



**SCIENTIFIC COMMITTEE
SIXTEENTH REGULAR SESSION**

**ELECTRONIC MEETING
12-19 August 2020**

Terms of Reference for 2021 Proposed Projects

WCPFC-SC16-2020/GN-IP-08 (Rev.04)
[31August2020](#)

Secretariat

<u>Project 90</u>	<u>Better data on fish weights and lengths for scientific analyses (Revised TOR)</u>
Objectives	<p>This project has three objectives</p> <p>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):</p> <ul style="list-style-type: none"> • identify the priority gaps in <u>conversion factor data</u> 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 • <u>present the findings at SC15 for review, acknowledging that some observer providers will voluntarily collect conversion factor data prior to SC15.</u> <p>The second component relates to investigating potential innovative methods to obtain <u>length-length conversion factor</u> data, including:</p> <ul style="list-style-type: none"> • explore the use of EM tools to capture multiple length measurements from fish e-measured by EM Analysts. <p>The third component relates to collecting the conversion factor data:</p> <ul style="list-style-type: none"> • 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 <u>fish catch</u> and bycatch <u>estimates</u> in the WCPO.
Note	<p>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.</p> <p>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.</p>

	<p>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) <i>Report of the Pacific Shark Life History Expert Panel Workshop, 28-30 April 2015; SC11-EB-IP-13</i>, and conversion factor data compiled from the Australia domestic longline fishery.</p> <p>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;</p> <ul style="list-style-type: none"> - Potential difficulty in measuring large specimens on small boats; - Evaluating the feasibility of weighing fish at sea. For example, consideration of the following: <ul style="list-style-type: none"> • 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	<p>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, <u>bycatch length data</u> 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.</p> <p><u>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</u></p>

	<p><u>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.</u></p> <p>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.</p> <p>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:</p> <ul style="list-style-type: none"> • 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	<p>Achievement of the objectives is subject to the following assumptions:</p> <ul style="list-style-type: none"> • 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. <p>• <u>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.</u></p>
Scope	<p>The proposed work programme comprises:</p> <ul style="list-style-type: none"> • 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;

	<ul style="list-style-type: none"> • ongoing co-ordination of sample collection and data submission; and • reporting on designs and progress with implementation and data collection. <p>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.</p>
Timeframe	57 months (from January 2019 through September 2023)
Budget	<p>2019 US\$60,000 2020 US\$30,000 2021 US\$20,000 + USD\$7,000 (transferred from Project 81) 2022 US\$75,000</p> <p>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.</p> <p>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.</p> <p>The 2019 funding also includes the costs to investigate and purchase 1-2 weighing devices in the initial implementation phase.</p> <p>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.</p> <p>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.</p> <p>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.</p>
References	<p>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.</p> <p>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.</p> <p>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.</p>

	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].
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Project 100b	Feasibility of Close-Kin Mark-Recapture (CKMR) assessment for South Pacific albacore in the WCPO (SC16-SA-IP-15)			
Rationale	Initial explorations suggest that a total of around 20–25,000 south pacific albacore, spread over a few years, might need to be sampled in order to reliably estimate population size and other management parameters via CKMR. Such a quantity seems broadly achievable, but a detailed analysis is required to develop an appropriate sampling strategy, and an evaluation of benefits and costs so the Scientific Committee can determine if CKMR is warranted for this stock.			
Objectives	<p>See WCPFC-SC16-2020/SA-IP-15 for more detail.</p> <ol style="list-style-type: none"> 1. An evaluation of the fisheries and locations where useful quantities of samples can be collected, noting that samples must include approximate capture location information, and some information on fish age or at least length. This should address overall spatial coverage, likely population composition of Pacific Island landings, and potential use of samples already in the WCPFC tissue bank. 2. Detailed design of stratified sampling schemes, including realistic consideration of achievable precision in a stock assessment context 3. Develop the necessary collaborative and stakeholder consultation arrangements to move to full-scale implementation. 4. Use existing albacore samples to develop a panel of genetic markers that can be used for determining kinship and sex, incorporating likely markers of population structure; 5. A costs and benefits comparison of adopting CKMR as a fishery monitoring tool for South Pacific albacore. 			
Budget	A total budget contribution from WCPFC of USD50,000 is requested for the above work. The SPC and CSIRO columns show additional in-kind contributions of expert time.			
	Activity	WCPFC	SPC	CSIRO
	Logistic Evaluation and Detailed Design	USD15,000 ^[A]	USD25,000 ^[B]	USD10,000 ^[C]
	Consultation (workshop)	USD15,000 ^[D]	USD5,000 ^[E]	
	Marker Development	USD10,000 ^[F]	USD10,000 ^[G]	
	Costs-Benefits Comparison	USD10,000 ^[H]	USD5,000 ^[I]	USD5,000 ^[C]

[A] CSIRO expertise in CKMR design and use in stock assessment

[B] SPC Sampling expert

[C] Additional CKMR modelling support

[D] Support workshop costs and CSIRO travel, assuming workshop can be held in the margins of existing meetings

[E] SPC Sampling and Assessment experts

[F] CSIRO expertise in locus selection for CKMR

[G] SPC Molecular Geneticist

[H] CSIRO expertise in CKMR for design and use in stock assessment

[I] SPC Assessment Scientist

Project 104	Terms of Reference for a project to identify appropriate LRPs for Southwest Pacific Ocean (SWPO) striped marlin and other billfish (SC16-MI-IP-12)
Objectives	Provide recommendations for performance indicators and related LRPs for SWPO striped marlin, and consider their relevance for other billfish in the WCPO.
Rationale	<p>In response to the WCPFC16 that “<i>noted with concern the current status of South Pacific striped marlin and agreed to revisit the limit reference point in 2020 at WCPFC17</i>” (para 54, WCPFC16-2019-outcomes). This project will aim to identify performance indicators and appropriate limit reference points (LRP) for Southwest Pacific Ocean striped marlin. While the focal species is striped marlin, the project should also consider the appropriateness of the recommendations for striped marlin, for other billfish (i.e. blue marlin, black marlin and swordfish) in the WCPO.</p> <p>The most recent stock assessment for SWPO striped marlin was conducted in 2019 (SC15), using data inputs up until 2017. The assessment indicated declining trends in biomass and that levels of depletion and indicators of fishing mortality (F) were in the vicinity of LRPs applied to the key tuna stocks in the WCPO. While uncertainty in the assessment outcomes were notable due to uncertainty in key biological parameters, many of the model runs from the uncertainty grid suggested the stock was likely overfished based on reference points used for tuna species. Concern over a lack of specific management reference points for SWPO striped marlin was raised and that a suitable LRPs for this stock should be identified.</p> <p>While the WCPFC has developed a 3-level hierarchical approach to defining LRPs for key species (https://www.wcpfc.int/harvest-strategy), this has not yet been applied to billfish species.</p> <p>This project will have the important objectives:</p> <ol style="list-style-type: none">1. Review options and identify ‘feasible’ candidate performance indicators and related LRPs for SWPO striped marlin, including LRPs for biomass depletion, spawning potential and fishing mortality.2. Identify and provide an assessment of the uncertainties associated with each feasible LRP option and their sensitivities to the various uncertainties identified.3. Based on outcomes of objectives 1 and 2, recommend performance indicators and related LRPs for SWPO striped marlin, and consider their relevance for other billfish in the WCPO (i.e. blue marlin, black marlin, swordfish).4. Provide an assessment of the appropriateness of the WCPFC hierarchical approach to defining LRPs to striped marlin and other billfish (blue marlin, black marlin and swordfish) in the WCPO.
Assumptions	SPC or another regional body has the personnel and budget available to undertake this work.
Scope	While this project will focus on the SWPO striped marlin, other billfish (i.e. blue marlin, black marlin and swordfish) will be considered in relation to the recommendations for striped marlin.

