SCIENTIFIC COMMITTEE
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Project 42: Pacific Tuna Tagging Project Report and Workplan for 2017-2020

WCPFC-SC13-2017/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 2016-17 under the banner of the PTTP including research voyages, tag recoveries, tag recovery and tag seeding activities, and tagging related analyses. Issues arising in 2017 for PTTP steering committee consideration are highlighted. The PTTP work planned for 2017-2020 is outlined and an agenda for the 2017 meeting of the PTTP steering committee is provided.

1.1 Programme objectives

The PTTP is a joint research project being 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 were revised in 2016 (PTTP Steering Committee, 2016) and 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, ideally with research cruises 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 these surveys). The SC took this recommendation forward to the Commission and at WCPFC13, the Commission agreed to the recommendation and allocated funds for 2017 and indicated funding for 2018-19 to implement this work (WCPFC, 2017).

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 2017 also shown. The spatial distribution of these research voyages in the Western and Central Pacific Ocean is shown given 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 SC12 in 2016 highlighted and the scheduled work for 2017 shown in red.

	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***
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***

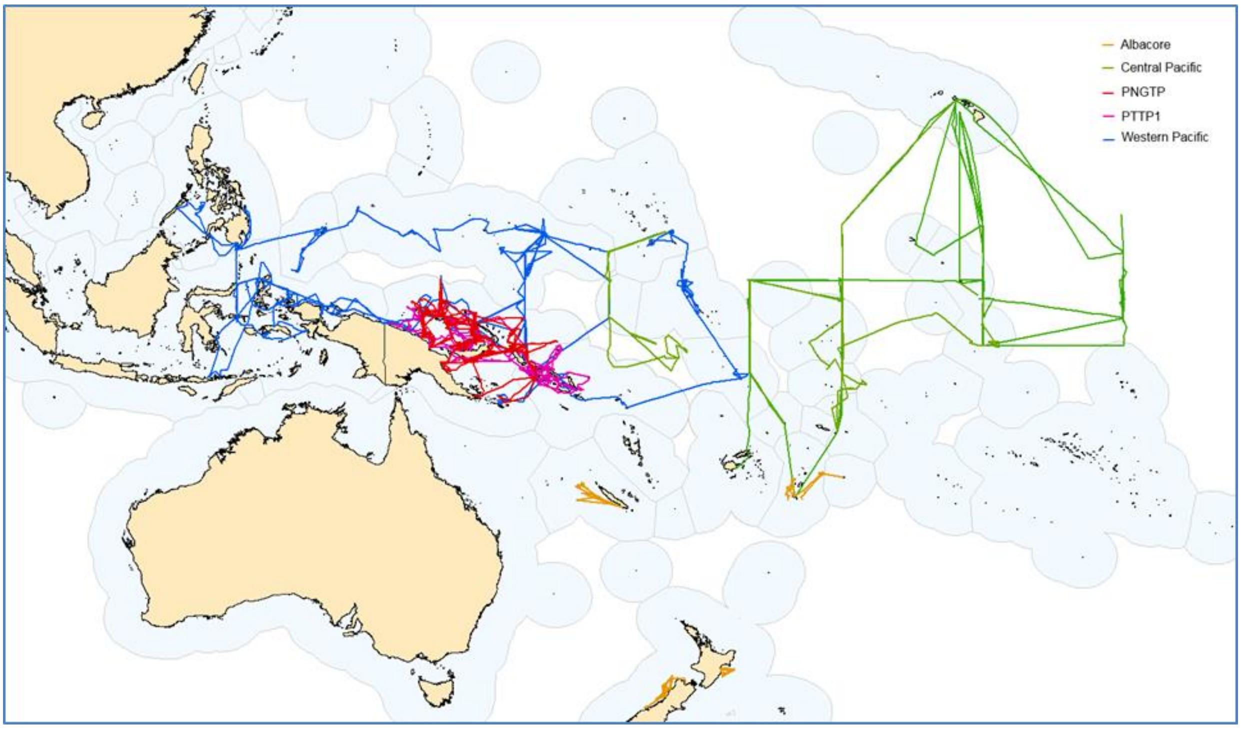

Figure 1. Tagging vessel tracks for all cruises for all PTTP research voyages to date. Legend relates to the operational areas described in Table 1.

2 SUMMARY OF PTTP ACTIVITIES IN 2016-2017

Since SC12 (SPC-OFP, 2016), PTTP activities have included two troll/handline cruises, CP12 in the Western Pacific, and a tagging trial cruise in PNG waters, continued implementation and refinement of tag recovery processes and tag seeding, data preparation for use in the post-SC additional analyses conducted on the skipjack stock assessment, and data preparation for use in the yellowfin and bigeye tuna stock assessments in 2017.

2.1 Tagging trial cruise in PNG waters

It had been proposed to equip the National Fisheries College (NFC) Fishing and Training Vessel (FTV) *Pokajam* with the appropriate fishing gears in PNG to assess the possibility of fishing for and tagging of bigeye tuna in the same manner as done for the CP cruises (Table 1). The *FTV Pokajam* is based in Kavieng which is conveniently situated not too far from and in between the longitudes 147°E and 156°E where TAO weather buoys are anchored.

A trial cruise was implemented in August 2012, targeting the two TAO buoys situated north of Manus Island on the 147°E longitude. Unfortunately, no bigeye schools were seen during this trial cruise. Nevertheless, this trial confirmed the suitability of *FTV Pokajam* for this kind of experiment and also permitted the NFC personnel to learn the techniques associated with this specific type of fishing.

The 2016 tagging trial cruise in PNG waters happened between the 13th and the 21st July, and targeted the two TAO weather buoys anchored at 2°S and 5°S latitude on the 156°E longitude (see Figure 2). It was discovered during the cruise that the 5°S TAO was missing. TriMarine USA, a purse seine fishing company, provided researchers with four dFAD positions, and subsequently two of them were visited in the Solomon Sea (see Figure 2).

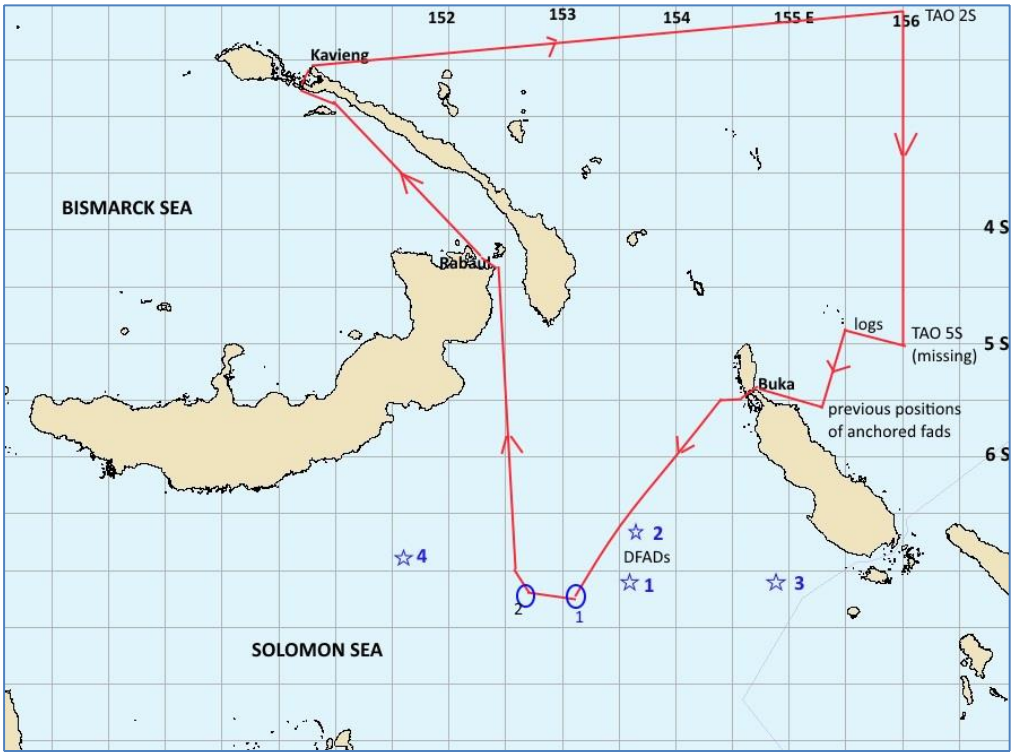

Figure 2. Cruise track during the July 2016 tagging trial cruise in PNG waters. The blue stars are the drifting Fad positions at the time they were provided by TriMarine. Number 1 and 2 were visited (blue circles).

The researchers only found a small tuna school associated with the TAO buoy at 2°S/156°E. The few yellowfin (17) and bigeye (2) caught were under 40cm in size and did not allow deployment of any archival tags. The attempts to catch bigger tuna at night with rod and reel were ruined by sharks and the bad weather conditions. No tuna were seen around the two visited dFADs. This experiment was however promising in that it proved that subject to finding fish, the *FTV Pokajam* could be used in near shore tagging research, and, more generally for the PTTP, that dFADs identified remotely by fishers could be targeted and fished with good guidance from shore.

2.2 CP12 tagging research voyage

CP12 was a research voyage of 35 days duration conducted in Sep-Nov 2016 targeting bigeye tuna aggregations associated with TAO oceanographic moorings, and drifting fish aggregations devices (dFADs). Following the CP11 experiments, CP12 was designed to augment data collection for studies on tuna movements, exploitation rates and fish aggregation device (FAD) association dynamics. In an attempt to cover the gap in bigeye tuna tagging data in the western part of the WCPO (west of the 180 meridian), the study area was selected to cover the 165°E and 156°E TAO mooring lines and the nearby waters (Figure 3). This cruise was primarily funded by the European Union, SPC and International Seafood Sustainability Foundation (ISSF). Tri Marine International also supported the cruise by allowing for the participation of a scientist and by providing positions of drifting FADs in the area of the research voyage operations. South Pacific Tuna Corporation also agreed to provide positions of nearby drifting FADs but it was not possible to visit these during the research voyage due to logistical constraints.

The Hawaii-based multipurpose vessel *Gutsy Lady 4* was chartered for the cruise (as previously used for CP11). A total of 2,135 fish (1575 bigeye, 371 yellowfin, 109 skipjack and 80 other fish as detailed in the acoustic tagging section) were tagged (Figure 4, Table 2). A majority (94%) of the total tagged fish were released in association with dFADs, and the rest in association with TAO buoys. Within this majority of releases, 93 archival tags were deployed on bigeye tuna, 28 on yellowfin tuna and two on skipjack. Four dFADs were equipped with a satellite communicating acoustic receiver manufactured by Vemco. These types of units utilize Iridium satellite communication and eliminate the need to retrieve the receiver to download information.

