). Overall, longline fishing gear has accounted for the vast majority of WCNPO MLS catches since the 1990's while catches by the Japanese driftnet fleet were predominant during 1977 to 1993. It should be noted that the Japanese driftnet catch during this period is highly uncertain due to possible inaccurate reporting as well as possible inclusion of catch from southern hemisphere, both of which cannot be verified at this moment.

Data and Assessment

106. Catch and size composition data were collected from ISC countries (Chinese Taipei, Japan, and

USA) and the WCPFC. Standardized catch-per-unit effort (CPUE) data used to measure trends in relative abundance were provided by Chinese Taipei, Japan, and USA. The WCNPO MLS stock was assessed using an age- and length-structured assessment Stock Synthesis (SS3) model fit to time series of standardized CPUE and size composition data. Life history parameters for growth and maturity were updated for this benchmark stock assessment. The value for stock-recruitment steepness used for the base case model was h = 0.87. The assessment model was fit to relative abundance indices and size composition data in a likelihood-based statistical framework. Maximum likelihood estimates of model parameters, derived outputs, and their variances were used to characterize stock status and to develop stock projections. Several sensitivity analyses were conducted to evaluate the effects of changes in model parameters, including natural mortality rate at age, stock-recruitment steepness, growth curve parameters, and female length at 50% maturity, as well as uncertainty in the input catch data and model structure.

Biological Reference Points

107. Biological reference points were computed for the base case model with SS3 (Table WCNPOMLS-2). The reference points were based upon 20% of the dynamic B_0 ($SSB_{(F=0)}$) averaged over the last 20 years (2001-2020), which corresponds to about 4 mean generation times for WCNPO-MLS. The point estimate of equilibrium annual catch at the dynamic $20\%SSB_{(F=0)}$ was calculated to be 4,468 mt. The point estimate of the spawning biomass to produce $20\%SSB_{(F=0)}$ (adult female biomass) was 3,660 mt. The point estimate of $F_{20\%SSB(F=0)}$, the fishing mortality rate to produce 20% of $SSB_{(F=0)}$ (average fishing mortality on ages 3 – 12) was 0.53 and the corresponding equilibrium value of spawning potential ratio at $20\%SSB_{(F=0)}$ was 22%.

Projections

108. Stock projections for WCNPO-MLS were conducted using SS3.30. No recruitment deviations nor log-bias adjustment were applied to the future projections. The absolute future recruitments were based on two deterministic scenarios: the expected stock-recruitment relationship and the average recruitment in the last 20 years (2001-2020). Projections started in 2021 and continued through 2040. The five levels of fishing mortality with the two recruitment scenarios and the ten catch levels with only the 20-year average recruitment scenario were applied for projections. The five fishing mortality scenarios were: F status quo (average F during 2018-2020), F_{MSY}, F at $20\%SSB_{(F=0)}$, F_{High} at the highest 3-year average during 1977-2017 (1998-2000), and F_{Low} at $F_{30\%}$. The ten catch level scenarios were: No catch (F=0), 500 mt catch, 1,000 mt catch, 1,500 mt catch, 2,000 mt catch, 2,300 mt catch, 2,400 mt catch, 2,500 mt catch, 3,000 mt catch, and 3,500 mt catch. Twenty results show the projected female spawning stock and catch biomasses under each scenario (Tables WCNPOMLS-3, WCNPOMLS-4, Figures WCNPOMLS-4 and WCNPOMLS-5).

a. Stock status and trends

109. SC19 noted the following conclusions on the stock status of the North Pacific striped marlin:

a) Estimates of population biomass from the base-case fluctuated around an average of 11,300 mt during 1977-2020 and was estimated to be 7,300 mt in 2020 (Figure WCNPOMLS-2a). Initial estimates of female spawning stock biomass (SSB) averaged around 4,700 mt in 1977-1979. SSB was at its highest level of 5,096 metric tons in 1977, and declined to its lowest level 1,080 mt in 2011. The time-series of SSB during 2011-2020 averaged about 1,200 metric tons, or about 33% of the dynamic 20-year $20\%SSB_{(F=0)}$ and about 42% of SSB_{MSY}. Overall, SSB exhibited a strong decline during 1992-1998 and has stabilized to an average of about 1,400 mt since then (Figure WCNPOMLS-2b). Estimated fishing mortality (arithmetic average of F for ages 3 – 12) increased from 0.53 $year^{-1}$ in 1977 to a peak of 1.42 $year^{-1}$ in 1998, and subsequently declined to 0.58 $year^{-1}$ in 2020 (Figure WCNPOMLS-2c).

It averaged roughly F=0.68 during 2018-2020 or about 28% above $F_{20\%SSB(F=0)}$ and 8% above F_{MSY}, with a relative fishing mortality of $F/F_{20\%SSB(F=0)} = 1.09$ in 2020. Fishing mortality has been above $F_{20\%SSB(F=0)}$ and F_{MSY} since the beginning of the assessment time period, but has had a declining trend since 1998.

b) Recruitment (numbers of age-0 fish) estimates averaged approximately 366,000 during 1977-2020. While the overall pattern of recruitment from 1977-2020 varied, there was an apparent declining trend in recruitment strength over time with higher recruitments observed during 1977-1992 and lower recruitments from 2000 to the present (Figure WCNPOMLS-2d). Recruitment from 2001-2020 averaged about 225,000 age-0 fish, which was 60% of the 1977-2020 average. The WCPFC has requested the BILLWG to provide estimates of stock status for WCNPO MLS relative to biological reference points based on 20% of a dynamic SSB_0 estimate ($SSB_{(F=0)}$), where SSB_0 is the moving average of the last 20 years SSB_0 estimates. Despite the relative large L_{50}/L_{inf} ratio for WCNPO MLS, the stock is expected to be highly productive due to its rapid growth and high resilience to reductions in spawning potential. Recent recruitments have been lower than expected and have been below the long-term average since 2000 (Figure WCNPOMLS-2b). Although fishing mortality has decreased since 2000, the two decades of low recruitment combined with consistent landings of immature fish have inhibited increases in spawning biomass since 2001.

110. SC19 noted the following stock status from the ISC:
Based upon these findings, the following information on the status of the WCNPO MLS stock is provided:

1) When the status of WCNPO MLS is evaluated relative to dynamic $20\%SSB_{F=0}$-based reference points, the 2020 spawning stock biomass of 1,696 mt is 54% below $20\%SSB_{F=0}$ (3,660 mt) and the 2018-2020 fishing mortality is about 28% above $F_{20\%SSB(F=0)}$.
2) Therefore, relative to $20\%SSB_{F=0}$-based reference points, the WCNPO MLS stock is very likely to be overfished (>99% probability) and is likely to be subject to overfishing (>66% probability, Figure WCNPOMLS-3).

b. Management advice and implications

111. **SC19 noted the following conservation information from the ISC, and recommended that the catch limit be set at 2,300 mt or lower due to concern about the reliability of the model and associated increased risk:**

a) Stock projections for WCNPO MLS were conducted using two deterministic scenarios for future recruitment: the expected stock recruitment relationship and the average recruitment in the last 20 years (2001-2020). Projections started in 2021 and continued through 2040. Five levels of fishing mortality with the two recruitment scenarios (Table WCNPOMLS-3) and the ten catch levels with only the 20-year average recruitment scenario (Table WCNPOMLS-4) were applied for projections. The five fishing mortality scenarios were: F status quo (average F during 20182-020), F_{MSY}, F at $20\%SSB_{F=0}$, F_{High} at the highest 3-year average during 1977-2017 (1998-2000), and F_{Low} at F30%. The ten catch level scenarios were: No catch (F=0), 500 t catch, 1,000 t catch, 1,500 t catch, 2,000 t catch, 2,300 t catch, 2,400 t catch, 2,500 t catch, 3,000 t catch, and 3,500 t catch.

b) Twenty results show the projected female spawning stock and catch biomasses under each scenario (Table WCNPOMLS-3 and Table WCNPOMLS-4; Figure WCNPOMLS-4 and Figure WCNPOMLS-5). When recruitment is assumed to be consistent with the stock recruitment relationship, then only two fixed F scenarios result in the WCNPO MLS stock rebuilding beyond SSB_{MSY} and $20\%SSB_{F=0}$: F_{Low} and $F_{20\%SSB(F=0)}$ (Figure WCNPOMLS-4a). In contrast, when recruitment is assumed to be the average over the last 20 years (2001-2020), none of the fixed F scenarios result in the stock rebuilding to or beyond $F_{20\%SSB(F=0)}$

and only one scenario, F_{Low}, resulted in the stock rebuilding above the SSB_{MSY} level (Figure WCNPOMLS-4b). Constant catch scenario results are different that the constant F projection results. At catch levels less than 2,400 t, the projections show that the WCNPO MLS stock rebuilds beyond the SSB_{MSY} and $20\%SSB_{F=0}$ levels by 2040 (Figure WCNPOMLS-4c).

c) The assumed recruitment levels for projections vary substantially for the two scenarios, with the average recruitment from the stock recruitment curve around 350,000 individuals per year and the recruitment from the low recruitment scenario around 225,000 individuals per year. In the past, the WG has recommended that management measures consider the low recruitment scenarios as the projections using the stock recruitment curve do not consider the long-term declining trend in recruitment (ISC21). If spawning biomass rebuilds to the target, which is about equal to the average spawning biomass observed during the 1977-1989 period, then recruitment may be expected to return to the high levels observed during the 1977-1989 period or about twofold higher than current recruitment (Figure WCNPOMLS-2d). The WG intends to provide additional stochastic ensemble projection results considering model uncertainty, as requested by WCPFC16. One of the important axes of uncertainty will be the assumptions on future recruitment.

d) Based on these findings, the following information on the conservation of the WCNPO MLS stock is provided by ISC:
   1) It is recommended that catch should be kept at or below the recent level (2018-2020 average catch = 2,428 t); and
   2) The results of deterministic projection show that when catches are 2,400 t, or less, the stock is expected to recover above SSB_{MSY} and near the 20% $SSB_{F=0}$ reference level by 2040, or sooner at the lower catch levels under a low recruitment regime (3,660 t).

Special Comments

112. While the WG agreed upon a base case model for WCNPO MLS, there is concern about the reliability of the base case results for providing conservation advice due to uncertainty in growth, Japanese driftnet catches and initial conditions of the model. The ISC22 Plenary requested that the WG continue working on the 2022 WCNPO MLS base case model, with a focus on the growth parameters, particularly incorporating the Richard's four parameter growth curve directly into the SS3 model, for presentation to ISC23. The WG concluded that a revised von Bertalanffy growth curve rather than the Richard's curve was the best information available at this time for use in the 2023 base case model, while highlighting the suite of sensitivity runs to show the sensitivity of the model to changes in the growth curve (Figure WCNPOMLS-6; see the list and description of the sensitivity runs in table 12 in ISC/23/ANNEX/14). The sensitivity runs show that the growth curve assumption may affect the interpretation of stock status. The WG also noted a concern that the estimation of initial F and thus the virgin biomass scale is largely affected by the selection of the growth curve, as the initial catch remains uncertain.

113. The WG recognized that substantial uncertainties have been discussed and documented in this stock assessment report. The high seas drift net catch data are highly uncertain owing to limited record availability, the estimation of life history parameters, such as growth, from limited data, and the mixing of the stock with other management areas, as revealed by genetic analyses. The WG evaluated the fit of several growth assumptions to the data and other diagnostics. The WG found that the stock assessment results showed large differences in estimated biomass among various growth curves. Future improvements of the growth curve are expected due to incoming data from the ongoing International Billfish Biological Sampling program, which will be followed by continued biological research and model development to address other sources of uncertainty.

Table WCNPOMLS-1. Reported catch (mt) used in the stock assessment along with annual estimates of population biomass (age-1 and older, mt), female spawning biomass (mt), relative female spawning biomass ($SSB/20\%SSB_{F=0}$), recruitment (thousands of age-0 fish), fishing mortality (average F, ages-3 – 12), relative fishing mortality ($F/F_{20\%SSB(F=0)}$), and spawning potential ratio of Western and Central North Pacific striped marlin.

Year	2014	2015	2016	2017	2018	2019	2020	Mean[1]	Min[1]	Max[1]
Reported Catch	2,745	3,272	2,456	2,256	2,177	2,695	2,412	5,383	2,177	10,912
Population Biomass	7,142	6,476	5,944	5,506	5,316	6,831	7,339	11,283	5,316	19,463
Spawning Biomass	1,142	1,293	1,305	1,238	1,223	1,158	1,696	2,266	1,081	5,118
Relative Spawning Biomass	0.31	0.35	0.35	0.33	0.33	0.31	0.46	0.61	0.29	1.38
Recruitment (age 0)	102,169	196,286	138,584	150,045	299,538	215,884	263,519	366,217	89,526	711,480
Fishing Mortality	0.77	0.91	0.70	0.74	0.69	0.77	0.58	0.89	0.53	1.42
Relative Fishing Mortality	1.46	1.70	1.31	1.39	1.30	1.45	1.09	1.67	1.00	2.67
Spawning Potential Ratio	0.14	0.11	0.16	0.16	0.16	0.14	0.20	0.13	0.06	0.23

[1] During 1977-2020

Table WCNPOMLS-2. Estimates of biological reference points along with estimates of fishing mortality (F), spawning stock biomass (SSB), recent average yield (C), and spawning potential ratio (SPR) of Western and Central North Pacific striped marlin, derived from the base case model assessment model, where $SSB_{F=0}$ indicates the average 20-year dynamic B0 estimate, $20\%SSB_{F=0}$ is the associated reference point, and MSY indicates the maximum sustainable yield reference point.

Reference Point	**Estimate**
$F_{20\%SSB(F=0)}$ (age 3-12)	0.53
F_{MSY} (age 3-12)	0.63
F_{2020} (age 3-12)	0.58
$F_{2018-2020}$	0.68
$SSB_{F=0}$	18,300 mt
$20\%SSB_{F=0}$	3,660 mt
SSB_{MSY}	2,920 mt
SSB_{2020}	1,696 mt
$SSB_{2018-2020}$	1,359 mt
$C_{20\%SSB(F=0)}$	4,468 mt
MSY	4,512 mt
$C_{2018-2020}$	2,428 mt
$SPR_{20\%SSB(F=0)}$	22%
SPR_{MSY}	18%
SPR_{2020}	20%
$SPR_{2018-2020}$	17%

Table WCNPOMLS-3. Projected median values of Western and Central North Pacific striped marlin spawning stock biomass (SSB, mt) and catch (mt) under five constant fishing mortality rate (F) and two recruitment scenarios during 2021-2040. For scenarios which have a 50% probability of reaching the target of 20%$SSB_{F=0}$, the year in which this occurs is provided; NA indicates projections that did not meet this criterion. Note that 20%$SSB_{F=0}$ is 3,660 mt.

