SCIENTIFIC COMMITTEE
11TH REGULAR SESSION

POHNPEI, FSM
5th -13th August 2015

PACIFIC TUNA TAGGING PROJECT REPORT AND WORKPLAN FOR 2015-2016

WCPFC-SC11-2015/RP-PTTP-02

SPC – OFP

1 Introduction

The steering committee report for the Pacific Tuna Tagging Programme (PTTP) for 2015 reports upon the tagging activities undertaken in 2014 under the banner of the PTTP, tag recoveries, and tag seeding activities. The objectives of the PTTP are specified in SC6-GN-IP-04. 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 and the Global Environment Facility. 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 is reported in this annual report.

The overall operational structure of the PTTP is as follows (with planned work for 2015-16 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*
	Oct 2016	*Central Pacific (CP12)*	*to be determined*
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*
	Nov 2015	*PNG (TAO trial)*	*FTV Pokajam*

The report provides a review of work undertaken in 2014-15, an update of the overall programme results to date and the proposed workplan for the PTTP for 2015-2016.

2 Summary of PTTP Activities in 2014-2015

Since SC10, PTTP activities comprised one troll/handline cruise, CP10, in the tropical central Pacific, continued implementation and refinement of tag recovery processes and tag seeding, and data preparation for use in the 2015 Pacific-wide bigeye tuna stock assessment.

CP10 was a cruise of 25 days duration conducted in Aug 2014 targeting bigeye tuna aggregations associated with the TAO oceanographic moorings (Figure 1) straddling the Equator at 170ºW. CP-10 was designed to include data collection on tuna movements, exploitation rates and fish aggregation device (FAD) association dynamics. This work is the result of collaborations between SPC, Tri Marine and ISSF and is detailed in the Acoustic tagging section of this report.

The Tonga-based multipurpose vessel *Pacific Sunrise* was chartered for the cruise. A total of 305 tuna (195 bigeye, 98 yellowfin and 12 skipjack) were tagged (Table 2). Within these releases, 24 archival tags were deployed on bigeye tuna and 8 on yellowfin tuna. Three drifting FADs 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. Sixty-eight fish were implanted with acoustic tags across the 3 equipped dFADs. Half of the fish were tuna (bigeye, skipjack and yellowfin) and the other half were composed of sharks, triggerfish, rainbow runner and wahoo (Table 1).

CP10 was an unusual cruise amongst the other Central Pacific tagging experiments. The cruise was hampered with the lack of large bigeye aggregations under the TAOs along the 170^{0}W meridian and with the abundance of natural bait in the area resulting in poor bite on our fishing gear. However the first attempt to release tagged fish around drifting FADs was successful.

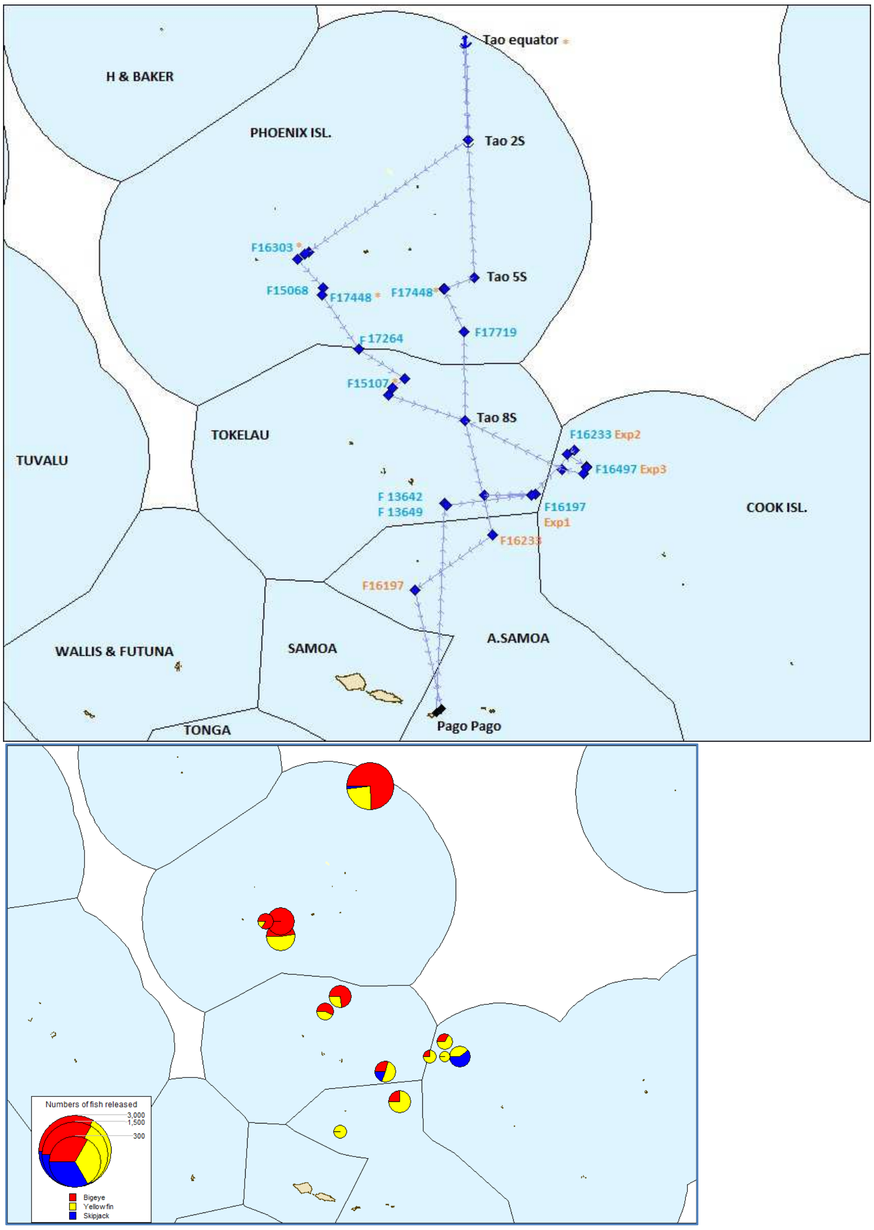

Figure 1. Cruise track (top figure) and distribution of tag releases during CP10 cruise. Exp1, Exp2 and Exp3 were the FADs equipped with VR4 acoustic receivers.

2.1 Acoustic tagging

The acoustic tagging component of the CP-10 cruise consisted of instrumenting 3 drifting fishing aggregating devices (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 24 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.
2. The behaviour of tuna and non-tuna species at dFADs to better understand the effects of dFADs on these species, including residency, vertical behaviour, and daily presence/absence patterns.

