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Review of available information on non-key shark species including mobulids and fisheries interactions

EB-WP-08

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Executive Summary

This analysis collates all the observed information for non-key sharks (NKS) in the Western and Central Pacific Ocean (WCPO) purse seine and longline fisheries. NKS include all elasmobranchs not listed key sharks by the Western and Central Pacific Fisheries Commission (WCPFC). In order to assess the detail of observer reporting over time, from 1994 to 2015, trends in reporting rates were assessed for purse seine and longline fisheries separately. We present the data for purse seine data separately for fish aggregating device (FAD) sets (associated) and free school sets (unassociated sets). For the longline fishery the data were seperated into albacore target (those sets where albacore comprised 50% or more of the tuna catch) and bigeye-yellowfin tuna sets (those sets where bigeye and yellowfin tuna combiled comprised more than 50% of the tuna catch).

The data showed that for both longline and purse seine key sharks make up about 85-90% of the elasmobranch catch. Observers on longline vessels are better at, or the logistics of the operation enable better species reporting of NKS. On longline vessels most (over 80%) NKS are recorded at the species level; for purse seine observed sets, species specific reporting became more prevalent in 2007 and has fluctuated between 50-60% of individuals being identified to species level. This may be a result of grab spill sampling. Some obvious species specific trends exist where reporting rates of, for example, pelagic stingray *Pteroplatytrygon violacea* have increased in recent years.

Observed catch distribution maps are presented for both purse seine and longline gear separately and nominal CPUE trends are also presented. The fate of fish and condition at capture and release of the top 20 species or species complexes are presented.

For *Manta birostris*, *Mobula* sp. and *P. violacea* distribution plots are presented grouped into five year periods from 1995-2015 for purse seine and longline fisheries each seperated by fleet type. In addition more detailed CPUE indices are presented for each gear type and set type.

Finally we review the available information on *M. birostris*; *Mobula* sp.; and *P. violacea* for consideration of these species for designation as WCPFC key sharks. As part of that assessment we suggest that the management of *M. birostris* and *P. violacea* could be enhanced if they were designated as key sharks by the WCPFC. However, improving observers abilities to identify individual *Mobula* sp. to a species level is likely to lead to improved information in the medium-term but listing them as a key shark species will probably not enhance the management of individual species at this stage.

The following recommendations are made:
Recommendation: Purse seine observer training programmes add emphasis to *Mobula* sp. identification as part of their curricula.
General recommendations for enhancing the key shark designation table:

- In future key shark species designation assessments tables include "Is the management of ________ likely to be enhanced by having it listed as a WCPFC key shark species?".
- In future key shark species designation assessments include "SCxx recommends that WCPFCyy list/does not list ________ as a key shark species".

1 Introduction

The Western and Central Pacific Fisheries Commission's (WCPFC) responsibilities for managing of sharks in the Western and Central Pacific Ocean (WCPO) derive from Articles 5(d) and 10.1(c) of the Convention which state that:
"*the members of the Commission shall assess the impacts of fishing, other human activities and environmental factors on target stocks, non-target species, and species belonging to the same ecosystem or dependent upon or associated with the target stocks.*"
and
"*the functions of the Commission shall be to adopt, where necessary, conservation and management measures (CMMs) and recommendations for non-target species and species dependent on or associated with the target stocks, with a view to maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened*".

Other international conventions such as the Convention on International Trade in Endangered Species (CITES) and the Convention on Migratory Species (CMS) relevant to sharks have been acceded to by most WCPFC Members, co-operating non-members (CNMs) and Participating Territories (CCMs). These two international conventions have listed shark species in their appendices, several of which are caught by fisheries in the WCPO. Several other non-binding international instruments, including the FAO International Plan of Action for the Conservation and Management of Sharks ("IPOA-Sharks"; FAO 1999) and United Nations General Assembly Resolutions 61/105 and 63/112 (UNGA 2006, 2008), emphasize the responsibilities of fishing and coastal States for sustaining shark populations, ensuring full utilisation of retained shark catch and improving shark data collection and monitoring.

In an attempt to support informed management decisions, ensure sound data reporting, and support members' obligations to other conventions and agreements, the WCPFC designated in 2008 a number of species as "key shark species". The process for designating new species is outlined by (Clarke and Harley, 2010). Once designated as key sharks, CCMs are required to report catch and effort information and support research efforts on those species (WCPFC, 2010). The initial list included blue shark (*Prionace glauca*), oceanic whitetip shark (*Carcharhinus longimanus*), mako sharks (*Isurus spp.*) and thresher sharks (*Alopias spp.*). Silky, porbeagle (*Lamna nasus*) (south of 30^{o}S), hammerhead sharks (winghead [*Eusphyra blochii*], scalloped [*Sphyrna lewini*], great [*Sphyrna mokarran*], and smooth [*Sphyrna zygaena*]) and whale sharks (*Rhincodon typus*) were added later. At the outset it was thought that mako and thresher sharks would need to be assessed as single groups (complexes) due to species mixing in reported data.

In 2015 the 11th Scientific Committee (SC11) developed a new Shark Research Plan for 2016-2020 (Brouwer and Harley, 2015). This plan was approved by WCPFC12 and a schedule of work was endorsed. Included in that list was a review of the available data for non-key shark elasmobranchs, scheduled for 2016. The specification was to assess the catch records for non-key shark elasmobranchs using existing observer and reported catch data. In addition, SC11 recommended that this review include the available information on mobulid species (mantas and devil rays) and their interactions with fisheries managed by the WCPFC for consideration of these species for designation as WCPFC key sharks (WCPFC, 2015).

While key sharks make up approximately 90% of the elasmobranch catch (Figure 1), the information on the make-up of the remaining non-key sharks (NKS) is seldom investigated. Here we summarize the information from observer records for NKS, which includes all elasmobranchs not listed as key sharks by the WCPFC (CMM2012-07).

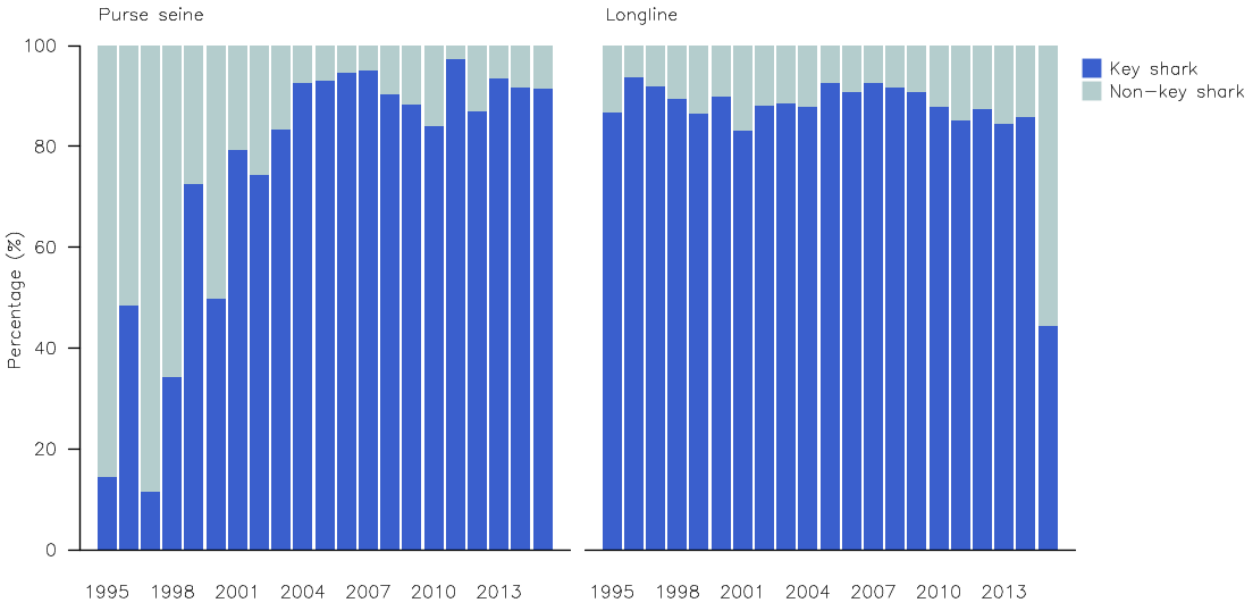

Figure 1: Observed reporting of elasmobranchs to key sharks and non-key sharks in the Western and Central Pacific Ocean purse seine and longline fleets from 1995-2015.

2 Methods

Logsheet data were not used here as there are no reporting requirements for NKS in most fleets such that there could be species misidentification in instances where NKS were reported, and reporting rates are likely to be biased over space and time. As a result only observer data were used for this analysis. The purse seine and longline observer data were extracted from the SPC database. These entries represent a mix of observer programmes managed by the SPC Regional Observer Programme (Cooks Islands, Fiji, Federated States of Micronesia, Kiribati, Marshall Islands, New Caledonia, Nauru, French Polynesia, Papua New Guinea, Palau, Samoa, Solomon Islands, Tonga and Vanuatu) and observer programmes managed by countries which have been incorporated into the SPC-held databases (Australia, China, Chinese Taipei, New Zealand, United States). Unless otherwise specified, we only used records spanning 1995 to 2015. Note the 2015 records are preliminary as not all of the observer records had been entered into the database at the time of the analysis.

2.1 Reporting rates and catch trends

All analyses were performed for purse seine and longline fisheries separately. When relevant, we split the purse seine results into associated or unassociated sets as these tend to capture a different assemblage of species. Similarly, we split the longline effort into albacore or bigeye-yellowfin targeting sets. Sets with 50% or more albacore by number in total tuna catch (albacore, bigeye, and yellowfin) were assigned to albacore target sets (>50%), the remainder were assigned as a bigeye-yellowfin sets. swordfish target sets were not separatly identified. This resulted in 27,924 and

72,304 observed albacore and bigeye-yellowfin target sets respectively over the 1995-2015 period. Sets with no tuna catch were ommitted.

Trends in taxonomic precision of reporting: In order to assess the taxonomic resolution of observer reporting over time, observer records for elasmobranchs were grouped by the taxonomic level (species, genus, family, order, infraclass) specified by the observer for the record.

Catch rates of NKS: For each species, an overall catch rate is presented for associated purse seine, unassociated purse seine and longline sets. For the purse seine data, we retained only spill samples due to the greater accuracy in species composition (Lawson and Sharples, 2011), this resulted in all observer sets being discarded before 2010 and about 20% thereafter. From 2010 to 2015 19,404 and 5,952 observed associated and unassociated sets, respectively, were retained in the analysis dataset, and the target tuna catch was then calculated as the sum of skipjack tuna catch (*in mt*). For the longline dataset, we split observer entries into albacore and bigeye-yellowfin target fisheries as described above. The target tuna catch was then calculated as the sum of albacore or yellowfin + bigeye tuna catch (in individuals). For each species or group, the number of sets per category (including zero observations), a catch rate, and number of observed individuals are presented.

Observer effort: Observer effort was calculated for purse seiners by adding the number of unique sets with at least one observer record and for longliners by adding the number of hooks observed for a given set. When that variable was missing but basket observed was present, we computed the number of hooks observed as the number of basket observed multiplied by the hooks between floats.

Spatial trends: As observer coverage is not evenly distributed across fleets in space and time, data are presented as fish per observed set for the purse seine sets and fish per 100 hooks for the longline sets. Maps were only showed if there were at least 20 individuals observed for the species or group over the 1995-2015 time period. We also included the distribution maps for key shark species for comparison.

Annual and seasonal trends in observer CPUE: For species/groups that had at least 10 individuals observed and with observations over three separate years for a given gear, we calculated the proportion of sets out of the total observed sets that had at least one individual of this species/group over years and over months. For those sets that had a catch record for the species/group, we also showed the distribution (median and interquartile range) of the number of individuals caught by 1000 hooks (longline) or by set (purse seine).

2.2 Fate and Condition

In addition to information on catch and effort, the longline observers record the fate and condition of each non-target individual caught both, at capture and at release (when applicable). The fate records were categorized as retained, discarded, finned or escaped; condition records were categorized, at capture and release, as alive, healthy, injured, dying or dead. For the longline fishery only, we summarize the distribution of fate and condition by year for the 20 most abundant species or groups reported, as ranked by the observed number of individuals caught.

2.3 Length measurements

When possible, observers on longline vessels record fish length using different measurements. We present the annual trend in the type of length measured. We used the main categories specified in the SPC longline observer form LL-4, that is: total length (TL), upper jaw to fork (UF), lower jaw to fork (LF), pectoral fin to fork (PF), total width (TW; typically for rays), carapace length (CL; typically for turtles), and not measured (NM).

2.4 Analyses for selected species

The SC11 requested that we include an assessment of *Manta birostris* and *Mobula* sp. for their designation as key sharks. In order to provide additional information on these species more detailed information are presented for *Manta birostris* and *Mobula* sp. In addition, we include the same analysis for *Pteroplatytrygon violacea* which is one of the most abundant NKS that interacts with purse seine and longline gear (Appendix 5). For these, in addition to the information presented above, we plot catch rates in 5 year intervals. We also calculated observed CPUE by year-quarter for each gear category. A smooth weighted on observer effort for the year-quarter was fitted using the mgcv package in R (Wood, 2006) to highlight general trends over time. For each of these species, a table is compiled as per Clarke and Harley 2010. These are included in Appendix 2 for consideration and discussion by SC12.

3 Results and Discussion

3.1 Reporting rates and catch trends

In an attempt to assess how well NKS have been reported by observers, an analysis was undertaken to quantify the level of reporting at the species level through time (Figure 2 and Figure 3). These data revealed that for the purse seine fishery NKS identification was poor prior to 2007 after which identification improved to some extent. By 2015 only around 50% of NKS were identified to the species level, but 80-90% were identified to genus level. In contrast, observers on longline vessels have been reporting NKS to species level since 1995, although some lower level of identification for some sets occurs, mostly prior to 2006. Since 2006 only a small proportion of NKS were not identified to the species level (Figure 3). This could have occurred if the observers failed to identify a less common species, or if the fish was not examined closely as it was released at the side of the vessel and not brought on-board.

This difference between longline and purse seine is in part due to the focus of observer training for the different vessels. While longline observer training programmes have traditionally had a focus on species identification as the observers get to handle the fish individually, for purse seine observers an increased focus on identifying bycatch occurred starting in 2005 only. In addition, purse seine observers do not always get to handle the bycatch before it is discarded and, based on the particular vessel, observers do not always get to handle the NKS before they are processed or discarded. Lastly, a high proportion of NKS bycatch in longline fisheries are made up of pelagic stingray *P. violacea*, which are easy to identify at the species level Figure 6.

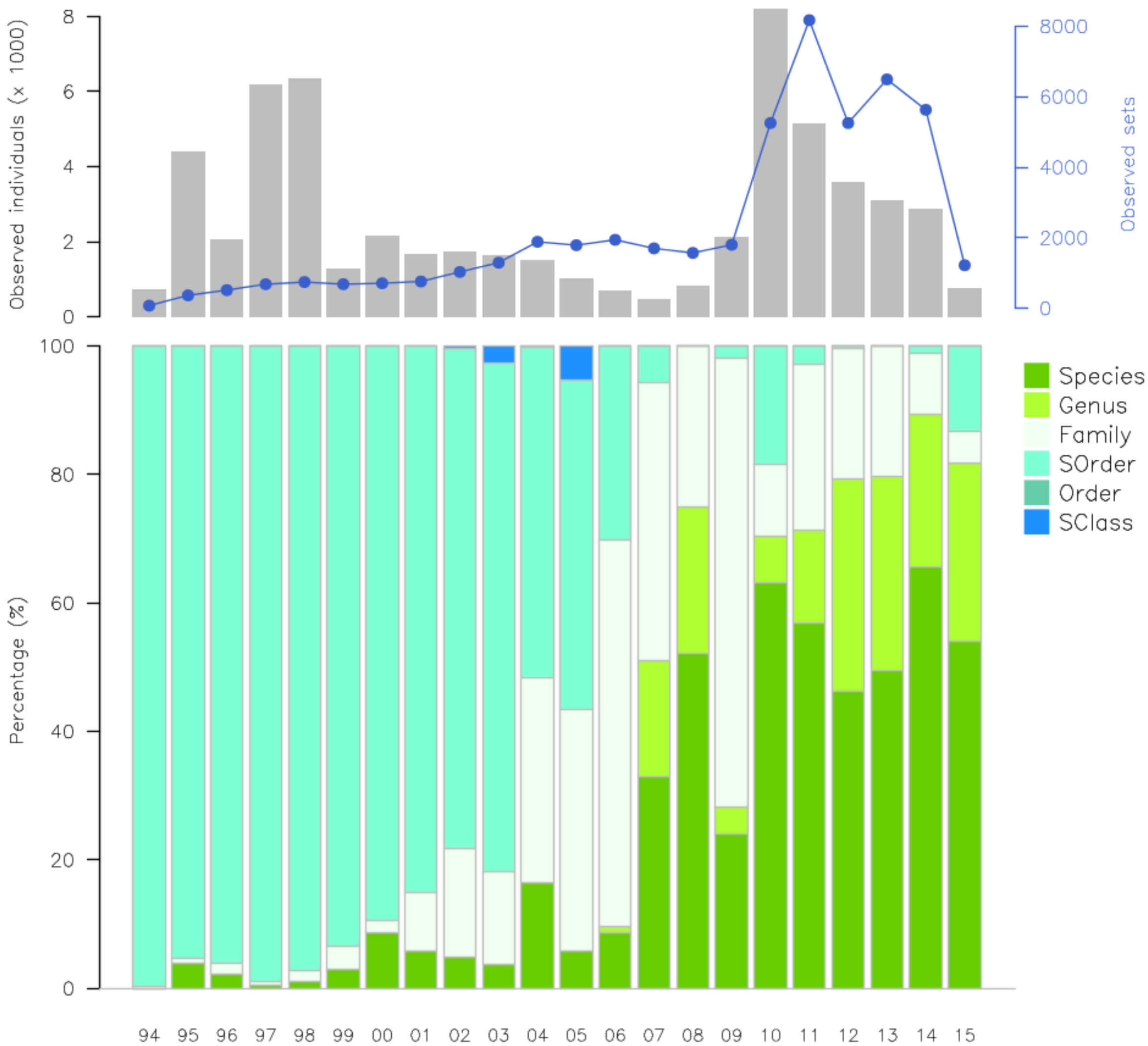

Figure 2: Taxonomic level of identified individuals for observed non-key sharks in the Western and Central Pacific Ocean purse seine fleets from 1995-2015.

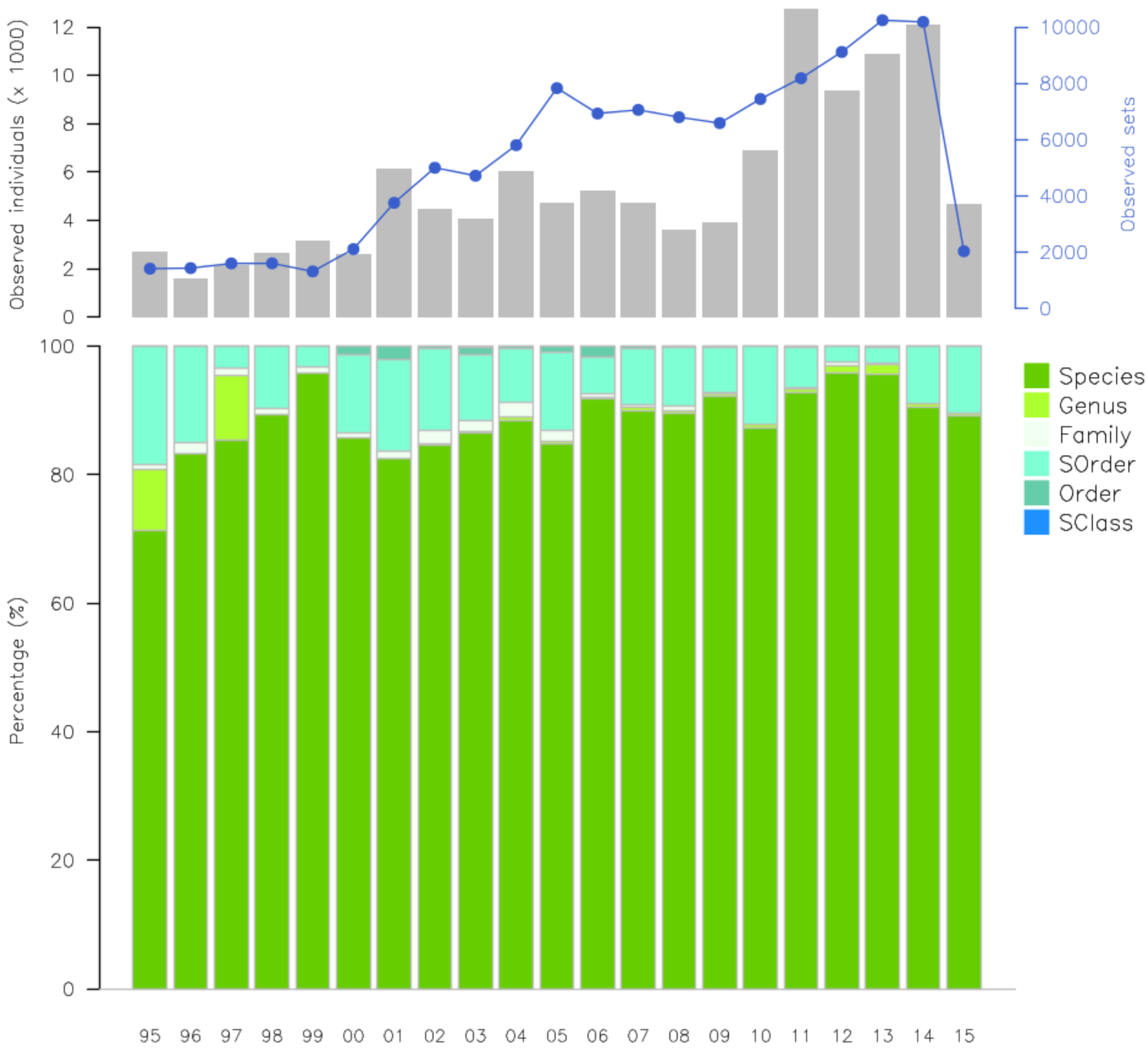

Figure 3: Taxonomic level of identified individuals for observed non-key sharks in the Western and Central Pacific Ocean longline fleets from 1994-2015.

For purse seine unassociated and associated sets (excluding any key sharks), it is apparent that more rays are landed than sharks (Figure 4 and Figure 5). Reporting of unidentifed shark or rays in the NKS group has declined, and within the rays improvements in identification are apparent with more individuals being reported to the species level, mostly (*M. birostris*) and some to genus level, mostly *Mobula sp.*. For sharks, a higher proportion of individuals are reported to genus level than as unidentified shark in recent years. Unassociated purse seine sets have fewer NKS individuals observed than associated sets but they have a higher proportion of rays compared to associated sets (Figure 4 and Figure 5). Species-specific catch rates (fish per set) standardized to the skipjack catch for associated and unassociated sets are reported in Appendix 5.

Carcharhinids make up a large proportion of the observations prior to 2009 for longline sets (excluding key sharks), after which *P. violacea* becomes strongly dominant. This switch in proportion to more *P. violacea* is probably a result of increased reporting in recent years. Similar to purse seine observations, after the key sharks, rays are the most common group (Figure 6). Species-specific catch rates standardized to the target tuna catch between albacore and bigeye-yellowfin target sets are reported in Appendix 5.

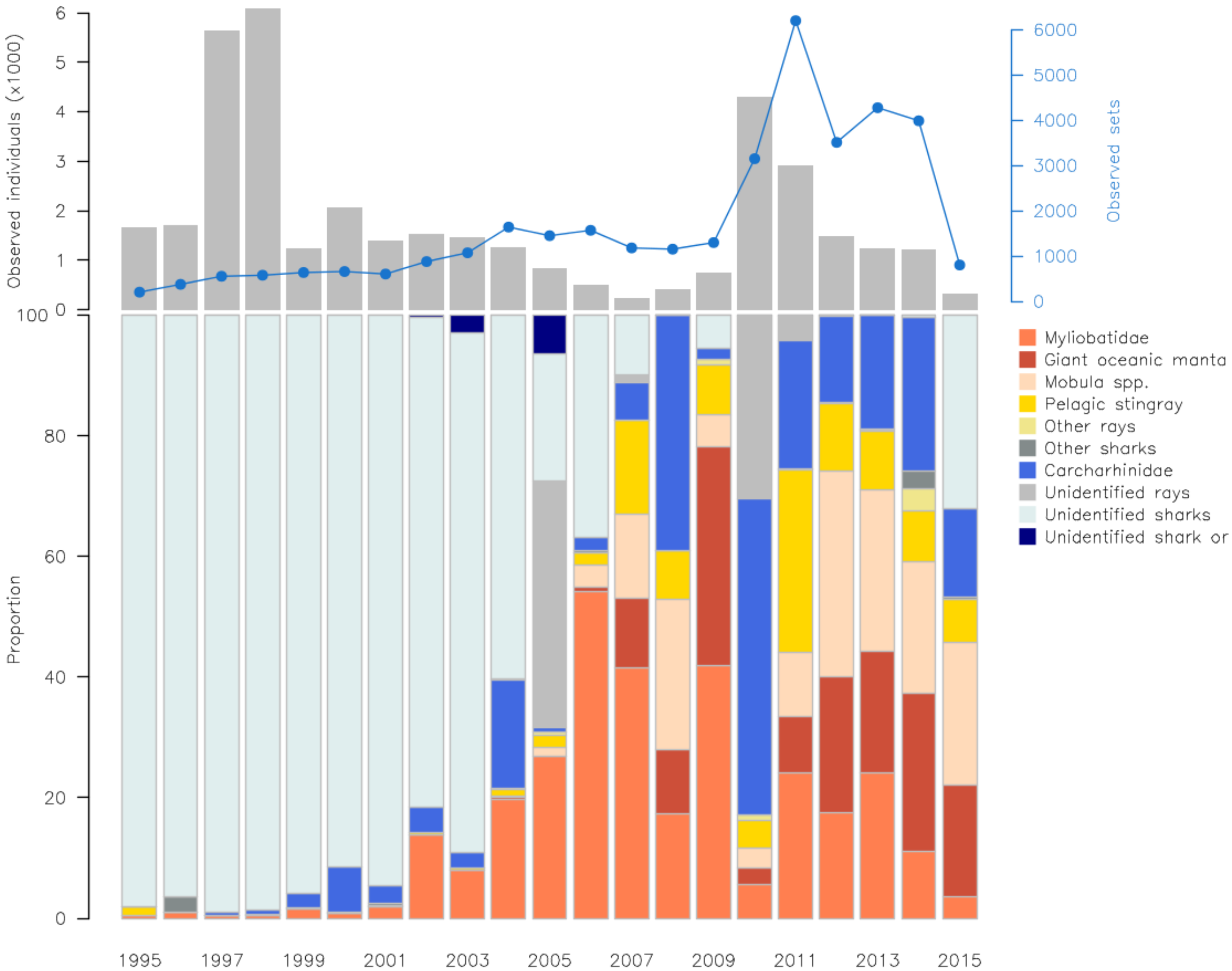

Figure 4: Top: Number of non-key sharks individuals observed in associated purse seine sets (including fish aggregating devices) for the Western and Central Pacific Ocean from 1995-2015, with the number of observed sets over time in blue (righthand axis). Bottom: Distribution of observed individuals by main species groups.

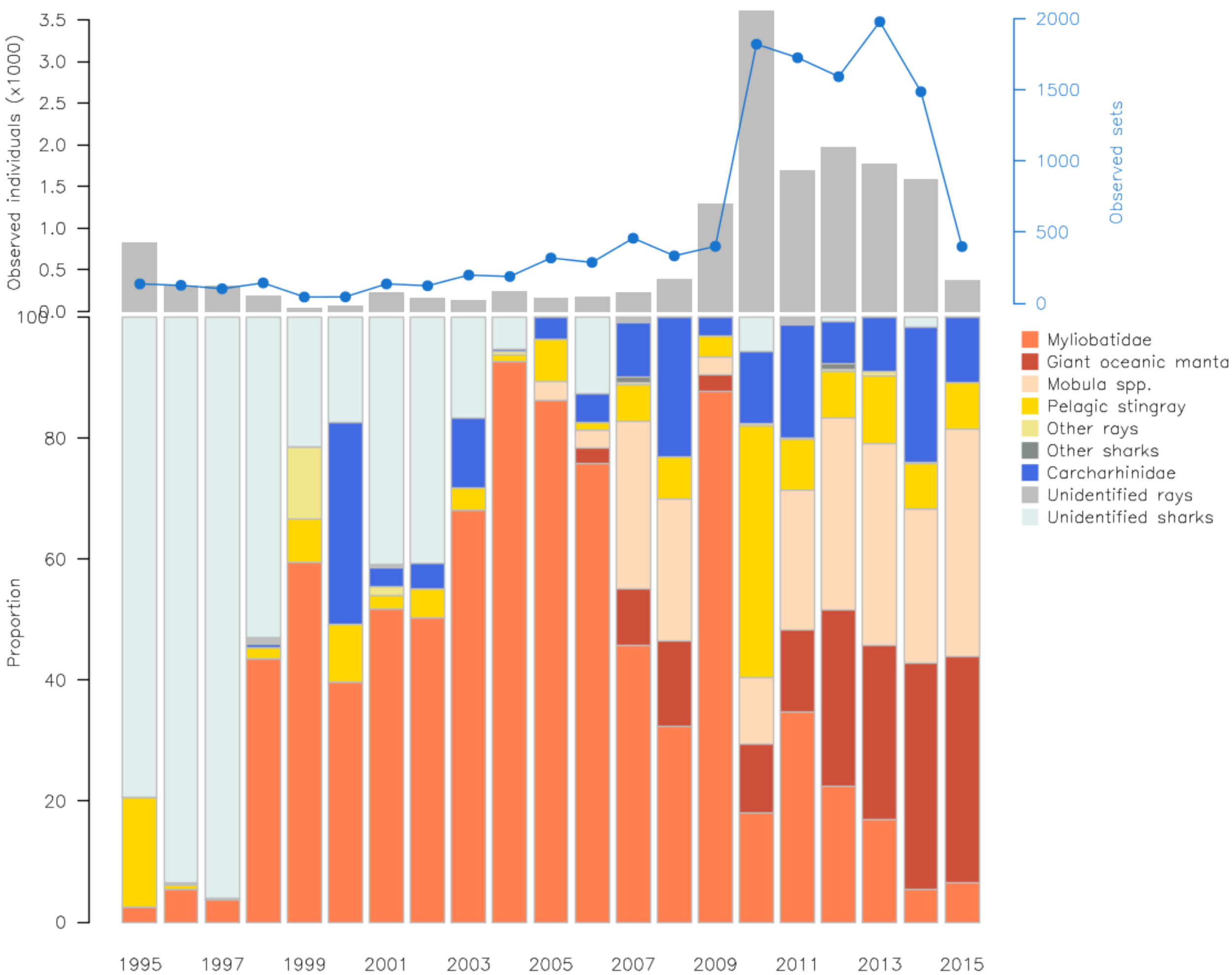

Figure 5: Top: Number of non-key sharks individuals observed in free school (unassociated) purse seine sets for the Western and Central Pacific Ocean from 1995-2015, with the number of observed sets over time in blue (righthand axis). Bottom: Distribution of observed individuals by main species groups.