Year	2021	2022	2023	2024	2025	2030	2040	Year when target achieved
Scenario 1: $F_{20\%SSB(F=0)}$, F_{Btgt}; Stock – Recruitment Curve								
SSB	2084	2412	2775	3071	3275	3620	3658	NA
Catch	2624	3041	3461	3803	4039	4426	4468	
Scenario 2: Highest F (Average $F_{1998-2000}$); Stock – Recruitment Curve								
SSB	2032	2217	2464	2663	2796	3017	3043	NA
Catch	3080	3386	3729	3997	4174	4461	4494	
Scenario 3: Low F ($F_{30\%}$); Stock – Recruitment Curve								
SSB	2390	3059	3758	4367	4825	5675	5783	2024
Catch	1807	2293	2770	3177	3477	4009	4072	
Scenario 4: F_{MSY}; Stock – Recruitment Curve								
SSB	2062	2369	2712	2991	3182	3504	3540	NA
Catch	2685	3090	3502	3836	4064	4439	4481	
Scenario 5: $F_{Status\ Quo}$ (Average $F_{2018-2020}$); Stock – Recruitment Curve								
SSB	2026	2291	2593	2837	3005	3289	3322	NA
Catch	2795	3170	3550	3854	4062	4406	4445	
Scenario 6: $F_{20\%SSB(F=0)}$, F_{btgt}; 20-year Average Recruitment								
SSB	2084	2343	2411	2392	2371	2351	2351	NA
Catch	2623	2886	2952	2924	2896	2871	2871	
Scenario 7: Highest F (Average $F_{1998-2000}$); 20-year Average Recruitment								
SSB	2032	2149	2130	2077	2046	2023	2022	NA
Catch	3080	3182	3131	3056	3014	2986	2986	
Scenario 8: Low F ($F_{30\%}$); 20-year Average Recruitment								
SSB	2390	2979	3296	3414	3456	3483	3484	NA
Catch	1806	2177	2368	2430	2447	2453	2454	
Scenario 9: F_{MSY}; 20-year Average Recruitment								
SSB	2062	2301	2355	2331	2308	2287	2287	NA
Catch	2684	2932	2987	2952	2921	2895	2895	
Scenario 10: $F_{Status\ Quo}$ (Average $F_{2018-2020}$); 20-year Average Recruitment								
SSB	2026	2225	2254	2220	2194	2171	2171	NA
Catch	2794	2996	3016	2968	2932	2905	2905	

Table WCNPOMLS-4. Projected median values of Western and Central North Pacific striped marlin spawning stock biomass (SSB, mt) under ten constant catches with low recruitment scenarios during 2021-2040. For scenarios that have a 50% probability of reaching the target of 20%$SSB_{F=0}$, the year in which this occurs is provided; NA indicates projections that did not meet this criterion. Note that 20%$SSB_{F=0}$ is 3,660 mt.

Year	2021	2022	2023	2024	2025	2030	2040	Year when target achieved
Scenario 11: No catch; 20-year Average Recruitment								
SSB	3097	4809	6370	7587	8486	10304	10644	2022
Scenario 12: 500 mt catch; 20-year Average Recruitment								
SSB	2907	4350	5639	6629	7358	8858	9159	2022
Scenario 13: 1,000 mt catch; 20-year Average Recruitment								
SSB	2719	3892	4915	5679	6236	7405	7660	2022
Scenario 14: 1,500 mt catch; 20-year Average Recruitment								
SSB	2537	3454	4213	4771	5160	5986	6182	2023
Scenario 15: 2,000 mt catch; 20-year Average Recruitment								
SSB	2361	3030	3540	3874	4106	4607	4738	2024
Scenario 16: 2,300 mt catch; 20-year Average Recruitment								
SSB	2258	2783	3152	3368	3509	3809	3895	2026
Scenario 17: 2,400 mt catch; 20-year Average Recruitment								
SSB	2224	2703	3026	3204	3316	3551	3619	NA
Scenario 18: 2,500 mt catch; 20-year Average Recruitment								
SSB	2190	2623	2901	3042	3126	3297	3347	NA
Scenario 19: 3,000 mt catch; 20-year Average Recruitment								
SSB	2026	2238	2303	2274	2230	2104	2058	NA
Scenario 20: 3,500 mt catch; 20-year Average Recruitment								
SSB	1868	1881	1779	1631	1505	1202	1083	NA

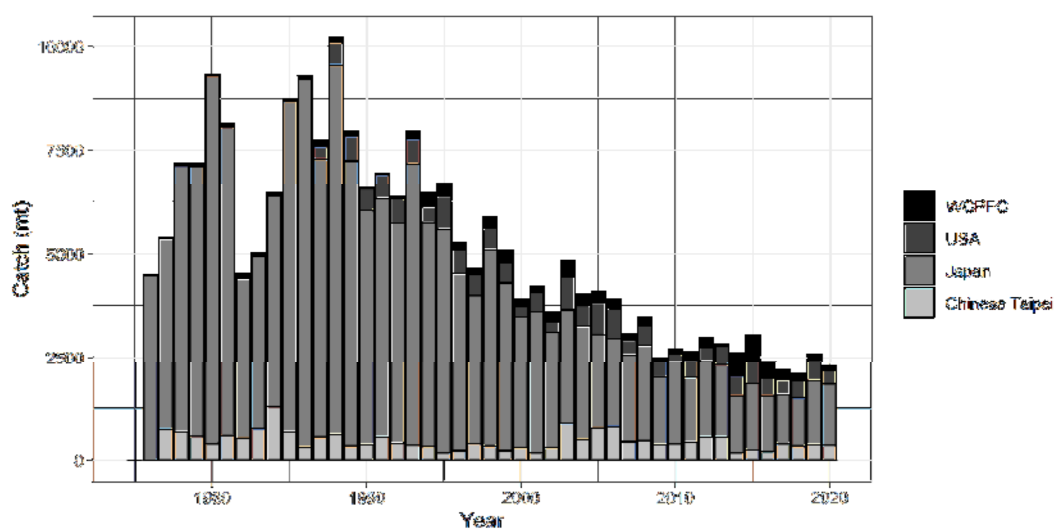


Figure WCNPOMLS-1. Annual catch biomass (mt) of Western and Central North Pacific striped marlin (*Kajikia audax*) by country for Japan, Chinese Taipei, the U.S.A., and all other countries during 1977-2020.

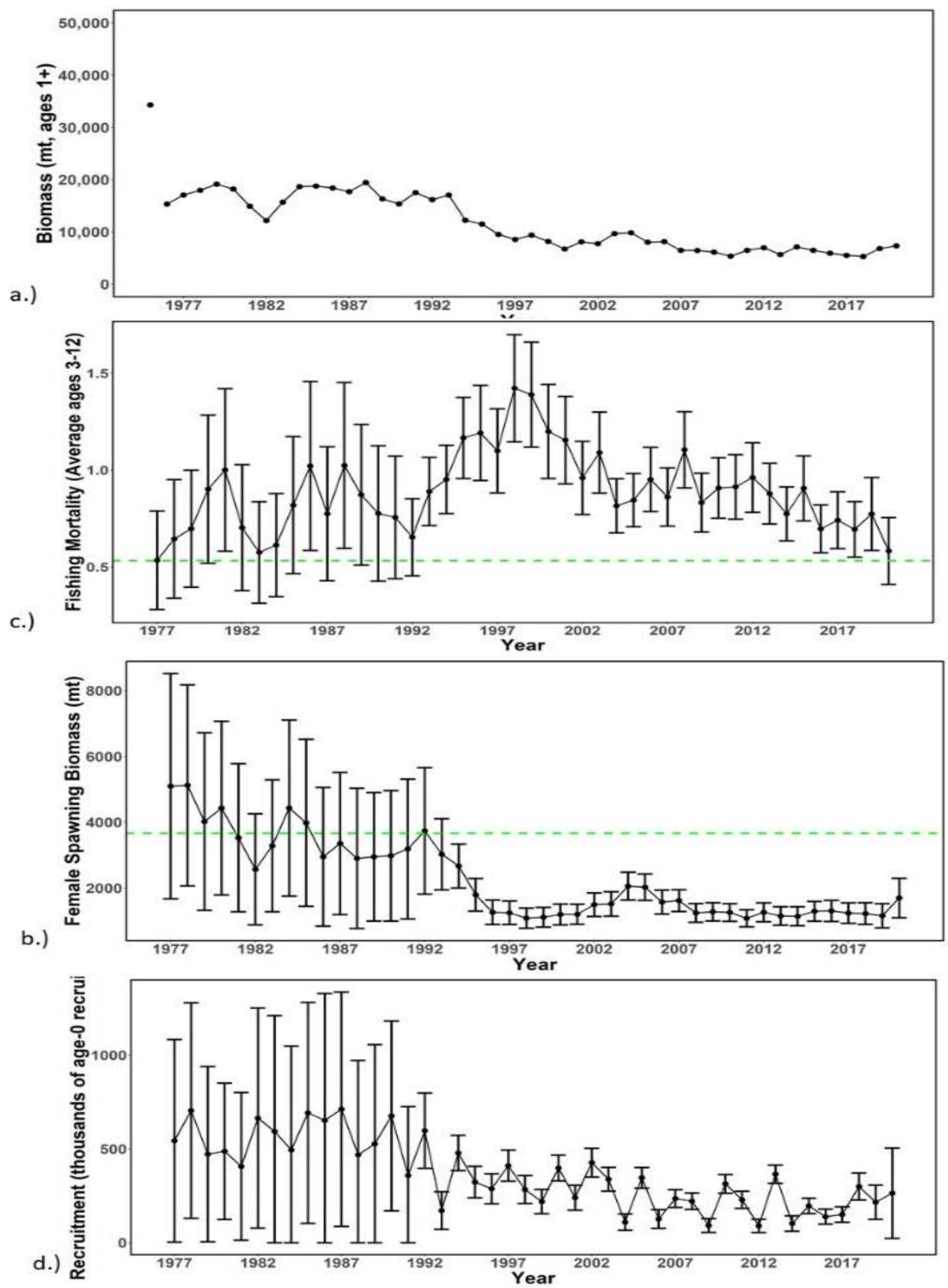


Figure WCNPOMLS-2. Time series of estimates of (a) population biomass (age 1+), (b) spawning biomass, (c) instantaneous fishing mortality (average for age 3-12, year^{-1}), and (d) recruitment (age-0 fish) for Western and Central North Pacific striped marlin (*Kajikia audax*) derived from the 2023 stock assessment. The circles represent the maximum likelihood estimates by year for each quantity and the error bars represent the uncertainty of the estimates (95% confidence intervals), green dashed lines indicate the dynamic $20\%SSB_{F=0}$ and $F_{20\%SSBF=0}$ reference point.

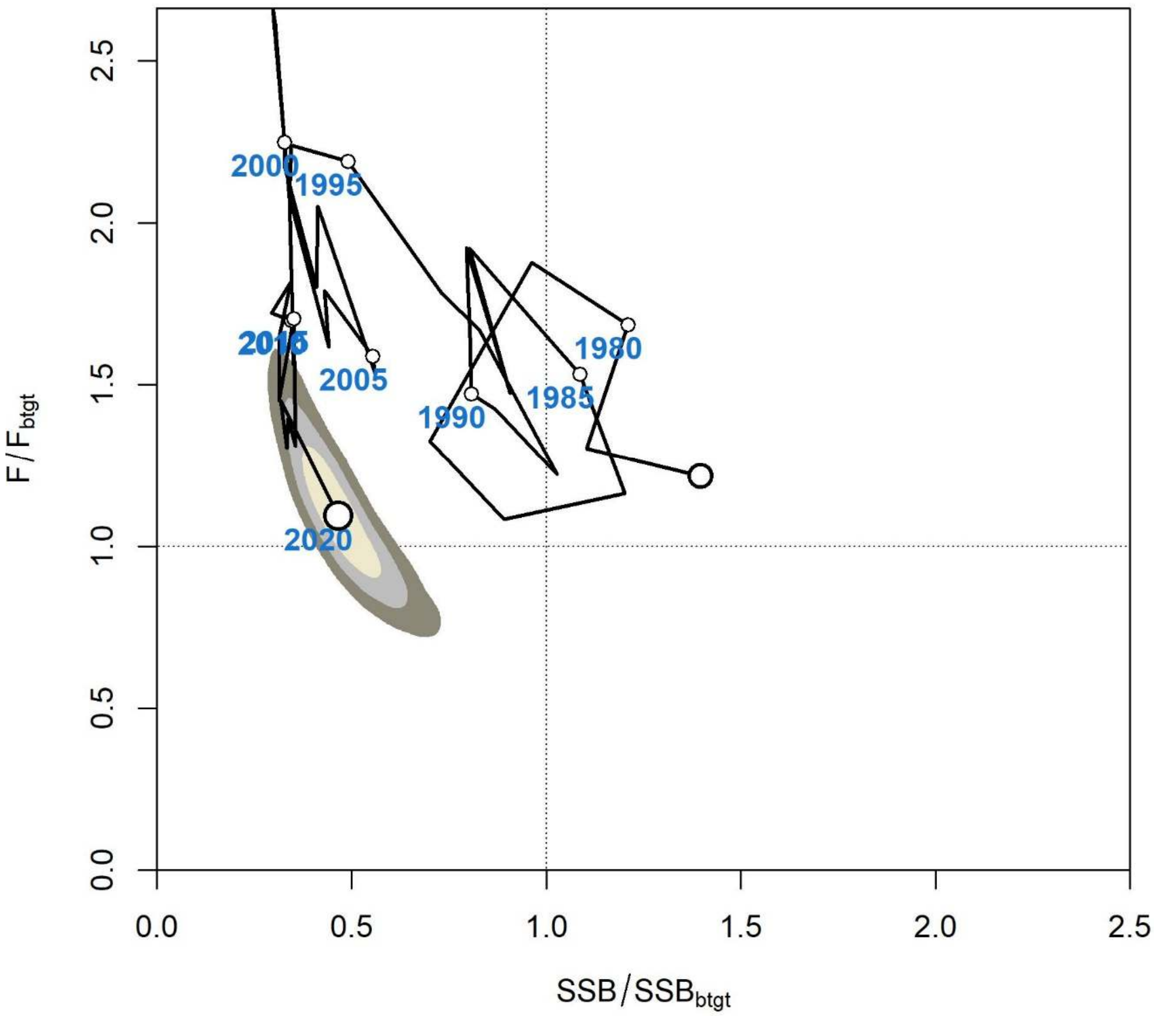
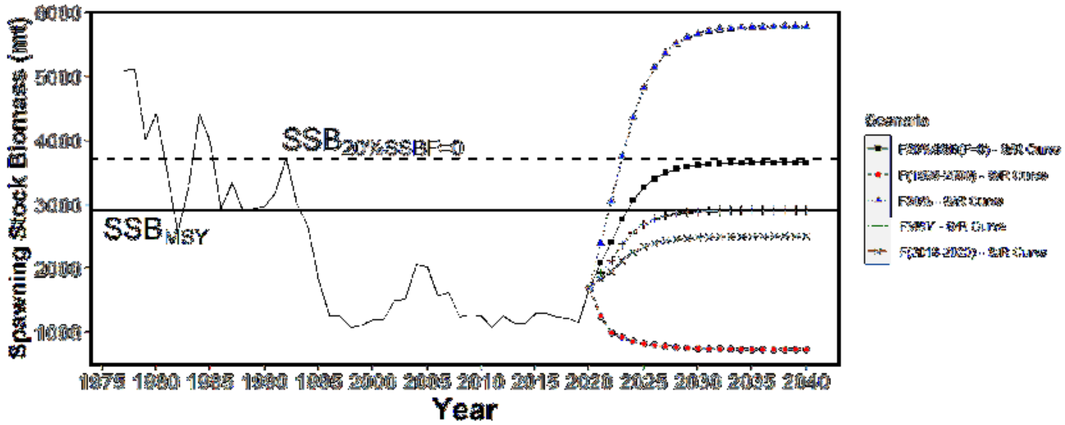
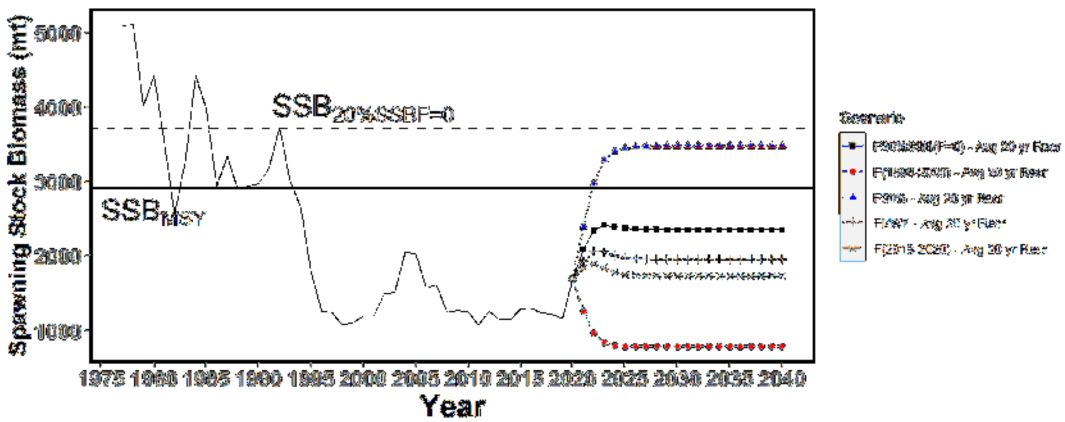


Figure WCNPOMLS-3. Majuro plot of the time series of estimates of relative fishing mortality (average of age 3-12) and relative spawning stock biomass of Western and Central North Pacific striped marlin (*Kajikia audax*) during 1977-2020. F_{btgt} and SSB_{btgt} refer to $F_{20\%SSBF=0}$ and $20\%SSB_{F=0}$, respectively. The large, un-labeled open circle indicates 1977, subsequent open circles are in 5-year increments. Shading indicates 50%, 80%, and 95% confidence intervals, respectively.

a.)



b.)



c.)

