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Project 35b: WCPFC Tuna Tissue Bank

WCPFC-SC17-2021/RP-P35b-01

SPC-OFP

EXECUTIVE SUMMARY

The WCPFC Tuna Tissue Bank (TTB) operations are supported by the WCPFC through Project 35b. Under this project, the Scientific Services Provider (SPC) is tasked with maintaining, developing and expanding the TTB. This paper updates SC17 on Project 35b activities since SC16 (as they pertain to the 2020-21 work plan endorsed by SC16). A work plan and budget for 2022, and indicative budgets for 2023 and 2024 are provided for this ongoing project. Key topics covered include:

Biological sampling and TTB progress during the period 1st July 2020 to 30 June 2021

i. 15,555 new biological samples, taken from 2,945 fish, were added to TTB holdings. SPC now houses 113,663 biological samples taken from 42,217 individual animal specimens.
ii. Training for observers, debriefers, and observer trainers continued. Twenty-eight staff undertook training in biological sample collection this year, with a total of 646 samplers trained to date. In addition to PIRFO-related training, sampling training and refresher courses were run in Papua New Guinea, New Caledonia, in the Philippines and in San Diego with the support of IATTC.
iii. New training resources were released. For example, the update of the Longline Observer Guide and the publication of the French version of the "Shark and ray identification manual".
iv. New sampling approaches have been developed to meet new requirements (sampling quality and strategy) and COVID-19 restrictions. A trial to investigate the benefits of including Electronic Monitoring and Artificial Intelligence to biological sampling in the field has also been organised.
v. The TTB acquired one new fatmeter and one refrigerated container. Cold storage in Noumea has been expanded, providing an extra 20m^3 of space. New access to cold-storage capacity has also been organised in Noro, Solomon Islands.
vi. The biological sampling feature in the *OnShore* app was fully rolled-out to industry in New Caledonia and in the Philippines. The same feature was developed in the *OLLO* app and is currently in use in New Caledonia.

TTB Access and Use during the period 1st July 2020 to 30 June 2021

One formal request was received from third parties to withdraw samples from the TTB. Several enquiries have been received to organise the extraction of samples from the TTB prior to formal requests being made to WCPFC.

At present, twenty projects are classified as 'ongoing' in using TTB samples for WCPFC-related work. Thirty-two projects are listed as 'completed' as at 30 June 2021. Seven Information Papers or Research Papers linked to the TTB will be submitted to SC17 this year. Eleven other books, peer-reviewed articles, conference papers or popular articles associated with TTB work were published.

The following recommendations arise from this report. We invite SC17 to:

- Continue to support initiatives to increase rates of observer- and port-based biological sampling, noting that this contribution is essential to the ongoing success of WCPFC's work.
- Incorporate the identified budget into the 2022 budget and the 2023-24 indicative budgets. The development of the WCPFC TTB is ongoing and considered essential.
- Support efforts to obtain further super-cold storage capacity to ensure longevity of TTB samples.
- Endorse that the work plan in Section 4 of this report should be pursued by the Scientific Services Provider, in addition to standard duties associated with maintenance and operation of the WCPFC TTB in 2021-22.
- Consider referring to the TTB as the "Pacific Marine Specimen Bank" to avoid confusion amongst users due to the current dual naming of the bank.

1. INTRODUCTION

The WCPFC Tuna Tissue Bank (hereafter, TTB) is a repository of biological samples from marine specimens collected from across the WCPO. The TTB is focussed primarily on samples from bigeye, yellowfin, albacore and skipjack tunas, yet also houses biological material from other pelagic species (e.g. swordfish, mahi mahi). The TTB is embedded within the Pacific Marine Specimen Bank (PMSB) repository that contains a broad diversity of samples from micronekton, seabirds, deep-water benthic and coastal fishes, among other taxa.

The TTB was officially established in 2015 (SPC-OFP 2017, 2019), though samples have been systematically collected since 2001. Through the TTB's creation, the WCPFC aimed to provide research institutions access to the sample collections needed to advance our understanding of the dynamics of tunas and related species in the WCPFC region. The initiative has proved highly successful, the TTB and its associated Biological Data System 'BioDaSys' database fostering inter-agency collaboration and strengthening research capacity across the region, as evidenced through ongoing and productive research partnerships involving TTB samples (see SPC-OFP 2019 and ANNEX 1, Table A4 for examples).

TTB operations are currently funded by the WCPFC through Project 35b. Under this project, SPC, as the Scientific Services Provider, is tasked with maintaining and developing the TTB and with expanding the inventory of samples held through national and regional biological sampling programmes.

Due to COVID-19 related travel restrictions, the 2nd meeting of the TTB Steering Committee was held via video conference through Microsoft Teams in July 2020, in preparation for SC16. At this meeting, the TTB Steering Committee acknowledged that ongoing contribution to the TTB was critical to the success of WCPFC's work, and recommended that financial support be continued to implement a 2020-21 work plan, as set out in Tuna Tissue Bank Steering Committee (2020)[SC16-2020/RP-P35b-03]. SC16 endorsed the work plan for 2020-21, as well as the proposed 2021 budget and indicative budgets for 2022-23.

Previous papers to the SC (SPC-OFP 2017, 2018, 2019, 2020) detail the history, developments and key objectives of Project 35b. This paper aims to update SC17 on Project 35b activities over the past 12 months (July 2020-June 2021), as they relate to the agreed 2020-21 work plan), and outlines planned actions for the next phase of work.

2. BIOLOGICAL SAMPLING AND TTB PROGRESS (2020-21)

This section summarises progresses between 1 July 2020 and 30 June 2021 on:

1) sampling activities, and TTB holdings as at June 30 2021;
2) training for biological sample collection;
3) the status of new sampling approaches;
4) recent developments regarding collaboration with the tuna industry;
5) the current status of sample storage facilities; and
6) recent developments regarding the BioDaSys database.

We refer readers to SPC-OFP (2020) [SC16-2020/RP-P35b-01] for background on sample collection protocols, associated observer training standards, and the key features of the BioDaSys database.

