SCIENTIFIC COMMITTEE
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Terms of Reference for Proposed Projects for 2024 - 2026

WCPFC-SC19-2023/GN-WP-07 (New numbering)
(21Aug2023)

Compiled by the Secretariat

Terms of Reference for Proposed Projects for 2024 – 2026

Contents

1. Essential, previously funded and no-cost extension projects – no priority ranking required

Project 35B	**WCPFC Pacific Marine Specimen Bank (PMSB)** **Essential project** **No Priority Ranking**
Objectives	The objective of the project is to maintain the Pacific Marine Specimen Bank with particular emphasis on WCPO bigeye, yellowfin, albacore and skipjack tunas, and swordfish, and, to facilitate transmission of samples to specified researchers with due cognizance of the WCPFC Tuna Tissue Bank Access Protocol.
Scope	The scope of ongoing work will include, but not limited to, the following: 1. Maintain and develop: ○ the public SPC webpage (www.spc.int/ofp/PacificSpecimenBank) informing interested parties of the tissue bank, including the rules of procedure to access samples from the tissue bank; ○ a secure web-accessed database holding non-public data; ○ a relational database that catalogues the samples to include sampling metadata; ○ The Noumea (SPC) storage site is maintained and expended as required; and ○ the Brisbane (CSIRO) storage site 2. Tissue sample utilisation and a record of outcomes/outputs will also be detailed in the relational database. 3. Subject to approval by the WCPFC Executive Director: ○ metadata will be made available to institutions or organizations responsible for providing scientific advice in fisheries through the web-accessible component of the database, and subsequently, and ○ SPC-OFP will facilitate the transmission of requested samples to specified researchers/organisations, and the return of unused and/or processed samples to the relevant storage facility. 4. Australia has provided access to their quarantine and sample storage infrastructure through CSIRO. Under current funding, samples are curated at the Brisbane site on an ongoing basis. CSIRO have committed to the in-kind contribution of maintaining space and transfer of specimens. The specific work is to: ○ Sort specimens on arrival and reconcile with quarantine data; ○ Enter data describing specimens received into BioDaSys; ○ Store specimens systematically so that they can be retrieved when requested; and ○ Laboratory and storage materials to complete curation. 5. As agreed at the annual project steering committee meeting (SC18-RP-P35b-02), in addition to maintaining and operating the WCPFC Tuna Tissue Bank in 2024, the Scientific Services Provider will: ○ continue to support initiatives to increase rates of observer biological sampling, noting that this contribution is essential to the ongoing success of WCPFC's work; and ○ pursue the proposed enhancement work listed in Section *Work Plan 2023*in the *Report of the Tuna Tissue Bank Steering Committee* (WCPFC-SC18-2020/RP-P35b-02).
Timeframe	January – December 2024
Budget	USD 107,373

Project 42	**Pacific Tuna Tagging Programme (PTTP)** **Essential project** **No Priority Ranking**
Objectives	To assist operations and activities related with the PTTP including new tag releases, tag recovery, and preparation of the 2024 PTTP Steering Committee meeting.

Scope	Conduct elements in the work plan as identified in the Report of the PTTP Steering Committee (SC19-RP-PTTP-01), including, but not limited to:
	• Subject to the decision by the PTTP Advisory Committee, support for the agreed tag-release cruise(s) for conventional and archival tagging and biological sampling in the western and central equatorial Pacific during 2024, targeting the agreed tropical tuna species:
	  o including the chartering of FV Soltai 105 and/or FV Gutsy Lady 4 as preferred vessels for tagging to maintain consistency with previous tagging operations in the western and central equatorial Pacific. SPC should consult with the WCPFC Science Manager on alternatives if these vessels are not available or alternate vessels are proposed.
	• While the exact composition of tags to be deployed will be confirmed prior to the cruise (via the PTTP Cruise Planning Advisory Committee), the design of the PTTP requires the use of the following tag types and suppliers:
	  o Hallprint™ conventional tags for all tagged fish;
	  o Wildlife Computers™, Vemco ™ and Lotek ™ tags for archival and satellite tagged marine organisms.
	  o Vemco ™ and Lotek ™ acoustic transmitters (and receivers).
	  SPC should consult with the WCPFC Science Manager on alternatives if these tags are not available;
	• Support identification of solutions for ensuring regional capability to implement tuna-tagging experiments in the longer term;
	• Maintain and enhance as appropriate the tag recovery network and pay tag rewards including via cash or t-shirt (or similar). Where appropriate, engage third-parties, such as WCPFC member fisheries authorities, industry associations and other fisheries service providers to act as agents for tag recovery. Third-party agents should be reimbursed for tag rewards dispensed plus any costs and expenses incurred in assisting with tag recovery;
	• Conduct PTTP data verification with VMS and Logbook, and cannery data;
	• Continue consolidation of the web-tagging database, recapture information and tagging database frameworks;
	• Conduct data analyses on tag reporting and seeding, fishing and natural mortality, tagging mortality, movement and tag simulation;
	• Facilitate conduct of PTTP Cruise Planning Advisory Committee meetings in 2023;
	• Support for the development and implementation of a work plan for 2024 tagging activities as outlined in the 2023 PTTP report to SC19; and
	• Preparation of PTTP Steering Committee meeting in conjunction with SC20 and production of the PTTP Progress Report and the 2024 Steering Committee Report.

Timeframe	January – December 2024
Budget	USD 800,000

<table>
<tr><td>Project 60</td><td>Improving Purse Seine Species Composition
Carryover 2021 budget
No Priority Ranking</td></tr>
<tr><td>Objectives</td><td>To improve the collection and representative nature of species composition data caught by purse-seine fisheries in the WCPO in order to improve the stock assessments of key target species in the WCPO.</td></tr>
<tr><td>Scope</td><td>The scope of work will include, but not limited to, the following items below:
1) General Tasks:
a) Continue to identify key sources of sampling bias in the manner in which species composition data are currently collected from WCPO purse seine fisheries and investigate how such biases can be reduced;
b) Review a broad range of sampling schemes at sea as well as onshore; develop appropriate sampling designs to obtain unbiased species composition data by evaluating the selected sampling procedures; extend sampling to include fleets, areas and set types where no representative sampling has taken place; verify, where possible, the results of the paired sampling against cannery, unloading and port sampling data;
c) Review current stock assessment input data in relation to purse-seine species composition and investigate any other areas to be improved in species composition data, including the improvements of the accuracy of collected data;
d) Update standard spill sampling methodology if required; and
e) Analyse additional data collected to evaluate the benefits of spill sampling compared to corrected grab-sampling.

2) Review the following activities for Project 60, with reporting the outcomes to SC20:
<table><tr><th>Activity</th><th>Priority</th></tr><tr><td>1. Paired grab-spill trips (target: 4 to 6):
• Targeting fleets with likely availability of comprehensive landings slips data (to be provided on a voluntary basis).
• Additional data should allow for improved estimates of bias correction factors, and provide a more powerful dataset for testing for species and/or school association specific correction factors</td><td>High</td></tr><tr><td>2. Continue to explore opportunities for collaboration with members, specifically undertaking comparisons of observer samples, and potentially model-based, species composition estimates, with accurate unloadings / landings / cannery data</td><td>High</td></tr><tr><td>3. Investigation of video-based sampling for estimation of species and size compositions</td><td>Medium</td></tr><tr><td>4. Cost-benefit analysis of alternative sampling approaches for long-term estimation of species compositions (i.e. at-sea sampling vs port sampling)</td><td>Medium</td></tr></table>
3) Continue to incorporate the following changes (as outcomes from Project 60) into the process for generating the aggregated purse seine species catch estimates:</td></tr>
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	• Multinomial-model based correction factors be used to correct existing and future grab sample data, rather than the estimates of 'availability'; • The beta-response models be used to generate catch estimates; and, • Observer samples are stratified by flag when used to directly estimate species compositions.
Timeframe	1 January 2023 to 31 December 2024
Budget	Carry over 2021 budget of $30K to 2024
References	SC17-ST-IP-04, SC18-ST-IP-03, SC19-ST-IP-03

Project 100c	**Preparing western and central Pacific tuna fisheries for application of close-kin-mark-recapture methods to resolve key stock assessment uncertainties.** **Continue until 2025** **No Priority Ranking**
Objectives	• Complete the base research needed for the application of close-kin-mark-recapture methods to WCPFC stocks to reduce the uncertainty in stock assessments. • Complete close-kin-mark-recapture feasibility studies for South Pacific albacore, Pacific bigeye and South-west Pacific Swordfish. • Develop and trial 'Standard Operating Procedures" for the cost effective and reliable collection of tissue samples necessary for close-kin-mark-recapture applications to WCPFC stocks. • Use trial samples to investigate and validate connectivity hypotheses via non-close-kin methods • Develop capacity within WCPFC to implement and evaluate close-kin-mark-recapture applications to WCPFC stocks. • Provide advice to the Scientific Committee on what data improvements are needed to enable best use of CKMR methods.
Rationale	A significant challenge for several WCPFC stocks assessments is estimating the absolute spawning biomass with the necessary precision to assist management decision making. Close-Kin-Mark-Recapture (CKMR) (Bravington et al 2016 a & b) is likely the most practical solution to resolve this issue. In addition, it can give us other information on population structure, connectivity, natural mortality and other key inputs as additional benefits. The successful application of CKMR is dependent on adequate background understanding of a species' biology and logistical considerations. Validating that understanding (e.g. about spatial connectivity) and evaluating the logistical feasibility is a necessary first step for implementing CKMR. The WCPFC South Pacific albacore stock has been identified by the Scientific Committee as a first candidate for CKMR (see reports of the SC15, SC16 and SC17-SA-IP-14). The approach has also been identified for potential application to bigeye tuna (see IATTC 2021 SC report) and an option for addressing stock assessment uncertainties associated with South-west Pacific Swordfish (SC17). CKMR takes advantage of modern genotyping methods to identify pairs of close relatives (e.g. parent-offspring, half-brother-sister) among large collections of tissue samples (i.e. biopsies). The number of kin-pairs found, and the way they are distributed in space and time, can be embedded into a population dynamics model and used to estimate important demographic parameters such as absolute adult abundance, mortality rates, and connectivity (Bravington et al 2017); the fundamental idea is that every animal was born with exactly one living mother and one living father, which it "marks" genetically. Unlike conventional mark-recapture, CKMR biopsies can be taken

