SCIENTIFIC COMMITTEE
13th REGULAR SESSION

Rarotonga, Cook Islands
9-17 August 2017

Project 35: Bigeye biology, and Project 35b: WCPFC Tuna Tissue Bank

WCPFC-SC13-2017/RP-P35-01

SPC-OFP

EXECUTIVE SUMMARY

Key Points for SC13 – Project 35

1. Analysis of bigeye tuna otolith and gonad samples are complete and WCPFC-SC13/SA-WP-01 (Farley et al., 2017) provides estimates of annual age and maturity status for the current stock assessment.
2. Project 35 is now complete in terms of contracted work and use of available funding.
3. **Regular age and growth analyses of specimens for all tuna and tuna-like stocks for future stock assessments should be budgeted for and aligned with the stock assessment schedule. The priority species for the next phase of work is yellowfin.**

Key Points for SC13 – Project 35b

4. The tuna tissue bank has processed the first three formal third party applications for access to samples, and the processing of a fourth request, recently approved, is underway.
5. Procedures for granting access to the WCPFC Tuna Tissue Bank by third parties have been tested and amended procedures recommended at SC12 are being used.
6. Training in biological sampling for observers and refresher courses continue. Over 5% of active senior observers contributing to the WCPFC Regional Observer Programme have had specialist training in biological sampling methods and procedures. WCPFC Regional Observer Programme training standards and training materials for biological sampling have been prepared and updated.
7. The web-based tool for WCPFC CCMs and external parties to query the WCPFC Tuna Tissue Bank continues to be improved. The web database has been accessed by over 4150 unique users from all over the world, with over 1300 page views since February 2017.
8. The deposits to the tuna tissue bank over the period 01 July 2016 through 30 June 2017 include an additional 1,175 specimens of which over 94% are from the five core species (albacore, bigeye, skipjack yellowfin and swordfish).
9. Two scientific reports and three scientific journal articles based on analyses of samples extracted from the WCPFC Tuna Tissue Bank have been published in 2016-2017, and appropriate acknowledgements given.
10. A small test of samples from the tissue bank during 2016-17 for DNA single nucleotide polymorphism quality found that current sampling protocols were suitable to support this work, but highlighted the need for continued vigilance in maintenance of the sample cold chain.
11. An **ongoing programme of work to maintain and enhance the WCPFC Tuna Tissue Bank is identified and it is recommended that the WCPFC SC endorse this** work.
12. The annual cost of supporting the WCPFC Tuna Tissue Bank now that it is established is USD97, 250. **The SC13 needs to decide if it wishes to place an indicative annual budget of USD97, 250 continuing in 2019 and 2020 (2018 is already in the indicative budget).** This comprises USD55, 000 for tuna tissue bank coordination, information management and training for samplers, USD25, 000 for sampling fees and freight, and USD17, 250 for the additional storage facility in Brisbane.
13. To facilitate better use of the TTB and the BioDaSys web-tool **it is proposed that researchers wishing to access more detailed information be able to apply for a login directly from the Scientific Services Provider. Only those data fields necessary to design research would be accessible to authenticated users.** Any specific request for samples would still require approval via the WCPFC access protocol.

1. BACKGROUND

The Western and Central Pacific Fisheries Commission (WCPFC) has identified that information gaps in key biological parameters reduce the reliability of current stock assessments and management measures for several large pelagic fish stocks in the Western and Central Pacific Ocean (WCPO). Recent analyses have demonstrated important spatial and temporal differences in the age, growth and reproductive biology's of tunas and billfishes which exert considerable influence on the estimation of stock status in relation to fisheries reference points. To reduce these uncertainties they have prioritised the work programme of its scientific committee to undertake stock-wide studies on the age, growth and reproductive biology of tunas and billfishes (Nicol et al., 2015).

Project 35 has been implemented over the last seven years (Nicol et al., 2011, 2014, 2015; Smith et al., 2016). It was originally designed to address the scientific committee's requirements for improved knowledge on albacore and bigeye tuna age, growth and reproductive biology. WCPFC has provided funding to collect 2500 otoliths and 300 gonads across the WCPO to estimate spatial variation in growth and reproductive biology. The European Union provided further funding in 2014 to extend this collection to other tuna and billfish species for the purposes of establishing a WCPFC tissue bank that would allow the WCPFC to have immediate access to biological material to answer stock biology and provenance questions. The project successfully met the sampling targets set (Nicol et al., 2015).

SC11 recommended that funding be continued to maintain Project 35: Bigeye Biology and WCPFC Tuna Tissue Bank, with particular emphasis on WCPO bigeye, yellowfin, and skipjack tunas (Anon., 2015a). SC11 also recommended that the Commission adopt the "WCPFC Tissue Bank Access Protocols" developed within Project 35 and modified by ISG-2 at SC11 (Anon., 2015a). Subsequently the Commission endorsed both recommendations (Anon., 2015b).

In 2016 WCPFC funded two projects to implement these recommendations. Those projects are Project 35 – Bigeye biology, and Project 35b – Tuna Tissue Bank. This report provides an update on progress for these two projects, and identifies key recommendations for ongoing work.

2. PROJECT 35 – BIGEYE BIOLOGY

Project 35 has been implemented over the last seven years. It was designed to address the scientific committee's requirements for improved knowledge on bigeye tuna age, growth and reproductive biology. SC10 recommended that Project 35 commence laboratory analyses of samples to provide updated estimates of age and growth, and reproductive biology, for stock assessment purposes.

2.1 CONTEXT

In 2008, the Western and Central Pacific Fisheries Commission (WCPFC) endorsed a "Comprehensive Research Plan on Pacific-wide Bigeye Growth and Reproductive Biology" and supported a pilot project to determine the sampling requirements for implementing this study, Project 35 (Anon., 2008). In 2009, a work plan for the pilot project was finalised and biological samples were subsequently collected through a regional sampling program. In 2011, the pilot project was completed in collaboration with CSIRO. Preliminary estimates of bigeye age and maturity were obtained for the bigeye stock assessment regions 3 and 4 and the sensitivity of the bigeye stock assessment to these estimates was evaluated (Nicol et al., 2011). After reviewing Project 35, the WCPFC supported the continuation of the sampling and analysis program to gain a better understanding of bigeye age and maturity. In late 2014, the WCPFC endorsed the 'analysis phase' of Project 35 (Anon., 2014). Specialised analysis of otoliths and ovaries is required to estimate length- and maturity-at-age of bigeye tuna for this project.

