Overview of purse-seine and longline bycatch issues in the western and central Pacific Ocean

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1. Introduction

This report briefly reviews and presents information on bycatch and bycatch issues in the industrialised fisheries of the western and central Pacific Ocean (WCPO)/ western and central Pacific Convention Area (WCP-CA) (Figure 1). Most of the information and data were available from the Oceanic Fisheries Programme (OFP) of the Secretariat of the Pacific Community (SPC), and data presented are mainly from the area of 15ºN to 30ºS. This represents the most readily available source of data for the region. The report does not review the data from Australia, New Zealand or the United States (Hawaii), as observer programmes, and bycatch reports and management are independently produced for these countries. Many reports are available from the Western and Central Pacific Fisheries Commission (WCPFC) website (see a range of national Fishery Reports and Ecosystem and By-catch Specialist Working Group reports, available at the Scientific Committee pages of the www.wcpfc.int/).

This report will briefly present the following information;

- A review of the LL and purse seine fisheries of the WCP-CA
- A review of bird, mammal, shark and turtle bycatch in WCP-CA industrialised fisheries (longline and purse-seine)
- A brief review of purse-seine bycatch of juvenile tunas associated with FADs in the WCP-CA and of birds, mammals, sharks and turtles
- A brief review of regional and national measures to address bycatch in the WCP-CA

2. Review of the LL and purse seine fisheries of the WCPO/WCP-CA

The WCPO and WCP-CA represent a large region of the Pacific Ocean basin (Figure 1). The areas includes some or all of the EEZs of coastal states and Pacific Island States and territories (PICTs), plus areas of international waters (high seas).

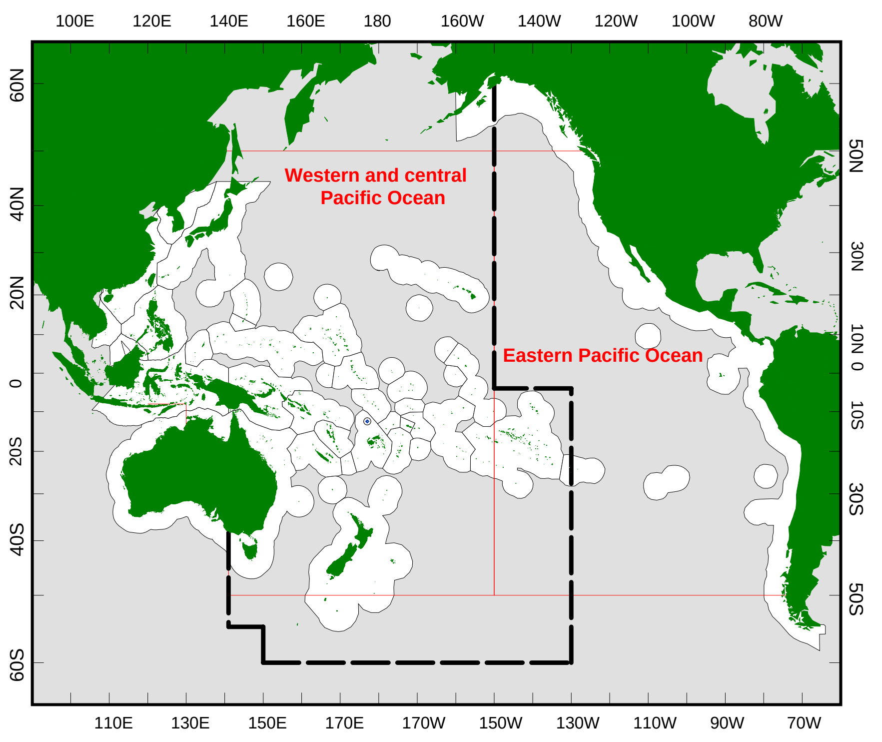
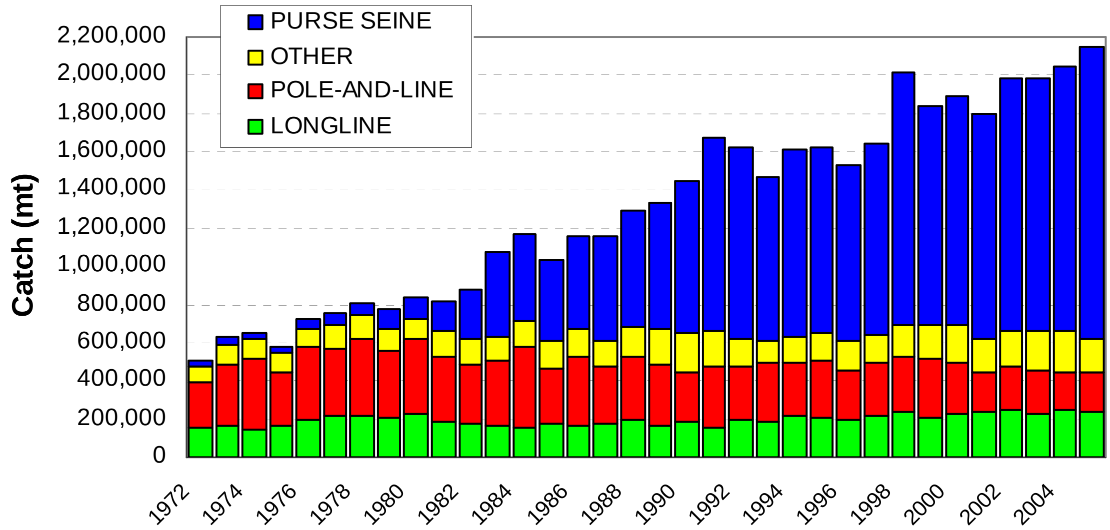


Figure 1. Boundaries of the WCPO and WCP-CA. Source: Williams and Reid (2006). White areas show the approximate limits of EEZ. However, many of these boundaries of PICTs have not been formally ratified.

Oceanic fishery data for the much of the WCPO have been centralised and managed by the OFP of the SPC since the late 1970s. This data forms the basis for monitoring and assessment work in the region, providing advice to individual countries and the Forum Fisheries Agency (FFA). With the establishment of the WCPFC in late 2004, the OFP also provides scientific advice and support to this regional fisheries management organisation (RFMO).

Catches from the WCP-CA have been dominated by the purse-seine fishery since the mid to late 1980s (Figure 2). Significant catches are also reported by the longline and pole-and-line fisheries of the WCP-CA. Total catches of tuna from the WCP-CA have exceeded 2 million metric tonnes (mt) in recent years (Appendix 1), representing approximately 50% of the world's annual tuna catches.



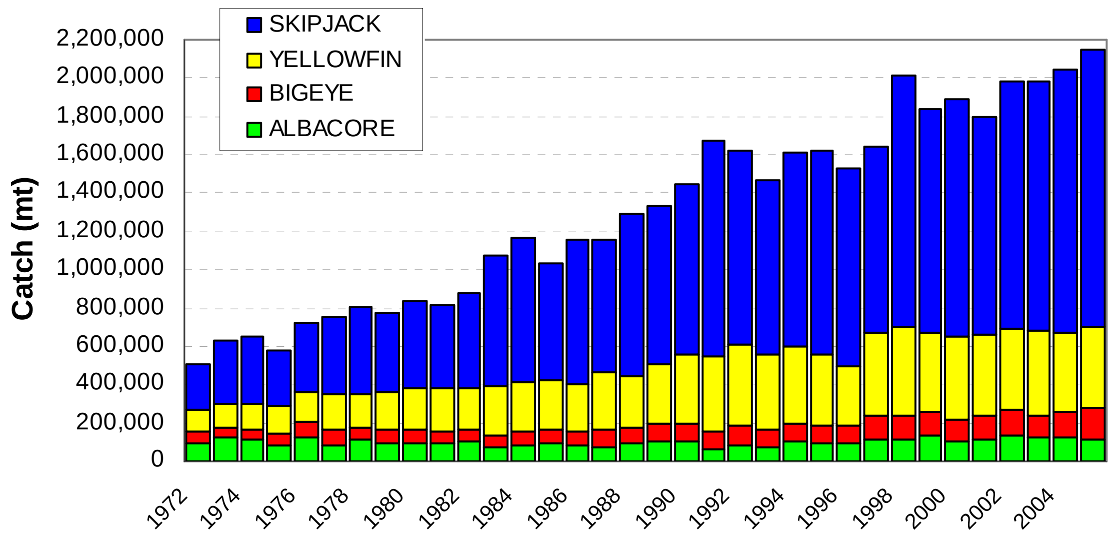


Figure 2. Annual catches by main method fishery (upper figure) and by tuna species (lower figure) in the WCP-CA, 1972–2005. Source: modified from Williams and Reid (2006).

Skipjack dominate tuna catches from the WCP-CA (Appendix 1), representing more than 65% of total tuna catches in recent years. Catches of skipjack have steadily increased, with a record catch in 2005 of more than 1.4 million mt (Figure 2). In addition, annual catches of more than 400,000 mt of yellowfin have been reported in recent years. Lower but significant catches of bigeye and albacore tuna (more than 100,000 mt per year per species in recent years) are also captured (Williams and Reid 2006). Significant catches of billfish are also reported (Appendix 1).

2.1 Purse-seine fishery of the WCP-CA

There was a rapid increase in the number of purse-seine vessels in the WCPO/WCP-CA between the early 1970s and the early 1990s (Figure 3). However, total numbers of purse-seine vessels have been capped at 205 within the main purse-sine areas of the WCPO. Skipjack tuna account for more than 80% of catches, although significant quantities of yellowfin and bigeye tuna are also captured (Appendix 1), a large proportion of which are small (less than 90 cm FL) (see section 3.2.1).

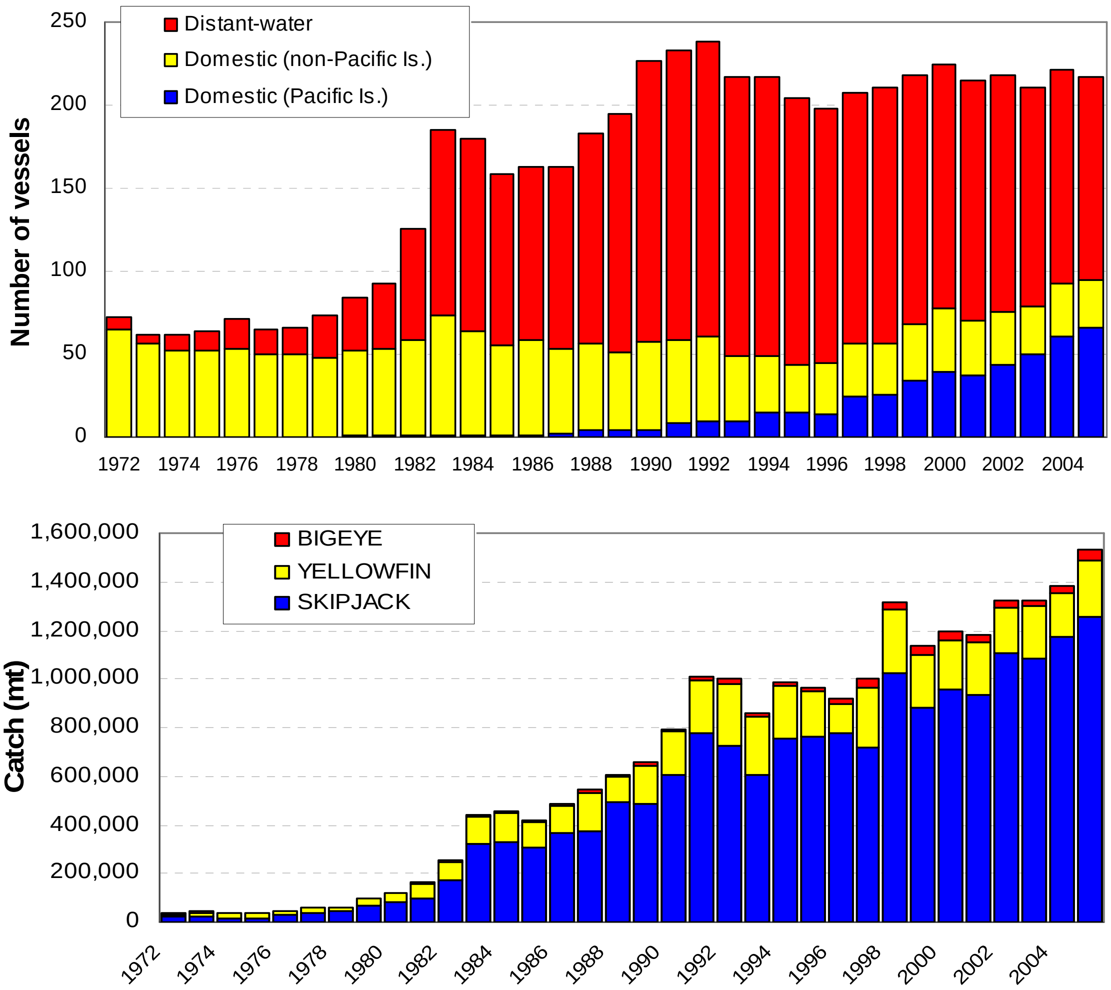


Figure 3. Number of purse-seine vessels operating in the WCP-CA (upper figure) and purse-seine catches (lower figure), 1972–2005. Source: modified from Williams and Reid (2006). The number of purse-seine vessels does not include the large number (~ 1,000) of domestic purse-seine and ring-net vessels operating mainly within the EEZs of Indonesia and the Philippines.

Purse-seine fishing is mainly confined to the western equatorial area of the WCP-CA, between approximately 10º north and south of the equator (Figure 4). The distribution of effort is more easterly during strong *El Niño* periods, and more westerly during neutral (2005) or strong *La Niño* periods. While sets on unassociated surface schools dominate the total effort, significant proportions of sets are made on schools associated with logs, drifting fish aggregating devices (FADs), or on anchored FADs. Large numbers of anchored FADs are present in some areas of the PNG and Solomon Islands EEZs.

The composition of tuna catches from unassociated sets (sets on free schools or schools associated with baitfish) vary from those from associated sets (logs, drifting or anchored

FADs). Higher proportions of yellowfin and bigeye are captured in associated sets, than compared to unassociated sets. In addition, much of the yellowfin captured in unassociated sets are large, adult fish (greater than 100 cm FL). In contrast, yellowfin and bigeye from associated sets are generally juveniles (less than 80–90 cm FL) (see section 3.2.1).

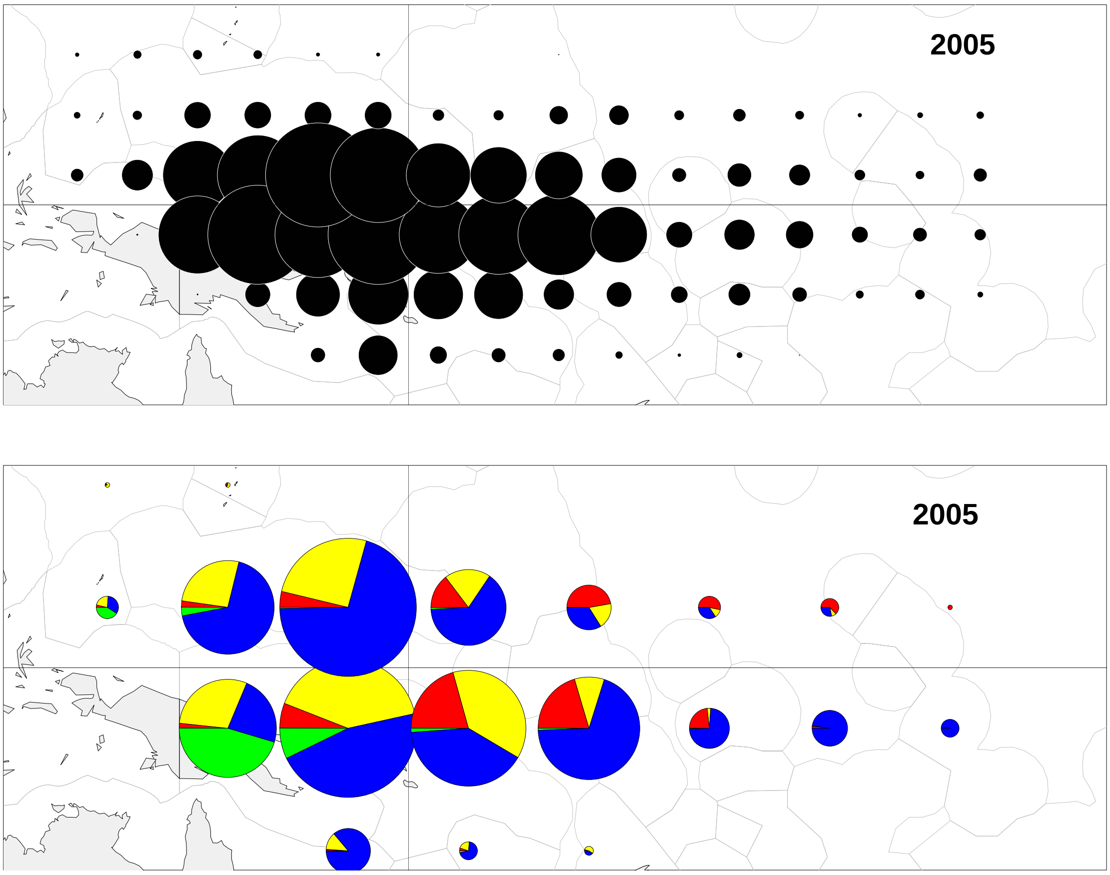


Figure 4. Distribution of total purse-seine effort (days, upper figure) and by set-type (lower figure) in the WCP-CA, 2005. Source: modified from Williams and Reid (2006). Area of the circles are proportional to total effort. Set-type codes for lower figure: blue, unassociated sets; yellow, log sets; red, drifting FAD sets; green, anchored FAD sets. Horizontal lines mark the equator. Vertical lines mark the 160ºE line of longitude.

