SCIENTIFIC COMMITTEE

FINAL REPORT
Project 97

2021-2025 Shark Research Plan

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Contents

Executive Summary

This document represents a proposal for the WCPFCs third Shark Research Plan (SRP) covering the years 2021-2025. The SRP was developed with input from an online Informal Working Group (SRP-IWG) comprised of Commission Members, Cooperating non-Members, and participating Territories (CCMs) and observers. This document includes a review of the previous plan (Appendix II). For each of the WCPFC Key Sharks, the plan summarises the available data; the current stock status; and presents report cards that summarise the assessment information and research requirements for each species. In addition, this proposal suggests guidelines for metrics to be included in assessments to ensure consistency in reporting and ease of comparison among species; and proposes a number of objectives for the SRP.

The document outlines a proposal for the 2021-2025 SRP direction and tables a project plan. Finally we make the following recommendations for the Scientific Committee's consideration:

1. SC adopt objectives to direct the 2021-2025 SRP.
2. SC adopt standardised assessment reporting metrics for Data Rich Assessments, and as a minimum report F/F_{MSY} and SB/SB_{MSY} or B/B_{MSY} or SB/SB_0 or B/B_0.
3. Where possible Data Rich Assessments should report depletion estimates ($SB/SB_{F=0}$).
4. To improve our understanding of Medium Data Assessment metrics, Data Rich Assessments are encouraged to, in addition to the above metrics, report F_{msm}, F_{lim} and F_{crash}, and present the ratios of F_{msm}/F_{crash} and F_{lim}/F_{crash} and F/F_{crash} for comparison with conventional metrics.
5. Medium Data Assessments that are unable to estimate the F/F_{MSY} due to a lack of fishery and/or biological data, are encouraged to report F_{msm}, F_{lim} and F_{crash}, and present the ratios of F_{msm}/F_{crash} and F_{lim}/F_{crash} and F/F_{crash}.
6. To facilitate future reporting, when undertaking the annual review of progress at the SC, the ISG should rate projects as complete, partial, ongoing and not done and provide a score to measure performance.
7. The SC develop an "agreed suite" of biological parameters (or upper and lower bounds) and units of measurement (e.g. total length) for use in WCPFC assessments and update the information sheets accordingly.
8. The SC review and agree on the data certainty criteria (Table 6) for the report cards and confirm a certainty rating for each species, when reviewing the report cards.
9. The SC review, and update annually if needed, the "agreed suite" of biological parameters; the report cards; and information sheets.
10. The SC is invited to consider the schedule of work outlined in Table 7 and Table 9 for 2021-2025.
11. The SC is invited to review the specific projects proposed in Table 7 and Table 9 for 2021 for finalisation prior to developing the SC budget.

SRP 2021-2025 project list. * indicates projects on the "long list" from Chin and Simpfendorfer (2019). ** indicates projects added in at SC16. Note: these projects may differ from the final agreed list at each SC.

Title	Priority	Start year	End year
1. Stock assessment			
(a) Determine the stock status for WCPFC Key Sharks			
i) Southwest Pacific blue shark assessment	High	2020	2021
ii) Northwest Pacific blue shark assessment	High	2021	2022
iii) Northwest Pacific shortfin mako shark assessment	High	2023	2024
iv) WCPO silky shark assessment	High	2022	2023
v) Pacific silky shark assessment	Medium	2022	2023
vi) Pacific bigeye thresher shark assessment	Medium	2021	2022
vii) Pacific whale shark assessment	Medium	2022	2023
vii)** Southwest Pacific mako shark assessment	High	2021	2022
(b) Develop reliable catch histories for WCPFC Key Sharks as far back in time as feasible			
i) Redefining the fleets currently assumed in the BSH NP stock assessment	Medium	2021	2022
ii) The development of alternative approaches to catch reconstructions based on estimates of the global fin trade	Medium	2024	2025
(c) Test and improve Medium and Data Poor assessment methods to inform management decisions			
i) Test and improve data poor assessment methods	Medium	2024	2025
ii) Include data poor assessment metrics as standard outouts for data rich assessments	High	Ongoing	Ongoing
2. Mitigation			
(a) Provide advice on mitigation Sharks with non-retention policies and unwanted elasmobranchs			
i) Investigate effective mitigation for WCPFC Key Sharks	Medium	2023	2025
ii) Investigate mitigation method trade-offs between mitigation methods for sharks, seabirds and sea turtles	Medium	2023	2025
(b) Provide advice on safe release methods and assess release survival of WCPFC Key Sharks			
i) Estimate longline silky and oceanic whitetip shark post release survival*	High	2021	2023
ii) Estimatepurse seine whale shark post release survival*	High	2021	2023
3. Biological data improvements			
(a) Increase the understanding of important biological parameters of WCPFC Key Sharks			
i) Silky shark and oceanic whitetip shark reproductive biology and longevity*	High	2023	2025
ii) Biology and life history of hammerhead sharks*	High	2023	2025
iii) Resolving blue shark reproductive biology*	Medium	2023	2025
iv) Biology of the longfin mako shark*	Medium	2023	2025
v) Life history of thresher sharks*	Medium	2023	2025
vi) Validated life history, biology, and stock structure of the shortfin mako in the south Pacific *	Medium	2023	2025
vii) Age validation and stock structure of the silky shark and oceanic whitetip shark*	Low	2023	2025
viii) Stock structure and life history of southern hemisphere porbeagle shark*	Low	2023	2025
4. Observer data collection			
(a) Improve spatio-temporal observer data for informing scientific needs			
i) Training observers in the WCPO to be proficient in species identification	High	Ongoing	Ongoing
ii) Training observers for extraction and storage of vertebrae and shark reproductive material	High	2021	Ongoing
iii) Training observers for on-deck reproductive staging	High	2021	Ongoing
iv) Measuring elasmobranchs on purse seine and longline vessels for length-length and length-weight conversion factor dvelopement	High	Ongoing	Ongoing

1 Introduction

The first Western and Central Pacific Fisheries Commission (WCPFC) Shark Research Plan (SRP) was developed to design, plan and co-ordinate research relevant to the management of elasmobranchs in the Western and Central Pacific Ocean (WCPO) (Clarke and Harley, 2010). At the 11^{th} meeting of the WCPFC Scientific Committee (SC) the SC agreed on the second phase of the SRP (Brouwer and Harley, 2015). The second SRP is due to end in 2020. This paper outlines a proposal for the 2021-2025 (3^{rd}) SRP. The 2021-2025 SRP builds on the previous two plans and the detailed review of the most recent plan, that is included as Appendix II.

The 2021-2025 SRP is a living document that can change as the information needs of the WCPFC evolve. The plan is assessed annually by the SC usually through an Informal Small Group (ISG) and the following years' work is finalised by the SC. It is anticipated that this document will be finalised at SC16, as will the 2021 project list. This plan was developed with input from an online Informal Working Group (SRP-IWG). Commission Members, Cooperating non-Members, and participating Territories (CCMs), and after consultation with the SRP-IWG, WCPFC Observers were invited to participate in the SRP-IWG. Seven CCMs, four WCPFC Observers, the WCPFC Secretariat and the WCPFC Science Service Provider participated in the SRP-IWG (Table 2).

This plan falls within the umbrella of 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.*" to this end the key focus of this plan are the WCPFC Key Sharks, but it does not preclude other elasmobranchs should the need arise for information on any other species. As with its forerunners this plan could also support the efforts of the WCPFCs members to meet their obligations under other relevant international instruments. Importantly, the WCPFC budget may not be sufficient (nor is it expected) to complete all the recommended work for successful implementation of the plan. Member countries and other organisations are encouraged to undertake some of the work through funding external to the WCPFC.

For each of the WCPFC Key Sharks, the plan will summarise the available data; the current stock status; and present report cards that summarise the assessment information and research requirements for each species. In addition, the plan proposes guidelines for metrics to be included in assessments to ensure consistency in reporting and ease of comparison between species; finally we outline a proposal for the 2021-2025 SRP direction and project plan; and make some overall recommendations for the 2021-2025 period. The species considered in this document along with their scientific names and species codes are listed in Table 3.

2 WCPFC Shark Data

For effective planning SC members should be aware of the data available for analysis. To this end, a data compilation is presented here. This data compilation is not intended as a detailed analysis of trends, but rather a compendium of the data available to inform the research planning process. In order to assess what data are available for analysis, the data held by the Pacific Community (SPC) were extracted. This included longline and purse seine logsheet and observer data. These data were collated in R (R-Core Team, 2020) and are presented for information. Note, for manta and mobulid rays, the data summaries, report cards and information sheets only include giant manta and giant devilrays, the remaining species are not included as there few data available for compilation, however please also note the work by Tremblay-Boyer and Hamer (2020) that is reviewing data available for assessment approaches for mobulids. As there has been a recent taxonomic re-definition of the species *Mobula mobular* (formally *Mobula japanica*) (White et al., 2018), all data entries as the code RMJ were changed to RMM for the analyses, and to be consistent with Park et al. (2019). In addition, while some WCPFC Key Sharks are defined as species groups, species specific data are presented here as biological information for a species group is generally of limited value. Finally, while the stock structure of most species is not well understood each species is considered as a single WCPO stock except for blue and shortfin mako sharks which are separated into stocks north and south of the equator for assessment purposes.

2.1 WCPFC data holdings

Figure 1 to Figure 18 show the WCPFC data availability for each species from 1990-2019 showing the data type, and the number of samples collected annually. These include length, biological data (including the number of samples housed in the WCPFC tissue bank (https://www.spc.int/ofp/PacificSpecimenBank); as well as observed and reported catch. Broadly speaking these data show that most of the data have been collected in the last decade. The analysis also shows large gaps in the biological data required for assessing the status of stocks. Some data, mostly liver, muscle and stomach samples were collected in the early 2000s, but the WCPFC has no ageing material for any of the Key Sharks. While some biological analyses have been conducted on some stocks outside of the SRP (Joung et al., 2018, Fujinami et al., 2019), the WCPFC has directed no sampling of its own. Longline observed catch data are frequently recorded, but logsheet data are less common. For species that are frequently recorded by observers in longline sets, such as blue shark, observed catch and the number of length samples are high (Figure 1, Figure 2, Figure 3, Figure 4).

More detail on length data are presented in Figure 19 to Figure 34 for longline and Figure 35 to Figure 50 for purse seine. These data were cleaned of errors, where any data greater than 10% higher than the globally recognised maximum size or below the length at birth were removed. On longline vessels different observer programmes use different length measurements, therefore conversion factors between these length measurements are needed, while some exist more data are required for most species. For the length plots presented here, lengths were all converted to upper jaw to caudal fork length (UF), using the data presented in Macdonald et al. (2020) and Table 4. For all length codes see Table 4. Overall the number of samples collected annually is increasing, with higher numbers of samples and better sex specific recording in the longline fishery when compared to the purse seine data. But for some species such as winghead sharks and manta rays few samples exist, making any detailed assessment of changes to the populations currently impossible. While sex specific data were not available for the purse seine catch, the longline length data show broadly similar trends for both male and female fish. In the longline fishery for blue, shortfin and longfin makos, and porbeagle sharks overall the fish size does not seem to be changing. However, silky, oceanic whitetip (possibly), and common, bigeye and pelagic thresher sharks all appear to be declining in size. In contrast, silky and oceanic whitetip sharks appear to be increasing in size in the purse seine fishery (this could be related to a switch from FAD to freeschool sets in the more recent years). Whale shark size seems to have declined after 2016 which may be as a result of prohibitions on setting on whale sharks, where in recent years, most of the whale shark catch is from a few freeschool sets that inadvertently catch juveniles which were unseen before the set commenced. Comparisons of trends in length need to be examined stock wide as spatial changes in observer coverage can influence length composition data.

Observed and reported longline catch rate data are shown in Figure 51 to Figure 64 for two periods separating the historic (1995-2004) and recent (2015-2019) periods. Commonly caught and reported species such as blue, silky and oceanic whitetip sharks have similar observed and reported distributions, and are broadly similar between time periods (Figure 51, Figure 52, Figure 53). For others, however, such as shortfin and longfin mako and common thresher sharks the observed and reported catch rates differs in space and time (Figure 54, Figure 55, Figure 56). The distribution data for porbeagle sharks is somewhat concerning (Figure 59), in both time periods the observed catch appears in New Zealand, the Tasman Sea and some catch in the Australian Exclusive Economic Zone (EEZ), but the reported catch is widespread and much of it is north of 25^{o}S. As porbeagle sharks are unlikely to occur north of 25^{o}S, this indicates that there is widespread misidentification of catch being reported as porbeagle shark in logsheets and that these data should be treated with caution. More detailed analysis of data by fleet and targeted re-training of skippers is required, as is the distribution of the newly completed *Shark and ray identification manual for observers and crew of the western and central Pacific tuna fisheries* (Park et al., 2019).

Observed catch data are presented as part of the stock specific information sheets (Figure 65 to Figure 82). For many species there is a large increase in the most recent years, which is likely a result of increased observer coverage rather than increased catch. These data also show that a large portion of the observed catch is from the longline fishery, but large observed catch is recorded in the purse seine catch for silky sharks, whale sharks and manta rays (Figure 67, Figure 80, Figure 81). The accompanying CPUE data show decreases in CPUE for a number of species. Somewhat concerning is the declining CPUE with increasing catch for blue sharks in both the north and south Pacific, silky and oceanic whitetip sharks and to a lesser extent shortfin mako sharks in the south Pacific. Both silky and oceanic whitetip sharks are experiencing overfishing, but Tremblay-Boyer and Neubauer (2019) noted a slight increase in CPUE in the most recent years for oceanic whitetip sharks. The declining trend for South Pacific blue sharks stresses the need to resolve the uncertainties in the assessment of that stock (Takeuchi et al., 2016). In addition, undertaking an assessment for shortfin mako sharks in the south Pacific should be prioritised as that stock has never been assessed. If an assessment is undertaken for shortfin mako sharks in the south Pacific, note should be taken of the misidentification of porbeagle sharks shown above as they are most likely shortfin mako sharks and catch re-classification will need to be considered for porbeagle sharks north of 25^{o}S.

2.2 Biological data

The stock specific information sheets (Figure 65 to Figure 82) contain a summary of the available life history information for each species, along with catch, CPUE, size data, stock status information, relevant International Conventions that apply and WCPFC Conservation and Management Measures (CMMs). Definitions for the metrics used in the information sheets can be found in Table 5.

The biological aspects of these sheets have been compiled from a number of sources, largely from data compilations like Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019) but also some specific species reports (Joung et al., 2018 and Fujinami et al., 2017). It is strongly recommended that analysts planning and undertaking new work check for updated investigations before relying on the parameters referenced here as work is ongoing worldwide. In addition, the parameters in this table are presented as a range, not necessarily the preferred value, which needs to be determined. Acknowledging that some geographical variability of biological parameters is likely it is recommended that the SC develop an ”agreed suite” of values (or upper and lower bounds - for application to assessment grids), as well as the agreed units (fork length or total length etc.) for these measurements to populate these sheets. Noting that using the best available estimate is preferable over a ”grid approach” for assessment inputs, but the grid could be used, where appropriate, for sensitivity analysis. The sheets should be updated by the SC as new information comes to light.

Blue sharks are widely distributed throughout the WCPO and are the most commonly caught species, while a number of biological investigations have been undertaken, there are no broad scale studies using the same methods to investigate their biology covering both the north and south Pacific. Fujinami et al. (2019) has undertaken a broad scale study of growth and maturity of blue sharks in the north Pacific and is likely the most reliable source of growth and maturity estimates for blue sharks in the north Pacific. South of the Equator, Joung et al. (2018) undertook an analysis of blue shark growth, but used different methods to that of Fujinami et al. (2019). There would be value in coordinating analyses using standard methods when undertaking these broad scale studies. These parameters, in particular the reproductive schedule, have a large impact on population modelling and therefore the WCPFC needs to be confident in their estimates. Recent work by Kai (2019) has demonstrated that evaluating the impacts of biological uncertainties using a numerical approach for estimating steepness for elasmobranchs could be a useful tool for estimating the stock recruit relationships.

Improving our understanding of stock structure for blue and shortfin mako sharks is still needed. Corrigan et al. (2018) investigated the stock structure of shortfin mako sharks using genetics and satellite tagging. However, that study had limited samples from the Pacific Ocean and is not able to conclusively resolve any stock structure within the Pacific. Despite this, the Corrigan et al. (2018) analysis suggests separation of stocks north and south of the Equator and there appears to be distinct populations in the southeastern and southwestern Pacific. Generally for the WCPFC Key Sharks, stock structures are either assumed or unknown and resolving stock structure should be a high priority for research. The expansion of satellite tagging using longer-term deployments of pop-up satellite tags would be useful for providing information on shark movement and connectivity. This work could also be linked to post-release mortality work using the same techniques. Close kin mark-recapture using genetic analysis and other genetic techniques could provide insights into stock structure. A feasibility study is currently underway and progressing this research should be considered in the light of that analysis.

The silky and oceanic whitetip shark assessments would benefit from more reliable, stock specific, information on age, growth, reproduction and maturity. Porbeagle and the thresher sharks have some information, but a single reliable set of biological information from the WCPO would be helpful as would information on the age-at-recruitment for all three species. There is a paucity of biological information on longfin mako and the hammerhead sharks, but catch of these species is less frequent, making a dedicated sampling programme challenging.

Information on whale sharks is sparse, and there are no useful growth parameters, little is known about the age-at-maturity or age-at-recruitment[1] nor the reproductive cycle. There is almost no information for manta rays, some studies have inferred data from other species, but species specific information is lacking. Any biological information from these species would be valuable. While efforts are made to release these charismatic megafauna alive, when incidental mortalities occur obtaining biological samples should be seen as a priority.

Reliable biological information along with reliable catch histories are probably the biggest data gaps for the WCPFC Key Sharks. Chin and Simpfendorfer (2019) reviewed the biological data gaps for the shark species including considering the logistics of data collection for biological work. They noted considerable challenges regarding the physical moving of samples around the Pacific, and collecting the samples when large sharks are cut free from longlines. However, these logistical issues are surmountable and should not be a deterrent to attempting to improve the biological estimates. To achieve this, additional observer training may be required, see below.

2.3 Fate and Condition data

The fate of sharks on longline vessels was assessed, as was the condition at capture and release (Figure 83 to Figure 97). These data show that for most species there is an increasing trend for sharks to be discarded, this is particularly evident for silky and oceanic whitetip sharks (Figure 85 and Figure 86), both of which have release policies in place in the Convention Area (CMM2011-04, CMM2013-08). While the condition on capture has not really changed over the analysis period, there is an increasing trend for releases to be alive and in good condition e.g. (Figure 84). These trends are probably a result of vessels taking up the release requirements of the Commission, but also national policies that apply more broadly than just silky and oceanic whitetip sharks, and also hint at improved handling of sharks in recent years.

3 Current Stock status

Four Key Sharks namely silky, oceanic whitetip, shortfin mako in the north Pacific, and blue sharks in the north Pacific have had Data Rich assessments[2] accepted by the WCPFC SC. South Pacific blue sharks have been assessed (Takeuchi et al., 2016) but the assessment had a high number of uncertainties which prohibited the SC from using it for making conclusive statements about the stock status and management recommendations. In addition, Medium Data assessments have been conducted on Pacific bigeye thresher and Southern Ocean porbeagle sharks and a Data Poor assessment has been undertaken for Pacific whale shark. All of the WCPFC Key Sharks have also been included in broad Ecological Risk Assessments (Kirby and Hobday, 2007 and Kirby, 2008).

The Data Rich assessment outcomes are presented in a Kobe plot (Figure 98). These data show that shortfin mako, and blue sharks in the north Pacific are not overfished and overfishing is not taking place. Silky sharks are overfished and oceanic whitetip sharks are overfished and overfishing is taking place. While there is considerable spread in the data for those assessments the stock status results are fairly unambiguous.

3.1 Guidelines for assessment reporting metrics

Reviewing both the Data Rich and Medium Data assessments it is apparent that there is a lack of standardised reporting making comparison between species difficult. Given that there is variability in SC participants understanding of complex stock assessments, standardised reporting would facilitate better comprehension and comparison of the outcomes. For Data Rich assessments this should be relatively

[1]Note: age-at-recruitment refers to the age-at-first capture and a better term in the context of non-target species could be age-at-first-vulnerability (AFV).

[2]**Data Rich Assessments** = full integrated stock assessment model using multiple sources of data including catch, effort and biological information in a model such as MULTIFAN-CL, Stock Syntheses or similar; **Medium Data Assessment** = Model that uses catch and effort data with/or without some biological parameters to get an estimate of fishing mortality (F) such as Surplus Production models; **Data Poor Assessments** = Analyses that estimate a level of risk but do not derive estimates of F.

straight forward and while the assessment teams are free to report any metrics they believe are informative, it is recommended that at a minimum Data Rich assessments report F/F_{MSY} and SB/SB_{MSY} or B/B_{MSY}, where possible reporting of depletion estimates ($SB/SB_{F=0}$) is also recommended. For the Medium and Data Poor assessments the results are often unclear and there are no standard method or ways to present these results. This makes it difficult for the SC to easily understand the results, and it makes it difficult to compare the results between species. Zhou et al. (2019) undertook an analysis of the reference points for elasmobranchs and recommended F_{msm}, F_{lim} and F_{crash} as reference points, however, this paper was not fully considered at SC15 it was considered that more work was required. While reference points have not been formally adopted by the WCPFC for elasmobranchs, in the interim the stock status metrics F_{msm}, F_{lim} and F_{crash} would be useful to include as standard metrics for Medium Data assessment reporting.

Using alternative metrics from Medium Data assessments, requires Members to understand their meaning and equivalents to conventional metrics. The values for these alternatives cannot be easily compared between species and little attention has been given to providing metrics such as F_{lim} and F_{crash} in a way that is easy for fishery managers to understand. One way to overcome this is to present them as ratios relative to F_{crash} (e.g. F/F_{crash}). The Zoom plot (Figure 99) has been developed as a proposal to visualise alternative reference points to facilitate consistency in their reporting to managers. In this plot the estimates are presented as ratios relative to F_{crash}; where F_{risk} is simply 10% below F_{crash}; and the remaining metrics F_{msm} and F_{lim} are ratios F_{msm}/F_{crash} and F_{lim}/F_{crash}. If F is estimated it can then be plotted as F/F_{crash}. This will allow easy comparison between species and a comparative visual for assessment outputs. It is recommended that the SC consider using these standard metrics for reporting purposes for Medium Data Assessments. While other metrics can still be reported (and should be, when exploring new assessment methods), it is recommended that some standardisation is considered for inclusion in all assessments.

Finally, Medium and Data Poor assessments, often use a number of metrics and report the results in different ways clouding ones understanding of the actual stock status. Therefore, reporting of some of these metrics alongside more familiar metrics would be a big step in increasing the SCs understanding of Medium and Data Poor metrics. Tremblay-Boyer and Neubauer (2019) noted that reporting alternative reference points such as F_{lim}, F_{crash}, F/F_{lim} and F/F_{crash} should be included in all assessments. It is therefore recommended that these be included in future Data Rich assessments alongside the conventional stock status metrics.

3.2 Report Cards

When reviewing the "*Analysis of observer and logbook data pertaining to Key Shark Species in the Western and Central Pacific Ocean*" (Rice, 2017) at SC13, the ISG requested that the author develop a series of report cards. These were initially presented in Rice (2018) and have been revised and updated here. Figure 100 presents an explanatory card, for each Key Shark the top bar of the card is colour coded for the priority given to it by the ISG at SC15, the card is then divided into three information sections for "Data Rich"; "Medium Data"; and "Data Poor" assessment types (see footnote 1 above for definitions). Within each of these groups there is a general list of data types, data required, comments as to weather or not the data are available within the WCPO and a ranking of the data certainty with an associated explanatory table (Table 6). There is a comment about the recommended assessment that could be attempted, and finally a list of the research needs for each species. Note that some fields such as stock structure and natural mortality, may have a "No" for the "Do we have it" column, but in the Degree of certainty field there may be a certainty rating. In these cases, there may be data available to estimate the parameter but the analysis has not been undertaken or accepted by the SC (e.g. Figure 101).

Figure 101 to Figure 118 present the species specific report cards. At SC15 the ISG ranked six species as having a high priority for research (South Pacific blue shark; blue sharks in the north Pacific; silky; oceanic whitetip; and shortfin mako in the north and south Pacific), three as medium priority (bigeye thresher; whale sharks; and giant manta rays), and the remaining nine species were assigned a low priority. SC16 should review these priorities. Of the high priority species all but two (South Pacific blue sharks and mako in the south Pacific) have had successful Data Rich assessments undertaken. This highlights the challenges of undertaking Data Rich assessments for sharks in the WCPO and possibly emphasises the importance of developing reliable Medium Data assessment methods.

Medium Data assessment methods such as those presented in Zhou et al. (2019) are possibly achievable for most Key Sharks at this stage, but many of these methods are new and in need of testing before they can he relied on for making management decisions. As noted above presenting their outputs as part of Data Rich assessments would be helpful.

Data Poor methods such as Ecological Risk Assessments have largely been done in the WCPO (Kirby and Hobday, 2007 and Kirby, 2008). As these methods provide little leverage or guidance for management action they are of limited value. Risk analyses that are more quantitative such as Zhou and Griffiths (2008) and ABNJ (2018c) are probably slightly more informative provided that data exist to undertake the analysis. Generally speaking Data Poor assessments should be seen as a last resort and only considered if a Medium Data assessment in not possible.

Overall the report cards along with the information sheets highlight the data gaps for the WCPFC Key Sharks and should be used to guide the 2021-2025 SRP. The SC should comment on the preferred assessment type for each species which would allow the ISG to decide on a path to assessment and also where to stop. For example for South Pacific blue sharks a Data Rich assessment should be technically possible, the aim here should therefore be to resolve the uncertainties highlighted by Takeuchi et al. (2016) and move toward a Data Rich assessment. However, for bigeye thresher sharks, where there are a number of life history uncertainties and catch data are relatively sparse resolving the data uncertainties to a level where a Medium Data Assessment is achievable should be the target in the short- to medium-term. The SC (through the ISG) should review the report cards; the data certainty criteria; and agree on the final assessment type (report card "Can we do it?" column) within the scope of this SRP as this would provide the direction for the underlying data collection priorities.