2.2 PROGRESS IN 2016-17

In early 2017, CSIRO provided estimates of annual age and maturity status of bigeye tuna from a selection of otoliths and ovaries collected under WCPFC Project 35. The age and maturity data, and associated estimates, obtained through the project included characterizing spatial and temporal variation

in the growth of bigeye tuna. SPC and CSIRO have jointly participated in the analyses of the age and maturity data to generate growth curves and maturity ogives (Farley et al., 2017).

The project reports age estimates for 1100 bigeye tuna with age estimates based on readings of transversely sectioned otoliths (1000 with annual counts, 100 with daily counts), and maturity and reproductive assessments of 200 bigeye tuna based on readings of histologically sectioned ovaries.

The outputs of the analyses were available for input into the 2017 bigeye tuna stock assessment (McKechnie et al., 2017). A final report has been submitted to the Scientific Committee of the WCPFC to document the results of the age, growth and maturity of the bigeye tuna in the WCPO: Farley, J., Eveson, P., Krusic-Golub, Sanchez, C., Roupsard, F., McKechnie, S., Nicol, S., Leroy, B., Smith, N., and Chang, S-K. 2017. Project 35: Age, growth and maturity of bigeye tuna in the Western and Central Pacific Ocean. WCPFC-SC13-2017/SA-WP-01. Thirteenth regular session of the scientific committee of the Western and Central Pacific Fisheries Commission. Rarotonga, Cook Islands, 9-17 August 2017.

2.4 ACKNOWLEDGEMENTS

The analyses conducted under Project 35 would not have been possible with the considerable efforts of the staff, agencies and observers of the WCPO. This project has been a Pacific Island Country and Territory collaboration from inception to completion. The following agencies and staff are especially thanked for their significant role in co-ordinating biological sampling across the region:

- Marshall Islands Marine Resources Authority, Marshall Islands (Berry Muller, Mark Bigler)
- Ministry of Fisheries, Fiji Islands (Netani Tavaga)
- National Oceanic Resources Management Authority, Federated States of Micronesia (Naiten Bradley Phillips Jr.)
- National Fisheries Authority, Papua New Guinea (Thomas Usu, Brian Kumasi)
- Ministry of Fisheries and Marine Resources, Solomon Islands (Charlyn Grace Golu)
- Ministry of Fisheries and Marine Resources, Kiribati; and,
- Ministry of Natural Resources, Environment and Tourism, Palau (Kathy Sisior).

The following observers and samplers are highlighted for their significant role:

- Derek Langitur and Jerke Anungar, MIMRA, Marshall Islands, for an incredible 520 otoliths sampled for the project
- Samplers with more than 50 bigeye tuna sampled
    - Damien Fiagori, Papua New Guinea
    - Lenest Debrum, Marshall Islands
    - Steve Peter, Federated States of Micronesia
    - Sailosi Naiteqe, Fiji Islands; and,
    - Tataua Rabunataai, Kiribati.

We are also very grateful to the support received from Luen Thai in Majuro and Palau, Kiribati Fish Limited (KFL) in Tarawa, Soltuna in Noro and National Research Institute of Far Seas Fisheries (NRIFSF) in Japan for access to fish and providing support to observer biological sampling. We gratefully acknowledge all the observers, port-samplers, observer co-ordinators, fisheries officers, skippers and fish processors across the Pacific involved in collecting, storing and transporting the otoliths and gonads for this project.

2.3 FUTURE WORK

The work specified under this project as currently specified is now complete. Consideration should be given to adopting a longer term plan of work to ensure age and maturity data to generate growth curves and maturity ogives, with focus on characterizing spatial and temporal variation in growth, are available for the key tuna stocks, not just for bigeye tuna (following the agreed schedule for tuna stock assessment. The priority species for the next phase of work is yellowfin tuna.

3. PROJECT 35B – WCPFC TUNA TISSUE BANK

The WCPFC Tuna Tissue Bank (TTB) has been established over several years and its ongoing operation is now funded by WCPFC through Project 35B. The objective of the project is to maintain the WCPFC TTB with particular emphasis on WCPO bigeye, yellowfin, albacore and skipjack tunas, and swordfish, and, to facilitate transmission of samples to specified researchers with due cognizance of the WCPFC TTB Access Protocols (Anon., 2017a). SPC as the Scientific Services Provider is tasked to maintain and develop the WCPFC TTB and through the biological sampling programme expand the inventory of samples held. This project currently runs to 31 December 2018 with funding for 2018 and 2019 subject to the decisions of WCPFC 14 and WCPFC 15.

This annual report briefly outlines:

- the history of the TTB
- sample collection techniques and systems, including updates on samples collected this year
- changes to sample storage facilities
- the TTB database and developments of BioDaSys
- recent use of the TTB, and
- work to maintain and enhance the TTB.

3.1 CONTEXT

WCPFC has established a TTB so that national and international fisheries research institutes can access the collections to undertake the necessary research to enhance understanding of the dynamics of tuna and related species in the WCPFC region (including analyses to estimate spatial and temporal explicit age, growth and reproductive parameters, and genetics for stock structure for use in stock assessments). In a broader ecosystem context the collections will also be used for trophic and system studies including diet analyses, stable isotopes, mercury and other biochemical elements for trophic structure and movements and taxonomic studies. Previous projects have seen a system of observer training, training of trainers, sample kit distribution, observer sampling at-sea and port-sampler sampling in port, sample transfer and sample curation established so that researchers can access an online database (Biological Database System – BioDaSys) of the WCPFC TTB. Procedures for granting access to the WCPFC TTB by third parties have been established and implemented (Anon 2017a.).

3.2 SAMPLE COLLECTION AND PROGRESS IN 2016-17

3.2.1 Sample collection

To simplify the sampling numbering system as much as possible the WCPFC ROP Observers are issued with biological sampling kits that include sample tags that are already numbered (see Figure 1). The database tracks the distribution of kits and sample tags allowing the coordinators of the repository to ascertain the status of sampling supplies allocated to each ROP Observer and to ensure that regional observer offices have sufficient stock to replenish observer supplies.

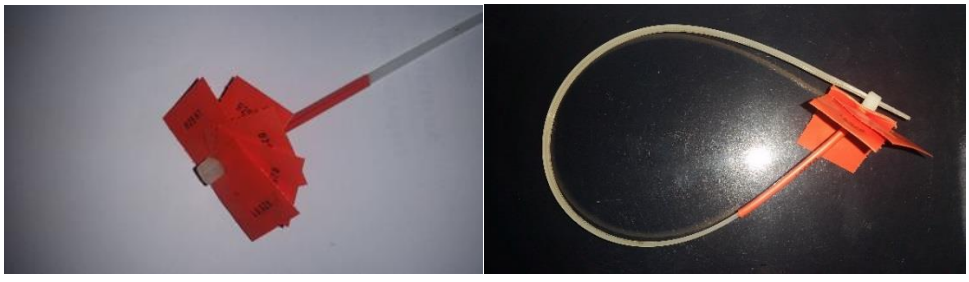


Figure 1. Photos of the cable tie tag that is issued to observers with unique numbers on them.