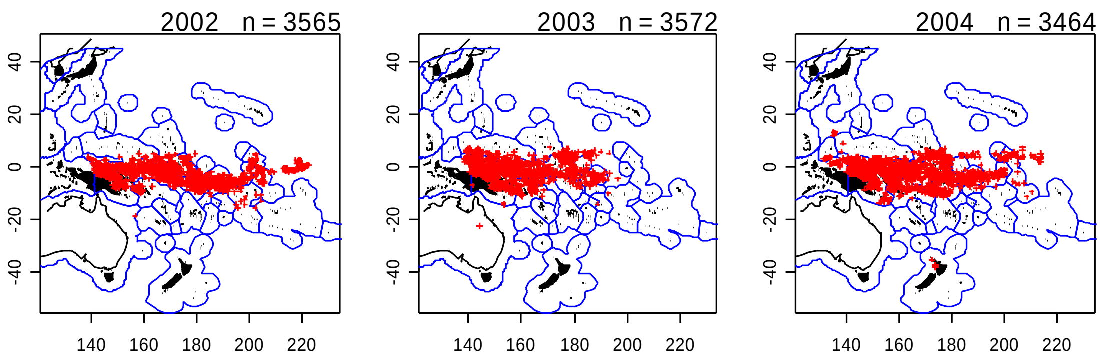


Figure 5. Position of observed purse-seine sets in the WCPO, 2002–2004. Source: observer data base held at SPC and Molony (2005a). Red dots record the position of an observed longline set. n =, indicates the total number of observed sets for each year. Data for 2003 and 2004 may be incomplete due to potential lags with data supply.

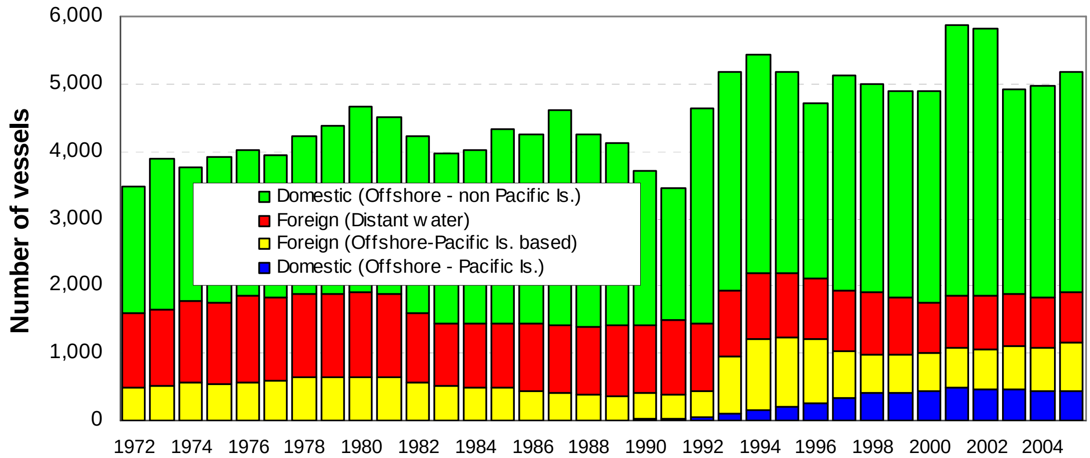
2.2 Longline fishery of the WCP-CA

Approximately 4,000–5,000 longline vessels have operated throughout the WCP-CA since the 1970s (Figure 6). The fleet is broadly divided into large freezer vessels operated by distant water fishing nations (DWFNs, principally Japan, Korea, China and Taiwan) and by offshore fleets (smaller vessels, fresh-chilled) operating from ports throughout the WCP-CA. There has been a recent development of domestic longline fleets of Pacific Island Nations and Territories (PICTs). Longline effort is dominated by distant water fleets, mainly operating in tropical areas.

Total catches by the longline fleet has been much lower than that of the purse-seine fleet, fluctuating between 200,000 mt and 250,000 mt in the past decade (Figure 6). While catches are lower, the catch is of high value. Catches are divided approximately evenly among albacore, bigeye and yellowfin tunas (Appendix 1).

The longline fleets can be broadly divided into three main fisheries, based on the area of operations and the target species. Shallow and deep tropical longline fisheries operate between approximately 15ºN and 10ºS in the WCP-CA (Figure 7). The tropical shallow longline (TSL) fishery typically targets yellowfin tuna and other commercial species with shallow sets, typically using less than 10 hooks between float (HBF). The tropical deep longline fishery (TDL) operates in the same area but targets bigeye, typically using sets with 10 or more HBF. The temperate albacore longline (TAL) fishery operates in sub-equatorial areas (10º–30ºS), mainly targeting albacore. There have been some recent shifts to targeting swordfish or other high valued species at certain times of the year in some regions. The spatial distribution of catches of the three main tuna species in the WCP-CA are shown in Figure 8.

This report will focus on bycatch issues within these three longline fisheries and the purse-seine fishery of the WCP-CA. Information from fisheries outside these areas (e.g. south of 30ºS and north of 15ºN) and from the fisheries in US waters of the WCP-CA (including Hawaii) is on briefly refered to in this report.



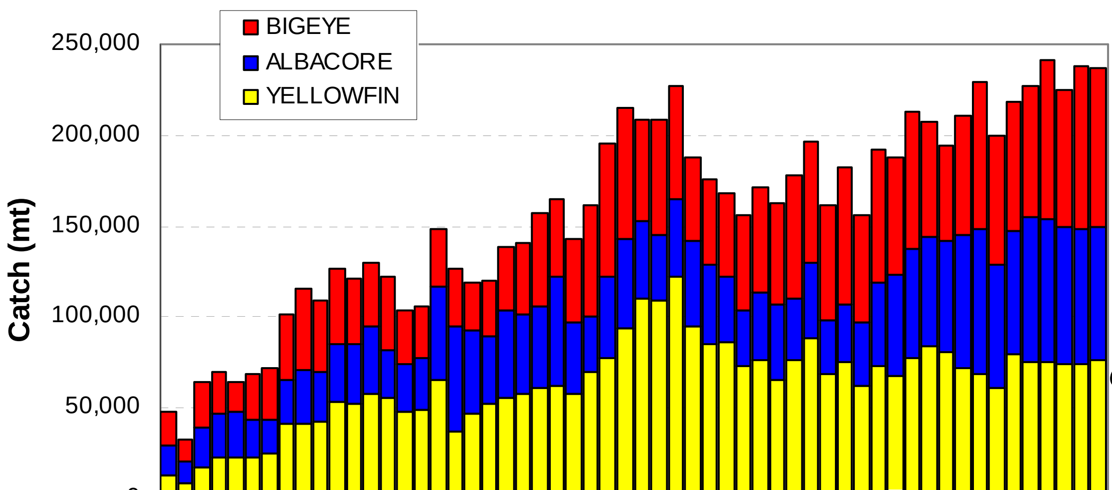


Figure 6. Number of longline vessels operating in the WCP-CA, 1972–2005 (upper figure) and longline catches (lower figure), 1950–2005). Source: modified from Williams and Reid (2006).

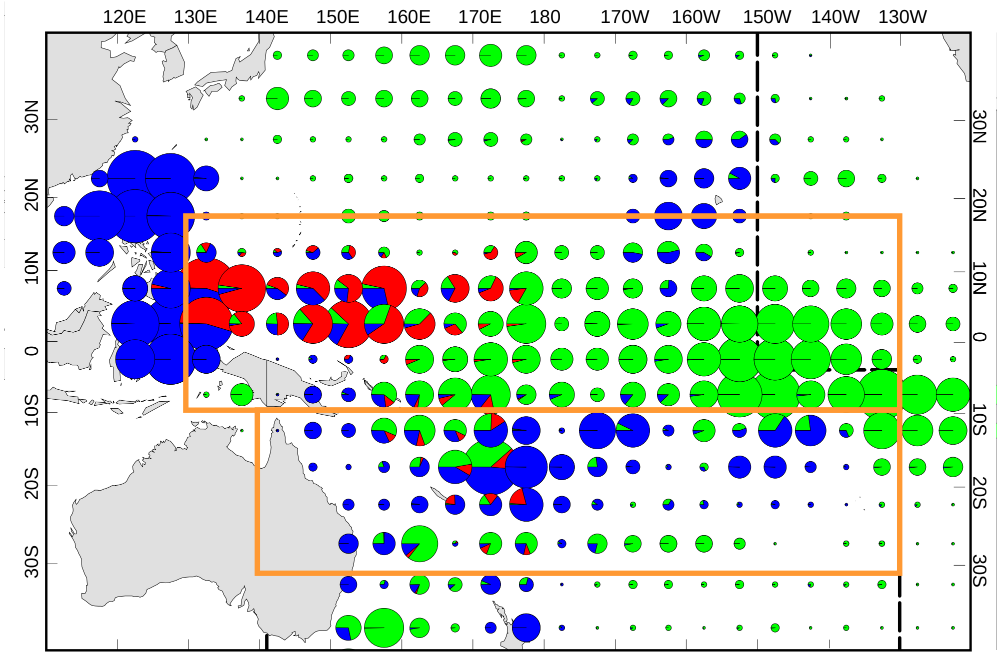


Figure 7. Longline effort (hooks) by major vessel class in the WCP-CA, 2000–2004. Source: modified from Williams and Reid (2006). Colour codes: blue, domestic fleets; red, foreign offshore fleets; green, distant water fleets. The top orange box defines the area of operations of the tropical shallow longline (TSL) and tropical deep longline (TDL) fisheries. The lower orange box defines the main region of the temperate albacore longline (TAL) fishery.

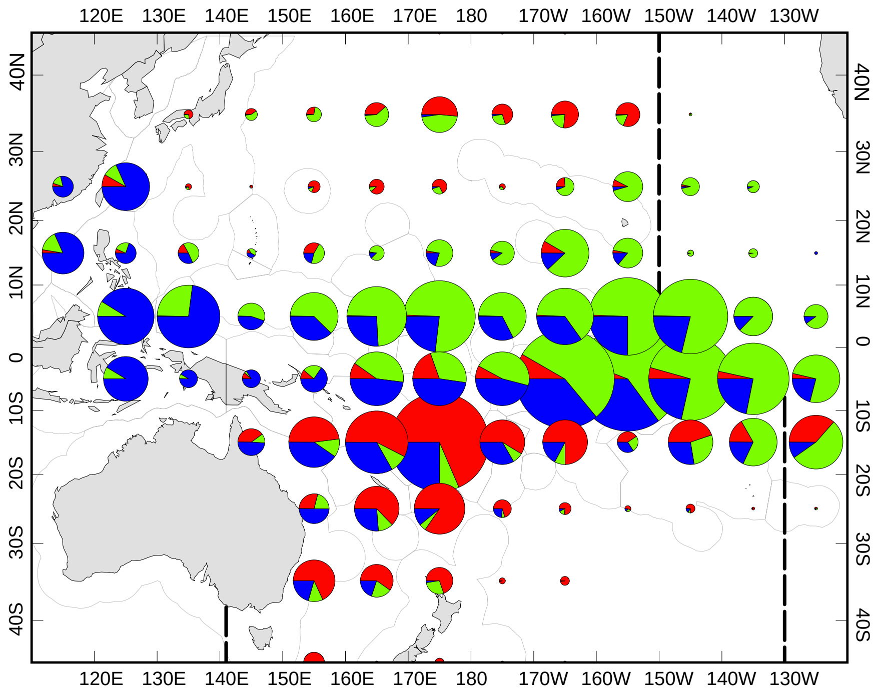


Figure 8. Longline catches (mt) by major tuna species in the WCP-CA, 2000–2004. Source: Williams and Reid (2006). Colour codes: blue, yellowfin; red, albacore; green, bigeye.

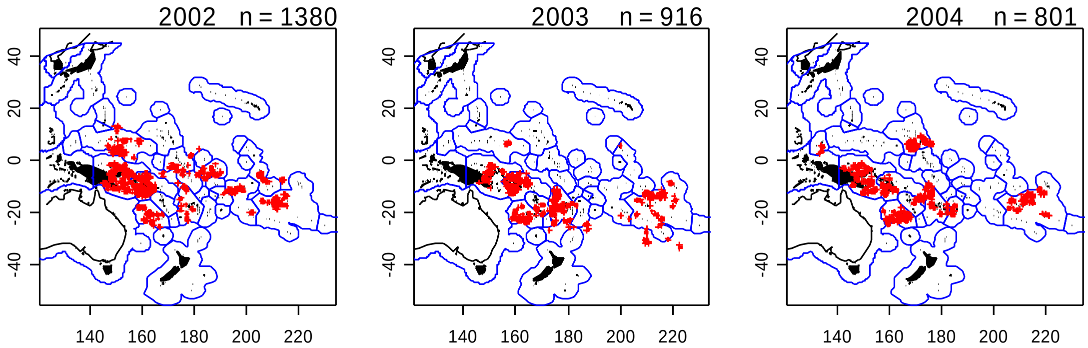


Figure 9. Position of observed longline sets in the WCPO, 2002–2004. Source: observer data base held at SPC and Molony (2005a). Red dots record the position of an observed longline set. n =, indicates the total number of observed sets for each year. Data for 2003 and 2004 may be incomplete due to lags with data supply.

3. Review of bird, mammal, shark and turtle bycatch in WCP-CA industrialised fisheries

Information on catches and bycatch species from the WCP-CA industrialised fisheries relies on logsheet, observer and port sampling data. Although coverage rates of all three data sources have improved (Figure 10, Table 1), all data sources represent significantly less than 100% coverage. Additionally, coverage rates are not evenly distributed among fleet, ports, gears or spatially.

Table 1. Observer coverage rates (%) for the four WCP-CA fisheries examined within this report, 1994–2004. Source: SPC observer data base and Molony (2005a).

Year	Longline fisheries			Purse-seine
	Tropical shallow	Tropical Deep	Temperate albacore	
1994	0.1	0.1	0.3	2.0
1995	0.1	0.1	0.3	2.0
1996	0.0	0.2	0.6	3.0
1997	0.1	0.4	0.9	3.0
1998	0.2	0.7	0.3	3.0
1999	0.1	0.4	0.3	2.0
2000	0.1	0.6	0.2	4.0
2001	0.0	0.7	0.2	5.0
2002	0.0	0.9	0.1	7.0
2003	0.0	0.7	0.7	6.0
2004	0.2	0.4	0.8	11.0

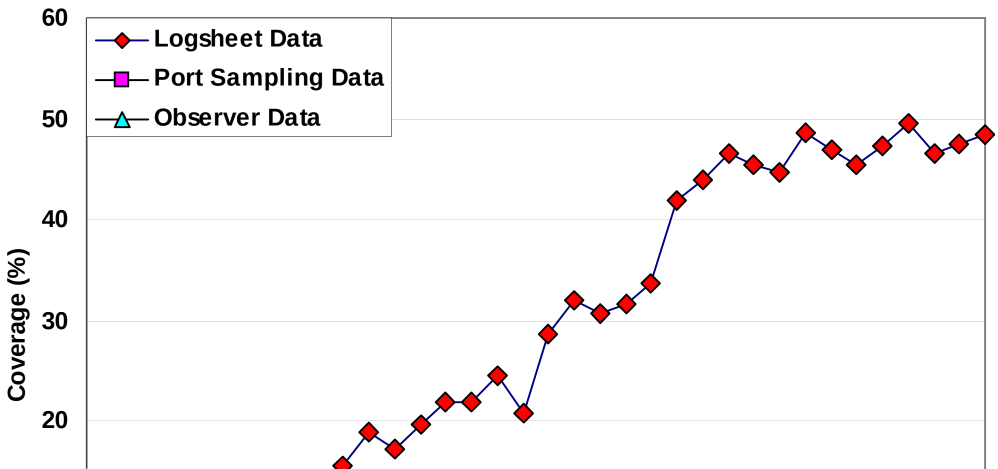


Figure 10. Coverage rates of the main data sources for estimating catches of all species in the WCP-CA, 1970–2005. Source: Williams and Reid (2006).

Logsheets typically record only the major retained species. These data are critical in estimating catches of target species but has traditionally provided very little information on bycatch species. In contrast, observer data provides information of all individuals and species captured. Other information is also recorded by observers (e.g. condition at landing, fate of individuals). However, observer coverage rates are less than 10% in the WCP-CA. OFP (2006) estimated that average annual coverage rate of the WCP-CA longline fishery was 0.65% between 1993 and 2004. Annual observer coverage rates for the WCP-CA purse-seine fleet has averaged 3.59% between 1995 and 2004 (OFP 2006). This means that estimates of bycatch must be generated from relatively low levels of observer data, resulting in wide confidence limits around point estimates (e.g. Molony 2005a, OFP 2006). Nonetheless, observers in the WCP-CA have recorded information on 279 species and 79 higher taxonomic groups since 1990 (Kirby 2006).

Due to limited data, observer records of birds, sharks, mammals and turtles were pooled within each year for each fishery (TSL, TDL, TAL and purse-seine). For the purse-seine fishery, estimates were stratified by set type. Nominal catch rates of each class were estimated for each fishery and raised to represent the total estimated catches of each class by each fishery. Ninety-five percent confidence intervals (95% CI) were also estimated. Given the low levels of data, confidence intervals were estimated using the entire time-series of observer data for each fishery (i.e. global confidence limits) (see Molony (2005a) for details). In addition, OFP (2006) estimated the catches of common bycatch species in the WCP-CA, also producing estimates with wide confidence intervals (see section 3.2.3). Given the low number of records for each class of bycatch species within each fishery and the WCP-CA, the annual estimates and confidence intervals remain highly uncertain.

With the exception of sharks, the interactions between major bycatch groups (birds, turtles and mammals) and the four commercial fisheries examined occurred at very low frequencies (Appendix 2).

3.1 Brief review of bird, turtle, mammal and shark bycatch in WCP-CA longline fisheries

3.1.1 Birds

Interactions between birds and longline fisheries in the WCP-CA region examined have been very low (less than 0.001 birds.hhooks^{-1}) since the mid 1990s, with only a single bird reported by observers in the these three longline fisheries since 1998. Between 1990 and 2004, there were 39 records of longline-bird interactions in the region examined. Most records (n=37) listed the bird as ‘unidentified’; two records listed the bird as ‘albatross’; thus information on the species involved is currently lacking.

Birds were only reported in the TSL fishery in 1995 and 1997, with annual average catch rates of between 0 and 0.0048 birds per hundred hooks (hhooks^{-1}) (Appendix 3). No interactions with birds were reported by observers from the TDL fishery between 1992 and 2004 (i.e. 0 birds. hhooks^{-1}).

Catch rates of birds reported in the TAL in varied between 0 and 0.0179 birds.hhooks^{-1}, although catch rates in most years were less than 0.005.hhooks^{-1}. While still low, observer coverage in the TAL is not evenly distributed, with most observers associated with fleets and fisheries within the sub-equatorial EEZs of the WCP-CA. A large Taiwanese longline fleet operates in the WCP-CA south of 20ºS and there is currently no observer coverage for this fleet. Thus bird-longline interactions for the TAL are likely to be under-estimated in the current report.