4 2021-2025 SRP Direction

4.1 Proposed objectives for the SRP

The previous SRP did not have any objectives but rather a number of broad themes under which projects fell, namely: Stock Assessment; Stock Structure; Biology; Mitigation; Data Improvements; and Review. While these themes were largely sensible, in order to respond directly to the management needs we feel that developing a set of objectives would be a more constructive approach under which to plan and direct the Commissions work. Noting the needs of the Commission will change, and that the development of Harvest Strategies will include an objective setting process that may include objectives for bycatch species, it is recommended that these objectives be considered draft at this stage.

To this end the following interim objectives are proposed under four broad areas of work for the 2021-2025 SRP:

1. Stock Assessment
   (a) Determine the stock status for WCPFC Key Sharks.
   (b) Develop reliable catch histories for WCPFC Key Sharks as far back in time as feasible.
   (c) Test and improve Medium and Data Poor assessment methods so that the results can inform management decisions.
2. Mitigation
   (a) Provide advice on mitigation for WCPFC Key Sharks with non-retention policies and unwanted elasmobranchs.
   (b) Provide advice on safe release methods, their application rates, and post-release survival of WCPFC Key Sharks.
3. Biological data improvements
   (a) Increase the understanding of important biological parameters of WCPFC Key Sharks such as growth, reproduction, stock structure and natural mortality rates.
4. Observer data collection
   (a) Improve spatio-temporal observer data for informing scientific needs.

The stock assessment objectives are intended to directly inform the WCPFC of the stock status of the relevant species, as well as include opportunities to refine the assessment methods and develop catch histories that will feed into the assessments, making them more reliable. The mitigation objectives should facilitate the development of effective mitigation of elasmobranch catch in both purse seine and longline fisheries, as well as ensure high survival of released individuals. Biological objectives are included to enhance our understanding of the biology and provide reliable biological parameters for stock assessments. The objective aimed at observers is specifically intended to improve biological data collection and ensure that the data collected are representative of the stock.

We believe that projects that are developed under this plan should attempt to address the objectives above and the new project list is therefore presented by objective in Table 7.

4.2 2021-2025 Direction

To address the proposed objectives the SRP will aim to undertake a number of stock assessments; and test and develop Medium Data assessment methods. The stock specific information sheets (Figure 65 to Figure 82) indicate that there is a paucity of information on release survival rates from fishing vessels and that stock specific life history information is deficient for most species. Finally, the fishery observers, who have a heavy workload that needs to be prioritised, play a vital role in data collection and the SRP needs to indicate where additional training is required and what data should be prioritised for collection.

4.3 2021-2025 Schedule of work

The 2021-2025 SRP schedule of work is outlined in Table 7 and in order to avoid duplication, work that is being undertaken outside of the SRP is listed in Table 8. This schedule needs to be considered along with the other work being undertaken within the WCPFC and the stock assessments in particular (Table 9) should be coordinated with the tuna assessments to ensure there are personnel and the budget available to undertake the work. **The SC is invited to review the project list, and schedule for the 2021-2025 period**. Once a final list of projects is agreed for 2021 the project specifications and budget will be developed. A draft list of projects for 2021 can be agreed intersessionally prior to SC and specifications for those can be drafted ahead of the SC if the IWG agrees on a 2021 project list.

The work programme within this SRP should be achievable, as a result some aspects of work that have been recommended by the stock assessments (e.g. Tremblay-Boyer and Neubauer, 2019) are included in that list while others, such as assessing the spatial trends in shark length for the longline dataset, have not been included as these could be taken up in the next assessment. If the work is required prior to, and in addition to, the assessment, that may need to be scheduled separately.

4.4 Observer data collection

Observers, when free to do so, are encouraged to collect biological material from dead Key Sharks. This data collection should include the collection of length, weight (when possible), ageing material (vertebrate samples), clasper length, uterine condition, number of embryos, embryo lengths. These data are important for assessing growth rates, maturity, fecundity and pupping areas. All these metrics are important when undertaking stock assessments and have been successfully collected by some observer programmes (e.g. Joung et al., 2018). CCMs observer programmes should train observers and encourage the collection of these data. These samples should be submitted to the WCPFC tissue bank and made available for analysis through the WCPFC. Developing and effective method of sample transfer to SPC will also need to be considered. When there are enough samples this will also provide an opportunity for staff of Pacific Island State members to access the material for post graduate studies and should be viewed as a beneficial capacity building opportunity.

Observer sampling, while essential, can be biased as observer coverage is not always spatially and temporally representative of fishing effort or the population distributions of non-target species. This bias in sample collection may vary by species, area, time and observer programme undertaking the collection. For example, the sampling coverage may be unbalanced between the North and South Pacific. So, priority should also be given to improving the spatial representation of observer programmes. It is important to note here that many WCPFC CCMs are meeting or exceeding their required observer coverage, but this requirement is for a percentage cover by year and there is no requirement to ensure that that is evenly spread over the fleet in time and space. Biological data such as growth and maturity information, do not need to be collected continuously, rather getting a large sample from a single species periodically is valuable. For the commonly caught species, consideration should therefore be given to focusing these collections targeting one or two species per year to maximise the data collection across the WCPO. This programme can then be rotated in a similar way to the stock assessments. However, for species caught infrequently, opportunistic (continuous) sampling may still need to be relied on. This may also be complicated for those species listed in the Appendix II of CITES and species with WCPFC non-retention policies, while allowances for sampling of dead fish have been included in CMMs non-detriment findings may be required to transport samples across international boundaries for some species.

It has been suggested that the length of any trailing branchlines when released, is one of the factors which affect post-release survival. Additionally, the branchline material may be influential. Estimates of the range and frequency of trailing line length and branchline type would be useful information. An ABNJ study in four countries is currently underway assessing the impact of trailing branchlines on release survival. Trailing branchlines are one influential factor, therefore considering the variety of variable operational patterns by fleet, size of shark, and the prevailing environment surrounding the release, it is necessary to identify the influential factors influencing post-release survival and then to develop best handling practice.

Depredation rates and general interactions between sharks and gear is not well studied. A part of mitigation is to asses whether it is feasible to reduce the interactions by changes to fishing methods etc. Depredation is currently not included as a source of mortality in stock assessment. Observers currently collect information on depredation by sharks, cetaceans and squid. An assessment of the unaccounted mortality would be valuable as would investigations into the rates of and ways to reduce depredation on longline sets.

In addition, the collection of electronic monitoring programmes is expanding and becoming more effective around the Pacific. Therefore in addition to physical the collection of information by observers. programmes should be developed to effectively collect relevant information on shark biology such as length, as well as capture and release fate and condition to the extent possible.

Four considerations for observers are listed in Table 7 all are a high priority, two are currently ongoing and the others should begin in 2021. However, consideration will need to be made of the CCMs other sampling needs and the observers work load when considering this additional training and sampling work.

4.5 Recommendations

1. SC adopt objectives to direct the 2021-2025 SRP.
2. SC adopt standardises assessment reporting metrics for Data Rich Assessments, and as a minimum report F/F_{MSY} and SB/SB_{MSY} or B/B_{MSY}, or SB/SB_0 or B/B_0.
3. Where possible Data Rich Assessments should report depletion estimates ($SB/SB_{F=0}$).
4. To improve our understanding of Medium Data Assessment metrics, Data Rich Assessments are encouraged to, in addition to the above metrics, report F_{msm}, F_{lim} and F_{crash}, and present the ratios of F_{msm}/F_{crash} and F_{lim}/F_{crash} and F/F_{crash} for comparison with conventional metrics.
5. Medium Data Assessments that are unable to estimate the F/F_{MSY} due to a lack of fishery and/or biological data, are encouraged to report F_{msm}, F_{lim} and F_{crash}, and present the ratios of F_{msm}/F_{crash} and F_{lim}/F_{crash} and F/F_{crash}.
6. To facilitate future reporting, when undertaking the annual review of progress at the SC, the ISG should rate projects as complete, partial, ongoing and not done and provide a score to measure performance.
7. The SC develop an “agreed suite” of biological parameters (or upper and lower bounds) and units of measurement (e.g. total length) for use in WCPFC assessments and update the information sheets accordingly.
8. The SC review and agree on the data certainty criteria (Table 6) for the report cards and confirm a certainty rating for each species, when reviewing the report cards.
9. The SC review, and update annually if needed, the ”agreed suite” of biological parameters; the report cards; and information sheets.
10. The SC is invited to consider the schedule of work outlined in Table 7 and Table 9 for 2021-2025.

11. The SC is invited to review the specific projects proposed in Table 7 and Table 9 for 2021 for finalisation prior to developing the SC budget.

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Tables

Table 2: Participants in the Shark Research Plan Informal Working Group.

Name	Affiliation
Francisco Abascal	EU
Orlando Fachada	EU
Stamatios Varsamos	EU
Julie Lloyd	FFA
Mikihiko kai	JP
Francois Prioul	NC
John Annala	NZ
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Paul Hamer	SPC
Joy Hsiangyi Yu	TW
Keith Bigelow	US
Felipe Carvalho	US
Melanie Hutchinson	US
Michael Kinney	US
Yonat Swimmer	US
Vu Duyen Hai	VN
Elaine Garvilles	WCPFC
SungKwon Soh	WCPFC
Bubba Cook	WWF

Table 3: Species names and codes used in this document. SP = South Pacific, NP = North Pacific.

English name	Scientific name	Code
Pelagic thresher	*Alopias pelagicus*	PTH
Bigeye thresher	*Alopias superciliosus*	BTH
Common thresher	*Alopias vulpinus*	ALV
Silky shark	*Carcharhinus falciformis*	FAL
Oceanic whitetip shark	*Carcharhinus longimanus*	OCS
Winghead shark	*Eusphyra blochii*	EUB
Shortfin mako - NP	*Isurus oxyrinchus*	SMA_NP
Shortfin mako - SP	*Isurus oxyrinchus*	SMA_SP
Longfin mako	*Isurus paucus*	LMA
Porbeagle shark	*Lamna nasus*	POR
Blue shark - SP	*Prionace glauca*	BSH_NP
Blue shark - NP	*Prionace glauca*	BSH_SP
Whale shark	*Rhincodon typus*	RHN
Scalloped hammerhead	*Sphyrna lewini*	SPL
Great hammerhead	*Sphyrna mokarran*	SPK
Smooth hammerhead	*Sphyrna zygaena*	SPZ
Giant manta	*Mobula birostris*	RMB
Giant devilray	*Mobula mobular*	RMM
Chilean devilray	*Mobula tarapacana*	RMT
Reef manta	*Mobula alfredi*	RMA
Manta and mobulid rays	Mobulidae	RMV
Generic shark code		SHK
Mako sharks		MAK
Thresher sharks		THR
Generic manta code		MAN

Table 4: Conversion factors used to convert lengths from Macdonald et al. (2020). LF = Lower jaw to fork in tail; PC = Nose to caudal peduncle; PF = Anterior base of pectoral fin to fork in tail; TL = Tip of snout to posterior end of dorsal caudal lobe; UF= tip of snout to caudal fork.

Species code	a	b	Conversion	Formula
ALV	0.53300	1.2007	TL to UF	a*TL-b
BSH	0.83130	1.3900	TL to UF	a*TL+b
BTH	0.55980	17.6660	TL to UF	a*TL+b
EUB				All UF
FAL				No TL or LF to UF (used only UF)
LMA				None (used only UF)
OCS	1.13477	12.5374	TL to UF	(TL-b)/a
POR	0.88960	0.3369	TL to UF	a*TL+b
PTH	1.85000	123.1200	TL to UF	(TL-b)/a
RHN				No LF to UF (used only UF)
SMA	0.89000	0.9520	TL to UF	a*TL+b
SPK	1.25330	3.4720	TL to UF	(TL-b)/a
SPL	1.30000	1.2800	TL to UF	(TL-b)/a
SPZ	0.84000	12.7200	TL to UF	a*TL+b

Table 5: Definitions of parameters in the species information sheets e.g. Figure 65.

Parameter	Definition
Assessment Type	Assessment type as per the report cards e.g. Figure 101
Stock Status	Stock status as agreed to the Scientific Committee in the assessment year
L max	L infinity as defined by a growth equation or if not available the maximum observed length
k	Growth coefficient (the rate at which length approached L infinity)
Len birth	Birth length
L0	The age at which the organisms would have had zero size
Max age	Maximum age
Age recruit	Age at recruitment to the fishery
Age mat	Age at maturity
Len mat	Length at maturity
Repro cycle	Number of months between births
Gestation	Length of the gestation period (months)
Litter size	Number of pups in a single letter
Pupping	Pupping season
Spawning	Mating season
M	Natural mortality estimate
r	Intrinsic rate of population increase
Conv factors	Do any conversion factors exist for length to weight and between different length measurements
Sex specific parameters	Are the biological parameters above defined by sex
Stock delineation	Stock management unit
Steepness	Measure od the stock recruit relationship
Release mortality	Percentage of observed releases that died
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	The Convention on the Conservation of Migratory Species of Wild Animals
IUCN red list	The International Union for Conservation of Nature Red List of Threatened Species

Table 6: SRP report card (e.g. Figure 101) data certainty criteria.

Data	High Certainty	Medium Certainty	Low Certainty
Data Rich			
Age	Stock specific, direct validation	Validated, estimates from neighbouring stock	Not validated or from outside Pacific
Maturity	Stock specific	Neighbouring stock	Outside Pacific
Stock structure	Definitive work based on a dedicated study	Estimated from observed catch	Estimated from catch
M	Age specific model estimates	Estimated from reliable biological parameters	Estimated from catch curve with unreliable estimate of F, or similar
Catch	$\geq$ 20 years accurate reported or observed catch	Reconstructed catch $\geq$20 years	<20 years observed or reported catch
Effort	$\geq$ 20 years accurate reported or observed effort in primary fisheries	$\geq$ 20 years accurate reported effort	<20 years observed or reported effort
Length	>20 years of length measurements, >100 samples per year	>20 years of length measurements, <100 samples per year	Some length measurements
Weight	High numbers of stock specific individual weights or length/weight regression	Length/weight regression and high numbers of length measurements	Some measured individual weights
Medium data			
Age	Stock specific	Estimates from neighbouring stock	Estimates from outside Pacific
Maturity	Stock specific	Neighbouring stock	Outside Pacific
Stock structure	Observed from tagging or genetics	Estimated from observed catch	Estimated from catch
Catch and Effort	$\geq$ 10 years accurate reported or observed catch and effort	Reconstructed catch $\geq$10 years with reported effort	<10 years observed or reported catch and effort data
Length	>10 years of length measurements, >100 samples per year	>10 years of length measurements, <100 samples per year	Some length measurements
Weight	High numbers of stock specific individual weights or length/weight regression	Length/weight regression	Some measured individual weights
Data Poor			
Catch observations	Observed catch high spatial coverage in relevant fisheries	Observed catch reasonable coverage in relevant fisheries	Some observed catch
Expert advice	Productivity and susceptibility estimates developed by a group of experts or not		

Table 7: SRP 2021-2025 project list. * indicates projects on the "long list" from Chin and Simpfendorfer (2019)

Title	Priority	Start year	End year
1. Stock assessment			
(a) Determine the stock status for WCPFC Key Sharks			
i) Southwest Pacific blue shark assessment	High	2020	2021
ii) Northwest Pacific blue shark assessment	High	2021	2022
iii) Northwest Pacific shortfin mako shark assessment	High	2023	2024
iv) WCPO silky shark assessment	High	2022	2023
v) Pacific silky shark assessment	Medium	2022	2023
vi) Pacific bigeye thresher shark assessment	Medium	2021	2022
vii) Pacific whale shark assessment	Medium	2022	2023
(b) Develop reliable catch histories for WCPFC Key Sharks as far back in time as feasible			
i) Redefining the fleets currently assumed in the BSH NP stock assessment	Medium	2021	2022
ii) The development of alternative approaches to catch reconstructions based on estimates of the global fin trade	Medium	2024	2025
(c) Test and improve Medium and Data Poor assessment methods to inform management decisions			
i) Test and improve data poor assessment methods	Medium	2024	2025
ii) Include data poor assessment metrics as standard out-outs for data rich assessments	High	Ongoing	Ongoing
2. Mitigation			
(a) Provide advice on mitigation Sharks with non-retention policies and unwanted elasmobranchs			
i) Investigate effective mitigation for WCPFC Key Sharks	Medium	2023	2025
ii) Investigate mitigation method trade-offs between mitigation methods for sharks, seabirds and sea turtles	Medium	2023	2025
(b) Provide advice on safe release methods and assess release survival of WCPFC Key Sharks			
i) Estimate silky and oceanic whitetip shark post release survival from WCPO longline fisheries*	High	2021	2023
ii) Estimate whale shark post release survival from WCPO purse seine fisheries*	High	2021	2023
3. Biological data improvements			
(a) Increase the understanding of important biological parameters of WCPFC Key Sharks			
i) Silky shark and oceanic whitetip shark reproductive biology and longevity*	High	2023	2025
ii) Biology and life history of hammerhead sharks*	High	2023	2025
iii) Resolving blue shark reproductive biology and reproductive schedule*	Medium	2023	2025
iv) Biology of the longfin mako shark*	Medium	2023	2025
v) Life history of thresher sharks*	Medium	2023	2025

vi) Validated life history, biology, and stock structure of the shortfin mako in the south Pacific *	Medium	2023	2025
vii) Age validation and stock structure of the silky shark and oceanic whitetip shark*	Low	2023	2025
viii) Stock structure and life history of southern hemisphere porbeagle shark*	Low	2023	2025
4. Observer data collection			
(a) Improve spatio-temporal observer data for informing scientific needs			
i) Training observers in the WCPO to be proficient in species identification	High	Ongoing	Ongoing
ii) Training observers for extraction and storage of vertebrae and shark reproductive material	High	2021	Ongoing
iii) Training observers for on-deck reproductive staging of elasmobranchs	High	2021	Ongoing
iv) Measuring elasmobranchs on purse seine and longline vessels for length-length and length-weight conversion factor dvelopement	High	Ongoing	Ongoing

Table 8: Ongoing elasmobranch research in the WCPO outside of the SRP.

CCM	Institute	Contact	e-mail	Species	Research topic	Start year	End year
Australia	CSIRO	Toby Patterson, Mark Bravington	Toby.Patterson@csiro.au; Mark.Bravington@csiro.au	Pelagic sharks of interest	Future project of interest: CKMR design and scoping of pelagic sharks in WCPFC	TBC	TBC
JP	National Research Institute of Far Seas Fisheries	Yasuko Semba	senbamak@affrc.go.jp	Pelagic shark species (incl. Mobula spp.)	Improvement of species identification using partial external characteristics and genetic information	2018	2025 (tentative)
JP	National Research Institute of Far Seas Fisheries	Yasuko Semba	senbamak@affrc.go.jp	Blue shark, Shortfin mako	Stock structure using genome data?(overlapped in other RFMO&ISC's Shark Research Plan)	2016	2025 (tentative)
JP	National Research Institute of Far Seas Fisheries	Yasuko Semba	senbamak@affrc.go.jp	Shortfin mako	Trophic status of adult SMA	2019	2025 (tentative)
JP	National Research Institute of Far Seas Fisheries	Mikihiko Kai	kaim@affrc.go.jp	Blue shark	Spatio-temporal patterns in sex-and-age-specific natural mortality rate	2019	2025 (tentative)
JP, MX, TW, US	ISC	Mikihiko Kai	kaim@affrc.go.jp	Blue sharks Shortfin- mako	Spatial distribution by sex and growth stages using Isotope analysis	2020	2024
JP, TW, US	ISC	Mikihiko Kai	kaim@affrc.go.jp	Blue sharks Shortfin- mako	Spatial distribution by sex and growth stages and stock boundary using tagging study	2020	2024
JP, US	ISC	Mikihiko Kai	kaim@affrc.go.jp	Shortfin mako	Age-and-growth study using cross-reading of vertebrae	2020	2024
JP, MX, TW, US	ISC	Mikihiko Kai	kaim@affrc.go.jp	Blue sharks Shortfin- mako	Redefinition of fleets with spatiotemporal consideration using cluster analysis with size data of each fleets	2019	2024
JP, MX, TW, US	ISC	Mikihiko Kai	kaim@affrc.go.jp	Blue sharks Shortfin- mako	CPUE prediction in the entire north Pacific using the R-Package of spatiotemporal model (VAST)	2021	2025
JP, TW, US	ISC	Mikihiko Kai	kaim@affrc.go.jp	Blue sharks Shortfin- mako	Spatial distribution by sex and growth stage using parasite	2021	2025
NC	FIU	Jmy J. Kiszka		All species	FinPrint	2015	
NC	IRD	Laurent Vignola		All species	APEX	2015	
NZ	TBC	John Annala	John.Annala@mpi.govt.nz	All	Determination of mitigation options for shark species taken as bycatch in NZ surface longline fisheries	TBC	TBC

Table 8: *(continued)*

CCM	Institute	Contact	e-mail	Species	Research topic	Start year	End year
USA	NOAA	Felipe Carvalho	felipe.carvalho@noaa.gov	All	Project 101 - Updated Monte Carlo simulations of the potential of longline shark mitigation approaches with improved data on gear configurations, catch rates, and post-release mortality levels.	TBC	TBC
USA	NOAA	Felipe Carvalho	felipe.carvalho@noaa.gov	All	Review available data regarding safe handling and release guidelines for sharks with the goal to identify best handling practices that can be recommended for adoption and implementation by the WCPFC.	TBC	TBC
USA	Hawaii Institute of Marine Biology (HIMB)	Melanie Hutchinson	melanier@hawaii.edu	Scalloped hammerhead	Habitat use and movement behaviour around Hawaii	2009	2020
USA	Joint Institute for Marine & Atmospheric Research (JIMAR)	Melanie Hutchinson	melanier@hawaii.edu	OCS, FAL	Habitat use and movement behaviour around Hawaii	2016	2024
USA	HIMB/ Hawaii Uncharted Research Collective	Melanie Hutchinson	Pacificsharktagger@gmail.com	OCS	Photo identification for demography	2005	No end
USA	JIMAR/HIMB	Melanie Hutchinson	melanier@hawaii.edu	OCS, FAL, SMA, BTH, BSH	Post release survival rates of sharks captured in tuna longline fisheries and identifying best handling practictes	2014	2021
USA	JIMAR/HIMB	Melanie Hutchinson	melanier@hawaii.edu	OCS, FAL, SMA, BTH, BSH	Habitat use and movement behaviour identifying environmental drivers and preferred habitat using archival tags and fishery data	2017	2022
USA	JIMAR/HIMB	Melanie Hutchinson	melanier@hawaii.edu	OCS, FAL, SMA, BTH, BSH	Winners and losers in a changing climate - habitat availability and how that may effect vulnerability	2019	2020

Table 8: ***(continued)***

CCM	Institute	Contact	e-mail	Species	Research topic	Start year	End year
USA	International Seafood Sustainability Foundation (ISSF)/ JIMAR	Melanie Hutchinson	melanier@hawaii.edu	RMT	Post release survival rates of Mobula tarapacana captured in a purse seine	2018	2020
USA	HIMB	Derek Kraft	kraftd@hawaii.edu	FAL	Global population structure of FAL	2012	2020
USA	ISSF/JIMAR	Melanie Hutchinson	melanier@hawaii.edu	FAL	Global analysis of FAL movements in IO, WCPO, ETP, ATL with an emphasis on vulnerability to drifting FAD entanglements.	2012	2021
USA	PIFSC	Michael Kinney	Michael.kinney@noaa.gov	Blue Shark	Redefining fleet definitions of north Pacific fisheries with spatiotemporal consideration of blue shark size data.	2019	2021
TW	National Taiwan Ocean University	K. M. Liu.	kmliu@mail.ntou.edu.tw	All	Studies of shark bycatch, abundance index and non-detriment findings in the three Oceans	TBC	TBC

Table 9: WCPFC SC shark stock assessment schedule 2021-2025. X = scheduled.

