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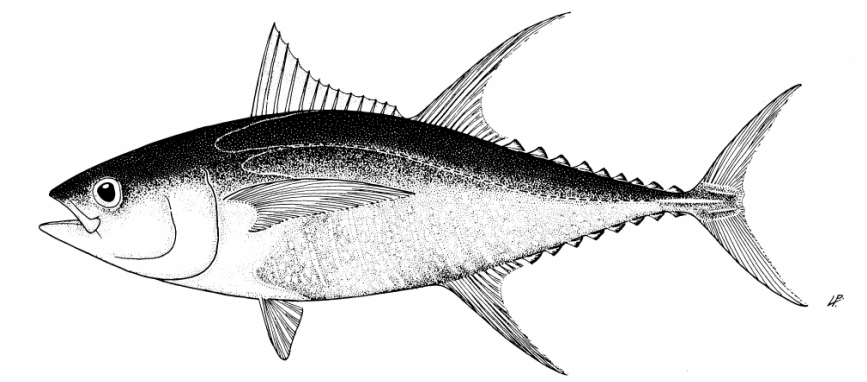
Estimates of the mortality of non-target species with an initial focus on seabirds, turtles and sharks



Brett Molony

Oceanic Fisheries Programme, Secretariat of the Pacific Community,
Noumea, New Caledonia

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Executive summary

Total numbers of individuals captured and the total number of mortalities of birds, sharks and turtles were estimated for the central region of Western and Central Pacific Fisheries Commission (WCPFC) area. In addition, total catches of marine mammals were also estimated.

While abundant logsheet data exists, the reporting rates of these four taxa are relatively low and observer data were used in order to generate estimates. Observer coverage of the WCPFC region varies among flags, fleets and areas and observer data for the WCPFC region is not centrally available from a single location. As a result observer data held at the Secretariat of the Pacific Community (SPC) were used.

Four fisheries were defined for the region of the WCPFC between 15ºN–31ºS; tropical shallow longline (TSL, 15ºN–10ºS, less than 10 hooks between floats (HBF)), tropical deep longline (TDL, 15ºN–10ºS, 10 or more HBF), temperate albacore longline (TAL, 10ºS–31ºS) and a single purse-seine fishery. Annual catches and mortality of each taxa for each of the four fisheries were estimated and raised by the estimated total effort in these fisheries to generate total annual catches and mortalities for each taxa.

Relatively few observer records of birds existed for the fisheries examined. Total annual catches of birds by these fisheries were less than 1,593 ± 8,714 (95% confidence intervals (CI)) birds per year between 1990 and 2004, with most birds suffering mortality. Most birds were reported from the TAL with fewer records of bird catches reported from the other fisheries. However, less than 100 birds per year were estimated to be captured by these four fisheries since 1998. Few birds were identified to species.

Fewer mammals were reported by observers in these fisheries and total annual catches were less than 1,362 ± 87,352 mammals per year during the period 1990–2004. In contrast to birds, most mammals were released alive by all fisheries, with annual mortalities estimated at 300 ± 3,986 mammals per year. The highest catches were reported from the TSL and purse-seine fisheries. Most fishery-mammal interactions in the purse-seine fishery were a result of deliberately setting upon whales in order to capture associated tuna schools. Most mammals were not identified to species.

As expected, the total annual catches of sharks were much higher than for the other taxa examined due to the high number of shark species, relatively high abundance of sharks compared to the other taxa, the existence of dedicated shark longline fisheries and that sharks and shark products (e.g. fins) are part of the commercial catch of all fleets. An annual estimated catch of 696,401 ± 907,848 sharks per year were captured by these four fisheries between 1990 and 2004, mainly by the TSL fishery. Annual estimated mortalities were relatively low but were likely to be underestimated due to the relatively low levels of observers reporting condition and fate of sharks. It is likely that estimated total shark mortalities for these four fisheries were similar to the estimated total catches. Most sharks were identified to species and catches were dominated by blue sharks, silky sharks, oceanic whitetip sharks and pelagic sting rays, although the relative abundances of shark species varied among fisheries and years.

An estimated 6,962 ± 22,567 turtles were captured by the four fisheries each year between 1990 and 2004, with an estimated total annual mortality of 931 ± 7,392 turtles per year. The highest catches were estimated from the TSL fishery as most turtles spend their time in the upper regions of the water column (less than 120 m). However, the highest turtle mortalities were estimated for the TDL fishery, likely a result of turtles being unable to surface if hooked on this deeper gear. Most turtles were not identified to species but a high proportion of olive ridley turtles were reported by observers.

Purse-seine set type was a major factor influencing catch rates of all taxa examined. Higher CPUEs of mammals, sharks and turtles were estimated from sets upon floating objects (i.e. associated sets), especially sets on logs and aFADS. Any management measures designed to reduce catches and mortalities of these taxa by the purse-seine fishery of the WCPFC should consider the influence of set-type.

While total annual catches and moralities were estimated for all taxa, confidence intervals around each estimate were relatively large. This is a result of the small number of records for each taxa (especially birds, mammals, turtles and individual species of sharks) and due low observer coverage rates. Increasing observer coverage rates for all fleets would result in more-robust estimates of catches and mortalities. Additionally, improving the rate of identification to the level of species and increasing the rates of observers reporting condition and fate of captured animals would also assist in the generation of more robust estimates of mortality. Additionally, centralising all observer data would provide a larger dataset in order to better estimate total catches and mortalities of all taxa.

Current observer programmes are primarily designed to record information on tuna catches. In future, specific observer programmes should be designed to address specific catch and bycatch issues, as has been done in other areas. For example, specific observer programmes could be designed to address the issues of interactions between birds, mammals and turtles with the newly developed shark and swordfish fisheries within the WCPFC area.

Finally, analyses of shark data were complicated by the large number of shark species and identifying target and non-target species of sharks for each of the four fisheries. More thorough research could be achieved by identifying and prioritising specific species of sharks important within each fishery, either by reviewing the shark species of Annex 1 of UNCLOS and/or by prioritising the list of species.

1. Introduction

The industrialised fisheries of the western and central Pacific Ocean (WCPO) captured approximately two million metric tones of tunas in 2004 (Williams and Reid 2004). Although albacore, bigeye, skipjack and yellowfin tunas have dominated annual catches from the WCPO, the fisheries also interact with and capture a large range of other species. Some non-tuna taxa, such as billfishes and sharks, are important components of the retained catches of industrialised fisheries in the region, especially in the longline fisheries.

However, the fisheries also interact with a range of other species with no commercial value or species with non-commercial values (e.g. turtles, birds). At the inaugural meeting of the Western and Central Pacific Fisheries Commission (WCPFC), issues of non-target catches in the WCPFC area were discussed and scientific advice on non-target catches was requested. Specifically, the request was to provide "*estimates of the mortality of non-target species with an initial focus on seabirds, turtles and sharks*", to be presented at the first meeting of the Scientific Committee in August, 2005.

This paper directly addresses the request from the WCPFC. Specifically, estimates of the total number of seabirds, turtles, sharks and mammals captured by the main method fisheries of the WCPO were presented for the period 1990–2004. Secondly, estimates of the numbers of mortalities of each taxa were provided. Where enough data existed, estimates of the total catches and mortalities of individual species were also provided. In addition, estimates of the total catches and mortalities of mammals were included as mammals are another non-target group that interacts with industrialised fisheries in the WCPO that also have a special non-commercial value (e.g. conservation). The estimates of mortality were discussed in terms of implications to the WCPFC stocks of major taxa where applicable using the International Union for the Conservation of Nature (IUCN) classification for common species (www.redlist.org). Finally, the limitations of the data and ways to redress the limitations are provided as advice to the WCPFC.

2. Methods

2.1 Fisheries

The industrialised longline and purse-seine fisheries of the WCPO were the focus of this report. These two method fisheries are the major fisheries of the WCPFC region in terms of effort and catches. Other method fisheries are either relatively minor (e.g. troll, sportfishing) or unlikely to significantly interact with birds, turtles, mammals or sharks in the region (e.g. pole-and-line fisheries).

2.2 Data sources

Individual vessel logsheets for the period 1990–2004 were examined for both the purse-seine and longline fisheries (Table 1). However, very few records of birds, mammals or turtles existed from a total of more than 1.6 million longline sets and 0.4 million purse-seine sets.

As a result, observer data for longline and purse-seine fisheries were used. While observer coverage rates are relatively low (typically less than 0.1% overall, Table 1), the data recorded included information on all species captured within an individual set (Tables 2–5). In addition, information about the condition of animals (e.g. dead or alive) and fate (e.g. retained or discarded) were also recorded in some cases. While observer data held at SPC were detailed, areas of the WCPFC north of approximately 15°N or south of approximately 31°S were not well represented. Thus, analyses were restricted to observer data from the central region of the WCPFC area (Figures 1 and 2).

2.3 Longline fisheries

The longline fishery of the central WCPFC was divided into three separate fisheries based on spatial regions (Figure 3) and gear configurations. The western tropical Pacific shallow longline (TSL) fishery was defined as operating between 15°N and 10°S with less than 10 hooks between floats (HBF). The western tropical Pacific deep longline (TDL) fishery operated within the same spatial region as the TSL fishery but with 10 or more hooks between floats. The temperate albacore longline (TAL) fishery was defined as operating between 10–31°S and encompassed all EEZs of Pacific Island States and Territories in the southern WCPFC region, with the exception of Australia and New Zealand. Longline fisheries to the north and south of these spatial regions were not considered due to the limited data currently held at SPC. Additionally, individual countries outside these regions (United States to the north-east; Australia and New Zealand to the south-west) report on catches of all species within their EEZs, including some of the species requested by the WCPFC (e.g. Bradford 2002).

All calculations for the longline fisheries assumed that HBF and latitude were the main variables affecting catch rates and not other variables, such as flag and season.

2.4 Purse-seine fishery

A single purse-seine (PS) fishery for the WCPFC area was considered, broadly operating between 10º north and south of the equator. However, the observer data for the PS fishery was divided into five set-types (Table 3) as set-type has a significant influence on catch rates and species compositions of purse-seine catches (e.g. Molony 2004). It was assumed that set-type was the main variable affecting catch rates and not other variables (e.g. flag).

2.5 Analyses

Observer data for each of the four fisheries (TSL, TDL, TAL and PS) were analysed separately. Data were restricted to the period 1990–2004 for the longline fisheries and 1994–2004 for the purse-seine fishery as these years provided relatively high levels of observer data. However, only limited observer data were available for the TSL fishery prior to 1993 and the TDL fishery prior to 1992 and analyses were restricted to the periods 1993–2004 and 1992–2004, respectively, for these two fisheries.

Observer records of the numbers of individuals for all species within each of the four main taxa (birds, mammals, sharks and turtles) were pooled within years for each fishery due to the low number of records for individual species (Tables 2–5). Initially, the position of sets capturing one or more individuals of each taxa were examined for each year (Figures 4–7) in order to determine areas of greatest interaction between each fishery and taxa within the WCPFC area.

The distributions of the number of individuals captured per set of birds, mammals and turtles were heavily skewed in all four fisheries, being dominated by sets with zero catches (Figure 8). Relatively few sets from any of the four fisheries reported any catches of these three taxa. While sets recording zero shark catches per set still dominated the shark data for all four fisheries, the numbers of sharks per set by the fisheries displayed a broadly log-normal distribution of catches per set. Subsequently, all data were log(n+1) transformed prior to the estimation of total catches and mortalities.

For each fishery, annual mean catches and mortalities per unit effort (CPUE as number per hundred hooks or number per purse-seine set) for each taxa were estimated. The overall standard deviations of each estimate were also calculated for each taxa for each fishery. As

sharks can be retained, discarded or partially retained (e.g. fins only), the mortality rates of sharks were examined using combinations of total mortalities, total retained, total finned and discarded and total discarded dead. Double counting was avoided (e.g. dead, or finned and discarded individuals were counted only once). However, due to the lack of records for most fields only total catches and total mortalities were used.

Estimates of the total number of hooks set annually for each longline fishery were generated from raised Catch and Effort System (CES) data held at the SPC. These data were applied to the CPUE and standard deviation estimates of catches and mortalities of each taxa to provide estimates of the numbers of each taxa captured and number of mortalities for each longline fishery. Similarly, estimates of the total number of purse-seine sets by set-type per year were generated from the CES raised database at the SPC. These data were applied to the estimates of CPUE and standard deviations of catches and mortalities of each taxa for the purse-seine fishery in order to generate estimates of total catches and mortalities of each taxa for each year. A summary of the calculations are provided in Appendix 1. As logsheets for all four fisheries are still outstanding for 2003 and 2004, catches and mortalities for 2003 and 2004 are likely to underestimated.

The relatively low numbers of records for birds, mammals and turtles interacting with the four fisheries restricted estimates of total catches and mortalities to the taxonomic level of class. A relatively high number of records for sharks allowed the estimation of total catches and mortalities at the species or genus level for common species. The minimum level was set at 1,000 individual records of any species or genus. This allowed the estimation of catches and mortalities of 13 species and two genera of sharks from the longline fisheries, and two species of shark and one family of rays for the purse-seine fishery.

3. Results

3.1 Logsheet data

A total of 1,681,213 longline sets were reviewed for this summary covering a period between November 1978 and October 2004. Logsheets described fishing activities in an area of the Pacific Ocean between 44.5°N–55.0°S and 100.8°E–85.3°W although effort was not evenly distributed temporally or spatially (Figure 3). Longline logsheets reported a total of 22 birds, 70 mammals, 348,748 sharks and 4 turtles over this period. Too few records existed for any taxa from these fisheries to provide useful estimates of mortality. Similarly, 260,698 purse-seine sets were available for the purse-seine fishery, recording a total of 3 birds, 41 mammals, 4,719 sharks and 1 turtle between 1995–2004.

Logsheets are designed primarily to record the capture of commercial species, specifically tunas and billfish. The recording of sharks on logsheets is increasing as sharks are becoming an important commercial catch in some regions of the WCPFC convention area. However, logsheet reporting rates of sharks are not 100%. Further species identifications are rarely accurate for non-target species and sharks, with most logsheet entries reporting catches in a general ‘shark’ category.

The capture of non-commercial species is rarely recorded on logsheets. Thus few records of the capture of mammals, turtles or birds existed in the logsheet database

3.2 Observer data

Much more data on the four taxa were available from the observer database for the four fisheries examined (Tables 2–5). However, a large proportion of records of birds, mammals and turtles were identified only to a relatively high taxonomic level and many unidentified

categories existed (e.g. Bird (unidentified), Marine mammal (unidentified)). In some cases, most data were unidentified below the class level (e.g. more than 80% of all turtle records from the purse-seine fishery were reported as 'Marine turtle (unidentified)).

While 'Sharks (unidentified)' were still a significant category in the longline and purse-seine databases (Table 4), most sharks were identified to a species or genus level. Sharks dominated the data of the four taxa under consideration, with very high catches reported from some individual sets.

3.2.1 Longline

3.2.1.1 Birds

A total of 3,887 birds were recorded by observers on longline vessels as being captured during longline sets in the WCPO since 1980 (Table 2) (Figure 4a). Most birds were recorded from longline sets in the New Zealand EEZ, within the Australian EEZ south of 31°S and to the north and east of the Hawaiian EEZ (Figure). Very few birds were recorded from observed longline sets in the WCPO outside of these areas (i.e. 15ºN–31ºS). Australia, New Zealand and Hawaii (United States) already have very detailed reporting of seabird interactions with longline fisheries (and other method fisheries) within their respective EEZs and fisheries, and have various mitigation measures in place.

The number of birds recorded per year by observers as being incidentally captured by longline gears has generally increased since 1988. However, the years of relatively high numbers of records were also the years of relatively high observer coverage. For example, the highest number of birds incidentally captured by longline gears in the WCPO was recorded in 1997 (Figure), which is also the year of overall highest observer coverage rates.

The observer data between 15ºN and 31ºS contained only 39 observer records of birds being captured by longline vessels in the WCPO, from 25 sets between 1990 and 2004 (Figure 4a). Thirty seven of these records listed the bird as "unidentified" and two records identified the birds as 'albatross'. Thus records do not provide information about the species involved.

Of the 39 birds captured in the WCPO by longline vessels, 28 were dead at time of retrieval of the longline, three were alive and eight were listed as not observed. Seventeen of the birds were immediately discarded, 21 were retained (one listed as being for crew consumption) and one bird had an unknown fate. Although few birds were captured by longline in the WCPO, only about 10% of birds were recorded by observers as being alive at time of capture.

In most cases, only a single bird was captured per set (Figure 8). However, a single afternoon longline set in 1991 captured 8 birds from 2,975 hooks (7 HBF) using clupeoid bait. This set was recorded in the Australian EEZ north of 31ºS. Only 12 birds from 8 sets were reported by observers as being captured by longline gear since 1995 in the WCPO, from a total of 6,846 observed sets, an interaction rate of approximately 0.11% of observed sets.

Few birds were recorded by observers within the TSL and TAL longline fisheries in the WCPO during 1990–2004, with no birds reported within the TDL (Figures 9–11). Nonetheless, the low estimates of CPUE of capture and mortality resulted in estimates of between 0 and 9,800 birds captured in the WCPO per year, with annual mortality rates between 24 and 100% (Table 6a).

3.2.1.2 Mammals

Observers recorded a total of 380 mammals interacting with longline fisheries in the WCPO between 1980 and 2004 (Table 3). Records of marine mammals from observers in the

longline fishery were dominated by New Zealand fur seals (n = 321, ca. 75.7% of records) (Table 3) which are reported by the Ministry of Fisheries under New Zealand reporting requirements. To focus on the WCPO, records south of 31°S were excluded (i.e. sets within the New Zealand and southern Australian EEZs and US longline operations within and north-east of the Hawaiian EEZ).

The reduced data set contained 22 records (Figure 5a). Records were dominated by unidentified marine mammal categories (n = 19, 86.4% of records). Two records listed the mammals as unidentified toothed whales. Therefore, most records did not provide accurate species identifications.

The condition of 19 longline captured mammals were recorded by observers. Most mammals (n=14, 73.7%) were alive at the time of capture with most (n=11) in a healthy condition at time of release. Five mammals were dead at time of capture. Thus, most mammals incidentally captured by the longline fisheries in the WCPO are released alive.

While all longline fisheries reported very low mammal CPUEs, the highest CPUEs for mammals were recorded in the TSL fishery (Figures 9–11). Most mammals captured by the TSL between 1994 and 1997 were recorded as dead by observers, however no mortalities have been reported from this fishery since 1997. No mortalities of mammals were observed in the TAL fishery.

When raised, the very low CPUEs of catches and mortalities of mammals resulted in estimates of up to 2,200 mammal interactions with the WCPO longline fisheries per year (Table 6b). However, mortality rates (the precent of individual captured that were reported as dead) were much lower than for birds, with annual rates generally being less than 30% in most years (Table 7b).

3.2.1.3 Sharks

More than 290,000 sharks representing more than 40 species were reported by observers from the longline fisheries of the WCPO from more than 21,000 sets (Table 4). Blue sharks dominated the observer longline data (approximately 196,000 records), with silky sharks (27,000 records) and pelagic sting rays (11,000 records) also reported in large numbers.

While very high CPUEs were reported from some sets (e.g. a maximum of 672 sharks were recorded from a single longline set of 800 hooks recorded in the TSL fishery), CPUEs varied between 0 and approximately 60 sharks per hundred hooks in the three longline fisheries (Figures 9–11). CPUEs were much higher in the TSL fishery. Annual total catches and mortalities were estimated for each fishery (Figures 12–14), however the condition of most sharks and fate were recorded as unknown.

Most sharks were captured by the TSL fishery, with lower but similar levels of sharks captured by the TDL and TAL fisheries (Table 7c). Mortalities showed a similar pattern among fisheries although they were likely to be underestimated due to the low reporting rates of condition (alive or dead) and fate (retained, discarded). Further, anecdotal reports suggest most if not all sharks captured by longline gears are killed before being discarded (P. Sharples, pers. comm.) and therefore estimates of total catches may be reasonable estimates of total mortality of sharks. Total shark catches (and therefore mortalities) were estimated between approximately 500,000 and 1,400,000 million sharks per year by the longline fisheries of the region of the WCPFC examined.

The CPUEs and mortality rates of the 15 most common species of sharks were examined for each longline fishery (Figures 15–17). Most of the individual species examined displayed the highest CPUEs (and mortality rates) within the TSL, including blue sharks and silky sharks

(Figure 15). Oceanic whitetip sharks and shortfin mako sharks displayed similar CPUEs in all three longline fisheries, suggesting a wide distribution of these species. Crocodile sharks displayed similar, relatively high CPUEs in both tropical longline fisheries suggesting a tropical distribution. Only mako sharks and thresher sharks displayed higher CPUEs in the TAL.

Total estimated catches and mortalities of blue sharks and pelagic string rays were highest from the TSL and TDL fisheries (Figures 18–20, Appendix 2). The highest estimates of total catches and mortality were recorded from the TSL for silky, oceanic whitetip, hammerhead and silvertip sharks. The highest catches and mortalities of porbeagle sharks were reported from the TDL fishery, while the highest estimates of thresher sharks and unidentified mako sharks were reported form the TAL fishery. Crocodile sharks displayed similar total catches and mortalities in all longline fisheries.

3.2.1.4 Turtles

A total of 481 turtles were reported by observers from the longline fisheries of the WCPO (Table 5), dominated by an unidentified category and olive ridley turtles. However, only 159 records of turtles existed in the observer data for longline fisheries between 15ºN and 31ºS of the WCPFC. Most turtles were reported in the tropical longline fisheries, west of 180º (Figure 7a). The highest CPUEs were reported from the TSL fishery (Figures 9–11). However, most turtles from this fishery were released alive. Despite lower CPUEs, a relatively high proportion of turtles captured in the TDL were reported dead at release. The estimated number of turtles captured in the TAL was very low.

Despite the low CPUEs, raised estimates generated annual catches of between 4,000 and 15,000 turtles per years by the longline fisheries (Table 7d). However, mortality rates were less than 26% in all years, with total annual mortalities estimated between 500 and 3,000 turtles per year.

3.2.2 Purse seine

A total of 27,644 purse-seine sets were observed in the WCPO between 1994 and 2004. The distribution of the number of observed sets by set-type varied among years (Figure 21).

3.2.2.1 Birds

From a total of 27,644 observed purse-seine sets in the WCPO between 1993 and 2004, only a single bird was reported as captured from a single purse-seine set (Figure 4b), an incidence of 0.0036% from all sets.

Overall, estimated total catches of birds by the tropical purse-seine fishery were extremely low, with an estimated maximum of 20 bird captures per year. However, the single record of a bird interaction with the purse-seine fleet does not allow robust estimates of catches or mortalities to be estimated. Nonetheless, the low incidence of bird captures by purse-seine operations in the WCPO indicates that the risks to the sustainability of tropical bird populations in the WCPO is negligible.

3.2.2.2 Mammals

A total of 687 marine mammals from 137 sets were reported by observers as captured by purse-seine vessels in the WCPFC between 1994 and 2004 (Table 3). Mammal observations were dominated by unidentified categories (unidentified marine mammals, n= 581 from 110 sets; unidentified dolphins and porpoises: n = 33 from 11 sets; unidentified toothed whales: n = 19 from 1 set; unidentified whales: n = 5 from 2 sets). A total of 49 mammals from 13

purse-seine sets were identified to species, dominated by common dolphins (n = 24 from 8 sets) and bottlenose dolphins (n = 18 from 3 sets).

Most purse-seine sets in which marine mammals were captured occurred in the western areas of the tropical WCPO, especially in the north-east section of the EEZ of Papua New Guinea, north-western area of the EEZ of the Solomon Islands and within the Kiribati EEZ (Gilbert Islands) (Figure 5b).

Most mammals were incidentally captured from sets upon floating objects (i.e. associated sets, n = 116 sets or 84.7% of sets capturing mammals), which comprised sets on logs (n=35 sets), sets on dFADs (n = 13 sets), sets on aFADs (n = 56 sets) and sets on live whales (n = 11 sets) or whale sharks (n = 1 set). In contrast, mammals were only reported from 16 sets on unassociated schools (7 sets on unassociated schools and 9 sets on baitfish associated schools).

The distribution of the number of sets capturing one or more mammals by set type was significantly different from the expected distribution based on the total number of observed sets by set type ($\chi^2_{[df=7]}$, P= 4.92×10^{-31}) (Figure 22). Much of the significance is due to the 'Animal' set-type in which sets are deliberately made on whales and whale sharks. A higher than expected proportion of sets on aFADs resulted in capturing mammals (approximately three times higher than expected). Similarly, sets on logs and whale sharks resulted in mammals being captured approximately 50% more often than expected. In contrast, sets on surface schools or schools associated with baitfish displayed a mammal capture rate approximately 70% lower than expected.

Most mammals captured in purse-seine sets were of unknown condition (i.e. condition was not recorded) at time of release (n = 629 or 91.6% of purse-seine captured mammals). Most mammals of known condition at time of captured were recorded as dead (n = 42) with 16 mammals reported in alive condition.

Most mammals incidentally captured during purse-seine operations were discarded (n = 652) with an additional 29 mammals escaping from the purse-seine net. Only 6 mammals (0.87%) were listed as being retained for unknown reasons. Five of these mammals were unidentified and a single common dolphin was retained. The very high discard rate (greater than 99%) indicates that mammals are not generally retained.

The CPUE of mammals for each set-type (Figure 23) resulted in an estimated total of less than 3,500 mammals captured per year, with a mortality rate of less than 10% (Figure 24, Table 7b).

Overall, the purse-seine fishery appears to be having little impact on the sustainability of marine mammal stocks in the WCPO. The largest interactions between the purse-seine fishery and marine mammals are the relatively few deliberate sets upon whales in order to capture associated tuna schools (486 sets of a total number of 27,640 observed sets, 1.76% of all sets). Nonetheless, a large proportion of marine mammals incidentally encountered by the purse-seine fishery were unidentified. Better identification of mammals by observers would increase the understanding of potential impacts of the purse-seine fishery on marine mammal stocks in the tropical WCPO.

Although a low overall impact, sets on associated schools especially around aFADs and logs resulted in a disproportionably high incidence of encountering marine mammals during purse-seine operations. This may be a result of floating objects retaining a diverse marine community which marine mammals exploit for food. However, a lower than expected incidence of mammals were captured by purse-seine operations on dFADs.

3.2.2.3 Sharks

A total of 44,180 sharks were reported by observers in the WCPO purse-seine fishery from 8,774 sets during 1994–2004 (Table 4). The sharks captured in the purse-seine fishery represented more than 20 species, dominated by silky sharks, oceanic whitetip sharks and manta rays. A large proportion of sharks were unidentified. The highest CPUEs were observed from sets around floating objects (Figure 25).

Shark catches were observed from a significantly higher than expected proportion of associated purse-seine sets ($\chi^2_{[df=7]}$, $P < 1.00x10^{-99}$) (Figure 26). Much higher than expected frequencies of sets on dFADs and logs captured sharks, while relatively low proportions of sets on baitfish and surface tuna schools captured sharks. However, the condition and fate of most sharks were reported as unknown, although mortality rates are expected to be high (up to 100%, P. Sharples, pers. comm.). Using the CPUE estimates, the total estimated catches of sharks by the purse-seine fishery varied between approximately 2,000 and 80,000 sharks per year (Table 7c).

Only four groups were represented by more than 1,000 observer records; silky sharks (21,585); oceanic whitetip sharks (4,799); Manta rays (unidentified (1,085); and sharks (unidentified (15,019)). Estimates of CPUE, total annual catches and total annual mortalities were calculated for silky sharks, oceanic whitetip sharks and manta rays. Silky sharks displayed much higher CPUEs (Figure 27), total catches and mortalities (Figure 28) than the other two taxa (Appendix 2). However, the CPUEs of all three species were much higher from sets around floating objects (aFADs, dFADs, animals and logs) than on unassociated sets (Figure 25), with the exception of low CPUEs of manta rays from dFAD sets.

Mortality rates for all species were relatively low. However, the condition and fate of most sharks were recorded as unknown and the mortality rates are likely to be underestimated. Assuming that catch rates were similar to mortality rates (that is, most sharks captured in purse-seine sets suffered mortality), the total estimated number of silky shark mortalities from the purse-seine fishery has averaged approximately 20,000 individuals per year since 1994 (Figure 28). Similarly, the total estimated mortalities of oceanic whitetip sharks and manta rays are approximately 4,000 and 1,500 individuals per year, respectively (Appendix 2).

3.2.2.4 Turtles

A total of 104 turtles were captured from 99 purse-seine sets in the WCPFC between 1995 and 2004 (Figure 7b), from a total of 27,644 observed sets, an incidence rate of approximately 0.36%. A single turtle was captured in 94 of the 99 observations, with 5 sets capturing two turtles per set (Figure 8d). Most observations of turtles being captured in purse-seine sets were reported in 2002 and 2003 (Figure 7b) but these two years also recorded higher than average numbers of observed sets. The highest turtle CPUEs were observed from sets on floating objects (Figure 29).

Most turtles reported by observers from the purse-seine fishery were not identified to species (80 out of 104 turtles, approximately 77%) (Table 4). Besides these unidentified turtles, 10 olive ridley turtles, 8 hawksbill turtles, 5 green turtles and 1 leatherback turtle were also reported.

Most purse-seine sets in which one or more turtles were captured were reported in the western tropical WCPFC, especially within and around the EEZs of Papua New Guinea, Federated States of Micronesia, Solomon Islands and Nauru (Figure 30). However, the distribution of purse-seine effort on the WCPO is broadly similar to the distribution of observed turtles captured by the purse-seine fleet.

More than 71% of all turtles observed captured by the purse-seine fishery in the WCPO were reported captured from associated sets (sets on floating objects and animals) (Figure 31). The distribution of turtles captured by set type was significantly different to the expected distribution based on total observed sets ($\chi^2_{[df=7]}$, P= 1.60×10^{-6}). Fewer than expected turtles were incidentally captured from sets on unassociated schools and baitfish-associated schools, with more than expected turtles captured from sets on logs, aFADs and whales. Similar to mammals, less than expected turtles were captured from sets around dFADs. Thus floating objects appear to attract turtles and sets on floating objects were more likely to capture turtles than sets on unassociated schools. The exception was for green turtles where more than 60% of all green turtles captured by the purse-seine fleet were from sets on unassociated schools.

Most turtles (n=75) were of unknown condition at the time of capture. Twenty five turtles were alive at the time of capture with 24 of these turtles classified as healthy. Four turtles were dead at the time of capture, of which one was reported as gear damaged. Most turtles (n=102) were discarded with one turtle reported as escaping from a set. A single turtle (marine turtle unidentified) was reportedly retained for crew consumption.

The raised data estimated annual total catches of approximately 200 turtles per year by the purse-seine fishery of the WCPO between 1990 and 2004 (Table 7d, Figure 24), with less than 20 mortalities per year. No turtle mortalities were recorded by observers from purse-seine sets in the WCPO in most years. However, the condition of most turtles were unknown.

4. Discussion

4.1 Data issues

Considerable logsheet and observer data from the longline and purse-seine fisheries were examined. However, logsheets are primarily designed to record information on the four major tuna species of the WCPO (albacore, bigeye, yellowfin and skipjack). As a result, information on other species is not often recorded on logsheets or records are underestimates of the true catches. For example, approximately 335,000 sharks were recorded from approximately 1.6 million longline sets (CPUE of 0.2 sharks per longline set). In contrast, approximately 290,000 sharks were reported by observers from approximately 21,000 longline sets (approximate CPUE of 14.2 sharks per set). Thus, logsheet data significantly underestimated shark catches. The reporting rates of other taxa within this report are rarely recorded on logsheets. Thus, observer data is the only data which can be used to provide reasonable estimates of catches of these taxa.