A total of 11 different DFADs were visited (see Figure 1) and tagged fish were released in association with 6 of them.

Table 1: Summary of animals implanted with acoustic tags during CP10

Species	Exp1	Exp2	Exp3	Total
Yellowfin	6	7	7	20
Skipjack	2	0	6	8
Bigeye	3	3	0	6
Silky shark	5	5	3	13
Rainbow runner	2	0	2	4
Triggerfish	5	5	5	15
Wahoo	0	1	0	1
Oceanic White Tip shark	0	1	0	1
Total	**23**	**22**	**23**	**68**

3 PTTP Results

The release numbers and recovery percentages to date of conventional and archival tags made during the 10 Central Pacific (CP) cruises, the PNGTP and Phase 1 and 2 of the PTTP are detailed in Table 2.

Table 2. CP, PNGTP and total PTTP releases numbers and % of recoveries to date of conventional and archival tags.

Project	Tag type	RELEASE NUMBERS				RECAPTURES PERCENTAGES			
		Skipjack	Yellowfin	Bigeye	Total	Skipjack	Yellowfin	Bigeye	Total
CP	Conventional	424	1,489	35,186	**37,099**	5.4	17.0	30.0	**29.1**
	Archival	30	158	556	**744**	0.0	5.7	15.3	**12.6**
PNGTP	Conventional	80,438	27,070	2,915	**110,423**	19.9	18.3	21.1	**19.6**
	Archival	0.0	68	12	**80**	na	23.5	58.3	**28.8**
Total PTTP	Conventional	246,632	105,744	44,518	**396,894**	17.3	16.8	28.1	**18.4**
	Archival	127	568	742	**1,437**	3.1	11.1	16.2	**13.0**

3.1 Biological sampling during tagging cruises

A total of 5822 stomach samples have been collected since the beginning of the PTTP, mainly from skipjack, yellowfin, bigeye and albacore tuna (Table 3). The examination of the stomachs is an ongoing process and is conducted in the laboratory at SPC headquarters. A total of 5492 stomachs, representing 94% of the samples collected, have been examined and the corresponding data entered into a dedicated database (Table 3).

Table 3. Total number of stomach samples collected and analysed to date.

PREDATOR SPECIES		COLLECTED	ANALYSED	% ANALYSED
SKJ	SKIPJACK	2621	2474	94%
YFT	YELLOWFIN	2107	2014	96%
BET	BIGEYE	429	357	83%
ALB	ALBACORE	245	245	100%
KAW	KAWAKAWA	124	118	95%
RRU	RAINBOW RUNNER	117	112	96%
FRI	FRIGATE TUNA	95	95	100%
DOL	MAHI MAHI / DOLPHINFISH / DORADO	51	45	88%
SWO	SWORDFISH	6	6	100%
WAH	WAHOO	7	6	86%
MSD	MACKEREL SCAD / SABA	5	5	100%
FAL	SILKY SHARK	4	4	100%
BUM	BLUE MARLIN	3	3	100%
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	**5822**	**5492**	**94%**

3.2 Conventional and archival tag recoveries for the PTTP

As at 15 July 2015, a total of 73,025 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 4. 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 2) 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 5). Initial observations of this data suggest increased tag rejection/fish mortality with archival tagging on some cruises.

The majority of recoveries have come from purse-seine vessels (91%), followed by pole and line and other gear types (4%), unknown (4%) and longline recoveries <1% (183 in total). Table 6 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 disproportionately low number of tag returns is evident for longline vessels. The same trend is observed if the analyses 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 transshipment (Figure 3). The information from transshipment on date and location of recovery is typically reported as unknown.

Recovery rates of CP9 and CP10 bigeye releases are substantially lower than for previous Central Pacific cruises (Table 4). The reason for this is not clear. No evidence was found of changes in fisheries that might explain this reduced recovery rate. Additionally, recovery rates of CP9 tags on fishing vessels were consistent with those from previous CP cruises for tags at equivalent times at liberty. However, recovery rates of CP9 tags on transshipment vessels and at other stages in the supply chain were comparatively low. This suggests that there are large numbers of CP9 tags that have been recovered in fisheries but have remained undetected in the supply chain, or that detection rates of CP9 tags on fishing vessels were higher than for previous CP cruises and that overall recovery rates of CP9 tags are low. Transhipment vessel VMS data available to SPC suggests higher proportions of central Pacific tuna were transported westwards in 2014 compared to previous years, to countries where there have been few bigeye tags reported historically. This might explain a lower detection rate of CP9 tags in these countries, but does not explain the low numbers of tags reported in countries to the east of the fishing grounds where high numbers of bigeye have historically been reported. It is possible that the low recovery rate of CP9 tags could be explained by large numbers of CP9 tags sitting in cold storage, though it would require unprecedented recovery rates at this stage to raise the CP9 recovery rate to that of previous CP tagging cruises.

Table 4. Tag releases and recaptures for the PTTP to date (15/07/2015)