Species	Stock	Last assessment	2021	2022	2023	2024	2025
Blue shark	Southwest Pacific	2016	X				
	Northwest Pacific	2017		X			
Mako shark	Southwest Pacific	-					
	Northwest Pacific	2018				X	
Porbeagle	Southwest Pacific	-					
	Southern Ocean	2017		?			
Silky shark	WCPO	2018			X		
	Pacific	2018			X		
Oceanic whitetip shark	WCPO	2019				X	
Pelagic thresher	WCPO	-					
Bigeye thresher	Pacific	2017		X			
Common thresher	WCPO	-					
Greater hammerhead	WCPO	-					
Smooth hammerhead	WCPO	-					
Scalloped hammerhead	WCPO	-					
Winghead shark	WCPO	-					
Whale shark	WCPO	-					
	Pacific	2018			X		
Giant manta	WCPO	-					
Reef manta	WCPO	-					
Spinetail mobula	WCPO	-					
General shark work	WCPO	-					

Figures

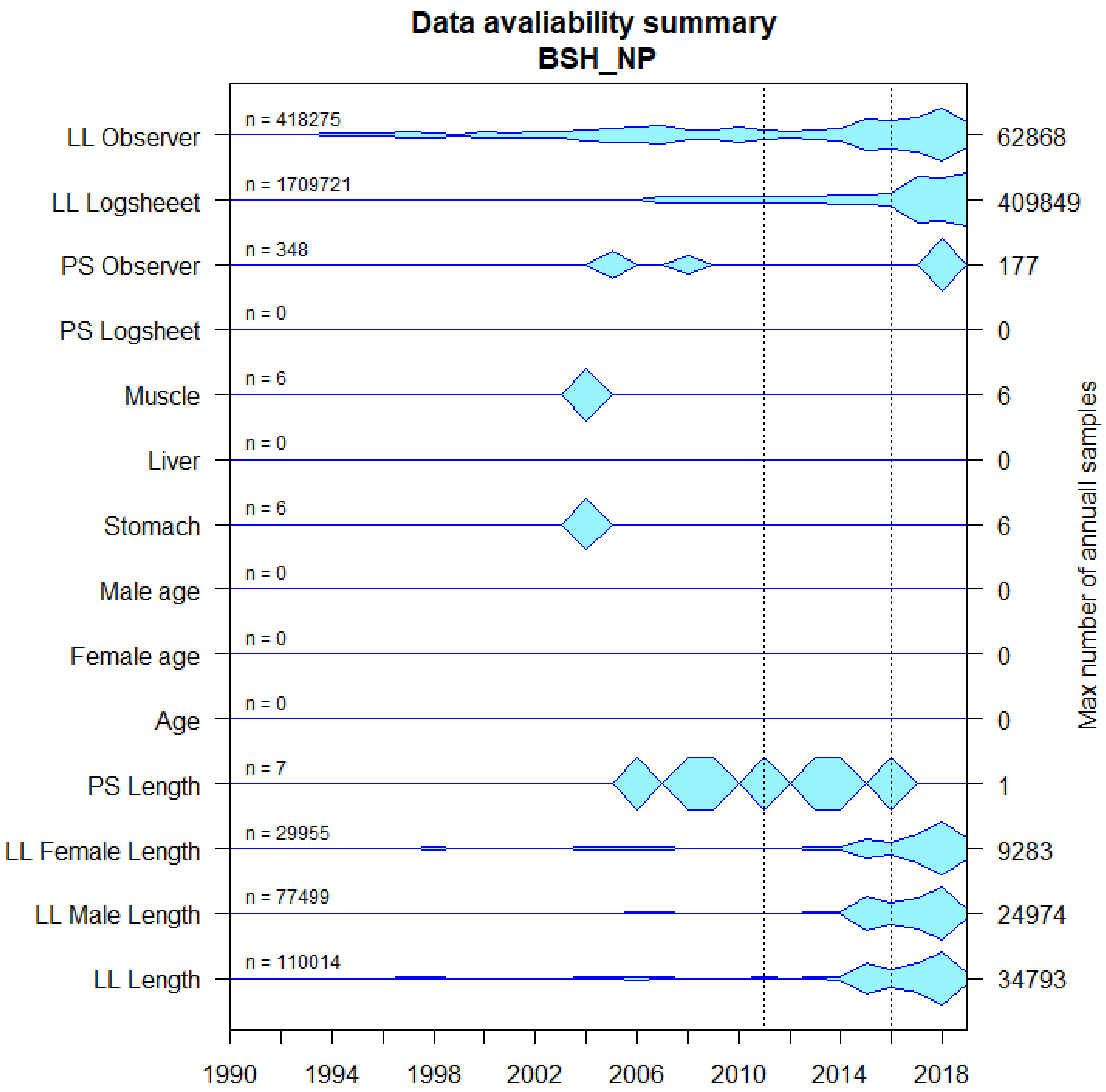


Figure 1: WCPFC data availability for blue sharks in the north Pacific from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (`https://www.spc.int/ofp/PacificSpecimenBank`).

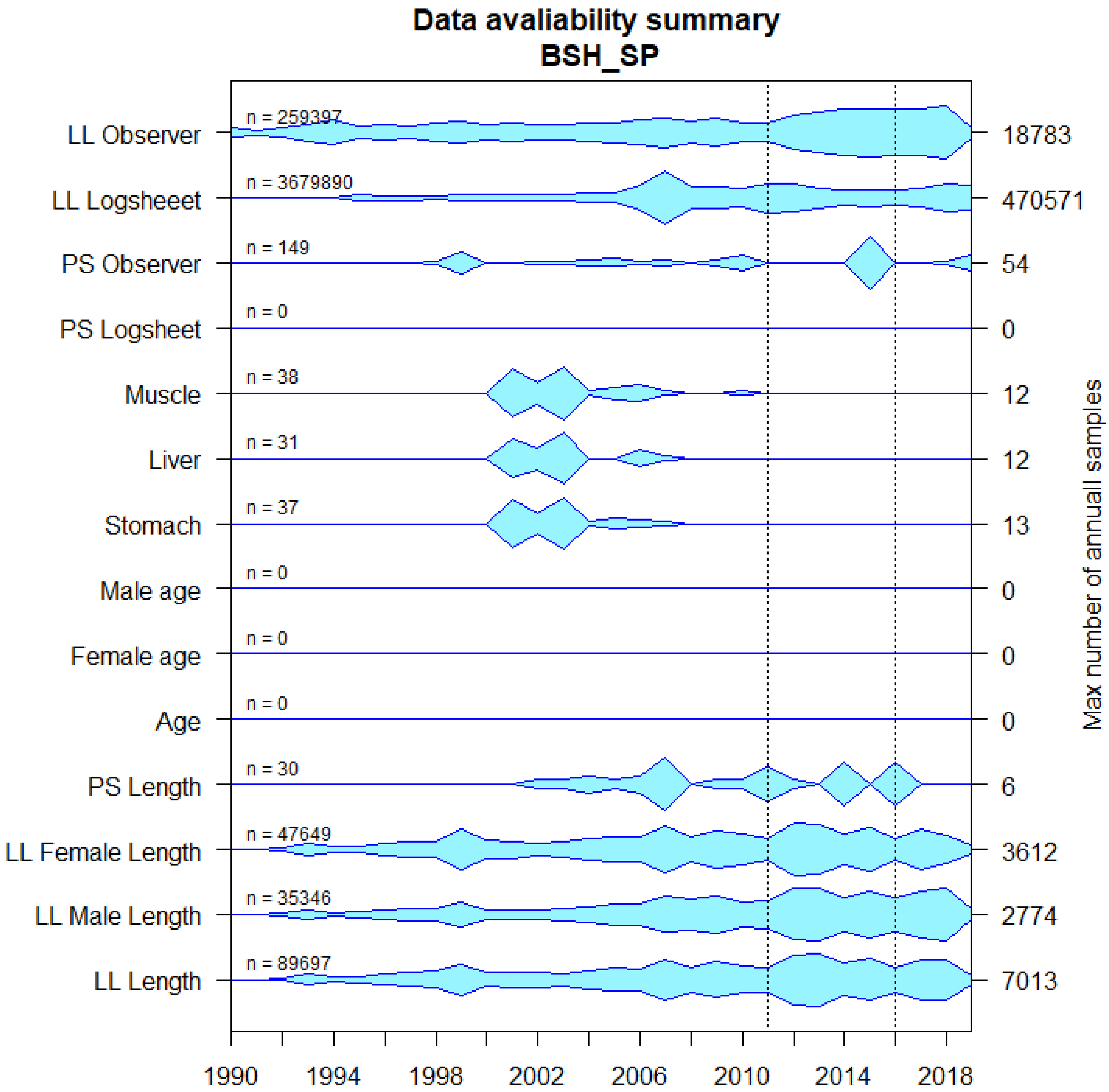


Figure 2: WCPFC data availability for South Pacific blue sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (`https://www.spc.int/ofp/PacificSpecimenBank`).

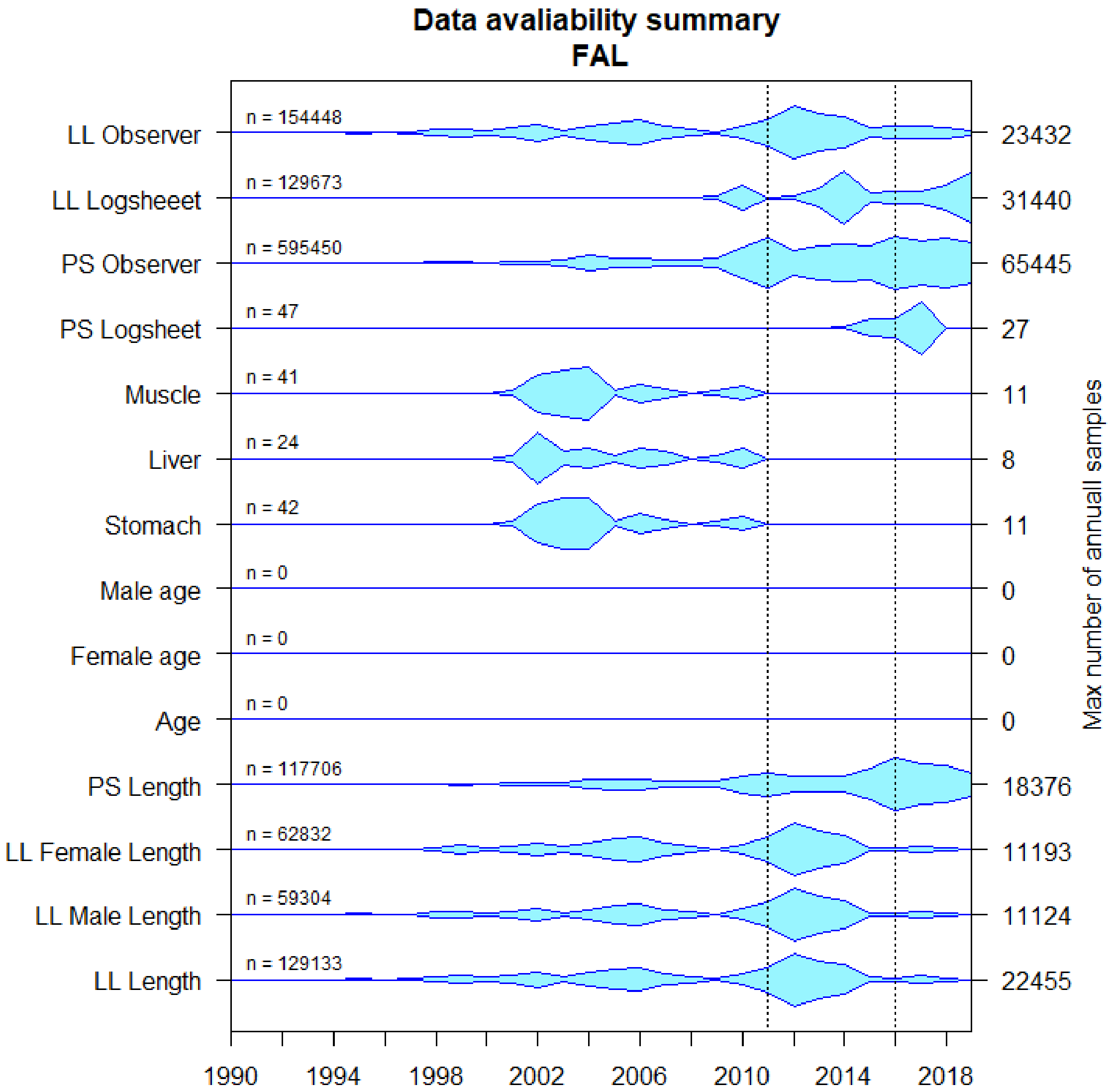


Figure 3: WCPFC data availability for silky sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (https://www.spc.int/ofp/PacificSpecimenBank).

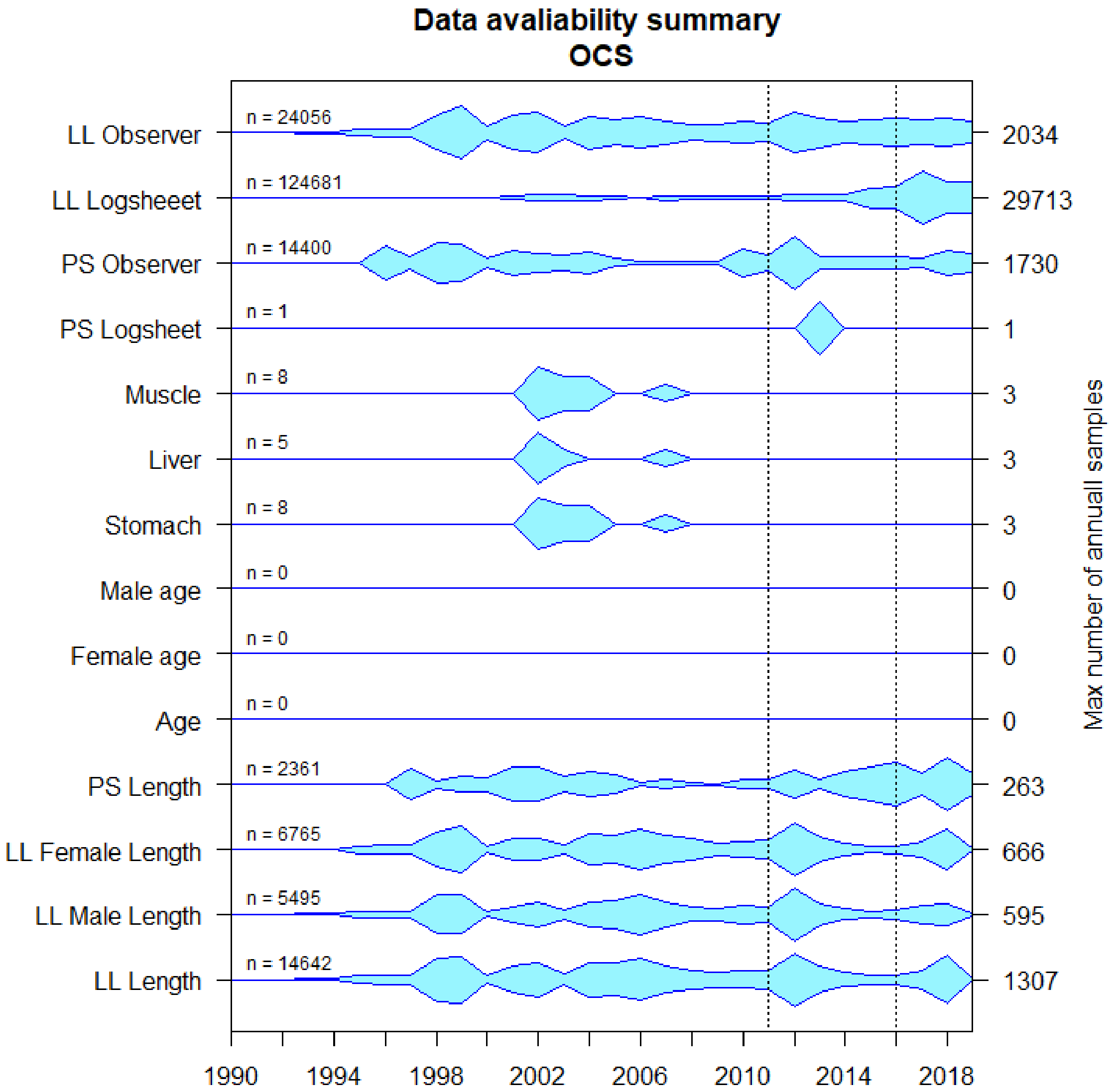


Figure 4: WCPFC data availability for oceanic whitetip sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (`https://www.spc.int/ofp/PacificSpecimenBank`).

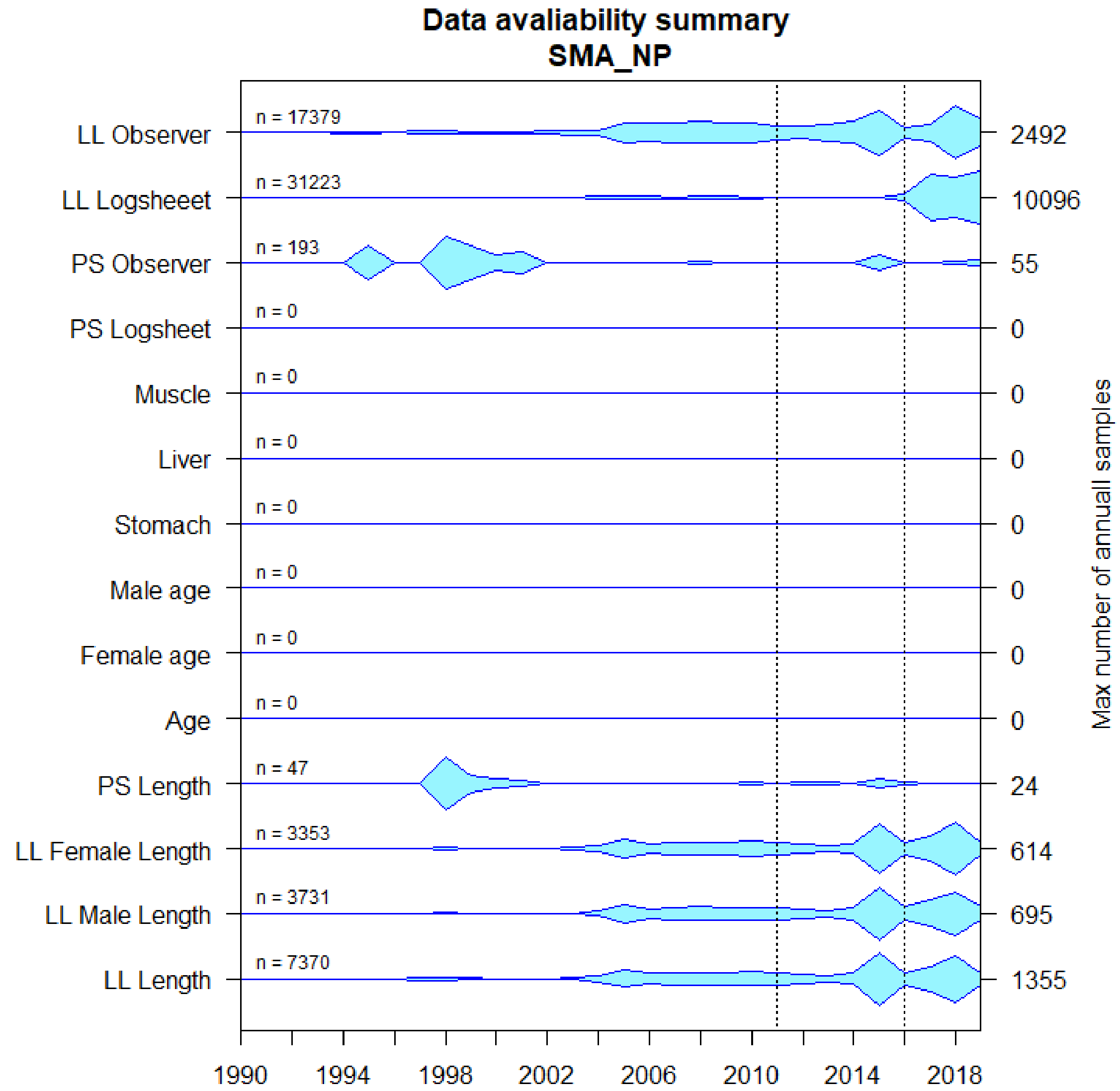


Figure 5: WCPFC data availability for shortfin mako sharks in the south Pacific from 1990-2019 showing the data type, and the maximum number of annual samples collected , the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (https://www.spc.int/ofp/PacificSpecimenBank).

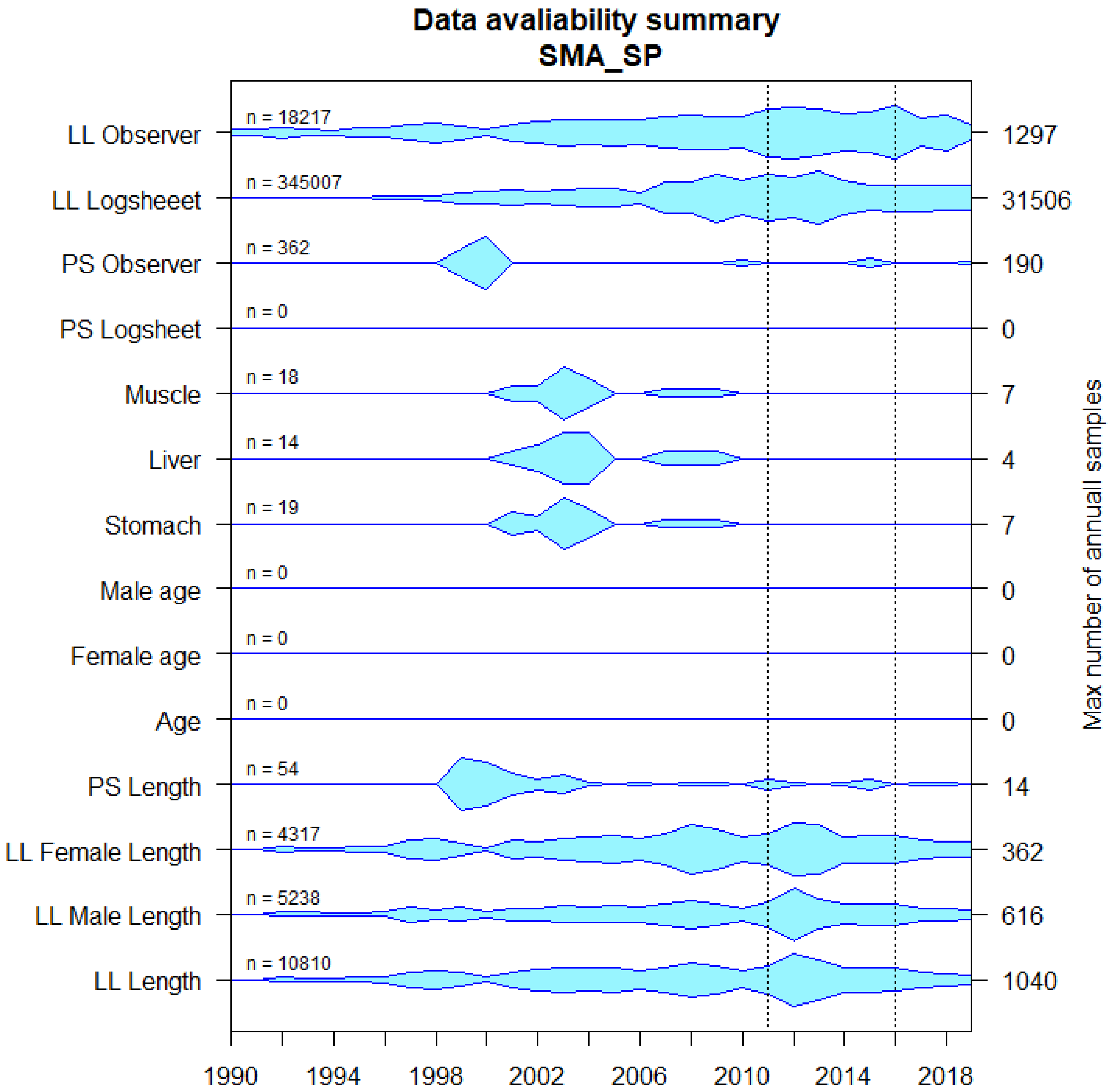


Figure 6: WCPFC data availability for shortfin mako sharks in the south Pacific from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (https://www.spc.int/ofp/PacificSpecimenBank).

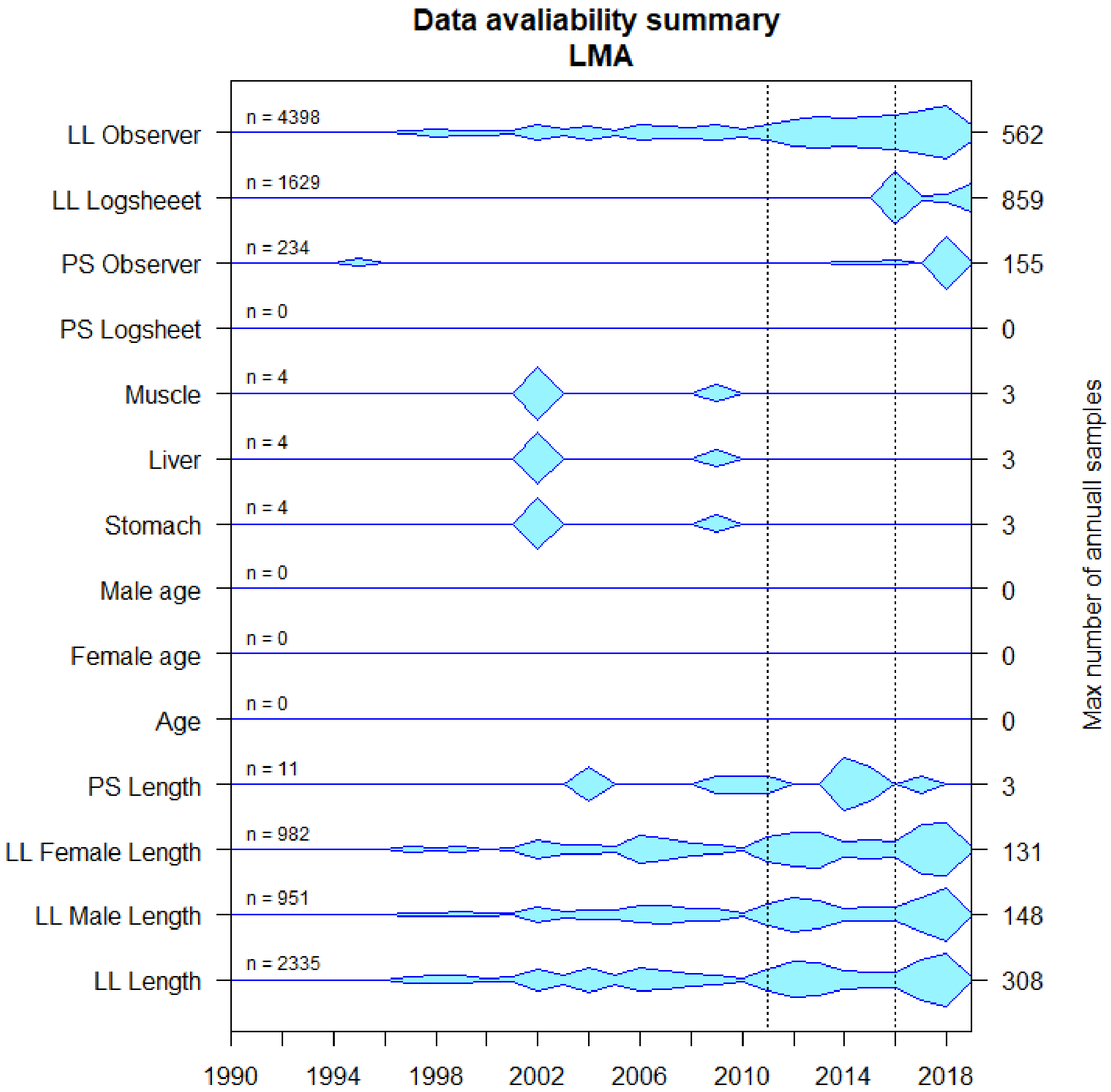


Figure 7: WCPFC data availability for longfin mako sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (`https://www.spc.int/ofp/PacificSpecimenBank`).

