SCIENTIFIC COMMITTEE
15TH REGULAR SESSION

Pohnpei, Federated States of Micronesia

12-20 August 2019

Project 42: Pacific Tuna Tagging Project Report and Work-plan for 2019-2022

WCPFC-SC15-2019/RP-PTTP-02

SPC-OFP

1 INTRODUCTION

This Pacific Tuna Tagging Programme (PTTP) report provides background on the PTTP to date, and covers the tagging activities undertaken in 2018-19 under the banner of the PTTP including research voyages, tag recoveries, tag recovery and seeding activities, and tagging related analyses. Issues arising in 2019 for PTTP Steering Committee consideration are highlighted. The PTTP work planned for 2019-2022 is outlined and an agenda for the 2019 meeting of the PTTP steering committee is provided in Appendix A.

1.1 Programme objectives

The PTTP is a joint research project, implemented by the Oceanic Fisheries Programme (OFP) of the Pacific Community (SPC). The goal of the Pacific Tuna Tagging Programme is to improve stock assessment and management of skipjack, yellowfin and bigeye tuna in the Pacific Ocean. The objectives of the PTTP, originally specified in WCPFC-SC6-2010/GN-IP-04, and revised in 2016 (PTTP Steering Committee, 2016), are:

1. To obtain data that will contribute to, and reduce uncertainty in, WCPO tuna stock assessments including estimation of overall and local exploitation rates, extent of mixing and appropriate spatial strata for use in assessments.

2. To obtain information to better understand the interactions between tropical tuna species and major fishing gears to support development of mitigation measures (where appropriate) and better interpret fisheries data (e.g., CPUE).

Under these objectives, information collected includes age-specific rates of movement and mixing, movement between this region and other adjacent regions of the Pacific basin, species-specific vertical habitat utilisation by tunas, and the impacts of FADs on behaviour.

1.2 Programme funding

Since its commencement in 2006, funding support for the PTTP has been provided by the PNG National Fisheries Authority, New Zealand Aid Agency, the Government of the Republic of Korea, Australian Centre for International Agricultural Research, European Community 8th European Development Fund, European Community 9th European Development Fund, European Community 10th European Development Fund, the French Pacific Fund, the Government of Taiwan, Heinz Australia, the Global Environment Facility, the International Seafood Sustainability Foundation, the European Union through voluntary contributions to WCPFC, and the WCPFC itself.

In 2011, SPC and the PNG National Fisheries Authority (NFA) began a three-year tag release programme in the PNG EEZ, funded by NFA. This project, referred to here as the PNG Tagging Project (PNGTP) is considered under the umbrella of the PTTP and where relevant is reported on in this annual Project 42 report.

In 2016 the PTTP steering committee recommended that SC normalise the tagging programme as part of the ongoing work of the SC (WCPFC-SC 2016). Ideally this would include research voyages every year alternating between skipjack via pole and line in one year and bigeye via handline and dangler fishing in the next, starting with skipjack in 2017 (noting that yellowfin would be adequately covered by both surveys). In 2018 SC endorsed the PTTP work-plan for 2018-2021 included a revised budget and reiterated its support for the ongoing tagging programme as part of the high priority work of the SC (WCPFC-SC, 2018). In 2018 at WCPFC15, the Commission agreed to the recommendation, allocating additional funds for 2019 and indicated funding for 2020-21 to continue this work (WCPFC, 2019).

1.3 Operational structure

The overall operational structure of the PTTP to date is given in Table 1, with the work completed since the last PTTP reported highlighted and the scheduled work for 2019 also shown. The spatial distribution of these research voyages in the Western and Central Pacific Ocean is shown in Figure 1.

Table 1: Period, area and vessel used in PTTP tagging research voyages since the inception of the programme. Work completed since the last PTTP report to SC14 in 2018 in bold and the scheduled work for 2019 shown in *italics*.

	Time period	Operational area	Tagging vessel
Phase 1	Aug – Nov 2006	PNG	*Soltai 6*
	Feb – May 2007	PNG	*Soltai 6*
	Oct – Nov 2007	Solomon Islands	*Soltai 6*
	Feb – Mar 2008	Solomon Islands	*Soltai 6*
	Apr 2008	Solomon Islands	*Soltai 105*
Phase 2 (to date)	May – Jun 2008	Central Pacific (CP1)	*Double D*
	Jun – Nov 2008	Western Pacific (WP1)	*Soltai 105*
	Mar – Jun 2009	Western Pacific (WP2)	*Soltai 105*
	May – Jun 2009	Central Pacific (CP2)	*Double D*
	Jul – Oct 2009	Western Pacific (WP3)	*Soltai 105*
	Oct – Nov 2009	Central Pacific (CP3)	*Aoshibi Go*
	May – Jun 2010	Central Pacific (CP4)	*Aoshibi Go*
	Oct – Nov 2010	Central Pacific (CP5)	*Pacific Sunrise*
	Oct 2011	Central Pacific (CP6)	*Pacific Sunrise*
	Nov – Dec 2011	Central Pacific (CP7)	*Aoshibi Go*
	Sep – Oct 2012	Central Pacific (CP8)	*Pacific Sunrise*
	Nov – Dec 2013	Central Pacific (CP9)	*Pacific Sunrise*
	Aug 2014	Central Pacific (CP10)	*Pacific Sunrise*
	Sep - Nov 2015	Central Pacific (CP11)	*Gutsy Lady4*
	Sep-Oct 2016	Central Pacific (CP12)	*Gutsy Lady4*
	Sep-Oct 2017	Western Pacific (WP4)	*Soltai 105*
	Jul-Aug 2018	**Central Pacific (CP13)**	***Gutsy Lady4***
	Jul-Sep 2019	*Western Pacific (WP5)*	*Soltai 105*
PNGTP	Apr – Jul 2011	PNG (PNGTP1)	*Soltai 105*
	Jan – Mar 2012	PNG (PNGTP2)	*Soltai 105*
	Aug 2012	PNG (TAO trial)	*FTV Pokajam*
	Apr – Jun 2013	PNG (PNGTP3)	*Soltai 101*
	July 2016	PNG (TAO trial)	*FTV Pokajam*

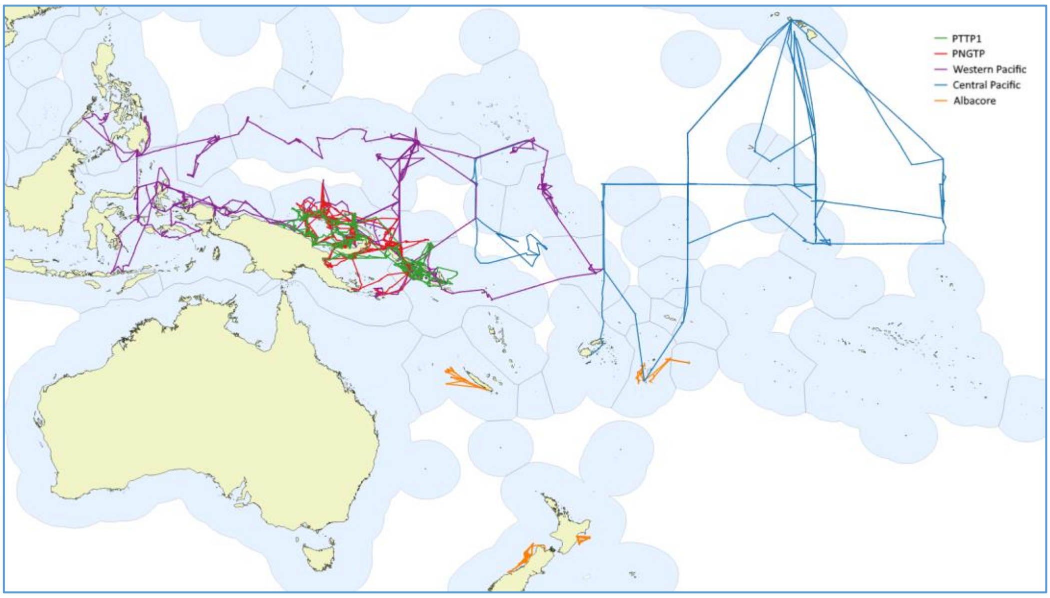

Figure 1: Tagging vessel tracks for all voyages for all PTTP research voyages up until CP13 (see Figure 2). Legend relates to the operational areas described in Table 1.

2 SUMMARY OF PTTP ACTIVITIES IN 2018-2019

Since SC14, PTTP activities have included one Central Pacific voyage, CP13, in the waters of Marshall Islands, FSM, Nauru, Tuvalu and the nearby International Waters, continued implementation and refinement of tag recovery processes and tag seeding, data preparation for use in the 2019 stock assessment for skipjack tuna, and analysis of electronic tagging data for an EU funded WCPFC project (Scutt Phillips et al. 2019, SC15-EB-WP-08). Research voyage WP5 preparations began in late 2018 and the vessel departed Noro, Solomon Islands, 22nd July 2019.

2.1 Central Pacific 13 tagging voyage

Following the CP12 experiment, CP13 was designed to augment data collection for studies on tuna movements, exploitation rates and FAD association dynamics. In an attempt to cover the gap in bigeye tuna tagging data from the west part of the WCPO (west of the 180 meridian), the study area was selected to cover the 165E and 180 TAO mooring lines and the nearby waters. To achieve this work, SPC chartered the Hawaii-based FV Gutsy Lady 4. The research voyage started from Majuro on the 16th of July for a total duration of 39 days (see voyage track in Figure 2). The European Union and the WCPFC jointly funded the cruise. Tri Marine also supported the cruise by providing positions of drifting FADs in the neighbourhood of the cruise. IRD/Marbec research unit and ISSF also contributed to the cruise in providing scientific personnel.
In addition to routine archival and conventional tag release activities, acoustic tagging experiments were also undertaken during the CP13 cruise as part of an EU-funded project on juvenile bigeye and yellowfin tuna bycatch mitigation. Eight drifting FADs were equipped with VR4 Global (Vemco, Amirix, Canada) satellite linked acoustic receivers (see Figure 2). Pressure sensitive acoustic tags (V13P) were implanted in the three major tuna species with a priority for bigeye. The aim of the experiment was to:

1. Collect simultaneous vertical behavior of tuna at dFADs in order to provide information for mitigating bycatch of juvenile bigeye and yellowfin tuna by WCPO purse seine fisheries.
2. Improve the interpretation of the echo sounder buoy data.
3. Collect data on the associative behavior of tuna at dFADs to estimate residency at FADs, and determine species-specific vulnerability while fish are associated.

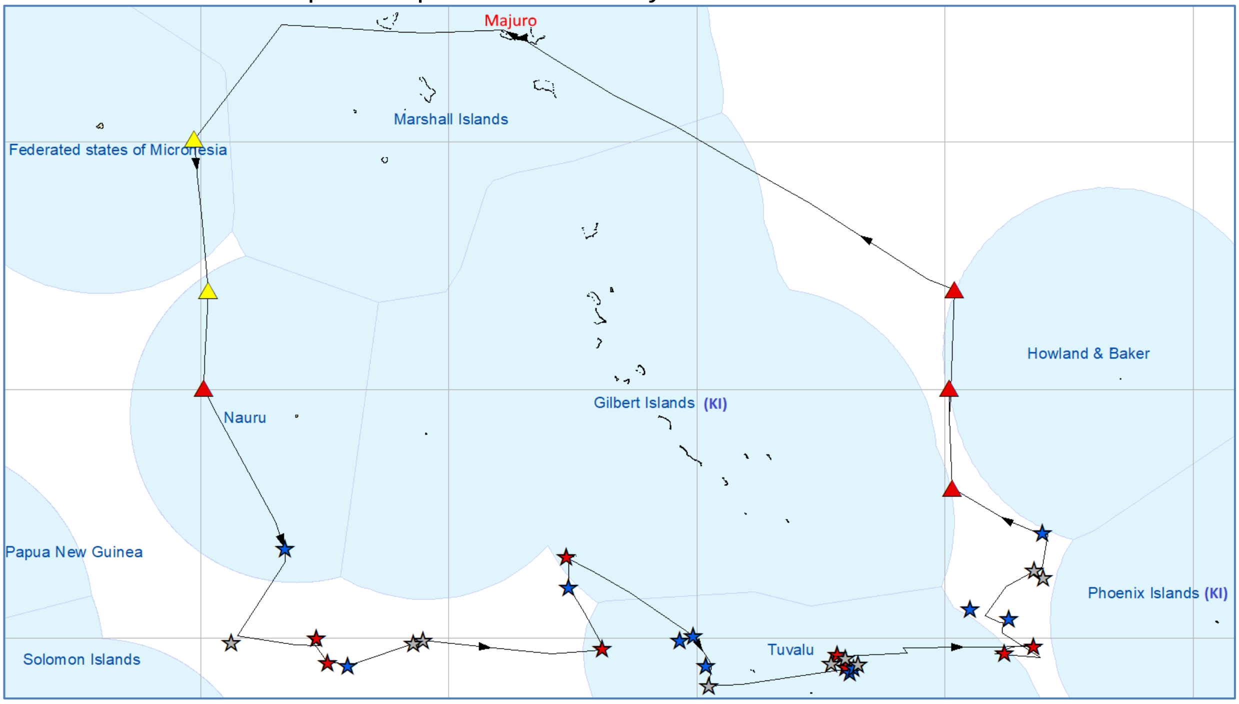

Figure 2: Voyage tracks during CP13. Red stars are dFADs equipped with a VR4 acoustic receiver. Blue stars are dFAD were some fish were tagged with archival and/or conventional tags. Grey stars are dFADs visited, but with no tagging events. Yellow triangles are the visited TAO buoys along the 165E line (The TAO buoys where fish were tagged are in red).