The very low coverage rates resulted in very large estimates of interactions and mortalities, and wide confidence intervals (Figure 11, Figure 12, Figure 13, Figure 14, Figure 15 and Figure 16). Nonetheless, total mortality of birds within the three longline fisheries examined in the WCP-CA was estimated at less than 100 birds per year since 1998, albeit with wide confidence intervals (Molony 2005a). A low or negligible level of fishery-seabird interactions in the tropical WCPO (north of 30ºS) was also reported by Watling (2002).

Other areas of the WCP-CA (e.g. south of 30ºS, north of 20ºS) have reported higher interactions between (longline) fisheries and seabirds (e.g. Baker and Wise 2005). This is due to many species of seabirds having a distribution generally confined to south of 30ºS (Waugh 2006, IATTC 2006) or north of approximately 20ºN (Watling 2002, IATTC 2006) in the Pacific Ocean, especially in areas west of 150ºW (IATTC 2006). It is also common that significant seabird breeding areas are located on islands within higher latitudes (e.g. Baker and Wise 2005, Stobutzki. et al. 2006). Thus, interactions between seabirds and fisheries, and therefore mortalities, are much higher in higher latitudes than in the tropical WCP-PA. (Refer to the references cited in this section for more details). However, not all sources of data useful for estimating total catches of seabirds (e.g. observer data) are currently centralised (Molony 2005a, OFP 2006). [This also applies to the catches of other bycatch taxa through this report]. In addition, the lack of observer coverage for some major longline fleets in the WCP-CA, (e.g. the Taiwanese longline fleet operating south of 20ºS) and the spatial distribution of observer coverage, is likely to result in estimates for bird–longline fishery interactions being significantly biased.

3.1.2 Mammals

Observers have reported a total of 22 mammals interacting with longline gears in the three longline fisheries examined in the WCP-CA (Molony 2005a). Nearly all records failed to identify the mammal to species level. Observers reported that most mammals (~74%) were released alive.

Most interactions were reported in the TSL fishery with catch rates up to 0.01 mammals. hhooks^{-1} in one year (Appendix 3). However, many years resulted in no interactions between longline fisheries and mammals. Again, raising the data resulted in high estimates of interactions and large confidence intervals, with mortality estimates of approximately 265 mammals per year during the 1990–2004 period (95% CI: 43–1,874) (Figure 11, Figure 12, Figure 13, Figure 14, Figure 15 and Figure 16). Catch rates and mortality rates have declined in recent years, with less than 200 mammal mortalities estimated from the three longline fisheries between 2000 and 2004.

It is worth noting that a significant issue in the region in regard to longline-mammal interactions is depredation of longline captured fish by toothed whales (Lawson 2001, Nishida and Tanio 2001). Details of depredation rates and impacts are unclear at the moment, although the perception by longline crews in some areas are that the populations of toothed whales are increasing, as are the rates of depredation. Observers do report evidence of damaged tuna, allocating the damage to sharks, squids or toothed whales. However, the rates of reporting this information are low. Nonetheless, the perception in some areas is that this is a big issue and management measures (e.g. improved data collection) should be considered.

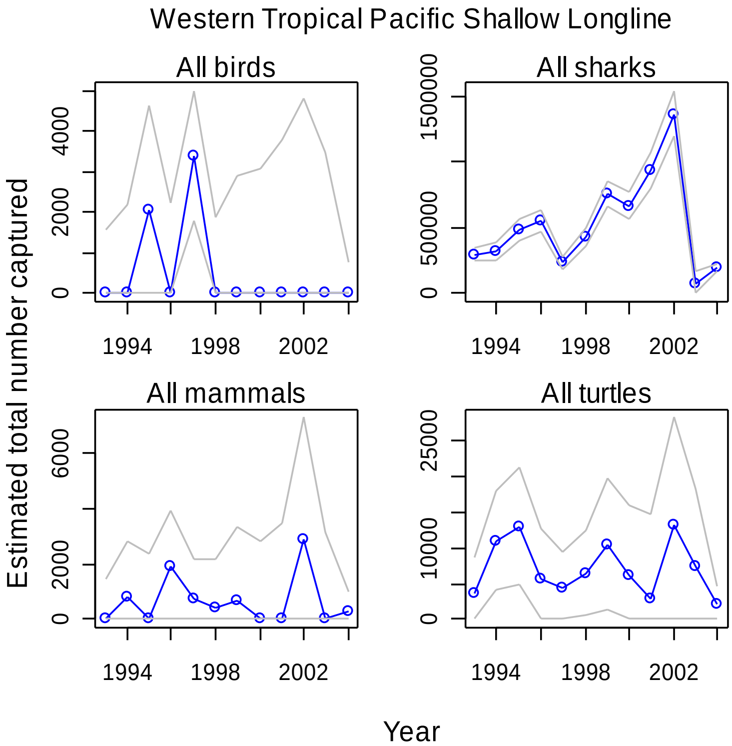


Figure 11. Estimated total catches (numbers, blue lines) of each major taxa by the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Grey lines represent 95% confidence intervals generated from global standard deviations for each taxa.

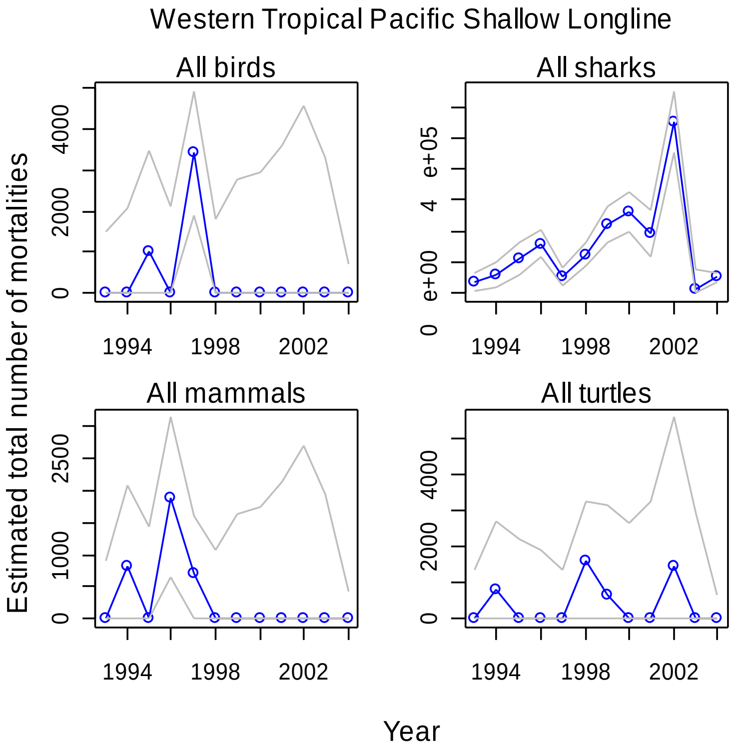


Figure 12. Total estimated mortalities (numbers, blue lines) of each major taxa by the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks. Grey lines represent 95% confidence intervals generated from global standard deviations for each taxa.

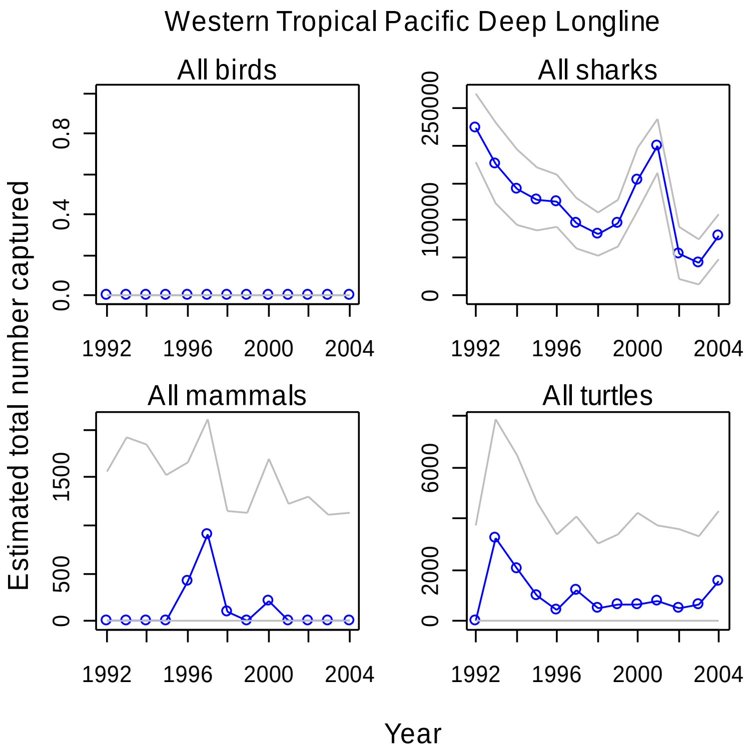


Figure 13. Estimated total catches (numbers, blue lines) of each major taxa by the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Grey lines represent 95% confidence intervals generated from global standard deviations for each taxa.

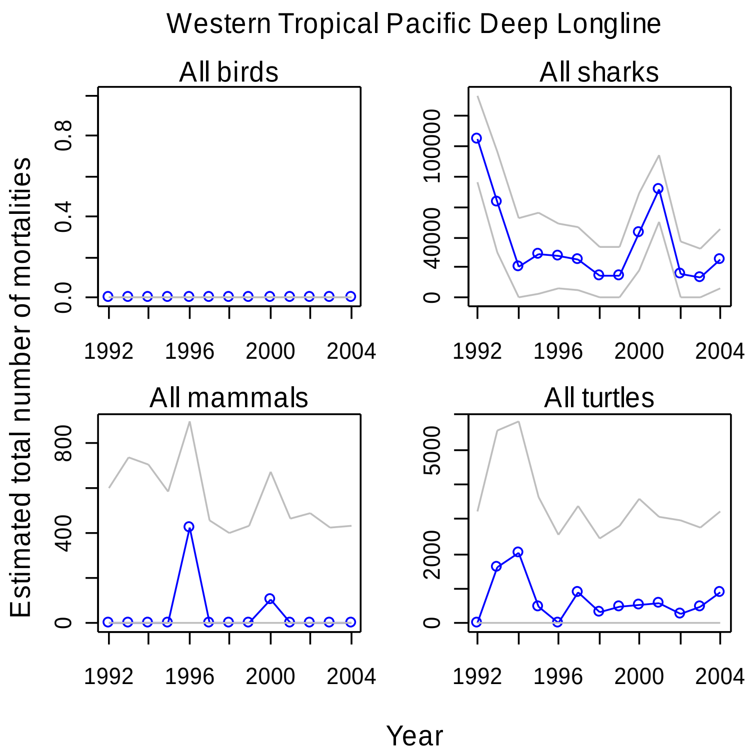


Figure 14. Total estimated mortalities (numbers, blue lines) of each major taxa by the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC. Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks. Grey lines represent ±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

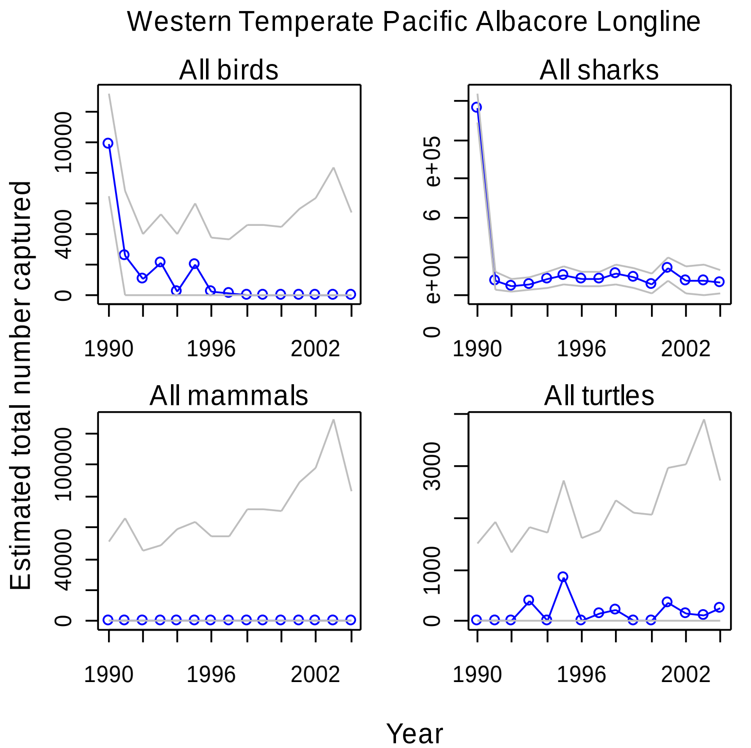


Figure 15. Estimated total catches (numbers, blue lines) of each major taxa by the temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC. Grey lines represent 95% confidence intervals generated from global standard deviations for each taxa.

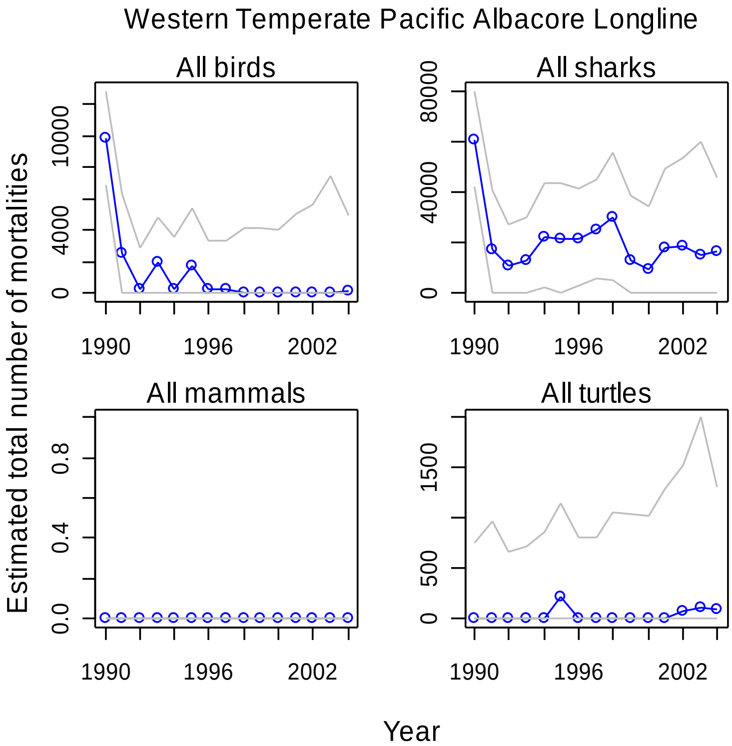


Figure 16. Total estimated mortalities (numbers, blue lines) of each major taxa by temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC. Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks. Grey lines represent 95% confidence intervals generated from global standard deviations for each taxa.

3.1.3 Sharks

Interactions between sharks and longline fisheries are more frequent than for other taxa (see Appendix 2). This is due to the higher relative abundance of sharks compared to turtles and mammals, and that some longline fisheries specifically target sharks in some areas of the WCP-CA. More than 290,000 observer records exist for sharks, with records for more than 40 species (Appendix 4). Shark catches in the three longline fisheries examined were much higher than those for birds, mammals and turtles (Figure 11, Figure 12, Figure 13, Figure 14, Figure 15 and Figure 16), dominated by blue, silky and oceanic whitetip sharks, and the pelagic sting-ray (Figure 17, Figure 18 and Figure 19).

Annual shark catches since 1990 have averaged more than 667,000 sharks (95% CI: 520,000–820,000), with a trend for increasing catches. However, records of fate are limited, although it is suspected that a high proportion of sharks are finned (i.e. suffer mortality). However, a resolution to reduce fining was tabled at WCPFC 3, and several countries have banned shark fining within their national waters (see section 4). Most sharks are reported from the TSL (Figure 11 and Figure 12), the fishery that includes most of the targeted-shark fisheries. Shark catches in the TAL have generally declined since 1990 (Figure 15 and Figure 16).

Many of estimates of catch rates and catches of sharks appear to decline late in the time series (2003 and 2004) (e.g. Figure 17). This is likely due to the incomplete logsheet data at the time of estimating catches, with logsheet data incomplete for 2003 and large amounts of data outstanding for the 2004 fishing year. It is more likely that catches of sharks are similar to, or higher than, those for 2000–2002.

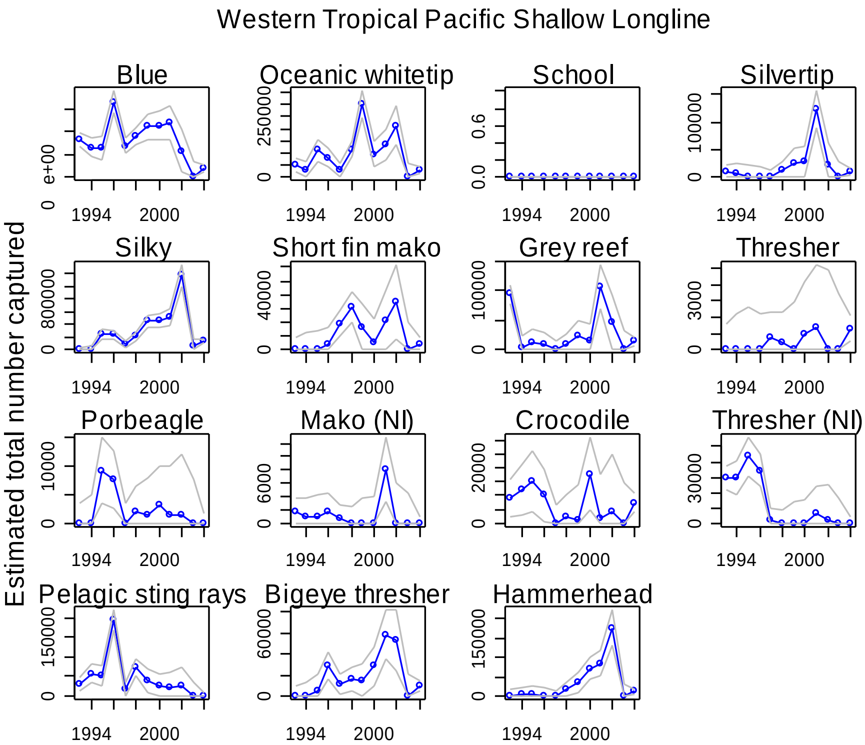


Figure 17. Estimated total catches (numbers, blue lines) of common shark taxa by the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a). Grey lines represent 95% confidence intervals generated from global standard deviations for each taxa. (NI), indicates an taxa not identified to species level. Scales of y-axes vary among taxa.