2.1 SAMPLING ACTIVITIES AND TTB HOLDINGS

2.1.1 Overview

The COVID-19-related restrictions on WCPO observer duties have disrupted normal biological sampling activities since early 2020. Despite these disruptions and thanks to the efforts from the still-operating observer programmes and the efforts of the port samplers, the number of fish sampled between July 2020 and June 2021 exceeds the average number of fish sampled annually over the last decade (Figures 1, 2).

In 2020-21, 15,555 new biological samples were collected from 2,945 fish and added to the TTB. Table 1a and 1b provide species-level breakdowns of the 2020-21 additions (Table 1a), together with total fish sample holdings as at 30 June 2021 (Table 1b). When all samples (e.g. seabirds, micronekton) are included, the PMSB now houses 113,663 biological samples taken from 42,217 individual animal specimens.

2.1.2 Observer-based sampling

Annual figures on the total number of fish sampled, the number of observer trips on which biological sampling occurred, and changes in mean sampling rate per trip compiled over the past nine years, are shown in Figure 1.

Following the peak in activity in 2015, the number of observer trips involving biological sampling gradually declined, with predictable consequences for sample numbers returned to the TTB. Signs of recovery were evident in 2019, with sampling rate rising sharply and a 64% increase in sample returns compared with 2018. From early 2020 onwards, WCPO-wide restrictions on observer coverage (due to COVID-19) have effectively removed opportunities for onboard sample collection in most countries. However, due to the contributions from observer programmes of Papua New Guinea, Philippines and New Caledonia in addition to the increase of the sampling rate, the number of fish sampled in 2020 continued the increasing trend observed in 2019 (Figure 1).

2.1.3 Port sampling

The number of port sampling events and samples collected are provided in Figure 2. The sampling rate has remained relatively stable over the past nine years (Figure 2). As mentioned in SPC-OFP (2020) [SC16-2020/RP-P35b-01], SPC planned to increase the efforts on biological sampling at port to compensate for the ongoing uncertainty around at-sea sample collection. This plan has seen the number of fish sampled returning to a level similar to the 2015-2016 reference years.

Given that the timing for lifting current restrictions on at-sea observer coverage is not yet defined, SPC will continue efforts to ensure that this positive trend in port sampling returns continues. A total of 724 fish have already been sampled in 2021, and SPC expects to achieve targets brought about through a new partnership with MRAG Asia Pacific Pty and Soltuna cannery in Solomon Islands, and the continuation of the long-standing collaboration with SOCSKARGEN Federation of Fisheries and Allied Industry Inc (SFFAII/BFAR) in the Philippines.

Table 1a. Additions to the TTB between 1 July 2020 and 30 June 2021. Note the number of samples may sometimes exceed the number of specimens (e.g. gonad samples for yellowfin). This occurs when multiple samples of the same tissue are taken from one specimen.

Species	No. of specimens	Hard parts		Reproduction	Multi-purpose				Diet	
		Otolith	Spine	Gonad	Blood	Muscle	Liver	Fin	Stomach	Fatmeter*
Yellowfin	1176	1109	865	1280	0	1176	957	0	960	96
Skipjack	740	709	679	736	0	748	737	0	738	19
Bigeye	466	437	417	490	0	489	378	0	371	125
Albacore	169	177	149	262	0	169	61	0	58	0
Mahi mahi	163	97	15	75	0	165	78	0	81	0
Wahoo	89	73	12	83	1	92	86	0	86	0
Silky shark	50	0	0	0	0	10	0	50	0	0
Rainbow runner	17	7	15	14	0	19	15	0	14	0
Striped marlin	15	8	13	15	0	15	15	0	15	0
Blue marlin	14	8	0	9	0	14	14	0	14	0
Pompano dolphinfish	8	0	1	8	0	9	8	0	8	0
Escolar	7	5	7	7	0	8	7	0	7	0
Longsnouted lancetfish	7	0	0	5	0	7	5	0	7	0
Gould's petrel	5	0	0	0	0	0	0	0	0	0
Oceanic white-tip shark	5	0	0	1	0	3	0	5	0	0
Moonfish / opah	4	1	2	1	0	3	4	0	3	0
Short-billed spearfish	3	1	3	3	0	4	3	0	3	0
Brilliant pomfret	2	0	2	2	0	2	2	0	2	0
Sickle pomfret	2	2	2	2	0	3	2	0	2	0
Great barracuda	1	0	0	1	0	1	1	0	1	0
Kawakawa	1	1	0	1	0	1	1	0	1	0
Ocean triggerfish	1	0	0	1	0	1	1	0	1	0
Total	**2945**	**2635**	**2182**	**2996**	**1**	**2939**	**2375**	**55**	**2372**	**240**

*Fatmeter is a measurement of percentage of fat not a type of sample. Fatmeter is included in the table but not counted as a sample

Table 1b. Samples available in the Pacific Marine Specimen Bank, including the TTB (at 30 June 2021).

Species	No. of specimens	Hard parts		Reproduction	Multi-purpose				Diet		Other *
		Otolith	Spine	Gonad	Blood	Muscle	Liver	Fin	Stomach	Fatmeter **	
Yellowfin	11042	6394	3093	7733	225	8109	6071	34	3251	1578	27
Skipjack	7574	3050	2436	3195	115	5694	5619	160	2786	2248	75
Albacore	6528	5224	3317	6335	24	3346	1506	0	982	638	19
Bigeye	5286	4099	1200	4112	116	3676	2098	1	1080	137	25
Mahi mahi / dolphinfish	638	176	21	120	12	482	303	0	144	0	0
Wahoo	450	123	21	103	1	319	320	0	112	0	12
Rainbow runner	416	17	1	49	0	292	294	0	93	0	0
Striped marlin	169	18	28	52	23	113	95	2	29	0	0
Swordfish	134	18	10	33	9	64	93	23	39	0	11
Other#	9980	3838	46	3283	54	1679	2937	135	89	0	2700
Total	**42217**	**22957**	**10173**	**25015**	**579**	**23774**	**19336**	**355**	**8605**	**4601**	**2869**