2.1.1 CP13 tag releases

Of the 39 days of charter during CP13, 11 days were spent steaming and/or checking buoys with no fish, and part or all of 28 days were spent fishing and tagging. The 5N, 2N and Equatorial TAOs on the 165E line (2S had gone adrift) were visited along with the 2S, Equatorial and 2N TAOs on the 180 meridian. In addition to the TAOs, 28 drifting FADs were visited (Figure 2), and most fishing occurred in International and Tuvalu waters. A smaller number of fish were also tagged and released in Nauru and Kiribati waters (spatial distribution of tag releases is given in Figure 3). Table 2 summarizes the number of fish tagged per species and tag type. The length frequency of fish tagged with conventional tags is shown in Figure 4.

Table 2: Numbers of tags deployed by tag type and species

Tag type	FAL	OCS	BET	SKJ	YFT	TOTAL
Archival			53	-	51	104
Archival and sonic tag			11	-	15	26
Acoustic depth tag			97	14	42	153
Yellow conventional			450	65	335	850
MiniPat satellite tag	**9**	**5**			**1**	**15**
Total fish tagged	**9**	**5**	**611**	**79**	**444**	**1148**

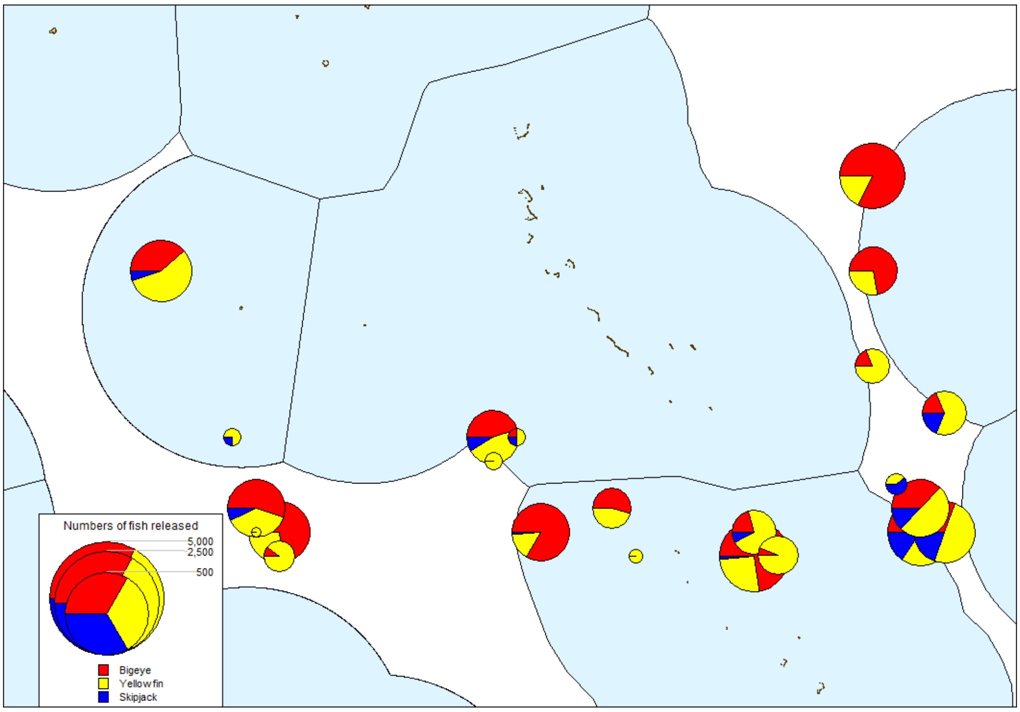

Figure 3. Distribution of tag releases during CP13.

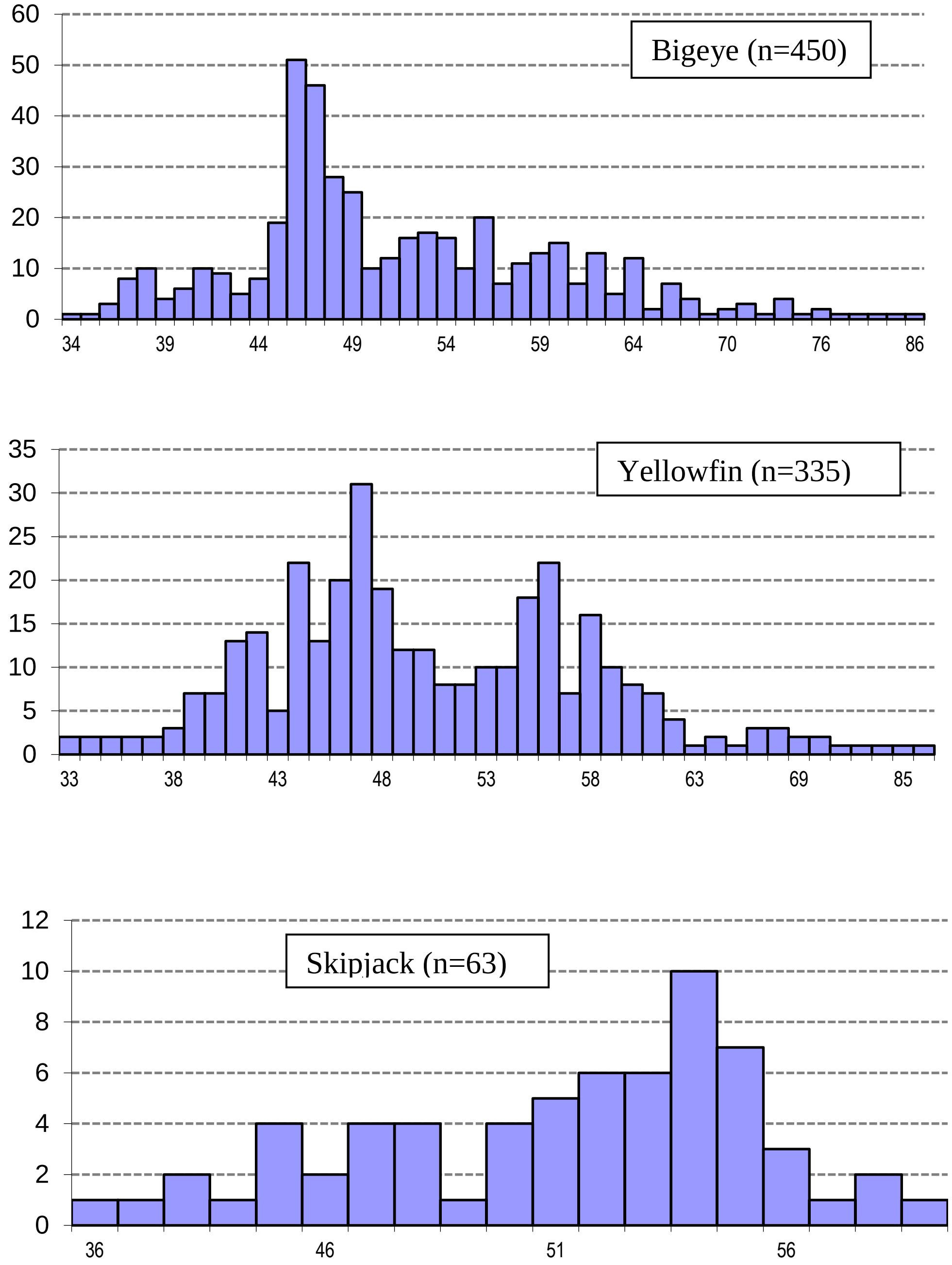

Figure 4: Size distribution (cm) of fish conventionally tagged during CP13

2.1.2 Biological sampling

As part as its planned activities, the CP13 voyage provided a significant number of biological samples (SC15-RP-P35b-01) as identified in Table 3.

Table 3: Number of samples per species and sample type

Species	nb of fish sampled	Muscle	Liver	Stomach	Gonad	Otolith	Spine	Blood
BET	79	79	61	61	59	61	61	35
BUM	8	8	8	8	5	0	0	0
DOL	14	14	14	14	0	0	0	0
RRU	16	16	16	16	1	1	1	0
SKJ	22	22	22	22	22	21	22	0
SSP	1	1	1	1	0	0	0	0
WAH	5	5	5	5	0	4	0	0
YFT	78	78	78	77	77	78	77	27
Total	**223**	**223**	**205**	**204**	**164**	**165**	**161**	**63**

2.1.3 CP13 implementation

The CP13 cruise was a challenging cruise to organize and implement. The number of electronic tags to deploy on fish associated with drifting FADs was exceeded by 30% compared to the cruise in the same area in 2016 (CP12). Coordination between all the actors involved to operate the research in a narrow time-frame during the FAD closure period was crucial. Having full access to a large quantity of purse seine industry drifting FADs was also a key component of the success of such experiment. Adequate jigging rod and reel combinations manned by skilled fishermen provided sufficient amounts of suitable fish for archival/sonic tag deployment. However, the capture and tagging of a large number of tuna with conventional tags using dangler fishing gear was not possible. This may have been due to unusually low quantities of bigeye tuna being associated with the dFADs investigated during the cruise, a relatively deep thermocline, or a combination of both.

3 PTTP RESULTS

The Pacific areas covered by the different tagging voyages implemented since 2006 are shown in Figure 1. Although there are noticeable gaps in coverage in the extreme east and west of the area, and in the southern latitudes, these are a direct result of the PTTP focus on the tropical tunas, and undertaking research voyages in areas and with methods permitting appropriate catch rates for these research purposes.

The release numbers and recovery percentages to date of conventional and archival tags made during the 13 Central Pacific (CP) voyages, the PNGTP, and Phase 1 and 2 of the PTTP are detailed in Table 4.

Table 4: CP, PNGTP and total PTTP tag release numbers, and % of recoveries to date (July 2019) of conventional and archival tags.

		Release numbers				Recapture rate (%)			
Project	**Tag Type**	**SKJ**	**YFT**	**BET**	**Total**	**SKJ**	**YFT**	**BET**	**Total**
CP	Archival	32	323	808	**1,163**	0	6.2	18.8	**14.8**
	Conventional	841	2,913	39,086	**42,840**	4.2	12.7	28.5	**26.9**
PNGTP	Archival	0	68	12	**80**	NA	27.9	58.3	**32.5**
	Conventional	80,444	27,065	2,915	**110,424**	20.3	18.6	21.3	**19.9**
Total PTTP	Archival	129	738	996	**1,863**	3.1	11	18.8	**14.6**
	Conventional	272,511	109,551	48,438	**430,500**	17.6	16.7	27	**18.4**

3.1 Biological sampling during tagging voyages

A total of 6478 stomach samples have been collected since the beginning of the PTTP, mainly from skipjack, yellowfin, bigeye and albacore tuna (Table 5).

Table 5: Total number of stomach samples collected and analysed to 30 June 2019.

