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Project 42: Pacific Tuna Tagging Project Report and Workplan for 2018-2021

WCPFC-SC14-2018/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 2017-18 under the banner of the PTTP including research voyages, tag recoveries, tag recovery and tag seeding activities, and tagging related analyses. Issues arising in 2018 for PTTP Steering Committee consideration are highlighted. The PTTP work planned for 2018-2021 is outlined and an agenda for the 2018 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 (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 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). In 2017 SC endorsed the PTTP workplan for 2017-2020 and supported ongoing tagging programme as part of the ongoing work of the SC (WCPFC-SC, 2017). In 2017 at WCPFC14, the Commission agreed to the recommendation and allocated funds for 2018 and indicated funding for 2019-20 to continue this work (WCPFC, 2018).

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 2018 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 SC13 in 2017 highlighted and the scheduled work for 2018 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*
	Jul-Aug 2018	Central Pacific (CP13)	*Gutsy Lady4*
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*

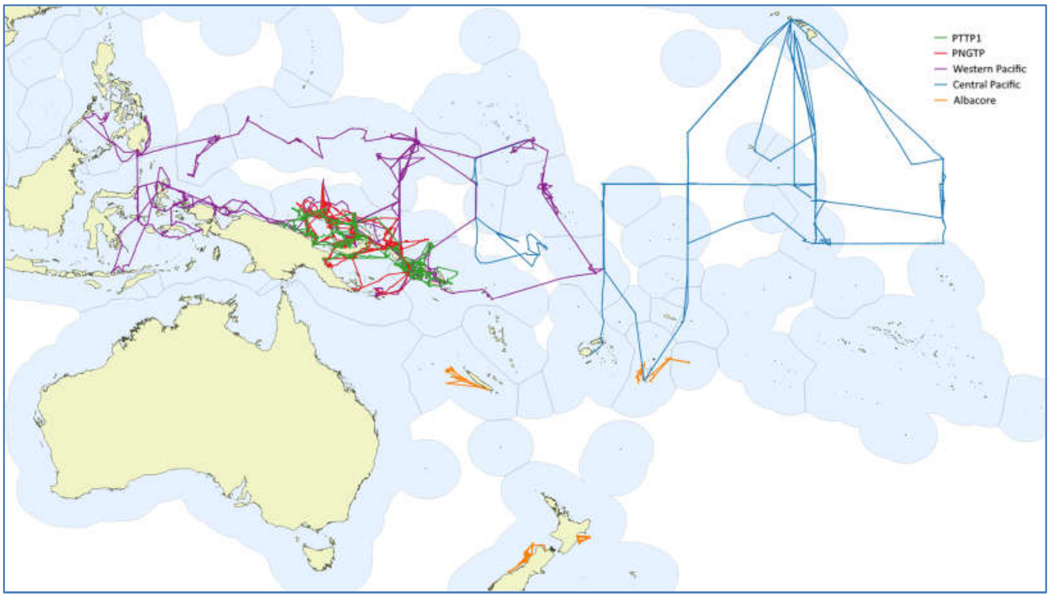

Figure 1: Tagging vessel tracks for all voyages for all PTTP research voyages to date. Legend relates to the operational areas described in Table 1.

2 SUMMARY OF PTTP ACTIVITIES IN 2017-2018

Since SC13 (SPC-OFP, 2017a), PTTP activities have included one large-scale pole and line voyage, WP4, in the waters of PNG and Solomon Islands, continued implementation and refinement of tag recovery processes and tag seeding, data preparation for use in the post-SC additional analyses conducted on the bigeye stock assessment, and data preparation for use in the albacore tuna stock assessment in 2018. Research voyage CP13 preparations began in late 2017 and the vessel departed Majuro, Marshall Islands, 16th July 2018.

2.1 WP4 pole and line tagging voyage

In the framework of the PTTP and following the recommendations of the 12th Scientific Committee, in 2017 the SPC implemented a new tagging experiment focussing on skipjack and yellowfin tuna (funded by WCPFC, Korea and SPC). To achieve this work, SPC chartered a Pole and Line vessel from the National Fisheries Developments (NFD)/Tri Marine (TMI) fishing fleet based in Noro/Western Province/Solomon Islands. The research voyage started from Noro on the 17th of September for a total duration of 50 days. The first 3 weeks of the charter were spent releasing tagged tuna in the waters of PNG, then the vessel moved west and south into the Solomon Island EEZ (see voyage tracks in Figure 2).

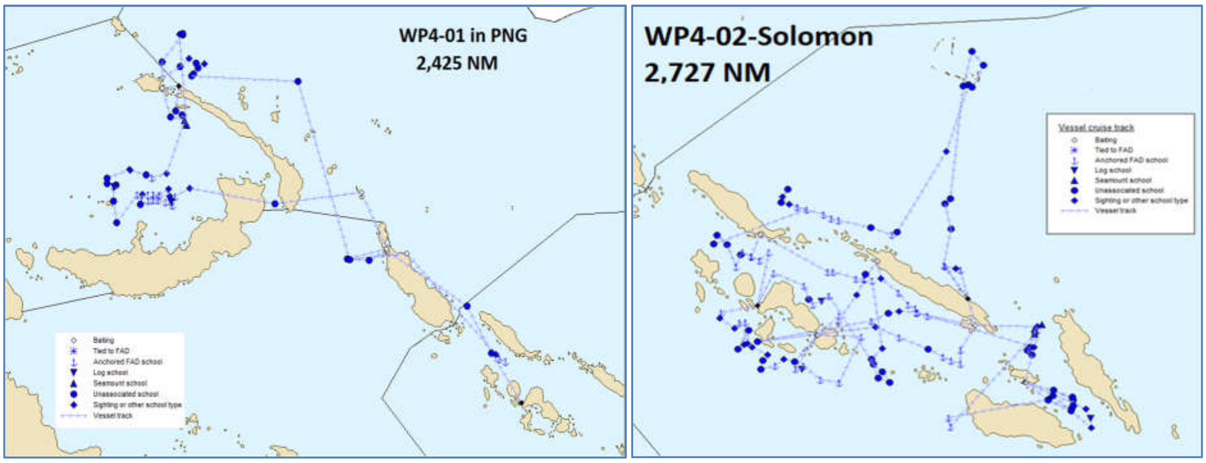

Figure 2: Voyage tracks during the Sep-Oct 2017 WP4 voyage in PNG (left) and Solomon (right) waters.

2.1.1 WP4 tag releases

In PNG: Over the 21 days of the voyage leg, 17 days were spent searching and fishing and four full or partial days in port. 6,641 fish were tagged and released during the voyage, at a relatively low (compared to previous tagging experiments in PNG waters) average of **390** fish per day. The species composition in total was 87% skipjack, 13% yellowfin with only 2 bigeye tuna tagged. No archival tags were released due to the lack of yellowfin or bigeye of suitable size.

In Solomon Islands: Over the 29 days of the voyage leg, 25 days were spent searching and fishing and four full or partial days in port. **21,139** fish were tagged and released during the voyage, at an average of **845** fish per day. The species composition in total was **93%** skipjack, **7%** yellowfin with only 18 individual bigeye tuna tagged. These percentages are quite different from previous tagging in the same area (**33%** of Y and B combined in 2007 and **61 %** in 2008). Very limited numbers of good size yellowfin and bigeye were caught during this voyage and only seven archival tags were released in five yellowfin and two bigeye tunas. Figure 3 shows the distribution of releases during the voyages.

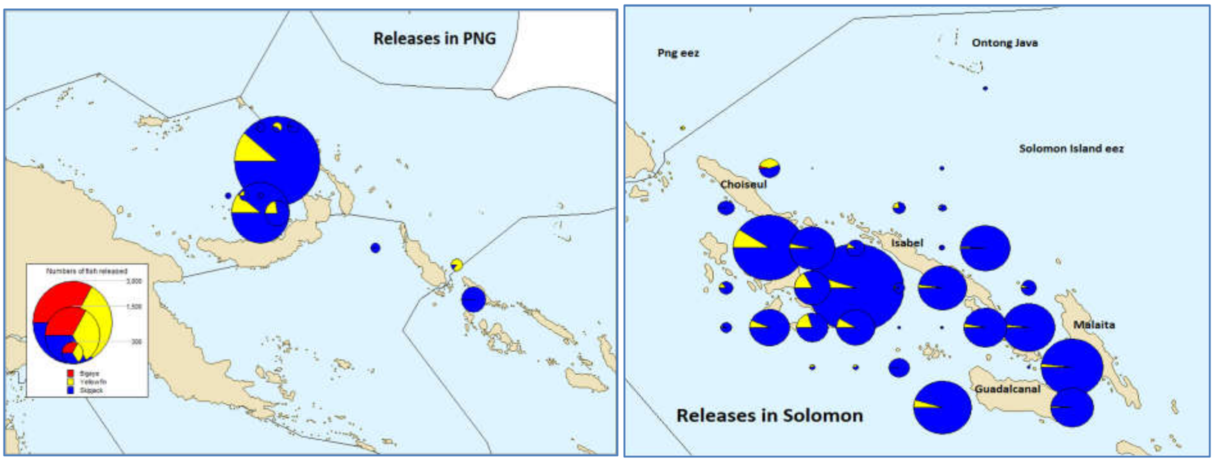

Figure 3. Distribution of tag releases per species in PNG (left) and Solomon (right) waters.