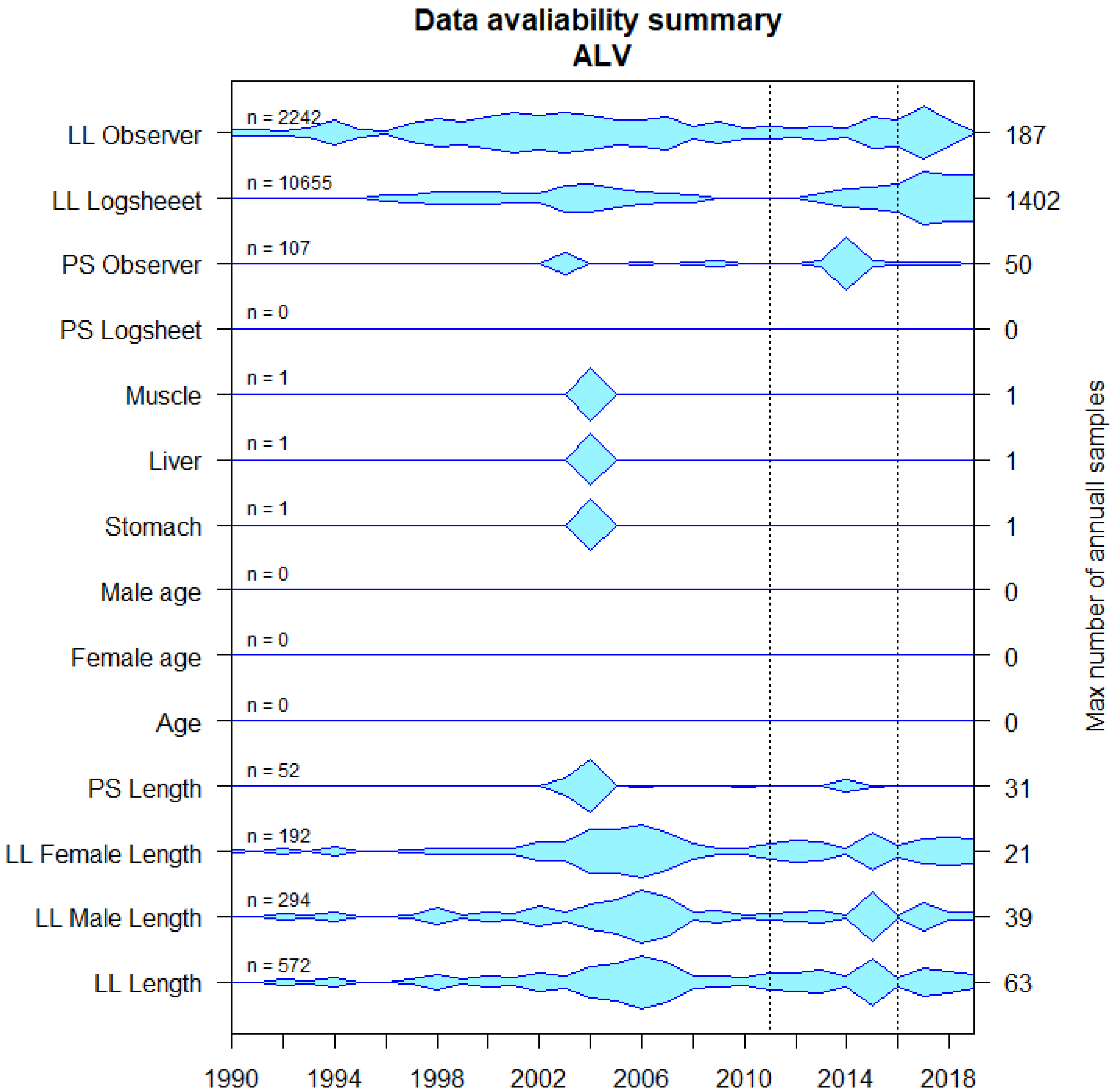


Figure 8: WCPFC data availability for common thresher sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (`https://www.spc.int/ofp/PacificSpecimenBank`).

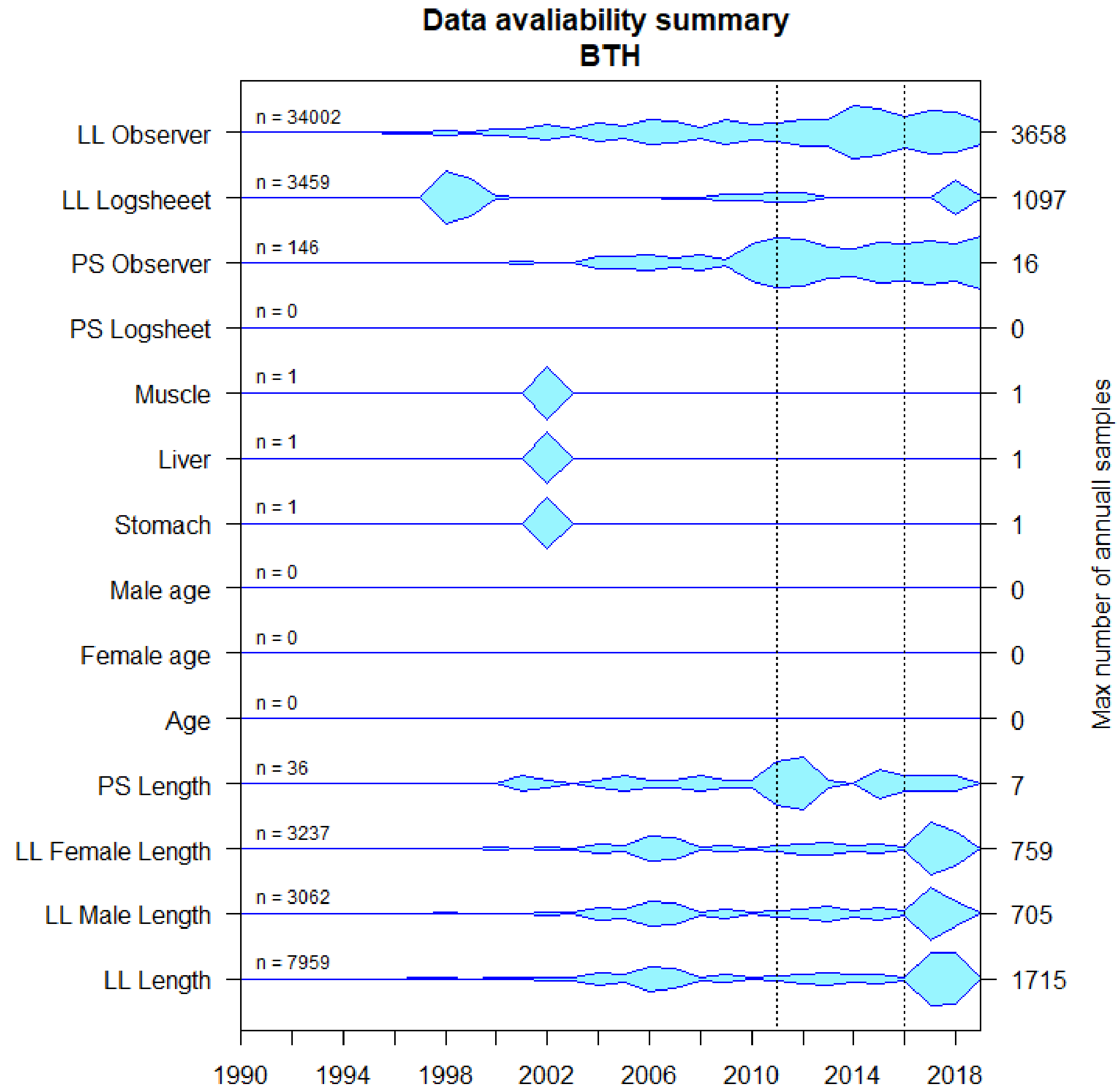


Figure 9: WCPFC data availability for bigeye thresher sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (https://www.spc.int/ofp/PacificSpecimenBank).

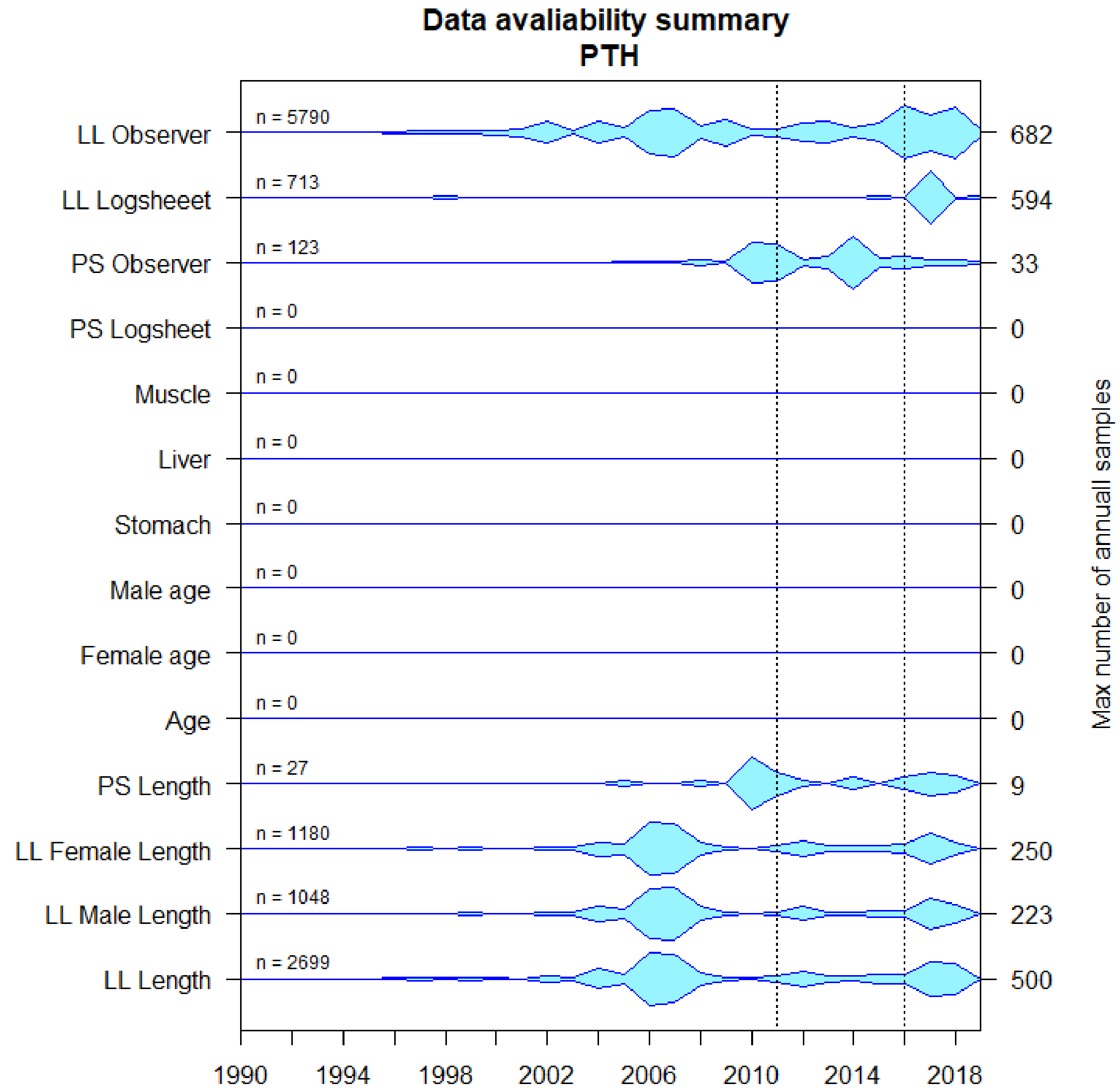


Figure 10: WCPFC data availability for pelagic thresher sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (`https://www.spc.int/ofp/PacificSpecimenBank`).

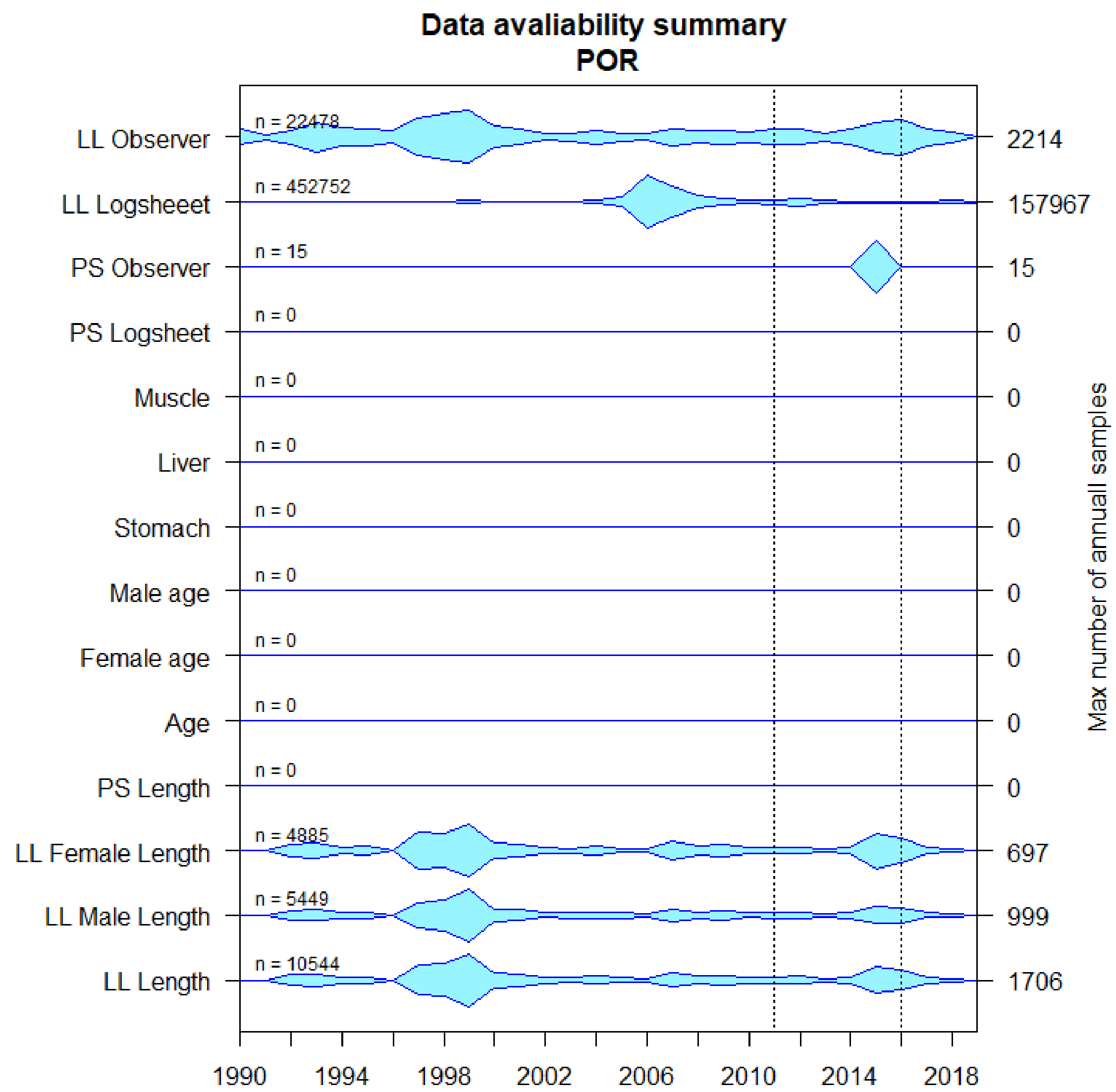


Figure 11: WCPFC data availability for porbeagle sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (`https://www.spc.int/ofp/PacificSpecimenBank`).

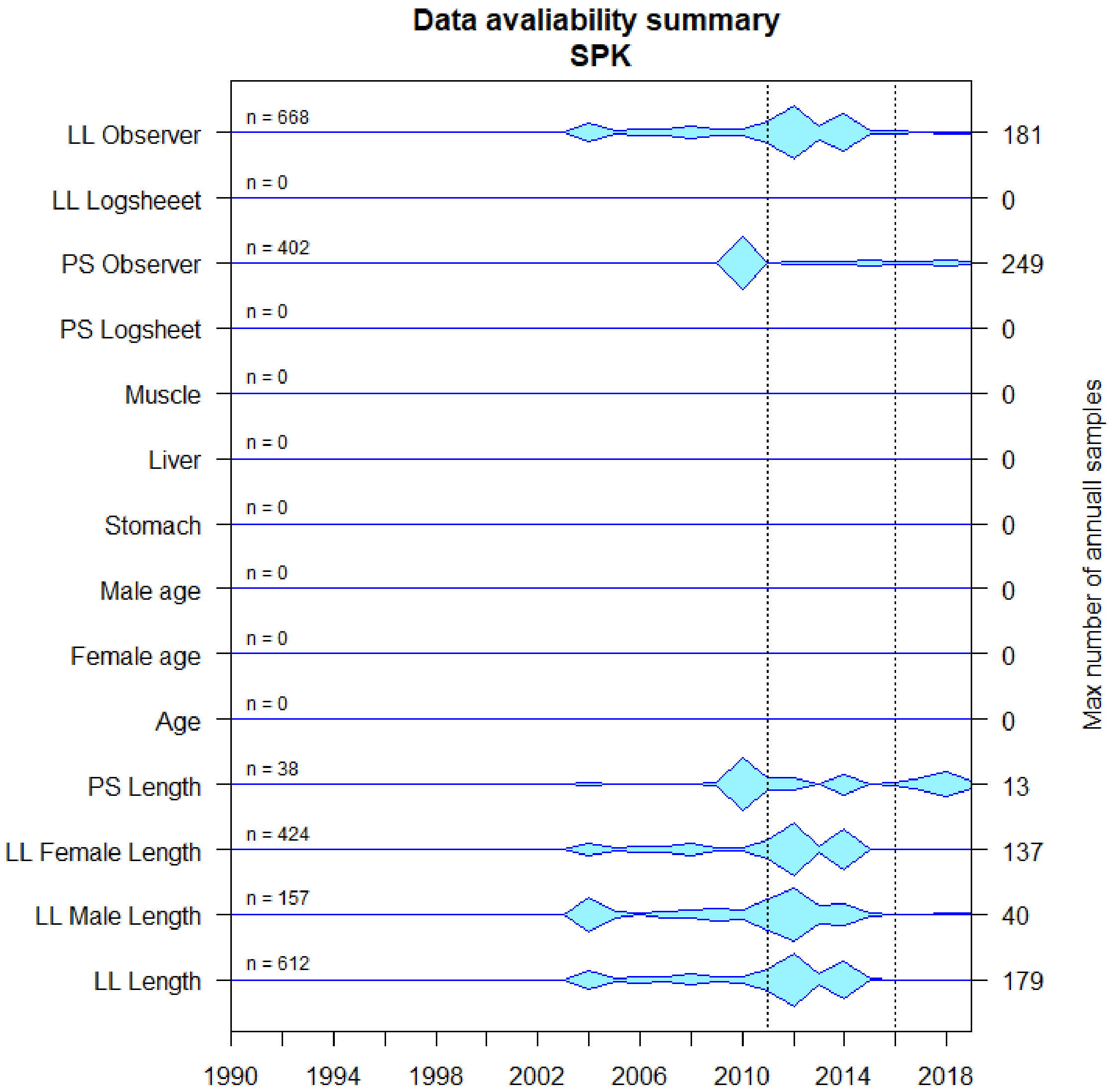


Figure 12: WCPFC data availability for great hammerhead sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (`https://www.spc.int/ofp/PacificSpecimenBank`).

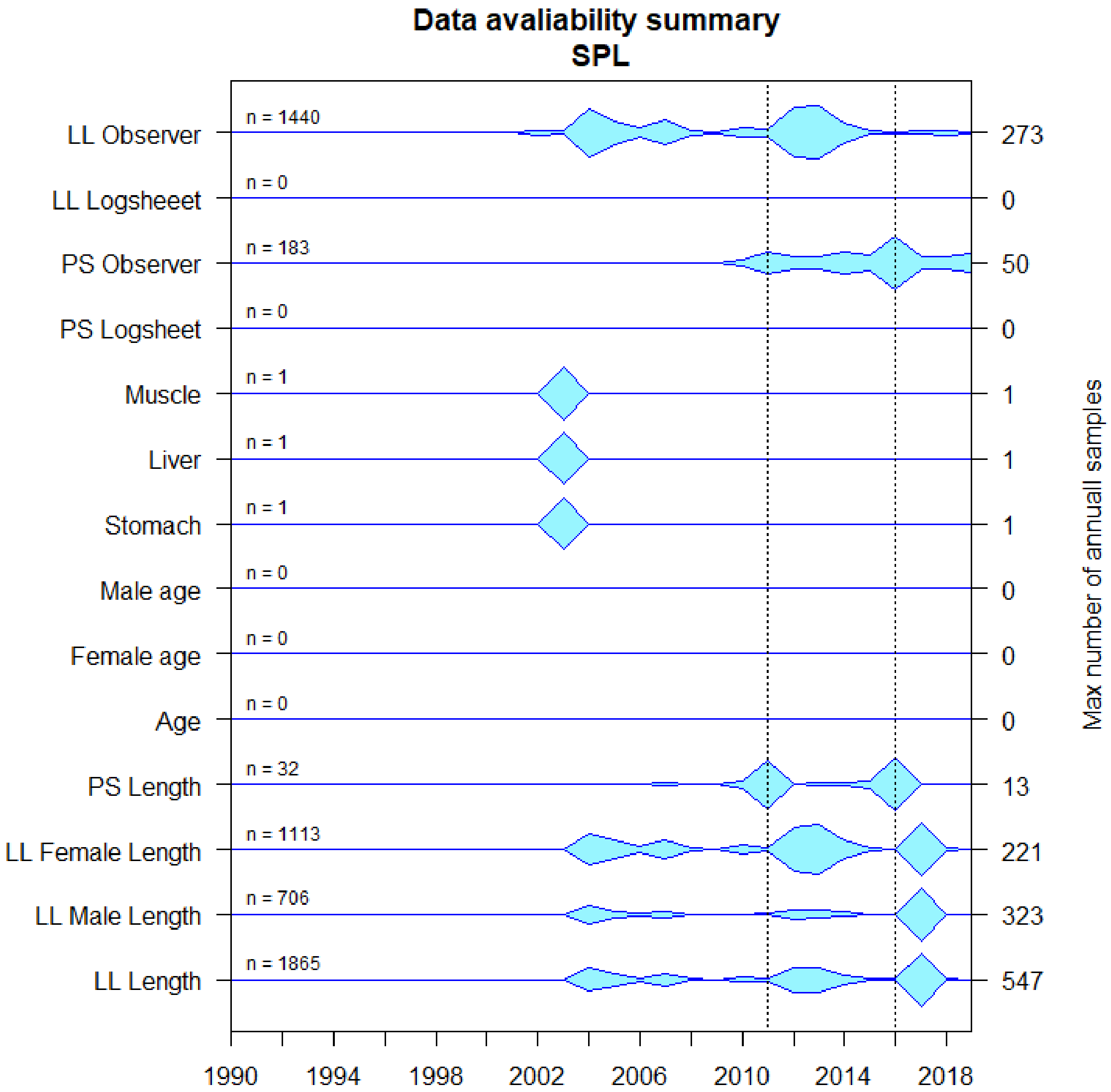


Figure 13: WCPFC data availability for scalloped hammerhead sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (https://www.spc.int/ofp/PacificSpecimenBank).