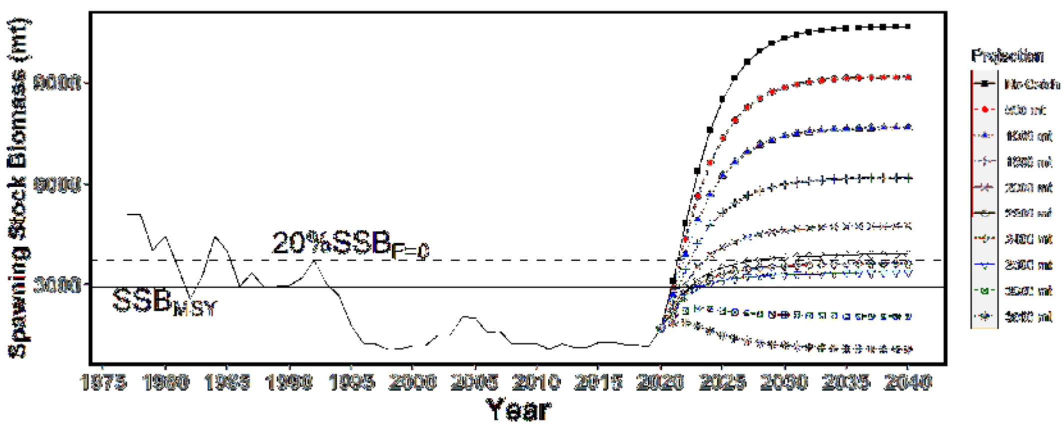
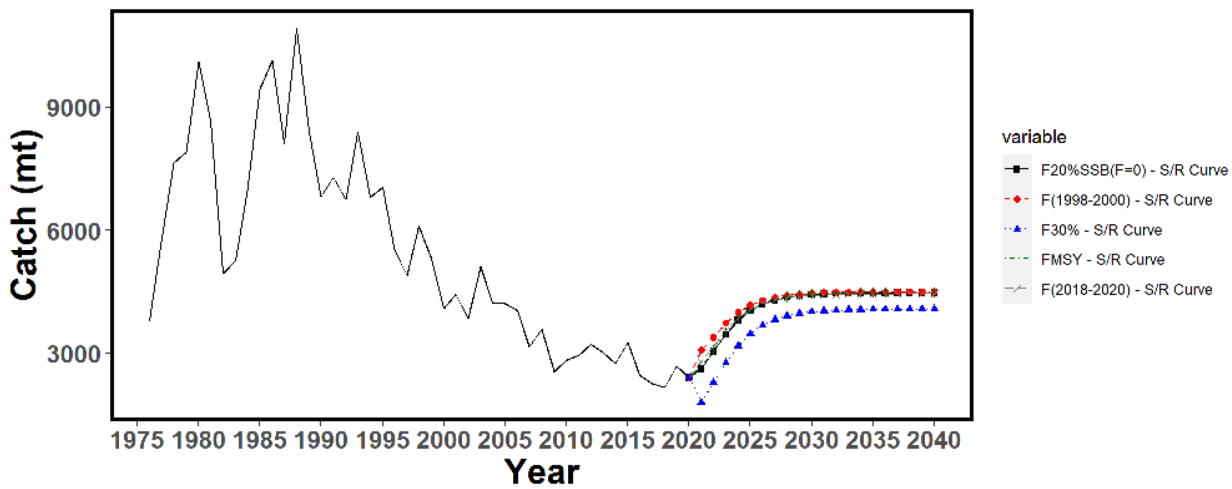


Figure WCNPOMLS-4. Historical and projected trajectories of spawning biomass from the Western and Central North Pacific striped marlin base case model based upon F scenarios: (a) F scenarios projected spawning biomass using recruitment estimated from the stock-recruitment curve; (b) F scenarios projected spawning biomass using average recruitment from 2001-2020. (c) Catch scenarios projected spawning biomass using average recruitment from 2001-2020. Dashed line indicates the spawning stock biomass at the dynamic 20%$SSB_{F=0}$ reference point. Solid line indicates the spawning stock biomass at SSB_{MSY}. The list of projection scenarios can be found in Table S3 and S4.

a.)



b.)

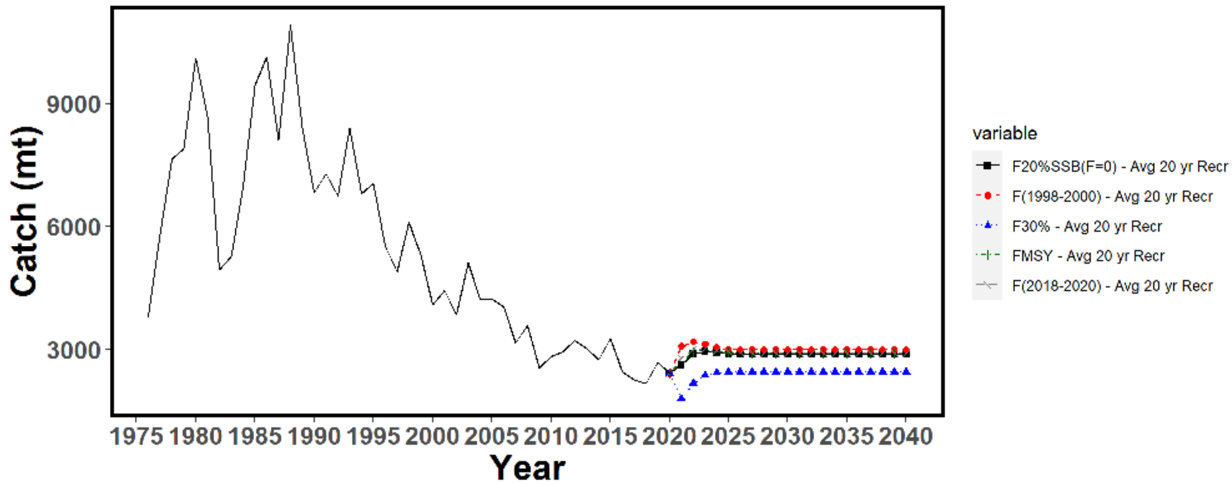


Figure WCNPOMLS-5. Historical and projected trajectories of catch from the Western and Central North Pacific striped marlin base case model based upon F scenarios: (a) F scenarios projected catch using recruitment estimated from the stock-recruitment curve; (b) F scenarios projected catch using recruitment estimated from 2001-2020 average. The list of projection scenarios can be found in Table S3.

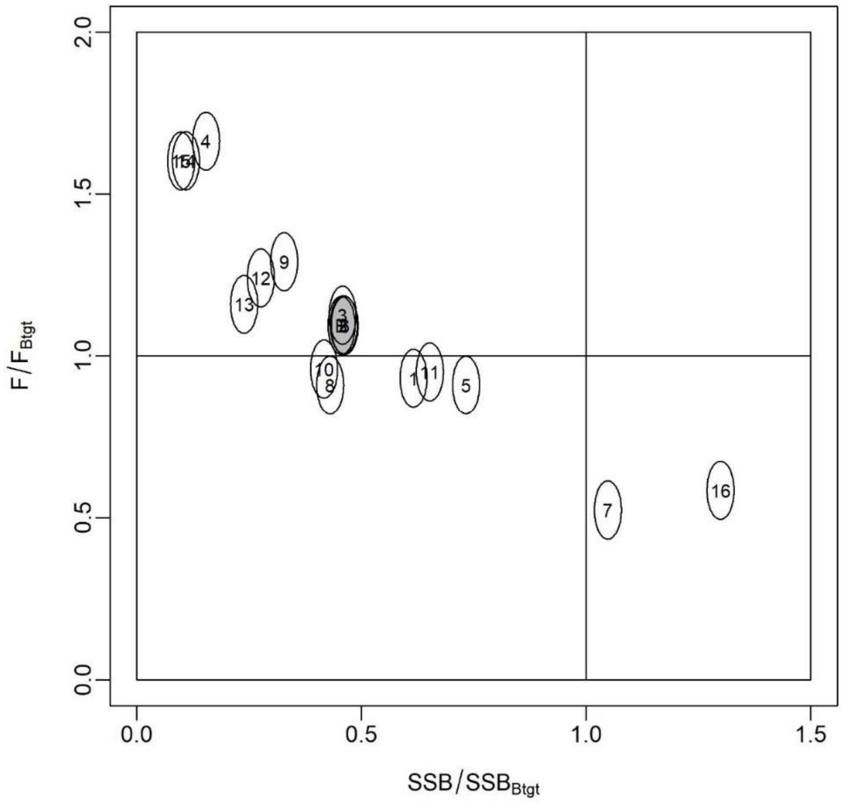


Figure WCNPOMLS-6. Majuro plot showing the terminal year stock status for the base-case model (gray circle, B) and the 16 sensitivity runs used to evaluate the sensitivity of the model to various model assumptions (circled numbers, circles are used as a visual aid). Models 12, 13, 15, and 16 are all sensitivity runs on assumptions on growth. See Table 12 in the stock assessment report for the full list and description of the sensitivity runs.

4.7 Projects and Requests

4.7.1 Characterization of stock assessment uncertainty (Project 113)

114. P. Neubauer (DRAGONFLY) presented SC19-SA-WP-12 (*Addressing uncertainty in WCPFC stock assessments: Review and recommendations from WCFPC Project 113*).

115. SC19 supported the recommendations made in the report and encouraged the SSP and the ISC to take necessary steps to implement them as appropriate. Most notably, the design of a standardized reporting template including language for stock status outcomes, management advice, and uncertainties and the development of consistent terminology regarding the description of the stock status probabilities relative to reference points are considered priority.

116. SC19 noted a consistent reporting format would support clear comparison among stocks and years.

117. **SC19 recommended that this project be included in the 2024 SC workplan and to the Tuna Research Plan**.

118. SC19 also noted the continuation of Project 113b to develop the standardized reporting template and language.

4.7.2 Application of Close-Kin Mark-Recapture Methods (Project 100c)

119. SC19 noted the progress being made on the CKMR preliminary study, and notes that this type of work has improved stock assessments in other tRFMOs and looks forward to seeing how the SPA assessment is improved in the future.

4.7.3 Options to provide information to the Scientific Committee

120. Noting the need for the SSP to have more time to complete the work required to conduct annual stock assessments and other analyses reviewed by the SC each year, **SC19 recommended that:**

1) **the data manager at the SSP liaise and consult with CCMs about the possibility of bringing forward the data submission deadline for fleets, especially historical data updates,**
2) **the Secretariat explore options for moving the dates of the SC meeting to a later period in the calendar year,**
3) **the Secretariat and SSP explore options for the WCPFC website to include a portal for CCMs to enter/edit/manage their ACE data submissions, and**
4) **the SSP develop guidelines for standardised structure/file layouts for Annual Catch Estimates and aggregate catch/effort data that can be used by CCMs to submit these data.**

121. Noting the need for further resources to assist the SSP in conducting annual stock assessments and other analyses related to the work of the Commission, **SC19 recommended that the Commission consider increasing the SSP's budget so that the number of full-time assessment scientists can be increased to four or five.**

4.7.4 Tuna Research Plan

122. An informal small group 3 (ISG03) met during the course of SC19 to review SC19-SA-WP-15 (*Draft Tuna Assessment Research Plan (TARP) for 'key' tuna species assessments in the WCPO, 2023-2026*) and the ISG03 Report is in Attachment 1.

4.7.5 Billfish Research Plan (Project 112)

123. An Informal Small Group (ISG04) met during the course of SC19 to review SC19-SA-WP-16 (*Draft billfish research plan, Project 112*), and the ISG04 report is contained in Attachment 2.

4.7.6 Reproductive biology of yellowfin tuna

124. S. Nicol (SPC-OFP) presented SC19-SA-WP-17 (*Concept note for a new EU supported study on the reproductive biology of yellowfin tuna*).

125. SC19 recognized the importance of biological parameters and acknowledged the valuable updates on the reproductive biology and spawning potential for yellowfin that this project could provide for stock assessments.

126. **SC19 agreed that the project should be expanded to include bigeye and skipjack tuna.**

127. **SC19 endorsed the project and recommended that the WCPFC co-finance EU 40,000 so that funding from the European Maritime, Fisheries and Aquaculture Fund could be accessed.**

128. SC19 noted that the project, if approved for WCPFC co-funding and EU funding, would be established as an SC project, and could commence in January 2024 with a final report to the SC scheduled in August 2026.

AGENDA ITEM 5 — MANAGEMENT ISSUES THEME

5.1 Development of harvest strategy framework for key tuna species

5.1.1 Skipjack tuna

5.1.1.1 Implementation of Management Strategy for WCPO skipjack tuna

129. SC19 noted that WCPFC19 had adopted CMM 2022-01 *Conservation and Management Measure on a Management Procedure for WCPO Skipjack Tuna*, which includes a repeating 3-year implementation schedule of the management procedure (MP). Also noting the request to review the performance and outputs of the initial run of the skipjack MP, and provide advice and recommendation to the Commission, SC19 reviewed SC19-MI-WP-01 (*WCPO skipjack management procedure*).

130. SC19 noted that the estimation method ran successfully and returned an estimate of $SB_{latest}/SB_{F=0}$ of 0.42, and that the corresponding scalar from the HCR was 1.0. Under the adopted MP outline in CMM 2022-01, this sets maximum effort in the purse seine and pole and line fisheries, and maximum catches in all other fisheries, at baseline levels (PS 2012 effort; PL 2001-04 effort; Region 5 domestic fisheries 2016-18 catches) for the subsequent management period (2024 to 2026).

131. Several CCMs noted that they were happy with this outcome, as it is consistent with the objective of relative stability in fishing levels between management periods.

132. SC19 noted that the data used to determine this estimate was not entirely consistent with that used for the dry run of the management procedure in the previous year. This change appears to be largely attributed to differences in the standardised pole and line indices, both for the historical time series and for most recent years. However, SC19 noted that SPC and Japanese colleagues will be working together to identify the issue in last year's dry run. Nevertheless, SC19 noted that the initial running of the skipjack MP was consistent with that predicted by the MSE and all data requirements were satisfied.

133. SC19 was informed that the contraction of pole and line fishing effort is impairing the ability to index relative abundance of WCPO skipjack across the equatorial region and diagnostic analyses indicate that it is likely to affect the future performance of the MP. The SSP explained that alternative options and advice for dealing with this issue will be presented to SC20.

134. SC19 noted that this is not just an issue for the estimation model of the MP but also for the stock assessment.

135. Noting that with maximum effort and catches now set in respective fisheries for the next three years, thus providing a time window for further work, SC19 recommends that a re-evaluation of the skipjack estimation method needs to be undertaken prior to the next implementation of the MP.