	just from dead animals, e.g. fishery catches; and unlike conventional fisheries data, CKMR can estimate absolute abundance directly, without needing to rely on catch rate data (Davies et al, 2020). Key requirements and logistical considerations of CKMR are: • CKMR requires information on the likely age of each juvenile and adult, so that kinship probabilities can be back-dated to juvenile birth and the likely fecundity of the potential parent at that time. Age estimates do not have to be perfect, but if the precision is poor then the model becomes unable to estimate abundance or other demographic parameters reliably (the parameters all become statistically confounded). • That sample tissues are of adequate quality to allow high-quality genotyping sufficient for kinship determination, and for age/length/sex determination (depending on what other associated measurements are available). • That the number of samples collected, and their spread across adult and juvenile cohorts, is adequate to give statistically clear results (i.e. to contain enough kin-pairs). • The fisheries sampled give adequate coverage of the managed population and sampling would be widespread enough to detect any spatial sub-structuring. Epigenetic age estimation just from biopsy tissue is expected to provide an alternative to large-scale otolith reading. This technology has emerged rapidly in the last couple of years and is highly automated and less expensive than otolith-reading (Mayne et al 2020, 2021). The DNA already prepared and extracted for CKMR can be re-used directly for epigenetic ageing. The main necessity for each new species is a one-time calibration against known-age samples that have associated biopsy tissue. One key question about epigenetic age is its precision; age estimates do not have to be perfect for CKMR, but the precision for each species will affect sample size requirements. There is currently no validated ageing process for swordfish to calibrate epigenetic age. An important task will be to value add to the existing WCPFC bomb radio-carbon work to validate ageing by extending the analyses to swordfish. CKMR estimates of absolute abundance are also robust to spatial structure in populations provided the sampling program for either the juveniles or adults (preferably both) is adequately well-mixed and/or spatially representative. Spatial structure would be detectable when sampling is well-spread, through the spatial distribution of parent-offspring-pairs (POPs) and Half-Sibling Pairs (HSPs), in comparison to unrelated pairs. . If there is no (or demographically irrelevant) spatial structure then there should be little or no spatial pattern in the detected POPs. Assumptions and hypothesis associated with spatial structure and connectivity can also be readily tested using alternate methods on the same samples collected for CKMR. Population genetics of tissue samples and isotope and chemical analyses of tissue and skeletal samples are able to be undertaken routinely during CKMR sample collection to validate the connectivity assumptions behind sampling designs. There are a number of other side benefits to these validation experiments. The routine application of population genetics aids the description of localised patterns in genetic variation which has direct benefits for MCS activities by providing a probabilistic framework for determining the origin of catch. Genome assembly (mapping the location of original chromosomes on the genome from which the DNA sequences originated from), formerly a difficult and expensive task for a new species, is a powerful tool that is becoming more readily available. For

	a modest one-off expenditure, possession of a genome-assembly enhances the efficiency of CKMR (more information content per sample collected). It is not essential for CKMR however, for large populations, the use of genome assembly can improve the precision of identifying half-sibling pairs and thereby increase the total number of kin pairs identified with sufficient confidence for population modelling for a given sample size. There is also scope for additional information for population dynamics modelling, including the ability to determine the sex of the individuals sampled for CKMR, improved understanding of connectivity and adaptive potential and variation, which is increasingly important for understanding how stock biomass will respond under climate change and other changes to environmental conditions. Given the many interrelated benefits of modern genotyping methods undertaking the base research needed for its application in the WCPFC would facilitate the maximum utility of samples collected. In addition, WCPFC is well placed to commence CKMR through its strategic investment in establishing the Tuna Tissue Bank and the associated network for sample collection and archiving.
Alignment with Stock Assessment Timeframes	South Pacific Albacore – The next SPA assessment is tentatively scheduled for 2024. Completion of base research in 2022 would provide preliminary results in time for the next stock assessment: epigenetic ageing could be used to age the catch of one or more fisheries in preparation for the 2024 assessment; population genetics and sample chemistry could be used to determine structure and connectivity between WCPO and EPO (if any). CKMR estimates would be expected to be integrated in the 2027 scheduled assessment. Bigeye tuna – IATTC has identified CKMR as a potential option for its assessment of bigeye tuna in the EPO. A feasibility study for its application (Pacific wide) would be prepared in time for the 2023 WCPFC assessment of bigeye where the SC could make an informed decision on the merits of future implementation. South-west Pacific Swordfish – Similar to SPA the assessment for SWPS is constrained by an uninformative index of abundance and uncertainty in the spatial connectivity within the spatial domain of the assessment. A feasibility study for application of CKMR would be prepared in time for the 2024 WCPFC assessment where the SC could make an informed decision on the merits and priority of implementation.
Assumptions	• WCPFC and CMM port and observer sampling opportunities resume in 2022. • CCMs are able to participate in capability training. • Epigenetics is a viable option for high volume ageing. • IATTC continues to prioritise bigeye tuna for CKMR design and application.
Scope of Work	• Calibrate and evaluate the precision of epigenetic ageing as tool for rapid and cost-effective ageing for high volume applications, with priority for South Pacific Albacore. • Assemble genomes for priority target species • Trial sample collection SOPs and train port samplers and observers • Establish sampling network and commence large-scale tissue sample collection (target 10,000 SPA samples) • Validate connectivity assumptions through genomic and indirect methods (elemental, isotope and/or fatty acid) • Provide advice to the Scientific Committee on the suitability of CKMR approaches given the data available.
Timeframe	Note this is a three-year project, substantially funded through partner agencies (see budget) but with a small contribution requested from WCPFC (~US$40k) to cover the epigenetic ageing approach for three stocks.

2023	Calibration of epigenetic ageing for south pacific albacore and bigeye tuna Completion of south pacific albacore CKMR feasibility study Capability training for WCPFC Draft SOPs Provision of Advice to SC
2024	Completion of Pacific bigeye feasibility study Completion of genome assembly for south pacific albacore and yellowfin Capability training for WCPFC Trial and implementation of SOP for SPA Provision of Advice to SC
2025	Completion of validation and verification experiments Completion of feasibility study for south west Pacific swordfish Calibration of epigenetic ageing for swordfish (including bomb radiocarbon dating to verify age estimates). Completion of genome assembly for bigeye Implement SOP for SPA (target collection of 10,000-15,000 samples) Provision of Advice to SC

Budget

		Partners				
Budget Component	WCPFC (€)	SPC (€)	European Union (€)	IATTC (€)	CSIRO (€)	Total (€)
Base Research						
Epigenetic Ageing (SPA)	11,000				2,000	13,000
Epigenetic Ageing (BET)	11,000				2,000	13,000
Epigenetic Ageing (SWO)	11,000				2,000	13,000
Swordfish Age validation			40,000		10,000	50,000
Genome (albacore)		20,000[1]				20,000
Genome (bigeye)			20,000			20,000
Genome (yellowfin)					20,000[2]	20,000
SOPs		40,000[3]	100,000			140,000
Feasibility						
South Pacific albacore		10,000[4]	10,000		10,000[4]	30,000
Pacific bigeye		10,000	10,000	10,000	5,000	35,000
SW Pacific		10,000	10,000		5,000	25,000

[1] Australian funded SPC and CSIRO joint activity to assemble SPA genome

[2] Australian funded CSIRO activity to assemble YFT genome

[3] Supported activity under the Pacific-European-Union-Marine-Partnership project

[4] SPC and CSIRO joint activity to draft feasibility study

	swordfish						
	Capability		10,000	10,000		10,000	30,000
	Validation		30,000[5]	70,000			100,000
	Advice		10,000			5,000	15,000
	Total	**33,000[6]**	**140,000**	**270,000**	**10,000**	**71,000**	**524,000**

References

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2. Bravington, M.V., Grewe, P.M. and Davies, C.R. (2016b). Absolute abundance of southern bluefin tuna estimated by close-kin mark-recapture. Nature Communications 7:13162. https://doi.org:10.1038/ncomms13162
3. Mark V. Bravington, J. Paige Eveson, Peter M. Grewe, and Campbell R. Davies 2017. SBT Close-Kin Mark-Recapture with Parent-Offspring and Half-Sibling Pairs: update on genotyping, kin-finding and model development. Working paper prepared for the Extended Scientific Committee for the Twenty Second Meeting of the Scientific Committee, Yogyakarta, Indonesia, 28 August -2 September, 2017. CCSBT-ESC/1709/12.
4. Campbell Davies, Mark Bravington, Paige Eveson, Matt Lansdell, Jorden Aulich and Peter Grewe 2020. Next-generation Close-kin Mark Recapture: Using SNPs to identify half- sibling pairs in Southern Bluefin Tuna and estimate abundance, mortality and selectivity. Final Report to FRDC, June 2020.
5. Benjamin Mayne, Oliver Berry, Campbell Davies, Jessica Farley and Simon Jarman (2019). A genomic predictor of lifespan in vertebrates. Scientific Reports. *Sci Rep* **9,** 17866. https://doi.org/10.1038/s41598-019-54447-w
6. Mayne, B., Espinoza, T., Roberts, D., Butler, G. L., Brooks, S., Korbie, D., & Jarman, S. (2021). Nonlethal age estimation of three threatened fish species using DNA methylation: Australian lungfish, Murray cod and Mary River cod. *Molecular Ecology Resources*, 00, 1– 9. https://doi.org/10.1111/1755-0998.13440

Project 109[7]	**Training observers for elasmobranch biological sampling** **No cost extension to 2024** **No Priority Ranking**
Objectives	Train observers to collect elasmobranch biological material for age growth and reproduction
Rationale	The 2020 WCPFC shark research plan has identified a number of data gaps in our knowledge of shark biology. For a number of species, we know little about their age, growth and reproduction. As a result, the collection of biological material is key to resolving this. While observers are trained to collect biological material from teleosts, specialist skills are needed for the collection of elasmobranch material. In addition, for some species sample collection is only possible under specific projects endorsed by the WCPFC. This project will develop material for observers to use and run training workshops for a

[5] SPC – Jed Macdonald
[6] =USD40,000
[7] Source: SC16-GN-IP-08

	core group of observers in elasmobranch sampling.
Assumptions	• Personnel are available to undertake this training work. • Observers are able to travel for training. • Specimens are able to be obtained for training purposes.
Scope	The scope of this project is twofold. Firstly, the development of material for methods for collection, recording, storing and measuring of samples. Secondly, the work will involve running workshops in selected locations to demonstrate the techniques for the observers, and then provide practical training on the collection of these samples.
Budget	0.25 FTE 25,000 Total $25,000 No cost extension requested to SC19

Project 115	**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.** **Continue to 2024 with no-cost extension** **No Priority Ranking**
Objectives	1. Conduct a review and analysis of all relevant data and other information to explore the possibility, or otherwise, of an increasing trend in skipjack tuna recruitment in the equatorial Pacific since the late 1980s. To consider bottom-up, production driven processes, and top-down, predation driven processes. 2. Develop plausible and defensible effort creep scenarios to apply to skipjack abundance indices, with a focus on pole-and-line indices and apply these in model runs of the 2022 skipjack diagnostic model.
Note	NA
Rationale	Several skipjack stock assessments have now recognised that the stability in the fishery dependent CPUE indices, assumed to inform on abundance trends (primarily pole-and-line fisheries), are highly influential on model estimations of a stable long-term biomass trend. To account for the stable biomass trend, in the face of increased catches over time, the assessment models predict that increased recruitment must have occurred. On the other hand, how well the CPUE indices indicate trends in abundance is open to discussion. If CPUE indices suffer from hyperstability due to improved fishing methods and uptake of new technologies over time (referred to as effort or efficiency creep), their stability may mask an underlying decline in stock biomass. This topic received considerable discussion at the 2022 Pre-assessment workshop, suggesting more detailed analysis is required (Hamer 2022). Subsequent to that meeting studies involving the Japanese pole-and-line fishery were conducted and reported to SC18 (Matsubara et al. 2022). This work suggested some level of effort creep was likely, at least 0.2% per quarter (i.e. 0.8% per year), since 1981 when key new technologies began being employed by the fleet. However, while this work provides a good basis, as noted in the Matsubara et al. paper, the results are provisional. Further work is required to increase the level of confidence in the quantification and temporal dynamics of effort creep to apply to stock assessments used for management advice. Finally, the current calculation of the pole-and-line CPUE uses vessel day as the

	effort metric and may be more prone to effort creep and hyperstability than alternatives. It is recommended that exploration of alternative metrics such as travel distance between fishing events be explored, at least for a recent period, and contrasted with the traditional effort metric of vessel day. This approach appeared promising when applied to purse seine CPUE analysis for the recent skipjack assessment (Teears et al. 2022) . This study is required to: 1. Conduct a detailed exploration of the plausibility and evidence for an increased skipjack recruitment trend, 2. Build on the recent study by Matsubara et al. (2022) to explore the occurrence and plausible scenarios of effort creep, 3. Apply plausible scenarios of effort creep assumptions to the 2022 skipjack assessment models to assess the implications for stock status estimates and trends, and provide a basis for consideration of effort creep scenarios to apply for next skipjack assessment. Preliminary investigations suggest there may be a link between environmental variability, particularly the size of the Pacific warm pool (see Kim et al. 2020, Lehodey 2003, SC18-EP-WP-01), and levels of skipjack recruitment and catches. This project will support further investigation of this hypothesis, along with a wider consideration of ecosystem drivers, and fishing down of predators that may influence skipjack recruitment. Overall, the work will contribute to improving the interpretation and approaches to the skipjack assessment.
Assumptions	Operational data from Japanese pole-and-line fishery is available to support the analysis. Japanese scientists will actively participate in the research in close collaboration with the SSP who will lead the modelling work. Oceanographic data sets and other data sets on the pelagic ecosystem of the equatorial Pacific are available to support work under objective 1, which will also be led by the SSP.
Scope	The recruitment investigation will focus on the equatorial Pacific region, including the east Asian waters where large numbers of small skipjack are taken, and the CPUE/effort creep work will primarily focus on the Japanese pole-and-line data. Work will continue on purse seine CPUE analysis and effort creep supported under the Pacific European Union Marine Partnership (PEUMP).
Timeframe	No cost extension requested, reporting to SC20.
Budget	$20,000 (primarily to support travel costs for collaborative work with Japanese scientists and to present work to the SC)
References	References are hyperlinked expect: Lehodey, P. (2003) SEPODYM application to skipjack tuna (*Katsuwonus pelamis*) in the Pacific Ocean: impact of ENSO on recruitment and population**.** SCTB16 Working Paper, SKJ-5.