PREDATOR SPECIES		COLLECTED	ANALYSED	% ANALYSED
ALB	ALBACORE	245	245	100%
YTL	AMBERJACK (LONGFIN YELLOWTAIL)	1	1	100%
BET	BIGEYE	538	428	80%
BUM	BLUE MARLIN	16	3	19%
FRI	FRIGATE TUNA	99	95	96%
NXI	GIANT TREVALLY	1	1	100%
KAW	KAWAKAWA	124	118	95%
MSD	MACKEREL SCAD / SABA	5	5	100%
DOL	MAHI MAHI / DOLPHINFISH / DORADO	101	45	45%
CNT	OCEAN TRIGGERFISH (SPOTTED)	1	0	0%
PLS	PELAGIC STING-RAY	1	1	100%
BRZ	POMFRETS AND OCEAN BREAMS	3	3	100%
CFW	POMPANO DOLPHINFISH	2	2	100%
RRU	RAINBOW RUNNER	162	112	69%
FAL	SILKY SHARK	4	4	100%
SKJ	SKIPJACK	2854	2474	87%
SWO	SWORDFISH	6	6	100%
WAH	WAHOO	21	6	29%
YFT	YELLOWFIN	2294	2017	88%
	TOTAL	6478	5566	86%

3.1.1 Tuna stomach contents

The examination of the stomachs is an ongoing process and is conducted in the laboratory at SPC, Noumea. A total of 5,566 stomachs, representing 86% of the samples collected, have been examined and the corresponding data entered into a dedicated database, BioDaSys (Table 5).

3.1.3 WCPFC Tuna Tissue Bank contribution

Additionally, the tagging research voyages provide a large volume of biological samples for the WCPFC Tuna Tissue Bank (total of 22,750 samples to date). A total of 8,076 fish have been sampled from which 7,868 samples have been analysed to date. For the WCPFC Tuna Tissue Bank as a whole, these tagging research voyage samples represent 25.7% of the total fish sampled, 25.7 % of the total samples collected, and 32 % of the analyses processed from the tissue bank (Table 6). In general, tagging research voyages continue to provide a key contribution to the WCPFC Tuna Tissue Bank and considerably add to the value of the cruises (SPC-OFP, 2017)

Table 6: Total number of samples collected from research tagging voyages and analysed to June 2019.

Predator species		Nb fish sampled	Total samples	Blood	Gonad	Liver	Muscle	Otolith	Spine	Stomach	Nb sample analysed	% analysed
ALB	ALBACORE	404	1514		269	276	277	259	188	245	874	57.7 %
YTL	AMBERJACK (LONGFIN YELLOWTAIL)	1	3			1	1			1	1	33.3 %
BET	BIGEYE	639	2480	63	250	536	589	342	162	538	802	38.8 %
BUM	BLUE MARLIN	21	80	5	13	20	21		5	16	3	5.45 %
BSH	BLUE SHARK	1	1				1				1	100 %
FRI	FRIGATE TUNA	99	308		4	99	99	3	4	99	96	31.1 %
NXI	GIANT TREVALLY	1	1							1	1	100 %
KAW	KAWAKAWA	124	316			96	96			124	118	37.3 %
MSD	MACKEREL SCAD / SABA	5	15			5	5			5	5	33.3 %
DOL	MAHI MAHI / DOLPHINFISH	102	315		31	87	88	7	1	101	46	16.8 %
CNT	OCEAN TRIGGERFISH (SPOTTED)	1	5		1	1	1	1		1	0	0 %
PLS	PELAGIC STING-RAY	1	3			1	1			1	1	33.3 %
BRZ	POMFRETS AND OCEAN BREAMS	1	3							3	3	100 %
CFW	POMPANO DOLPHINFISH	1	4			1	1			2	2	50 %
RRU	RAINBOW RUNNER	163	506		21	156	156	10	1	162	112	24.7 %
SSP	SHORT-BILLED SPEARFISH	1	3			1	1			1	0	0 %
FAL	SILKY SHARK	1	12			4	4			4	4	33.3 %
SKJ	SKIPJACK	3667	9358		306	2795	2886	305	221	2845	3064	33.1 %
SWO	SWORDFISH	6	15		1	4	4			6	10	66.6 %
WAH	WAHOO	21	71		6	20	20	4		21	6	11.5 %
YFT	YELLOWFIN	2816	7737	41	352	2210	2246	345	249	2294	2719	37.4 %
	Total	**8076**	**22750**	**109**	**1254**	**6313**	**6497**	**1276**	**831**	**6470**	**7868**	**36.4 %**

3.2 Conventional and archival tag recoveries for the PTTP

As at 21 June 2019, a total of 79,625 tagged tuna had been recaptured and the data reported to SPC. The numbers of conventional tag recoveries by species and by main tagging voyage are given in Table 9. Tag attrition follows the expected declining pattern (Figure 5) with the rate of decline in skipjack tag returns indicating their shorter expected lifespan and higher natural mortality compared to yellowfin and bigeye tuna. The recovery rates of yellowfin and bigeye tagged with archival tags and conventional tags vary depending on voyage (Table 8), with some suggestion of increased tag rejection/fish mortality for archival-tagged fish on some voyages.

There is a notable reduction in bigeye conventional tag recovery rate from CP9 onwards. These changes from ~30+% up to voyage CP8, fall to 14% for CP9, between 3 to 16% for CP10 to CP12, and currently only 2.1% for last year's CP13 cruise as shown in Table 7.

For CP10 to CP13 there are significant changes in the distribution of tag releases and subsequent fishing activity which may explain the differences in recapture rates. During these voyages, release methods changed with 45 to 95% of releases made on dFADs, as opposed to 100% at TAO buoys, as in previous voyages. This has also changed the species composition of tag releases, with less bigeye being tagged on dFADs compared to tagging on TAO buoys. It may be that fish have more time and a greater propensity to disperse from dFADs before fishing recommenced following the FAD closure period, thus reducing the tag recapture rate.

Delays in obtaining recovery information from WP4 tags, reported as recovered but not returned to SPC, have caused significant issues incorporating tagging data into the current stock assessment for WCPO skipjack (SC15-SA-WP-05). While some delays are inevitable, it highlights the importance of an efficient tag recovery system that promptly reports tags for timely inclusion in stock assessments and other analyses.

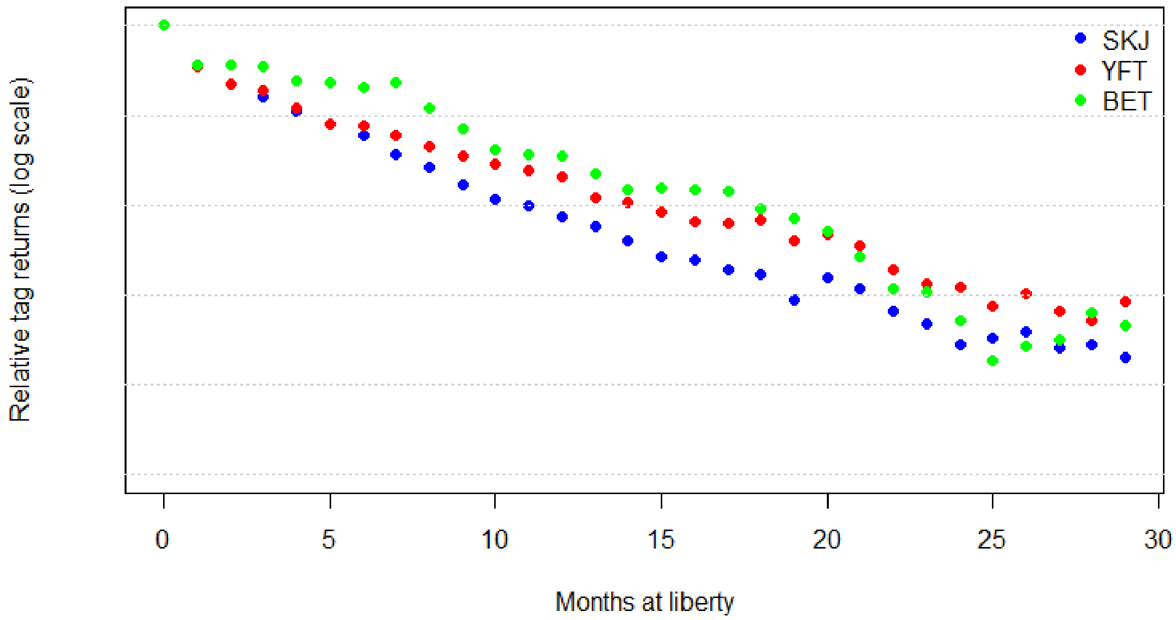

Figure 5: Tag recoveries by time at liberty for skipjack, yellowfin and bigeye tuna. Note that the values on the y-axis are uninformative and thus omitted. At the top-left the points (overlaid so as only BET shows) are the (species) specific maximum logarithm of recoveries, standardised so that the attrition curves all start at the same value. The gradient is a proxy for total mortality.

Table 7: Tag releases and recaptures for the PTTP to date (as at 18/07/2019).

	Releases				Recoveries (% recovered)			
Voyages	SKJ	YFT	BET	Total	SKJ	YFT	BET	Total
PG1					2,646	1,806	229	4,681
Aug-Nov 2006	13,948	7,806	562	22,316	(19%)	(23.1%)	(40.7%)	(21%)
PG2					2,509	1,719	8	4,236
Feb-May 2007	26,493	12,845	129	39,467	(9.5%)	(13.4%)	(6.2%)	(10.7%)
SB1					1,976	784	18	2,778
Oct-Nov 2007	7,479	3,565	139	11,183	(26.4%)	(22%)	(12.9%)	(24.8%)
SB2					1,765	2,422	62	4,249
Feb-Apr 2008	15,327	14,405	414	30,146	(11.5%)	(16.8%)	(15%)	(14.1%)
CP1					4	25	575	604
May-Jun 2008	57	116	1,736	1,909	(7%)	(21.6%)	(33.1%)	(31.6%)
WP1					6,378	2,059	362	8,799
Jun-Nov 2008	37,691	17,647	1,467	56,805	(16.9%)	(11.7%)	(24.7%)	(15.5%)
WP2					4,612	2,356	490	7,458
Mar-Jun 2009	34,207	13,919	3,145	51,271	(13.5%)	(16.9%)	(15.6%)	(14.5%)
CP2					5	27	573	605
May-Jun 2009	169	205	2,309	2,683	(3%)	(13.2%)	(24.8%)	(22.5%)
WP3					6,699	1,430	197	8,326
Jul-Oct 2009	30,722	7,340	735	38,797	(21.8%)	(19.5%)	(26.8%)	(21.5%)
CP3					2	64	1,770	1,836
Oct-Nov 2009	66	237	4,802	5,105	(3%)	(27%)	(36.9%)	(36%)
CP4					1	13	514	528
May-Jun 2010	7	120	2,284	2,411	(14.3%)	(10.8%)	(22.5%)	(21.9%)
CP5					7	46	1,963	2,016
Nov-Dec 2010	40	228	6,090	6,358	(17.5%)	(20.2%)	(32.2%)	(31.7%)
PNGTP1					5,772	2,482	60	8,314
Apr-Jul 2011	28,730	11,571	355	40,656	(20.1%)	(21.5%)	(16.9%)	(20.4%)
CP6					0	29	1,036	1,065
Oct-Oct 2011	2	123	3,804	3,929	(0%)	(23.6%)	(27.2%)	(27.1%)
CP7					1	21	1,455	1,477
Nov-Dec 2011	52	245	4,212	4,509	(1.9%)	(8.6%)	(34.5%)	(32.8%)
PNGTP2					7,243	1,703	523	9,469
Jan-Mar 2012	28,312	9,607	2,008	39,927	(25.6%)	(17.7%)	(26%)	(23.7%)
CP8					2	32	2,308	2,342
Sep-Oct 2012	20	140	6,014	6,174	(10%)	(22.9%)	(38.4%)	(37.9%)
PNGTP3					3,309	879	45	4,233
Apr-Jun 2013	23,402	5,955	564	29,921	(14.1%)	(14.8%)	(8%)	(14.1%)
CP9					2	11	624	637
Nov-Dec 2013	29	135	4,296	4,460	(6.9%)	(8.1%)	(14.5%)	(14.3%)
CP10					0	6	4	10
Aug-Aug 2014	12	98	195	305	(0%)	(6.1%)	(2.1%)	(3.3%)
CP11					6	26	197	229
Sep-Nov 2015	231	775	1,966	2,972	(2.6%)	(3.4%)	(10%)	(7.7%)
PG6					0	2	0	2
Jul-Jul 2016	0	17	2	19	(NA%)	(11.8%)	(0%)	(10.5%)
CP12					3	83	248	334
Sep-Oct 2016	109	371	1,575	2,055	(2.8%)	(22.4%)	(15.7%)	(16.3%)
WP4					5,044	329	0	5,373
Sep-Nov 2017	25,456	2,376	20	27,852	(19.8%)	(13.8%)	(0%)	(19.3%)
CP13					2	7	15	24
Jul-Aug 2018	79	443	611	1,133	(2.5%)	(1.6%)	(2.5%)	(2.1%)
					47,988	**18,361**	**13,276**	**79,625**
Totals	**272,640**	**110,289**	**49,434**	**432,363**	**(17.6%)**	**(16.6%)**	**(26.9%)**	**(18.4%)**

Table 8: Comparison of archival and conventional tag recoveries by species and voyage for the PTTP, 2006-2018.