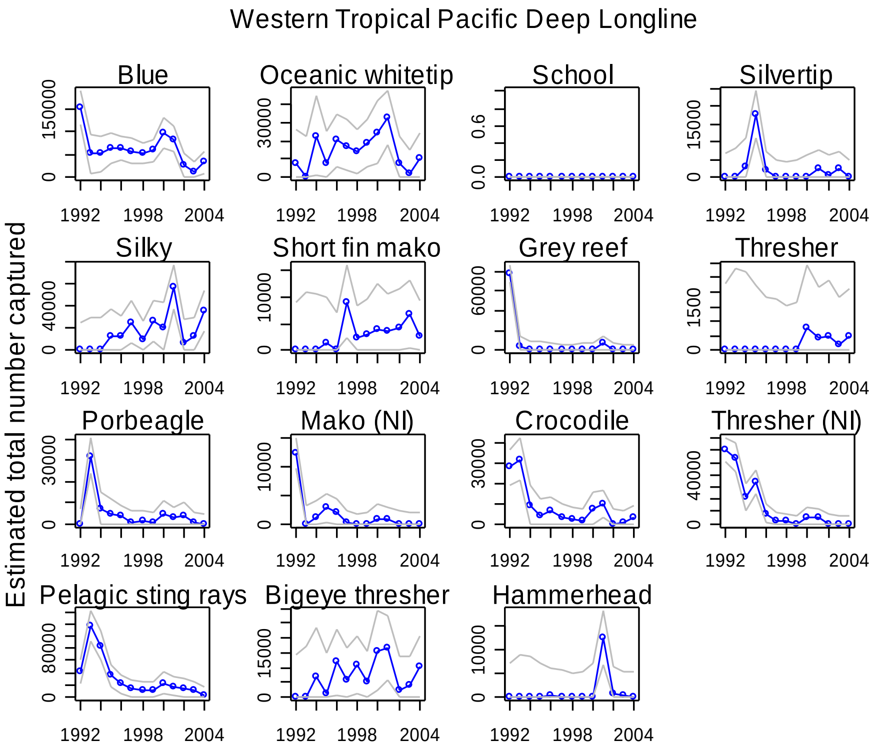


Figure 18. Estimated total catches (numbers, blue lines) of common shark taxa by the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a). Grey lines represent 95% confidence intervals generated from global standard deviations for each taxa. (NI), indicates an taxa not identified to species level. Scales of y-axes vary among taxa.

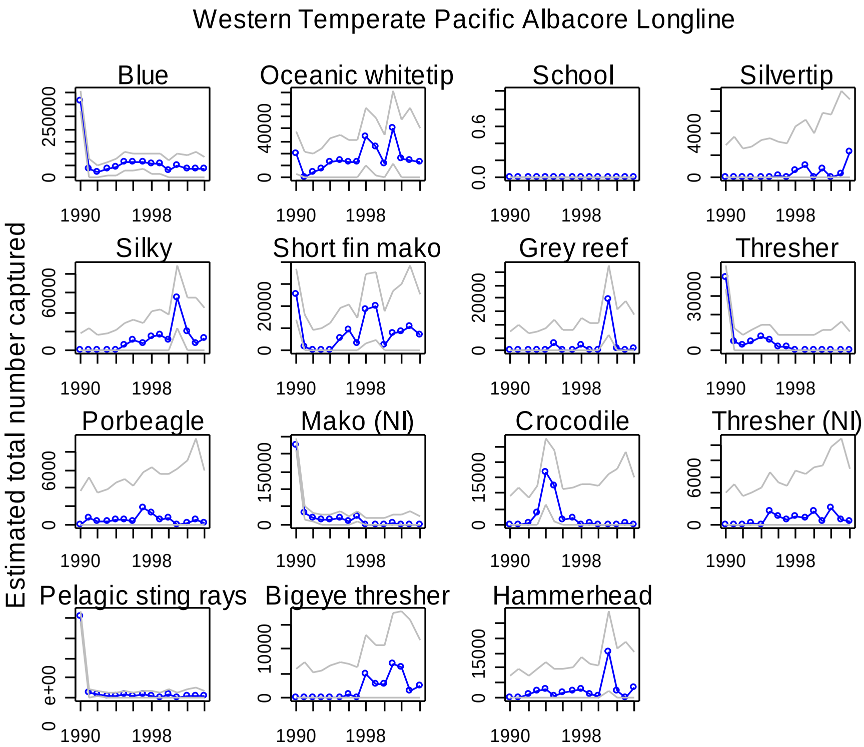


Figure 19. Estimated total catches (numbers, blue lines) of common shark taxa by the temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a). Grey lines represent 95% confidence intervals generated from global standard deviations for each taxa. (NI), indicates an taxa not identified to species level. Scales of y-axes vary among taxa.

3.1.4 Turtles

A total of 159 records of turtles exist for the three longline fisheries examined in the WCP-CA, 1990–2004. Many turtles were not identified to species by observers. Of those species identified by observers, olive ridley (21% of records) and green (17% of records) turtles were most common. Leather back turtles represented approximately 10% of observer records.

Mean annual catch rates of all turtles in all three longline fisheries were generally less than 0.002.hhooks^{-1} (Appendix 2). The highest catch rates were in the TSL fishery (Figure 11, Figure 12, Figure 13, Figure 14, Figure 15 and Figure 16), especially in areas west of 170ºE (Molony 2005a). However, observers in the TSL reported that most turtles captured were released alive. A higher mortality rate was reported in the TDL, likely due to the difficulties of hooked turtles reaching the surface if captured on deeper set gears.

Despite the low nominal catch rates and high rate of release of live turtles, the mean mortality rate was estimated at approximately 918 turtles per year (95% CI: 0–6,134) (Molony 2005 a). This is similar to a previous estimate by OFP (2001). However, mortality rates have declined since the late 1990s.

3.2 Brief review of purse seine bycatch of juvenile tunas associated with FADs and of birds, mammals, sharks and turtles

3.2.1 Review of the bycatch of juvenile tunas associated with FADs

The purse-seine fishery of the WCP-CA primarily targets skipjack. However, yellowfin and bigeye tuna are also commonly captured by the purse-seine fishery (Figure 3) (Williams and Reid 2006). Most of the catches of bigeye by the purse-seine fishery are reported from associated sets (i.e. sets on floating objects, including logs and FADs) (Figure 20). Significant catches of yellowfin are also reported from unassociated sets (Figure 20).

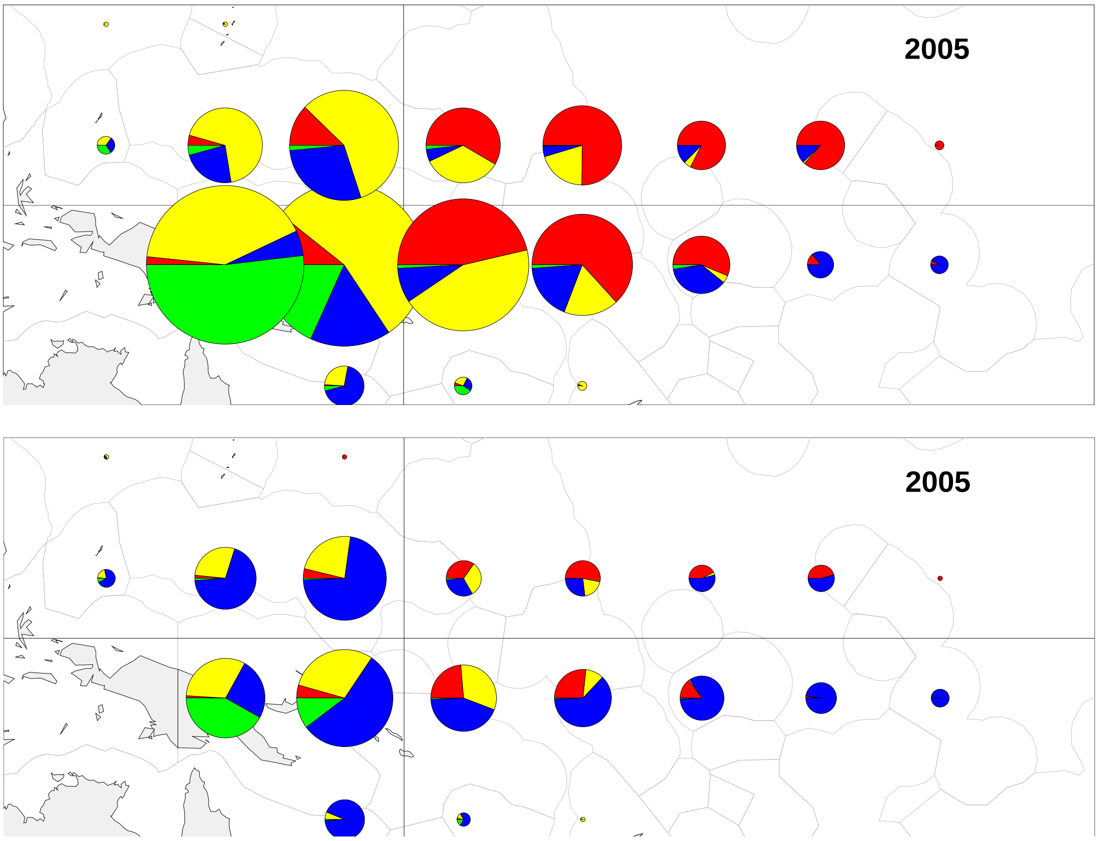


Figure 20. Catches of bigeye (upper figure) and yellowfin (lower figure) tuna by the purse-seine fishery of the WCP-CA, 2005. Source: Williams and Reid 2006. Blue, unassociated sets; yellow, log sets; red, drifting FAD sets; green, anchored FAD sets. Circle size is proportional to catches.

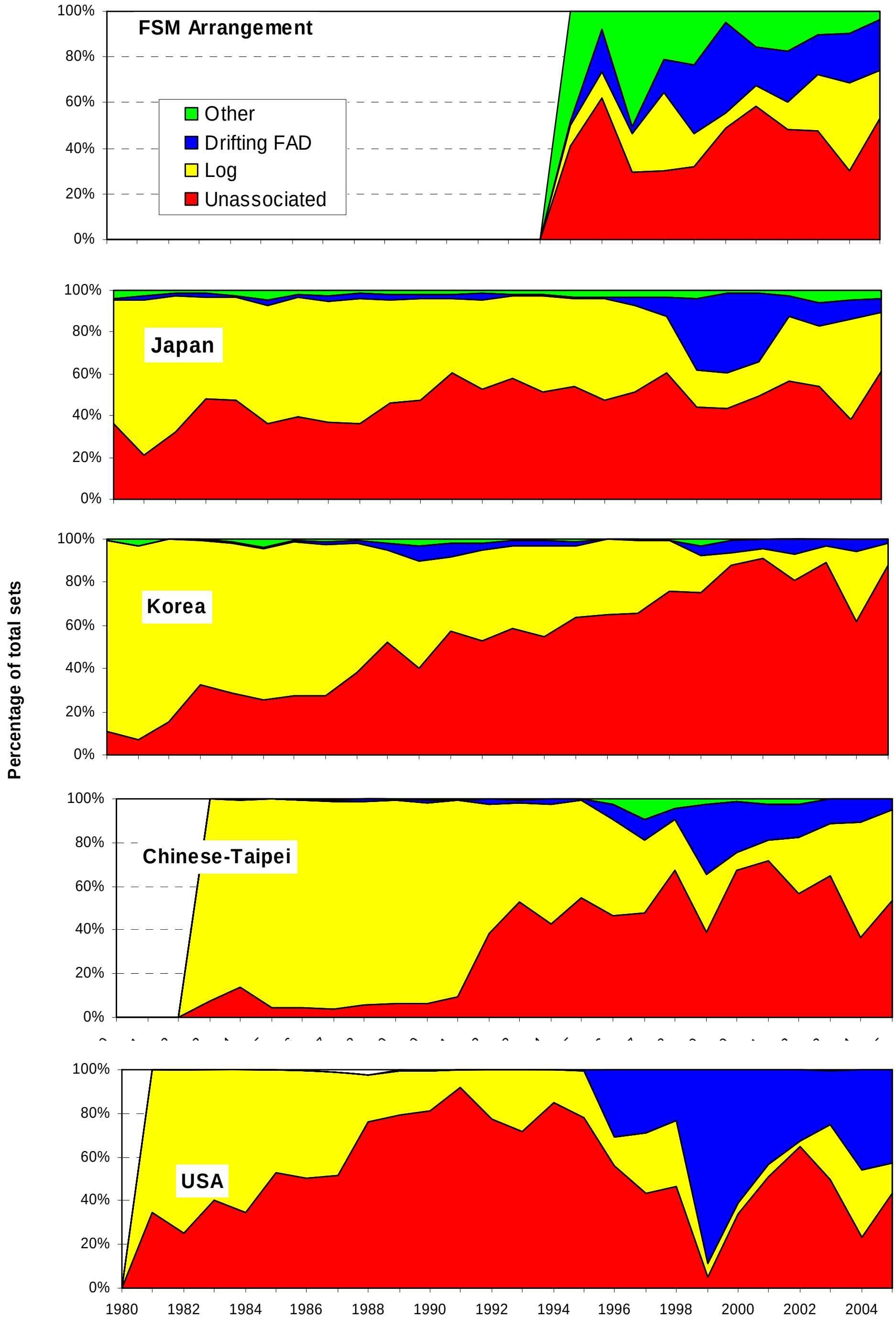


Figure 21. Percentage of total sets by school type for the major purse-seine fleets operating in the WCP–CA, 1980–2005. Source: data base held by SPC and Williams and Reid (2006). Other includes other associated set types

Differences exist in the size distribution and proportions of tuna species captured from associated and unassociated sets. Higher proportions of bigeye are captured in associated sets (FAD/Log) than in unassociated sets (School) (Figure 22). Additionally, nearly all bigeye captured in associated sets are less than 80 cm Fork Length (FL), with most less than 60 cm FL (Figure 23). A slightly lower proportion of yellowfin are reported from associated sets than from unassociated sets (Figure 22). However, yellowfin from associated sets display a smaller size distribution than yellowfin captured from unassociated sets. Overall, purse-seine fisheries capture mainly juvenile bigeye and yellowfin, well below the size of first reproduction and below the size that would maximise yield per recruit.

Table 2. Estimated total number of sets, percentage of associated sets and tuna catches by set type and species in the WCP-CA, 1994–2005. Source: SPC data base. Set codes: Assoc., sets on tuna schools associated with floating objects (logs, anchored FADs, drifting FADs, animals); Unaasoc., sets on free schools of tuna, not associated with a floating structure.

Year	Number of sets			Bigeye		Skipjack		Yellowfin	
	Assoc.	Unassoc.	% Assoc.	Assoc.	Unassoc.	Assoc.	Unassoc.	Assoc.	Unassoc.
1994	15,296	20,950	42.2	10,426	1,134	384,182	335,738	79,685	152,247
1995	15,882	21,114	42.9	10,754	1,083	341,356	372,755	81,267	119,346
1996	21,531	18,612	53.6	19,897	2,082	447,447	290,245	81,134	48,998
1997	47,712	23,716	66.8	37,794	3,644	404,367	265,844	151,823	117,099
1998	34,164	29,012	54.1	20,001	4,201	570,859	405,909	88,010	195,909
1999	28,053	15,632	64.2	27,539	750	623,310	225,521	168,019	71,339
2000	29,359	26,335	52.7	23,536	1,082	536,502	383,329	113,911	114,926
2001	22,572	25,852	46.6	26,018	4,265	432,804	439,744	93,243	152,810
2002	26,648	26,344	50.3	25,776	2,974	594,765	470,676	106,668	99,924
2003	21,647	24,439	47.0	21,538	1,151	502,305	515,864	117,546	139,264
2004	43,620	20,932	67.6	29,381	2,400	875,825	257,616	131,063	75,273
2005	17,484	22,210	44.0	30,981	5,407	523,323	480,022	86,144	107,389

As a result of capturing small fish in associated sets, the impacts of unassociated sets by the purse-seine fishery on WCPO stocks of bigeye and yellowfin are out of proportion with catches (Figure 24). This is most evident for bigeye, where the recent impacts by the purse-seine fishery on associated sets is estimated to have been responsible for reducing the total biomass by more than 20%. For yellowfin, the reduction in total biomass attributable to the purse-seine fishery on associated sets is more than 10%, similar to the impact of the purse-seine fishery on unassociated sets, but much larger than the impact of longline fishing.

In addition, the bycatch from the purse-seine fishery varies between unassociated and associated sets. For example, observers report significantly higher frequencies of capturing mammals, sharks and turtles from associated sets (logs, aFADs and dFADs) than from sets on unassociated schools of tuna (free schools and baitfish associated schools) (Molony 2005a) (e.g. sharks, Figure 25 and Figure 26). Thus, purse-seine fishing on tuna schools associated with floating objects (i.e. associated sets; logs and FADs) has a higher frequency of interaction and higher catch rates of mammals, sharks and turtles than fishing on unassociated sets. There is also a small proportion of purse-seine fishing that target tuna schools associated with whales and whale sharks, increasing the interactions between the fishery and marine mammals and a protected species of shark (Figure 26).

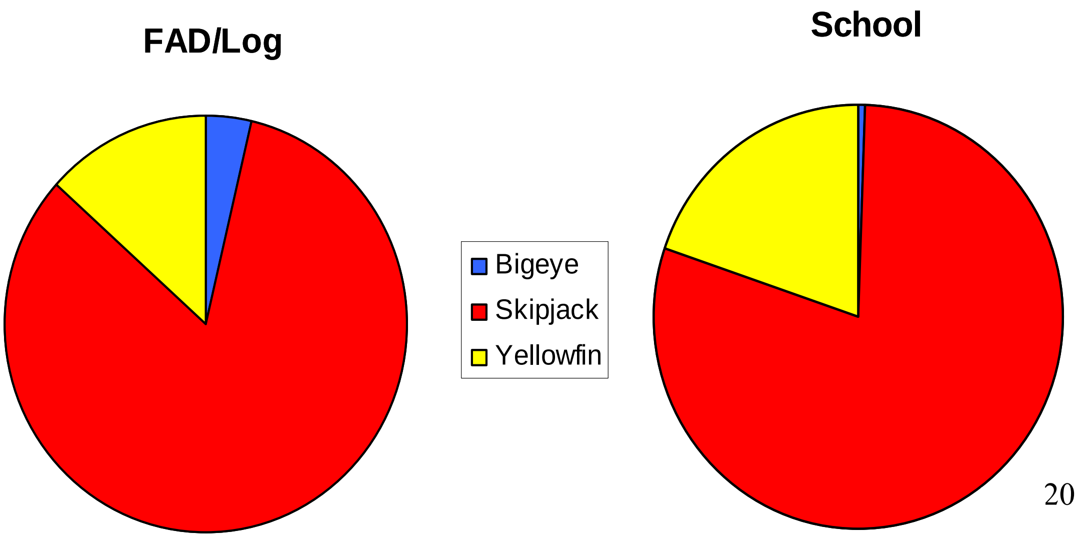


Figure 22. Proportions of the three main tuna species captured from associated sets (FAD/Log, left hand figure) and unassociated sets (School, right hand figure). Source: Williams and Reid 2006. Catches of yellowfin and bigeye from associated sets are dominated by small, juvenile individuals. Catches of yellowfin from unassociated sets are dominated by large, adult individuals.