Logsheet coverage rates were not evenly distributed in all regions of the WCPFC. For example, while Australia and New Zealand logsheet coverage rates of foreign licensed vessels are virtually 100%, logsheet coverage rates for other areas has been less than 0.1% for many years, although coverage rates are improving (Lawson 2004).

While the catches reported by observers are relatively detailed (for example, relatively few sharks were pooled into the unidentified shark category by observers within the longline fisheries), a significant proportion of records lacked information on condition and fate of individuals. These two data fields are essential in the estimation of mortality rates of taxa and the limited data are likely to have affected the estimated mortalities presented within this report. However, the mortality rates of some taxa can be accurately assumed (e.g. most sharks are likely to have been retained completely or finned and therefore suffered mortality).

With the exception of several species of sharks, the number of observer records for most of the species examined within this report were relatively few. The data for most species were

dominated by zeros (i.e. most species were not recorded from most longline or purse-seine sets).

However, the low observer coverage rates resulting in that the estimated catches and mortalities being raised considerably to provide total estimates for the area examined. For example, annual estimates of catches and mortalities generated from observer data were raised by a factor of between 50 and 1,000 times. Thus, the recording of a single individual once in the dataset resulted in the estimation of a significant total catch. Further, the recording of a single mortality also created large estimates of mortality (e.g. mammals, Table 7b).

Given the issues of the low observer coverage rates, the generally low rates of identification to the species level (especially for birds, turtles and mammals), and the small number of records, the estimated catches and mortalities within this report had relatively wide confidence intervals, highlighting the uncertainty around each estimate.

4.2 Birds

Overall, very few birds were reported by observers from the longline and purse-seine fisheries in the area examined. Thus, the interaction of the industrialised fleets with birds between 15ºN and 31ºS were extremely low and too low to generate reliable estimates of catches and mortalities. When condition or fate were recorded, a significant proportion of all bird records for the longline fisheries examined indicated that the birds were dead at release. The highest rates of bird capture were generated for the TAL fishery, suggesting the interactions between birds and the TAL were relatively high. However, compared to estimates from more southern temperate regions of the WCPFC (Watling 2002), the interactions between the industrialised fisheries and birds on the central WCPFC region were relatively low.

In conclusion, the risk of industrialised fishing to the sustainability of bird populations in the region of the WCPFC examined is very low. However, many resident and transient seabirds in the tropical Pacific are listed as threatened by the IUCN (Watling 2002) and reducing seabird-fishery interactions in the region may improve the status of these bird stocks. Improved identification of birds by observers and improved reporting of condition and fate would improve the understanding of the interactions between birds and industrialised fisheries in the region.

4.3 Mammals

Similar to birds, very few mammals were reported by observers within the longline fisheries of the region examined. Therefore, the overall impact of longline fisheries with marine mammals appears very low. The highest estimates of total catches were generally reported within the TSL fishery (Table 7), with very low estimates generated for the TAL fishery.

Somewhat higher estimated numbers of mammal mortalities were reported from the two tropical longline fisheries during the late 1990s, especially in the western tropical Pacific. However, very few mortalities have been recorded in recent years. Mammals were also captured in low numbers by the TAL but no mortalities have been reported.

Most interactions between mammals and the industrialised fisheries in the region examined were recorded within the purse-seine fishery, especially in the western tropical Pacific. This is largely a result of sets being made on tuna schools associated with whales. However, disproportionably high capture rates of mammals were also reported from purse-seine sets around aFADs and logs. This may be a result of floating objects retaining diverse marine communities which marine mammals exploit for food. However, a lower than expected incidence of mammals were captured by purse-seine operations on dFADs. While the estimated numbers of whales ‘captured’ by the purse-seine fishery were higher than for the

longline fisheries, the mortality rates were low and no mortalities have been observed since 1998. However, the condition of most mammals were not recorded.

While the identification of most mammals was not to the level of species, very few records existed for dolphins. This is in contrast with the purse-seine fishery in the eastern Pacific Ocean (EPO) where sets on tunas associated with dolphins schools were a significant set-type (Hall 1998). Compared to the EPO, the interactions between mammals and the purse-seine fishery of the WCPFC were very low. However, most records of mammal catches from the fisheries examined were reported in the tropical western Pacific, west of approximately 180ºE (Figure 5). Future, more detailed analyses of mammal-fishery interactions may focus on this region and may consider dividing the purse-seine fishery of the WCPFC into at least two separate fisheries, with division between the two fisheries set at 180ºE.

Overall, there are low levels of interactions between marine mammals and the industrialised fisheries of the WCPO. Thus the risk of the industrialised fisheries to the sustainability of marine mammal appear to be low. However, as most mammals captured by the longline fishery in the WCPO were not identified to the species level, the risks to individual species using IUCN criteria could not be assessed. Better species identification would permit a more thorough understanding of the impacts of fishing on mammals stocks of the WCPFC.

4.4 Sharks

Estimates of catches and mortalities of sharks were higher than for any other taxa examined in the current report. Sharks are more diverse and generally more abundant than turtles, mammals and seabirds in the tropical Pacific. Further, dedicated shark fisheries have been established in several EEZs within the region examined. Thus catches of sharks by at least some industrialised longline fisheries are deliberate, contrasting to the catches of other taxa discussed in this report.

An annual catch of more than 1.35 million sharks was estimated from observer data for the TSL fishery in 2002, with catches averaging approximately 500,000 sharks per year. Shark catches in the TSL were dominated by seven species of sharks and pelagic sting rays (Figure 15), with silky sharks being the most commonly captured species in the TSL fishery.

Shark catches in the TDL were much lower than for the TSL, with between 100,000 and 200,000 sharks captured by each of these fisheries per year. The estimated number of sharks annually captured in the TAL were generally less than 100,000. Thus, the observer data suggested that sharks were more common in the upper part of the water column in tropical waters of the region of the WCPFC examined. Mortality rates were generally less than 30% in most years. However, this is likely to have underestimated the actual mortality rate as records of condition or fate of captured sharks were not available for more 50% of records. Further, the rate of shark-finning and/or retention is relatively high throughout the region. Thus the total mortalities of sharks in the longline fisheries of the region examined are likely to approach the estimated total catches.

Shark catches in the longline fisheries were dominated by blue sharks. These sharks are listed as ‘low risk/not threatened’ by the IUCN (www.redlist.org) (Table 4) due to the relatively high fecundity of this species compared to other species of sharks (Last and Stevens 1994). Other species of sharks commonly captured by the longline fisheries of the region were also listed as ‘low risk/not threatened’ or not listed by the IUCN (www.redlist.org) (Table 4). However, three species of sharks listed as ‘vulnerable’ by the IUCN were captured by the longline fisheries in the region, although in very low levels (basking shark (n=138), great white shark (n=48), whale shark (n=2)). Further, the IUCN only lists the north Pacific stock of basking shark as ‘vulnerable’ (www.redlist.org). The total catches of these three species by the longline fisheries of the region examined were very low.

While most sharks were not listed as threatened by the IUCN (www.redlist.org), the CPUEs estimated from observer data for some of the major species were lower in recent years (Figures 15–17). For example, blue, oceanic whitetip, silky, and crocodile sharks, and pelagic sting rays, all showed a decline in CPUE in recent years. While these trends may suggest declines in relative abundances of theses species, the changes in CPUE may also be due to changes in gear configurations and the spatial distribution of fishing effort within each fishery. Further, the identification of species by observers has also improved as displayed by the reduction in the CPUE of unidentified threshers in the TSL, and subsequent increases in thresher shark CPUE.

Estimated shark catches for the purse-seine fishery of the WCPFC were less than 80,000 per year (Table 7c). While the total mortalities were much lower, anecdotal evidence suggested that most sharks captured by the purse-seine fishery are dead by the time they are removed from the net. Further, shark finning is also reported by observers within the purse-seine fishery.

The three major most commonly reported species of sharks captured by the purse-seine fishery (silky, oceanic whitetip and manta rays) are not listed by the IUCN. However, approximately 34% of shark records in the observer database for purse-seine fishery are of 'unidentified' sharks. Thus, better species identification is required to more accurately determine the total catches, and therefore impacts, of the purse-seine fishery on sharks stocks in the WCPFC.

A relatively large number of whale sharks were reported by observers from the purse-seine fishery, largely a result of sets being made on tuna schools associated with these sharks. However, disproportionably high capture rates of sharks were also reported from purse-seine sets on schools of tunas associated with floating objects (Figure 25). Similar to mammals, the reason that sharks are more commonly captured associated with floating objects is likely to be due to increased feeding opportunities.

Overall, the industrialised fisheries of the region examined captured significant numbers of sharks. This is mainly due to sharks forming part of the commercial catches for many longline fisheries in the region. Further, dedicated shark fisheries exist in some regions of the WCPFC. Finally, the high prices paid for shark fins are also likely to result in a high proportion of sharks being finned. As a result, many sharks that interact with the industrialised fisheries are likely to suffer mortality.

Formal stock assessments for species of sharks in the Pacific Ocean are currently limited. A blue shark assessment for the north Pacific (Kleiber et al. 2001) indicated that significant numbers of blue sharks are captured by longline fisheries in the region. However, the assessment by Kleiber et al. (2001) indicated that current levels of catch for blue sharks are sustainable in terms of stock dynamics and fishery effort and that the north Pacific stock could sustain higher levels of effort and catch. The three longline fisheries examined in the current report captured an estimated average of 243,269 ± 52,513 blue sharks per year between 1993 and 2004, and it is likely that the blue shark stock in the south Pacific can also sustain this level of annual catch. Formal stock assessments for other species of sharks are underway and more are planned in the future. However, assessments for many shark species are currently not available and the catch estimates of other species presented in this report cannot be placed in perspective with other estimates.

While the total catches presented within this report appear realistic in terms of the order of magnitude of the estimates, an increased level of observer coverage would assist in the generation of more robust estimates. In addition, increasing the rates of identification of sharks to species level and the conditions and fates of sharks, would also benefit the

generation of more accurate estimates, especially for sharks captured within the purse-seine fishery. These additional data would be important inputs to any future assessment for sharks in the WCPFC area.

4.5 Turtles

Observers reported five species of turtles and an unidentified category being captured within the four fisheries examined in the present report (Table 7d), with the highest estimated total catches being generated for the TSL fishery (Table 7d). Estimates of turtle catches from the TDL fishery were much lower but higher than the estimates of total turtle catches from the TAL. Catches of turtles by the purse-seine fishery were relatively low (less than 1,000 turtles per year for each fishery). However, the highest mortality rates of turtles were estimated for the TDL fishery. The lower mortality rates of turtles in the TSL compared to the TDL maybe due to the shallower gear allowing incidentally captured turtles to reach the surface to breathe, whereas the deeper set gear of the TDL does not.

The relatively high estimated catches of turtles by the TSL fishery were expected. The shallow hook depth places hooks in the surface waters (less than 100 m) where all species of turtles spend nearly all their time (Beverly et al. 2004, Hays et al. 2004). Further, most species of turtles spend much of their lives within the tropics. The high mortality rates of turtles from the TDL were also expected as a proportion of hooks are generally set in the upper 150 m and thus interact with turtles. However, the increased depth of the set does not permit hooked turtles to surface as easily as the shallow set hooks in the TSL, resulting in relatively high mortality rates.

More than 70% of all turtles captured by the purse-seine fishery were reported from associated sets, particularly around logs and aFADs (Figures 29). However, where condition and fate were recorded, most turtles were released in a healthy condition, with very few mortalities or injuries recorded. A single turtle was retained for crew consumption. Overall it appeared that the purse-seine fishery induced a relatively low level of mortality on marine turtles in the WCPFC area.

Most records of turtle catches from the fisheries examined were reported from the tropical western Pacific, west of approximately 170ºE (Figure 7), similar to previous reports (OFP 2001). The higher turtle-fishery interactions in this region may be due to the proximity of nesting beaches in the western central Pacific. Future, more detailed analyses of turtle-fishery interactions may focus on this region and may consider further dividing the longline and purse-seine fisheries within the tropical regions of the WCPFC into fisheries east and west of 170ºE, in order to better estimate turtle-fishery interactions.

All species of marine turtles are listed as ‘endangered’ or ‘critically endangered by the IUCN (www.redlist.org) (Table 5). However, more than 50% of all turtle records by observers were not identified to the species level. Increasing the species identification rates by observers in all fisheries would permit a better assessment of the impacts of fishing on turtles stocks.

While the mortality of any marine turtles by longline and purse-seine fisheries of the WCPFC should be avoided where possible, other sources of human-induced turtle mortality also exist in the region. For example, other fisheries (e.g. trawl fisheries, Hays et al. 2003, Ferraroli et al. 2004), turtle capture for cultural and traditional uses, and coastal developments on nesting beaches (OFP 2001) also induce direct and indirect turtle mortalities. At this stage however, it is not possible to compare the relative impacts of all human-induced mortalities on turtle stocks of the WCPFC region.

4.6 Conclusions and recommendations

Each of the four fisheries displayed differences in catches and mortalities of each taxa examined. However, the estimated mortalities of birds and mammals induced by the four fisheries examined in the current report were relatively low. Although formal estimates of the impacts of each fishery on the stock status of birds and mammals were not undertaken, the low number of observer reports suggested that the levels of impacts are relatively low. The major direct interaction with mammals appears to be with the purse-seine fishery, likely a result of sets directly upon marine mammals in order the capture associated schools of tuna.

There are however, anecdotal reports of significant interactions between toothed whales and the longline fisheries examined in the current report (e.g. Nishida and Tanio 2001). Depredation of tunas from longlines by toothed whales was not examined in this report but is likely to be an area of interest in the future.

Estimates of turtle mortalities in the WCPFC as a result of industrialised fisheries appeared to be at a higher level than the mortalities of birds and mammals. However, the estimated mortalities have been relatively low in recent years. This may be a result of both increased attention to turtle issues, changes in gear configurations and type (e.g. deeper setting of gear and the use of circle hooks) (e.g. Beverly et al. 2004) and training of crews in correct turtle handling. However, the significance of the mortality estimates on the stock status of the species and the relativities with other sources of human-induced mortalities are unclear at present.

Large catches of sharks were reported in all fisheries, especially the TSL fishery which includes specific sharks fisheries. Formal stock assessments for most species are lacking. However, most sharks are not listed as threatened by the IUCN (www.redlist.org). Better estimates of shark catches through increased observer rates would allow the generation of more robust estimates of mortality for each species.

Purse-seine set type was a major factor influencing catch rates of all taxa examined. More sharks, turtles and mammals were reported from associated sets, especially sets on logs and aFADS. Thus, any management measures designed to reduce catch rates and mortalities of these taxa by the purse-seine fishery of the WCPFC should consider the influence of set-type.

It is likely that the impacts of fishing on these four taxa will be the focus of further attention and reserach in the future. In order to improve future analyses the following recommendations should be considered;

1. Increasing observer coverage rates

Observer coverage rates are relatively low. This results in relatively low levels of data and considerable raising of the data in order to generate total catches and mortalities. Further, the influence of single observation is relatively large. By expanding the observer coverage rates, more accurate estimates of catches and mortality will be able to be generated.

Additionally, observer coverage rates are not evenly distributed among flags or areas and are not in proportion to the distribution of effort within each fishery (Appendix 3). Further, the distribution of starting times for sets varies between observed sets and logsheet sets (Appendix 4). Thus, raising estimates of mortality from the observer coverage to the entire fishery introduces potentially significant biases.

2. Increasing the identification of all individuals to species level

The high proportions of records that identified individuals to genus, family or class does not allow for accurate assessments of the impacts of fishing mortality and interactions on individual species. Better identification of all taxa is required.

3. Increasing the rates of reporting of fate and condition of all individuals captured.

Fate and condition at capture and release are essential data for the estimation of mortality rates and impacts of fishing. However, a majority of records lacked information for one or both of these categories. Thus assumptions about the likely mortality rates had to be imposed. Higher levels of recording of at least one of these variables would greatly assist the estimates of mortality for each species.

4. Designing species observer programmes to address specific objectives and issues (e.g. NOAA turtle programme)

While the current observer programme allows the estimation of catches of a wide range of species, including major tunas, the programme was not specifically designed to estimate the mortalities of the taxa requested. For example, turtle-fishery interactions near Hawaii were recently examined with a specific observer programme designed to address specific objectives, coupled with high observer coverage rates. The resulting turtle CPUEs were much higher than previous estimates under a generic observer programme (M. McKoy, pers. comm.). While new programmes are currently being developed in the WCPFC area (e.g. the FFA and NOAA turtle programme), consideration should be given to designing specific programmes to address specific objectives.

5. Consider reviewing the species listed within Annex 1 of UNCLOS to make the list more appropriate to the WCPFC area.

While the request referred to non-target sharks, it was not clear which species of shark are targeted in the WCPFC area. While sharks may be targeted by some fisheries (e.g. a subset of the TSL fishery), sharks are a bycatch in others (e.g. purse-seine). Further, the WCPFC is responsible for the management of only a subset of species as identified in Annex 1 of UNCLOS. While this annex is generic and identifies highly migratory species, some species of shark (and other taxa) on Annex 1 are rare or absent from the WCPFC region, while other species which could be included under the annex (e.g. some members of the family *Carcharhinidae*, such as grey reef sharks, *C. amblyrhynchos*) are not likely to be highly migratory. The Commission should consider modifying the species listed under Annex 1 to specifically reflect the species of highly migratory sharks to be considered for management in the WCPFC region.

6. Centralising the observer data to all areas of the WCPFC to allow all data to be accessed easily from a single location

This report relied entirely on observer data held at SPC. While other data exist in the WCPFC region and the Pacific, there is no centralised location for all data sources. Centralisation should be considered to allow easier and more rapid access to the observer data for future analyses.

7. Prioritising the species for future research

There are more than 40 species of sharks and rays listed within the SPC observer database, and more than 180 species of sharks and 100 species of rays in the WCPFC region (Last and Stevens 1994). Future research should focus on the most important species of sharks. Importance of each species could be determined by using a combination of biological (e.g. age at first maturity, fecundity), catch (e.g. total catch estimates, trends in annual estimated catches, CPUEs) and stock status variables (e.g. IUCN listings, www.redlist.org) in a risk-analysis type framework. This framework could also be applied to other species that interact with the industrialised fisheries of the WCPFC region.

8. Considering focussing on the interactions of the four taxa with newly developing fisheries.

Several new fisheries have recently developed in the WCPFC, including regional longline fisheries that specifically target sharks or swordfish. Longline sets in these fisheries use relatively few HBF and most of the hooks are within the upper 100 m of the water column. As seen in the estimated catches and mortalities from the TSL fishery, the interactions between

longline fisheries using few HBF with sharks and turtles are relatively high. Consideration should be given to assessing interactions between these new shark and swordfish fisheries and specific taxa (e.g. turtles, sharks, other fishes).

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7. Tables

Table 1. Total observed effort (millions of longline hooks or number of purse-seine sets) and total effort of the four fisheries defined within the report. Sources: observer and CES databases held at SPC. Coverage rates estimated by dividing effort total annual observer effort with total (CES) estimated effort per year.

a). Western tropical Pacific shallow longline

	Effort (millions of hooks)		Estimated observer
Year	Observer	Total estimated	coverage rate
1993	0.05	128.81	0.000
1994	0.15	177.51	0.001
1995	0.14	208.31	0.001
1996	0.07	179.92	0.000
1997	0.12	128.72	0.001
1998	0.26	153.49	0.002
1999	0.24	235.38	0.001
2000	0.17	251.10	0.001
2001	0.15	308.31	0.000
2002	0.19	388.88	0.000
2003	0.03	280.32	0.000
2004	0.14	61.62	0.002

b). Western tropical Pacific deep longline

	Effort (millions of hooks)		Estimated observer
Year	Observer	Total estimated	coverage rate
1992	0.01	130.18	0.000
1993	0.07	159.16	0.000
1994	0.10	152.35	0.001
1995	0.17	126.27	0.001
1996	0.17	102.47	0.002
1997	0.42	98.98	0.004
1998	0.59	87.50	0.007
1999	0.39	93.76	0.004
2000	0.79	122.83	0.006
2001	0.69	101.02	0.007
2002	0.99	107.16	0.009
2003	0.65	92.05	0.007
2004	0.36	93.53	0.004

Table 1, continued. Total observed effort (millions of longline hooks or number of purse-seine sets) and total effort of the four fisheries defined within the report. Sources: observer and CES databases held at SPC. Coverage rates estimated by dividing effort total annual observer effort with total (CES) estimated effort per year.

c). Western temperate Pacific albacore longline

	Effort (millions of hooks)		Estimated observer
Year	Observer	Total estimated	coverage rate
1990	0.01	78.88	0.000
1991	0.32	100.52	0.003
1992	0.56	70.26	0.008
1993	0.26	74.70	0.003
1994	0.29	90.48	0.003
1995	0.31	96.95	0.003
1996	0.47	83.82	0.006
1997	0.72	83.83	0.009
1998	0.35	109.92	0.003
1999	0.31	109.72	0.003
2000	0.23	107.73	0.002
2001	0.27	135.93	0.002
2002	0.13	150.79	0.001
2003	1.29	198.39	0.007
2004	0.98	127.75	0.008

d). Western tropical Pacific purse-seine

	Effort (number of sets)		Estimated observer
Year	Observer	Total estimated	coverage rate
1994	1,174	67,952	0.02
1995	1,341	70,208	0.02
1996	2,215	73,110	0.03
1997	2,211	75,959	0.03
1998	2,685	99,779	0.03
1999	1,837	90,164	0.02
2000	2,127	51,012	0.04
2001	2,364	46,163	0.05
2002	3,560	53,962	0.07
2003	3,631	58,682	0.06
2004	3,368	29,611	0.11

Table 2. Species of birds listed in SPC observer database, 1980–2004. Code, international species code as used in SPC databases; IUCN code, Red Book status of each species, either vulnerable (VU), endangered (EN) or not threatened (NT) (full details at www.redlist.org), missing value indicates that the species is not listed in the Red Book; Stock status, as given in the IUCN Red Book, either increasing (↑), declining (↓) or stable (→). Blanks indicate that not enough information exists to determine status.

Common name	Scientific name	Code	IUCN code	Stock status	Numbers in observer database	
					Longline	Purse-seine (sets)
Albatross	*Diomedea* spp.	ALZ			579	0
Bird (unidentified)	Aves	BIZ			1,533	1 (1)
Black petrel	*Procellaria parkinsoni*	PRK	VU		5	0
Black-browed mollymawk	*Thalassarche* (*Diomedea*) *melanophrys*	DIM	EN	↓	22	0
Black-footed albatross	*Phoebetria nigripes*	B19	EN	↓	730	0
Campbell Island black-browed mollymawk	*Diomedea melanophrys impavida*	B02	EN	↓	33	0
Cape pigeon	*Daption capensis*	DAC			7	0
Flesh-footed shearwater	*Puffinus carneipes* (*creatopus*)	PFC	VU		124	0
Grey headed albatross	*Thalassarche* (*Diomedea*) *chrysostoma*	DIC	VU	↓	4	0
Grey petrel	*Procellaria cinerea*	PCI	NT		126	0
Laysan albatross	*Phoebetria immutabilis*	B20	VU	↓	519	0
Light-mantled sooty albatross	*Phoebetria palpebrata*	PHE	NT	↓	38	0
New Zealand white capped mollymawk	*Thalassarche* (*Diomedea*) *cauta steadi*	DCU	NT	↑	16	0
Northern giant petrel	*Macronectes halli*	MAH	NT		2	0

Table 2, continued. Species of birds listed in SPC observer database, 1980–2004. Code, international species code as used in SPC databases; IUCN code, Red Book status of each species, either vulnerable (VU), endangered (EN) or not threatened (NT) (full details at www.redlist.org), missing value indicates that the species is not currently in the Red Book; Stock status, as given in the IUCN Red Book, either increasing (↑), declining (↓) or stable (→). Blanks indicate that not enough information exists to determine status.

Common name	Scientific name	Code	IUCN code	Stock status	Numbers in observer database	
					Longline	Purse-seine (sets)
Salvin's albatross	*Thalassarche* (*Diomedea*) *salvini*	B11	VU	→	5	0
Seagull	*Larus* spp.	B12			1	0
Sooty shearwater	*Puffinus griseus*	PFG	NT		4	0
Southern giant petrel	*Macronectes giganteus*	MAI	VU		7	0
Southern royal albatross	*Diomedea epomophora epomophora*	DIP	VU	→	8	0
Wandering albatross	*Diomedea exulans*	DIX	VU	↓	107	0
White-chinned petrel	*Procellaria aequinoctialis*	PRO	VU		17	0
Total birds by gear					*3,887*	*1* *(1)*
Total birds						*3,888*

Table 3. Species of mammals listed in SPC observer database, 1980–2004. Code, international species code as used in SPC databases; IUCN code, Red Book status of each species, either data deficient (DD) vulnerable (VU), endangered (EN), lower risk (LR) or not threatened (NT) (full details at www.redlist.org), missing values indicates that the species is not currently in the Red Book; Stock status, as given in the IUCN Red Book, either increasing (↑), declining (↓) or stable (→). Blanks indicate that not enough information exists to determine status.

Common name	Scientific name	Code	IUCN code	Stock status	Numbers in observer database	
					Longline	Purse-seine (sets)
Bottlenose dolphin*	*Tursiops truncatus*	DBO	DD		3	18 (3)
Common dolphin*	*Delphinus delphis*	DCO	Not listed for WCPFC		3	24 (8)
Dolphins / porpoises (unidentified)*	*Delphinidae*	DLP			2	33 (12)
Dusky dolphin*	*Lagenorhynchus obscurus*	DDU	DD		1	0
Humpback whale*	*Megaptera novaeangliae*	HUW	VU	↑	2	0
Marine mammal (unidentified)	Mammalia	MAM			15	581 (132)
New Zealand fur seal	*Arctocephalus forsteri*	SEA			321	0
Pygmy killer whale*	*Feresa attenuata*	KPW	DD		0	1 (1)
Risso's dolphin*	*Grampus griseus*	DRR	DD		7	0
Seals	*Otariidae, phocidae*	SXX			3	0
Short-finned pilot whale	*Globicephala macrorhynchus*	SHW	LR		4	2 (2)
Sperm whale	*Physeter macrocephalus*	SPW	VU		2	0
Spinner dolphin	*Stenella longirostris*	DSI	LR		2	4 (1)
Toothed whales (blackfish)	Odontoceti	ODN			2	19 (2)
Whale (unidentified)	Cetacea	WLE			11	5 (2)
Total mammals by gear					*380*	*687 (163)*
Total mammals						*1,067*

Table 4. Species of sharks and rays listed in SPC observer database, 1980–2004. Code, international species code as used in SPC databases; IUCN code, Red Book status of each species, either data deficient (DD) vulnerable (VU), endangered (EN), lower risk (LR) or not threatened (NT) (full details at www.redlist.org), missing values indicates that the species is not currently in the Red Book; Stock status, as given in the IUCN Red Book, either increasing (↑), declining (↓) or stable (→). Blanks indicate that not enough information exists to determine status. [*, North pacific stock of basking shark is endangered, (EN A1ad)].

Common name	Scientific name	Code	IUCN code	Stock status	Numbers in observer database	
					Longline	Purse-seine (sets)
Basking shark*	*Cetorhinus maximus*	BSK	VU	?	138	0
						3
Bigeye thresher	*Alopias superciliosus*	BTH			2,445	(3)
Bignose shark	*Carcharhinus altimus*	CCA			27	0
	Carcharhinus			?		
Blacktip reef shark	*melanopterus*	BLR	LR./NT		344	0
				?		24
Blacktip shark	*Carcharhinus limbatus*	CCL	LR./NT		1,441	(10)
				?		39
Blue shark	*Prionace glauca*	BSH	LR./NT		196,192	(19)
Broadsnouted sevengill				?		
shark	*Notorynchus cepedianus*	NTC	DD		2	0
				?		1
Bronze whaler shark	*Carcharhinus brachyurus*	BRO	NT		269	(1)
Bull shark	*Carcharhinus leucas*	CCE	LR./NT	?	15	0
Bullhead sharks	*Heterodontiformes*	HDQ	DD		121	0
Carpet shark	*Cephaloscyllium isabella*	CPS			2	0
Cookie cutter shark	*Isistius brasiliensis*	ISB			106	0
	Pseudocarcharias			?		44
Crocodile shark	*kamoharai*	PSK	LR./NT		1,799	(10)
Dusky shark	*Carcharhinus obscurus*	DUS	LR./NT	?	514	0
	Carcharhinus			?		3
Galapagos shark	*galapagensis*	CCG	NT		648	(1)
Great hammerhead	*Sphyrna mokarran*	SPK	DD	?	62	0
				?		2
Great white shark	*Carcharodon carcharias*	WSH	VU		48	(1)
	Carcharhinus					17
Grey reef shark	*amblyrhynchos*	AML			2,059	(4)
						15
Hammerhead sharks	*Sphyrna* spp.	SPN			1,320	(17)
						28
Long finned mako	*Isurus paucus*	LMA			670	(7)

Table 4, continued. Species of sharks and rays listed in SPC observer database, 1980–2004. Code, international species code as used in SPC databases; IUCN code, Red Book status of each species, either data deficient (DD) vulnerable (VU), endangered (EN), lower risk (LR) or not threatened (NT) (full details at www.redlist.org), missing values indicates that the species is not currently in the Red Book; Stock status, as given in the IUCN Red Book, either increasing (↑), declining (↓) or stable (→). Blanks indicate that not enough information exists to determine status.

Common name	Scientific name	Code	IUCN code	Stock status	Numbers in observer database	
					Longline	Purse-seine (sets)
						303
Mako sharks	*Isurus* spp.	MAK			2,986	(67)
Manta rays						1,085
(unidentified)	Mobulidae	MAN			270	(648)
				?		4,799
Oceanic whitetip shark	*Carcharhinus longimanus*	OCS	LR./NT		9,140	(1,113)
						87
Pelagic sting-ray	*Dasyatis violacea*	PLS			11,950	(67)
Pelagic thresher	*Alopias pelagicus*	PTH			703	0
Plunkets shark	*Scymnodon plunketi*	F54	NT	?	4	0
Porbeagle shark	*Lamna nasus*	POR	LR./NT	?	16,217	0
	Batoidimorpha					8
Rays, skates and mantas	(Hypotrmata)	BAI			181	(7)
				?		40
Salmon shark	*Lamna ditropis*	LMD	DD		80	(1)
				?		1
Sandbar shark	*Carcharhinus plumbeus*	CCP	LR./NT		204	(1)
Scalloped hammerhead	*Sphyrna lewini*	SPL	LR./NT	?	15	0
School shark	*Galeorhinus galeus*	GAG	VU	↓	2,439	0
Seal shark / black shark	*Dalatias licha*	SCK	DD	→	52	0
						15,019
Sharks (unidentified)	*Elasmobranchii*	SHK			3,420	(2,461)
Sharpsnouted sevengill				?		
shark	*Heptranchias perlo*	HXT	NT		1	0
				?		422
Short finned mako	*Isurus oxyrhinchus*	SMA	LR./NT		5,278	(83)
						21,585
Silky shark	*Carcharhinus falciformis*	FAL			27,019	(3,989)
	Carcharhinus					424
Silvertip shark	*albimarginatus*	ALS			1,150	(138)
Smooth hammerhead	*Sphyrna zygaena*	SPZ	LR./NT	?	38	0
Spiny dogfish	*Squalus acanthias*	DGS	LR./NT	?	92	0
				?		12
Thresher	*Alopias vulpinus*	ALV	DD		1,108	(6)
						83
Thresher sharks nei	*Alopias* spp.	THR			1,038	(39)

Table 4, continued. Species of sharks and rays listed in SPC observer database, 1980–2004. Code, international species code as used in SPC databases; IUCN code, Red Book status of each species, either data deficient (DD) vulnerable (VU), endangered (EN), lower risk (LR) or not threatened (NT) (full details at www.redlist.org), missing values indicates that the species is not currently in the Red Book; Stock status, as given in the IUCN Red Book, either increasing (↑), declining (↓) or stable (→). Blanks indicate that not enough information exists to determine status.