136. **SC19 recommended that the Commission take into consideration the successful running of**

the skipjack MP as outlined in SC19-MI-WP-01 and its output, which sets maximum effort in the purse seine and pole-and-line fisheries and maximum catches in all other fisheries to their respective baseline levels for the period 2024-2026, when implementing CMM 2022-01.

5.1.1.2 Monitoring strategy for WCPO skipjack tuna

137. Noting the Commission's request to review the elements of the monitoring strategy as set out in ANNEX III of CMM 2022-01, and information provided by the SSP on the elements of the harvest strategy to be included in the monitoring strategy, SC19 reviewed SC19-MI-WP-02 (*Monitoring the WCPO skipjack management procedure*).

138. SC19 noted the aspects of the MP that may be considered for inclusion in the monitoring strategy and the Commission body at which those considerations can be made (Annex III, Table 2, also shown in Table 1 of SC19-MI-WP-02).

139. In order to simplify and streamline the monitoring process for the Commission and its subsidiary bodies, SC19 supported the concept of compiling a summary monitoring report consisting of a summary table that identifies the elements of the monitoring programme that may require additional work or through which major problems may be identified, along with a few short paragraphs to provide further details of the work required to address those issues. The priority of any issues identified can be determined based on the considered severity of the issue and the amount of work required to address it.

140. An example of such a summary report is attached as Attachment 3.

141. While noting that this report covers all the elements of the MP to be reviewed, SC19 also noted a need for both the TCC and the Commission to provide input into the development of this report considering the elements of the monitoring strategy that have been assigned to each body to review.

142. SC19 also noted that the initial development and implementation of this monitoring strategy, and the associated report, will likely be an iterative process, with some time-lags before each body will be able to fulfil some of its roles. For example, given the MP will be first implemented in 2024, TCC will only first be able to monitor compliance in 2025. Once this initial phase in period is complete, review and updating of the monitoring report should be undertaken annually by each body. However, as the MP and stock assessment are only run every three years, some elements of the monitoring strategy will not be able to be reviewed and updated on an annual basis.

143. SC19 noted that as this is the first year for which this MP has been run, there is limited ability to monitor its full performance now. However, to initiate the development of the monitoring report, SC19 reviewed those elements of the monitoring strategy assigned to the SC. The outcomes of that review are shown in the draft monitoring report listed in Attachment 3 and show that SC19 supported the conclusions of SC19-MI-WP-02, that the outcomes of initial running the skipjack MP were consistent with that predicted by the MSE and that all data requirements were satisfied. Some priorities for future work are also noted.

144. Finally, SC19 noted that the annual review of each element of the monitoring strategy will provide an opportunity for the Commission and its two subsidiary bodies to review, and where necessary (depending on the degree of impact on the MP), update the management objectives to ensure the overall harvest strategy remains appropriate as the nature of the fishery evolves over time.

145. **Noting that the Commission is scheduled to adopt a monitoring strategy for skipjack tuna in 2023, SC19 supported the proposed monitoring strategy as outlined in SC19-MI-WP-02 and**

recommended that it be considered for adoption following further discussion by TCC and the Commission.

146. **SC19 recommended that the Commission take note of the initial review of the skipjack MP under the proposed monitoring strategy as outlined in SC19-MI-WP-02 and consider the proposed monitoring strategy summary report drafted by SC and TCC and advise accordingly.**

5.1.2 South Pacific Albacore Tuna

5.1.2.1 Target reference point (TRP)

147. SC19 noted that the Commission is scheduled to adopt a target reference point (TRP) for South Pacific albacore tuna in 2023 and reviewed SC19-MI-WP-03 (*Update to further inform discussions on South Pacific albacore objectives and the TRP*).

148. SC19 examined the update from the table of possible outcomes to SP albacore tuna under candidate TRPs presented to WCPFC19-2022-15 by the Scientific Service Provider. It was noted that the change to the methodology, whereby failed projections are now included in the summary metrics, resulted in slightly more pessimistic outcomes. The set of candidate TRPs presented in Table 1 was considered to be extensive and no requests were made for further additions prior to consideration by WCPFC20.

149. SC19 noted that according to the latest stock assessment for SP albacore tuna (accepted by SC17) the stock was not considered overfished or to be undergoing overfishing, and that an updated stock assessment was due for presentation at SC20 in 2024.

150. Several CCMs noted the importance of SP albacore tuna fisheries to their economy and encouraged the adoption of a TRP for SP albacore tuna by WCPFC20. The importance of economic considerations when selecting a TRP, notably when reviewing the changes in catch limits resulting from the adoption of specific TRPs, was also mentioned.

151. Several CCMs noted that TRPs defined from specific depletion levels are susceptible to changes in our perception of stock status that occurs with each successive stock assessment, or between the stock assessment and the set of operating models used to develop a management procedure. It was recommended that a TRP be set based on stock status in a reference set of years instead, noting that multiple years provide increased robustness against peculiarities that may be present in a single specific year.

152. Some CCMs noted that there are features in the 2021 SP albacore assessment that are still being investigated, most notably the pronounced low estimated recruitment in 2016 and the projected dip in biomass depletion levels. As such the suggestion was that WCPFC20 adopt an interim TRP conditional on the results of the next SP albacore assessment scheduled for SC20.

153. SC19 noted the proposal by the South Pacific Group and Australia for an interim TRP submitted at the Fourth meeting of the South Pacific Albacore Roadmap Intersessional Working Group. The proposed iTRP is based on the estimated average depletion of the SP ALB over the period 2017-2019 and is outlined in SPA-RM-IWG04 Working Paper 3.

154. **SC19 recommended that WCPFC20 reviews the list of candidate TRPs outlined in SC19-MI-WP-03 when adopting a TRP for SP albacore tuna and consider a TRP that is based on a set of reference years instead of a specific level based on a biomass depletion percentage.**

5.1.2.2 South Pacific Albacore operating models

155. SC19 noted that under the indicative Harvest Strategy Work Plan (WCPFC19-2022- 19a_rev2), SC19 is scheduled to agree on the operating models to use for the Management Strategy Evaluation of SP albacore tuna and that the Commission is scheduled to adopt a management procedure (MP) for SP albacore tuna in 2024.

156. SC19 thanked the Scientific Service Provider (SSP) for their presentation of SC19-MI-IP-08 (*Factors contributing to recent and projected declines in south Pacific albacore stock status*) investigating potential explanations for the 2016 "recruitment dip" predicted by the 2021 stock assessment which carries forward to a significant projected biomass decline over recent years. SC19 noted that SC19-MI-IP-08 findings do not resolve whether the recruitment dip is real or a misspecification of the model. While there is some evidence that the recruitment dip might be real, specifications of the stock assessment model might also have exacerbated the extent of the recruitment dip in the projections and within the OMs.

157. Several CCMs were concerned about the development of a reference grid based on operating models that estimate a recruitment dip, noting that the evaluated performance of MPs would in part reflect a response to that dip and be misleading, particularly in the short term. There was support for continued research investigating improvements to the operating models, especially in light of the revised stock assessment to be completed in 2024.

158. The SSP noted that it would be possible to recondition the OM grid if required following SC20 and highlighted that the main matter of interest was changes in the relative performance of each of the MPs being tested under any updated OM, although other metrics might also be of interest to CCMs.

159. SC19 also reviewed SC19-MI-WP-04 (*Selecting and Conditioning Operating Models for* South *Pacific Albacore*) outlining a candidate OM reference grid to use for testing management procedures for SP albacore tuna.

160. SC19 noted the importance of model diagnostics for assessing the performance of operating models and thanked the Scientific Service Provider for their development of a Shiny app (SC19-MI-IP-03) with such diagnostics. It was suggested that CPUE diagnostics also be included for future consideration by SC20.

161. Despite some concerns, several CCMs agreed that the current OM and proposed reference grid were appropriate to enable MP development testing to progress. There was also support for the SSP to evaluate performance of MPs with the first year of simulated operation in 2025 (using data up to 2023). 2025 is the first year a MP would be implemented under the current HS workplan within the ongoing MSE simulation framework. There was also support for using $SB_{recent}/SB_{F=0}$ as a management quantity to further reduce the potential impact of some of the modelling concerns.

162. In light of the concerns about the suitability of the current operating models, it was suggested that the reference set be treated as interim, conditional on future investigations of operating model specifications and the identification of additional OMs where relevant. SC19 supported the SSP's suggestion to expand the OM reference set to incorporate a scenario where the recent estimated 'recruitment dip' was less pronounced.

163. Several CCMs noted the importance of considering expanded areas of uncertainty as part of the robustness set and proposed, at this stage, that this should include scenarios of climate change and CPUE hyperstability, however further robustness tests may be required.

164. **SC19 recommended the use and development of the reference OM set provided in Table 1 of**

SC19-MI-WP-04 over the next year to allow the continued progress and evaluation of candidate MPs for SPA.

165. **Further SC19 recommended that SC20 again consider formally adopting the reference OM set for SPA noting the ongoing investigations that might require a reconditioning of the reference set ahead of SC20, and the potential for other changes in light of the 2024 SPA stock assessment**.

5.1.2.3 South Pacific albacore tuna management procedures

166. SC19 noted that according to the Harvest Strategy Work Plan, SC19 is scheduled to provide advice to the Commission on the performance of candidate management procedures for South Pacific albacore. As such, SC19 reviewed an update on the progress of developing and testing MPs for South Pacific albacore presented by the Scientific Service Provider (SSP), including estimation model options, HCR designs, and preliminary evaluations and consideration of performance indicators.

167. SC19 thanked the SSP for their presentation of SC19-MI-WP-05 ("Developing management procedures for South Pacific albacore") and SC19-MI-WP-06 ("Evaluation of candidate management procedures for South Pacific albacore") and noted the inclusion of a clear list of items informing management procedure design for which feedback was sought.

168. Some CCMs noted that while they are able to provide feedback on aspects of MP development to inform technical discussions, decisions on specific configurations ultimately could only be made by the Commission since they relate to management issues.

169. One CCM noted that there were several influential decisions to be made with regards to MP settings and sought clarification as to the best mechanism to support feedback on each of these settings noting the lack of guidance on the best approach to conduct these discussions. It was clarified that CCMs could provide feedback on specific MP features as part of the SC19 plenary discussions.

170. Other CCMs mentioned further opportunities for detailed feedback to the SSP on MP settings for exploration, for instance the stakeholder engagement and capacity building activities undertaken by the SSP under the project "Pacific Tuna Management Strategy Evaluation" (see SC19-MI-IP-05), the South Pacific Albacore Roadmap Intersessional Working Group and the SP albacore tuna-focused Science Management Dialogue tentatively planned under the Roadmap for 2024 (WCPFC-SPALB-RM-2023-00).

171. SC19 noted its support for the use of the age-structured surplus production model (ASPM) as the estimation model and a 3-year cycle for MP update consistent with the stock assessment cycle for SP albacore tuna.

172. Several CCMs noted that they supported a harvest strategy that could account for both effort and catch controls in recognition of the diversity of management approaches across the region. It was also suggested that, due to its small impact on the overall stock, options for the troll fishery to be treated differently within the MP could be considered in future updates.

173. Several CCMs further noted that, while all sources of commercial mortality on the SP albacore stock should ideally be covered by the MP, EPO catches (outside of WCPFC management) could be fixed at recent levels for the purpose of MP evaluation and development. SC19 encouraged the Commission to seek compatible measures in the IATTC to address this gap in the management of SPA that may impact the effectiveness of an adopted MP.

174. SC19 requested that a dry run of one or more of the candidate MPs be presented to SC20 next year,

similar to that done for skipjack tuna at SC18.

175. Some CCMs stated ongoing concerns with the impact of the recruitment dip on MP testing. While there was support for MP evaluation to start in 2025 as a partial solution to the recruitment dip it was emphasized that there was still a clear impact of the dip on the performance of candidate MPs over the short term (2026-34).

176. Several CCMs noted the importance of accounting for environmental impacts when testing the MP, for example as part of the robustness set.

177. SC19 noted that the projections from the initial MP testing appeared more pessimistic than those conducted as part of the 2021 SP albacore tuna stock assessment. The SSP responded that, unlike in the 2021 stock assessment, there was no down-weighting of the SEAPODYM movement axis in the operating model grid, leading to a more pessimistic outcome for stock status.

178. In response to a question on the impact of the HCRs across regions and fisheries the SSP clarified that, for the current set of evaluations, all fisheries were impacted equally by the catch scalars prescribed by the Harvest Control Rule.

179. SC19 sought clarifications with respect to the conditions that would exacerbate population crashes that sometimes occur in the simulations. As this feature had not been investigated by the SSP, it was noted that the type of management input (effort or catch) might impact this behaviour, and that asymmetrical catch constraints might be considered as a possible solution.

180. Several CCMs noted that a representative set of MPs needed to be available to support discussions at WCPFC20 but that the number of candidate MPs could easily expand to unmanageable levels when considering multiple options applied across different MP settings. As such, it was encouraged that the number of MPs presented to the Commission be kept to manageable levels (e.g., 10 or less) so that the Commission could provide clear input on desirable features for future exploration.

181. **SC19 recommended that WCPFC20 review the current set of 6 candidate MPs for initial consideration, noting the diverse range of MP configurations provided by the SSP is sufficient to support discussions on desirable features and design priorities.**

182. **SC19 further recommended that the Commission provide guidance based on these exploratory MPs on features to be further developed by the SSP, including performance indicators, controlled fisheries and control mechanisms, and HCR shape and design.**

5.1.3 Mixed fisheries MSE framework

183. Noting the work reviewed by previous SC meetings in developing a multi-species modelling framework for including mixed fishery interactions when developing and testing harvest strategies for the four main WCPO tuna stocks, SC19 reviewed an update on the development of this framework outlined in SC19-MI-WP-07 (Mixed fishery harvest strategy update).

184. One CCM stated that although the current diagram depicts that the purse-seine fleets catching bigeye are only controlled by the skipjack MP regardless of the stock status of bigeye, it has not agreed with such a one-way hierarchy of multi-species MP application. Noting that the mixed fishery approach has not yet been agreed, they suggested that the Commission is the most appropriate place for this decision to be made. Another CCM also suggested that the decision hierarchy of the MPs may not be a topic for SC, but for fishery managers.

185. Several CCMs supported the more flexible approach to management objectives described in the paper. Noting the difficulty of getting agreement on management objectives among CCMs who have different visions of how stocks and fisheries should be managed, and that reaching agreement on the form and level of management objectives has been made more difficult by modelling changes, they supported the threshold approach to the nature of the yellowfin management objective as outlined in the paper. They also noted that the relatively large yellowfin catches taken within archipelagic waters strengthens the need for such a flexible approach. They also expressed support for developing a threshold-type management objective for bigeye.

186. Several other CCMs noted the progress made in the development of the mixed-fishery harvest strategy approach and encouraged the Commission to keep the mixed-fishery strategies and questions in mind while developing target reference points for bigeye and yellowfin, as well as development of the MPs.

187. One CCM noted that discussions between the Philippines, Indonesia and Vietnam indicated concern about future management of yellowfin tuna in the WCPO and stated a preference for yellowfin tuna being controlled by a separate MP. However, it was also noted that a separate harvest strategy is presently being developed for Indonesian archipelagic waters and could help alleviate some of those issues.

188. In response to the views expressed, the presenter noted that the mixed fishery framework is a proposal, and not a decision. The current plan is to build the modelling framework and see how it performs for bigeye and yellowfin. If it suggests that these are not well managed under the current mixed fishery framework, then another approach will be needed.

189. One CCM noted that a TRP should specify fishery conditions that managers would like to achieve and that they believed it would be more logical if this made reference to conditions in a fishery over several specified years instead of a depletion-based TRP value. They noted that this is a decision for the Commission.