Releases by school association and by species for each voyage leg are given in Tables 2 and Table 3.

Table 2: Release per species and school association in PNG waters.

school association	BET	SKJ	YFT	Total	%
Seamount	0	2195	253	**2448**	**37**
Drifting Fad	1	32	58	**91**	**1**
Anchored Fad	0	2157	271	**2428**	**37**
Log	0	123	13	**136**	**2**
free school	1	1301	236	**1538**	**23**
Total	**2**	**5808**	**831**	**6641**	100

Table 3: Release per species and school association in Solomon waters.

School association	BET	SKJ	YFT	TOTAL	%
Seamount	-	853	20	**873**	**4**
Whale shark	-	436	25	**461**	**2**
Drifting FAD	2	810	38	**850**	**4**
Anchored FAD	4	12213	895	**13113**	**62**
Log	-	794	223	**1017**	**5**
Free school	12	4510	303	**4825**	**23**
Total	**18**	**19616**	**1504**	**21139**	100

Figures 4 and 5 display the length frequency for the fish tagged on each voyage leg.

2.1.2 Biological sampling

As part as its planned activities, the WP4 voyage provided a significant number of biological samples as identified in Table 4.

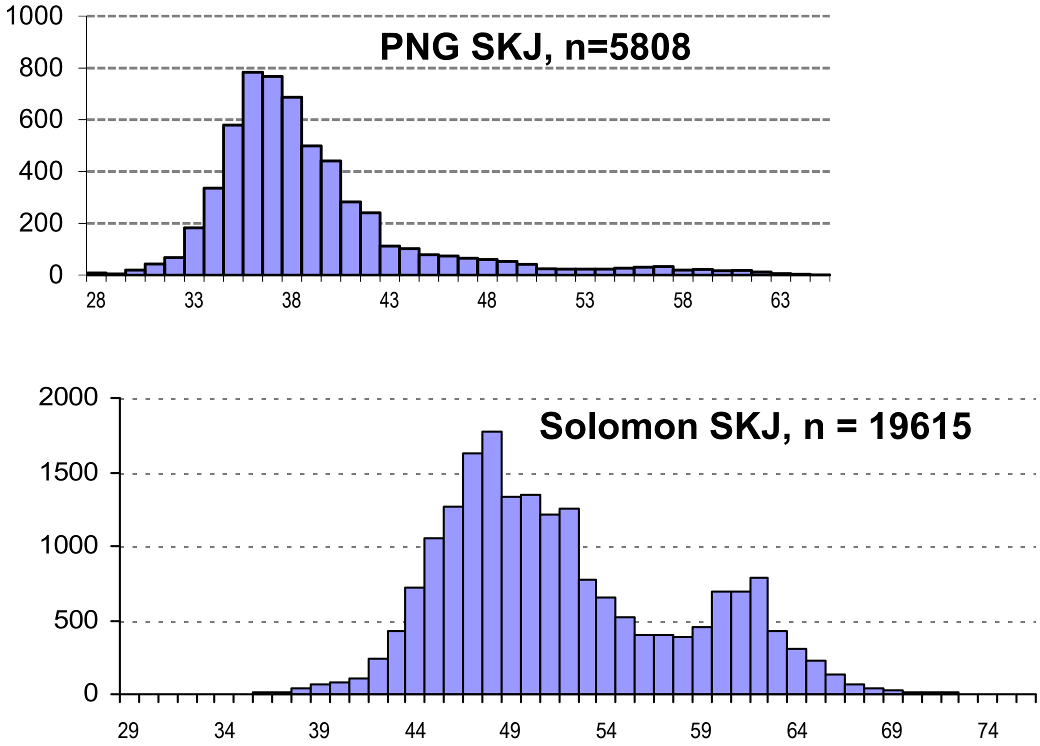

Figure 4: Length frequencies for tagged skipjack in PNG (top) and Solomon (bottom).

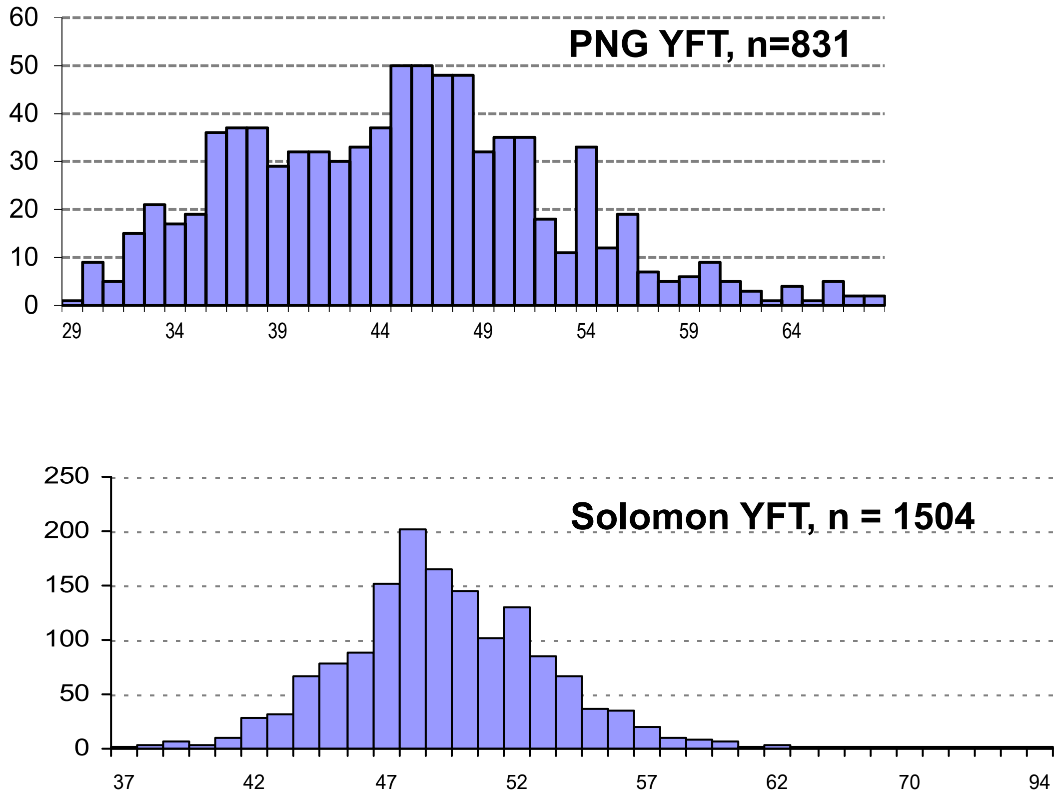

Figure 5: Length frequencies for tagged yellowfin in PNG (top) and Solomon (bottom).

Table 4: Number of samples per species and sample type

Species	Gonad	Liver	Muscle	Otolith	Spine	Stomach	Total
FRIGATE TUNA	4	4	4	3	4	4	23
MAHI MAHI / DOLPHINFISH	11	11	11	7	1	11	52
OCEAN TRIGGERFISH (SPOTTED)	1	1	1	1		1	5
RAINBOW RUNNER	13	13	13	9	1	13	62
SKIPJACK	183	182	182	178	173	183	1081
YELLOWFIN	79	79	79	78	69	78	462
Total	**291**	**290**	**290**	**276**	**248**	**290**	**1685**

2.1.3 WP4 result

The lack of bait and fish hampered the PNG leg of the WP4 voyage, resulting in in 50% lower success than expected from past experiences in those waters. In contrast, the skipjack tagging in Solomon Islands waters was exceptional in terms of the numbers and size of the fish tagged. The pole and line method of tag and release again allowed large-scale release of tagged skipjack tuna in a relatively short period. In summary, this was a very successful research voyage.

2.1.4 Papua New Guinea support

The PNG National Fisheries Authority (NFA) supported the PNG leg of the WP4 voyage by providing an additional tagger, a biological sampler and a security agent, and by helping vessel logistics in Buka port. Additionally, the NFA maintain the PNG Tag Recovery Officer network and have provided funding for tag rewards paid in PNG in 2017. An MoU between SPC and NFA has been renewed in 2018 to maintain ongoing collaboration for the PTTP.

2.1.5 WP4 key lessons

For any future WP pole and line campaigns to be successful, two challenges remain. In PNG waters better access to reliable bait grounds will need to be established. This will require support from NFA, especially with visits to all key bait ground areas to negotiate access in advance of the tagging research voyages. This is a time consuming and challenging task in remote areas, often with difficult access other than by sea.