	<p>Development of LRPs for SWPO striped marlin under this ToR will be based primarily on ‘biological sustainability’ and ‘conservation’ objectives as opposed to social or economic considerations. The concept of avoiding recruitment overfishing and the stock being depleted to the extent that recruitment potential becomes impaired is therefore highly relevant to developing LRPs for SWPO striped marlin.</p> <p>The scope of this work does not include definitions of probability of breaching any LRP or associated management actions, as these require management and stakeholder advice. The work should report on the uncertainty in estimation of candidate LRPs, considering the available data and other information for striped marlin in the SWPO or elsewhere throughout the species range. A review of existing LRPs for striped marlin or similar species of billfish should be conducted along with the suitability of the WCPO hierarchical approach for defining a LRP for SWPO striped marlin and billfish in general.</p> <p>Key activities within the scope of this ToR:</p> <ol style="list-style-type: none"> 1. Literature review of LRPs used for striped marlin (and other billfish with similar biological characteristics, i.e. blue marlin, black marlin, swordfish) in other jurisdictions, 2. Meta-analysis to provide insights into the levels of depletion and fishing mortality that may serve as appropriate LRPs for SWPO striped marlin and consider relevance for other billfish, 3. Assess the appropriateness of the WCPFC hierarchal approach for defining LRPs for billfish in the WCPO, and if not appropriate recommend alternatives, 4. Review the key data requirements and feasibility of potential LRP options considering currently available information for SWPO striped marlin, 5. Estimate candidate LRPs and their associated uncertainties for SWPO striped marlin, and; 6. Recommend additional information requirements to improve the estimation of LRPs for SWPO striped marlin and other billfish (i.e. blue marlin, black marlin, swordfish) <u>as either target or non-target species.</u>
Budget	<p>Salary \$25,000 Travel to SC17 \$6,000 Total: \$31,000</p>

Project 105	Bomb radiocarbon age validation for bigeye and yellowfin tunas in the WCPO (SC16-SA-IP-17)
Objectives	To test the validity of age estimates for bigeye and yellowfin tuna from the western and central Pacific Ocean (WCPO) using bomb radiocarbon dating.
Rationale	As seen from the recent assessment of WCPO bigeye tuna (BET; McKechnie et al., 2017; Vincent et al., 2018), the specification of growth in integrated stock assessment models, such as MULTIFAN-CL, can have profound effects on stock status indicators. It is therefore essential that such assessments utilize the best growth data and/or growth model estimates possible within such assessments. To this end, WCPFC in recent years has commissioned extensive research efforts to collect and analyze BET (Farley et al., 2018; 2019; 2020a), and more recently yellowfin tuna (YFT; Farley et al., 2020a) otoliths to estimate growth to inform stock assessments. This work has relied mostly on counting presumed annual opaque zones in otolith sections to provide the basis for

	<p>determining annual age. Limited age validation of the otolith reading approach was made through an analysis of several strontium chloride (SrCl₂) marked tuna otoliths that were tagged and recaptured. A recent workshop held at IATTC on BET and YFT growth (Farley et al. 2019) made the following conclusion: “Further direct age validation studies for bigeye and yellowfin daily and annual ageing methods, spanning the entire size range and expected range of longevity, are urgently needed in the Pacific.”</p> <p>Recently, annual age reading protocols for YFT and BET in the Gulf of Mexico were validated using bomb 14C dating (Andrews et al. 2020). The study used an innovative approach to the method where the post-peak bomb 14C decline period (~1980–2000) was used to successfully validate YFT aged 2 to 18 years and BET 3 to 17 years. This new approach is well-suited to shorter lived species and was recently applied to Pacific bluefin tuna (PBT; Ishihara et al. 2017). This method relies on otolith 14C levels in the core (earliest growth) as compared to formation years of a 14C reference, often a validated coral core chronology, for the region of interest to determine if the calculated birth year from growth zone counts is consistent with the 14C reference. At the most recent SPC pre-assessment workshop (April 2020), the bomb radiocarbon method was presented using BET 0+ aged fish (young-of-the-year) from the WCPO to investigate the distribution of 14C in otoliths in time. Based on regional coral records and the results from PBT (see Figure 1 of Farley et al. 2020b; SC16-SA-IP-17), the approach looks promising for a full application of bomb radiocarbon dating to BET with an extension of its use to YFT.</p> <p>As a first step to a potential age-validation study in the WCPO, an expert workshop was held in July 2020 to examine the feasibility and research design for such a project (Farley et al. 2020b). During this workshop, Kai Okamoto (NRIFSF) presented the preliminary BET bomb radiocarbon results and proposed a draft workplan. As a follow-up to the workshop, Allen Andrews (University of Hawaii) presented a research plan proposal for bomb 14C dating of YFT in the WCPO. These proposals have since been combined as a collaborative effort to increase efficiency and to take advantage of new 14C accelerator mass spectrometry (AMS) technology at the Ion Beam Physics Lab of ETH Zürich, Switzerland.</p>
Assumptions	<ul style="list-style-type: none"> • Otoliths identified as available by project partners are provided in timely manner. • Otoliths provided by project partners, and those from the WCPFC Tuna Tissue Bank, are of sufficient quality to determine 14C levels. • Otoliths from the WCPFC Tuna Tissue Bank will be released without needing to have the research proposal approved by the SC Research Committee. • Work to be completed by project partners is finished on time. • Covid-19 travel restriction are lifted to allow travel to ETH Zürich, Switzerland. • Allen Andrews and NRIFSF will undertake the core work and actively collaborate with CSIRO and the Scientific Services Provider in the conduct of the analyses.
Scope	<p>Otoliths of juvenile YFT and BET tuna collected through time from the WCPO will be used to establish a reference curve for bomb-produced ¹⁴C that will provide a baseline for testing the validity of adult YFT and BET age and longevity estimates.</p> <p>The reference curve will be composed of 0+ aged fish that were collected from fishing regions where both juveniles and adults have been collected over a 20-year period to reflect the post-peak bomb ¹⁴C decline. Coral records that are proximal to the region indicate the reference record will be common across the latest 20 years (2000 to 2020);</p>