Common name	Scientific name	Code	IUCN code	Stock status	Numbers in observer database	
					Longline	Purse-seine (sets)
				?		2
Tiger shark	*Galeocerdo cuvier*	TIG	LR./NT		453	(2)
Velvet dogfish	*Scymnodon squamulosus*	SSQ			241	0
Whale shark	*Rhincodon typus*	RHN	VU	↓	2	124 (73)
Whip stingray	*Dasyatis akajei*	WST			103	10 (5)
Whitenose shark	*Nasolamia velox*	CNX			12	0
Whitetip reef shark	*Triaenodon obesus*	TRB	LR./NT	?	61	0
Zebra shark	*Stegostoma fasciatum*	OSF	VU	?	10	0
Total sharks by gear					*292,651*	*44,180 (8,774)*
Total sharks						*336,831*

Table 5. Species of turtles listed in SPC observer database, 1980–2004. Code, international species code as used in SPC databases; IUCN code, Red Book status of each species, either data deficient (DD) critically endangered (CR) or endangered (EN) (full details at www.redlist.org), missing values indicates that the species is not currently in the Red Book; Stock status, as given in the IUCN Red Book, either increasing (↑), declining (↓) or stable (→). Blanks indicate that not enough information exists to determine status.

Common name	Scientific name	Code	IUCN code	Stock status	Numbers in observer database	
					Longline	Purse-seine (sets)
Green turtle	*Chelonia mydas*	TUG	EN	↓	44	5 (5)
Hawksbill turtle	*Eretmochelys imbricata*	TTH	CR		12	8 (7)
Leatherback turtle	*Dermochelys coriacea*	LTB	CR		65	1 (1)
Loggerhead turtle	*Caretta caretta*	TTL	EN		180	0
Marine turtle (unidentified)	Testudinata	TTX			76	80 (76)
Olive ridley turtle	*Lepidochelys olivacea*	LEO	EN		104	10 (10)
Total turtles by gear					*481*	*104 (99)*
Total tropical turtles					*580*	

Table 6. Definitions of purse-seine set types as used throughout the analyses.

Set-type	Definition
aFAD	Sets on anchored FADS
Animal	Sets on a live animals. Includes sets on whales, whale sharks and other animals
dFAD	Sets on drifting FADS
Log	Sets on natural floating logs
Unassociated	Sets on unassociated surface schools of tuna or tuna associated with baitfish schools.

Table 7. Final estimates of total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of all birds, mammals, sharks and turtles of all WCPO longline fisheries, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

a). Birds

	Fishery																				
	Purse-seine				Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990													9,824	13,236	9,824	12,885	9,824	13,236	9,824	12,885	1.00
1991													2,632	6,938	2,551	6,414	2,632	6,938	2,551	6,414	0.97
1992									0	0	0	0	1,101	4,108	262	2,957	1,101	4,108	262	2,957	0.24
1993					0	1,625	0	1,537	0	0	0	0	2,117	5,318	1,999	4,870	2,117	6,942	1,999	6,407	0.94
1994	0	567	0	0	0	2,239	0	2,119	0	0	0	0	214	4,081	214	3,683	214	6,887	214	5,802	1.00
1995	0	586	0	0	2,069	4,698	1,034	3,521	0	0	0	0	1,975	6,126	1,759	5,482	4,044	11,410	2,793	9,004	0.69
1996	0	610	0	0	0	2,269	0	2,147	0	0	0	0	248	3,831	248	3,462	248	6,710	248	5,609	1.00
1997	0	634	0	0	3,405	5,033	3,405	4,945	0	0	0	0	209	3,791	209	3,423	3,613	9,458	3,613	8,368	1.00
1998	0	833	0	0	0	1,936	0	1,832	0	0	0	0	0	4,697	0	4,214	0	7,466	0	6,045	-
1999	0	753	0	0	0	2,969	0	2,809	0	0	0	0	0	4,688	0	4,206	0	8,409	0	7,015	-
2000	0	426	0	0	0	3,167	0	2,997	0	0	0	0	0	4,603	0	4,130	0	8,196	0	7,127	-
2001	0	385	0	0	0	3,888	0	3,680	0	0	0	0	0	5,808	0	5,210	0	10,082	0	8,890	-
2002	0	450	0	0	0	4,905	0	4,641	0	0	0	0	0	6,443	0	5,780	0	11,798	0	10,421	-
2003	20	490	0	0	0	3,535	0	3,346	0	0	0	0	0	8,477	0	7,605	20	12,502	0	10,950	0.00
2004	0	247	0	0	0	777	0	735	0	0	0	0	90	5,549	90	4,988	90	6,574	90	5,723	1.00
Mean	*2*	*544*	*0*	*0*	*456*	*3,087*	*370*	*2,859*	*0*	*0*	*0*	*0*	*1,227*	*5,846*	*1,144*	*5,287*					
Total																	*1,593*	*8,714*	*1,440*	*7,574*	

Table 7, continued. Final estimates of total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of all birds, mammals, sharks and turtles of all WCPO longline fisheries, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

b). Mammals

	Fishery																				
	Purse-seine				Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990													0	52,345	0	0	0	52,345	0	0	-
1991													0	66,707	0	0	0	66,707	0	0	-
1992									0	1,603	0	614	0	46,628	0	0	0	48,232	0	614	-
1993					0	1,487	0	911	0	1,960	0	750	0	49,570	0	0	0	53,017	0	1,662	-
1994	0	16,835	0	2,957	835	2,884	835	2,091	0	1,876	0	718	0	60,046	0	0	835	81,642	835	5,767	1.00
1995	92	17,394	64	3,055	0	2,404	0	1,474	0	1,555	0	595	215	64,565	0	0	307	85,919	64	5,125	0.21
1996	3,402	18,113	428	3,182	1,889	3,968	1,889	3,164	425	1,688	425	909	0	55,628	0	0	5,717	79,397	2,743	7,254	0.48
1997	727	18,819	23	3,306	715	2,202	715	1,627	911	2,131	0	467	161	55,802	0	0	2,514	78,954	738	5,399	0.29
1998	1,033	24,720	0	4,342	406	2,178	0	1,086	103	1,181	0	413	220	73,181	0	0	1,761	101,260	0	5,841	0.00
1999	1,474	22,338	0	3,924	668	3,385	0	1,665	0	1,155	0	442	0	72,811	0	0	2,142	99,689	0	6,031	0.00
2000	22	12,638	0	2,220	0	2,898	0	1,777	216	1,729	108	687	330	71,847	0	0	568	89,111	108	4,684	0.19
2001	18	11,437	0	2,009	0	3,558	0	2,181	0	1,244	0	476	350	90,578	0	0	368	106,817	0	4,667	0.00
2002	1,121	13,369	0	2,348	2,909	7,401	0	2,751	0	1,320	0	505	165	100,241	0	0	4,196	122,331	0	5,605	0.00
2003	1,441	14,538	0	2,554	0	3,235	0	1,983	0	1,134	0	434	0	131,657	0	0	1,441	150,564	0	4,971	0.00
2004	273	7,336	5	1,289	313	1,025	0	436	0	1,152	0	441	0	84,777	0	0	587	94,290	5	2,166	0.01
Mean	*873*	*16,140*	*47*	*2,835*	*645*	*3,052*	*287*	*1,762*	*127*	*1,518*	*41*	*573*	*96*	*71,759*	*0*	*0*					
Total																	*1,362*	*87,352*	*300*	*3,986*	

Table 7, continued. Final estimates of total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of all birds, mammals, sharks and turtles of all WCPO longline fisheries, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

c). Sharks

	Fishery																				
	Purse-seine				Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990													964,471	1,039,785	60,809	80,449	964,471	1,039,785	60,809	80,449	0.06
1991													75,664	122,094	17,631	41,275	75,664	122,094	17,631	41,275	0.23
1992									222,041	269,407	104,462	133,896	50,382	82,729	10,831	27,324	272,423	352,135	115,293	161,219	0.42
1993					295,916	349,458	34,163	64,936	175,090	230,003	62,729	97,354	61,149	95,862	13,212	30,785	532,154	675,323	110,104	193,075	0.21
1994	14,174	119,483	6,552	6,103	312,123	382,675	57,515	100,166	142,311	194,089	20,911	53,236	82,218	124,617	22,546	43,983	550,826	820,864	107,524	203,488	0.20
1995	51,743	123,448	23,379	6,306	476,354	562,867	111,164	162,230	127,935	171,158	29,121	56,159	104,645	150,785	21,280	44,183	760,677	1,008,258	184,945	268,878	0.24
1996	25,386	128,552	15,571	6,566	550,405	629,826	159,847	205,441	125,128	160,868	27,130	49,145	86,727	126,461	21,778	41,658	787,647	1,045,708	224,325	302,811	0.28
1997	35,552	133,560	19,939	6,822	233,013	284,400	52,097	83,267	95,548	129,284	25,294	46,540	88,126	127,921	25,341	45,304	452,239	675,165	122,669	181,934	0.27
1998	53,529	175,445	28,691	8,962	426,924	493,237	124,236	162,849	81,337	111,061	14,991	33,618	109,134	161,040	29,917	56,019	670,924	940,783	197,835	261,447	0.29
1999	86,306	158,537	41,781	8,098	753,897	858,941	222,764	282,727	95,258	127,362	14,059	33,977	90,995	142,035	13,325	38,996	1,026,455	1,286,874	291,928	363,798	0.28
2000	24,907	89,693	17,261	4,581	664,249	771,577	261,017	325,530	154,458	197,436	43,182	69,794	61,504	110,425	9,437	34,560	905,118	1,169,132	330,897	434,465	0.37
2001	38,611	81,169	20,184	4,146	930,616	1,066,286	193,070	269,317	198,845	236,426	71,983	94,634	137,179	201,462	18,354	50,200	1,305,252	1,585,344	303,591	418,297	0.23
2002	42,026	94,882	21,606	4,846	1,361,425	1,538,890	549,622	652,918	56,678	91,746	15,381	38,131	79,472	147,658	18,787	54,077	1,539,601	1,873,176	605,396	749,972	0.39
2003	52,189	103,180	27,569	5,270	76,231	173,559	14,611	80,189	44,271	74,256	12,957	32,494	72,441	160,775	14,898	61,103	245,132	511,770	70,035	179,057	0.29
2004	14,966	52,065	9,335	2,659	193,205	220,564	52,318	67,876	78,504	110,014	25,520	45,629	70,751	128,667	16,709	46,626	357,426	511,309	103,882	162,791	0.29
Mean	*39,945*	*114,547*	*21,079*	*5,851*	*522,863*	*611,023*	*152,702*	*204,787*	*122,877*	*161,778*	*35,978*	*60,354*	*142,324*	*194,821*	*20,990*	*46,436*					
Total																	*696,401*	*907,848*	*189,791*	*266,864*	*696,401*

Table 7, continued. Final estimates of total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of all birds, mammals, sharks and turtles of all WCPO longline fisheries, 1990–2004 Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

d). Turtles

	Fishery																				
	Purse-seine				Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	**Total**	**CI**	**Mort.**	**CI**	**Total**	**CI**	**Mort.**	**CI**	**Total**	**CI**	**Mort.**	**CI**	**Total**	**CI**	**Mort.**	**CI**	**Total**	**CI**	**Mort.**	**CI**	**Ratio**
1990													0	1,536	0	769	0	1,536	0	769	
1991													0	1,958	0	980	0	1,958	0	980	
1992									0	3,850	0	3,282	0	1,368	0	685	0	5,218	0	3,967	
1993					3,670	8,811	0	1,391	3,262	7,979	1,630	5,647	403	1,859	0	728	7,336	18,648	1,630	7,766	0.22
1994	0	5,821	0	1,638	11,025	18,132	835	2,752	2,044	6,555	2,044	5,890	0	1,762	0	882	13,068	32,270	2,878	11,163	0.22
1995	438	6,014	138	1,693	13,051	21,392	0	2,249	1,002	4,739	501	3,686	861	2,751	215	1,161	15,352	34,896	854	8,788	0.06
1996	479	6,263	53	1,763	5,674	12,857	0	1,943	425	3,457	0	2,584	0	1,633	0	817	6,578	24,209	53	7,107	0.01
1997	87	6,506	0	1,832	4,298	9,437	0	1,390	1,244	4,175	916	3,414	161	1,794	0	817	5,790	21,913	916	7,453	0.16
1998	280	8,547	0	2,406	6,503	12,637	1,623	3,282	515	3,104	309	2,516	220	2,361	0	1,072	7,518	26,649	1,932	9,276	0.26
1999	243	7,723	0	2,174	10,426	19,834	668	3,210	665	3,440	499	2,864	0	2,137	0	1,070	11,335	33,135	1,167	9,318	0.10
2000	0	4,369	0	1,230	6,266	16,283	0	2,711	648	4,282	540	3,638	0	2,098	0	1,050	6,914	27,033	540	8,630	0.08
2001	44	3,954	0	1,113	2,765	15,045	0	3,329	825	3,815	564	3,112	350	2,998	0	1,325	3,984	25,812	564	8,880	0.14
2002	203	4,622	0	1,301	13,109	28,636	1,454	5,655	523	3,694	299	3,001	165	3,102	83	1,553	14,000	40,054	1,836	11,510	0.13
2003	383	5,026	0	1,415	7,296	18,480	0	3,027	683	3,407	487	2,809	107	3,971	107	2,041	8,469	30,884	594	9,292	0.07
2004	59	2,536	0	714	2,197	4,658	0	665	1,563	4,334	910	3,271	271	2,760	90	1,336	4,091	14,288	1,001	5,986	0.24
Mean	*202*	*5,580*	*17*	*1,571*	*7,190*	*15,517*	*382*	*2,634*	*1,031*	*4,371*	*669*	*3,516*	*169*	*2,273*	*33*	*1,086*					
Total																	*6,962*	*22,567*	*931*	*7,392*	

8. Figures

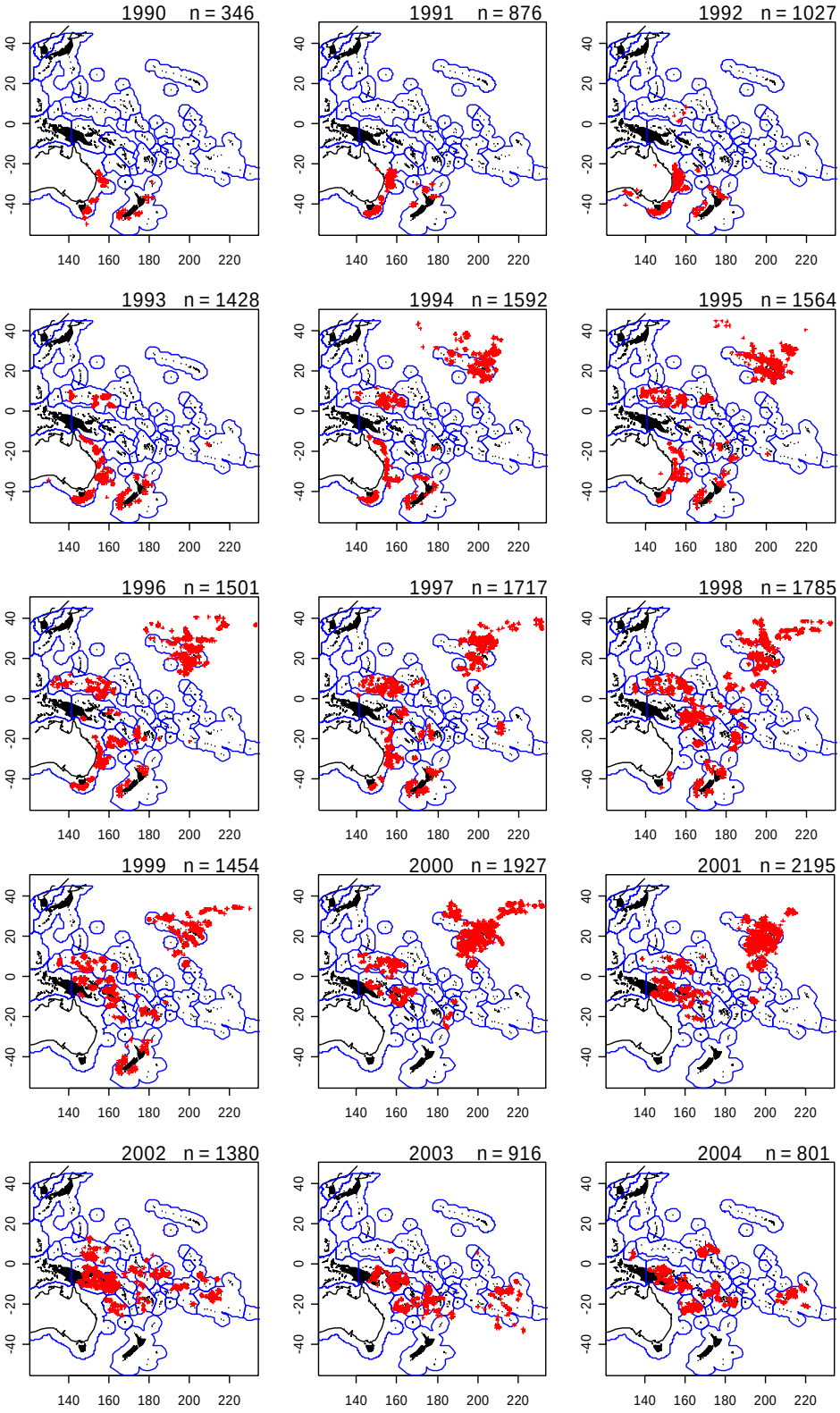

Figure 1. Position of observed longline sets in the WCPO, 1990–2004. Source: observer longline data held by SPC. n denotes the number of observed sets per year.

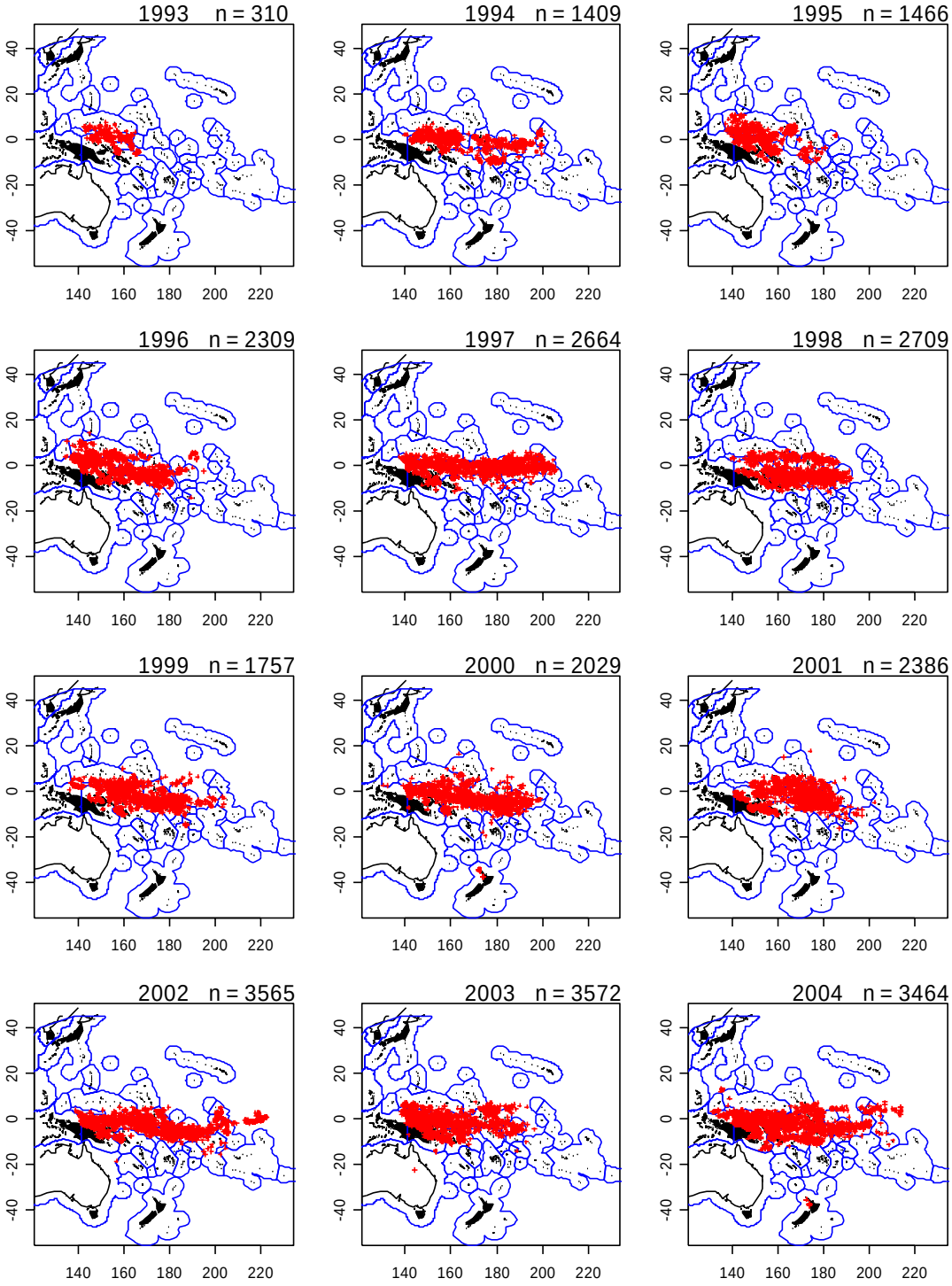

Figure 2. Position of observed purse-seine sets in the WCPO, 1993–2004. Source: observer purse-seine data held by SPC. Data for 2004 may be incomplete. n denotes the number of observed sets per year.

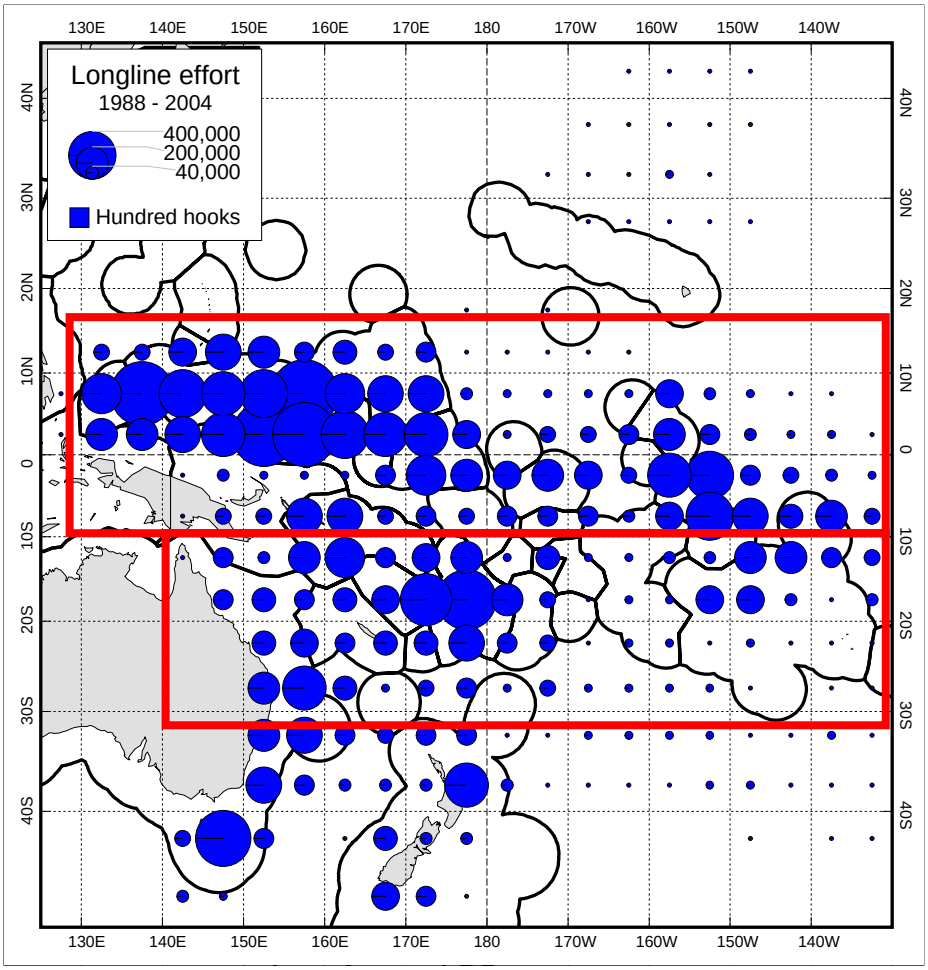

Figure 3. Longline effort (hundreds of hooks) by all fleets in the WCPO, 1988–2004. Source: logsheet data held by the SPC. The red boxes indicate the approximate spatial boundaries of the two tropical longline fisheries (upper box) and the temperate albacore longline fishery (lower box).

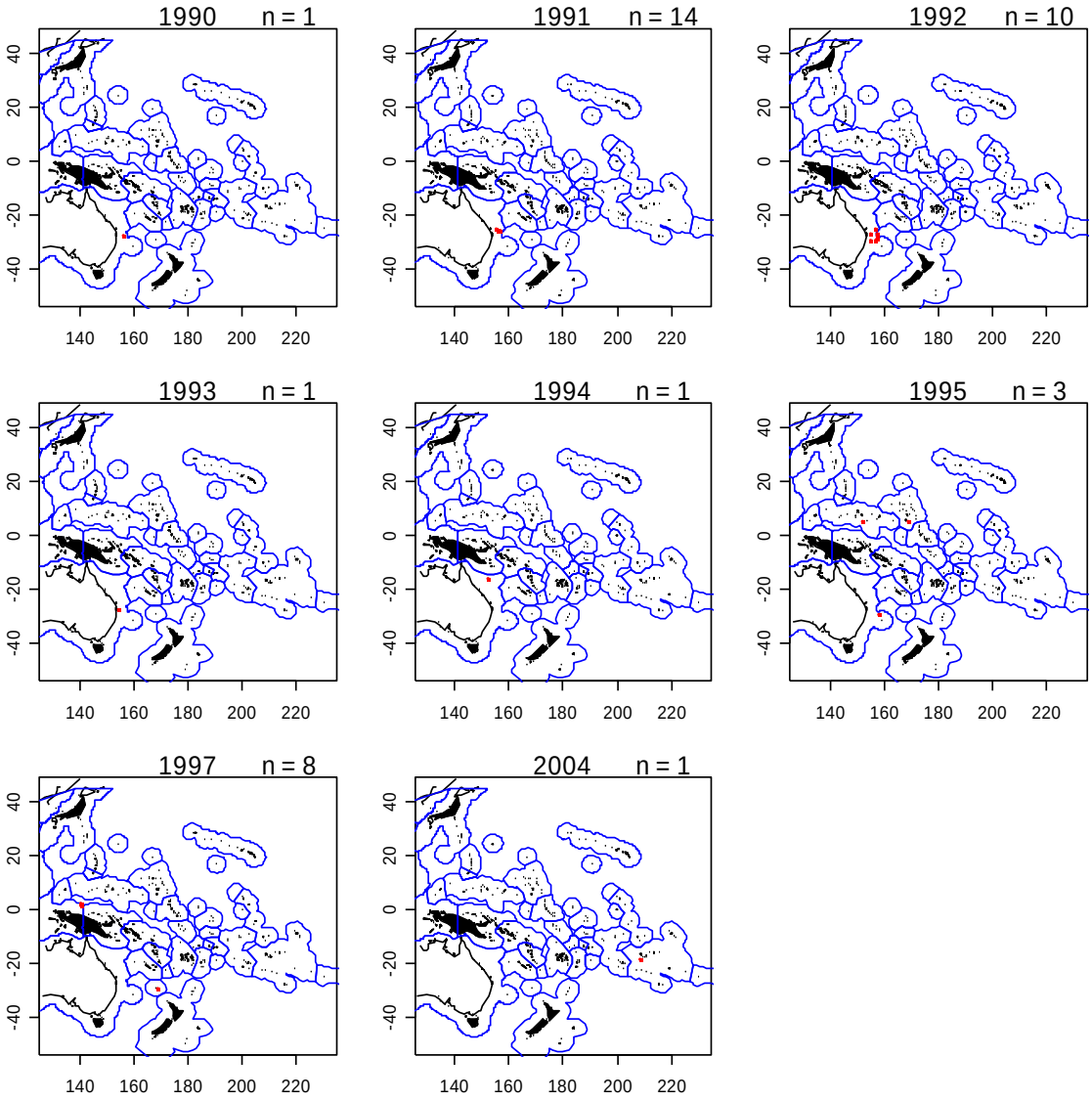

Figure 4a. Position of observed longline sets in which one or more birds were captured in the WCPO, 1997–2004, excluding sets south of 31°S and observed sets on US vessels within and north-east of the Hawaiian EEZ. Source: observer longline data held by SPC. Missing years indicate that no birds were observed captured from longline sets in that year.

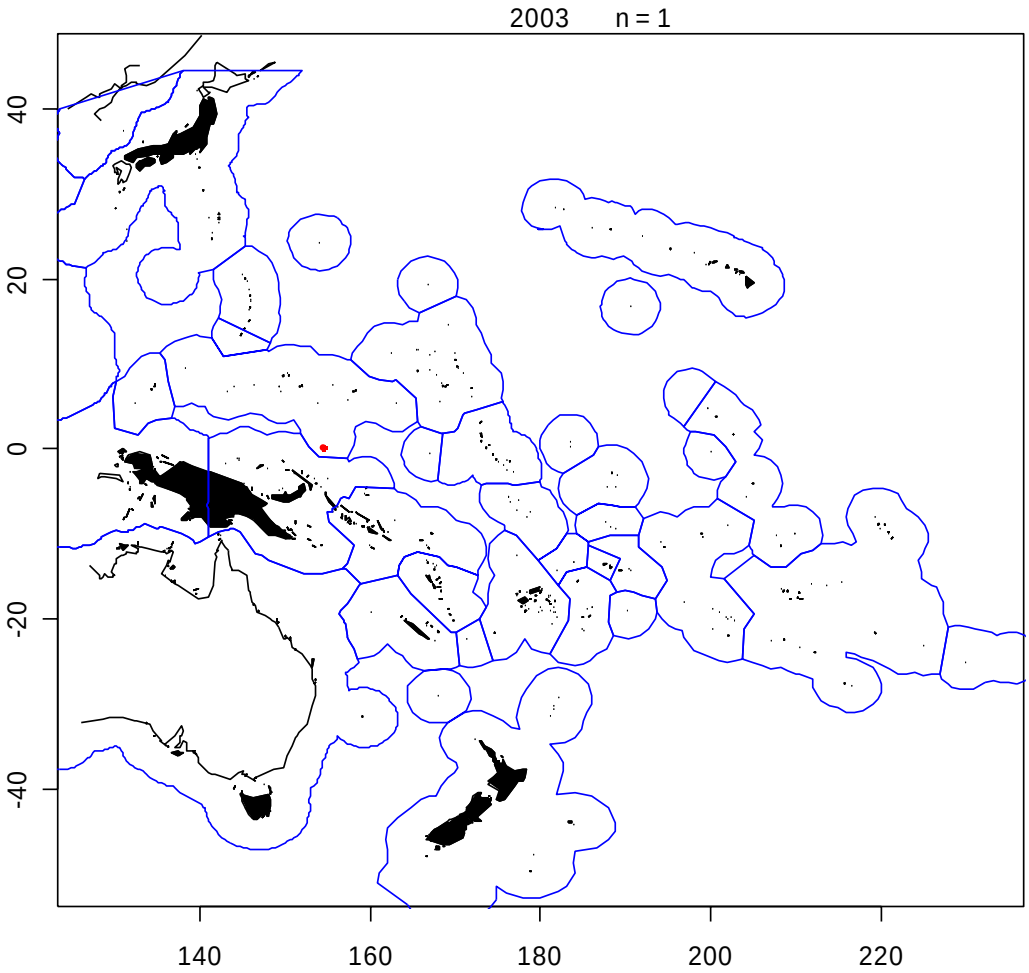

Figure 4b. Position of the observed purse-seine set in which a single bird was captured in the WCPO, 1995–2004. Source: observer purse-seine data held by SPC.