The second challenge goes to the future of pole and line based research. As already reported to SC12 and SC13 (SPC-OFP 2016, SPC-OFP 2017a), the operational issues in getting a suitable research platform at a reasonable cost have reached limits that will constrain or even totally compromise future implementation of a similar tagging voyage. Currently there are only two options for pole and line vessel charter – NFD in Solomon Islands, as done for WP4, and Japan-based vessels. Based on the experience during WP4, the currently available vessels at NFD are becoming marginal because of cost, age and availability of spare parts. Japanese pole-and-line vessels, while they are larger and more flexible in their operational areas, are expensive, can only be chartered for a limited duration (due to the need to return to Japan to take on bait) and are not necessarily actually available for charter. It seems that unless we can share the costs of chartering a Japanese vessel with the Japan Far Seas Fisheries Research Laboratory, this option will remain out of reach. The most viable option for the region may well be to obtain its own (possibly shared with other RFMOs) suitable research platform. Following the discussions at SC13, SPC has made some progress in obtaining robust information 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 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 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) voyages, the PNGTP and Phase 1 and 2 of the PTTP are detailed in Table 5.

Table 5: CP, PNGTP and total PTTP tag release numbers, and % of recoveries to date (July 2018) of conventional and archival tags.

Project	Tag Type	Release Numbers				Recapture Percentages			
		SKJ	YFT	BET	Total	SKJ	YFT	BET	Total
CP	Archival	32	257	744	**1,033**	0.0	7.8	19.5	**16.0**
	Conventional	762	2,536	38,539	**41,837**	4.2	14.2	28.8	**27.4**
PNGTP	Archival	0	68	12	**80**	NA	27.9	58.3	**32.5**
	Conventional	80,444	27,065	2,915	**110,424**	20.2	18.6	21.2	**19.8**
Total PTTP	Archival	129	672	932	**1,733**	3.1	12.1	19.3	**15.3**
	Conventional	272,401	109,133	47,891	**429,425**	17.2	16.6	27.2	**18.2**

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. 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.

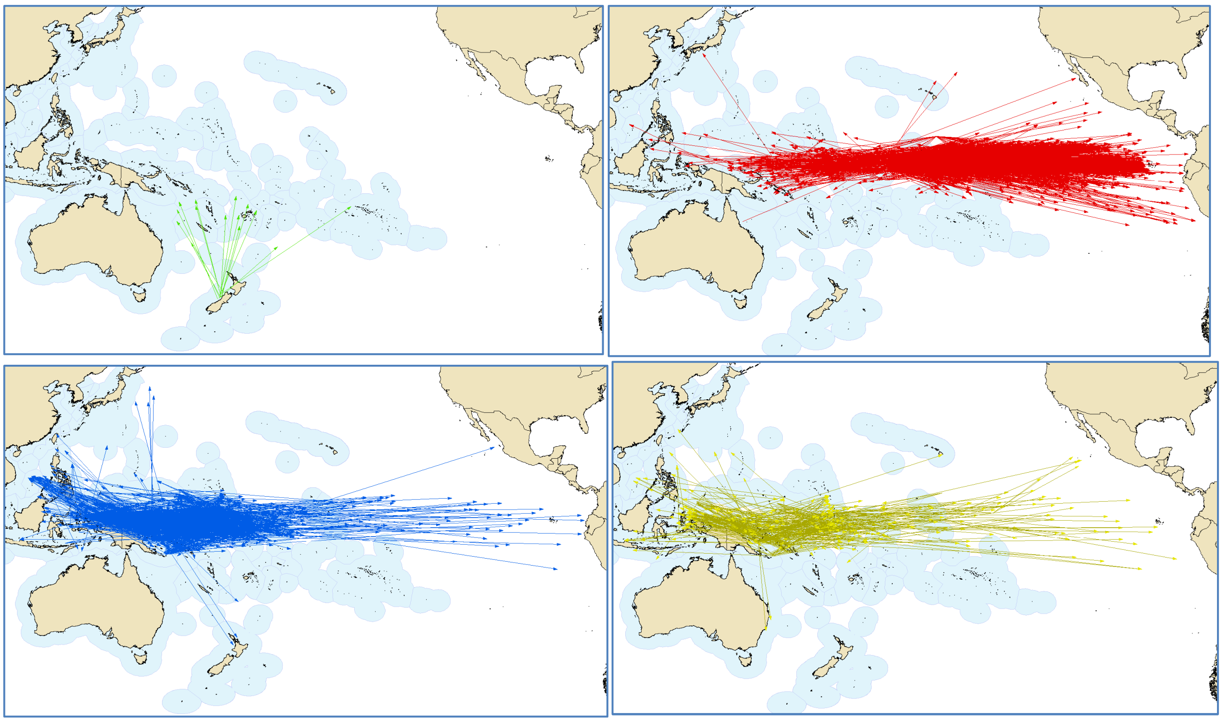

Figure 6A: Displacement of tagged tuna. Albacore (green) top left, bigeye (red) top right, skipjack (blue) bottom left and yellowfin (yellow) bottom right. All recoveries for all years with displacement >1000 nm.

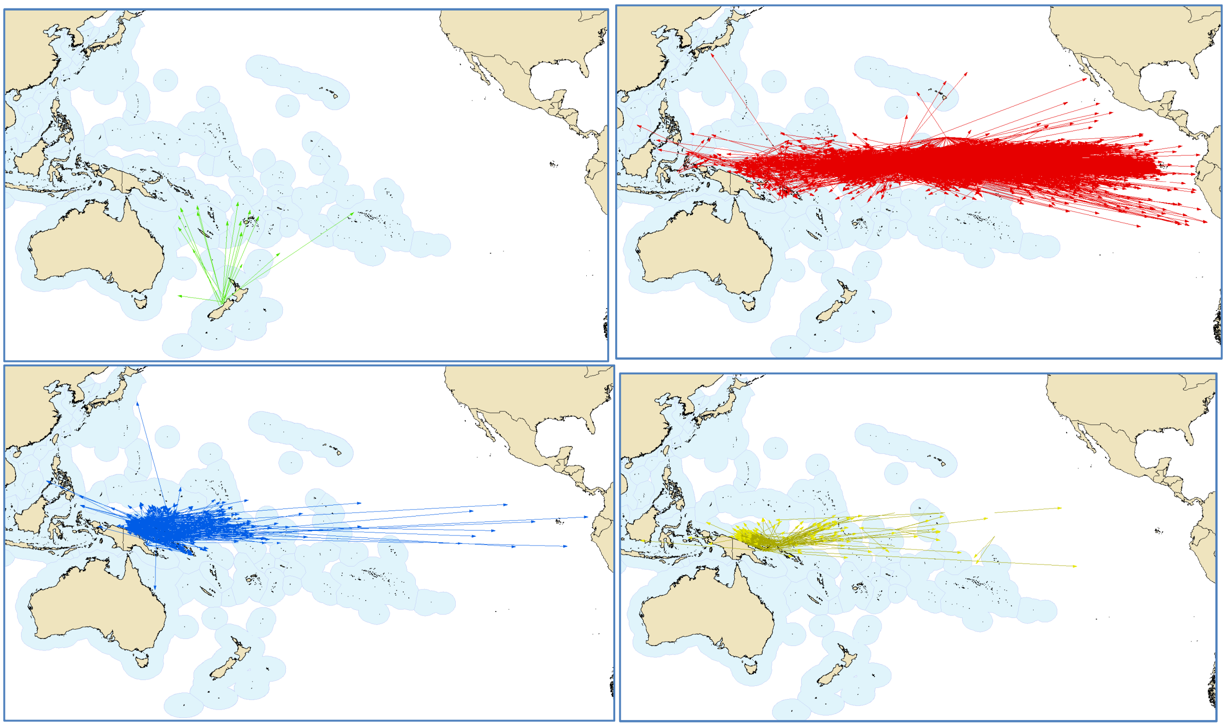

Figure 6B: Displacement of tagged tuna. Albacore in green (top left), bigeye in red (top right), skipjack in blue (bottom left) and yellowfin in yellow (bottom right). Showing all recoveries with displacements >500nm since 2007 for ALB and BET and since 2012 for SKJ and YFT.