Cruises	Releases				Number recovered (% recovered)			
	SKJ	YFT	BET	Total	SKJ	YFT	BET	Total
PG1 Aug-Nov 06	13,948	7,806	562	**22,316**	2,645 (19%)	1,806 (23.1%)	229 (40.7%)	**4,680 (21%)**
PG2 Feb-May 07	26,493	12,845	129	**39,467**	2,501 (9.4%)	1,717 (13.4%)	8 (6.2%)	**4,226 (10.7%)**
SB1 Oct-Nov 07	7,479	3,565	139	**11,183**	1,975 (26.4%)	784 (22%)	18 (12.9%)	**2,777 (24.8%)**
SB2 Feb-Apr 08	15,327	14,405	414	**30,146**	1,765 (11.5%)	2,419 (16.8%)	62 (15%)	**4,246 (14.1%)**
CP1 May-Jun 08	57	116	1,736	**1,909**	4 (7%)	25 (21.6%)	574 (33.1%)	**603 (31.6%)**
WP1 Jun-Nov 08	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 09	34,207	13,919	3,145	**51,271**	4,608 (13.5%)	2,352 (16.9%)	488 (15.5%)	**7,448 (14.5%)**
CP2 May-Jun 09	169	205	2,309	**2,683**	5 (3%)	26 (12.7%)	569 (24.6%)	**600 (22.4%)**
WP3 Jul-Oct 09	30,722	7,340	735	**38,797**	6,695 (21.8%)	1,430 (19.5%)	197 (26.8%)	**8,322 (21.5%)**
CP3 Oct-Nov 09	66	237	4,802	**5,105**	2 (3%)	62 (26.2%)	1,754 (36.5%)	**1,818 (35.6%)**
CP4 May-Jun 10	7	120	2,284	**2,411**	1 (14.3%)	13 (10.8%)	507 (22.2%)	**521 (21.6%)**
CP5 Nov-Dec 10	40	228	6,090	**6,358**	7 (17.5%)	46 (20.2%)	1,936 (31.8%)	**1,989 (31.3%)**
PNGTP1 Apr-Jul 11	28,730	11,571	355	**40,656**	5,766 (20.1%)	2,472 (21.4%)	60 (16.9%)	**8,298 (20.4%)**
CP6 Oct-Oct 11	2	123	3,804	**3,929**	0 (0%)	27 (22%)	1,020 (26.8%)	**1,047 (26.6%)**
CP7 Nov-Dec 11	52	245	4,212	**4,509**	1 (1.9%)	19 (7.8%)	1,440 (34.2%)	**1,460 (32.4%)**
PNGTP2 Jan-Mar 12	28,312	9,607	2,008	**39,927**	7,217 (25.5%)	1,682 (17.5%)	519 (25.8%)	**9,418 (23.6%)**
CP8 Sep-Oct 12	20	140	6,014	**6,174**	2 (10%)	32 (22.9%)	2,284 (38%)	**2,318 (37.5%)**
PNGTP3 Apr-Jun 13	23,397	5,960	564	**29,921**	3,034 (13%)	823 (13.8%)	40 (7.1%)	**3,897 (13%)**
CP9 Nov-Dec 13	29	135	4,296	**4,460**	1 (3.4%)	9 (6.7%)	546 (12.7%)	**556 (12.5%)**
CP10 Aug-Aug 14	12	98	195	**305**	0 (0%)	3 (3.1%)	0 (0%)	**3 (1%)**
Total	**246,760**	**106,312**	**45,260**	**398,332**	**42,607 (17.3%)**	**17,805 (16.7%)**	**12,613 (27.9%)**	**73,025 (18.3%)**

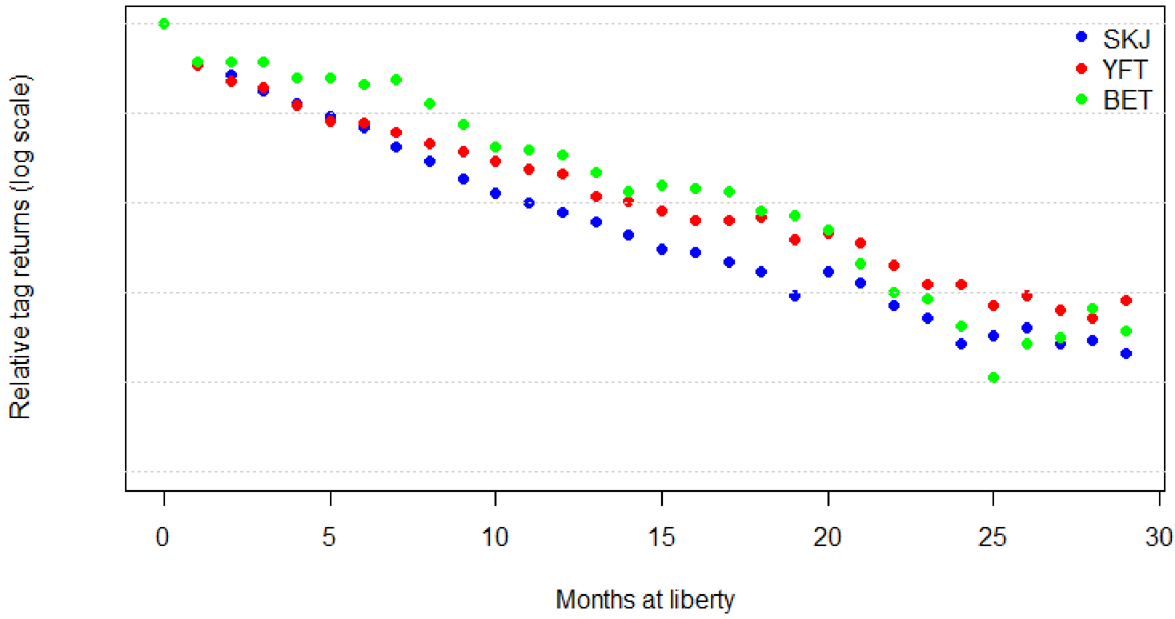

Figure 2. Tag recoveries by time at liberty for skipjack, yellowfin and bigeye tuna.

Table 5. Comparison of archival and conventional tag recoveries by species and cruise.

	Archival Recoveries (%) (Number tagged)				Conventional Recoveries (%) (Number tagged)			
Cruises	**SKJ**	**YFT**	**BET**	**Total**	**SKJ**	**YFT**	**BET**	**Total**
PG1 Aug-Nov 06	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 07	0% (1)	8.6% (187)	0% (23)	**7.6% (211)**	9.4% (26,492)	13.4% (12,658)	7.5% (106)	**10.7% (39,256)**
SB1 Oct-Nov 07		0% (5)	0% (7)	**0% (12)**	26.4% (7,479)	22% (3,560)	13.6% (132)	**24.9% (11,171)**
SB2 Feb-Apr 08		13.6% (22)	0% (1)	**13% (23)**	11.5% (15,327)	16.8% (14,383)	15% (413)	**14.1% (30,123)**
CP1 May-Jun 08		40% (5)	22.2% (45)	**24% (50)**	7% (57)	20.7% (111)	33.4% (1,691)	**31.8% (1,859)**
WP1 Jun-Nov 08		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 09	0% (39)	1.8% (56)	3.7% (81)	**2.3% (176)**	13.5% (34,168)	17% (13,863)	15.8% (3,064)	**14.6% (51,095)**
CP2 May-Jun 09		0% (9)	12.3% (81)	**11.1% (90)**	3% (169)	13.3% (196)	25.1% (2,228)	**22.8% (2,593)**
WP3 Jul-Oct 09	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 09		14.3% (28)	20.6% (107)	**19.3% (135)**	3% (66)	27.8% (209)	36.9% (4,695)	**36.1% (4,970)**
CP4 May-Jun 10		10% (20)	5.1% (39)	**6.8% (59)**	14.3% (7)	11% (100)	22.5% (2,245)	**22% (2,352)**
CP5 Nov-Dec 10			15.5% (58)	**15.5% (58)**	17.5% (40)	20.2% (228)	31.9% (6,032)	**31.4% (6,300)**
PNGTP1 Apr-Jul 11		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 11		0% (2)	13.7% (51)	**13.2% (53)**	0% (2)	22.3% (121)	27% (3,753)	**26.8% (3,876)**