2. Previously agreed projects that will require priority ranking

Project 68	**Estimation of seabird mortality and risk across the WCPFC Convention Area** **Priority Ranking**
Objectives	• Fulfil the requirement under the WCPFC seabird CMMs to estimate the total number of seabirds being killed per year in WCPFC fisheries. • Assess mortality per year over the ten years since the first WCPFC seabird CMM, as requested under CMM2006-02, CMM 2007-04 and CMM 2012-07, and assess whether there is any detectable trend. • Provide advice to the Scientific Committee on what data improvements are needed to enable better analyses to be made.
Rationale	Monitoring and enumerating the total number of seabirds being killed per year in WCPFC fisheries is a requirement under WCPFC's seabird CMMs. Project 68 has generated estimates of seabird mortalities in WCPO longline and purse seine fisheries for the time period 2015 to 2018 (Peatman et al., 2019). There have also been a number of global and regional assessments of risk to seabirds from tuna longline fisheries (e.g. Abraham et al., 2019; Birdlife South Africa, 2019; Ochi et al., 2018). Analyses of seabird bycatch have generally had to contend with incomplete or imbalanced observer coverage of key fleets as well as varying levels of species identification of seabird captures, leading to uncertainties in capture rates of seabird species. Peatman et al. (2019) recommended that further work include assessing the risk to seabird populations resulting from estimated seabird mortalities of WCPFC fisheries. To date there have been limited assessments of risk of WCPFC fisheries to north Pacific albatrosses, or the more equatorial seabird populations. This gap of coverage could be addressed by carrying out a WCPFC-wide risk assessment, potentially to a subset of seabird populations depending on the data available.
Assumptions	• There is additional seabird bycatch data available to warrant revisiting assessments of risk to seabird species from WCPFC fisheries in the southern hemisphere. • There is sufficient data held by WCPFC for estimating mortality and risk from WCPFC fisheries for northern hemisphere and equatorial seabirds. • CCMs and other partners and stakeholders are able to contribute data and expertise to the conducting of risk assessments for seabirds in the WCPFC jurisdiction. • IATTC is able to assist with estimates for straddling populations of seabirds. • CCSBT is able to assist with estimates for Southern Hemisphere seabird populations through the ongoing Southern Hemisphere Spatially Explicit Fisheries Risk Assessment lead by CCSBT.

Scope	• Identify the limitations in the data available.
	  ○ Document what information is available on species that overlap with the WCPFC fisheries, their population status, any tracking data (or already established spatial distributions that are more complex than binary presence absence) and any estimates on their biological parameters such as Rmax (the theoretical maximum breeding rate).
	  ○ Document current observer data to assess the level of coverage in each fishery, both spatially and temporally.
	• Estimate species-specific seabird mortalities (where feasible) and risks associated with interactions with WCPFC fisheries (where feasible).
	• Describe the methods used to estimate total mortalities including treatment of data gaps.
	• Provide advice to the Scientific Committee on the suitability of risk assessment

	approaches given the data available. • Generate advice on what further level of seabird assessment at species level can be conducted, given the amount and quality of data currently available.
Timeframe	2024 – Data Compilation, Gaps Analyses, and Risk Assessments 2025 - Reporting to WCPFC Scientific Committee
Budget	USD 75,000 *Note: Adapted from indicative budget from FAC16* • *2024: $30,000 + $10,000 provided by NZ* • *2025: $35,000*
References	Abraham, E., Richard, Y.,Walker, N., Gibson, W., Ochi, D., Tsuji, S., Kerwath, S.,Winker, H., Parsa, M., Small, C., Waugh, S., 2019. Assessment of the risk of surface longline fisheries in the Southern Hemisphere to albatrosses and petrels, for 2016. Report prepared for the 13th Meeting of the Ecologically Related Species Working Group (ERSWG13) of the Commission for the Conservation of Southern Bluefin Tuna (CCSBT-ERS/1905/17). Birdlife South Africa, 2019. Report of the Final Global Seabird Bycatch Assessment Workshop. WCPFC-SC15-2019/EB-WP-07. Ochi, D., Abraham, E., Inoue, Y., Oshima, K., Walker, N., Richard, Y. & Tsuji, S., 2018. Preliminary assessment of the risk of albatrosses by longline fisheries. WCPFC-SC14-2018/EB-WP-09 Peatman, T., Abraham, E., Ochi, D., Webber, D. and Smith, N., 2019. Project 68: Estimation of seabird mortality across the WCPFC Convention Area. WCPFC-SC15-2019/EB-WP-03.

Project 90	**Better data on fish weights and lengths for scientific analyses** **Funded since 2019** **Proposal for project extension** **Priority Ranking**
Objectives	This project has three objectives The first component aims to identify gaps, address those gaps which can be resolved with existing information, and develop the sampling plan and protocol to resolve additional gaps, through the following activities (but not limited to): • identify the priority gaps in conversion factor data for the WCPFC key tuna species, key shark species, and key billfish species • expand the conversion factors to cover the WCPFC key shark species for groups: mako, thresher and hammerhead shark, after gap analysis against existing conversion factors • produce a list of species of special interest (SSIs, excluding key shark species) that require conversion factor data • produce a list of commercially important bycatch species (not covered in the items above) • include more information on source of data for each conversion factor (e.g. reference of study, sample size, R2, minimum/maximum size of sample, etc.) in tables of conversion factors which will inform the need for more data collection • produce a list of the remaining bycatch species that require conversion factor data • produce standard protocols for conversion factor data collection to be

	collected by observers and port samplers, • prioritize this list so that the most important work is achieved, and • present the findings at SC15 for review, acknowledging that some observer providers will voluntarily collect conversion factor data prior to SC15. The second component relates to investigating potential innovative methods to obtain length-length conversion factor data, including: • explore the use of EM tools to capture multiple length measurements from fish e-measured by EM Analysts. The third component relates to collecting the conversion factor data: • systematically collect representative samples of length measurements of bycatch species support future estimation of fish bycatch in the WCPO; and • systematically collect length:length, length:weight and weight:weight data on all species to better inform future estimation of fish catch and bycatch estimates in the WCPO.
Note	Although these three objectives are distinct, they have been combined into a single project to avoid any possible duplication of effort and, as there will likely be combined tasking of Pacific Island observers and port-samplers, in future data collection arising from the project. The project acknowledges that flag state CCMs with national port sampling and observer programmes may also want to collect conversion factor data using the standard protocols established under this project; these initiatives would be an invaluable contribution to the project. The project will also involve the work in transferring the conversion factor information compiled from other sources, such as the information presented in Clarke et al. (2015) *Report of the Pacific Shark Life History Expert Panel Workshop, 28-30 April 2015; SC11-EB-IP-13*, and conversion factor data compiled from the Australia domestic longline fishery. Project 90 implementation acknowledges that issues of observer safety, overall workload and work conditions are paramount. The development of the data collection protocols for conversion factor measurements through observers should take into account the challenges with on-board observer activities, including, but not limited to; - Potential difficulty in measuring large specimens on small boats; - Evaluating the feasibility of weighing fish at sea. For example, consideration of the following: • Ensure any weighing equipment does not hinder the fishing operation. • Simplifying the process of any onboard weight measurements; • To what extent the assistance of the crew will be expected, and • Avoiding duplicate weighing of specimens by keeping and weighing removals. – Note that any sharks which fishers are not allowed to retain will not be in the observer protocol for this project.
Rationale	Estimates of bycatch are currently collected through the ROP in units of number, weight or both. In order to convert from numbers to weight, and vice versa, it is

	necessary to have information on both the size of caught individuals, and appropriate length:weight relationships for the species in question. This conversion between numbers and weight allows analyses of bycatch data to use the full observer dataset, rather than a subset with a consistent unit of measurement, therefore maximising the utility of the bycatch data recorded by observers. Furthermore, bycatch length data allows for consideration of the life-stages of individuals. This information could be of particular interest when considering bycatches of SSIs. There are currently insufficient, or unrepresentative, length samples for species caught in purse seine and longline fisheries, with the exception of bigeye, yellowfin and bigeye in purse seine catches, which are sampled through observer grab samples. This project would fill this data gap. The project is not constrained to bycatch species alone. The 2020 stock assessment reports for bigeye and yellowfin presented to SC16 both noted that the conversion factor used to convert longline caught bigeye and yellowfin individuals ("gilled-and-gutted" weight to whole weight) was based on less than 100 samples from longline vessels operating in the Solomon Islands and the Federated States of Micronesia. As this conversion factor is applied to all longline caught fish not processed using the Japanese style of gilling (and removing the operculum), gutting, and tailing the fish, small changes to this conversion factor could have a significant effect on the stock assessments. These reports highlighted the importance of allocating resources to collect additional samples across a number of fleets in the region to improve this conversion, as far as possible across the extent of the WCPO. To this end, an extension of Project 90 into 2022 is sought, with a budget of USD75,000 estimated. This is to support the additional activities required by observers to undertake this work across the region and fleets, as well as cover material costs expected to arise. In 2021, limited additional resources carried from other WCPFC SC projects (specifically Project 81) will be used to provide a proof of concept of the weight-weight conversion approach, and to allow better estimation of the potential costs involved in the 2022 programme. Note that these activities will apply to all relevant stocks, while the timeline aims to allow improved conversion factors to be applied within the next bigeye and yellowfin stock assessments scheduled for 2023. At least SEVEN (7) Pacific Island member countries with observer programmes have expressed interest in participating in conversion factor data collection, as long as funding support is available to cover any reasonable request for the additional work required by observers and port samplers. Accordingly, this project addresses objectives arising from discussions at SC13 about the results of regional estimates of purse seine and longline bycatch (Peatman et al., 2017; Peatman et al., 2018a; Peatman et al., 2018b). As a result of the discussions in 2017, SC13 recommended that the Scientific Services Provider be tasked with: • designing and co-ordinating the systematic collection of representative samples of length measurements of bycatch species; and • a project to design and co-ordinate the systematic collection of length:length, length:weight and weight:weight data on all species to better inform bycatch estimation.
Assumptions	Achievement of the objectives is subject to the following assumptions: • sufficient data are available to support the sampling design analyses; • sampling designs can be developed which are statistically robust and would