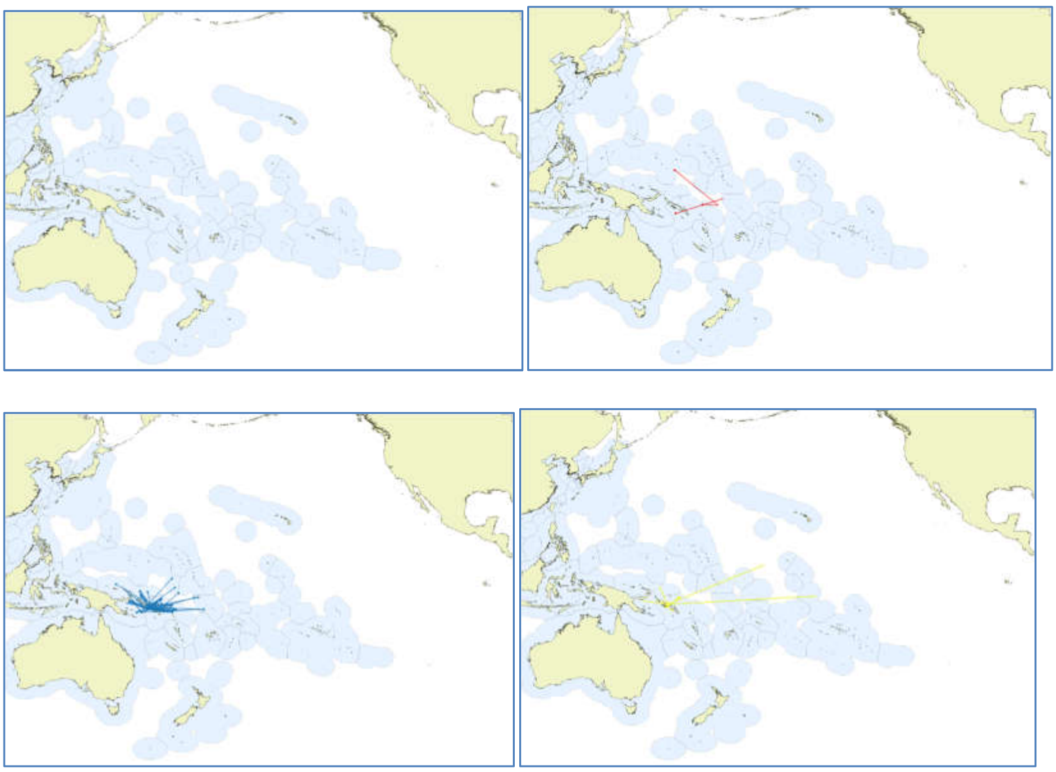

Figure 6C: Displacement of tagged tuna. Albacore in green (top left), bigeye in red (top right), skipjack in blue (bottom left) and yellowfin in yellow (bottom right). Showing all recoveries with displacements >300nm in the last year.

3.1 Biological sampling during tagging voyages

A total of 6279 stomach samples have been collected since the beginning of the PTTP, mainly from skipjack, yellowfin, bigeye and albacore tuna (Table 6).

Table 6: Total number of stomach samples collected and analysed to 30 June 2018.

PREDATOR SPECIES		COLLECTED	ANALYSED	% ANALYSED
ALB	ALBACORE	245	245	100%
YTL	AMBERJACK (LONGFIN YELLOWTAIL)	1	1	100%
BET	BIGEYE	477	367	77%
BUM	BLUE MARLIN	12	3	25%
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	87	45	52%
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	145	112	77%
FAL	SILKY SHARK	4	4	100%
SKJ	SKIPJACK	2832	2474	87%
SWO	SWORDFISH	6	6	100%
WAH	WAHOO	16	6	38%
YFT	YELLOWFIN	2218	2017	91%
	TOTAL	6279	5505	88%

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 5,505 stomachs, representing 88% of the samples collected, have been examined and the corresponding data entered into a dedicated database, BioDaSys (Table 6).

3.1.2 Tuna fat content

The tagging research voyages have provided the opportunity to measure the fat content of 4,167 specimens (Table 7). 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. A recent analysis of the fat-meter measurements taken on skipjack, albacore and yellowfin highlighted:

- Juvenile albacore caught around New Zealand have an average fat content higher than adult albacore caught in subtropical areas (Tonga and New Caledonia). Juvenile albacore are in a fast growing phase and do have access to high quantities of high-energy content krill as food around New Zealand. Fat content increases with size for juvenile albacore between 45 and 80 cm, while it does not present a significant trend for adult tuna between 80 and 110 cm.

- Adult skipjack tuna caught in equatorial waters have higher fat content than juvenile skipjack caught in the same waters. It is hypothesized that adult fish have better access to prey. During the juvenile phase the fat content increases with the fish size between 25 and 50 cm. No difference in fat content has been recorded according to sex. No difference in fat content has been recorded between fish caught in free schools or under FADs. However, a FAD fish might have spent only a few hours under a FAD or a free school fish might have just left a FAD a few hours ago. The potential FAD effect is a complex topic to study, and it requires more sampling and analysis particularly to clarify how long the fish has spent under FADs and how many FADs it visited in the past weeks to properly identify and differentiate. Impact of ENSO on the fat content was explored but due to inadequate sample size, was inconclusive.
- Only juvenile yellowfin have been sampled and they show an increasing trend in fat content with size between 25 and 80 cm. No difference in fat content has been recorded according to sex. Fish caught under FADs have a significantly lower fat content than fish caught in free schools. However, a FAD fish might have spent only a few hours under a FAD or a free school fish might have just left a FAD a few hours ago. The potential FAD effect is a complex topic to study, and it requires more sampling and analysis particularly to clarify how long the fish has spent under FADs and how many FADs it visited in the past weeks to properly identify and differentiate. Impact of ENSO on the fat content was explored but due to inadequate sample size, was inconclusive.
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Table 7: Total number of specimens where fat content has been analysed during tagging research voyages to 30 June 2018.

PREDATOR SPECIES		NB fish sampled
SKJ	SKIPJACK	2180
YFT	YELLOWFIN	1562
BET	BIGEYE	134
ALB	ALBACORE	287
FRI	FRIGATE TUNA	1
	TOTAL	4164

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 21,585 samples to date). In addition to the *fat-meter* analyses (see 3.2.1 above), a total of 6,479 fish have been sampled from which 7,063 samples have been analysed to date. For the WCPFC Tuna Tissue Bank as a whole, these tagging research voyage samples including fatmeter analysis represent 25.1% of the total fish sampled, 25.5 % of the total samples collected, and 32.1 % of the analyses processed from the tissue bank (Table 8). In general tagging research voyages continue to provide a key contribution to the WCPFC Tuna Tissue Bank and its utility (SPC-OFP, 2017b)

Table 8: Total number of samples collected from research tagging voyages and analysed to July 2018.

Predator species		Nb fish sampled	Total samples	Blood	Gonad	Liver	Muscle	Otolith	Spine	Stomach	Nb sample analysed	% analysed
FRI	FRIGATE TUNA	99	308		4	99	99	3	4	99	95	30.8%
ALB	ALBACORE	404	1514		269	276	277	259	188	245	786	51.9%
BET	BIGEYE	560	2065	30	191	475	510	281	101	477	632	30.6%
BRZ	POMFRETS AND OCEAN BREAMS	3	3							3	3	100.0%
BSH	BLUE SHARK	1	1				1				0	0.0%
BUM	BLUE MARLIN	13	55	5	8	12	13		5	12	3	5.4%
CFW	POMPANO DOLPHINFISH	2	4			1	1			2	2	50.0%
CNT	OCEAN TRIGGERFISH (SPOTTED)	1	5		1	1	1	1		1	0	0.0%
DOL	MAHI MAHI / DOLPHINFISH	88	273		31	73	74	7	1	87	45	16.5%
FAL	SILKY SHARK	4	12			4	4			4	4	33.3%
KAW	KAWAKAWA	124	316			96	96			124	118	37.3%
MSD	MACKEREL SCAD / SABA	5	15			5	5			5	5	33.3%
NXI	GIANT TREVALLY	1	1							1	1	100.0%
PLS	PELAGIC STING-RAY	1	3			1	1			1	1	33.3%
RRU	RAINBOW RUNNER	146	453		20	139	139	9	1	145	112	24.7%
SKJ	SKIPJACK	3654	9236		284	2773	2864	284	199	2832	2576	27.9%
SWO	SWORDFISH	6	15		1	4	4			6	10	66.6%
WAH	WAHOO	16	52		6	15	15			16	6	11.5%
YFT	YELLOWFIN	2739	7251	15	275	2133	2169	268	173	2218	2235	30.8%
YTL	AMBERJACK (LONGFIN YELLOWTAIL)	1	3			1	1			1	1	33.3%
	Total	**7868**	**21585**	**50**	**1090**	**6108**	**6274**	**1112**	**672**	**6279**	**6646**	**30.8%**

3.2 Conventional and archival tag recoveries for the PTTP

As at 21 June 2018, a total of 78,259 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 recoveries have occurred over the duration of the project, and are expected to continue. 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 voyage (Table 10). Initial observations of this data suggest increased tag rejection/fish mortality with archival tagging on some voyages.

There is a notable reduction in bigeye conventional tag recovery rate from CP9 onwards (from ~30+% up to voyage CP8, down to 14% for CP9 and between 3 to 15% 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 voyages, the release method changed with 45 to 95% of the releases being done on dFADs, as opposed to 100% at TAO buoys in previous voyages. 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 voyages 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 voyages.

The observed reduction in bigeye recovery rate for the CP9 voyage (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 the CP9 voyage have not reported all their tag recoveries. This needs further investigation.