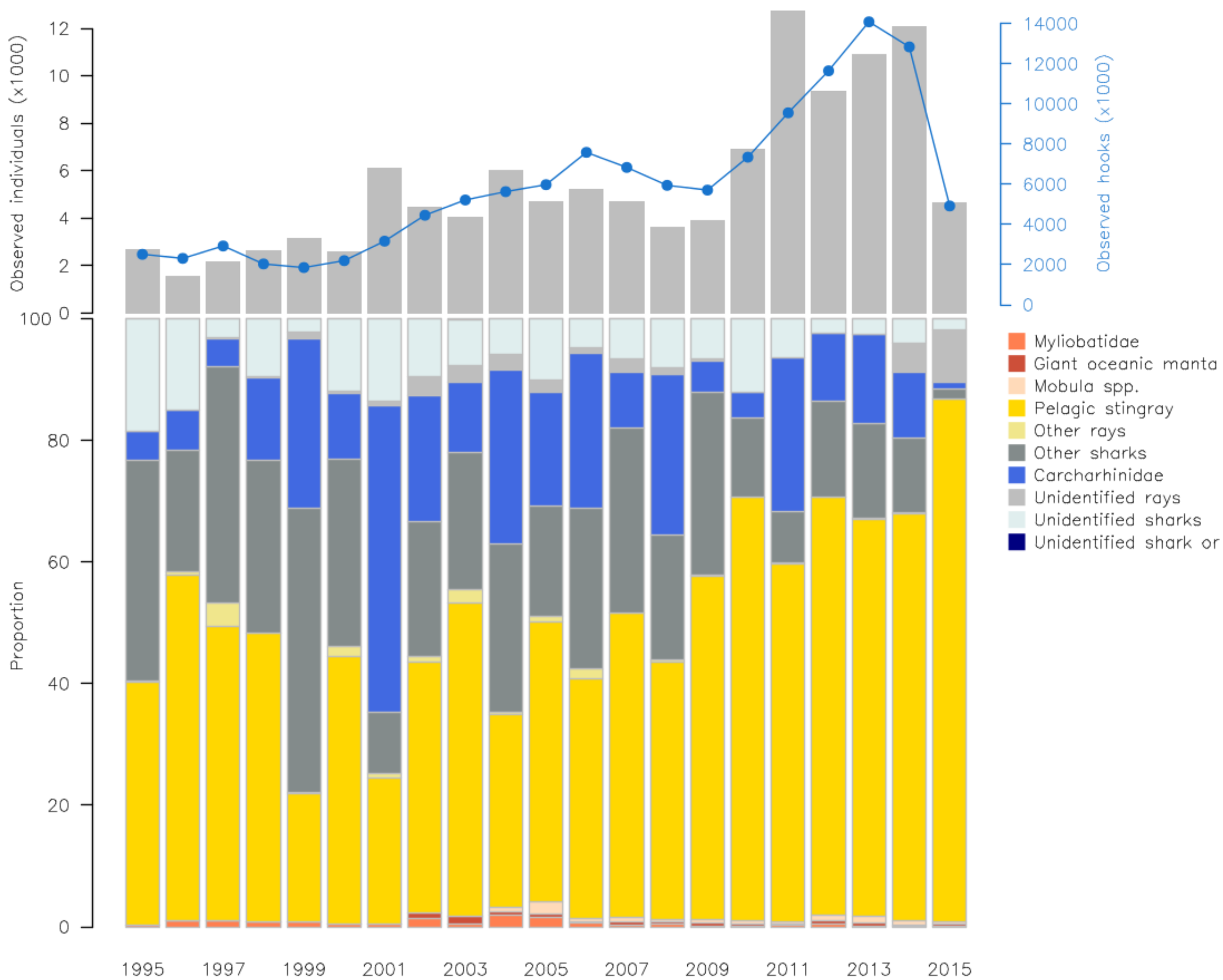

Figure 6: Top: Number of non-key sharks individuals observed in longline sets for the Western and Central Pacific Ocean from 1995-2015, with the number of observed hooks over time in blue (righthand axis, in thousand hooks). Bottom: Distribution of observed individuals by main species groups.

3.2 Spatial distribution of catch

Distribution maps for the most prominent groups are shown in Figure AI 7 to Figure AI 12. For a full set of distribution maps for all species, see Appendix 5. The distributions observed in the purse seine fishery is heavily biased to 10^oN to 10^oS due to the the bulk of the purse seine effort taking place in that region.

For the carcharhinids there are few distinct patterns that emerged between 10^oN to 10^oS. Some species such as *Carcharhinus altimus* and *C. leucas* seem to be more prevalent in the western part of the region (Figure AI 7). Similarly for the dasyatids and myliobatids the distribution reflects the distribution of purse seine fishing effort Figure AI 8 and Figure AI 9. *M. birostris* and *P. violacea* both seem to have a break in their distribution to the northeast of Papua New Guinea, however this is most likely a result of reporting as for both species reporting to the species-level only became more prevalent after 2008 and the high seas pockets within the WCPFC were closed to fishing at that time, resulting in a paucity of species-specific information in the high seas pocket regions. These gaps in the distribution are not apparent in the longline data (Figure AI 11 and Figure AI 12) where vessels are not restricted from fishing in the high seas pockets.

The longline fishing effort is more widely distributed and therefore potentially more useful to assess species distributions (Figure AI 10, Figure AI 11 and Figure AI 12). Gaps in the observed effort in the northwest, southeast as well as some zones with no or little longline effort result in what appears, probably incorrectly, to be gaps in the distribution. Despite this, some trends are apparent. For the Carcharhinidae, *C. albimarginatus* and *C. obscurus* have a more south westerly distribution while *C. plumbeus* is distributed more to the northeast. For the Dasyatidae which is primarily represented by *P. violacea*, the distribution mirrors that of the longline effort as it is relatively commonly observed. In addition, high densities of this species are apparent to the northeast of Hawaii, in Palau and towards the Equator east of 160^oW. Lastly, observations of myliobatids are less common in the longline fishery and their distribution is fairly patchy, however, a high density area for *M. birostris* exists north northwest of Hawaii.

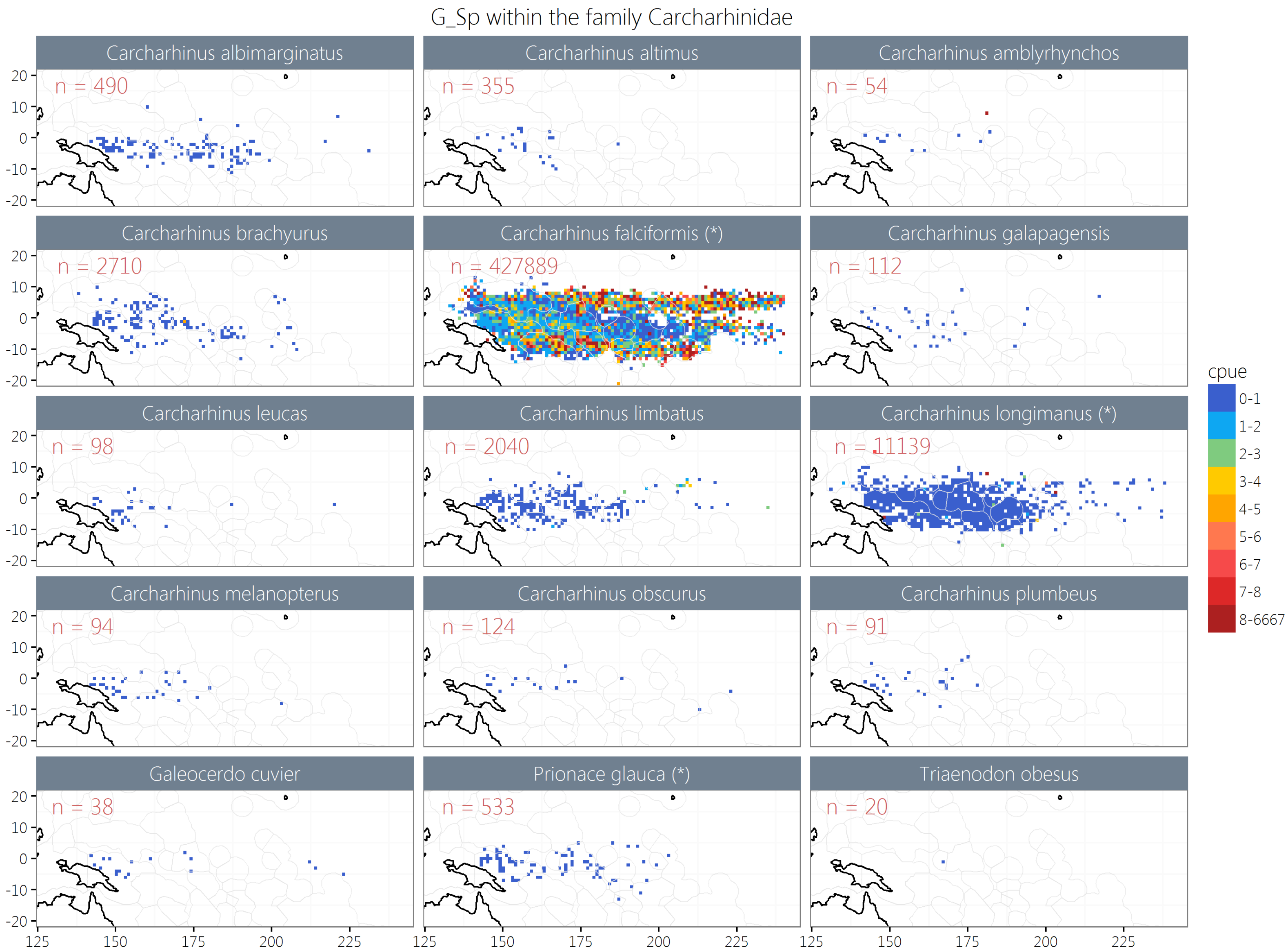

Figure 7: Distribution of carcharhinid species observed in purse seine sets within the Western and Central Pacific Ocean, 1995-2015. Observations have been standardised to observed fish per observed set in each one degree cell. * indicates a key shark designation within the WCPFC.

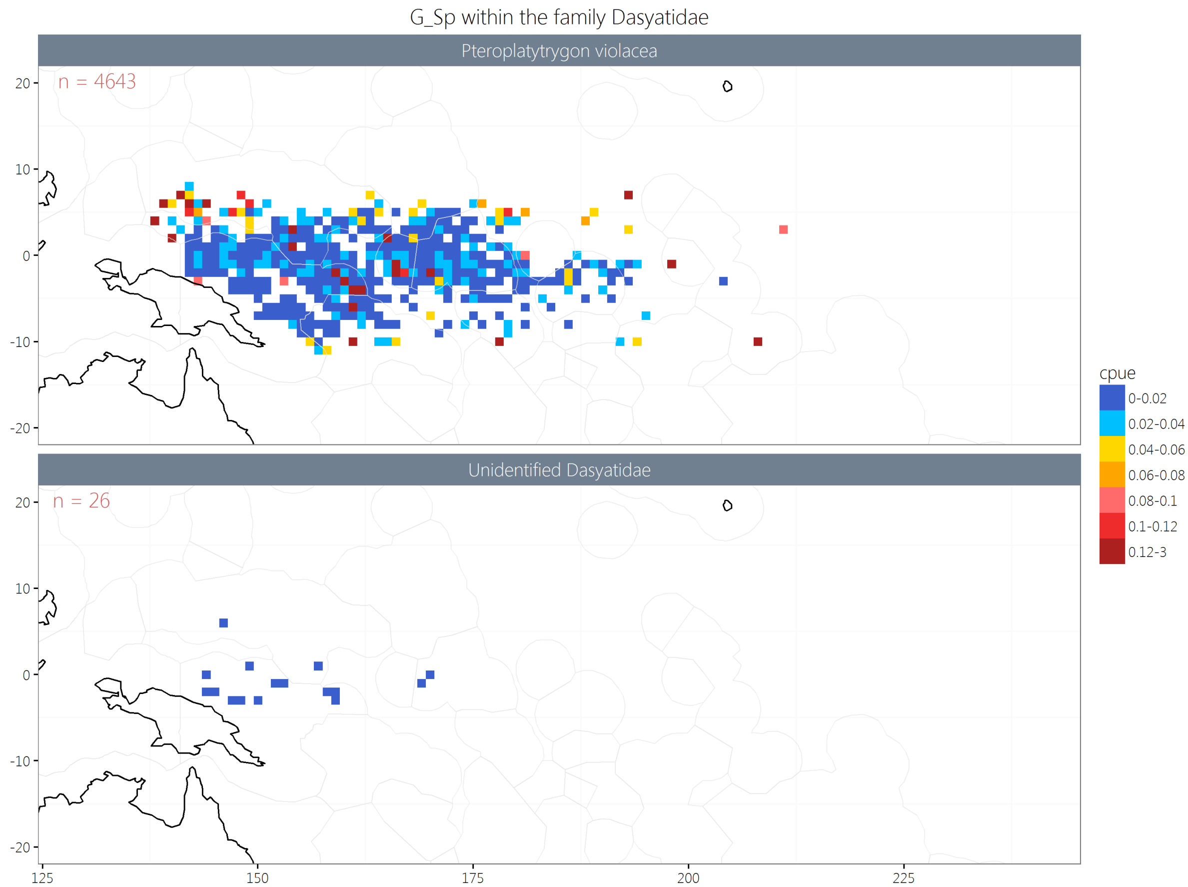

Figure 8: Distribution of dasyatid species observed in purse seine sets within the Western and Central Pacific Ocean 1995,-2015. Observations have been standardised to observed fish per observed set in each one degree cell.

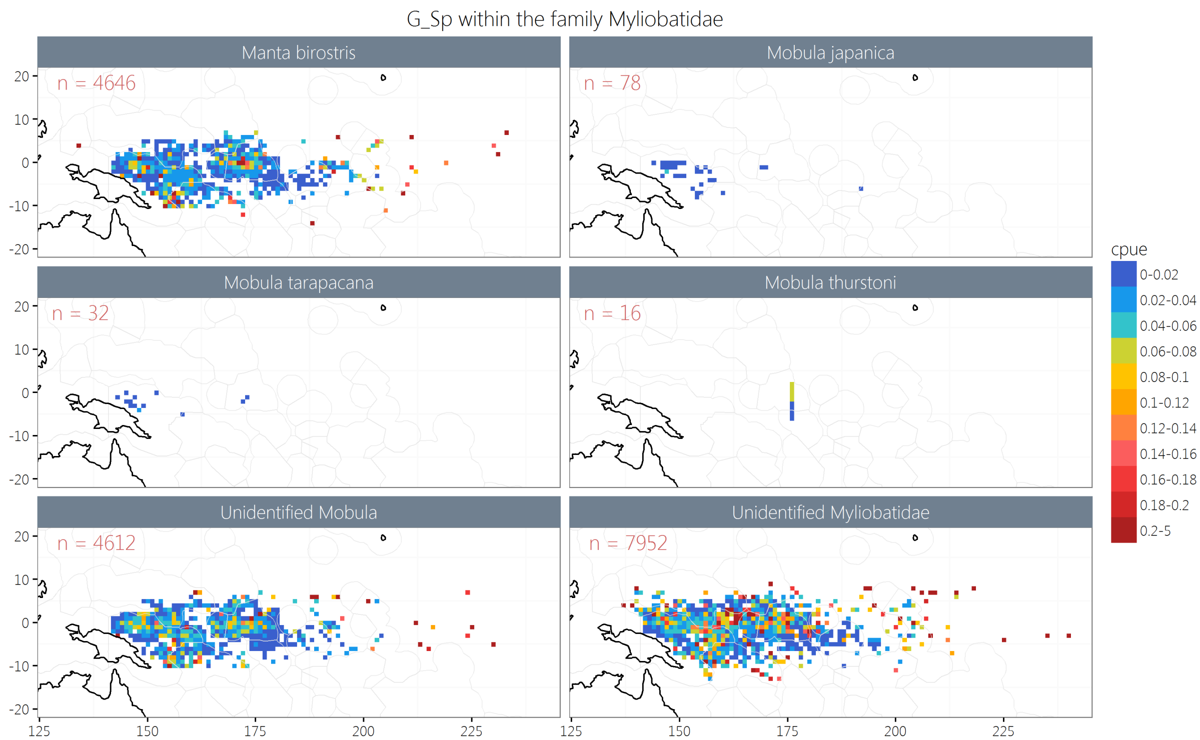

Figure 9: Distribution of myliobatid species observed in purse seine sets within the Western and Central Pacific Ocean, 1995-2015. Observations have been standardised to observed fish per observed set in each one degree cell.

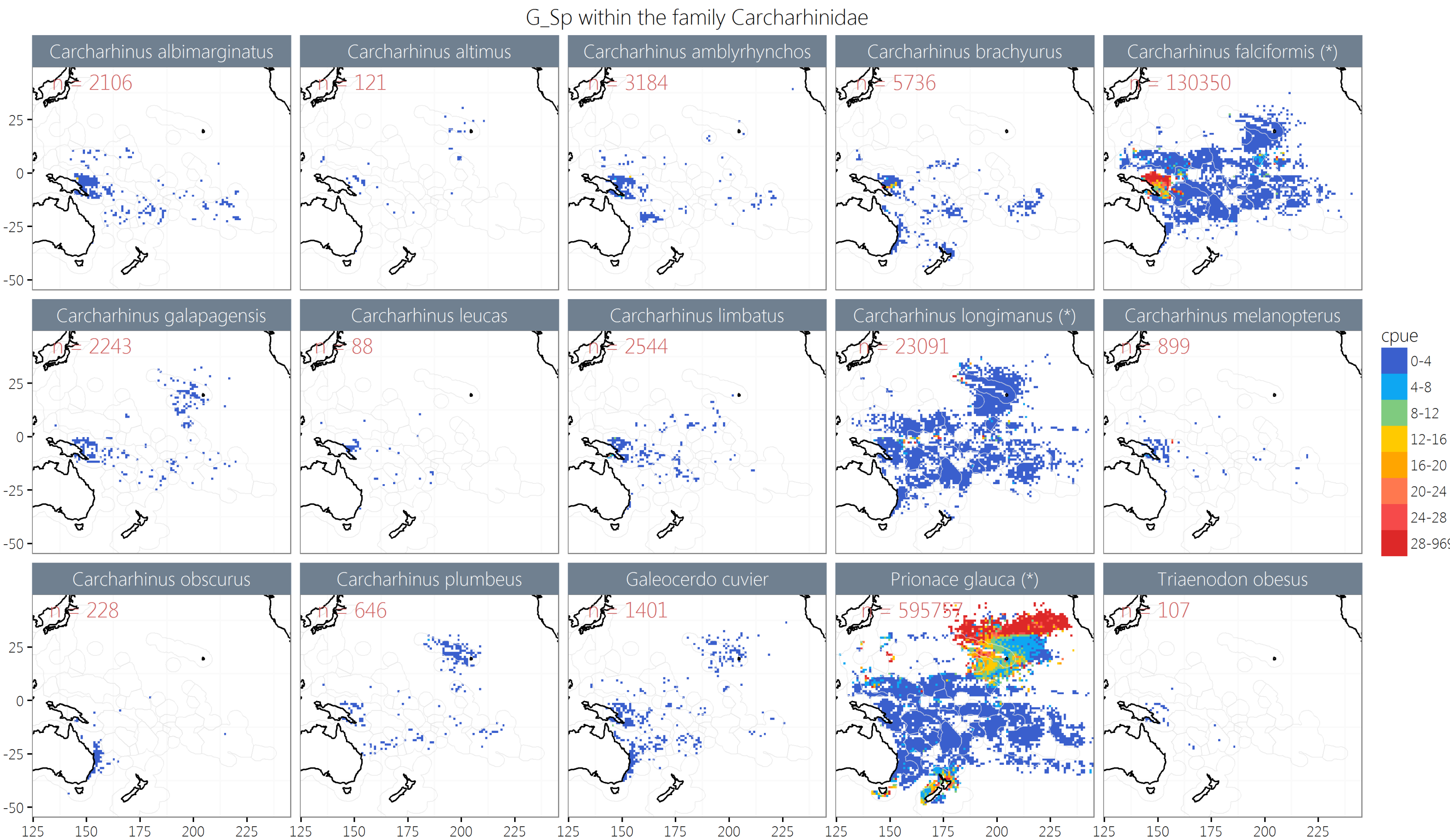

Figure 10: Distribution of carcharhinid species observed in longline sets within the Western and Central Pacific Ocean, 1995-2015. Observations have been standardised to observed fish per observed hundred hooks in the one degree cell. * indicates a key shark designation within the WCPFC.

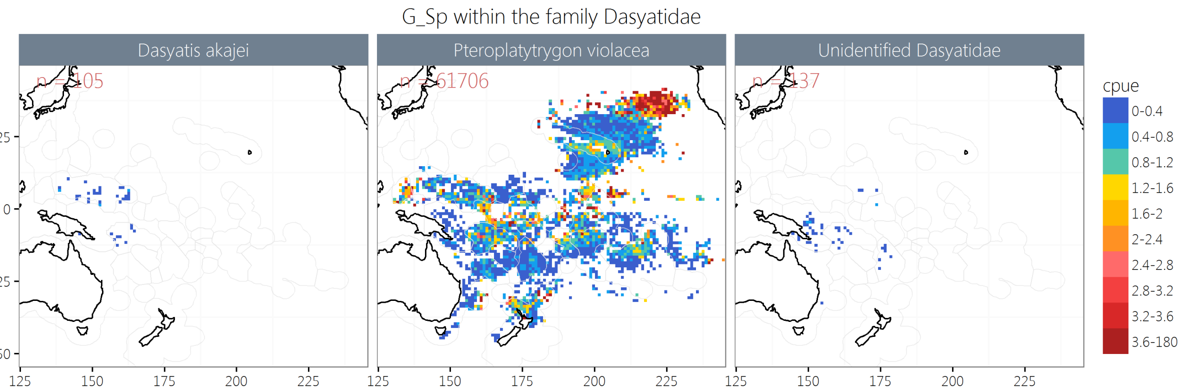

Figure 11: Distribution of dasyatid species observed in longline sets within the Western and Central Pacific Ocean, 1995-2015. Observations have been standardised to observed fish per observed hundred hooks in the one degree cell.

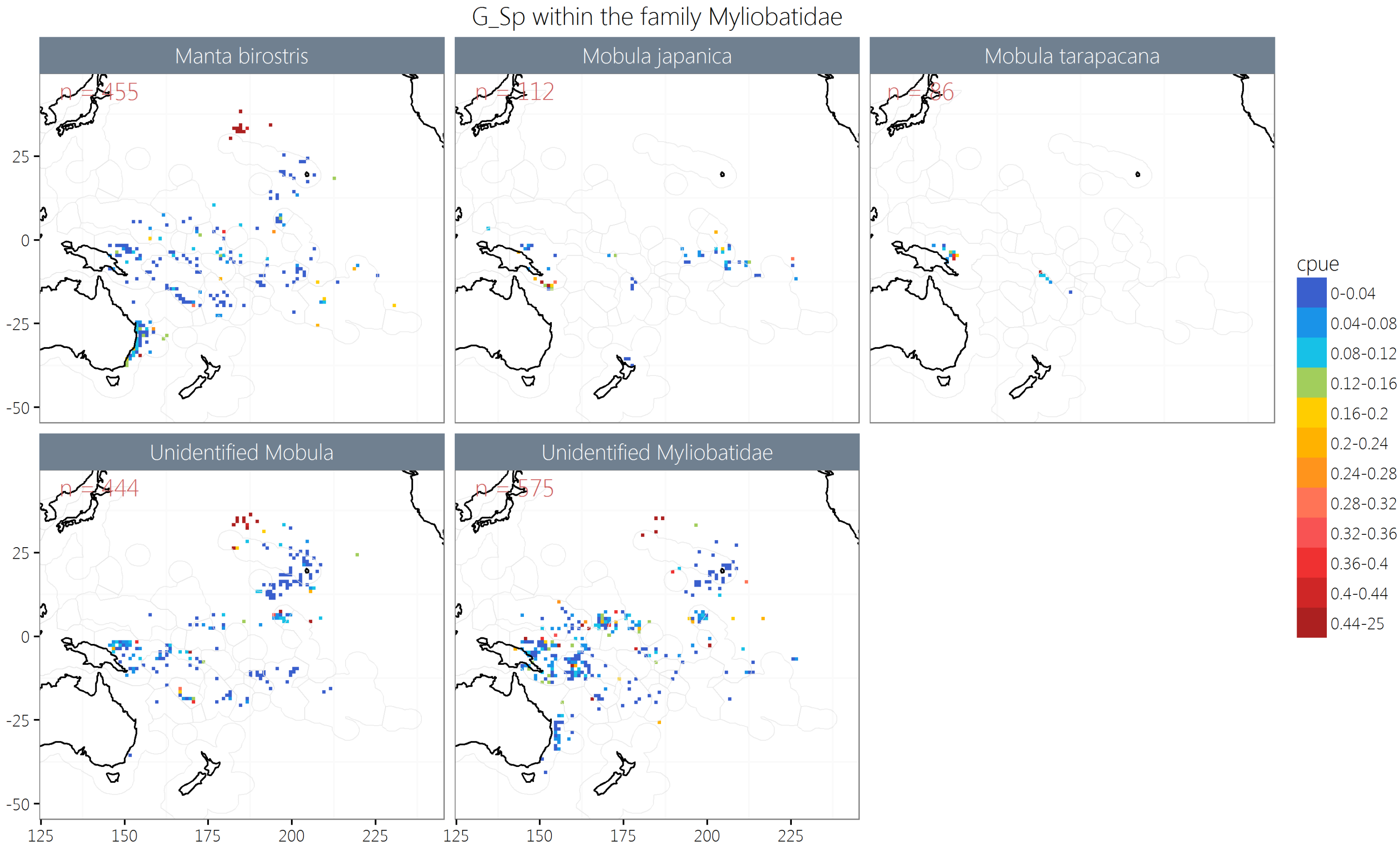

Figure 12: Distribution of myliobatid species observed in longline sets within the Western and Central Pacific Ocean, 1995-2015. Observations have been standardised to observed fish per observed hundred hooks in the one degree cell.

3.3 Temporal trends in catch rates

Catch rate information can be useful for providing indices of abundance. For these to be informative, however, they should be standardised to account for factors that systematically influence catchability, which may themselves be unrelated to fish abundance. Despite this unstandardized CPUE information can provide a snapshot of of potential abundance trends and an informative flag for further investigation. Appendix 5 contains CPUE trends for species where data existed for more than more than three years. These data for some species such as *Galeorhinus galeus* seem to be informative for providing some insight into annual and interannual trends but should be subject to more rigorous standardisation prior to being used for providing management advice. Moreove,r the bulk of the data come from a single country and therefore have limited interest for the WCPFC at the basin scale.

A few species that are widely distributed within the WCPO have CPUE trends that may warrant further investigation, two are discussed here. *M. birostris* is predominantly caught in the purse seine sets. The purse seine CPUE information (Figure AI 13) mostly shows trends indicative of increased reporting from 2009 to 2015. The *M. birostris* longline CPUE data show fairly consistent trends in positive catch (Figure AI 14) with the mean CPUE showing a slight but continuous decline and no apparent seasonality. It may be more informative in future analyses to split the CPUE north and south of the equator to investigate seasonality more appropriately; and an analysis of distribution by quarter for each hemisphere could be informative. See subsection 4.1 for further discussion on spatial and temporal trends for this species.

As with *M. birostris*, *P. violacea* purse seine CPUE is fairly uninformative but suggests increased reporting from 2009 to 2015. The longline observer records for *P. violacea* could be informative if standardised, there are copious records, possibly showing some seasonality (Figure AI 15) . However, as with *M. birostris*, to make these data more informative, a north/south hemisphere split may help to inform the population dynamics for this species. See subsection 4.3 for further discussion on spatial and temporal trends for this species.

While the CPUE data for *M. birostris* and *P. violacea* could warrant further investigation it must be noted that large gaps in the longline observer coverage exist. These are particularly noticeable in the high seas areas to the northwest and south east of the WCPO (Figure AI 17), it is also clear that the observer coverage is not spatially representative of the fishing effort.

Lastly, the current dataset contained many records for *Mobula* sp. that cover a wide area of the WCPO. Two main species within this genus are landed in the WCPO fisheries and their known distributions appear to overlap, such that it is hard to attribute the records to specific species. It would be uninformative to attempt to interpret CPUE trends for this group as we have no way to separate the records to species level and have no information on how different the productivities are for each species. Abundance trends at the group level can be misleading if one species within a group increases in abundance as another is being depleted (e.g. see Dulvy et al., 2000, for an example of shifting community structure of skates in the North Sea).