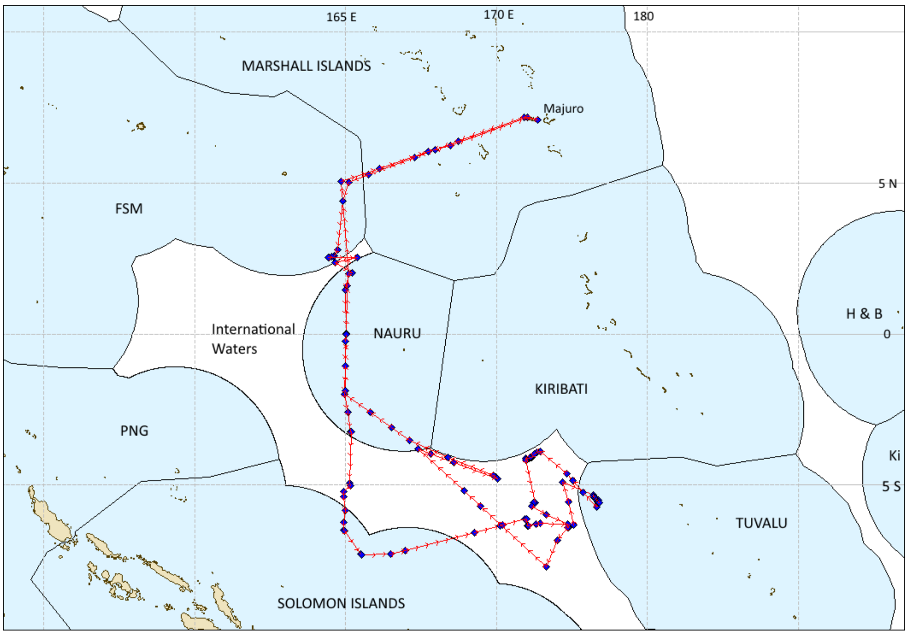

Figure 3. CP12 cruise trajectory over 35 days during Sep-Nov 2016. The 5°N, 2°N, equator, 2°S and 5°S TAOs on the 165°E line were visited along with 15 dFADs in FSM, Solomon, Tuvalu, and international waters. Those dFAD positions where tagging occurred are shown in Figure 4.

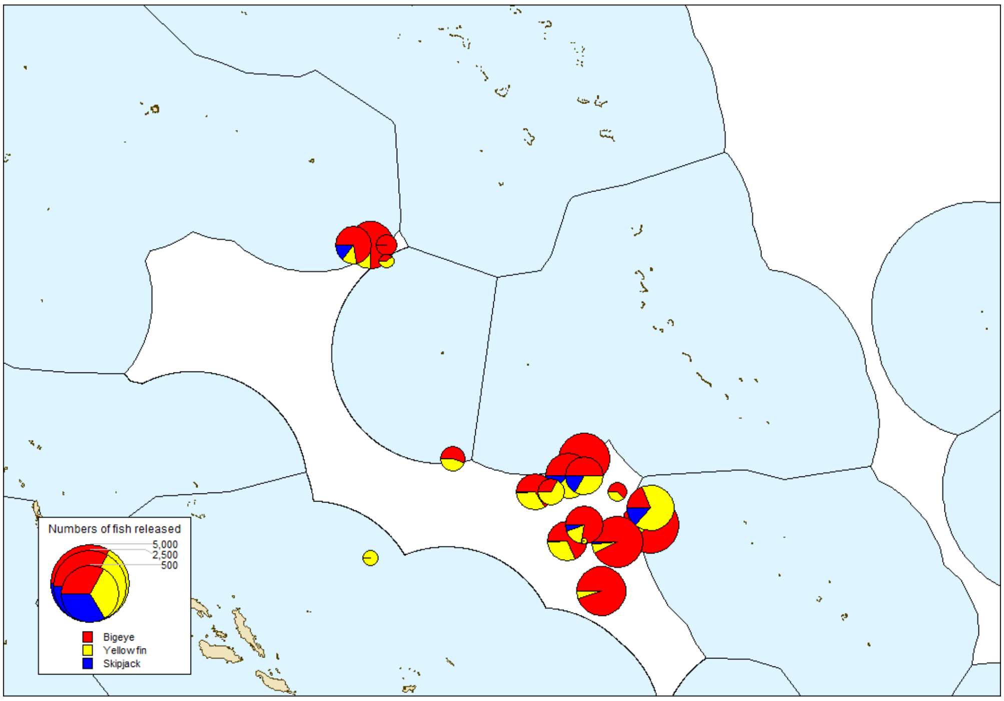

Figure 4. Distribution of tag releases at dFADs during CP12 cruise.

Table 2: Number of fish tagged per species and tag type during CP12. Five YFT and 12 BET were double-tagged with sonic and archival tags.

Tag type	BET	YFT	SKJ	others	Total
Sonic	17	10	29	55	**111**
Archival	93	28	2		**123**
satellite				25	**25**
Conventional Y13	1465	333	78		**1876**
Total fish tagged	**1575**	**371**	**109**	**80**	**2135**

2.2.1 *CP12 Acoustic tagging*

The acoustic tagging component of the CP12 cruise consisted of instrumenting four dFADs with VR4 Global satellite communicating acoustic receivers manufactured by Vemco. Tagging of the main species associated with the dFADs was done with coded, pressure sensitive acoustic tags (maximum 23 per dFAD) to investigate:

1. Vertical behaviour of species at dFADs to improve processing of echo sounder buoy data, in order to better distinguish different species from echo sounder buoy data, and
2. The behaviour of tuna and non-tuna species at dFADs to estimate residency at FADs and determine species specific vulnerability during the day at dFADs.

A total of 15 different dFADs were visited (see Figure 5) and tagged fish were released in association with 7 of them. Over a hundred (n=128) fish were implanted with acoustic tags across the four acoustic equipped dFADs. Details of acoustically tagged fish species are given in Table 3.

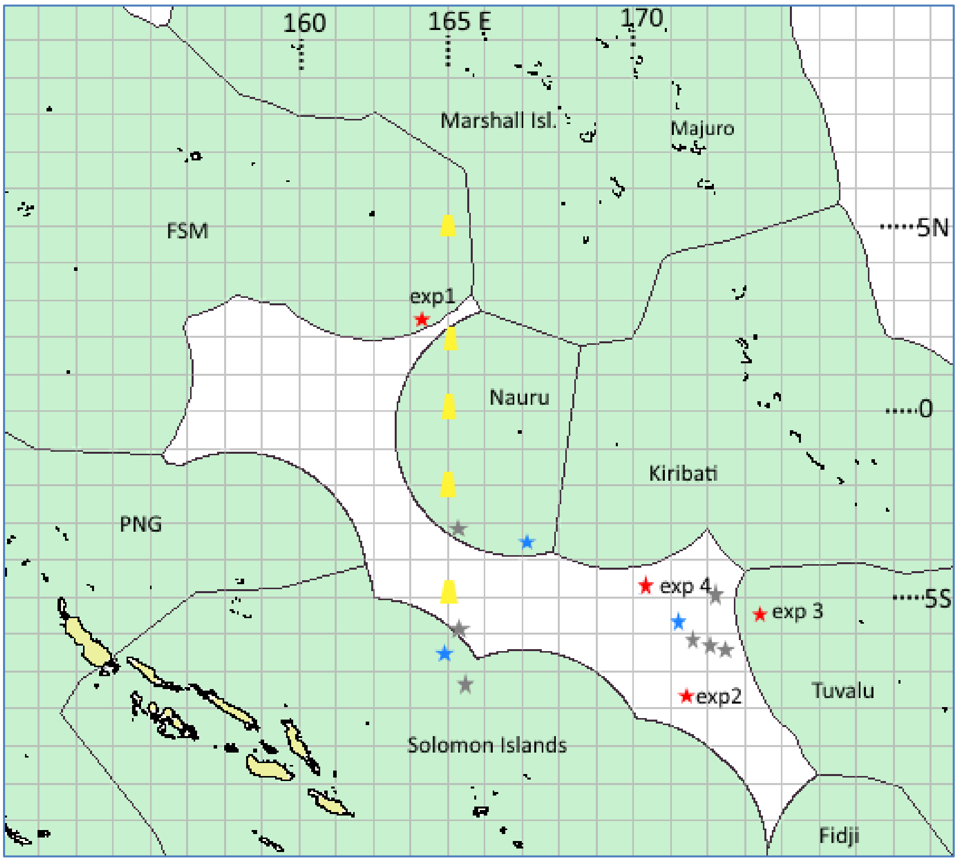

Figure 5. Positions of the visited dFADs. Red stars are dFADs equipped with VR4. Blue stars are dFAD where some fish were tagged with archival tags. Grey stars are dFADs with no tagging or few conventional tags. Yellow trapezoids are the visited TAOs along the 165°E line.

Table 3: Summary of animals implanted with acoustic tags during CP12. In brackets, number of fish that also received an archival tag.

Species	Exp.1	Exp.2	Exp.3	Exp.4	Total
YFT	4	5 (3)	3(1)	3(1)	15
SKJ	7		6	16	29
BET	5(3)	10 (2)	7 (4)	7 (3)	29
FAL	3	6	10	7	26
RRU	3	8	2		13
CNT	3	5	5	3	16
Total	25	34	33	36	128

2.2.2 *CP12 achievement*

The CP12 cruise met or exceed all targets for tagging and deployment of experimental gear. It also highlighted that the methods developed in the central Pacific could be applied successfully in the western Pacific. At the same time the operational issues in getting a suitable research platform into the western area constrained the amount of time available for research at sea. This latter point, and the associated costs associated are one of several factors which begin to build the case for identifying a long-term multi-purpose tagging platform in the WCPFC area (see Section 4 for additional discussion of this issue).

3 PTTP RESULTS

The Pacific areas covered by the different tagging cruises 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 with appropriate catch rates for research purposes.

The release numbers and recovery percentages to date of conventional and archival tags made during the 12 Central Pacific (CP) cruises, 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 2017) of conventional and archival tags.

		Release Numbers				Recapture Percentages			
Project	**Tag Type**	**SKJ**	**YFT**	**BET**	**Total**	**SKJ**	**YFT**	**BET**	**Total**
CP	Archival	32	257	744	**1,033**	0.0	7.4	18.8	**15.4**
	Conventional	762	2,536	38,539	**41,837**	4.2	13.8	28.6	**27.3**
PNGTP	Archival	0	68	12	**80**	NA	27.9	58.3	**32.5**
	Conventional	80,453	27,088	2,915	**110,456**	20.2	18.5	21.2	**19.8**
Total PTTP	Archival	129	667	930	**1,726**	3.1	12.0	18.8	**15.0**
	Conventional	246,985	106,826	47,873	**401,684**	17.4	16.8	27.1	**18.4**

The number of tags released over time are substantial for the tropical tuna species, but small for albacore. The displacements as reported for the recaptures are shown in Figure 6 A-C. Note that these are only straight line displacements for tagged tuna between their release and recovery positions.