Biological sampling kits contain data sheets, pencils, knives, saws, cutters, cable tags, sample jars and bags, and instructions have been updated (see Figure 2 and Smith et a. (2016) *Appendix I* for Sampling Instruction Sheets). From 2016 instructions now also include swordfish head and anal ray sampling, blood sampling, and otolith extraction quality codes, as well as precise instruction for coordination at port (Smith et al., 2016). Gonad sampling and fixation instructions have also been developed for port sampling (see Smith et al. (2016) *Appendix II*).

Figure 2. Examples of the equipment and supplied provided to observers in the biological sampling kits.

3.2.2 Observer Training Standards

Standards for training of observers in biological sampling have been updated and accepted into the PIRFO training standards (see Appendix I for the December 2016 PIRFO Biological Sampling Competency Standard). Theoretical modules in understanding scientific sampling requirements and data collection have been updated, giving further skills to the observers in interpreting information from multiple sampling strategies. A video on swordfish head collection (e.g., for onshore processing for otoliths) has been developed and is now provided at all biological sampling upgrade trainings. The observer manual created and updated to the current sampling requirement (see Smith et al. (2016) *Appendix IV* for Biological sampling manual for observers and port samplers) is now used for all observer biological sampling upgrade trainings and available in each members' country to brief observers before placement. A training manual has also been prepared (see Smith et al. (2016) *Appendix V* for Observer training modules for biological sampling) and is still currently under revision to include new training procedures.

3.2.3 Observers and Observer Trainers

Senior observers that remain active in the WCPFC ROP and within National Programmes continue to be identified and provided with training in biological sampling, including fish hard part extraction, tissue sampling, gonad sampling and data recording. Training has also included sample handling and transportation. An additional twenty one observers were trained in 2016-17 bringing the total trained to 480. A refresher training held in Fiji updated skills of 12 Fijian observers. This provides a sufficient number of observers for the collection of samples over the spatial domain of the WCPO and ensures that observers can be deployed on the appropriate vessel trips to implement a variety sampling strategies to meet WCPFC-SC requirements. Table 1 provides a summary of the changes this year in observer

training by nationality. Table 2 provides a summary of the number of observer trainers who can now deliver biological sampling training by nationality. Supervision in delivering the biological sampling modules was undertaken for one Solomon Islands and one Federated States of Micronesia trainer. All the trainers were updated on the new training material and modules developed in 2016.

Table 1. Summary of observers trained in biological sampling by nationality. Changes from 2015-16 indicated by ~~strikethrough~~.

Country	No. of OBS	Country	No. of OBS
Cook Islands	~~4~~	Papua New Guinea	79
Fiji	31	Palau	12
Federated States of Micronesia	78 ~~64~~	Solomon Islands	64 ~~63~~
Kiribati	47	Chinese Taipei	33
Marshall Islands	39	Tonga	19 ~~13~~
Nauru	9	Tuvalu	10
New Caledonia	2	Vanuatu	25
French Polynesia	5	Samoa	23

Table 2. Summary of observer trainers trained to deliver biological sampling training by nationality.

Country	No. of trainers
Federated States of Micronesia	2
Kiribati	1
Marshall Islands	2
Nauru	1
Papua New Guinea	2
Solomon Islands	2

3.2.4 TTB Sample Collections

Samples continue to be collected by national "at sea" and "port" observers across the WCPO. Observers collect to a strategy that optimizes the number of samples per set and maximizes sampling across sets and trips to create the greatest temporal spatial coverage possible. Opportunistic sampling on scientific cruises has also been undertaken.

In 2016-17 an additional 6,452 samples were collected from 1,175 fish and deposited in the TTB (Table 3a). This comprised 440 yellowfin, 382 skipjack, 164 bigeye, 107 albacore, 13 swordfish, 38 striped marlin, and 31 other species of fish. The provisional total SPC Marine Specimen Bank incorporating the WCPFC TTB sample holdings to 30 June 2017 include 29,406 individual specimens (Table 3b). The tables below summarise the tissue samples per species. These data do not include samples awaiting cataloguing. Note the numbers of samples is greater than the number of fish as multiple samples are often available for the same fish (e.g. muscle tissue from different positions on the body, gonad samples in different storages). The quantity and details of such samples have not yet been verified due to the extended length of some observer trips, or the requirement to complete consecutive trips and the biological sampling information having not yet been submitted by the observer.

The distribution of samples by tissue type provided in Nicol et al. (2015) is now available via BioDaSys (see Section 3.4) and accordingly are no longer plotted in this paper. The rate of sampling of various

species in key areas is monitored, and to the extent possible, observer tasking is directed to ensure spatial, species and temporal spread across the WCPO.

To recognise the effort involved in biological sampling and those who put in the effort, sampling appreciation certificates were distributed in late 2015 to encourage and acknowledge the work of the samplers across the WCPO (see Smith et al. (2016), *Appendix VI* Certificates of Appreciation). It is intended to continue this recognition in future by selecting observers from each country that contribute most to the sampling collection during each year. A dedicated special printed shirt "Biological Sampler of the Year" will be distributed to each selected observer.

Table 3a. Summary of 2016-17 additions to the WCPFC Tuna Tissue Bank (01 Jul 2016 – 30 Jun 2017).

Species		Hard-parts		Reproduction	Multi-purpose				Diet
	Curated	Otoliths	Spines	Gonads	Blood	Muscle	Liver	Fin	Stomach
Bigeye	164	117	94	178	5	164	143	0	141
Yellowfin	440	366	259	573	39	437	392	0	390
Skipjack	382	353	215	547	21	381	382	0	382
Albacore	107	69	94	106	15	105	93	0	94
Swordfish	13	6	1	9	5	11	11	13	11
Striped Marlin	38	0	0	17	26	37	25	0	2
Wahoo	6	1	1	6	0	6	6	0	6
Mahi Mahi	5	0	0	4	0	5	4	0	5
Rainbow Runner	6	0	0	6	0	6	6	0	6
Other#	14	0	3	12	10	13	13	0	4

Table 3b. Total holdings in SPC Marine Specimen Bank incorporating the WCPFC TTB (30 Jun 2017).