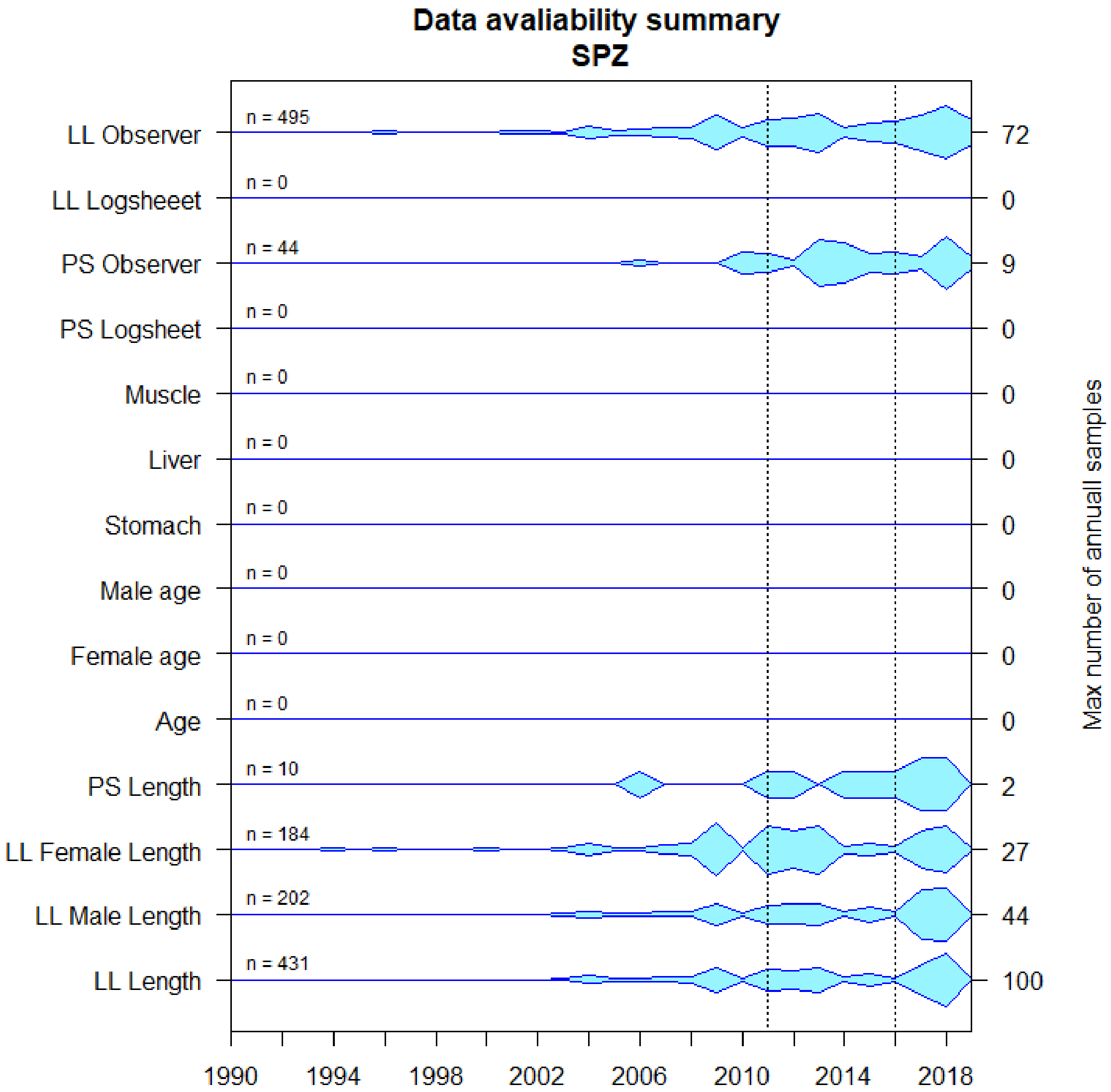


Figure 14: WCPFC data availability for smooth hammerhead sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (https://www.spc.int/ofp/PacificSpecimenBank).

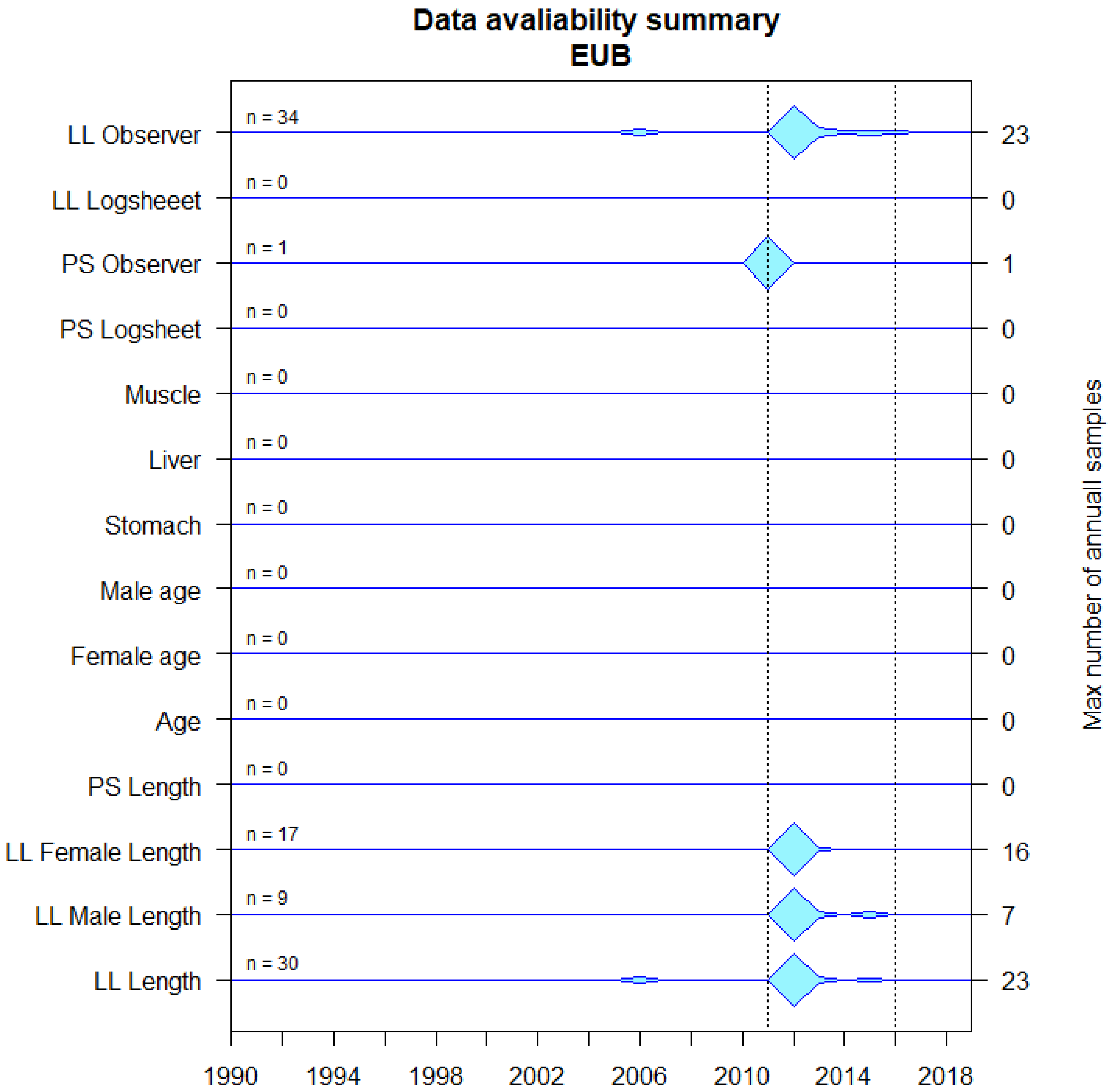


Figure 15: WCPFC data availability for winghead sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (`https://www.spc.int/ofp/PacificSpecimenBank`).

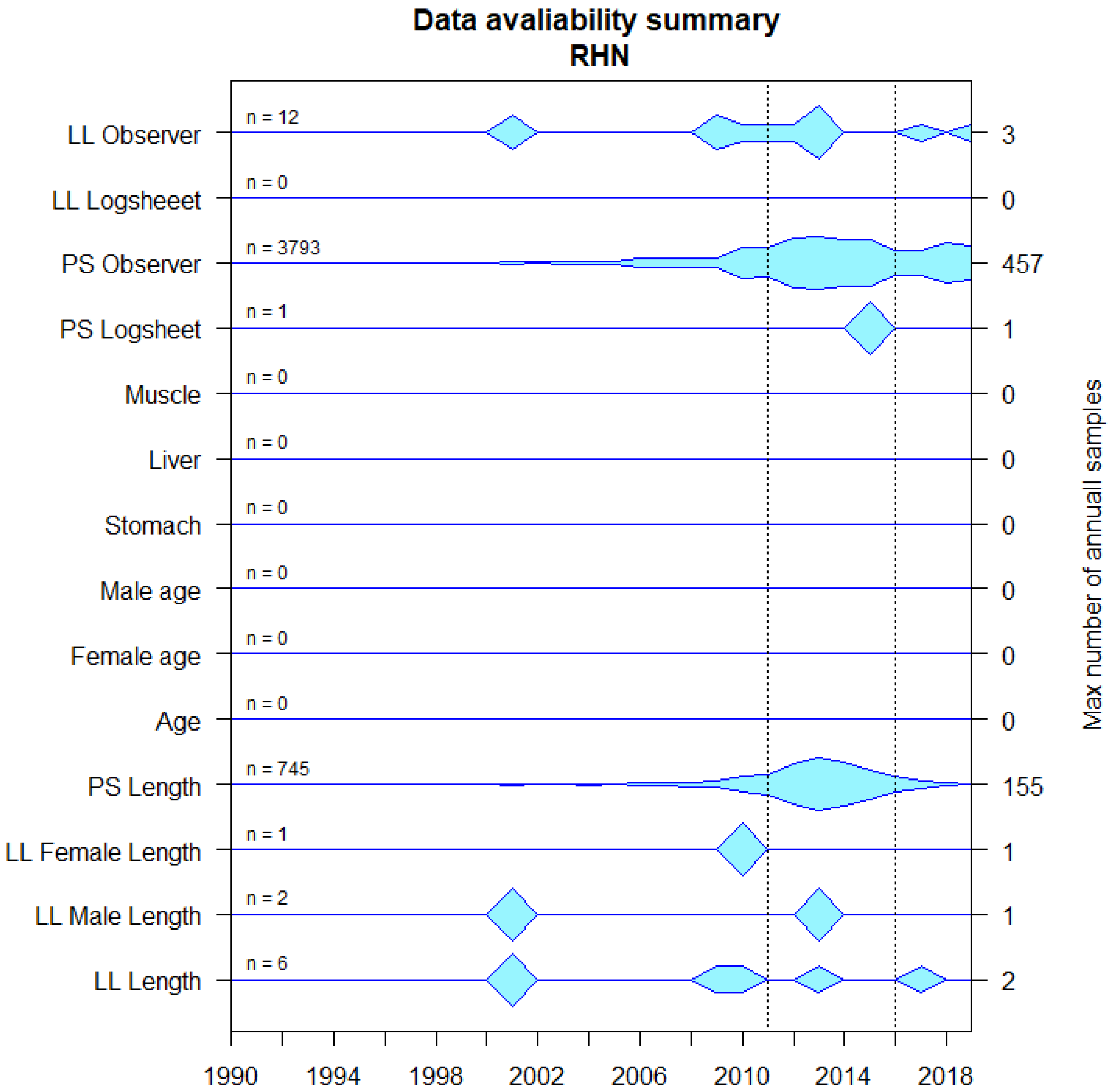


Figure 16: WCPFC data availability for whale sharks from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (`https://www.spc.int/ofp/PacificSpecimenBank`).

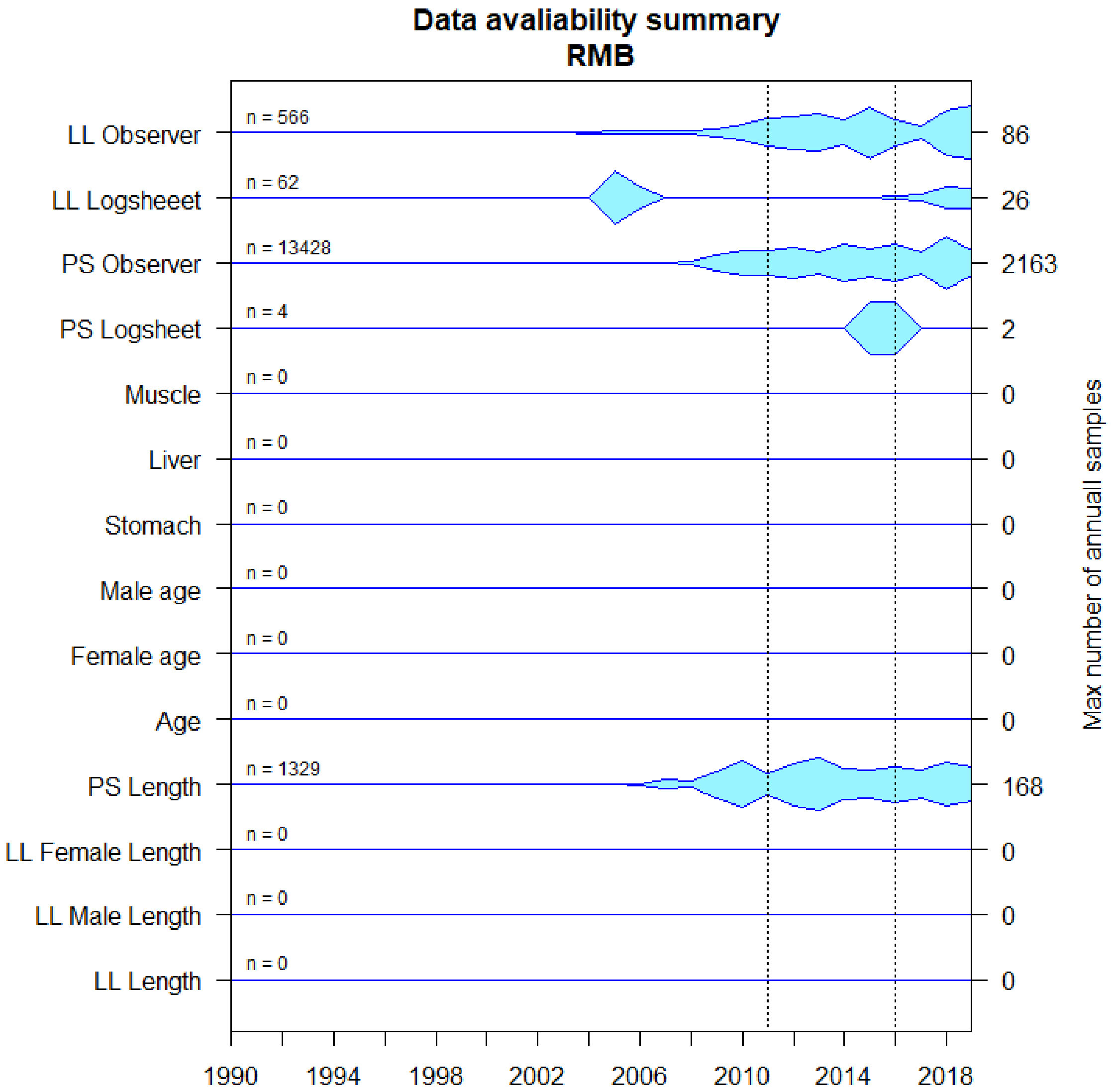


Figure 17: WCPFC data availability for giant manta rays from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (`https://www.spc.int/ofp/PacificSpecimenBank`).

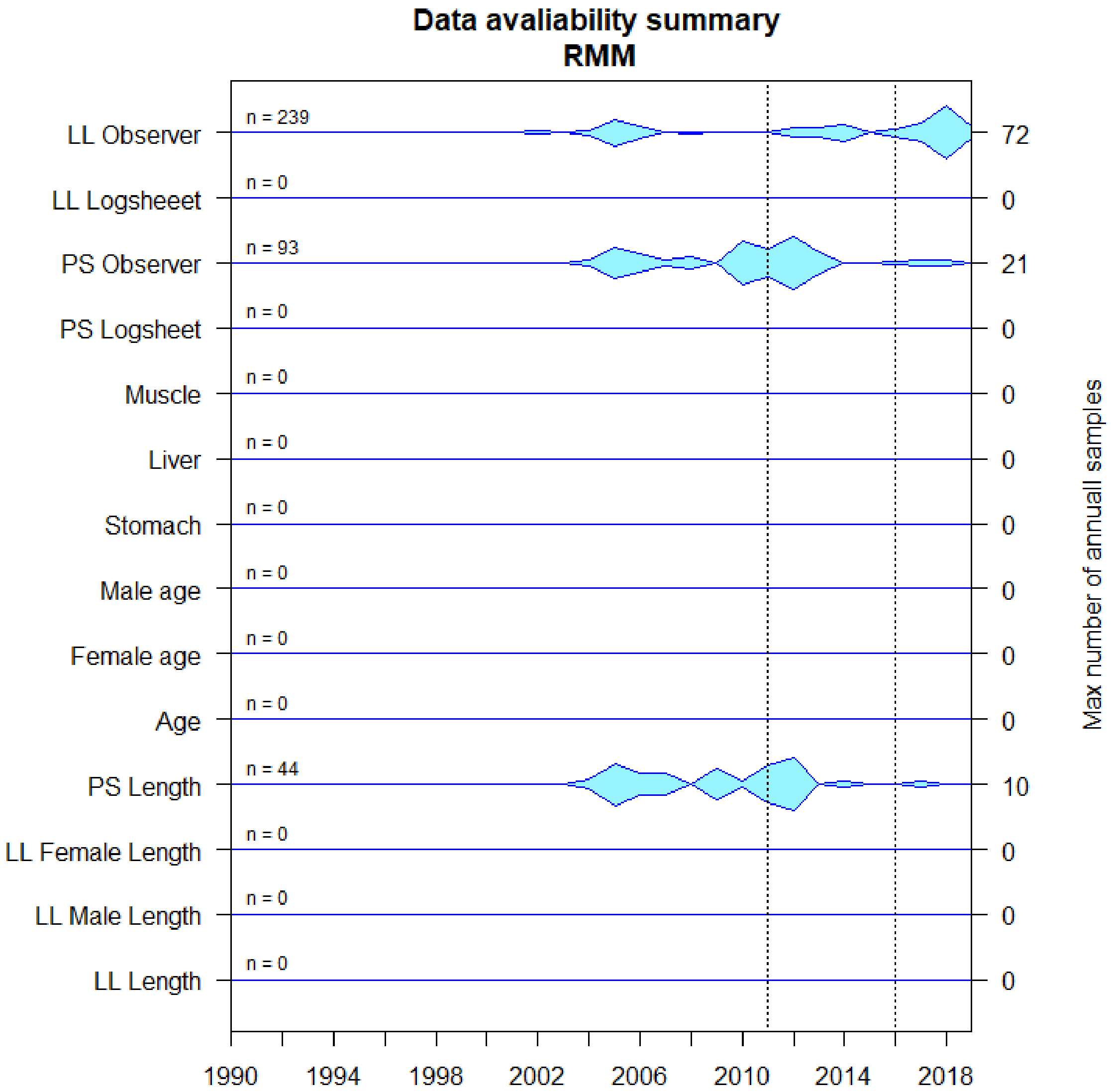


Figure 18: WCPFC data availability for giant devilray from 1990-2019 showing the data type, and the maximum number of annual samples collected, the width of the line represents the amount of data available relative to the biggest annual sample (number to the right). The vertical dashed line is the start year of each of the first two shark research plans. LL and PS observer and logsheet are the number of observed and reported individuals from the longline and purse seine fisheries respectively; Muscle, Liver and Stomach are the number of samples housed in the WCPFC tissue bank (https://www.spc.int/ofp/PacificSpecimenBank).

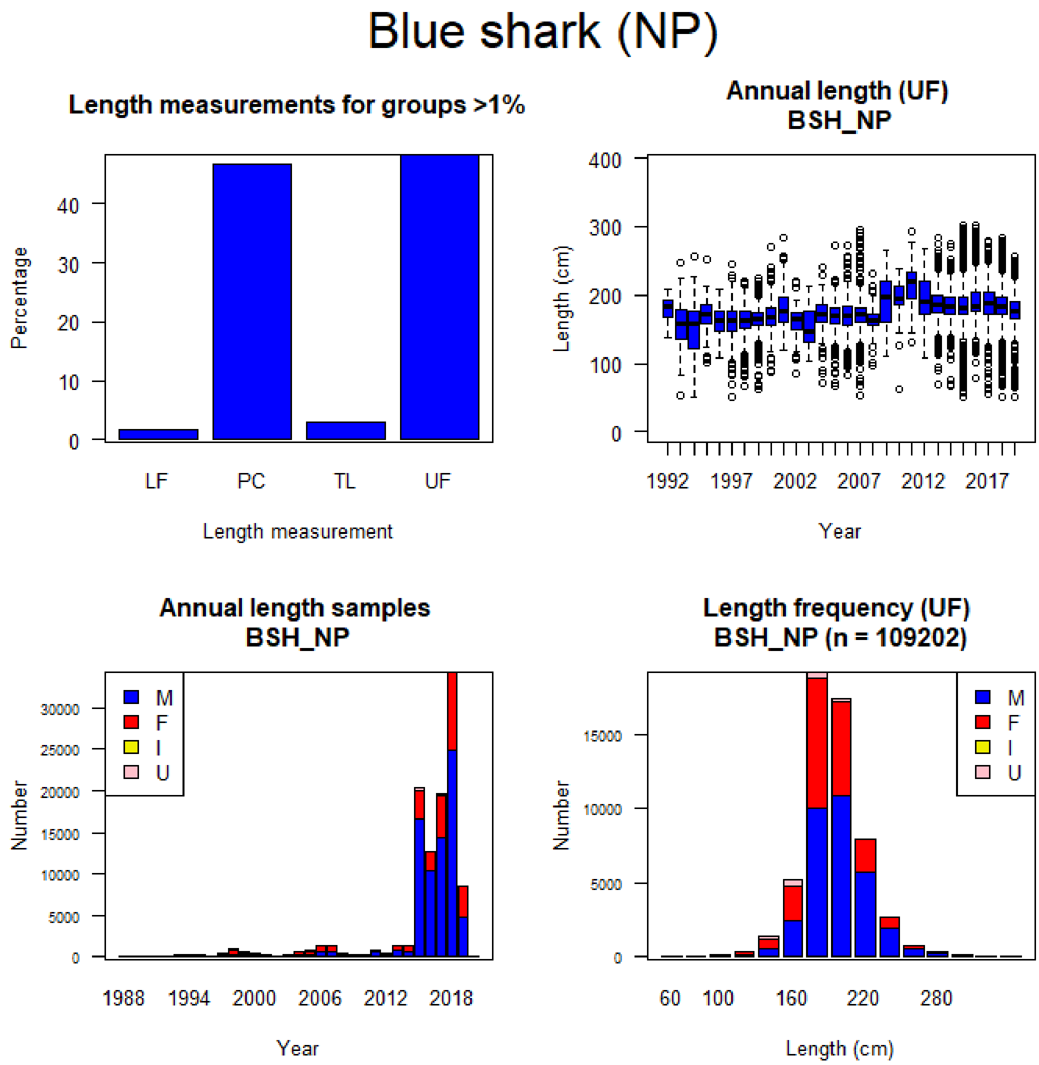


Figure 19: WCPFC observed longline length data for blue sharks in the north Pacific, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

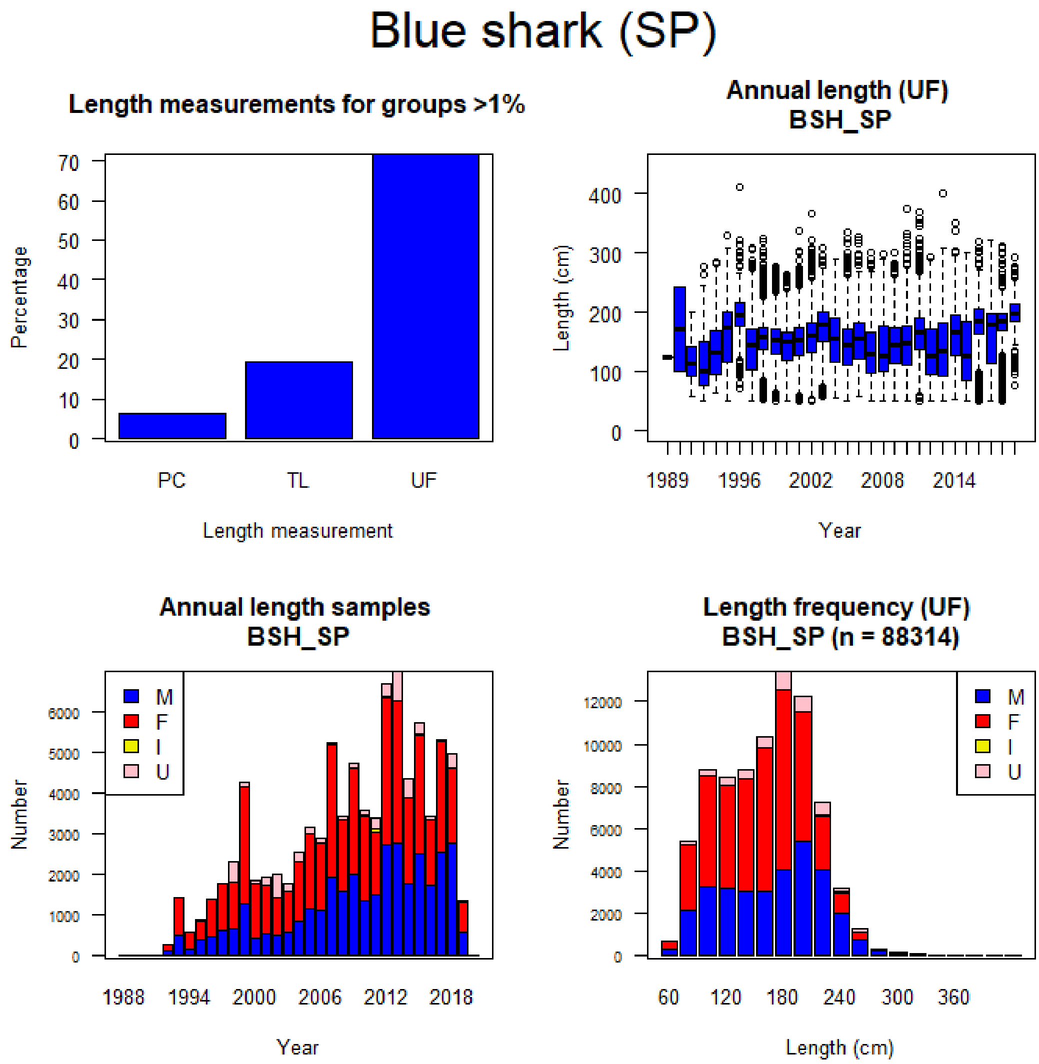


Figure 20: WCPFC observed longline length data for South Pacific blue sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