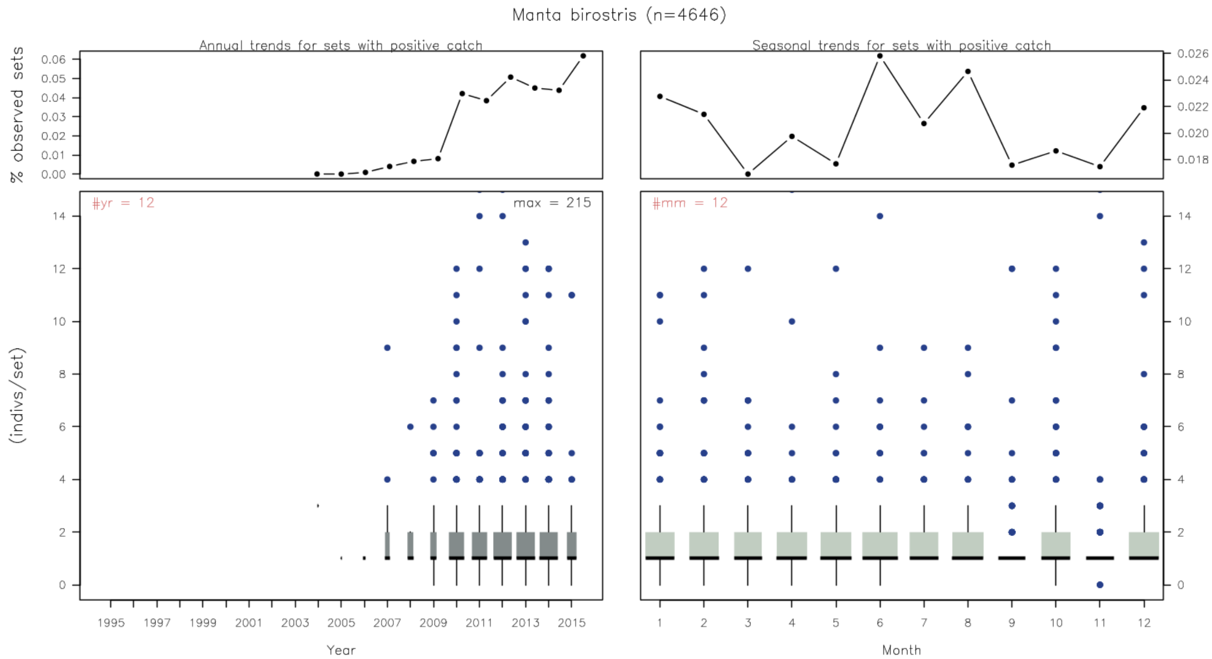

Figure 13: Unstandardized CPUE for *Manta birostris* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

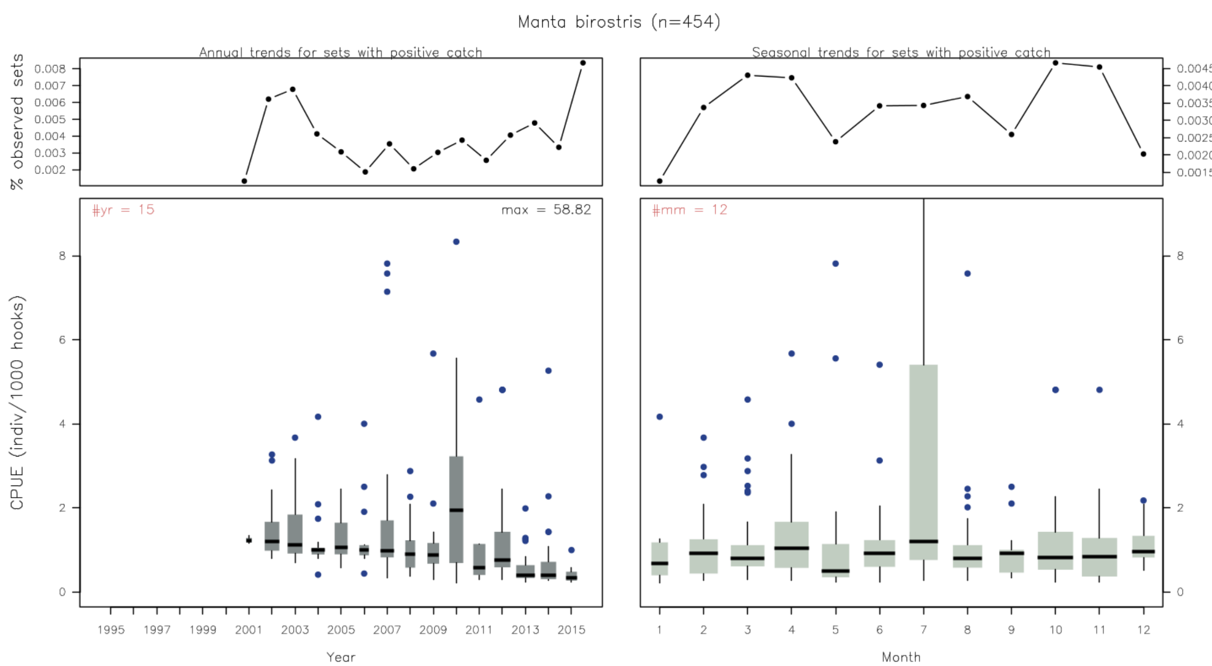

Figure 14: Unstandardized CPUE for *Manta birostris* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

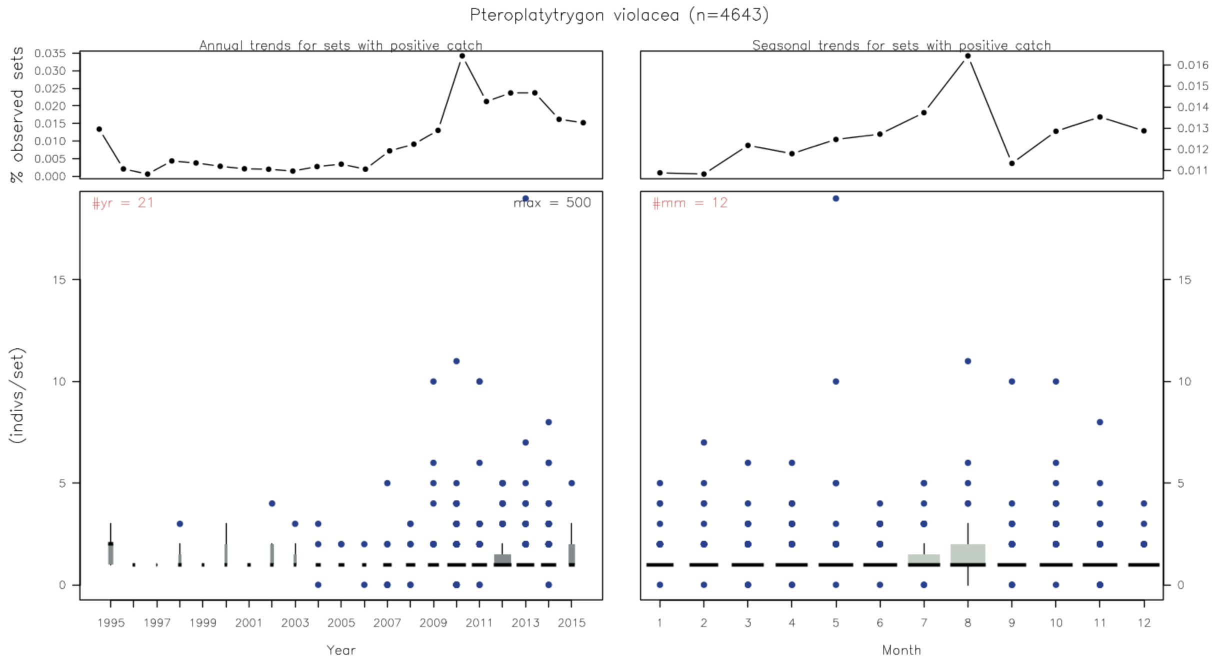

Figure 15: Unstandardized CPUE for *Pteroplatytrygon violacea* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

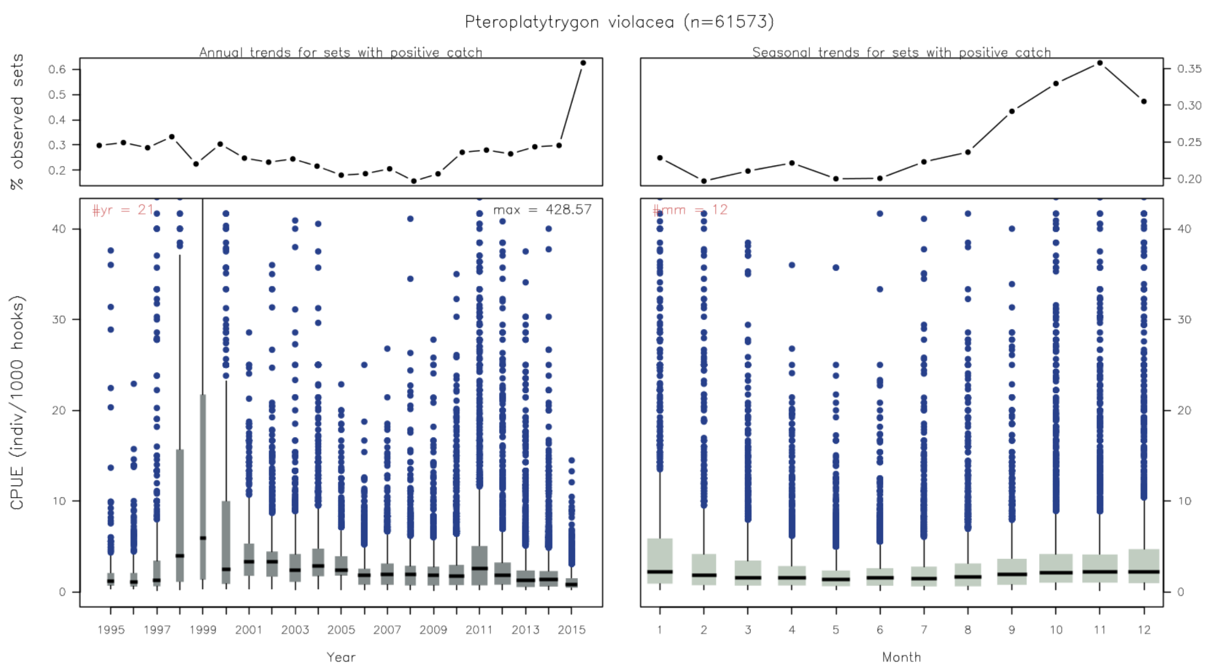

Figure 16: Unstandardized CPUE for *Pteroplatytrygon violacea* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

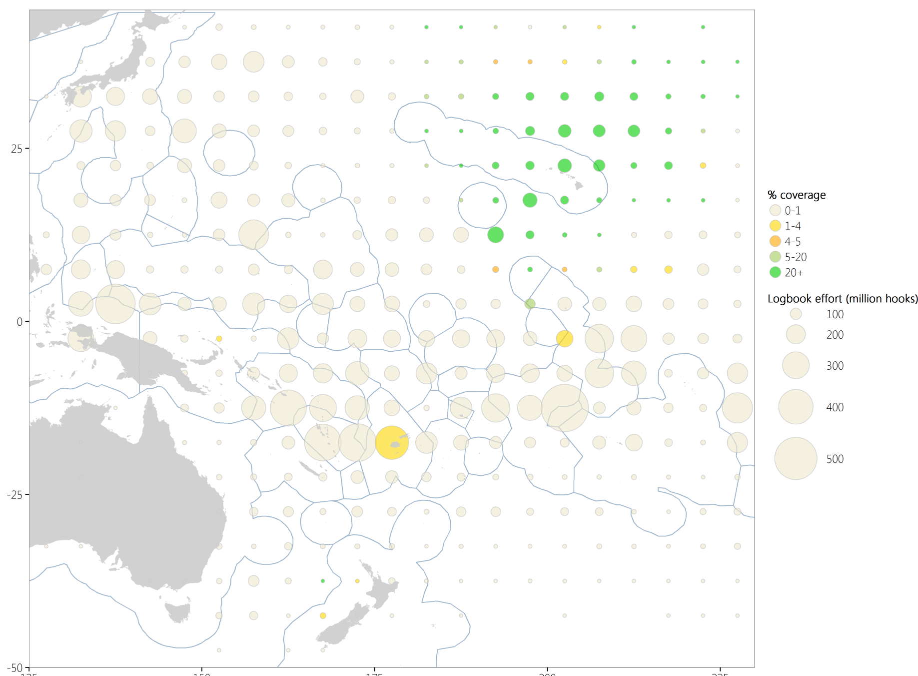

Figure 17: Distribution of longline hooks set and observed sets from 1995-2015 in the Western and Central Pacific Ocean.

3.4 Fate and condition

No fate or condition data are available for the purse seine catch, so we focus here on longline observations. For non-key shark species, the recorded fate revealed that through time sharks are utilised to some extent while rays, skates and dogfish are discarded (Figure AI 18). Of the sharks *G. galeus*, *C. amblyrhynchos*, and *C. limbatus* have the highest retention rates. *C. brachyurus*, *C. melanopterus* and *Galeocerdo cuvier* have the highest finning rates. Generally speaking, in the most recent years, finning has declined, probably as a result of regulations enacted in countries that make up a relatively high proportion of the longline observer records.

In terms of condition at capture, approximately half of the observed sharks are dead when first observed, while most of the rays are reported as alive and healthy (Figure AI 19). While the trends for each species are variable from year to year, there are no obvious systematic trends, with the exception of the rays where there is a clear trend for better reporting from 2003 onwards. At the time that the fish is discarded or released, some trends are evident in fish condition. Overall the condition for most of the NKS at release is unknown (Figure AI 20). The most obvious systematic change is with the rays where as the reporting increases. As almost all are alive when first observed, but then discarded dead. This is likely to be a result of either poor handling on-board the vessel, or the fish may be put aside while the crew deal with other target catch before returning the ray back to the sea.

While most *P. violacea* are discarded dead, a high proportion of *M. birostris* are released alive and injured. It is not known what the survival rates of these fish are post-release. If the WCPFC wanted to fully quantify the fishing mortality of these species, post-release mortality needs to be quantified. Studies of post-release mortality in *Mobula japanica* in New Zealand have shown that an estimated 57% of fish released from purse seine sets die within a few days of release (Francis and Jones, ress).

Figure 18: Reported fate for the 20 most caught species or species complex within the observed longline sets from 1995-2015 in the Western and Central Pacific Ocean. Fates are categorized as Retained (RET), Discarded (DIS), Escaped (ESC), Finned (FIN) and Unknown (UNK).

Figure 19: Reported condition on arrival at the vessels for the 20 most caught species or species complex within the observed longline sets from 1995-2015 in the Western and Central Pacific Ocean.

Figure 20: Reported condition when discarded (if applicable) for the 20 most caught species or species complex within the observed longline sets from 1995-2015 in the Western and Central Pacific Ocean.

3.5 Length data

Given the variability in the nature of the length data collected, even for more common NKS species, we produce here an assessment of the type of length data that exist for NKS. The NKS were separated into sharks (sharks and dogfish) and rays. For the shark, in most years less than 50% of individuals are measured, but the measurements taken were inconsistent (Figure AI 21). Only 20-40% of shark NKS were measured as upper jaw to fork length and there was a large group of "other" measurements. The rays are seldom measured (Figure AI 22) and most of those that are measured use total width with a few total length and upper jaw to fork length measurements. These inconsistencies indicate a need to convert length measurements to a standard measurement. While some length-length conversion factors exist for the target species and some key sharks, few exist for NKS.

We **recommend a review of conversion factors** to assess what length-length and length-weight conversion factors exist, to add existing conversion factors to the SPC data base (provided they are based on an appropriate sample number and cover most of the size range of the species). For species and length measurements that are lacking, conversion factors should be developed through the collection of length-length and length-weight data on SPC observer form LL5. This is particularly important for the ray NKS which seem to be data poor at this stage. This work was recommended as part of the 2016 shark research plan (Brouwer and Harley 2015), however, at this stage that analysis has not yet begun. More precise measuring guidelines for observers for rays would also be useful. Lastly, it would be useful to know why some individuals are not being measured, this should be recorded by observers.

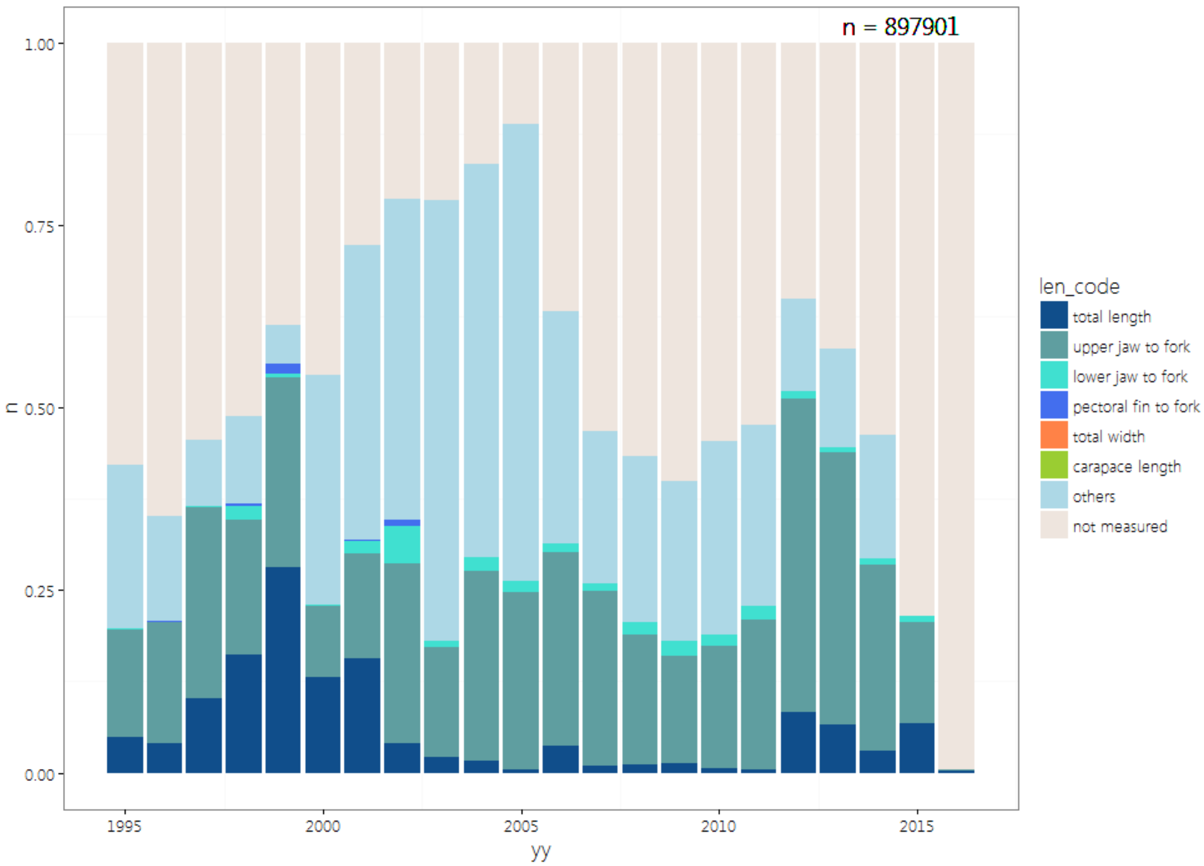

Figure 21: The length measurements collected by observers for shark NKS from 1995-2015 in the Western and Central Pacific Ocean longline fishery.

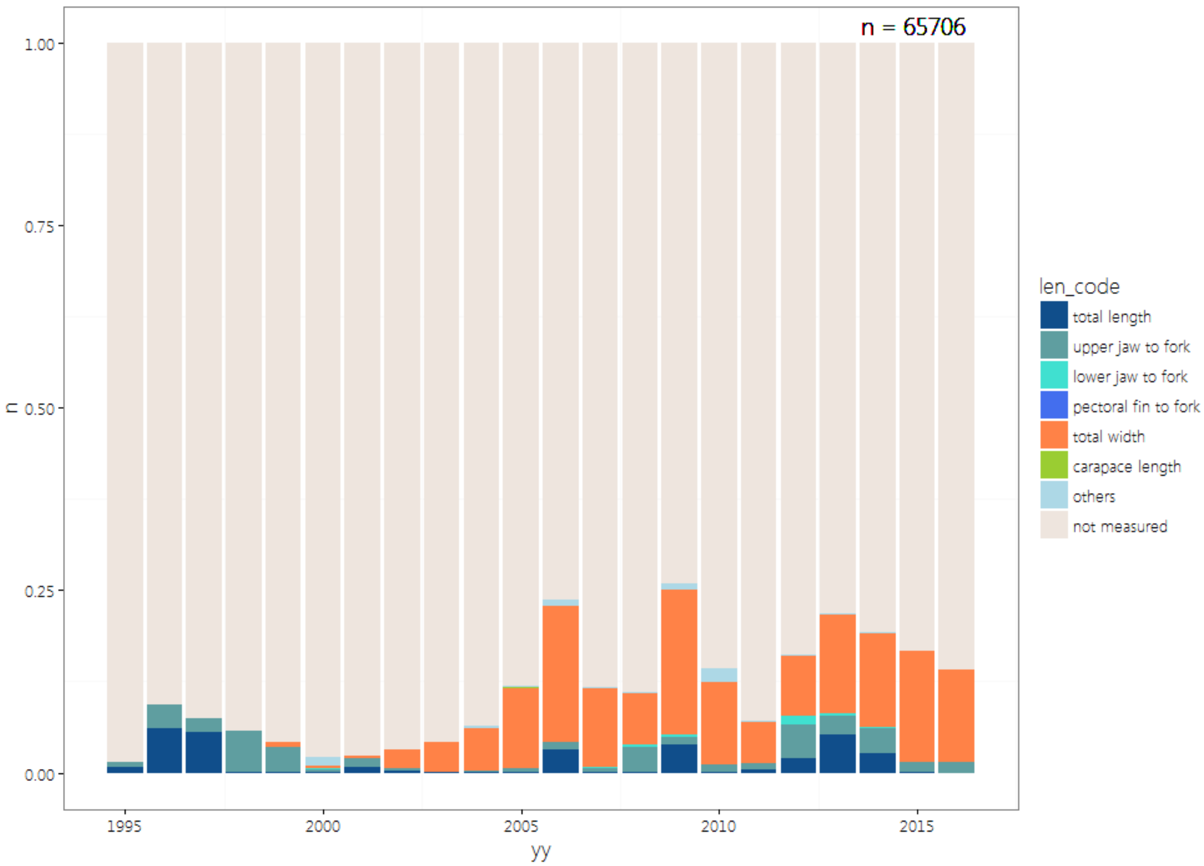

Figure 22: The length measurements collected by observers for ray NKS from 1995-2015 in the Western and Central Pacific Ocean longline fishery.

4 Analyses of selected species

In order to provide more detailed information for the most common NKS we undertook more detained investigations for *M. birostris*, *Mobula* sp. and *P. violacea*. Here we assess species distribution and catch rate in the purse seine and longline fisheries. The longline data were assessed separately for albacore and bigeye-yellowfin target sets; and purse seine was separated into associated and unassociated sets.

4.1 Giant manta ray - *M. birostris*

The distribution for *M. birostris* for both purse seine (Figure AI 23) and longline (Figure AI 24) show strong reporting trends where there are few data available in the first 15 years of the time series and the bulk of the data appear in the last five year period. As a result of this few informative temporal trends are available. *M. birostris* are widely distributed and show few areas of high density except for a small area north of Hawaii. The high density area that appears in the longline data along the east coast of Australia from 2000-2009 is not seen in the most recent period, this is likely a result of declines in the longline fishing effort in that region rather than a decline in abundance.

Similarly, the purse seine CPUE data show strong reporting trends and are likely unhelpful when assessing trends in abundance (Figure AI 25). However, the longline CPUE series, while short, may be more informative (Figure AI 25). These data show that in both the albacore target sets and the bigeye-yellowfin sets *M. birostris* are observed less frequently in 2010-2015 than they were in 2000-2005. These trends may warrant further investigation, however, it is not known to what extent the biomass has changed prior to 2000. More detailed analyses on the spatial changes in CPUE would also be informative. Assessing other sources of information such as the Japanese training vessel data may also be useful for future analyses.

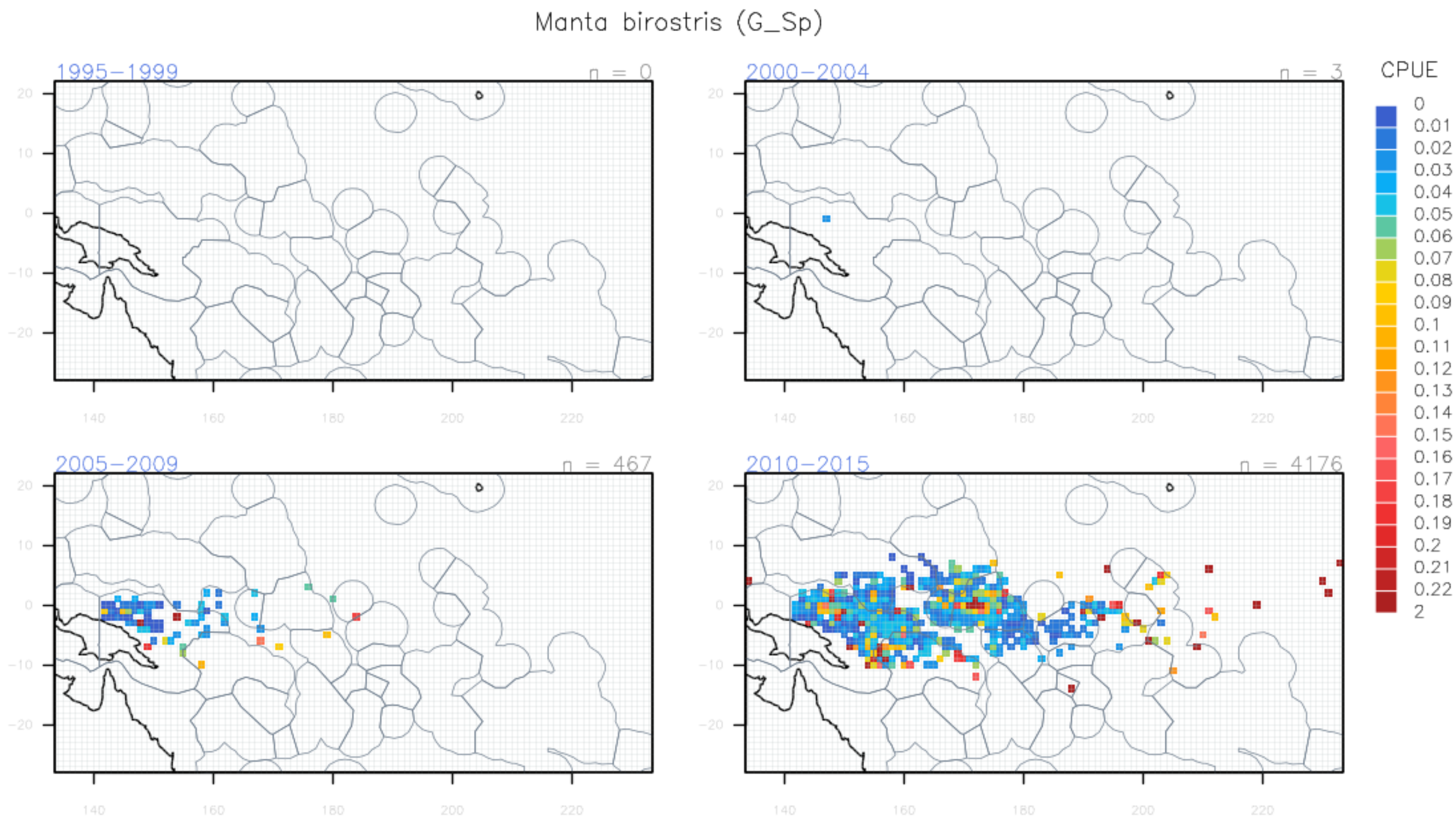

Figure 23: Distribution of *M. birostris* observed in purse seine sets by five year periods within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per observed set using the 95^{th} percentile.

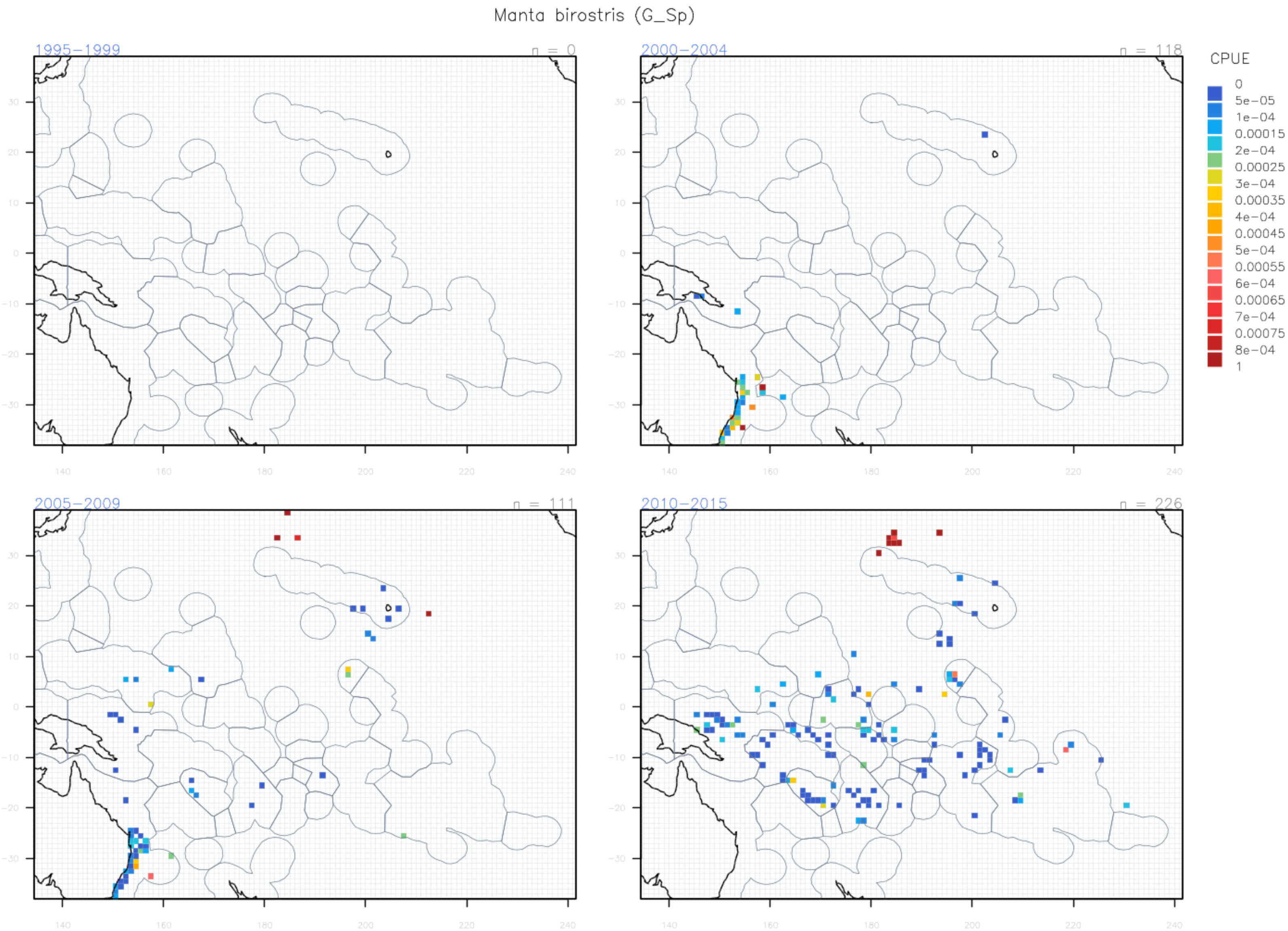

Figure 24: Distribution of *M. birostris* observed in longline sets by five year periods within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per observed hook using the 95^{th} percentile.

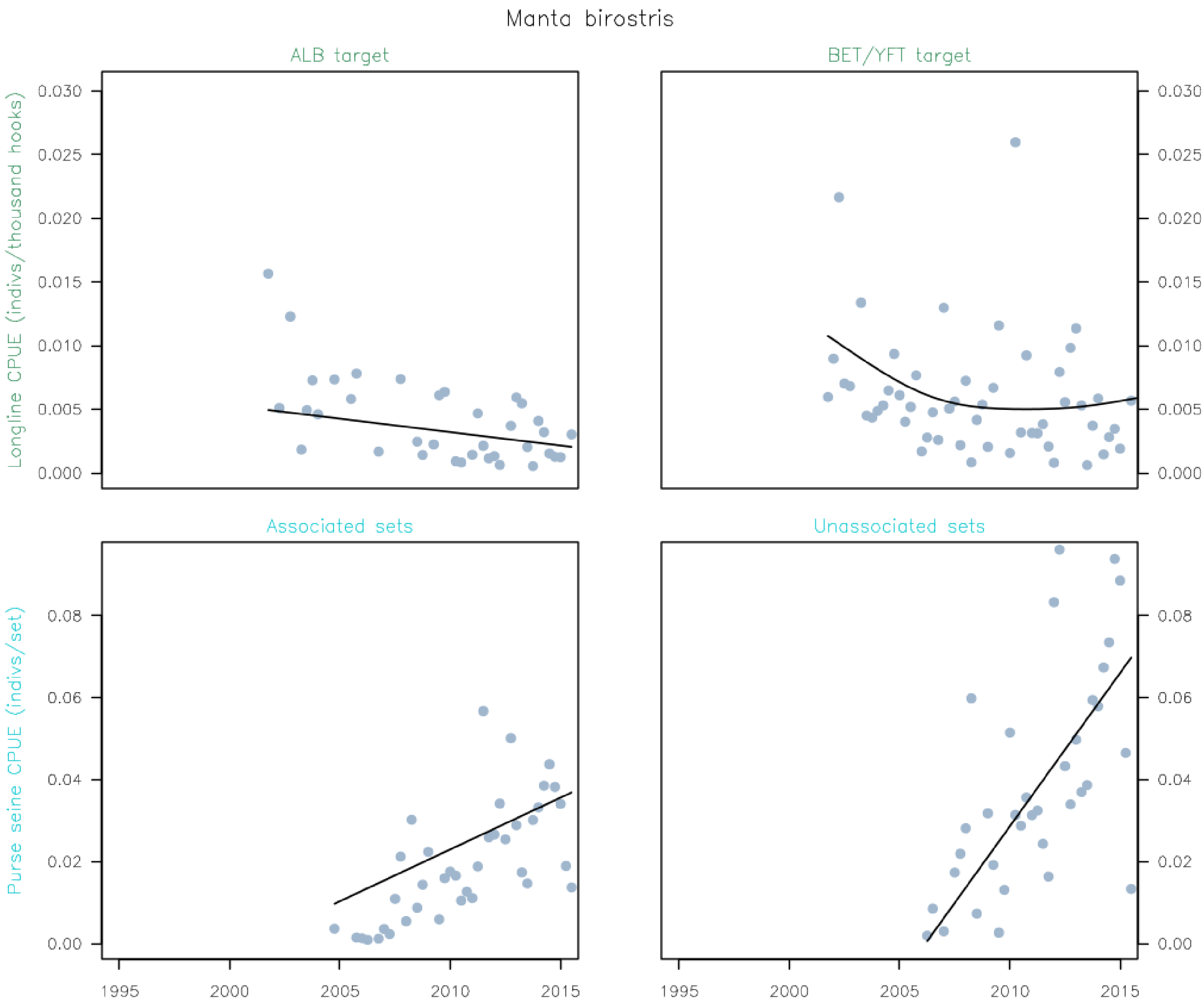

Figure 25: Observed CPUE for *M. birostris* in longline and purse seine sets by set type within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per observed hook using the 95^{th} percentile.

4.2 Devil rays - *Mobula* sp.

The distribution for *Mobula* sp. for both purse seine (Figure AI 26) and longline (Figure AI 27) show strong reporting trends where there are few data available in the first 15 years of the time series and the bulk of the data appear in the last five year period. As a result of this, few informative temporal trends are available. *Mobula* sp. are widely distributed and show few areas of high density except for a small area north of Hawaii. No temporal changes in distribution are detectable.