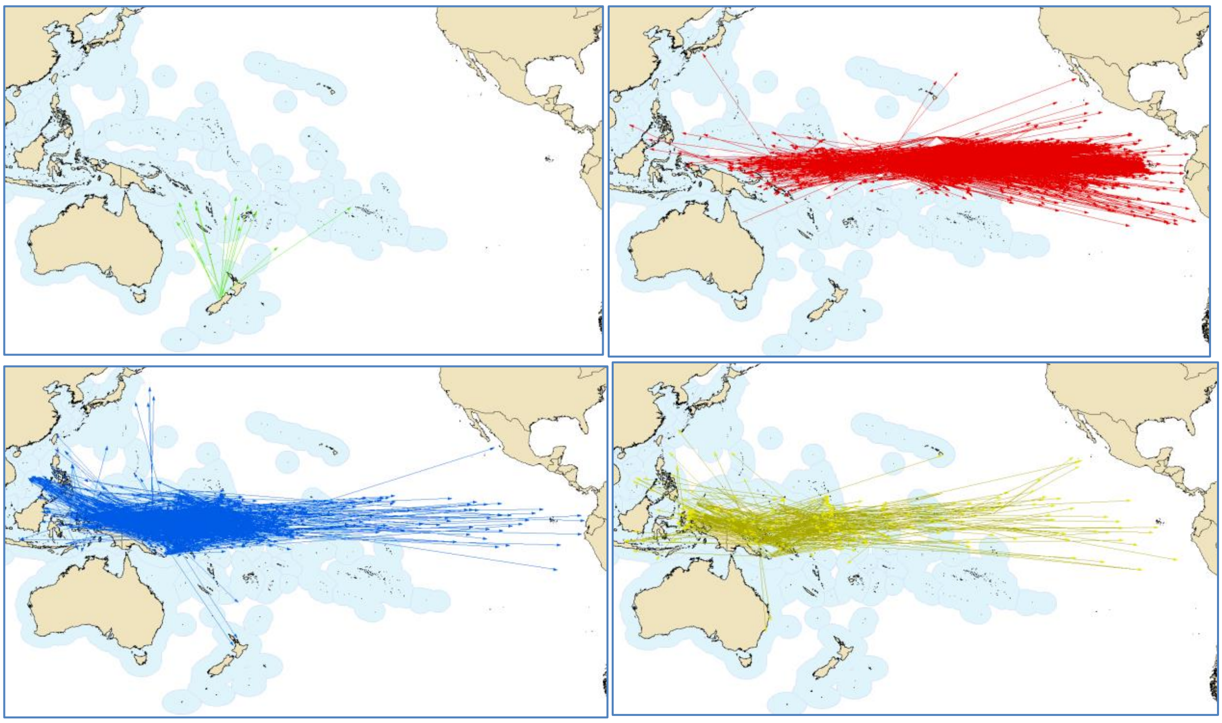

Figure 6A. Displacement of tagged tuna. Albacore in green (top left), bigeye in red (top right), skipjack in blue (bottom left) and yellowfin in yellow (bottom right). All recoveries for all years with displacement >1000 nm.

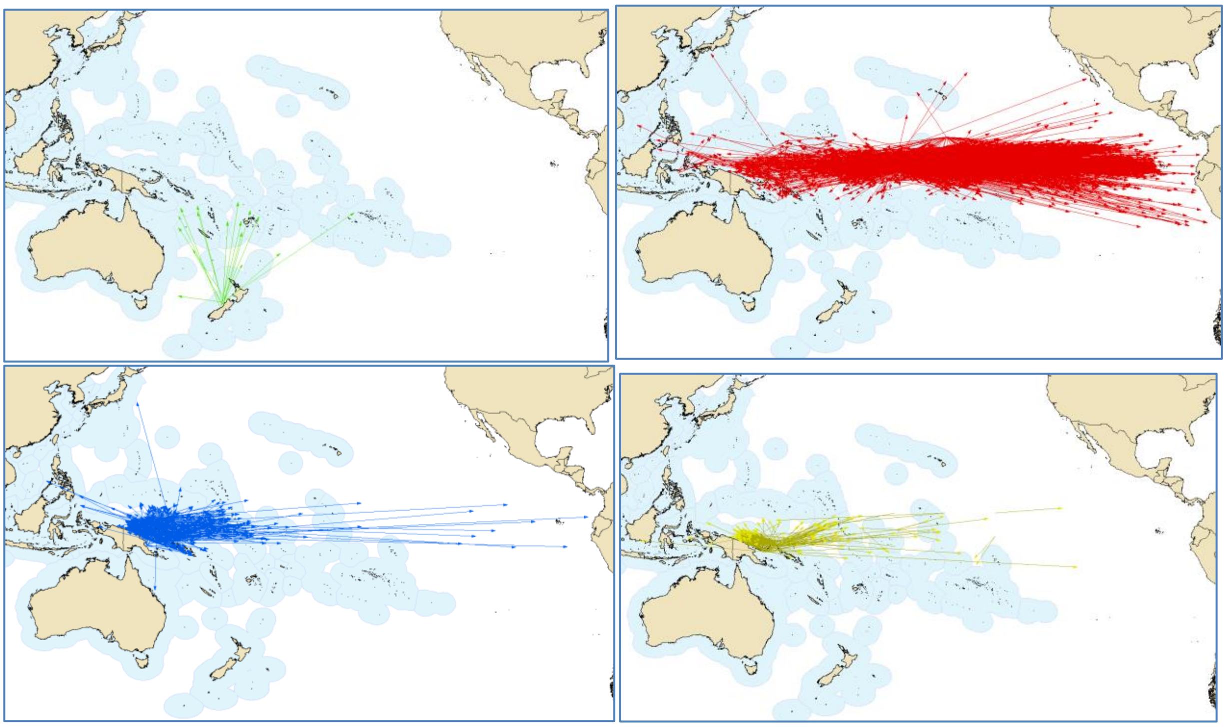

Figure 6B. Displacement of tagged tuna. Albacore in green (top left), bigeye in red (top right), skipjack in blue (bottom left) and yellowfin in yellow (bottom right). Showing all recoveries with displacements >500nm since 2007 for ALB and BET and since 2012 for SKJ and YFT.

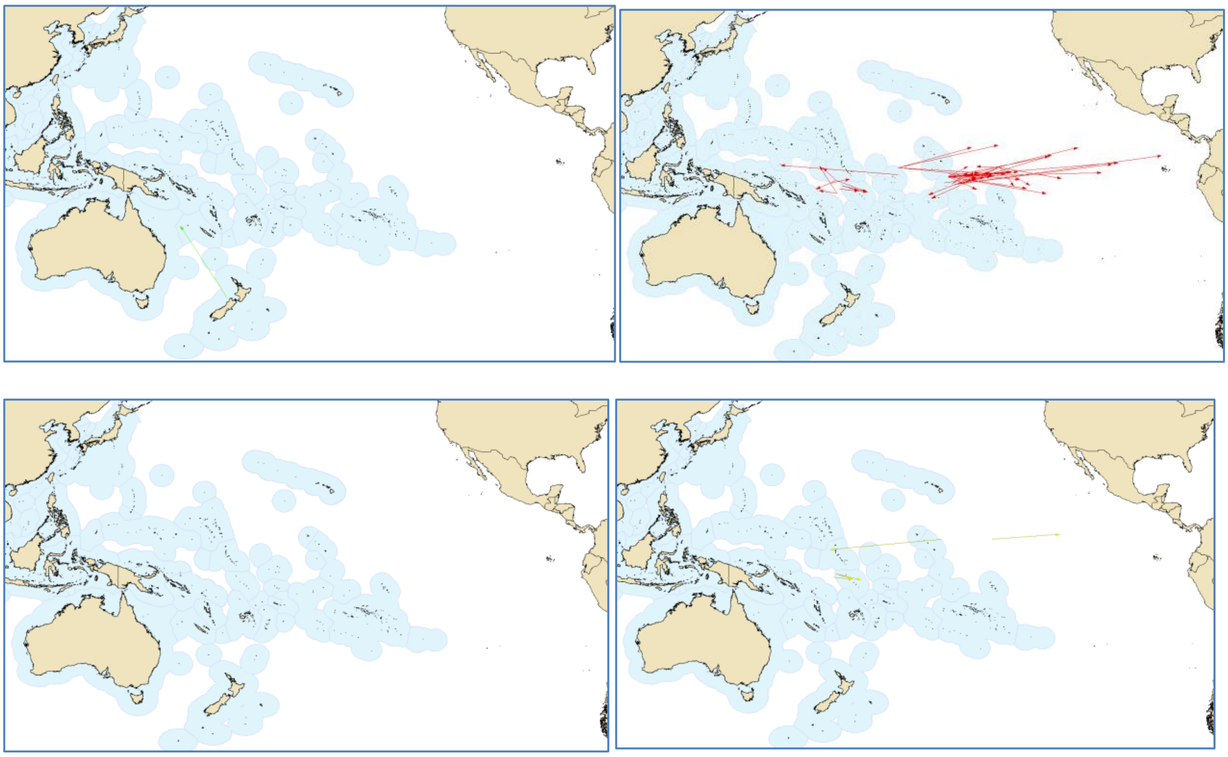

Figure 6C. Displacement of tagged tuna. Albacore in green (top left), bigeye in red (top right), skipjack in blue (bottom left) and yellowfin in yellow (bottom right). Showing all recoveries with displacements >300nm in the last year.

The results highlight a general lack of information for albacore, and that data in the most recent years relates largely to bigeye tuna in the central Pacific area.

3.1 Biological sampling during tagging cruises

A total of 5989 stomach samples have been collected since the beginning of the PTTP, mainly from skipjack, yellowfin, bigeye and albacore tuna (Table 5). The examination of the stomachs is an ongoing process and is conducted in the laboratory at SPC, Noumea. A total of 5492 stomachs, representing 92% of the samples collected, have been examined and the corresponding data entered into a dedicated database, BioDaSys (Table 5).

Table 5. Total number of stomach samples collected and analysed to July 2017.

PREDATOR SPECIES		COLLECTED	ANALYSED	% ANALYSED
SKJ	SKIPJACK	2649	2474	93%
YFT	YELLOWFIN	2140	2014	94%
BET	BIGEYE	477	357	75%
ALB	ALBACORE	245	245	100%
KAW	KAWAKAWA	124	118	95%
RRU	RAINBOW RUNNER	132	112	85%
FRI	FRIGATE TUNA	95	95	100%
DOL	MAHI MAHI	76	45	59%
SWO	SWORDFISH	6	6	100%
WAH	WAHOO	16	6	38%
MSD	MACKEREL SCAD / SABA	5	5	100%
FAL	SILKY SHARK	4	4	100%
BUM	BLUE MARLIN	12	3	25%
BRZ	POMFRETS AND OCEAN BREAMS	3	3	100%
CFW	POMPANO DOLPHINFISH	2	2	100%
NXI	GIANT TREVALLY	1	1	100%
YTL	AMBERJACK (LONGFIN YELLOWTAIL)	1	1	100%
PLS	PELAGIC STING-RAY	1	1	100%
	TOTAL	**5989**	**5492**	**92%**

The tagging research voyages have provided the opportunity to measure the fat content of 4,167 specimens (Table 6). This fat content research is important in the context of ecosystem dynamics and due the specialist nature of the sampling, cannot be conducted by observers undertaking biological sampling on industrial fishing vessels.

Additionally, the tagging research voyages have provided a large volume of biological samples for the WCPFC Tuna Tissue Bank (total of 19,963 samples). In addition to the *fatmeter* analyses, a total of 6,188 fish have been sampled from which 5,827 samples have been analysed to date. For the WCPFC Tuna Tissue Bank as a whole, these tagging research voyage samples represent 22.1% of the total fish sampled, 22.3 % of the total samples collected, and 26.1 % of the analyses processed from the tissue bank (Table 7).

Table 6. Total number of specimens where fat content analysed during tagging research voyages to July 2017.

PREDATOR SPECIES		NB fish sampled
SKJ	SKIPJACK	2180
YFT	YELLOWFIN	1563
BET	BIGEYE	135
ALB	ALBACORE	287
KAW	KAWAKAWA	1
FRI	FRIGATE TUNA	1
	TOTAL	4167

Table 7. Total number of samples collected from research tagging voyages and analysed to July 2017.

