SCIENTIFIC COMMITTEE
FIFTH REGULAR SESSION

10-21 August 2009
Port Vila, Vanuatu

Encounter rates and life status for marine turtles in WCPO longline and purse seine fisheries

WCPFC-SC5-2009/EB-WP-07

Peter Williams, David Seán Kirby, Steve Beverly

Oceanic Fisheries Programme, Secretariat for the Pacific Community,
BP D5, 98848 Nouméa Cédex, New Caledonia

Background

This paper is an updated and abridged version of that prepared by the Oceanic Fisheries Programme of the Secretariat of the Pacific Community (SPC-OFP) for the Secretariat of the Pacific Regional Environment Programme (SPREP) in 2001. A fully updated version of the original paper, including marine turtle species identification, biology and ecology, is under development as part of the FFA Sea Turtle Action Plan.

This paper provides a brief overview of interaction rates with marine turtles in the oceanic fisheries of the Western and Central Pacific Ocean (WCPO), in response to the Commission's request that SC5 determine what encounter rates are considered 'minimal'. Fisheries with 'minimal' encounter rates may be exempt from requirements to use circle hooks and finfish bait under WCPFC-CMM-2008-03 on the Conservation and Management of Sea Turtles. The paper does not provide a single definition of 'minimal' encounter rates but it does provide an evidence base for that determination by SC5, as well as some cautionary advice on estimation and interpretation of encounter rates. It is for CCMs to develop operational definitions of shallow-set swordfish longline fisheries under the CMM, and relevant background information on setting strategies in relation to depth (i.e. hooks-between-floats) is provided here to assist with that task.

The essential data for analysis of marine turtle encounters, as for other bycatch analyses, are those collected by scientific observers, using well established protocols that are undergoing continuous improvement. The regional picture presented here is only possible to develop because national data holdings are made available to by SPC member countries and territories, in order to improve the information available to all contributors. We acknowledge the observers themselves and the observer programmes responsible for collecting the data.

This review uses three sub-areas of the SPC Statistical Area, itself a sub-area of the WCPFC Convention Area (WCPFC-CA): the western tropical Pacific (WTP, 10°N–10°S), the western sub-tropical Pacific (WSP, 10°S–35°S) and the western temperate Pacific (WTeP, 35°–45°S). The SPC Statistical Area was used for this study as data were not available for the sub-tropical and temperate north Pacific, north of 10°N.

Of the >2 million metric tonne average annual tuna catch in the WCPO, around 70% is taken by purse-seine, 10% by longline, 10% by pole-and-line and 10% by 'other' fisheries comprised of troll gear and a variety of artisanal gears, mostly in Indonesia and the Philippines. This review evaluates marine turtle encounters in longline and purse seine fisheries only as bycatch in the remaining fisheries is either considered non-existent (e.g. pole-and-line, troll) or there is no information available (e.g. artisanal gears). The emphasis is on marine turtle encounter rates under different setting strategies. Total encounters and total mortalities are not estimated as the available data would not permit statistical confidence in the results (see Lawson 2004[1]). We recognise that this remains an ongoing task for the Scientific Committee and this work can be carried out when more comprehensive data are available from the WCPFC Regional Observer Programme. At this stage, however, there have been sufficient data collected to provide useful information on observed encounter rates such that we can provide some scientific basis to the discussion concerning the application of the CMM.

[1]Lawson T (2004) Observer coverage rates and the reliability of estimates of CPUE for offshore longliners of the Western and Central Pacific Ocean. Working Paper SWG–4. 17th Meeting of the Standing Committee on Tuna and Billfish, 9—18 August 2004, Majuro, Republic of the Marshall Islands.

Overview of marine turtle encounters in WCPO longline fisheries

Incidental catch of marine turtles in the longline fishery occurs when opportunistic-feeding marine turtles encounter baited longline hooks, or when they are accidentally entangled with the longline gear. Turtle mortalities, when they occur, are directly related to entanglement or hooking with the longline gear and typically result from drowning. Marine turtles that are hooked or entangled not long before being hauled on board may survive the encounter, especially if they are handled correctly by fishing crew (see WCPFC Guidelines for the Handling of Sea Turtles: GN-WP-13 & GN-WP-14). In the western tropical Pacific, 'life status' has been recorded for 96% of the 262 individual turtles encountered over the period 1990 to 2007: 41% of these were 'dead' or 'barely alive', while 55% were alive (27% were alive and 'healthy', 12% were alive and 'Injured/stressed', 16% were alive with condition 'Not specified'; Table 1).