Similar to *M. birostris* the purse seine CPUE data show strong reporting trends and are likely unhelpful for assessing trends in abundance (Figure AI 28). The longline CPUE series, while short, and variable may be more informative (Figure AI 28). These data show that in both the albacore target sets and the bigeye-yellowfin sets *Mobula* sp. are observed less frequently in 2010-2015 than they were in 2000-2005. These trends may warrant further investigation, however, it is not known to what extent the biomass has changed prior to 2000. As there are two distinct species in the WCPO, it is not know which of these may be driving any trends.

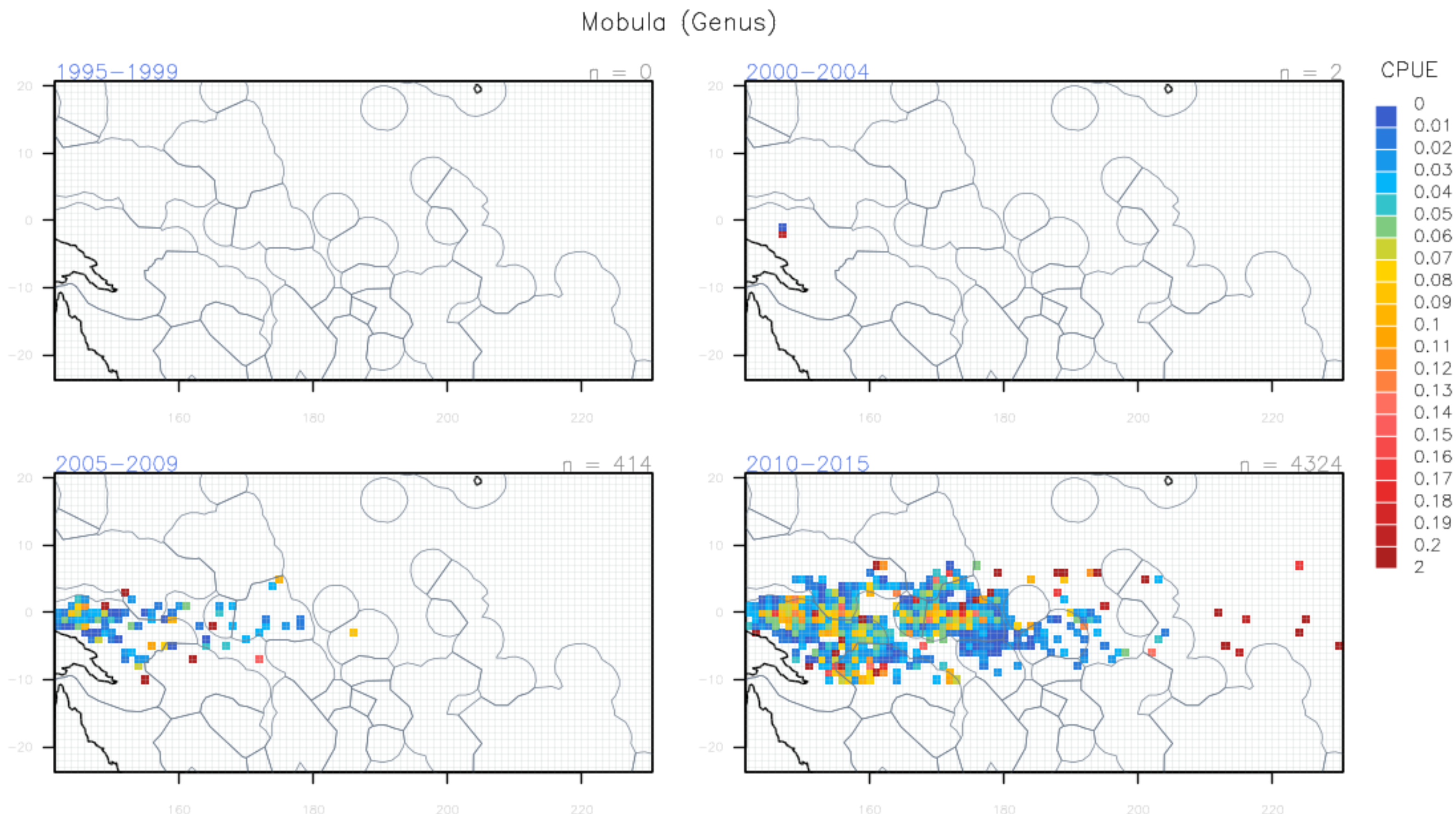

Figure 26: Distribution of *Mobula* sp. observed in purse seine sets by five year periods within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per observed set using the 95^{th} percentile.

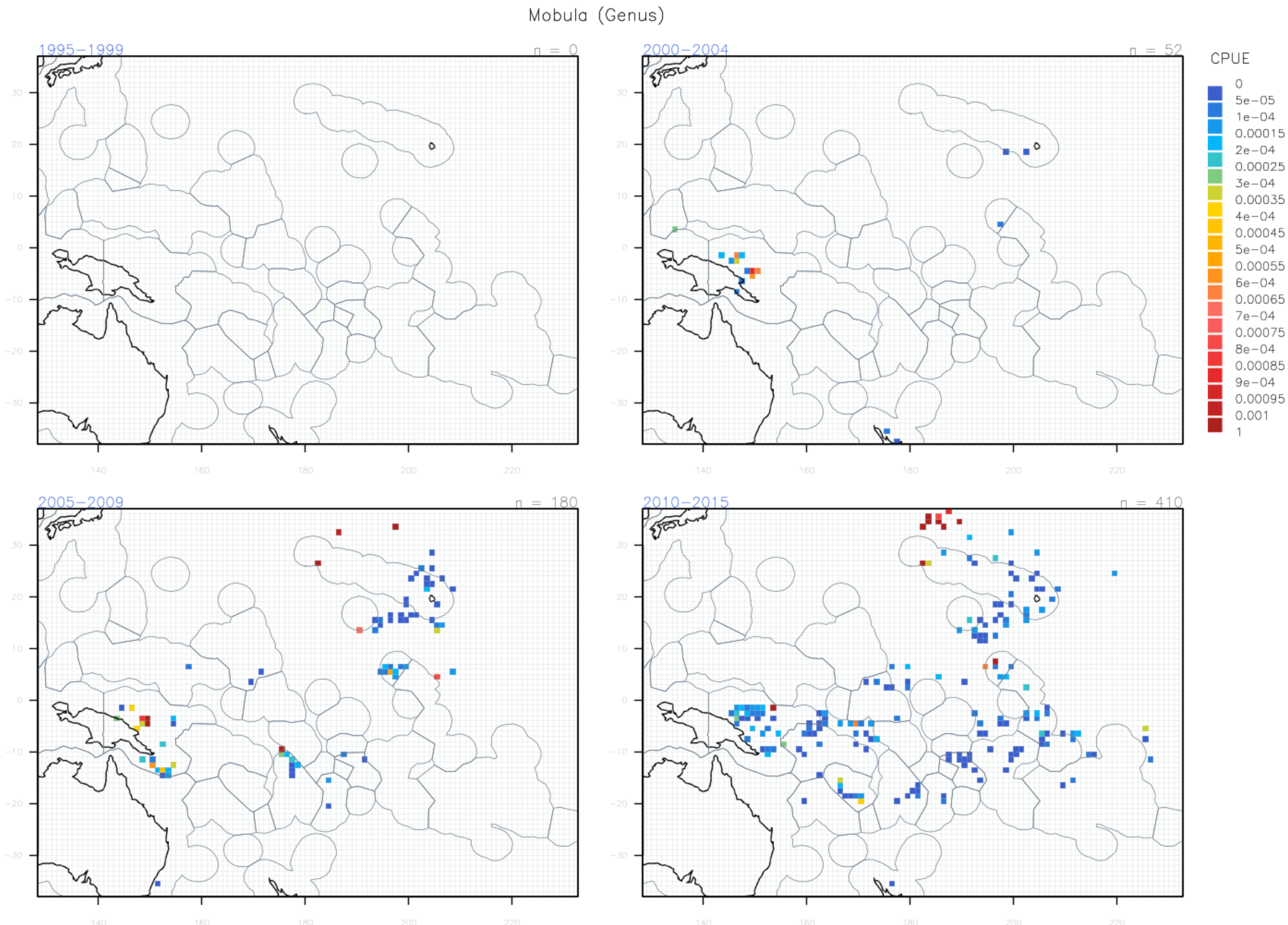

Figure 27: Distribution of *Mobula* sp. observed in longline sets by five year periods within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per observed hook using the 95^{th} percentile.

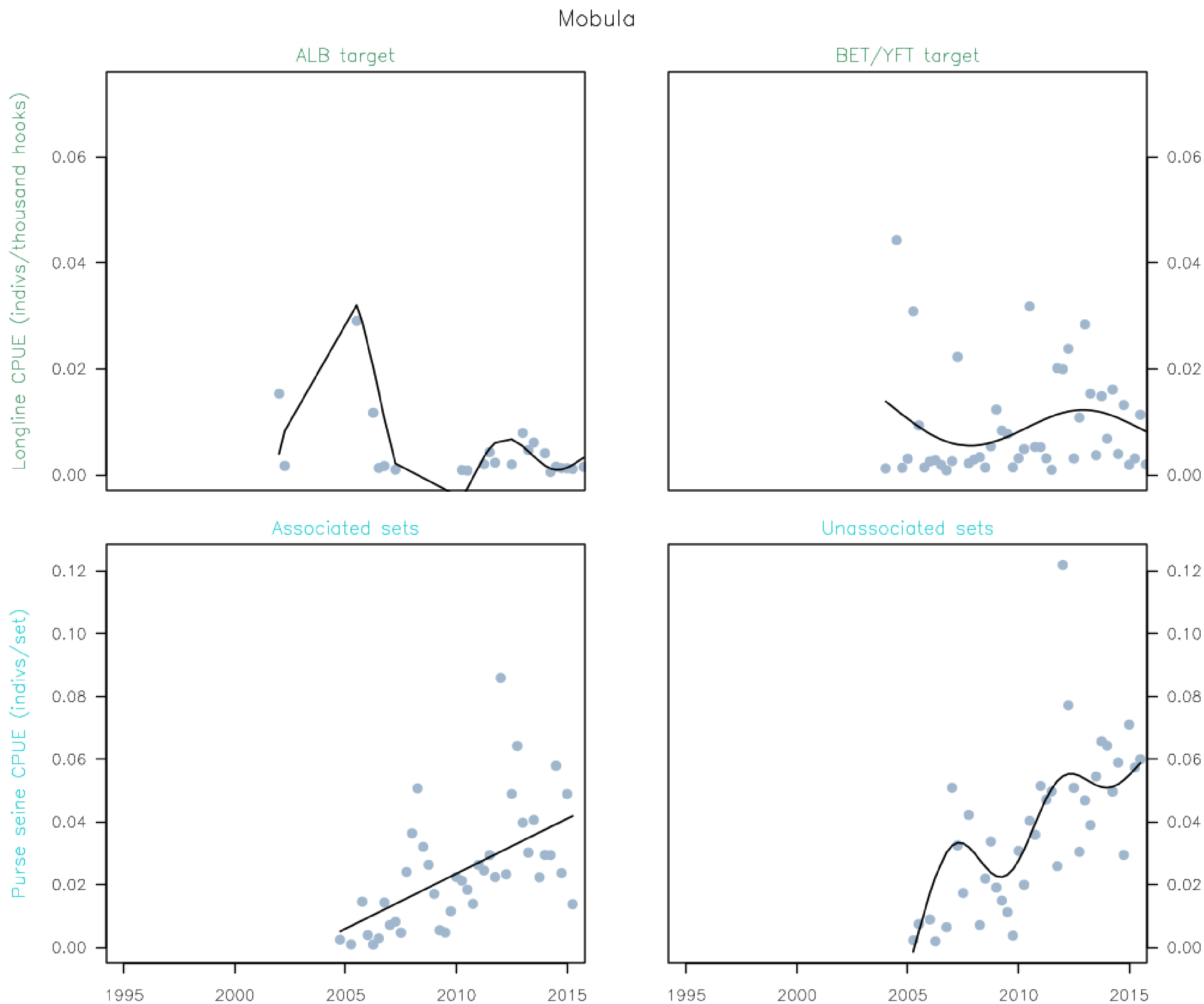

Figure 28: Observed CPUE for *Mobula* sp.in longline and purse seine sets by set type within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per observed hook using the 95^{th} percentile.

4.3 Pelagic stingray - *P. violacea*

The distribution of *P. violacea* for both purse seine (Figure AI 29) and longline (Figure AI 30) show some reporting trends where there with fewer data available in the first 15 years of the time series and the bulk of the data appear in the last five year period. *P. violacea* are widely distributed and show some areas of high density such as northeast of Hawaii. Few temporal trends are apparent, but there appears to be some shift of fish density from south of Hawaii where high CPUE areas are noticeable between 2000 and 2009 but these seem to be less dense in the most recent period.

The CPUE data for *P. violacea* from both purse seine and longline gear (Figure AI 31) show a long time series of data. These data show that in both the albacore target and the bigeye-yellowfin longline sets *P. violacea* CPUE has been variable. While trends in the unassociated purse seine sets were the most variable, CPUE declined in both gears and all set types from the mid-1990s to the mid-2000s and then seemed to increase again after 2010. As these trends are apparent in two different gear types and all set types they may be indicative of changes in the underlying biomass and could be useful in future investigations of this species.

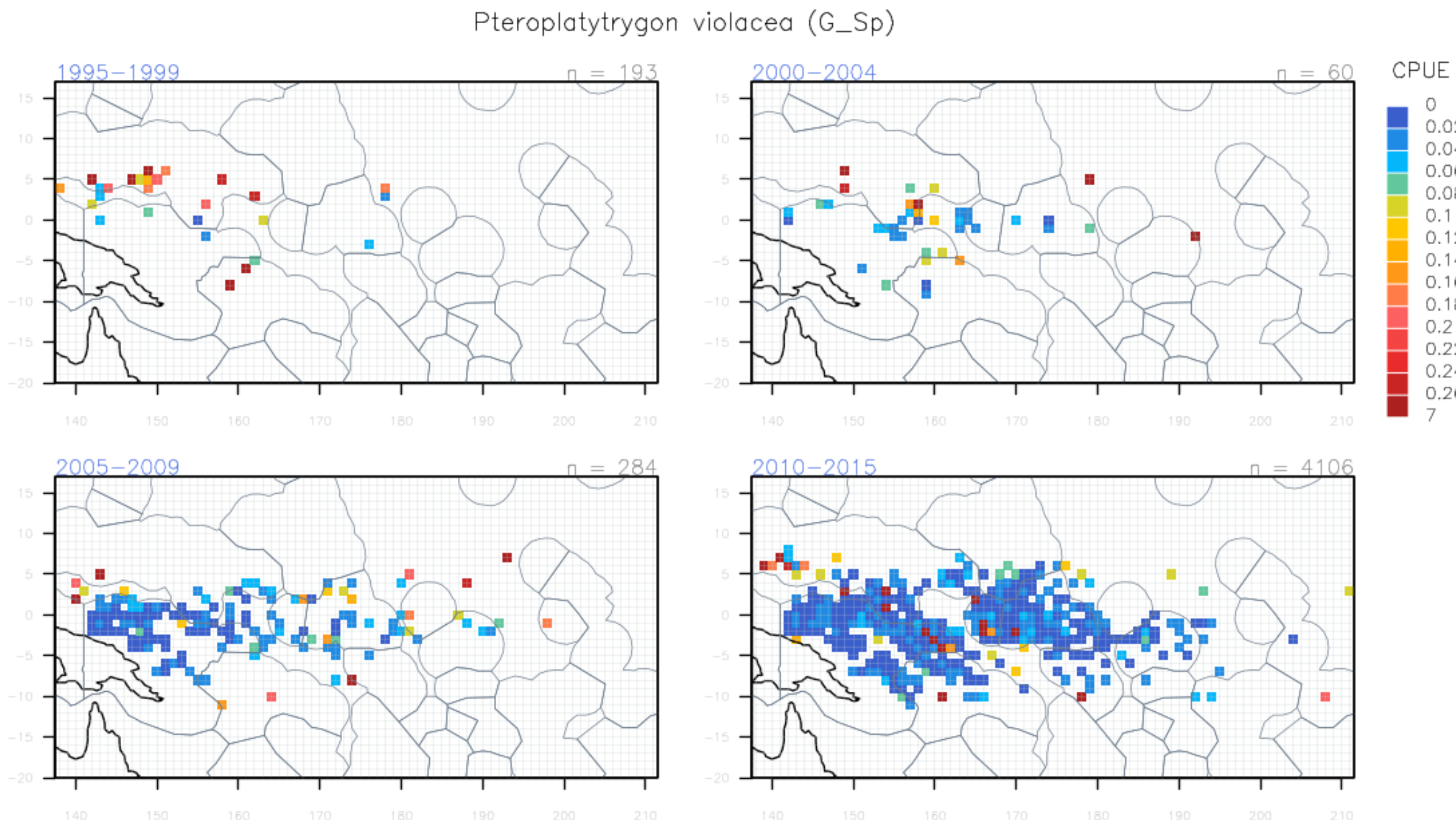

Figure 29: Distribution of *P. violacea* observed in purse seine sets by five year periods within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per observed set using the 95^{th} percentile.

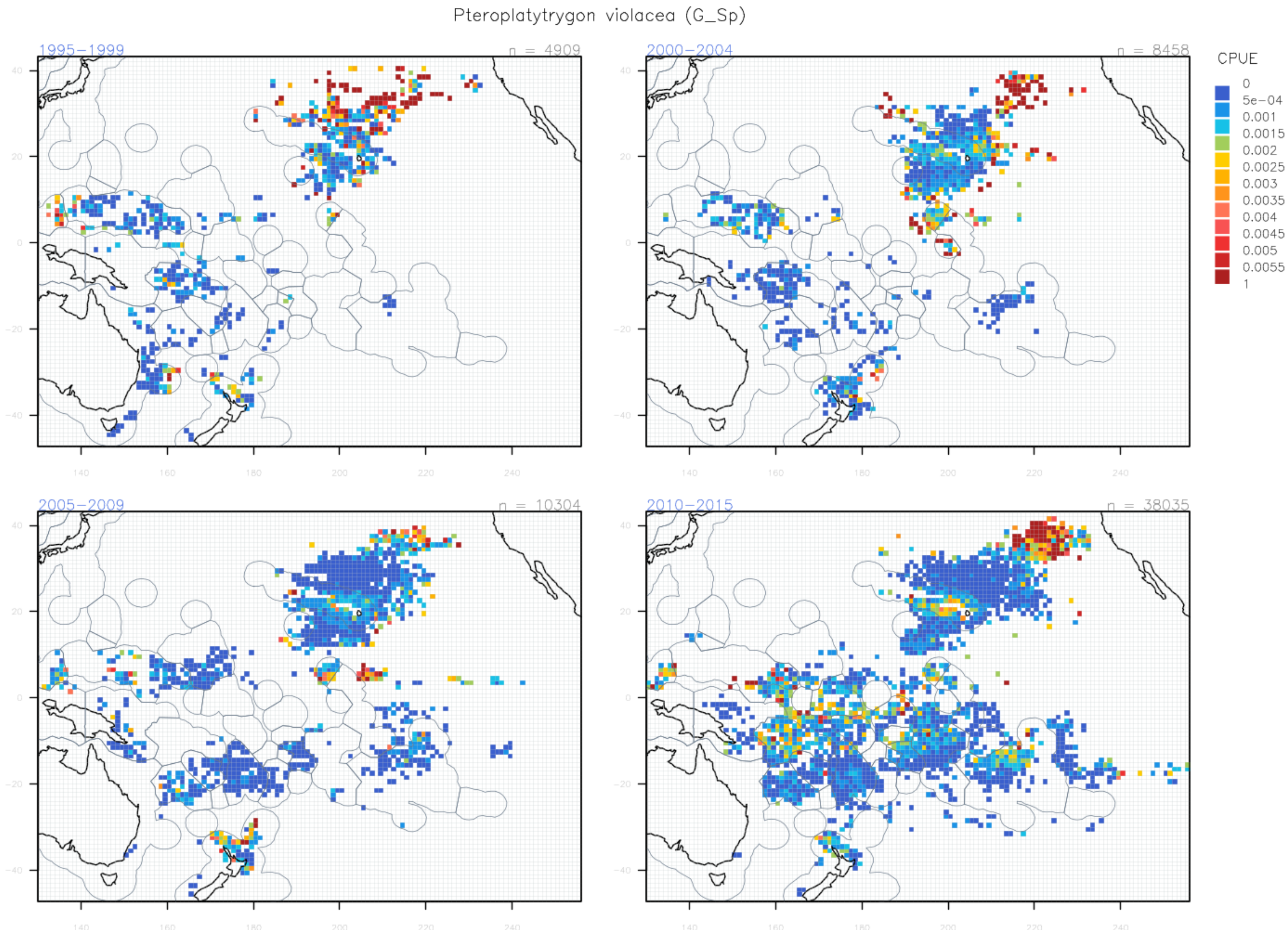

Figure 30: Distribution of *P. violacea* observed in longline sets by five year periods within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per observed hook using the 95^{th} percentile.

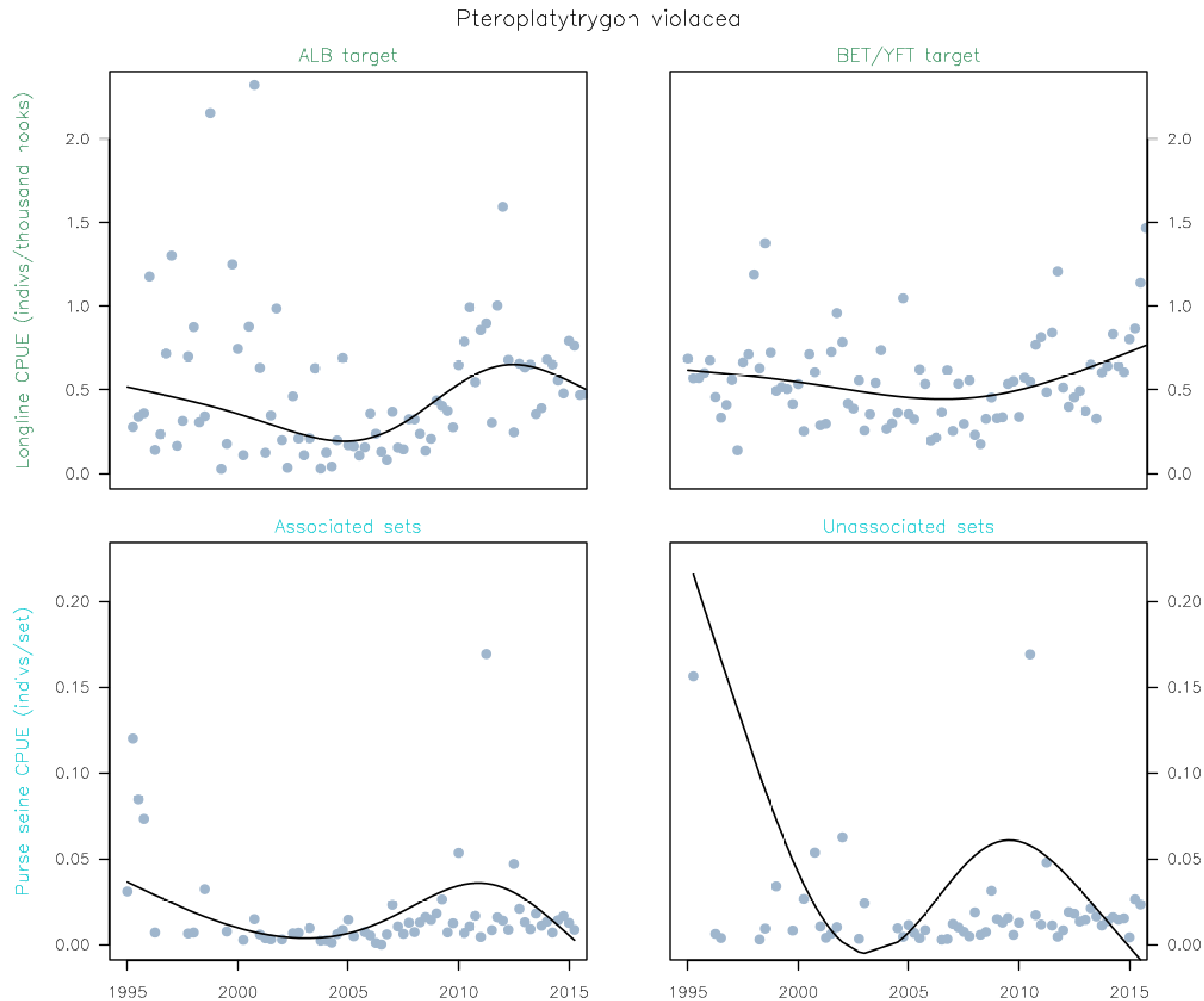

Figure 31: Observed CPUE for *P. violacea* in longline and purse seine sets by set type within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per observed hook using the 95^{th} percentile.

5 Assessment for the designation as key shark

In 2015 the SC11 recommended that a review of the available information mantas and devil rays and their interactions with fisheries managed by the WCPFC be undertaken for consideration of their designation as WCPFC key sharks (WCPFC, 2015). We review the available information on *M. birostris*; and *Mobula* sp.; in addition we include a similar review for *P. violacea* that has some of the highest NKS catch in both purse seine and longline fisheries within the WCPFC-CA. This assessment is done individually for each species and follows the methods outlined by (Clarke and Harley, 2010). This required that a table be completed for each, these are presented in Appendix 2 for the SC12 to review.

As part of this assessment we suggest that the management of *M. birostris* and *P. violacea* could be enhanced if they were designated as key sharks by the WCPFC. However, improving observers abilities to identify individual *Mobula* sp. to a species level is likely to lead to improved information in the medium-term but listing them as a key shark species will probably not enhance the management of individual species at this stage.

In addition, based on the analyses, we make the following recommendations:

- Increased observer training for the identification of *Mobula* sp. particularly on purse seine vessels.
- Review conversion factors for length-length and length-weight.

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Appendix I - Catch distribution and trends of NKS

The following plots are designed to present some information on the distribution of species not discussed in the text. In addition where enough data exists we have plotted CPUE information for each species for both purse seine sets and longline sets. these data were not split by set type as was done in the main text as for may species few data exist and splitting by set type could lead to a loss if infromation for data depauperate species. Included here is a table of catch numbers and catch rate by set type (Appendix 1, Table A1).

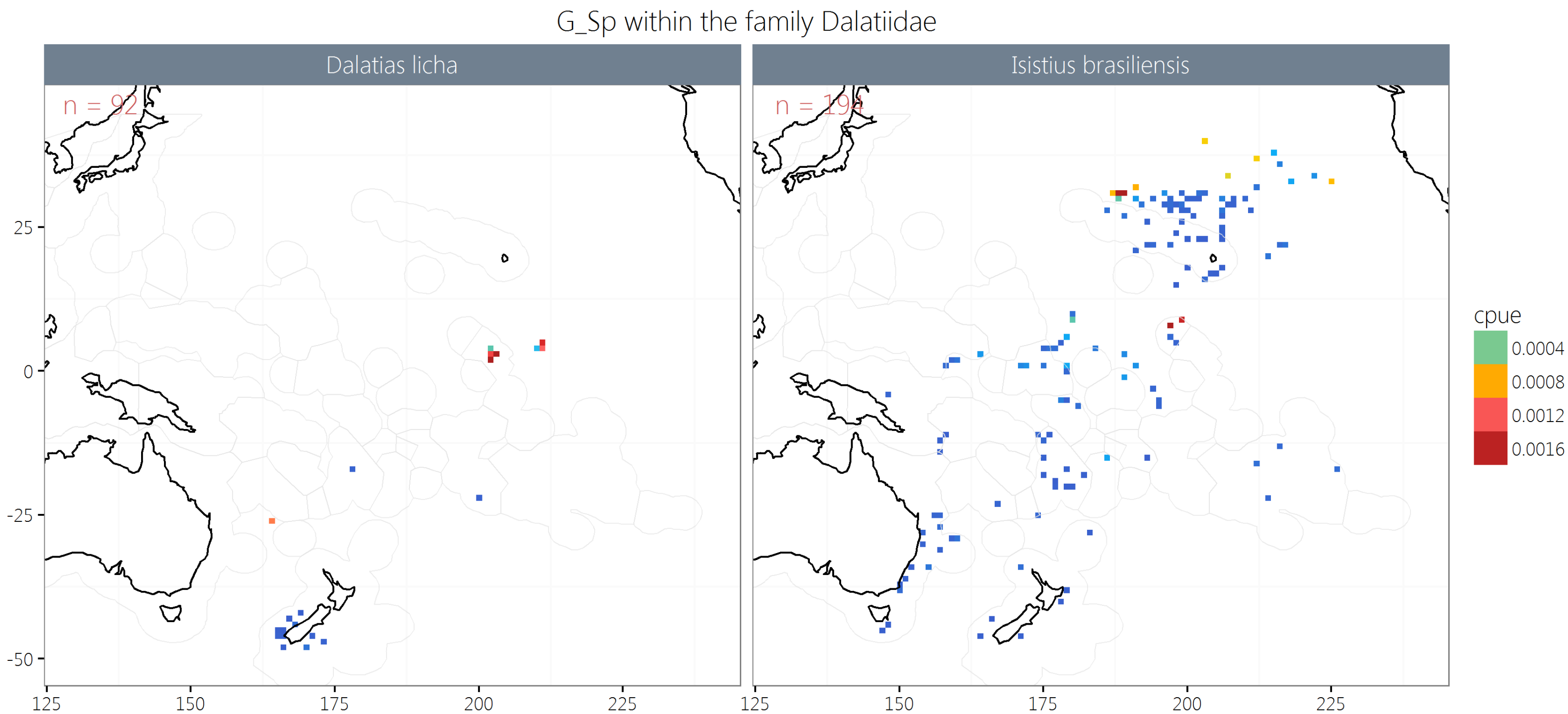

Figure AI 1: Distribution of dalatiids observed in longline sets within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per 1000 hooks in each one degree cell. * indicates a key shark designation within the WCPFC.

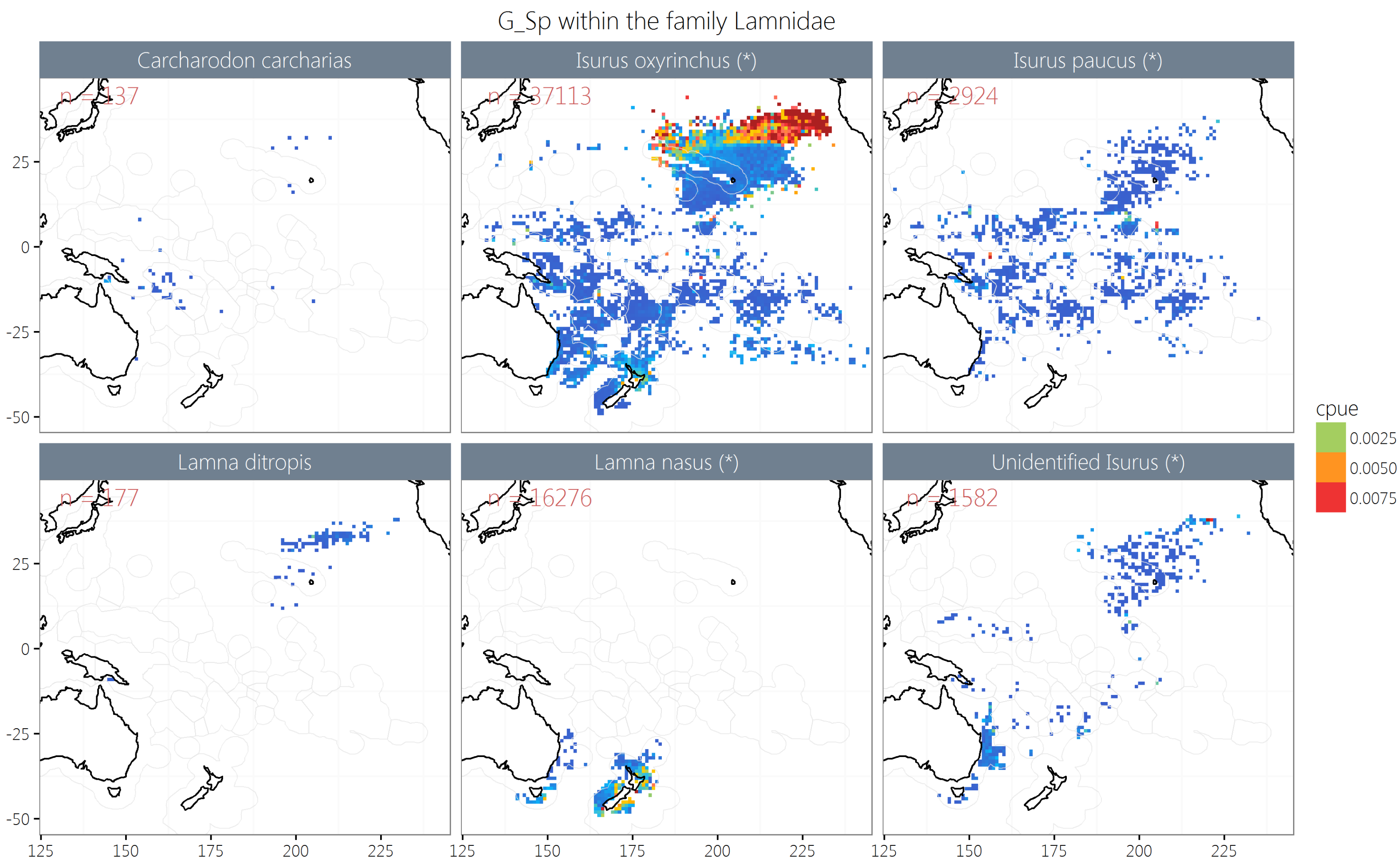

Figure AI 2: Distribution of lamnid sharks observed in longline sets within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per 1000 hooks in each one degree cell. * indicates a key shark designation within the WCPFC.