PREDATOR SPECIES		NB FISH SAMPLED	TOTAL SAMPLES	MUSCLE	OTOLITH	GONAD	STOMACH	BLOOD	LIVER	SPINE	NB SAMPLES ANALYZED	% ANALYZED
SKJ	SKIPJACK	2703	8209	2736	106	101	2649	0	2591	26	2619	31.9%
YFT	YELLOWFIN	2180	6798	2101	188	196	2140	15	2054	104	2185	32.1%
BET	BIGEYE	540	2063	512	279	189	477	30	475	101	376	18.2%
ALB	ALBACORE	284	1514	277	259	269	245	0	276	188	245	16.2%
RRU	RAINBOW RUNNER	133	391	126	0	7	132	0	126	0	112	28.6%
KAW	KAWAKAWA	124	316	96	0	0	124	0	96	0	118	37.3%
FRI	FRIGATE TUNA	95	285	95	0	0	95	0	95	0	95	33.3%
DOL	MAHI MAHI	76	221	63	0	20	76	0	62	0	45	20.4%
WAH	WAHOO	16	52	15	0	6	16	0	15	0	6	11.5%
BUM	BLUE MARLIN	13	58	13	0	8	12	5	12	8	3	5.2%
SWO	SWORDFISH	6	15	4	0	1	6	0	4	0	6	40.0%
MSD	MACKEREL SCAD / SABA	5	15	5	0	0	5	0	5	0	5	33.3%
FAL	SILKY SHARK	4	12	4	0	0	4	0	4	0	4	33.3%
BRZ	POMFRETS AND OCEAN BREAMS	3	3	0	0	0	3	0	0	0	3	100.0%
CFW	POMPANO DOLPHINFISH	2	4	1	0	0	2	0	1	0	2	50.0%
YTL	AMBERJACK (LONGFIN YELLOWTAIL)	1	3	1	0	0	1	0	1	0	1	33.3%
NXI	GIANT TREVALLY	1	1	0	0	0	1	0	0	0	1	100.0%
PLS	PELAGIC STING-RAY	1	3	1	0	0	1	0	1	0	1	33.3%
	TOTAL	**6188**	**19963**	**6050**	**832**	**797**	**5989**	**50**	**5818**	**427**	**5827**	**29.2%**

3.2 Conventional and archival tag recoveries for the PTTP

As at 22 July 2017, a total of 74,002 tagged tuna had been recaptured and the data reported to SPC. The numbers of conventional tag recoveries by species and by main tagging cruise are given in Table 8. Tag recoveries have occurred over the duration of the project, and are expected to continue for several years. Tag attrition follows the expected declining pattern (Figure 7) with the rate of decline in skipjack tag returns indicating their shorter expected lifespan and higher natural mortality when compared to yellowfin and bigeye tuna. The recovery rates of yellowfin and bigeye tagged with archival tags and conventional tags vary depending on cruise (Table 9). Initial observations of this data suggest increased tag rejection/fish mortality with archival tagging on some cruises.

There is a notable reduction in bigeye conventional tag recovery rate from CP9 onwards (from ~30+% up to cruise CP8, down to 14% for CP9 and between 2 to 11% for CP10 to CP12, as shown in Table 8.

For CP10, CP11 and CP12 there are significant changes in the distribution of tag releases and subsequent fishing activity which appear to readily explain the differences in recapture rates. During these cruises, the release method changed with 45 to 95% of the releases being done on dFADs, as opposed to 100% at TAO buoys in previous cruises. This also changed the species composition of tagging with 20 to 30% less bigeye being tagged on dFADs compared to tagging on TAO buoys. Further, the dFADs were not fished in the following month as it was the FAD closure period (previously many fish were recaptured during this period, Figure 7). The assumption is that fish had more time to disperse before fishing recommenced, thus reducing the tag recapture rate. Also no large school aggregations were found around the TAO buoys during those two cruises with the maximum releases on one buoy being around 200 fish, whereas 1000-4000 fish had been released on at least one TAO buoy during the previous CP cruises.

The observed reduction in bigeye recovery rate for the CP9 cruise (14% c.f. 30 %+) is less readily explained. Possibly some of the fleets that increased their effort in the Phoenix and Line Islands EEZ after CP9 cruise have not reported all their tag recoveries. This needs further investigation.

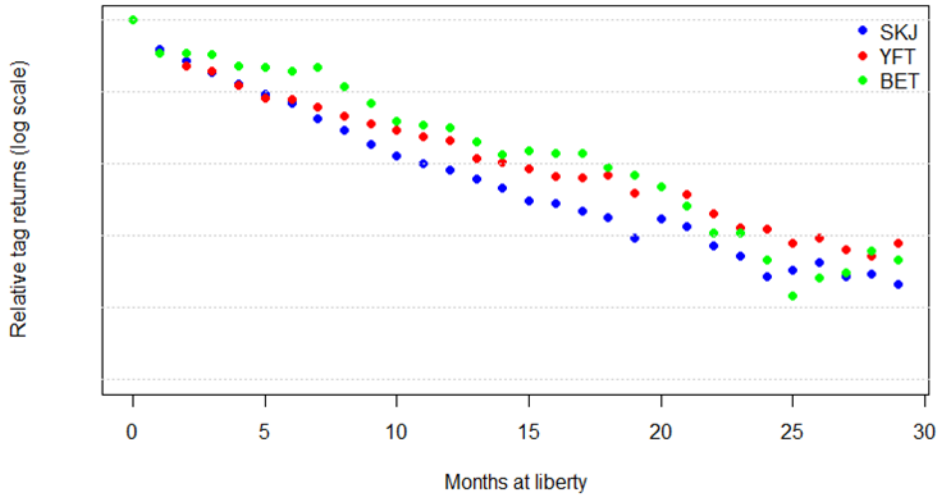

Figure 7. Tag recoveries by time at liberty for skipjack, yellowfin and bigeye tuna. Note that the values on the y-axis are uninformative and thus omitted. At the top-left the points (overlaid so as only BET shows) are the (species) specific maximum logarithm of recoveries, standardised so that the attrition curves all start at the same value. The gradient is a proxy for total mortality.

Table 8. Tag releases and recaptures for the PTTP to date (as at 24/05/2017).

Cruises	Releases				Number recovered (% recovered)			
	SKJ	YFT	BET	Total	SKJ	YFT	BET	Total
PG1 Aug-Nov 2006	13,948	7,806	562	**22,316**	2,646 (19%)	1,806 (23.1%)	229 (40.7%)	**4,681 (21%)**
PG2 Feb-May 2007	26,493	12,845	129	**39,467**	2,509 (9.5%)	1,719 (13.4%)	8 (6.2%)	**4,236 (10.7%)**
SB1 Oct-Nov 2007	7,479	3,565	139	**11,183**	1,976 (26.4%)	784 (22%)	18 (12.9%)	**2,778 (24.8%)**
SB2 Feb-Apr 2008	15,327	14,405	414	**30,146**	1,765 (11.5%)	2,422 (16.8%)	62 (15%)	**4,249 (14.1%)**
CP1 May-Jun 2008	57	116	1,736	**1,909**	4 (7%)	25 (21.6%)	575 (33.1%)	**604 (31.6%)**
WP1 Jun-Nov 2008	37,691	17,647	1,467	**56,805**	6,378 (16.9%)	2,058 (11.7%)	362 (24.7%)	**8,798 (15.5%)**
WP2 Mar-Jun 2009	34,207	13,919	3,145	**51,271**	4,608 (13.5%)	2,354 (16.9%)	489 (15.5%)	**7,451 (14.5%)**
CP2 May-Jun 2009	169	205	2,309	**2,683**	5 (3%)	27 (13.2%)	573 (24.8%)	**605 (22.5%)**
WP3 Jul-Oct 2009	30,722	7,340	735	**38,797**	6,699 (21.8%)	1,430 (19.5%)	197 (26.8%)	**8,326 (21.5%)**
CP3 Oct-Nov 2009	66	237	4,802	**5,105**	2 (3%)	64 (27%)	1,770 (36.9%)	**1,836 (36%)**
CP4 May-Jun 2010	7	120	2,284	**2,411**	1 (14.3%)	13 (10.8%)	513 (22.5%)	**527 (21.9%)**
CP5 Nov-Dec 2010	40	228	6,090	**6,358**	7 (17.5%)	46 (20.2%)	1,961 (32.2%)	**2,014 (31.7%)**
PNGTP1 Apr-Jul 2011	28,730	11,571	355	**40,656**	5,768 (20.1%)	2,477 (21.4%)	60 (16.9%)	**8,305 (20.4%)**
CP6 Oct-Oct 2011	2	123	3,804	**3,929**	0 (0%)	29 (23.6%)	1,036 (27.2%)	**1,065 (27.1%)**
CP7 Nov-Dec 2011	52	245	4,212	**4,509**	1 (1.9%)	21 (8.6%)	1,451 (34.4%)	**1,473 (32.7%)**
PNGTP2 Jan-Mar 2012	28,312	9,607	2,008	**39,927**	7,230 (25.5%)	1,697 (17.7%)	521 (25.9%)	**9,448 (23.7%)**
CP8 Sep-Oct 2012	20	140	6,014	**6,174**	2 (10%)	32 (22.9%)	2,298 (38.2%)	**2,332 (37.8%)**
PNGTP3 Apr-Jun 2013	23,411	5,978	564	**29,953**	3,257 (13.9%)	868 (14.5%)	45 (8.0%)	**4,170 (13.9%)**
CP9 Nov-Dec 2013	29	135	4,296	**4,460**	1 (3.4%)	10 (7.4%)	619 (14.4%)	**630 (14.1%)**
CP10 Aug-Aug 2014	12	98	195	**305**	0 (0%)	6 (6.1%)	4 (2.0%)	**10 (3.3%)**
CP11 Sep-Nov 2015	231	775	1,966	**2,972**	6 (2.6%)	20 (2.6%)	188 (9.6%)	**214 (7.2%)**
PG6 Jul-Jul 2016	0	17	2	**19**	0 (NA%)	0 (0%)	0 (0%)	**0 (0%)**
CP12 Sep-Oct 2016	109	371	1,575	**2,055**	3 (2.7%)	76 (20.5%)	171 (10.9%)	**250 (12.2%)**
Total	**247,114**	**107,493**	**48,803**	**403,410**	**42,868 (17.3%)**	**17,984 (16.7%)**	**13,150 (26.9%)**	**74,002 (18.3%)**

Table 9. Comparison of archival and conventional tag recoveries by species and cruise for the PTTP, 2006-2016.