includes: 153 species from 60 different families (Acanthuridae, Alepisauridae, Alopiidae, Anoplogastridae, Apogonidae, Balistidae, Berycidae, Blenniidae, Bramidae, Carangidae, Carcharhinidae, Caristiidae, Chiasmodontidae, Dactylopteridae, Dalatiidae, Dasyatidae, Diodontidae, Echeneidae, Emmelichthyidae, Engraulidae, Ephippidae, Exocoetidae, Fistulariidae, Fregatidae, Gempylidae, Holocentridae, Istiophoridae, Kyphosidae, Lamnidae, Lampridae, Lethrinidae, Lobotidae, Lophotidae, Lutjanidae, Malacanthidae, Mobulidae, Molidae, Monacanthidae, Myliobatidae, Nemichthyidae, Nomeidae, Octopodidae, Ommastrephidae, Ostraciidae, Paralepididae, Pomacentridae, Procellariidae, Pseudocarchariidae, Scombridae, Scombrolabracidae, Scopelarchidae, Serranidae, Sphyraenidae, Sphyrnidae, Sulidae, Syngnathidae, Tetraodontidae, Trachipteridae, Trichiuridae) and zooplankton samples

* includes: beak, gill, vertebrae, jaw, brain, guano, skeleton, bird regurgitate, feather, heart, whole community

** Fatmeter is a measurement of percentage of fat not a type of sample. Fatmeter is included in the table but not counted as a sample

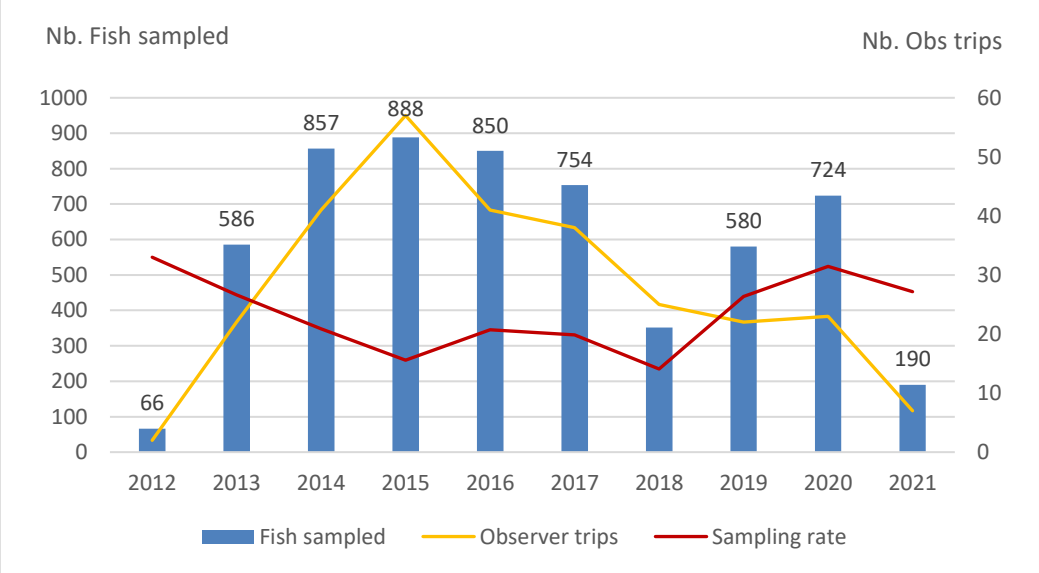

Figure 1. Total number of fish sampled by **observers** (blue histogram and numbers above); observer trips during which biological samples were collected (orange line), and the mean sampling rate per trip (i.e. mean number of fish sampled/trip) (red line) calculated annually between 2012 and 2021. Note that number of observer trips and sampling rate relate to the secondary y-axis.

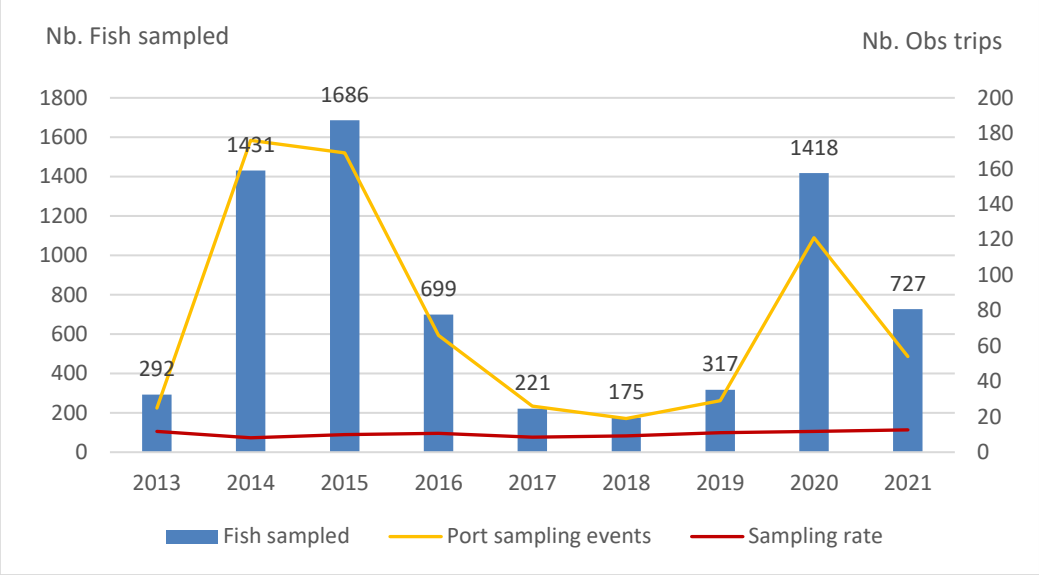

Figure 2. Total number of fish sampled by **port samplers** (blue histogram and numbers above), port sampling events during which biological samples were collected (orange line), and the mean sampling rate per event (i.e. mean number fish sampled/event) (red line) calculated annually between 2013 (when the port sampling programme started) and 2021. Note that number of observer trips and sampling rate relate to the secondary y-axis.