Figure 1 and see Figure 4 of Andrews et al. (2018)). The measurable monotonic decline variability with a strong central tendency will provide a basis for validation of age for adults using otolith cores (within the first year of growth). This approach is similar to the recent success demonstrated for YFT and BET in the northwestern Atlantic Ocean where ages approaching 20 years, along with an age reading protocol that is similar to what is now being used in parts of the Pacific Ocean, were validated for each species using regional coral and otolith reference materials (Andrews et al. 2020). The proposed study has the advantage of juvenile tuna otoliths that cover the entire 20-year reference period to be used in validating the estimated birth years of recently collected adults (i.e., 2015 has fish aged 1-14 years = birth years 2014-2001).

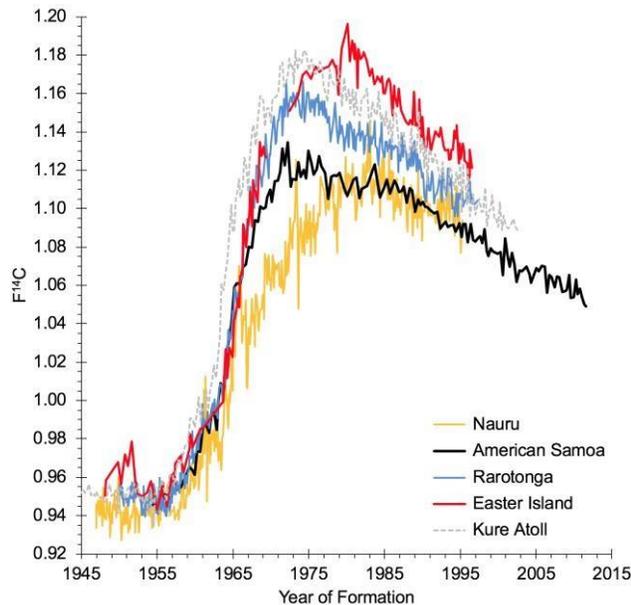


Figure 1. Cross section of coral radiocarbon records from north to south Pacific Ocean showing an apparent dovetailing of reference records in the most recent years (>2000) — this observation is consistent with air-sea diffusion of radio-CO₂ as the marine system becomes the bomb-produced radiocarbon reservoir (see Andrews et al. (2016) for first indication of crossover). The absence of other records to confirm the most recent years will be remedied with the 0+ aged tuna otoliths from the region of interest, thereby providing the most reliable temporal reference for the earliest otolith growth of adult tuna.

The selected 0+ aged otoliths used to establish the reference curve (60 from each species) will be sampled manually by isolating the first few months of growth using well-established sectioning and grinding techniques. Andrews et al. (2020) utilized a multi-step approach to core isolation that led to extraction of several months of material in a verifiable manner (Figure 2). This otolith material will be processed using a state-of-the-art system that uses gas-AMS, as opposed to graphite-AMS (sample loss during this process), which is a major step forward in terms of increased efficiency and precision for sample masses that are on the order of 10 times smaller than required for other methods (see Andrews et al. 2019) — this approach avoids the potential problems associated with the inclusion of more recently formed material (see Ishihara et al. (2017) for potential problems with large core extraction masses). In addition, the sample handling time is reduced by eliminating the graphitization step and thereby decreases costs without loss of precision.

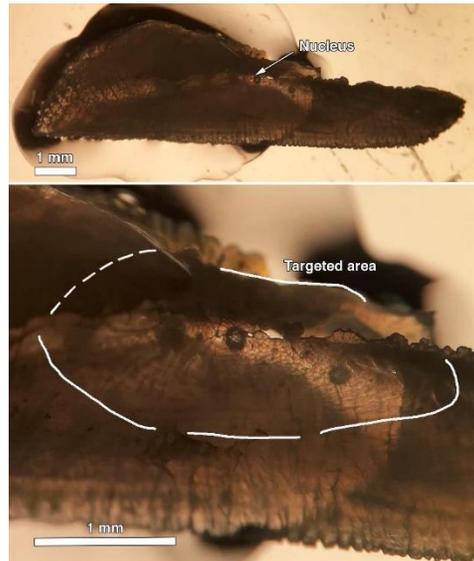


Figure 2. Whole yellowfin tuna otolith with close-up showing how the otolith core will be targeted, as was demonstrated by Andrews et al. (2020). Target area was estimated to be several months of growth based on daily increment observations.

The series of adults used to test the validity of age estimates (40 YFT and 100 BET) will be cored in the same manner as stated above and the measured ^{14}C levels compared to the juvenile otolith reference curve. The variability of the decline reference record will be reduced by comparison of the slopes and intercepts of the respective decline regressions and the concordance of adult ^{14}C data within the 95% prediction intervals of the reference (Figure 3; Andrews et al. 2020).

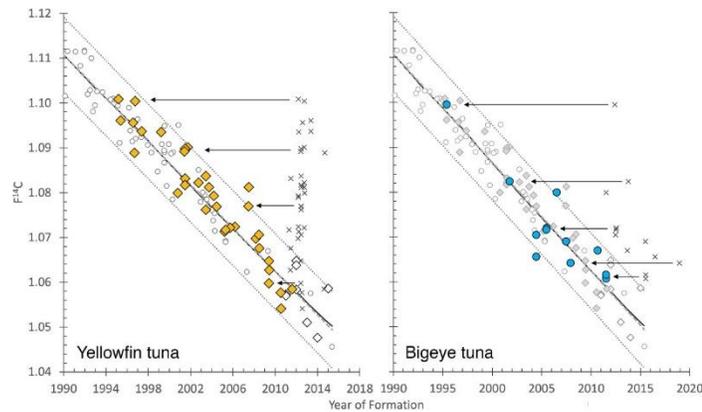


Figure 3. Plot of adult YFT and BET otolith core measurements as show at collection (X's) and projected back to estimated birth years from age estimates made using growth zone counting. These data are compared with a consistent bomb-produced ^{14}C decline reference consisting of coral and otoliths, of which juvenile YFT are included and aligned (Andrews et al. 2020).