	support future estimation of fish bycatch in the WCPO; • current observer equipment (e.g. callipers) is suitable for the length sampling protocols; • suitable and cost-effective equipment can be sourced for robust weight data collection; • data collection can be integrated into existing sampling events in-port and at-sea;. • resources are available within selected countries to undertake this work; and • the sub-regional DCC observer conversion factors form will be the basis for data collection. • Regional observers, as well as other approaches (e.g. port and market sampling) are able to undertake the additional activities required to develop weight-weight conversion factors across the region.
Scope	The proposed work programme comprises: • data compilation activities; • subsequent statistical analysis activities to design future sampling approaches; • evaluation of designs for practical field application; • trials of selected sampling approaches in the field along with trials of equipment required to complete the sampling designs; • finalisation of future sampling protocols; • development of associated training standards; • incorporation of training into trainer trainings and biological sampling trainings as required; • ongoing co-ordination of sample collection and data submission; and • reporting on designs and progress with implementation and data collection. It is intended that a preliminary report would be prepared for SC15 and more comprehensive reports for SC16, SC17 and SC18, with a final report at SC19. An extension to this project is proposed for 2024 and 2025 to enhance the spatial coverage of conversion factor data to areas to the central and eastern WCPO.
Timeframe	January 2019 through December 2025
Budget	2019 US$60,000 2020 US$30,000 2021 US$20,000 + USD$7,000 (transferred from Project 81) 2022 US$75,000 2024 US$20,000 2025 US$20,000 Note that this funding is intended to cover the work of the Scientific Services Provider in the design and co-ordination of this work. This will cover the analytical components identified in the scope of the project. It will also cover trials of methodologies identified at-sea and in-port. The funding in 2019 includes the costs to cover the additional work for selected observers from some observer providers, which will inform the process for refining the budget for this project in subsequent years. The 2019 funding also includes the costs to investigate and purchase 1-2 weighing devices in the initial implementation phase.

	The additional funding in 2021 will contribute to the estimated costs required to scope activities for the weight-weight conversion data collection, which will inform the process for refining the budget for this project in 2022. The estimated budget for 2022 will support the additional work of observers to undertake the data collection on weight-weight conversions, as well as the work of other groups within the region. Funding requested for 2024 and 2025 is intended to support port and observer sampling. It does not cover the costs of CCMs in implementing the protocols or the purchase of related equipment. This will require co-funding or additional funding depending on the designs selected in the design and testing phase and may require additional requests for funding from SC15.
References	SC19-ST-IP-04. Project 90 update: Better data on fish weights and lengths for scientific analyses Peatman, T., Allain, V., Caillot, S., Williams, P., and Smith, N. 2017. Summary of purse seine fishery bycatch at a regional scale, 2003-2016. SC13-ST-WP-05. Thirteenth regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission. Rarotonga, Cook Islands, 9-17 August 2017. Peatman, T., Bell, L., Allain, V., Caillot, S., Williams, P., Tuiloma, I., Panizza, A., Tremblay-Boyer, L., Fukofuka, S., and Smith, N. 2018a. Summary of longline fishery bycatch at a regional scale, 2003-2017. SC13-ST-WP-02. Fourteenth regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission. Busan, Republic of Korea, 8-16 August 2018. Peatman, T., Allain, V., Caillot, S., Park, T., Williams, P., Tuiloma, I., Panizza, A., Fukofuka, S., and Smith, N. 2018b. Summary of purse seine fishery bycatch at a regional scale, 2003-2017. SC13-ST-IP-04. Fourteenth regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission. Busan, Republic of Korea, 8-16 August 2018. Ducharme-Barth, N., Vincent, M., Hampton, J., Hamer, P., Williams, P. and Pilling, G. 2020. Stock assessment of bigeye tuna in the western and central Pacific Ocean. WCPFC-SC16-2020/SA-WP-03 [REV3]. Vincent, M., Ducharme-Barth, N., Hamer, P., Hampton, J., Williams, P. and Pilling, G. 2020. Stock assessment of yellowfin tuna in the western and central Pacific Ocean. WCPFC-SC16-2020/SA-WP-04 [REV3].

Project 108	**Silky shark stock assessment in the WCPO** **Continue to 2024 (2023 budget funded; 2024 indicative budget of $50,000)** **Priority Ranking**
Objectives	Undertake a stock assessment of silky sharks in the western Pacific Ocean
Notes	Depending on the priorities of the SC for the work to be undertaken by the Scientific Services Provider (SSP), this project may be undertaken within the

	service agreement with the SSP or alternatively as a standalone project with a separate funding allocation. This will need to be decided by the SC18 considering the other priorities.
Rationale	This stock was last assessed as a Pacific wide stock in 2018 (SC14-SA-WP-08) using data from 1980-2016. The WCPO stock was last assessed in 2013 (SC9-SA-WP-03). As this species is unproductive and susceptible to overfishing, one objective of this assessment is to establish and examine key areas of uncertainty and the impacts on stock productivity estimates of stock status. Since the last assessment, more catch and effort data as well as observer data are available. The observer data will be an important component of this assessment as since CMM 2013-08 came into force, silky sharks in the WCPO have had a non-retention policy and the catch data should therefore be absent from July 2014. However, release data are still available from observer records. This project is designed to assess the stock status of silky sharks in the western Pacific Ocean using the most informative approach with respect to the available data. The assessment should assess the stock status against conventional stock assessment metrics as well as those suggested in the WCPFC 2021-2025 Shark Research Plan (SC16-EB-IP-01 rev1).
Assumptions	• Much of the existing fisheries and biological data are readily available. • Assessment personnel are available to undertake this work.
Scope	• Review the previous assessment in the WCPO as well as other subsequent shark assessments to assess and improve on methods to increase the understanding of data strengths and weaknesses, and update stock status. • Review of ways to deal with the input data for shark assessments (presented to a dedicated agenda item at the 2024 PAW). • Provide a data characterization, data compilation and catch reconstruction analyses. • Update WCPO longline catch estimates and abundance indices using recent observer data. • Present the stock status in terms of the metrics outlined in the 2021-2025 Shark Research Plan. • Prepare reports containing the above results for SC20. • If the data are too poor to undertake a full quantitative assessment, then a medium data assessment may be appropriate.
Timeframe	March 2023 - August 2024 March 2023 - April 2024 (data compilation, fishery characterization and catch reconstructions) March 2024 - August 2024 (Stock assessment)
Budget	1.5 FTE ($140,000) ($50,000 – 2023, $90,000 – 2024) Travel to SC20 ($10,000) Total: $150,000
References	SC16-EB-IP-01 rev1 2021-2025 Shark Research Plan (23July) - Rev.01 / Project 97 (SRP) - Final Report SC14-SA-WP-08 Pacific-wide Silky Shark (Carcharhinus falciformis) Stock Status Assessment (22 July 2018) and Addendum SC9-SA-WP-03 Updated Stock assessment of silky shark in the western and central Pacific Ocean

Project 113b	**Develop stock status and management advice template for consistent reporting of stock assessment outcomes, uncertainties and risk** **Extended project with 2024 budget requested** **Priority Ranking**
Objectives	Develop in consultation with assessment working groups and fisheries managers, a reporting template for stock status and management advice from WCPFC stock assessments.
Notes	
Rationale	Project 113 reviewed the use of model ensembles and characterization of uncertainty in stock assessment models used to provide advice to the WCPFC. The review found that reporting of uncertainty was inconsistent between stock assessments, even within assessments that used consistent methods to characterize uncertainty. For instance, the quantities reported, terminology used for reporting, and consideration of risk are not consistent between assessments and species. A key recommendation from Project 113 suggested that, to allow for a consistent application of the precautionary principle, as mandated by the WCPFC convention, more consistent reporting should be developed. A straightforward way to improve and standardise reporting of uncertainty and risk is to develop a template for reporting uncertainties alongside the provision of stock status and management advice. The international expert group on "Addressing Uncertainty in Fisheries Science and Management" convened by the National Aquarium in the United States in 2015 suggested that an "[i]nnovative approach" would be to "create a table or checklist indicating the major sources of uncertainty for that fishery, how they are addressed and by whom, and at what point in the process they are considered...This tool would promote understanding among all participants and would also highlight to all how the system already accounts for certain types of uncertainty and where effort needs to be focused to address concerns" (Cadrin et al. 2015). In addition, a clear accounting for uncertainties is important in the context of adequately representing risk when developing harvest strategies, to ensure that such strategies are robust to key uncertainties. Templates for reporting assessment advice are in use in a number of jurisdictions and councils. For example, ICES provides a standardised structure to provide management advice, and New Zealand's plenary reports have a standardised tabulated reporting format for both status and uncertainty (see "Guidelines for Status of the Stocks Summary Tables" in Fisheries New Zealand 2022). This project aims to develop a reporting template based on international best practice, with reference to WCPFC convention and CMMs in effect.
Assumptions	• Mandate from SC19 to develop reporting templates based on recommendations from PROJ113
Scope	1. Develop, in consultation with assessment working groups and fisheries managers, a reporting template for stock status and management advice from WCPFC stock assessments. Elements that should be considered as part of this development are: • Develop consistent terminology around uncertainty and risk, including a set of required measures to be provided for stock assessments in the WCPFC

	• Clear communication about quality of information determining stock status and management advice. • Qualification and quantification of uncertainties. ◦ (a) Data quality. ◦ (b) Model/population: structural uncertainty. ◦ (c) Key parameters (parameter and estimation uncertainty). • Key uncertainties and potential impacts – qualify the likely impact of above uncertainties for stock status and management advice. • Research recommendations to address key uncertainties. 2. Present the developed template for consideration at SC20
Timeframe	March 2023 - August 2024
Budget	0.3 FTE ($30,000) Travel to SC20 ($10,000) Total: $40,000

Project 114	**Improved coverage of cannery receipt data for WCPFC scientific work**[8] **Continue to 2025 (2023 budget funded, 2024 and 2025 indicative budget of $60,000 and $35,000, respectively)** **Priority Ranking**
Objectives	This project's overarching objective is to continue the work first started by Lewis (2017) to improve the coverage of cannery receipt data through collaboration with relevant port state CCM authorities. The specific objectives will cover: 1. Identifying the gaps in the cannery receipt data submissions to the WCPFC; 2. In Year 1 of the project (as an initial step), a) collaboration with one interested port state CCM, to approach several (but at least one) companies to request the provision of cannery data, using the *WCPFC Guidelines for the Voluntary Submission of Purse seine Processor data by CCMs to the Commission*[9]. It is envisaged that agreement to submit cannery data will require agreement for data confidentiality and other aspects, to be set out in Memorandum of Understanding (MOU) similar to that outlined in Lewis (2017). b) As a key activity, document the protocols for how cannery receipt data are collected, including an assessment of the accuracy of species identification, particularly on how to distinguish juvenile bigeye and juvenile yellowfin tuna, and any requirements for sub-sampling certain size/species categories, noting the confidentiality of this information; 3. The documentation of the experience from Year 1 to outline a plan for approaching other processor companies in Years 2 and 3 of the project; 4. In Years 2 and 3 of the project, continuation of the work in collaborating with additional relevant port state CCMs, to approach companies to request the provision of cannery data. Also, to revise/improve the protocols as mentioned in 2(b) as necessary; 5. The provision of annual reports of project activities to the WCPFC Scientific Committee;

[8] WCPFC-SC18-2022/ST--IP-11 rev1
[9] https://www.wcpfc.int/doc/data-07/guidelines-voluntary-submission-purse-seine-processor-data-ccms-commission