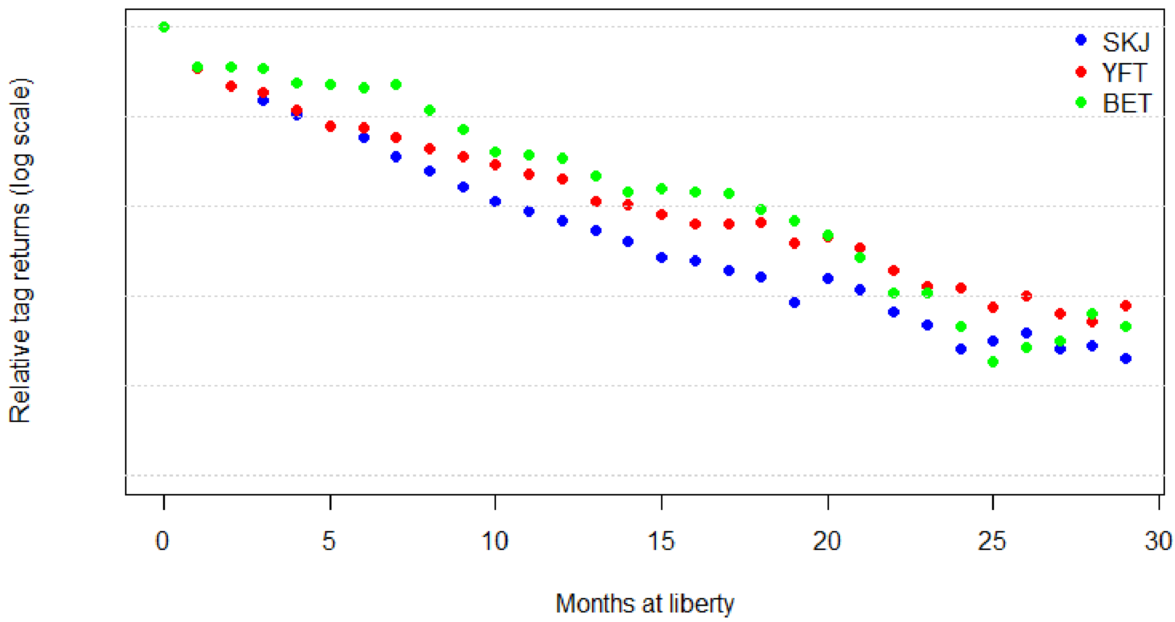

Figure 7: Tag recoveries by time at liberty for skipjack, yellowfin and bigeye tuna. Note that the values on the y-axis are uninformative and thus omitted. At the top-left the points (overlaid so as only BET shows) are the (species) specific maximum logarithm of recoveries, standardised so that the attrition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

Table 9: Tag releases and recaptures for the PTTP to date (as at 21/06/2018).

	Releases				Number recovered (% recovered)			
Voyages	SKJ	YFT	BET	Total	SKJ	YFT	BET	Total
PG1 Aug-Nov 2006	13,948	7,806	562	**22,316**	2,645 (19%)	1,806 (23.1%)	229 (40.7%)	**4,680 (21%)**
PG2 Feb-May 2007	26,493	12,845	129	**39,467**	2,508 (9.5%)	1,719 (13.4%)	8 (6.2%)	**4,235 (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%)	2,353 (16.9%)	489 (15.5%)	**7,450 (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%)	1,962 (32.2%)	**2,015 (31.7%)**
PNGTP1 Apr-Jul 2011	28,730	11,571	355	**40,656**	5,771 (20.1%)	2,479 (21.4%)	60 (16.9%)	**8,310 (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**	7,232 (25.5%)	1,697 (17.7%)	521 (25.9%)	**9,450 (23.7%)**
CP8 Sep-Oct 2012	20	140	6,014	**6,174**	2 (10%)	32 (22.9%)	2,304 (38.3%)	**2,338 (37.9%)**
PNGTP3 Apr-Jun 2013	23,402	5,955	564	**29,921**	3,261 (13.9%)	870 (14.6%)	45 (8%)	**4,176 (14%)**
CP9 Nov-Dec 2013	29	135	4,296	**4,460**	1 (3.4%)	11 (8.1%)	619 (14.4%)	**631 (14.1%)**
CP10 Aug-Aug 2014	12	98	195	**305**	0 (0%)	6 (6.1%)	4 (2.1%)	**10 (3.3%)**
CP11 Sep-Nov 2015	231	775	1,966	**2,972**	6 (2.6%)	25 (3.2%)	192 (9.8%)	**223 (7.5%)**
PG6 Jul-Jul 2016	0	17	2	**19**	0 (NA%)	2 (11.8%)	0 (0%)	**2 (10.5%)**
CP12 Sep-Oct 2016	109	371	1,575	**2,055**	3 (2.8%)	81 (21.8%)	235 (14.9%)	**319 (15.5%)**
WP4 Sep-Nov 2017	25,425	2,335	20	**27,780**	3,950 (15.5%)	209 (9%)	0 (0%)	**4,159 (15%)**
Total	**272,530**	**109,805**	**48,823**	**431,158**	**46,825 (17.2%)**	**18,209 (16.6%)**	**13,225 (27.1%)**	**78,259 (18.2%)**

Table 10: Comparison of archival and conventional tag recoveries by species and voyage for the PTTP, 2006-2017.

	Archival Recoveries (%) (Number tagged)				Conventional Recoveries (%) (Number tagged)			
Voyages	**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			22.4% (58)	**22.4% (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)	38.3% (5,996)	**37.8% (6,156)**
PNGTP3 Apr-Jun 2013		26.7% (30)	0% (1)	**25.8% (31)**	13.9% (23,402)	14.5% (5,925)	8% (563)	**13.9% (29,890)**
CP9 Nov-Dec 2013		0% (1)	19.5% (41)	**19% (42)**	3.4% (29)	8.2% (134)	14.4% (4,255)	**14.1% (4,418)**
CP10 Aug-Aug 2014		12.5% (8)	4.2% (24)	**6.2% (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)	3.3% (704)	9.7% (1,871)	**7.5% (2,806)**
PG6 Jul-Jul 2016					NA% (0)	11.8% (17)	0% (2)	**10.5% (19)**
CP12 Sep-Oct 2016	0% (2)	14.3% (28)	15.1% (93)	**14.6% (123)**	2.8% (107)	22.4% (343)	14.9% (1,482)	**15.6% (1,932)**
WP4 Sep-Nov 2017		0% (5)	0% (2)	**0% (7)**	15.5% (25,425)	9% (2,330)	0% (18)	**15% (27,773)**
Total	**3.1% (129)**	**12.1% (672)**	**19.3% (932)**	**15.3% (1,733)**	**17.2% (272,401)**	**16.6% (109,133)**	**27.2% (47,891)**	**18.2% (429,425)**

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 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 TROs have been appointed in Honiara and Noro, negotiations with Kiribati MFMRD to re-establish a full time TRO position in Tarawa are still in progress, and a new MOU with PNG has been established to maintain the PNG TRO network and initiate the recruitment of a TRO in Lae

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 research voyages 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.

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 12). Major unloading and processing facilities as well as transhipping vessels in port have been visited by TROs over the last 12 months (excepted for Tarawa and LAE (PNG) where TRO positions have not as yet been re-established). An additional SPC staff is now entering tag recovery information into TagDager and undertaking validation process.

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 2018, a total of 570 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 (Table 13). 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 13 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 570 kits distributed to observer coordinators, 417 have been given to observers for deployment, of which 352 tag seeding datasheets have been received for observer trips.