Cruises	Archival Recoveries (%) (Number tagged)				Conventional Recoveries (%) (Number tagged)			
	SKJ	YFT	BET	Total	SKJ	YFT	BET	Total
CP7 Nov-Dec 11	0% (30)	0% (85)	10.9% (92)	**4.8%** **(207)**	4.5% (22)	11.9% (160)	34.7% (4,120)	**33.7%** **(4,302)**
PNGTP2 Jan-Mar 12		36.8% (19)	87.5% (8)	**51.9%** **(27)**	25.5% (28,312)	17.5% (9,588)	25.6% (2,000)	**23.6%** **(39,900)**
CP8 Sep-Oct 12			44.4% (18)	**44.4%** **(18)**	10% (20)	22.9% (140)	38% (5,996)	**37.5%** **(6,156)**
PNGTP3 Apr-Jun 13		20% (30)	0% (1)	**19.4%** **(31)**	13% (23,397)	13.8% (5,930)	7.1% (563)	**13%** **(29,890)**
CP9 Nov-Dec 13		0% (1)	17.1% (41)	**16.7%** **(42)**	3.4% (29)	6.7% (134)	12.7% (4,255)	**12.4%** **(4,418)**
CP10 Aug-Aug 14		12.5% (8)	0% (24)	**3.1%** **(32)**	0% (12)	2.2% (90)	0% (171)	**0.7%** **(273)**
Total	**3.1%** **(127)**	**11.1%** **(568)**	**16.2%** **(742)**	**13%** **(1,437)**	**17.3%** **(246,633)**	**16.8%** **(105,744)**	**28.1%** **(44,518)**	**18.4%** **(396,895)**

Table 6. Tag returns by gear type and by project for fish at liberty for at least 1 year before recovery

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	88	3	77	0	3	0	0	0	2	1	6
PTTP Phase 2 - Central Pacific #3	3	196	2	176	0	7	0	0	0	1	1	12
PTTP Phase 2 - Central Pacific #4	1	57	1	54	0	2	0	0	0	0	0	1
PTTP Phase 2 - Central Pacific #5	7	347	7	340	0	3	0	0	0	0	0	4
PTTP Phase 2 - Central Pacific #6	4	94	3	90	0	1	0	0	1	0	0	3
PTTP Phase 2 - Central Pacific #7	1	192	1	181	0	10	0	1	0	0	0	0
PTTP Phase 2 - Central Pacific #8	0	51	0	46	0	4	0	0	0	0	0	1
PTTP Phase 2 - Central Pacific #9	0	17	0	17	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	250	2	238	2	4	0	0	0	0	0	8	0
PNGTP - Papua New Guinea #2	231	39	227	38	2	1	0	0	0	0	2	0
PNGTP - Papua New Guinea #3	39	5	38	4	0	1	0	0	1	0	0	0
Total	**1,795**	**1,267**	**1,665**	**1,167**	**32**	**52**	**3**	**1**	**45**	**7**	**50**	**40**

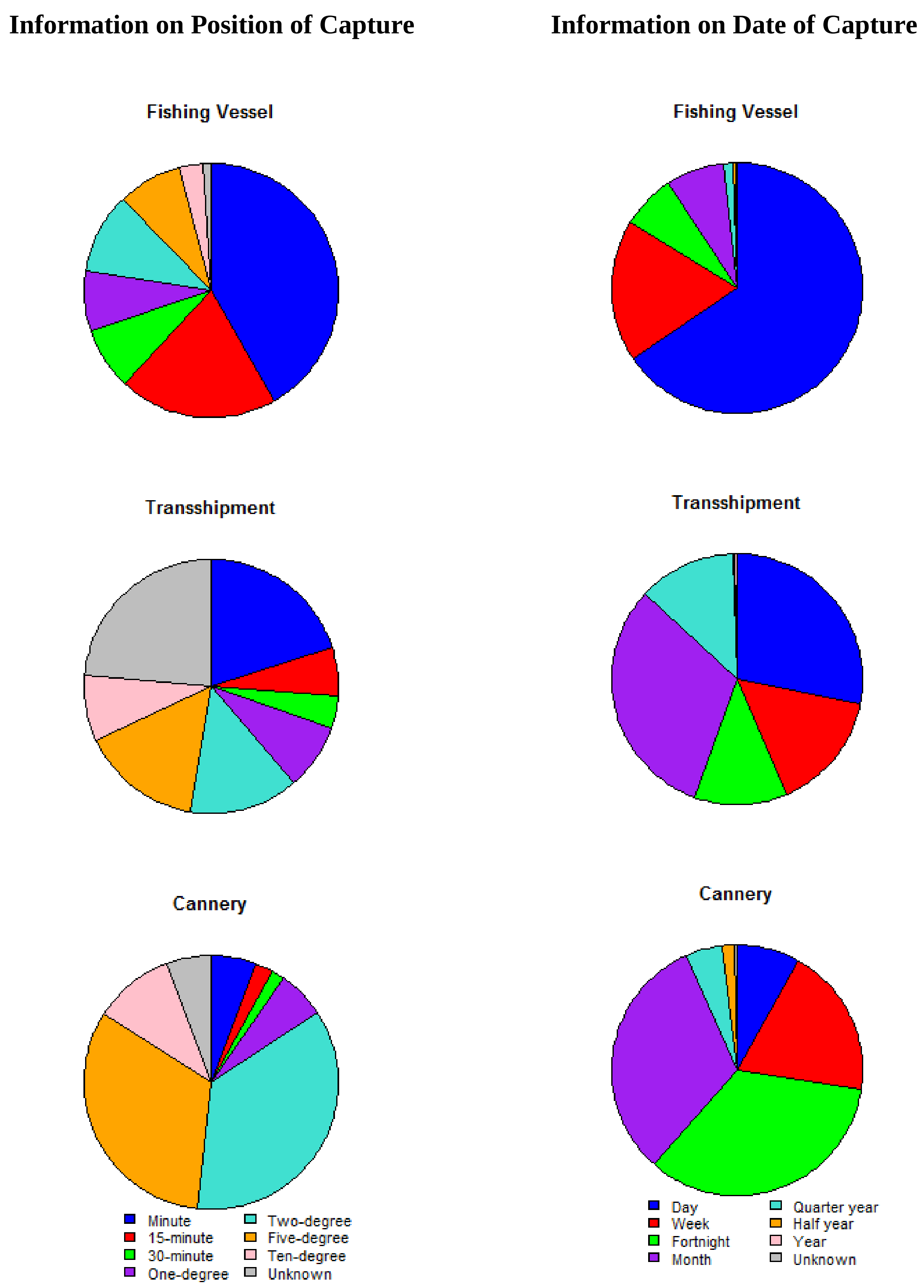

Figure 3. Location and date of tag recovery accuracy information for recoveries on fishing vessels, during transshipment and at canneries.