Table 1. Life status of marine turtles encounters observed in WCPO longline sets by sub-area (1990–2007)

				ALIVE (%)					
Area	Observed Sets	Turtles	Released (%)	Healthy	Injured/ stressed	Barely Alive	Not specified	Not specified	DEAD
WTP (10°N-10°S)	8,003	262	91%	27%	12%	5%	16%	4%	36%
WSP (10°S-35°S)	7,935	66	92%	62%	12%	5%	9%	3%	9%
WTEP (south of 35°S)	8,925	19	89%	26%	5%	0%	42%	21%	5%

Post-release mortality can occur despite the animal being released in an apparent healthy state. However, studies have also shown that a hook may pass through the digestive system of a turtle with no obvious adverse effects. Hooks may also become encysted inside a turtle and therefore naturally prevented from piercing internal organs. For this reason, fishers are advised not to de-hook deeply hooked turtles as they may have a better chance of survival with a hook remaining inside than if the de-hooking itself causes further internal damage (see GN-WP-13 & GN-WP-14).

Observers have covered most longline fleets throughout the SPC Statistical Area with at least one trip, although overall coverage at <1%[2] is very low (Figs. 1 & 2). Fleets for which observer data are most lacking, especially in regards to marine turtle and other bycatch, are the Chinese, Japanese, Korean, Spanish, Chinese Taipei and Vanuatu distant-water longline fleets and the offshore fleets of Chinese Taipei; these fleets collectively account for ca. 65-70% of the WCPFC Convention Area tuna catch. Other fleets do collect observer data but due to national restrictions these data are not available for regional analyses.

Observations clearly show (Fig. 2b) that tropical areas have higher incidence of turtle encounters than temperate areas (3% vs. <1%, Table 2). Species composition changes with latitude (data not shown), with leatherback/loggerhead turtle encounters being more prevalent in sub-tropical to temperate waters, while species encountered in tropical/sub-tropical waters include Olive Ridley, green, loggerhead, hawksbill, flatback and leatherback turtles. Leatherbacks are also observed in deep-set longline fisheries: this species is a deep-diving forager that is more vulnerable to entanglement than hooking, as it cannot swim backwards.

[2]See http://www.spc.int/oceanfish/Html/Statistics/Coverage/index.asp for observer coverage by gear, fleet and year.

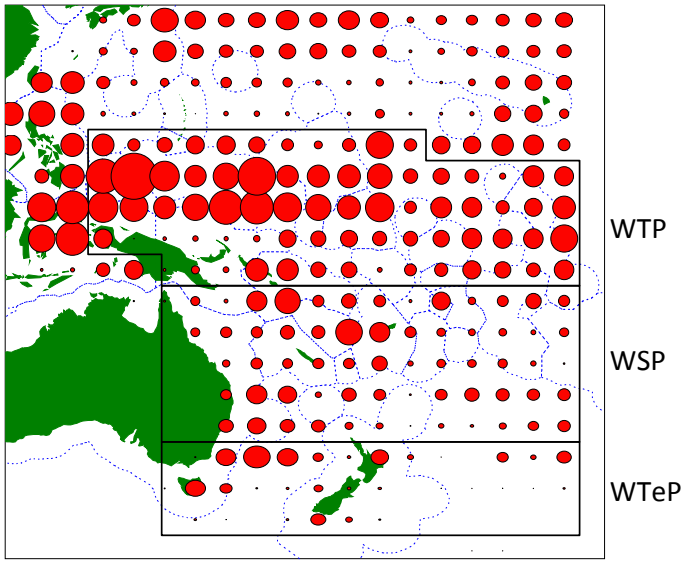

Fig. 1. Distribution of longline effort in the WCPO showing SPC Statistical Area and sub-areas of the tropical (WTP), the sub-tropical (WSP) and the temperate (WTeP) Pacific