Species		Hard-parts		Reproduction	Multi-purpose				Diet
	Curated	Otoliths	Spines	Gonads	Blood	Muscle	Liver	Fin	Stomach
Bigeye	4304	1975	517	3344	82	2823	1527	0	790
Yellowfin	8327	4215	1257	4982	212	5670	4260	0	1865
Skipjack	5730	1458	906	1671	122	4102	4062	0	1451
Albacore	4171	2417	869	2411	29	1263	1149	0	334
Swordfish	119	13	10	31	11	67	91	19	38
Striped Marlin	137	0	1	24	22	81	65	0	6
Wahoo	339	29	1	12	0	219	221	0	14
Mahi Mahi	350	0	0	21	16	215	192	0	31
Rainbow Runner	343	0	0	7	0	220	222	0	20
Other#	5586	3755	12	3213	32	836	2842	78	24

#includes lancetfishes, kawakawa, blue marlin, frigate and bullet tuna, moonfish, black marlin, escolar, spearfish, barracudas, mackerel scad, triggerfishes, blue shark, pelagic stingray, manta ray, silky shark, sailfish, Spanish mackerel, oilfish, short-finned and long-finned mako sharks, snake mackerel, pomfrets, trevallies, blue chub, oceanic white-tip shark, filefishes, batfishes, fangtooth, devil ray, sandbar shark, sergent major, tiger shark, alfonsinos, amberjack, anchovies, bigeye thresher shark, bronze whaler shark, bull shark, unicornfish, crocodile shark, flying gurnards, gemfish, hammerhead sharks, reef sharks and squids.

3.3 SAMPLE STORAGE INFRASTRUCTURE

The TTB has long-term storage facilities at SPC Headquarters in Noumea, New Caledonia and at CSIRO, Brisbane, Australia. The specific work completed by CSIRO includes sorting specimens on arrival and reconciling with quarantine data, entering data describing specimens received into BioDaSys, storing specimens systematically so that they can be retrieved when requested and providing laboratory and storage materials to complete curation.

The storage in Noumea has been expanded again this year by an additional 20% to cope with demand. These facilities are currently being provided in kind to the project by both organisations. The project does contribute to costs for several of the short-term/staging facility infrastructure.

Numerous short-term/staging storage facilities in the key ports of the WCPO have been established, with changes in 2016-17 identified (see Table 4). Note that strategic investment in a super-cold storage facility will be required in the next few years to ensure the longevity and relevance of the WCPFC TTB (see Smith et al. (2017) for further discussion on this concept).

Table 4. Locations and storage capacity for the WCPFC Tuna Tissue Bank.

Port	Country	Freezer Capacity	Comment
Noro	Solomon Islands	15 m^3 Blast freezer (-30°C)	Soltuna Cannery
Honiara	Solomon Islands	0.7 m^3 (-18°C)	Min. Fisheries and Marine Resources
Port Moresby	Papua New Guinea	~~1~~ 0.36 m^3 (-18°C)	National Fisheries Authority
Kavieng	Papua New Guinea	0.7 m^3 (-18°C)	National Fisheries College
Rabaul	Papua New Guinea	0.7 m^3 (-18°C)	National Fisheries Authority
Lae	Papua New Guinea	~~0.7~~ 0.36 m^3 (-18°C)	National Fisheries Authority
Madang	Papua New Guinea	0.7 m^3 (-18°C)	National Fisheries Authority
Wewak	Papua New Guinea	0.7 m^3 (-18°C)	National Fisheries Authority
Koror	Palau	0.1 m^3 (-18°C)	Natural Resources, Environment, Tourism
~~General Santos~~	~~Philippines~~	~~0.21 m^3 (-18°C)~~ ~~15 m^3 Blast Freezer (-30°C)~~	~~Bureau of Fisheries and Aquatic Resources~~ ~~Well Delight Network Corporation~~
~~Kaohsiung~~	~~Chinese Taipei~~	~~0.7 m^3 (-18°C)~~	~~Sun Yat-Sen University~~
Yaizu	Japan	15 m^3 (-18°C)	National Research Institute of Far Seas Fisheries, Shimizu
Pohnpei	Federated States of Micronesia	0.7 m^3 (-18°C)	National Oceanic Resources Management Authority
Majuro	Marshall Islands	0.7 m^3 (-18°C) 15 m^3 Blast Freezer (-30°C) 15 m^3 Blast Freezer (-30°C)	Marshall Islands Marine Resources Authority Marshall Islands Fishing Venture Pan Pacific Foods cold storage
Honolulu	USA	10 m^3 (-18°C)	NOAA
Aiwo	Nauru	0.15 m^3 (-18°C)	Fisheries and Marine Resources Authority
Tarawa	Kiribati	15 m^3 Blast Freezer (-30°C)	Kiribati Fish Limited
Papeete	French Polynesia	0.7 m^3 (-18°C)	Resources marine et minieres
Pago Pago	American Samoa	0.5 m^3 (-18°C)	Min. Marine and Wildlife Resources
Apia	Samoa	0.5 m^3 (-18°C)	Min. Agriculture and Fisheries
Suva	Fiji	0.7 m^3 (-18°C)	Min. Fisheries and Forests
Port Villa	Vanuatu	0.2 m^3 (-18°C)	Min. Agriculture, Livestock, Forestry, Fisheries Biosecurity
Noumea	New Caledonia	7.3 ~~5~~ m^3 (-18°C)	SPC
Brisbane	Australia	20 m^3 Blast Freezer (-30°C)	CSIRO

3.4 THE TUNA TISSUE BANK DATABASE - BIODASYS

A central feature of the TTB repository is a relational database that catalogues the samples, the Biological Data System (BioDaSys). A standalone web portal for the Specimen Tissue Bank was released (www.spc.int/ofp/PacificSpecimenBank) in February 2017. Specific information includes sample number; all tissues that were collected from that individual fish; the condition of these samples; species and its measurements; all information on where each sample comes from and how and when it was collected; who collected the sample; the location(s) where it is currently stored, how it was transported and who transported it to its current location. Developments of BioDaSys during 2016-17 are identified below.