In addition to the analysis of otolith material for ^{14}C levels via gas-AMS, it is proposed that a pioneering technology be used to investigate the uptake of ^{14}C within adult BET otoliths through ontogeny. The recent development of gas-AMS by members of the Ion Beam Physics Lab (ETH Zürich; Mini Carbon Dating System (MICADAS) by Ionplus (<https://www.ionplus.ch/micadas>)) has led to a laser ablation (LA) adaptation for continuous measurement of ^{14}C from a carbonate sample scan (shells, speleothems, deep-sea coral; Welte et al. 2016). This innovative method has been extended to include measurement of a complete bomb-produced ^{14}C signal within the otoliths of individual red snapper, providing evidence of a 60-year lifespan (Andrews et al. 2019). Of interest for this approach are the potential changes in the uptake of ^{14}C to the otolith of vertically migrating BET. The questions are: 1) does the uptake of ^{14}C to the otoliths of BET change through ontogeny as the species increasingly occupies cooler waters (expected to be ^{14}C -depleted), and 2) can the much smaller otoliths be used in LA-AMS to reveal these changes through time and provide a relation to age? As part of this proposal, whole otoliths of three older adult BET will be mounted in an exploratory manner to be scanned for ^{14}C with LA-AMS across the growth axes.

This work will provide unprecedented results for BET and YFT in the WCPO with ^{14}C baselines that can be utilized in numerous future studies of the pelagic environment. The resulting manuscripts and peer-reviewed publications will provide new information on the use of BET and YFT otoliths in estimating growth parameters and potentially monitoring changes in stock age-structure through time. The bomb ^{14}C reference can lead to use of this technique with other pelagic fishes, such as other tunas (i.e., skipjack, albacore), billfishes (e.g., blue marlin; Andrews et al. 2018), and a potentially sharks (e.g., oceanic whitetip; Passerotti et al. *In review*). In addition, the shared technology will open avenues to other working groups to pursue use of methods that provide greater precision on smaller sample masses, coupled with the revelation of LA-AMS technology, in other life history studies of the marine environment

References

Andrews, A.H., D. Siciliano, D.C. Potts, E.E. DeMartini, and S. Covarrubias. 2016. Bomb radiocarbon and the Hawaiian Archipelago: Coral, otoliths and seawater. *Radiocarbon* 58(3): 531-548 ([dx.doi.org/10.1017/RDC.2016.32](https://doi.org/10.1017/RDC.2016.32))

Andrews, A.H., R.L. Humphreys, and J.D. Sampaga. 2018. Blue marlin (*Makaira nigricans*) longevity estimates confirmed with bomb radiocarbon dating. *Canadian Journal of Fisheries and Aquatic Science* 75: 17-25 ([dx.doi.org/10.1139/cjfas-2017-0031](https://doi.org/10.1139/cjfas-2017-0031))

Andrews, A.H., C. Yeman, C. Welte, B. Hattendorf, L. Wacker, and M. Christl. 2019. Laser ablation AMS reveals complete bomb ^{14}C signal in an otolith with confirmation of 60-year longevity for red snapper (*Lutjanus campechanus*). *Marine and Freshwater Research* 70: 1768–1780 ([dx.doi.org/10.1071/MF18265](https://doi.org/10.1071/MF18265))

Andrews, A.H., A. Pacicco, R. Allman, B.J. Falterman, E.T. Lang, and W. Golet. 2020. Validated longevity of yellowfin (*Thunnus albacares*) and bigeye (*Thunnus obesus*) tuna of the northwestern Atlantic Ocean. *Canadian Journal of Fisheries and Aquatic Science* 77: 637–643 ([dx.doi.org/10.1139/cjfas-2019-0328](https://doi.org/10.1139/cjfas-2019-0328))

	<p>Farley J., Eveson P., Krusic-Golub K., Clear N., Sanchez C., Roupsard F., Satoh K., Smith N., and Hampton J. (2018) Update of bigeye age and growth in the WCPO. WCPFC Project 81. WCPFC-SC14-2018/SA-WP-01, Busan, Republic of Korea, 8-16 August 2018.</p> <p>Farley J., Krusic-Golub K., Clear N., Eveson P., Smith N., and Hampton J. (2019) Project 94: Workshop on yellowfin and bigeye age and growth. WCPFC-SC15-2019/SA-WP-02, Pohnpei, Federated States of Micronesia, 12-20 August 2019.</p> <p>Farley J., Krusic-Golub K., Eveson P., Clear N., Roupsard F., Sanchez C., Nicol S., and Hampton J. (2020a) Age and growth of yellowfin and bigeye tuna in the western and central Pacific Ocean from otoliths. WCPFC-SC-16-2020/SC16-SA-WP-02, Online, 11-20 August 2020a.</p> <p>Farley J., Andrews A., Clear N., Hampton J. Ishihara T., et al. (2020b). Report on the bomb radiocarbon age validation workshop for tuna and billfish in the WCPO. WCPFC-SC16-2020/SA-IP-17. Online, 11-20 August 2020.</p> <p>Ishihara, T., Abe, O., Shimose, T., Takeuchi, Y., and Aires-Da-Silva, A. 2017. Use of post-bomb radiocarbon dating to validate estimated ages of Pacific bluefin tuna, <i>Thunnus orientalis</i>, of the North Pacific Ocean, Fish. Res. 189: 35–41. (dx.doi.org/10.1016/j.fishres.2016.12.016)</p> <p>McKechnie S., Pilling G., Hampton J. (2017). Stock assessment of bigeye tuna in the western and central Pacific Ocean. WCPFC-SC13-2017/SA-WP-05. Rarotonga, Cook Islands 9–17 August 2017.</p> <p>Passerotti, M.S., A.H. Andrews, and L.J. Natanson. In review. Inferring life history characteristics of the oceanic whitetip shark <i>Carcharhinus longimanus</i> from vertebral bomb radiocarbon. Submitted to <i>Frontiers in Marine Science</i>.</p> <p>Vincent MT, Pilling GM, Hampton, J. (2018). Incorporation of updated growth information within the 2017 WCPO bigeye stock assessment grid, and examination of the sensitivity of estimates to alternative model spatial structures. WCPFC-SC14-2018/ SA-WP-03. Busan, Republic of Korea 8-16 August 2018.</p> <p>Welte, C., L. Wacker, B. Hattendorf, M. Christl, J. Fohlmeister, S.F.M. Breitenbach, L.F. Robinson, A.H. Andrews, A. Freiwald, J.R. Farmer, C. Yeman, H.-A. Synal, and D. Günther. 2016. Laser Ablation – Accelerator Mass Spectrometry: a novel approach for rapid radiocarbon analyses of carbonate archives at high spatial resolution. <i>Analytical Chemistry</i> 88: 8570–8576 (dx.doi.org/10.1021/acs.analchem.6b01659)</p>								
Timeframe	12 months.								
Budget	<p>A total budget request from WCPFC is 97,980 USD</p> <table data-bbox="412 1759 1224 1890"> <tr> <td>Salary (AH Andrews):</td> <td>65,000 USD</td> </tr> <tr> <td>Salary (CSIRO):</td> <td>7,500 USD</td> </tr> <tr> <td>Travel (2 weeks @ ETH Zürich, AH Andrews):</td> <td>8,580 USD AMS</td> </tr> <tr> <td>analyses (ETH Zürich):</td> <td>42,900 USD Laser</td> </tr> </table>	Salary (AH Andrews):	65,000 USD	Salary (CSIRO):	7,500 USD	Travel (2 weeks @ ETH Zürich, AH Andrews):	8,580 USD AMS	analyses (ETH Zürich):	42,900 USD Laser
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analyses (ETH Zürich):	42,900 USD Laser								