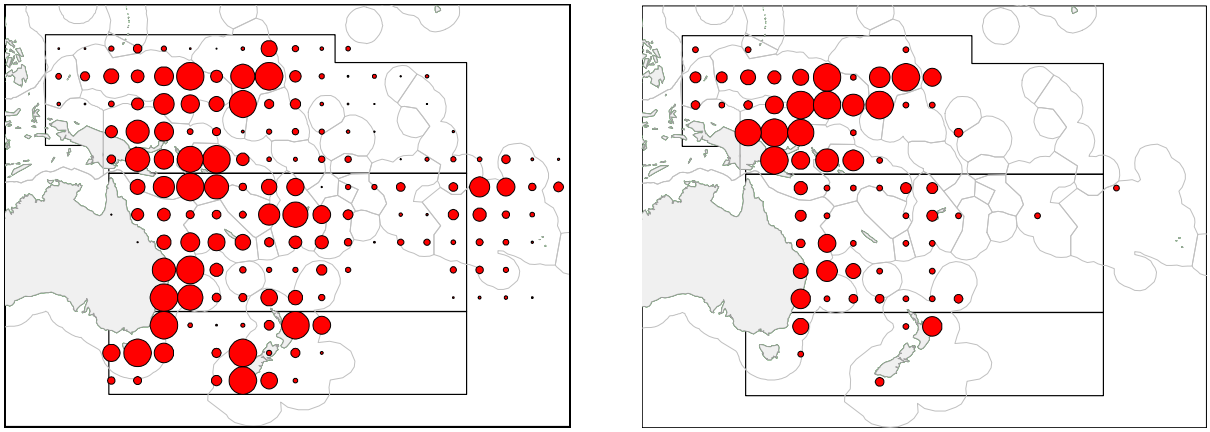

Fig. 2. Relative distribution of observed (a, left) longline sets and (b, right) marine turtle encounters (1990–2007)

Calculation of encounter rates

Marine turtle encounter rates have been calculated in several ways, as follows:

$$\textit{Incidence} = 100 \times \text{Number of sets encountering} \geq 1 \text{ turtle} \; / \sum (\text{sets})$$

$$\textit{Mean} \text{ CPUE} = \sum \; (\text{Encounters / hooks value for each set}) \; / \; \sum (\text{sets})$$

$$\textit{Nominal} \text{ CPUE} = \sum (\text{Encounters}) \; / \; \sum (\text{hooks})$$

For a perfect Poisson distribution, *Mean* CPUE will equal *Nominal* CPUE, but with the highly skewed distributions that we observe for rare bycatch species (Fig. 3) and a large range in values of 'hooks per set', *mean* CPUE is not representative (see the large CVs in Tables 2 & 3) and therefore shouldn't be used. As the *median* CPUE is '0' this is also not informative; *nominal* CPUE is therefore probably the most useful metric.