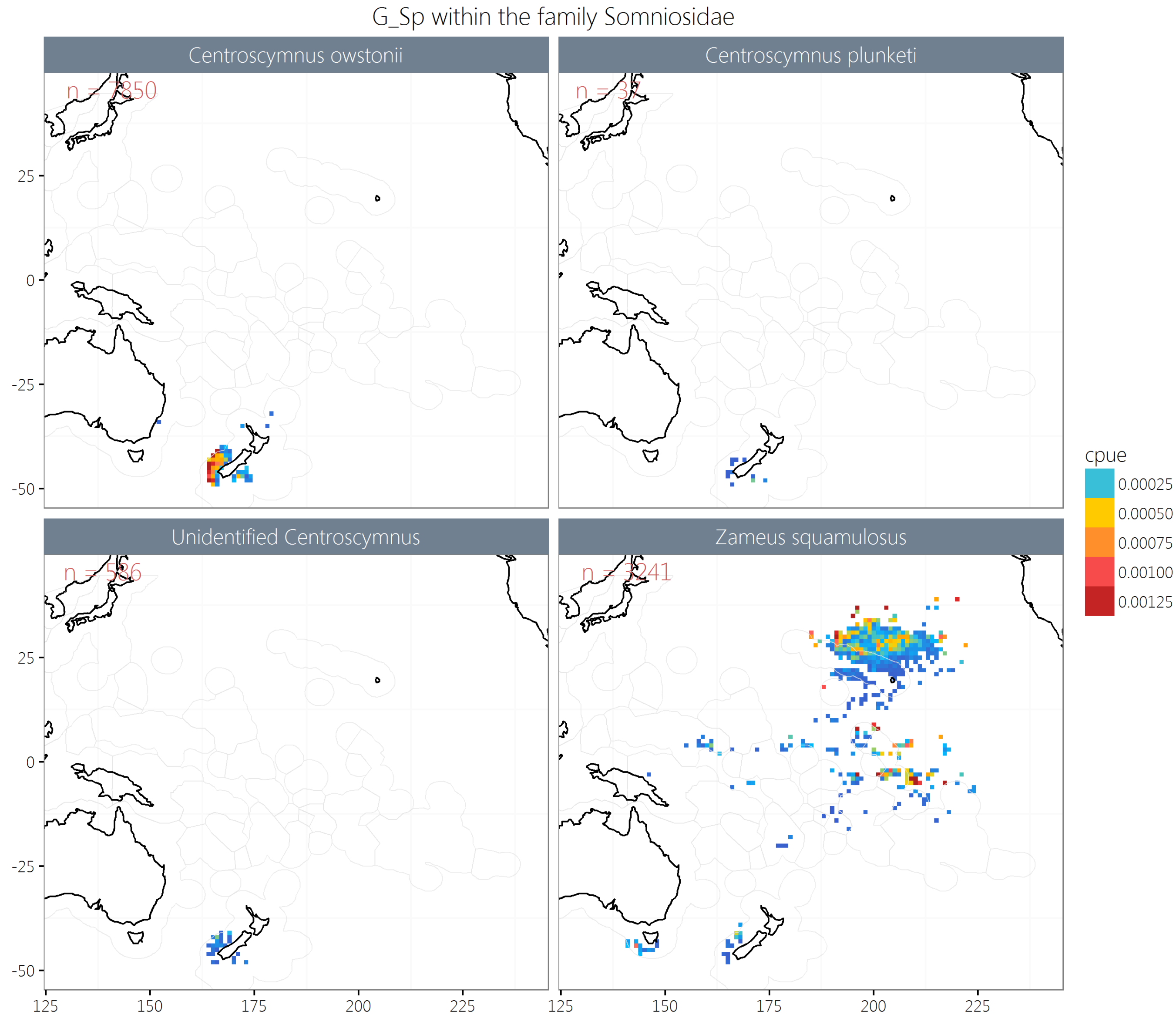

Figure AI 3: Distribution of somniosids observed in longline sets within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per 1000 hooks in each one degree cell. * indicates a key shark designation within the WCPFC.

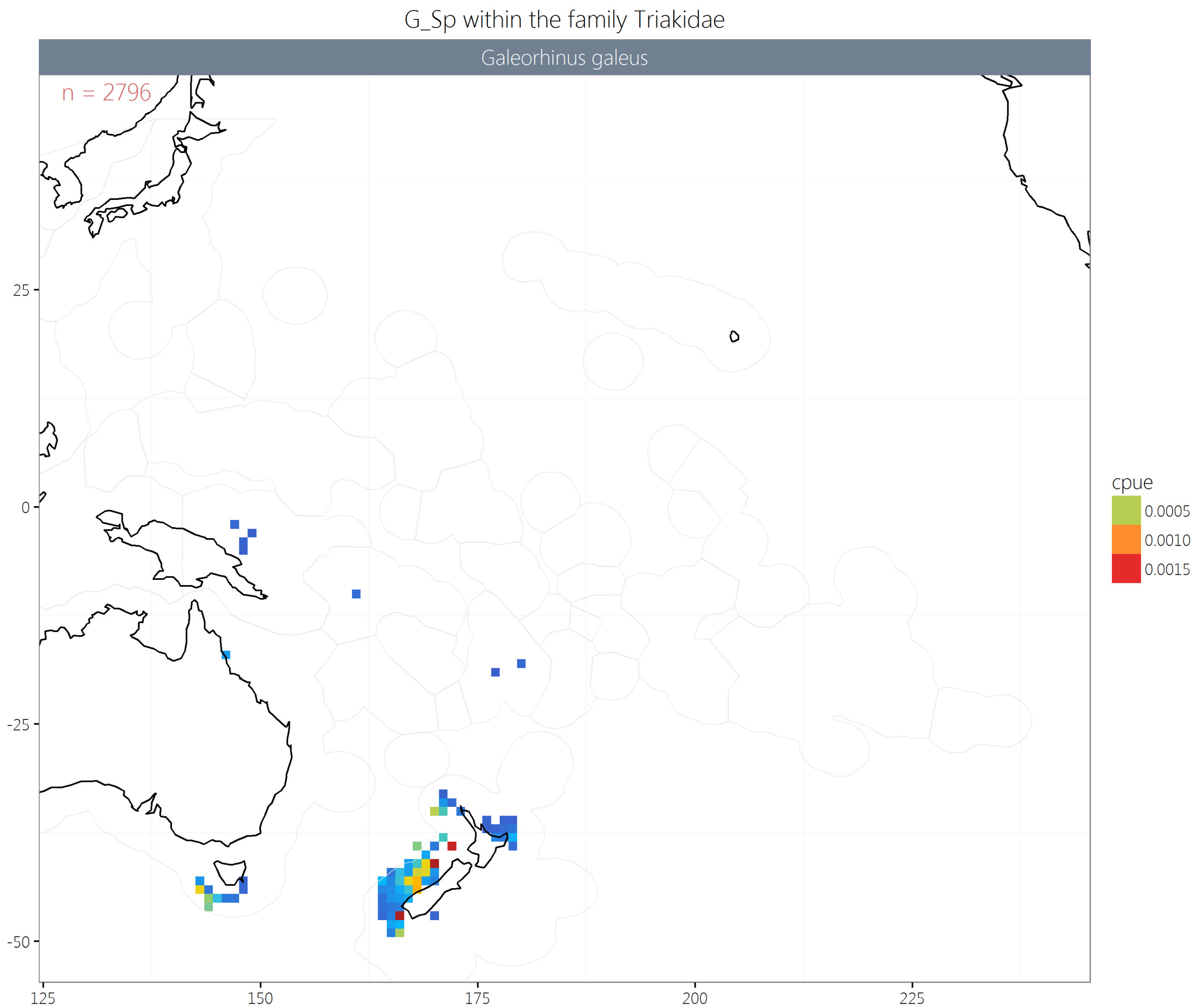

Figure AI 4: Distribution of triakids observed in longline sets within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to observed fish per 1000 hooks in each one degree cell. * indicates a key shark designation within the WCPFC.

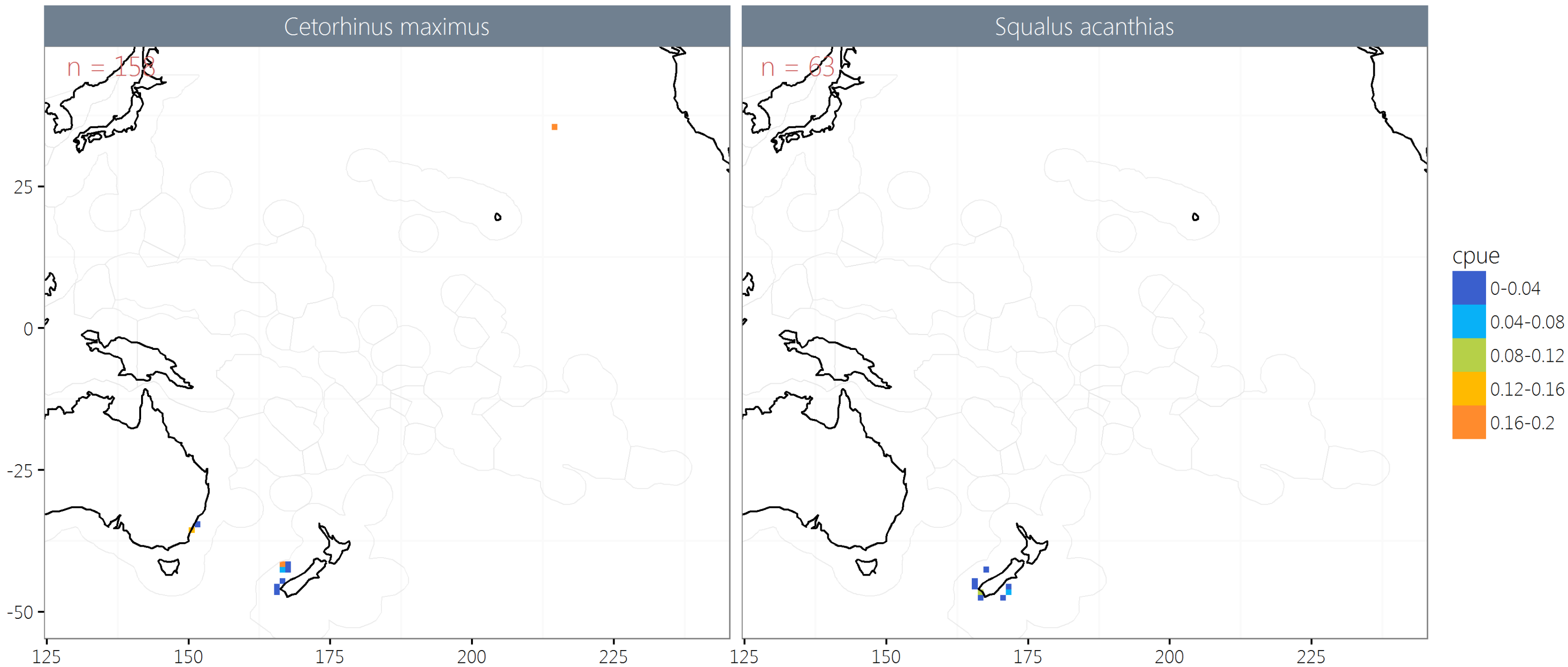

Figure AI 5: Distribution of two species observed in longline sets within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to fish per 1000 hooks in each one degree cell.

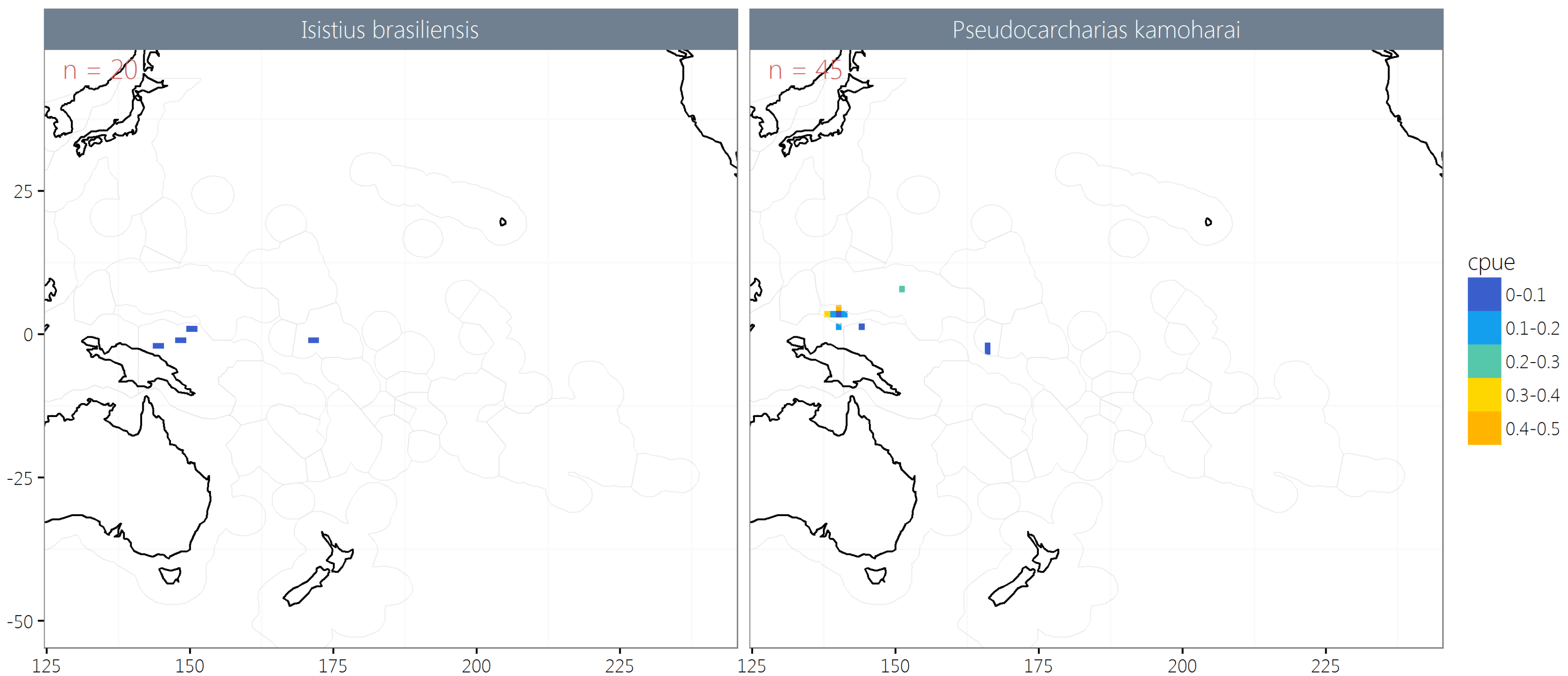

Figure AI 6: Distribution of two species observed in purse seine sets within the Western and Central Pacific Ocean from 1995-2015. Observations have been standardised to fish per observed set in each one degree cell.

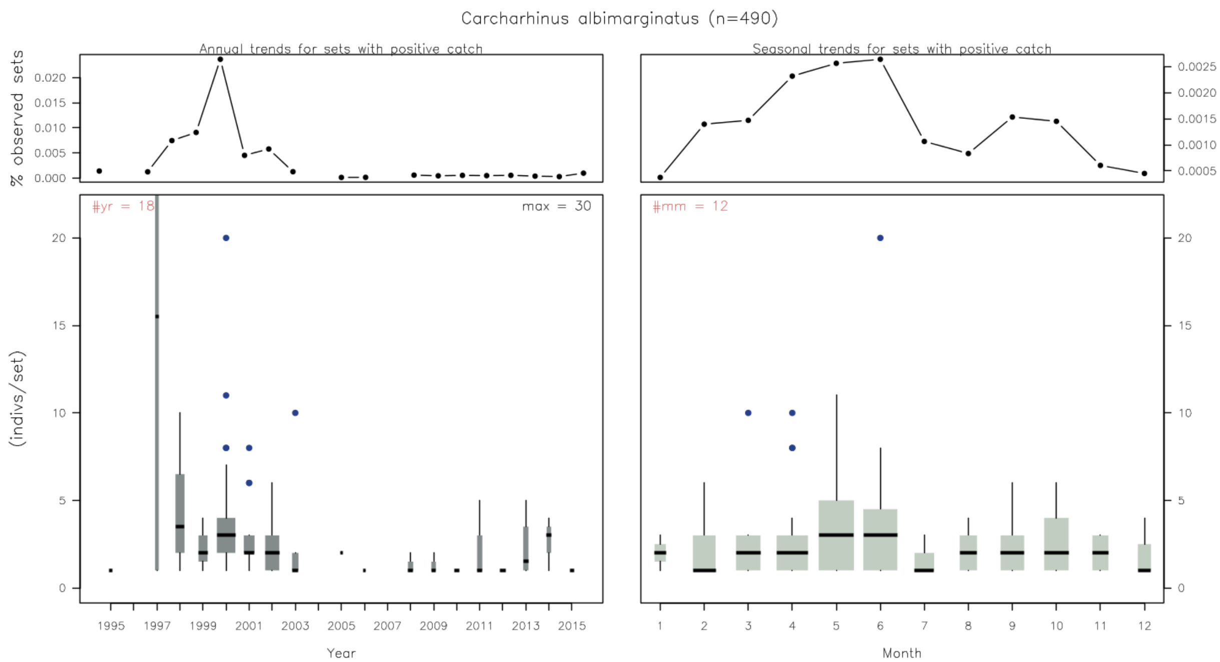

Figure AI 7: Unstandardized CPUE for *Carcharhinus albimarginatus* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

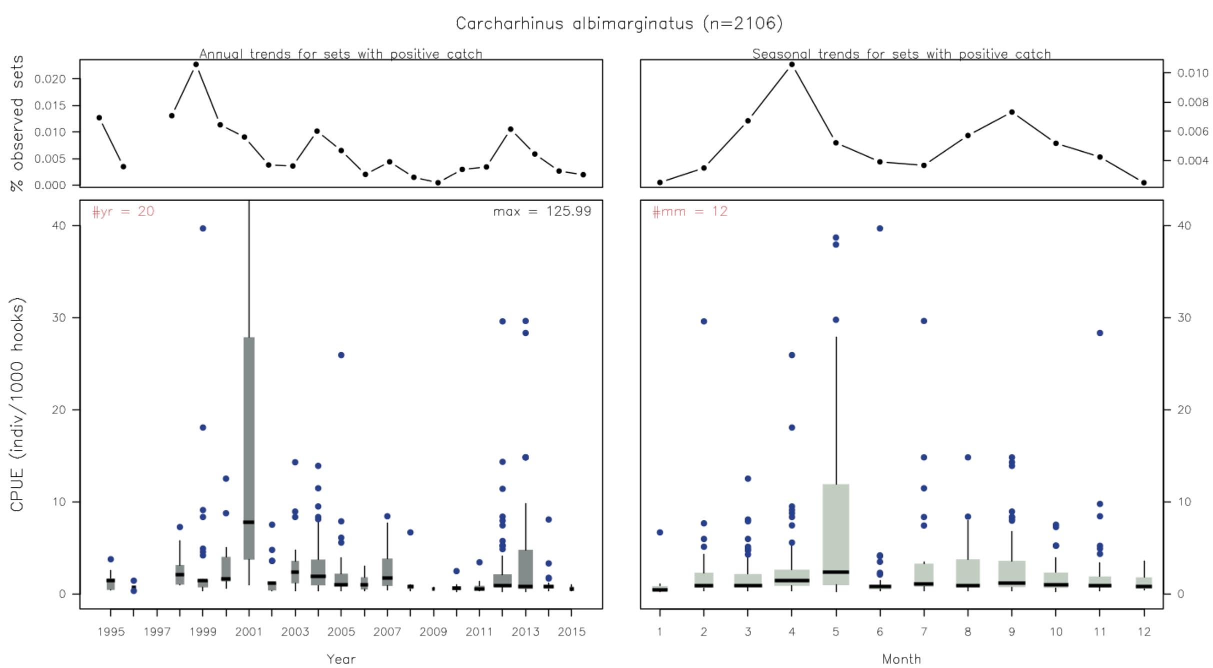

Figure AI 8: Unstandardized CPUE for *Carcharhinus albimarginatus* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

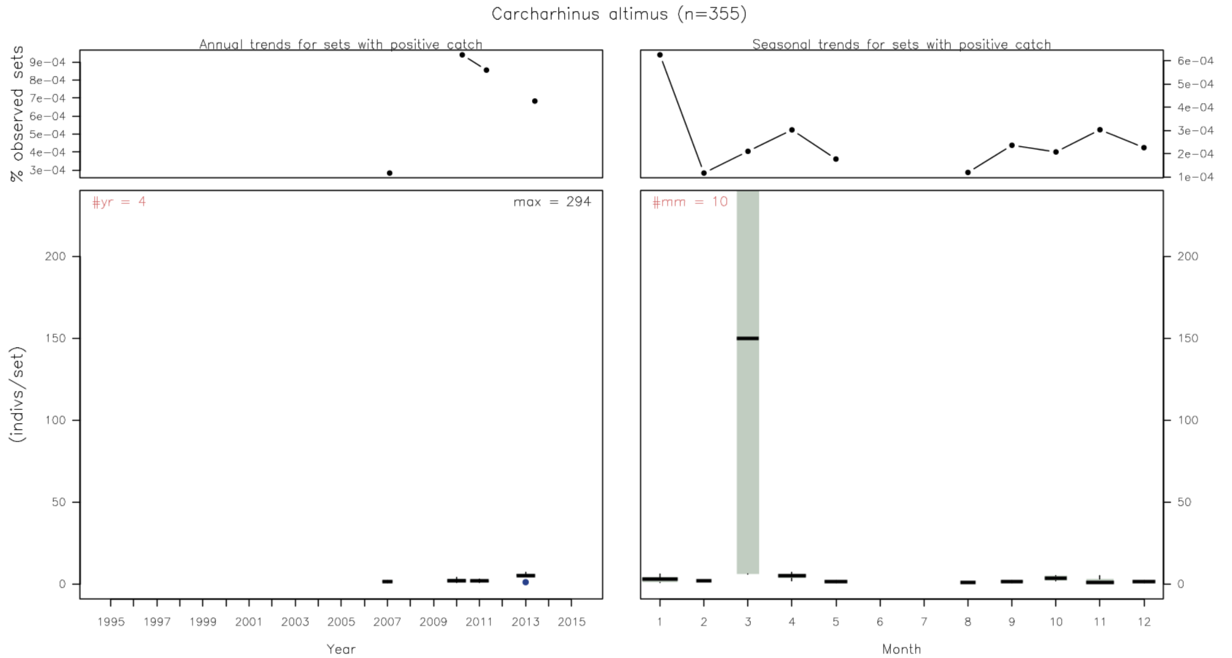

Figure AI 9: Unstandardized CPUE for *Carcharhinus altimus* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

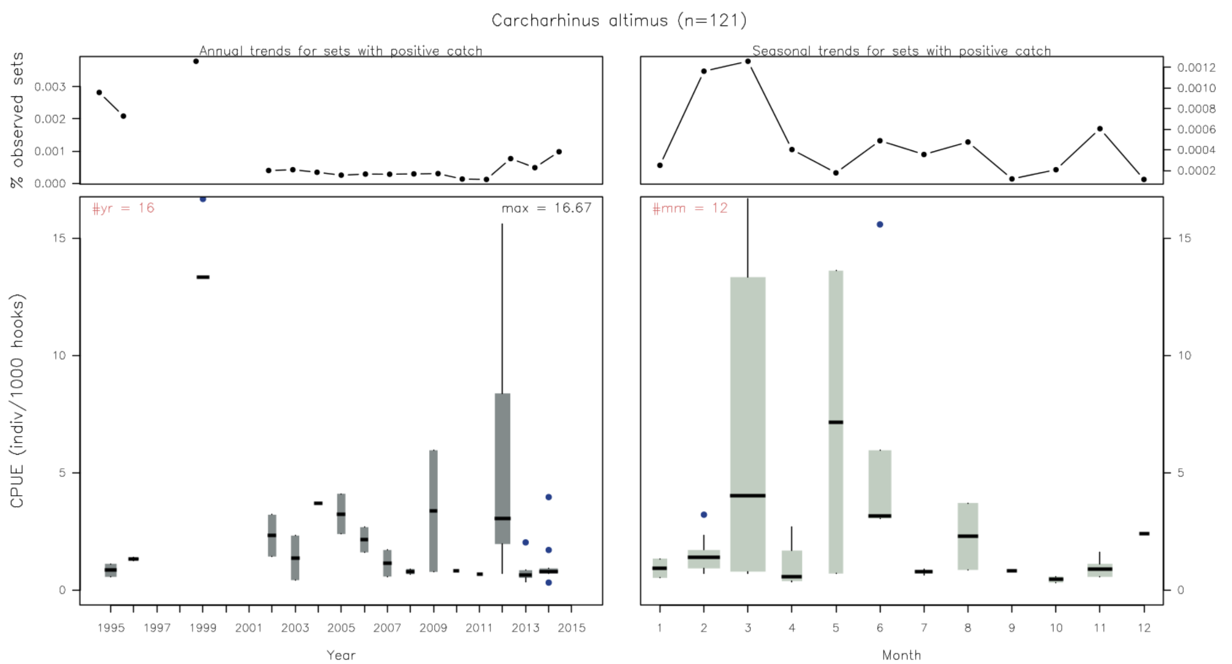

Figure AI 10: Unstandardized CPUE for *Carcharhinus altimus* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

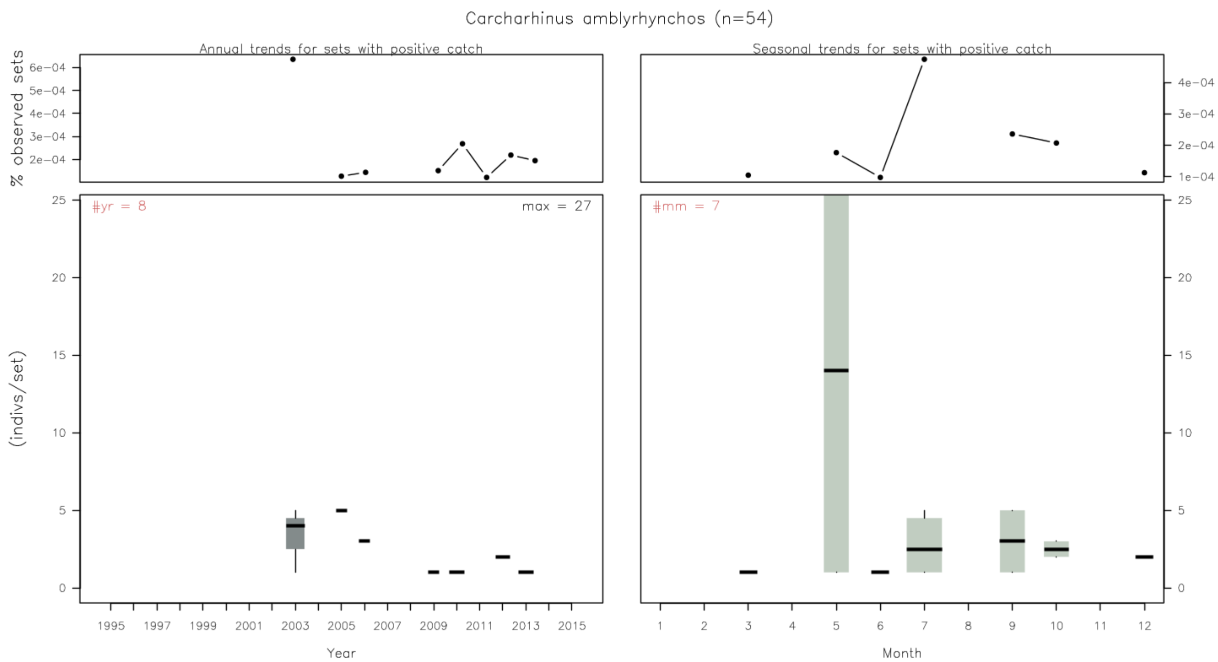

Figure AI 11: Unstandardized CPUE for *Carcharhinus amblyrhynchos* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

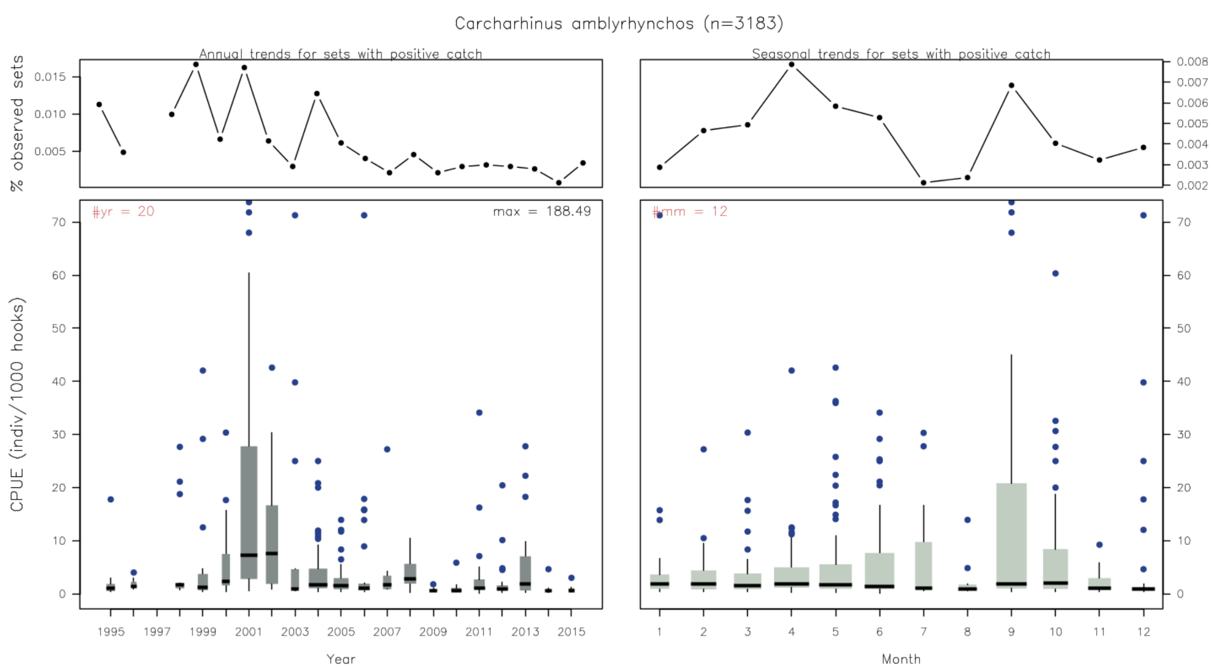

Figure AI 12: Unstandardized CPUE for *Carcharhinus amblyrhynchos* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