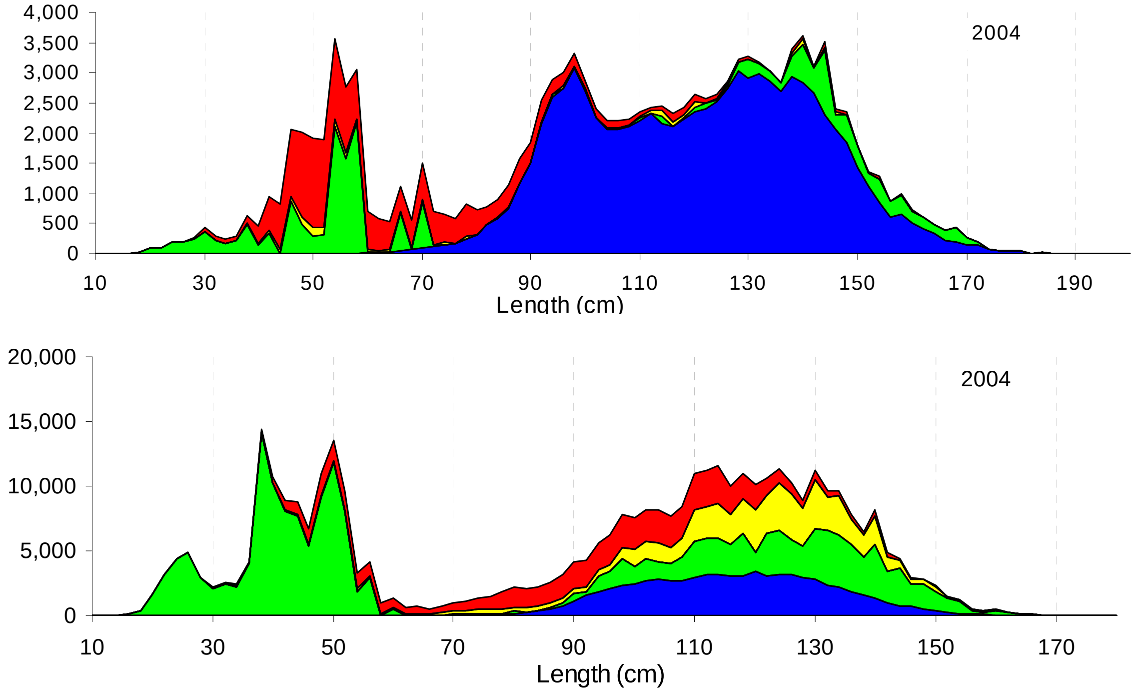


Figure 23. Size distribution of bigeye (upper figure) and yellowfin (lower figure) captured in the main industrialised fisheries of the WCP-CA, 2004. Source: Williams and Reid (2006). Green, catches by Indonesia and Philippines; red, catches from associated sets by the purse-seine fishery; yellow, catches from unassociated sets by the purse-seine fishery; blue, catches by the longline fisheries. Y-axes in metric tonnes.

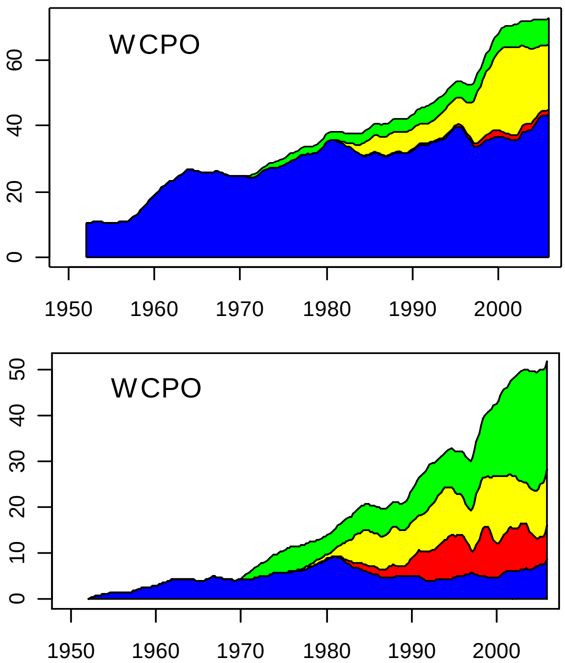


Figure 24. WCPO-wide estimates of reductions in total biomass of bigeye (upper figure) and yellowfin (lower figure) due to fishing (i.e. fishing impacts). Sources: Hampton et al. (2006a, b). Green, catches by Indonesia and Philippines; red, catches from unassociated sets by the purse-seine fishery; yellow, catches from associated sets by the purse-seine fishery; blue, catches by the longline fisheries. Y-axes in percent reductions from virgin (pre-fished) biomass tonnes.

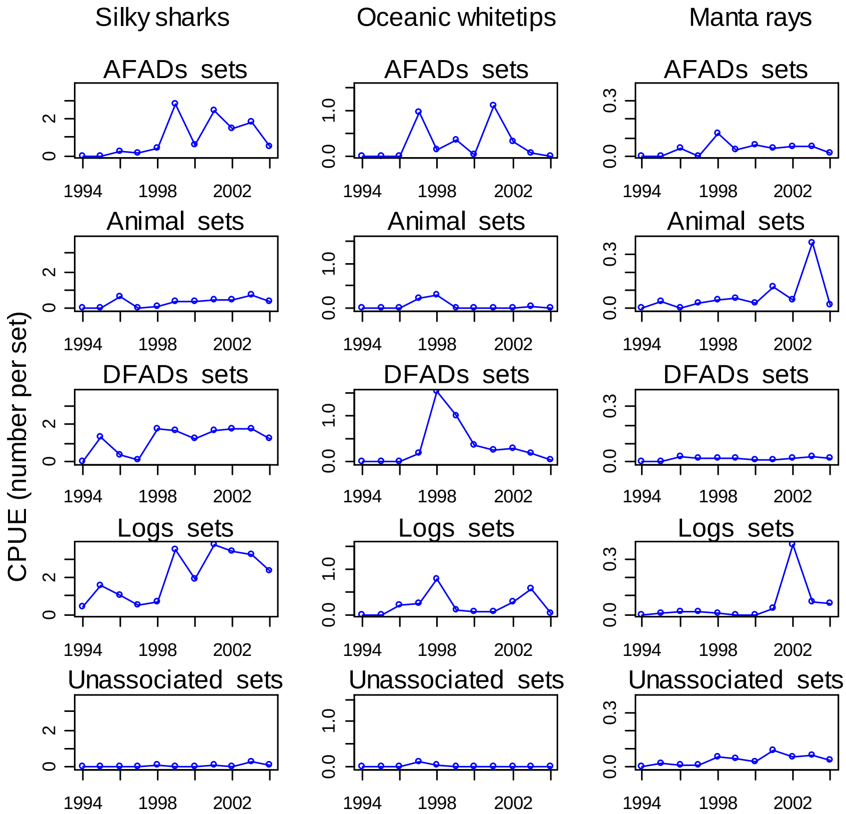
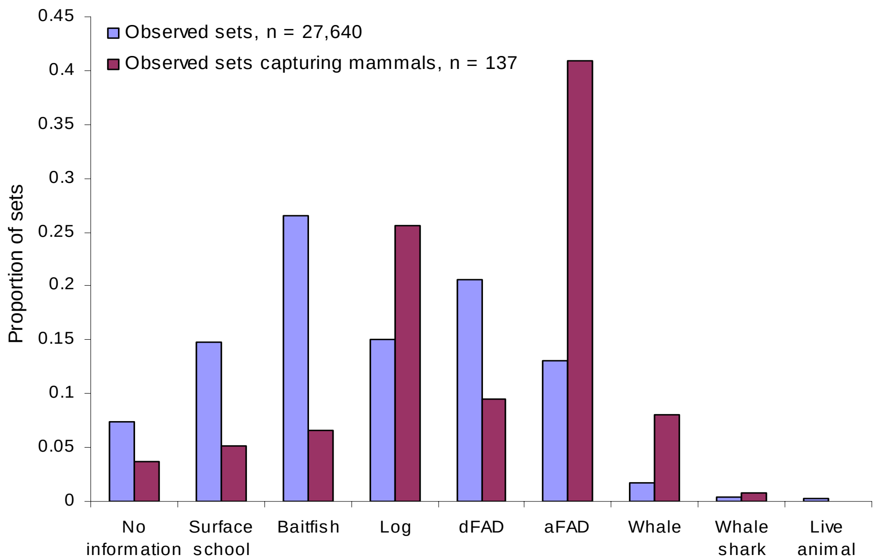
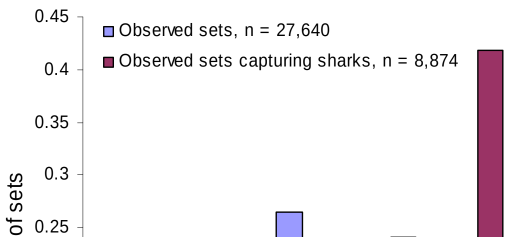


Figure 25. Nominal catch rates by set type of the three most common taxa of shark bycatch by the purse-seine fishery of the WCP-CA, 1994–2004. Source: observer database maintained by SPC and Molony (2005a). Scales of y-axes vary among figures. Set types: AFADs, anchored FADs; Animal sets, sets of whales and whale sharks; DFADs, sets on drifting FADs; Logs sets, sets on logs; Unassociated sets, sets of free schools of tuna or schools associated with baitfish.





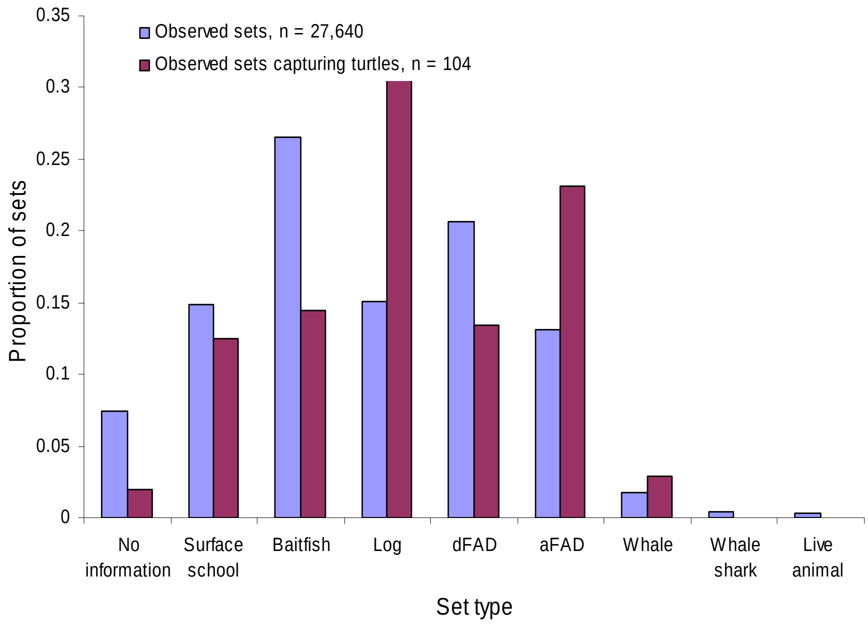


Figure 26. Proportion of observed sets (blue bars) and observed sets capturing one or more mammals (upper figure), sharks (middle figure) or turtles (lower figure) (red bars) by set-type in the WCP-CA, 1994–2004. Source: Molony 2005a.

3.2.2 Summary interactions with the purse-seine fishery and birds, mammals, sharks and turtles.

3.2.2.1 Birds

It seems interactions between birds and the purse-seine fishery are insignificant in then WCP-CA, with a single interaction and no mortalities recorded in the purse-seine fishery since 1994 (Figure 27).

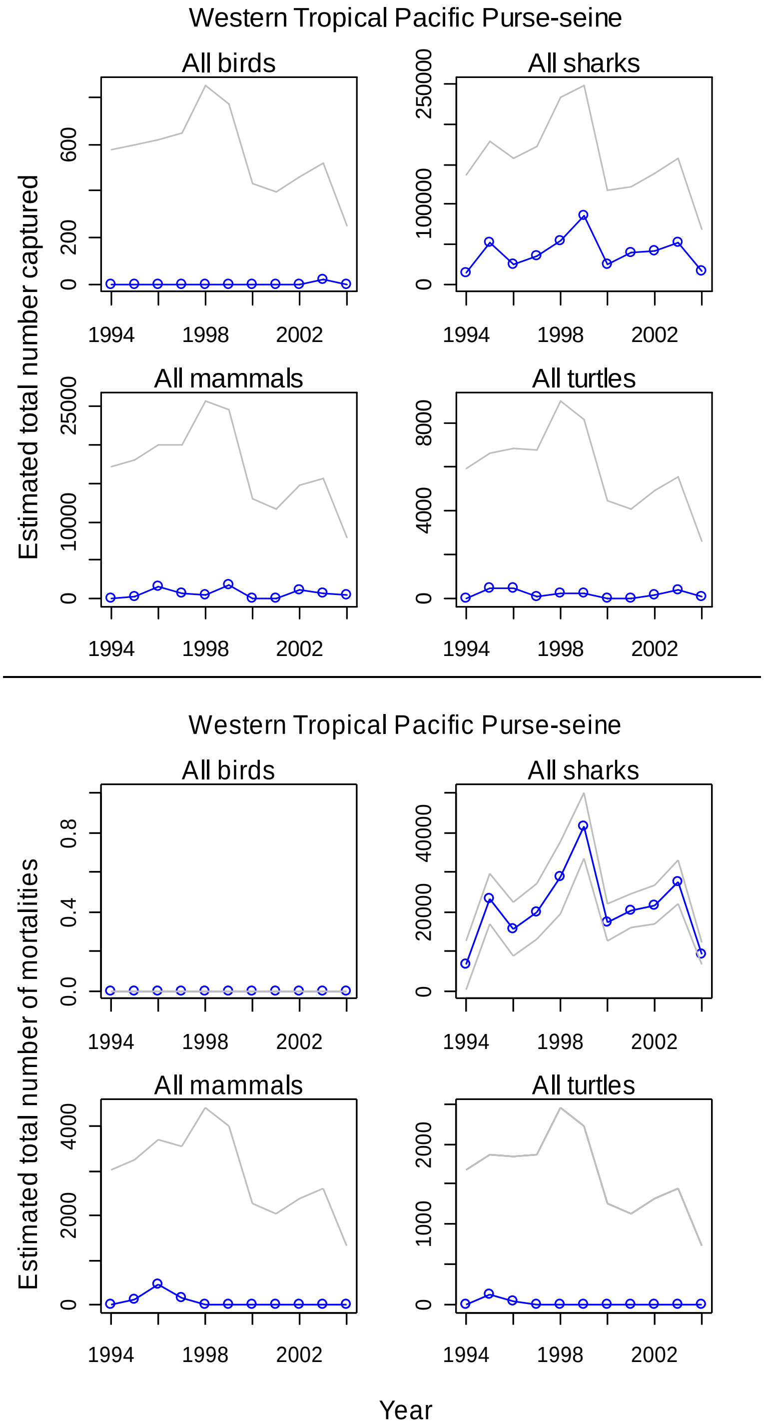


Figure 27. Estimated total catches (upper figures) and mortalities (lower figures) of major classes of bycatch by the purse-seine fishery of the WCP-CA, 1994–2004. Source: observer database maintained by SPC and Molony (2005a). Grey lines represent 95% confidence intervals generated from global standard deviations for each class. Scales of y-axes vary among figures.

3.2.2.2 Mammals

Interactions have been reported between the purse-seine fishery and mammals. However, total levels of interactions have been very low, with less than 10 mortalities in total estimated since 1998. Similar to the longline fishery, there are large confidence intervals around all estimates (Figure 27). Most interactions occur with sets on associated schools (logs, FADs) or with sets made on tuna schools associated with whales.

3.2.2.3 Sharks

Relatively large catches of sharks have been observed in the purse-seine fishery of the WCPO (Figure 27), with the highest interactions observed during sets on associated schools of tuna (e.g. FADs, logs) (Figure 25). While a large number of sharks are discarded, it is likely that many suffer mortality though suffocation while the net is being pursed and brailed (P. Sharples, pers. comm.). However, details of fate are not always recorded by observers. In addition, a small number of sets are made on tuna schools associated with whale sharks (Figure 26).

Observers have reported 26 taxa of sharks being captured in the purse-seine fishery of the WCP-CA, including unidentified categories. However, catches are dominated by silky and oceanic whitetip sharks, and unidentified manta rays (Molony 2005a) (Figure 28).

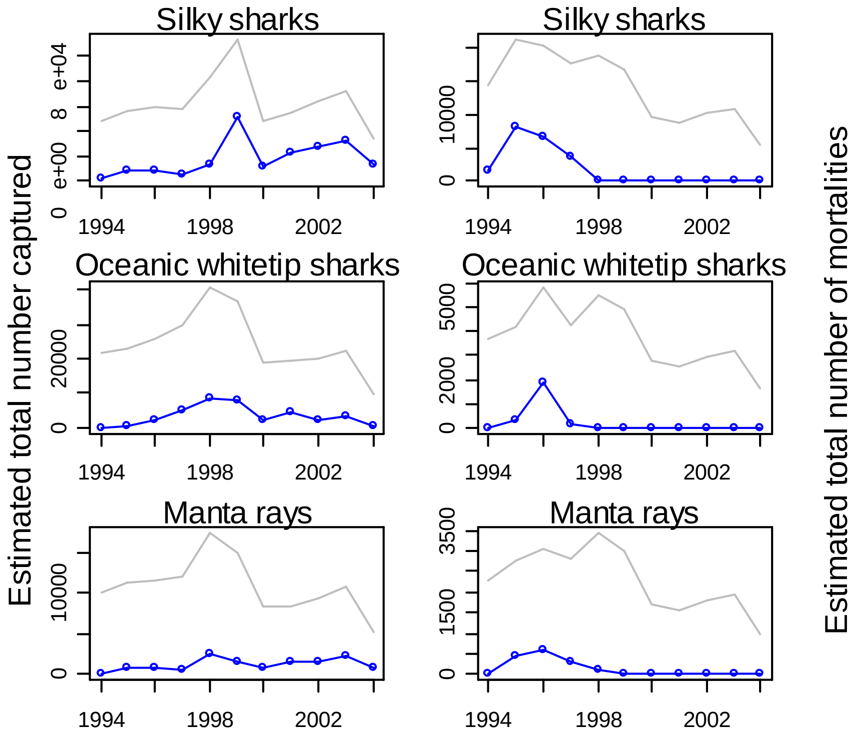


Figure 28. Estimated total catches (left hand figures) and mortalities (right hand figures) of major taxa of sharks by the purse-seine fishery of the WCP-CA, 1994–2004. Source: observer database maintained by SPC and Molony (2005a). Grey lines represent upper 95% confidence intervals generated from global standard deviations for each class. Scales of y-axes vary among figures.