	ablation-AMS (ETH Zürich): 3,000 USD Supplies/Equipment: 6,000 USD Unspent from Project 98: (-35,000 USD*) *Note that funding for Project 98 (35,000 USD) was not spent as the workshop was held online. The funds can contribute to the project costs. Note that this project budget covers the work by Dr. Allen Andrews and CSIRO. It does not cover costs of other project partners.
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Project 106	Ageing of South Pacific albacore
Objectives	To further improve age estimate for South Pacific albacore, focusing on the New Zealand troll fishery, for input into the 2021 stock assessment.
Rationale	<p>The next South Pacific albacore assessment is currently scheduled for 2021. One area of uncertainty is the age of albacore, particularly understanding differences found in age-at-length estimates and modes in the catch-at-size data for the troll fishery (Tremblay-Boyer et al 2018). The length modes in the troll fishery are separated by 10 cm, while the von Bertalanffy growth curve for all South Pacific albacore combined indicates 20 cm growth per year in the youngest age classes (Williams et al. 2012). The difference is less when restricting the age-at-length data to fish caught in southern latitudes, however, there are still inconsistencies that need to be examined before the next stock assessment.</p> <p>The project would use a combination of daily and annual ageing methods using otoliths collected and analysed in previous studies (i.e., Williams et al. 2012; Farley et al. 2013). The project will begin by examining available OTC marked otoliths to help validate daily age estimates from the longitudinal sectioning plane. Otoliths will then be selected and read (longitudinal section) to estimate the daily age of albacore in the NZ troll fishery, to a maximum fish size that reliable ages can be obtained. The daily age estimates will be compared to the annual age estimates obtained from the ‘sister’ otoliths by Farley et al (2013). Before this can be done, we plan to re-estimate decimal age of the fish using the method developed for bigeye and yellowfin tuna by Farley et al (2020), based on counts of opaque zones and otolith measurements. To do this, we will first determine (i) the relationship between otolith size and daily age in young fish, and (ii) mean width of each annulus for a representative sample of fish caught throughout the South Pacific. The new decimal age will be compared with daily age estimates and the modes in the length frequency data. Fin spines may also be examined to verify age estimates. This work will improve the age estimates for the troll fishery for input to the 2021 stock assessment.</p>
Objectives	<ol style="list-style-type: none"> 1. Prepare and read available albacore otoliths marked with OTC to determine if increments formed daily (frontal sections, max 4 otoliths). 2. Prepare and read (daily age) up to 60 otoliths from ALB in the New Zealand troll fishery to a maximum fish size that age can be reliably obtained (frontal sections). 3. Determine the relationship between otolith size and daily age in young fish. 4. Mark and measure the (annual) opaque zones in up to 600 sectioned otoliths to determine the mean width of each annulus. 5. Follow the new age algorithm from Farley et al. (2020) to estimate decimal age of all the ALB examined.

	<p>6. Compare the new decimal age of albacore in the NZ troll fishery with the modes in the length frequency to determine if an inconsistency remains.</p> <p>References</p> <p>Farley, J., Krusic-Golub, K., Eveson, P., Clear, N., Rouspard, F., Sanchez, C., Nicol, S., and Hampton, J. (2020). Age and growth of yellow and bigeye tuna in the western and central Pacific Ocean from otoliths. WCPFC-SC16-2020/SC16-SA-WP-02.</p> <p>Farley JH, Williams AJ, Clear NP, Davies CR, Nicol SJ (2013) Age estimation and validation for South Pacific albacore tuna (<i>Thunnus alalunga</i>). J Fish Biol 82: 1523-1544. doi:10.1111/jfb.12077.</p> <p>Tremblay-Boyer L, Hampton J, McKechnie S, Pilling G. 2018. Stock assessment of South Pacific albacore tuna. WCPFC-SC14-2018/ SA-WP-05, Rev. 2.</p> <p>Williams AJ, Farley JH, Hoyle SD, Davies CR, Nicol SJ (2012) Spatial and sex-specific variation in growth of albacore tuna (<i>Thunnus alalunga</i>) across the South Pacific Ocean. PLoS ONE 7(6): e39318. doi:10.1371/journal.pone.0039318.</p>
Timeframe	6 months
Budget	<p>A total budget request from WCPFC is 20,000<u>23,000</u> USD</p> <p>*Note that this 20,000 USD covers the CSIRO and FAS components of the work, including reading otoliths and preparing reports.</p> <p><u>3,000 USD covers the administrative and project management component by SPC OFP.</u></p>