3.3 Tag Recovery

Full-time Tag Recovery Officers continue their duty in Wewak, Madang, Lae, Honiara, Rabaul, Tarawa, Philippines and Manta. These officers are coordinated by the central TRO at SPC. All full-time TRO (except for those in Rabaul) and TRO in Thailand are still entering data in a specialized database that allows importation of recovery information directly into an SPC database. This database has been improved to incorporate more data control systems and to capture information regarding transshipment if tags are reported from carriers unloading at port and Canneries. Recovery information is received at SPC on a monthly 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 7). Major unloading and processing facilities as well as transshipping vessels in port have been visited by TROs over the last 12 months.

3.4 Tag Seeding

From February 2007 to June 2015, 458 tag seeding kits (consisting of seeding tags, applicators, guide books and data forms) for a total of 8,438 tags have been given to observer coordinators and TRO in 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 8 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 training courses. Tag Recovery Officers in the ports of Pohnpei, Honiara, Lae, Madang, Wewak and Tarawa 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 TROs.

Of the 458 kits distributed to observer coordinators, 324 have been given to observers for deployment, of which 307 tag seeding datasheets have been received for these observer trips. Currently, SPC is holding returned seeded tags from an additional 20 kits for which the datasheets have not yet been provided. It is worth noting that it can take 6 months or more for datasheets to be returned. Logsheets have not been returned for 8 tag seeding kits that have been deployed since January 2014.

Since June 2014, 13 kits have been deployed, using a total of 226 tags. This is a lower rate of deployment in comparison to last year’s (56 kits for 1341 tags).

As at 15th July 2015, there have been 6,287 reported tags that have been seeded and 3,613 of these 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. Tables 9 and 10 detail the reporting of vessel name by location and cannery. 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 657 tags, was absent from the recovery information for 138 tags and was correct for 2,818 tags.

Table 7. 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	1,931	97.41	92.72	0.21	0.21	0.00	0.37	6.49	3.52	0.36	26.31	24.96
China	17	76.47	7.69	0.00	0.00	0.00	0.00	92.31	76.47	0.00	5.88	70.59
Fishing vessel	544	92.28	80.08	1.79	0.00	0.00	15.34	2.79	1.84	0.74	3.68	3.68
FSM	546	76.37	97.12	0.48	0.00	0.00	0.00	2.40	2.56	0.73	10.07	30.40
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	9,465	24.30	45.30	4.17	1.35	0.00	14.78	34.39	22.75	11.43	15.91	71.38
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	3,017	63.74	90.80	4.52	0.00	0.00	0.78	3.90	3.65	4.81	20.12	4.81
Kiribati (Kiritimati)	280	58.21	89.57	0.00	3.07	0.00	0.00	7.36	4.64	7.86	24.64	10.36
Kiribati (Tarawa)	954	80.08	69.50	0.13	0.52	0.00	0.52	29.32	22.33	4.51	16.14	7.55
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	918	88.24	87.04	10.00	0.37	0.00	0.49	2.10	1.53	2.07	12.09	28.00
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)	8,359	54.62	68.29	5.50	0.04	0.00	4.80	21.38	16.58	4.40	26.46	66.00
Philippines (Frabelle)	351	49.86	97.71	0.57	1.71	0.00	0.00	0.00	7.12	3.13	0.85	27.35
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)	6,771	80.17	88.17	10.26	0.06	0.02	0.04	1.46	1.74	1.28	3.51	8.03
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	91.67	100.00	0.00	0.00	0.00	0.00	0.00	0.00	8.33	16.67	0.00
PNG (NFA)	515	82.33	69.34	6.13	0.47	0.00	1.18	22.88	17.28	1.55	11.84	23.11
PNG (other)	1,076	77.88	70.64	0.84	0.12	0.00	0.12	28.28	6.13	2.32	14.78	12.45
PNG (Pacific Blue Sea Fishing)	248	41.53	92.23	7.77	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00
PNG (RBL Fishing)	961	55.36	99.62	0.19	0.00	0.00	0.00	0.19	0.52	2.19	7.60	6.76
PNG (RD)	9,516	93.51	80.07	17.97	0.06	0.00	0.03	1.87	1.77	0.51	2.30	3.93
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	40.47	67.87	19.76	0.00	0.00	0.00	12.37	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)	1,862	67.35	89.63	3.75	0.08	0.00	0.40	6.14	4.24	2.31	4.35	6.34
PNG (TSP Marine)	455	72.31	99.39	0.00	0.00	0.00	0.00	0.61	0.00	1.10	7.25	2.42
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)	280	83.57	75.21	3.85	2.56	0.00	0.00	18.38	15.00	0.36	14.64	10.00
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)	178	85.96	86.27	2.61	0.00	0.00	0.00	11.11	16.85	2.81	11.24	28.65
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	217	33.18	4.17	0.00	0.00	0.00	93.06	2.78	0.46	0.00	10.14	1.38
Taiwan	67	91.04	95.08	0.00	0.00	0.00	0.00	4.92	0.00	0.00	23.88	0.00
Thailand	10,319	63.79	93.65	3.74	0.09	0.00	0.05	2.48	1.31	0.06	95.38	1.20
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	240	60.00	65.97	2.08	2.78	0.00	5.56	23.61	15.83	0.00	12.92	28.75

Table 8: Number of seeded tags deployed per EEZ since the beginning of the project

EEZ	Releases
Not known yet	2,540
American Samoa	2
Cook Islands	44
Federated states of Micronesia	212
Fiji	7
Gilbert Islands	342
Howland & Baker	4
Indonesia	7
International waters H4	56
International waters H5	40
International waters I2	109
International waters I5	4
International waters I9	5
Jarvis	5
Marshall Islands	40
Nauru	83
Papua New Guinea	1,681
Phoenix Islands	222
Samoa	4
Solomon Islands	474
Tokelau	134
Tuvalu	272
Total	**6,287**