	6. Where coverage of cannery data is adequate, the continuation of the analyses started in Peatman (2020b); 7. The WCPFC Science Service Provider (SSP) continuing the management and data quality assurance of purse seine processor data submission, including the identification of key gaps and resolving duplicate processor data (e.g. when valuable Final Outturn [FOT] data are provided from a different source).
Rationale	Observers on purse seine vessels collect tuna species composition data which is a fundamental input to estimating the purse seine tuna catch by species. However, even at 100% observer coverage, only ~0.1% of the catch can be sampled for species composition estimation, given the disruptions sampling causes to the brailing operation (see Hampton and Williams, 2016, Lawson, 2014 and Peatman, 2020a). At this level of sampling, the precision of the estimates declines with progressively higher resolution of the strata required (that is, estimates at the set level are not precise). Purse seine processor (cannery) data have been identified as a potentially important source of data for verifying the estimates of purse seine tuna species catch determined from observer data (Lewis and Williams, 2016; Williams, 2017). The COVID-19 pandemic has resulted in a reduction in observer coverage in recent years (~50% in 2020 and ~10% in 2021), and therefore represents another important reason for considering the use of cannery data in estimation of purse seine tuna species composition as a supplement to observer information (Peatman et al., 2022). Peatman (2020b) demonstrates the utility of cannery receipts data (for the US purse seine fleet) as an independent dataset for validation of observer sample-based species composition estimates. Wider availability of comprehensive cannery receipts data would enable the benefits of cannery data to be realized for other purse seine fleets operating in the WCPO. The Guidelines for the Voluntary Submission of Purse seine Processor data by CCMs to the Commission provide a mechanism for improving the coverage of cannery data for potential use.
Assumptions	Achievement of the objectives is subject to the following assumptions: • Cooperation with relevant port state CCM authorities; • Cooperation with processor companies; • Cannery receipt data align to the *Guidelines for the Voluntary Submission of Purse seine Processor data by CCMs to the Commission*; • The quality of cannery receipt data is appropriate;
Scope	The proposed activities include: • Seeking interest from relevant port-state CCMs to participate in Year 1 of the project; • Selection of a suitable contractor; • Initial collaboration (through email/virtual meetings) to plan a visit to the port state CCM country, include potentially identifying a cooperative processing company before the visit; • Informing relevant flag and coastal state CCMs of any planned visits, and engaging with these CCMs during the project as required; • Conduct the visit (1-2 weeks) under Year 1 objectives; • Contractor liaison with the WCPFC Secretariat and SSP;

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Preparation of consultant report for year 1 activities (objectives 1, 2 and 3), including a plan for Year 2 and 3 activities;
Consultant conducting Year 2 and 3 activities (Objective 4), in liaison with SSP and WCPFC Secretariat;
Preparation and presentation of reports to SC;
Ongoing work required under Objectives 6 and 7.

It is intended that annual reports will be prepared for SC19, SC20 and SC21.
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<tr><td>Timeframe</td><td>36 months (from January 2023 through December 2025)</td></tr>
<tr><td>Budget[10]</td><td>
<table>
<tr><th>Year</th><th>Indicative budget</th><th>Anticipated work</th></tr>
<tr><td>2023</td><td>US$35,000</td><td>Covers the cost of an appropriate consultant and travel to cover Objectives 2, 3 and 5 (and Objective 1, in collaboration with the SSP).</td></tr>
<tr><td>2024</td><td>US$60,000</td><td>Covers the cost of an appropriate consultant and travel to cover Objectives 4 and 5 (in collaboration with the SSP).</td></tr>
<tr><td>2025</td><td>US$35,000</td><td>Covers the cost of an appropriate consultant and travel to cover Objectives 4 and 5 (in collaboration with the SSP).</td></tr>
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The consultant will be managed/coordinated through the WCPFC Secretariat and the SSP.

The SSP may cover some of the work of the consultant where there are difficulties in engaging a consultant related to timing, or it is more efficient for the SSP to undertake that work, for example, in conjunction with travel for other reasons.
The SSP will also be directly involved in activities under Objectives 1, 5, 6 and 7.

Williams (2023) provides a summary of the project activities in the first six months of Year 1 (2023) which will be updated in the Year 1 report for WCPFC20.

A revision to the indicative budgets for Years 2 and 3 (2024 and 2025) may be necessary after the first year's activities.
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<tr><td>References</td><td>

Hampton, W.J. and P.G. Williams, 2016. Annual estimates of purse seine catches by species based on alternative data sources. SC12 ST-IP-03. Twelfth Regular Session of the Scientific Committee of the WCPFC (SC12). Bali, Indonesia. 3–11 August 2016.
Lawson, T. 2014. Comparison of the species composition of purse-seine catches determined from logsheets, observer data, market data, cannery receipts and port sampling data. WCPFC-SC10-2014-ST-WP-02.
Lewis, A.D. and P.G. Williams, 2016. Potential use of cannery receipt data for the scientific work of the WCPFC. SC12 ST-WP-03. Twelfth Regular Session of the Scientific Committee of the WCPFC (SC12). Bali, Indonesia. 3–11 August 2016.
Lewis, A.D. 2017. Pilot Study of the Potential for using Non-ISSF Associated Cannery Receipt Data for the work of the WCPFC. SC13 ST-IP-05. Thirteenth Regular Session of the Scientific Committee of the WCPFC (SC13). Rarotonga, Cook Islands. 9–18 August 2017.

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[10] ISSF supports the proposal for a project to improve the submission of cannery data and offers to contribute $10,000 annually as cofinancing for the project.

	Peatman, T., Smith, N., Park, T., and S. Caillot. (2018). Better purse seine catch composition estimates: recent progress and future work plan for Project 60. WCPFC-SC14-2018/ST-WP-02. Fourteenth Regular Session of the Scientific Committee of the WCPFC (SC13). Busan, Republic of Korea. 8–16 August 2018. Peatman, T. (2020a). Project 60: Progress towards achieving SC15 recommendations. WCPFC-SC16-2020/ST-IP-04. Sixteenth Regular Session of the Scientific Committee of the WCPFC (SC16). Online Meeting. 11–20 August 2020. Peatman, T. (2020b). USA Purse seine catch composition. WCPFC-SC16-2020/ST-IP-05. Sixteenth Regular Session of the Scientific Committee of the WCPFC (SC16). Online Meeting. 11–20 August 2020. Williams, P.G. 2017. An update on cannery data with potential use to the WCPFC. SC13 ST-WP-04. Thirteenth Regular Session of the Scientific Committee of the WCPFC (SC13). Rarotonga, Cook Islands. 9–18 August 2017. Williams, P.G. 2023. PROJECT 114 UPDATE: Progress in improving CANNERY RECEIPT DATA for WCPFC scientific work. SC19 ST-IP-06. Nineteenth Regular Session of the Scientific Committee of the WCPFC (SC19). Koror, Palau. 16–24 August 2023.

3. New proposals where no priority ranking is required (e.g. in kind contribution)

Project 116 (P19X1)	**Estimating impacts to sharks between 20N and 20S** **In-kind contribution (USA)** **No Priority Ranking**
Objectives	Fulfill the requirement under the WCPFC Conservation and Management Measure for Sharks (CMM 2022-04) to estimate the impact of fishing on sharks in the area between 20N and 20S. Provide advice to the Scientific Committee on potential mitigation measures that might benefit shark species between 20N and 20S.
Rationale	WCPFC Conservation and Management Measure for Sharks (CMM 2022-04) specifies: *28. In 2024, and commencing periodically thereafter, the SC shall review the impact of fishing gear on sharks that are not retained, including oceanic whitetip shark and silky shark, inside and outside of the area between 20 N and 20 S, and provide advice on potential mitigation measures that would benefit such shark species.*
Assumptions	There is sufficient data held by WCPFC to estimate the impact of fishing on sharks in the Convention Area by WCPFC managed fisheries.
Scope	Identify the limitations in the data available. Estimate shark mortalities between 20N and 20S (where feasible) and risks associated with interactions with WCPFC fisheries (where feasible). Describe the methods used to estimate total mortalities including treatment of data gaps. Provide advice to the Scientific Committee on the impact of WCPFC managed fisheries on oceanic whitetip shark and silky shark inside and outside the area between 20N and 20S. Provide advice to the Scientific Committee on mitigation methods that may benefit shark species between 20N and 20S.
Timeframe	To be completed in 2024 for review at SC20
Budget	In-kind contribution from USA
References	

Project P117 (P19X2)	**WCPFC tuna biological sampling plan** **In-kind contribution** **No Priority Ranking**
Objectives	To identify sampling gaps in biological data (age & growth) stored within the SPC Tuna Tissue Bank and to develop a biological sampling plan to collect age and

	growth information for key WCPFC tuna species with address those sampling gaps.
Rationale	Biological information such as age and growth are a key component of integrated assessment models, and are often difficult to properly estimate within assessment models. Currently, age and growth data are collected in an ad-hoc manner within the WCPFC absent a formal sampling plan (and stored in the SPC Tuna Tissue bank); which could be problematic in terms of appropriately developing a representative growth curve. The recent 2022 yellowfin peer review recommended that growth be estimated internally, and that an appropriate sampling plan be developed to obtain representative population length-at-age data (Punt et al., 2023). The current assessments for WCPO bigeye (Day et al., 2023) and yellowfin (Magnusson et al., 2023) tuna both estimate growth internally on the basis of the 2022 yellowfin tuna peer review and identify issues with the representativeness of the sampling. Additionally, the issue of spatially varying growth was raised at the SPC pre-assessment workshop, and was highlighted that future assessment software be capable of dealing with spatially varying growth (Hamer 2023). However, the ability to model any spatially varying processes in growth is dependent on having data collected from a sufficiently robust sampling plan that these spatially varying processes can be identifiable. On a related note, the ISC has developed a length-based proportional international billfish sampling (IBS) program for north Pacific billfish species (Kinney et al., 2023), the aim of which is to develop a data set to develop robust growth estimates and to begin interrogating the issue of spatially varying growth. Collection of samples as a part of the IBS is scheduled to wrap up in 2024 and preliminary simulation evaluation of spatial growth estimation models is underway.
Scope	This proposal seeks to leverage the existing efforts and experience within the WCPFC region in order to (in an initial phase): 1. Develop at the WCPFC level a robust, statistically structured biological sampling plan to enhance current activities, with an initial scope of collecting age & growth information for key tuna species (bigeye tuna, yellowfin tuna, skipjack tuna, and south Pacific albacore tuna); 2. Evaluate the existing biological samples contained within the SPC Tuna Tissue Bank relative to the sampling plan developed in (1); 3. Conduct a gap analysis to identify additional samples that need to be collected (e.g., spatiotemporal strata, size bins, sexes, etc.); as an example Day et al. 2023 highlight the lack of samples in the north central Pacific Ocean as a potentially important data gap. 4. Within a simulation framework, evaluate the robustness of the sampling plan developed in (1) to anticipated logistical challenges of implementing the plan across the WCPFC area, and to understand the limitations of the existing data following the gap analysis in (3). A subsequent phase would consist of the implementation of (1) with the collection of the additional samples defined in (3). A structured sampling program should directly translate into stock assessments with more reliable estimates of growth (and potential reductions in uncertainty), the ability to identify spatially varying processes in growth, and with sufficient temporal observations to identify how growth may be changing as a function of climate change.
Time frame	To be reported to SC20. A one-day hybrid workshop is proposed in the margins of

	the 2024 PAW to review progress and provide guidance for finalization of design
Budget	SSP complementary projects to fund the technical analyses, participation in the hybrid meetings in the margins of the 2024 PAW will be at participants' own expense. If there are cost implications resulting from that workshop, they will be the subject of an updated or new project ToR for the consideration of SC20.
References	Day et al., 2023. *Stock assessment of bigeye tuna in the western and central Pacific Ocean: 2023*. WCPFC-SC19-2023/SA-WP-05 Hamer 2023. *Report from the SPC Pre-assessment Workshop - April 2023*. WCPFC-SC19-2023/SA-IP-01 Kinney et al., 2023. *Length-Based Proportional Sampling for Life History Research: Establishing Uniform Sampling for North Pacific Billfish Species*. WCPFC-SC19-2023/SA-IP-11 Magnusson et al., 2023. *Stock assessment of yellowfin tuna in the western and central Pacific Ocean: 2023*. WCPFC-SC19-2023/SA-WP-04 Punt et al., 2023. *Independent Review of Recent WCPO Yellowfin Tuna Assessment*. WCPFC-SC19-2023/SA-WP-01