Project X1	Billfish research plan
Objectives	Develop a WCPFC research plan for billfish for 2022-2026.
Rationale	<p>At the WCPFC SC16 meeting there were a number of projects proposed on swordfish and striped marlin for work required to meet the management needs of these species. Much of this work is required as there is a lack of understanding of stock structure and factors influencing billfish catch, which is needed for mitigation studies as well as CPUE standardization. In addition, for some species there is a need to collect and analyses basic biological information as well as characterize the fisheries catching them.</p> <p>A number of these proposed projects were considered by SC16 in a series of online for a (namely Discussion Forum, 10, 12 and 14). With competing priorities for work for the available budget as well as personnel resources, and to co-ordinate work so that project results align in a meaningful manner, a number of Forum participants recommended that a billfish research plan be developed to collate the available data, and prioritise the work required to fill the data gaps for WCPO billfish.</p> <p>This work will:</p> <ul style="list-style-type: none"> • Review the assessment schedule within the existing Stock Assessment Schedule and consider the data needs of these assessments; • Develop a workplan for to ensure the data needs of the planned assessments are met prior to the assessment year;

	<ul style="list-style-type: none"> • Note the recommendations from recent project outcomes to inform the WCPFCs billfish management needs; • Propose the direction that the work over the next five years should take; and • Develop a prioritised draft schedule of work for consideration by SC17.
Assumptions	SPC or another regional body has the personnel and budget available to undertake this work.
Scope	<ol style="list-style-type: none"> 1. This document will focus on the WCPFC billfish species including the marlins, swordfish, sailfish and shortbilled spearfish. 2. Collate the available data in a series of summary plots and tables. 3. Develop a research plan. 4. Develop a draft list of prioritised projects for the 2021-2026 period.
Budget	0.4 FTE (\$40,000) Travel to SC17 (\$6,000) Total \$46,000

Project X2	Southwest Pacific Ocean blue shark stock assessment
Objectives	Undertake a stock assessment of blue sharks in the southwest Pacific Ocean
Rationale	<p>This stock was last assessed in 2016 (SC12-SA-WP-08) using data from 1994-2014. That assessment was the first attempt to assess this stock. The stock assessment software MULTIFAN-CL was used for the assessment. A number of challenges were experienced in the development of this assessment. Catch data are generally of poor quality and have to be reconstructed, such that both catch inputs and the resulting CPUE time-series are uncertain. A major objective of this assessment is therefore to establish and examine key areas of uncertainty, and the impacts on estimates of stock status.</p> <p>SC12 noted that there were a number of data uncertainties within the South Pacific blue shark assessment, with regard to historical longline catch and CPUE estimates. The data-poor nature of the South Pacific blue shark assessment indicated that an improvement in the amount of and quality of available biological and fishery information will be required in order to develop a useful integrated stock assessment model. Since then more catch and effort data are available and a broad scale age and growth analysis has been undertaken.</p> <p>This project is therefore designed to assess the stock status of blue sharks in the south Pacific Ocean using medium data assessment methods and if possible a data rich (fully integrated) stock assessment approach if possible, if not then using medium data assessment methods. The assessment should assess the stock status against conventional stock assessment metrics as well as those suggested in the WCPFC 2020 shark research plan (SC16-EB-IP-01 rev 1).</p>
Assumptions	<ul style="list-style-type: none"> • Much of the existing fisheries and biological data are readily available. • Assessment personnel are available to undertake this work.
Scope	Reviewing the previous shark assessment in the WCPO to assess and improve on methods to increase the understanding of data strengths and weaknesses, and update stock status. Update WCPO longline catch estimates and abundance indices using recent observer data. The analysis should consider what might be appropriate limit reference points for this species, and note the work tabled in the Management Issues theme in 2019 and 2020 as well as the WCPFC 2020 shark research plan (SC16-EB-IP-01 rev1). In the absence of any agreed reference points present the stock status in terms the metrics outlined in the shark research plan. Prepare a report containing the

	above results for SC17. If the data are too poor to undertake a full quantitative assessment, then a medium data assessment may be appropriate.
Budget	1 FTE (\$94,000) Travel to SC17 (\$6,000) Total \$100,000

Project X3	Silky shark stock assessment
Objectives	Undertake a stock assessment of silky sharks in the western Pacific Ocean
Rationale	<p>This stock was last assessed in 2018 (SC14-SA-WP-08) using data from 1980-2016. That assessment was the first attempt to assess this stock. SC14 noted that given the inherent uncertainty in the assessment the estimates of stock status should be considered indicative only. Although these estimates are not considered a reliable basis for management decision-making, they represented progress since the 2013 assessment. This species is unproductive and susceptible to overfishing and major objective of this assessment is therefore to establish and examine key areas of uncertainty, and the impacts on estimates of stock status.</p> <p>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 CMM2013-08 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.</p> <p>This project is designed to assess the stock status of silky sharks in the western Pacific Ocean using a data rich (fully integrated) stock assessment approach. The assessment should assess the stock status against conventional stock assessment metrics as well as those suggested in the WCPFC 2020 shark research plan (SC16-EB-IP-01 rev1).</p>
Assumptions	<ul style="list-style-type: none"> • Much of the existing fisheries and biological data are readily available. • Assessment personnel are available to undertake this work.
Scope	<p>Reviewing the previous assessment in the WCPO to assess and improve on methods to increase the understanding of data strengths and weaknesses, and update stock status. Update WCPO longline catch estimates and abundance indices using recent observer data. The analysis should consider what might be appropriate limit reference points for this species, and note the work tabled in the Management Issues theme in 2019 and 2020 as well as the WCPFC 2020 shark research plan (SC16-EB-IP-01 rev 1). In the absence of any agreed reference points present the stock status should be presented in terms the metrics outline in the shark research plan. Prepare a report containing the above results for SC18.</p> <p>If the data are too poor to undertake a full quantitative assessment, then a medium data assessment may be appropriate.</p>
Budget	1 FTE (\$94,000) Travel to SC17 (\$6,000) Total \$100,000