190. **SC19 supported continuing the work on the development of the mixed fishery MSE framework and recommended that WCPFC20 take note of the progress to date and provide feedback.**

5.1.4 Progress of the WCPFC Harvest Strategy Workplan

191. SC19 noted the adoption by WCPFC19 of the updated *Indicative Workplan for the Adoption of Harvest Strategies under CMM 2014-06* (Attachment M, WCPFC19 Summary Report).

192. SC19 also noted the presentation made by Australia on behalf of FFA which outlined proposed changes that will be presented to WCPFC20, including the following two 'high-level' changes: i) as a contingency allow for a potential one-year delay in the adoption of a MP for SP-albacore, noting potential issues with the operating models, and ii) reschedule the adoption of a MP for bigeye and yellowfin to 2026 to avoid subsequent running of the MP in the same year the stock assessment is conducted.

193. SC19 was informed that the Marine Stewardship Council Conformity Assessment Bodies are developing milestones for harvest strategies that will apply to MSC certified fisheries in the WCPO. However, SC19 also noted that the place for this important planning is within the Commission and its subsidiary bodies.

194. SC19 noted that the second of these proposed revisions would result in the adoption of the MP for bigeye and yellowfin in the same year that the updated stock assessments are provided to the SC. The

presenter noted that the optimal timing of these items can often be difficult, but this proposal would result in a similar process to that undertaken for skipjack and would avoid the longer-term issue of coinciding running the MP with the stock assessment.

195. Several CCMs articulated their strong commitment to the successful implementation of the remainder of the Harvest Strategy Work Plan. They also encouraged continued capacity-building initiatives as they greatly assist CCMs, particularly SIDS, to participate fully in this complex process and have the confidence in the harvest strategy development process, and its outcomes when implemented. They suggested that such activities focus on topics such as agreeing to a management objective, the selection of a target reference point, management procedure design and performance indicators.

196. **SC19 recommended that the Commission take note of the above views when updating the Harvest Strategy Workplan at WCPFC20**.

5.2 Implementation of CMM 2021-01

5.2.1 Review of effectiveness of CMM 2021-01

197. SC19 noted that WCPFC 19 had agreed that the process to revise the Tropical Tuna Measure (TTM) will be based on CMM 2021-01 without a complete overhaul, and at least two workshops will be needed to make progress towards the adoption of a revised TTM in 2023. Based on the request to provide recommendations to the Commission on the effectiveness of CMM 2021-01, SC19 reviewed SC19-MI-WP-08 (*Updates to table 9 of the evaluation of CMM 2021-01*).

198. SC19 noted that SC19-MI-WP-08 evaluates the potential for CMM 2021-01 to achieve its objectives for each of the three WCPO tropical tuna (bigeye, yellowfin and skipjack) stocks. The current evaluations are based on the 2020 SC-agreed stock assessments for bigeye and yellowfin (last year of data is 2018) and the 2022 assessment for skipjack (last year of data is 2021). These evaluations now need to be updated to take account of the updated stock assessments for bigeye and yellowfin adopted by SC19 (last year of data is 2021) and the interim MP adopted for skipjack in 2022.

199. Several CCMs noted, that relative to the FAD set effort levels and the longline catches of bigeye and yellowfin, the TTM is performing adequately. However, as noted by the SSP in their previous evaluation presented at WCPFC19, since 2020 the evaluation of longline bigeye and yellowfin catches are below the expected range under the TTM. Additionally, the actual changes in catch relative to the 2016-2018 average baseline suggests the assumption of a direct relationship between the catch scalars may not be appropriate and may require further investigation.

200. SC19 supported the current analysis framework described in SC19-MI-WP-08. However, it queried as to how the 30-year projections used in the analyses will account for the effort levels in the skipjack fishery now being set every three years based on the adopted interim MP, as implementing the MP would reduce catch if stock biomass decreased. The SSP noted that while this needs to be finalised, these projections just present alternative scenarios that bound future levels between optimistic and fully utilised scenarios.

201. SC19 noted that the SSP is planning to have the updated projections ready for the TTMW4 in September. The updated evaluations will include an update to the baseline period which will now be 2019-2021. The SSP also explained that the preliminary FAD set scalar of 1.19 for the purse seine fisheries in the fully-utilised conditions, is the ratio of effort in 2012 divided by the effort in the period 2019-2021.

202. **SC19 recommended that the updates to SC19-MI-WP-08 be forwarded to both TTMW4 and**

the Commission for their consideration in reviewing the Tropical Tuna Measure.

AGENDA ITEM 6 — ECOSYSTEM AND BYCATCH MITIGATION THEME

6.1 Ecosystem and Climate Indicators

203. **SC19 noted that the SSP has completed a first screening of a subset of potential indicators for adoption and based on this experience recommended that the criteria identified at SC12 are appropriate for the initial screening of candidate indicators. However, more specific criteria are needed for testing and adoption**.

204. **SC19 recommended adoption of the proposed workplan for the development and testing of ecosystem and climate indicators for the period 2024-2027.**

6.2 FAD Impacts

6.2.1 Research on non-entangling and biodegradable FADs (Project 110)

205. SC19 noted that limited information on dFAD designs and materials is available from 2020 to 2023 due to low observer coverage, and there is a need for additional data fields or more systematic data to be recorded to adequately assess the designs, materials, and type of dFADs deployed in the WCPO.

206. **SC19 recommended that further studies are implemented to quantify the effectiveness and the entanglement frequency of Species of Special Interest (SSI) in the WCPO on dFAD designs, including Low Entanglement Risk dFADs, Non-Entangling dFADs and Biodegradable dFADs.**

207. To help reduce marine pollution and ecosystem impacts linked to the use of dFADs, SC19 promotes the reduced use of plastics and non-biodegradable materials in the construction of dFADs and the use of non-entangling FADs, as required from CMM 2021-01 and implemented beginning in January 2024.

208. SC19 noted the delays in the activities from Project 110 due to the COVID-19 pandemic and updated timing of activities, and supported the no-cost project extension with a final anticipated report to be presented at SC21 in 2025.

209. SC19 highlighted the importance of the on-going research activities led by SPC and ISSF, in collaboration with fishing industry, to trial non-entangling and biodegradable dFADs in the WCPO to inform implementation of the requirements under CMM 2021-01. SC19 supported the TOR for a follow-up project to enhance SC Project 110 by trialling additional non-entangling and biodegradable dFADs and to investigate alternative construction locations and locally sourced materials.

210. SC19 supports CCMs to encourage their purse seine vessels to participate in trials of biodegradable FADs of Category I and II (all FAD components are biodegradable except for flotation devices and GPS buoy).

6.2.1.1 Extension to EU supported biodegradable FAD Project

6.2.2 FAD Management Options IWG Issues

211. **SC19 recommended that the FADMO-IWG and TCC review the timelines for the stepwise**

introduction of biodegradable dFADs considering the expected outcomes of projects related to the design, cost-effectiveness and performance of biodegradable dFADs (e.g., jelly FADs) in the WCPO and other oceans.

212. SC19 viewed that moving to biodegradable FADs is important for reducing marine pollution and other impacts. However, SC19 noted that it is challenging for some CCMs, especially for purse seine operators that are going through a major process of eliminating netting in FADs, to meet the non-entangling requirement for 2024 and further noted that trials for biodegradable FADs are still ongoing. In this regard SC19 noted that, for some CCMs, the year 2025 to start the transition to biodegradable FADs implementation may not be viable.

213. SC19 noted IATTC's biodegradable FAD implementation program, which includes timelines with the mandatory use of categories I to IIIb by 2026 (Table FAD-1); and categories I to II by 2029, which could be reviewed by TCC and the FADMO IWG for consideration in the WCPO.

TABLE FAD-1: Preliminary categories of drifting FADs biodegradability levels (from non-biodegradable to 100% biodegradable) for the gradual implementation of biodegradable drifting FADs. *In year X, FADs of either category III(a) (biodegradable tail) or/and category III(b) (biodegradable raft) are required/implemented simultaneously.*

Categories[1]	**Potential Timeline** *(Suggestion 1)*	**Potential Timeline** *(Suggestion 2)*	**Remarks**
Category I. The FAD is made of 100% biodegradable materials.	Year X + 3	Year X + d	Year X will be determined by the WCPFC and subject to review based on available information and availability of materials
Category II. The FAD is made of 100% biodegradable materials except for plastic-based flotation components (e.g., plastic buoys, foam, purse-seine corks).	Year X + 2	Year X + c	Year X will be determined by the WCPFC and subject to review based on available information and availability of materials
Category III(a). The subsurface part of the FAD is made of 100% biodegradable materials, whereas the surface part and any flotation components contain non-biodegradable materials (e.g., synthetic raffia, metallic frame, plastic floats, nylon ropes).	Year X	Year X +b	Year X will be determined by the WCPFC and subject to review based on available information and availability of materials
Category III(b). The subsurface part of the FAD contains non-biodegradable materials, whereas the surface part is made of 100% biodegradable materials, except for, possibly, flotation components.	Year X	Year X +a	Year X will be determined by the WCPFC and subject to review based on available information and availability of materials
Category IV. The surface and subsurface parts of the FAD contain non-biodegradable materials.	Current	Year X	

Note* These definitions do not apply to electronic buoys attached to FADs to track them.

[1] The Categories were renumbered as follows: Category III = Category III(a); Category IV = Category III(b) and Category V = Category IV

214. **SC19 recommended the FADMO IWG and TCC consider incentivising the use of biodegradable dFADs.**

215. SC19 noted that some CCMs suggested one example of an incentive could be to allow biodegradable dFADs to be deployed during the FAD closure.

216. SC19 noted the limitation in the scientific analyses of FAD tracking data due to the current incomplete data. SC19 noted the importance of complete FAD tracking data, including for historical periods, to support scientific analyses to detect trends in dFAD use; to evaluate the effectiveness of paragraph 21 of the Tropical Tuna Measure (CMM 2021-01); to determine the origin of FADs and buoys found stranded; and to explore spatial management options to reduce stranding events.

217. SC19 supported the suggestion of the FADMO IWG on requiring the provision of the daily location records from buoys attached to dFADs to be provided, including historical periods, with research organizations (SPC), with research organizations within CCMs, or with the Commission

218. SC19 noted that, based on the information available, no vessel monitored more than 350 active buoys per day (the current buoy number limit under CMM 2021-01), with 90% of the vessels monitoring less than 130 buoys per day. It was noted these results were limited to the fleets that have provided tracking information since January 2023 and some differences for at least one fleet have been noted. **SC19 recommended that the FADMO IWG and TCC further discuss the active FAD buoy limit and provide advice to TTMW4 and the Commission on this issue**.

219. **SC19 recommended that options should be developed by the FADMO IWG and TCC for reporting the number of active buoys per vessel (paragraph 21 of CMM 2021-01); and to develop processes to i) report the number of dFADs and buoys deployed and retrieved per year; ii) report lost and abandoned dFAD; and iii) to eventually abandon and deactivate buoy communication (paragraph 22 of CMM 2021-01).**

220. SC19 highlighted the need for in-situ data collection to better quantify FAD stranding events and the impacts of FADs on marine and coastal environments; and encouraged the expansion of the in-country stranded FAD data collection programs to other CCMs.

221. SC19 highlighted the need to promote FAD retrieval, preferably by the owner of the buoy attached, and eventually through dedicated programs, before FADs are abandoned or lost and ultimately reach coastal areas. **SC19 recommended that options for increased FAD detection and retrieval should be considered, including economic aspects and standards required for programs to be effective. SC19 recommended that a FAD recovery program/strategy be an agenda item for the FADMO IWG.**

222. SC19 supported the Pacific-wide collaboration on dFAD research, in particular on harmonising data collection processes, increasing non-confidential data exchanges and collaborating on data analyses.

6.3 Sharks

6.3.1 Review of Conservation and Management Measures for sharks

223. **SC19 recommended that, given the reduction in observer coverage over the COVID years and the amendments made to the shark CMM in 2022, it would be more effective to postpone the review of CMM 2022-04 to 2027**, and this is proposed in the Shark Research Plan.

224. SC19 noted a need to support better data collection, particularly for less commonly caught species

interactions and the utility of electronic technologies to complement monitoring and estimation of their interactions.

6.3.2 Mid-term Review of 2021-2025 Shark Research Plan (Project 97b)

225. **SC19 agreed to extend the current shark research plan (SRP) to 2030 to encompass two assessment cycles.**

226. **SC19 agreed to the changes in Table 5 of the SC19-EB-WP-06 *Shark Research Plan Mid-term Review* (reproduced as Table SHK-1 below), as discussed by the Informal Small Group (ISG05), and recommended continuation of the ISG-Sharks at future SC meetings for annual ongoing review and amendment of the SRP**.

227. Noting that integrated stock assessments for elasmobranchs are challenging and can sometimes not succeed, **SC19 recommended that, to the extent possible, integrated shark assessments projects undertaken within the WCPFC should also include a data-poor component so that advice on stock status can still be provided even if the integrated assessment approach fails**.

228. SC19 encouraged future integrated elasmobranch stock assessments presented to SC to include data-limited stock status metrics such as those outlined in SC17 report Table MI-01, if they can be estimated.

TABLE SHK-1. Table 5 of the Shark Research Plan 2021-2025 Mid-term Review (SC19-EB-WP-06), as discussed by the Informal Small Group (ISG05) during SC19.

Stock assessment				
Title	Priority	Start year	End year	Comments
(a) Determine the stock status for WCPFC Key Sharks				
i) Southwest Pacific blue shark assessment	High	2026	2028	
ii) North Pacific blue shark assessment	High	2026	2027	
iii) Southwest Pacific shortfin mako shark assessment	High	2027	2028	
iv) North Pacific shortfin mako shark assessment	High	2023	2024	Data preparatory meeting in November 2023 assessment scheduled for presentation to SC20
v) WCPO silky shark assessment	High	2022	2024	Underway 1-year (papers for SC19 SA-WP-10; SA-IP-09)
vi) WCPO oceanic whitetip shark assessment	High	2024	2025	
vii) Fishery characterisation of manta and mobulid rays and whalesharks	High	2024	2025	SC19 survey 91% high 2024 agreed start date
viii) Fishery characterisation of hammerhead and thresher sharks	Medium	2025	2026	SC19 survey 86% Medium and agree on start date
(b) Develop reliable catch histories, assessment methods and data imput improvements				
i) Redefining the fleets currently assumed in the BSH NP stock assessment	Medium	2021	2022	Work completed (ISC/21/SHARKWG-2/I-01) the results indicate that no change to the fleet composition used in the assessment was required.
ii) Developing a statistically robust and spatial/temporal optimized sampling strategy for biological data collection - consider ISCs approach.	High	2024	2025	SC19 survey 100% agreement
iii) Future options for assessments with less data due to ongoing reduction in retention of sharks (i.e. degradation of data for CPUE and estimation of catch)	Medium	2026	2027	SC19 survey 64% medium starte date 2024-2027 chose the mid
iv) Spatio-temporal abundance patterns and drivers of abundance indices for SP shortfin mako	Medium	2025	2026	SC19 survey 55% medium starte date 2025
v) Satellite tagging of mako sharks (juveniles and adults) in NZ, AU and the high seas east of NZ (genetic analysis also mentioned regarding natal homing)	Medium	2025	2027	SC19 survey 75% medium start 2025 (need 2 years for this work)
vi) Feasibility of tag-recapture methods to obtain estimates of M (for SP shortfin mako)	Medium	2025	2026	SC19 survey 60% medium start date 2025
(c) Test and improve Medium and Data Poor assessment methods to inform management decisions				
i) Include data poor assessment metrics as standard outputs for data rich assessments where posssible	High	Ongoing	Ongoing	Done in SP-BSH, SP-mako? SC Shark ISG may want to review these and provide a specific list for future assessments.
(d) Assess the success of management				
i) Review the impact of CMM-2022-04	High	2027	2028	SC19 survey 100% agreement on priority and start date