3.4.1 New Features

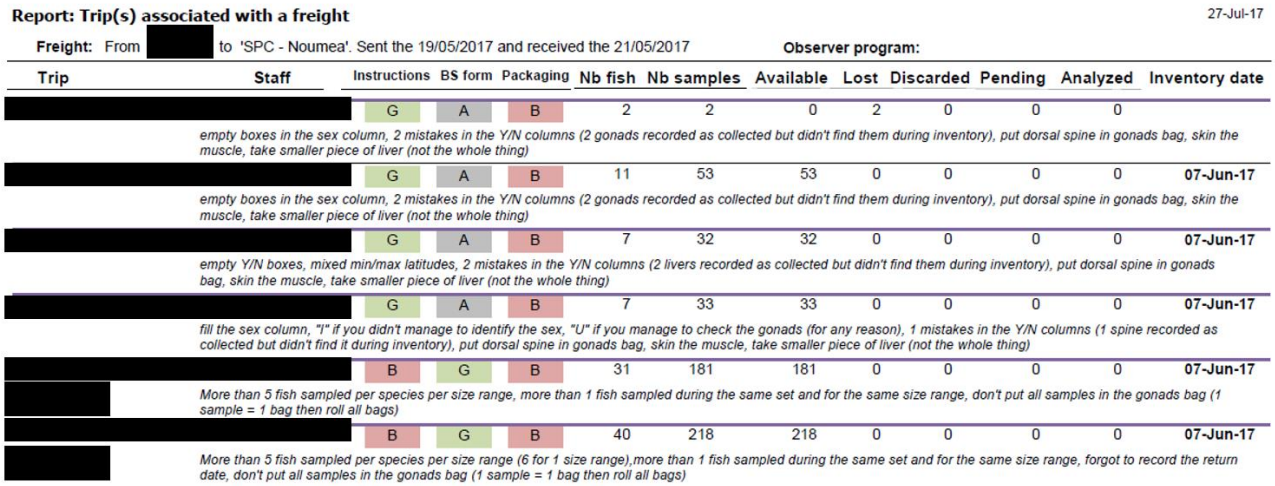
Two new data processes have been added to BioDaSys to keep track of:

- orphan samples – samples arriving at SPC without data such as catch position, catch date, species identification, etc.
- lost samples – samples supposed to be stored in Brisbane but not found during the inventory on site, which could be explained by unrecorded freight to another location, or samples that were noted as sampled on the biological sampling form but missing during final inventory at Noumea or Brisbane.

Tracking these processes allows quick feedback to affected staff and thus promotes a higher chance to retrieve missing information (see Figure 3 for an example).

Additional data fields per sample/shipment Financial expenses per transport are now also included in the freight section to improve future budgeting for the project. Sampling targets per member country, as agreed in implementing arrangements, are also now included in BioDaSys and monitored.

Meta-data about the fishing/sampling trip that the sample came from is also included. A third aspect of the database catalogues the analysis of the samples. This includes a description of the laboratory analyses, WCPFC project number and the primary information derived from these analyses (e.g. sample weights, analyses performed and resulting estimates (e.g. age, reproductive status, chemical composition, etc.) and who undertook the analyses and their contact details (see Section 3.X). Subject to the approval of the data dissemination protocols by the Scientific Committee of the WCPFC it is expected all data will be available to institutions or organizations responsible for providing scientific advice in fisheries through the web-accessible component of the database.



Report: Trip(s) associated with a freight 27-Jul-17

Freight: From [redacted] to 'SPC - Noumea'. Sent the 19/05/2017 and received the 21/05/2017 **Observer program:**

Trip	Staff	Instructions	BS form	Packaging	Nb fish	Nb samples	Available	Lost	Discarded	Pending	Analyzed	Inventory date
[redacted]		G	A	B	2	2	0	2	0	0	0	
empty boxes in the sex column, 2 mistakes in the Y/N columns (2 gonads recorded as collected but didn't find them during inventory), put dorsal spine in gonads bag, skin the muscle, take smaller piece of liver (not the whole thing)												
[redacted]		G	A	B	11	53	53	0	0	0	0	07-Jun-17
empty boxes in the sex column, 2 mistakes in the Y/N columns (2 gonads recorded as collected but didn't find them during inventory), put dorsal spine in gonads bag, skin the muscle, take smaller piece of liver (not the whole thing)												
[redacted]		G	A	B	7	32	32	0	0	0	0	07-Jun-17
empty Y/N boxes, mixed min/max latitudes, 2 mistakes in the Y/N columns (2 livers recorded as collected but didn't find them during inventory), put dorsal spine in gonads bag, skin the muscle, take smaller piece of liver (not the whole thing)												
[redacted]		G	A	B	7	33	33	0	0	0	0	07-Jun-17
fill the sex column, "I" if you didn't manage to identify the sex, "U" if you manage to check the gonads (for any reason), 1 mistakes in the Y/N columns (1 spine recorded as collected but didn't find it during inventory), put dorsal spine in gonads bag, skin the muscle, take smaller piece of liver (not the whole thing)												
[redacted]		B	G	B	31	181	181	0	0	0	0	07-Jun-17
[redacted]												
More than 5 fish sampled per species per size range, more than 1 fish sampled during the same set and for the same size range, don't put all samples in the gonads bag (1 sample = 1 bag then roll all bags)												
[redacted]		B	G	B	40	218	218	0	0	0	0	07-Jun-17
[redacted]												
More than 5 fish sampled per species per size range (6 for 1 size range),more than 1 fish sampled during the same set and for the same size range, forgot to record the return date, don't put all samples in the gonads bag (1 sample = 1 bag then roll all bags)												

Figure 3: Example of report generated from BioDaSys on inventory of samples and related fields for debriefing and curating the samples.

3.4.2 Tracking of Samples

The sample database (BioDaSys) tracks sampling trips undertaken by observers, port sampling events, quality of the sampling, as well as payment of samplers allowing the sampling coordinators to follow vessels on which sampling is undertaken (Figure 3). This allows enhanced coordination of the reception of the samples, as well as the debriefing of the observer upon arrival. These changes have improved the ability to monitor the quality of the sampling undertaken and to coordinate payment for samples. In particular, the database allows validation of the sample collection position using VMS and logsheet tracks which increase the data quality control of the repository. Debriefing documents have been updated providing further control on the quality of the samples. A new component of the database capture biological sampling training provided by SPC since 2009, with a link to the trainees results and the quality of the samples and the data provided per sampler. Feedback on the quality of the sampling over time can be provided to the samplers and the coordinators and quality control reports per member countries are generated after the inventory of the samples.

3.4.3 Web Accessibility

A web-based tool has been implemented to allow WCPFC members to track the collection of samples (via BioDaSys). It includes interactive maps where the user can obtain information on the number, type, species and length classes of samples collected from particular EEZ and high seas areas (see Figure 5). An on-line query system is also included to allow more detailed information on each sample to be

viewed (e.g. date and location of sample and types of samples taken from the individual, sample quality; see Figure 4). The web tool is currently available at: http://www.spc.int/ofp/PacificSpecimenBank. The on-line query tool has been accessed by over 4150 unique users from all over the world (Figure 6). Since the release of the standalone web portal in February 2017, it has been used by 120 unique users, mostly from the Pacific area with over 1300 pages viewed.