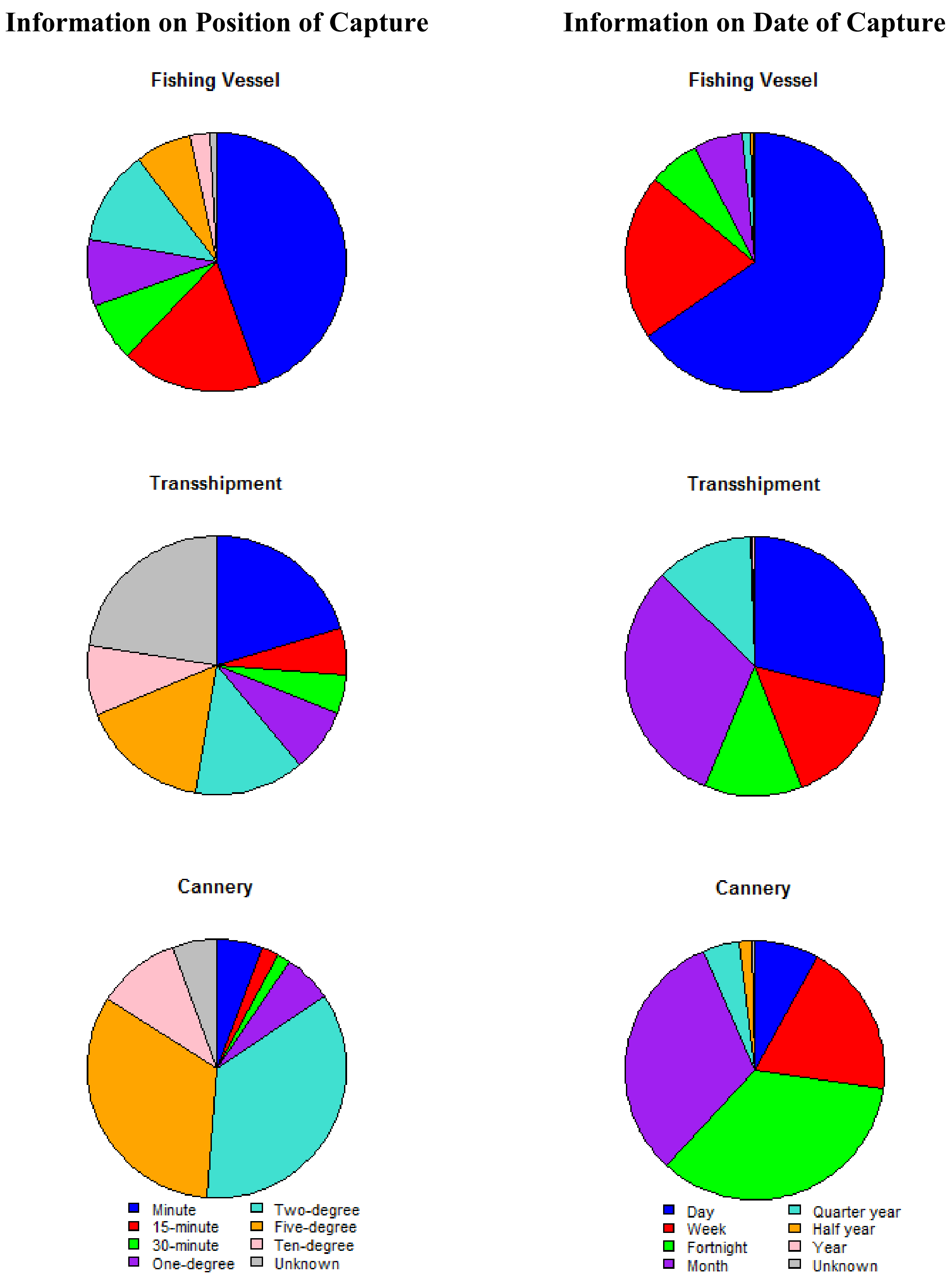

Figure 8: Location and date of tag recovery accuracy information for recoveries on fishing vessels, during transhipment and at canneries.

Since June 2017, 9 kits have been deployed, using a total of 237 tags. This is a lower rate of deployment in comparison to the previous year (11 kits for 294 tags). As at 1st July 2018, there have been 7,254 reported tags that have been seeded and 3,981 (54.8%) of these have been returned to SPC. Tables 14 and 15 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 639 tags, was absent from the recovery information for 183 tags and was correct for 3159 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 calculated for the revised regional structure included in the 2017 bigeye update assessment, using the approach outlined in Peatman et al. (2016). The RR prior parameters were insensitive to the shift of the northern boundary between regions 1 & 2 and 3 & 4 due to the low levels of purse seine effort between 10N and 20N west of 140E.

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).

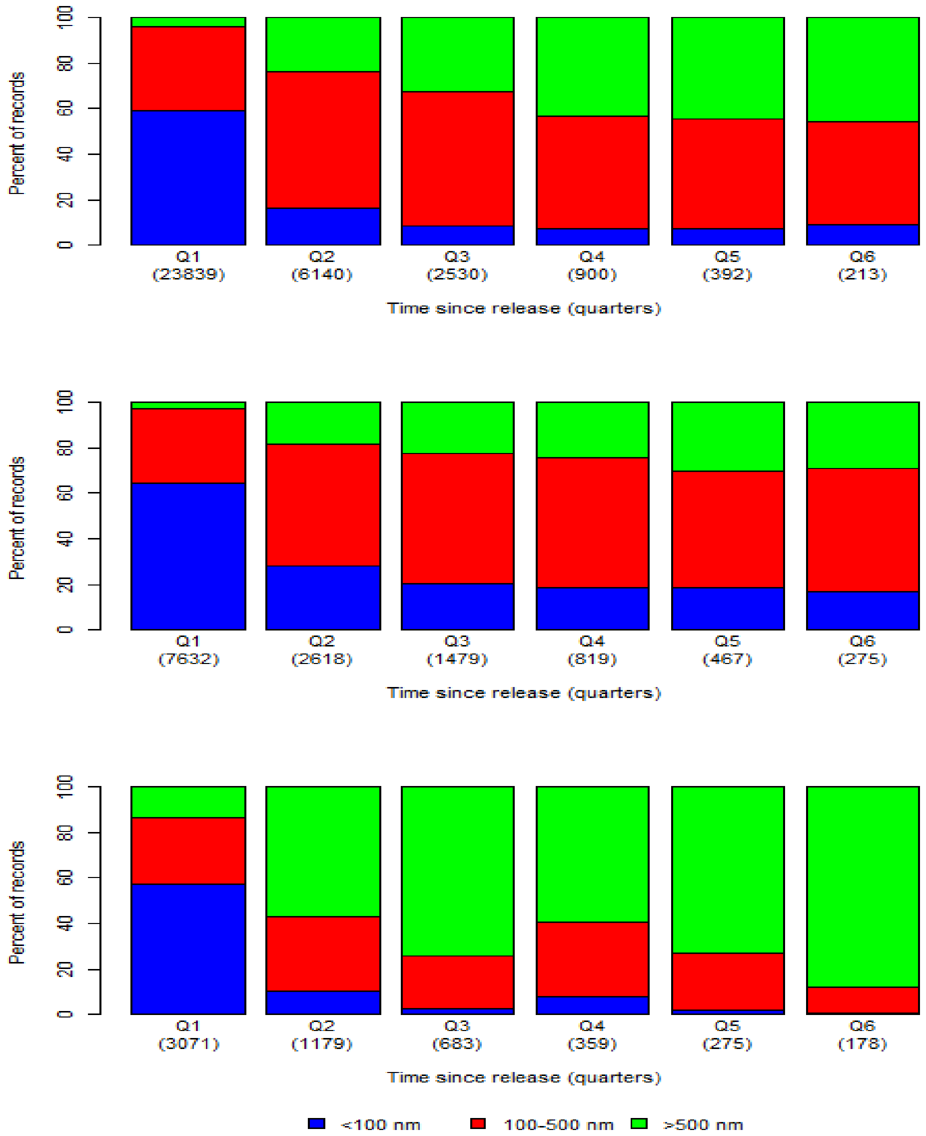

Figure 9: Reported recoveries within 100 nm, 100-500 nm and >500 nm in the first 6 quarters (18 months) since release for skipjack (upper graph), yellowfin (middle graph) and bigeye (lower graph). The sample size for each quarter is provided in the parentheses below the quarter label on the x-axis.

Table 11: Tag recoveries by gear type with ≥1 year at liberty.

	Recoveries		Purse Seine		Longline		Pole & Line		Other		Unclassified	
Project	**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	58	1	54	0	3	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	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	72	0	66	0	5	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	6	21	6	21	0	0	0	0	0	0	0	0
PTTP Phase 2 - Central Pacific #12	0	6	0	6	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	262	44	240	23	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	254	2	241	2	5	0	0	0	0	0	8	0
PNGTP - Papua New Guinea #2	240	40	236	39	2	1	0	0	1	0	1	0
PNGTP - Papua New Guinea #3	43	6	41	4	0	2	0	0	2	0	0	0
PNGTP TAO trial Voyage #2	1	0	1	0	0	0	0	0	0	0	0	0
Total	**1,821**	**1,365**	**1,689**	**1,247**	**33**	**69**	**3**	**1**	**47**	**7**	**49**	**41**

Table 12: 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	35	42.86	20.00	0.00	0.00	0.00	0.00	80.00	80.00	0.00	2.86	77.14
Fishing vessel	557	92.82	80.46	1.74	0.00	0.00	15.09	2.71	1.80	0.72	3.59	4.85
FSM	697	89.10	96.78	0.81	0.16	0.00	0.00	2.25	2.15	1.00	9.76	25.25
FSM (SPC)	189	61.90	68.38	15.38	0.85	0.00	11.97	3.42	1.06	0.00	5.29	3.17
IATTC	9,625	25.11	47.12	3.97	1.45	0.00	14.40	33.06	23.78	10.58	14.48	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	74.62	91.91	3.80	0.09	0.00	0.71	3.49	3.73	4.79	20.07	4.85
Kiribati (Kiritimati)	343	80.17	92.00	0.00	2.55	0.00	0.00	5.45	5.25	21.28	20.41	24.20
Kiribati (Tarawa)	1,038	84.39	72.03	0.11	0.68	0.00	0.46	26.71	21.58	3.37	17.53	9.54
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	1,014	90.14	88.40	8.86	0.44	0.00	0.44	1.86	1.38	2.56	12.13	26.23
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)	8,444	56.68	67.09	4.35	0.06	0.00	7.71	20.79	16.65	4.73	26.40	65.67
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)	6,774	82.03	88.45	10.02	0.05	0.02	0.04	1.42	1.74	1.31	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

Source	Recov.	% Valid.	% VMS	% Logsheet	% Archival	% Buffer	% Other	% None	% No vessel name	% Vessel but no date	% Vessel but no position	% No length
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	93.59	80.07	17.95	0.06	0.00	0.03	1.89	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
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)	1,083	97.88	78.87	12.55	0.00	0.00	0.00	8.58	8.59	1.02	1.94	55.96
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)	508	46.26	75.32	3.83	2.55	0.00	0.00	18.30	8.27	0.59	13.39	22.24
Solomon Islands (NFD)	7,838	92.12	81.20	18.46	0.01	0.00	0.00	0.32	0.15	2.04	9.31	13.91
Solomon Islands (other)	200	78.50	85.35	2.55	0.00	0.00	0.00	12.10	17.00	3.00	10.50	33.00
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	240	56.25	2.22	0.00	0.74	0.00	95.56	1.48	0.42	0.00	9.17	2.08
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	10,748	63.32	93.45	3.64	0.16	0.00	0.04	2.70	1.44	0.06	95.37	1.65
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	293	65.53	56.77	1.56	10.94	0.00	6.77	23.96	14.68	0.00	10.58	33.11

Table 13: Number of seeded tags deployed per EEZ since the beginning of the project.