	Archival Recoveries (%) (Number tagged)				Conventional Recoveries (%) (Number tagged)			
Cruises	**SKJ**	**YFT**	**BET**	**Total**	**SKJ**	**YFT**	**BET**	**Total**
PG1 Aug-Nov 2006	100% (1)	37% (46)	44% (25)	**40.3% (72)**	19% (13,947)	23.1% (7,760)	40.6% (537)	**20.9% (22,244)**
PG2 Feb-May 2007	0% (1)	9.1% (187)	0% (23)	**8.1% (211)**	9.5% (26,492)	13.4% (12,658)	7.5% (106)	**10.7% (39,256)**
SB1 Oct-Nov 2007		0% (5)	0% (7)	**0% (12)**	26.4% (7,479)	22% (3,560)	13.6% (132)	**24.9% (11,171)**
SB2 Feb-Apr 2008		22.7% (22)	0% (1)	**21.7% (23)**	11.5% (15,327)	16.8% (14,383)	15% (413)	**14.1% (30,123)**
CP1 May-Jun 2008		40% (5)	24.4% (45)	**26% (50)**	7% (57)	20.7% (111)	33.4% (1,691)	**31.8% (1,859)**
WP1 Jun-Nov 2008		0% (13)	38.9% (36)	**28.6% (49)**	16.9% (37,691)	11.7% (17,634)	24.3% (1,431)	**15.5% (56,756)**
WP2 Mar-Jun 2009	0% (39)	3.6% (56)	3.7% (81)	**2.8% (176)**	13.5% (34,168)	17% (13,863)	15.9% (3,064)	**14.6% (51,095)**
CP2 May-Jun 2009		11.1% (9)	17.3% (81)	**16.7% (90)**	3% (169)	13.3% (196)	25.1% (2,228)	**22.8% (2,593)**
WP3 Jul-Oct 2009	5.4% (56)	7.7% (13)	0% (1)	**5.7% (70)**	21.8% (30,666)	19.5% (7,327)	26.8% (734)	**21.5% (38,727)**
CP3 Oct-Nov 2009		21.4% (28)	34.6% (107)	**31.9% (135)**	3% (66)	27.8% (209)	36.9% (4,695)	**36.1% (4,970)**
CP4 May-Jun 2010		10% (20)	12.8% (39)	**11.9% (59)**	14.3% (7)	11% (100)	22.6% (2,245)	**22.1% (2,352)**
CP5 Nov-Dec 2010			20.7% (58)	**20.7% (58)**	17.5% (40)	20.2% (228)	32.3% (6,032)	**31.8% (6,300)**
PNGTP1 Apr-Jul 2011		15.8% (19)	0% (3)	**13.6% (22)**	20.1% (28,730)	21.4% (11,552)	17% (352)	**20.4% (40,634)**
CP6 Oct-Oct 2011		50% (2)	15.7% (51)	**17% (53)**	0% (2)	23.1% (121)	27.4% (3,753)	**27.2% (3,876)**
CP7 Nov-Dec 2011	0% (30)	1.2% (85)	16.3% (92)	**7.7% (207)**	4.5% (22)	12.5% (160)	34.9% (4,120)	**33.9% (4,302)**
PNGTP2 Jan-Mar 2012		42.1% (19)	87.5% (8)	**55.6% (27)**	25.5% (28,312)	17.6% (9,588)	25.7% (2,000)	**23.6% (39,900)**
CP8 Sep-Oct 2012			44.4% (18)	**44.4% (18)**	10% (20)	22.9% (140)	38.2% (5,996)	**37.8% (6,156)**
PNGTP3 Apr-Jun 2013		26.7% (30)	0% (1)	**25.8% (31)**	13.9% (23,411)	14.5% (5,948)	8.0% (563)	**13.9% (29,922)**
CP9 Nov-Dec 2013		0% (1)	19.5% (41)	**19% (42)**	3.4% (29)	7.5% (134)	14.4% (4,255)	**14.1% (4,418)**
CP10 Aug-Aug 2014		12.5% (8)	4.2% (24)	**6.3% (32)**	0% (12)	5.6% (90)	1.8% (171)	**2.9% (273)**
CP11 Sep-Nov 2015		2.8% (71)	11.6% (95)	**7.8% (166)**	2.6% (231)	2.6% (704)	9.5% (1,871)	**7.2% (2,806)**
PG6 Jul-Jul 2016					NA% (0)	0% (17)	0% (2)	**0% (19)**
CP12 Sep-Oct 2016	0% (2)	10.7% (28)	10.8% (93)	**10.6% (123)**	2.8% (107)	21.3% (343)	10.9% (1,482)	**12.3% (1,932)**
Total	**3.1% (129)**	**12% (667)**	**18.8% (930)**	**15.0% (1,726)**	**17.4% (246,985)**	**16.8% (106,826)**	**27.1% (47,873)**	**18.4% (401,684)**

The majority of recoveries have come from purse-seine vessels (91.5%), followed by pole and line and other gear types (4%), unknown (4.2%) and longline recoveries <1% (223 in total). Table 10 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 received from canneries or via transhipment (Figure 8). The information from transhipment on date and location of recovery is typically reported as unknown. To improve understanding of tag recovery patterns, the number of fish caught by purse seine needs to be compared with the numbers caught by longline to explore whether tag recoveries are really disproportionate or not between the fleets.

3.3 Tag Recovery staff

Across the region the previously full-time Tag Recovery Officers (TROs) have now taken on other duties at their respective local fisheries agencies, however they generally continue to act as TROs. New Fisheries officers in American Samoa, Tonga, Samoa, Taiwan and Tuvalu are now acting as TROs. As of mid-2017, negotiations with Kiribati MFMRD to re-establish a full time TRO position in Tarawa are still under progress.

Regular emails, visit in countries, as well as meetings held at SPC allow to maintain constant contact with the existing network. Prior to the 2016 CP tagging cruise, a general email outlining the importance of the tag recovery scheme was sent to the TRO network as well as industries and fishing vessels.

Recovery information is received at SPC from TROs on a semester basis. The establishment of these TRO positions has provided greater opportunity for collection of tags during unloading, transhipments and processing in canneries with more complete and reliable capture information (Table 11). Major unloading and processing facilities as well as transhipping vessels in port have been visited by TROs over the last 12 months.

3.4 Tag Seeding

To date nearly 56% 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 2017, a total of 527 tag seeding kits (consisting of seeding tags, applicators, guide books and data forms) for a total of 13,467 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. When a kit is not completely deployed during a trip, the kit is either kept aside or used in another kit for deployment. Table 12 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, 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 527 kits distributed to observer coordinators, 363 have been given to observers for deployment, of which 339 tag seeding datasheets have been received for observer trips.

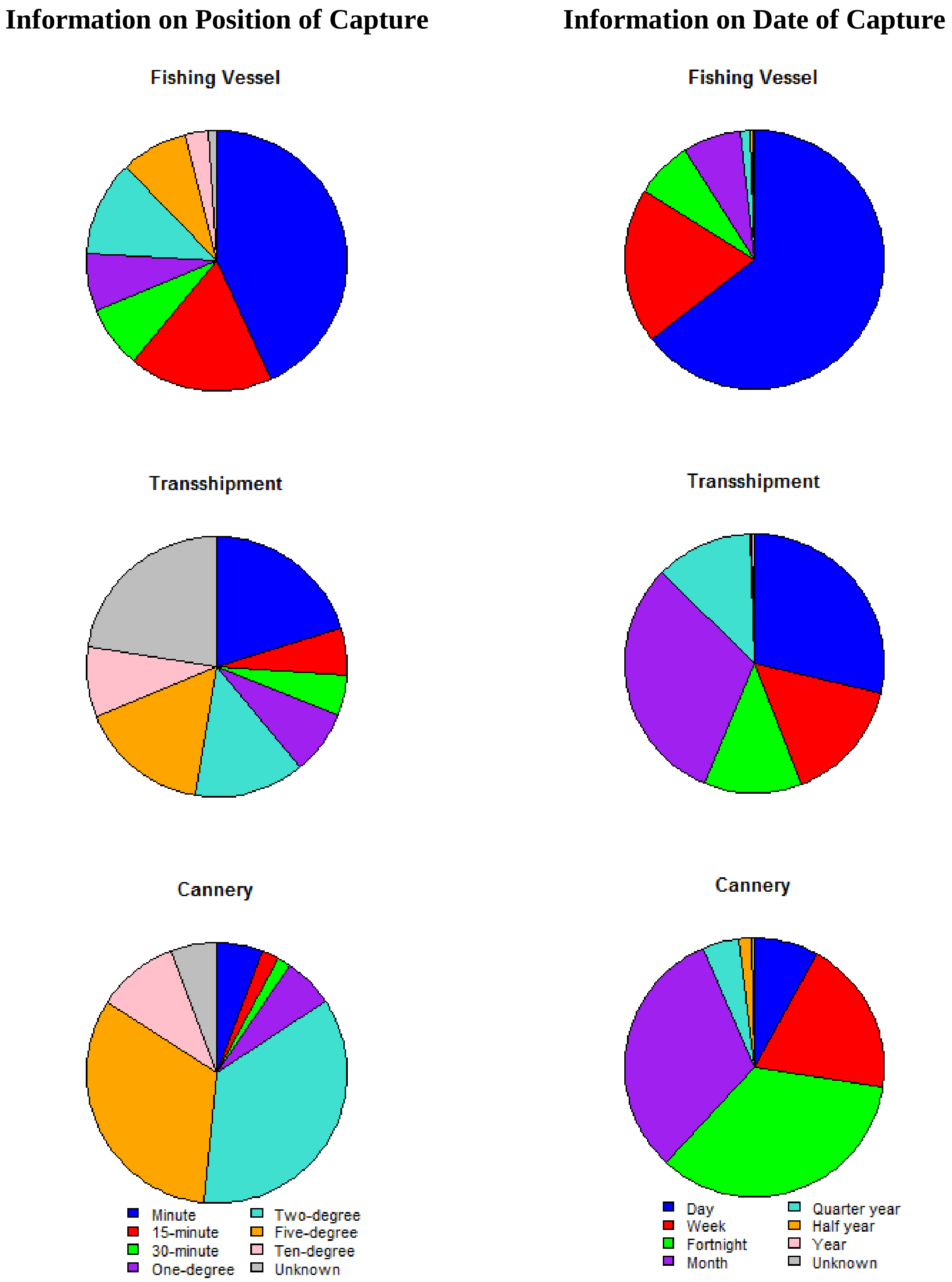

Figure 8. Location and date of tag recovery accuracy information for recoveries on fishing vessels, during transhipment and at canneries.

Since June 2016, 11 kits have been deployed, using a total of 294 tags. This is a lower rate of deployment in comparison to the previous year (19 kits for 516 tags). As at 1st June 2017, there have been 7,017 reported tags that have been seeded and 3,927 (55.96%) of these have been returned to SPC. Tables 13 and 14 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 658 tags, was absent from the recovery information for 145 tags and was correct for 2955 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 were updated for the 2016 bigeye and yellowfin assessments using the approach outlined in Peatman et al. (2016). The RR prior parameters were calculated for the regional structures used in the 2014 assessment models, and the alternative regional structure suggested at the 2017 pre-assessment workshop. The RR prior parameters were insensitive to the different regional structures, given the low levels of purse seine effort in the areas where the region boundaries were moved. At the time of updating the reporting rate parameters, the proportion of tags seeded in 2015 that were detected and reported was lower than for previous years. It is too early to tell if this is due to delays in tag detection and reporting, or low reporting rates for the seeded tags.

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 9).

3.7 TagEst models

Development of spatially explicit advection-diffision-reaction models of skipjack and yellowfin has continued over the past year, using TagEst (Sibert et al., 1999). The models allow estimation of movement and mortality, taking in to account the spatial and temporal distribution of both tag releases and fishing effort. Advective and diffusive movement parameters, fleet catchabilities and natural mortality were estimated, with fleet-specific reporting rates fixed based on analyses of tag seeding experiments.

Models have now been fitted to conventional tagging data from the PTTP, RTTP, and for skipjack, the SSAP. Early work identified a tendency for recoveries shortly after release to be underestimated, with longer-term recoveries overestimated. For the RTTP models, examination of release, recovery and fishing effort distributions suggested errors in position for tag recoveries, fishing effort, or both, particularly in the Solomon Islands EEZ. Decreasing the spatial resolution of the models to 2 degree squares resolved the underestimation of short-term recoveries. For the PTTP models, it was necessary to both decrease the spatial resolution to 2 degree squares, and exclude recoveries in the same time-step as release, to achieve satisfactory model fits.