	Archival Recoveries (%) (Number tagged)				Conventional Recoveries (%) (Number tagged)			
Voyages	**SKJ**	**YFT**	**BET**	**Total**	**SKJ**	**YFT**	**BET**	**Total**
PG1	100%	37%	44%	40.3%	19%	23.1%	40.6%	20.9%
Aug-Nov 2006	(1)	(46)	(25)	(72)	(13,947)	(7,760)	(537)	(22,244)
PG2	0%	9.1%	0%	8.1%	9.5%	13.4%	7.5%	10.7%
Feb-May 2007	(1)	(187)	(23)	(211)	(26,492)	(12,658)	(106)	(39,256)
SB1		0%	0%	0%	26.4%	22%	13.6%	24.9%
Oct-Nov 2007		(5)	(7)	(12)	(7,479)	(3,560)	(132)	(11,171)
SB2		22.7%	0%	21.7%	11.5%	16.8%	15%	14.1%
Feb-Apr 2008		(22)	(1)	(23)	(15,327)	(14,383)	(413)	(30,123)
CP1		40%	24.4%	26%	7%	20.7%	33.4%	31.8%
May-Jun 2008		(5)	(45)	(50)	(57)	(111)	(1,691)	(1,859)
WP1		0%	38.9%	28.6%	16.9%	11.7%	24.3%	15.5%
Jun-Nov 2008		(13)	(36)	(49)	(37,691)	(17,634)	(1,431)	(56,756)
WP2	0%	3.6%	3.7%	2.8%	13.5%	17%	15.9%	14.6%
Mar-Jun 2009	(39)	(56)	(81)	(176)	(34,168)	(13,863)	(3,064)	(51,095)
CP2		11.1%	17.3%	16.7%	3%	13.3%	25.1%	22.8%
May-Jun 2009		(9)	(81)	(90)	(169)	(196)	(2,228)	(2,593)
WP3	5.4%	7.7%	0%	5.7%	21.8%	19.5%	26.8%	21.5%
Jul-Oct 2009	(56)	(13)	(1)	(70)	(30,666)	(7,327)	(734)	(38,727)
CP3		21.4%	34.6%	31.9%	3%	27.8%	36.9%	36.1%
Oct-Nov 2009		(28)	(107)	(135)	(66)	(209)	(4,695)	(4,970)
CP4		10%	12.8%	11.9%	14.3%	11%	22.7%	22.2%
May-Jun 2010		(20)	(39)	(59)	(7)	(100)	(2,245)	(2,352)
CP5			22.4%	22.4%	17.5%	20.2%	32.3%	31.8%
Nov-Dec 2010			(58)	(58)	(40)	(228)	(6,032)	(6,300)
PNGTP1		15.8%	0%	13.6%	20.1%	21.5%	17%	20.5%
Apr-Jul 2011		(19)	(3)	(22)	(28,730)	(11,552)	(352)	(40,634)
CP6		50%	15.7%	17%	0%	23.1%	27.4%	27.2%
Oct-Oct 2011		(2)	(51)	(53)	(2)	(121)	(3,753)	(3,876)
CP7	0%	1.2%	16.3%	7.7%	4.5%	12.5%	35%	34%
Nov-Dec 2011	(30)	(85)	(92)	(207)	(22)	(160)	(4,120)	(4,302)
PNGTP2		42.1%	87.5%	55.6%	25.6%	17.7%	25.8%	23.7%
Jan-Mar 2012		(19)	(8)	(27)	(28,312)	(9,588)	(2,000)	(39,900)
CP8			44.4%	44.4%	10%	22.9%	38.4%	37.9%
Sep-Oct 2012			(18)	(18)	(20)	(140)	(5,996)	(6,156)
PNGTP3		26.7%	0%	25.8%	14.1%	14.7%	8%	14.1%
Apr-Jun 2013		(30)	(1)	(31)	(23,402)	(5,925)	(563)	(29,890)
CP9		0%	19.5%	19%	6.9%	8.2%	14.5%	14.2%
Nov-Dec 2013		(1)	(41)	(42)	(29)	(134)	(4,255)	(4,418)
CP10		12.5%	4.2%	6.2%	0%	5.6%	1.8%	2.9%
Aug-Aug 2014		(8)	(24)	(32)	(12)	(90)	(171)	(273)
CP11		2.8%	12.6%	8.4%	2.6%	3.4%	9.9%	7.7%
Sep-Nov 2015		(71)	(95)	(166)	(231)	(704)	(1,871)	(2,806)
PG6					NA%	11.8%	0%	10.5%
Jul-Jul 2016					(0)	(17)	(2)	(19)
CP12	0%	14.3%	17.2%	16.3%	2.8%	23%	15.7%	16.3%
Sep-Oct 2016	(2)	(28)	(93)	(123)	(107)	(343)	(1,482)	(1,932)
WP4		0%	0%	0%	19.8%	13.9%	0%	19.3%
Sep-Nov 2017		(5)	(2)	(7)	(25,456)	(2,371)	(18)	(27,845)
CP13		0%	6.2%	3.1%	2.5%	1.9%	2%	2%
Jul-Aug 2018		(66)	(64)	(130)	(79)	(377)	(547)	(1,003)
	3.1%	**11%**	**18.8%**	**14.6%**	**17.6%**	**16.7%**	**27%**	**18.4%**
Total	**(129)**	**(738)**	**(996)**	**(1,863)**	**(272,511)**	**(109,551)**	**(48,438)**	**(430,500)**

The majority of recoveries have come from purse-seine vessels (92%), followed by pole and line and other gear types (4%), unknown (4%) and longline recoveries <0.5% (224 in total). Table 11 shows the number of recoveries by gear type for yellowfin and bigeye that have been at liberty for at least 1 year before recapture. After 1 year at liberty, the fish should be approximately 80cm-100cm in length and available to purse-seine and longline fleets.

The same trend is observed if the analysis is restricted to just the spatial domain of the purse-seine fleet (10°N to 10°S). The accuracy of information returned from tags recovered on fishing vessels remains higher than that which is received from canneries or via transhipment (Figure 7). The date and location of recapture from recoveries during transhipment is typically reported as unknown.

3.3 Tag Recovery Network

Across the WCPO, many, previously full-time, Tag Recovery Officers (TROs) have now taken on other duties at their respective local fisheries agencies. Following the signing of a MoU between PNG NFA and SPC, new TROs have now been appointed in Lae and Port Moresby. From July 2018 to July 2019, 252 tags were recovered by NFA and rewards were paid. New grant agreements have been signed with MIMRA, with five contracts for TROs renewed, while negotiations with Kiribati MFMRD to re-establish a full time TRO position in Tarawa are still in progress. Negotiation with MFMR to sign a new Grant agreement for the Noro office, Solomon Islands is also in progress, as well as the recruitment of a full time TRO in the Philippines.

Regular emails, visits in countries, as well as meetings held at SPC allow maintenance of constant contact with the existing network. Emails to raise awareness on the tagging program prior to, and at the end of research voyages are now part of the ongoing awareness program. The PIRFO website is also use as a portal for awareness among observers. The messaging application “Slack” has been recently introduced to enhance the TROs network, allowing rapid exchanges of information between the officers, feedback on tag recovery information, and any issues encountered with the TROtag Database. The TROtag manual was updated and tutorial videos were developed to provide training on how to enter tag information in the database, alongside the use of “Slack” as a means of information sharing.

SPC receives recovery information from TROs on a semester basis. The establishment of new TRO positions has provided greater opportunity for collection of tags during unloading, transhipments and processing in canneries, with more complete and reliable capture information (Figure 6, Tables 10). Major unloading and processing facilities, as well as transhipping vessels in port, have been visited by TROs over the last 12 months, except for Tarawa, where TRO positions have not yet been re-established. SPC staff continue to enter tag recovery information into TagDager and undertaking the necessary validation processes.

In order to retrieve whole tagged fish released with strontium chloride or with an archival tag, a new reward system has been developed. On board purse seine vessels, observers are rewarded USD 50 to place the fish aside, to keep the fish frozen at all times, to coordinate the collection of biological samples onshore and to collect associated data. On-board longline vessel tagged fish are now purchased whole at a rate of USD 10 /kg. New Posters were created during early 2019 to disseminate this information, and are currently under translation for circulation across the tag recovery network.

3.4 Tag Seeding

To date nearly 55% of seeded tags have been returned to SPC. In addition to allowing estimation of tag reporting rates, the tag seeding data also allow the error rate in tag return information to be determined (see Section 3.5; Peatman et al., 2016). From February 2007 to July 2019, a total of 572 tag seeding kits (consisting of seeding tags, applicators, guide books and data forms) for a total of 14,335 tags have been given to observer coordinators and TROs in Tonga, Ecuador, PNG, Solomon Islands, Fiji, FSM, Marshall Islands, Kiribati, New Zealand and American Samoa for deployment on purse seine vessels by senior observers. Since 2011, kits have been modified to contain a mix of steel head and plastic barb tags to test the effect of tag type. Following analyses showing no significant effect of tag type in seeding experiments, the use of steel head tags for tag seeding has now been discontinued. When a kit is not completely deployed during a trip, the kit is either kept aside or used in another kit for deployment. Table 11 details the number of seeded tags deployed per EEZ to date.

To aid in the implementation of tag seeding experiments, training is provided as part of the PIRFO observer upgrade training courses. Tag Recovery Officers in the ports of Pohnpei, Honiara, Rabaul, Madang, Pago Pago, Port Moresby and Majuro continue to liaise closely with observer coordinators, observer debriefers and observers to implement tag seeding experiments and to recover the tag seeding logs for deployed kits. Tag seeding debriefing materials are used by both TROs and local debriefers. Of the 572 kits distributed to observer coordinators, 429 have been given to observers for deployment, of which 358 tag seeding datasheets have been received for observer trips.

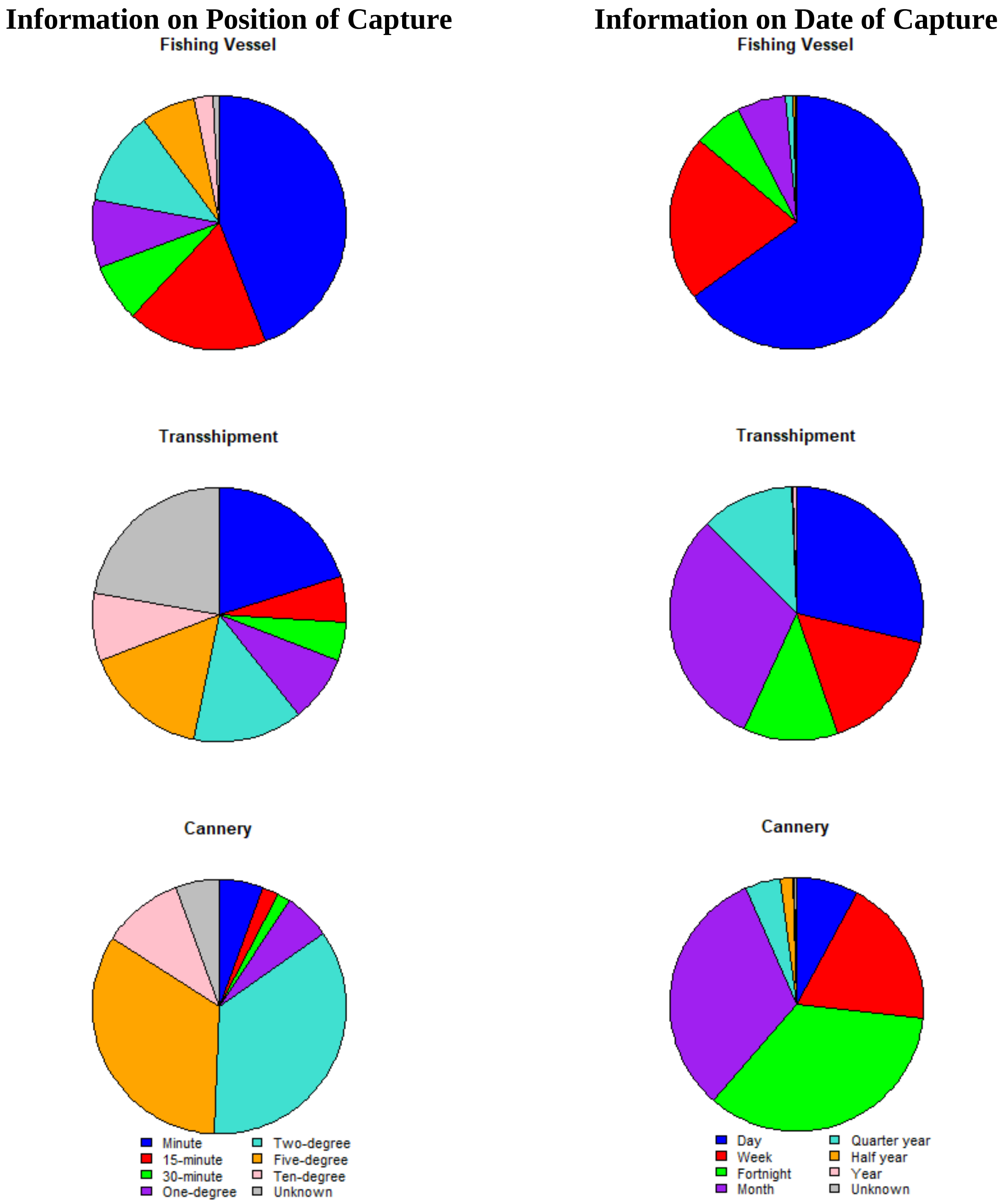

Figure 6: Location and date of accuracy information for tag recoveries on fishing vessels, during transhipment and at canneries.