EEZ	Releases
Not known yet	1,801
American Samoa	3
Cook Islands	62
Federated states of Micronesia	328
Fiji	7
Gilbert Islands	635
Howland & Baker	4
Indonesia	7
International waters H4	88
International waters H5	73
International waters I2	114
International waters I4	25
International waters I5	15
International waters I6	59
International waters I9	5
Jarvis	5
Marshall Islands	91
Nauru	224
Northern Line Islands	20
Other international waters	4
Papua New Guinea	2,047
Phoenix Islands	390
Samoa	20
Solomon Islands	624
Tokelau	184
Tuvalu	419
Total	**7,254**

Table 14: 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	8,553	231	71	23	137	59.3
HONIARA, Solomon Islands	1,558	473	79	2	392	82.9
LAE, PNG	5,457	192	41	5	146	76.0
LONDON, Kiribati	162	2	0	0	2	100.0
MADANG, PNG	2,880	300	59	0	241	80.3
MAJURO, Marshalls	1,201	280	29	0	251	89.6
MANTA, Ecuador	1,473	48	13	0	35	72.9
NORO, Solomon Islands	10,772	52	20	1	31	59.6
PAGO PAGO, A. Samoa	2,169	523	45	22	456	87.2
POHNPEI, FSM	982	134	39	0	95	70.9
PORT MORESBY, PNG	524	80	14	0	66	82.5
RABAUL, PNG	396	133	34	0	99	74.4
SAMUTSAKOM, Thailand	10,705	611	242	6	363	59.4
SAN DIEGO, USA	8,274	193	35	78	80	41.5

Recovery location	All tag recoveries	Tag seeding recoveries (TSR)	Wrong vessel reported (TSR)	No vessel reported (TSR)	Correct vessel reported (TSR)	% correct vessel
SHIMIZU, Japan	3,001	7	2	1	4	57.1
TARAWA, Kiribati	1,033	176	6	4	166	94.3
VIDAR, PNG	7,149	192	13	1	178	92.7
WEWAK, PNG	6,984	253	88	1	164	64.8

Table 15: 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	15	0	0	0.0
EKSAKHON COLD STORAGE CO., LTD	30	6	0	24	80.0
ISA VALUE	8	4	0	4	50.0
PATAYA FOOD INDUSTRIES LTD.	131	94	0	37	28.2
PREMIER CANNING INDUSTRY	1	1	0	0	0.0
R.S. Cannery Co., Ltd.	36	9	0	27	75.0
Songkla Canning PLC.	62	44	0	18	29.0
SOUTHEAST ASIAN PACKAGING	50	8	0	42	84.0
Thai Union Manufacturing Co.	57	10	0	47	82.5
TROPICAL CANNING	15	2	0	13	86.7
Unicord	1	1	0	0	0.0
Unicord Public Co., Ltd.	111	23	2	86	77.5

3.7 Tagging simulator

The Ikamoana individual-based model, which has been developed specifically for examining movement hypotheses for pelagic species, is now available to be applied to the design and analysis of the PTTP or other monitoring programmes (Scutt Phillips et al., 2018). Movement parameterisations for a skipjack-specific model have been incorporated from a recent SEAPODYM solution (Senina et al. 2016), allowing the movement of both individual or cohesive schools of skipjack to be simulated in the Pacific Ocean. Historical or future fishing effort can be exerted upon modelled cohorts, and the levels of depletion (or any other spatiotemporally varying data) tracked and compared between individuals. An initial suite of simulations for skipjack tag releases in assessment regions 2 and 5 have been undertaken to examine the degree of tag mixing that may have occurred during recent years of differing ENSO phase. Model runs consisted of simulating an entire cohort of skipjack tuna in the Pacific Ocean, and comparing the relative catch per assessment region over time with that experienced by fish released only at typical tag release event locations in a separate simulation.

Preliminary results suggest similar conclusions to previous work on mixing (e.g. Kolody & Hoyle 2015). Under the current movement assumptions, it appears that within-region mixing rarely occurs within a time-frame consistent with current stock assessment assumptions. However, simulation results are highly dependent on the environmental forcing of the ENSO phase being examined, and some examples of relatively more complete mixing appear possible under certain temporal and release location scenarios. In particular, releases in the

Solomon Sea show lower initial dispersal than other locations but good levels of mixing in region 5, particularly during a 2010 La Niña simulation scenario. Conversely, more oceanic releases in the EEZ of the Federated States of Micronesia exhibited better mixing in region 2 during the non-La Niña time periods simulated. Simulated releases in the Bismarck Sea area were, in general, consistently over-depleted compared to fish of the same cohort for all assessment regions into which tagged fish subsequently moved.

It is clear that a balance must be obtained between releases in logistically more challenging locations, which appear to drive greater within-region mixing of tagged fish, and releases in core fishing areas where high fishing effort and lower effort result in tag return data that are less representative of the entire, untagged cohort in that region. Further examination of these results and additional simulations would provide guidance on future design of PTTP skipjack research voyages. Additionally such work may reveal scenarios under which historic tag returns previously not used in MF-CL assessment due to the presently assumed mixing period of one quarter, could now be included for more data-rich assessments.

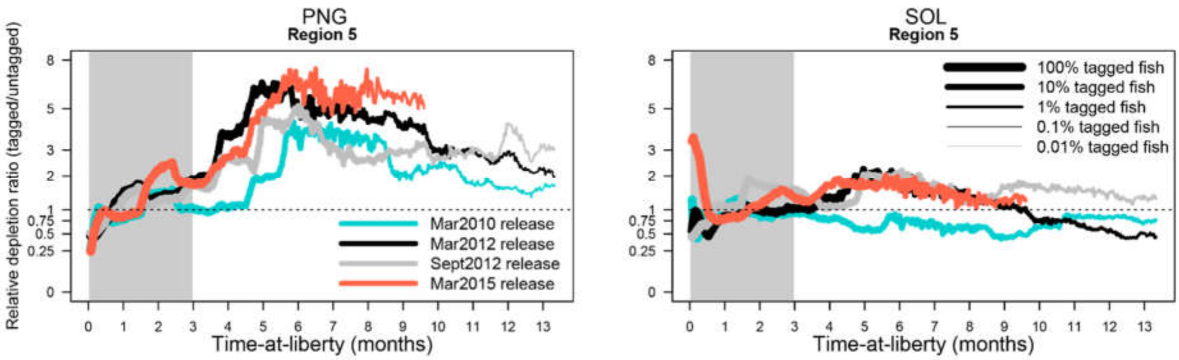

Figure 10: Example comparison of relative depletion ratios between simulated tagged schools and the untagged cohort in assessment regions 5, during the first 14 months at liberty for skipjack released at 40cm FL. Results are shown for releases from a Bismarck Sea location (left, 'PNG') and Solomon Sea location (right, 'SOL'). Line colours denote different temporal release scenarios, with line widths showing the percentage tag fish in region. Note non-linear scales for the y-axes and line-width.

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 SC13, no new tag recapture has been reported with the total of 31 recoveries (1%) for the project. Movements of recaptured fish for which we received accurate recovery position are displayed in Figure 11.