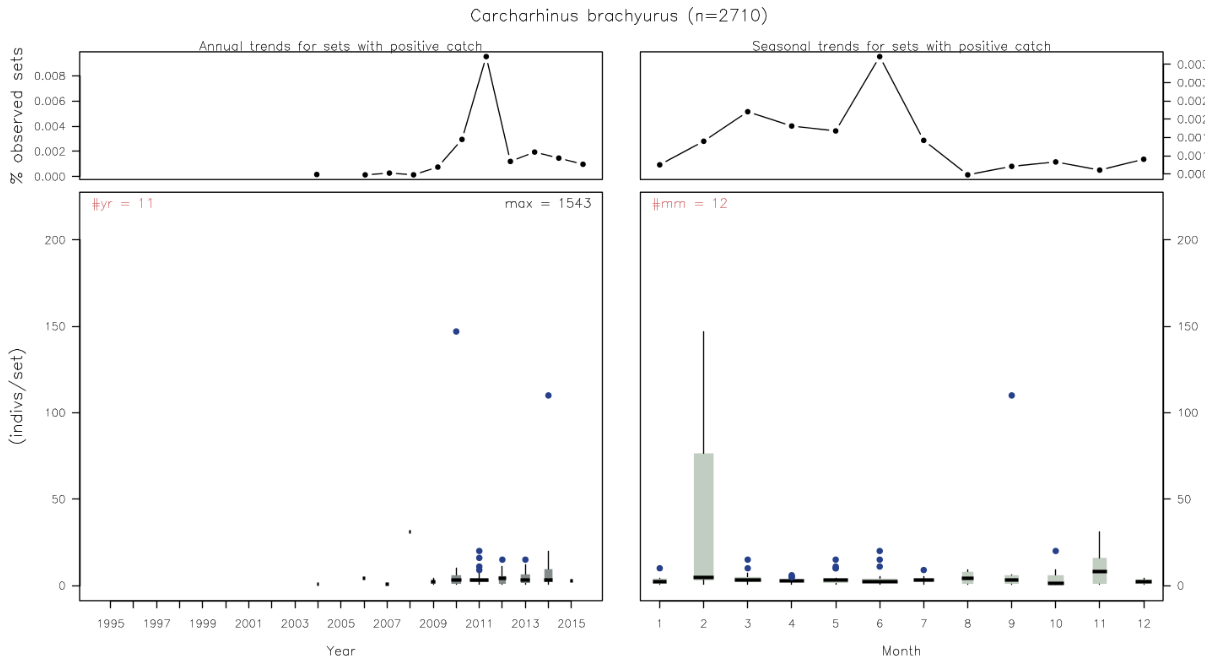

Figure AI 13: Unstandardized CPUE for *Carcharhinus brachyurus* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

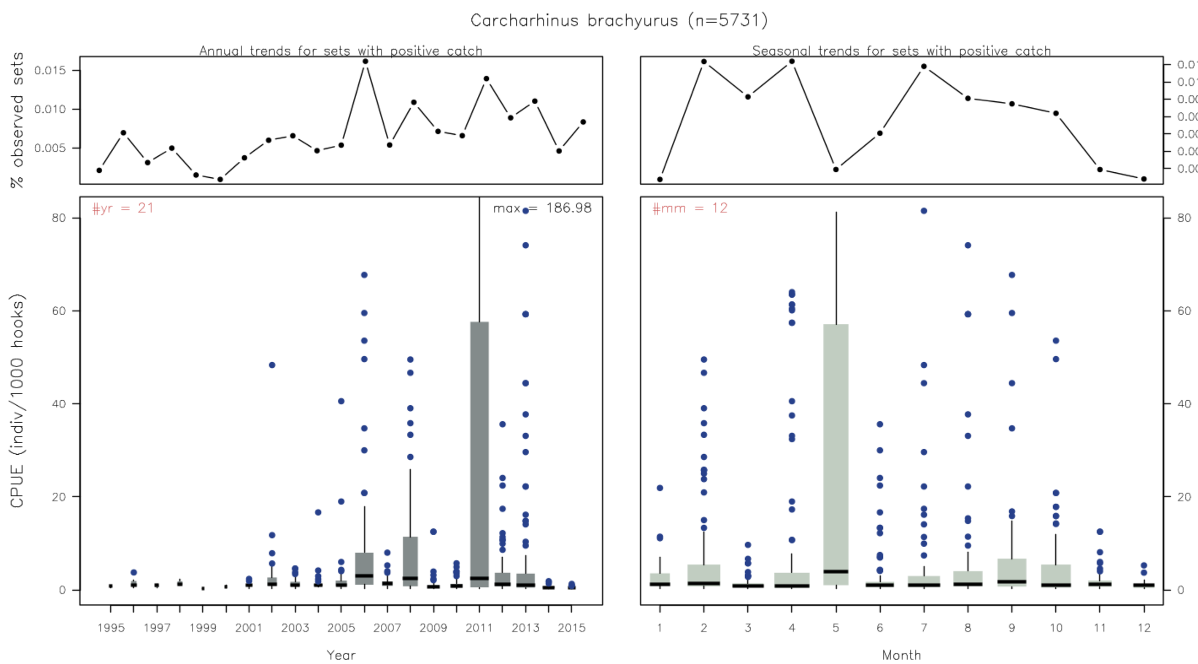

Figure AI 14: Unstandardized CPUE for *Carcharhinus brachyurus* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

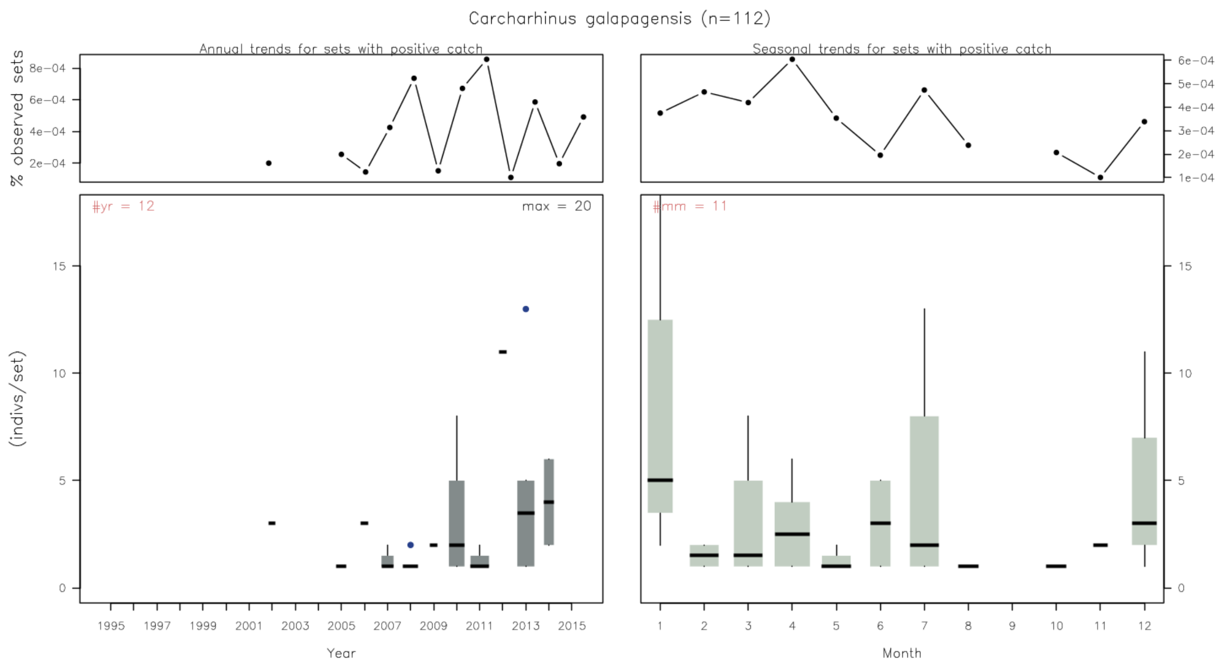

Figure AI 15: Unstandardized CPUE for *Carcharhinus galapagensis* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

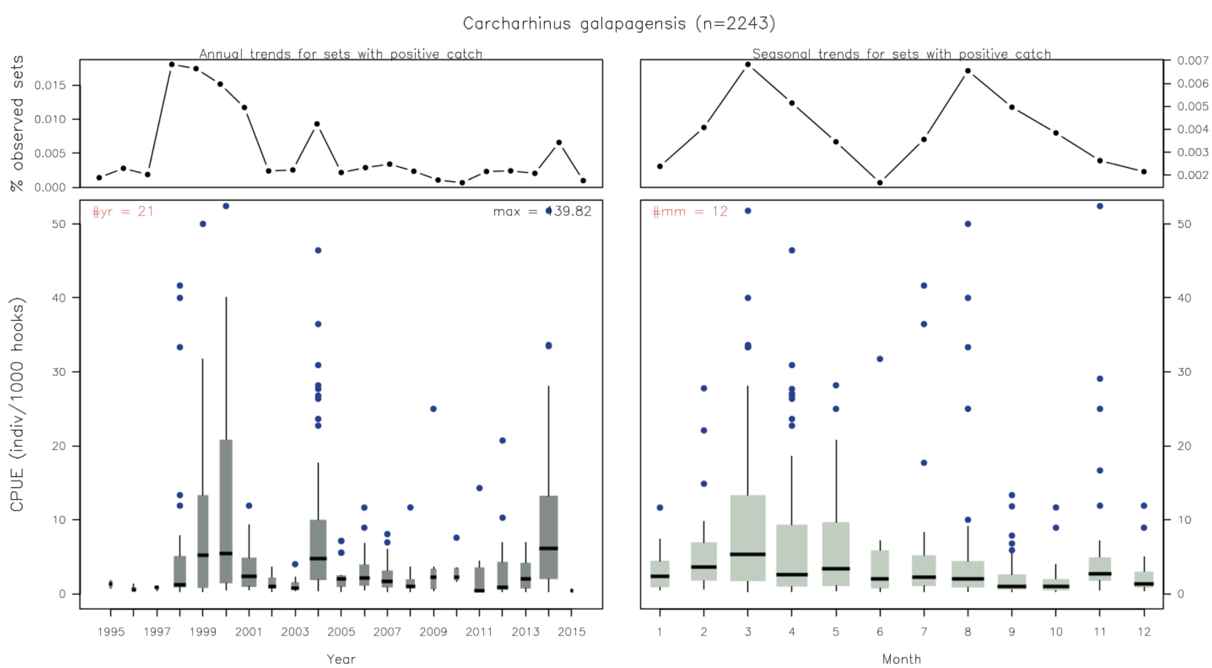

Figure AI 16: Unstandardized CPUE for *Carcharhinus galapagensis* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

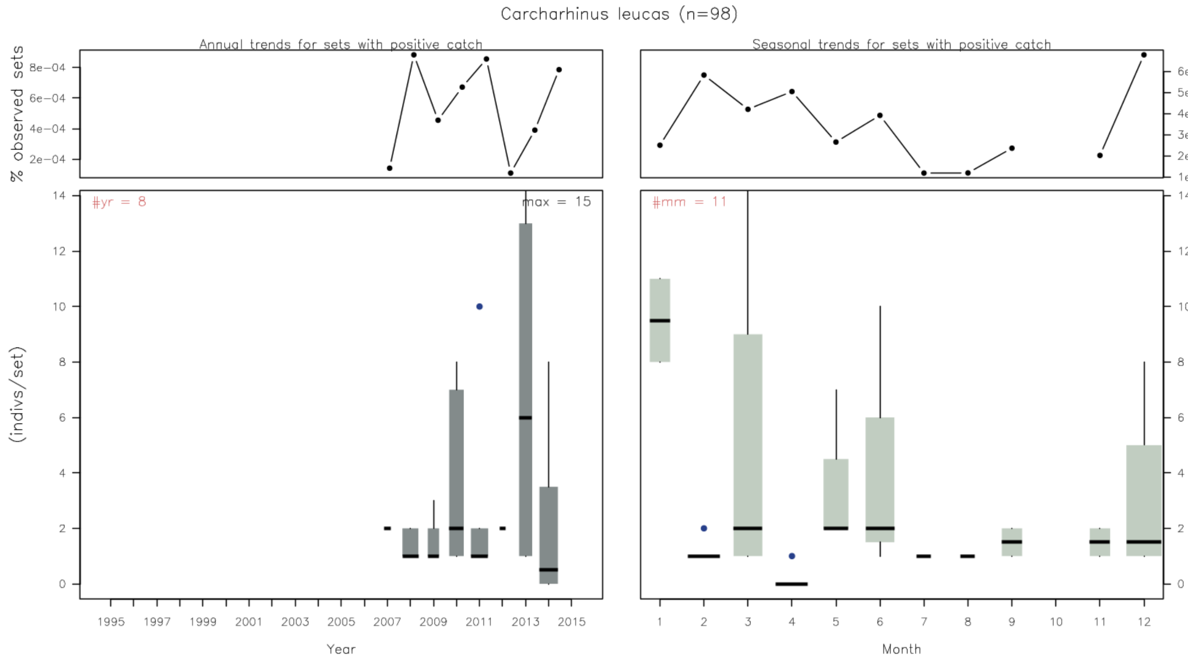

Figure AI 17: Unstandardized CPUE for *Carcharhinus leucas* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

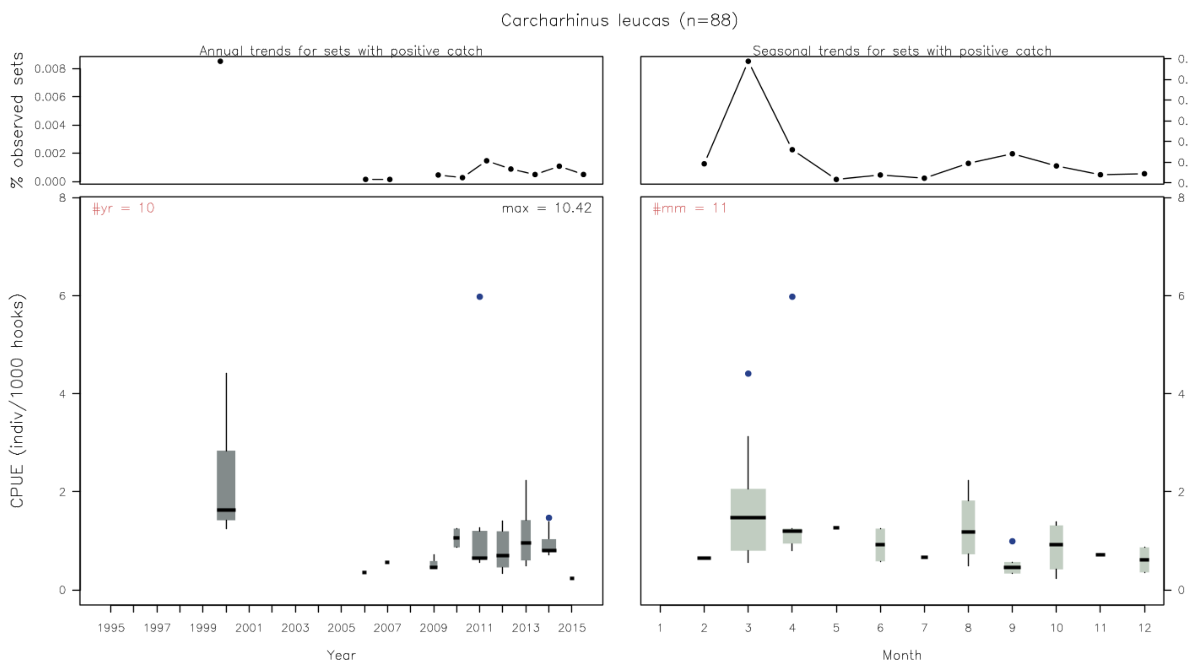

Figure AI 18: Unstandardized CPUE for *Carcharhinus leucas* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

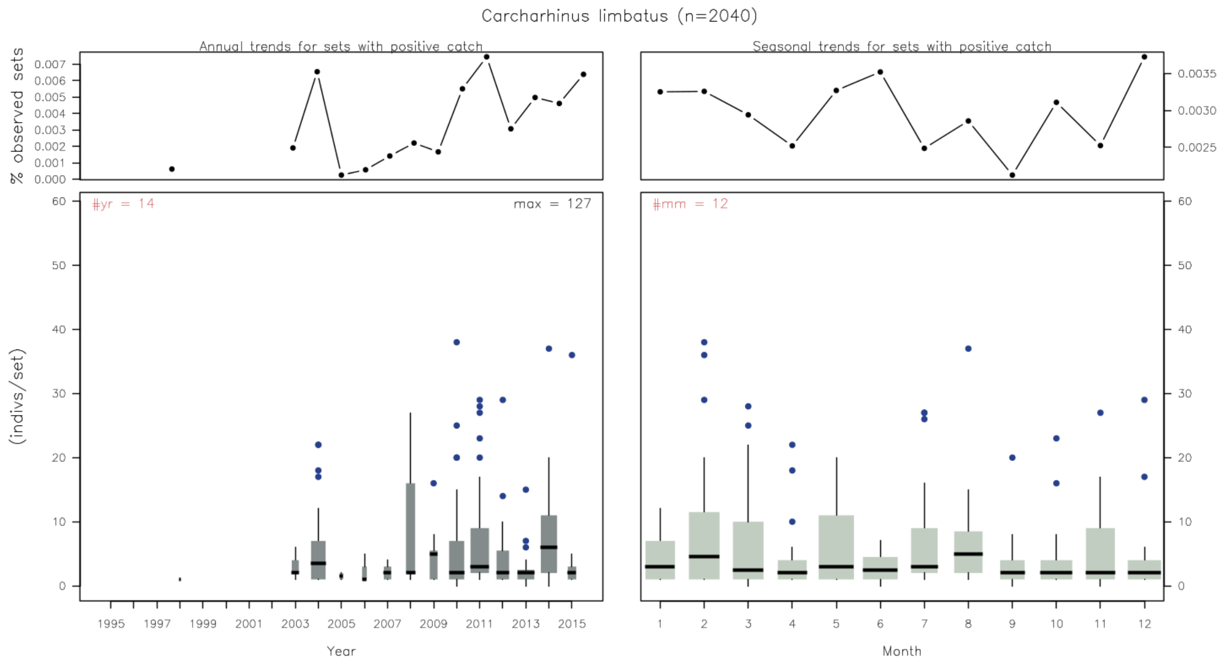

Figure AI 19: Unstandardized CPUE for *Carcharhinus limbatus* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and annually (right).

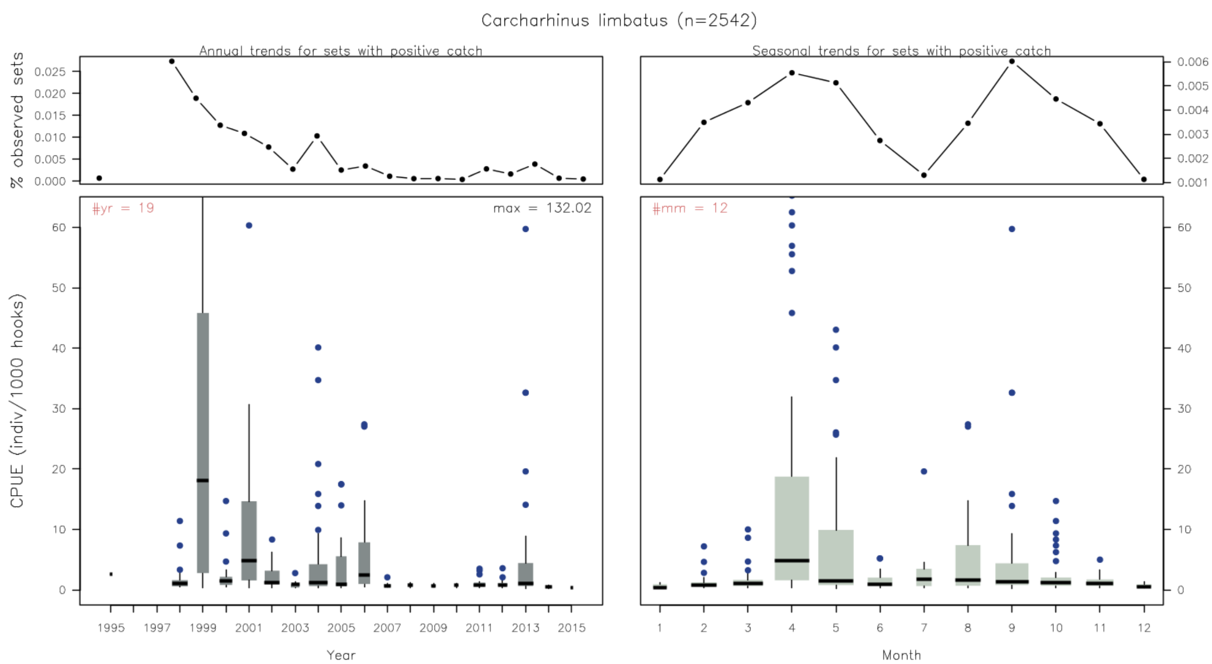

Figure AI 20: Unstandardized CPUE for *Carcharhinus limbatus* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

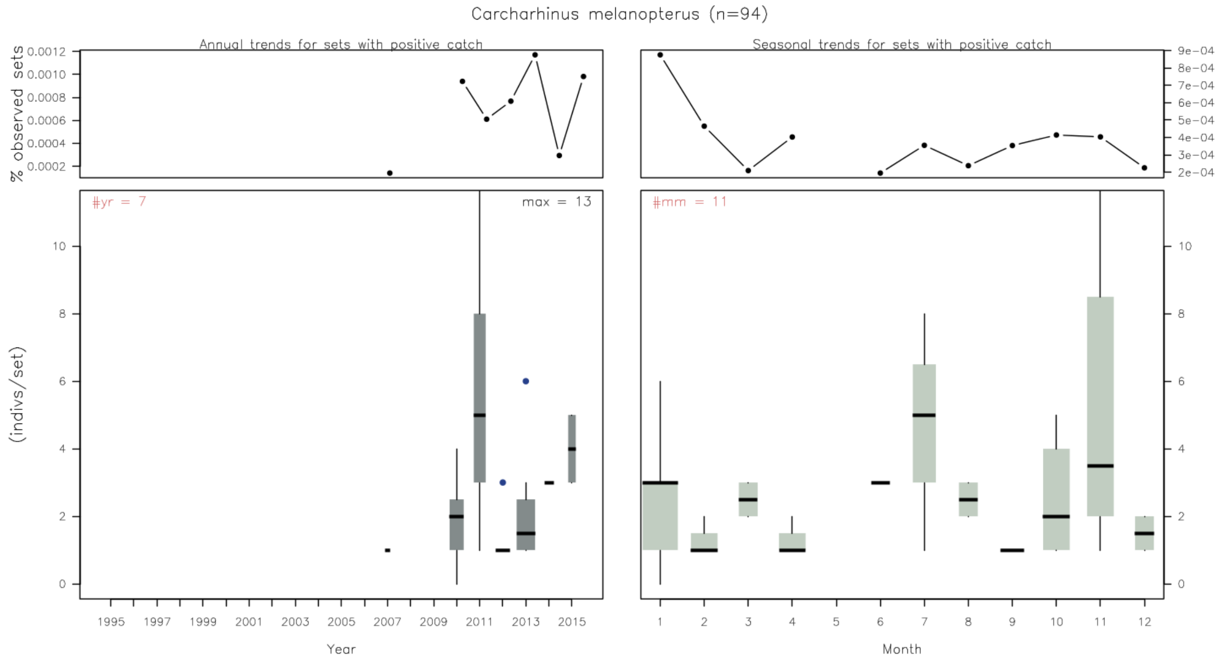

Figure AI 21: Unstandardized CPUE for *Carcharhinus melanopterus* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

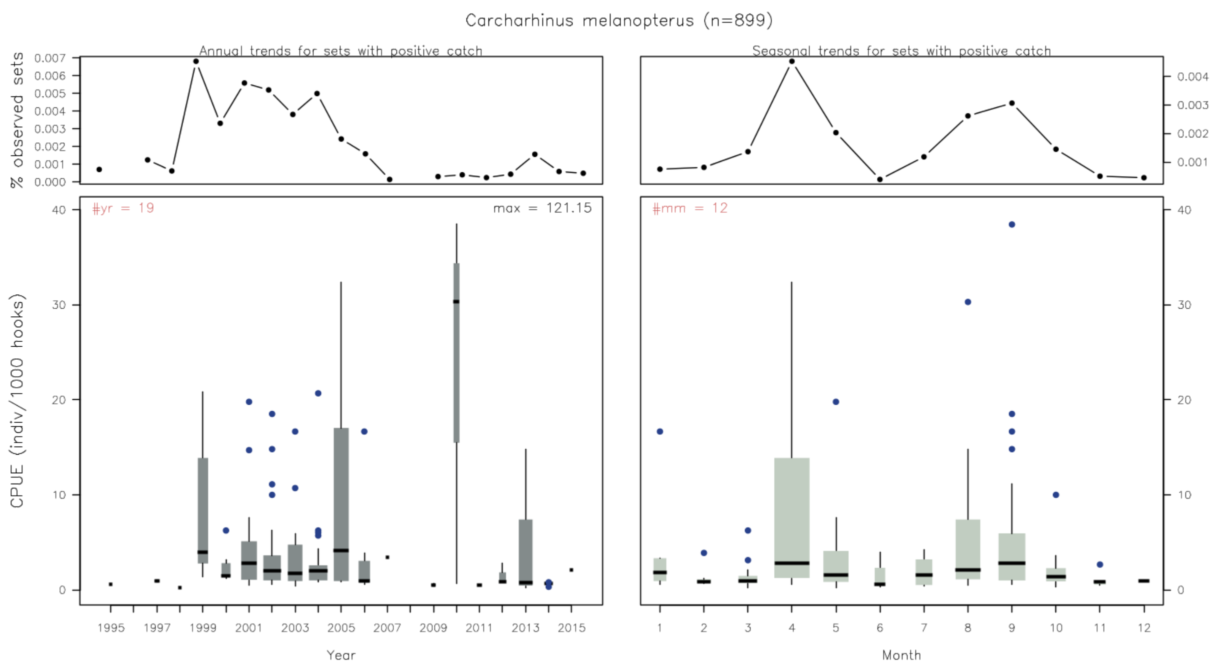

Figure AI 22: Unstandardized CPUE for *Carcharhinus melanopterus* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

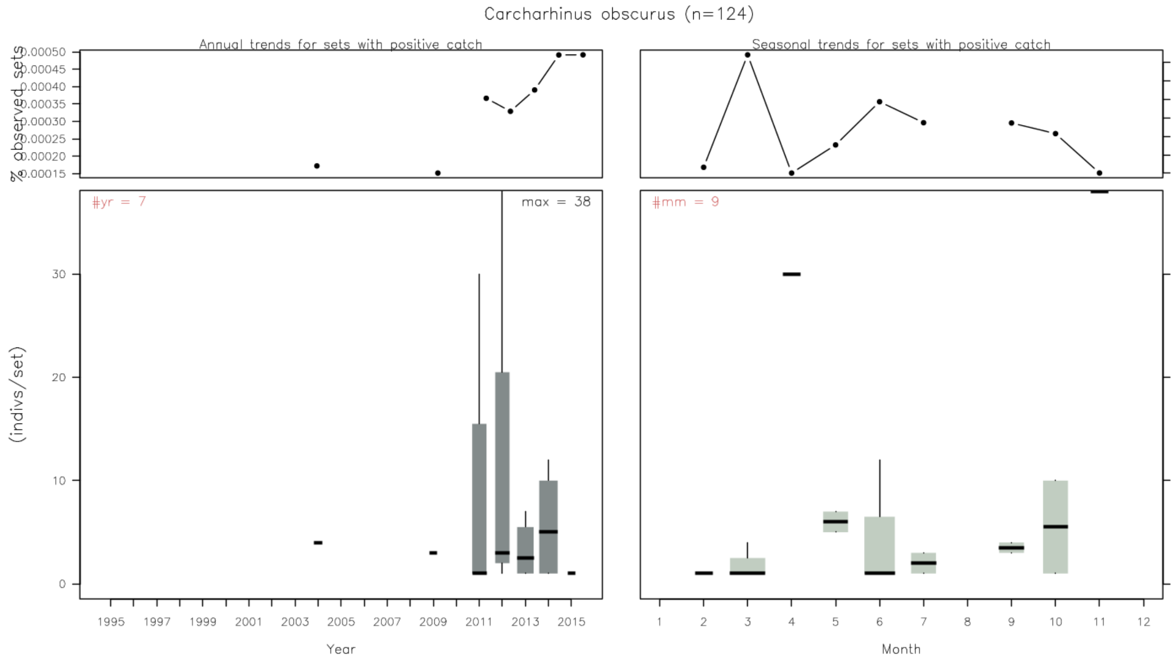

Figure AI 23: Unstandardized CPUE for *Carcharhinus obscurus* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

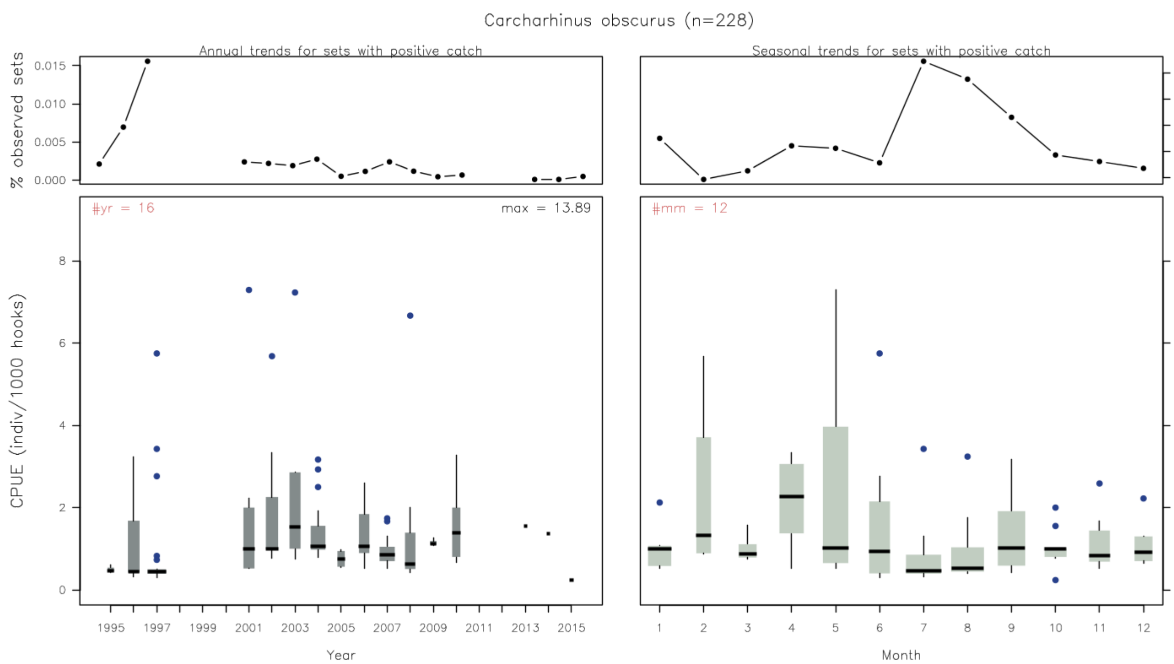

Figure AI 24: Unstandardized CPUE for *Carcharhinus obscurus* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

