SCIENTIFIC COMMITTEE
TWENTY-FIRST REGULAR SESSION

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Progress against the 2023-2030 Billfish Research Plan - 2025

WCPFC-SC21-2025/SA-IP-18 REV 1

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Amendments in this revision:

- Based on the feedback from the ISG billfish the BRP was amended.
- The amendments respond to the original recommendations in SA-IP-18.
- Revised project ToRs are included in Appendix 1.

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Introduction

The Billfish Research Plan (Brouwer and Hamer 2023) (Project 112) was adopted by SC19 and endorsed by WCPFC20 in 2023. The current Billfish Research Plan (BRP) is the 1st phase of the WCPFC's BRP. When reviewing the BRP SC19 recommended that it be extended to 2030. The 2023-2030 BRP is a living document that can evolve based on the information needs and priorities of the WCPFC. The plan has short annual reviews to evaluate the progress and ensure that the next years' work remains relevant and required.

Purpose and tasks of the BRP

The purpose of this document is to review progress against the BRP tasks to facilitate future planning of WCPFC billfish research. The project list is included in Table 1. In addition, Table 2 is provided to update the Scientific Committees assessment schedule for billfish. It was previously suggested that data rich assessments be attempted for blue marlin; striped marlin; and swordfish, with standardised CPUE analyses and fishery characterisations for black marlin, sailfish and shortbill spearfish. At SC19 the ISG-Billfish suggested that prior to beginning any assessment or analysis of these species it is important to develop conceptual models for these species, and identify the most appropriate assessment approaches. A workshop to review stock assessment methods for billfish is proposed below to address this.

For SC21 one scheduled project was completed, southwest Pacific swordfish stock assessment (SC21-SA-WP-05, SA-IP-11, SA-IP-12, SA-IP-13 and SA-IP-14). In addition, a revised assessment for southwest Pacific striped marlin has been tabled (SA-WP-06, SA-WP-07, SA-IP-13, SA-IP-14 and SA-IP-15) as have projections for north Pacific striped marlin (SA-WP-04).

One project (Stock assessment project 6 - Assessment approaches for WCPO black marlin, sailfish and shortbill spearfish) was not started. Given the difficulty in running billfish assessments the authors believe that there would be value in conducting a review of stock assessment methods for billfish. This should include low and high information stocks as well as multi-model approaches (low and high information for the same stock) and Bayesian assessment methods as is done in the shark assessments. This would preferably be done as an in-person workshop (and would benefit from including people who have successfully completed this type of approach for sharks). The review should be Pacific wide and include participation from IATTC and ISC. We suggest this be tabled as a joint bycatch assessment workshop for billfish and sharks. The focus should be pan-Pacific but could also invite experts from other tuna RFMOs. It is recommended that this be discussed at the ISG - billfish as SC21 and, if approved, a project specification be included. It is suggested that Stock assessment project 6 be repurposed as a ToR for this workshop.

There are two new projects scheduled to start in 2026 pending agreement at the SC21 ISG-Billfish and approval of the budget by WCPFC21. The first project, *Pacific blue marlin stock assessment*, would be undertaken by ISC subject to resourcing, if this is required to be outsourced by WCPFC, a ToR should be developed by SC21 ISG-Billfish. The second project, biology project 3, *Undertake directed longitudinal tagging of Southwest Pacific swordfish to reduce the uncertainty in movement rate*, was due to start this year. However, this project would likely be logistically complex, expensive and will have a small sample size and the results would be of limited use in the context of application within stock assessments. The authors suggest that this project would be more valuable and sample a wider range of fish if it is re-purposed as a genetics project, that could also include age validation and epigenetic aging work. It is recommended that this be discussed at the ISG - billfish at SC21 and, if

approved, a project specification be included. Note that some elements of this may be included in the general billfish biology work (SA-WP-11) and cost saving areas of overlap (such as sample collection and design) should be sought if possible.

Recommendations to SC21

1. SC21 ISG-Billfish review the work plan and project list for the 2025/26 year and make recommendations to SC21 for any changes the SC may want to consider.
2. SC21 ISG-Billfish review the project specifications and make any changes for SC21's review.
3. Re-purpose the Biology project 3 (SWO tagging) as a genetics project and develop the ToR at SC21 ISG-billfish, if approved. This was accepted by the ISG and an amended ToR is in Appendix 1.
4. The WCPFC host a joint bycatch - billfish and sharks - assessment methods workshop and amend Stock assessment project 6 (new TOR) if approved by SC21 ISG-billfish. This was accepted by the ISG and an amended ToR is in Appendix 1.