Table 9: Vessel reported per locations of 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	8,473	213	86	22	105	49.3
HONIARA, Solomons	1,144	469	12	2	455	97.0
LAE, PNG	5,453	192	28	5	159	82.8
LONDON, Kiribati	102	1	0	0	1	100.0
MADANG, PNG	2,879	300	59	0	241	80.3
MAJURO, Marshalls	1,093	177	21	0	156	88.1
MANTA, Ecuador	1,354	44	11	0	33	75.0
NORO, Solomons	8,308	52	20	1	31	59.6
Noumea, New Caledonia	315	15	1	2	12	80.0
PAGO PAGO, A. Samoa	1,917	500	37	22	441	88.2
POHNPEI, FSM	841	73	6	0	67	91.8
PORT MORESBY, PNG	524	80	15	0	65	81.2
RABAUL, PNG	395	132	29	0	103	78.0
SAMUTSAKOM, Thailand	10,316	545	200	6	339	62.2
SAN DIEGO, USA	8,206	166	38	70	58	34.9
SHIMIZU, Japan	2,996	7	2	1	4	57.1
TARAWA, Kiribati	971	158	5	1	152	96.2
VIDAR, PNG	7,149	192	13	1	178	92.7
WEWAK, PNG	6,956	254	70	1	183	72.0

Table 9: 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	30	4	0	26	86.7
ISA VALUE	6	1	0	5	83.3
PATAYA FOOD INDUSTRIES LTD.	129	93	0	36	27.9
R.S. Cannery Co., Ltd.	36	9	0	27	75.0
Songkla Canning PLC.	62	34	0	28	45.2
SOUTHEAST ASIAN PACKAGING	50	8	0	42	84.0
Thai Union Manufacturing Co.	33	3	0	30	90.9
TROPICAL CANNING (THAILAND)	9	2	0	7	77.8
Unicord Public Co., Ltd.	86	16	1	69	80.2

3.5 Analysis of Tag Seeding data

The tag seeding dataset provides an opportunity to compare reported date and positions of tag recoveries against the known date and position of the tag seeding process and explore what variables influence the accuracy of the reported data. Additionally, the tag seeding dataset allows for comparison between the actual errors in reported recovery date and position and the estimated accuracy of these data determined through the validation and verification of tag recovery data undertaken by SPC. Errors in reported recovery date and position were mainly affected by where tags were discovered, i.e. the country where tags were reported and whether the tags were discovered on the fishing vessel, a transhipment vessel, in a cannery etc. The accuracy of reported date and positions of tag recovery were not influenced by the distance or duration of fishing trips on which seeding took place. Analysis of available tag seeding data indicated that the validation process has been accurately determining the accuracy of reported date and positions of recovery of 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 4).

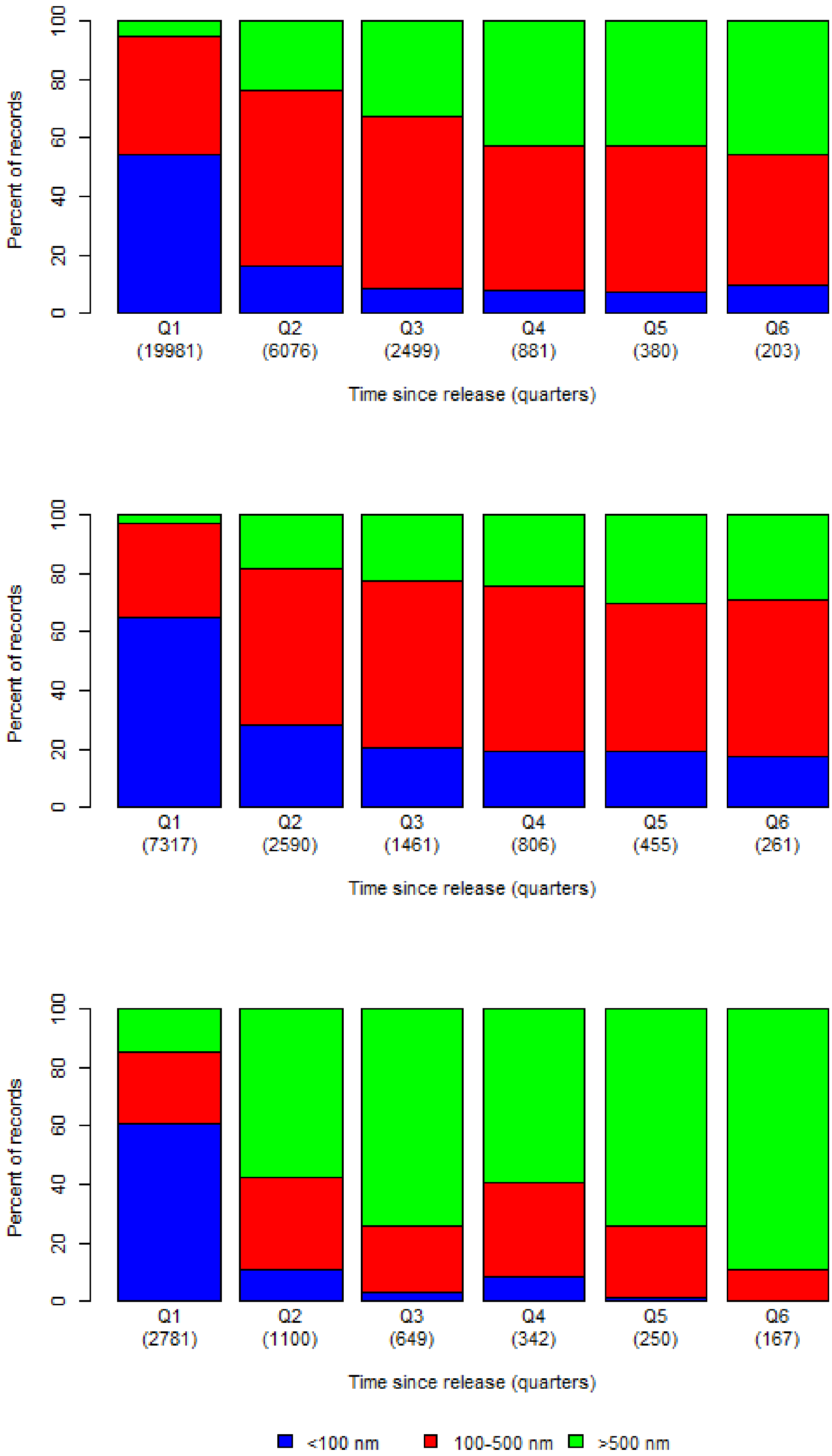

Figure 4. Reported recoveries within 100 nm, 100-500 nm and >500 nm in the first 6 quarters (18 months) since release for skipjack (upper graph), yellowfin (middle graph) and bigeye (lower graph). The sample size for each quarter is provided in the parentheses below the quarter label on the x-axis.