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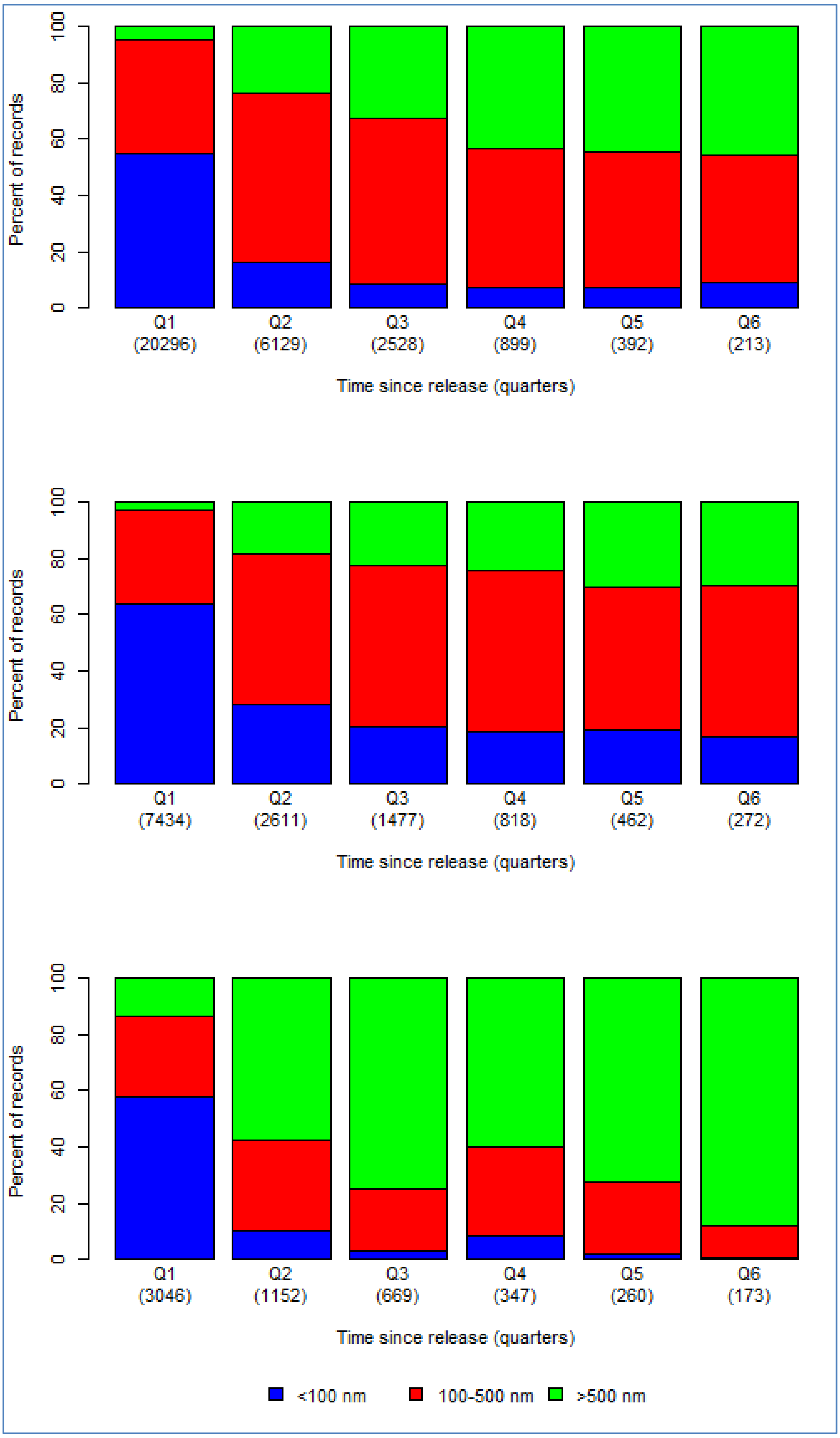

Figure 9. Reported recoveries within 100 nm, 100-500 nm and >500 nm in the first 6 quarters (18 months) since release for skipjack (upper graph), yellowfin (middle graph) and bigeye (lower graph). The sample size for each quarter is provided in the parentheses below the quarter label on the x-axis.

Table 10. 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	55	0	3	0	0	0	0	0	1
PTTP Phase 2 - Central Pacific #5	7	350	7	342	0	4	0	0	0	0	0	4
PTTP Phase 2 - Central Pacific #6	5	97	4	90	0	4	0	0	1	0	0	3
PTTP Phase 2 - Central Pacific #7	2	194	2	181	0	12	0	1	0	0	0	0
PTTP Phase 2 - Central Pacific #8	0	52	0	44	0	7	0	0	0	0	0	1
PTTP Phase 2 - Central Pacific #9	0	69	0	63	0	5	0	0	0	0	0	1
PTTP Phase 2 - Central Pacific #10	1	1	1	1	0	0	0	0	0	0	0	0
PTTP Phase 2 - Central Pacific #11	1	3	1	3	0	0	0	0	0	0	0	0
PTTP Phase 2 - Western Pacific #1	152	12	130	12	1	0	2	0	14	0	5	0
PTTP Phase 2 - Western Pacific #2	263	43	241	22	9	14	0	0	3	4	10	3
PTTP Phase 2 - Western Pacific #3	160	23	147	20	1	3	0	0	7	0	5	0
PNGTP - Papua New Guinea #1	253	2	240	2	5	0	0	0	0	0	8	0
PNGTP - Papua New Guinea #2	243	40	239	39	2	1	0	0	0	0	2	0
PNGTP - Papua New Guinea #3	45	6	43	5	0	1	0	0	2	0	0	0
Total	**1,820**	**1,336**	**1,688**	**1,220**	**33**	**67**	**3**	**1**	**46**	**7**	**50**	**41**

Table 11. 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	2,183	96.34	93.20	0.19	0.48	0.00	0.33	5.80	3.11	1.65	28.03	23.77
China	34	44.12	20.00	0.00	0.00	0.00	0.00	80.00	82.35	0.00	2.94	79.41
Fishing vessel	559	92.49	80.46	1.74	0.00	0.00	15.09	2.71	1.79	0.72	3.58	5.19
FSM	566	87.10	97.36	0.41	0.20	0.00	0.00	2.03	2.47	0.71	10.25	29.68
FSM (SPC)	182	40.11	91.78	2.74	1.37	0.00	0.00	4.11	1.10	0.00	5.49	3.30
IATTC	9,584	24.81	46.93	4.04	1.47	0.00	14.30	33.26	23.83	10.59	14.50	70.90
Indonesia	5,984	81.23	0.12	0.00	0.00	95.19	3.25	1.44	2.07	0.00	5.01	5.60
IOTC	10	30.00	0.00	0.00	0.00	0.00	0.00	100.00	70.00	0.00	30.00	20.00
Japan	3,030	74.49	92.07	3.81	0.09	0.00	0.71	3.32	3.73	4.79	20.07	4.85
Kiribati (Kiritimati)	342	79.82	92.67	0.00	1.83	0.00	0.00	5.49	4.97	5.85	20.47	23.98
Kiribati (Tarawa)	1,022	85.52	72.20	0.11	0.46	0.00	0.46	26.77	21.82	3.42	17.81	8.71
Korea	610	68.69	16.23	1.19	0.24	0.00	0.48	81.86	82.30	0.00	4.10	9.84
Marshall Islands	980	89.80	87.95	9.20	0.45	0.00	0.45	1.93	1.43	1.94	11.84	26.43
Nauru	2	100.00	0.00	0.00	0.00	0.00	0.00	100.00	50.00	0.00	50.00	50.00
Philippines (direct)	8,438	56.07	67.05	4.40	0.06	0.00	7.80	20.69	16.65	4.48	26.36	65.69
Philippines (Frabelle)	352	51.99	97.27	0.55	1.64	0.00	0.55	0.00	7.39	3.12	0.85	27.56
Philippines (NFRDI)	175	49.71	59.77	4.60	0.00	0.00	4.60	31.03	10.29	0.00	10.29	13.71
PNG (China Fisheries Association)	7	14.29	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85.71	85.71
PNG (Dologen ltd)	1	100.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PNG (Fairwell Fishery)	28	53.57	60.00	20.00	0.00	0.00	0.00	20.00	3.57	10.71	39.29	32.14
PNG (Fong Seong Fishery)	7	100.00	85.71	14.29	0.00	0.00	0.00	0.00	0.00	28.57	28.57	0.00
PNG (Frabelle)	6,772	82.06	88.45	10.02	0.05	0.02	0.04	1.42	1.74	1.30	3.51	8.06
PNG (Japanese Far Sea Tuna Association)	2	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	0.00	0.00
PNG (Korean Overseas Association)	3	66.67	100.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	33.33	33.33
PNG (Luminar Fishing)	12	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	8.33	16.67	0.00
PNG (NFA)	515	85.63	70.07	5.22	0.45	0.00	2.27	22.00	17.28	1.55	11.84	22.91
PNG (other)	1,076	79.65	71.30	0.82	0.12	0.00	0.12	27.65	6.13	2.23	14.78	12.45
PNG (Pacific Blue Sea Fishing)	274	70.44	95.34	4.66	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.00
PNG (RBL Fishing)	962	72.14	99.71	0.14	0.00	0.00	0.00	0.14	0.52	2.18	7.59	6.76
PNG (RD)	9,517	93.52	80.08	17.97	0.06	0.00	0.03	1.87	1.77	0.53	2.30	3.94
PNG (RR Fishing)	30	83.33	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PNG (Sepik Coastal Agencie)	10	100.00	90.00	0.00	0.00	0.00	0.00	10.00	10.00	0.00	10.00	10.00
PNG (SST)	1,438	43.53	62.94	13.58	0.00	0.00	11.98	11.50	36.16	1.39	29.62	34.49

Source	Recov.	% Valid.	% VMS	% Logsheet	% Archival	% Buffer	% Other	% None	% No vessel name	% Vessel but no date	% Vessel but no position	% No length
PNG (Taiwan Deep Sea Association)	19	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	15.79	5.26
PNG (TPJ Fishing)	1,860	69.09	89.18	4.36	0.08	0.00	0.39	5.99	4.25	2.31	4.35	6.34
PNG (TSP Marine)	457	83.81	99.48	0.00	0.00	0.00	0.00	0.52	0.00	1.09	7.22	2.41
Solomon Islands (Global Investment)	1,081	97.59	78.77	12.61	0.00	0.00	0.00	8.63	8.60	0.93	1.85	55.87
Solomon Islands (Korean Deep Sea Association)	355	59.15	100.00	0.00	0.00	0.00	0.00	0.00	0.28	10.14	14.08	7.32
Solomon Islands (MFMR)	281	83.27	75.21	3.85	2.56	0.00	0.00	18.38	14.95	0.36	14.59	9.96
Solomon Islands (NFD)	4,000	88.82	62.26	37.32	0.03	0.00	0.00	0.39	0.20	0.15	3.72	3.25
Solomon Islands (other)	180	85.56	86.36	2.60	0.00	0.00	0.00	11.04	16.67	2.78	11.11	28.33
Solomon Islands (Soltai)	3,070	92.74	79.87	10.89	0.00	0.00	0.56	8.68	7.13	0.16	1.53	2.70
Solomon Islands (Taiwan Deep Sea Association)	559	95.35	100.00	0.00	0.00	0.00	0.00	0.00	0.00	1.79	1.97	1.07
Solomon Islands (Western Solomon ventures limited)	11	63.64	100.00	0.00	0.00	0.00	0.00	0.00	0.00	27.27	27.27	9.09
Tagging vessel	218	51.83	2.65	0.00	0.88	0.00	94.69	1.77	0.46	0.00	10.09	1.38
Taiwan	69	91.30	95.24	0.00	0.00	0.00	0.00	4.76	0.00	0.00	23.19	0.00
Thailand	10,606	63.64	93.47	3.64	0.12	0.00	0.04	2.73	1.45	0.06	95.31	1.47
Vanuatu	30	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other	263	61.60	58.64	1.85	12.96	0.00	4.94	21.60	15.21	0.00	11.79	28.14

Table 12: Number of seeded tags deployed per EEZ since the beginning of the project.