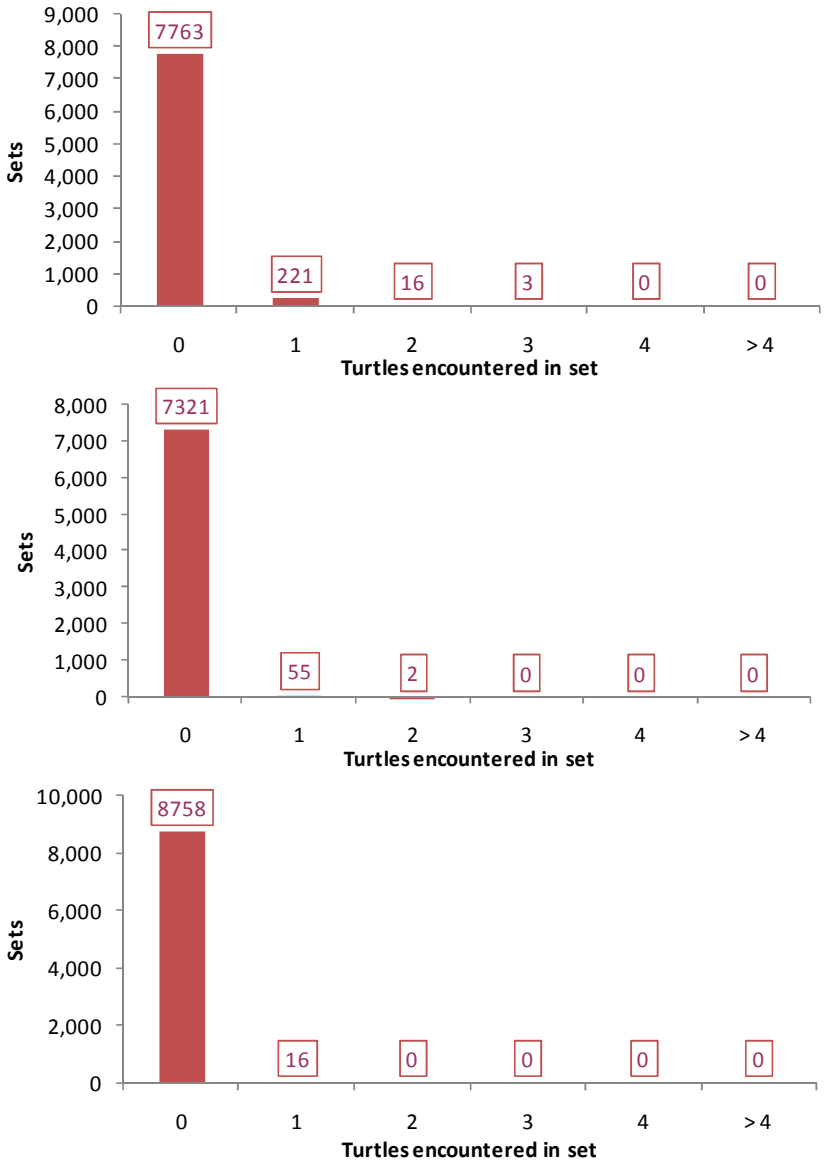

Fig. 3. Frequency of marine turtle encounters in the WCPO longline fisheries. WTP (top), WSP (middle) and WTeP (bottom); based on observer data (1990–2007)

Influence of setting strategies

Of the various factors affecting marine turtle encounter rates in WTP longline fisheries, the depth of set appears to be the most important. Although there is a relationship between depth and time of set, such that shallow sets are usually made at night while deep sets are usually made during the day (Figs. 4 & 5), the data show that incidence of marine turtle encounters is higher for all shallow sets than for any deep sets (>4.5% vs. <2.4%, Table 3). This difference is even more apparent when nominal CPUE is calculated: encounter rates for shallow-setting vessels are then up to an order of magnitude higher than for deep-setting vessels. The data for deep-setting vessels also show that encounters are likely to be on the shallowest hooks (Fig. 6).