References

Brodziak, J. 2024. Rebuilding Plan Scenarios for the Western and Central North Pacific Ocean Striped Marlin Stock in 2024. SC20-SA-IP-15.

Brouwer, S. and Hamer, P. 2023. Billfish research plan 2023 – 2027. SC19-SA-WP-16.

Brouwer, S. and Hamer, P. 2024. Progress against the 2023 – 2027 billfish research plan - 2024. SC20-EB-IP-09.

Holdsworth. J. C. 2024. Striped marlin catch and CPUE in the New Zealand sport fishery, 2019-20 to 2021-22 SC20-SA-IP-17.

ISC. 2024. Western and Central North Pacific Striped Marlin Assessment Consensus Peer Review SC20-SA-WP-12.

Neubauer, P., Castillo-Jordán, C., Day, J. and Hamer, P. 2025. Exploring the potential for observer CPUE for southwest Pacific swordfish (Xiphias gladius) and striped marlin (*Kajikia audax*). WCPFC-SC21-SA-IP-13.

SPC-OFP. 2024. WCPFC Billfish Biological Sampling Plan. SC20-SA-IP-13.

Relevant recent publications from outside of the WCPFC

Bolin, J., Evans, K., Schoeman, D., Spillman, C. M., Moore, T. S., Hartog, J. R. Cummins, S. F., Scales, K.L., Vanalderweireldt, M.R., Sandolo, F. and Durieux, E.D.H. 2023. Age estimates derived from hard parts of swordfish *Xiphias gladius* from the north-western Mediterranean Sea. https://doi.org/10.1111/jfb.15558.

Rosa, D., Mosqueira, I., Fu, D. et al. 2023. Management strategy evaluation operating model conditioning: a swordfish case study. *Re.v Fish Biol. Fisheries*. https://doi.org/10.1007/s11160-024-09868-w.

Tracey, S. Pepperell, J. and Wolfe, B. 2023. Post release survival of swordfish (*Xiphias gladius*) caught by a recreational fishery in temperate waters. Rev. Fish Biol. Fisheries. https://doi.org/10.1016/j.fishres.2023.106742.

Tracey, S.R., Wolfe, B.W., Hartmann, K. et al. 2023. Movement behaviour of swordfish provisions connectivity between the temperate and tropical southwest Pacific Ocean. *Sci Rep* 13, 11812. https://doi.org/10.1038/s41598-023-38744-z

Table 1: *The 2021-2030 billfish work as agreed at SC19 and updated for 2025.*

1. Stock assessment				
Title	**Priority**	**Start year**	**End year**	**Comments**
Assessment 1) North Pacific striped marlin stock assessment	High	2023	2023	Completed (2023) - assessment accepted by SC19 (SC19-SA-WP-11 and SC20-SA-WP-12). Projections provided for 2025 (SA-WP-04)
Assessment 2) Southwest Pacific striped marlin stock assessment	High	2024	2025	Completed (2024) – evaluated but rejected by SC20 (SC20-SA-WP-03 and SC20-SA-IP-06) Revised assessment tabled at SC21 (SA-WP-06 and SA-WP-07) other relevant papers (SA-IP-13, SA-IP-14 and SA-IP-15).
Assessment 3) North Pacific swordfish stock assessment	High	2023	2023	Completed (2023) – assessment accepted by SC19 (SC19-SA-WP-09).
Assessment 4) Southwest Pacific swordfish stock assessment	High	2025	2025	Completed tabled for SC21 review (SA-WP-05) other relevant papers (SA-IP-11, SA-IP-12, SA-IP-13 and SA-IP-14).
Assessment 5) Pacific blue marlin stock assessment	High	2026	2026	Previous assessment successfully conducted by the ISC.
Assessment 6) Assessment approaches for WCPO black marlin, sailfish and shortbill spearfish	Medium	2027	2027	Develop a low information assessment for these species based on the outcomes of the 2026 workshop. .
Assessment 7) Joint bycatch assessment workshop for billfish and sharks	TBD	2026	2026	Host a workshop to assess the best approaches for assessing lower information bycatch species.