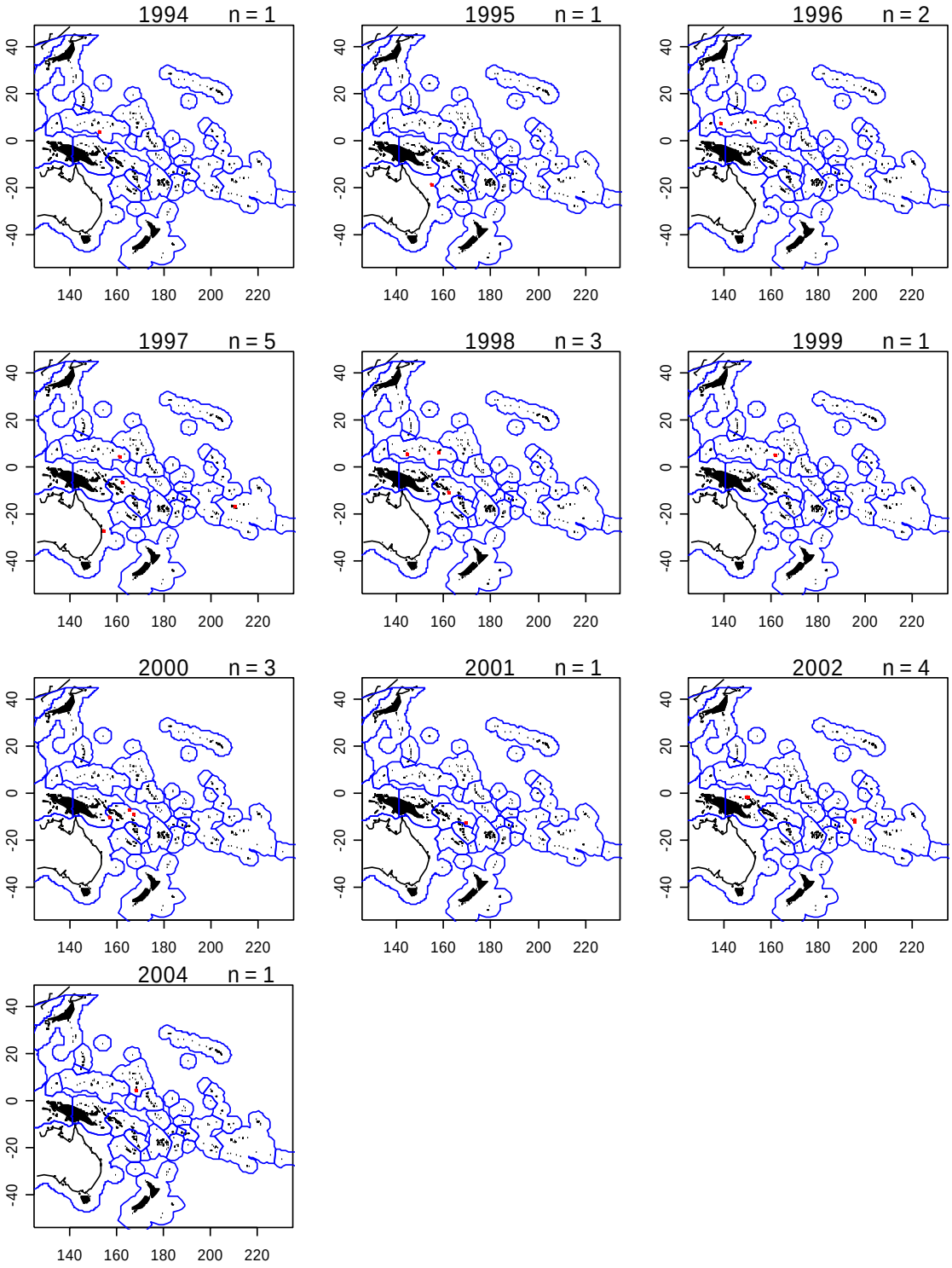

Figure 5a. Position of observed longline sets in which one or more mammals were captured in the WCPO, 1989–2004, excluding sets south of 31°S and observed sets on US vessels within and north-east of the Hawaiian EEZ. Source: observer longline data held by SPC. Missing years indicate that no mammals were observed captured from longline sets in that year.

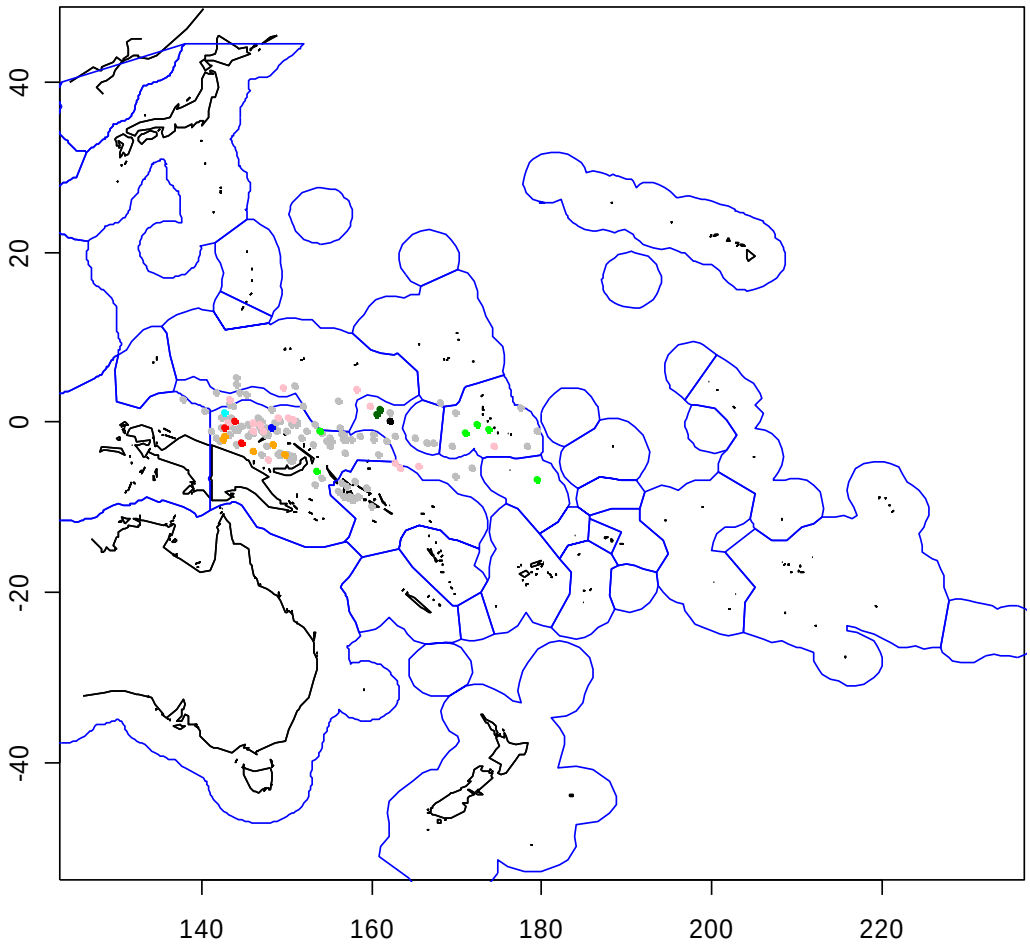

Figure 5b. Position of observed purse-seine sets in which one or more mammals were captured in the WCPO, 1995–2004. Source: observer longline data held by SPC. Codes: grey, marine mammal (unidentified); pink, dolphins/porpoises (unidentified); orange, common dolphin; red, bottlenose dolphin; green, whale (unidentified); dark blue, toothed whales (blackfish); light blue, pygmy killer whale; dark green, short-finned pilot whale; black, spinner dolphin.

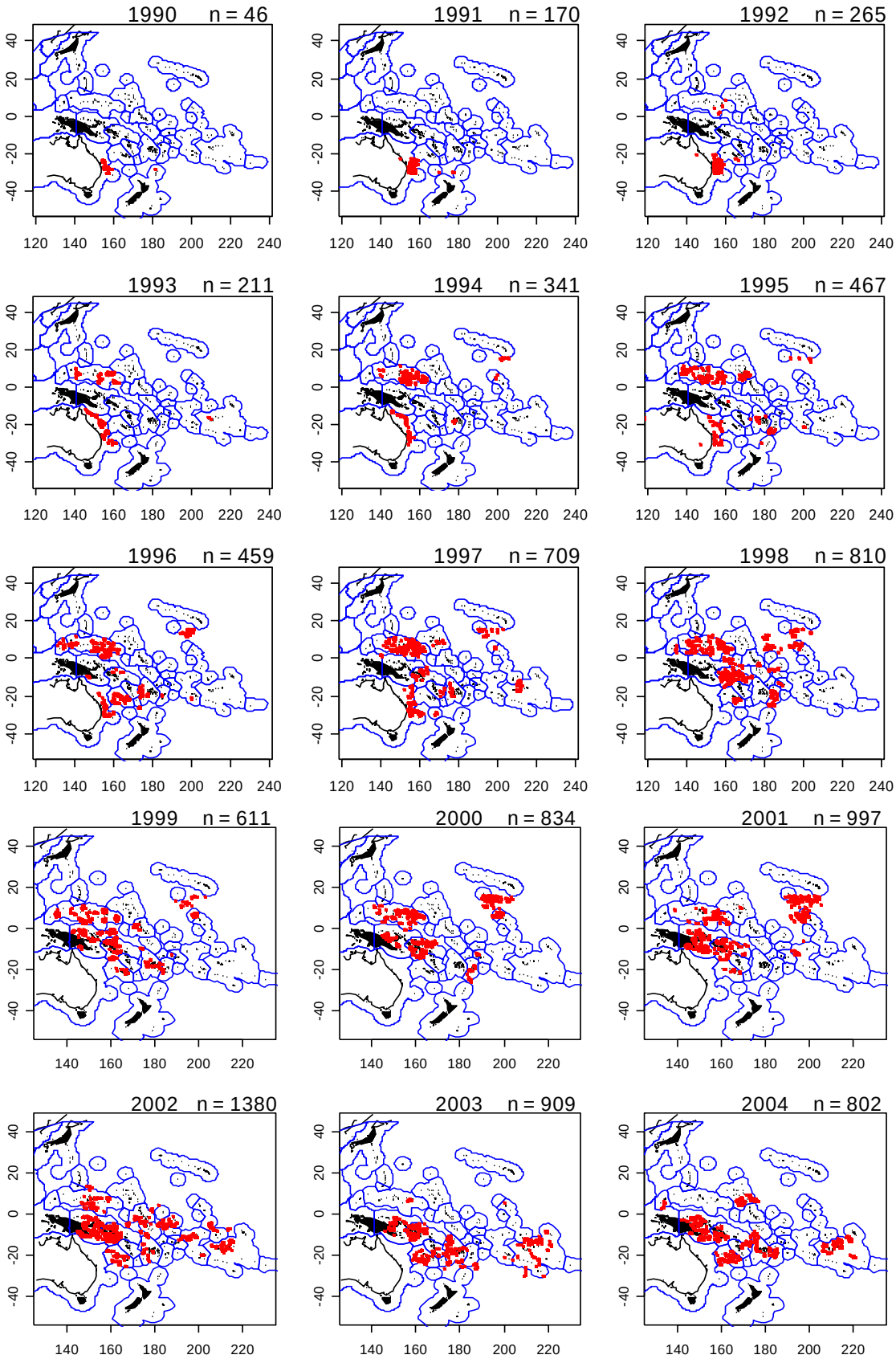

Figure 6a. Position of observed longline sets in which one or more sharks were captured in the WCPO, 1989–2004, excluding sets south of 31°S and observed sets on US vessels within and north-east of the Hawaiian EEZ. Source: observer longline data held by SPC. n= number of sets in which one or more sharks were captured.

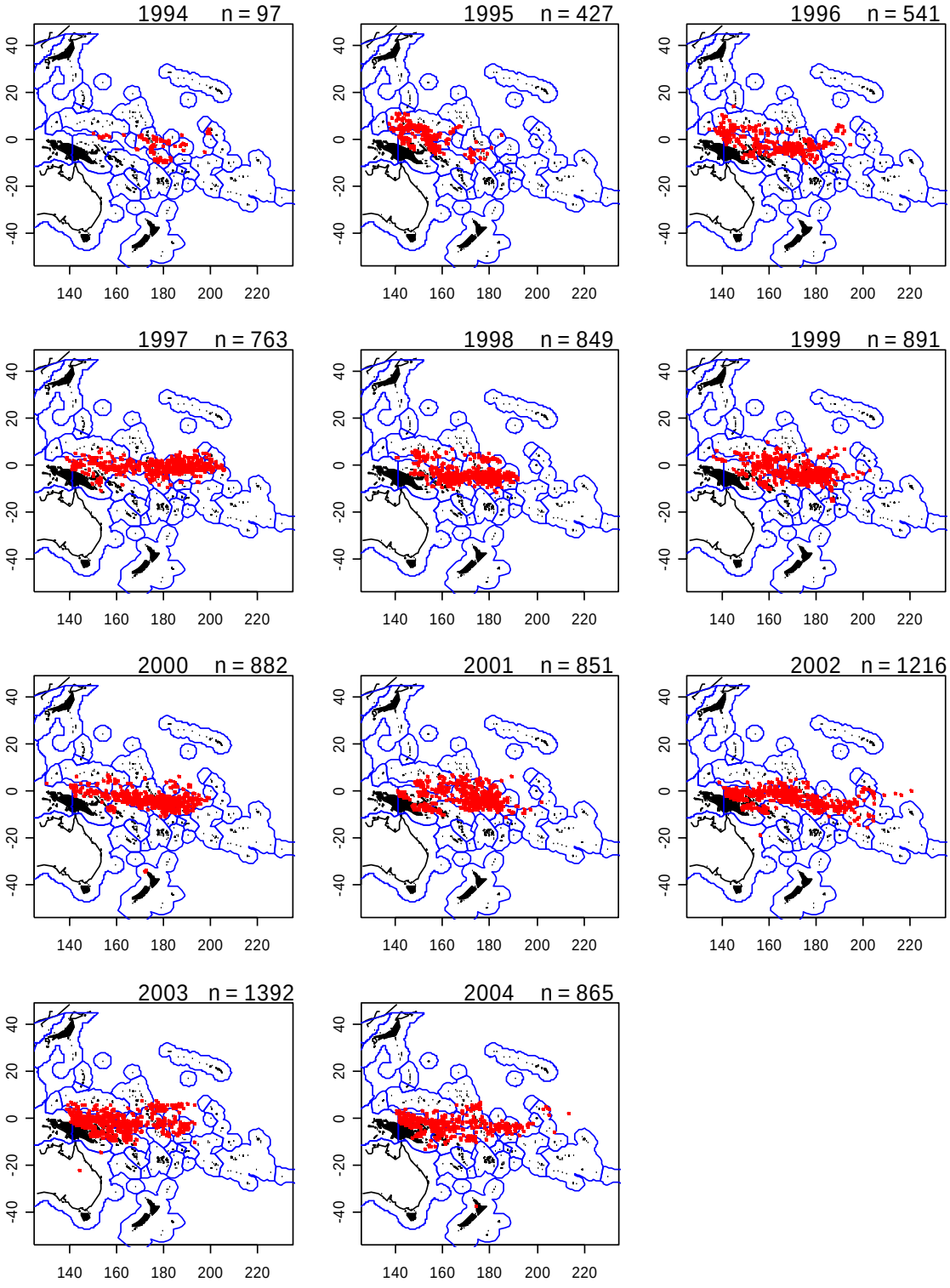

Figure 6b. Position of observed purse-seine sets in which one or more sharks were captured in the WCPO, 1994–2004. Source: observer purse-seine data held by SPC. n= number of sets in which one or more sharks were captured.

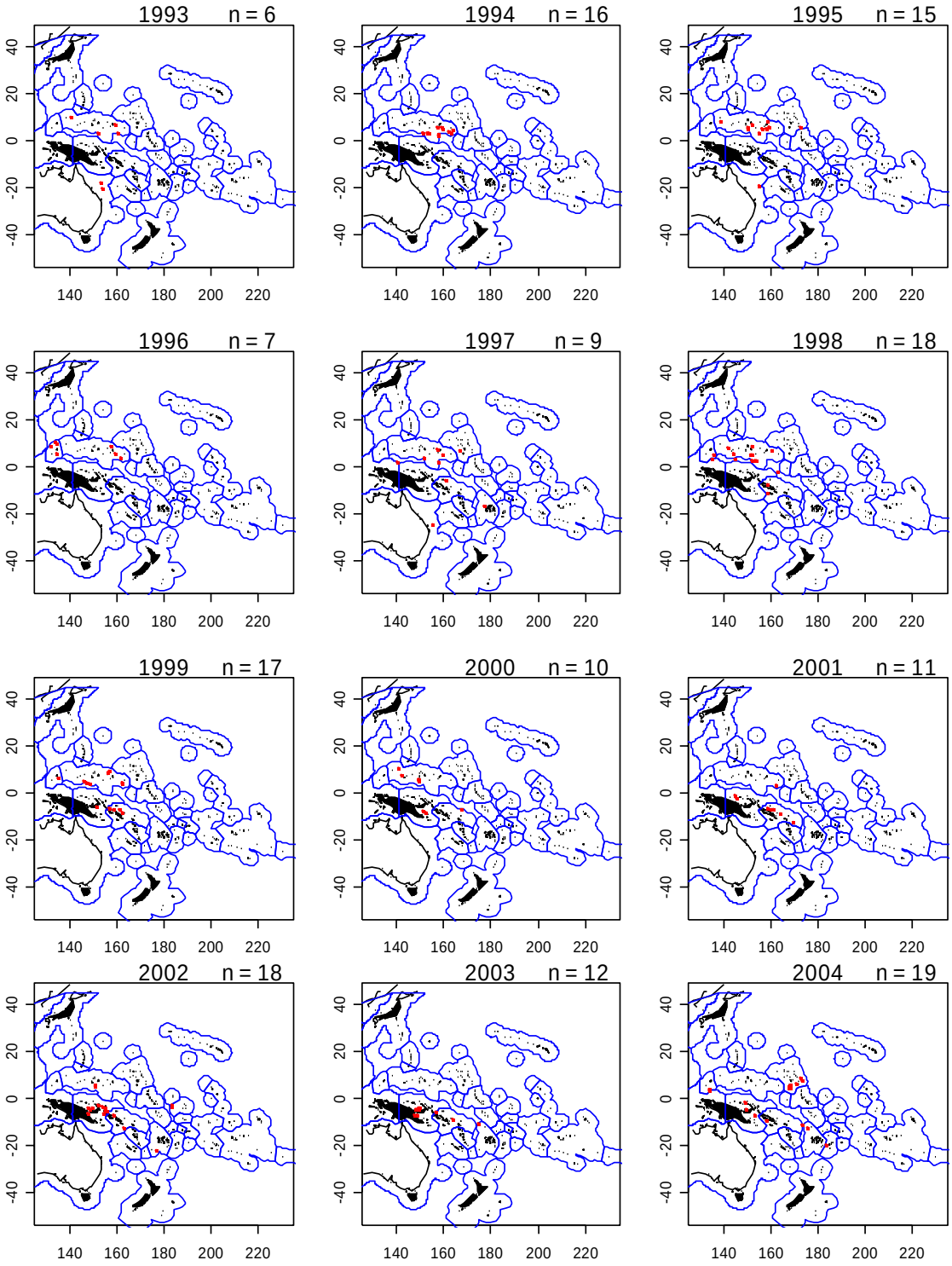

Figure 7a. Position of observed longline sets in which one or more turtles were captured in the WCPO, 1989–2004, excluding sets south of 31°S and observed sets on US vessels within and north-east of the Hawaiian EEZ. Source: observer longline data held by SPC. Missing years indicate that no turtles were observed captured from longline sets in that year.

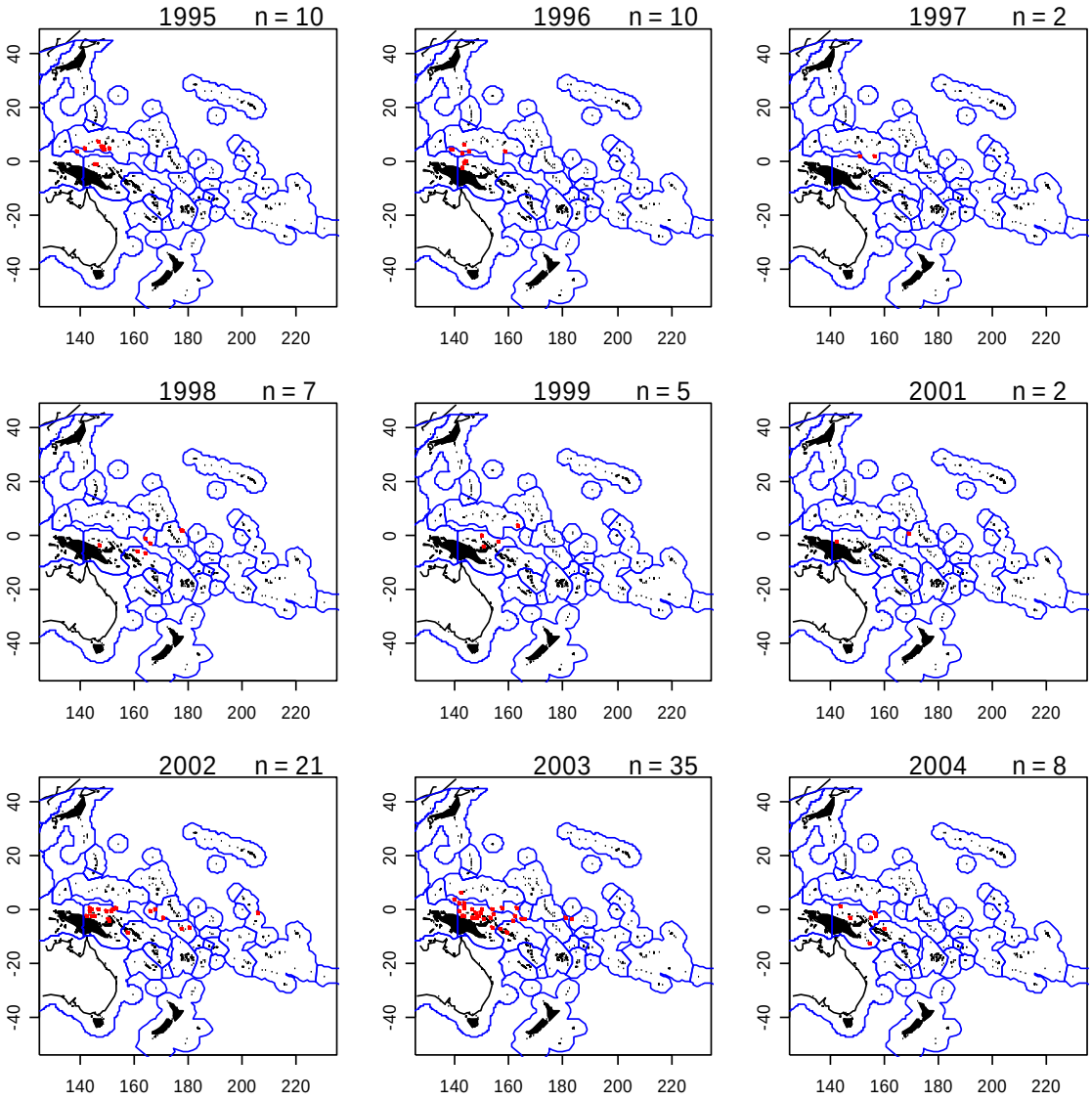

Figure 7b. Position of observed purse-seine sets in which one or more turtles were captured by all fleets in the WCPO, 1994–2004. Source: observer purse-seine data held by SPC. Missing years indicate that no turtles were observed captured from purse-seine sets in that year.

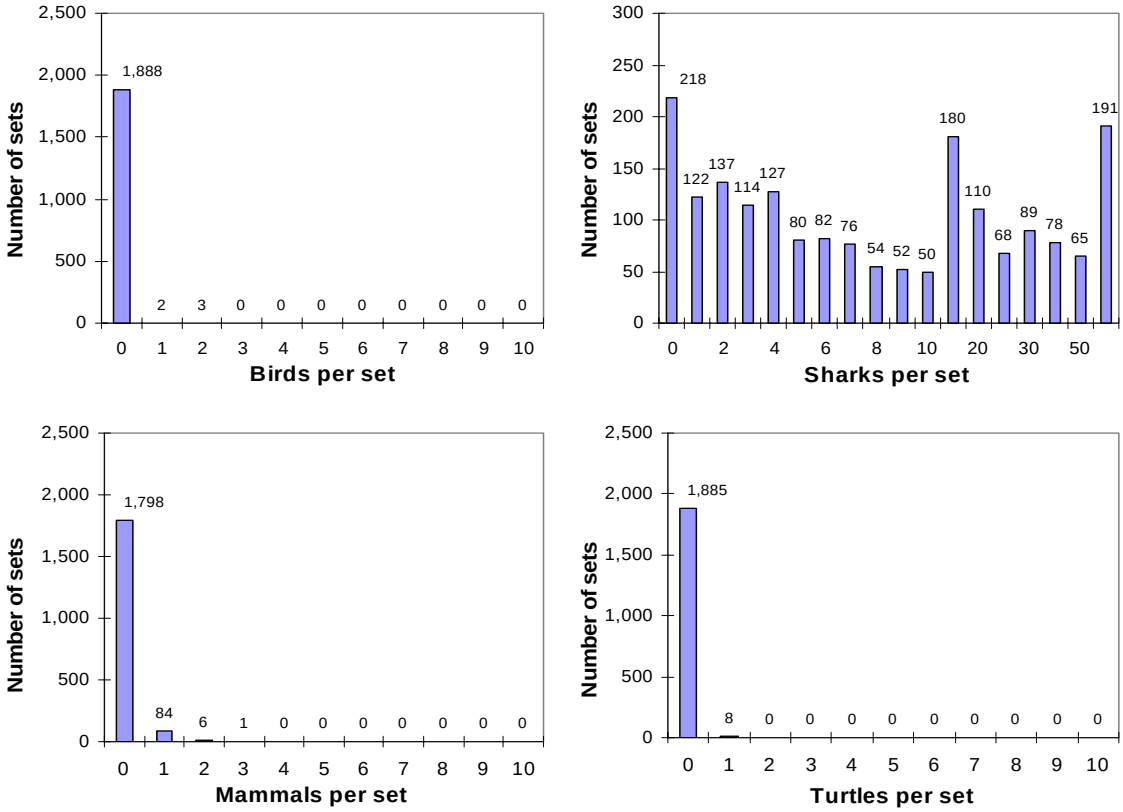

Figure 8a. Frequency of occurrence of major taxa in sets of the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Total numbers of sets for each frequency category are provided above each bar.

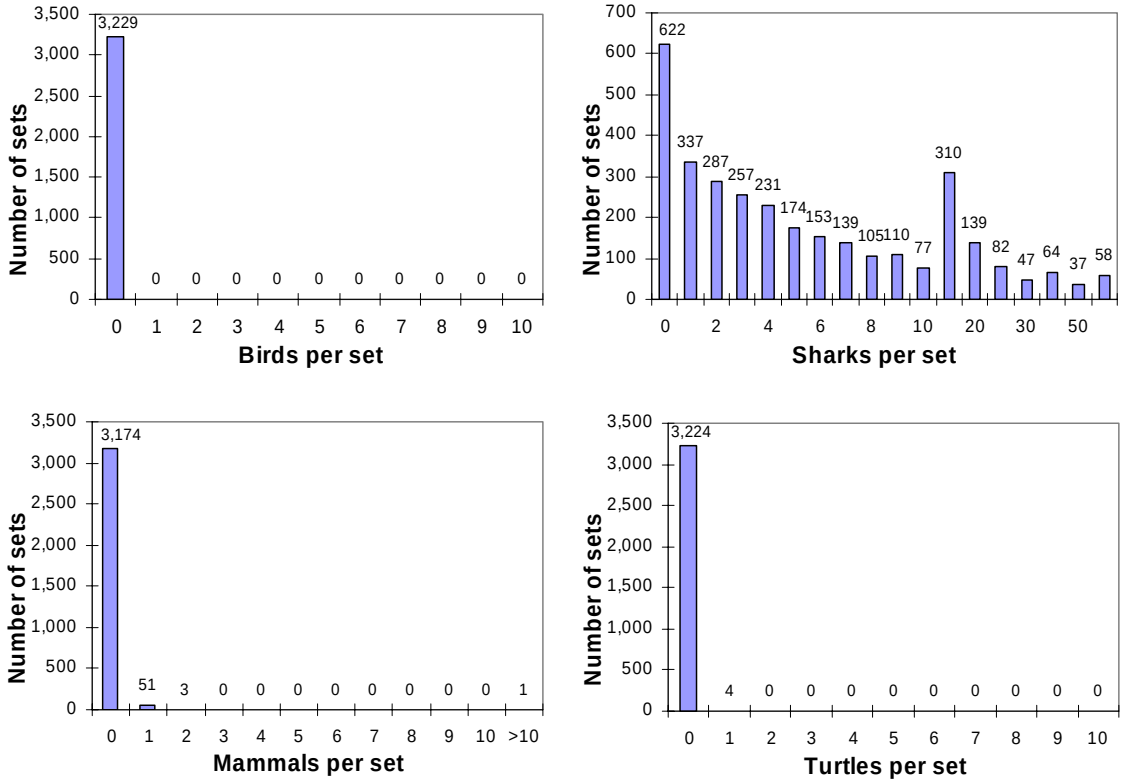

Figure 8b. Frequency of occurrence of major taxa in sets of the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Total numbers of sets for each frequency category are provided above each bar.