Mitigation				
Title	Priority	Start year	End year	Comments
(a) Provide advice on mitigation Sharks with non-retention policies and unwanted elasmobranchs				
i) Investigate effective mitigation for WCPFC Key Sharks	Medium	2023	2025	To do - still planed project scheduled for proposal at SC19
ii) Investigate mitigation method trade-offs between mitigation methods for sharks, seabirds and sea turtles	Medium	2023	2025	To do - still planed project scheduled for proposal at SC19
(b) Provide advice on safe release methods and assess release survival of WCPFC Key Sharks				
i) Estimate silky and oceanic whitetip shark post release survival from WCPO longline fisheries	High	2025	2026	SC19 survey 59% high priority. Some work undertaken in EPO (IATTC - Shaffer) preliminary results indicate a post-release mortality rate of 5.7% for silky sharks Hutchinson and Bigelow - OCS (67-92% survival) FAL (100% survival)
ii) Estimate whale shark post release survival from WCPO purse seine fisheries	TBD	TBD	TBD	Hot spot analysis suggested as part of assessment project a) vi) postpone until those results are on the table
iii) Estimate the retention time of elasmobranchs entangled in FADs	Low	2025	2027	SC19 survey 50% low

Biology				
Title	Priority	Start year	End year	Comments
(a) Increase the understanding of important biological parameters of WCPFC Key Sharks				
i) Silky shark and oceanic whitetip shark reproductive biology and longevity	High	2027	2030	To do - still planed but probably delayed due to COVID delays for observer training in biological data collection. Schedule work once enough samples have been collected.
ii) Biology and life history of hammerhead sharks	High	2025	2027	To do - still planed but probably delayed due to COVID delays for observer training in biological data collection. Schedule work once enough samples have been collected.
iii) Resolving blue shark reproductive biology and reproductive schedule	Medium	2025	2027	To do - still planed but probably delayed due to COVID delays for observer training in biological data collection. Schedule work once enough samples have been collected.
iv) Biology of the longfin mako shark	Medium	2025	2027	To do - still planed but probably delayed due to COVID delays for observer training in biological data collection. Schedule work once enough samples have been collected.
v) Life history of thresher sharks	Medium	2025	2027	If not assessment this can get a lower priority
vi) Validated life history, biology, and stock structure of the shortfin mako in the south Pacific	Medium	2025	2027	To do - still planed but probably delayed due to COVID delays for observer training in biological data collection. Schedule work once enough samples have been collected.
vii) Age validation and stock structure of the silky shark and oceanic whitetip shark	Low	2025	2027	To do - still planed but probably delayed due to COVID delays for observer training in biological data collection. Schedule work once enough samples have been collected.
viii) Stock structure and life history of southern hemisphere porbeagle shark	Low			Move to CCSBT
ix) Biology of manta and mobulid rays	High	2027	2030	SC19 survey 45% high (35% medium and 20% low) start date most 2027
x) Stock structure of manta and mobulid rays	High	2027	2028	SC19 survey 50% high
xi) Stock structure of hammer head sharks	Low	2026	2030	SC19 survey 55% low
xii) Genetic CKMR (and stock structure and natal homing) scoping study all species	Medium	2026	2027	82% medium with a start date of 2026
xiii) Review of non lethal approaches to collect life-history data (e.g. reproductive status from blood samples) to inform observer training	Medium	2025	2026	45% medium (35% high 20% low)

Observer data				
Title	Priority	Start year	End year	Comments
(a) Improve spatio-temporal observer data for informing scientific needs				
i) Training observers in the WCPO to be proficient in species identification	High	Ongoing	Ongoing	Material developed by SPC: Park T., Marshall L., Desurmont A., Colas B. and Smith N. 2019. Shark and ray identification manual for observers and crew of the western and central Pacific tuna fisheries. Noumea, New Caledonia: Pacific Community. 79 p. Observer training ongoing
ii) Training observers for extraction and storage of vertebrae and shark reproductive material	High	2021	Ongoing	SPC currently looking at getting the protocols developed for shark biological sampling through a consultant. This should also ensure that observer training covers good sampling practices for tissue samples to reduce cross-contamination.
iii) Training observers for on-deck reproductive staging of elasmobranchs	High	2021	Ongoing	SPC currently looking at getting the protocols developed for shark biological sampling through a consultant
iv) Measuring elasmobranchs on purse seine and longline vessels for length-length and length-weight conversion factor development	High	Ongoing	Ongoing	ROP training conversion factor measurements have just been introduced - COVID delay.

6.4 Seabirds

6.4.1 Review of seabird research

6.4.2 Review of CMM on seabirds (CMM 2018-03)

229. SC19 noted that Aotearoa New Zealand was offering to lead a review of CMM 2018-03 "To ensure that effective mitigation methods are required and applied across the Convention Area where there is bycatch risk to vulnerable seabirds from longline fishing" and that its proposed scope would include I) the spatial extent of required mitigation methods, II) the Southern Hemisphere mitigation options and specifications, and III) the Northern Hemisphere mitigation options and specifications. To ensure a meaningful and collaborative review of CMM 2018-03, Aotearoa New Zealand was also offering to establish and lead informal intersessional meetings with interested CCMs to review the latest scientific evidence on seabird bycatch mitigation and gather views on the review of CMM 2018-03. Aotearoa New Zealand would aim to draft a revision of CMM 2018-03 for submission to SC20, TCC20, and WCPFC21. SC19 supported this approach to the review of CMM 2018-03.

6.5 Sea turtles

6.5.1 Review of sea turtle research

6.5.2 Review of Sea Turtle CMM (CMM 2018-04)

230. **SC19 suggests development of a best practices and guidelines to minimize the impact of FADs on sea turtles to inform CCMs of potential impacts. Ideally this would include detailed information on Fully Non-entangling FAD and ideas related to a "FAD WATCH" program**.

6.6 Cetaceans

231. SC19 noted the value of improving the understanding of interaction rates, particularly species-specific rates, of cetaceans in the WCPO fisheries, in particular those species of conservation concern.

232. **SC19 did not support the proposal from the IWC to engage in an ABNJ project focussed on assessing and mitigating cetacean bycatch and its impacts on cetacean populations in the WCPO**.

6.7 Bycatch management

AGENDA ITEM 7 OTHER RESEARCH PROJECTS

7.1 Pacific Marine Specimen Bank (Project 35b)

233. SC19 noted the progress report of the Pacific Marine Specimen Bank Project (SC19-RP-P35b-01). **SC19 endorsed the following recommendations from the PMSB Steering Committee (SC19-RP-P35b-02)**:

1) Continue to support initiatives to increase rates of observer biological sampling, noting that this contribution is essential to the ongoing success of the WCPFC's work.
2) Incorporate the identified budget into the 2024 budget and the 2025-26 indicative budgets, as development of the WCPFC PMSB is intended to be ongoing and is considered essential.
3) Support efforts to obtain further super-cold storage capacity to ensure longevity of PMSB

samples.

4) Endorse the work plan in Section 5 of SC19-RP-P35b-01 to be pursued by the SSP, in addition to standard duties associated with maintenance and operation of the WCPFC PMSB in 2023-24.

7.2 Pacific Tuna Tagging Project (Project 42)

234. SC19 noted the report of ongoing progress in the implementation of the PTTP (SC19-RP-PTTP-01). **SC19 endorsed the following recommendations from the PTTP Steering Committee (SC19-RP-PTTP-02):**

1) Note the successful 2022 WP6 tagging voyage despite the mechanical issues arising from the ageing charter vessel;
2) Note the urgent need for refurbishment of the current pole & line tagging platform in time for the scheduled 2024 skipjack-focused tagging cruise;
3) Note the critical importance of effective tag seeding to informing stock assessment, support further increasing recent improvements in deployment number and fleet, and assist with developing alternative approaches to understand the flow of tags through tuna product networks;
4) Note the need for continued member participation and support in cruise permitting, tag reporting, and industry support of the tagging programme (e.g., through the sharing of drifting FAD buoy data);
5) Support 2024 tagging programme, work-plan and associated budget (noting recommended increase in the WCPFC contribution to USD 800,000);
6) Support the 2025-2026 tagging programme, work-plan, and indicative budget (Noting further incremental increases in WCPFC contribution for a more balanced SSP co-financing of 25%).

7.3 West Pacific East Asia Project

235. **Based on the End of Project Gap Analysis (SC19-RP-WPEA-02), SC19 recommended the development of a new project proposal for the next phase of WPEA work that is relevant to the WCPFC, to begin immediately after the current WPEA-ITM project expires at the end of 2024**.

7.4 Other Projects

AGENDA ITEM 8 — COOPERATION WITH OTHER ORGANISATIONS

AGENDA ITEM 9 — SPECIAL REQUIREMENTS OF DEVELOPING STATES AND PARTICIPATING TERRITORIES

AGENDA ITEM 10 — FUTURE WORK PROGRAM AND BUDGET

10.1 Development of the 2024 work programme and budget, and projection of 2025-2026 provisional work programme and indicative budget

236. There were no objections raised regarding the progress and results of 2023 SC projects through the Online Discussion Forum.

237. **Based on the outputs of Informal Small Group 6 (ISG06), SC19 recommended the proposed work program and budget for 2024 and indicative budget for 2025 – 2026 together with CCM's priority scores to the budgeted projects in Table WP-01 (below) to the Commission**.

TABLE WP-01. Recommended Future Work Program and Budget for 2024 – 2026. Average score is based on Table WP-01 *SC Project Scoring Table* in the SC17 Summary Report (annexed below), with priority rankings: 6&9 = High; 3&4 = Medium; 1&2 = Low. 'No. CCMs' represent the number of CCMs which provided scores on that project. (Excel file at SC19-GN-WP-07a, and P19X*i* represents an arbitrary Project ID number proposed by SC19)

No.	Project Title	2023	2024	2025	2026	Notes	CCM Score	#CCMs
	Sub-item 1. Scientific services							
1	SPC-OFP scientific services		1,000,734	1,020,749	1,041,164	Budget: 2% annual increase		Essential
	Sub-item 2. Scientific research							
2	SPC Additional resourcing		180,204	183,808	187,484	Budget: 2% annual increase TOR: MFCL work		Essential
3	SPC FIRST additional stock assessment scientist		165,000	168,300	171,666	Budget: 2% annual increase		TBC at WCPFC20
4	SPC SECOND additional stock assessment scientist		165,000	168,300	171,666	Budget: 2% annual increase		TBC at WCPFC20
5	**P35b**. WCPFC Pacific Marine Specimen Bank		107,373	109,520	111,711	**Responsibility: SPC** Budget: 2% annual increase		Essential
6	**P42.** Pacific Tuna Tagging Program		800,000	875,00	950,00	**Responsibility: SPC**		Essential
7	**P60.** Purse seine species composition					**Responsibility: SPC** Carry over 2021 budget of $30,000 to 2023		No scoring required
8	**P100c**. Preparing WCP tuna fisheries for application of CKMR methods to resolve key SA uncertainties. (Duration: 2023 - 2025)					**Responsibility: SPC** Funding: WCPFC, SPC, EU, IATTC and CSIRO Budget (matching fund) approved at WCPFC18		No scoring required
9	**P109**. Training observers for elasmobranch sampling					**Responsibility: SPC** (On-going)		No scoring required

10	**P115**. Exploring evidence and mechanisms for a long-term increasing trend in recruitment of skipjack tuna in the equatorial Pacific and the development and modelling of defensible effort creep scenarios					**Responsibility: SPC** Continue to 2024 with no-cost extension		No scoring required
11	**P19X1**. Estimating impacts to sharks between 20N and 20S					**Responsibility: USA** (In-kind contribution by USA)		No scoring required
12	**P19X2.** WCPFC tuna biological sampling plan					**Responsibility: SPC** (In-kind contribution by USA--- with budget implication in the future)		No scoring required
13	**P19X3.** WCPFC billfish biological sampling plan					**SPC complementary projects**		No scoring required
14	**P68.** Seabird mortality		30,000	35,000		**Responsibility: SPC** Indicative budget approved at WCPFC18 Total budget for 2024 + 2025 = $75,000 ($10,000 will be provided by NZ in 2024)	**4.9**	**24**
15	**P90**. Length weight conversion (WCPFC17 endorsed the extension of P90 to 57 months until Sep. 2023)		20,000	20,000		**Responsibility: SPC** (On-going)	**6.2**	**23**
16	**P108**. WCPO silky shark assessment (50K)		100,000			**Responsibility: SPC** Indicative budget approved for 2024 was $50K at WCPFC18; Total 2024 = $100,000 ($40,000 for risk assessment +	**7.4**	**24**

						$10,000 for travel to SC20)		
17	**P113b.** Develop stock status and management advice template for consistent reporting of stock assessment outcomes, uncertainties and risk		40,000			**Responsibility: WCPFC tendered activity**	**7.6**	**23**
18	**P114**. Improved coverage of cannery receipt data for WCPFC scientific work		60,000	35,000		**Responsibility: SPC**	**5.4**	**24**
19	**P19X4:** Terms of Reference for a project to support additional work on trialling and supporting development of non-entangling and biodegradable FADs in the WCPO		29,000			**Responsibility: SPC** EU Project (funding of **USD 242,000**) that should be signed by November 2023. WCPFC's matching fund **(**Euro 44,000) is required for this contract. ISSF confirmed to support $20,000. WCPFC matching fund requried: $29,000	**8.0**	**24**
20	**P19X5.** Updated reproductive biology of tropical tunas		44,000			**Responsibility: SPC** EU Project (funding of **Euro 200,000**) that should be signed in November 2023. WCPFC's matching fund (**Euro 40,000**) is required.	**7.1**	**23**
21	**P19X6.** Ecosystem and Climate Indicators		20,000	20,000	15,000	**Responsibility: SPC**	**7.0**	**24**
22	**P19X7.** Scoping study on longline effort creep in the WCPO		30,000			**Responsibility: SPC**	**5.7**	**24**
23	**P19X8**. Scoping the next		50,000	50,000	50,000	**Responsibility: SPC**	**7.7**	**24**

	generation of tuna stock assessment software							
24	**P19X9.** Manta, mobulid and whale shark fisheries characterisation, CPUE standardisation and data-poor assessment		56,000			**Responsibility: SPC**	**5.2**	**24**
25	**P19X10.** Oceanic whitetip assessment in the WCPO (2024-2025)		60,000	60,000		**Responsibility: SPC**	**7.0**	**24**
26	**P19X11**. Developing a statistically robust and spatial/temporal optimized sampling strategy for shark biological data collection		40,000	45,000		**Responsibility: WCPFC tendered activity**	**5.0**	**23**
	Total Sub-item 2.	**1,231,938**	**1,996,577**	**894,928**	**707,527**			
	Total SC budget (Sub-items 1+2)	**2,063,050**	**2,997,311**	**1,915,677**	**1,748,691**			
	Total Sub-item 2 (WCPFC19 INDICATIVE)		**1,267,577**					

SC17 Summary Report – Table WP-01. SC project scoring table. Colours represent priority rankings (6,9 = High; 3,4 = Medium; 1,2 = Low):

		Importance to WCPFC Management Outcomes or to the functioning of the SC		
	Rank	Low	Moderate	High
Feasibility: Likelihood of Success	Low	1	2	3
	Moderate	2	4	6
	High	3	6	9

Notes:

Importance criteria evaluate the significance of the outcomes of the proposal in contributing to the successful management of the WCPFC stocks or the functioning of the SC (e.g. is the proposal aligned with the WCPFC research and/or management priorities; does the proposal contribute to the effective planning and functioning of the SC; are the intended outputs/benefits well-defined and relevant; what is the level of impact and likelihood that the proposal outputs will be adopted; is the proposal cost effective). High= Essential; Moderate=Important but not essential; Low=Not Important.

Feasibility criteria evaluate the proposal's potential for success i.e., how likely is the proposal to achieve its stated objectives (e.g. are the objectives clearly stated, is the methodology sound, are the project objectives realistic and likely to be achieved, does the research team [if identified] have the ability, capacity and track record to deliver the outputs).