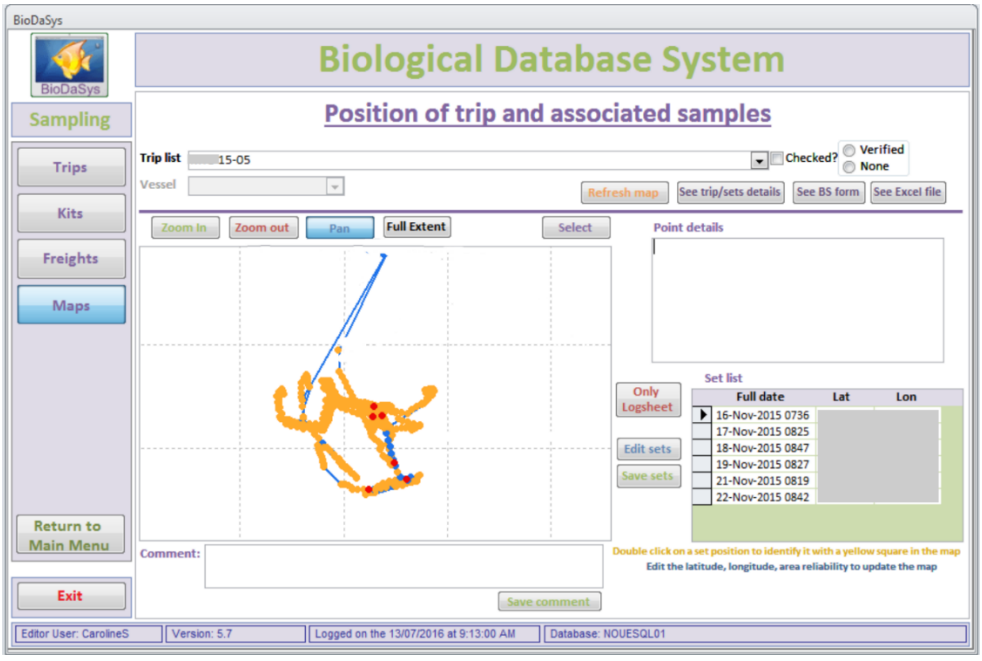


Figure 4. Example of trip information in BioDaSys as used by sampling coordinators to monitor and improve sample collection and data quality.

The web interface will be progressively updated in the following months to follow the refactoring of the BioDaSys backend system which has been completely redeveloped in order to support the WCPFC TTB. Initially a system to manage biological sampling in the Pacific Ocean (trips, sampled fish, samples and associated analysis), BioDaSys is now a full-featured infrastructure to allow for example to verify and validate data provided by samplers (see Section 3.4.1), to track freights, samples movements and pending analysis. A range of developments continue including developing clear protocols on the way specimens are stored and related information in the database, the physical size of a specimen on arrival (e.g. volume or mass for a muscle sample) and changes to the sample size as a result of any use through approved access to the TTB.

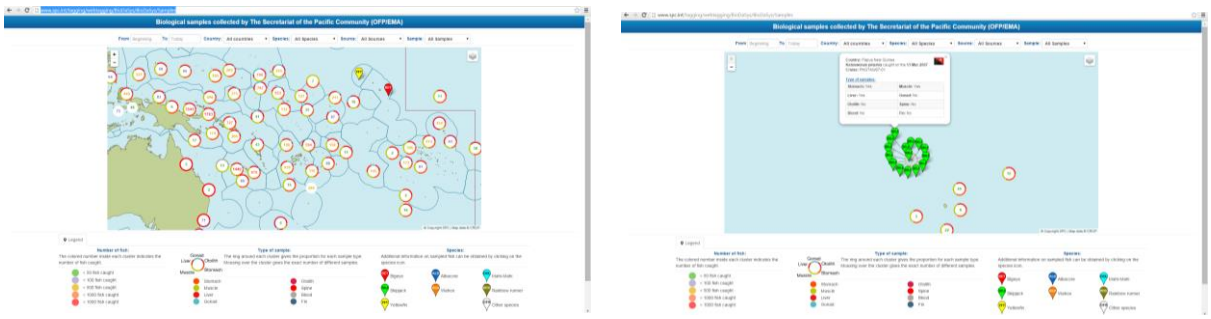


Figure 5. Web query tool for the WCPFC Tuna Tissue Bank.

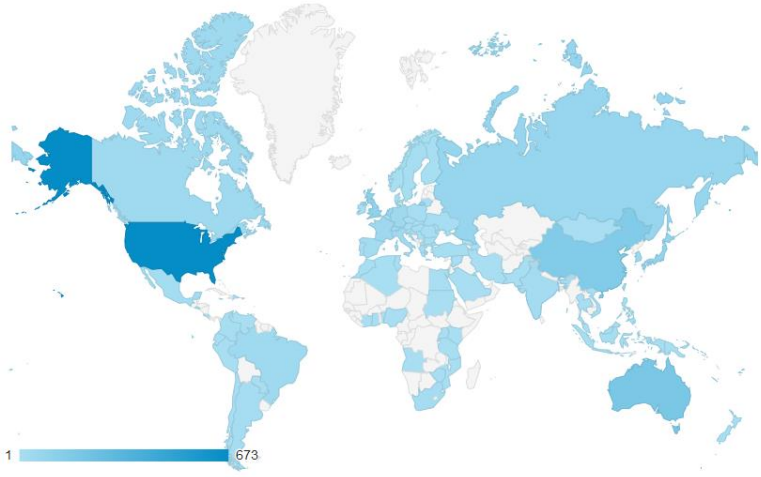


Figure 6. Global distribution of BioDaSys web tool unique users by country (noting that for 27% of users, no country of origin is available).

At present the more detailed information – as is generally needed to design research studies – is not available without an approved login. At present there is no official process for obtaining an approved login. Accordingly, SPC needs to prepare a data extract subject to the WCPFC data access rules and provide that extract to potential researchers. To facilitate better use of the TTB and the BioDaSys web-tool it is proposed that those researchers wishing to access more detailed information be able to apply for a login directly from the Scientific Services Provider (noting that a web-based registration process with authentication would likely be most efficient). Only those data fields necessary to design research would be accessible to authenticated users. Any specific request for samples would still require approval via the access protocol (see Section 3.5.3).

3.5 TUNA TISSUE BANK ACCESS

3.5.1 Access Protocols

Making samples available to third party organisations for analyses maybe an option that the Scientific Committee pursues to fast track certain analyses. A protocol for accessing the TTB for subsequent laboratory and data analyses by third party organisations was adopted by the WCPFC-SC in 2015 (Anon 2015a). Procedures for granting access to the WCPFC tuna tissue bank by third parties were refined based on Smith et al. (2016) in at SC12 (Anon., 2017) and were subsequently endorsed by the Commission (Anon., 2017b). They are also available for researchers and interested parties online on BioDaSys at: http://www.spc.int/ofp/PacificSpecimenBank/Home/About.