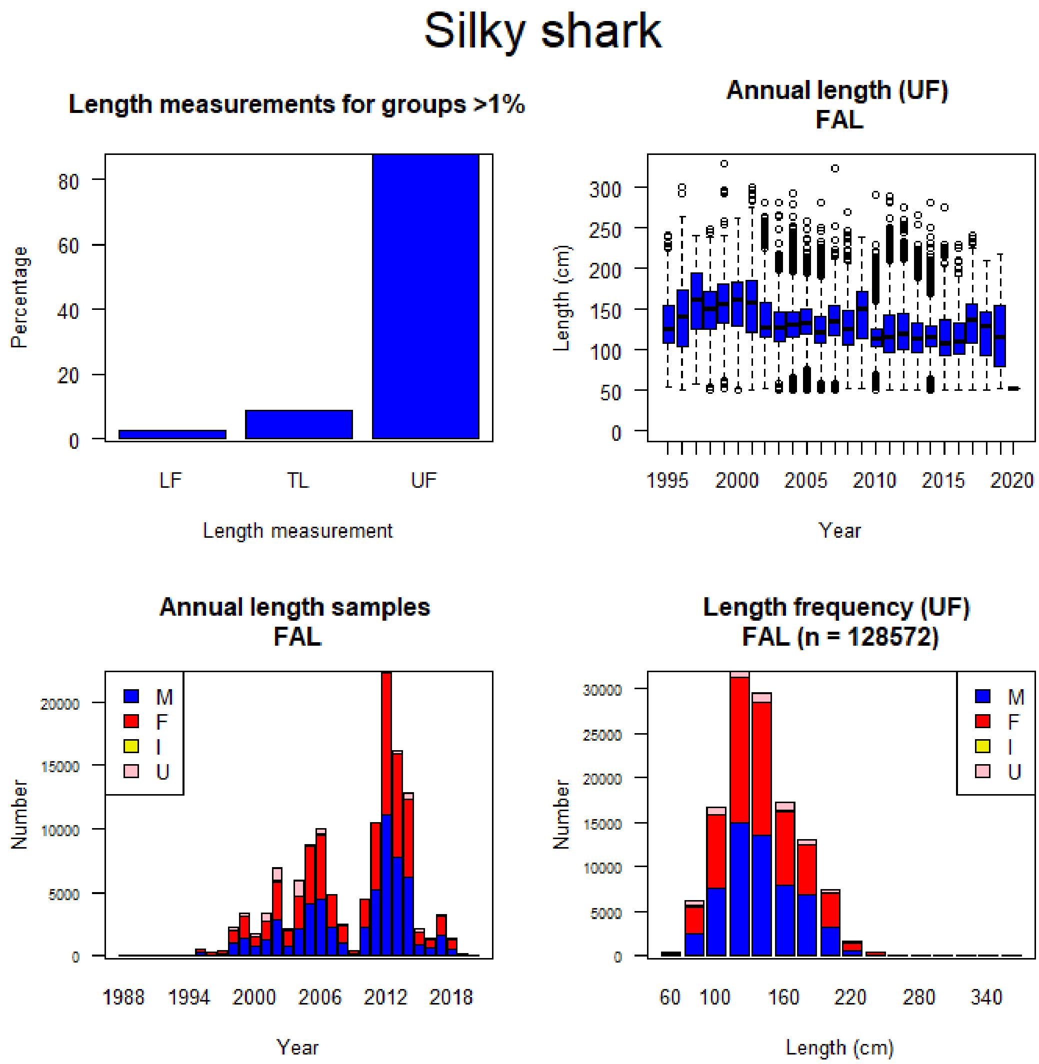


Figure 21: WCPFC observed longline length data for silky sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

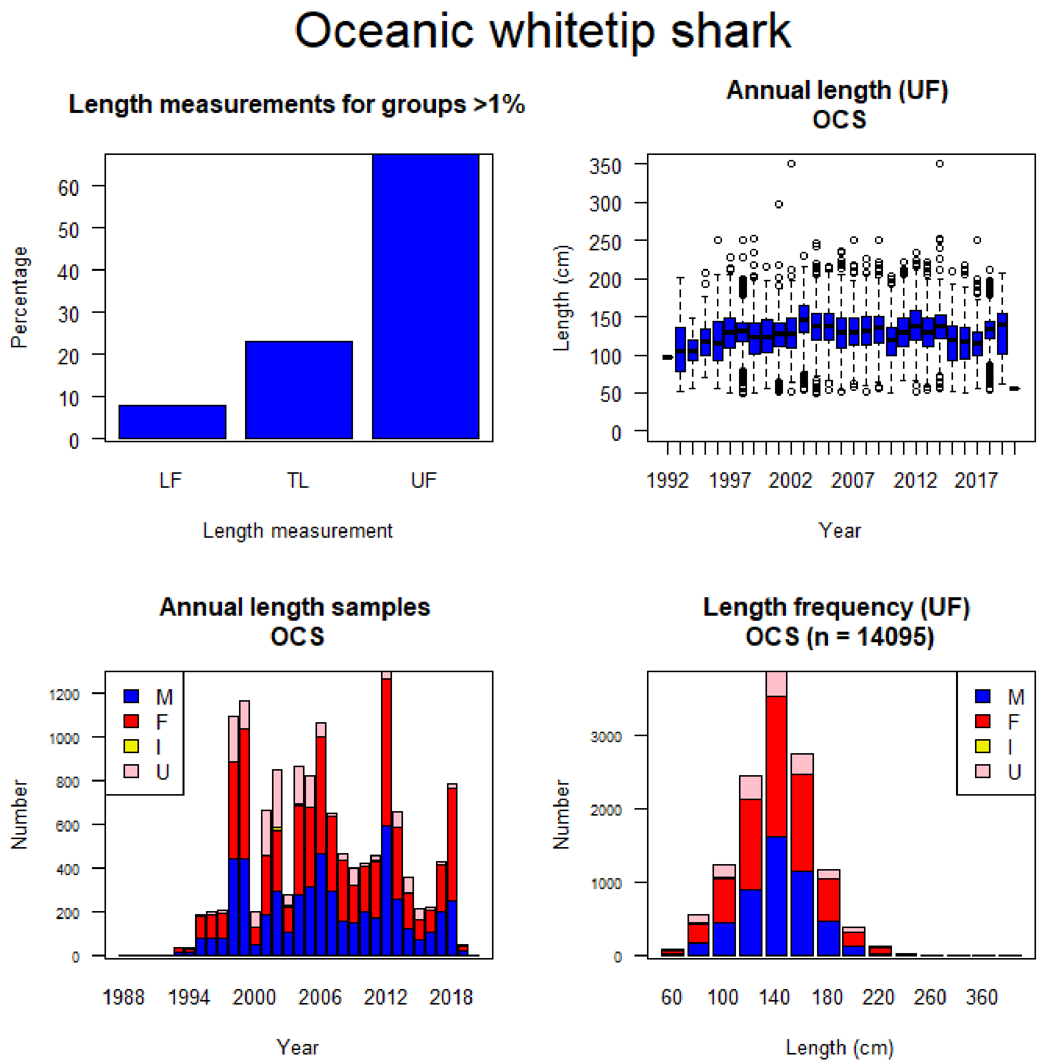


Figure 22: WCPFC observed longline length data for oceanic whitetip sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

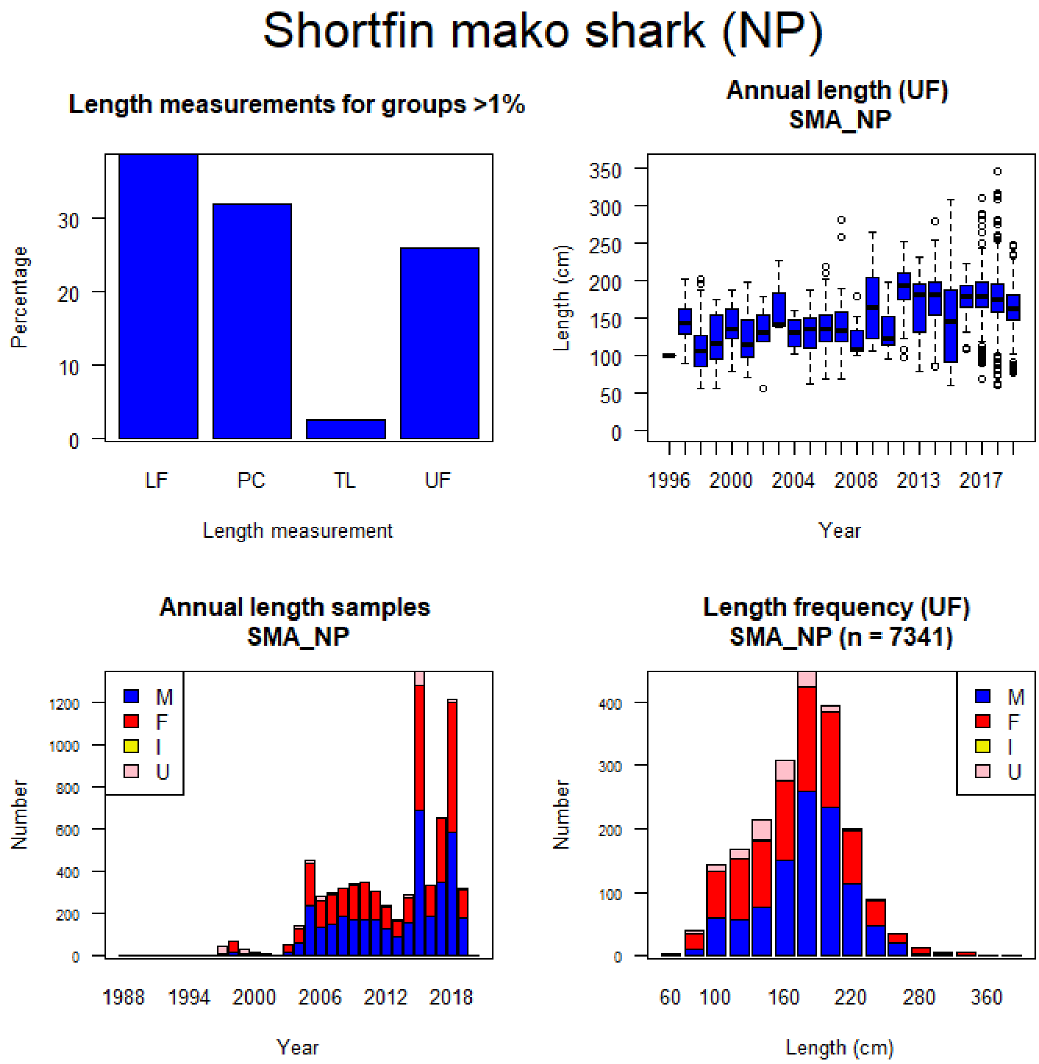


Figure 23: WCPFC observed longline length data for shortfin mako sharks in the north Pacific, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

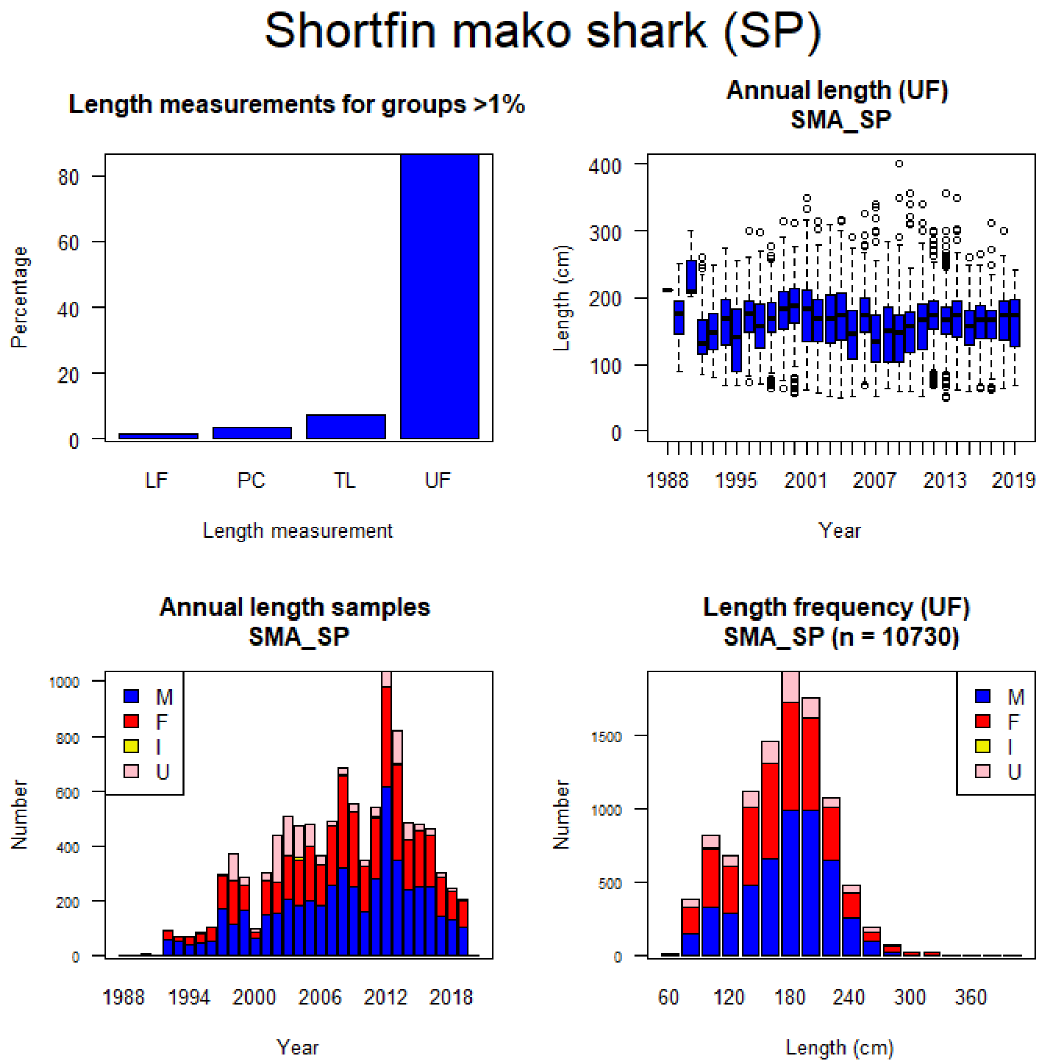


Figure 24: WCPFC observed longline length data for shortfin mako sharks in the south Pacific, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

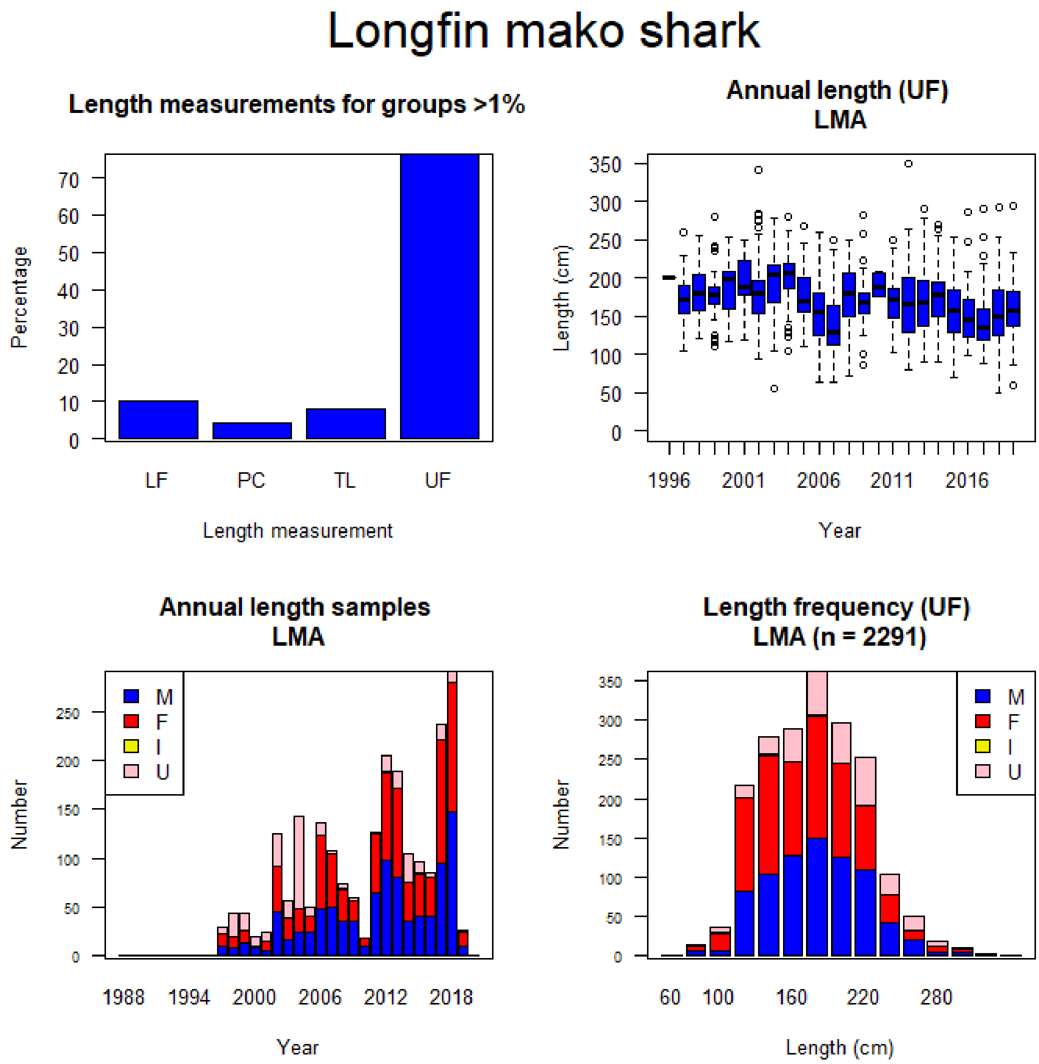


Figure 25: WCPFC observed longline length data for longfin mako sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

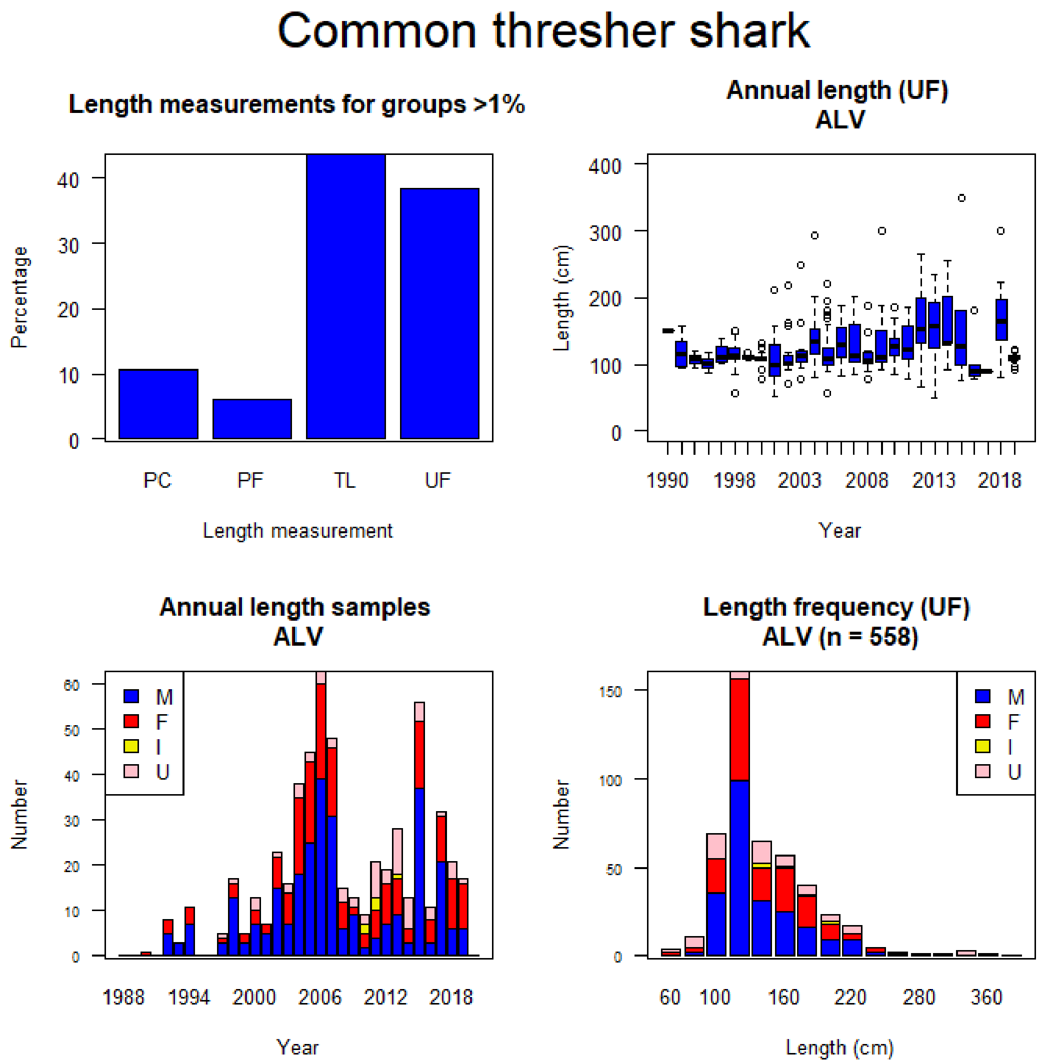


Figure 26: WCPFC observed longline length data for common thresher sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

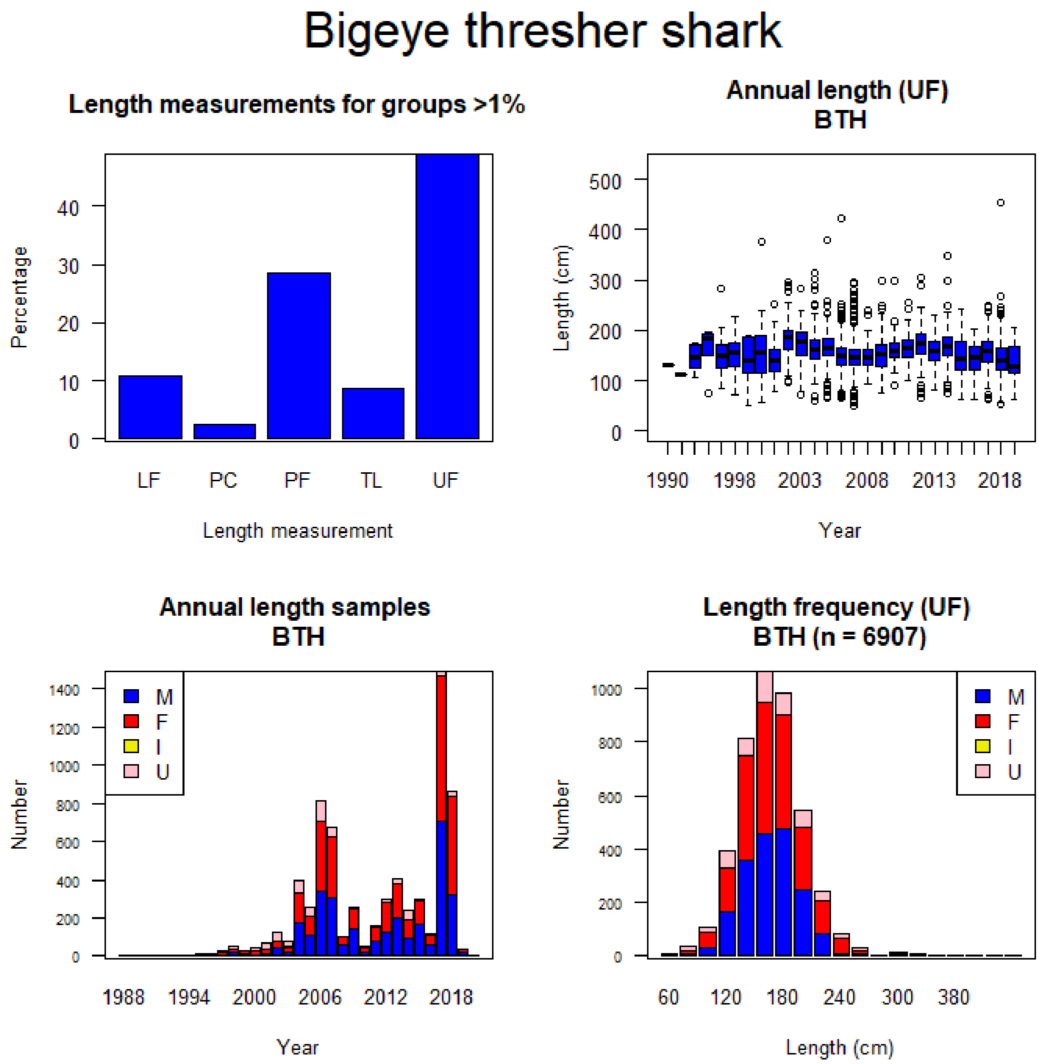


Figure 27: WCPFC observed longline length data for bigeye thresher sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