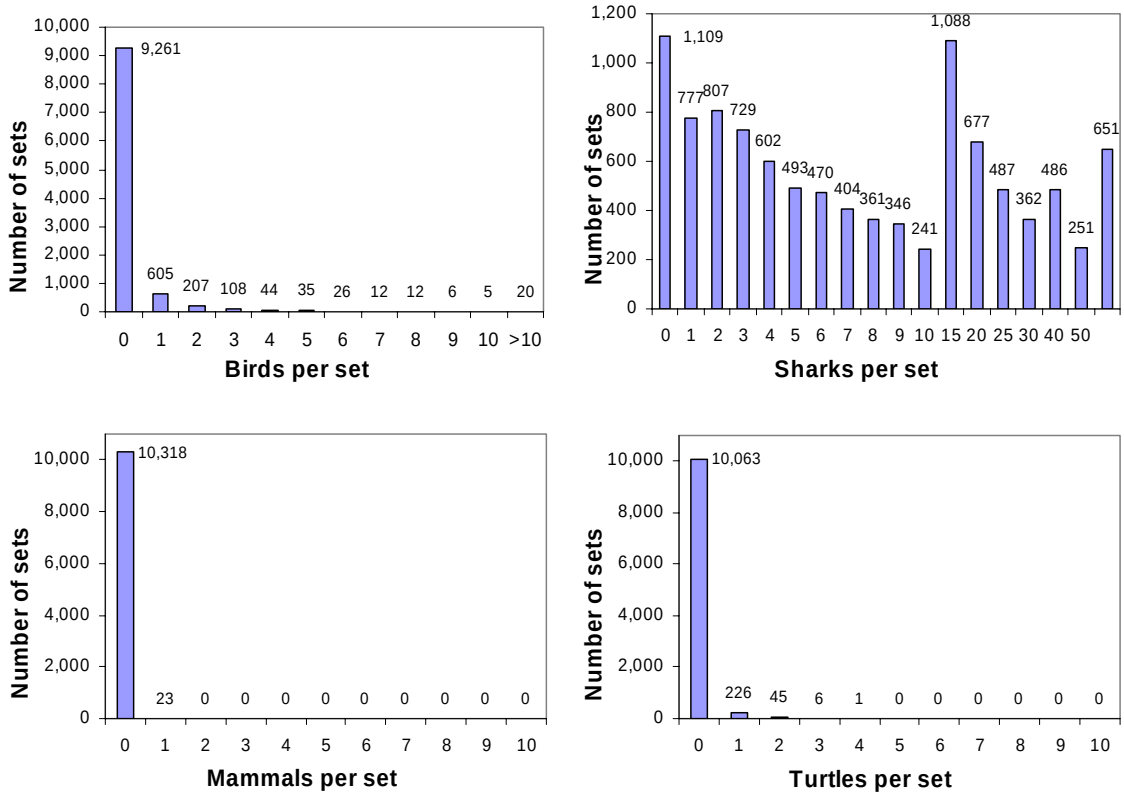

Figure 8c. Frequency of occurrence of major taxa in sets of the temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC. Total numbers of sets for each frequency category are provided above each bar.

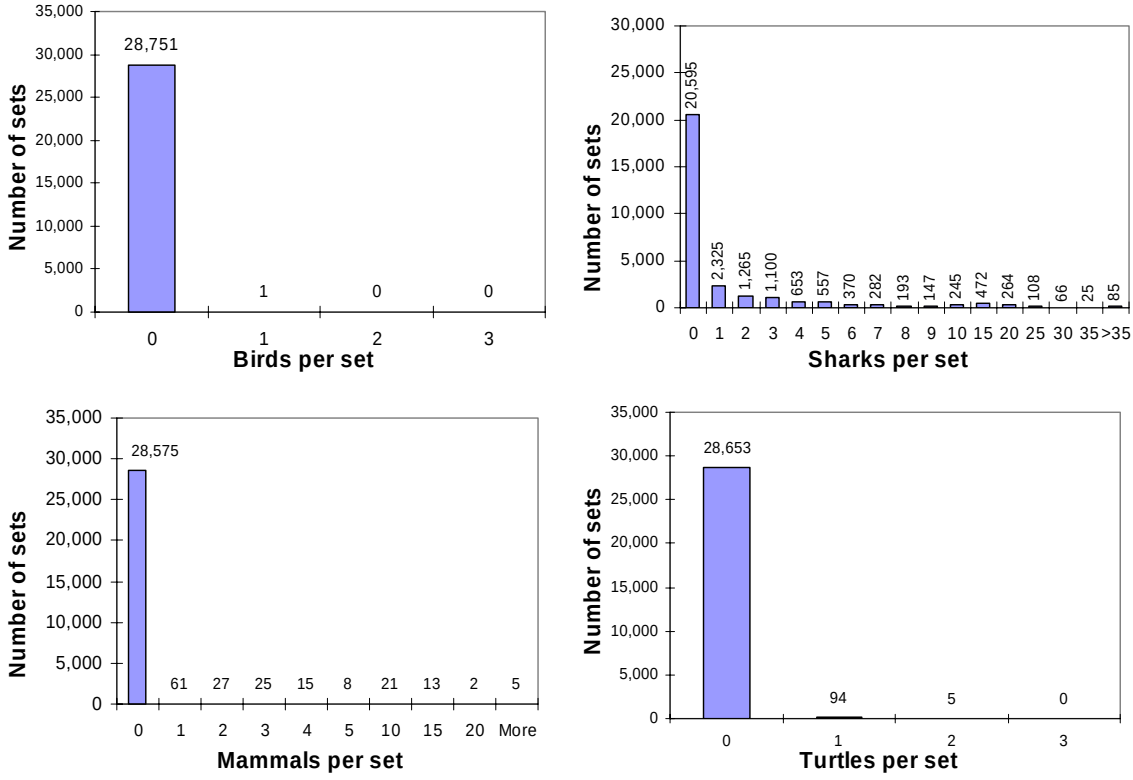

Figure 8d. Frequency of occurrence of major taxa in sets by the purse-seine fishery of the tropical western Pacific, 1994–2004. Source: observer database maintained by SPC. Total numbers of sets for each frequency category are provided above each bar.

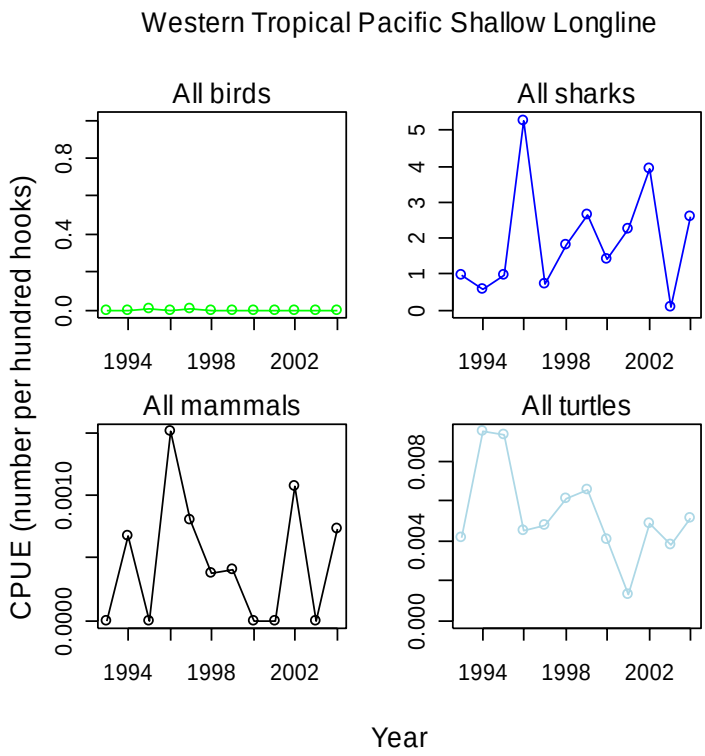

Figure 9a. Estimated catch per unit effort (number per hundred hooks) of each major taxa by the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC.

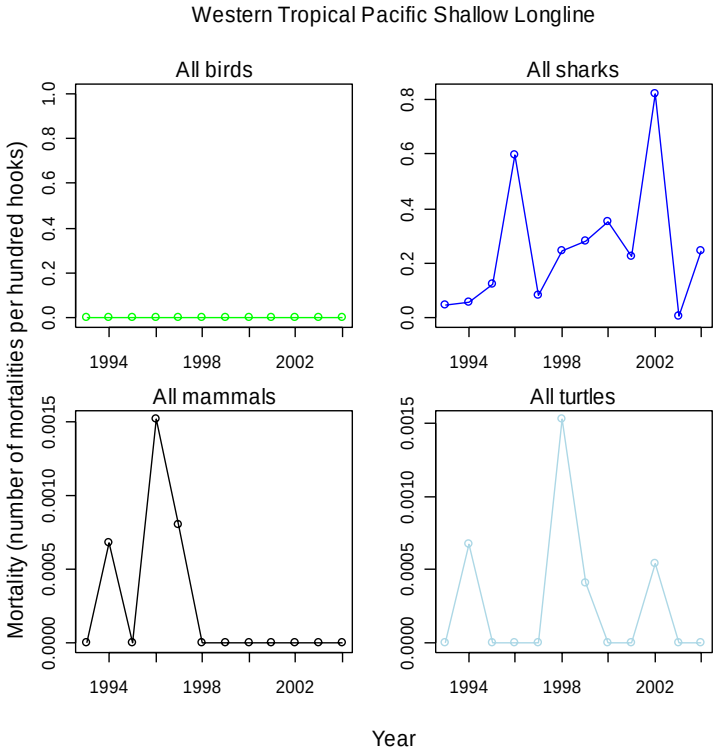

Figure 9b. Estimated mortality rates (number of observed mortalities per hundred hooks) of each major taxa in the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks.

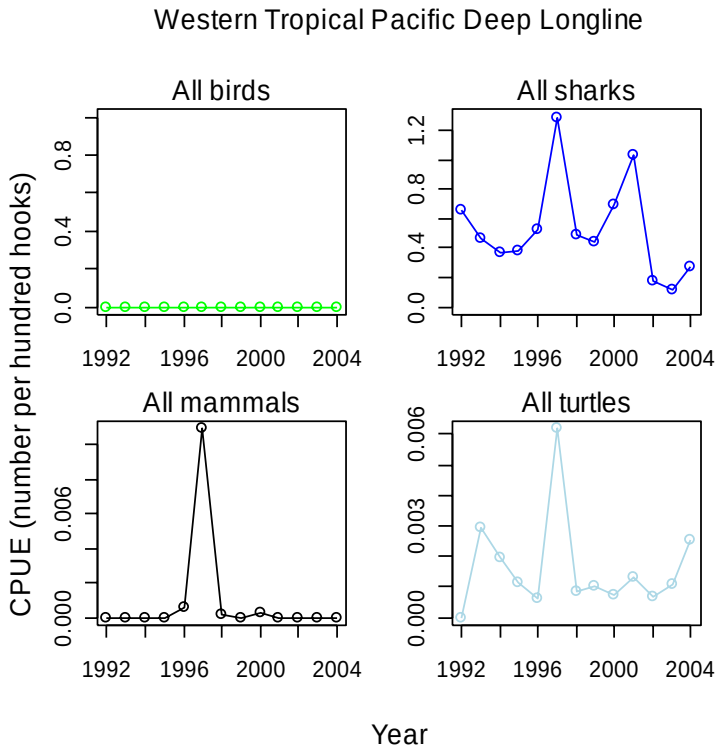

Figure 10a. Estimated catch per unit effort (number per hundred hooks) of each major taxa by the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC.

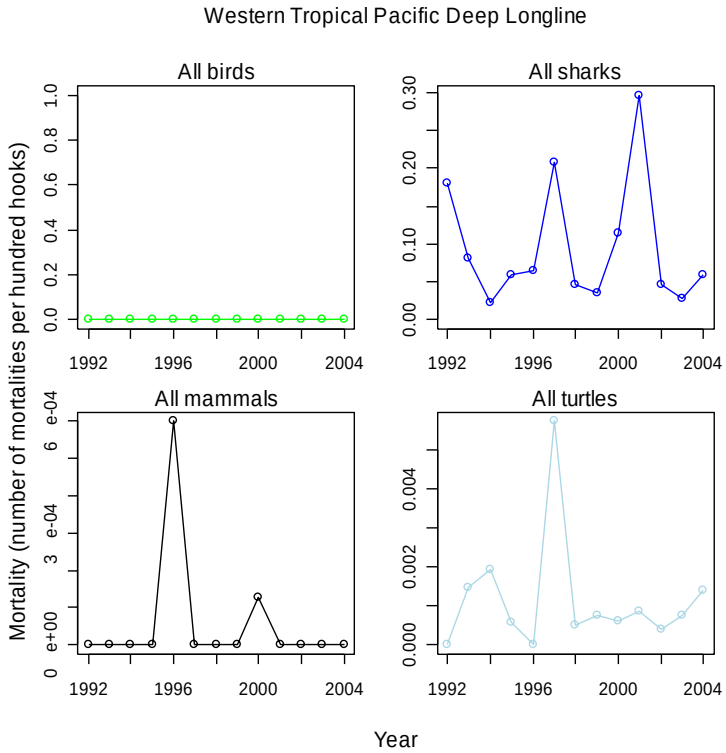

Figure 10b. Estimated mortality rates (number of observed mortalities per hundred hooks) of each major taxa by the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks.

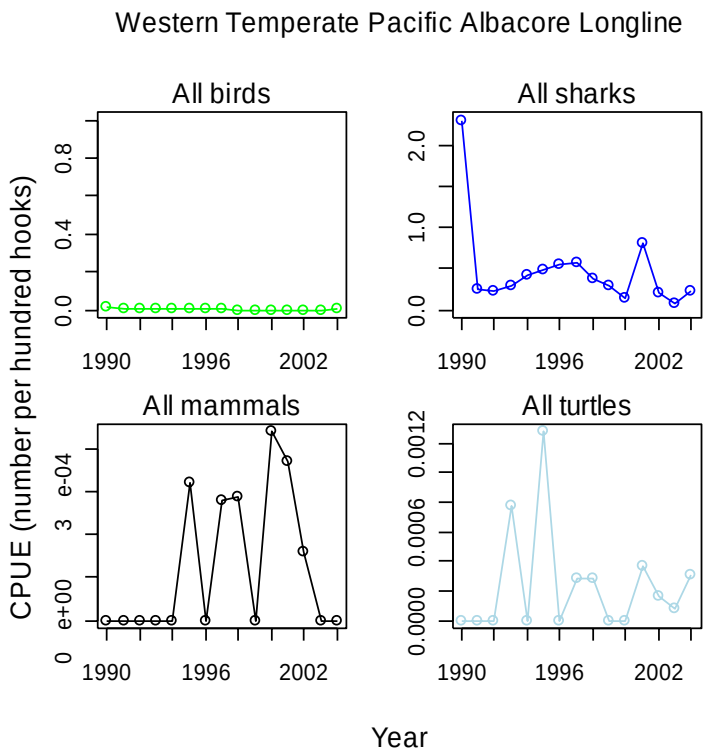

Figure 11a. Estimated catch per unit effort (number per hundred hooks) of each major taxa by the temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC.

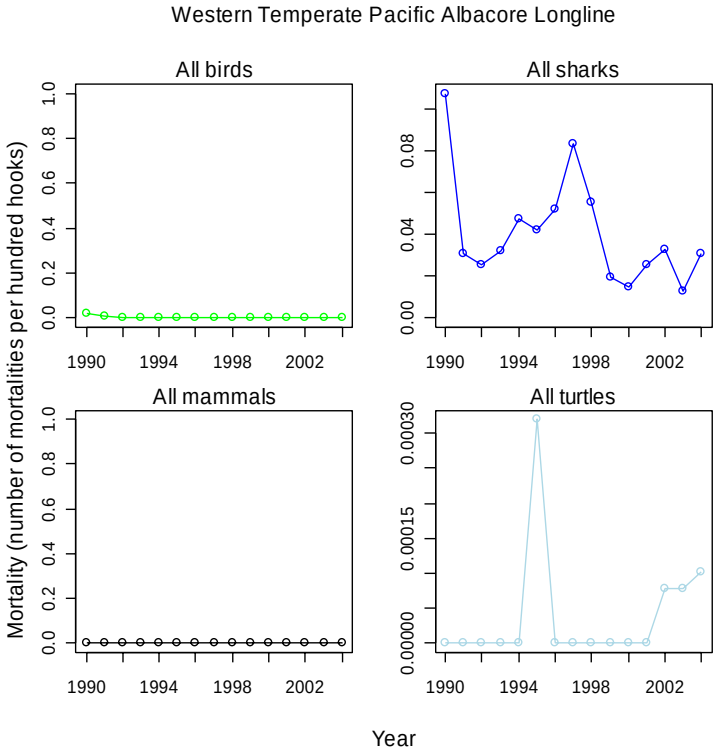

Figure 11b. Estimated mortality rates (number of observed mortalities per hundred hooks) of each major taxa in the temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC. Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks.

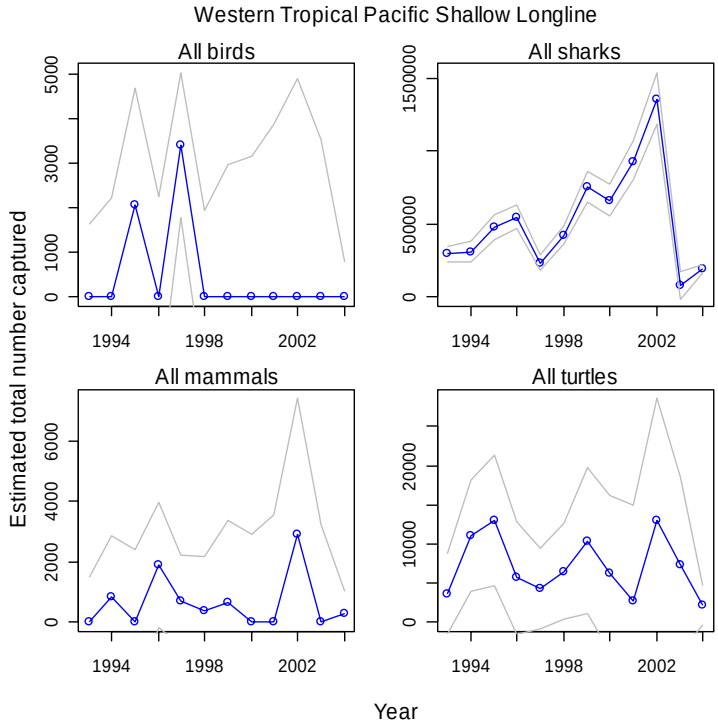

Figure 12a. Estimated total catches (numbers, blue lines) of each major taxa by the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Grey lines represent ± two times the global standard deviations for each taxa.

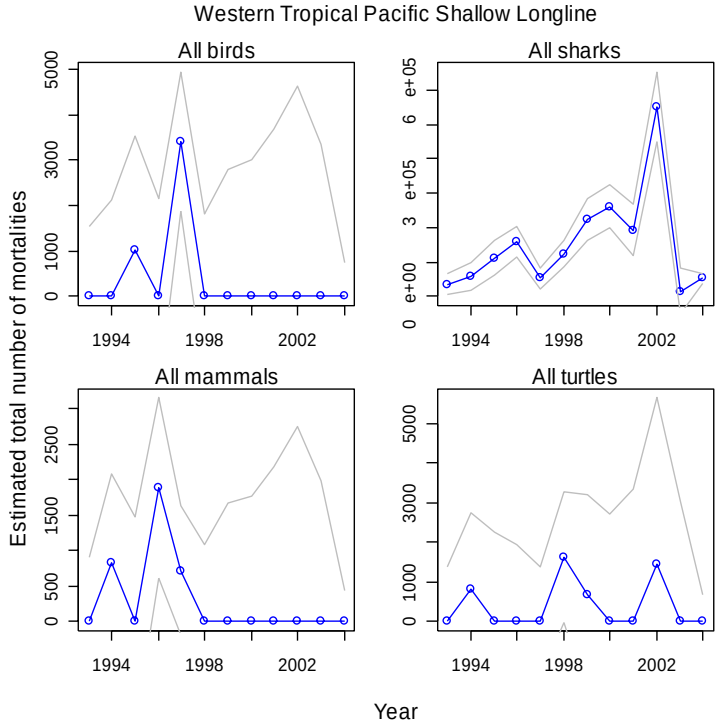

Figure 12b. Total estimated mortalities (numbers, blue lines) of each major taxa by the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks. Grey lines represent ± two times the global standard deviations for each taxa.

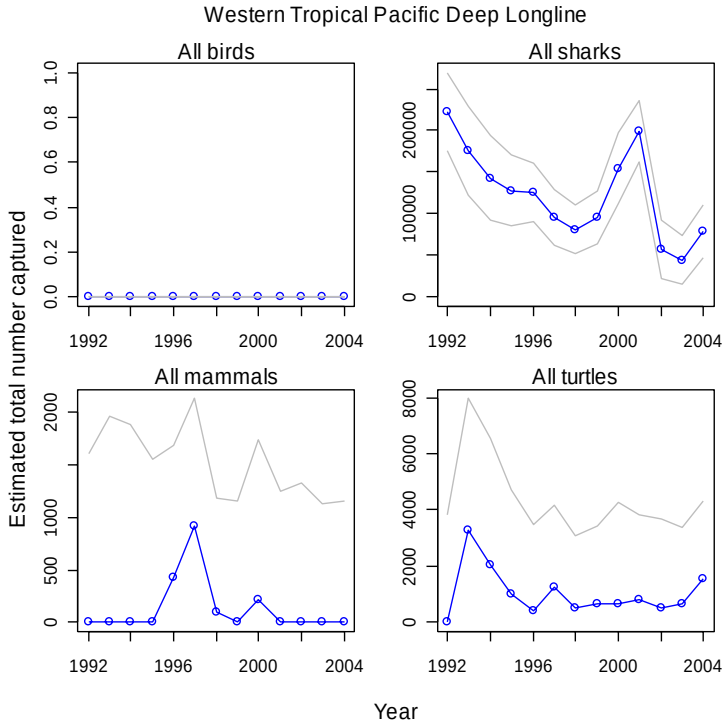

Figure 13a. Estimated total catches (numbers, blue lines) of each major taxa by the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Grey lines represent ± two times the global standard deviations for each taxa.

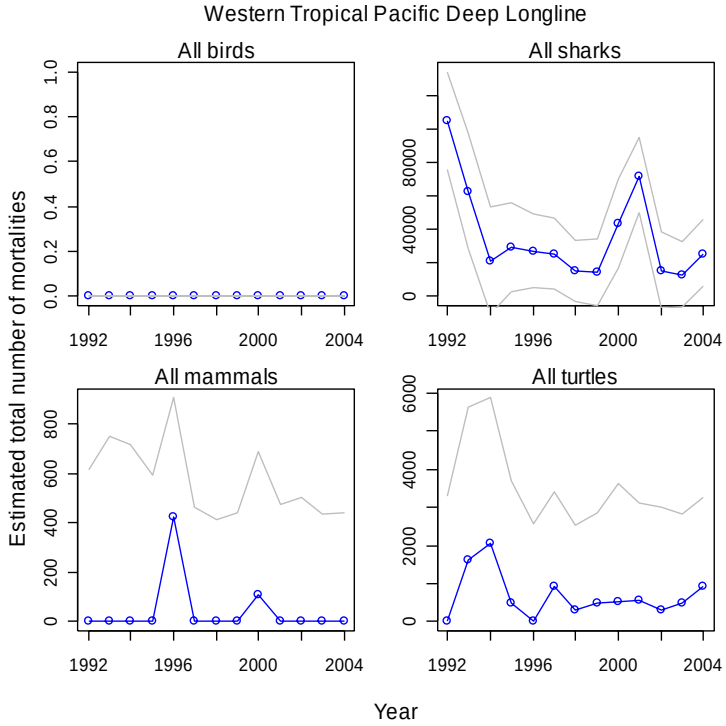

Figure 13b. Total estimated mortalities (numbers, blue lines) of each major taxa by the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks. Grey lines represent ± two times the global standard deviations for each taxa.

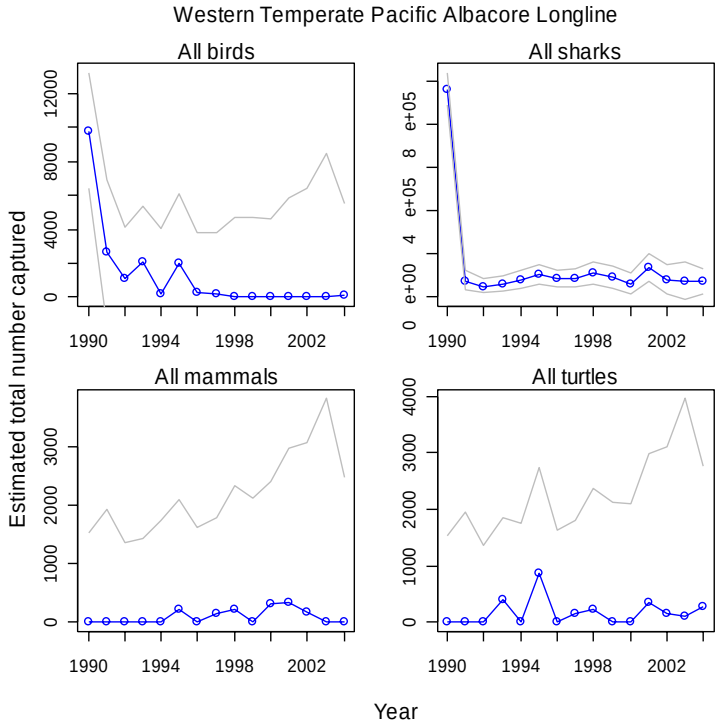

Figure 14a. Estimated total catches (numbers, blue lines) of each major taxa by the temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC. Grey lines represent ± two times the global standard deviations for each taxa.

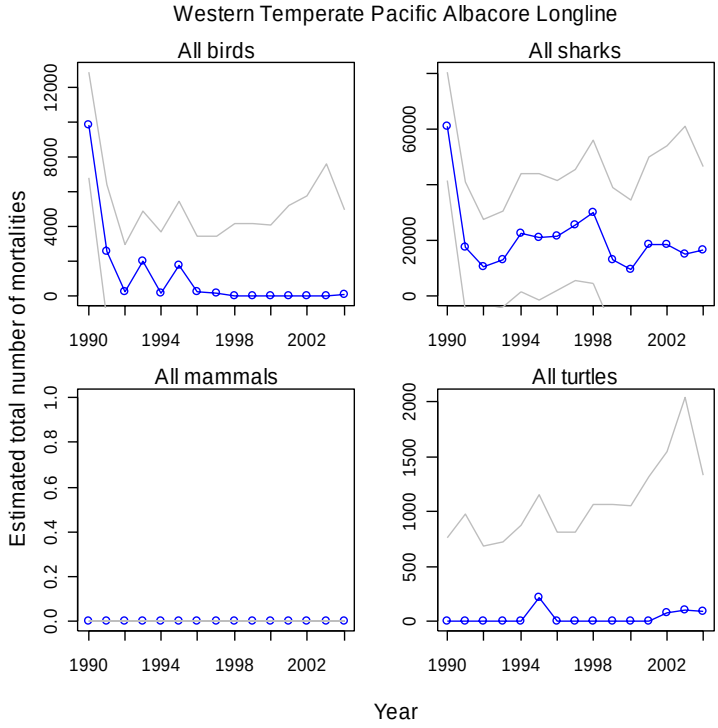

Figure 14b. Total estimated mortalities (numbers, blue lines) of each major taxa by temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC. Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks. Grey lines represent ± two times the global standard deviations for each taxa.

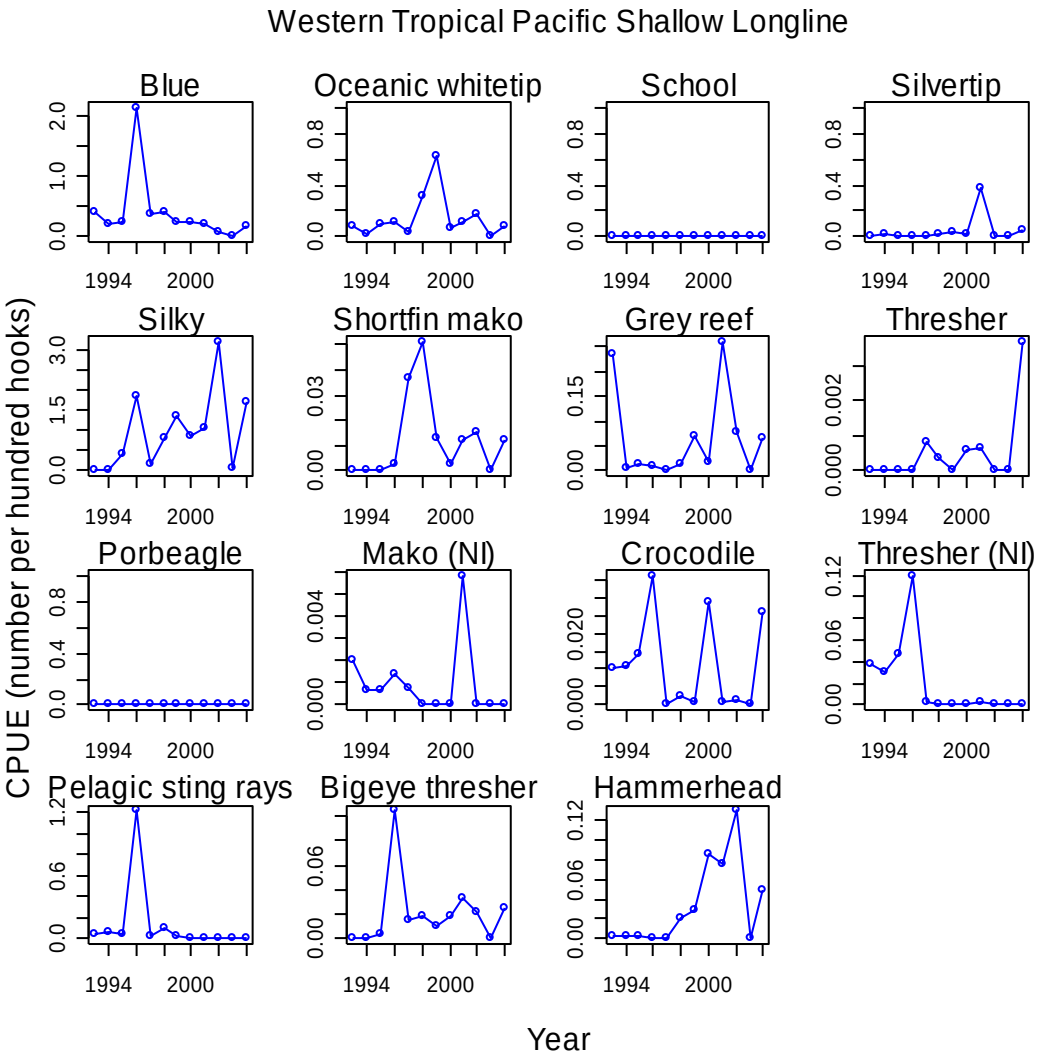

Figure 15. Estimated catch per unit effort (number per hundred hooks) of common shark taxa by the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. (NI), indicates an taxa not identified to species level.