AGENDA ITEM 11 — ADMINISTRATIVE MATTERS

11.1 Future operation of the Scientific Committee

238. SC19 considered the outputs of the Informal Small Group 2 (ISG02) convened to discuss the future operation of the Scientific Committee, recorded in Attachment 4.

239. **SC19 recommended that the options outlined in the Table to Attachment 4 be further explored by the Secretariat, SC Chair, Vice-Chair and Convenors in order to develop recommendations for improving the structure and functioning of the SC, to be presented to SC20.**

240. **SC19 recommended that the Commission consider reducing the length of SC to 7 days in 2024. The length of future SC meetings should be further considered following the 7-day SC20, particularly considering the workload for subsequent SC meetings**.

11.2 Election of Officers of the Scientific Committee

241. SC19 nominated Emily Crigler (USA), who is the current SC Vice Chair, as future SC Chair, noting her excellent performance as Acting Chair for the SC19 meeting.

11.3 Next meeting

242. SC19 recommended to the Commission that SC20 would be held from 14 – 21 August 2024, and that, subject to confirmation in December, Tonga offered to host SC20 in 2024.

AGENDA ITEM 12 — OTHER MATTERS

AGENDA ITEM 13 — ADOPTION OF THE SUMMARY REPORT OF THE NINETEENTH REGULAR SESSION OF THE SCIENTIFIC COMMITTEE

243. SC19 adopted the recommendations of SC19 in session.

244. **SC19 agreed that the Summary Report of the 19th Regular Session of the WCPFC Scientific Committee would be adopted intersessionally according to the following indicative schedule:**

Indicative Schedule	Actions to be taken
24 August 2023 Close of SC19	By 4 September, *SC19 Outcomes Document* will be distributed to all CCMs and observers (within 7 working days, Rules of Procedure).
By 31 August	Secretariat will receive a Draft Summary Report from the rapporteur.
By 7 September	Secretariat will clear the Draft report, and distribute the cleaned report to all Theme Convenors for review.
By 14 September	Theme conveners will review the report and return it back to the Secretariat
By 19 September	The Secretariat will post/distribute the draft Summary Report (including the Executive Summary) to all for CCMs' and Observers' review
By 31 October	Deadline for the submission of comments from CCMs and Observers

AGENDA ITEM 14 CLOSE OF MEETING

245. The SC Chair closed SC19 at 1:32pm Koror time on Thursday, 24 August 2023.

Attachment 1

The Commission for the Conservation and Management of
Highly Migratory Fish Stocks in the Western and Central Pacific Ocean
Scientific Committee
Nineteenth Regular Session
Koror, Palau
16-24 August 2023

Report from ISG-3 Draft Tuna Assessment Research Plan (TARP) for 'key' tuna species assessments in the WCPO, 2023-2026

The request from Head of Delegation meeting of SC19 for informal small group 3 (ISG-03) was to review Tuna Assessment Research Plan (TARP, SC19-SA-WP-15).
The requests from SC19-SA-WP-15 to the ISG were to:

1) assess the draft TARP,
2) fill identified gaps and
3) identify priority work areas for the development of new SC project proposals for consideration at SC19.

The convenor suggested that the scope of 1 and 2 were very broad for the ISG to consider in the time allotted and these items could be addressed intersessionally.

Members indicated there were three new projects for SC19 consideration:

1) Scoping study on longline effort creep in the WCPO,
2) WCPFC tuna biological sampling plan and

There are 54 projects within the Tuna Assessment Research Plan (TARP) for 'key' tuna species assessments in the WCPO, 2023-2026. Thirty-seven projects are funded in 2024 and perhaps longer. The ISG-3 reviewed the titles of the 17 unfunded projects (Table 1). A project proposal has been developed for three project addressing reproductive biology. The remaining 14 projects were reviewed and two projects were prioritized for proposals for SC19 consideration: 1) Investigation of approaches to ensure WCPO assessment software remains fit-for-purpose, including enhancing existing or developing new modelling software and 2) Project 113b - Develop stock status and management advice template for consistent reporting of stock assessment outcomes, uncertainties and risk.

There was one project added to the TARP - Simulation evaluation of alternative spatial structures and model configuration/complexity of the assessment models.

Table 1. Unfunded projects within the research plan for WCPO 'key' tuna stocks (subset of SC19-SA-WP-15).

Stock/Focus area	**Research need**	**Activity**	**Funding** (incl. SC budget lines)	**Timescale** 2023[1]	2024	2025	2026	**Lead**
Common across stocks	Improved stock assessment software performance and features suited to WCPFC tuna	Explore approaches to capture spatial patterns and variation in biological parameters into assessments	**Not currently resourced**		(X)	(X)	(X)	TBD
		Investigation of approaches to ensure WCPO assessment	Existing WCPFC SC 'additional	X	(X)	(X)	(X)	SSP/SC

	assessments	software remains fit-for-purpose, including enhancing existing or developing new modelling software	resourcing SPC' funding line; **additional resources required**					
	Improved abundance indices	Proposal for a cross-tuna-RFMO workshop on abundance indices modelling to apply best practice, and to consider approaches for standardisation of size composition data.	**Not currently resourced**	(X)	(X)			SC
	Improved fishery input data	Improved data for WPEA fisheries (E1(7))	NZ-funded WPEA project, **not currently resourced post March 2025**	X	(X)	(X)	(X)	WCPFC Sec
		Improved accounting for discards and longline depredation losses in stock assessments	**Not currently resourced**		(X)	(X)		TBD
		Improved/enhanced collection of logbook and observer longline data, including the use of EM, to improve SC analyses (CPUE standardisation focus)	**Requires WCPFC mandate**	(X)	(X)	(X)		SC
	Biological inputs	Enhanced collection of fish hard parts and measurements from across the WCPO region for all relevant stocks, with a focus on age-length data (E4(6))	SC Project 35b, **additional resources required**	X	(X)	(X)	(X)	SSP/SC
		Further investigation of input size composition data, with review of all size composition data for tuna assessments (E1(1); E1(2); E1(3))	Existing SPC resourcing, **additional resources required**	X	(X)	(X)	(X)	SSP
Skipjack	Biological inputs	Update estimates of reproductive potential (E4(4))	EU and SC supporting funding being		(X)	(X)		SSP

			sought (SC19-SA-WP-17)					
		Validate growth and improve growth estimates	Other resourcing, **additional resourcing may be required**	X	(X)	(X)		AU/SSP
Bigeye	Biological inputs	Age validation and improved growth estimates	(SC Project 105 complete) **Additional resourcing required**		(X)	(X)		TBD
		Update reproductive biology estimates (E4(4))	EU and SC supporting funding being sought (SC19-SA-WP-17)		(X)	(X)		SSP
		Improved weight conversion factors (e.g. G&G to whole wt) (E4(5))	SC Project 90. **Additional resourcing required**	X	(X)	(X)		SSP/SC
Yellowfin	Biological inputs	Age validation and improved growth estimates	(SC Project 105 complete) **Additional resourcing required**		(X)	(X)		TBD
		Update reproductive biology estimates (E4(4))	EU and SC supporting funding being sought (SC19-SA-WP-17)		(X)	(X)		SSP
		Improved weight conversion factors (e.g. G&G to whole wt) (E4(5))	SC Project 90. **Additional resourcing required**	X	(X)	(X)		SSP/SC
South Pacific albacore	Biological inputs	Ongoing NZ troll fishery characterisation and CPUE	**Additional resources may be required**	(X)	(X)			NZ/TBD

Attachment 2

The Commission for the Conservation and Management of
Highly Migratory Fish Stocks in the Western and Central Pacific Ocean
Scientific Committee
Nineteenth Regular Session
Koror, Palau
16-24 August 2023

Report from ISG-04 (ISG-Billfish)

There was a request from SC19-SA-WP-16 ("Billfish research plan 2023 - 2027") for ISG-Billfish to review the following recommendations:

1. Extend the BRP to 2030
2. Evaluate, streamline, schedule and prioritize the projects listed in SC19-SA-WP-16 Table 7 and to develop ToRs for any projects given high priority for 2024.
3. Take into account metrics listed SC19-SA-WP-16 Tables 4 & 5 when reporting assessment results
4. It is recommended that standardised CPUE analyses and fishery characterisations be undertaken for black marlin, sailfish and shortbill spearfish and that the SC19 ISG-billfish consider prioritisation and timing for this work.
5. It is recommended that a stratified sampling program be designed to make biological sampling most efficient and useful.
6. It is also recommended that the SC discuss how to incorporate the SC17 recommendations on Limit Reference Points into the BRP and develop a process to make recommendations to the Commission on agreed LRPs for use within assessments.
7. It is also recommended that on all longline logsheets vessels record time as UTC and not ships time so that local time can be estimated.

1. Extension of the BRP to 2030

This was supported by ISG-04 on the basis that is sensible for long term planning, and suggest that an annual ISG Billfish (held at SC) be convened to inform ongoing and future projects planning.

2. Evaluate, streamline, schedule and prioritize the projects

The majority of ISG-04 time was spent discussing projects listed in SC19-SA-WP-16 Table 7 in order to evaluate, streamline, schedule and prioritized projects since there were a number of projects with similar scope and overlapping themes. The ISG-04 discussed the need for improved biological data for all billfish species (swordfish, striped marlin, blue marlin, black marlin, sailfish, and short-billed spearfish) within the WCPFC convention area, since this was a feature of many of the project proposals. The ISG-04 noted that the ISC has developed and implemented a structured sampling plan for three billfish species in the north Pacific Ocean (SC19-SA-IP-11), and identified that prior to collecting the needed biological data it would be important to develop a structured sampling plan in collaboration with the ISC similar to the one proposed in SC19-SA-IP-11. The ISG-04 also noted that once a sampling plan is developed there will likely have to be subsequent prioritization and scheduling needed to define which data is collected. The ISG-04 acknowledged that ToRs for the collection of the biological data according to the sampling plan may have to be developed in subsequent years.

The ISG-04 also discussed the need for conducting a feasibility study for the application of close-kin mark-recapture (CKMR) to SWPO swordfish. The ISG-04 noted that there are existing efforts underway in the region to develop scoping studies for applying CKMR to SWPO swordfish as a part of WCPFC Project 100c.

Following these discussions, the working group identified three projects as high priority: development of a structured biological sampling plan for billfish, application of CKMR for SWPO swordfish, and a directed longitudinal tagging project for SWPO swordfish. The ISG-04 proposed scheduling the development of the biological sampling plan for 2024, and a ToR was subsequently developed. The ISG-04 deferred developing a ToR for exploring the feasibility of applying CKMR to SWPO swordfish pending the results of WCPFC Project 100c. The ISG-04 proposed scheduling the tagging study for 2025/2026 and deferred developing a ToR until SC20.

3. Take into account metrics listed in SC19-SA-WP-16 Tables 4 & 5 when reporting assessment results

The ISG-04 was generally supportive of reporting the metrics listed SC19-SA-WP-16 Tables 4 & 5 when reporting assessment results on a voluntary basis. However, the ISG-04 also noted that for some of the metrics listed, specific percentage values are undefined.

4. Standardised CPUE analyses and fishery characterisations for black marlin, sailfish and shortbill spearfish

The ISG-04 assigned assessment of black marlin, sailfish, and short-billed spearfish as a medium priority item. However, prior to beginning any assessment or analysis of these species the ISG-04 suggested developing conceptual models for these species to identify the most appropriate modelling approach. The ISG-04 proposed that this characterization/conceptual modelling work could take place in 2025, and development of ToR was deferred until SC20. Related to these species, ISG-04 made the request to ISG-01 that short-billed spearfish and sailfish be added into the SciData, and this will be considered at TCC19.

5. Development of a stratified sampling program for biological data

The ISG-04 discussed this issue and identified it as a high priority item. A ToR was developed with a proposed start date of 2024.

6. Discuss how to incorporate the SC17 recommendations on Limit Reference Points into the BRP and develop a process to make recommendations to the Commission on agreed LRPs for use within assessments

The ISG-04 developed the following text for SC19 to put forward to WCPFC20:

Noting that SC17 agreed a framework for selecting LRPs for billfish species, SC19 seeks general guidance from the Commission on whether in the case of non-targeted species it is acceptable to have a higher level of risk to the stock and a lower biomass LRP compared with the equivalents for target species.

7. Logsheet reporting in UTC time

The ISG-04 made the request to ISG-01 that longline vessels record time as UTC and not ships time so that local time can be determined. Following discussion within ISC-01, SC19 recommended that the date of start of set and time of start of set should be, where required, reported in a way that can be linked back to GMT/UTC.

Appendix I: Updated Table 6 for inclusion in revised SC19-SA-WP-16

Stock assessment				
Title	Priority	Start year	End year	Comments
Assessment 1) North Pacific striped marlin stock assessment	High	2023	2023	Previous assessment successfully conducted by the ISC
Assessment 2) Southwest Pacific striped marlin stock assessment	High	2024	2024	Previous assessment successfully conducted by the SPC
Assessment 3) North Pacific swordfish stock assessment	High	2023	2023	Previous assessment successfully conducted by the ISC
Assessment 4) Southwest Pacific swordfish stock assessment	High	2025	2025	Previous assessment successfully conducted by the SPC
Assessment 5) Pacific blue marlin assessment	High	2026	2026	Previous assessment successfully conducted by the ISC
Assessment 6) Modelling approaches for WCPO black marlin, sailfish and shortbill spearfish	Medium	(2025)	(2025)	Develop conceptual models for each species to identify appropriate modelling approaches for low catch low information assessments

Appendix II: Updated Table 7 for inclusion in revised SC19-SA-WP-16

Biology				
Title	Priority	Start year	End year	Comments
Biology 1) Development of a statistically robust sampling plan for the collection of fisheries dependent biological samples (by sex), including but not limited to age, size frequency data, and genetic samples for WCPO swordfish (north and south).	High	2024	2025	
Biology 2) Biology of south Pacific striped marlin, blue marlin, black marlin, shortbill spearfish and sailfish in the WCPO from longline fisheries.	High	2025	2028	Collect samples (fin spines and otoliths) and then undertake age growth and reproductive analyses to get growth and maturity parameters to inform productivity rates of this species. Length-weight and length-length conversion factor data collection for SP striped marlin.
Biology 3) Undertake directed longitudinal tagging of southwest Pacific swordfish to reduce the uncertainty in movement rate.	High	2025	2027	

Attachment 3

The Commission for the Conservation and Management of
Highly Migratory Fish Stocks in the Western and Central Pacific Ocean
Scientific Committee
Nineteenth Regular Session
Koror, Palau
16-24 August 2023

WCPO skipjack management procedure monitoring report

This summary monitoring report is intended to provide an overview of the status of the management procedure (MP) for WCPO skipjack tuna and to allow for information to be collated progressively as elements of the MP are considered by different groups and Commission bodies (as outlined in the Appendix).

The summary monitoring report lists the elements of the WCPO skipjack MP monitoring programme, the status of those elements after review by the relevant body of the Commission, and identifies those elements that may require additional work or through which problems have been identified. Highlighted elements have a priority placed on the corresponding issue, based on the issue's considered severity and the amount of work likely required to address it. This is summarised in the table below. This report also includes summary paragraphs following the table, which provide further details of the work required.

Each of the Commission's bodies is requested to review and update their previous comments on an annual basis, as necessary.