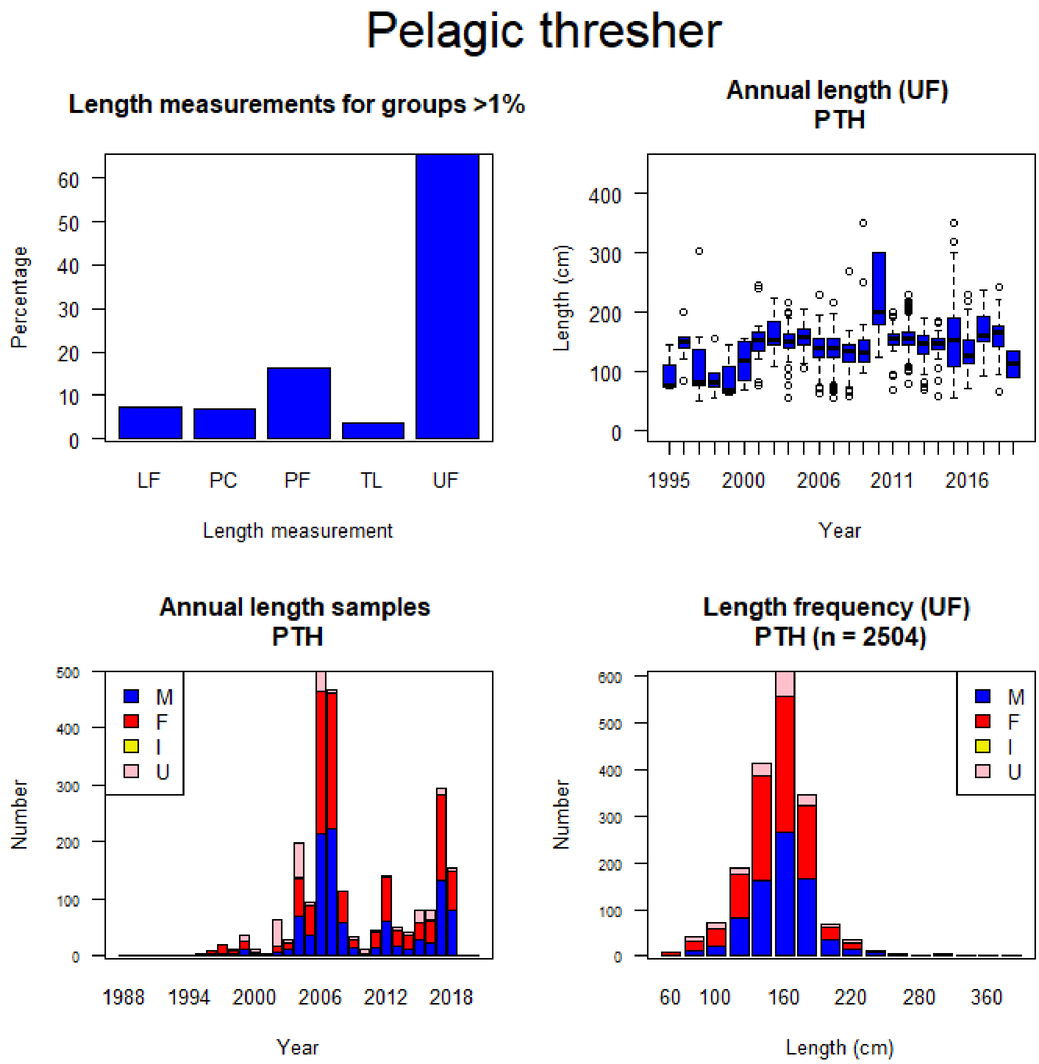


Figure 28: WCPFC observed longline length data for pelagic thresher sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

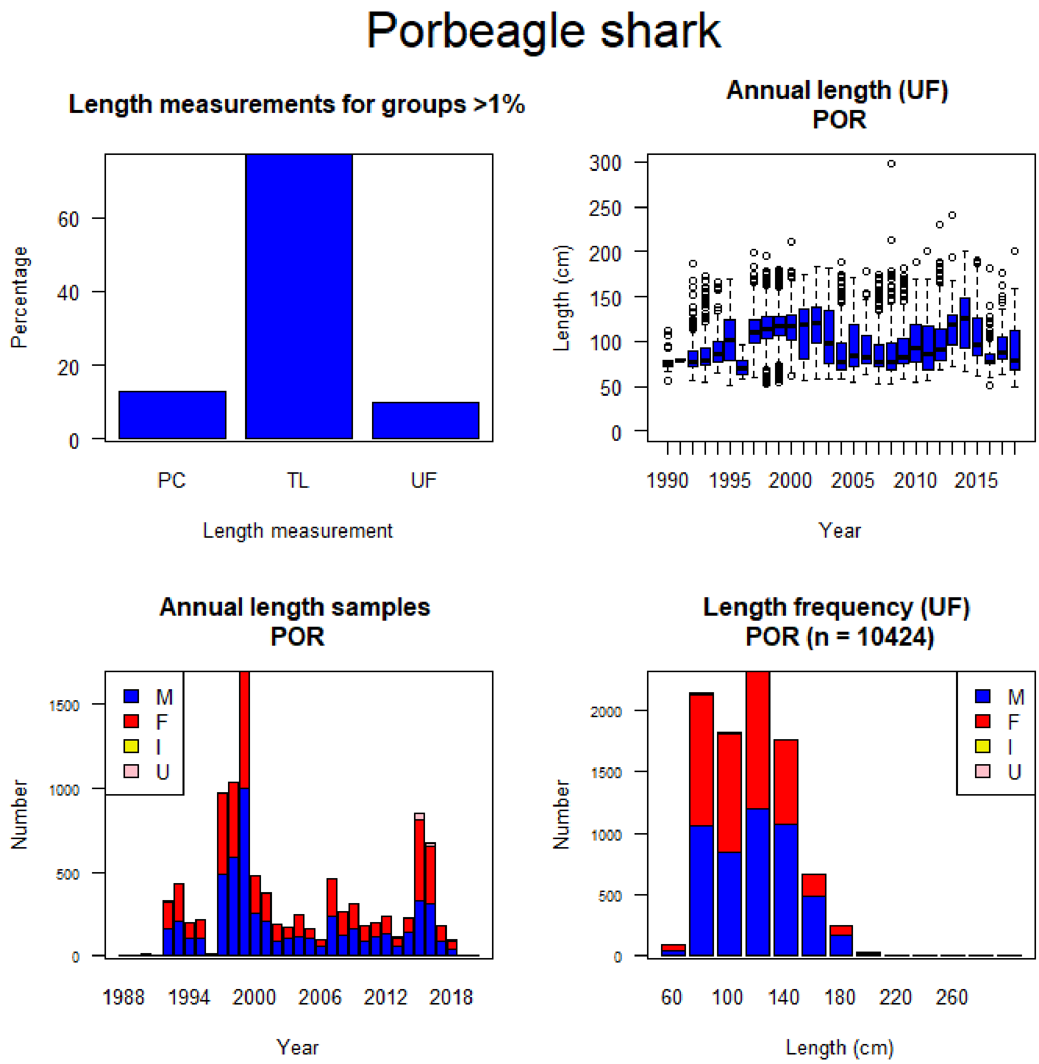


Figure 29: WCPFC observed longline length data for porbeagle sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

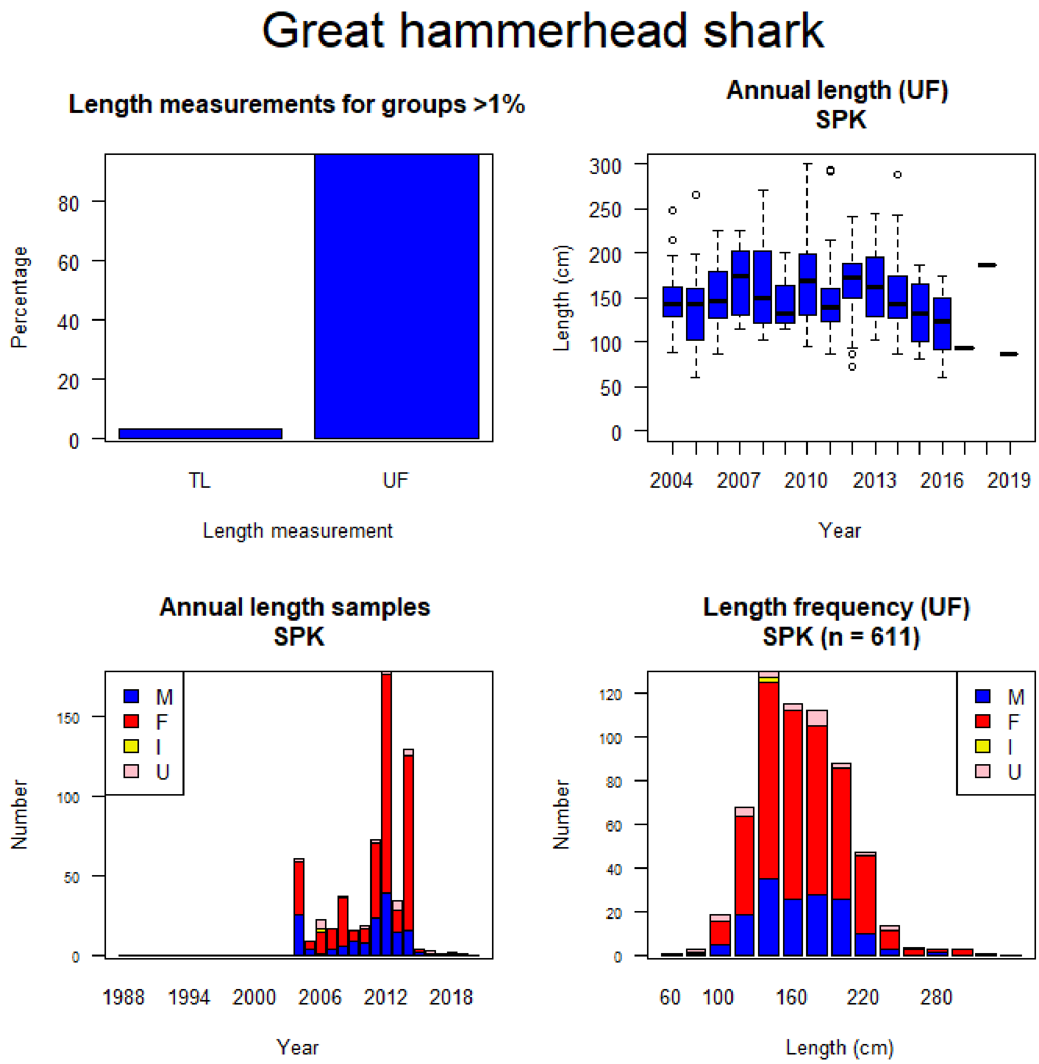


Figure 30: WCPFC observed longline length data for great hammerhead sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

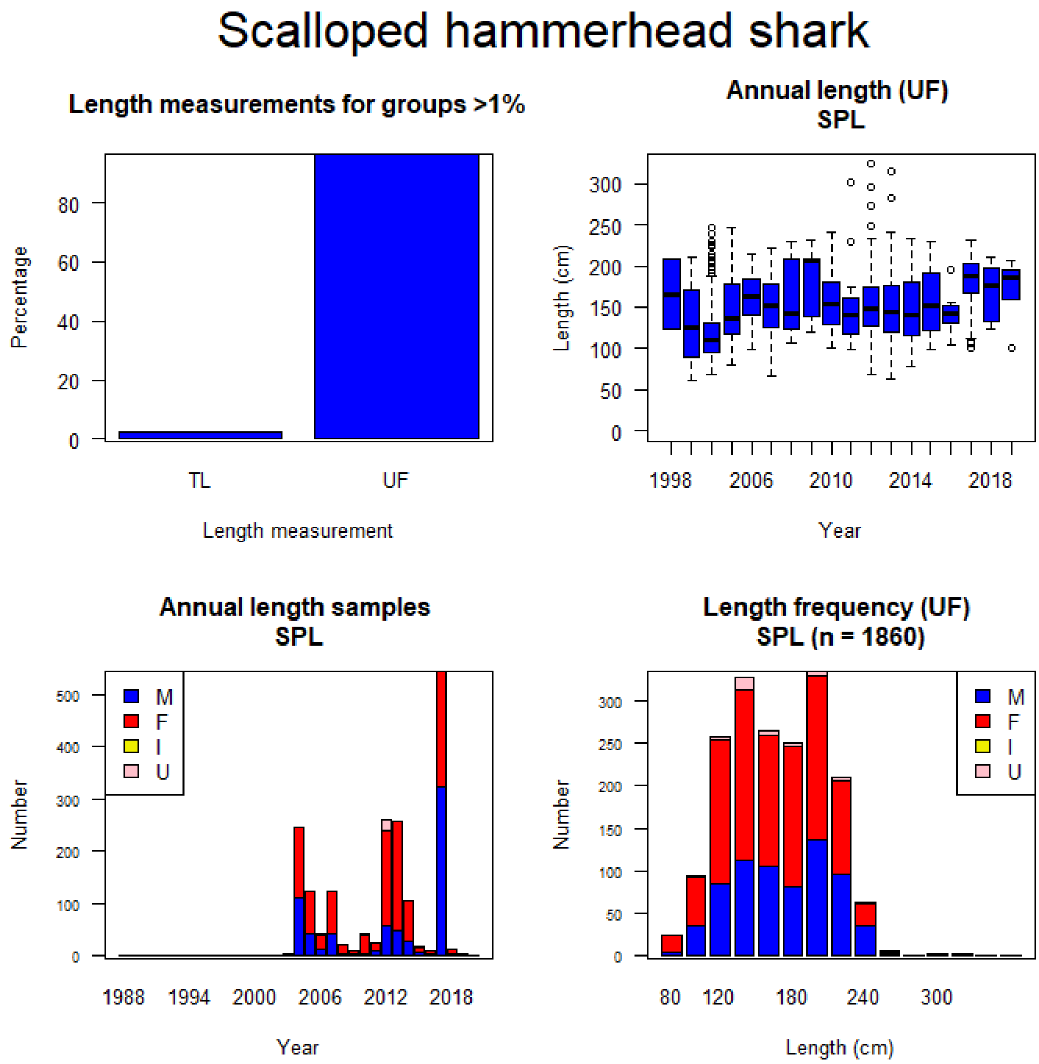


Figure 31: WCPFC observed longline length data for scalloped hammerhead sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

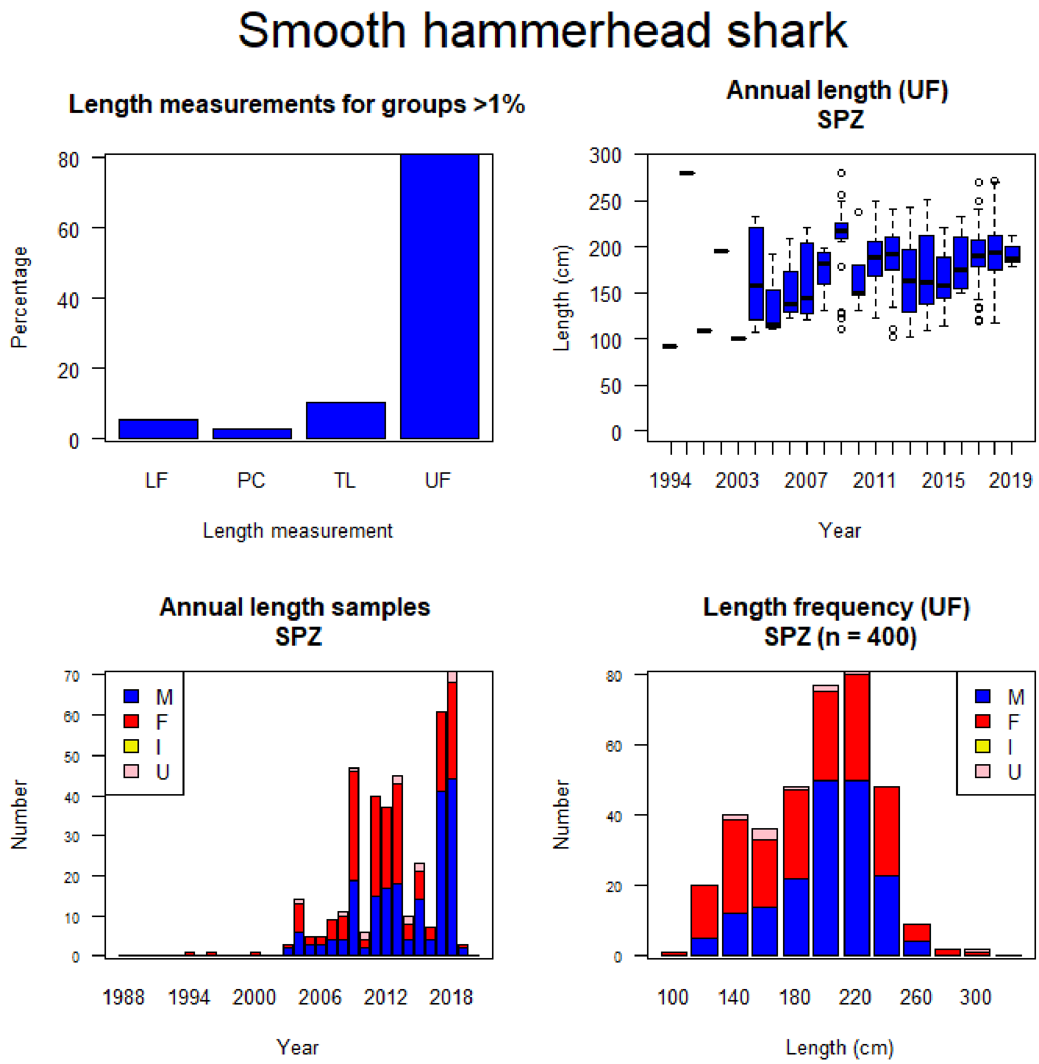


Figure 32: WCPFC observed longline length data for smooth hammerhead sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

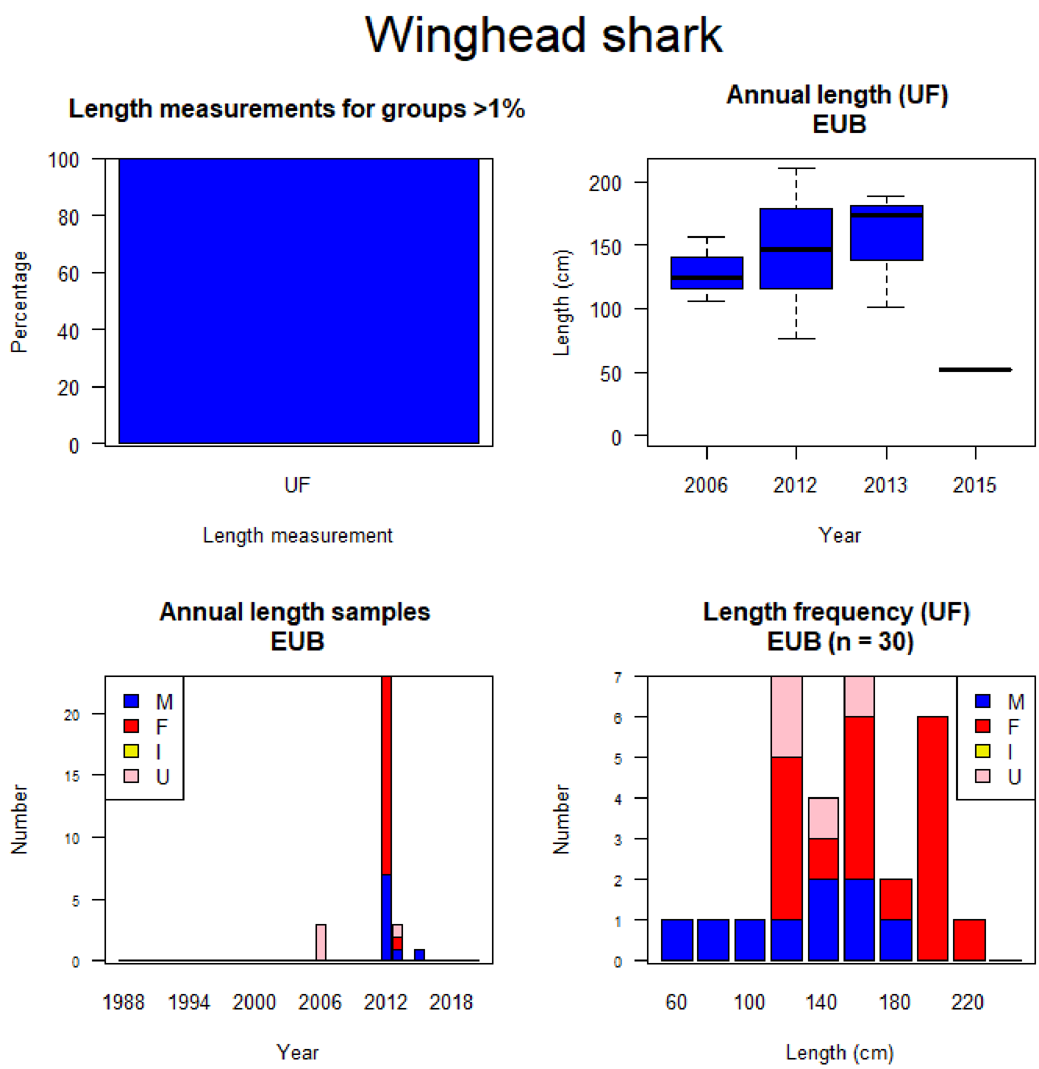


Figure 33: WCPFC observed longline length data for winghead sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

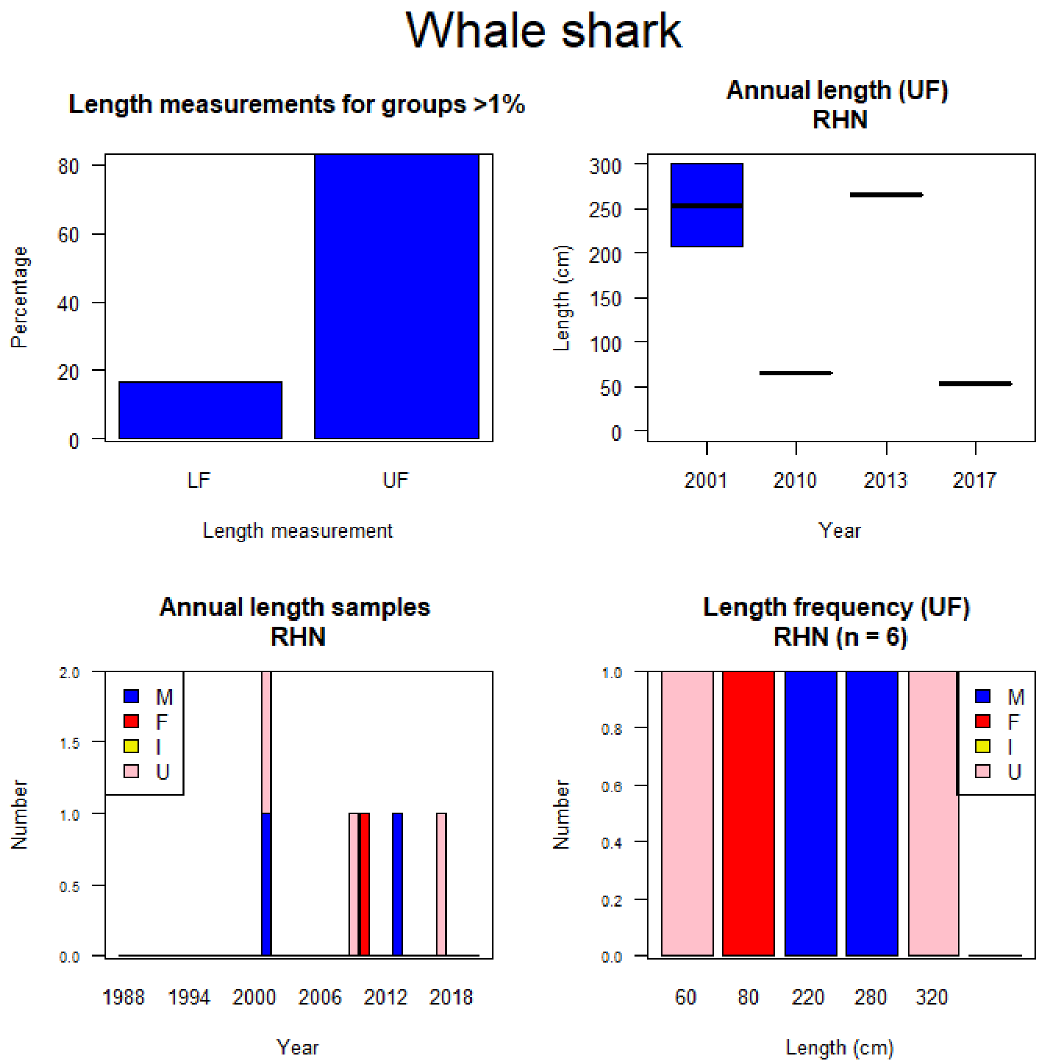


Figure 34: WCPFC observed longline length data for whale sharks, showing the length measurement type (top left); distribution of annual length measurements (top right); number of length samples by sex from each year (bottom left); and the length frequency distribution by sex (bottom right). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers. M = Male; F = Female; I = Immature; U = Unknown.