Project 118 (P19X3)	**WCPFC billfish biological sampling plan** **No budget required** **No Priority Ranking**
Objectives	To identify sampling gaps in biological data stored within the SPC Tissue Bank and to develop a biological sampling plan to collect information for WCPFC billfish species which address those sampling gaps.
Rationale	Biological information are a key component of integrated age-structured assessment models, and data-limited assessment approaches and are often difficult to adequately estimate within assessment models. The ISC has developed a length-based proportional international billfish biological sampling (IBBS) program for north Pacific billfish species (Kinney et al., 2023), the aim of which is to develop a data set to develop robust biological parameters including growth and maturity estimates and to begin interrogating the issue of spatially varying biological characteristics. Collection of samples as a part of the IBBS is scheduled to wrap up in 2024 and preliminary simulation evaluation of spatial growth estimation models is underway. Within the rest of the WCPFC, biological data are collected in an ad-hoc manner absent a formal sampling plan (and stored in the SPC Tissue bank); which could be problematic in terms of appropriately developing a representative data and biological relationships for stock assessment.
Assumptions	Assumes that regional partners/agencies including but not limited to SPC, the ISC billfish working group and/or the IATTC have the capacity to support staff involvement on this project.
Scope	This proposal seeks to leverage the existing efforts and experience within the WCPFC region in order to (in an initial phase): 1. Work with the ISC billfish working group to develop at the WCPFC level

	a robust, statistically structured biological sampling plan to enhance current activities, with an initial scope of collecting biological information (e.g., length composition, age, growth, maturity, and genetic data) for key billfish species (swordfish, striped marlin, blue marlin, black marlin, sailfish, and short billed spearfish); 2. Evaluate the existing biological samples contained within the SPC Tuna Tissue Bank relative to the sampling plan developed in (1); 3. Conduct a gap analysis to identify additional samples that need to be collected (e.g., spatiotemporal strata, size bins, sexes, etc.); 4. Within a simulation framework, evaluate the robustness of the sampling plan developed in (1) to anticipated logistical challenges of implementing the plan across the WCPFC area, and to understand the limitations of the existing data following the gap analysis in (3). A subsequent phase would consist of the implementation of (1) with the collection of the additional samples defined in (3). A structured sampling program should directly translate into stock assessments with more reliable representations of biological characteristics, the ability to identify spatially varying processes in biology, and with sufficient temporal observations to identify how biological characteristics may be changing as a function of climate change.
Time frame	To be reported to SC20. A one-day hybrid workshop is proposed in the margins of the 2024 PAW to review progress and provide guidance for finalization of design
Budget	SSP complementary projects to fund the technical analyses, participation in the hybrid meetings in the margins of the 2024 PAW will be at participants own expense. If there are cost implications resulting from that workshop, they will be the subject of an updated or new project ToR for the consideration of SC20.
References	Kinney et al., 2023. *Length-Based Proportional Sampling for Life History Research: Establishing Uniform Sampling for North Pacific Billfish Species*. WCPFC-SC19-2023/SA-IP-11

4. New projects that will require priority ranking

Project 119 (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** EU Project that should be signed by November 2023, and WCPFC's matching fund (Euro 44,000) is required. ISSF confirmed to support $20,000. **Priority Ranking**
Objectives	This project has the general objectives: 1. To enhance WCPFC project 110 with the deployment of additional non-entangling and biodegradable FADs to increase the robustness of the results and related management and industry advice. 2. To increase the regional capacity to support industry uptake and use of non-entangling and biodegradable FADs in the WCPO.
Rationale	This project aims to build on the current WCPFC project 110. Project 110 is discovering the highly challenging nature that implementing drifting non-entangling and biodegradable FADs in the WCPO presents. These challenges include limited regional materials availability, high freight time and supply chain bottlenecks for materials sourced from outside the region, lack of trained regional personal and facilities for constructing non-entangling and biodegradable FADs, including suitable storage facilities, and a general unpreparedness and in some cases complacency of the purse seine industry in the WCPO for transitioning to non-entangling and biodegradable FADs. Project 110 has also recognised that the level of visits and purse seine sets on individual FADs is lower than expected. Industry partners involved in the Project 110 do so as part of their day-to-day fishing operations and treat the trial FADs the same as standard drifting FADs; that is, they typically will not go out of their way to disproportionately visit and or set on the trial FADs. Furthermore, delays due to procurement challenges and industry inability to commit to participate due to COVID19, have also led to delayed deployments. This has mean that the recently deployed trial FADs time at-sea time will now overlap with the FAD closure, precluding any visits by purse seiners for 3 months. These issues mean the level of data obtained per trial FAD deployment is now lower than expected when planning Project 110 and additional FAD deployments are needed to increase the statistical rigour and robustness of advice from these experimental trials. While our collaborative efforts on non-entangling and biodegradable FAD trials in the Pacific region with the International Sustainable Seafood Foundation (ISSF) have been incredibly beneficial in many areas of the work (i.e., joint training activities, applying standardised designs and materials to allow pooling of data across trials in different regions of the Pacific), more opportunity to deploy non-entangling and biodegradable FADs and work with industry will be important to underpin transition to wide use of non-entangling and biodegradable FADs in the WCPO. Project 110 has built expertise and gained momentum after being severely impacted by COVID19 and will now be extended (at no cost) to December 2025 to allow the current trial deployments and analytical work to be completed and reported. This additional project will capitalise on the momentum and expertise in Project 110 by supporting deployment of additional (up to 150) non-entangling and biodegradable FADs that can be analysed alongside those deployed in Project 110.

	Project 110 has also provided an opportunity to understand the training requirements, logistical and materials supply obstacles to building and supplying non-entangling and biodegradable FADs to purse seine fleets in the WCPO. The project has trained local staff in construction methods in Pohnpei (Federated States of Micronesia), and training by ISSF has also occurred in Pago Pago (American Samoa), and Manta (Ecuador). SPC also now has in house staff with expertise to run training in non-entangling and biodegradable FAD construction, based on the ISSFs developed jelly-FAD design. However, additional bases for non-entangling and biodegradable FAD construction need to be identified and training in those location is required to facilitate non-entangling and biodegradable FADs supply options and support wider industry adoption. Further, the core materials for the non-entangling and biodegradable FADs in the current trial have had to be shipped into Pacific locations from as far away as Spain and are not locally readily available. This adds to time delays, expense and carbon footprint of non-entangling and biodegradable FADs. Therefore, exploration of alternative material supply options and/or locally produced materials are required to support industry adoption and enhance the environmental credentials of non-entangling and biodegradable FADs use in the WCPO. This additional project will also provide opportunity to explore alternatives for materials sourcing and non-entangling and biodegradable FAD construction locations in the WCPO.
Assumptions	SPC has the personnel available to undertake this work and or suitable consultants are available to support SPC to conduct the work. Travel in the region remains open to run training and explore materials options and alternative locations to construct and supply non-entangling and biodegradable FADs. Industry partners remain engaged in deploying non-entangling and biodegradable FADs, supporting data collection and cover costs of satellite buoys for at least 150 additional non-entangling and biodegradable FADs. Industry engages in training activities and advice on regional supply options for non-entangling and biodegradable FADs.
Scope	The project has two key work areas, the first being to construct and deploy up to 150 additional non-entangling and biodegradable FADs (using the jelly FAD design as the basis). The second work area is to build regional capacity to support the purse seine industry to adopt non-entangling and biodegradable FADs. This component will involve running additional trainings on non-entangling and biodegradable FAD construction at selected locations that are considered suitable as hubs for non-entangling and biodegradable FAD manufacture and direct supply to purse seine vessels. These locations will be chosen based on criteria such as analysis of purse seine visits for transhipment/restocking etc., discussions with industry representatives, consideration of materials availability and supply logistics and suitable port areas and facilities for materials storage and construction. Options for regional materials supply that require less transport and or identify suitable materials that can be locally sourced or produced will be explored.
Budget	Salary: (SPC scientific and technical) 70,000 Euro Operational (materials, freight, and labour for 150 bioFADs): 70,000 Euro Travel (training workshops, communications, investigate materials and construction options in WCPO): 50,000 Euro Project management cost: 28,000 EU **Total: 218,000 Euro (242,000 USD)** **20% co-funds contribution from WCPFC 44,000 Euro (49,000 USD)**

	Note: ISSF has offered 20,000 USD, so WCPFC co-funds can reduce to 29,000 USD

Project 120 (P19X5)	**Updated reproductive biology of tropical tunas** EU Project that should be signed in November 2023 WCPFC's matching fund (Euro 40,000) is required. **Priority Ranking**
Objective	1. Provide updated estimates on the reproductive biology of tropical tunas in the WCPO to improve WCPFC stock assessments. 2. Establish baselines of reproductive potential for tropical tunas in the WCPO for monitoring the impacts of climate change.
Rationale	A significant challenge for WCPFC tropical tuna stocks assessments is the estimation of spawning potential. Uncertainty in estimates of the parameters used to define spawning potential can decrease the precision of spawning biomass estimates that are used to assist management decision making. Spawning potential for tropical tuna is affected by a number of intrinsic factors, including size-related, age-related, and spatial changes in: sex ratio, annual fecundity per kg (spawning fraction x batch fecundity), and egg viability. Previous studies on the reproductive biology of tropical tunas have been limited in their geographic coverage, but a compilation of these studies indicates that the parameters used to estimate spawning potential vary with longitude and latitude. The last study to examine the reproductive biology across a broad spatial range for yellowfin tuna was published in 2000 (Itano, 2000). No such study has been undertaken for bigeye or skipjack tuna in the WCPO. Spawning potential is also expected to be strongly influenced by climate change, however, without baseline estimates the ability to detect and attribute change is limited.
Assumptions	1. Gonads stored in the Pacific Marine Specimen Bank are suitable for histological analyses. 2. Gaps in geographic locations * fish size * species can be filled through additional observer and port sampling in the first year of the study.
Scope	Year 1 • QC the gonads held in the PMSB for histological analyses and identify key gaps in spatial representation. • Quantify and resolve uncertainties associated with maturation staging from frozen samples (multiple-reader quality assessment). • Sample collection to fill key gaps. • Commence histological and laboratory analyses. Year 2 • Histological and laboratory analyses. Year 3 • Updated estimates of reproductive biology.
Timeframe	2024-2026
Budget	Euro40,000 (WCPFC co-finance contribution to access Euro200,000 via the European Maritime, Fisheries and Aquaculture Fund)
Reference	SC19-SA-WP-17