2.1.4 Scientific cruises

Scientific cruises continued to be an important source of biological samples for TTB holdings, contributing 33,790 samples to date. As at June 30 2021, a total of 9,275 fish have been sampled during various SPC-led cruises, from which 11,977 samples have been analysed (ANNEX 1, Table A1). For the TTB as a whole, tagging cruises have supplied 22% of the total fish specimens sampled and 24.3% of the total samples collected, with 25.8% of the analyses conducted for biological or ecological applications to date using cruise-related samples.

This contribution of biological samples adds considerable value to the tagging cruises (SPC-OFP 2017). The 2020 central Pacific cruise (CP14) added 4,044 new biological samples and 241 fatmeter records to the TTB (collected on 712 fish). 3,072 of these samples were taken from tunas (467 individuals), incorporating a range of sample types (e.g. muscle, gonad, liver, otolith, stomach, dorsal spines, live biopsy) that have various downstream scientific applications (ANNEX 1, Table A1, Table A2

During CP14, tunas tagged with conventional white tags also received an injection of strontium chloride ($SrCl_2$) (SPC-OFP 2020). This leaves a permanent, visible mark on the tagged fishes' otoliths that, upon recapture, allows the number of growth increments formed post-release to be compared with the known days at liberty – in effect, providing an age validation tool. As at 30 June 2021, a total of 506 skipjack, 162 bigeye tuna and 105 yellowfin tuna have been injected with $SrCl_2$, with, so far, 5 sets of marked otoliths returned to the TTB and 2 whole fish still awaiting processing. In addition, samples were collected from 1 tuna tagged with a conventional yellow tag and from 2 tuna tagged with an archival tag, samples are still in country awaiting to be sent to the TTB. Tissue biopsy have been taken on tagged fish during CP14. A biopsy is a $3mm^3$ muscle sample collected with a sterile biopsy punch tool, the stress caused by a live biopsy is negligeable. Live biopsy allowed us to maximise the collection of genetic material for future tuna dynamics and stock structure studies.

2.2 TRAINING OBSERVERS, DEBRIEFERS, TRAINERS AND OTHER SAMPLERS

2.2.1 Training update

Over the past 12 months, three SPC fisheries officers took part in sea safety training and are now allowed to board commercial longliners to collect samples. Further, 22 observers, two port samplers and four SPC fisheries officers undertook training in biological sample collection, with a total of 646 samplers trained to date. In addition to PIRFO training, samplers are also trained by local fisheries officers and fisheries scientists for specific projects. Training and refresher courses were run in Papua New Guinea, New Caledonia, in the Philippines and in San Diego with the support of IATTC. Table 2a provides a regional summary of those trained in biological sampling, by nationality, and skills that contribute to the TTB, as at June 30, 2021.

Table 2a. Number of samplers* (includes at-sea observers, port samplers, debriefers, trainers, cannery employees, fisheries officers, fishing vessel captains and crew) trained or refreshed in the collection of biological samples, debriefers trained in debriefing biological sampling, and observer trainers trained to deliver biological sampling training, by nationality. Note that number of debriefers, trainers, and samplers that were trained by fisheries officers in country are also counted in the number of samplers.

Country	No. of samplers	No. of debriefers	No. of trainers
American Samoa	7	1	
Chinese Taipei	33		
Cook Islands	4		
Federated States of Micronesia	72	7	3
Fiji	39	8	
French Polynesia	16		
Hawaii	1		
Japan	3		
Kiribati	5	3	1
Marshall Islands	49	1	2
Nauru	9	2	1
New Caledonia	29		
Pacific Community	24	1	6
Palau	18		
Papua New Guinea	173	11	4
Philippines	8		
Samoa	27	1	
Solomon Islands	69	7	2
Tonga	18	4	
Tuvalu	9	3	
United States	8		1
Vanuatu	25	1	

2.2.2 New training tools

The Longline Observer Guide, 2021 was revised by SPC and is an update of the 2007 version. The update was necessary to reflect changes in the observer data forms (version 2018) and data collection

protocols. The implementation of new regional Conservation and Management Measures (CMMs) has also changed some of the focus of the observers role, such as an increasing focus on collecting data on species of special interest (SSIs) and mitigation measures to prevent their capture. Some shark and pelagic ray species have also had their status changed to SSIs, requiring specific catch and interaction data to be collected by observers so that flag states can report on the impact of the fishery on SSIs.

The guide includes the protocols for measurement conversion factors (comparative morphometric measurements) and tag returns.

https://www.pirfo.org/index.php/resources/downloads/category/33-manuals?download=191:spc-longline-observer-guide-english-vs-2021

The publication of the illustrated new *Manuel d'identification des requins et des raies* (the French version of the *Shark and ray identification manual*, Park et al. 2019) was published in 2020. Hard copies have been distributed to the New Caledonian and French Polynesian fisheries agencies. The purpose of this guide is to improve identification of shark and ray species encountered by observers and crew working in WCPO tuna fisheries. An electronic version can be found on the SPC FAME site:

https://fame1.spc.int/fr/component/content/article/249

A video tutorial on how to sample a frozen tagged fish is now available on YouTube and has been used to guide and refresh samplers collecting samples from frozen tuna in port and in canneries (Solomon Islands, Thailand, American Samoa).

https://youtu.be/yd7DFAARgck

A series of 22 tutorial videos on how to identify, extract and collect samples from four species (tunas, mahi mahi, wahoo and billfish) as well as how to collect biological sampling data are currently in production. These will be used as training material for observers, fisheries officers, fishing captains and crew, or to be used as informative technical material for high school and university science students.

2.3 NEW TUNA SAMPLING APPROACHES

In SPC-OFP (2020), following formal endorsement at the 20th Regional Observer Coordinator Workshop in February 2020, SPC set out the intention to field test alternative, at-sea biological sampling approaches detailed in Macdonald et al. (2020), that optimise purse-seine observer efforts for tuna sample collection. The primary goal of these approaches is to expand tuna sampling coverage for the TTB in space and time, and in a systematic fashion, and to ensure that the highest-quality biological material is available for the scientific analyses/applications needed to meet WCPFC objectives. A full roll-out of these field trials has not been possible to date, due to restrictions on travel and observer coverage put in place as a result of the COVID-19 pandemic.