3.2.2.4 Turtles

Observers have reported 104 interactions between turtles and the WCP-CA purse-seine fishery between 1994 ad 2004. The highest rates of interactions were reported during associated sets (logs, FADs) (Figure 26). Raising the data resulted in an estimate of less than 500 turtle-fishery interactions per year with the WCP-CA purse-seine fishery, 1994–2004, albeit with wide confidence limits (Figure 27). The mortality rate was estimated to be very low, with no mortalities of turtles reported by observers in this fishery since 1997 (Molony 2005a). Most turtles are not identified to species (77%), with olive ridley and hawksbill turtles being the most common species identified by observers. A single leatherback turtle was identified by observers within the purse-seine fishery between 1994 and 2004.

3.2.3 Other bycatch issues

OFP (2006) provided estimates of the total catches (metric tonnes) of the main bycatch species in the longline and purse-seine fisheries of the WCP-CA to the WCPFC in 2006. Estimates were provided for 12 bycatch species for the WCP-CA longline fishery and seven bycatch species for the purse-seine fishery (Figure 29, Figure 30and Figure 31).

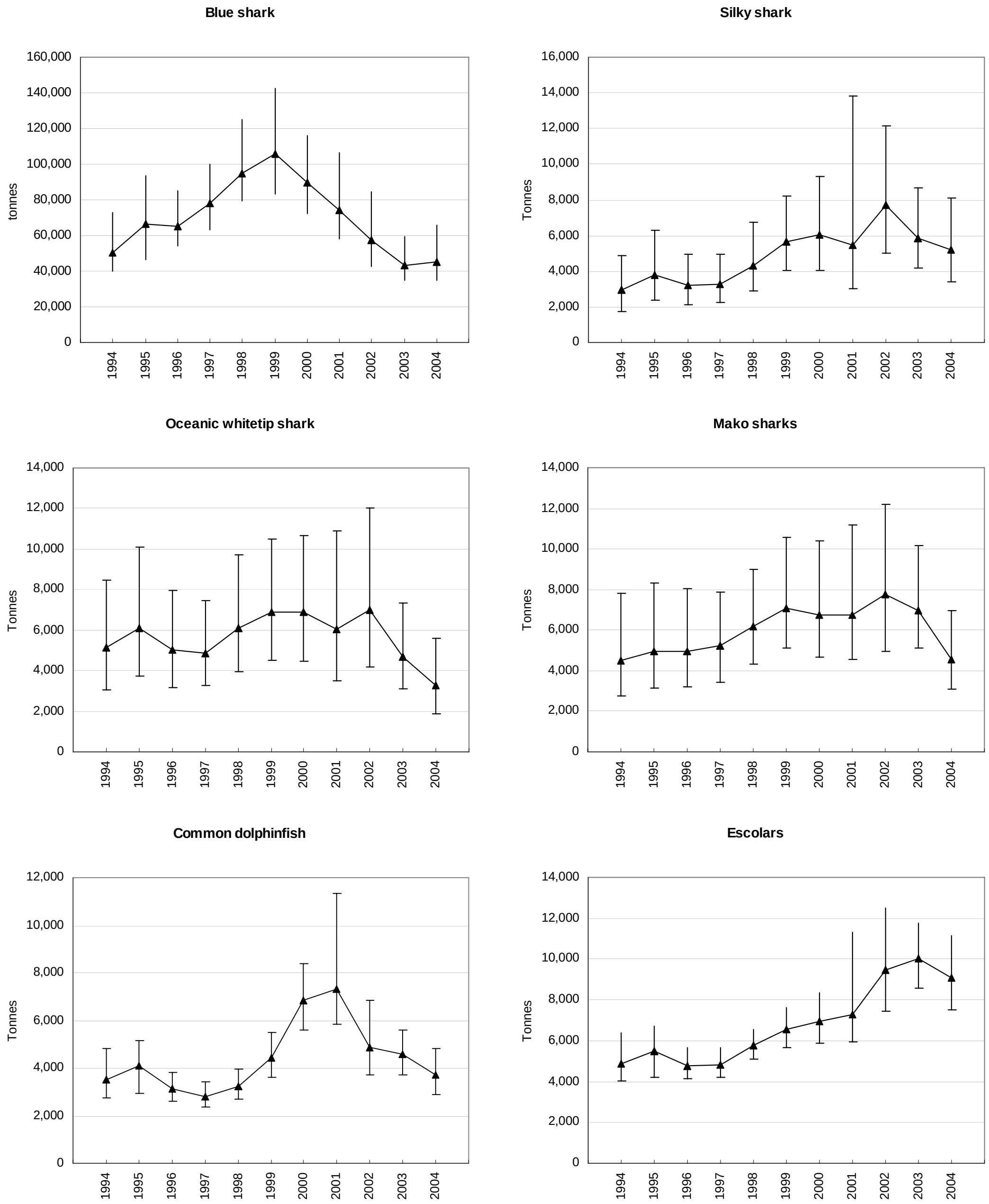


Figure 29. Estimated catches of main non-target species (Blue sharks, silky sharks, oceanic whitetip shark, mako sharks, common dolphinfish (mahimahi) and escolars) by longline vessels in the WCP-CA, 1995–2004. Source: OFP (2006). Error bar and point estimates were generated from 1,000 random samples for the posterior distribution of model coefficients.

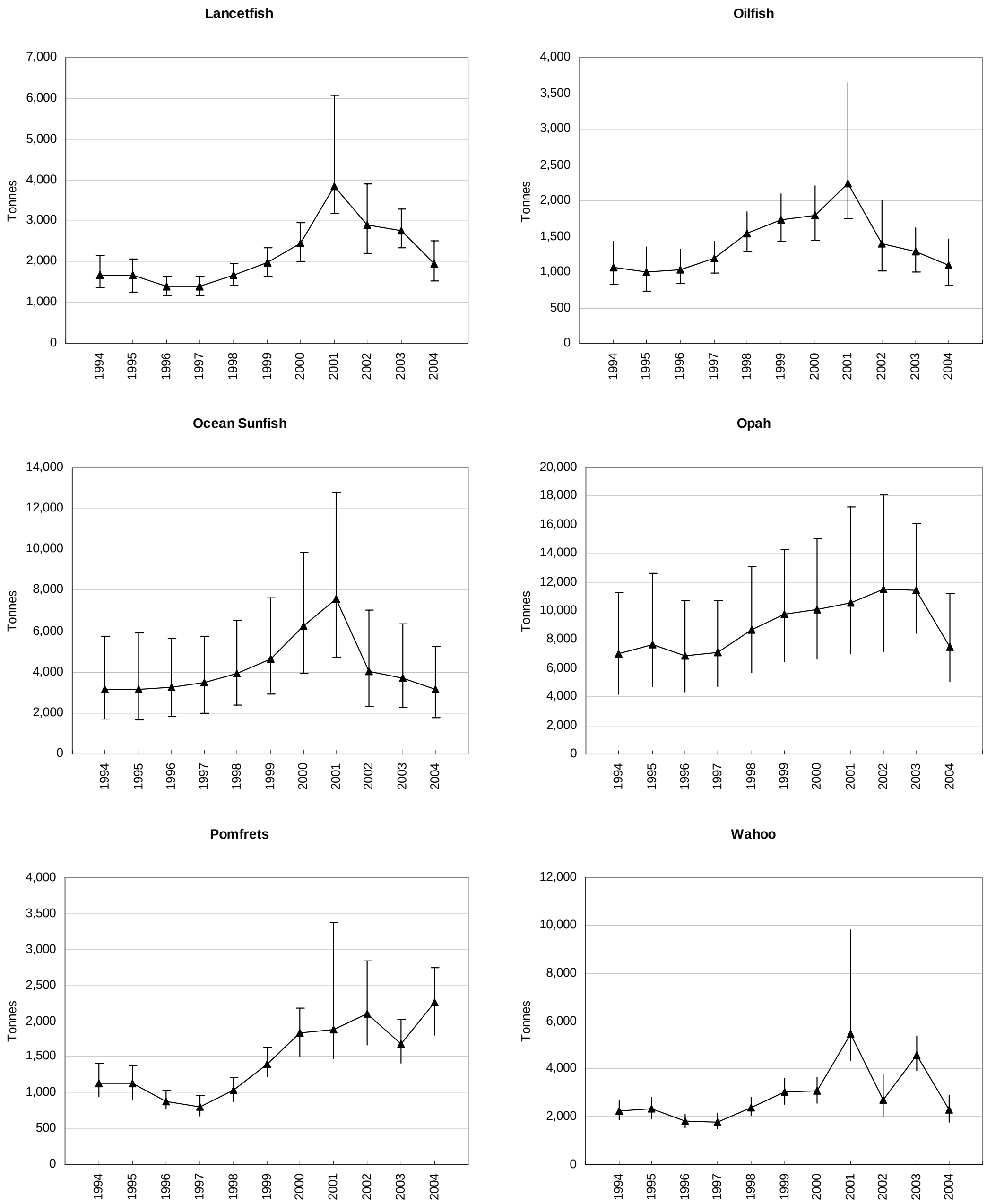


Figure 30. Estimated catches of main non-target species (lancetfish, oilfish, ocean sunfish, opah, pomfrets and wahoo) by longline vessels in the WCP-CA, 1995–2004. Source: OFP (2006). Error bar and point estimates were generated from 1,000 random samples for the posterior distribution of model coefficients.

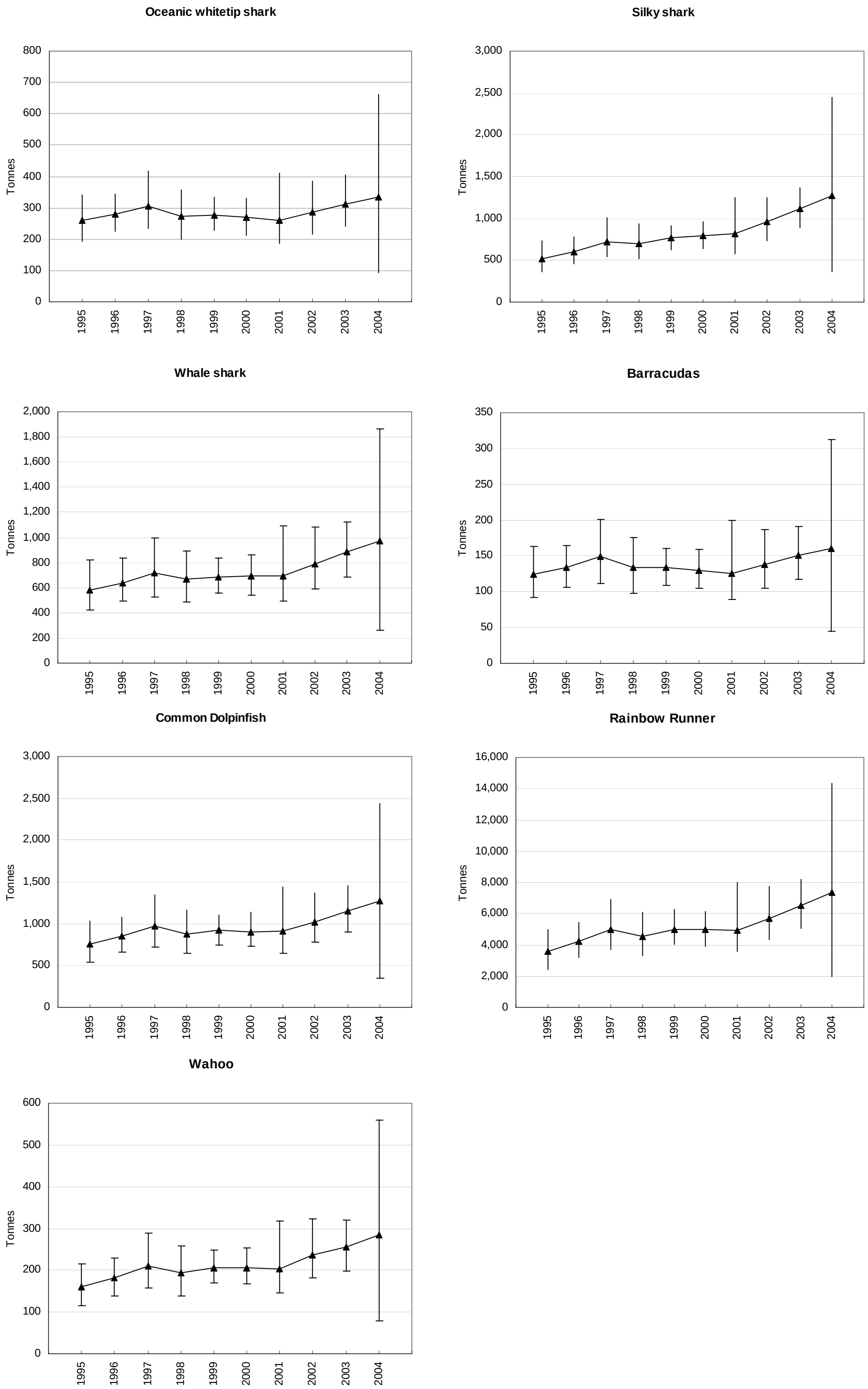


Figure 31. Estimated catches of main non-target species (oceanic whitetip shark, silky shark, whale shark, barracudas, common dolphinfish (mahimahi), rainbow runner and wahoo) by purse-seine vessels in the WCP-CA, 1995–2004. Source: OFP (2006). Error bar and point estimates were generated from 1,000 random samples for the posterior distribution of model coefficients and stratified by set-type.

4. Brief review of regional and national measures to address bycatch

The two major regional organisations that contribute to the management of fisheries and stocks in the WCP-CA are the Western and Central Pacific Fisheries Commission (WCPFC) and the Forum Fisheries Agency (FFA). The WCPFC commenced operations in 2004 while the FFA has been active in the region for more than 25 years. In addition, the Oceanic Fisheries Programme (OFP) of SPC has been developing and encouraging logsheet, observer and port sampling protocols for member countries in the WCPO for several decades.

4.1 Regional measures

A wide range of measures have been implemented and/or proposed in the region. A brief summary includes;

- Conservation and management measure on sharks caught in association with fisheries in the western and central Pacific Ocean (www.wcpfc.int/wcpfc3/pdf/WCPFC3-2006-P04%20[FFA%20Members%20-%20Sharks].pdf[1]): promoting the reduction and avoidance of shark bycatch, encouraging the live release of sharks and reducing shark fining by encouraging the landing of carcasses with fins attached.
- Conservation and management measure to mitigate the impact of fishing for highly migratory fish stocks on seabirds (www.wcpfc.int/wcpfc3/pdf/WCPFC3-2006-DP03%20Rev.%201%20[FFA%20Members%20-%20Seabirds].pdf[1]): requiring the use of bird mitigation devices on longline vessels operating north of 23ºN and south of 30ºS in the convention area (the regions of highest interactions), and the encouragement of the development of further mitigation tools and strategies. This proposal is in addition to the 2005 resolution on seabirds (www.wcpfc.int/wcpfc2/pdf/WCPFC2_Records_G.pdf).
- Limits to total effort (and therefore bycatch interactions) for longline vessels targeting albacore south of 20ºS (www.wcpfc.int/wcpfc2/pdf/WCPFC2_Records_E.pdf) or north of the equator (www.wcpfc.int/wcpfc2/pdf/WCPFC2_Records_F.pdf), and proposed limits on fisheries targeting swordfish south of 20ºS (www.wcpfc.int/wcpfc3/pdf/WCPFC3-2006-DP02%20[FFA%20Members%20-%20Swordfish].pdf[1]) and striped marlin south of 15ºS (www.wcpfc.int/wcpfc3/pdf/WCPFC3-2006-DP08%20[Australia%20-%20striped%20marlin].pdf[1]).
- The 2005 resolution to reduce sea-turtle–fishery interactions, reduce sea-turtle mortality and encourage the safe handling and release of all incidentally captured sea turtles (www.wcpfc.int/wcpfc2/pdf/WCPFC2_Records_J.pdf). This resolution also encourages the further research into the use of circle hooks and other mitigation measures (of which a review was undertaken by the FFA in 2006).
- The 2005 resolution to avoid, reduce, or release alive, incidentally captured species of non-target fish, especially mahimahi, wahoo and rainbow runner (www.wcpfc.int/wcpfc2/pdf/WCPFC2_Records_I.pdf).
- Limits to longline and purse-seine effort on bigeye and yellowfin (www.wcpfc.int/wcpfc2/pdf/WCPFC2_Records_D.pdf). This includes research to develop methods to reduce catches of juvenile bigeye and yellowfin by purse-seine fisheries using FADs. A proposal to further strengthen this resolution was tabled in 2006 (www.wcpfc.int/wcpfc3/pdf/WCPFC3-2006-DP01%20[FFA%20Members%20-%20CMM%20YFT%20and%20BET].pdf[1]).

In addition, the FFA and the WCPFC have encouraged the application of ecosystem approaches to fishery management (EAFM) and the use of the precautionary principle in the

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[1] These are proposals and are still pending. The resolutions from the 2006 meeting of the WCPFC will be finalised after 9th February 2007. See www.wcpfc.int for more details.

management of fish stocks and associated species under the jurisdiction of the WCPFC (FFA 2004). It is worth noting that the WCPFC is the first ‘tuna’ Commission not to use ‘tuna’ in its title (c.f. IOTC, IATTC, ICAT, CCSBT), highlighting the broader approach to fisheries management in the WCP-CA.