Project 121 (P19X6)	**Ecosystem and Climate Indicators** **Priority Ranking**
Objectives	• Develop and test candidate ecosystem and climate indicators to track the impact of

	climate and ecosystem changes on WCPFC fisheries and ecosystems. • Provide technical advice to the Scientific Committee on the suitability of criteria used for testing and evaluating the performance of candidate indicators. • Support the Scientific Committee in developing tools to communicate ecosystem and climate change impacts to WCPFC and external stakeholders and interest group.
Note	
Rationale	Fisheries management decisions are, at their simplest, informed risk management. Data describing fisheries are collected. Scientists, economists, compliance analysts, and the like derive information from the data and bring their respective knowledge to bear to put that in front of fisheries managers. Those managers are then able to use that knowledge and make decisions which minimise risk – on many issues including for example stock sustainability, the population status of species of special interest, and fishers' incomes. In stock assessment we are constantly striving – through obtaining better data, developing a greater understanding of the ecology of the target species, and improving our modelling approaches – to develop greater precision as to stock status and at the same time reduce the biases in our predictions of stock status. With greater precision we are able to both better specify the range of plausible outcomes resulting from decisions, and reduce the risk in those decisions. But tuna do not live in isolation from the ecosystem which supports them. At its simplest, if the system in which they live is sick, the tuna population cannot thrive despite the wisest decisions based on single-species stock assessment. To make truly wise decisions we need to consider the ecosystem with the stock. Even in their simplest implementation ecosystem indicators should enable more precise specification of the range of decisions leading to desired or effective outcomes, and reduce the risk of bad outcomes from those decisions through better understanding of the cause of potential stock assessment biases. Especially for the longer-lived tunas, ecosystem indicators should increasingly provide early warning of when issues may arise. Such forecasts allow time for management response in near real-time rather than trying to catch up years later. This will be particularly important as we move to making decisions in a Harvest Strategy framework and detecting when climate and ecosystem changes fall outside the ranges of uncertainty against which a management procedure was tested, and whether broader ecosystem objectives are being met. WCPFC has already recognised the importance of preparing the region to adapt to the emerging impacts of climate change (see Resolution 2019-01 "Resolution on Climate Change as it relates to the Western and Central Pacific Fisheries Commission"). Well-designed climate indicators should provide information on the pace at which physical properties of the WCPO are approaching climate change-induced tipping points. This will not only be important for adapting the region's tuna fisheries to the impacts of climate change but also provide necessary information for WCPFC members to voice the impact of climate change on tuna fisheries at global forums such as UNFCCC. In addition to the role that ecosystem and climate indicators play in assisting with the formulation of management advice and decisions, they can also be effective in communicating information within WCPFC's membership and to external stakeholders and interest groups.
Assumptions	• WCPFC and the Scientific Committee continue to require the development of ecosystem and climate indicators.

<table>
<tr><td></td><td>• External funds remain available to support the development, testing and analyses of ecosystem and climate indicators.</td></tr>
<tr><td>Scope</td><td>• Technical analyses to develop and test candidate indicators.
• WCPFC member and expert workshops to refine indicators.
• Scientific Committee Reporting.
• Routine preparation of adopted indicators
• Development of tools for communication to WCPFC and wider stakeholders</td></tr>
<tr><td>Activities</td><td>
<table>
<tr><th rowspan="2">Task</th><th rowspan="2">Activity</th><th colspan="4">Schedule</th></tr>
<tr><th>SC20</th><th>SC21</th><th>SC22</th><th>SC23</th></tr>
<tr><td>Initial screening of candidate indicators</td><td>Apply criteria endorsed at SC12 to candidate indicators that are relevant for monitoring impacts on purse seine and long-line fisheries and tuna species productivity</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Test candidate indicators</td><td>Fully develop methodology for developing and testing candidate indicators</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Test candidate indicators</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Expert Workshop</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Adoption Workshop</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Indicator validation</td><td>SC review and evaluation that adopted</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Communication tools</td><td>Report cards</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Dashboards</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>TFAR</td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Timeframe</td><td>A timeframe of five-years is proposed for this project, after which preparation of adopted indicators should be regularised into the work of the Scientific Committee or an alternative approach will need to be considered to progress the work (if minimal progress has been achieved).</td></tr>
<tr><td>Budget</td><td>This is a no-cost project for 2023. Any budgetary support required by the SSP or members beyond 2023 is subject to approval once specific workplans and proposal are reviewed and prioritised by the Scientific Committee. A budget of US$20,000 per year is required for 2024 and 2025 to support participation in workshops by WCPFC experts. A further budget of US15,000 per year is required for 2026 and 2027 to support SSP work to validate adopted indicators and support communication tools.</td></tr>
<tr><td>References</td><td>SC19-EB-WP-01</td></tr>
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Project 122 (P19X7)	**Scoping study on longline effort creep in the WCPO** **Priority Ranking**
Objectives	This project has the general objectives: 1. To survey literature to assess how existing understanding of effort creep can inform our treatment of longline effort creep in WCPO stock assessments; 2. To suggest approaches to investigate longline effort creep in the WCPO 3. To liaise with CCMs with regards to ideas, feasibility and interest in collaboration to quantify longline effort creep

Rationale	Effort creep occurs when a unit of fishing effort becomes more effective at catching fish over time. It can be challenging to estimate because technological changes leading to improvement in effort effectiveness are often poorly documented in the type of records used by fisheries scientists to conduct stock assessment and ancillary analyses. Effort creep has been recognised as an issue in both purse seine and longline fisheries in the WCPO. Initiatives to improve understanding of purse seine effort creep have been ongoing, including the submission of an annual paper reviewing key metrics to the Scientific Committee since 2016 (Hamer et al. 2023). Effort creep is also known to be present in longline fisheries but has been poorly explored. It has been listed as an issue in prior stock assessments for most tuna species as well as MSE development papers (e.g., Scott et al. 2023). However, longline effort creep can be harder to formally document given the longevity of the longline fishing effort in the WCPO (starting in the 1950s), the diversity of the fleets concerned, and the absence of fields recording key metrics of effort efficiency. Ideally, effort creep would be accounted for in CPUE standardisation by the inclusion of additional fields representing operational covariates that improve catchability. As it is unlikely such fields exist or could be reconstructed for the WCPO, one feasible alternative is to include scenarios of effort creep in stock assessments as has already been considered in previous stock assessments. However, given the paucity of research on this topic in the WCPO (but see Ward & Hindmarsh 2007, Ward 2008, Satoh et al. 2023), it is unclear at this stage what would constitute reasonable rates of increase to use for scenarios. Also, scenarios discussed so far (e.g. Scott et al. 2023) typically assume linear increase, but increased rates in periods of new technology uptake might also be relevant. In light of these challenges, this project would undertake a comprehensive survey of the scientific literature (including the grey literature) to see how existing understanding of effort creep in fisheries could inform scenarios of longline effort creep in the WCPO, and whether approaches used elsewhere could be applied in the WCPO to improve local understanding of effort creep. References: Hamer, P., Tears, T., PNAO (2023) Examining Indicators of Effort Creep in the WCPO Purse Seine Fishery. WCPFC-SC19-2023/MI-IP-07. Satoh, K., Ochi, D., Inoue, Y., Matsumoto, T., Ijima, H, Yokoi, H., Hasegawa, T., Okamoto, K. (2023). A preliminarily analysis of variations in the fishing gear configurations and practices of Japanese longliners in the western and central Pacific Ocean since 2007. WCPFC-SC19-2023/SA-IP-13. Scott, R., Yao, N., Scott, F., Natadra, R., Pilling, G. (2023). Selecting and Conditioning Operating Models for South Pacific Albacore. WCPFC-SC19-2022/MI-WP-04. Ward, P., & Hindmarsh, S. (2007). An overview of historical changes in the fishing gear and practices of pelagic longliners, with particular reference to Japan's Pacific fleet. *Reviews in Fish Biology and Fisheries*, *17*, 501-516. Ward, P. (2008) Empirical estimates of historical variations in the catchability and fishing power of pelagic longline fishing gear. Reviews in Fish Biology and Fisheries, 18, 409-426.

Assumptions	SPC has the personnel available to undertake this work and or suitable consultants are available to support SPC to conduct the work. CCMs are interested in participating in discussions on potential future effort creep studies.
Scope	This project will: 1. Undertake a literature review to: (i) summarise existing research investigating effort creep in longline fisheries or other gears, (ii) survey useful approaches used by other researchers to investigate and/or quantify effort creep, (iii) consider appropriateness of existing scenarios of effort creep assuming linear increase rates based on existing literature. 2. Suggest approaches to investigate longline effort creep in the WCPO; 3. Liaise with CCMs with regards to ideas, feasibility and interest in collaboration to quantify longline effort creep. Options include an online workshop or a session following the PAW meeting.
Budget	US$30,000

Project 123 (P19X8)	**Scoping the next generation of tuna stock assessment software** **Priority Ranking**
Objectives	The objective of the project is to ensure WCPFC tuna stock assessments remain robust and the best available scientific information through the appropriate planning for a state of the art successor to the MULTIFAN-CL assessment software.
Rationale	Following the retirement of the lead developer of MULTIFAN-CL (MFCL), Dave Fournier, future advances to the software will not be as mathematically innovative as they were in the past. While this does not render MFCL obsolete, it flags the need to plan and identify whether existing software exists, or new software must be developed, to support the specificities and future requirements of WCPO tuna stock assessments. This process should ensure duplication is avoided and that future modelling requirements are identified. A first step would be to review existing software for potential suitability, to take advantage of existing frameworks that could be modified to fit the specific current and future needs for WCPO tuna. Such a review can provide a 'base' set of software requirements that could then be compared in simulation studies to evaluate the value of specific features and performance of alternative software. In turn, wider collaboration in this venture is important and desirable, to enable a wider user and development group, for example across tRFMOs. Collaboration is important to bring together people with expertise in WCPFC assessments and/or the use of the alternative modelling software. Most models, including MFCL and Stock Synthesis that are applied to tuna assessments are age structured, while much of the data collected to inform model estimations is in terms of size and many of the processes are length-based. There is therefore value in first considering the underlying model structure most suitable for tuna assessments, and the benefits of considering length- or length-age structured

	formulations, which have the potential to also allow scenarios where spatially and temporally varying growth rates may be modelled, given that this might be expected to be important with changing climate influences. We refer to the 2023 PAW discussion on this topic for more details.
Assumptions	SPC has the personnel (or contracted scientist) and budget available to undertake/co-ordinate this work. Other tRFMOs and regional agency collaborators will support their stock assessment modellers to collaborate.
Scope of work	The project is divided into stages, as follows: 1. Review and identify a list of necessary features for software to do tuna stock assessments and identify existing software platforms that have these features or capacity to develop these. 2. Conduct a simulation scoping study to evaluate the degree of bias incurred in management advice due to length-based processes in time and space not being accurately modelled by age-structured models. This would identify whether moving to a length- or length-age structure brings sufficient benefits. This work could take advantage of the approaches used for existing simulation frameworks, such as the NOAA/NIWA spatial simulation study of Indian Ocean yellowfin tuna. Development of a simulation framework could additionally be used to progress current MFCL assessments by evaluating alternative spatial structures or the impacts of increasing/reducing model complexity on the estimation of management quantities of interest. However, these additional uses for a simulation framework are outside the scope of the current ToR. 3. If a length-age-structured model is deemed appropriate, evaluate the utility of existing length-based models (e.g. including, but not limited to, GADGET, CASAL2, spatial L-SCALA) as the basis for a future assessment platform, likely to be based in TMB, and recommend an approach. 4. Undertake the development of the new assessment software in TMB, including identification of those necessary to mirror the functionality in MFCL in any new software, and existing MFCL code that can be ported across to a new framework. This may include porting the existing MFCL software to the TMB platform to ensure an equivalent model exists on which to build the additional length-structure components, and testing for equivalence using the existing C++ code. 5. Throughout, generate collaborative opportunities to work with other agencies on developing a new TMB model, ensuring a diverse user base. This is anticipated to be a multi-year endeavour. As a result, the current ToR focuses on the first and second scoping stages of the project, as well as stage 5. Based upon the findings of that study, further project ToRs would be developed to progress the work. Findings would be reported to SC each year.
Timeframe	2024-2026
Budget	For this first phase (elements 1, 2, 5): 0.35 FTE annually for 3 yrs: $40,000 pa Travel to project partners: $10,000 pa Total: $50,000 pa for 3 yrs (total = $150,000) Notes: Element 5 will require in kind salary support from collaborators and likely additional

	funding to undertake workshops with travel support. If new significant software development is needed (stages 3,4) then a fulltime developer over at least 3 years likely needed to lead the work.
References	SC19-SA-IP-01