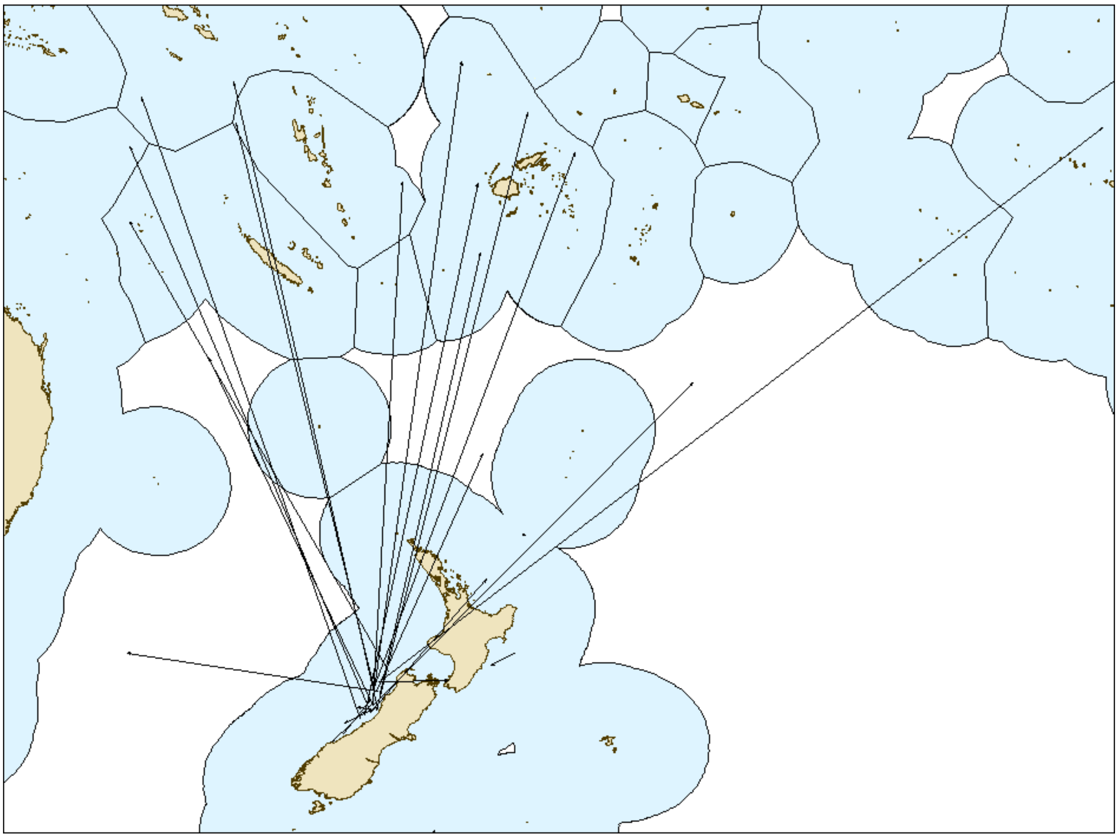

Figure 11: Release-recovery arrow map for albacore tags reported to SPC.

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 authorised users. The purpose of the web tagging data system is to:

- identify fake recovery: e.g. tags lost/tag used for training or publicising the tagging project/tag already recovered;
- access the release information (vessel, date of release, latitude and longitude of release, species, length);
- help to validate “date found” (the “date found” cannot be a date before the “date release”).
- estimate “date caught” when date found is only provided
- search release information relative to tags seeded; and
- provide full access to the TagDager DB from any authorised users connected to the web.

These improvements to the tag databases will improve tag quality and significantly reduce the risk of attempted tag reward fraud.

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, and again in 2017, the successful WP4 and the CP12 voyage now underway, 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 have to constrain the amount of at-sea time and thus the amount and spatial distribution of tagging which can be undertaken. The other is that to complete research targets we need to seek additional funding. The increased funding from WCPFC in 2017 and 2018 and in the indicative budget for out years will help this.

Second is the availability of suitable research vessels. The most reliable and successful approach – globally, and in the WCPO – 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 that can be utilised for this research. Those that remain are in high demand for industrial fishing as they produce a sought after product, especially those in the north Pacific. Those that remain in the south Pacific are either too small, or are rapidly ageing and through a combination of deterioration and limited spare parts availability no longer offer sufficiently reasonable conditions to be used for research (see Section 2.1.5). This creates considerable difficulty in procuring a vessel for this pole and line research, and means that we become a price-taker as the market is non-existent. This is a very significant cost pressure on the research programme. WP4 in 2017 was only possible due to a significant input of funding from SPC-OFP (approximately one-third of the total costs of around USD 675,000). That source of funds has now been fully utilised and we do not anticipate that SPC will be able to supplement funding for tagging cruises to the same extent in the future.

Although several suitable longline vessels exist in the region for the various line fishing techniques used to target bigeye tuna (although very few possess the range required for our current research needs), 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, especially to allow fishing throughout the day and night. This in turn limits the amount of tagging that can be completed, with the consequence that either more time at-sea is required, or less research is conducted. The space for science staff is even more substantive an issue in pole and line based tagging.

These issues build a strong 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 that face the same cost pressures – makes 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. The preliminary results of that work are available to inform PTTP steering committee discussions. A more comprehensive cost analysis of such an approach to fisheries and ecosystem research for WCPFC is urgently required to progress this concept. 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 2018 meeting (Appendix I) with a view to progressing such a consultancy as soon as practical.

5 PTTP 2018-2021 workplan

The PTTP Steering Committee will meet during SC14. A draft agenda for the meeting is attached at Appendix 1. The workplan identified in 2017 (SPC-OFP, 2017a) has been completed. The proposed workplan for the PTTP for 2018-2021 is highlighted in Table 16 below. The workplan recognises the decisions of SC in 2016 to normalise the tagging programme (WCPFC SC, 2017) and the decisions of SC in 2017 where this rolling medium-term research workplan was endorsed (WCPFC-SC 2017).

6 RECOMENDATIONS

SC14 is invited to note the report of ongoing progress in implementation of the PTTP. In particular we recommend that SC:

- Note the successful 2017 research voyage, including participation from local science staff in PNG waters;
- Support the 2019 tagging programme, and associated budget;
- Support the 2020-2021 tagging programme, and associated indicative budget;
- Consider and support the PTTP workplan for 2018-2021; and
- Support a project to address the increasingly urgent issue of cost-effectiveness of vessel charter in relation to acquiring a dedicated tagging vessel.

Table 16: Proposed PTTP workplan for the period 2018-2021.

ACTIVITIES		2018	2019	2020	2021
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.		Plans to be refined after assessing viable available options		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.	A charter arrangement has been concluded with an Hawaiian LL company to use their FV GutsyLady4 to implement a 35 day research voyage from mid-July	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.				
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.		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.				

7 ACKNOWLEDGEMENTS

Material for this report was provided by T. Peatman[1], S. Caillot[1], B. Leroy[1], F. Roupsard[1], J. Muir[2], J. Scutt Phillips[1, 4], C. Sanchez[1], T. Usu[3], B. Sabub[3], J. Hampton[1], and N. Smith[1].

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APPENDIX I

Proposed agenda for the 2018 PTTP Steering Committee meeting

PROVISIONAL AGENDA
PACIFIC TUNA TAGGING PROGRAMME STEERING COMMITTEE
17:30-19:00, Thursday 9 August 2017 (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*
3			**WORK PLAN 2018-2021**
	3.1		2018 Bigeye research voyage (RP-PTTP-02)
	3.2		Tag recovery network (RP-PTTP-02)
	3.3		2019 Skipjack research voyage (RP-PTTP-02)
	3.4		Research voyages beyond 2019 (RP-PTTP-02)
	3.5		Related work in 2019 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)

Investigating the potential for a WCPFC tag research vessel	
Project	**Investigating the potential for a WCPFC tag research vessel**
Objectives	To explore the costs and benefits of the permanent use of an adaptable research vessel dedicated to the collection of the data used in tuna stock assessment in the WCPO.
Rationale	**A. Rationale for project** **1. General** 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). Concurrently the fleet of vessels available to charter for research, especially in pole and line fisheries, are becoming increasingly difficult to procure or no longer meet standards necessary for the conduct of research. Accordingly it is 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. **2. SC 13 and SC 14** At SC13 the PTTP Steering Committee considered the issue of the availability of suitable tagging vessels, especially for pole and line based research, at its 11th meeting during SC13. The PTTP Steering Committee endorsed the proposal outlined in SC13-RP-P42-02 Appendix II and recommended that SC13 support an assessment of the cost-effectiveness of acquiring a dedicated tagging vessel (SC13-RP-P42-01).

	The 2018 report of the PTTP highlights the increased urgency of conducting this work (SPC-OFP 2018). At SC14…to be completed at meeting. **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 necessitates 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. The WP4 charter cost jumped to 420,000 USD/month. Recent enquiries to utilise vessels from the north Pacific suggest considerably higher costs. ➢ 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). ➢ A pre-assessment of some of the operational costs of an appropriate platform that could be built to address all the tuna research needs for the Pacific Ocean has been provided to SPC by F&S, a consultancy office specialized in the fisheries sector. That work would be available to this project.
Scope	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. However, the current approach is not sustainable so the cost

	benefit analysis will need to consider alternate benchmarks in combination with the current approach. The scope of work includes undertaking this assessment utilising suitable external experts. A report will be prepared and provided to SC15 for its consideration.
Timeframe	Start early 2019, completed by late 2019
Budget	2019 USD$125,000 *Note that this covers the Scientific Services Providers input to the project, the cost of the external consultancy and reporting of the project outcomes to SC.
References	PTTP Steering Committee. 2017. Report of the Pacific Tuna Tagging Programme Steering Committee. SC13-RP-PTTP-01. Thirteenth regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission. Rarotonga, Cook Islands, 9-17 August 2017. PTTP Steering Committee. 2018. Report of the Pacific Tuna Tagging Programme Steering Committee. SC14-RP-PTTP-01. Fourteenth regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission. Busan, Korea, 8-17 August 2018. SPC-OFP. 2017. Project 42: Pacific Tuna Tagging Project Report and Workplan for 2017-2020. SC13-RP-PTTP-02. Thirteenth regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission. Rarotonga, Cook Islands, 9-17 August 2017. SPC-OFP. 2018. Project 42: Pacific Tuna Tagging Project Report and Workplan for 2018-2021. SC14-RP-PTTP-02. Fourteenth regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission. Busan, Korea, 8-17 August 2018.