SPC and CSIRO, Australia, have recently collaborated on related at-sea experiments designed to test the efficacy of various onboard sampling procedures for maintaining muscle tissue integrity and minimising contamination risk for downstream genetic analyses on tropical tunas (see SC17-EB-IP-12). These experiments involve the application of sterile biopsy punch tools to take clean muscle samples from tunas. They were carried out during the CP14 tuna tagging cruise in 2020 and on three trips on New Caledonian longline vessels in early 2021. It is envisaged that once COVID-19 travel restrictions ease and observer placements increase, these protocols could be rolled out to observers onboard purse seine and longline vessel across the region, the resulting samples contributing importantly to WCPFC's ongoing genetic and genomics research programmes.

During the 15th Central Pacific Tuna Tagging Cruise number, an Electronic Monitoring (EM) system will be tested specifically for monitoring biological sampling operations. The concept is to use an EM system and an Artificial Intelligence tool to identify and measure specimens and to identify the types of samples collected. If this concept is successful, the potential for using EM to assist biological sampling operations on future tagging cruises and commercial operations will be investigated further.

2.4 SAMPLE STORAGE INFRASTRUCTURE

The TTB is curated at SPC Headquarters, in Nouméa, New Caledonia, and at CSIRO in Brisbane and in Hobart, Australia (SPC-OFP 2019; Portal et al. 2020).

Collectively, the TTB are equipped with:

- 1 microscope, 2 stereomicroscopes, 1 X-ray machine for fish examination, 1 low-speed, diamond-blade cutting saw to section otoliths, 1 fume hood to manipulate solvents, 1 high-precision scale, 2 low- precision scales, 1 photographic system, 2 fatmeters all located in Nouméa;
- 3 solvent cabinets (1 in Nouméa, 2 in Hobart);
- 5 dry cabinets for otolith storage (4 in Nouméa and 1 in Hobart);
- 2 cabinets to store collection/reference specimens in alcohol (2 in Nouméa);
- 2 dry cabinets to store gonads in paraffin and gonads and otoliths mounted on slides (1 in Nouméa, 1 in Hobart);
- 1 dry cabinet to store dorsal spines (1 in Hobart);
- 2 ultra-cold -80°C freezers to guarantee long-term quality of samples for genetic analyses (~1m^3 in Nouméa);
- ~48m^3 of -20°C cold-storage facilities at SPC and CSIRO (43m^3 in Nouméa, 2m^3 in Hobart, 2m^3 in Brisbane); and
- numerous short-term/staging -20°C storage facilities in the key ports of the WCPO

In 2020-21, one fatmeter was acquired and improvements were conducted in the SPC, Noumea laboratory in terms of Health and Safety measures.

Notably, cold storage in Noumea has been expanded by purchasing a -20°C refrigerated container, providing and extra 20m^3 storage space for samples. New access to cold-storage capacity has also been organised in Noro in the Solomon Islands, with previous arrangements for storage options in other regions still in place (ANNEX 1, Table A3).

Note that strategic investment in a large super-cold storage facility is required to ensure the longevity and relevance of the TTB (see Smith et al. 2017 for further discussion on this point).

2.5 DEVELOPMENTS IN BIODASYS

2.5.1 Overview and access

A central feature of the TTB repository is BioDaSys – a relational database that catalogues samples and their associated metadata, and records when changes in sample status occur, thus ensuring traceability of the work conducted. The key features of the database are reported in (SPC-OFP 2019), including information and rules around access via the standalone web portal at: (www.spc.int/ofp/PacificSpecimenBank).

The website, which incorporates searching tools and interactive maps, is publicly accessible, including to WCPFC members and scientists, providing an interface for the BioDaSys database (see Fig. 7 in SPC-OFP 2019 for an example).

In agreement with WCPFC data access rules, certain information on each sample is unavailable to researchers outside of SPC-OFP, who must apply for a login (directly from SPC) to gain access. Even with a login, only those data fields necessary for designing research projects are accessible to authenticated users. Moreover, any specific requests for samples still require approval via the access protocol outlined in Section 3.1 (below) and detailed in SPC-OFP (2019).

2.5.2 Electronic Reporting (ER) links to BioDaSys – an update

During 2020, the ER application *OnShore* was used by port samplers to collect data at landing sites. Also, during 2020, the ER application *OLLO* was used by longline fisheries observers to collect data during at sea missions. *OnShore* and *OLLO* allow the collection of data on species and length as well as data about the biological samples collected for each specimen sampled (Table 3a, Table 3b).

Data collected using *OnShore* and *OLLO* are uploaded to the regional database TUFMAN2 and then are automatically transferred into BioDaSys.

Between July 2020 and June 2021, *OnShore* was used in French Polynesia, the Philippines, Tonga, Marshall Islands, FSM, Fiji and New Caledonia (*by SPC OFP staff*). *OLLO* was used in New Caledonia, French Polynesia and Tonga.

Table 3a. General OnShore and OLLO usage summary table

Total number of OnShore sampling events	904
Total number of OnShore samples	135,044
Total number of OnShore samples with bio sampling data	810
Total number of OLLO trips	18
Total number of OLLO specimens for which there is bio sampling data	83

Table 3b. OnShore and OLLO usage per country

Country	OnShore sampling events	OLLO trips
FJ	16	
FM	141	
MH	315	
NC		9
OFP	18	
PF	207	6
PH	34	
TO	158	3
VU	11	
WS	4	

3. TTB ACCESS AND USE

3.1 ACCESS PROTOCOLS

A protocol for accessing the TTB for laboratory and data analyses by third party organisations was endorsed by the Commission in 2016 (Anon. 2016; SPC-OFP 2019), details of which are available here: www.spc.int/ofp/PacificSpecimenBank/Home/About.