Since June 2018, nine kits have been deployed from which five kits were distributed by NFA, using a total of 240 tags. This is at the same rate of deployment in comparison to the previous year (9 kits for 237 tags), though continuing a trend of low deployment rates compared to previous years. As at 3rd July 2019, there have been 7,384 reported tags that have been seeded and 4,095 (55%) of these have been returned to SPC. Tables 12 and 13 detail the reporting of vessel name by location and cannery, respectively. The accurate reporting of vessel name is particularly important for validation of location and time of recapture using VMS and log book data. Vessel name was reported incorrectly for 806 tags, was absent from the recovery information for 145 tags, and was correct for 3110 tags.

3.5 Analysis of Tag Seeding data

Data from tag seeding experiments have been used to estimate prior distributions for reporting rates for use in MULTIFAN-CL assessments of tuna stocks in the Western Central Pacific Ocean. These prior distributions are used to minimise bias in assessments resulting from the non-reporting (or detection) of tag recoveries, and as such are a critical input to the MULTIFAN-CL models.

Reporting rate (RR) prior parameters have been updated for the 2019 skipjack assessment (Peatman et al., 2019 SC15-SA-IP-06). The approach to calculating the prior parameters has been revised, with substantial increases in penalty parameters. A variety of analyses did not detect any significant tag type effect on reporting rates, suggesting that shedding rates of seeded tags have not varied between steel-head and plastic dart tags. As such, it was recommended that seeding experiments continue with plastic dart tags, which will ensure consistency with conventional tag types used throughout the PTTP, and may reduce the chances of tag seeding experiments being compromised. A significant reduction in tag reporting was detected for tag seeding experiments in 2015. However, it is difficult to explore this in detail given the relatively low numbers of seeding experiments in recent years. In this context, a power analysis was undertaken to explore the number of seeding experiments required to detect step-changes in reporting rates, and provide guidance on the number of tag seeding experiments moving forwards. Current levels of tag seeding are insufficient to allow detection of modest increases or reductions in tag reporting rates (+ /- 15 %) within three years. Increasing the number of seeding experiments, and improving the coverage of fleets, will be essential if tag seeding experiments are to be an effective component of the PTTP moving forward.

3.6 Analyses of Movement

Movement trends observed from both conventional and archival tags are consistent with expectations for highly migratory species with larger movements positively related to time at liberty (Figure 7).

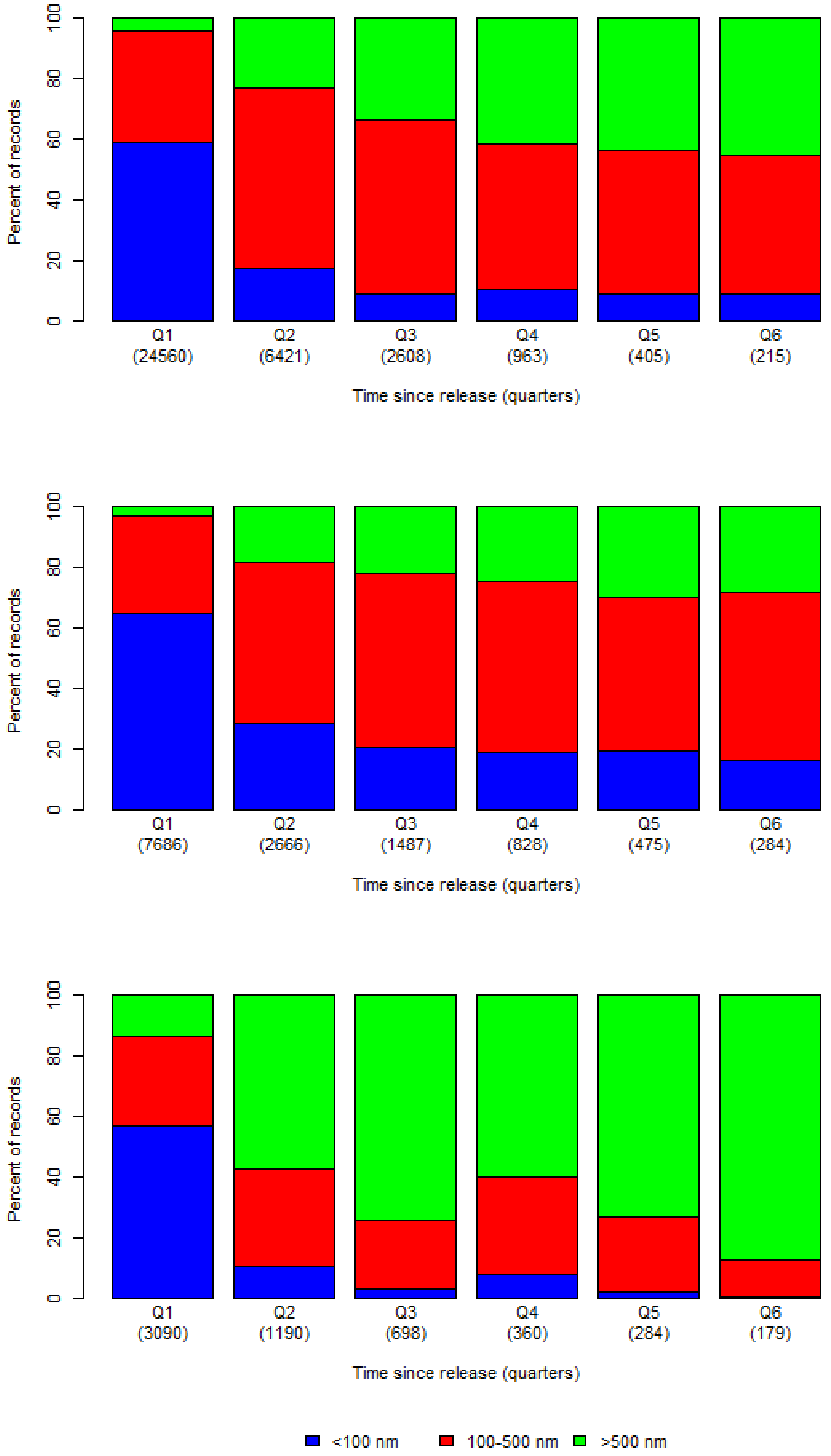

Figure 7: Reported recoveries within 100 nm, 100-500 nm and >500 nm in the first 6 quarters (18 months) since release for skipjack (upper graph), yellowfin (middle graph) and bigeye (lower graph). The sample size for each quarter is provided in the parentheses below the quarter label on the x-axis.

Table 9: Tag recoveries by gear type with ≥1 year at liberty.

Project	Recoveries		Purse Seine		Longline		Pole & Line		Other		Unclassified	
	YFT	BET	YFT	BET	YFT	BET	YFT	BET	YFT	BET	YFT	BET
PTTP Phase 1 - Papua New Guinea tagging project	408	9	364	6	13	1	1	0	18	0	12	2
PTTP Phase 1 - Solomon Islands tagging project	272	8	263	8	2	0	0	0	1	0	6	0
PTTP Phase 2 - Central Pacific #1	0	84	0	74	0	2	0	0	0	0	0	8
PTTP Phase 2 - Central Pacific #2	4	87	3	77	0	2	0	0	0	2	1	6
PTTP Phase 2 - Central Pacific #3	3	197	2	176	0	8	0	0	0	1	1	12
PTTP Phase 2 - Central Pacific #4	1	59	1	54	0	4	0	0	0	0	0	1
PTTP Phase 2 - Central Pacific #5	7	351	7	342	0	5	0	0	0	0	0	4
PTTP Phase 2 - Central Pacific #6	5	96	4	89	0	4	0	0	1	0	0	3
PTTP Phase 2 - Central Pacific #7	2	198	2	181	0	16	0	1	0	0	0	0
PTTP Phase 2 - Central Pacific #8	0	54	0	44	0	9	0	0	0	0	0	1
PTTP Phase 2 - Central Pacific #9	0	73	0	66	0	6	0	0	0	0	0	1
PTTP Phase 2 - Central Pacific #10	1	2	1	2	0	0	0	0	0	0	0	0
PTTP Phase 2 - Central Pacific #11	7	23	7	23	0	0	0	0	0	0	0	0
PTTP Phase 2 - Central Pacific #12	0	10	0	8	0	2	0	0	0	0	0	0
PTTP Phase 2 - Western Pacific #1	153	12	131	12	1	0	2	0	14	0	5	0
PTTP Phase 2 - Western Pacific #2	263	45	241	23	9	15	0	0	3	4	10	3
PTTP Phase 2 - Western Pacific #3	160	23	147	20	1	3	0	0	7	0	5	0
PTTP Phase 2 - Western Pacific #4	3	0	3	0	0	0	0	0	0	0	0	0
PNGTP - Papua New Guinea #1	256	2	243	2	5	0	0	0	0	0	8	0
PNGTP - Papua New Guinea #2	245	40	240	39	3	1	0	0	1	0	1	0
PNGTP - Papua New Guinea #3	49	6	47	4	0	2	0	0	2	0	0	0
PNGTP TAO trial Cruise #2	1	0	1	0	0	0	0	0	0	0	0	0
Total	**1,840**	**1,379**	**1,707**	**1,250**	**34**	**80**	**3**	**1**	**47**	**7**	**49**	**41**

Table 10: Tag recoveries by source and validation.