2. 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	Completed (2024)- (SC20-SA-IP-13) Additional work in 2025 (SC21-SA-WP-14)
Biology 2) Biology of South Pacific striped marlin, blue marlin, black marlin,	High	2025	2028	Project initiated under WCPFC project 125 - update report expected at SC21 (SC21-SA-WP-11).

shortbill spearfish and sailfish in the WCPO from longline fisheries.				
Biology 3) Southwest Pacific swordfish epigenetics and stock structure.	High	2026	2028	This project has been re-purposed as Southwest Pacific swordfish epigenetics and stock structure.

Table 2: Billfish stock assessment table. Note this includes all assessment types from data rich to low information assessment models. The assessment type will be determined by the SC ISG-Billfish for each successive year. Billfish assessments are currently scheduled 5-yearly, but 4-yearly for swordfish. A = Assessment; L/C = Low information assessment or characterisation; X = Scheduled work moved; U = Assessment tabled but not accepted. Note: for SW Pacific swordfish there may be utility in moving the assessment to a 2-year body of work. This table will be reviewed by the Joint bycatch assessment workshop for billfish and sharks.

Species	**Stock**	**Last assessment**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Striped marlin	N Pacific	2023		A				A			
	SW Pacific	2025			U	A					A
Swordfish	N Pacific	2023		A					A		
	SW Pacific	2025				A					Start finish 2031?
Blue marlin	Pacific	2021					A				
Black marlin	WCPO	Never						L/C			
Sailfish	WCPO	Never						L/C			
Shortbill spearfish	WCPO	Never						L/C			

Appendix 1 – Draft project specs for 2025/26 projects for evaluation and completion by SC21 ISG-Billfish

Part A: Administrative Summary	
1. Project Title	**Southwest Pacific swordfish epigenetics and stock structure**
2. Organization	Submitted by the BRP
3. Administrative Contact	TBD - SPC
4. Principal Investigator (PI) and CV	TBD - SPC
5. Commencement and Completion Date	1 March 2026 - 31 August 2027
6. Project Budget Summary	Overview of major cost categories: ○ 0.5 FTE $50,000 ○ Travel to SC23 $10,000 ○ Operating Costs (e.g., equipment, supplies) - $40,000 ○ Other Costs (e.g., sub-contracts, dissemination) - NA
Part B: Project Proposal Description	
1. Project Title	As above
2. Background and Need	See Rationale
3. Objectives and Benefits	Using genetic samples collected by the ROP observers to evaluate the stock structure of southwest Pacific swordfish and develop length-at-age estimates using epigenetic analysis.
4. Note	Genetic samples can be used for both stock structure as well as epigenetic analysis. Ideally for stock structure a minimum of 80 fish from each stock would be required. Dividing the region into 4 parts south of the equator (NW, NE, SW, SE) this would mean at least 240 samples would be needed for stock structure. Fewer samples would be needed for epigenetic ageing work, but they would require a sister fin spine or, preferably, otolith samples to verify the age clock from epigenetics.
5. Rationale	The Billfish research plan (BRP) has noted that there is a need to resolve the stock structure of swordfish, but also there is a need to get better age estimates. In 2025 the BRP suggested amending a project to tag and release swordfish to change the work into a generic analysis to evaluate stock structure as the results would likely have a greater utility and the work would be logistically easier and could sample more fish for the same price as tagging. Given the issues with getting age estimates and since a single sample could be used for both stock derivation and epigenetic ageing, it is suggested that both be evaluated. Epigenetics are used to estimate the chronological age of an organism. Epigenetic modifications, such as DNA methylation, accumulate in a predictable way as an organism ages. By analysing