Project P19X9	**Manta, mobulid and whale shark fisheries characterisation, CPUE standardisation and data-poor assessment** (This will replace the whale shark stock assessment) **Priority Ranking**
Objectives	To assess the trends in catch and gears catching manta and mobulid rays and whale sharks, undertake a fishery data characterisation and attempt CPUE standardisation and data poor stock assessment methods for these species.
Notes	Data poor stock assessment methods chosen can be decided by the assessment team and informed by the data characterisation.
Rationale	Whale sharks were last assessed in 2018 as a risk analysis of the Indo-Pacific Ocean whale shark population from Pacific Ocean purse-seine fisheries. The risk assessment model suggested that the risk from Pacific Ocean fisheries alone is moderate to low, but not insignificant given potential other sources of mortality and uncertainty. Manta and mobulid rays have never been the subject of a detailed fishery analysis within the WCPO. Whale sharks have been listed on CITES Appendix II since 2003, mantas since 2014 and mobulid rays since 2017. CITES Appendix II listing means that these are species "not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival." As such any transfer of biological material from these species between countries will require a CITES non-detriment finding. This work is required to investigate trends in these stocks and attempt to get an understanding of their population status within the WCPO.
Assumptions	• Much of the existing fisheries and biological data are readily available. • Assessment personnel at the SSP or consultants with suitable expertise are available to undertake this work.
Scope	• Review the previous work in the WCPO as well as other subsequent work on methods to increase the understanding of species with low levels of information available. • Describe the fisheries catching these species, the gear associated with the capture events and spatial temporal dynamics of catches. • Develop standardised CPUE indices for each species, by gear. • Develop an estimate of total interactions and mortalities by gear type. • Investigate data poor assessment methods for these species and provide an estimate of fishery impact for each species using these methods and/or any relevant metrics tables from SC17 report table MI-01. • Undertake a hot spot analysis and recommend target areas for opportunistic tagging of whale sharks and mantas inadvertently caught in fishing gear.
Timeframe	March 2024 - August 2024
Budget	0.5 FTE ($46,000) Travel to SC20 ($10,000) Total: $56,000
References	P. Neubauer, Y. Richard, and S. Clarke. SC14-SA-WP-12 (Rev 1) Risk to the Indo-Pacific whale shark (*Rhincodon typus*) population from interactions with Pacific

	purse seine fisheries.

Project 124 (P19X10)	**Oceanic whitetip assessment in the WCPO (2024-2025)** **(2024-2025, assessment supported by shark ISG)** **Priority Ranking**
Objectives	Undertake a stock assessment of oceanic whitetip in the western and central Pacific Ocean
Notes	Depending on the priorities of the SC for the work to be undertaken by the Scientific Services Provider (SSP), this project may be undertaken within the service agreement with the SSP or alternatively as a standalone project with a separate funding allocation. This will need to be decided by the SC19 considering the other priorities.
Rationale	This stock was last assessed in 2019 (Tremblay-Boyer et al 2019; SC15-SA-WP-06) using data from 1995-2016. The stock was found to be overfished and overfishing was occurring. Recent work on projections under alternative mortality scenarios highlighted the dependence of recovery on current levels of fishing mortality (Rice et al. 2021, Bigelow et al. 2022). As this species is unproductive and susceptible to overfishing, one objective of this assessment is to establish and examine recent trends, especially with respect to potential signs of increases shown in the previous stock assessment, and to update projections based on updated trends in recent biomass. This project is designed to assess the stock status of oceanic whitetip shark in the western and central Pacific Ocean using the most informative approach with respect to the available data. The assessment should assess the stock status against conventional stock assessment metrics as well as those suggested in the WCPFC 2021-2025 Shark Research Plan (SC16-EB-IP-01 rev1). Noting that integrated stock assessments for elasmobranchs are challenging and can sometimes fail to succeed, SC19 recommended that integrated shark assessments project undertaken by the WCPFC also consider including a data-poor assessment/risk analysis component so that advice on stock status can still be provided even if the integrated assessment approach fails, and to improve our understanding of the reliability of data poor assessments. It was noted that this could incur additional costs to do the assessment work. In addition, to improve our understanding of the reliability of data poor assessment metrics, SC19 encouraged that future integrated elasmobranch stock assessments presented to SC also report data-limited stock status metrics such as the those outlined in SC17 report table MI-01, if they can be estimated.
Assumptions	• Much of the existing fisheries and key biological parameters are readily available. • Assessment personnel are available to undertake this work.
Scope	• Review the previous assessment in the WCPO as well as other subsequent shark assessments to assess and improve on methods to increase the understanding of data strengths and weaknesses, and update stock status. • Review of ways to deal with the input data for oceanic whitetip (presented to a dedicated agenda item at the 2024 PAW).

	• Provide a data characterization, data compilation and catch reconstruction analyses (2024). • Update WCPO catch estimates and abundance indices using recent observer data (2024). • Conduct an integrated stock assessment in feasible (2025) • **Addition option:** Alongside the integrated assessment, develop at least one alternative stock assessment (e.g., medium information method; risk assessment) to compare with the integrated assessment results (2025). • Present the stock status in terms of the metrics outlined in the 2021-2025 Shark Research Plan. (2025) • Update stock projections for Oceanic whitetip using mortality estimates used in Bigelow et al. 2022 and any new information available. • Prepare reports containing the above results for SC20 and SC21.
Timeframe	March 2024 - August 2025 March 2024 - April 2025 (data compilation, fishery characterization and catch reconstructions) March 2025 - August 2025 (Stock assessment)
Budget	1.5 FTE Year 1 - 2024 $50,000, plus travel to SPC PAW and SC21 $10,000 = $60,000 Year 2 - 2025 $50,000, plus travel to SPC PAW and SC21 $10,000 = $60,000 Addition option: at least one alternative low or medium data stock assessment (e.g., risk assessment) add $30,000 (2025) Total: $150,000
References	SC16-EB-IP-01 rev1 2021-2025 Shark Research Plan (23July) - Rev.01 / Project 97 (SRP) - Final Report Bigelow, Keith and Rice, Joel and Carvalho, Felipe "Future Stock Projections of Oceanic Whitetip Sharks in the Western and Central Pacific Ocean" (2022), WCPFC-SC18-2022/EB-WP-02 Rice J, Carvalho F, Fitchett M, Harley S, Ishizaki A. 2021. Future Stock Projections of Oceanic Whitetip Sharks in the Western and Central Pacific Ocean. WCPFC-SC17-2021/SA-IP-21. Tremblay-Boyer L, Carvalho F, Neubauer P, Pilling G. 2019. Stock assessment for oceanic whitetip shark in the Western and Central Pacific Ocean. WCPFC-SC15-2019/SA-WP- 06. Report to the WCPFC Scientific Committee. Fifteenth Regular Session. 12–20 August 2018. Pohnpei, Federated States of Micronesia. Tremblay-Boyer L. Neubauer P. 2019. Historical catch reconstruction and CPUE standardization for the stock assessment of oceanic whitetip shark in the Western and Central Pacific Ocean. WCPFC-SC15/SA-IP-17. Report to the Western and Central Pacific Fisheries Commission Scientific Committee. Fifteenth Regular Session. 12–20 August 2018. Pohnpei, Federated States of Micronesia.

Project P19X11	**Developing a statistically robust and spatial/temporal optimized sampling strategy for shark biological data collection** **Priority Ranking**

Objectives	1. To develop a sampling plan for key shark species in WCPO that considers both scientific and stock assessment needs, and logistical feasibility. 2. To consider the implications of increased non-retention of sharks for biological sampling and CITES listings for the collection and movement of biological samples.
Notes	Note that only about 25% in the longline and 50% of sharks in the purse seine fishery arrive at the vessel dead, and only these may be available for sampling. CMM2022-04 has provisions for allowing the sampling of dead sharks. Note that while non-lethal sampling could be undertaken in some circumstances, observer safety concerns will need to be addressed prior to that sampling commencing. Noting that some samples will require CITES non-detriment findings (NDFs), SPC has been asked to provide capacity support to train Pacific Island Staff in the development of NDFs if they are required.
Rationale	Biological information/data are a key component for assessment of fishing impacts, stock status and risk assessments for key WCPFC sharks. Recent assessments of sharks have suffered or had increased uncertainty due to the limitations and/or lack of regionally representative data on biological parameters such as maturity schedules, fecundity, and growth. Suitably collected genetic samples are also limited and need to increase to allow for more detailed studies on population structure and aspects such as natal homing, and to start building a sample base to support future investigations of Close Kin Mark Recapture (CKMR) for estimating population size. Previously collected samples have come from ad hoc sampling. However, this approach can be wasteful of sampling effort and a more considered spatio-temporal and species focused sampling strategy is important to improve the scientific outcomes and utility from any sample collections. The increased non-retention of sharks is making fishery dependent data a less reliable source of information on population trends/stock status. None-the-less fishery interactions with sharks will continue and the WCPFC is obliged to report on the status and fishery risks for key sharks. Novel techniques might be required to obtain biological samples, and these will need to be considered as part of this work. Finally, the increased non-retention for most sharks except blue sharks, presents a challenge for biological sampling. This challenge is further compounded by CITES listing of some sharks that have implications for biological sampling and movement of samples. These issues will need to be considered in designing a biological sampling program.
Assumptions	Regional partners/agencies including SPC, observer and port sampling programs of WCPFC CCMs have capacity and will support sample collection, sample sharing and sample curation. Sampling challenges due to non-retention and CITES implications can be resolved.

Scope	This proposal seeks to: 5. Conduct a sample gap analysis: Review and prioritize biological sampling requirement for WCPFC key sharks and consider these in relation to the availability of pre-existing samples held by SPC Pacific Specimen Tissue Bank, and potentially other repositories. 6. Develop a feasible sampling plan designed to fill the identified gaps as best as possible, considering the issue of non-retention and CITES Appendix II listings. 7. Step 2 would require specification of the species, spatial and temporal coverage, and numbers of samples required by specific sample types. The capacity to collect required samples, and over what time frame, should be assessed based on realistic information and simulation based on known capacity of sample collectors and species availability to be sampled at the required locations (e.g., observers and port sampling programs). 8. Consider the options/requirements for sampling and movement of samples for species that are controlled under CITES regulations. This would likely include the need to identify where non-detrimental finding applications would be required to allow sampling to occur. 9. Estimate additional costs that would be required to co-ordinate (likely by SPC) and implement a sampling plan. The project should consider approaches used by ISC to develop their biological sampling plans, and work collaboratively with ISC scientists.
Time frame	This project could occur over 2 years. The gap analysis could be done in the first 6 months of 2024 and involve a workshop with shark scientists from WCPFC CMMs to identify sampling priorities. The gap analysis could be presented to SC20. The second phase to design a feasible sample plan could occur in the second year, with the plan and CITES related requirements and cost estimates for implementation presented to SC21.
Budget	Year 1 – 2024 $40,000 (gap analysis, including workshop, report to SC20) Year 2 – 2025 $45,000 (sampling plan design, CITES implications, costing for implementation, report to SC21).