Source	Recov.	% Valid.	% VMS	% Logsheet	% Archival	% Buffer	% Other	% None	% No vessel name	% Vessel but no date	% Vessel but no position	% No length
American Samoa	2,263	97.79	92.72	0.18	0.45	0	0.32	6.33	3	0	30.53	23.82
China	38	39.47	20	0	0	0	0	80	73.68	0	2.63	71.05
Fishing vessel	557	92.82	80.46	1.74	0	0	15.09	2.71	1.8	0	3.59	4.85
FSM	735	91.97	97.04	0.74	0.15	0	0	2.07	2.04	0	8.71	24.08
FSM (SPC)	213	65.73	74.29	12.14	0.71	0	10	2.86	0.94	0	4.69	4.69
IATTC	9,627	25.13	47.09	3.97	1.45	0	14.39	33.11	23.78	0	14.48	70.89
Indonesia	5,985	81.22	0.12	0	0	95.19	3.25	1.44	2.09	0	5.01	5.61
IOTC	10	30	0	0	0	0	0	100	70	0	30	20
Japan	3,036	74.51	91.87	3.8	0.13	0	0.71	3.49	3.72	0	20.09	4.94
Kiribati (Kiritimati)	344	80.23	91.67	0	2.9	0	0	5.43	5.23	0	20.35	24.13
Kiribati (Tarawa)	1,045	85.84	72.58	0.11	0.67	0	0.45	26.2	21.53	0	17.61	9.86
Korea	611	68.74	16.19	1.19	0.48	0	0.48	81.67	82.16	0	4.26	9.98
Marshall Islands	1,067	92.03	89	8.25	0.41	0	0.41	1.93	1.41	0	12.56	25.68
Nauru	2	100	0	0	0	0	0	100	50	0	50	50
Philippines (direct)	8,446	56.71	67.1	4.34	0.06	0	7.7	20.79	16.65	0	26.41	65.68
Philippines (Frabelle)	363	50.96	96.22	1.08	1.62	0	1.08	0	7.44	0	3.58	29.75
Philippines (NFRDI)	175	49.71	59.77	4.6	0	0	4.6	31.03	10.29	0	10.29	13.71
PNG (China Fisheries Association)	7	14.29	100	0	0	0	0	0	0	0	85.71	85.71
PNG (Dologen ltd)	1	100	0	100	0	0	0	0	0	0	0	0
PNG (Fairwell Fishery)	28	53.57	60	20	0	0	0	20	3.57	0	39.29	32.14
PNG (Fong Seong Fishery)	7	100	85.71	14.29	0	0	0	0	0	0	28.57	0
PNG (Frabelle)	6,850	82.25	88.36	10.01	0.05	0.02	0.04	1.53	1.72	0	3.49	8.03
PNG (Japanese Far Sea Tuna Association)	2	100	100	0	0	0	0	0	0	0	0	0
PNG (Korean Overseas Association)	3	66.67	100	0	0	0	0	0	0	0	33.33	33.33
PNG (Luminar Fishing)	12	100	100	0	0	0	0	0	0	0	16.67	0
PNG (NFA)	605	88.93	72.12	4.28	0.37	0	1.86	21.38	16.53	0	15.7	20.66

Source	Recov.	% Valid.	% VMS	% Logsheet	% Archival	% Buffer	% Other	% None	% No vessel name	% Vessel but no date	% Vessel but no position	% No length
PNG (other)	1,155	74.55	71.2	0.81	0.12	0	0.35	27.53	6.15	0	15.67	15.41
PNG (Pacific Blue Sea Fishing)	274	70.44	95.34	4.66	0	0	0	0	0	0	0.73	0
PNG (RBL Fishing)	962	75.47	99.72	0.14	0	0	0	0.14	0.52	0	7.69	6.76
PNG (RD)	9,517	94.36	80.06	17.96	0.06	0	0.03	1.89	1.77	0	2.3	3.94
PNG (RR Fishing)	30	83.33	100	0	0	0	0	0	0	0	0	0
PNG (Sepik Coastal Agencie)	10	100	90	0	0	0	0	10	10	0	10	10
PNG (SST)	1,462	46.72	62.96	13.91	0	0	10.98	12.15	35.77	0	30.51	33.93
PNG (Taiwan Deep Sea Association)	19	100	100	0	0	0	0	0	0	0	15.79	5.26
PNG (TPJ Fishing)	1,860	71.61	89.19	4.58	0.08	0	0.38	5.78	4.25	0	4.3	6.34
PNG (TSP Marine)	457	92.34	99.53	0	0	0	0	0.47	0	0	7.22	2.41
Solomon Islands (Global Investment)	1,083	97.88	78.87	12.55	0	0	0	8.58	8.59	0	1.94	55.96
Solomon Islands (Korean Deep Sea Association)	355	59.15	100	0	0	0	0	0	0.28	0	14.08	7.32
Solomon Islands (MFMR)	935	88.56	90.7	1.21	0.85	0	1.81	5.43	4.6	0	30.37	39.57
Solomon Islands (NFD)	8,164	93.19	81.98	17.56	0.01	0	0	0.45	0.88	0	8.95	15.47
Solomon Islands (other)	204	86.27	77.27	2.27	0	0	8.52	11.93	17.16	0	10.78	33.33
Solomon Islands (Soltai)	3,225	93.09	80.88	10.33	0	0	0.53	8.26	6.82	0	4.19	6.45
Solomon Islands (Taiwan Deep Sea Association)	559	95.35	100	0	0	0	0	0	0	0	1.97	1.07
Solomon Islands (Western Solomon ventures limited)	11	63.64	100	0	0	0	0	0	0	0	27.27	9.09
Tagging vessel	241	56.43	2.21	0	0.74	0	95.59	1.47	0.41	0	9.13	2.07
Taiwan	69	91.3	95.24	0	0	0	0	4.76	0	0	23.19	0
Thailand	10,882	64.59	93.44	3.64	0.18	0	0.04	2.69	1.46	0	95.39	1.66
Vanuatu	30	100	100	0	0	0	0	0	0	0	0	0
Other	297	65.32	56.7	2.06	10.82	0	6.7	23.71	15.15	0	10.44	33.67

Table 11: Number of seeded tags deployed per EEZ since the beginning of the project.

EEZ	Releases
Not known yet	338
American Samoa	4
Cook Islands	67
Federated states of Micronesia	503
Fiji	7
Gilbert Islands	841
Howland & Baker	8
Indonesia	7
International waters H4	103
International waters H5	145
International waters I2	119
International waters I3	10
International waters I4	35
International waters I5	99
International waters I6	106
International waters I7	1
International waters I9	5
Jarvis	5
Marshall Islands	131
Nauru	297
Northern Line Islands	25
Palau	5
Papua New Guinea	2,560
Phoenix Islands	488
Samoa	24
Solomon Islands	722
Tokelau	200
Tuvalu	529
Total	**7,384**

Table 12: Accuracy of recapture vessel reported for seeded tag recoveries, by location.

Recovery location	All tag recoveries	Tag seeding recoveries (TSR)	Wrong vessel reported (TSR)	No vessel reported (TSR)	Correct vessel reported (TSR)	% correct vessel
GENERAL SANTOS, Philippines	8,553	231	58	23	150	64.9
HONIARA, Solomon Islands	1,633	474	74	2	398	84
LAE, PNG	5,534	199	29	5	165	82.9
LONDON, Kiribati	163	2	0	0	2	100
MADANG, PNG	2,882	300	42	0	258	86
MAJURO, Marshalls	1,251	285	84	0	201	70.5
MANTA, Ecuador	1,475	48	11	0	37	77.1
NORO, Solomon Islands	11,269	52	20	1	31	59.6
PAGO PAGO, A. Samoa	2,249	595	58	22	515	86.6
POHNPEI, FSM	1,031	159	13	0	146	91.8
PORT MORESBY, PNG	545	94	1	0	93	98.9
RABAUL, PNG	502	161	13	0	148	91.9
SAMUTSAKOM, Thailand	10,839	613	244	6	363	59.2
SAN DIEGO, USA	8,273	193	60	78	55	28.5
SHIMIZU, Japan	3,005	7	1	1	5	71.4
TARAWA, Kiribati	1,047	176	6	4	166	94.3
VIDAR, PNG	7,149	192	13	1	178	92.7
WEWAK, PNG	7,048	280	79	2	199	71.1

Table 13: Vessel reported per cannery (Thailand).

Cannery Name	Tag seeding recoveries	Wrong vessel reported	No vessel reported	Correct vessel reported	% correct vessel reported
ASIAN ALLIANCE INTERNATIONAL	21	0	1	20	95.2
CHOTIWAT	15	12	0	3	20
EKSAKHON COLD STORAGE CO., LTD	30	5	0	25	83.3
ISA VALUE	8	1	0	7	87.5
PATAYA FOOD INDUSTRIES LTD.	131	94	0	37	28.2
PREMIER CANNING INDUSTRY	1	1	0	0	0
R.S. Cannery Co., Ltd.	36	9	0	27	75
Songkhla Cannng	1	1	0	0	0
Songkla Canning PLC.	62	43	0	19	30.6
SOUTHEAST ASIAN PACKAGING	50	17	0	33	66
Thai Union Manufacturing Co.	57	14	0	43	75.4
TROPICAL CANNING	15	2	0	13	86.7
Unicord	2	1	0	1	50
Unicord Public Co., Ltd.	111	22	2	87	78.4

3.7 Ikamoana tag simulations

The Ikamoana tag simulation tool (Scutt Phillips et al. 2018) was used to examine the potential movement of tagged skipjack tuna from two locations near to planned releases during this year's upcoming WP5 trip. Simulated tag releases were undertaken using behavioural forcing from SEAPODYM (Senina et al. 2016), under historical environmental and fishing effort scenarios, assuming releases of 40cm fork length skipjack during September 2012 (an ENSO neutral period). The results were used to guide subsequent tag recovery effort, particularly for those planned releases west of the warm pool region where returns have historically been low.

While there remains uncertainty regarding simulated fish behaviour and estimated recaptures, particularly to the west of the warm pool, such simulations are useful to examine where fish may move (Figure 8), and given historical fishing effort, where they may be caught (Figure 9). In light of the results of these simulation experiments, additional tag recovery effort is planned in the Philippines with the aim of increasing recovery rates around the maritime continent area.

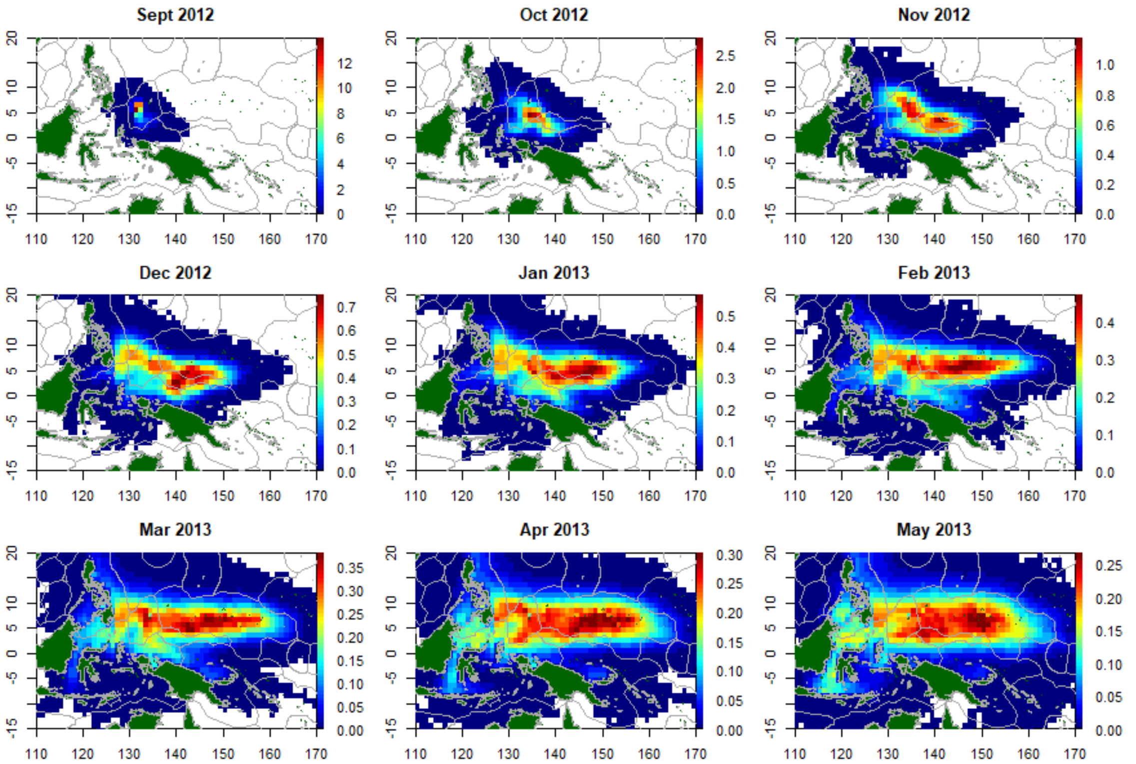

Figure 8: Simulated, relative density of tagged fish each month following Sept 2012 release in Palau, excluding fishing and natural mortality. Density is given in percentage at 1° grid cell resolution, with country EEZs marked in grey.