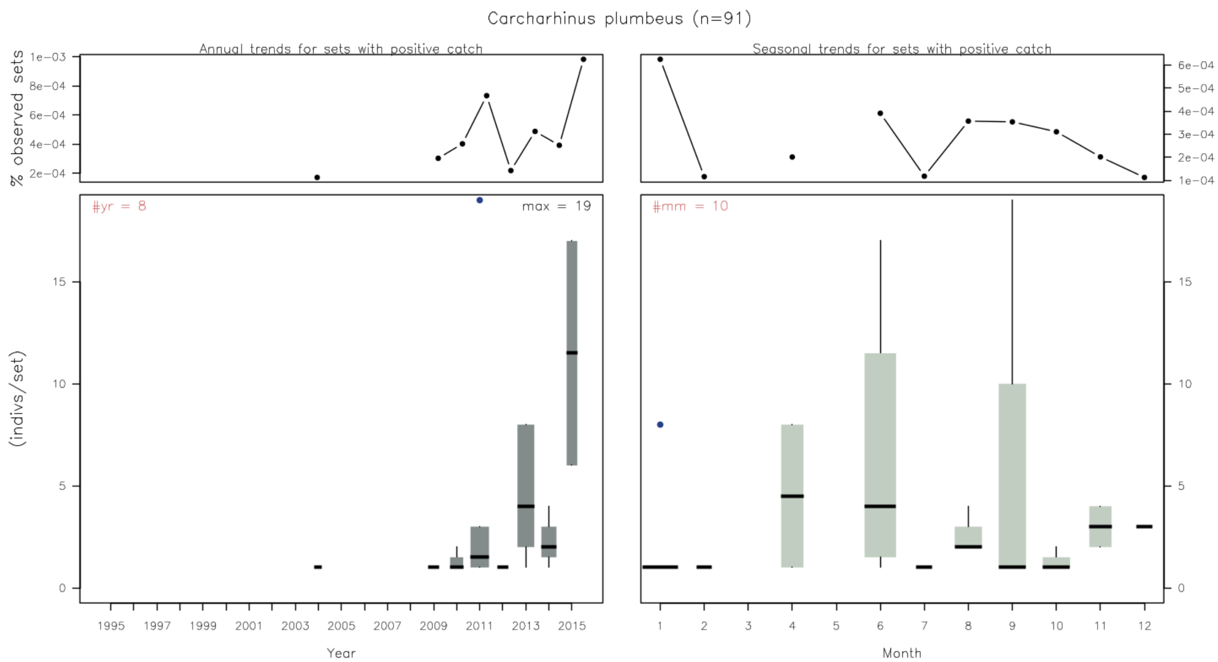

Figure AI 25: Unstandardized CPUE for *Carcharhinus plumbeus* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

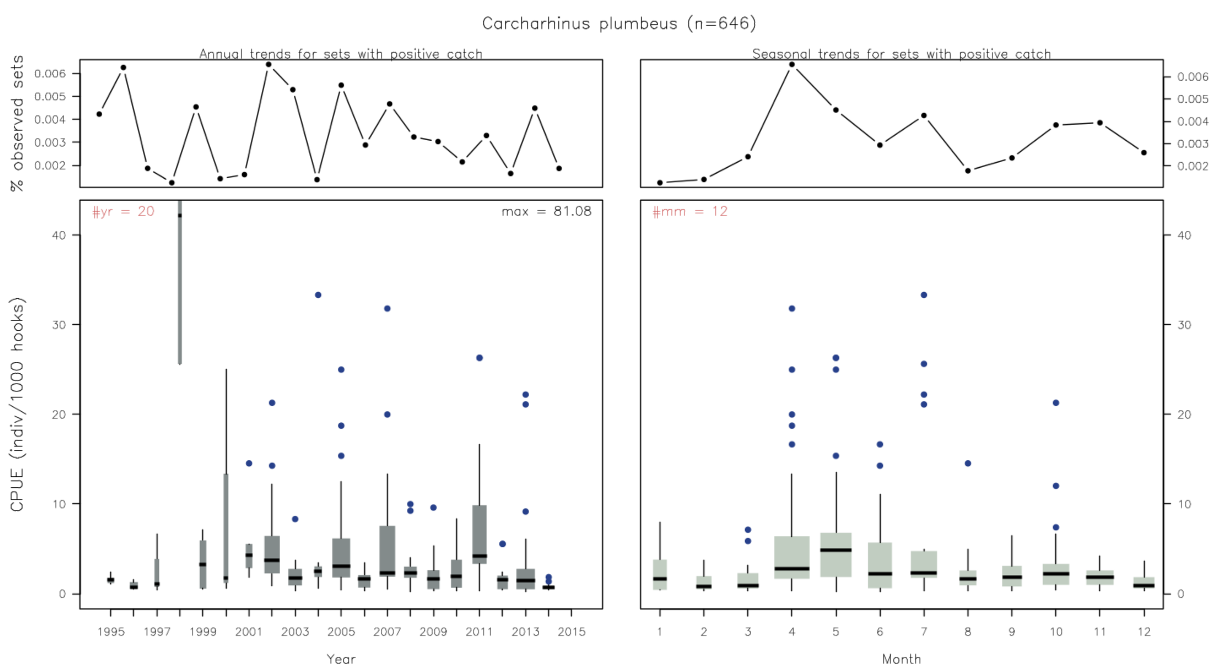

Figure AI 26: Unstandardized CPUE for *Carcharhinus plumbeus* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

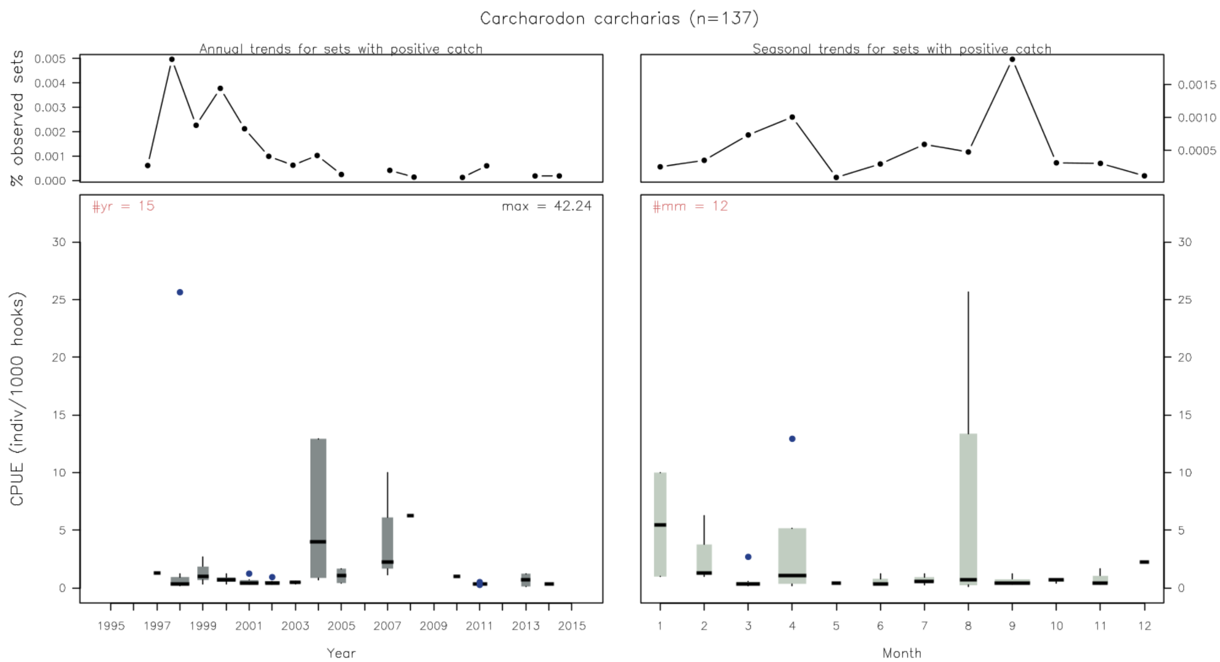

Figure AI 27: Unstandardized CPUE for *Carcharodon carcharias* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

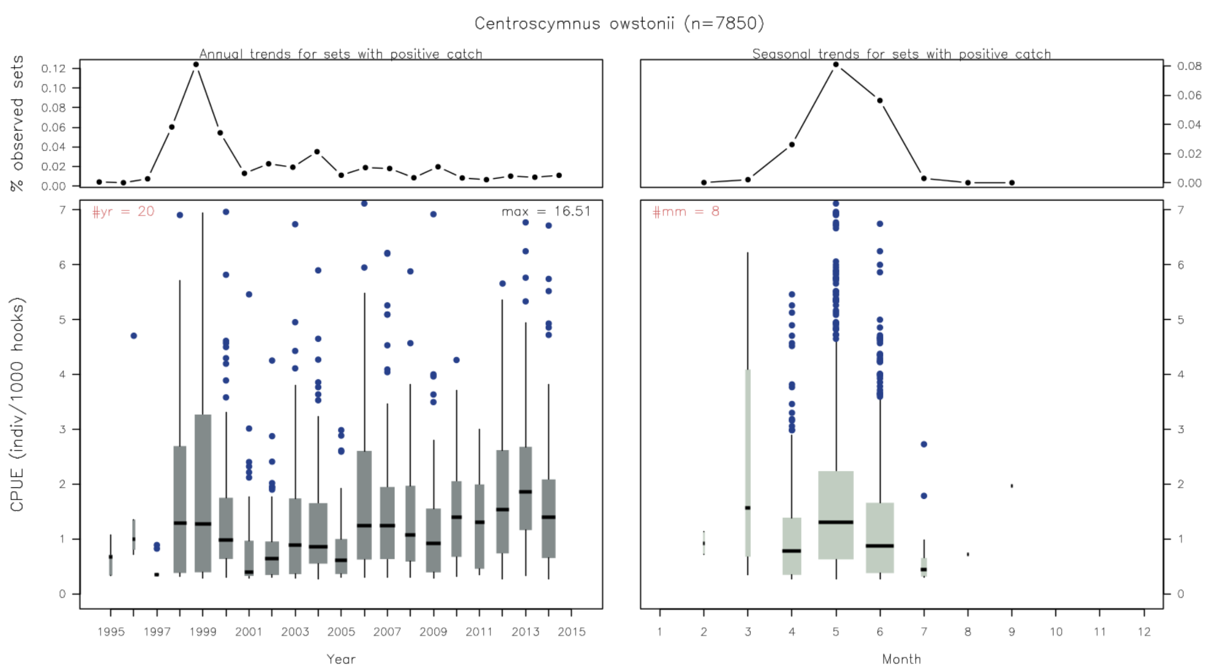

Figure AI 28: Unstandardized CPUE for *Centroscymnus owstonii* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

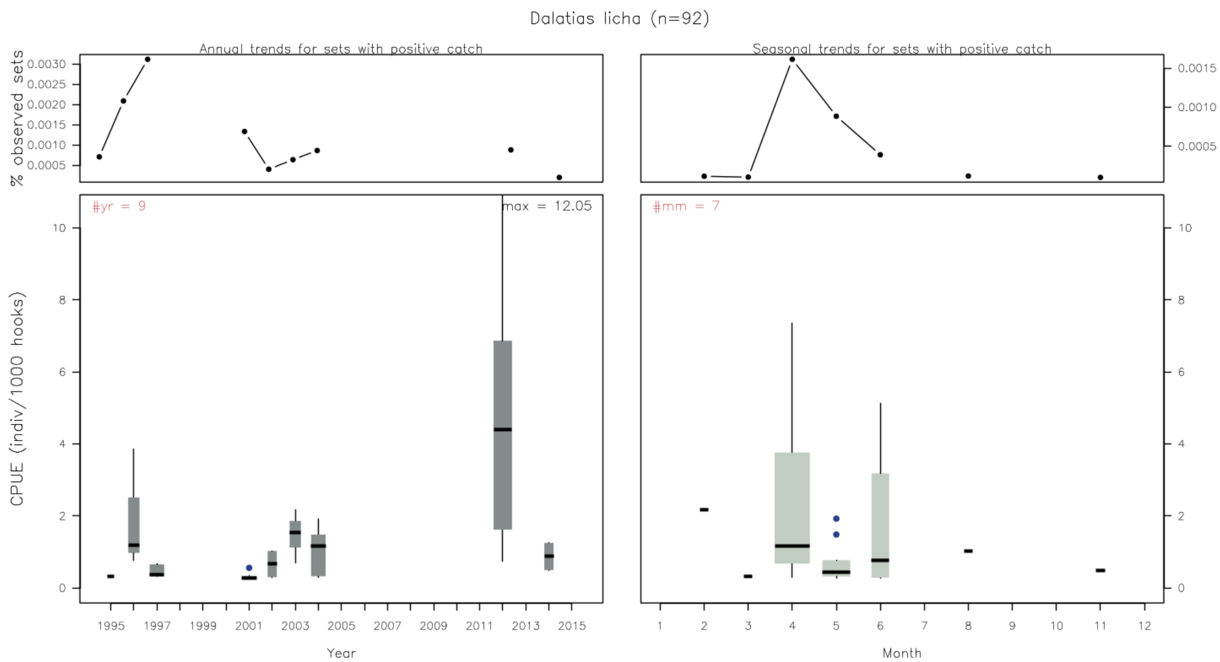

Figure AI 29: Unstandardized CPUE for *Dalatias licha* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

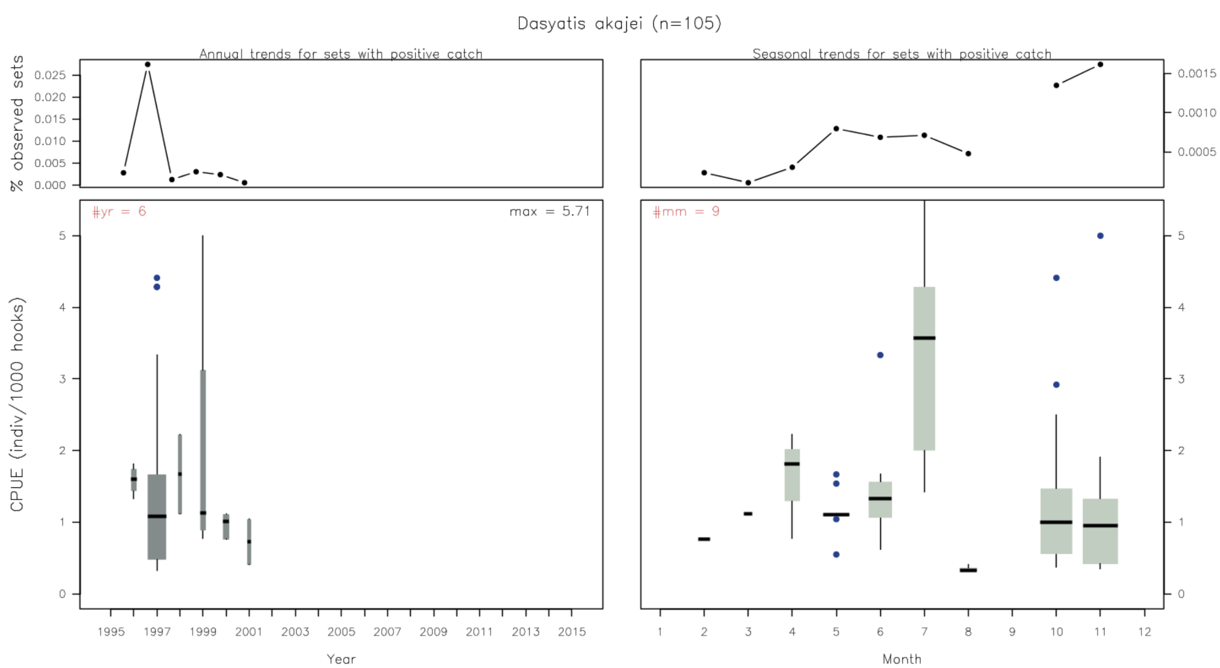

Figure AI 30: Unstandardized CPUE for *Dasyatis akajei* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

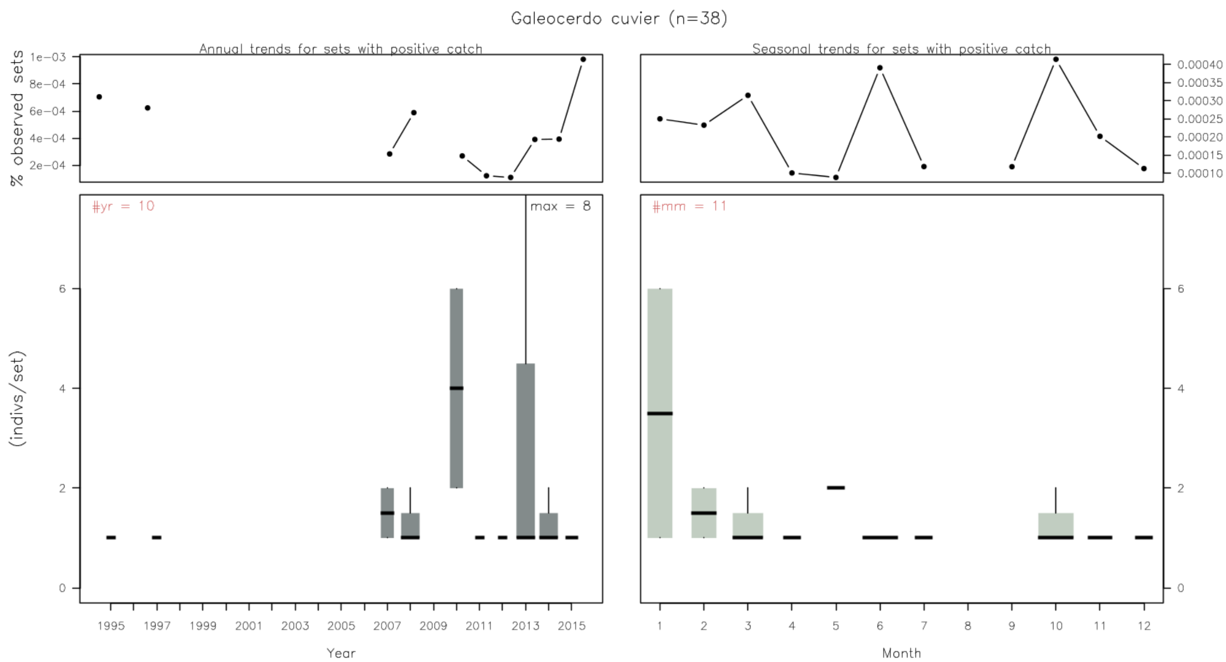

Figure AI 31: Unstandardized CPUE for *Galeocerdo cuvier* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

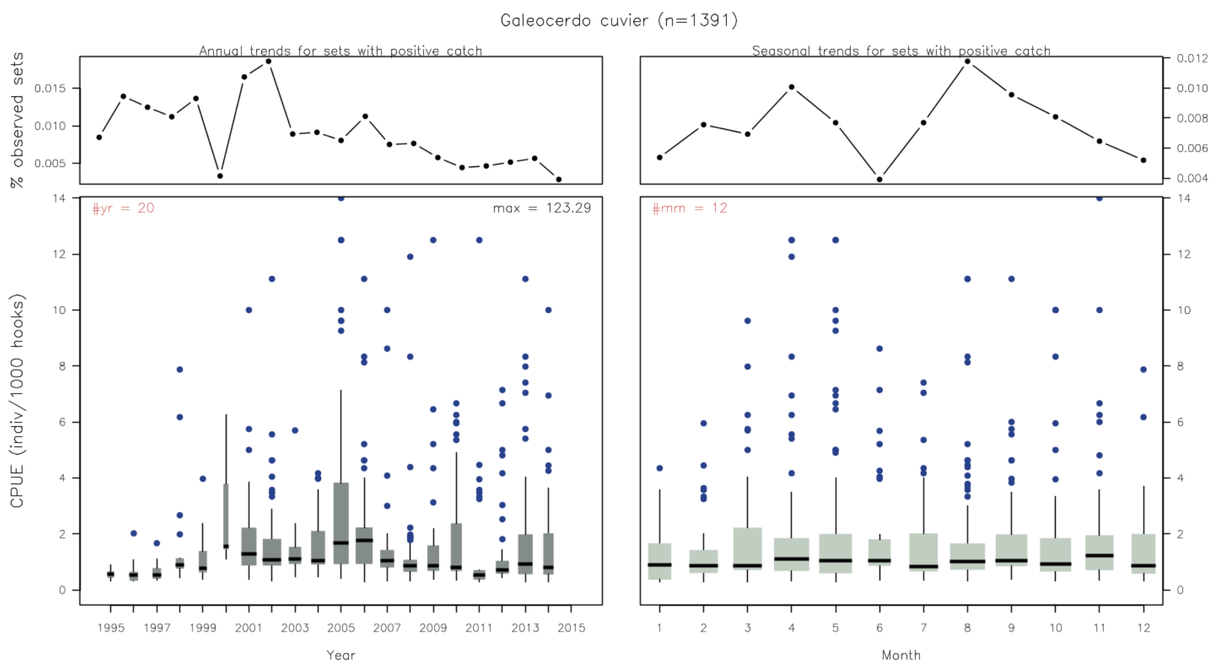

Figure AI 32: Unstandardized CPUE for *Galeocerdo cuvier* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

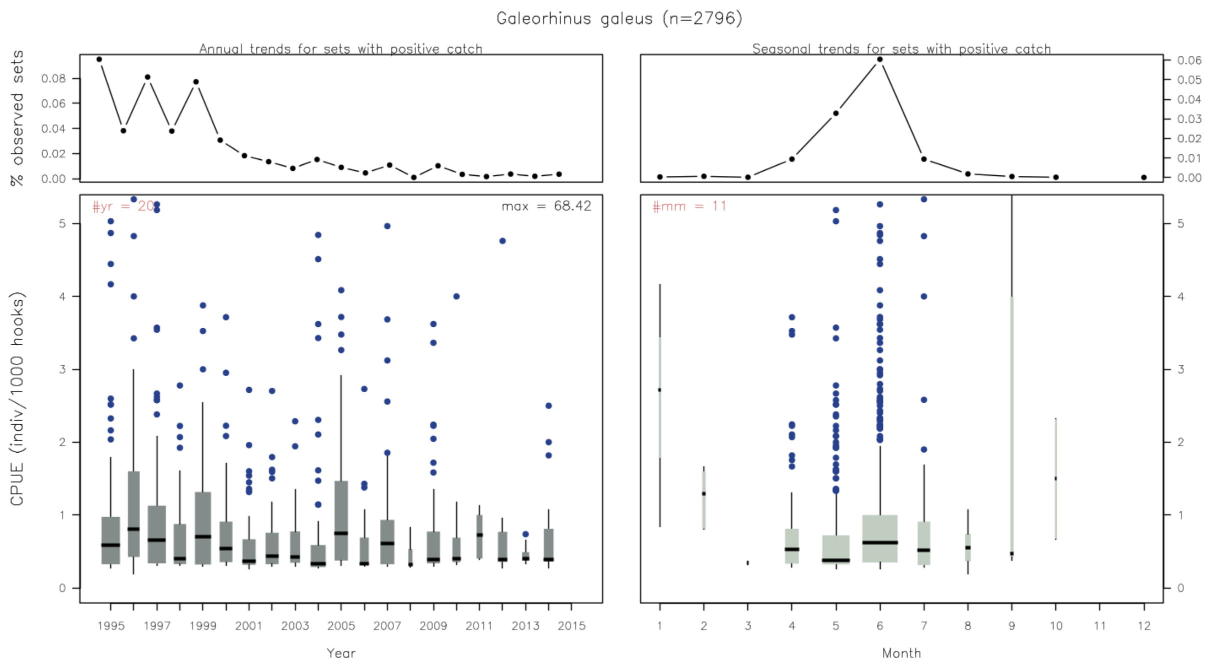

Figure AI 33: Unstandardized CPUE for *Galeorhinus galeus* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

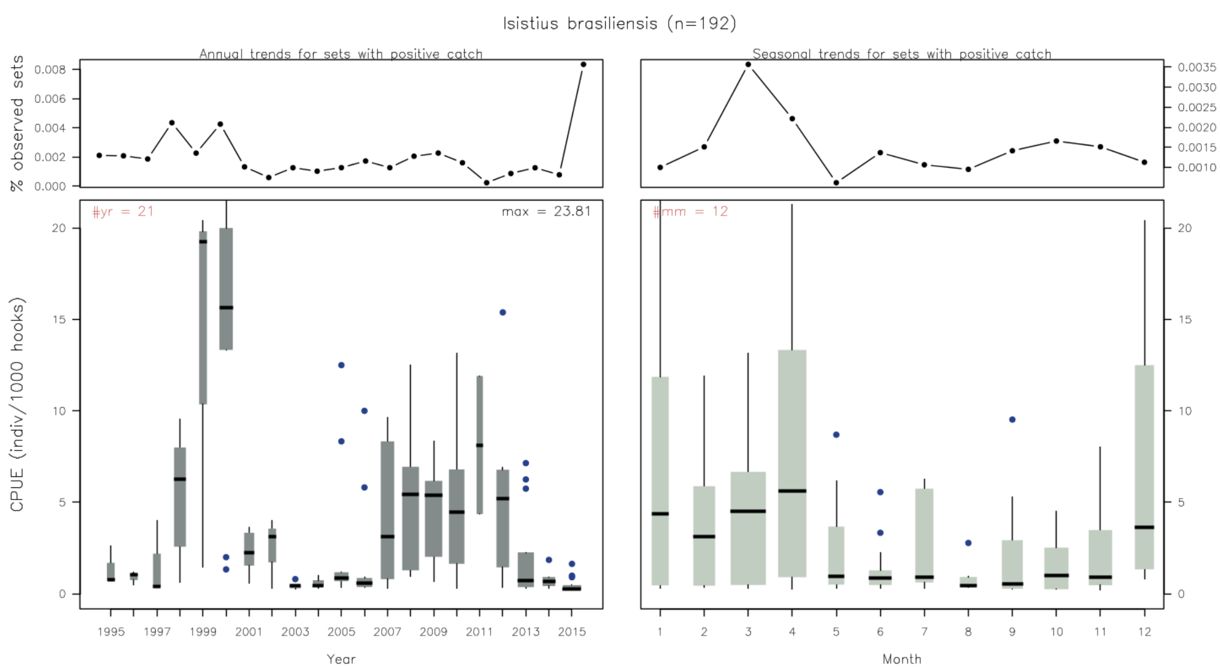

Figure AI 34: Unstandardized CPUE for *Isistius brasiliensis* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

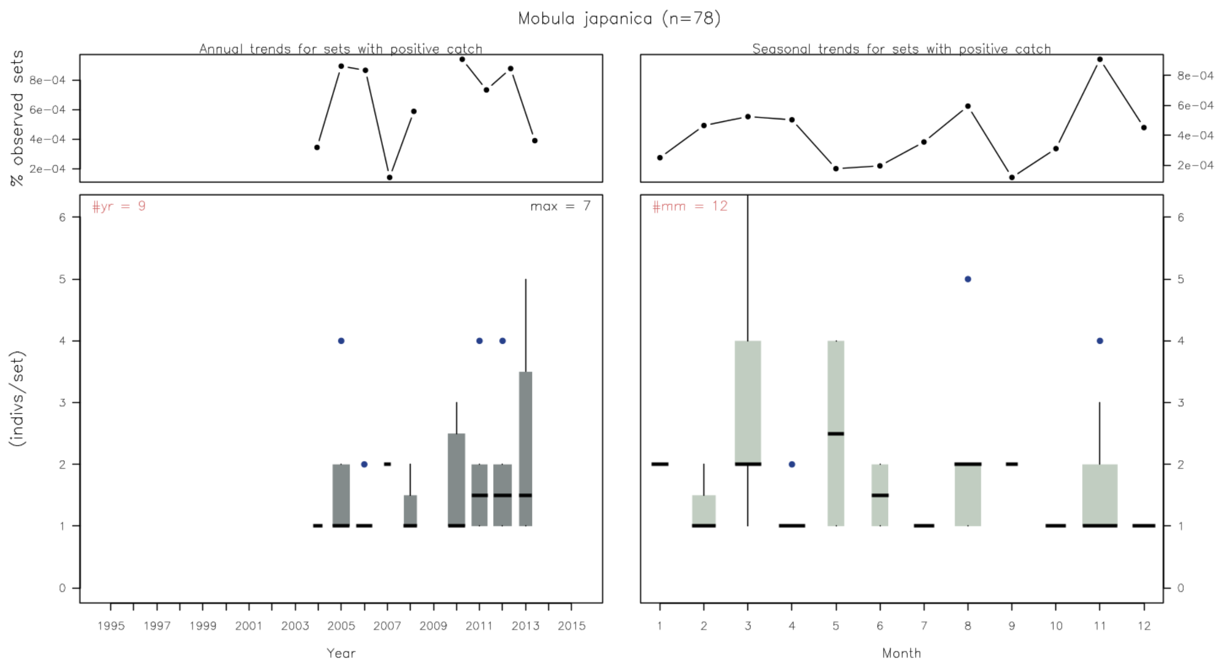

Figure AI 35: Unstandardized CPUE for *Mobula japanica* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

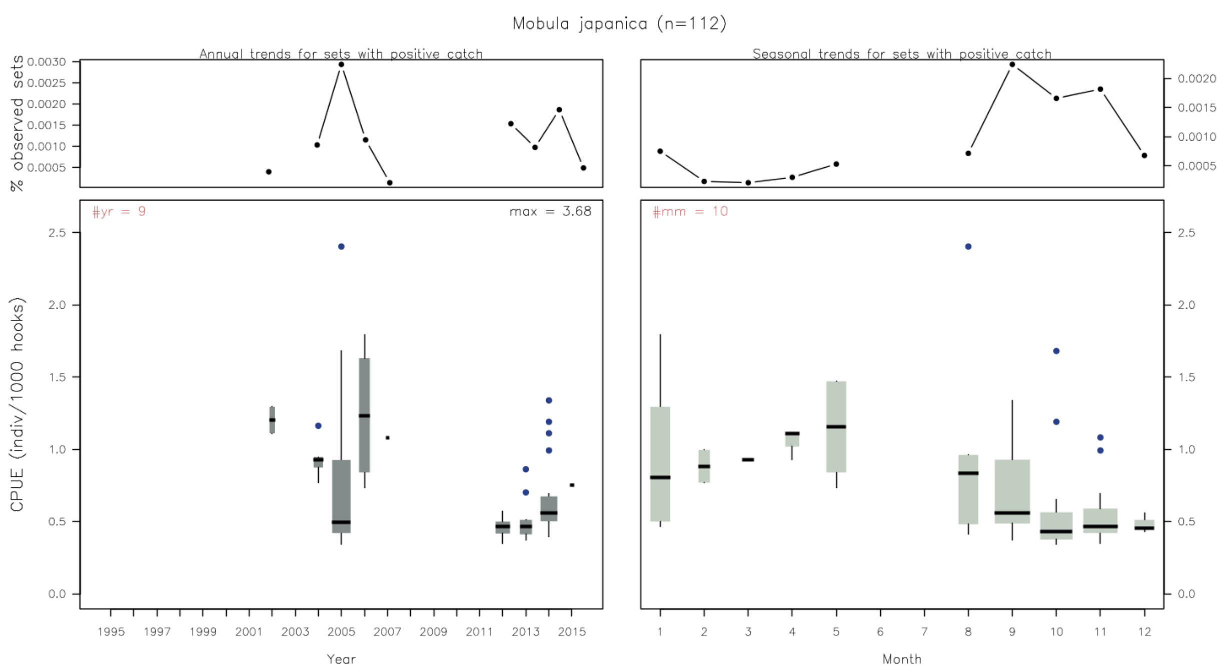

Figure AI 36: Unstandardized CPUE for *Mobula japanica* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