Project X6	Silky and oceanic whitetip shark post release survival
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Objectives	Estimate silky and oceanic whitetip shark post release survival from WCPO longline fisheries
Rationale	<p>Since CMM2013-08 came into force silky sharks in the WCPO have had a non-retention policy enforced since from July 2014. Oceanic whitetip shark retention is also prohibited withing the WCPO (CMM2011-04). Understanding the survival of released fish is therefore key to estimating the effectiveness of non-retention policies for these species. This project is designed to plan the required number of the mortality tag deployments from commercial longline vessel and then execute the plan and undertake the data analysis.</p> <p>A number of tags have been deployed under the auspices of the ABNJ (WCPFC-SC13-2017/EB-IP-06 and WCPFC-SC15-2019/EB-WP-01), with 117 tags deployed on silky sharks. The first task of this programme is to assess if enough data exit for silky sharks and if the silky shark component has been completed by this other work what would be a practical replacement species to consider.</p> <p>Following, this the work will asses the appropriate spatial and temporal requirements for tag deployment and determine the number of sharks needed to tag and release to address the research question. This work should be reviewed by SC18 and pending that review the fish should be tagged and results analysed and the results presented to SC20.</p>
Assumptions	<ul style="list-style-type: none"> • Assessment personnel are available to undertake this work. • Observers will be available to be trained and deploy the tags from commercial vessels.
Scope	<p>This project is designed to plan the required number of releases by shark catch condition category. Then using the results undertake experiments to estimate post-release survival of key sharks. This work should include: fish released from longline gear; specific information on each individuals' release condition; include individuals released that are "lively and likely to survive" as well as those "alive but moribund"; include a detailed account of the gear that caught the fish (e.g. hook type, leader type...); and be undertaken across a representative selection of the size range in the catch. It is envisaged that a two-staged approach be used to investigate this. Firstly, tagging with PSAT or mortality tags (after taking a blood sample), and secondly, using blood chemistry to estimate mortality rates on a larger sample size e.g. Hutchinson et al. (2013). Note that Clarke et al. (2013) calculated that the "minimum number of tags required to obtain a reasonable estimate of mortality rate for each condition class and stratum is 12. This allows for failure of two tags, leaving 10 results from which to estimate mortality. We stress that this number of tags may not provide a precise estimate of mortality rate, and the estimate may also be adversely affected (biased) by other factors not accounted for in the experiment (e.g. shark size, soak time, different handling practices aboard vessels). For example, a sample size of 10 means that mortality rates are calculated in increments of 10%, and the error around that percentage would depend on the actual proportional mortality. The key to getting reasonable mortality estimates from small tag numbers is the consistent application of condition criteria across observers". This would indicate that for silky sharks with a 3-class condition scale 36 tags would be required to be deployed in each Region assessed.</p>
Budget	<p>100,000 in 2021 200,000 in 2022 and 200,000 in 2023 Total \$500,000</p>

Project X7	Whale shark post release survival
Objectives	Estimate whale shark post release survival from WCPO purse seine fisheries
Rationale	<p>Since CMM2012-04 came into force purse seine vessels are prohibited from deliberately setting on whale sharks. However, juvenile whale sharks are often found in deeper water and can be difficult to be seen, as a result they may get caught inadvertently from time to time. When this happens, the vessel is required to release the fish. Understanding the survival of these released individuals is therefore key to estimating the effectiveness of the measure designed to protect this species.</p> <p>This project is designed to plan the required number of the mortality tag deployments from commercial purse seine vessel and then execute the plan and undertake the data analysis.</p> <p>This the work will asses the appropriate spatial and temporal requirements for tag deployment and determine the number of sharks needed to tag and release to address the research question. This work should be reviewed by SC18 and pending that review the fish should be tagged and results analysed and the results presented to SC20.</p>
Assumptions	<ul style="list-style-type: none"> • Assessment personnel are available to undertake this work. • Observers will be available to be trained and deploy the tags from commercial vessels.
Scope	This work should have two phases. Phase 1: designed to plan the required number of releases by shark catch condition category and determine the best and most cost effective method to assess whale shark stock structure in the Pacific Ocean; and Phase 2: pending approval from SC17, undertake the tagging to estimate post-release survival of whale sharks. This work should include: fish released from purse seine gear; specific information on each individuals' release condition; include individuals released that are "lively and likely to survive" as well as those "alive but moribund".
Budget	100,000 in 2021 200,000 in 2022 and 200,000 in 2023 Total \$500,000

Project X8	Training observers for elasmobranch biological sampling
Objectives	Train observers to collect elasmobranch biological material for age growth and reproduction
Rationale	<p>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.</p> <p>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.</p> <p>This project will develop material for observers to use and run training workshops for a core group of observers in elasmobranch sampling.</p>

Assumptions	<ul style="list-style-type: none"> • 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	<p>The scope of this project is twofold. Firstly, the development of material for methods for collection, recording, storing and measuring of samples.</p> <p>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.</p>
Budget	<p>0.25 FTE 25,000 Total \$25,000</p>

Project X10	<u>Non-entangling and biodegradable FAD trials in the WCPO</u>
Background	<p>Recent estimates indicate that the number of FAD deployments in the WCPO has ranged between 23,000 and 40,000 per year (SC16-MI-IP-13). Traditional FAD designs can lead to entanglement and unnecessary mortality of Species of Special Interest (SSIs; sharks, turtles). Of increasing concern is the rate of subsequent abandonment and beaching of deployed FADs, recently estimated at 41% and 7%, of tracked FADs, respectively (SC16-MI-IP-14). The resulting marine pollution, ghost fishing and ecosystem impacts on coastal environments are of increasing concern to the communities of the region and fishery stakeholders.</p> <p>In recognition of the need to reduce the environmental and ecological impacts of FADs in the WCPO, CMM 2018-01, includes requirements that:</p> <ul style="list-style-type: none"> • all FADs in the WCPO should comply with low-entanglement design specifications (as described in CMM 2018-01) from January 2020, and; • the use of biodegradable materials to construct FADs is encouraged. <p>Recent review of observer data shows limited use of non-entangling and/or biodegradable FAD designs in the WCPO (SC16-EB-IP03). However, 2020 data are limited, and it is therefore not yet possible to identify any recent response to the requirements of CMM 2018-01. Importantly, greater support to National fisheries agencies and information to help guide industry on construction and use of effective non-entangling and biodegradable FADs will be essential to drive wider industry uptake.</p> <p>While trials of non-entangling and biodegradable FADs adapted to the WCPO (SC16-EB-IP-08) have been initiated by ISSF, in collaboration with industry, government and SPC, much additional work and collaborative action is required if non-entangling/biodegradable FADs are to become the ‘norm’ in the WCPO.</p> <p>This project is developed to build on the recent trials in the WCPO. It will provide the required robust information to industry on the designs, types of materials, performance and cost-effectiveness of non-entangling and biodegradable FADs in the WCPO.</p>
Objectives	<p>The project has following objectives:</p> <ol style="list-style-type: none"> 1. Design/refine cost-feasible non-entangling and biodegradable FADs; informed by previous trials in the WCPO and other oceans, industry and National fishery agency