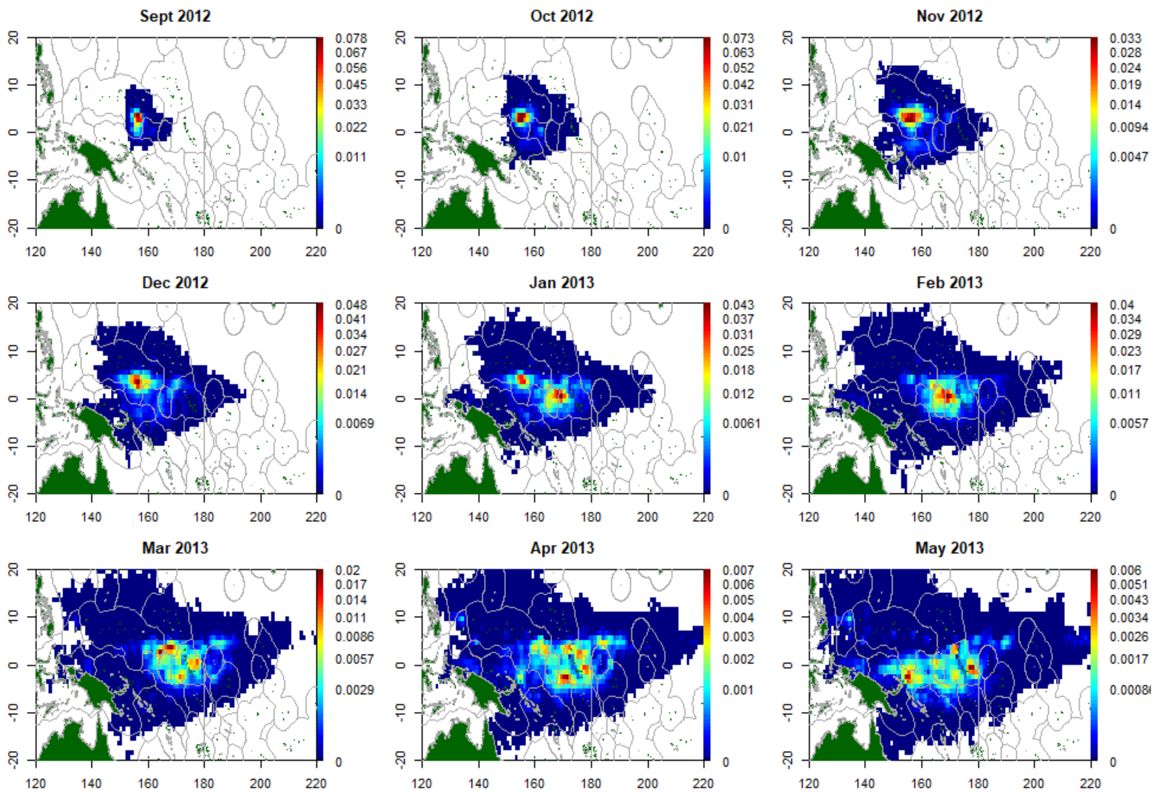

Figure 9: Simulated, relative recapture of tagged fish each month following Sept 2012 release in FSM. Recaptures are shown as percentage of all tagged fish released (note non-linear colour scale).

3.8 Albacore tagging

A description of albacore tagging activities was outlined previously in WCPFC-SC5-2009/GN IP-16 and WCPFC-SC6-2010/GN IP-06. Since SC14, two tags have been reported after being washed ashore in New Zealand. This increases the total reported tags, but not the number of informative recoveries, which remain at 31 (1%) for the project. Following a recovery in New Caledonia during 2017, the reward for white tags from albacore tuna tagged with oxytetracycline has been increased to US$250, and conventional tags to $US20, for recoveries in New Caledonia and French Polynesia.

3.9 Database improvements

Along with the tagging website (www.spc.int/tagging), there is a new dedicated web application (The Web tagging Data System) allowing access to the tagging database (TagDager) which helps to verify and process new tagging data (http://www.spc.int/tagging/webtagging). Note this is only available to approved and authorised users. The purpose of the web tagging data system is to:

- identify fake recoveries: e.g. lost tags, those used for training or publicity, or tags already recovered;
- access the release information (vessel, date of release, latitude and longitude of release, species, length);
- help to validate “date found”;
- estimate “date caught” when date found is only provided;
- search release information relative to tags seeded;
- provide full access to the TagDager DB from any authorised users connected to the web; and
- visualisations data access to CP13 sonic tagging data are now available on the SPC webtagging site.

These improvements to the tag databases will improve tag quality and significantly reduce the risk of attempted tag reward fraud. The TROtag database used by the Regional TROs has been enhanced with additional financial components, and allows better traceability of payment and faster financial reconciliation. Furthermore, a beta version of a mobile tuna tagging application to facilitate the collection of information by TROs has now been developed. Although not complete, the framework for linking directly to SPC tag recovery coordinators and the TagDager database is in place, including the ability to upload images of physical tags. Continued development is anticipated, before an eventual roll-out to selected TROs for trial.

3.10 CP13 Sonic tagging

The aim of CP13 was the release of conventional tagging of bigeye and yellowfin tuna, but this cruise also involved extensive tagging of fish using acoustic telemetry ‘sonic’ tags. These fish were released at drifting FADs equipped with acoustic receivers as part of the WCPFC EU funded project *WCPFC Mitigating bycatch of bigeye tuna and yellowfin tuna juveniles by purse seine fisheries*.

These tag releases provide very high quality presence and depth data, whenever fish are in the presence of the acoustic receiver through which data are transmitted. Greater detail and analyses are provided in Scutt Phillips et al. (2019, SC15-EB-WP-08), but a summary of sonic tag releases is given in Table 2 and below in Table 14. Of note is that fish detected at a second receiver, following their initial association with the FAD of release, may be considered as fishery-independent mark-recapture data. Though the number of sonic tags and receivers were limited in CP13, larger scale adoption of these experiments could provide mark-recapture type data for estimating natural mortality and movement.

Table 14. Summary of data obtained from sonic tag releases during CP13

Species	No.	Data reported	Percentage	Second receiver data	Percentage	Total days of data	Mean days of data/tag
Bigeye	108	97	89.8	13	11.6	1258	11.6
Yellowfin	57	45	78.9	3	9.3	529	9.3
Skipjack	14	13	92.9	0	4.2	59	4.2

3.11 Electronic double-tag returns

A number of fish tagged with both archival and sonic telemetry tags were released during CP13 as part of the WCPFC EU funded project *WCPFC Mitigating bycatch of bigeye tuna and yellowfin tuna juveniles by purse seine fisheries*. Four archival tags have been recaptured and returned from this project already, of which two of those are from double-tagged bigeye tuna. These data provide some of the most detailed behavioural information on individual tropical tuna available, allowing examination of fine-scale vertical behaviour throughout time-at-liberty, accurate times and positions of fish whilst associating with sonic receivers, and estimates of horizontal movement from light-based geolocation which can be constrained using these known periods of association (Scutt Phillips et al. 2019, SC15-EB-WP-08).

Two double tagged bigeye tuna were recaptured following CP13, one released at 89cm FL (AgTag) and the other at 72cm FL (AuTag). Both fish associated with their FAD of release, for 11 and 7 days, respectively, as confirmed by detections from the attached sonic receiver. Both fish were then at liberty for 3 and 4 months respectively, with AgTag briefly passing a second sonic receiver attached to another FAD in the area, before being recaptured. Horizontal geolocation estimates were calculated using Wildlife Computers GPE3 algorithm, and overlaid with the known positions of each individual fish while associating with receiver equipped FADs (Figure 10). In both cases, geolocation algorithms failed to capture any of the known horizontal movements from the sonic tag confirmed positions while fish associated with receiver equipped FADs.

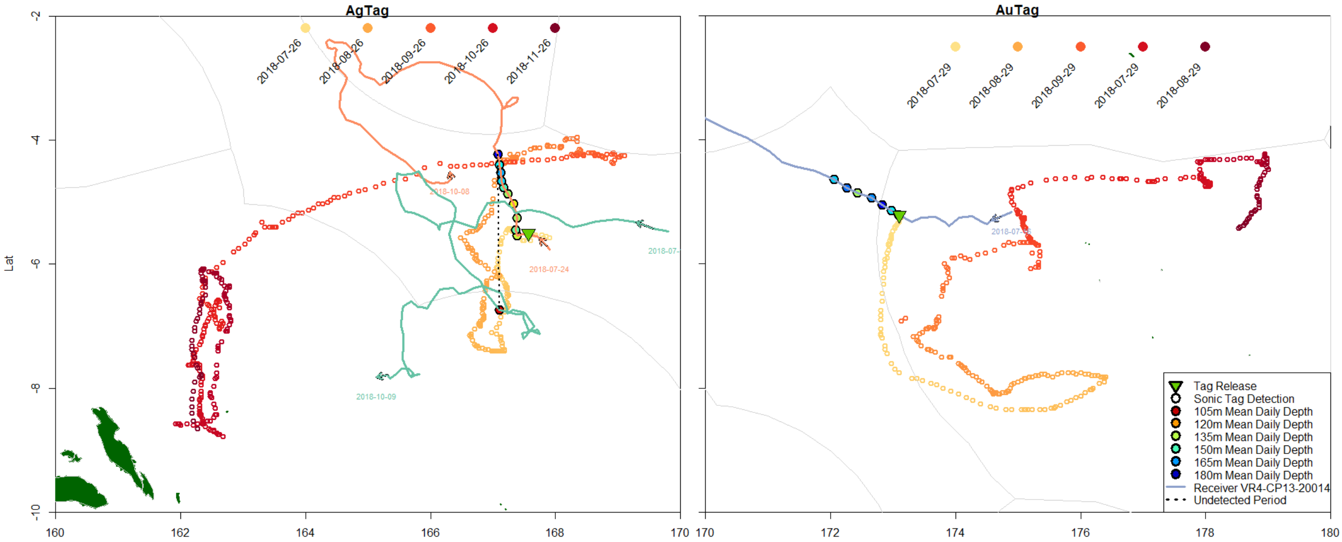

Figure 10: Estimated geolocation tracks (hollow circles) for double tagged bigeye tuna AgTag (left) and AuTag(right). Overlaid are known locations from sonic tag detections (coloured circles) along the trajectories of receiver equipped drifting FADs (solid lines).

These results again highlight the uncertainty with light-based geolocation for tropical tunas in equatorial areas, while providing insight into the fine-scale nature of FAD association by these individuals. Of note are the sustained departures from the drifting FAD of release by both of these fish, typically followed by a return in the second half of the night or just before dawn (Figure 11). Both fish also exhibited a slow disassociation with their FADs of release, with day- and night-time departures becoming longer over a period of 3-4 days, though fish always returned before dawn, before permanent abandonment of the FAD (Scutt Phillips et al. 2019, SC15-EB-WP-08).

Although data from these double-tagged fish are not numerous, they have the potential to add significant value to the broader dataset of electronic tags within the PTTP, through validation and classification of FAD-association behaviours that can potentially be applied to archival returns from non-sonically tagged fish. Furthermore, the variability in these returns to the FAD during pre-dawn periods by sonic tagged bigeye tuna has been highlighted in the work on this project, and should be examined for the potential in mitigation against bycatch of this species (Scutt Phillips et al. 2019, SC15-EB-WP-08).