	these modifications in a biological sample, an "epigenetic clock" is used to determine age. These can then be used to produce length-at-age estimates. The epigenetic clocks should be calibrated against otolith of fin spine derived age estimates.
6. Assumptions	Sufficient existing fisheries and biological data are readily available from the WCPO or other sources. See note for details. The biological material has been collected by the ROP observers. Personnel are available to undertake this work.
7. Scope of Work	Identify and collate the genetic samples housed on the WCPFC tissue bank. **Phase 1 - 2026** 1. Purchase biopsy punches, viles and other materials required to store and transport genetic samples, as well as RNALater solution. 2. Distribute these to the relevant observer programs. 3. Get observer to commence sampling and ship the samples back to SPC in Noumea. 4. Get observer to sample genetics and collect vertebral samples. **Phase 2 - 2027** 1. Once sufficient samples exist: a) undertake a genetic analysis to assess the stock structure and determine the genetic age of the fish sampled. b) Assess if genetic and otolith samples have been collected from the same fish. Where samples exist estimate the age from the otolith samples to calibrate the genetic age. 2. Produce length-at-age estimates.
8. Activity Schedule	TBD
9. Project Outcomes	Report document and presentation to SC23.
10. Forms of Results	Report document and presentation to SC23.
11. Methods	TBD
12. Data Management Plan / Data Sets Required	TBD
13. Other Related Projects	
14. Collaborations	Requires samples to be collected and be made available from the RoP.
15. Project Staff and CVs	TBD
16. Risks of Project Not Achieving Objectives	Risk that genetic material will not be able to be collected and that otolith and/or fin spine samples cannot be collected from the same fish as the genetic samples. Requires samples to be collected and be made available from the RoP
17. Timeframe	As above
18. Budget	As above
19. References	SC21-SA-IP-18

Part A: Administrative Summary	
1. Project Title	**Joint bycatch assessment workshop for billfish and sharks**
2. Organization	Submitted by the BRP
3. Administrative Contact	TBD - SPC
4. Principal Investigator (PI) and CV	TBD - SPC
5. Commencement and Completion Date	1 March 2026 - 31 August 2026
6. Project Budget Summary	Overview of major cost categories: o Costs for invited experts and facilitator - $50,000 o Travel to SC22 $10,000 o Operating Costs (e.g., equipment, supplies) - NA o Other Costs (e.g., sub-contracts, dissemination) - NA
Part B: Project Proposal Description	
1. Project Title	As above
2. Background and Need	See Rationale
3. Objectives and Benefits	See scope of work
4. Note	NA
5. Rationale	The BRP and the SRP have both highlighted the need for a workshop to standardise and find the most appropriate stock assessment model types to evaluate bycatch billfish shark stocks. Furthermore, for low information stocks some guidance would be useful for outputs for fishery characterisations. The BRP suggested that Stock assessment project 6 be repurposed as a ToR for a stock assessment methods workshop. Given the difficulty in running billfish assessments the BRP indicated that there would be value in conducting a review of stock assessment methods for billfish. This should include low and high information stocks as well as multi-model approaches (low and high information for the same stock) and Bayesian assessment methods as is done in the shark assessments. This would preferably be done as an in-person workshop and would benefit from including people who have successfully completed this type of approach for sharks. The review should be Pacific wide and include participation from IATTC and ISC. There would be most value in having the workshop as a joint bycatch assessment workshop for billfish and sharks. The focus should be pan-Pacific but could also invite experts from other tuna RFMOs.
6. Assumptions	Personnel are available to undertake this work. A venue can be found to host the workshop.
7. Scope of Work	1. Host a workshop to assess the best approaches for assessing lower information bycatch species. 2. Invite experts who have undertaken successful stock assessments of billfish and sharks, and those involved in the

	assessment of these stocks in other RFMOs particularly the IATTC. 3. Review assessments that are considered to be successful for billfish and sharks in tuna RFMOs, including CKMR possibilities. 4. Evaluate successes and failures. 5. Recommend assessment methods for bycatch billfish and sharks. 6. Summarise the best practice for these assessments and list potential reference points for reporting stock status for these species. 7. Note that not all stocks would have the same level of information available to them and as such a tiered approach based on the certainty of the data available for the assessment may be required. 8. Include low information characterisations and provide information as to what information would be useful for inclusion in these fishery characterisations. 9. Provide input to the stock assessment schedule including any commentary on aligning north and south Pacific assessments.
8. Activity Schedule	Identify experts and venue (March 2026) Run the workshop (April/May 2026) Compile the report and submit to SC22 (June/July 2026)
9. Project Outcomes	Report document and presentation to SC22.
10. Forms of Results	Report document and presentation to SC22.
11. Methods	TBD
12. Data Management Plan / Data Sets Required	NA
13. Other Related Projects	NA
14. Collaborations	TBD
15. Project Staff and CVs	TBD
16. Risks of Project Not Achieving Objectives	Not all experts may be available for the workshop.
17. Timeframe	As above
18. Budget	As above
19. References	SC21-SA-IP-17 SC21-SA-IP-18