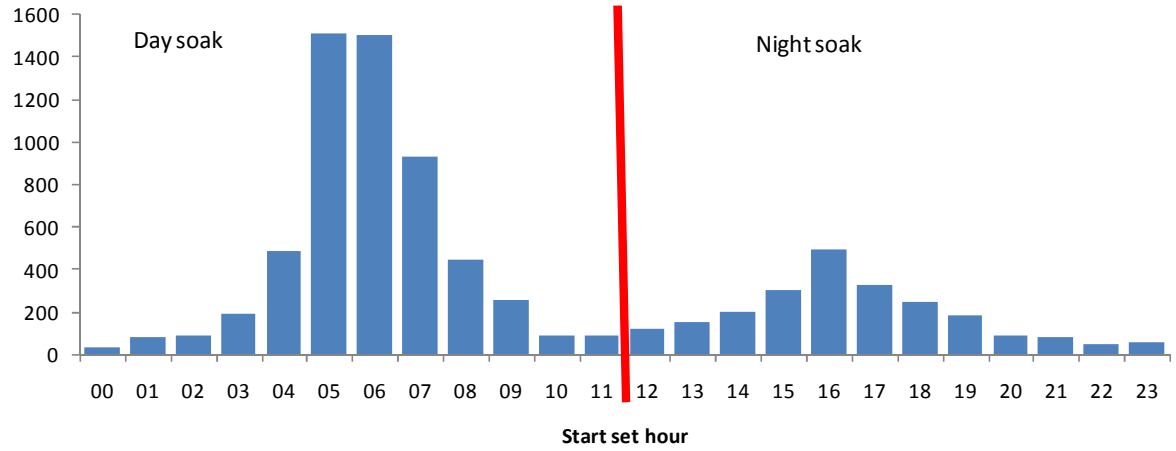

Fig. 4. Frequency of start set hours for longline fleets observed in the WTP. 'Day' soak: any set that **started** before 12:00; 'Night' soak: any set that started after 12:00

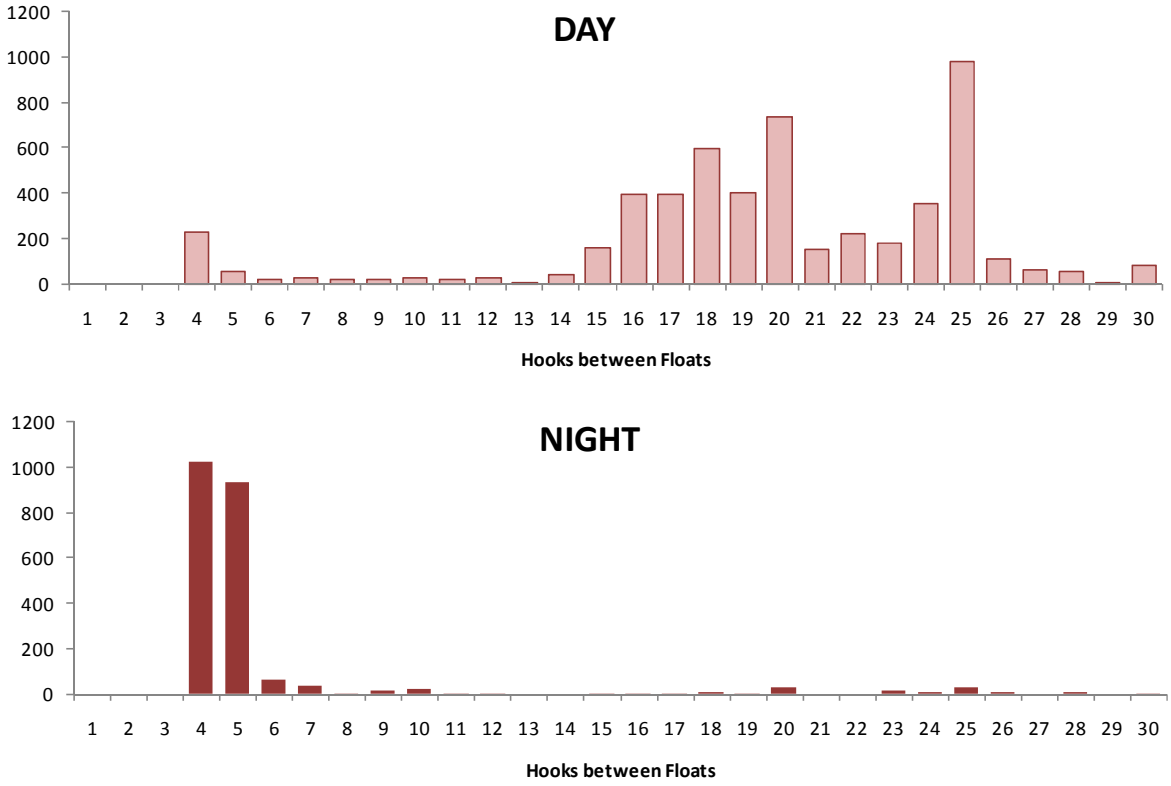

Fig. 5. Frequency of 'Hooks between Floats' (HBF) in WTP from which setting strategies of longline fleets is inferred: few HBF denotes shallow setting, many HBF denotes deep setting