One of the recent developments of the WCPFC was to request an ecological risk assessment (Hobday et al. 2006) of species interacting with commercial fisheries in the WCP-CA (Kirby 2006). This was to provide information and advice to the WCPFC about high risk species (based on life-history characteristics and fisheries interactions) potentially assisting the WCPFC to develop management measures for these species. It is likely that this approach will also be used at a national level.

The OFP has undertaken a range of regional programmes to promote the importance of, as well as assist, in the documentation of catches of all species and to reduce the impacts of fishing on non-target species. This has included the development and maintenance of logsheet programmes and data bases (including the development of systems to allow countries to cross-reference various data sources to reduce incidences of missing data), training observers in data recording and correct handing and release of sea turtles, the development and placement of regional observer co-ordinators, research in the biology and ecology of tuna and billfish species, understanding and modelling the impacts of environment and the ecosystem on productivity of fishery stocks, undertaking stock assessments using the data collected, provision of scientific advice in regard to management options and scenarios (in conjunction with the FFA), and assistance with the development of national reports and inputs to national pelagic fishery management plans. More information and details are available at www.spc.int/oceanfish/. OFP is also the current provider of scientific services to the WCPFC.

4.2 National measures

As members of the WCPFC, Pacific Islands Countries and Territories (PICTs) have an obligation to develop national measures that are compatible with the WCPFC’s principles and measures for the conservation and management of highly migratory fish stocks and associated species. In addition, most Pacific Island Countries are FFA members, and many of the proposals and draft resolutions listed in the previous section were developed by member countries through the assistance of FFA. Thus, the national measures are very similar to the WCPFC resolutions and proposals and include;

- Management actions to reduce or avoid incidental catches of seabirds and turtles;
- Training of observers and crew in the correct handling and release techniques for incidentally captured turtles;
- Bans on shark fining in some EEZs;
- Promoting the live release of sharks;
- Increased observer coverage to allow better estimates of bycatch;
- Closed areas and the consideration of large MPAs in some EEZs;
- Gear restrictions in some countries (e.g. banning the use of steel leaders on longline gears to reduce shark bycatch);
- Obligations to retain certain bycatch species to supply local markets (e.g. mahimahi);
- Limiting the total number of vessels (effort) able to operate within an EEZ.

This is not by any means an exhaustive or complete list of the management measures to reduce and avoid bycatch at a national level.

5. Summary

As in other regions, a large number of non-target species interact with industrialised fisheries in the WCP-CA. By weight, sharks, rays and other non-target species account for 35% of total longline catches and 1.8% of total purse-seine catches in the WCP-CA (excluding the domestic fisheries of Indonesia, the Philippines and Chinese Taipei) (OFP 2006). However, the estimates of interaction rates, total catches and total mortalities are limited due to limited data, resulting in wide confidence limits around estimates. Nonetheless, positive measures and steps are underway to better document and estimate bycatch (through improved logsheets and observer reporting rates), reduce interaction rates and to reduce mortality rates. These measures are being implemented at national and regional levels (e.g. WCPFC, FFA, OFP), addressing national, regional and international initiatives.

Further progress towards reducing or avoiding bycatch will continue. One of the major challenges faced in the WCP-CA is the management of the bigeye and yellowfin stocks, especially in regard to the capture of small and juvenile fish, principally by the purse-seine fishery on associated sets (e.g. FADs, logs). If effort restrictions or reductions were introduced to reduce fishery impacts on these two tuna stocks, then fishery interactions with bycatch species would also be reduced (less effort = fewer interactions). In addition, new innovations in fishery methods are likely to reduce bycatch and interaction rates with unwanted species, with many of these innovations likely to arise from within fishing industries (e.g. Beverly et al. 2004).

It is also important that all sectors in the WCP-CA appreciate that their fisheries operate in an ecosystem, and thus any management actions or inactions will affect more than just the target species. Modern management of fisheries in the WCP-CA will likely take into consideration more than the target species, requiring that all species that interact with industrialised fisheries and wider issues are discussed and prioritised, and managed accordingly.

Additionally, it is also worth remembering that fisheries and countries have a direct economic incentive to reduce or avoid bycatch of unwanted species. Bycatch compete with hooks and bait (longline fishery) or can damage tunas in purse-seine nets. Removing some bycatch species can also require time and effort, and potentially increase the risks to crew members when being handled.

Finally, in a holistic approach to fisheries management, it must be noted that non-commercial fishery sources of mortality of some bycatch species may be as important or more important than commercial fishery sources of mortality (e.g. Kaplan 2005). For example, turtles are an important part of the culture of peoples in many PICTs in the WCP-CA. Artisanal fishing of adult turtles and egg harvesting are also major sources of mortality, at least in some areas (Kinch 2003). In addition, coastal development along nesting beaches and feral terrestrial animals that consume eggs (e.g. rats, pigs and dogs) all contribute to risks and total mortality of turtle and seabird populations and stocks. Extensive coastal fisheries (e.g. trawl fisheries) also operate in the WCP-CA and also capture significant levels of bycatch. A total ecosystem approach to the management of at-risk species, including more than just the industrialised fisheries, must be taken to ensure the sustainability of stocks of all species in the WCP-CA.

6. Acknowledgements

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Appendix 1. Estimates of annual catches of tuna and billfish major species in the WCP-CA.

Table A1.1. Provisional estimates of catches of target tuna species by longline and purse-seine fisheries and total tuna catches in the WCP-CA, 2005. Source: Williams and Reid (2006). All estimates in metric tones (mt), rounded to the nearest 1,000 mt. Tuna catches of other fisheries, including pole-and-line and troll fisherius, have been included in the total WCP-CA catch estimates. Total longline catches for skipjack have not been provided but are included in the total catch for this fishery.

Species	Longline	Purse-seine	Total WCP-CA
Skipjack	–	1,250,000	1,443,000
Yellowfin	77,000	231,000	423,000
Bigeye	87,000	42,000	163,000
Albacore	73,000	0	115,000
Total	242,000	1,523,000	2,145,000

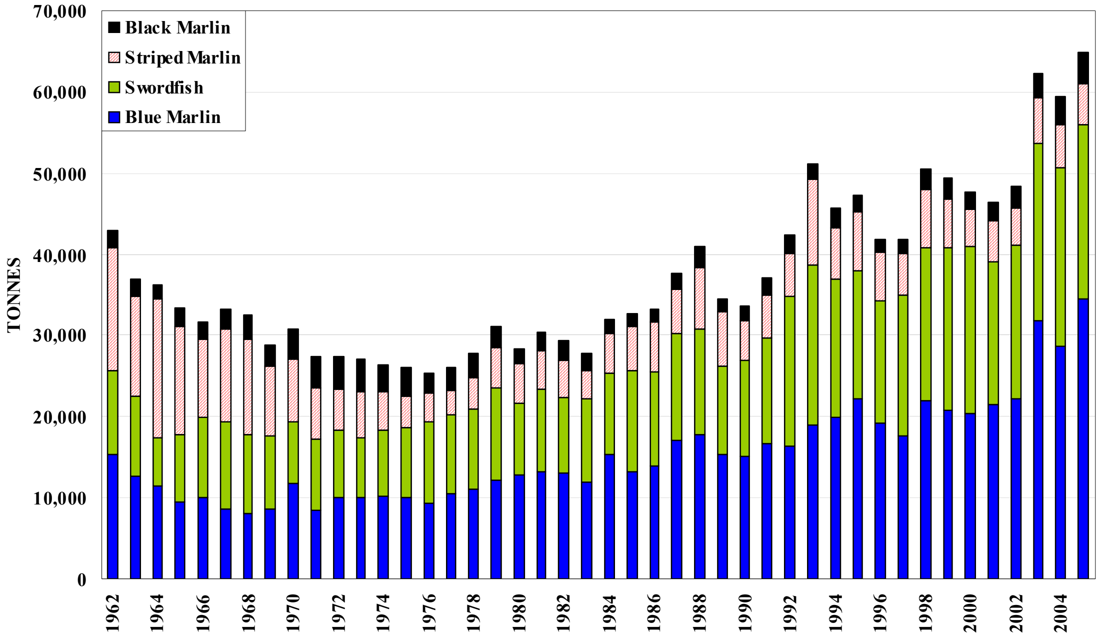

Figure A1.1. Estimated catches of major billfish species by industrialized longline and purse-seine fisheries of the WCP-CA, 1962–2005. Source: OFP (2006).

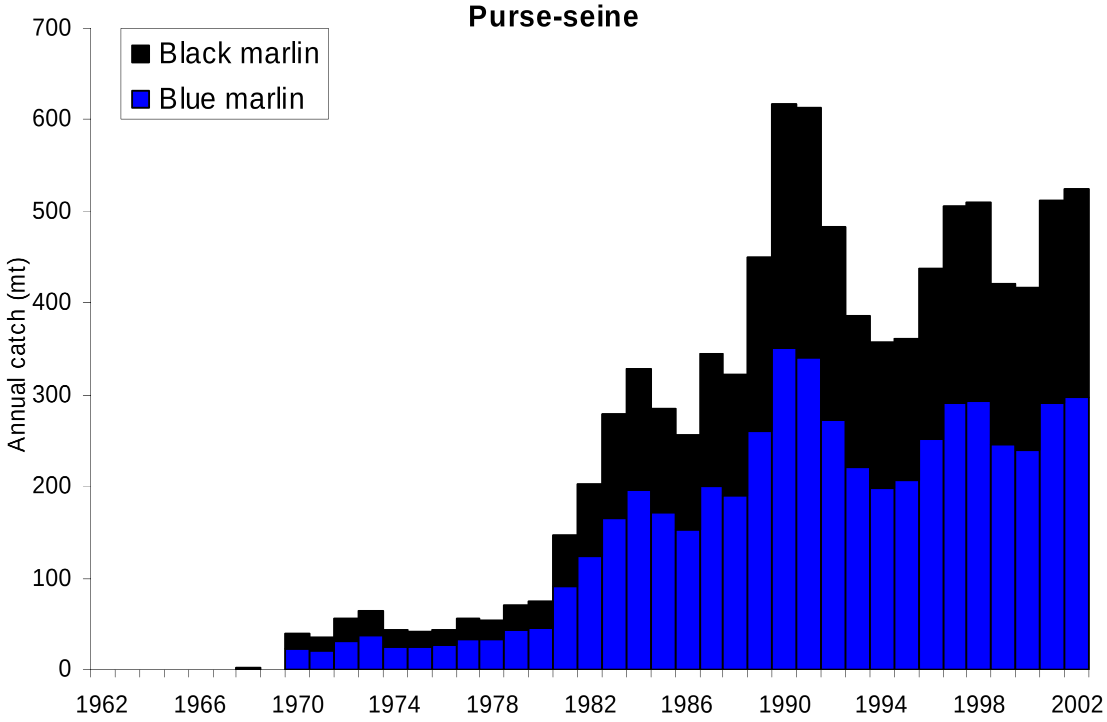

Figure A1.2. Estimated catches of major billfish species by industrialized purse-seine fisheries of the WCP-CA, 1962–2002. Source: Molony (2005b).

Appendix 2. Summary of the interaction rates of each class (birds, sharks, mammals and turtles) within each of the four industrialised fisheries examined. (From Molony 2005a).

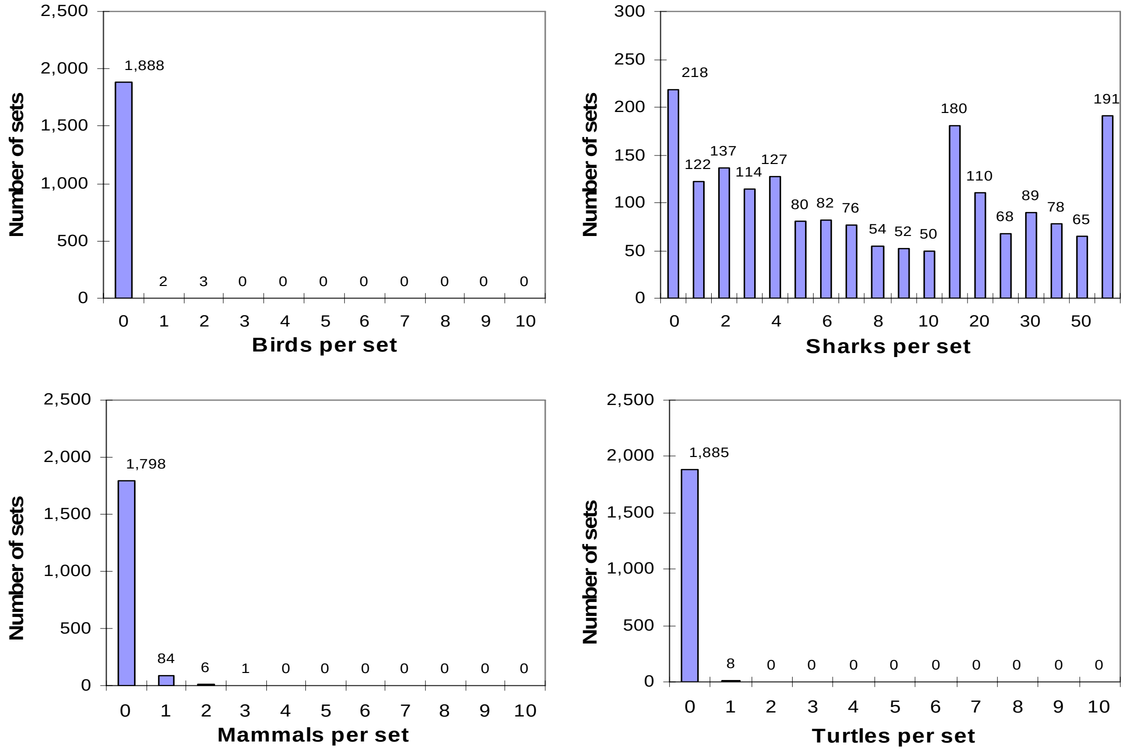

Figure A2.1. Frequency of occurrence of major taxa in sets of the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a). Total numbers of sets for each frequency category are provided above each bar.

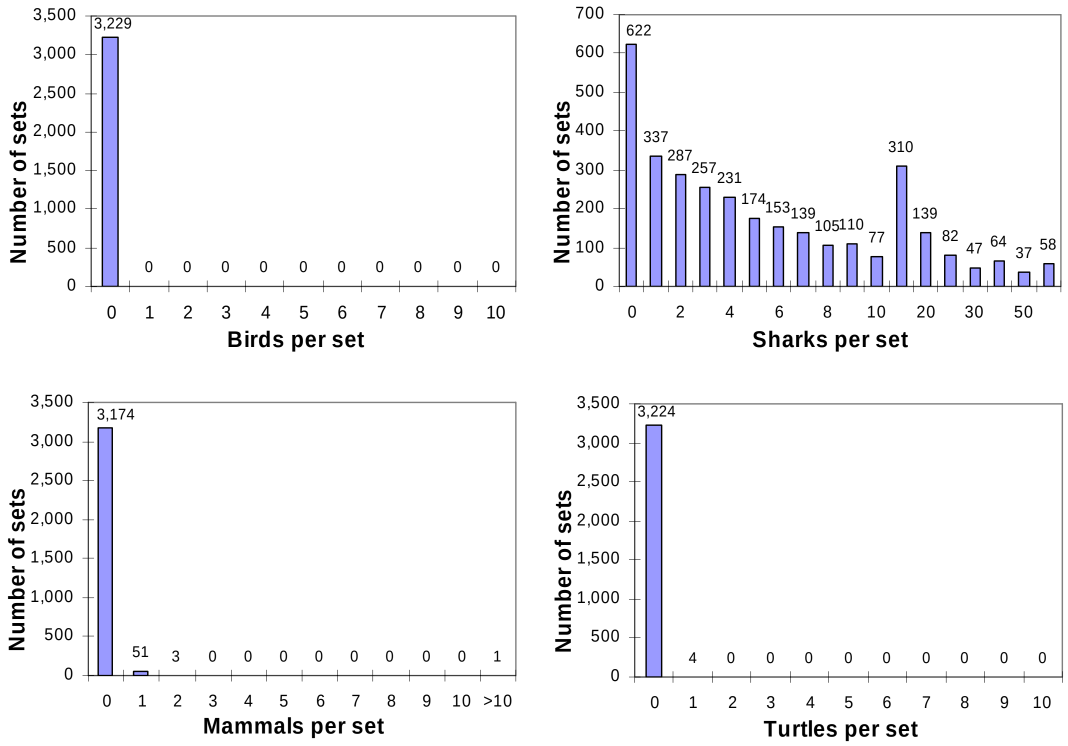

Figure A2.2. Frequency of occurrence of major taxa in sets of the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a). Total numbers of sets for each frequency category are provided above each bar.

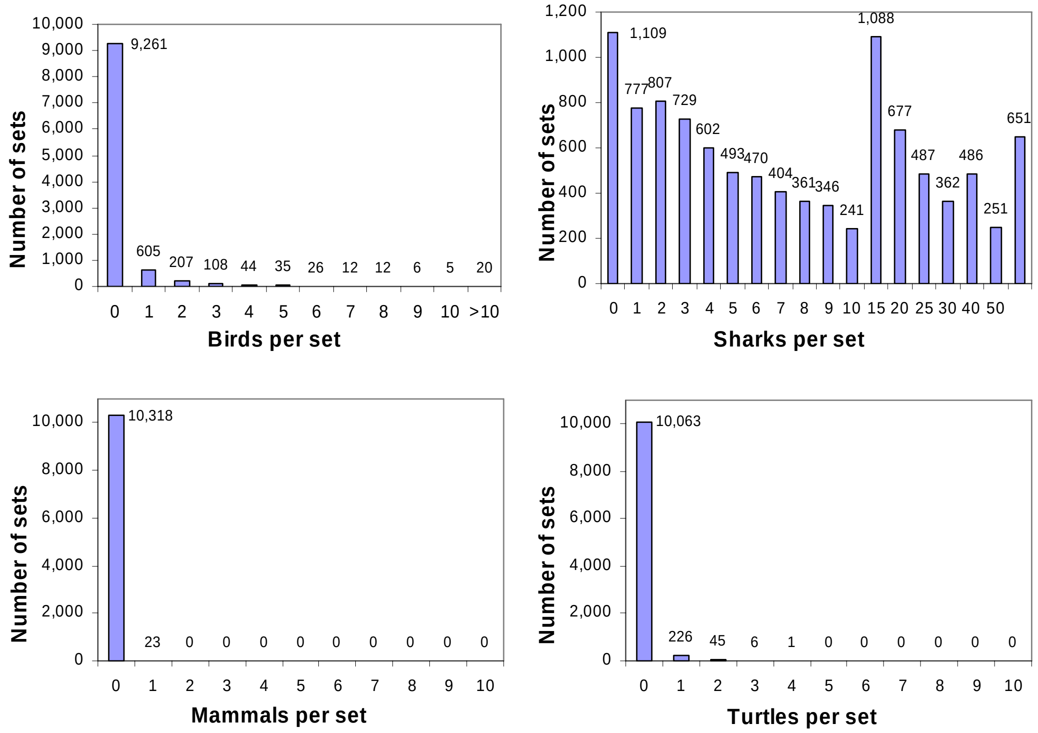

Figure A2.3. Frequency of occurrence of major taxa in sets of the temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a). Total numbers of sets for each frequency category are provided above each bar.