EEZ	Releases
Not known yet	2,219
American Samoa	3
Cook Islands	52
Federated states of Micronesia	238
Fiji	7
Gilbert Islands	490
Howland & Baker	4
Indonesia	7
International waters H4	68
International waters H5	73
International waters I2	114
International waters I4	10
International waters I5	10
International waters I6	15
International waters I9	5
Jarvis	5
Marshall Islands	60
Nauru	151
Northern Line Islands	20
Other international waters	4
Papua New Guinea	1,966
Phoenix Islands	331
Samoa	14
Solomon Islands	614
Tokelau	161
Tuvalu	376
Total	**7,017**

Table 13: Vessel reported per locations of seeded tag recovery.

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	8,550	231	81	23	127	55.0
HONIARA, Solomons	1,144	469	12	2	455	97.0
LAE, PNG	5,454	192	27	5	160	83.3
LONDON, Kiribati	162	2	0	0	2	100.0
MADANG, PNG	2,880	300	59	0	241	80.3
MAJURO, Marshalls	1,168	249	20	0	229	92.0
MANTA, Ecuador (IATTC Tags)	1,470	48	13	0	35	72.9
NORO, Solomons	8,308	52	20	1	31	59.6
Noumea, New Caledonia	387	34	3	3	28	82.4
PAGO PAGO, A. Samoa	2,169	523	40	22	461	88.1
POHNPEI, FSM	848	73	6	0	67	91.8
PORT MORESBY, PNG	524	80	14	0	66	82.5
RABAUL, PNG	396	133	29	0	104	78.2
SAMUTSAKOM, Thailand	10,563	578	216	6	356	61.6
SAN DIEGO, USA (IATTC Tags)	8,208	166	32	76	58	34.9
SHIMIZU, Japan	2,998	7	2	1	4	57.1
TARAWA, Kiribati	1,026	176	6	4	166	94.3
VIDAR, PNG	7,149	192	13	1	178	92.7
WEWAK, PNG	6,984	253	65	1	187	73.9

Table 14: 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	11	0	1	10	90.9
CHOTIWAT	15	6	0	9	60.0
EKSAKHON COLD STORAGE CO., LTD	31	5	0	26	83.9
ISA VALUE	6	1	0	5	83.3
PATAYA FOOD INDUSTRIES LTD.	131	94	0	37	28.2
Premier Canning	1	1	0	0	0.0
R.S. Cannery Co., Ltd.	36	9	0	27	75.0
Songkla Canning PLC.	62	42	0	20	32.3
SOUTHEAST ASIAN PACKAGING	50	8	0	42	84.0
Thai Union Manufacturing Co.	39	5	0	34	87.2
TROPICAL CANNING	15	2	0	13	86.7
Unicord Public Co., Ltd.	108	21	2	85	78.7

Decreasing the spatial resolution of the models to 2 degree squares resolved the underestimation of short-term recoveries. For the PTTP models, it was necessary to both decrease the spatial resolution to 2 degree squares, and exclude recoveries in the same time-step as release, to achieve satisfactory model fits.

The estimated movement dynamics for both skipjack and yellowfin show variability both between species and tagging programmes. However, a consistent feature across all models is comparatively low rates of movement for tagged fish in the region surrounding the Solomon Islands main group archipelago (see Figure 10). Kleiber and Hampton (1994) detected a tendency for skipjack to remain in the Solomon Islands main group archipelago (MGA) based on SSAP data. The TagEst models suggest that low rates of skipjack in the MGA have persisted through the SSAP, RTTP and PTTP, with yellowfin displaying similarly reduced mobility in the region. This has a number of implications, not least on tag mixing at the spatial scale of the Multifan assessment models, and warrants further investigation using the individual based model IKAMOANA (see Section 3.8).

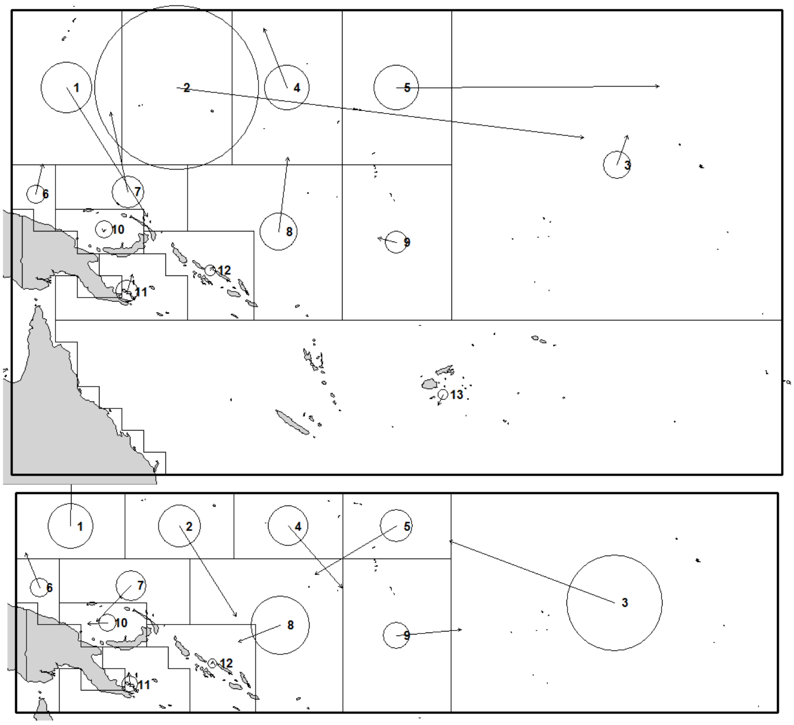

Figure 10. TagEst derived movement of yellowfin tuna in the Western Pacific fitted to conventional tag data from the RTTP (top panel) and PTTP (bottom panel). Arrow lengths are proportional to advective movement rate. Circle areas are proportional to diffusive movement rate.

3.8 Tagging simulator

An individual-based simulation modelling tool has recently been developed for skipjack tuna in the WCPO, named IKAMOANA (Scutt Phillips et al., 2016), some of which can be explored online at: www.drjscutt.com/IKAMOANA/Skipjack.mp4. It provides a framework to examine the potential movement of individual tuna schools under a variety of behavioural assumptions, such as those estimated in the SEAPODYM model (Senina et al., 2016). The tool can be easily extended to other species such as yellowfin and bigeye, for which there already exist estimated movement parameterisations.

The IKAMOANA model is now being used in the context of tagging to explore the potential effect of differing tag release locations, climatologies, and tagging strategies on the potential bias present in the data obtained from such programmes for skipjack. Preliminary results show that current tag mixing assumptions may seldom be met, in agreement with some previous studies (e.g. Kolody and Hoyle, 2013), but that there potentially exist optimal locations and strategies with which to tag skipjack for maximising the use of tag return data for stock assessment. In particular, while tagged fish may rarely distribute in a manner representative of the untagged population, the relative mortality experienced due to fishing can be informative if the correct tagging strategies are chosen.

The current project developing this model is due to finish by the end of 2017, but it is anticipated that project outputs will include publications on differing tagging programme scenarios for skipjack tuna in the WCPO. It is suggested that the use of IKAMOANA for tagging simulation, under the assumptions of SEAPODYM or other behavioural information obtained from analyses of conventional or electronic tagging data (e.g. Scutt Phillips, 2017; Peatman et al., 2016), offers an approach to effectively support the ongoing design and analysis of tagging experiments as part of the PTTP (Figure 11).

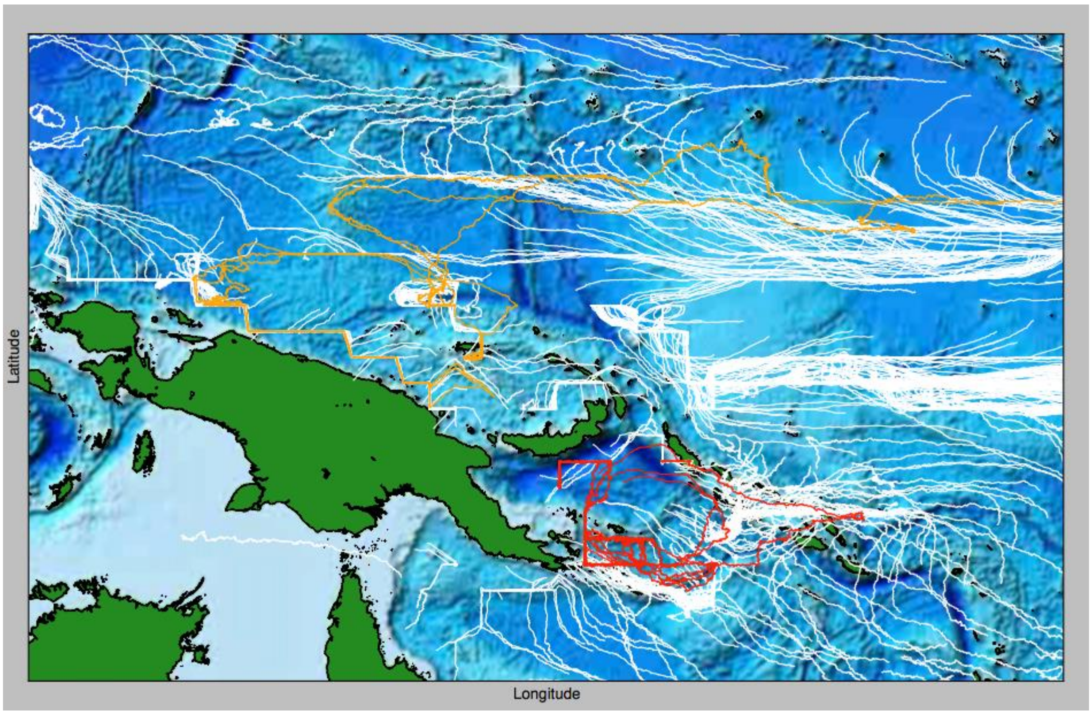

Figure 11. IKAMOANA tagging simulation output, showing the potential movements of skipjack schools tagged at two different tagging sites around Papua New Guinea and the Solomon Islands (red, orange), in relation the movements of the local population (white). Movements are ocean forcings and are drawn from the most recent SEAPODYM solution for skipjack tuna.

3.9 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 SC12, one new tag recapture has been reported with the total of 30 recoveries (1%) for the project. Movements of recaptured fish for which we received accurate recovery position are displayed in Figure 11.