3.5.2 Access in 2016-17

Apart from pre-approved WCPFC projects (e.g. CSIRO work on bigeye tuna under Project 35, ongoing work by the Scientific Services Provider), there has been one new request to withdraw samples from the TTB in 2016-17 (Evans et al., 2017). That request was sent to the WCPFC Research Sub-Committee for approval, with the proposal subsequently approved and sample extraction about to begin. Table 5 outlines the projects that have previously and/or are currently accessing the TTB for WCPFC work, including the three recent requests.

Table 5. Projects that have previously or currently access the WCPFC Tuna Bank (<u>new for 2016-17</u>).

Project Description	Samples Used	Technique	Organisation	WCPFC-SC Project No
Age and Growth				
Bigeye Growth Curves	Otolith	Ageing	SPC CSIRO Sun Yat-Sen University	35
Albacore Growth Curves	Otolith	Ageing	SPC CSIRO	39
Swordfish Growth Curves	Otolith/Spines	Ageing	CSIRO	71
Reproductive Biology				
Bigeye Maturity Ogives	Gonads	Histology	SPC CSIRO	35
Albacore Maturity Ogives	Gonads	Histology	SPC CSIRO	39
Albacore Reproductive Biology	Gonads	Histology	SPC CSIRO	39
Trophic dynamics				
Ecosystem Effects of Fishing	Stomach Muscle Survey	Diet Analyses DNA metabarcoding Taxonomy Fatty Acid	SPC University Canberra Curtin University CSIRO	37, 46
FAD impacts on trophic dynamics	Muscle Liver	Isotope	SPC University Southampton	37
Ecosystem and species Biogeography	Stomach	Diet Analyses	SPC University of Tokyo	TBP
PNG Long-term Climate Monitoring	Stomach e-DNA	Diet Analyses DNA metabarcoding	SPC University Canberra Curtin University	TBP
SEAPODYM	Stomach e-DNA	Diet Analyses DNA metabarcoding	SPC University Canberra Curtin University	62
Global scale analysis of tropical food web dynamics to understand climate impact on top predators (swordfish, four main tunas)	Muscle	Stable isotope analyses, fatty acid analyses	IRD SPC CSIRO	62
Movement				
South Pacific Albacore	Otolith	Trace Element	SPC	38
Spatial Variations in concentrations of metal contaminants in food webs of SPO	Muscle Blood	Isotopes & Mercury	IRD/SPC	TBP
Stock Provenance				
Indonesia-west Pacific tropical tuna stock structure	Fin	DNA - Microsatellite	CSIRO	TBP
Global tropical tuna stock structure	Fin	DNA – NGS	University Bologna	TBP
Albacore	Muscle	DNA - mitochondrial	AZTI	TBP
Black marlin	Muscle, liver	DNA - SNP	University of Queensland	TBP
WCPO tuna stock structure and movement for albacore, skipjack, yellowfin and bigeye	Muscle	DNA - SNP	University of the South Pacific	TBP
<u>WCPO tuna stock structure</u>	**<u>Muscle</u>**	**<u>DNA - SNP</u>**	**<u>CSIRO</u>**	**<u>TBP</u>**
Food Safety				
Spatial Variations in concentrations of metal contaminants in food webs of the South Pacific Ocean	Muscle Blood	Mercury Accumulation	IRD/SPC	TBP
Marine plastic pollution and seafood safety	Stomach	Composition	CSIRO	TBP

*TBP = To Be Provided

3.5.3 Papers and reports based on the Tuna Tissue Bank published in 2016-2017

The three researchers withdrawing specimens from the TTB in 2015-16 have provided annual progress reports to the WCPFC Secretariat. Two papers have been submitted to the scientific committee of the WCPFC to report the results on the age, growth and maturity of the bigeye tuna in the WCPO (Farley et al., 2017; McKechnie et al., 2017).

Two global studies were published in the scientific literature using data from stomach examination:

Olson, R.J., Young, J.W., Ménard, F., Potier, M., Allain, V., Goñi, N., Logan, J.M., Galván-Magaña, F., 2016. Bioenergetics, Trophic Ecology, and Niche Separation of Tunas. In: B.E. Curry (Ed.), Advances in Marine Biology. Academic Press, Vol.74, Chap.4: 199–344.

Duffy, L.M., Kuhnert, P., Pethybridge, H.R., Young, J.W., Olson, R.J., Logan, J.M., Goñi, N., Romanov, E., Allain, V., Staudinger, M., Abecassis, M., Choy, C.A., Hobday, A.J., Simier, M., Galván-Magaña, F., Potier, M., Ménard, F., 2017. Global trophic ecology of yellowfin, bigeye, and albacore tunas: understanding predation on micronekton communities at ocean-basin scales. Deep Sea Research Part II: Topical Studies in Oceanography 140, 55-73. doi:10.1016/j.dsr2.2017.03.003

One WCPO study was published in the scientific literature based on the analysis of stable isotope from muscle samples:

Houssard, P., Lorrain, A., Tremblay-Boyer, L., Allain, V., Graham, B.S., Menkes, C.E., Pethybridge, H., Couturier, L.I.E., Point, D., Leroy, B., Receveur, A., Hunt, B.P.V., Vourey, E., Bonnet, S., Rodier, M., Raimbault, P., Feunteun, E., Kuhnert, P.M., Munaron, J.-M., Lebreton, B., Otake, T., Letourneur, Y., 2017. Trophic position increases with thermocline depth in yellowfin and bigeye tuna across the Western and Central Pacific Ocean. Progress in Oceanography. 154, 49–63. doi:10.1016/j.pocean.2017.04.008.

3.6 WORK TO MAINTAIN AND ENHANCE THE TUNA TISSUE BANK

This report as a whole identifies the maintenance of the WCPFC Tuna Tissue Bank in 2016-17, and identifies a range of enhancements (e.g. observer training in Section 3.2, storage in Section 3.3 and data curation in Section 3.4).

3.6.1 Additional Enhancements in 2016-17

Modern genetic research using single nucleotide polymorphism (SNP) approaches requires high quality tissue samples. One issue identified as a possible risk for WCPFC Tunas Tissue Bank specimens is that cross-contamination between species/within species may occur because of the way tuna are processed on longline vessels in particular. The other key issue raised is whether the cold chain is sufficiently well maintained to ensure samples provide sufficient genetic information for high quality results. To assess these issues for the WCPFC Tuna Tissue Bank SPC and CSIRO undertook a small collaborative study during 2016-17. A small set of samples of tuna tissue (n = 20) was withdrawn from the WCPFC Tuna Tissue Bank and assessed for quality in SNP analyses. One of the samples was deliberately selected on the basis that the cold chain had been interrupted. CSIRO ran the samples with a batch of other material and reported that all but one had passed the required quality standards (K. Evans, CSIRO, Australia, pers. com.). The outlier was the sample with a compromised cold chain. This small test provides considerable assurance of the quality of samples collected by observers and their utility in modern DNA-SNP analyses.