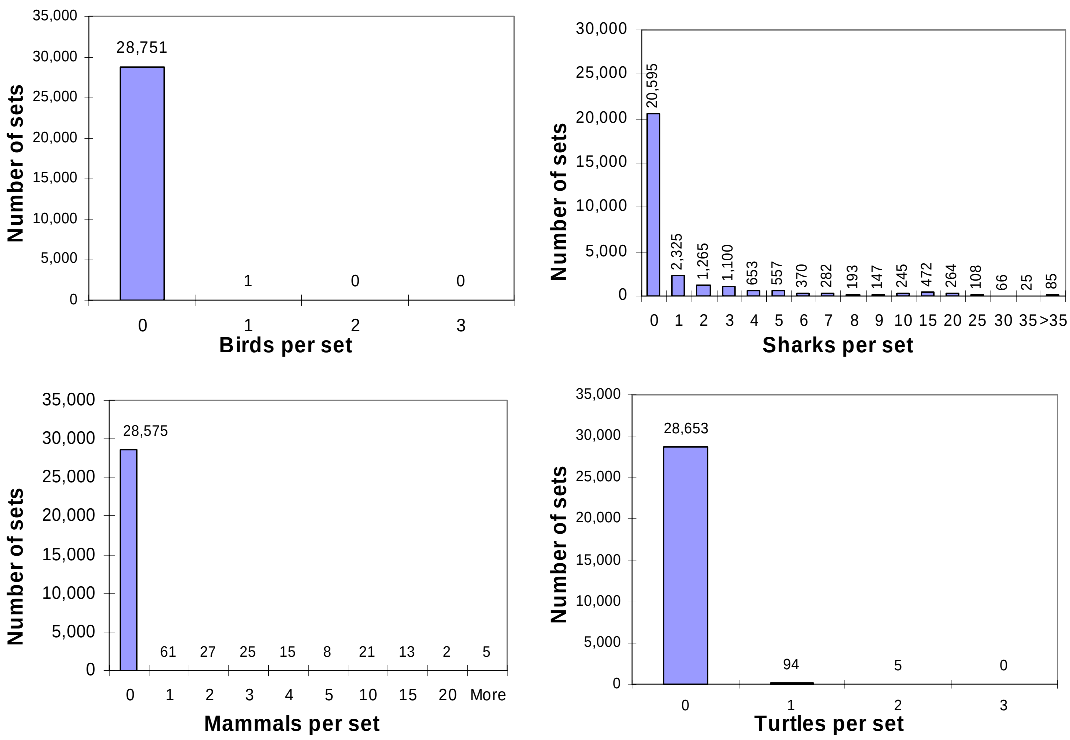

Figure A2.4. Frequency of occurrence of major taxa in sets by the purse-seine fishery of the tropical western Pacific, 1994–2004. Source: observer database maintained by SPC and Molony (2005a). Total numbers of sets for each frequency category are provided above each bar.

Appendix 3. Nominal catch rates (interaction rates) and mortality rates of each class (birds, sharks, mammals and turtles) within each of the three industrialised longline fisheries examined. (From Molony 2005a).

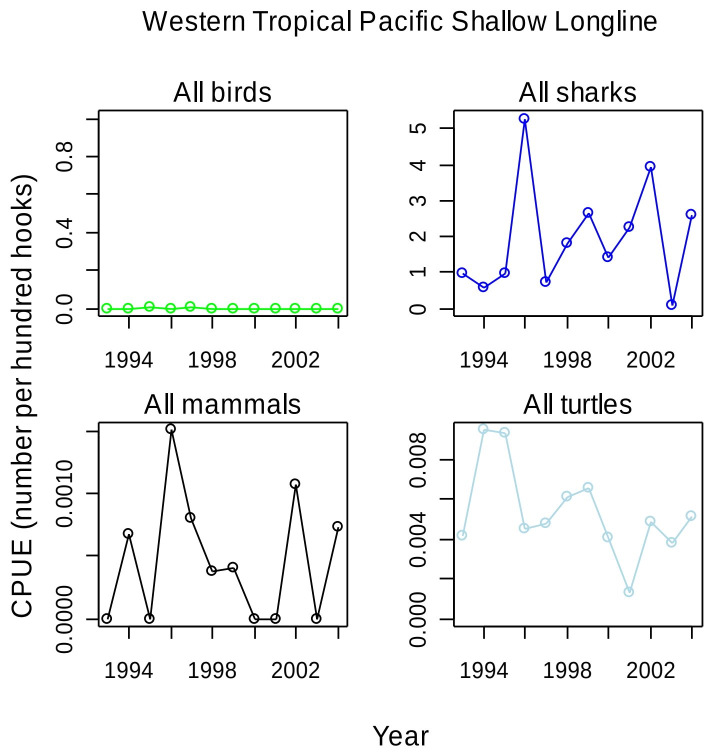

Figure A3.1. Estimated nominal catch per unit effort (number per hundred hooks) of each major taxa by the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a).

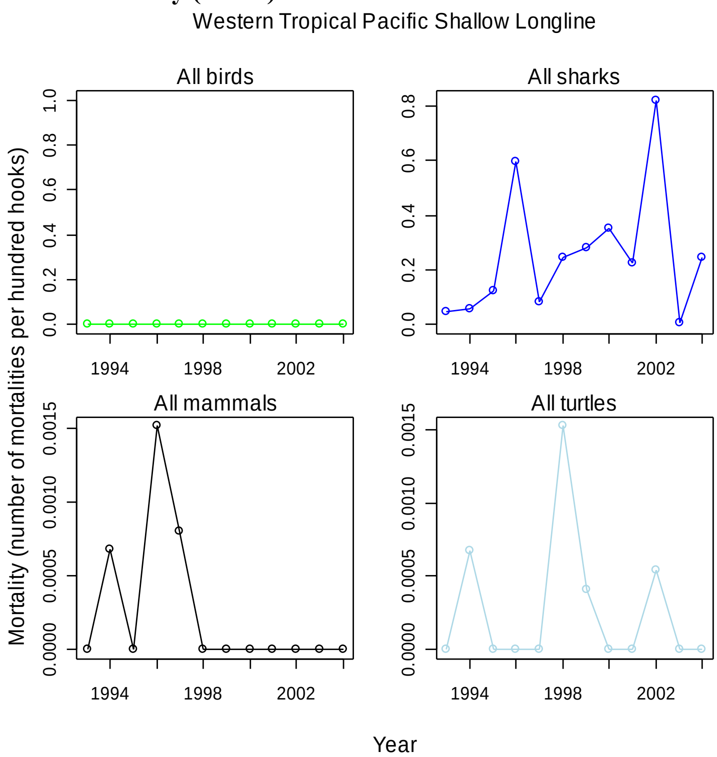

Figure A3.2. Estimated nominal mortality rates (number of observed mortalities per hundred hooks) of each major taxa in the tropical shallow Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a). Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks.

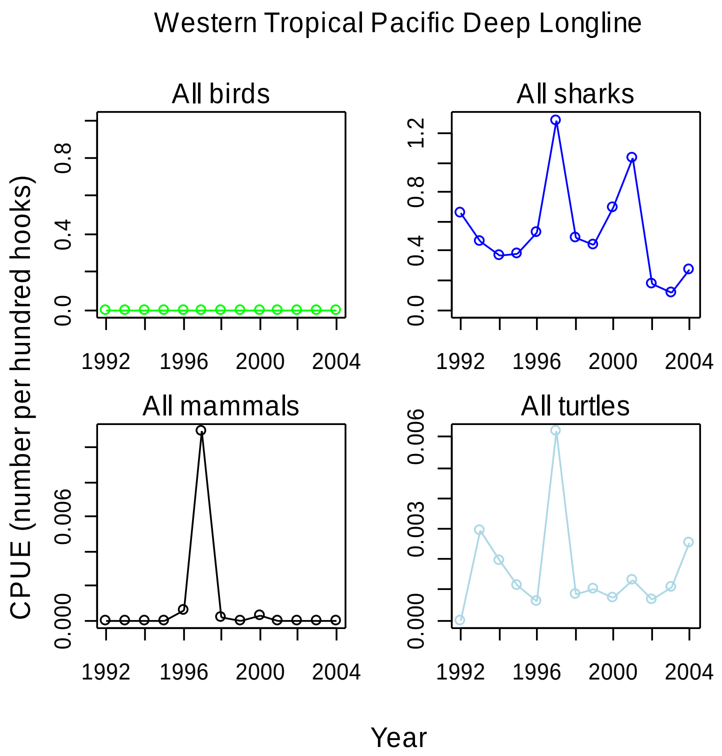

Figure A3.3. Estimated nominal catch per unit effort (number per hundred hooks) of each major taxa by the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a).

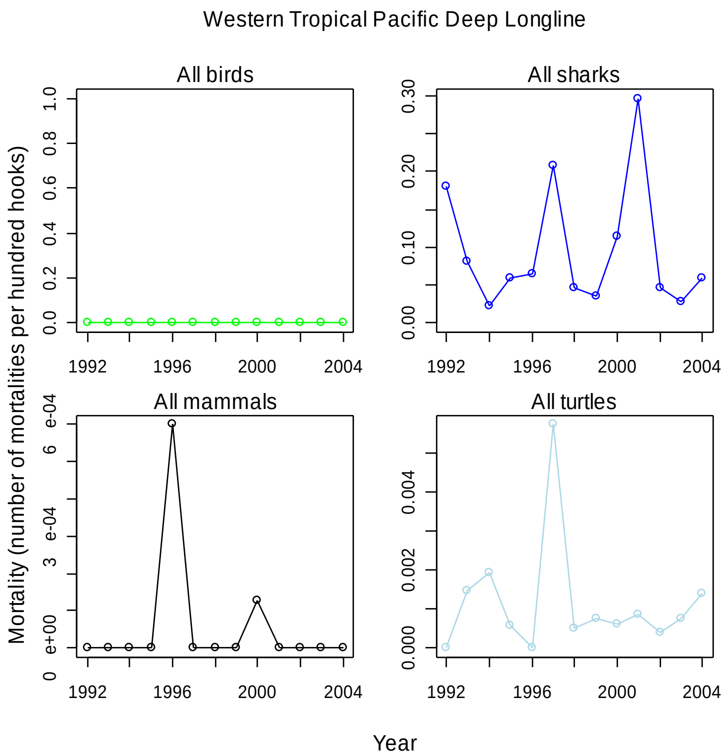

Figure A3.4. Estimated nominal mortality rates (number of observed mortalities per hundred hooks) of each major taxa by the tropical deep Pacific longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a). Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks.

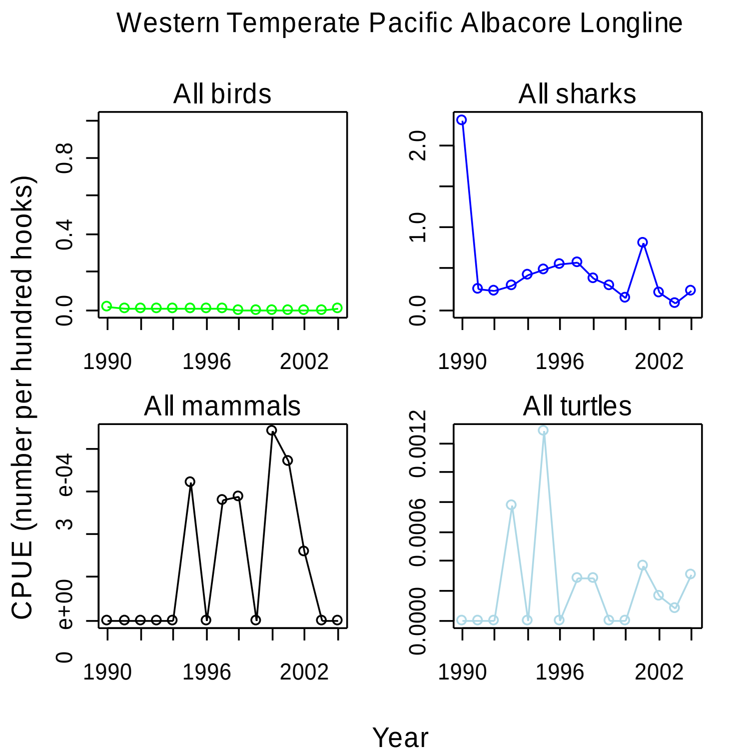

Figure A3.5. Estimated nominal catch per unit effort (number per hundred hooks) of each major taxa by the temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a).

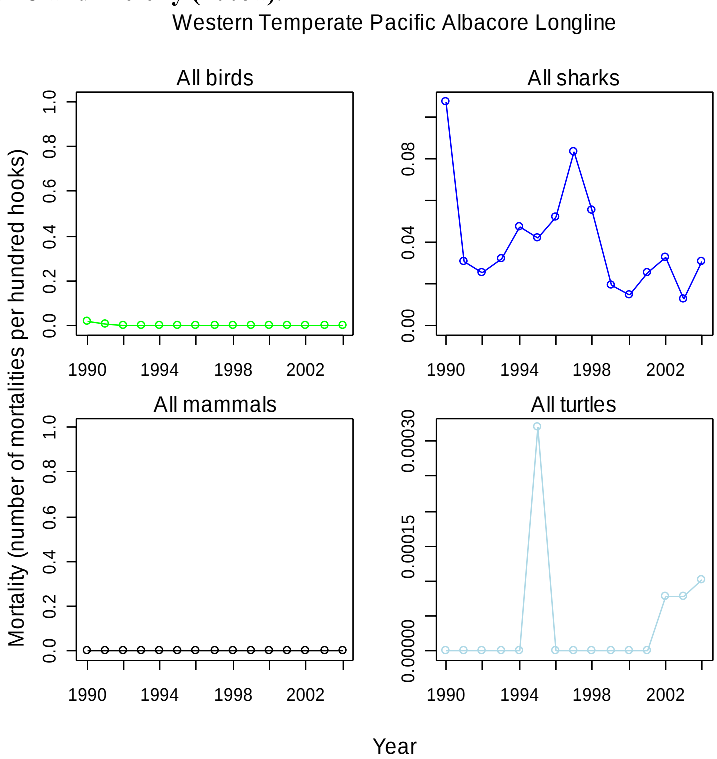

Figure A3.6. Estimated nominal mortality rates (number of observed mortalities per hundred hooks) of each major taxa in the temperate Pacific albacore longline fishery, 1990–2004. Source: observer database maintained by SPC and Molony (2005a). Shark mortalities include observed mortalities, plus retained plus finned and discarded sharks.

Appendix 4. Summary of observer records for sharks from longline and purse-seine fisheries throughout the WCP-CA, 1990–2004. (From Molony 2005a).

Table A4.1. Species of sharks and rays listed in SPC observer database, 1990–2004. 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
Bigeye thresher	*Alopias superciliosus*	BTH			2,445	3 (3)
Bignose shark	*Carcharhinus altimus*	CCA			27	0
Blacktip reef shark	*Carcharhinus melanopterus*	BLR	LR./NT	?	344	0
Blacktip shark	*Carcharhinus limbatus*	CCL	LR./NT	?	1,441	24 (10)
Blue shark	*Prionace glauca*	BSH	LR./NT	?	196,192	39 (19)
Broadsnouted sevengill shark	*Notorynchus cepedianus*	NTC	DD	?	2	0
Bronze whaler shark	*Carcharhinus brachyurus*	BRO	NT	?	269	1 (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
Crocodile shark	*Pseudocarcharias kamoharai*	PSK	LR./NT	?	1,799	44 (10)
Dusky shark	*Carcharhinus obscurus*	DUS	LR./NT	?	514	0
Galapagos shark	*Carcharhinus galapagensis*	CCG	NT	?	648	3 (1)
Great hammerhead	*Sphyrna mokarran*	SPK	DD	?	62	0
Great white shark	*Carcharodon carcharias*	WSH	VU	?	48	2 (1)
Grey reef shark	*Carcharhinus amblyrhynchos*	AML			2,059	17 (4)
Hammerhead sharks	*Sphyrna* spp.	SPN			1,320	15 (17)
Long finned mako	*Isurus paucus*	LMA			670	28 (7)
Mako sharks	*Isurus* spp.	MAK			2,986	303 (67)
Manta rays (unidentified)	Mobulidae	MAN			270	1,085 (648)
Oceanic whitetip shark	*Carcharhinus longimanus*	OCS	LR./NT	?	9,140	4,799 (1,113)
Pelagic sting-ray	*Dasyatis violacea*	PLS			11,950	87 (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

Table A4.1, continued. Species of sharks and rays listed in SPC observer database, 1990–2004. 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)
Rays, skates and mantas	Batoidimorpha (Hypotrmata)	BAI			181	8 (7)
Salmon shark	*Lamna ditropis*	LMD	DD	?	80	40 (1)
Sandbar shark	*Carcharhinus plumbeus*	CCP	LR./NT	?	204	1 (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
Sharks (unidentified)	*Elasmobranchii*	SHK			3,420	15,019 (2,461)
Sharpsnouted sevengill shark	*Heptranchias perlo*	HXT	NT	?	1	0
Short finned mako	*Isurus oxyrhinchus*	SMA	LR./NT	?	5,278	422 (83)
Silky shark	*Carcharhinus falciformis*	FAL			27,019	21,585 (3,989)
Silvertip shark	*Carcharhinus albimarginatus*	ALS			1,150	424 (138)
Smooth hammerhead	*Sphyrna zygaena*	SPZ	LR./NT	?	38	0
Spiny dogfish	*Squalus acanthias*	DGS	LR./NT	?	92	0
Thresher	*Alopias vulpinus*	ALV	DD	?	1,108	12 (6)
Thresher sharks nei	*Alopias* spp.	THR			1,038	83 (39)
Tiger shark	*Galeocerdo cuvier*	TIG	LR./NT	?	453	2 (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*