3.7 *Bigeye vertical behaviour*

Catchability and selectivity of bigeye fisheries

Analysis of bigeye vertical behaviour was undertaken using archival tag data to explore the influence of physical and environmental variables on the catchability and selectivity of bigeye fisheries operating in the Western and Central Pacific. Data from 53 archival tagged bigeye were used, with positions ranging from 150°E to 100°W. Behavioural classifications were assigned to each fish on a daily basis to allow separate analyses of characteristic vertical behaviour and behaviour suggesting association with FADs or other objects. Average bigeye depths were modelled as a function of the explanatory variables using generalised additive models. Thermocline depth had the greatest impact on average depths of bigeye during day and night-time, with bigeye moving deeper with increasing thermocline depth regardless of whether fish displayed characteristic or associative behaviour. However thermocline depth was correlated with a range of environmental variables, for example dissolved oxygen levels, which likely contributed to the apparent influence of thermocline depth. Fish length also impacted bigeye depth, particularly for bigeye displaying characteristic behaviour whose average depths increased with size of the individual. The results have application for estimating catchability and selectivity for the various fisheries and regions used in the WCPFC bigeye stock assessment.

Classification of Vertical Behaviours

Two approaches have been applied to classifying the vertical behaviour of bigeye. The first has replicated previous work from the EPO by IATTC (Schaefer & Fuller, 2010) and allows for direct comparison with this work. More recently scientists in Japan have applied the same methods for the analyses of tags in the north-west Pacific (Matsumoto et al. 2013). Only 47 CP archival tagged bigeye were used in our analyses (8,217 days of data in total); 51–134 cm in length (mean = 86.9 cm); 0.87–3.44 years of age (mean = 1.89 years); and at liberty from 36 to 851 days (mean = 183 days). The depth and temperature records were examined for three daily behaviour types: characteristic, associative (associated with floating objects), and other. For the three length classes, 51–79.9 cm, 80–99.9 cm, and 100–134 cm, when exhibiting characteristic behaviour, the proportions of time and average durations of events were 45.3 % (mean = 5.1 days), 62.6 % (mean = 8.5 days), 79.2 % (mean = 17.5 days), and the average daytime depths and temperatures were 284 m and 12.6 °C, 305 m and 12.7 °C, and 312 m and 12.1 °C, respectively. For the same three length classes, when exhibiting associative behaviour, the proportions of time and average durations of events were 9.5 % (mean = 1.9 days), 4.8 % (mean = 1.9 days), and 6.0 % (mean = 1.8 days), and the average daytime depths and temperatures were 101 m and 23.2°C, 105 m and 23.1 °C, and 74 m and 22.3 °C, respectively. There is a significant positive correlation between the proportion of time fish exhibit characteristic behaviour and increasing length, and significant negative correlations between the proportion of time bigeye tuna exhibit associative and other behaviour with increasing length.

The second approach applied multivariate-normal hidden Markov chain modelling (HMM) to each individual time series (Scutt Phillips et al 2015). The advantage of this approach is that it takes into account largely ignored problems of bias in manual classification, autocorrelation, and noise. For these analyses all bigeye and yellowfin archival tag recoveries from the PTTP were used. Based on the results from the analyses described above two state HMMs were applied using depth and temperature variables resulting in the classification of a deep state and a shallow state for each individual. Meta-analyses of the population of HMM models was then applied to summarise the data.

Shallow states for each species described by the model are typified by a relatively confined spectrum of diving amplitudes and an associated narrow range of warm thermal habitat with both variability in depth and temperature differing between the two species. Diving behaviours associated with a shallow state are comparable to behaviours in bigeye tuna classified as surface, associative or the night-time component of type I "characteristic" behaviour (Schaefer & Fuller 2010, Evans et al. 2008), and behaviours in yellowfin tuna classified as shallow or associative (Schaefer et al. 2009).

Relative deep states were typified by higher diving amplitudes and colder thermal habitat with state distribution means differing between species. The high amplitude of vertical movement associated with deep state behaviour in bigeye tuna, is likely to be a result of the characteristic thermoregulatory ascents undertaken by bigeye during the day (Holland et al. 1992). Deep states identified in bigeye tuna were centred in colder water at the bottom of the thermocline, and although temperatures were lower than those associated with deep states in yellowfin tuna they were not necessarily deeper. The deep states identified for yellowfin were associated with greater levels of movement through the water column than shallow states. This may be explained by yellowfin tuna being centred towards the bottom of the epipelagic layer within the thermocline. Variability in the vertical movements of yellowfin tuna is indicative of individuals undertaking vertical movements to depths below the thermocline for brief periods, comparable to the repetitive bounce diving behaviour described in yellowfin tuna in the eastern Pacific Ocean (Schaefer et al. 2011, Schaefer et al. 2014).

Behavioural switching between the two states is generally weighted in favour of time spent in shallow states, with the largest bigeye tuna examined here approaching an almost even proportion of time spent in each state. Switching of states associated with day and night was more pronounced in bigeye, although there was considerable variation within all individuals of both species.

3.8 Effect of fish length on horizontal displacements

Previous exploratory analyses of RTTP and PTTP conventional tagging data had suggested a potential relationship between fish length at release and horizontal displacements. Data from conventional tagging of bigeye, skipjack and yellowfin from the RTTP, PTTP and the Indian Ocean Regional Tuna Tagging Programme (IO-RTTP) were analysed to further explore the effect of fish size on horizontal displacements of tagged fish at recovery. The effects of fish length on displacement were dependent on species, the location of release and time at liberty. Estimated displacements of skipjack generally increased with increasing release length, whereas estimated displacements of bigeye and yellowfin tuna generally decreased with increasing release length. Archival tagging data provide an additional data source to explore the effect of fish size on movement. Data from archival tagged bigeye and yellowfin suggested that short-term displacements increased with increasing fish size.