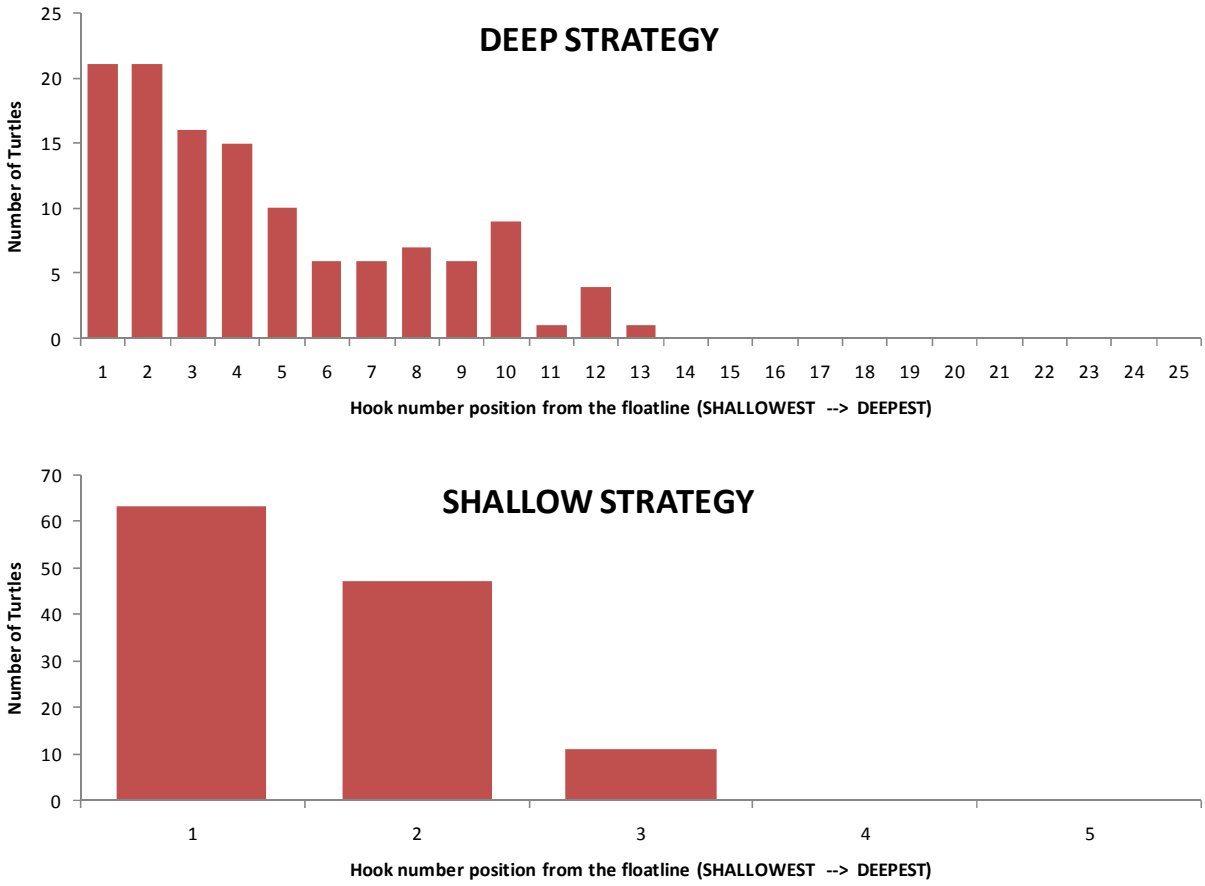

Fig. 6. Marine turtle encounters by hook number position from the float-line for (top) "deep-setting" and (bottom) "shallow-setting" longline vessels in the WTP (1990–2007)

Table 2. Encounter rates for marine turtles observed in WCPO longline sets by sub-area (1990–2007)

Area	Observed Sets	Turtles	Incidence (%)	Nominal CPUE	Mean CPUE	SE	CV
WTP (10°N-10°S)	8,003	262	3.0%	0.0193816	0.2784867	0.1081970	38.9%
WSP (10°S-35°S)	7,378	59	0.8%	0.0038703	0.0062981	0.0009064	14.4%
WTEP (south of 35°S)	8,774	16	0.2%	0.0007480	0.0014403	0.0003967	27.5%