A page dedicated to the sample requests has been created to clarify the workflow and provide more details to future applicants.

3.2 USE OF TTB AND PMSB SAMPLES (2009-2021)

There was one formal request from third parties to withdraw samples from the TTB or PMSB in 2020-21. Several informal enquiries were registered from university-based researchers around sample availability and access rights in the context of future collaborative projects.

At present, nineteen projects are classified as 'pending' in accessing samples from the TTB for WCPFC-related work, led by SPC and/or other national and international organisations (Table 3). Thirty-two projects utilising TTB/PMSB samples are 'completed' as at 30 June 2021 (ANNEX 1, Table A4).

3.3 STANDARDISATION OF NAME

The dual labelling of the collection as the TTB and PMSB results in some confusion among participants and users of the bank. To avoid this confusion, we recommend the adoption of the PMSB as the preferred name. If the steering committee and scientific committee are in agreement, we will revise the access protocols and advisory material for the TTB to reflect this change.

3.4 OUTPUTS ASSOCIATED WITH THE TTB (2020-21)

Annual progress reports from all projects currently accessing specimens from the TTB have been provided to the WCPFC Secretariat. Seven additional papers, linked either directly or indirectly to the TTB, will be submitted to SC17 this year as Information Papers or Research Papers. A total of eleven other books, peer-reviewed journal articles, conference papers or popular articles associated with TTB work were published during the 2020-21 reporting period. These include Moore et al. (2020), Rees et al. (2020), Anderson et al. (2020), Vaux et al. (2021), Medieu et al (2021), Bodin et al. (2021), Ravache et al. (2021), Receveur et al. (2021). Moreover, several completed projects have journal articles currently in review for publication in scientific journals (e.g. Medieu et al (2021)).

Table 3. Projects that currently access the TTB and/or the PMSB.

Project description	Samples Used	Analysis	Lead agency	WCPFC-SC Project No.	Status
Age and growth					
Using otolith growth chronologies and chemistry in deep-water *Etelis* species to answer key ecological questions in the Indo-Pacific.	Otolith	otolith growth chronologies, microchemistry	University of Adelaide	TBP	ongoing
Climate impacts on Pacific pelagic fishes	Otolith, gonad	microchemistry, histology	University of Melbourne	TBP	ongoing
Trophic dynamics					
Isoscapes and trophic dynamics of ocean sunfish in eastern Pacific Ocean	diet data	taxonomy	University of Victoria	TBP	ongoing
Diet diversity of the human predator	Diet data, isotope data	taxonomy, isotope	University of Hawaii	TBP	ongoing
Western Tropical Pacific Ecopath model	stomach	morphological taxonomy	SPC	TBP	ongoing
Movement					
C14 analysis of WCPO-BET otoliths	otolith	ageing, microchemistry	FRA*	98	ongoing
Spatial variation in concentrations of metal contaminants in food webs	muscle, blood	isotopes	IRD[#], SPC	TBP	ongoing
Stock structure					
WCPO tuna stock structure	otolith	shape morphometrics	SPC	TBP	ongoing
Stock structure of tropical tunas in the Indo-Pacific	Muscle	genetics	CSIRO	TBP	ongoing
Testing the panmixia hypothesis in WCPO skipjack using otolith chemistry, otolith shape, muscle isotopes and genetics	Otolith, muscle	shape morphometrics, genetics	SPC	TBP	ongoing
Blue Marlin trophic and spatial ecology	muscle	fatty acids	Macquarie University	TBP	ongoing
Genetic Structure of Pacific Albacore	muscle	genetics	Oregon State University	TBP	ongoing
Biology, ecology and population structure of sailfish	muscle	genetics	University of Queensland	TBP	ongoing
Food safety and tuna flesh characterisation					
Mushy Tuna Syndrome	muscle	biochemistry	University of Queensland	TBP	ongoing
Fatty acid content in South Pacific tunas and swordfish	muscle	fatty acids	IRD[#]	TBP	ongoing
TIPTOP: South Pacific tunas - persistent organic pollutants and microplastics	muscle	microplastics, persistent	IRD[#], IFREMER°, SPC	TBP	ongoing

		organic pollutants			
Spatial variation in metal contaminant concentrations in food webs of the South Pacific Ocean	muscle, blood	mercury, fatty acids	IRD[#], SPC	TBP	ongoing
MERTOX: Unravelling the origin of methylmercury toxin in marine ecosystems	muscle	mercury, isotopes, selenium, metals, nutrients	IRD[#]	TBP	ongoing
Fatmeter	muscle	fatmeter	SPC	TBP	ongoing
Taxonomy					
Maurolicus phylogeography	specimens	genetics	University of Bergen	TBP	ongoing

* Japanese National Research Institute of Far Seas Fisheries, # French National Research institute for Sustainable Development, ° French National Institute for Ocean Science

4. TUNA TISSUE BANK 2021-22 WORK PLAN

Actions planned for 2021-22, continuing from previous years, include:

- Completion of a document on standard operating procedures for the TTB.
- Provision of training to Vanuatu and Samoa and to members interested in using *OnShore* for biological sampling.
- Creation of species reference guides to improve species identification. In particular, the production and distribution of new ID books (e.g. seabirds, in French and in English) and the production of a new ID book on billfishes.
- Investigation of the use of temperature probes to monitor conditions in portable cold-storage units (e.g. 'Eskies') during transportation for sample quality traceability.
- Continued updating and improvement of training materials for biological sampling.
- Continued development and enhancement of E-reporting apps.

New actions planned for 2021-22 include:

- Contribution to improvements in 'measurement conversion factor' data in the Solomon Islands, linked through WCPFC Project 90.
- Creation of a contract template to submit to WCPFC members to comply with Nagoya protocol.
- Development of the collaboration with MRAG to increase the sample collection (numbers, spatial and temporal coverage) and improve efficiency of the logistics.
- Investigation of DNA degradation over time to aid in developing protocols for genetics sampling.
- Development of infrastructure in Noumea (e.g. laboratory extension).