Monitoring report summary table

Item	MP element	Commission Body	Status and comments	Priority
		1. Review MP performance		
1.1	Comparison with stock assessment	SC19	Will be reviewed following implementation of the MP through the stock assessment scheduled in 2025, noting however that there will only be one year of MP implementation included within that assessment.	
1.2	Data availability & quality	SC19	The level of pole and line CPUE data in tropical regions is declining over time. If this trend continues, there may be insufficient information to inform the MP. Work should begin to evaluate alternative MPs that are robust to this potential decline in pole and line data availability.	**High**
		TCC19		
1.3	Other sources of data	SC19	No new information noted at SC19.	-
		TCC19		
1.4	EM performance	SC19	The EM showed acceptable performance.	
		2. Review of the MP		
2.1	Management objectives	WCPFC20		-
2.2	Scope of the MP	SC19	No new information at the time of SC19.	-
		TCC19		
		WCPFC20		

2.3	Exceptional circumstances	SC19	None identified by SC19.	-
		TCC19		
		WCPFC20		
3. Review MSE framework				
3.1	Operating model grid	SC19	The OM grid (robustness set) to be augmented with climate change scenarios. Further consideration of the OM grid is also suggested given the predicted outcomes of the adopted MP and the 2022 stock assessment showed some departure for the historical period. These issues will be considered for inclusion when the current MP is reviewed.	Medium
3.2	Calculation of performance indicators	SC19	No new information at the time of SC19.	-
3.3	Modelling assumptions	SC19	While no major issues are identified, any re-evaluation of the skipjack EM (identified under 1.2) may require a re-evaluation of the modelling framework.	**High**
3.4	Data availability and quality	SC19	Generally good	
		TCC19		

Further Details

1. Review MP performance

1.1 Comparison against stock assessment outcomes: With the first implementation of MP outputs in 2025, the stock assessment for WCPO skipjack in 2026 will be the first in which the impact of the MP on stock status will be experienced. There will only be one year of MP implementation included within that assessment, so this comparison will be preliminary. A comparison of the MSE predicted outcomes of the adopted MP and the 2022 stock assessment shows good correspondence for the most recent years but shows some departure for the historical period. This is considered under 3.1.

1.2 Data availability and quality: Sufficient data were available to run the MP. However, it was noted that pole and line fishing effort in tropical regions continues to decline and this presents a potential problem for the future running of the MP. A re-evaluation of the estimation method is recommended prior to the next implementation of the MP. This issue is a high priority.

1.3 Other sources of data: No other sources of data have been identified.

1.4 EM performance: Overall the estimation method performed well and provided estimates of stock status within the prediction range of the MSE.

2. Review MP

2.1 Management objectives: No change noted by SC19.

2.2 Scope of the MP: No change noted by SC19.

2.3 Exceptional circumstances: None identified by SC19.

3. Review MSE framework

3.1 Operating model grid: OM grid to be extended to include climate change scenarios (robustness set). In particular the effects of warm pool expansion in WCPO. These analyses require further analysis of the SEAPODYM outputs and may occur over an extended timeframe. This issue is considered to be of medium priority. The comparison of the MSE predicted outcomes of the adopted MP and the 2022 stock assessment did show some departure for the historical period. This is not considered a major problem affecting the MP but some further investigation of the OM grid may be required.

3.2 Calculation of performance indicators: No change in performance indicators required at this time.

3.3 Modelling assumptions: no issues identified; however, re-evaluation of the skipjack EM (identified above) may require a re-evaluation of the modelling framework (for example the calculation of simulated data used to test the MP). This issue is of high priority.

3.4 Data availability and quality: Generally good - some changes may be required depending on the approach adopted to address the decline in pole and line fishing in tropical regions.

Appendix to Attachment 3. Elements of the management procedure that may be considered for inclusion in the monitoring strategy and the Commission body at which those considerations can be made. (Table 2 of Annex III, CMM 2022-01).

MP Element	**Commission Body**	**Monitoring Considerations**
	1. Review MP performance	
Comparison of predicted MP performance against latest assessment outcomes	SC	Check that the MP is performing as expected
Data availability to run the MP	SC/TCC	Check availability, quantity and quality of data necessary to run the MP (e.g. the estimation method)
Other sources of data to monitor performance	SC/TCC	Identify other data as available, that may not be included in the MSE framework, to inform calculation of performance indicators (economic, social, ecosystem, etc.)
Performance of the estimation method	SC	Confirm the EM is performing well and not subject to estimation failure
	2. Review of the MP	
Management objectives	Commission	Check that overall objectives of the MP remain appropriate
Scope of the management procedure	SC/TCC/Comm	Confirm the fisheries controlled by the MP, and the method of control, remains appropriate
Exceptional circumstances	SC/TCC/Comm	Drawing on all of the above, have events (unexpected, extra-ordinary) occurred such that remedial action is required to either review modify or replace the MP
	3. Review MSE framework	
Operating model grid	SC	Ensure that the most important sources of uncertainty are included in the OM grid
Calculation of performance indicators	SC	Check for appropriate representation of objectives by performance indicators
Modelling assumptions	SC	Consider the technical details of the simulation and testing framework
Data availability to support the MSE framework	SC/TCC	Improvements to data collection to either enhance the OM framework or to reduce uncertainty included in the OM grid

Attachment 4

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean
Scientific Committee
Nineteenth Regular Session
Koror, Palau
16-24 August 2023

Summary of Online Discussion Forum Comments on Future Operations of the Scientific Committee

GN-WP-06 (Rev.01)
Comments Received from USA, SPC, PNAO, Chinese-Taipei, EU, FFA, MI-Theme Convenor

Objective
Efforts must be taken in order to retain the quality and presentation of highly valuable scientific information in whatever approach is taken. Future operations of the SC must continue to provide high-quality scientific advice to the Commission.

USE OF ALTERNATIVE PLATFORMS

ODF
Can be seen as a useful complementary tool to provide feedback on papers/topics that are not discussed in plenary. At present it is not seen as providing a viable option to replace the substantive discussion and review of papers during plenary. Also, seen as peripheral to the main SC record, and so not widely used. It may result in many instances in moving the work of the SC to other formats that might not be as efficient as in-person meetings.

May be useful for administrative agenda items, and for technical feedback 0(but again may not be used as delegates like to get views on the record).

Virtual Meetings:
Can be useful for small meeting groups but unlikely to replace SC plenary. Some issues associated with timing, etc. Many benefits from in-person meetings.

One suggestion is to take other RFMO's experience into consideration. For example, the SPRFMO SC meeting takes 5 days, but there are many intersessional working group held in virtual. The intersessional working group might help to reduce the SC meeting time, but too many virtual meetings will lead to increasing burden on members.

Video presentations
Little support as not many if any benefits from this approach. Likely to increase workload for both presenters and delegates, so does little to reduce workload. May be useful for some very specific matters (e.g., training materials).

STREAMLINED SC THEME AGENDA

Not much support of streamlining the SC agenda by reducing the number of items discussed as this is likely to reduce the functioning of the SC. Furthermore, important issues which had been discussed in previous in-person SCs did not get the scrutiny that they deserved during the streamlined SCs. Any time-savings from restructuring SC should be re-invested to increase discussion (e.g. stock assessments) rather than to reduce it.

Possibly some scope for re-prioritising WPs as IPs to save presentation time. However, any additional time is likely to be needed to allow more time for discussing WPs (as noted at this meeting).

Suggestions:

- move to 2-year assessment cycle, but may not save time at the SC.
- Condense theme sessions to be closer to one another, such that Theme sessions occur over a period of 3-4 days, which could reduce the duration of stay for a few delegates from larger delegations. For example, all MI theme sessions occur over days 1 – 3, all SA theme sessions occur over days 4-6, etc. However, need for time drafting recommendations, consideration of these drafts, and final discussion and adoption adds more days.
- Some CCMs have suggested that assessments should be streamlined or simplified to fit more appropriately as elements of the monitoring strategy of management procedures as the harvest strategy approach is developed.
- The EB agenda item could be streamlined by addressing species groups in a rolling 3 or 4 year programme instead of having management of sharks, seabirds and turtles on the agenda annually, noting that this would likely require appropriate CMM amendments.
- Simplified approach to some shark assessments in the face of very uncertain data

The idea of exploring whether possible to swap TCC and SC, as proposed in SC19-SA-WP-14, has general support.

SC DOCUMENT DEADLINES

The ~1 month deadline for submitting papers would provide additional time for members to review science. However, highly dependent on SSP schedules. Consideration of an earlier data deadline may be useful.

ADAPTATION OPTIONS FOR PROVISION OF SSP INPUT (from SC19-SA-WP-14)

No.	Adaptation option	Benefits	Drawbacks
1	Move data provision deadline from end April to earlier in the year (and maintain/move SC meeting timing (#4)).	Gives more time for supporting analyses to be performed, reviewed, updated.	Most recent year of data unlikely to be included in the assessment (SKJ) unless option #2 also pursued. Later-in-the-year updates to e.g., longline data may limit supporting analyses for all assessments. Could affect indicators/SPA trends papers etc. similarly.
2	Provide data more frequently throughout the year. For example, propose an additional data submission deadline for earlier in the year (e.g. end of February) to cover: (i) submission of updated ACE and AGGREGATE	Allows supporting analyses to be initiated earlier. Internal automatic checking on data entry should improve data quality and reduce manual checking processes. Data from the purse seine fishery are available in a more timely manner that other fisheries and would assist skipjack assessments in being as up to date as possible. Updates to data from previous years (*y*-2, *y*-3, *y*4) should usually	Region-wide and consistent adoption of ER required. Data checking processes need to be undertaken rapidly. Improves ability to undertake analyses by 2 months only.

	data for previous years (*y*-2, *y*-3, *y*-4, etc.), and (ii) submissions of ACE, AGGREGATE and SIZE data for (*y*-1) for the purse seine and other key fisheries for skipjack. (see discussions arising from the ER&EMWG on data provision at WCPFC19).	be available for this earlier deadline to assist in assessments for other stocks.	
3	Adopt mechanisms for more efficient data provisions, including: - Guidelines for standardised structure/file layouts for Annual Catch Estimates and aggregate catch/effort data are used by countries to submit their data. - Consideration of a new portal/app on the WCPFC web site for CCMs to enter/edit/manage their ACE data submissions.	Saves time on loading and checking the data submission into the WCPFC databases. Approach is consistent with the requirement to submit standardised operational catch/effort and observer data according to the WCPFC ER SSPs and the recent update to the Scientific data to be provided to the Commission (ANNEX 2).	Some initial work required by CCMs to change data submission formats, although the WCPFC SSP would assist CCMs to work towards any new requirements.
4	Move SC later in the year (and maintain/move data provision deadline (#1)).	Allows data provision up to the most recent year to be incorporated within (SKJ) assessment (if data provision deadline maintained; but see also #2, #3). Gives more time for supporting analyses to be performed, reviewed, updated.	Limited time for subsequent further analyses prior to that year's Commission meeting (e.g. during TT CMM years, for harvest strategy analyses, where managers require advice based upon SC outputs).
5	Move deadline for data input papers specifically earlier in the year.	Would provide greater time for SC feedback on input analyses.	Analyses undertaken early in the calendar year may not be updated with the latest information if the data deadline were not pushed earlier (#1). Current limited human resources available to undertake analyses well in advance of the assessment year and provide outputs for review. Additional burden on assessment scientists to re-run analyses once finalised data/suggested changes received.

			If data provision deadline maintained, analyses may need to be reduced and assessments simplified to achieve the deadline. Feedback on analyses would need to be rapidly received, as they may not lead to changes if the time available prior to the assessment finalisation were insufficient.
6	Increase resources to the SSP to provide additional person-power to deliver outputs.	More resources allow additional work to be performed, earlier in the year. For example, an additional staff position dedicated to data preparation and analysis and the development and maintenance of streamlined approaches for assessment reporting and repeatability. This would also help mitigate the time lost in inevitable staff turnover and the associated training and development requirement that typically must occur of new assessment staff.	Still constrained by the existing data/paper deadlines. Feedback on analyses would need to be rapidly received, as they may not lead to changes if the time available prior to the assessment finalisation were insufficient. Implications for SC budget.
7	Develop tools for more efficient review and feedback	Online tools such as GitHub and R Shiny apps allow interested regional scientists to view data inputs as they are produced. This could also extend to standard plots for model development and diagnostics. Can provide up to date information on assessments as they develop, rather all information being received close to the SC meeting. Perceived issues could be communicated directly to the SPC assessment scientists for wider consideration.	This approach requires staff resources to step away from assessment work to create, structure and populate tools and repositories in the initial stages. The tools would need to be easily accessible by all interested regional scientists. There is a risk that this type of more real time 'view/review' could lead to specific influences on assessments, without wider SC review. Requires time allocation by SPC scientists to keep up with feedback/comments and respond to these if necessary. There would be a need to be selective in the information provided to avoid representing a 'branch' of the assessment development process that is subsequently abandoned due to issues. Housing of the apps incurs some costs based upon the number of users/views/bandwidth levels required.
8	Reduce number of assessments performed each year.	Allows more assessment scientist time to be brought to bear on the assessment with existing resources. Reduces the volume of information/papers SC needs to review.	Without an increase in SSP funding to allow more scientist-time per assessment (#6), there would be a reduced number of assessments performed, the frequency of assessments for a stock would be reduced, and status advice for a stock developed less frequently.
9	Move to a cycle of 'update' and 'full' assessments	Allows more focus on one assessment each year (dependent upon the cycle period). Allows SC to focus their review on the 'full' assessment that year.	'Update' assessments do not necessarily allow the 'best available scientific information' to be developed. Ongoing improvements to assessments would not be actioned for all stocks in a timely manner. This approach may not be consistent with the use of the assessment as part of the harvest strategy's monitoring strategy
10	Extend the period over	Allows greater time to perform	Dependent on approach, if analyses were not re-

	which tuna assessments are performed to two years (as per recent decision for shark assessments). For example, perform a "preliminary assessment" that may be more focussed on structural and modelling changes, rather than data changes. Following SC review in the first year, that structure could then be fixed and a data update applied for the year 2 assessment.	input analyses, receive SC review, then perform the assessment. Assessments would be of comparable rigour to that currently provided.	run, it could increase the lag in the data relative to the year in which advice is provided by 1 year (to 2 to 3 years historically). This is significant, particularly for skipjack tuna where most of the population will not have been 'seen' within the assessment being considered. If SC's review 'set' the approach for data input development in the prior year, it would still increase assessment workloads under the current assessment cycle, as analyses could still need to be re-run with finalised data – particularly if issues were then identified - and reports re-written. Improvements to assessment inputs due to learnings from other assessments/reviews would be delayed by a year. Appears to provide little gain over the current approach where SC inputs to a data input approach in one year are adopted for the next assessments in line.
11	Reduce analyses/representation of uncertainty (size of the grid) in assessments and/or model diagnostics presented.	Assessment and assessment report production would be faster, providing more time post SC review. Saves SC some time spent in review of SC documents.	Does not significantly assist in the earlier delivery of input data analyses for SC review. Reducing grid size would result in a limited gain in personnel time. A grid with fewer uncertainty factors might not represent the full uncertainty and could thus underestimate the actual risk of unwanted management outcomes. Reduction in diagnostics will provide a slightly greater gain in time but reduce transparency and utility. Does not assist in the review of assessment inputs, which may inform uncertainty grid structure. Assessments may not continue to meet global 'best practice' or 'good practice' guidelines.
12	Improve planning of SC budget so that funding to support specific inputs does not delay their production.	Allows work on specific inputs to be started well in advance of the assessment being considered.	Only applies to specific (generally biological) assessment inputs, not those based on fisheries data.
13	Reduce the overall scope of issues considered across SC.	Reduces review workload of SC members allowing them to concentrate on assessments.	Reduces the ability of Scientific Committee to cover the range of topics for which advice is needed. Potentially slows down the incorporation of advice in management action.
14	Switch the timing of the SC and TCC meetings (TCC in August, SC in September)	Provides more time post data deadline to develop the stock assessments. Minimises the impact on the global meeting calendar	Limited time for subsequent further analyses prior to that year's Commission meeting (e.g. during TT CMM years, for harvest strategy analyses, where managers require advice based upon SC outputs). Impact on the preparation and activities of TCC needs to be considered.