Notes

- Boundaries representing sub-areas have not been strictly adhered to in cases where catch and effort are more representative of one sub-area than another. For example, the boundary between the WTP and WSP was moved from 10°S to 11°S.
- Sets with missing effort information (e.g. hooks set) have been excluded.
- **SE** is the standard error in the estimate of **Mean CPUE**
- **CV** is the coefficient of variation, i.e. the ratio of SE to the mean CPUE

Table 3. Marine turtle encounters by setting strategy for WTP longline sets (1990–2007). Categories for setting strategy are ranked in descending order of *nominal* CPUE

Setting Strategy								
Target Depth	Soak time	Observed Sets	Turtles	Incidence (%)	Nominal CPUE	Mean CPUE	SE	CV
Shallow	Day	455	24	4.6%	0.0539071	2.2539446	1.3432966	59.6%
Shallow	[all]	2,565	129	4.6%	0.0519582	0.8280394	0.3373397	40.7%
Shallow	Night	2,110	105	4.6%	0.0515323	0.5205574	0.2901155	55.7%
[all]	Night	2,265	109	4.5%	0.0481218	0.4863164	0.2702717	55.6%
Deep	Night	155	4	0.6%	0.0175801	0.0201961	0.0100774	49.9%
[all]	Day	5,670	152	2.4%	0.0136271	0.1984780	0.1080071	54.4%
Deep	[all]	5,370	132	2.3%	0.0120696	0.0191724	0.0021701	11.3%
Deep	Day	5,215	128	2.2%	0.0119525	0.0191420	0.0022146	11.6%

Notes

- **Incidence** is the percentage of sets encountering turtles
- **Nominal CPUE** and **Mean CPUE** expressed as number of marine turtles per 1,000 hooks
- **SE** is the standard error in the estimate of **Mean CPUE**
- CV is the coefficient of variation

Overview of marine turtle encounters in the WTP purse seine fishery

Purse seine vessels operate almost exclusively in tropical waters (10°N–10°S; Fig. 7). As with the longline fishery, scientific observers have described marine turtle encounters by purse seine gear in both quantitative and qualitative form. Marine turtles are often found near logs and other drifting debris, attracted by the diverse prey items in the vicinity, and are sometimes found within the pursed net after a school of tuna has been encircled. In most cases, turtles are encountered alive in the net and are subsequently scooped up and released over the side. Turtle mortalities in the purse seine fishery, when they occur, are due to drowning as a result of entanglement in the net or, in rare instances, to being crushed during the process of loading the net on-board. There is also the possibility of entanglement of marine turtles and other species underneath FADs.

There is an incentive for fishing crew to identify and release turtles before the net is hauled through the power blocks because this avoids damage to the gear and disruption to fishing. Observers can usually see whether marine turtles have been discarded prior to brailing so information on encounter rates is considered to be representative. However, it is often not possible to identify the species of marine turtle encountered or to clearly establish its life status from the deck of the vessel. The purse-seine observer data collection form GEN-2 has only recently included provision for recording life status. Historical information on marine turtle species identification and life status is therefore quite poor for the purse seine fishery.

The current level of coverage provided by observer data, while spatially representative (Fig. 8) and much higher than for longline, is not sufficient to provide statistically robust estimates of total marine turtle encounters in WCPO purse seine fisheries (see Lawson 2006[3]). This situation is expected to change as the purse seine fleet moves towards 100% coverage. The information presently available is at least adequate to estimate nominal encounter rates by set type and these are detailed in Table 4.

The percentage of purse seine sets that encounter marine turtles ('incidence', equivalent to turtles per 100 sets) is generally a lot lower than for the longline fisheries, i.e. 0.2%–4.6% for longline (Tables 2 & 3) vs. 0.3%–1.6% for purse seine (Table 4). Encounter rates are highest in animal-associated sets, drifting log sets and anchored FAD sets, and lowest for drifting FADs. This reflects the time it takes for multi-species assemblages to form under drifting objects, with marine turtle encounter rates being highest for those set types where the object or school is floating for longest.