5. BUDGET

The annual cost of supporting the WCPFC Tuna Tissue Bank now that it is established is USD97,200 baselined in 2018, with an annual inflation adjustment agreed by the Commission in 2018 for outyears. The proposed budget for 2021 is 101,180 and the indicative annual budgets for 2022 and 2023 are

USD 103,204 and USD 105,269 respectively. This comprises 60% for TTB coordination, information management and training for samplers, 23% for sampling fees and freight, and 17% for the additional storage facility in Brisbane.

6. RECOMMENDATIONS

The following recommendations arise from this report on the TTB in 2020-21. We invite SC17 to:

- 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.
- Incorporate the identified budget into the 2022 budget and the 2023-24 indicative budgets, as development of the WCPFC TTB is intended to be ongoing, and is considered essential.
- Support efforts to obtain further super-cold storage capacity to ensure longevity of TTB samples.
- Endorse that the work plan in Section 4 of this report should be pursued by the Scientific Services Provider, in addition to standard duties associated with maintenance and operation of the WCPFC TTB in 2021-22.
- Consider referring to the TTB as the "Pacific Marine Specimen Bank" to avoid confusion amongst users due to the current dual naming of the bank.

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The TTB is reliant on the observers, debriefers, observer trainers and observer managers across the region. Support is also received from fishing companies across the region, and from research institutes for providing access to fish and support for observer-based biological sampling.

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ANNEX 1.

Table A1. Total number of samples collected from scientific tagging cruises and analysed as at 30 June 2021.

Predator species		Fish collected	Total samples	Blood	Gonad	Liver	Muscle	Otolith	Spine/fin	Stomach	Fat meter	Samples analysed	% analysed
ALB	Albacore	404	1873	0	269	276	277	259	188	245	287	1121	60%
BET	Bigeye	929	4729	63	536	823	903	660	459	823	268	1167	25%
BSH	Blue shark	1	1	0	0	0	1	0	0	0	0	0	0%
BUM	Blue marlin	33	131	5	22	31	33	1	11	28	0	3	2%
CFW	Pompano dolphinfish	9	37	0	8	9	10	0	1	9	0	1	3%
CNT	Ocean triggerfish (spotted)	2	9	0	2	2	2	1	0	2	0	0	0%
DOL	Mahi mahi / dolphinfish	171	624	0	89	155	160	34	16	170	0	46	7%
EBS	Brilliant pomfret	2	10	0	2	2	2	0	2	2	0	0	0%
FAL	Silky shark	54	72	0	0	4	14	0	100	4	0	4	6%
FRI	Frigate tuna	99	309	0	4	99	99	3	4	99	1	96	31%
GBA	Great barracuda	1	4	0	1	1	1	0	0	1	0	0	0%
KAW	Kawakawa	136	322	0	1	97	97	1	0	125	1	118	37%
LAG	Moonfish / opah	2	10	0	1	2	2	1	2	2	0	0	0%
LEC	Escolar	7	41	0	7	7	8	5	7	7	0	0	0%
MLS	Striped marlin	10	45	0	7	8	12	2	8	8	0	0	0%
MSD	Mackerel scad / saba	5	15	0	0	5	5	0	0	5	0	5	33%
NXI	Giant trevally	1	1	0	0	0	0	0	0	1	0	1	100%
OCS	Oceanic white-tip shark	5	9	0	1	0	3	0	10	0	0	0	0%
PLS	Pelagic sting-ray	1	3	0	0	1	1	0	0	1	0	1	33%
RRU	Rainbow runner	206	670	0	49	199	199	17	1	205	0	112	17%
SKJ	Skipjack	4056	13669	0	558	3058	3153	720	803	3107	2376	5110	37%
SSP	Short-billed spearfish	4	20	0	3	4	5	1	3	4	0	0	0%
SWO	Swordfish	6	26	0	1	4	4	0	0	6	0	21	81%
TST	Sickle pomfret	2	13	0	2	2	3	2	2	2	0	0	0%
WAH	Wahoo	85	392	0	67	84	88	56	12	85	0	6	2%
YFT	Yellowfin	3043	10752	41	540	2400	2441	560	531	2485	1692	4164	39%
YTL	Amberjack (longfin yellowtail)	1	3	0	0	1	1	0	0	1	0	1	33%
Total		**9275**	**33790**	**109**	**2170**	**7274**	**7524**	**2323**	2160	7427	4625	11977	35%

¤ Fatmeter is a measurement of percentage of fat not a type of sample. Fatmeter is included in the table but not counted as a sample

Table A2. Total number of stomach samples collected during tagging cruises and analysed to 30 June 2021.

Predator species		***Collected***	**Analysed**	**% analysed**
ALB	Albacore	245	245	100%
BET	Bigeye	823	440	53%
BRZ	Pomfrets and ocean breams	3	3	100%
BUM	Blue marlin	28	3	11%
CFW	Pompano dolphinfish	10	2	20%
CNT	Ocean triggerfish (spotted)	2	0	0%
DOL	Mahi mahi / dolphinfish	170	46	27%
EBS	Brilliant pomfret	2	0	0%
FAL	Silky shark	4	4	100%
FRI	Frigate tuna	99	95	96%
GBA	Great barracuda	1	0	0%
KAW	Kawakawa	125	118	94%
LAG	Moonfish / opah	2	0	0%
LEC	Escolar	7	0	0%
MLS	Striped marlin	8	0	0%
MSD	Mackerel scad / saba	5	5	100%
NXI	Giant trevally	1	1	100%
PLS	Pelagic sting-ray	1	1	100%
RRU	Rainbow runner	205	112	55%
SKJ	Skipjack	3116	2587	83%
SSP	Short-billed spearfish	4	0	0%
SWO	Swordfish	6	6	100%
TST	Sickle pomfret	2	0	0%
WAH	Wahoo	85	6	7%
YFT	Yellowfin	2485	2159	87%
YTL	Amberjack (longfin yellowtail)	1	1	100%
Total		**7440**	**5834**	**78%**

Table A3. Locations and cold-storage capacity in key ports for the Tuna Tissue Bank.