3.9 FAD effects

<u>Near shore FADs</u>

Significant numbers of the large quantities of yellowfin and skipjack tuna tagged in the PNG and Solomon Islands EEZs have been released within 12 nautical miles of shore. This included tagging tuna on near-shore FADs in these areas. In PNG, where industrial fishing is excluded within the 12 nm zone, tuna were at liberty longer than those released on FADs without the exclusion zone in the Solomon Islands. Additionally recapture probabilities of near-shore releases in some areas of PNG were lower than for nearby off-shore releases, a feature not observed for near-shore releases in the Solomon Islands. This suggests that mortality rates are higher for tuna in the areas without exclusion. These results suggest that exclusion zones may be important considerations for near-shore FAD placement.

Classification of Surfacing Behaviour

The horizontal movement analyses based on the geolocation of archival tags was combined with the HMM analyses of vertical behaviour to examine patterns in surface behaviour in bigeye and yellowfin tuna. While the behaviour typically assumed to be linked to FAD-association is a clear and sustained residence near the surface, the analyses showed the exhibition of a more broadly defined surface-association behaviour that is highly variable across individual fish. It is likely that this variability may be explained by processes working at different scales. Preliminary results suggest that floating objects may contribute to concentrating tuna horizontally at local scales and islands and other bathymetric features may effect vertical behaviour at larger spatial scales regardless of the density of floating objects in the region. Understanding surfacing behaviour in this context may have important management consequences. Current management measures that invoke spatial closure of certain regions to restrict the catch of surface gears may only be beneficial if they co-occur with these larger spatial scale processes. More broadly, restricting the number of sets on floating objects may be more effective where local scale effects predominate.

4 Albacore Tagging

A description of albacore tagging activities was outlined previously in SC6 GN IP-06 and SC5 GN IP-16. Since SC10, 4 additional tag recaptures have been reported bringing the total to 27 recoveries (1%) for the project. Movements of recaptured fish for which we received accurate recovery position are displayed in Figure 5.

Figure 5. Release-recovery arrow map for albacore tags reported to SPC

5 PTTP 2015-2016 work plan

	Task	2015	2016
TAGGING			
1.	**CP11** *Background*: 8 week cruise focusing upon the NOAA TAO Oceanographic Buoys along the 170°, 155˚ and 140˚W meridian (waters of Kiribati, Phoenix and Line Islands, Jarvis Island (US) and High Seas). This is the eleventh Central Pacific cruise designed to improve overall spatial coverage of PTTP tag releases in areas difficult to access between the Date line and French Polynesia and investigate movement parameters and vertical habitat utilization of tuna in the central Pacific region. This cruise will be undertaken in collaboration with ISSF, Trimarine and Garavilla to study residential time of tuna and bycatch around drifting fads. The cruise will charter the *FV Gutsy Lady4*, a multi-purpose pelagic handline/longline vessel which is based in Honolulu, HI/USA. *Target*: BET 5,000 conventional tags; BET & YFT 150 Archival Tags, equip 4 drifting fads with sonic listening station	■	
2.	Additional CP cruise(s) subject to funding		■
TAG RECOVERY			
1.	Support of TROs in PNG, Philippines, Thailand key Pacific Island locations and in Ecuador	■	■
DATA MANAGEMENT			
1.	PTTP data verification with VMS and Logbook	■	■
2.	Consolidation of the web tagging framework	■	■
DATA ANALYSES			
1.	Tag reporting and seeding Purpose: Estimation is a direct scalar for fishing mortality. Tasks: (1) Routine update of analyses;	■	■
2.	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: (1) Routine update of analyses.	■	■
3	Movement Purpose: Provide external validation to estimates from within MFCL and SEAPODYM. Tasks: (1) Routine update of analyses.	■	■
		■	■

Acknowledgements

Material for this report was provided by T. Peatman[1], S. Caillot[1], B. Leroy[1], J. Muir[2], J. Scutt Phillips[1], C. Sanchez[1], S. Hoyle[1], T. Usu[3], B. Kumasi[2], B. Sabub[2], L. Kumoru[2], D. Fuller[4], K. Schaefer[4], J. Hampton[1], S. Nicol[1].

References

Evans K, Langley A, Clear NP, Williams P, Patterson T, Sibert J, Hampton J, Gunn JS (2008) Behaviour and habitat preferences of bigeye tuna (Thunnus obesus) and their influence on longline fishery catches in the western Coral Sea. Can J Fish Aquat Sci 65:2427-2443.

Holland KN, Brill RW, Chang RKC, Sibert JR, Fournier DA (1992) Physiological thermoregulation n bigeye tuna (Thunnus obesus). Nature 358:410-412.

Matsumoto T, Kitagawa T, Kimura S (2013) Vertical behavior of bigeye tuna (Thunnus obesus) in the northwestern Pacific Ocean based on archival tag data. Fish Ocean 22:234-246.

Schaefer KM, Fuller DW (2010) Vertical movements, behavior, and habitat of bigeye tuna (Thunnus obesus) in the equatorial eastern Pacific Ocean, ascertained from archival tag data. Mar Biol 157:2625-2642.

Schaefer KM, Fuller DW, Aldana G (2014) Movements, behavior, and habitat utilization of yellowfin tuna (Thunnus albacares) in waters surrounding Revillagigedo Islands Archipelago Biosphere Reserve, Mexico. Fish. Ocean. 23: 65-82.

Schaefer KM, Fuller DW, Block BA (2009) Vertical movements and habitat utilization of skipjack (Katsuwonus pelamis), yellowfin (Thunnus albacares), and bigeye (Thunnus obesus) tunas in the equatorial eastern Pacific Ocean, as ascertained through archival tag data. In Nielsen JL, Arrizabalaga H, Fragoso N, Hobday A, Lutcavage M, Sibert J (eds), Reviews: Methods and Technologies in Fish Biology and Fisheries, Vol 9, Tagging and Tracking of Marine Animals with Electronic Devices, Springer publication, pp 121-144.

Schaefer KM, Fuller DW, Block BA (2011) Movements, behavior, and habitat utilization of yellowfin tuna (Thunnus albacares) in the Pacific Ocean off Baja California, Mexico, determined from archival tag data analyses, including unscented Kalman filtering. Fish. Res. 112:22-37.

Scutt Phillips J, Patterson TA, Leroy B, Pilling GM, Nicol SJ (2015) Objective classification of latent behavioral states in bio-logging data using multivariate-normal hidden Markov models. Ecological Applications, 25:1244-1258.

[1] Secretariat of the Pacific Community, Noumea, New Caledonia
[2] International Seafood Sustainability Foundation and the University Hawaii, Honolulu, USA
[3] National Fisheries Authority, Port Moresby, Papua New Guinea
[4] Inter American Tropical Tuna Commission, La Jolla, USA