Observers are instructed to inform the captain and crew of their obligations regarding protected and endangered species, even though there may not be any formal requirement in their fishing access agreement. There are no observed reports of turtles being kept for crew consumption on purse seine vessels, although, as in the longline fishery, this may well occur on vessels without observers.

[3]Lawson T (2006) Observer coverage rates and reliability of CPUE estimates for purse seiners in the western and central pacific ocean. Information Paper ST IP-3. 2nd Regular Session of the WCPFC Scientific Committee, Manila

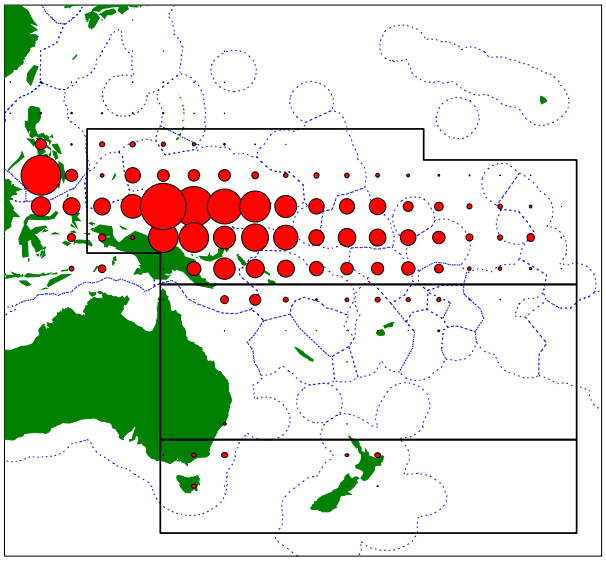

Fig. 7. Distribution of purse seine effort in the WCPO

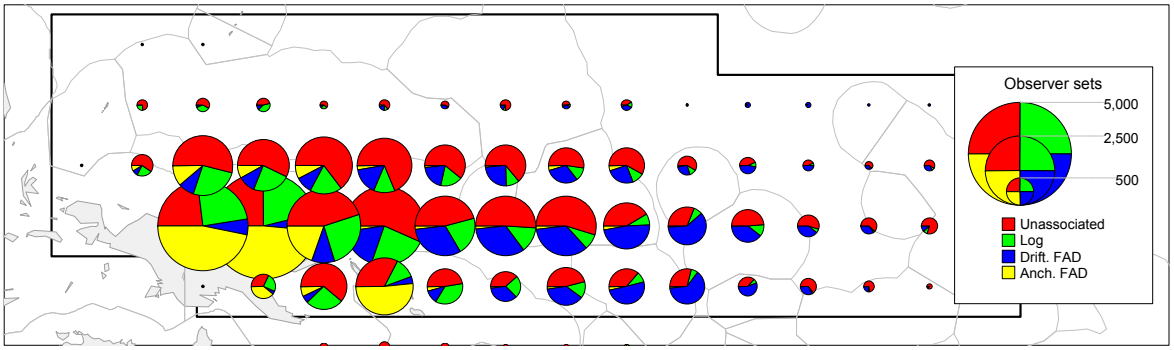

Fig. 8. Distribution of purse seine observer effort: marine turtle encounters are observed throughout the range of the fishery and in proportion to observer effort

Table 4. Marine turtles encountered in the WTP purse seine fishery, by set type (according to observer data, 1995–2007)

School Association	Observed Sets	Turtles	Incidence (%)	Nominal CPUE	SE	CV
Unassociated	11,604	71	0.6%	0.6118580	0.0744184	12.2%
Drifting Log	7,713	60	0.8%	0.7779074	0.1000425	12.9%
Drifting FAD	8,284	23	0.3%	0.2776437	0.0578158	20.8%
Anchored FAD	6,799	53	0.8%	0.7795264	0.1086753	13.9%
Animal-Associated	559	9	1.6%	1.6100179	0.5328116	33.1%

Notes:
- **Incidence** is the percentage of sets encountering turtles
- **Nominal CPUE/Mean CPUE** are effectively the same as **Incidence** expressed as number of marine turtles per 100 sets
- **SE**: standard error in the estimate of **Nominal CPUE**
- **CV**: coefficient of variation