Port	Country	Freezer Capacity	Comments
Noro	Solomon Islands	15 m^3 Blast freezer (-30^oC)	Soltuna Cannery
Honiara	Solomon Islands	0.7 m^3 (-18^oC)	Min. Fisheries and Marine Resources
Port Moresby	Papua New Guinea	0.36 m^3 (-18^oC)	National Fisheries Authority
Kavieng	Papua New Guinea	0.7 m^3 (-18^oC)	National Fisheries College
Rabaul	Papua New Guinea	0.3 m^3 (-18^oC)	National Fisheries Authority
Lae	Papua New Guinea	0.36 m^3 (-18^oC)	National Fisheries Authority
Madang	Papua New Guinea	0.7 m^3 (-18^oC)	National Fisheries Authority
Wewak	Papua New Guinea	0.7 m^3 (-18^oC)	National Fisheries Authority
Koror	Palau	0.1 m^3 (-18^oC)	Natural Resources, Environment, Tourism
Yaizu	Japan	15 m^3 (-18^oC)	National Research Institute of Far Seas Fisheries, Shimizu
Pohnpei	FSM	0.7 m^3 (-18^oC)	National Oceanic Resources Management Authority
Majuro	Marshall Islands	0.7 m^3 (-18^oC)	Marshall Islands Marine Resources Authority
		15 m^3 Blast Freezer (-30^oC)	Marshall Islands Fishing Venture
		15 m^3 Blast Freezer (-30^oC)	Pan Pacific Foods cold storage
Honolulu	USA	10 m^3 (-18^oC)	NOAA
Aiwo	Nauru	0.15 m^3 (-18^oC)	Fisheries and Marine Resources Authority
Tarawa	Kiribati	15 m^3 Blast Freezer (-30^oC)	Kiribati Fish Limited
Papeete	French Polynesia	0.7 m^3 (-18^oC)	Resources marine et minières
Pago Pago	American Samoa	0.5 m^3 (-18^oC)	NOAA
General Santos	Philippines	0.5 m^3 (-18^oC)	SOCSKSARGEN Federation of Fishing and Allied Industries, Inc
		15 m^3 Blast Freezer (-30^oC)	Well-Delight Network Corporation
Apia	Samoa	0.5 m^3 (-18^oC)	Min. Agriculture and Fisheries
Suva	Fiji	0.7 m^3 (-18^oC)	Min. Fisheries and Forests
Port Villa	Vanuatu	0.2 m^3 (-18^oC)	Min. Agriculture, Livestock, Forestry, Fisheries Biosecurity

Table A4. Projects that have previously accessed the TTB and/or the PMSB.

Project description	Samples used	Analysis	Lead agency	WCPFC-SC Project No.	Completion date
Age and growth					
Albacore growth curve - extension project	Otolith	ageing	CSIRO	100b	2021
Striped marlin ageing project	Otolith	ageing	CSIRO	99	2021
Yellowfin growth curves	Otolith, spine	ageing	CSIRO, SPC	82	2018
Bigeye/yellowfin ageing comparison	otolith	ageing	CSIRO, IATTC		2018
Bigeye growth curves	otolith	ageing	SPC, CSIRO, Sun Yat-Sen University	35, 81	2016
Swordfish growth curves	Otolith, spine	ageing	CSIRO	71	2016
Deepwater snapper project	otolith	ageing	SPC	?	2015
Albacore growth curves	otolith	ageing	SPC, CSIRO	39	2012
Reproductive biology					
Bigeye maturity ogives	gonads	histology	SPC, CSIRO	35	2016
Deep water snapper project	gonads	histology	SPC	?	2015
Albacore maturity ogives	gonads	histology	SPC, CSIRO	39	2012
Albacore reproductive biology	gonads	histology	SPC, CSIRO	39	2012
Trophic dynamics					
Ecosystem effects of fishing	stomach, muscle	diet analyses, DNA metabarcoding, Taxonomy, fatty acid	SPC, University of Canberra Curtin University, CSIRO	37, 46	2014
FAD impacts on trophic dynamics	muscle	isotopes	SPC University Southampton	37	2013
Size-based Food Web	muscle	isotopes	Rhodes University		2013
Movement					
Pacific Bluefin tuna movement dynamics	Muscle, otolith	isotope microchemistry	Texas A&M University Galveston		2019
DNA microbiome	stomach	DNA microbiome	University of Canberra, SPC		2018
Deepwater snapper project	muscle, fin	DNA	University of Canterbury		2015

PFRP tuna trophic & movement	muscle	mercury isotopes	Louisiana State University, SPC		2007
	muscle	isotopes	Louisiana State University, University of Hawaii, SPC		
South Pacific albacore	otolith	microchemistry	SPC	38	2012
Ecosystem monitoring					
BIOPELAGOS: pelagic biodiversity	micronekton	morphological taxonomy	SPC, MNHN Concarneau		2019
	seabird stomach regurgitate	DNA	University of Canberra, SPC		
	fish eye	DNA	IRD, SPC		
	acoustic data	acoustic	IRD, SPC		
Stock structure					
Population genomic variation in North and South Pacific albacore	muscle	DNA	Oregon State University		2019
Bigeye and wahoo ocean basin attribution	muscle	DNA	Thünen Institute of Fisheries Ecology		2018
WCPO tuna stock structure	muscle	DNA	CSIRO		2018
WCPO tuna stock structure and movement (albacore, skipjack, yellowfin and bigeye)	muscle	DNA	University of the South Pacific		2016
Black marlin	muscle, liver	DNA	University of Queensland		2016
Global tropical tuna stock structure	fin	DNA	University of Bologna		2014
Albacore	muscle	DNA	AZTI		2012
Blue shark and Mako shark	fin	DNA	University of Aberdeen		2011
Indonesia-west Pacific tropical tuna stock structure	fin	DNA	CSIRO		2009
Food Safety and tuna flesh characterisation					
Omega-3 project	muscle	lipids	CSIRO		2010
Selenium and mercury in yellowfin and bigeye tuna	muscle	mercury, selenium	University of Washington		2009