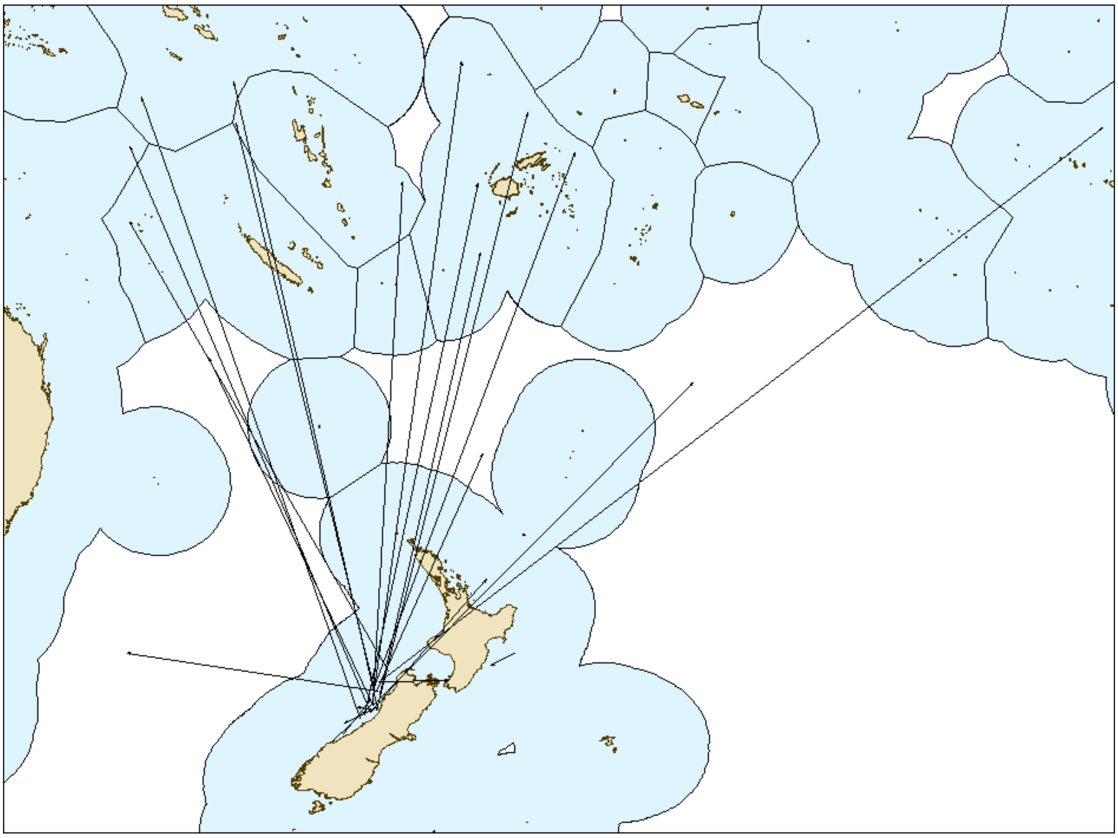

Figure 11. Release-recovery arrow map for albacore tags reported to SPC.

4 ISSUES ARISING

By just about any measure, the PTTP has been very successful to date and with the significant commitment from the Commission to ongoing funding in late 2016, this programme looks set to continue as a strong part of WCPFCs science for the medium term. However, there remain significant issues facing the success of any tuna tagging research in the region.

First is the issue of increasing costs of vessel time. This has two major effects, one is that to stay within existing budgets we constrain the amount of at-sea time and thus the amount of tagging which can be undertaken (see Section 2.2.2). The other is that to complete research targets we need to seek additional funding. The increased funding from WCPFC in 2017 and in the indicative budget for out years will help this. However, access to a more cost effective research vessel would also make the tagging programme more sustainable.

Second is the availability of suitable research vessels. The most reliable and successful approach – globally – for large-scale tagging of skipjack tuna is to use the pole and line method of fishing. At the same time this fleet has shrunk globally to the point where there now remain only a very small number of vessels in the Pacific region which can be utilised for this research.

Those that remain are in high demand for industrial fishing as they produce a sought after product. This creates considerable difficulty in procuring a vessel for this research, and means that we become a price-taker as the market is non-existent. Another significant cost pressure on the research programme. Although several suitable longline vessels exist in the region for the various line fishing techniques used to target bigeye tuna, the reality is that none are designed for research fishing. By way of example a constraint often encountered is the number of science staff that can be placed on the vessel. This in turn limits the amount of science that can be completed in a day, with the consequence that either more time at-sea is required, or less research is conducted.

These issues begin to build a case for identifying a long-term multi-purpose tagging platform in the WCPFC area. Integrating WCPFC biological sampling and other tuna ecosystem research into the design – areas of research which face the same cost pressures – make the case even stronger. Obviously such a proposal would need to be carefully investigated before moving to deciding to obtain such a platform. Accordingly, SPC has let a small consultancy to undertake a pre-assessment of some of the operational costs of a dedicated tuna research vessel for the Pacific Ocean. It is hoped the preliminary results of that work will be available to inform PTTP steering committee discussions. A more comprehensive cost analysis of such an approach to fisheries and ecosystem research for WCPFC is required to progress this concept further. SPC have prepared a draft terms of reference for such an analysis (see Appendix II). It is intended that the PTTP Steering Committee discuss this matter further at its 2017 meeting (Appendix I) with a view to progressing such a consultancy as soon as practical.

5 PTTP 2017-2020 workplan

The proposed workplan for the PTTP for 2017-2020 is highlighted in Table 15 below. The workplan recognises the decisions of SC in 2016 to normalise the tagging programme (WCPFC SC, 2017).

6 RECOMENDATIONS

SC13 is invited to note the report of ongoing progress in implementation of the PTTP. In particular we recommend that SC:

- Consider the 2018 tag release programme, and associated budget;
- Consider the PTTP workplan for 2017-2020; and
- Consider the issue of cost-effectiveness of vessel charter in relation to acquiring a dedicated tagging vessel.

Table 15: Proposed PTTP workplan for the period 2017-2020.

	ACTIVITIES	2017	2018	2019	2020
TAGGING					
1.	**Pole and line tagging research voyage** Target is skipjack, with secondary target of yellowfin Following SC12 recommendation to implement a skipjack tagging experiment every second year, a pole and line cruise is scheduled for 2017 and biennially thereafter. Note also critical component of biological sampling in support of Project 35b.	A charter arrangement has been concluded with the NFD fishing company to use their P&L FV Soltai 105 to implement a 50 day cruise from mid-September.		Plans to be refined after 2017 voyage, but most likely a very similar research voyage in 2019.	
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 2018 and biennially thereafter. Note also critical component of biological sampling in support of Project 35b.		Focus in the Western Pacific to recognize the lack of tags in that area to date		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.				
5.	Develop new tag recovery poster.				
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				
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 analyses of optimal design for 2019 research voyage.				
PLANNING					
14.	Review and update research plan	Ongoing annual task for rolling plan.			
15.	Consultancy on cost-effectiveness of a research vessel.				

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APPENDIX I

Proposed agenda for the 2017 PTTP Steering Committee meeting

PROVISIONAL AGENDA
PACIFIC TUNA TAGGING PROGRAMME STEERING COMMITTEE
17:30-19:00, Thursday 10 August 2017
(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*
3			**WORK PLAN 2017-2020**
	3.1		2017 Skipjack research voyage (RP-PTTP-02)
	3.2		Tag recovery network (RP-PTTP-02)
	3.3		2018 Bigeye research voyage (RP-PTTP-02)
	3.4		Research voyages beyond 2018 (RP-PTTP-02)
	3.5		Related work in 2018 and beyond (RP-PTTP-02)
	3.6		Cost-effectiveness of a dedicated vessel (RP-PTTP-02)
4			**OTHER REGIONAL OR SUB-REGIONAL TAGGING**
5			**ADMINISTRATIVE MATTERS**
6			**ADOPTION OF REPORT**

APPENDIX II

Proposal for a study to assess the operational costs of a dedicated tuna research vessel for the Pacific Ocean

(DRAFT Terms of Reference)

A. Project Description

More than 70% of the global tuna catch are fished in the Pacific Ocean for an estimated value of over US$6 billion. The harvesting level of tuna resources and the efficiency of the involved industrial fleet henceforth impose a very responsive management mode. The management measures need to be supported by strong evidence based on high quality data allowing stock assessment containing a minimum of uncertainty. The data obtained independently from the fishing fleets have become essential and the science based management bodies have the responsibility to support their analysis with the best scientific evidence available. This requires a continuous acquiring of mortality rates for the impacted species, a detailed knowledge of their biology, along with their behaviour in response to fishing gears and in response to the variations in their environment. Assessing the fishing impact on the whole ecosystem requires collecting data on all the species living in association with tuna and tuna-like species, data about their prey and the pelagic ecosystem. The collection of all this information requires the permanent use of an adaptable research vessel properly designed for the purpose. There are currently no suitable tuna research vessels available in the region (or beyond).

Accordingly it seems to be the appropriate timing to carefully explore the permanent use of an adaptable research vessel dedicated to the collection of the data used in tuna stock assessment.

B. Current availability of suitable research platforms

1. For tagging experiments

Tagging studies are commonly used in fisheries research to improve estimation of animal population size, mortality, movement (spatial stock structure) and growth. Until now, large scale tuna tagging campaigns for skipjack tuna have chartered medium-size commercial fishing boats around 200 GT tonnage (199 GT for last PTTP, 237 GT for IOTP) for cost reasons, and also due to size restrictions on bait ground access and restricted suitable anchorage in some areas. Releasing a large number of conventionally tagged tuna implies the use of a pole-and-line vessel, but suitable such tagging platforms are becoming increasingly scarce worldwide. In most countries, pole-and-line fleets have been replaced by purse-seine fleets.

Research cruises more orientated towards electronic tagging and targeting all size tuna and their associated species need a more polyvalent tagging platform that could deploy a large variety of fishing gears (horizontal and vertical longlines, troll lines, danglers, rod and reel etc…). Catching and handling large size fish requires a working deck with easy access to the sea and a boat with high manoeuvrability facilitated by steering commands located at the working deck level. For example the design of a standard Japanese pole and line vessel is not suitable for the purpose. In the Pacific, some longline type fishing boats have been used to target the tuna schools that are associated with floating objects, mainly the oceanographic buoys (TAOs) that are anchored along the equator and the drifting FADs used by the purse seine fleet. The distances involved between floating objects and from ports with appropriate facilities for deploying a research voyage require the use of long range (> 6,000 nm) platforms which are not common in the region for the necessary size of fishing vessels for successful research.

2. For collecting ecosystem biological and physical data

This necessitate the use of gears that are usually not found on a commercial tuna fishing vessel, including : trawling nets to catch tuna prey and plankton size organisms, CTDs to collect sea water temp/depth profiles, and multi-beam echo-sounders that can manage continuous records of highly detailed bio-acoustic data.

Boats used in this type of research are typically from the oceanographic vessel category. They are usually linked to governmental scientific institutes. To operate the different types of gears used at an ocean wide scale, those vessels need to be large (>400 GT). To cover important operational and maintenance costs, their use is often shared between multidisciplinary research projects. Their availability is therefore limited, subjected to utilisation applications that need to be planned years in advance.

C. Arguments for the construction of a new multipurpose platform dedicated to tuna research:

1. Practicality:

- Tuna tagging data are likely to become increasingly important and need to be collected continuously rather than episodically. Other types of data need to be continuously collected to monitor the ecosystem changes.
- The pole and line vessels that can currently still be chartered are disappearing along with the associated fisher knowledge on operations and bait grounds. These platforms cannot cover all the different data collection needs.
- The global applicability of continuous data collection is likely to facilitate collaboration between the different tuna commissions (RFMOs). The cumulated needs at the Pacific scale could probably cover most parts of the yearly schedule of a single boat.
- A crew specifically recruited and trained to the specific research methods and strategies will be more capable than a commercial fishing boat crew that often need a long training period before they become fully efficient.

2. Cost:

- Continuous research would avoid the substantial establishment costs needed each time a new programme is started.
- Some examples:
  - Previous recent charter costs, including fuel, for a long range tuna tagging platform (about 200GRT) were situated between 150,000 and 200,000 USD/month. Last offer (March 2017) was more than the double of these figures.
  - The total tagging platform charter costs spent during each of the last large tagging projects (PTTP and IOTP) is over the current estimated cost for building a new boat of around 35 metres/200GRT (*Between 5 and 8 USD millions, IOTP vessels were built at about 4 USD millions in 2000*). Last estimation for the currently running (2017) AOPT total charter cost is 9.1 million Euro (ICCAT, SCRS/2014/092).

D. Project tasks

The project would assess the full range of operational costs, including options on governance, inter-RFMO vessel sharing, multiple research modes, and future vessel replacement. These costs should be compared with the costs and benefits of the current approach.