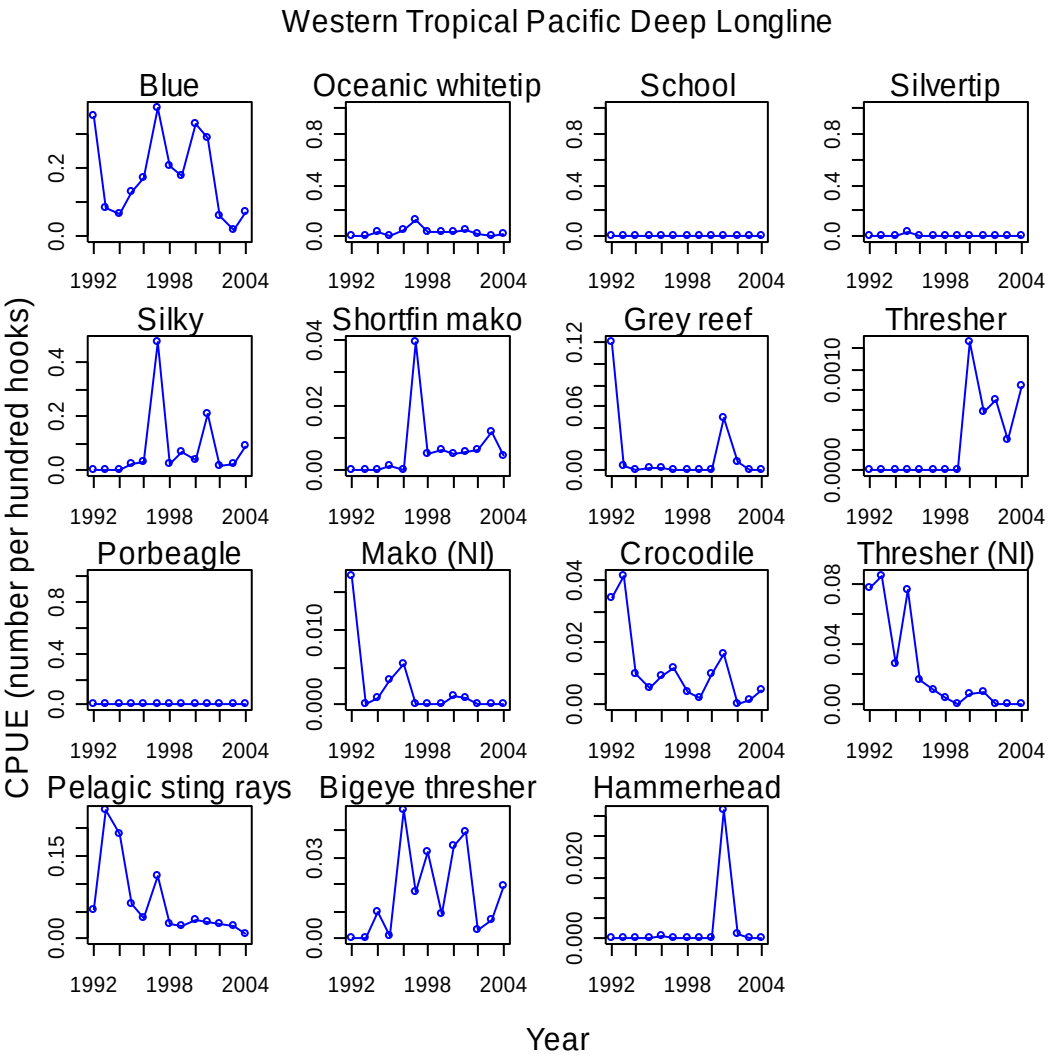

Figure 16. Estimated catch per unit effort (number per hundred hooks) of common shark taxa by the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. (NI), indicates an taxa not identified to species level.

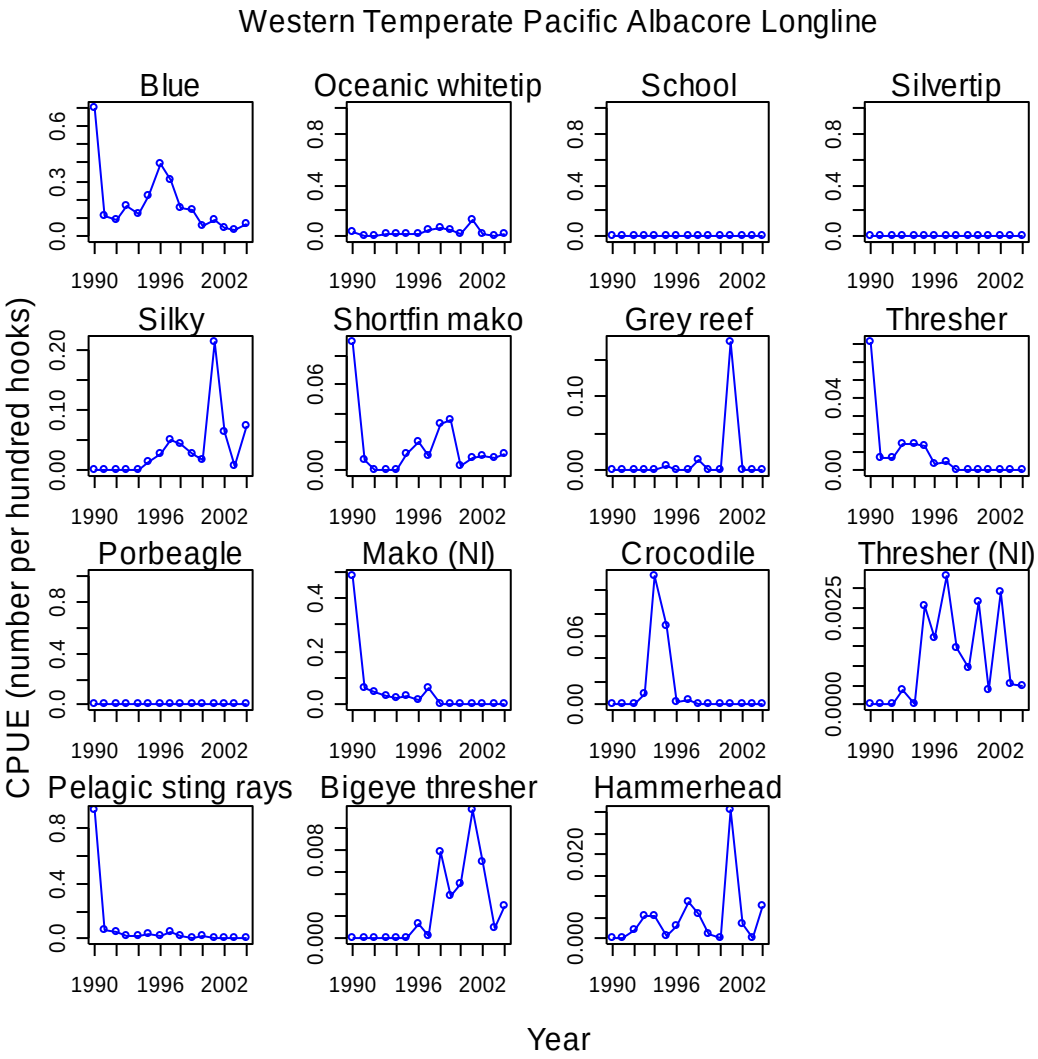

Figure 17. Estimated catch per unit effort (number per hundred hooks) of common shark taxa by the temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC. (NI), indicates an taxa not identified to species level.

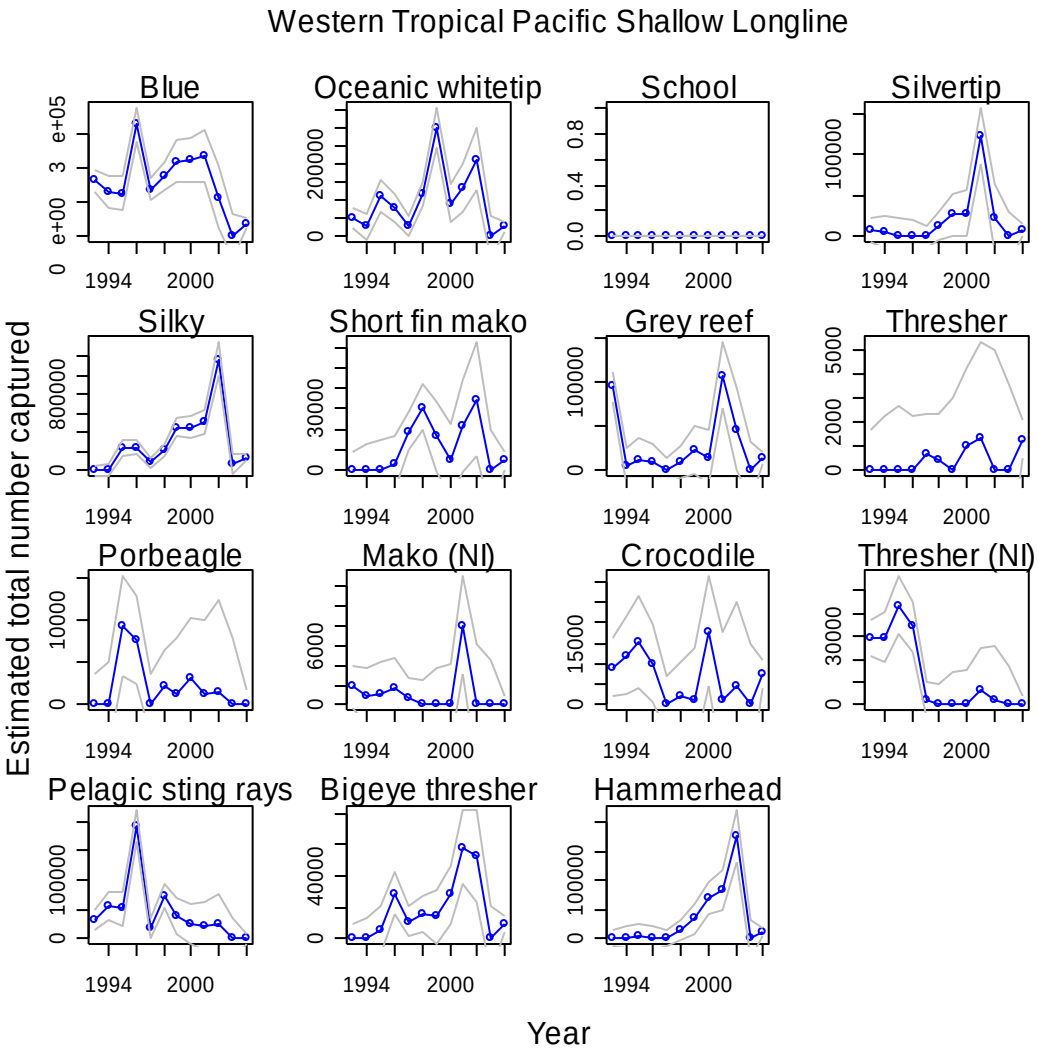

Figure 18. Estimated total catches (numbers, blue lines) of common shark taxa by the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Grey lines represent ± two times the global standard deviations for each taxa. (NI), indicates an taxa not identified to species level.

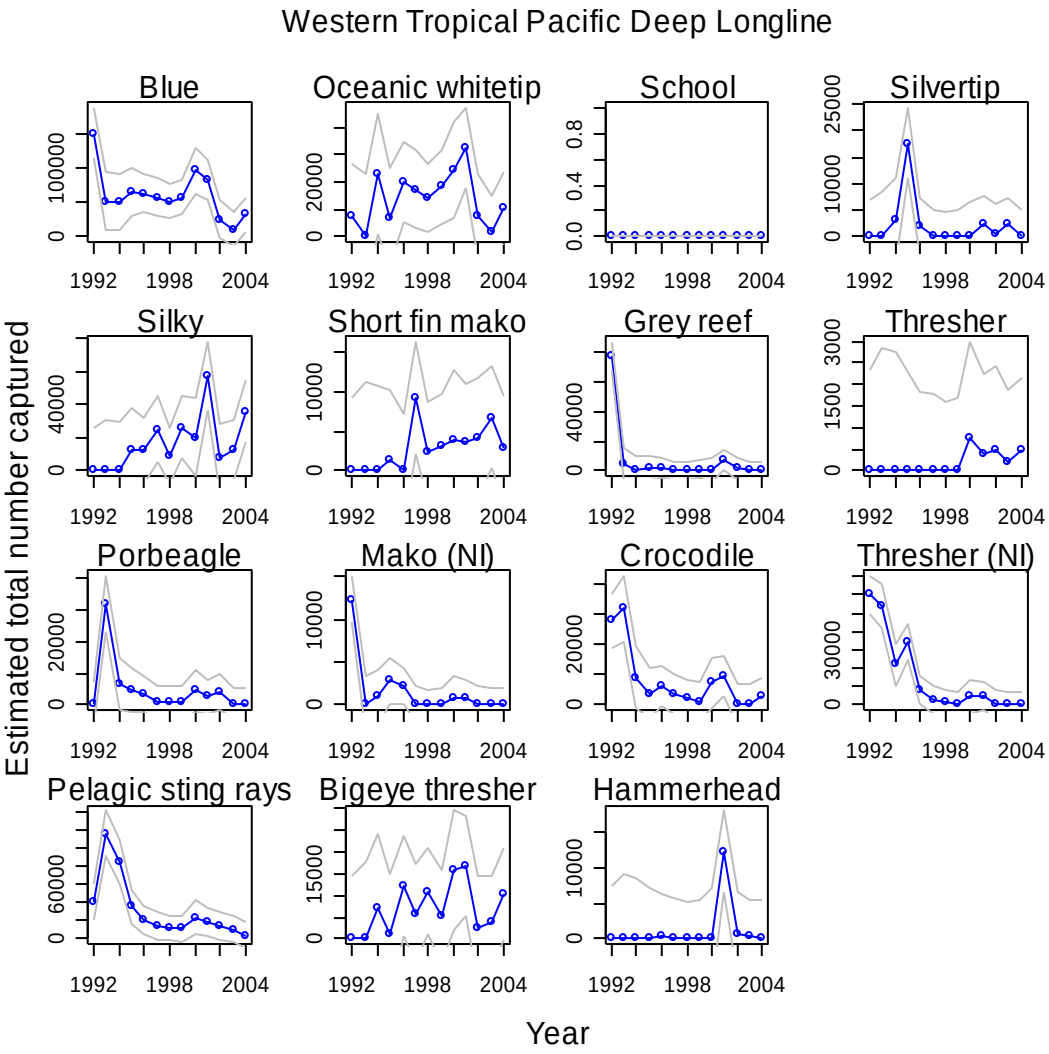

Figure 19. Estimated total catches (numbers, blue lines) of common shark taxa by the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Grey lines represent ± two times the global standard deviations for each taxa. (NI), indicates an taxa not identified to species level.

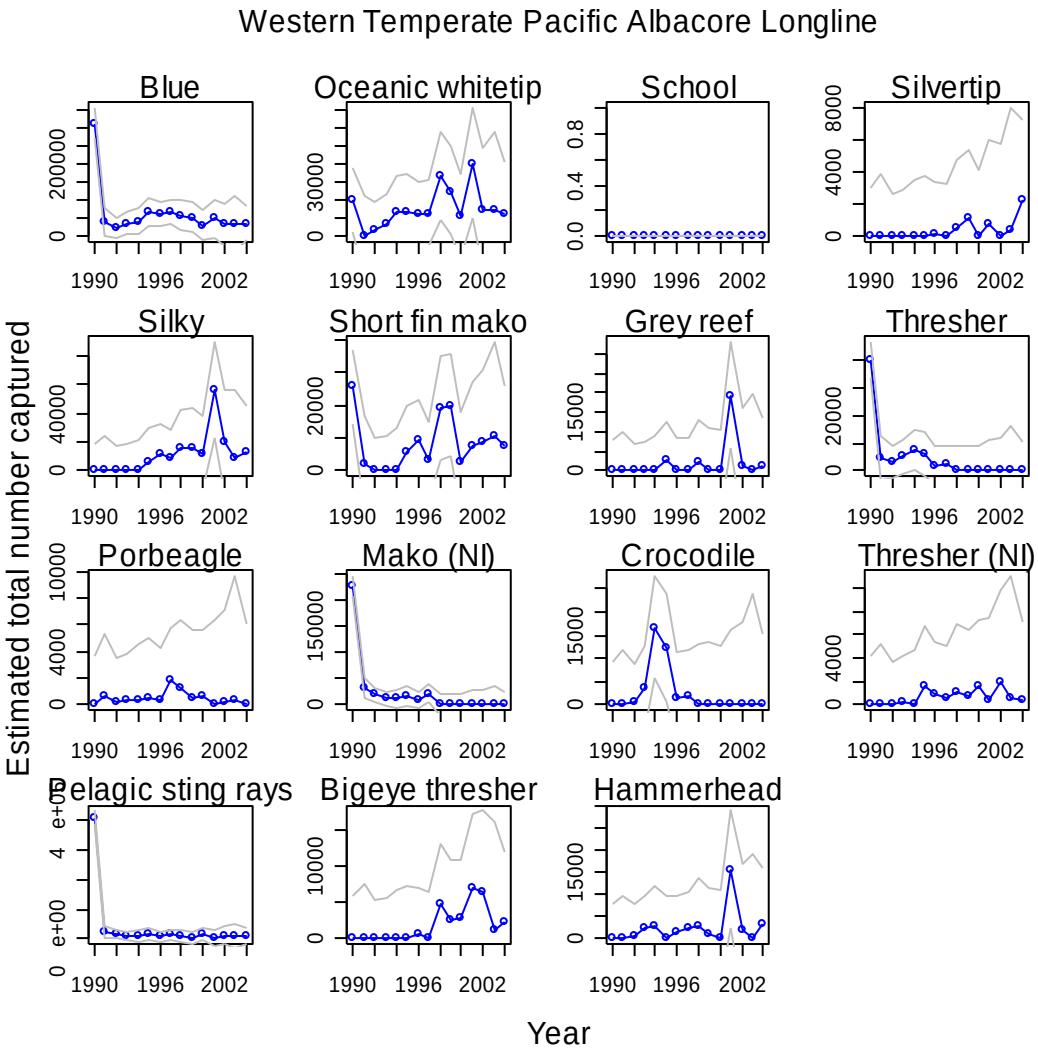

Figure 20. Estimated total catches (numbers, blue lines) of common shark taxa by the temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC. Grey lines represent ± two times the global standard deviations for each taxa. (NI), indicates an taxa not identified to species level.

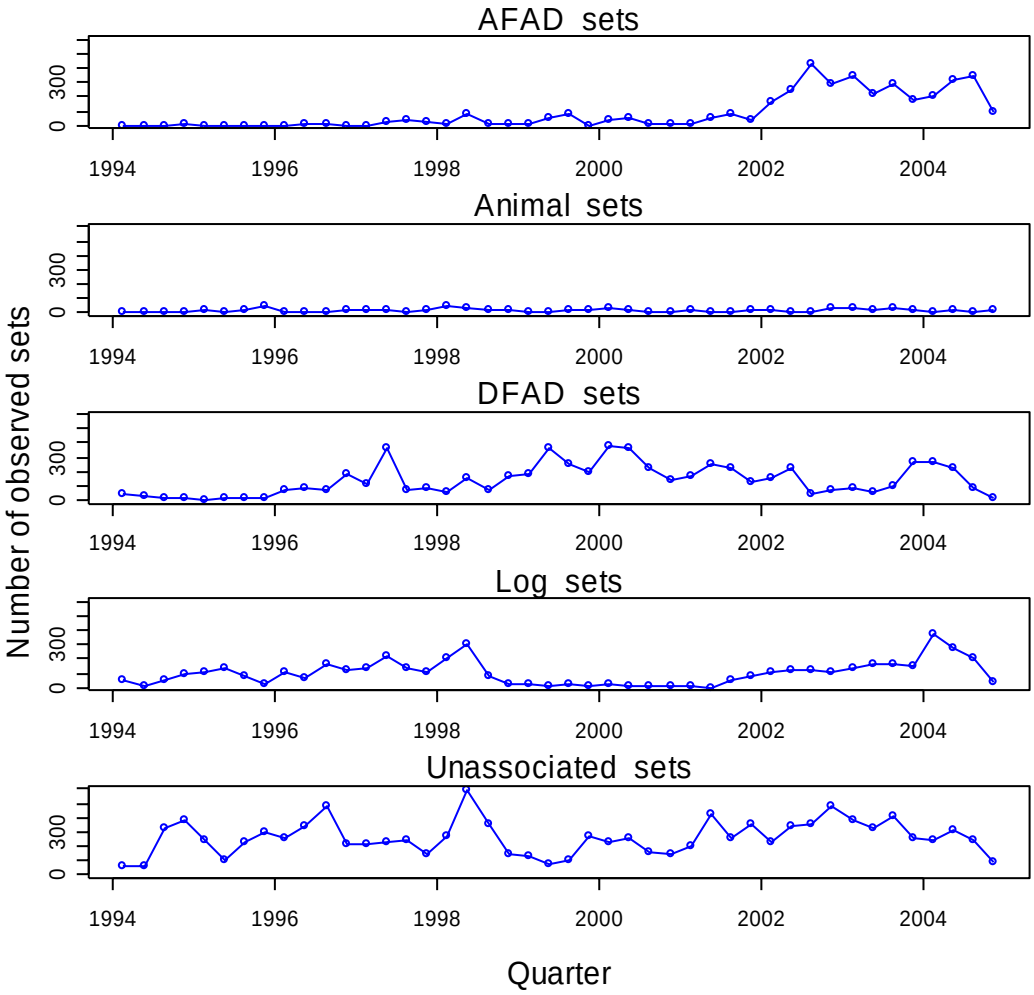

Figure 21. Quarterly number of observed purse-seine sets by set type in the WCPO, 1994–2004. Source: SPC observer database.

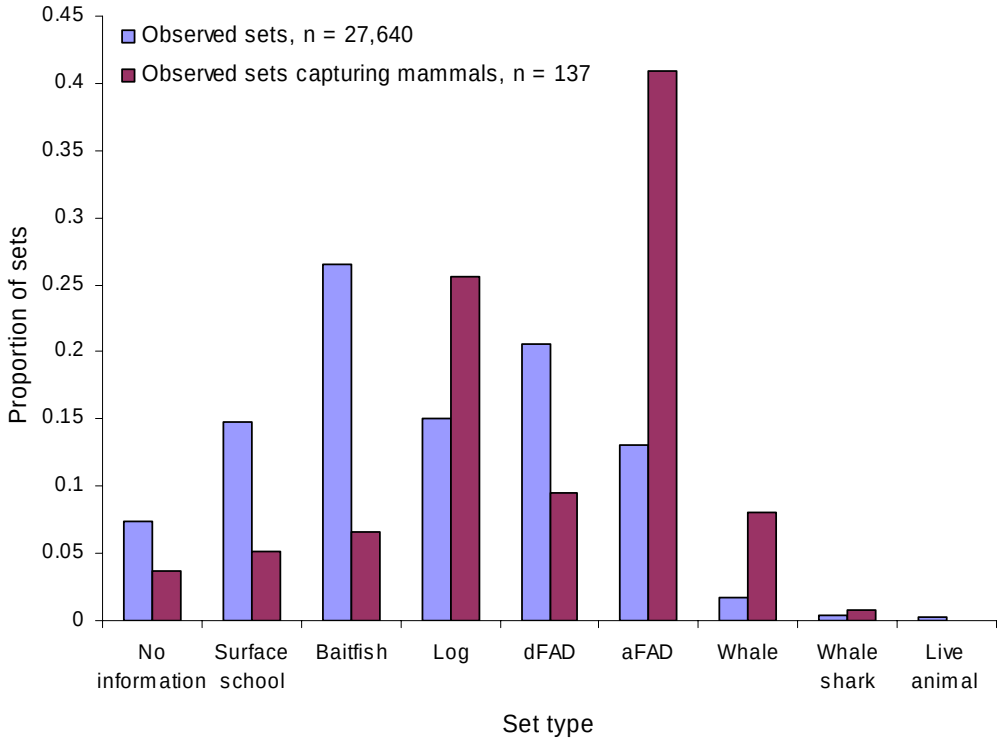

Figure 22. Distribution of the set types of observed purse-seine sets and observed purse-seine sets in which one or more mammals were incidentally captured by all fleets in the WCPO, 1995–2004. Upper figure, individual set types. Lower figure, pooled set types. Source, observer data held by SPC.

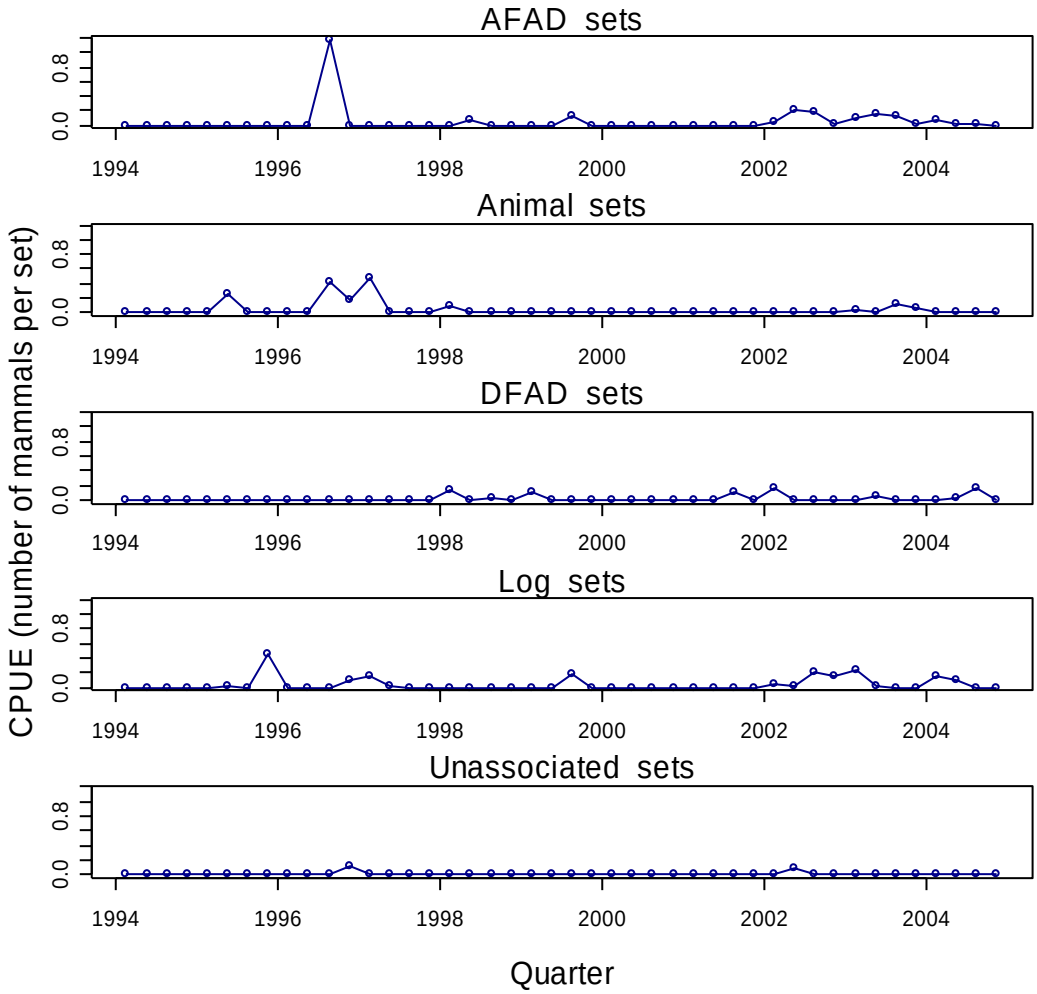

Figure 23. Quarterly catch per unit effort of mammals (number of mammals per set) in observed purse-seine sets by set type in the WCPO, 1994–2004. Source: SPC observer database.

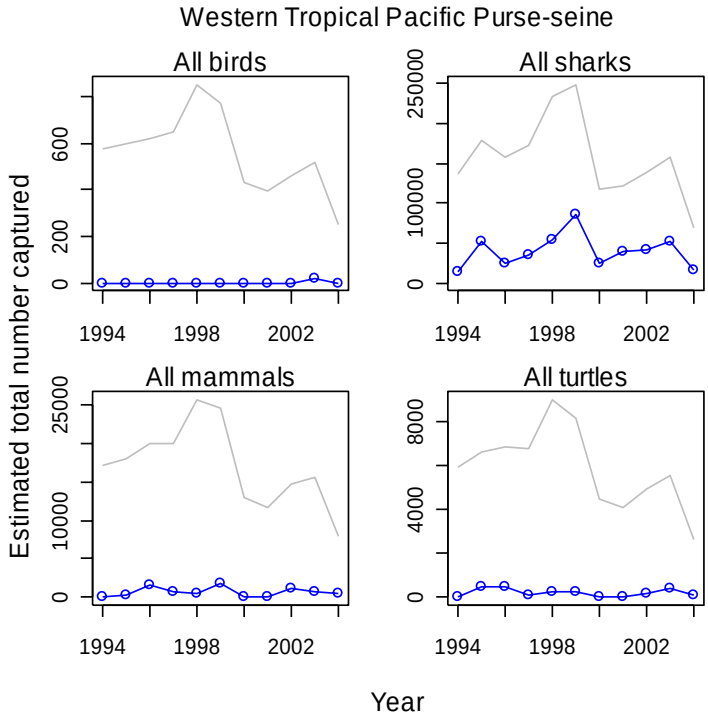

Figure 24a. Estimated total catches (numbers, blue lines) of each major taxa by the tropical Pacific purse-seine fishery, 1990–2004. Source: observer database maintained by SPC. Grey lines represent ± two times the global standard deviations for each taxa.

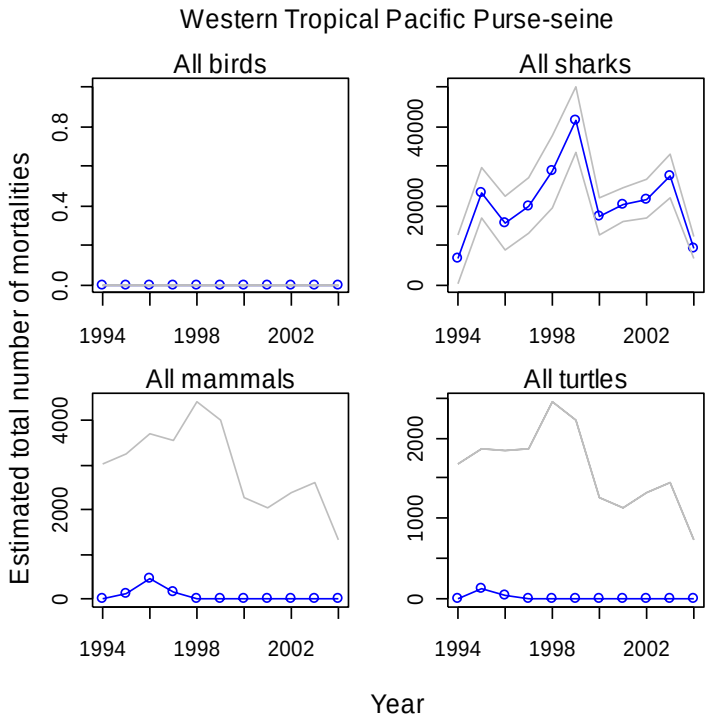

Figure 24b. Total estimated mortalities (numbers, blue lines) of each major taxa by the tropical Pacific purse-seine fishery, 1990–2004. Source: observer database maintained by SPC. Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks. Grey lines represent ± two times the global standard deviations for each taxa.