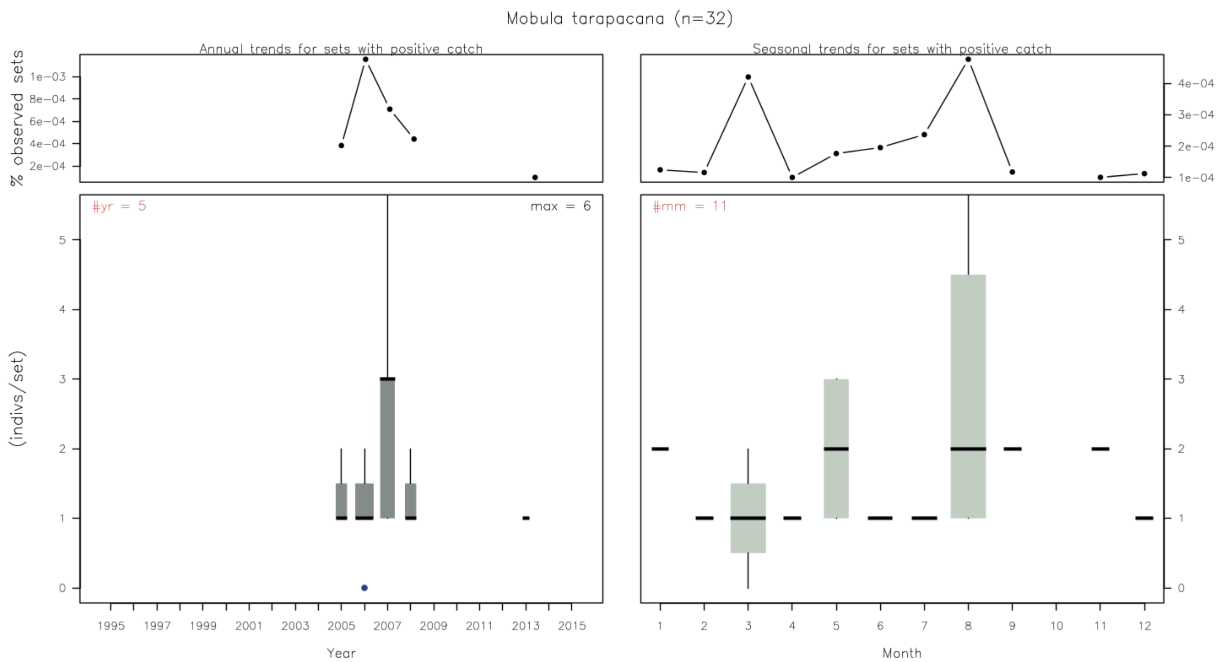

Figure AI 37: Unstandardized CPUE for *Mobula tarapacana* from purse seine sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

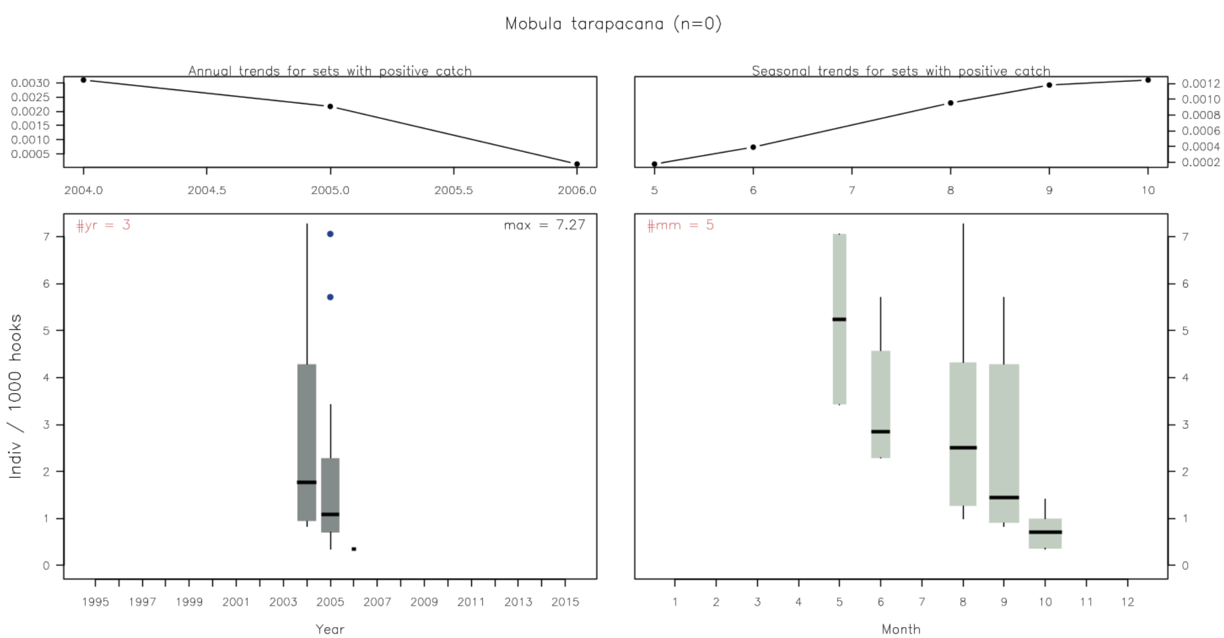

Figure AI 38: Unstandardized CPUE for *Mobula tarapacana* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

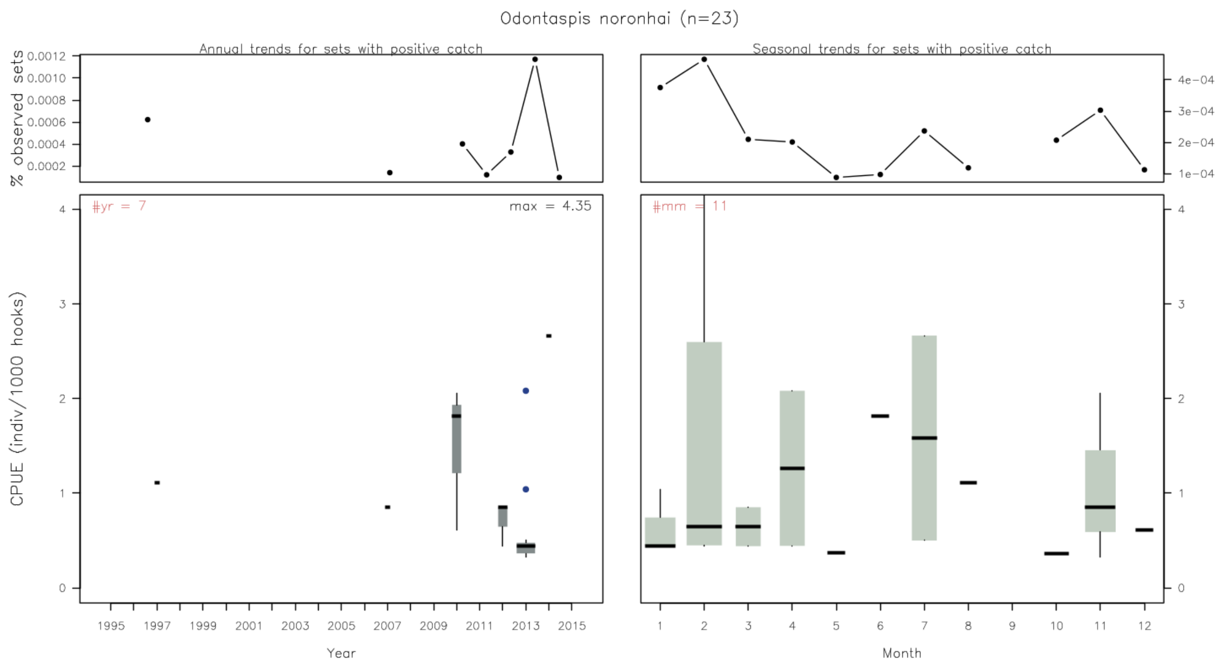

Figure AI 39: Unstandardized CPUE for *Odontaspis noronhai* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

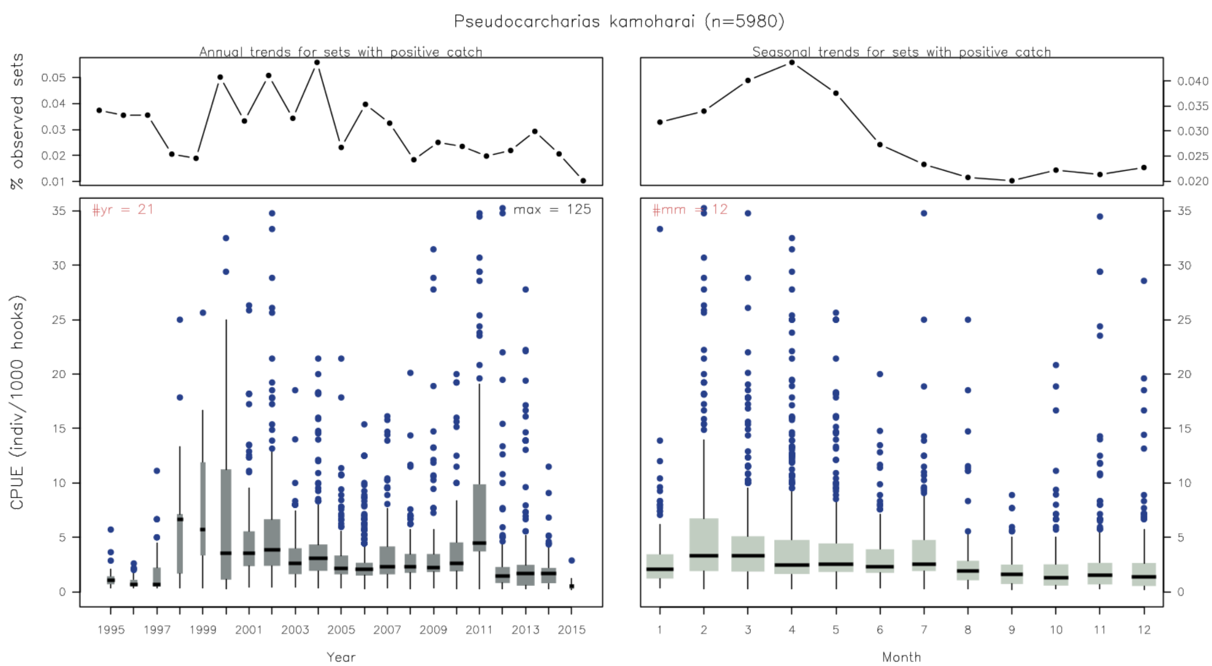

Figure AI 40: Unstandardized CPUE for *Pseudocarcharias kamoharai* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

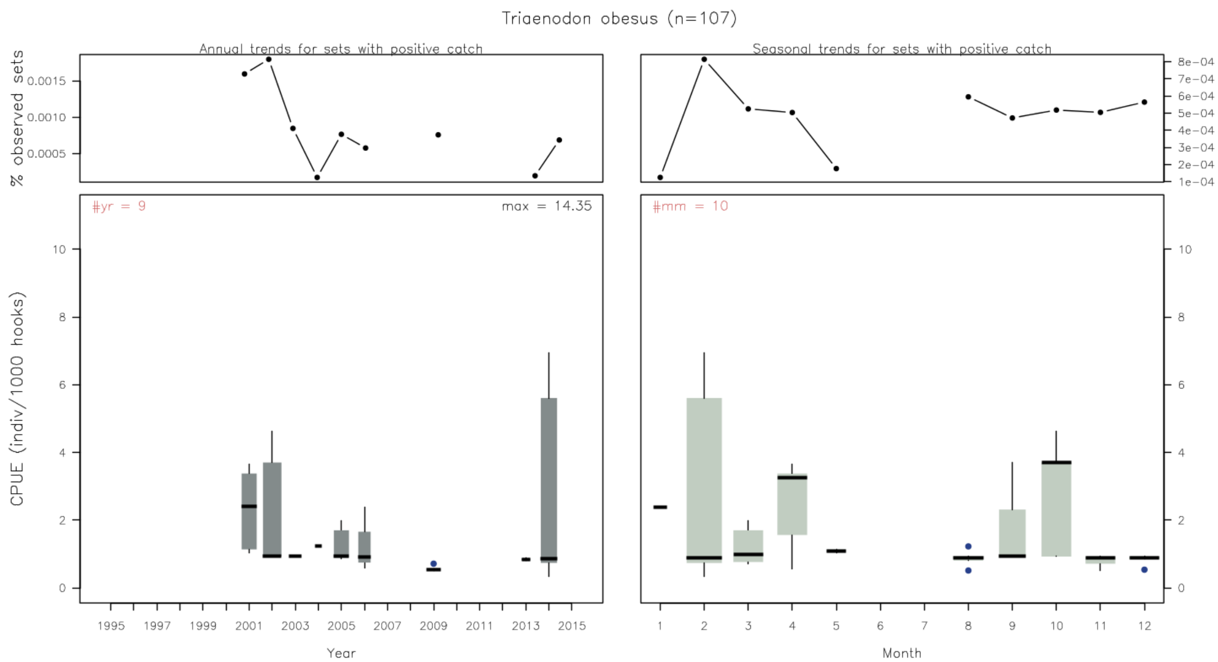

Figure AI 41: Unstandardized CPUE for *Triaenodon obesus* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

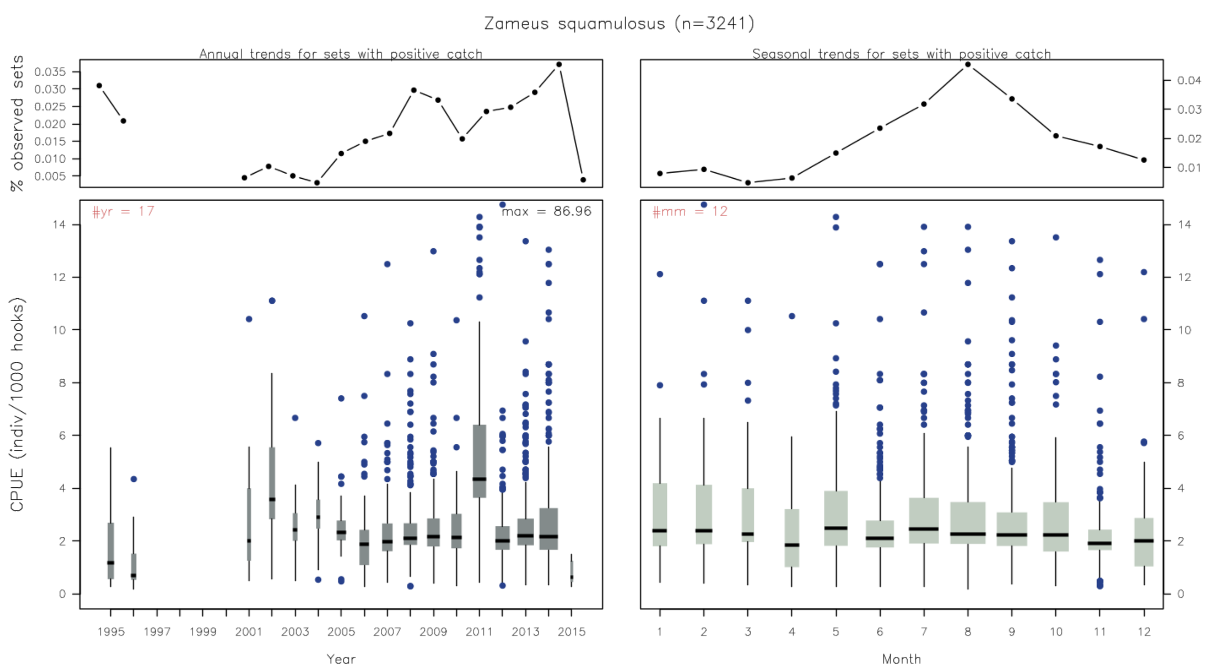

Figure AI 42: Unstandardized CPUE for *Zameus squamulosus* from longline sets within the Western and Central Pacific Ocean 1995-2015 (left) and monthly (right).

Table AI 1: Total number of fish observed (n) in the Western and Central Pacific Ocean from 1994-2015, in the assocated (ASS), and unassocated (UNA) purse seine fisheries; albacore (ALB) target; and bigeys and yellowfin tuna (BET-YFT) target longline fisheries.

Species	**ASS n**	**ASS rate**	**UNA n**	**UNA rate**	**ALB n**	**ALB rate**	**BET-YFT n**	**BET-YFT rate**
Alopias pelagicus	37	0.0001	2	0.0000	268	0.0003	3560	0.0036
Alopias superciliosus	3582	0.0058	6	0.0000	1355	0.0017	26184	0.0265
Alopias vulpinus	11	0.0000	1	0.0000	1005	0.0013	446	0.0005
Carcharhinus albimarginatus	16	0.0000	39	0.0002	155	0.0002	1095	0.0011
Carcharhinus altimus	33	0.0001	308	0.0016	7	0.0000	105	0.0001
Carcharhinus amblyrhynchos	31	0.0001	4	0.0000	111	0.0001	1602	0.0016
Carcharhinus brachyurus	2379	0.0038	221	0.0011	324	0.0004	3105	0.0031
Carcharhinus brevipinna							2	0.0000
Carcharhinus falciformis	222340	0.3593	22243	0.1139	5619	0.0072	89482	0.0907
Carcharhinus galapagensis	21	0.0000	47	0.0002	49	0.0001	1147	0.0012
Carcharhinus leucas	46	0.0001	31	0.0002	10	0.0000	64	0.0001
Carcharhinus limbatus	693	0.0011	490	0.0025	60	0.0001	1137	0.0012
Carcharhinus longimanus	2583	0.0042	316	0.0016	3925	0.0051	16855	0.0171
Carcharhinus melanopterus	31	0.0001	29	0.0001	21	0.0000	513	0.0005
Carcharhinus obscurus	112	0.0002			79	0.0001	127	0.0001
Carcharhinus plumbeus	46	0.0001	15	0.0001	58	0.0001	414	0.0004
Carcharhinus tilstoni							14	0.0000
Carcharodon carcharias			1	0.0000	28	0.0000	51	0.0001
Centrophorus squamosus					4	0.0000		
Centroscymnus crepidater					3	0.0000		
Centroscymnus owstonii					4428	0.0057	3	0.0000
Centroscymnus plunketi					17	0.0000		
Cetorhinus maximus	1	0.0000			79	0.0001	1	0.0000
Dalatias licha	1	0.0000	1	0.0000	25	0.0000	42	0.0000
Dasyatis akajei					3	0.0000	100	0.0001
Dasyatis brevicaudata					2	0.0000	3	0.0000
Etmopterus baxteri					2	0.0000	4	0.0000
Eusphyra blochii	1	0.0000			1	0.0000	32	0.0000
Galeocerdo cuvier	22	0.0000	4	0.0000	149	0.0002	989	0.0010
Galeorhinus galeus	5	0.0000			1609	0.0021	28	0.0000
Heptranchias perlo					1	0.0000		
Isistius brasiliensis			18	0.0001	38	0.0000	134	0.0001
Isurus oxyrinchus	328	0.0005	20	0.0001	14414	0.0186	17610	0.0179
Isurus paucus	6	0.0000	1	0.0000	693	0.0009	2078	0.0021
Lamna ditropis					80	0.0001	75	0.0001

Table AI 1: *(continued)*

Species	ASS n	ASS rate	UNA n	UNA rate	ALB n	ALB rate	BET-YFT n	BET-YFT rate
Lamna nasus	15	0.0000			10980	0.0142	113	0.0001
Manta birostris	1079	0.0017	1478	0.0076	96	0.0001	335	0.0003
Megachasma pelagios			1	0.0000				
Mobula eregoodootenkee	1	0.0000						
Mobula japanica	25	0.0000	10	0.0001	47	0.0001	56	0.0001
Mobula kuhlii	0	0.0000						
Mobula tarapacana			1	0.0000	26	0.0000	57	0.0001
Mobula thurstoni			16	0.0001				
Notorynchus cepedianus	32	0.0001			14	0.0000		
Odontaspis noronhai	1	0.0000			1	0.0000	19	0.0000
Prionace glauca	46	0.0001	38	0.0002	193368	0.2494	310619	0.3149
Pseudocarcharias kamoharai					163	0.0002	5610	0.0057
Pteroplatytrygon violacea	1405	0.0023	1184	0.0061	25739	0.0332	34011	0.0345
Rhincodon typus	426	0.0007	438	0.0022	3	0.0000	4	0.0000
Sphyrna lewini	16	0.0000	18	0.0001	56	0.0001	1016	0.0010
Sphyrna mokarran	25	0.0000	9	0.0000	93	0.0001	385	0.0004
Sphyrna zygaena	15	0.0000	1	0.0000	67	0.0001	270	0.0003
Squalus acanthias	1	0.0000			32	0.0000		
Squalus megalops					1	0.0000	1	0.0000
Squatina tergocellatoides					3	0.0000	4	0.0000
Stegostoma fasciatum							1	0.0000
Torpedo fairchildi					10	0.0000	3	0.0000
Triaenodon obesus	20	0.0000			1	0.0000	40	0.0000
Unidentified Alopias	9	0.0000	14	0.0001	199	0.0003	2566	0.0026
Unidentified Carcharhinidae							2	0.0000
Unidentified Carcharhiniformes					6	0.0000	56	0.0001
Unidentified Centroscymnus					147	0.0002		
Unidentified Dasyatidae	1	0.0000	8	0.0000	22	0.0000	107	0.0001
Unidentified Heterodontiformes							42	0.0000
Unidentified Isurus	61	0.0001	10	0.0001	909	0.0012	557	0.0006
Unidentified Mobula	1319	0.0021	1413	0.0072	55	0.0001	349	0.0004
Unidentified Myliobatidae	1169	0.0019	1122	0.0057	59	0.0001	464	0.0005
Unidentified Raja	39	0.0001	25	0.0001	9	0.0000	7	0.0000
Unidentified Rajidae	46	0.0001			5	0.0000	4	0.0000
Unidentified Rajiformes					21	0.0000	208	0.0002

Table AI 1: *(continued)*

Species	ASS n	ASS rate	UNA n	UNA rate	ALB n	ALB rate	BET-YFT n	BET-YFT rate
Unidentified ray	1418	0.0023			426	0.0005	1312	0.0013
Unidentified Rhinobatidae							2	0.0000
Unidentified shark	113	0.0002	216	0.0011	1427	0.0018	5655	0.0057
Unidentified shark or ray					7	0.0000	1	0.0000
Unidentified Sphyrna	26	0.0000	104	0.0005	61	0.0001	1284	0.0013
Unidentified Squalidae					18	0.0000	15	0.0000
Unidentified Squalus							2	0.0000
Unidentified Squatinidae					1	0.0000	3	0.0000
Urolophus cruciatus					1	0.0000		
Urolophus viridis							1	0.0000
Zameus squamulosus			1	0.0000	135	0.0002	2770	0.0028

Appendix II - Species Considered for Designation as Key Sharks

Table AII 1: Assessment criteria to designate manta rays (*Manta birostris*) as a key shark species in the Western and Central Pacific Ocean.

PROPOSAL FOR THE DESIGNATION OF WCPFC KEY SHARK SPECIES Nomination for (check all that apply):		
✓Key species - Data Provision		✓Key Species - Assessment
Species/Taxa Nominated		
Scientific Name(s): *Manta birostris*		Common Name(s): Giant manta ray
If more than one species is included in this nomination explain why: NA		
In WCPF Convention Area? (see Section 2.1)		
✓Yes	No	Explain: This species occurs circumglobally in most tropical and subtropical seas, but sometimes also in temperate waters. They are found from coastal to open ocean waters (Ebert and Stehmann, 2013). In the WCPO, this species is widely distributed and has been noted by fishery observers in purse seine and longline catch throughout the tropical WCPO, but most commonly west of 180^oW.
Impacted by Fishing?		
✓Yes	No	Explain: According to (CITES, 2016) the main threat to mantas is fishing, whether targeted or incidental. In the WCPO, this species is a regular bycatch in both purse seine and longline gear, and are also caught by coastal fisheries for local subsistence. They have been targeted for human consumption, and for cartilage and gill filaments for Asian markets; often processed for fish meal, and the large livers for fish oil (Ebert and Stehmann, 2013). In the WCPO this species is observed ate a rate of 0.0017 per asociated purse seine sets and 0.0076 for unassocated set. THey are observed ata rate of 0.001-0.003 per 1000 hooks in longline sets.
Particular Ecological Concern?		
✓Yes	No	Explain: According to (CITES, 2016), while giant manta rays are widely distributed and highly migratory, actual populations appear to be sparsely distributed and highly fragmented within this broad range. Overall population size is unknown. The decline of these small subpopulations may result in regional depletion or extinctions with the reduced possibility of successful recolonization. To aggravate this situation, this species is thought to be longlived and have extremely low reproductive output (one pup per litter). These biological constraints contribute to its slow or lack of recovery from population reductions. Kirby and Hobday (2007) undertook an Ecological Risk Assessment (ERA) for the WCPFC. Depending on the specific metrics included, *M. birostris* was assessed as having a medium to high risk.
Adequate Data to Support Detailed Assessment?		

Yes	✓No If no, is additional logsheet data collection practical? ✓Yes	Explain: In the WCPO pelagic fisheries, the majority of the manta ray catch is likely to be *M. birostris* as *M. alfredi* are normally associated with coastal waters. As such, while the two species are not distinguished in the records, the longline and purse seine fisheries are most likely dominated by *M. birostris*. Therefore, logsheet reporting will generate useful infromation.

Is the management of *Manta birostris* likely to be enhanced by having it listed as a WCPFC key shark species?
Manta birostris have recently been added to CITES Appendix II. As such, while they can still be landed by fisheries as either target or bycatch species, any export of products derived from these species will require a non-detriment finding. CITES recomends that non-detriment findings include information on the distribution, population trends and harvest. A WCPFC key shark designation for this species will require enhanced reporting by vessels which will assist countries wanting to export these products in meeting this obligation. Furthermore, due to the ecological concern for *Manta birostris*, enhanced reporting could improve the effectiveness of analysis of catch and effort trends in future. It is therefore likely that, given the current management regime, perceived stock status, ease of identification and wide distribution through the low latitudes of the WCPO, listing of *Manta birostris* as a key shark species would enhance its management by the WCPFC.

Recommendation: SC12 recommends that WCPFC13 list/does not list *Manta birostris* as a key shark species.

Table AII 2: Assessment criteria to designate *Mobula* sp. as a key shark species in the Western and Central Pacific Ocean.

PROPOSAL FOR THE DESIGNATION OF WCPFC KEY SHARK SPECIES Nomination for (check all that apply):		
✓Key species - Data Provision		✓Key Species - Assessment
Species/Taxa Nominated		
Scientific Name(s): *Mobula* sp.		Common Name(s): Mobula rays or devil rays
If more than one species is included in this nomination explain why: In the WCPO there are three *Mobula* species recorded in observer records. However, due to identification uncertainty, almost all (97.4%) are recorded as unidentified *Mobula* sp. therefore separating the species as for designation seems impractical at this stage.		
In WCPF Convention Area? (see Section 2.1)		
✓Yes	No	Explain: *Mobula sp.* occur circumglobally in most tropical and subtropical seas, and less frequently in temperate waters. They are found from coastal to open ocean waters (Ebert and Stehmann, 2013). In the WCPO they appear to be widely distributed and have been noted by fishery observers in purse seine and longline catch throughout the tropical WCPO, but more commonly west of 180^{o}W.
Impacted by Fishing?		
✓Yes	No	Explain: According to (CITES, 2016) the main threat to *Mobula sp.* is fishing, whether targeted or incidental. These species are a regular bycatch in both purse seine and longline gear, and are caught by coastal fisheries for local subsistence. They have been targeted human consumption and for cartilage and gill filaments for Asian markets; often processed for fish meal, and the large livers for fish oil (Ebert and Stehmann, 2013). In the WCPO these species are seldom observed only 0.0001 per set in the purse seine sets and 0.0001 fish per 1000 hooks in longline sets.
Particular Ecological Concern?		
✓Yes	No	Explain: While *Mobula sp.* are widely distributed and highly migratory within a broad range, actual populations (species?) appear to be sparsely distributed and highly fragmented. Overall population size is unknown. Kirby and Hobday (2007) undertook an Ecological Risk Assessment (ERA) for the WCPFC. Depending on the specific metrics included, both *Mobula* species were assessed as having medium to high risk fromfisheries interactions.
Adequate Data to Support Detailed Assessment?		
Yes	✓No If no, is additional logsheet data collection practical? ✓No	Explain: Apart from *M. thurstoni* which has a marking on its dorsal fin, these species are difficult to distinguish and it is unlikely that fishers will be able to accurately identify them at the species level.

Is the management of *Mobula* sp. likely to be enhanced by having it listed as a WCPFC key shark species? Due to the ecological concern for this group, enhanced reporting could allow more effective analysis of catch and effort trends in future. It is therefore likely that, given the current management regime, perceived stock status, and wide distribution throughout the WCPO, listing *Mobula* sp. as a key shark species could enhance the informaion collected on this group by the WCPFC. In spite of this, these species are difficult to tell apart and it is likely that only some observers would be able to identify the individuals at the species level, so that enhanced reporting is unlikely to lead to species-specific information in the short-term. **It is recommended that** for this group improving observers abilities to identify individuals to the species-level is likely to lead to improved information in the medium-term, but listing mobula rays as a key shark species will probably not enhance the management of individual species in this group by the WCPFC at this stage.

Recommendation: SC12 recommends that observer training programmes add emphasis to mobulid species identification as part of their curricula.

Recommendation: SC12 recommends that WCPFC13 list/does not list *Mobula* sp. as a key shark species.

Table AII 3: Assessment criteria to designate pelagic stingrays (*Pteroplatytrygon violacea*) as a key shark species in the Western and Central Pacific Ocean.

PROPOSAL FOR THE DESIGNATION OF WCPFC KEY SHARK SPECIES Nomination for (check all that apply):		
✓Key species - Data Provision		✓Key Species - Assessment
Species/Taxa Nominated		
Scientific Name(s): *Pteroplatytrygon violacea*		Common Name(s): Pelagic stingray
If more than one species is included in this nomination explain why: NA		
In WCPF Convention Area? (see Section 2.1)		
✓Yes	No	Explain: This species occurrs circumglobally in most tropical oceans. They are found from coastal to open ocean waters (Ebert and Stehmann, 2013). As the name suggests they are pelagic occurring from the edge of continental and insular shelves into the open ocean, usually in the upper 100 m. In the WCPO this species is wiedly distributed and has been noted by fishery observers in purse seine and longline catch throughout the tropical and temperate WCPO.
Impacted by Fishing?		
✓Yes	No	Explain: This species is a regular bycatch in both purse seine and longline gear, and are caught by coastal fisheries for local subsistence. They are utilised for their wings and the livers for fish oil. In the WCPO, apart from already designated key shark species, this species is the elasmobranch most frequently caught in observed longline sets.
Particular Ecological Concern?		
Yes	✓No	Explain: Kirby and Hobday (2007) undertook an Ecological Risk Assessment (ERA) for the WCPFC. This work included *P. violacea* (listed as *Dasyatis violacea*) and, irrespective of the specific metrics included, they recorded *P. violacea* as having a mediun risk. This was largly due to their medium vulnerability to most fishing gear used in the WCPFC as well as their medium productivity.
Adequate Data to Support Detailed Assessment?		
Yes	✓No If no, is additional logsheet data collection practical? ✓Yes	Explain: *P. violacea* are easy to identofy so logsheet data collection is possible.

Is the management of *Pteroplatytrygon violacea* likely to be enhanced by having them listed as a WCPFC key shark species?
A WCPFC key shark designation for this species will require enhanced reporting by vessels, which will build on the observer data set. In time, the data accumulated could add value to the management of this species through the WCPFC's ability to estimate fishing mortality. Enhanced reporting could allow more effective analysis of catch and effort trends in future. It is therefore likely that, given the current management regime, perceieved stock status, ease of identification and wide distribution through the WCPO, listing *P. violacea* as a key shark species could enhance its management by the WCPFC.

Recommendation: SC12 recommends that WCPFC13 list/does not list *Pteroplatytrygon violacea* as a key shark species.

If it is determined by SC12 that any of these species meet the criteria and are recommended for designation as key shark species, consideration will be necessary as to how each could be incorporated into the WCPFC Shark Research Plan (WCPFC 2015 Attachment H).

General recommendations for enhancing the key shark designation table:

- In future key shark species designation assessments tables include "Is the management of ________ likely to be enhanced by having it listed as a WCPFC key shark species?".
- In future key shark species designation assessments include "SCxx recommends that WCPFCyy list/does not list ________ as a key shark species".

References

CITES (2016). Consideration of proposals for amendment of appendices i and ii. *CoP17 Prop. 44.*

Ebert, D. and Stehmann, M. (2013). Sharks, batoids, and chimaeras of the north atlantic. *FAO Species Catalogue for Fishery Purposes. No. 7. Rome, FAO. 523 pp.*

Kirby, D. and Hobday, A. (2007). Ecological risk assessment for the effects of fishing in the western and central pacific ocean: Productivity-susceptibility analysis. *Third Scientific Committee Meeting of the Western and Central Pacific Fisheries Commission, Honolulu, USA, 13-24 August 2007. WCPFC-SC3-EB-SWG/WP-1.*