	<p>input, and readily available (locally or shipped) suitable construction materials.</p> <ol style="list-style-type: none"> 2. Undertake at-sea experiments to compare the performance of non-entangling and biodegradable FADs to traditional FADs. 3. Provide robust scientific advice to industry and National fisheries managers on the performance of non-entangling and biodegradable FAD designs. 4. Increase regional support and partnerships on FAD research with various stakeholders in the WCPO.
Rationale	<ul style="list-style-type: none"> • Builds upon work by organizations such as ISSF and National fisheries agencies in the development of non-entangling and biodegradable FAD designs. • Extend the trials started in the WCPO and lesson learned so far, specifically accounting for the diversity in conventional FAD design preference that exists between fleets. • Trials should be sufficiently extensive to examine the influence of spatial and potentially oceanographic factors. • Necessary project to build a bridge between the concept of non-entangling/biodegradable FADs and eventual broad industry adoption in the WCPO.
Assumptions	<ul style="list-style-type: none"> • Willing industry collaborators can be identified. Industry partners will collaborate and provide traditional FAD and associated satellite buoys and data as in-kind contributions. • Materials are available locally or can be shipped in, and experienced labor is available in selected regional ports to guide and conduct FAD construction. • Fishing industry and fisheries agencies will provide space for the construction of FADs at their seaports in return for the capacity building opportunities with interested local partners. • Enough data will be collected across different designs to allow conclusive statistical analyses (further planning required to assess suitable numbers and designs within budget). • Given the limited time period available (i.e. no multi-year replication) to the project, the results are assumed to be representative of longer-term performance. • If provided adequate funding, staff from National fisheries agency will be available to support and help co-ordinate local activities. • Observer coverage will be enough (pending COVID restrictions) by the time field trials begin (i.e. from October 2021). • FAD designs and trials will be ready to be undertaken by October 2021, the end of the 2021 overall FAD closure period.
Scope	<p>Use relevant information available from ISSF studies and previous trials worldwide, and in collaboration with industry, National fisheries agencies and local FAD construction experts (workshop) to identify plausible FAD materials and designs to trial.</p> <p>Establishing regional point(s) for the construction of the non-entangling and biodegradable FADs for the project (include a capacity building component).</p> <p>Design, implement and co-ordinate at-sea experimental FAD trials across the WCPO [following normal deployment and fishing activities areas] to be completed over at least 10 months (2021-2022). Aim for 220 experimental FADs compared with 220 traditional (currently used) FADs. These trials will be performed in partnership with industry (including skippers) and the observer programme to ensure marking, deployment, identification and monitoring/data recording of FADs in a consistent and coordinated way. Two levels of industry participation are anticipated: (1) the fleets that deploy the FADs</p>

and are actively engaged in the research depending on their fishing activities. (2) All other fleets that find and/or fish the experimental FADs. Information from (2) will be critical to the success of the research. Observer involvement and coverage will be important and they will be supported by SPC/ISSF in monitoring and data collection. The monitoring program will be developed in collaboration with the industry partners and skippers and observers to ensure it is feasible given their other work activities.

A communications and engagement strategy and materials will be developed and implemented to ensure the work is well known across the purse seine fleets and communities in the WCPO.

Comparative analyses of the performance (aggregative power and behaviour, catch rates per species), costs and handling requirements, effective lifespan (and condition at different times-at-sea) of non-entangling and biodegradable FADs compared to conventional low-entanglement risk FADs, and traditional designs.

Analyses will be made on data that includes catch rates, as well as data from echo-sounder buoys deploy on FADs, building on knowledge gained through Project 88 (FAD acoustics).

Timeframe The expected timeline for project delivery:

- Funding agreement: March 2021
- Planning workshop, project co-investigators SPC/ISSF, industry partners; Communication and engagement strategy; FAD design, materials and construction logistics workshops: April – June 2021
- Initiate FAD construction phase (in-country visits pending COVID): July – August 2021
- Progress report to SC17 – August 2021
- FAD constructions: August – October 2021
- Field trials: October 2021 – October 2022 (start post 2021 FAD closure)
- Data and analysis and report – October 2022 – February 2023
- Progress report to SC18 – August 2022
- Industry/stakeholder workshop to present results – March 2023
- Final Report to SC19 and project end – August 2023

30 months duration (March 2021 – August 2023)

Indicative Budget	Salary costs (total project)	Months (spread across project)	Cost
	SPC staff: 1 scientist x 8 months (manage project, data analyses, reporting, planning, support industry engagement)	8	USD 90,000 (EUR 76,030)
In-country fishery officers support	6	USD 40,000 (EUR 33,730)	
	Sub-total salaries	USD 130,000 (EUR 109,620)	
	Cost of FADs	Per FAD	Cost

	Purchase of biodegradable material and labor to construct FADs (ropes and canvas) (160 FADs)	USD 600	USD 96,000 (EUR 81,000)	
	Shipping biodegradable materials		USD 20,000 (EUR 16,860)	
	Buoys to track experimental FADs (160 buoys/\$1100 each)	USD 1,100	USD 176,000 (EUR 148,400)	
	Monthly air-time and buoy communication (160 experimental buoys / 8 months)	USD 350	USD 56,000 (EUR 47,200)	
		Sub-total FADs	USD 350,000 (EUR 295,000)	
	Communications and engagement		Cost	
	Workshops x 3, extension materials		USD 25,000 (EUR 21,100)	
	Travel			
	At least one in country visit for SPC and ISSF project staff, contribution to WCPFC attendance for SPC scientist		USD 20,000 (EUR 16,900)	
		Sub-total comms and travel	USD 45,000 (EUR 38,000)	
		Project total funds request	USD 525,000 (EUR 444,000)	
	In-kinds			
	Conventional FADs to be deployed by industry (220 FADs) + the buoys and monthly air communication. Industry partner contribution. Supply of 60 non-entangling/biodegradable FADs and buoys to supplement the project.*	Industry partner(s) in-kind contribution	(USD 330,000)	
	National fisheries agency staff time		(USD 10,000)	
	ISSF staff (industry coordination and liaison, oversea field deployments, observer coordination, FAD construction)	ISSF in-kind contribution	(USD 40,000)	
	Cash contributions			
	EU cash contribution – USD 420,000 (EUR 355,000)			
	Cash co-funding ISSF - USD 20,000 (EUR 17,000) WCPFC - USD 85,000 (EUR 72,000)			
	Note: budget is based on USD, conversion to the Euro approximate at 27/8/2020			
Additional considerations	If the current COVID-related impacts on fishing, travel and observer placement in the WCPO extend well into the 2021 calendar year, this will have impacts on the ability to coordinate and undertake trials and collect data during the field trials. While, in this instance we will use remote/online communication as much as practical, if the field trials cannot be initiated by early November 2021 we may require revisions of project timelines, such as a no cost extension.			

	<p>*Industry partners in-kind contributions subject to agreement, once selected fleets have been identified. The number of non-entangling and biodegradable FADs might be adjusted depending on the industry in-kind contribution.</p>
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