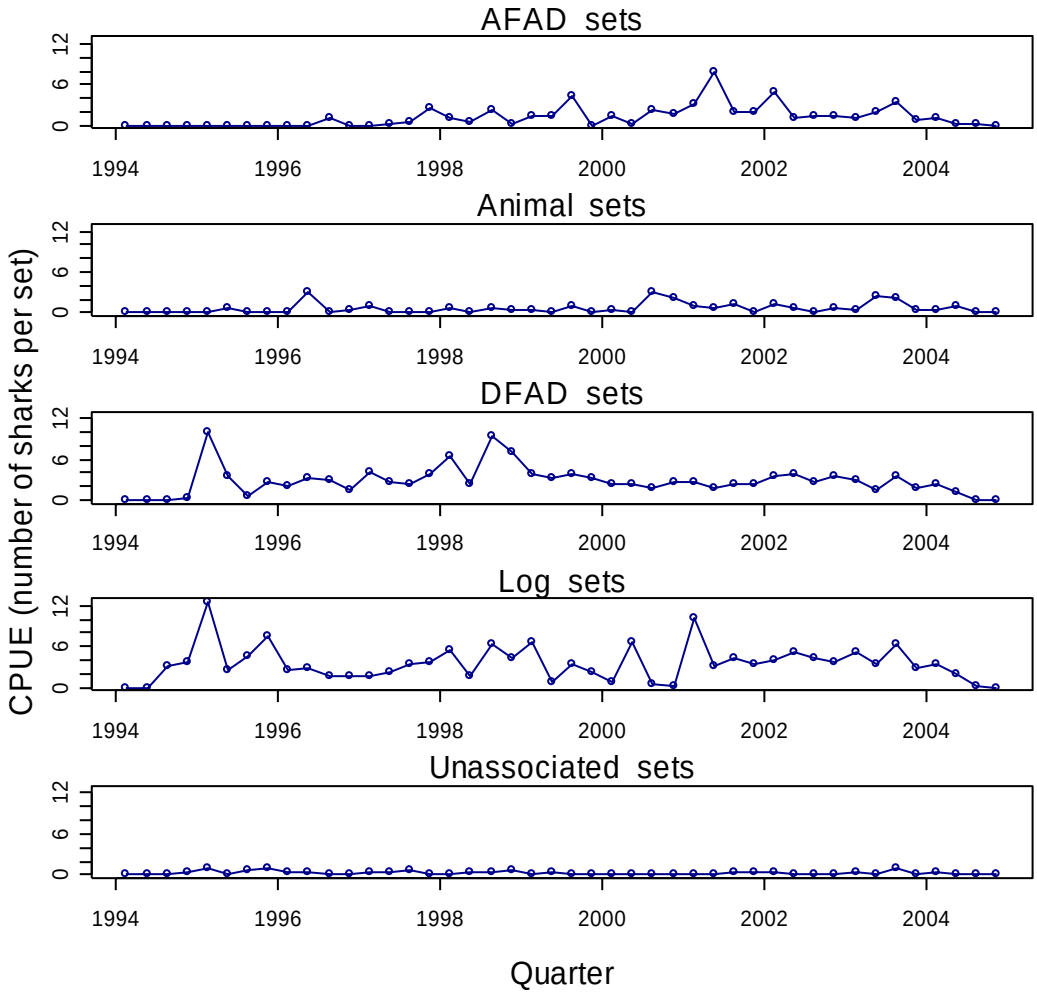

Figure 25. Quarterly catch per unit effort of sharks (number of sharks per set) in observed purse-seine sets by set type in the WCPO, 1994–2004. Source: SPC observer database.

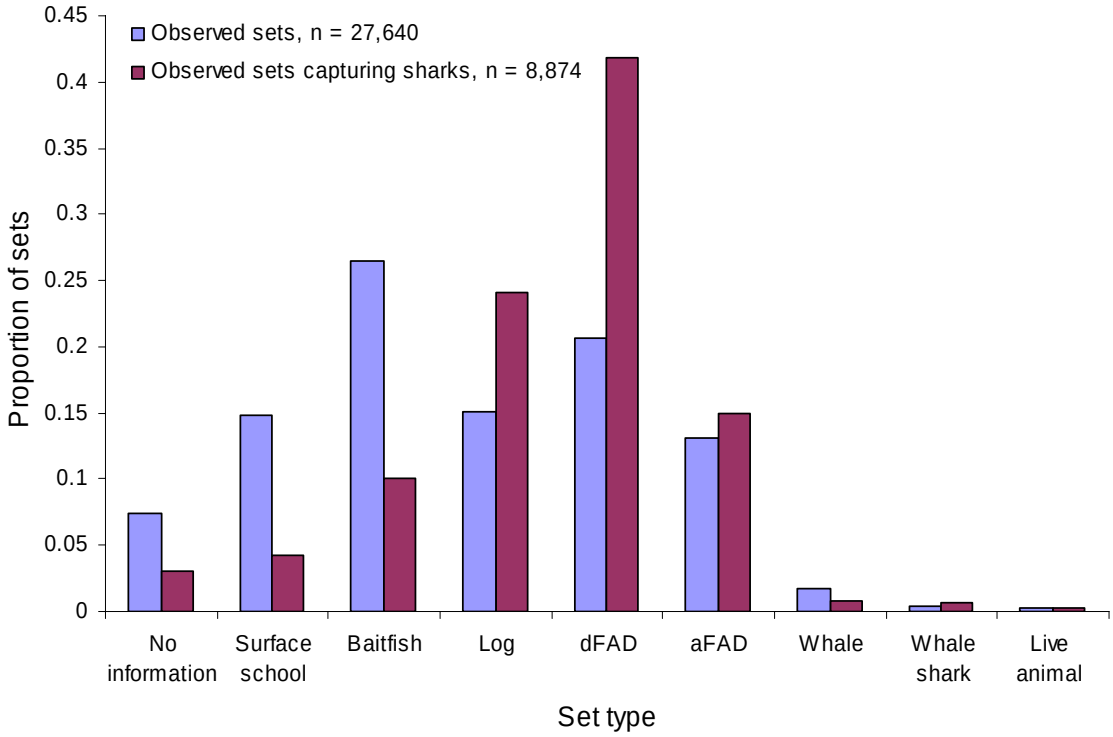

Figure 26. Distribution of the set types of observed purse-seine sets and observed purse-seine sets in which one or more sharks were captured by all fleets in the WCPO, 1994–2004. Upper figure, individual set types. Lower figure, pooled set types. Source, observer data held by SPC.

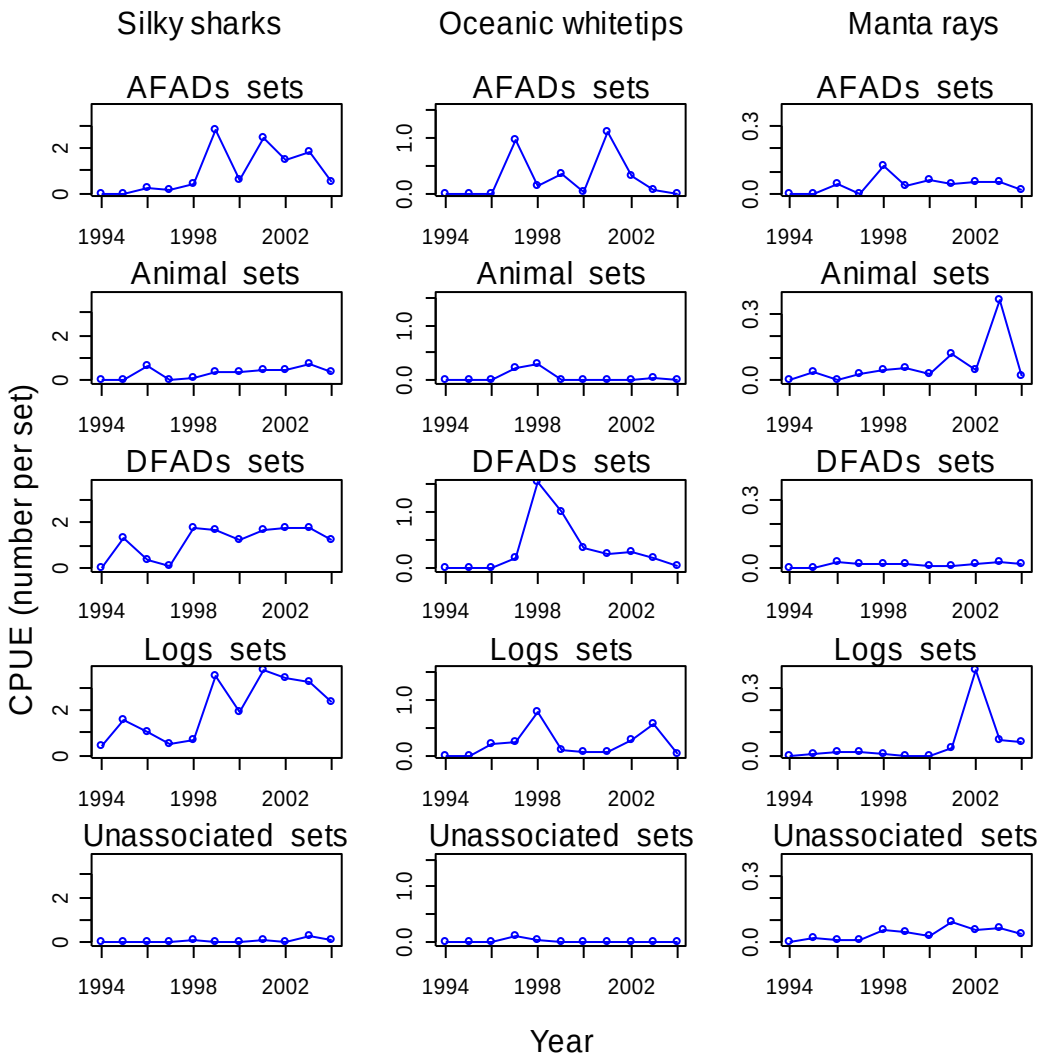

Figure 27. Estimated catch per unit effort (number per set) of major shark taxa by the western Pacific purse-seine fishery, 1994–2004. Source: observer database maintained by SPC. Manta rays are not identified to species.

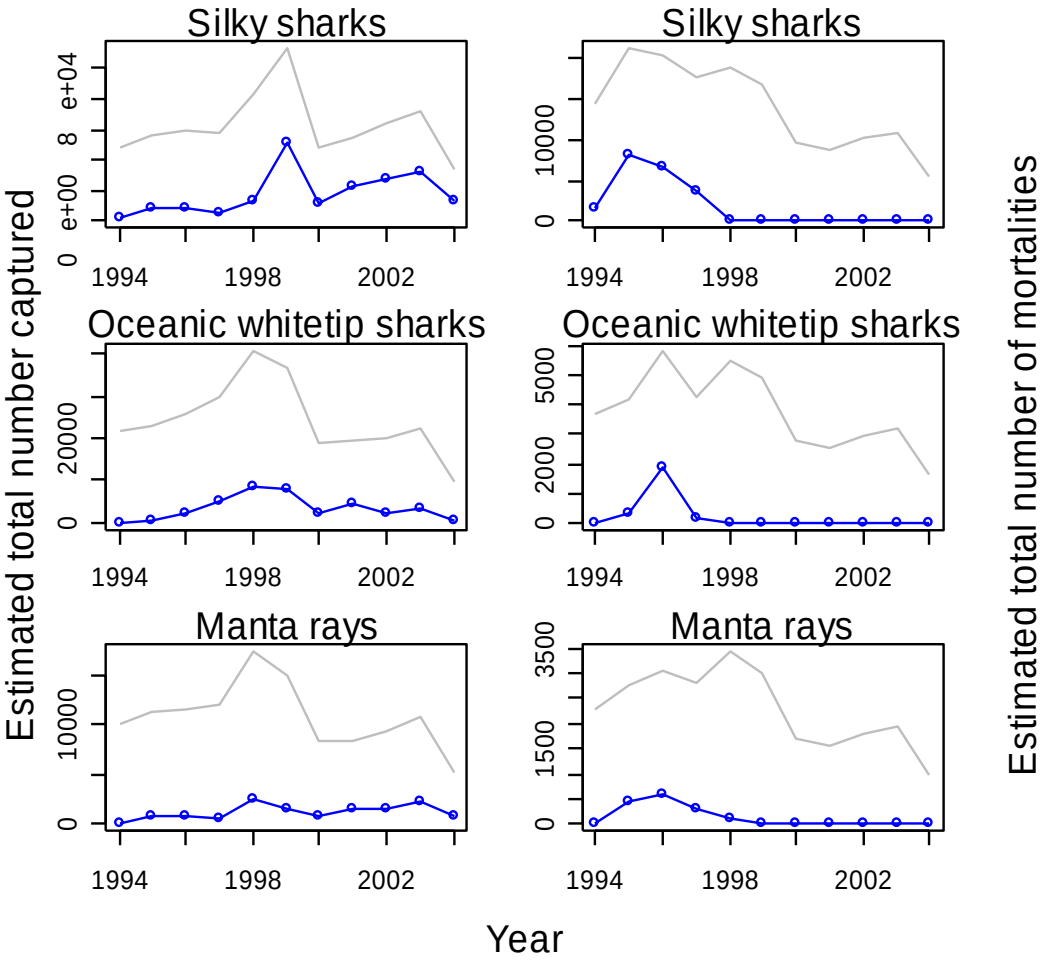

Figure 28. Estimated total catches (left hand series) and total estimated mortalities (right hand series) of each major shark taxa captured by the western Pacific purse-seine fishery, 1994–2004. Source: observer database maintained by SPC. Shark mortalities include observed mortalities, plus retained, plus finned and discarded sharks. Grey lines represent ± one standard deviation of each estimate. Manta rays are not identified to species.

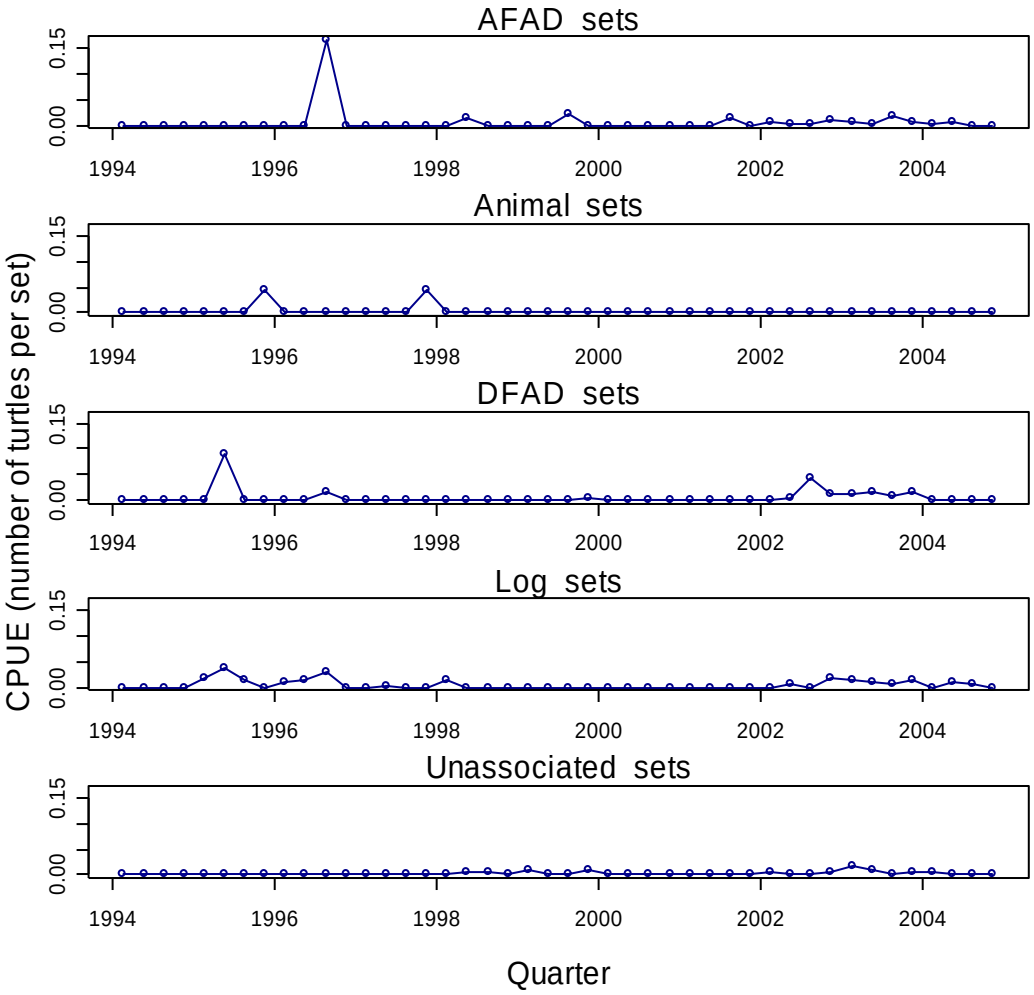

Figure 29. Quarterly catch per unit effort of turtles (number of turtles per set) in observed purse-seine sets by set type in the WCPO, 1994–2004. Source: SPC observer database.

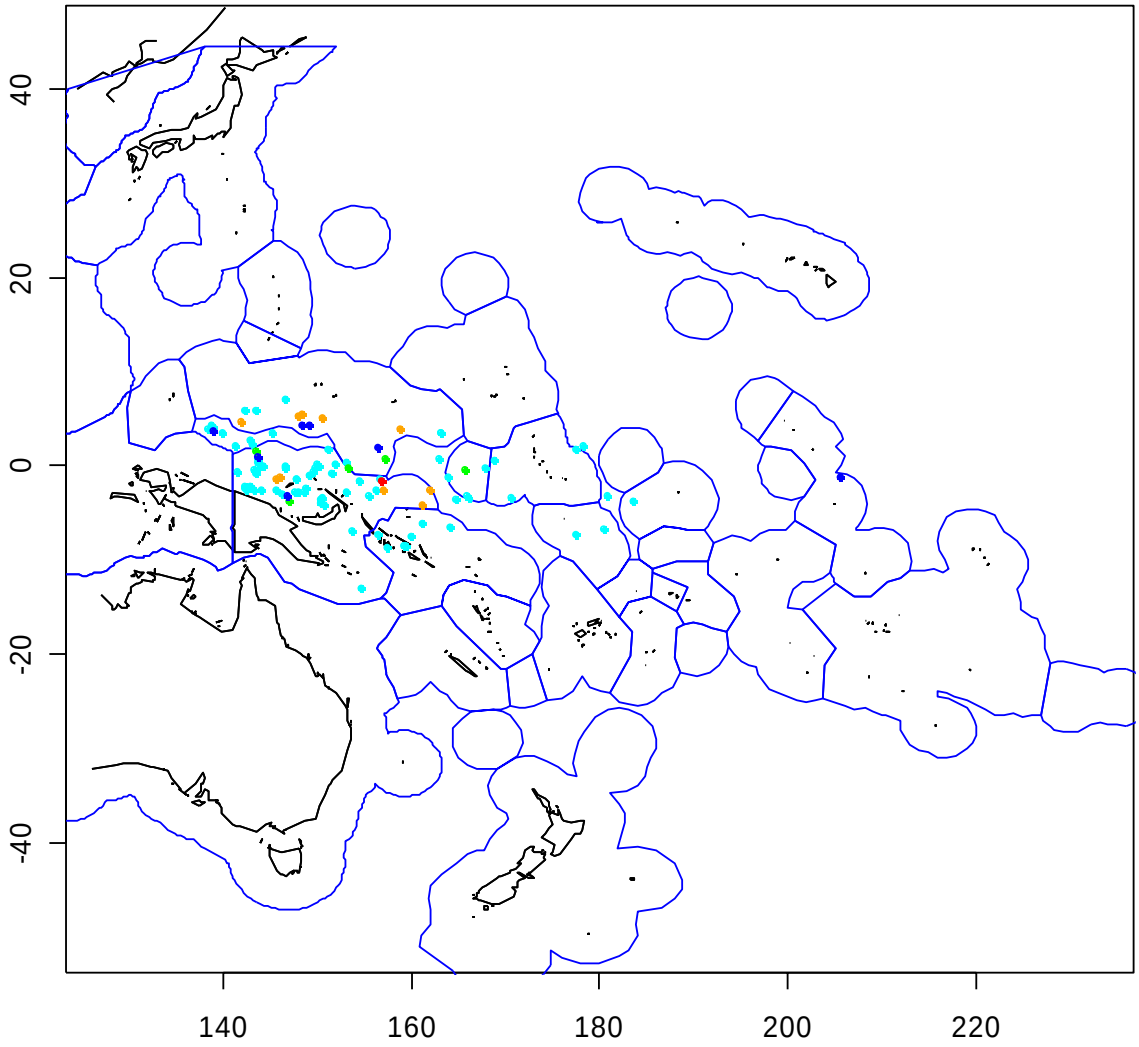

Figure 30. Position of observed purse-seine sets in which one or more turtles were captured by all fleets in the WCPO, 1995–2004. Source: observer purse-seine data held by SPC. Codes: red, leatherback turtles; green, green turtles; dark blue, hawksbill turtle; brown, loggerhead turtle; orange, olive ridley turtle; light blue, unidentified marine turtle.

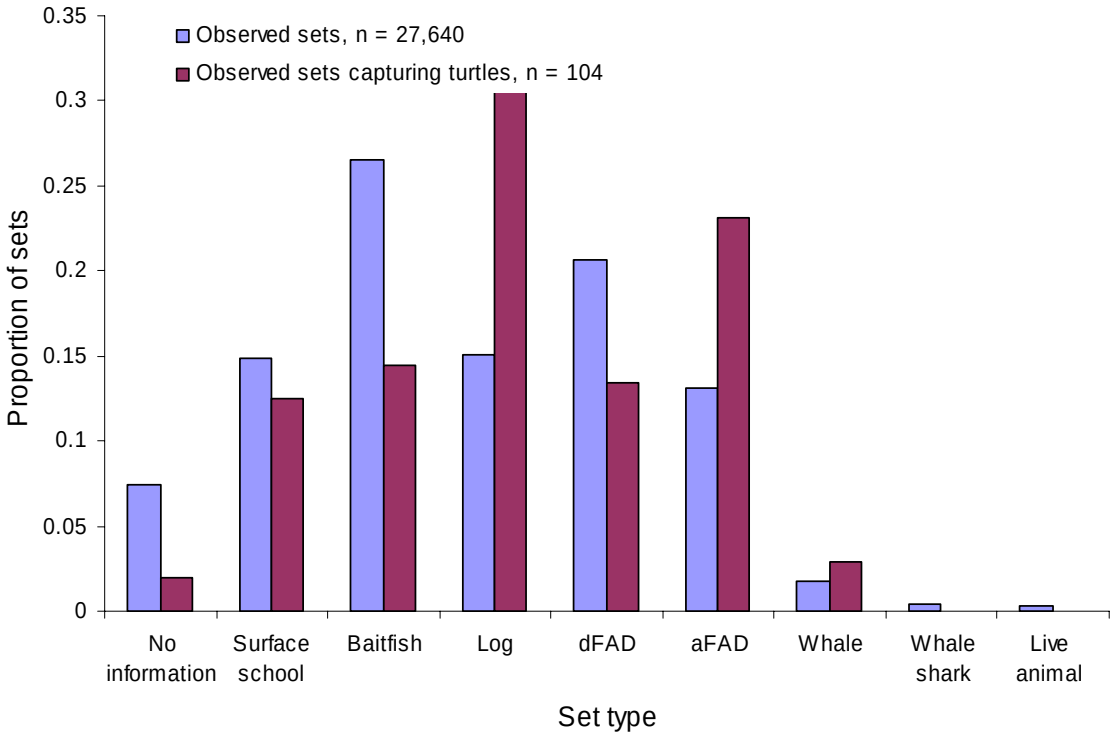

Figure 31. Distribution of the set types of observed purse-seine sets and observed purse-seine sets in which one or more turtles were incidentally captured by all fleets in the WCPO, 1995–2004. Upper figure, individual set types. Lower figure, pooled set types. Source, observer data held by SPC.

9. Appendices

Appendix 1. Formula used to calculate CPUEs for total catches and total mortalities, standard deviations, confidence intervals and total estimates.

$$\text{Annual CPUE of total numbers per taxa} = \frac{\Sigma(\text{number of individuals observed per year})}{\Sigma(\text{total observed effort per year})}$$

$$\text{Annual CPUE of mortality per taxa} = \frac{\Sigma(\text{number of mortalities observed per year})}{\Sigma(\text{total observed effort per year})}$$

A unit of effort was defined as one hundred hooks for the longline fisheries and one set for the purse-seine fishery.

Due to the low number of observations, global standard deviations (SDs) were used to provide more robust estimates of confidence intervals around for each estimated CPUE. Global SDs (i.e. for the entire dataset for each taxa) were used as the number of records per taxa were relatively low. Global standard deviations provide more robust estimates of uncertainties around each calculated CPUE. SDs were calculated for each taxa examined, both for total estimated catches and total estimated mortalities per taxa, via;

$$\text{SD of total number per taxa} = \sqrt{\frac{\Sigma(\text{number of individuals observed}^2)}{\text{Number of records}}}$$

$$\text{SD of total mortality per taxa} = \sqrt{\frac{\Sigma(\text{number of mortalities observed}^2)}{\text{Number of records}}}$$

Confidence intervals (CIs) were calculated by adding and subtracting two times the estimated SD from the mean for each taxa;

$$CI = CPUE \pm 2(SD * \text{total effort})$$

A factor of two was used to approximate 95% confidence intervals.

Total catches and mortalities per taxa for each fishery were calculated by multiplying the annual CPUEs by the annual estimated total effort for each fishery;

$$\text{Total catch} = CPUE \times \text{annual estimated total effort.}$$

Similarly, total CIs were constructed by multiplying the CI by the total annual effort for each fishery;

$$\text{Total CI} = CI \times \text{annual estimated total effort.}$$

Appendix 2. Estimated annual catches and mortalities of species of sharks commonly recorded by observers in the four fisheries examined. Only species with more than 1,000 records in the longline or purse-seine fisheries were analysed. Only sharks identified to species are presented.

Table A1. Final estimated total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of commonly reported species of sharks of the four fisheries examined, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

a). Silky sharks (*Carcharhinus falciformis*)

	Fishery																				
	Purse-seine				Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990													0	9,416	0	4,249	0	9,416	0	4,249	-
1991													0	12,000	0	5,415	0	12,000	0	5,415	-
1992									0	12,518	0	7,301	0	8,388	0	3,785	0	20,906	0	11,086	-
1993					0	23,005	0	12,556	0	15,304	0	8,927	0	8,917	0	4,024	0	47,227	0	25,506	-
1994	2,027	46,952	1,735	12,650	0	31,704	0	17,303	0	14,650	0	8,545	0	10,802	0	4,874	2,027	104,107	1,735	43,371	0.86
1995	8,011	48,510	8,011	13,070	242,384	37,204	49,843	20,304	12,609	12,142	6,271	7,082	6,033	11,573	861	5,222	269,037	109,429	64,987	45,678	0.24
1996	8,522	50,516	6,627	13,610	241,140	32,134	52,601	17,538	12,182	9,853	3,149	5,747	11,603	10,007	1,364	4,515	273,447	102,510	63,741	41,410	0.23
1997	5,336	52,484	3,577	14,140	82,183	22,990	26,521	12,547	24,859	9,518	10,444	5,552	8,578	10,007	2,730	4,515	120,957	94,999	43,273	36,754	0.36
1998	13,946	68,943	185	18,575	211,739	27,413	61,500	14,961	9,268	8,413	2,756	4,907	15,407	13,122	6,744	5,921	250,360	117,892	71,185	44,364	0.28
1999	50,641	62,299	0	16,784	451,486	42,038	135,563	22,943	26,007	9,016	2,749	5,259	16,441	13,098	2,342	5,910	544,575	126,451	140,654	50,896	0.26
2000	12,324	35,246	0	9,496	454,686	44,846	169,786	24,476	20,270	11,810	7,697	6,889	12,043	12,861	2,503	5,803	499,324	104,764	179,985	46,663	0.36
2001	22,925	31,896	0	8,593	514,666	55,064	100,546	30,052	56,912	9,714	24,092	5,666	55,438	16,227	7,416	7,322	649,940	112,901	132,053	51,633	0.20
2002	27,343	37,285	93	10,045	1,162,580	69,454	449,065	37,905	7,448	10,304	3,093	6,010	19,843	18,001	5,786	8,122	1,217,214	135,043	458,037	62,083	0.38
2003	31,947	40,545	0	10,924	72,123	50,064	14,278	27,323	12,082	8,851	4,485	5,163	8,423	23,684	3,329	10,686	124,576	123,144	22,092	54,096	0.18
2004	13,481	20,460	0	5,512	137,644	11,005	31,917	6,006	35,959	8,993	11,069	5,245	13,341	15,250	5,196	6,881	200,426	55,708	48,182	23,645	0.24
Mean	*17,864*	*45,012*	*1,839*	*12,127*	*297,553*	*37,244*	*90,968*	*20,326*	*16,738*	*10,853*	*5,831*	*6,330*	*11,143*	*12,890*	*2,551*	*5,816*					
Total																	*276,792*	*85,100*	*81,728*	*36,457*	

Table A1, continued. Final estimated total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of commonly reported species of sharks of the four fisheries examined, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

b). Oceanic whitetip sharks (*Carcharhinus longimanus*)

	Fishery																				
	Purse-seine				Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990													19,770	8,551	0	3,603	19,770	8,551	0	3,603	0.00
1991													0	10,897	0	4,592	0	10,897	0	4,592	-
1992									7,766	9,240	0	4,912	3,906	7,617	401	3,210	11,672	16,857	401	8,122	0.03
1993					50,088	13,264	1,834	5,142	0	11,296	0	6,006	6,985	8,097	521	3,412	57,074	32,658	2,355	14,560	0.04
1994	0	21,912	0	3,716	27,944	18,279	3,341	7,086	22,783	10,813	5,114	5,749	13,129	9,809	2,357	4,133	63,856	60,812	10,812	20,685	0.17
1995	317	22,639	317	3,840	110,841	21,450	18,595	8,316	7,192	8,962	2,506	4,765	13,633	10,509	2,191	4,429	131,984	63,560	23,609	21,349	0.18
1996	1,972	23,575	1,864	3,999	78,567	18,527	17,242	7,183	20,065	7,273	3,972	3,867	12,109	9,087	2,130	3,829	112,714	58,462	25,208	18,877	0.22
1997	5,085	24,493	123	4,154	27,251	13,255	4,298	5,139	17,230	7,025	4,827	3,735	12,850	9,087	2,459	3,829	62,416	53,861	11,708	16,858	0.19
1998	8,760	32,174	6	5,457	116,234	15,805	16,063	6,127	14,095	6,210	1,108	3,302	33,264	11,916	9,775	5,021	172,353	66,106	26,952	19,908	0.16
1999	7,803	29,074	0	4,931	300,757	24,238	52,692	9,396	18,401	6,655	1,262	3,538	25,046	11,894	3,810	5,012	352,007	71,860	57,765	22,878	0.16
2000	2,459	16,449	0	2,790	92,912	25,857	21,314	10,024	24,634	8,718	5,324	4,635	10,962	11,679	2,696	4,921	130,967	62,702	29,335	22,370	0.22
2001	4,282	14,885	0	2,525	133,807	31,748	7,728	12,308	32,442	7,170	10,643	3,812	40,457	14,735	2,860	6,209	210,989	68,539	21,231	24,854	0.10
2002	2,402	17,400	0	2,951	213,897	40,044	83,105	15,524	7,410	7,605	3,549	4,044	15,231	16,346	4,555	6,888	238,939	81,396	91,209	29,407	0.38
2003	3,272	18,922	0	3,209	0	28,865	0	11,190	1,618	6,533	487	3,473	14,341	21,507	4,512	9,063	19,231	75,826	4,999	26,936	0.26
2004	250	9,548	0	1,619	26,854	6,345	4,587	2,460	10,554	6,638	3,312	3,529	12,739	13,849	1,878	5,836	50,397	36,380	9,777	13,444	0.19
Mean	*3,327*	*21,006*	*210*	*3,563*	*98,263*	*21,473*	*19,233*	*8,325*	*14,169*	*8,011*	*3,239*	*4,259*	*15,628*	*11,705*	*2,676*	*4,933*					
Total																	*108,958*	*51,231*	*21,024*	*17,896*	