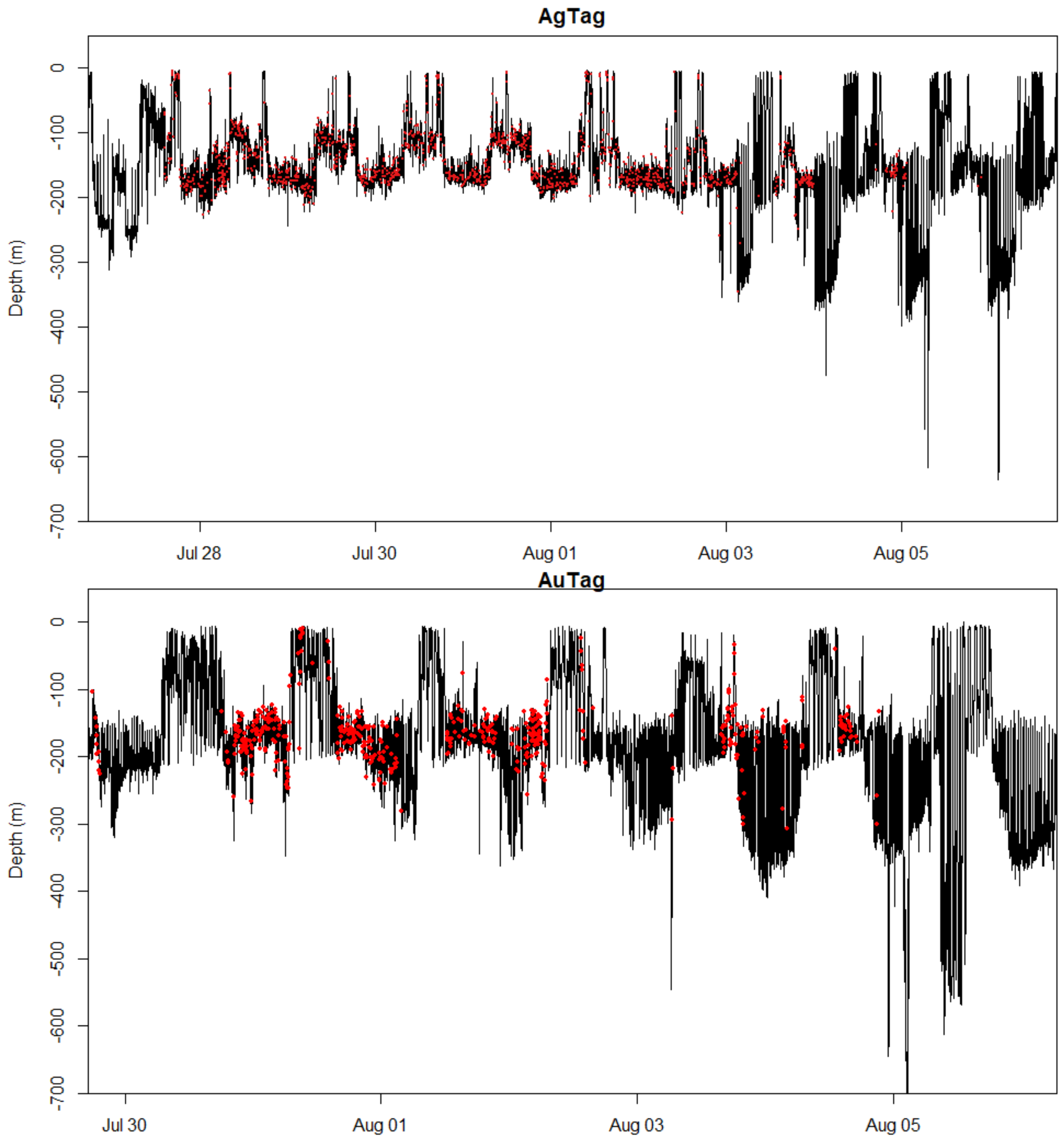

Figure 11: Archival tag recorded dive profile after release for double-tagged fish AgTag (top) and AuTag (bottom). Sonic tag detections and transmitted depth data while fish were associated with receiver-equipped FADs are overlaid in red circles.

4 ISSUES ARISING

The PTTP continues to be a highly successful programme and with the significant commitment from the Commission to ongoing funding, the successful CP13 and the WP5 voyage now underway, this programme, already recognised as an ongoing high priority, is a real strength of

WCPFCs science for the medium term. However, there remain significant issues facing the success of any tuna tagging research programme in the region.

1. The ongoing difficulty in maintaining an effective tag recovery network remains apparent. Delays in the transmission of tag recovery information to SPC, following reports of recovery, has resulted in difficulties in comprehensive data assimilation for this year's WCPO skipjack tuna stock assessment (SC15-SA-WP-05). This reinforces the need to improve and maintain an effective recovery network, despite the introduction of other responsibilities, such as biological sample collection, for TROs across the region.

2. The past year continued the trend of low numbers of tag seeding kit deployments for observers. As highlighted by an information paper on tag seeding analyses (SC15-SA-IP-06), the current levels of deployments are far below those required to likely detect changes in reporting rate. Furthermore, tag seeding analyses suggest reduced reporting of conventional tags in recent years, although this is uncertain due to the recent drop in tag seeding experiments.

3. Providing external validation of movement estimates from within MULTIFAN-CL and SEAPODYM remains difficult. Adequate analytical effort is required to undertake stand-alone, separate analyses of tagging and other data to provide such movement estimates. Furthermore, the apparent low return rate of conventional tags from the most recent CP13 voyage requires examination. Continued tag-related analyses and development of tools such as the Ikamoana tuna movement simulator provide a framework to examine the effects of mixing and movement, and optimise future tagging voyages.

4. A strong case for identifying a long-term multi-purpose tagging platform in the WCPO remains. Integrating WCPFC biological sampling and other tuna ecosystem research into the design, areas of research that face the same cost pressures, makes the case even stronger. Investigations have continued in 2019, with direct support from New Zealand, and a feasibility study will be advertised in order to provide expert advice on the operations, cost and procurement of such a vessel. Issues of increasing charter costs of commercial vessels, alongside a decreasing number of appropriate platforms, continues to make this a critical concern.

5 PTTP 2018-2021 work-plan

The PTTP Steering Committee will meet during SC15. A draft agenda for the meeting is attached at Appendix 1. The work-plan identified in 2018 (SPC-OFP, 2018) has been completed. The proposed work-plan for the PTTP for 2019-2022 is highlighted in Table 15 below, and the 2019 work-plan is well advance, including successful negotiations around access to a pole and line vessel for WP5. The work-plan recognises the decisions of SC in 2016 to normalise the tagging programme (WCPFC SC, 2017), the decisions of SC in 2017 where this rolling medium-term research work-plan was endorsed (WCPFC-SC 2017) and the decisions of SC in 2018 to normalise the tagging research plan as part of the ongoing high priority science work of WCPFC (WCPFC SC, 2018).

6 RECOMENDATIONS

SC15 is invited to note the report of ongoing progress in implementation of the PTTP. In particular we recommend that SC:

- Note the successful 2018 CP13 tagging voyage
- Note the importance of effective tag seeding to estimating reporting rates, and support increased deployment and fleet coverage of tag seeding experiments
- Note the need for continued member participation and support in tag reporting;
- Support the 2020 tagging programme, and associated budget;

- Support the 2021-2022 tagging programme, and associated indicative budget; and
- Consider and support the PTTP work-plan for 2019-2022;

Table 15: Proposed PTTP work-plan for the period 2019-2022.

	ACTIVITIES	2019	2020	2021	2022
TAGGING					
1.	**Pole and line tagging research voyage** Target is skipjack, with secondary target of yellowfin. Following SC recommendations to implement a skipjack tagging experiment every second year, a pole and line research voyage is scheduled for 2019 and biennially thereafter. Note also critical component of biological sampling in support of Project 35b.	A charter arrangement has been concluded with NFD for use of the Soltai 105 Pole & Line vessel to implement 62-day WP5 research voyage		Plans to be refined after assessing viable available options	
2.	**Dangler/troll tagging research voyage** Target is bigeye, with secondary target of yellowfin. Following SC12 recommendation to implement a bigeye tagging experiment every second year, a dangler/troll experiment is scheduled for 2020 and biennially thereafter. Note also critical component of biological sampling in support of Project 35b.		Focus in the Central Pacific to continue view of bigeye across the WCPO	Dependent on outcome of obtaining a suitable pole and line vessel, it may be appropriate to undertake a second consecutive year of dangler/troll research	Focus in the Central Pacific to continue view of bigeye across the WCPO
TAG RECOVERY					
3.	Establish new TRO positions where required.				
4.	Ongoing support of TROs in PNG, Philippines, Thailand and key Pacific Island locations.				
6.	Review and revise tag rewards scheme.				
DATA MANAGEMENT					
7.	PTTP data verification with VMS and Logbook, and cannery data.				
8.	Consolidation of the web tagging database framework.				
9.	New tools to consolidate collection of recapture information.	Tuna Tagging Application is in development			
DATA ANALYSES					
10.	Tag reporting and seeding.	Purpose: Estimation is a direct scalar for fishing mortality. Tasks: Routine update of analyses, reporting to SC.			
11.	Fishing and natural mortality.	Purpose: Provide external validation to estimates from within MFCL and identify fishing mortality changes in response to expansion of the WCPO fisheries. Tasks: Routine update of analyses, reporting to SC.			
12.	Movement.	Purpose: Provide external validation to estimates from within MFCL and SEAPODYM. Tasks: Routine update of analyses, reporting to SC.			
13.	Ikamoana tag-simulation analyses.	FSM/Palau tag release scenarios undertaken to inform recovery effort	Undertake tag release simulations to inform MF-CL tag mixing period	Optimal design for 2021 skipjack-focused research voyage	
PLANNING					
14.	Review and update research plan	Ongoing annual task for rolling plan.			

7 ACKNOWLEDGEMENTS

We gratefully acknowledge the voluntary contributions from the Republic of Korea, European Union, Papua New Guinea, Australia, New Zealand and ISSF. We acknowledge the support of national fisheries administrations, observer programmes and the tuna fishing industry in assisting with the project, in particular in the recovery of recaptured tags. We also thank New Zealand for their funding of the investigations into a tuna research vessel for the Pacific. Particular thanks also to Dr Tony Lewis for his considerable efforts in negotiations around the charter of a pole and line vessel and efforts in preparation for WP5.

Material for this report was provided by J. Scutt Phillips[1], T. Peatman[1], B. Leroy[1], F. Roupsard[1], C. Sanchez[1], J. Hampton[1], and N. Smith[1].

1 The Pacific Community (SPC), Noumea, New Caledonia

8 REFERENCES

Peatman, T., Caillot, S., Leroy, B., McKechnie, S., Roupsard, F., Sanchez, C., Nicol, S., and N. Smith. 2016. Analysis of tag seeding data and reporting rates. WCPFC-SC12-2016/SA-IP-13, Bali, Indonesia, 3–11 August 2016.

PTTP Steering Committee. 2016. Report of the Pacific Tuna Tagging Programme Steering Committee. WCPFC-SC12-2016/RP-PTTP-01, Bali, Indonesia, 3–11 August 2016.

Scutt Phillips, J., Sen Gupta, A., Senina, I., van Sebille, E. Van, Lange, M., Lehodey, P., Hampton, J., Nicol, S., 2018. An individual-based model of skipjack tuna (*Katsuwonus pelamis*) movement in the tropical Pacific ocean. Prog. Oceanogr. 164, 63–74. https://doi.org/10.1016/j.pocean.2018.04.007

Scutt Phillips, J., Leroy, B., Peatman, T., Escalle, L., Smith, N., 2019. Electronic tagging for the mitigation of bigeye and yellowfin tuna juveniles by purse seine fisheries. WCPFC-SC15-2019/EB-WP-08, Scientific Committee Fifteenth Regular Session. Pohnpei, Federated States of Micronesia, 12-20 Aug.

Senina, I., Lehodey, P., Calmettesa, B., Nicol, S., Caillot, S., Hampton, J., & Williams, P. (2016). Predicting skipjack tuna dynamics and effects of climate change using SEAPODYM with fishing and tagging data. Scientific Committee Twelfth Regular Session. Bali, Indonesia, 3-11.

SPC-OFP. 2018. Project 42: Pacific Tuna Tagging Project Report and Workplan for 2018-2019. WCPFC-SC14-2018/RP-PTTP-02, Busan, South Korea, 8-16 August 2018.

SPC-OFP. 2017. Project 35: Bigeye biology, and Project 35b: WCPFC Tuna Tissue Bank. WCPFC-SC12-2016/ RP-P35-01, Rarotonga, Cook Islands, 9–17 August 2017.

WCPFC-SC. 2016. Summary Report. Twelfth Regular Session of the Scientific Committee, Bali, Indonesia, 5-9 August 2016. The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean.

WCPFC-SC. 2017. Summary Report. Thirteenth Regular Session of the Scientific Committee, Rarotonga, Cook Islands, 9-17 August 2017. The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean.

WCPFC. 2018. Summary Report Issued 16-Mar-18. Fourteenth Regular Session of the Commission, Manila, Philippines, 3-7 December 2017. The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean.

Appendix A. Proposed agenda for the 2019 PTTP Steering Committee meeting

PROVISIONAL AGENDA
PACIFIC TUNA TAGGING PROGRAMME STEERING COMMITTEE
17:30-19:00, xxxx yy August 2019 (tbc)
(Venue TBC)

1			**PRELIMINARIES**
	1.1		Review and adoption of agenda
2			**PTTP PROGRESS REPORT**
	2.1		PTTP Activities (RP-PTTP-02)
		2.1.1	*At-sea*
		2.1.2	*Tag recovery*
		2.1.3	*Tag data analyses*
		2.1.4	*Tag seeding analyses (SA-IP-06)*
3			**WORK PLAN 2019-2022**
	3.1		2019 Skipjack research voyage (RP-PTTP-02)
	3.2		Tag recovery network (RP-PTTP-02)
	3.3		2020 Bigeye research voyage (RP-PTTP-02)
	3.4		Other elements of the work-plan (RP-PTTP-02)
4			**RELATED TAG ACTVITIES**
	4.1		Tagging experiment design and Ikamoana simulations
	4.2		Electronic tagging at drifting FADs
		4.2.1	*Bigeye and yellowfin bycatch mitigation (EB-WP-08)*
		4.2.2	*Double tagged bigeye tag returns (RP-PTTP-02)*
5			**OTHER REGIONAL OR SUB-REGIONAL TAGGING**
6			**ADMINISTRATIVE MATTERS**
7			**ADOPTION OF REPORT**