It further suggests that no specific changes are required to the current sampling protocols, but highlights the need for continued vigilance in maintenance of the sample cold chain.

3.6.2 Future Maintenance and Enhancements

This project is intended to be ongoing. Given the success of the TTB to date, consideration should be given to incorporating the budget into the 2019-20 indicative budgets. The following additional work arises from this report on the TTB in 2016-17. Note that most should be completed within the existing proposed budget. Where additional resources would be required, they are identified.

In addition to maintaining and operating the TTB, in 2016-17 proposed enhancement work includes:

a. Further investment in training standards and in observer and observer trainer training to enhance biological sampling as an ROP observer core duty ensuring that the repository continues to develop – note that this requires support from the TTC, but does not require additional resourcing at this time;
b. Developing approaches to better ensuring marlin are correctly identified at time of sample collection, including better species identification guides and ensuring those working at sea and in port have species identification guides available;
c. Further development of protocols for standard TTB extraction approaches and having such protocols stored on BioDaSys (e.g. for otoliths for sectioning);
d. Development of protocols for managing the longevity of specimens in the bank;
e. Enhancing access to meta-data to plan research proposals is identified and discussed in Section 3.2.7. The list of sample features and data fields to be released need to be agreed. It is noted that with respect to the location of the samples (which are linked to fishing operations in the case of observer sampling), latitude and longitude are critical for scientific research, but also potentially sensitive. It is recommended that sample locations be released at 1 degree resolution for research design purposes. A multi-level login is proposed, with regular authorised users in one category, authorised users for a specific individual project (time-bound) and general access. The information available at each level would be based on need; and
f. Designing and seeking funding for strategic investment in a super-cold storage facility, required to ensure the longevity and relevance of the WCPFC Tuna Tissue Bank (see Smith et al., 2017), noting that the cost of the design work has been met by New Zealand.

4. RECOMENDATIONS

The following recommendations arise from this report on the TTB in 2016-17. Note that most should be completed within the existing proposed budget. Where additional resources would be required, they are identified:

- Regular age and growth analyses of specimens for all tuna and tuna-like stocks for future stock assessments should be budgeted for and aligned with the stock assessment schedule (additional resources required), with yellowfin tuna the next priority species;
- As the WCPFC Tuna Tissue bank is intended to be ongoing, and given its success and measured quality to date, incorporate the identified budget into the 2019-20 indicative budgets;
- SC participants should visit http://www.spc.int/ofp/PacificSpecimenBank and provide feedback inter-sessionally to SPC;
- In addition to maintaining and operating the WCPFC Tuna Tissue Bank in 2017-18, the work plan in Section 3.6.2 a.-d. should be pursued by the Scientific Services Provider;
- Support the recommendation to develop a multi-level login to BioDaSys, especially for those planning research as identified in 3.6.2 e.; and,
- To ensure the longevity and relevance of the WCPFC Tuna Tissue Bank support the initiative identified in Smith et al. (2017).

5. ACKNOWLEDGEMENTS

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APPENDIX I

Biological Sampling Competency Standard

Excerpt from Pacific Community. 2016. PIRFO TRAINING FRAMEWORK 2016 for FFA/SPC. Prepared by Grant Carnie. December 2016 Version 2. 140 pp.

PIROBS3.06E – Carry out biological sampling of catch

Functional area	**Observer and port sampling operations**
Prerequisites	**PIRFO Observer, Port Sampler or Fisheries Officer**

Descriptor

This unit covers the performance outcomes, skills and knowledge necessary for a person to identify anatomical parts of a fish, carry out biological sampling of catch, store and record collected samples, deploy tags and record and report relevant details of a tagged species.

Elements	Performance criteria
1. Demonstrate knowledge of catch sampling and tagging programmes	1.1 Understand the importance of biological sampling of catch, the types and use of information collected in catch sampling programmes and the role of a sampler in collecting samples 1.5 Understand the importance of regional tagging programmes, the ways that information from tagging is used and the recording and reporting information from tags 1.6 Understand the purpose and protocols of tag seeding
2. Identify key internal organs and fish body part commonly collected in sampling programs	2.4 Locate and identify the main internal organs and hard parts in selected species 2.5 Determine the sex of selected species using established sex identification methods
3. Collect biological samples from selected species	3.1 Use the correct tools to remove biological samples 3.2 Dissect selected species and remove organs and hard parts using techniques in accordance with pre-determined biological sampling protocols 3.3 Label collected samples, store and record in accordance with specified procedures
4. Deploy tags in selected species	4.1 Insert tags in accordance with specified protocols 4.2 Record, track and report the deployment of tags in accordance with specified protocols
5. Record and report the landing of a tagged species	5.1 Identify tagged species from landed catch and follow specified procedures to collect relevant information 5.2 Record and report relevant information pertaining to the tagged species in accordance with specified protocols

Evidence guide

Each unit of competency has an evidence guide that relates directly to the performance criteria. Its purpose is to guide assessment of the unit in the workplace and/or training program. The following components provide information to assist this purpose.

Required knowledge

The essential knowledge and understanding a person needs to perform work to the required standard include:

- Sampling and tagging programmes in the Western & Central Pacific Ocean fisheries
- Use and importance of information collected from sampling and tagging programmes
- Key internal organs and hard parts collected for sampling programmes
- Procedures for deploying tags in selected species
- Procedures for collecting, storing, recording and reporting biological samples and tagged species

Required skills

The essential skills a person needs to perform work to the required standard include:

- Locating and identifying the main internal organs and hard parts collected for biological sampling programmes
- Dissecting selected species and removing selected biological samples safely and correctly
- Deploying tags in selected species in accordance with agreed protocols
- Recording data, labelling and storing biological samples in accordance with agreed protocols
- Recording and reporting correctly the deployment and the landing of tagged species

Literacy skills used for:

- Interpreting information relating to sampling and tagging programmes in accordance with agreed protocols
- Collecting data and information
- Completion forms correctly

Numeracy skills used for:

- Recording data

Critical aspects of competence

Assessment must confirm the ability to:

- Identify the sex of a selected species
- Dissect the selected species, identify and remove key organs and label and store correctly
- Record information required for a biological sampling and tagging programme
- Record and report information gathered from selected species

Assessment must confirm knowledge of:

- Major sampling and tagging programmes in the Western & Central Pacific Ocean fisheries
- Procedures for collecting, storing, recording and reporting biological samples from selected species