Table A1, continued. Final estimated total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of commonly reported species of sharks of the four fisheries examined, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

c). Blue sharks (*Prionace glauca*)

	Fishery																
	Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990									314,293	14,844	0	4,653	314,293	14,844	0	4,653	0.00
1991									38,519	18,917	3,036	5,929	38,519	18,917	3,036	5,929	0.08
1992					150,679	16,850	43,970	6,494	25,276	13,223	1,940	4,145	175,955	30,072	45,910	10,638	0.26
1993	164,573	15,082	13,975	5,985	50,561	20,600	13,369	7,939	37,787	14,057	4,144	4,406	252,920	49,739	31,488	18,330	0.12
1994	130,951	20,784	11,025	8,248	50,940	19,719	2,044	7,599	42,486	17,028	4,542	5,337	224,377	57,531	17,610	21,184	0.08
1995	127,228	24,390	22,771	9,678	64,567	16,343	4,809	6,298	65,698	18,244	5,411	5,719	257,493	58,977	32,991	21,695	0.13
1996	328,242	21,066	71,282	8,360	63,199	13,263	4,512	5,111	63,022	15,775	11,059	4,945	454,463	50,104	86,853	18,416	0.19
1997	138,314	15,072	19,369	5,981	57,849	12,812	7,822	4,937	65,877	15,775	9,078	4,945	262,040	43,658	36,270	15,863	0.14
1998	177,943	17,971	38,496	7,132	51,801	11,325	2,329	4,364	59,041	20,686	4,795	6,484	288,785	49,982	45,620	17,980	0.16
1999	220,507	27,559	42,140	10,936	58,082	12,136	4,541	4,677	54,063	20,647	1,954	6,472	332,652	60,342	48,636	22,085	0.15
2000	225,050	29,400	45,792	11,667	96,708	15,897	18,809	6,127	30,330	20,274	2,309	6,355	352,089	65,572	66,910	24,148	0.19
2001	237,461	36,099	34,270	14,325	82,882	13,076	14,708	5,039	48,967	25,580	2,860	8,018	369,310	74,754	51,839	27,382	0.14
2002	114,796	45,532	12,503	18,068	25,610	13,869	1,539	5,345	32,955	28,376	3,786	8,894	173,361	87,777	17,829	32,308	0.10
2003	0	32,821	0	13,024	11,092	11,914	1,640	4,591	33,680	37,335	2,423	11,703	44,773	82,069	4,064	29,318	0.09
2004	38,426	7,215	3,926	2,863	32,500	12,105	3,891	4,665	37,079	24,041	4,271	7,536	108,005	43,360	12,088	15,064	0.11
Mean	*158,624*	*24,416*	*26,296*	*9,689*	*61,267*	*14,608*	*9,537*	*5,630*	*63,271*	*20,320*	*4,107*	*6,369*					
Total													*243,269*	*52,513*	*33,410*	*19,000*	

Table A1, continued. Final estimated total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of commonly reported species of sharks of the four fisheries examined, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

d). Porbeagle sharks (*Lamna nasus*)

	Fishery																
	Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990									0	1,833	0	1,833	0	1,833	0	1,833	-
1991									661	2,336	661	2,336	661	2,336	661	2,336	1.00
1992					0	3,501	0	3,501	262	1,633	262	1,633	262	5,134	262	5,134	1.00
1993	0	1,811	0	1,811	31,956	4,281	31,956	4,281	403	1,736	403	1,736	32,359	7,827	32,359	7,827	1.00
1994	0	2,496	0	2,496	6,739	4,098	6,739	4,098	428	2,103	428	2,103	7,167	8,696	7,167	8,696	1.00
1995	9,228	2,929	9,228	2,929	4,809	3,396	4,809	3,396	556	2,253	556	2,253	14,594	8,577	14,594	8,577	1.00
1996	7,621	2,529	7,621	2,529	3,408	2,756	3,408	2,756	372	1,948	372	1,948	11,401	7,233	11,401	7,233	1.00
1997	0	1,810	0	1,810	656	2,662	656	2,662	1,844	1,948	1,844	1,948	2,500	6,420	2,500	6,420	1.00
1998	2,098	2,158	2,098	2,158	1,194	2,353	1,194	2,353	1,229	2,554	1,229	2,554	4,521	7,066	4,521	7,066	1.00
1999	1,335	3,309	1,335	3,309	665	2,522	665	2,522	488	2,550	488	2,550	2,489	8,380	2,489	8,380	1.00
2000	3,045	3,530	3,045	3,530	4,595	3,303	4,595	3,303	659	2,504	659	2,504	8,299	9,337	8,299	9,337	1.00
2001	1,382	4,334	1,382	4,334	2,627	2,717	2,627	2,717	0	3,159	0	3,159	4,009	10,210	4,009	10,210	1.00
2002	1,454	5,467	1,454	5,467	4,099	2,882	4,099	2,882	165	3,504	165	3,504	5,719	11,853	5,719	11,853	1.00
2003	0	3,941	0	3,941	487	2,476	487	2,476	426	4,610	426	4,610	913	11,027	913	11,027	1.00
2004	0	866	0	866	0	2,515	0	2,515	90	2,969	90	2,969	90	6,350	90	6,350	1.00
Mean	*2,180*	*2,932*	*2,180*	*2,932*	*4,710*	*3,036*	*4,710*	*3,036*	*506*	*2,509*	*506*	*2,509*					
Total													*6,332*	*7,485*	*6,332*	*7,485*	

Table A1, continued. Final estimated total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of commonly reported species of sharks of the four fisheries examined, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

e). Pelagic string rays (*Dasyatis violacea*)

	Fishery																
	Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990									412,406	7,845	0	1,833	412,406	7,845	0	1,833	0.00
1991									22,693	9,998	661	2,336	22,693	9,998	661	2,336	0.03
1992					40,652	9,519	0	3,501	18,683	6,989	262	1,633	59,335	16,507	262	5,134	0.00
1993	32,172	8,551	0	1,811	116,174	11,637	31,956	4,281	8,276	7,430	403	1,736	156,622	27,617	32,359	7,827	0.21
1994	57,163	11,783	0	2,496	84,453	11,140	6,739	4,098	9,123	9,000	428	2,103	150,739	31,923	7,167	8,696	0.05
1995	51,818	13,828	9,228	2,929	35,342	9,232	4,809	3,396	14,367	9,643	556	2,253	101,527	32,703	14,594	8,577	0.14
1996	192,635	11,943	7,621	2,529	21,266	7,493	3,408	2,756	8,184	8,338	372	1,948	222,085	27,773	11,401	7,233	0.05
1997	17,647	8,545	0	1,810	14,079	7,237	656	2,662	14,044	8,338	1,844	1,948	45,769	24,120	2,500	6,420	0.05
1998	72,290	10,189	2,098	2,158	12,337	6,398	1,194	2,353	11,191	10,933	1,229	2,554	95,817	27,520	4,521	7,066	0.05
1999	38,245	15,625	1,335	3,309	11,299	6,856	665	2,522	3,931	10,913	488	2,550	53,475	33,393	2,489	8,380	0.05
2000	25,061	16,668	3,045	3,530	23,338	8,981	4,595	3,303	17,775	10,716	659	2,504	66,174	36,365	8,299	9,337	0.13
2001	21,035	20,466	1,382	4,334	17,850	7,387	2,627	2,717	2,100	13,520	0	3,159	40,986	41,372	4,009	10,210	0.10
2002	24,244	25,814	1,454	5,467	13,680	7,835	4,099	2,882	10,254	14,998	165	3,504	48,178	48,647	5,719	11,853	0.12
2003	0	18,608	0	3,941	10,885	6,730	487	2,476	11,791	19,733	426	4,610	22,677	45,070	913	11,027	0.04
2004	941	4,090	0	866	3,843	6,838	0	2,515	8,838	12,706	90	2,969	13,622	23,635	90	6,350	0.01
Mean	*44,438*	*13,842*	*2,180*	*2,932*	*31,169*	*8,252*	*4,710*	*3,036*	*38,244*	*10,740*	*506*	*2,509*					
Total													*100,807*	*28,966*	*6,332*	*7,485*	

Table A1, continued. Final estimated total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of commonly reported species of sharks of the four fisheries examined, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

f). Shortfin mako sharks (*Isurus oxyrhinchus*)

	Fishery																
	Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990									25,646	5,609	0	2,687	25,646	5,609	0	2,687	0.00
1991									2,159	7,147	0	3,424	2,159	7,147	0	3,424	0.00
1992					0	4,622	0	2,242	0	4,996	0	2,393	0	9,618	0	4,635	-
1993	0	4,584	0	1,782	0	5,651	0	2,741	0	5,311	0	2,544	0	15,546	0	7,067	-
1994	0	6,317	0	2,456	0	5,409	0	2,624	0	6,434	0	3,082	0	18,159	0	8,161	-
1995	0	7,413	0	2,882	1,295	4,483	0	2,175	5,607	6,893	2,317	3,302	6,902	18,789	2,317	8,358	0.34
1996	3,584	6,403	1,791	2,489	0	3,638	0	1,765	9,336	5,960	2,627	2,855	12,921	16,001	4,419	7,109	0.34
1997	19,293	4,581	1,431	1,781	9,228	3,514	1,726	1,705	3,076	5,961	1,462	2,855	31,597	14,055	4,620	6,341	0.15
1998	30,893	5,462	6,503	2,124	2,450	3,106	495	1,507	19,076	7,816	7,078	3,744	52,419	16,384	14,076	7,374	0.27
1999	16,418	8,376	3,731	3,257	3,091	3,329	264	1,615	19,957	7,801	3,954	3,737	39,466	19,506	7,948	8,608	0.20
2000	5,077	8,936	0	3,474	4,010	4,361	711	2,115	2,503	7,660	1,512	3,669	11,590	20,957	2,223	9,259	0.19
2001	21,483	10,972	7,728	4,266	3,723	3,587	638	1,740	7,689	9,665	2,100	4,630	32,896	24,223	10,466	10,635	0.32
2002	34,559	13,839	11,898	5,380	4,231	3,804	1,957	1,845	8,962	10,722	1,750	5,136	47,752	28,364	15,605	12,361	0.33
2003	0	9,975	0	3,878	6,791	3,268	1,423	1,585	10,941	14,107	2,468	6,757	17,732	27,350	3,890	12,220	0.22
2004	4,771	2,193	1,255	853	2,764	3,320	910	1,611	7,541	9,084	2,097	4,351	15,077	14,597	4,262	6,814	0.28
Mean	*11,340*	*7,421*	*2,861*	*2,885*	*2,891*	*4,007*	*625*	*1,944*	*8,166*	*7,678*	*1,824*	*3,678*					
Total													*19,744*	*17,087*	*4,655*	*7,670*	

Table A1, continued. Final estimated total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of commonly reported species of sharks of the four fisheries examined, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

g). Bigeye thresher sharks (*Alopias superciliosus*)

	Fishery																
	Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990									0	2,963	0	1,033	0	2,963	0	1,033	-
1991									0	3,777	0	23	0	3,777	0	23	-
1992					0	7,186	0	2,318	0	2,640	0	9	0	9,826	0	2,327	-
1993	0	4,753	0	509	0	8,786	0	488	0	2,806	0	21	0	16,345	0	1,018	-
1994	0	6,550	0	232	7,069	8,410	2,044	305	0	3,399	0	23	7,069	18,359	2,044	560	0.29
1995	5,175	7,686	2,069	287	1,002	6,970	501	150	0	3,642	0	23	6,177	18,299	2,570	460	0.42
1996	28,948	6,639	24,251	497	11,933	5,657	6,930	127	692	3,149	0	13	41,574	15,445	31,182	638	0.75
1997	11,139	4,749	3,581	199	5,859	5,464	545	49	161	3,149	0	9	17,159	13,363	4,125	256	0.24
1998	15,483	5,663	6,980	113	10,788	4,830	2,394	31	4,808	4,130	660	23	31,080	14,623	10,034	167	0.32
1999	14,174	8,685	4,400	185	5,209	5,176	333	50	2,730	4,122	244	26	22,113	17,983	4,976	261	0.23
2000	28,215	9,265	15,858	282	15,600	6,780	2,789	32	2,833	4,048	330	35	46,649	20,093	18,977	349	0.41
2001	58,454	11,376	20,458	384	16,530	5,577	5,614	30	7,088	5,107	1,862	37	82,072	22,059	27,935	451	0.34
2002	52,841	14,348	17,130	404	2,406	5,915	268	22	6,404	5,665	1,584	9	61,652	25,929	18,983	435	0.31
2003	0	10,343	0	1,979	3,948	5,081	1,342	29	1,278	7,454	213	11	5,225	22,878	1,554	2,020	0.30
2004	9,496	2,274	1,569	87	10,214	5,163	3,312	54	2,369	4,800	415	10	22,079	12,236	5,295	151	0.24
Mean	*18,661*	*7,694*	*8,025*	*430*	*6,966*	*6,230*	*2,005*	*284*	*1,891*	*4,057*	*354*	*87*					
Total													*22,857*	*15,612*	*8,512*	*677*	

Table A1, continued. Final estimated total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of commonly reported species of sharks of the four fisheries examined, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

h). Grey reef sharks (*Carcharhinus amblyrhynchos*)

	Fishery																
	Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990									0	3,903	0	1,121	0	3,903	0	1,121	-
1991									0	4,974	0	1,429	0	4,974	0	1,429	-
1992					77,766	4,318	56,717	3,544	0	3,477	0	999	77,766	7,795	56,717	4,543	0.73
1993	94,950	7,609	6,587	3,362	4,218	5,279	0	4,333	0	3,696	0	1,062	99,168	16,585	6,587	8,757	0.07
1994	4,320	10,486	1,670	4,633	0	5,053	0	4,148	0	4,477	0	1,286	4,320	20,017	1,670	10,067	0.39
1995	11,325	12,305	2,402	5,436	1,503	4,188	501	3,438	2,617	4,797	861	1,378	15,445	21,291	3,764	10,252	0.24
1996	8,974	10,628	1,791	4,696	1,526	3,399	0	2,790	0	4,148	0	1,192	10,500	18,175	1,791	8,677	0.17
1997	0	7,604	0	3,359	0	3,283	0	2,695	0	4,148	0	1,192	0	15,035	0	7,246	-
1998	8,880	9,067	3,079	4,006	0	2,902	0	2,382	2,021	5,439	569	1,563	10,901	17,409	3,648	7,950	0.33
1999	23,232	13,904	5,200	6,143	929	3,110	763	2,553	244	5,429	0	1,560	24,405	22,444	5,963	10,255	0.24
2000	15,438	14,833	4,655	6,553	0	4,074	0	3,344	0	5,331	0	1,532	15,438	24,238	4,655	11,428	0.30
2001	107,796	18,213	23,658	8,046	7,136	3,351	5,489	2,750	19,340	6,726	0	1,932	134,272	28,290	29,147	12,729	0.22
2002	46,888	22,972	29,599	10,149	1,303	3,554	1,155	2,917	1,129	7,462	675	2,144	49,320	33,988	31,429	15,210	0.64
2003	0	16,559	0	7,316	0	3,053	0	2,506	0	9,817	0	2,820	0	29,429	0	12,642	-
2004	14,372	3,640	1,255	1,608	364	3,102	0	2,546	1,101	6,322	391	1,816	15,837	13,064	1,645	5,970	0.10
Mean	*28,015*	*12,318*	*6,658*	*5,442*	*7,288*	*3,744*	*4,971*	*3,073*	*1,763*	*5,343*	*166*	*1,535*					
Total													*30,491*	*18,442*	*9,801*	*8,552*	

Table A1, continued. Final estimated total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of commonly reported species of sharks of the four fisheries examined, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

i). Crocodile sharks (*Pseudocarcharias kamoharai*)

	Fishery																
	Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990									0	4,683	0	1,260	0	4,683	0	1,260	-
1991									0	5,968	0	1,606	0	5,968	0	1,606	-
1992					28,056	4,366	0	2,225	525	4,172	0	1,122	28,581	8,538	0	3,348	0.00
1993	9,196	3,431	1,834	2,352	31,926	5,338	15,696	2,721	3,567	4,435	605	1,193	44,689	13,204	18,134	6,266	0.41
1994	12,007	4,729	835	3,242	8,966	5,109	0	2,604	16,733	5,372	2,555	1,445	37,706	15,210	3,390	7,291	0.09
1995	15,267	5,549	5,782	3,804	3,889	4,235	1,503	2,158	12,275	5,756	1,418	1,548	31,432	15,540	8,703	7,511	0.28
1996	10,133	4,793	8,333	3,286	6,294	3,437	1,703	1,752	1,458	4,977	248	1,339	17,885	13,206	10,284	6,376	0.57
1997	0	3,429	0	2,351	3,552	3,320	492	1,692	1,909	4,977	241	1,339	5,461	11,726	733	5,382	0.13
1998	2,160	4,089	0	2,803	2,261	2,934	575	1,496	0	6,526	0	1,756	4,421	13,549	575	6,054	0.13
1999	1,335	6,270	0	4,298	1,193	3,145	264	1,603	244	6,514	0	1,752	2,772	15,929	264	7,654	0.10
2000	17,884	6,689	11,106	4,585	7,370	4,119	2,738	2,100	0	6,396	0	1,721	25,254	17,205	13,844	8,406	0.55
2001	1,382	8,213	0	5,630	9,506	3,388	2,281	1,727	0	8,070	0	2,171	10,889	19,671	2,281	9,528	0.21
2002	4,365	10,359	4,365	7,102	75	3,594	0	1,832	83	8,952	0	2,408	4,522	22,905	4,365	11,342	0.97
2003	0	7,467	0	5,119	576	3,087	226	1,573	213	11,779	0	3,169	789	22,333	226	9,861	0.29
2004	7,500	1,641	2,482	1,125	2,764	3,137	1,381	1,599	0	7,585	0	2,040	10,264	12,363	3,864	4,764	0.38
Mean	*6,769*	*5,555*	*2,895*	*3,808*	*8,187*	*3,785*	*2,066*	*1,929*	*2,467*	*6,411*	*338*	*1,725*					
Total													*14,978*	*14,135*	*4,444*	*6,443*	

Table A1, continued. Final estimated total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of commonly reported species of sharks of the four fisheries examined, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

j). Silvertip sharks (*Carcharhinus albimarginatus*)

	Fishery																
	Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990									0	1,510	0	978	0	1,510	0	978	-
1991									0	1,924	0	1,246	0	1,924	0	1,246	-
1992					0	3,378	0	2,222	0	1,345	0	871	0	4,723	0	3,093	-
1993	8,430	6,908	1,834	2,079	0	4,130	0	2,716	0	1,430	0	926	8,430	12,468	1,834	5,721	0.22
1994	6,121	9,520	1,670	2,865	3,066	3,954	1,619	2,600	0	1,732	0	1,122	9,187	15,206	3,289	6,586	0.36
1995	0	11,172	0	3,362	17,689	3,277	1,503	2,155	0	1,856	0	1,202	17,689	16,304	1,503	6,718	0.08
1996	0	9,649	0	2,904	1,952	2,659	1,277	1,749	124	1,605	124	1,039	2,076	13,913	1,401	5,691	0.67
1997	0	6,904	0	2,077	0	2,569	0	1,689	0	1,605	0	1,039	0	11,077	0	4,806	-
1998	12,477	8,232	4,299	2,477	0	2,271	0	1,493	569	2,104	440	1,363	13,046	12,607	4,739	5,333	0.36
1999	26,349	12,624	6,685	3,798	0	2,433	0	1,600	1,120	2,100	244	1,360	27,469	17,157	6,929	6,759	0.25
2000	28,215	13,467	11,778	4,052	108	3,188	108	2,096	0	2,062	0	1,336	28,323	18,716	11,886	7,484	0.42
2001	121,971	16,535	15,686	4,975	2,502	2,622	1,800	1,724	812	2,602	0	1,685	125,285	21,759	17,486	8,385	0.14
2002	22,062	20,856	0	6,276	598	2,781	149	1,829	0	2,886	0	1,869	22,660	26,523	149	9,974	0.01
2003	0	15,034	0	4,524	2,475	2,389	1,843	1,571	382	3,797	275	2,460	2,857	21,220	2,118	8,554	0.74
2004	8,508	3,305	1,255	994	0	2,427	0	1,596	2,309	2,445	1,055	1,584	10,817	8,177	2,310	4,174	0.21
Mean	*19,511*	*11,184*	*3,601*	*3,365*	*2,184*	*2,929*	*638*	*1,926*	*354*	*2,067*	*143*	*1,339*					
Total													*17,856*	*13,552*	*3,576*	*5,700*	

Table A1, continued. Final estimated total catches (Total, in numbers), mortalities (Mort.) and approximate 95% confidence intervals (CI) of commonly reported species of sharks of the four fisheries examined, 1990–2004. Ratio: the proportion of each taxa reported as dead by observers; *Mean*, mean of estimates for each fishery for the year range examined; *Total*, total estimated annual average for all fisheries combined. Blank cells indicate no records for individual fishery and year combinations.

k). Thresher sharks (*Alopias vulpinus*)

	Fishery																
	Tropical shallow longline				Tropical deep longline				Temperate albacore longline				Overall				
Year	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Total	CI	Mort.	CI	Ratio
1990									40,036	3,158	0	2,016	40,036	3,158	0	2,016	0.00
1991									4,585	4,024	1,452	2,570	4,585	4,024	1,452	2,570	0.32
1992					0	1,171	0	669	3,007	2,813	1,590	1,796	3,007	3,984	1,590	2,465	0.53
1993	0	820	0	259	0	1,431	0	818	5,149	2,990	1,328	1,910	5,149	5,242	1,328	2,987	0.26
1994	0	1,131	0	358	0	1,370	0	783	7,284	3,622	4,396	2,313	7,284	6,123	4,396	3,454	0.60
1995	0	1,327	0	420	0	1,135	0	649	6,075	3,881	2,975	2,478	6,075	6,343	2,975	3,547	0.49
1996	0	1,146	0	362	0	921	0	527	2,027	3,356	784	2,143	2,027	5,423	784	3,032	0.39
1997	715	820	0	259	0	890	0	509	2,409	3,356	899	2,143	3,124	5,066	899	2,911	0.29
1998	406	978	0	309	0	787	0	450	0	4,401	0	2,810	406	6,165	0	3,569	0.00
1999	0	1,499	0	474	0	843	0	482	244	4,392	0	2,805	244	6,735	0	3,761	0.00
2000	1,015	1,599	0	506	774	1,104	216	631	0	4,313	0	2,754	1,789	7,017	216	3,891	0.12
2001	1,382	1,964	0	621	404	908	0	519	350	5,442	350	3,475	2,136	8,314	350	4,615	0.16
2002	0	2,477	0	783	492	964	193	551	0	6,037	0	3,855	492	9,477	193	5,189	0.39
2003	0	1,785	0	565	195	828	0	473	0	7,943	0	5,072	195	10,555	0	6,109	0.00
2004	1,308	392	313	124	470	841	364	481	90	5,114	90	3,266	1,869	6,348	768	3,871	0.41
Mean	*402*	*1,328*	*26*	*420*	*180*	*1,015*	*59*	*580*	*4,750*	*4,323*	*924*	*2,760*					
Total													*5,228*	*6,265*	*997*	*3,599*	

Appendix 3. Summaries of the observer data used in the analyses within the current report.

Table A2. Pooled number of observed longline sets by flag for the longline fisheries used in the analyses, 1990–2004 Source, SPC observer database. Flag codes: AS, American Samoa; CK, Cook Islands; CN, China; FJ, Fiji; FM, Federated States of Micronesia; FR, France; JP, Japan; KR, Korea; NC, New Caledonia; NZ, New Zealand; PF, French Polynesia; PG, Papua New Guinea; PW, Palau; SB, Solomon Islands; TO, Tonga; TW, Taiwan; US, United States; WS, Western Samoa.

	Flag																		
Year	**AS**	**CK**	**CN**	**FJ**	**FM**	**FR**	**JP**	**KR**	**NC**	**NZ**	**PF**	**PG**	**PW**	**SB**	**TO**	**TW**	**US**	**VU**	**WS**	**Total**
1990							47													47
1991							173													173
1992							254	8	4	1										267
1993			18				149	5			3					36				211
1994			29	6	7		180									95	24			341
1995		6	107	34	4		170			8					18	75	49	1		472
1996		2	76	12	12		178		59			10			3	63	48			463
1997			87	23	42		312				64			67		70	46			711
1998	2		87		42		124	54	26					50	71	255	102		7	820
1999			82	60	19		101	24	22			76		60	18	95	53		2	612
2000			71		50		59					60	10	94	23	118	340		10	835
2001			111		27		55		20			262		74		24	411		14	998
2002	60	22	6	45	22		56	163	50		66	285		551		54				1,380
2003		2	24	151	10			1	79	9	164	107		280		82				909
2004			160	76	46	43	3		49		124	166		12	31	90		2		802
Total	*62*	*32*	*858*	*407*	*281*	*43*	*1,861*	*255*	*309*	*18*	*421*	*966*	*10*	*1188*	*164*	*1,057*	*1,073*	*3*	*33*	*9,041*

Table A3. Number of observed purse-seine sets by flag for the purse-seine fishery used in the analyses, 1994–2004. Source, SPC observer database. Flag codes: AS, American Samoa; AU, Australia; CN, China; FM, Federated States of Micronesia; JP, Japan; KI, Kiribati; MH, Republic of the Marshall Islands; NZ, New Zealand; PF, French Polynesia; PG, Papua New Guinea; PH, Philippines; SB, Solomon Islands; TW, Taiwan; US, United States; VU, Vanuatu.

	Flag															
Year	**AS**	**AU**	**CN**	**FM**	**JP**	**KI**	**KR**	**MH**	**NZ**	**PF**	**PG**	**PH**	**SB**	**TW**	**US**	**VU**	**Total**
1994				66	99		307			37				299	601		1,409
1995				46	141	29	162				71			200	798	19	1,466
1996				9	118		343		26		28	31		586	1,149	19	2,309
1997					75		226		44	76	82	190		410	1,541	20	2,664
1998				78	57	38	349			61	83	39	38	903	1,026	38	2,710
1999				28	29	19	308			23	41	18	108	457	687	39	1,757
2000				82	117	13	286			35	85	41	60	457	853		2,029
2001		25		47	123		151	28		87	171	187	31	445	1,091		2,386
2002			48	95	94	39	57	78			958	542	221	203	1,231		3,566
2003				175		44	66	158			1,340	738	134	64	717	137	3,573
2004	42			122			127	242			1,155	902	51	154	627	43	3,465
Total	*42*	*25*	*48*	*748*	*853*	*182*	*2,382*	*506*	*70*	*319*	*4,014*	*2,688*	*643*	*4,178*	*10,321*	*315*	*27,334*

Appendix 4. Distribution of observer and logsheet records of starting times of longline and purse-seine sets used in the analyses within the current report.

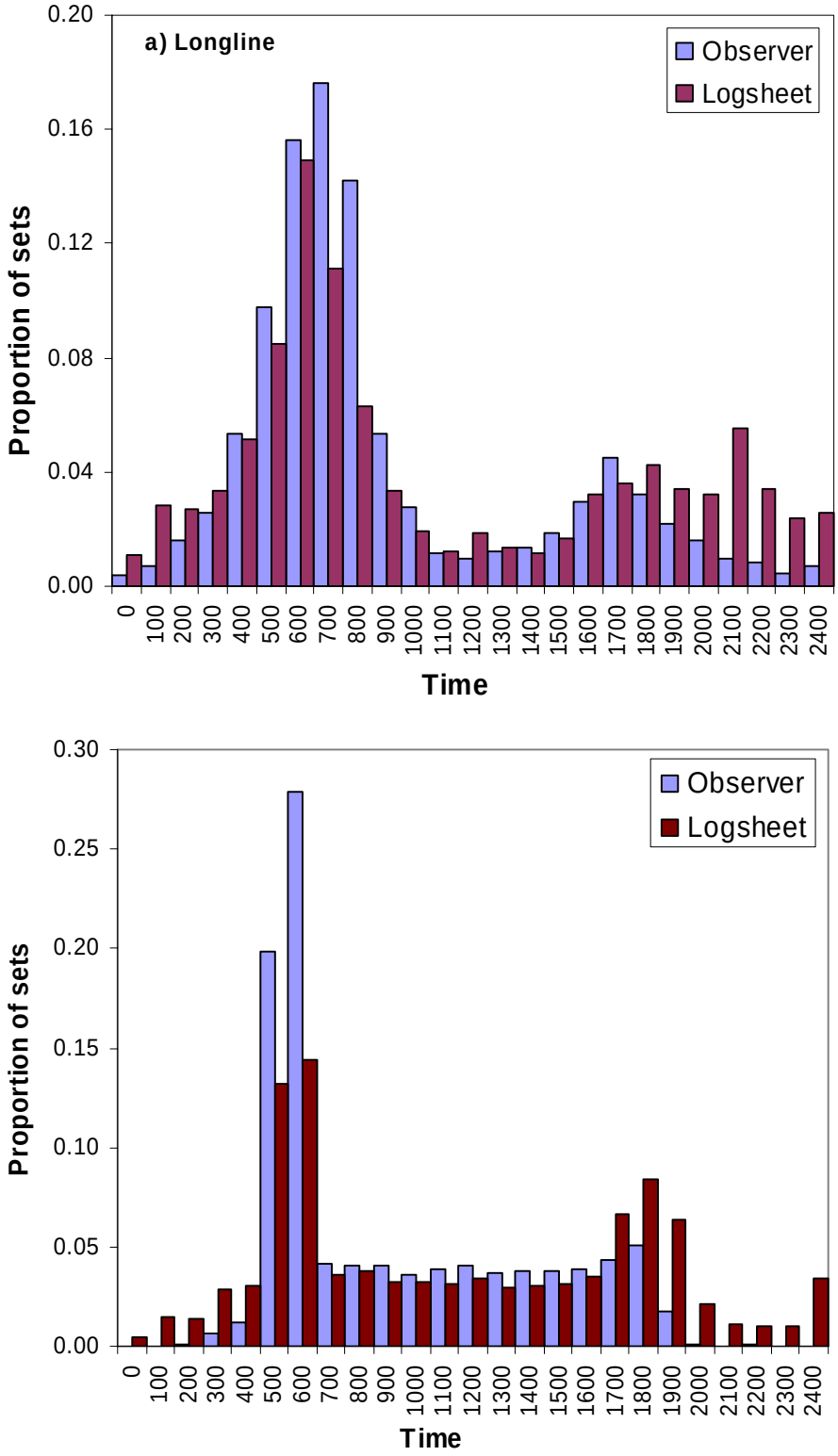

Figure A1. Proportion of observed and logsheet set start times for the longline (upper figure) and purse-seine (lower figure) fisheries used in the analyses. Source, SPC observer and logsheet data.