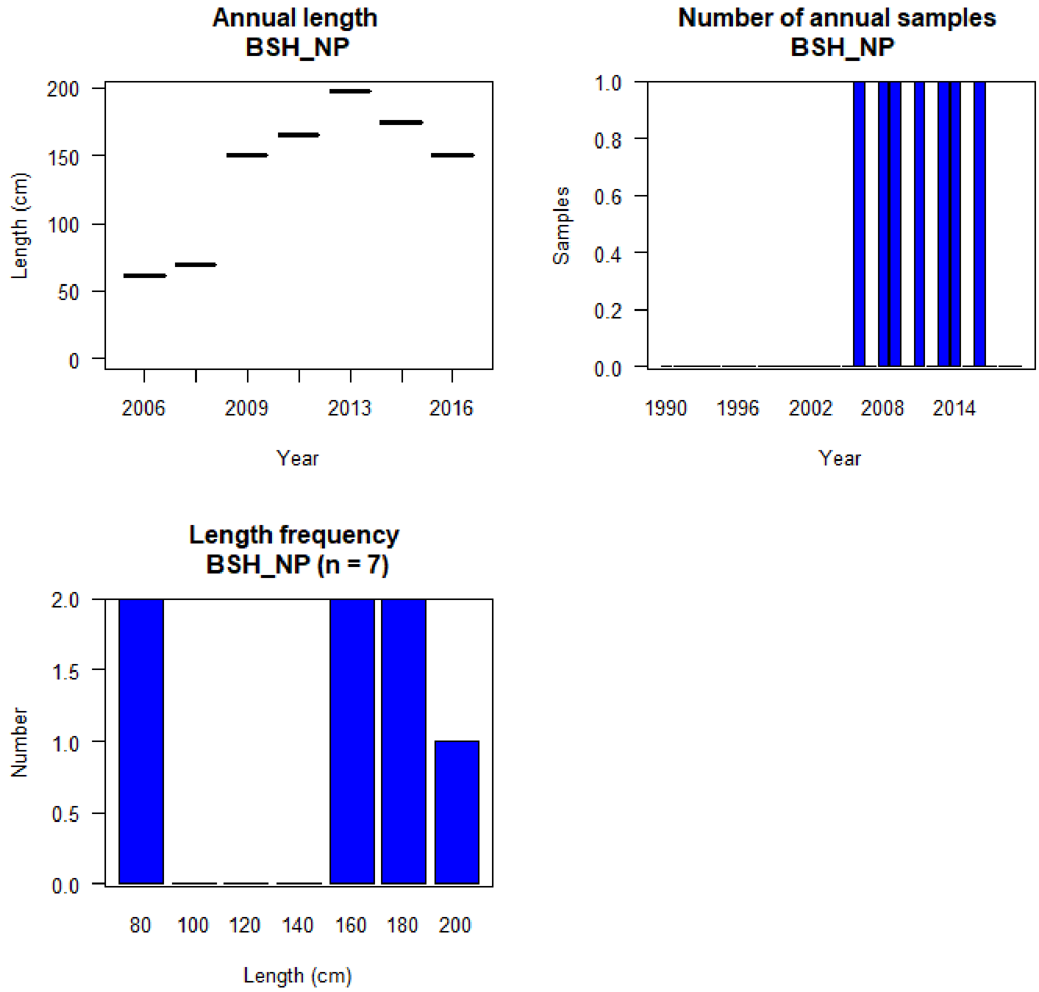


Figure 35: WCPFC observed purse seine length data for blue sharks in the north Pacific, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

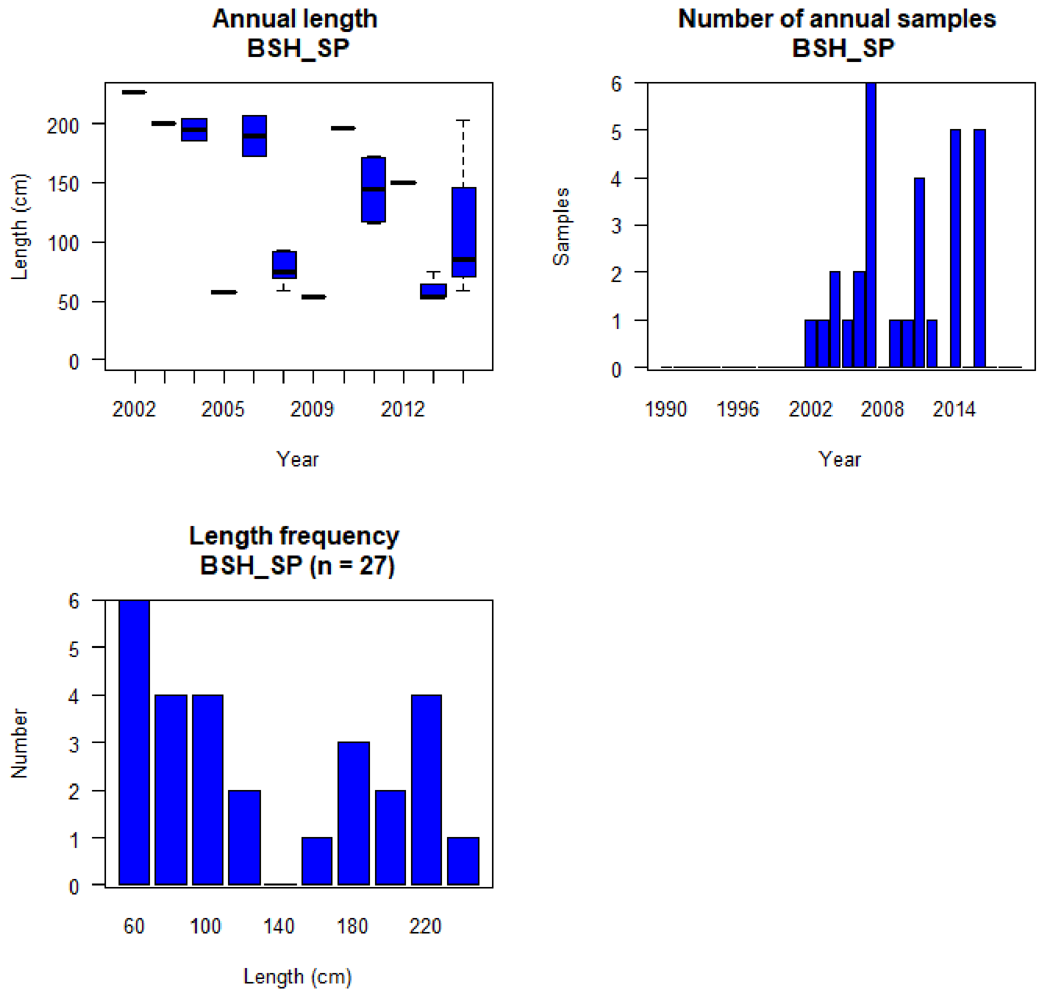


Figure 36: WCPFC observed purse seine length data for South Pacific blue sharks, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

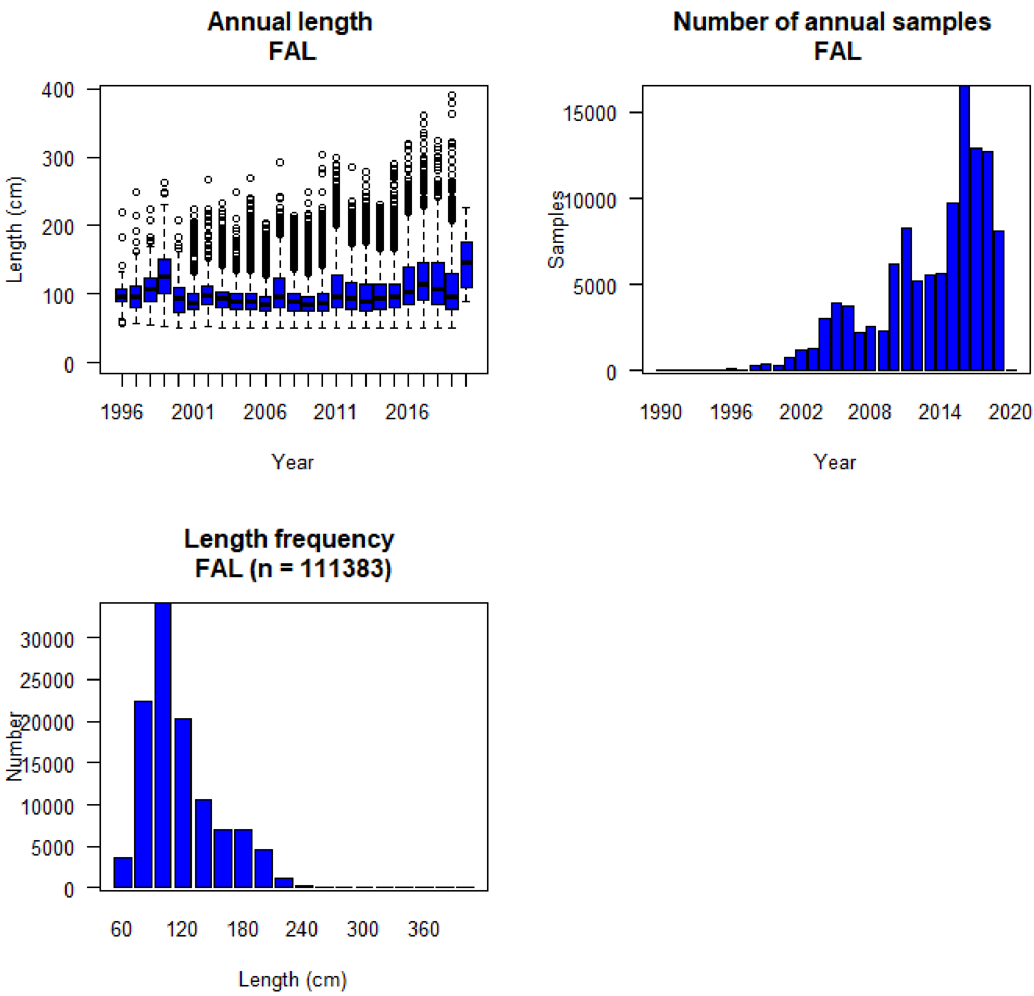


Figure 37: WCPFC observed purse seine length data for silky sharks, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

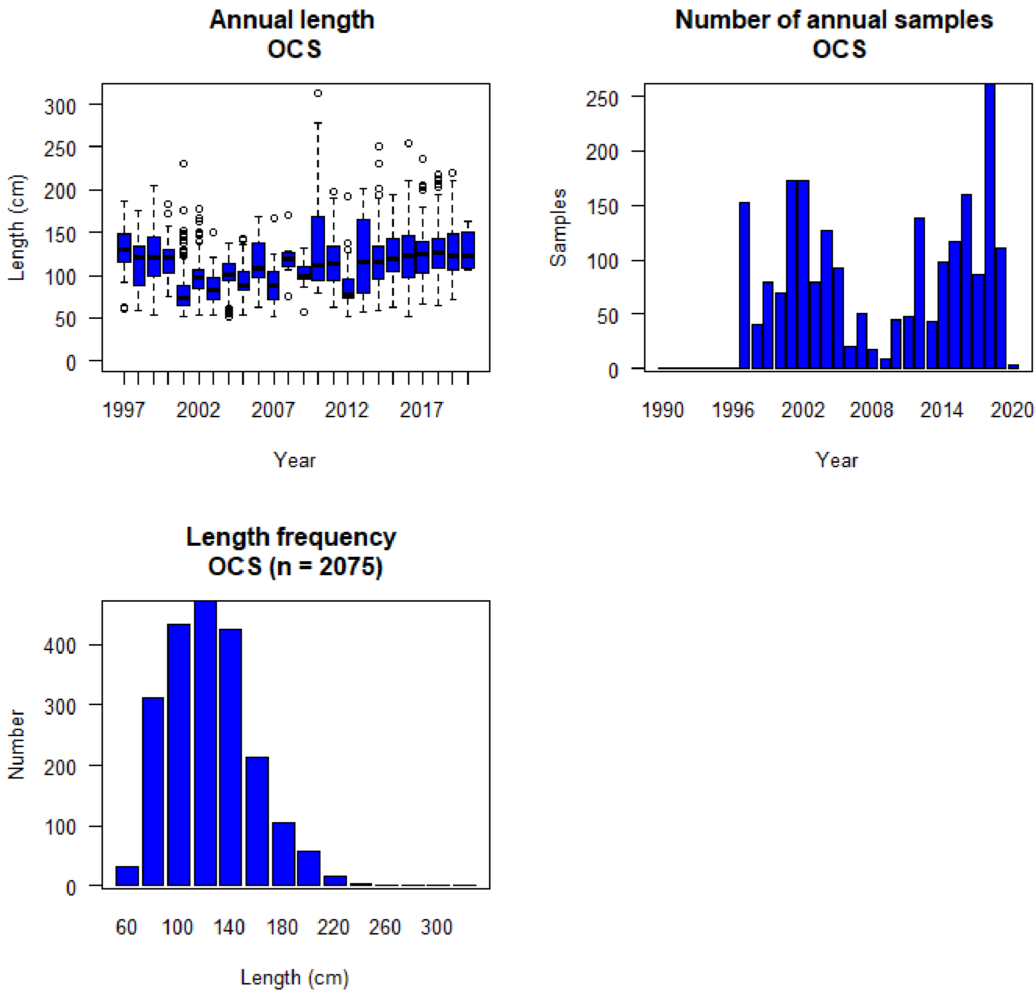


Figure 38: WCPFC observed purse seine length data for oceanic whitetip sharks, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

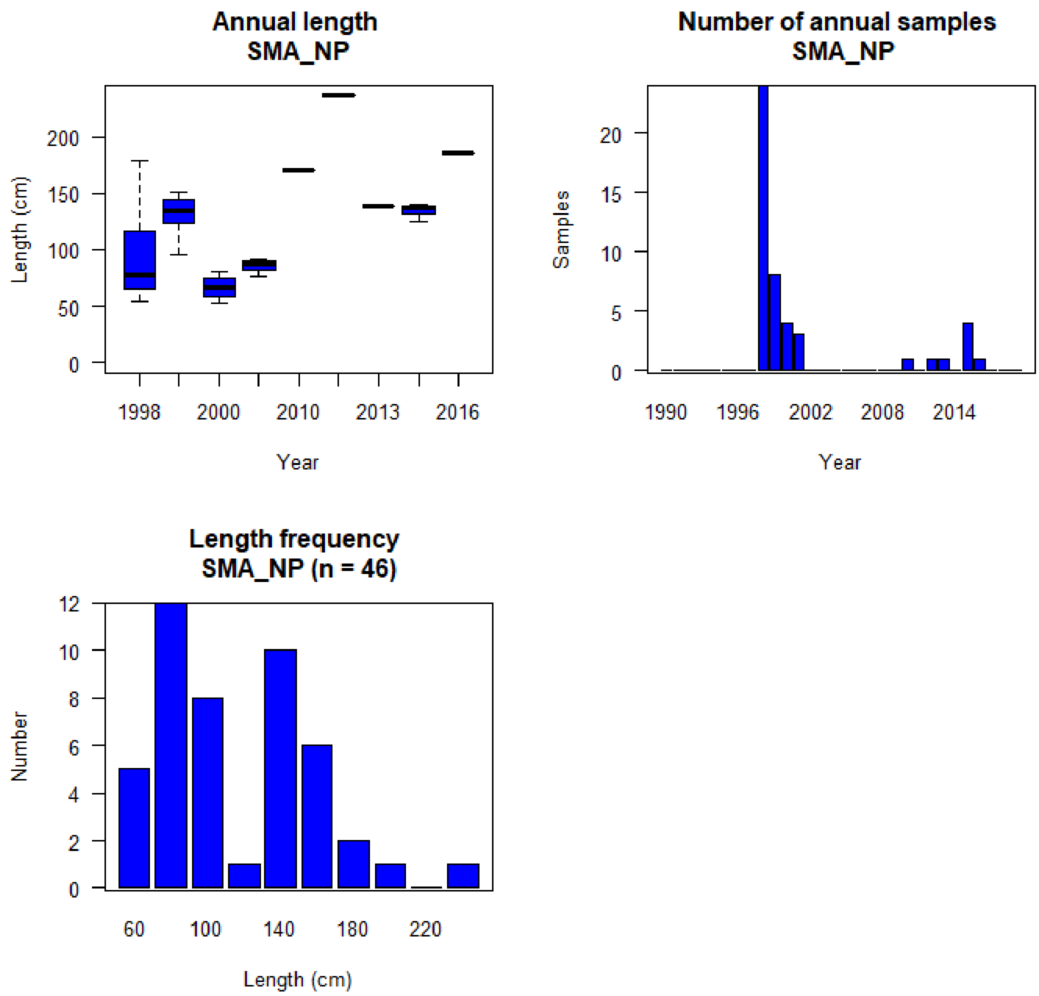


Figure 39: WCPFC observed purse seine length data for shortfin mako sharks in the north Pacific, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

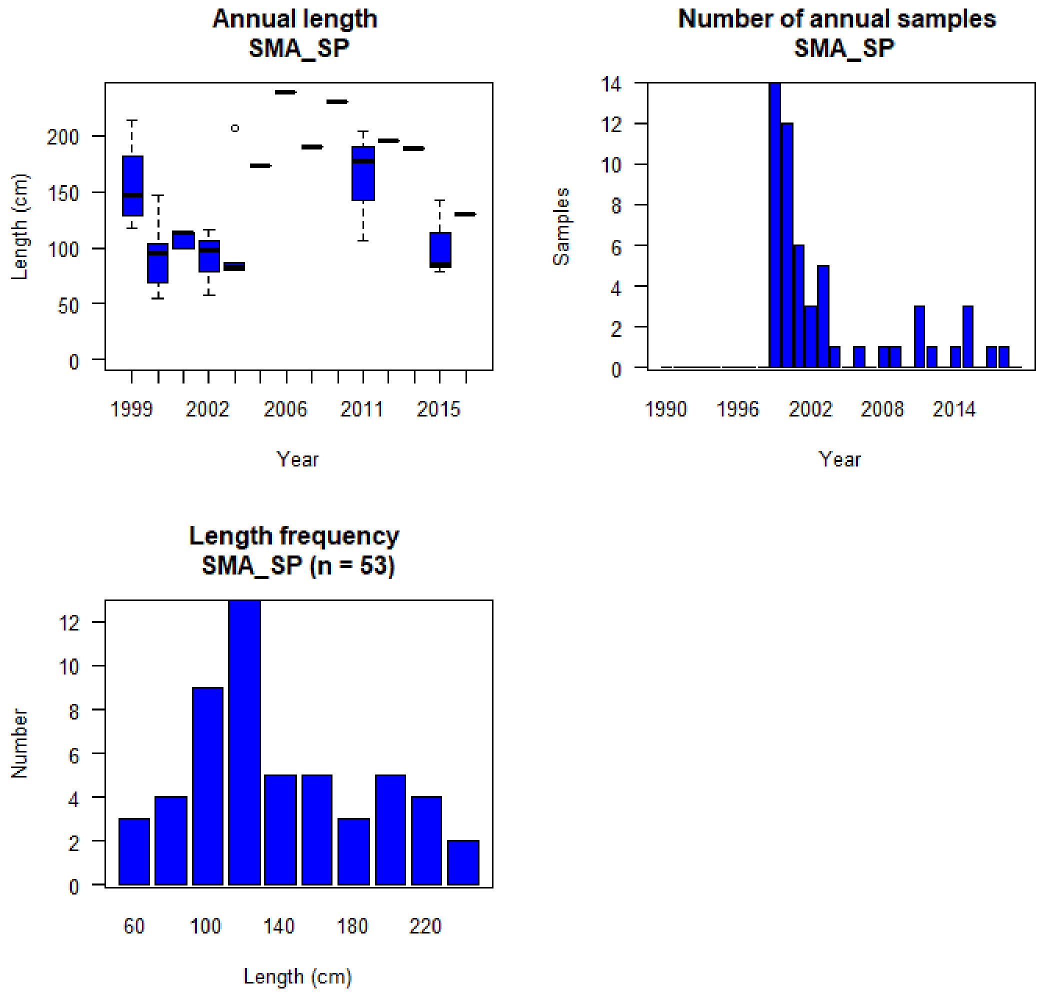


Figure 40: WCPFC observed purse seine length data for shortfin mako sharks in the south Pacific, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

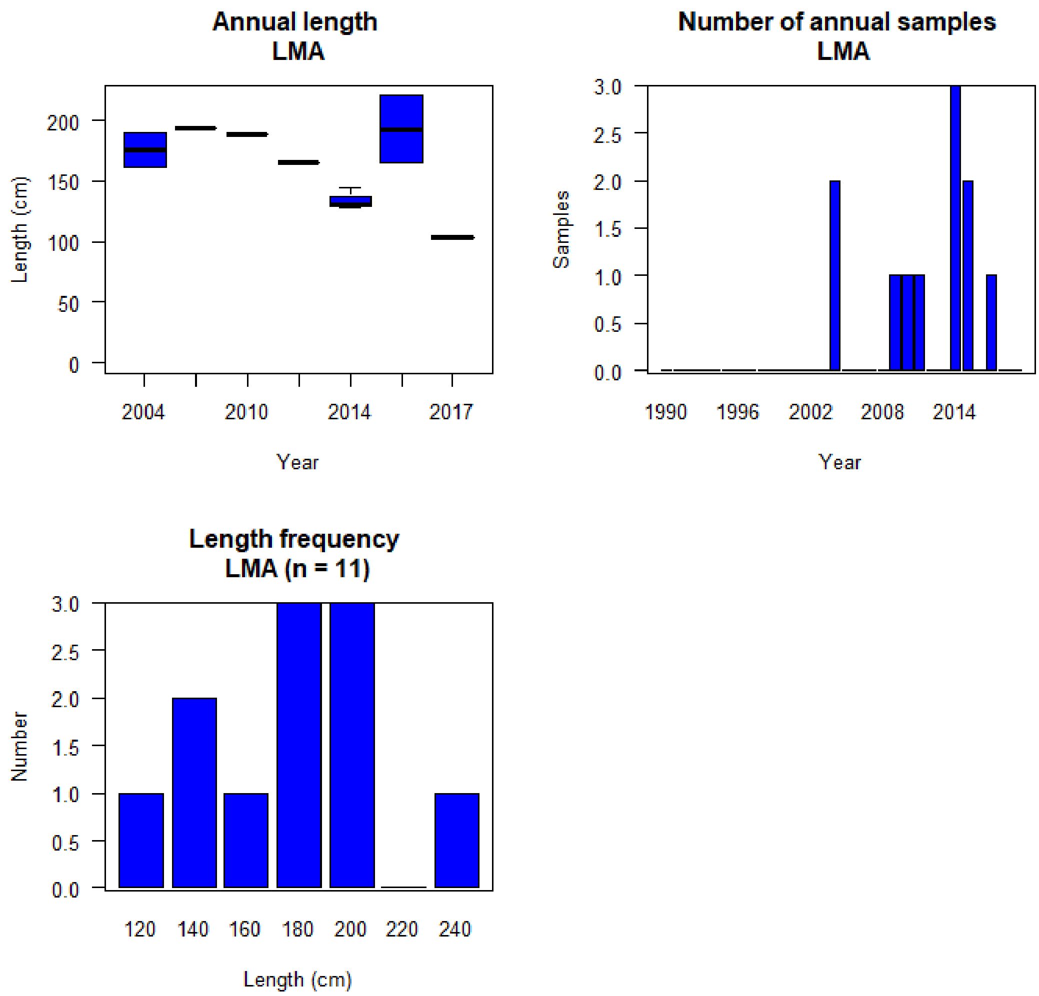


Figure 41: WCPFC observed purse seine length data for longfin mako sharks, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

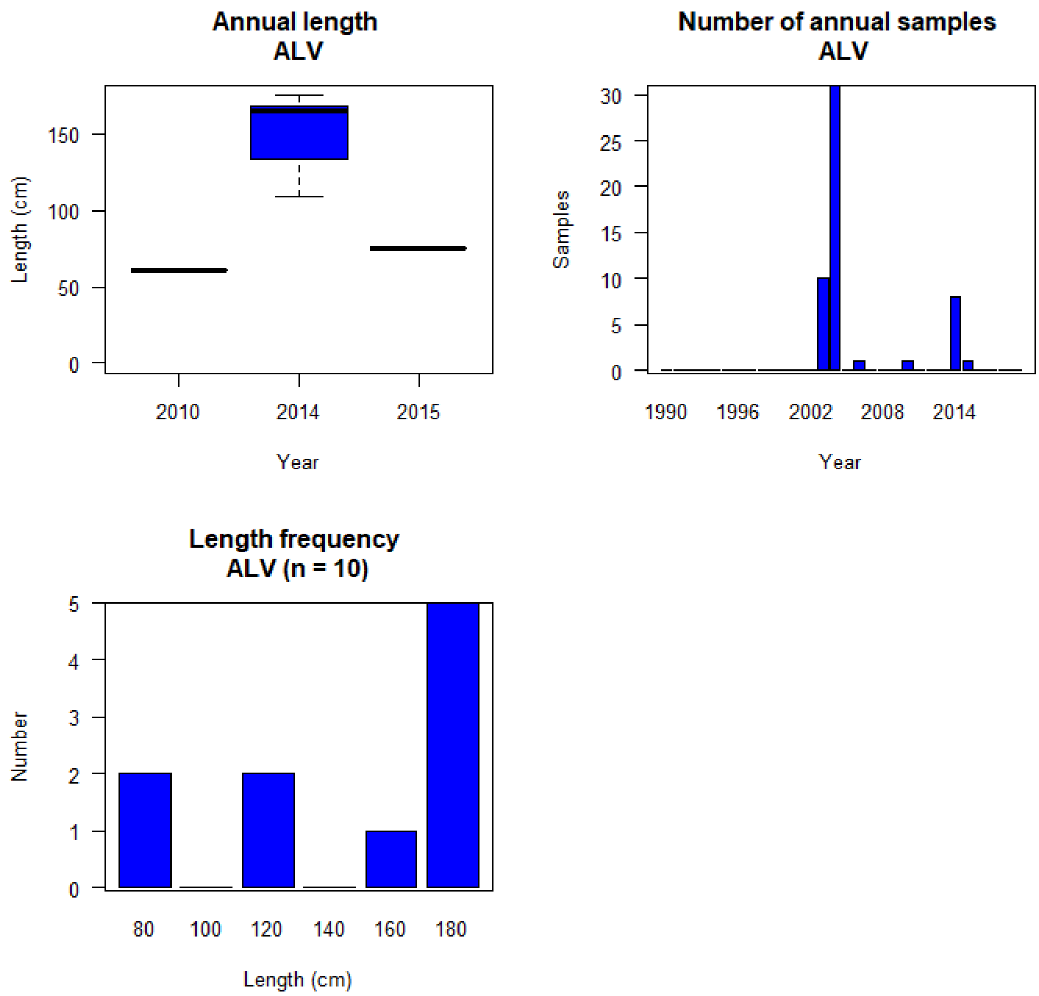


Figure 42: WCPFC observed purse seine length data for common thresher sharks, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

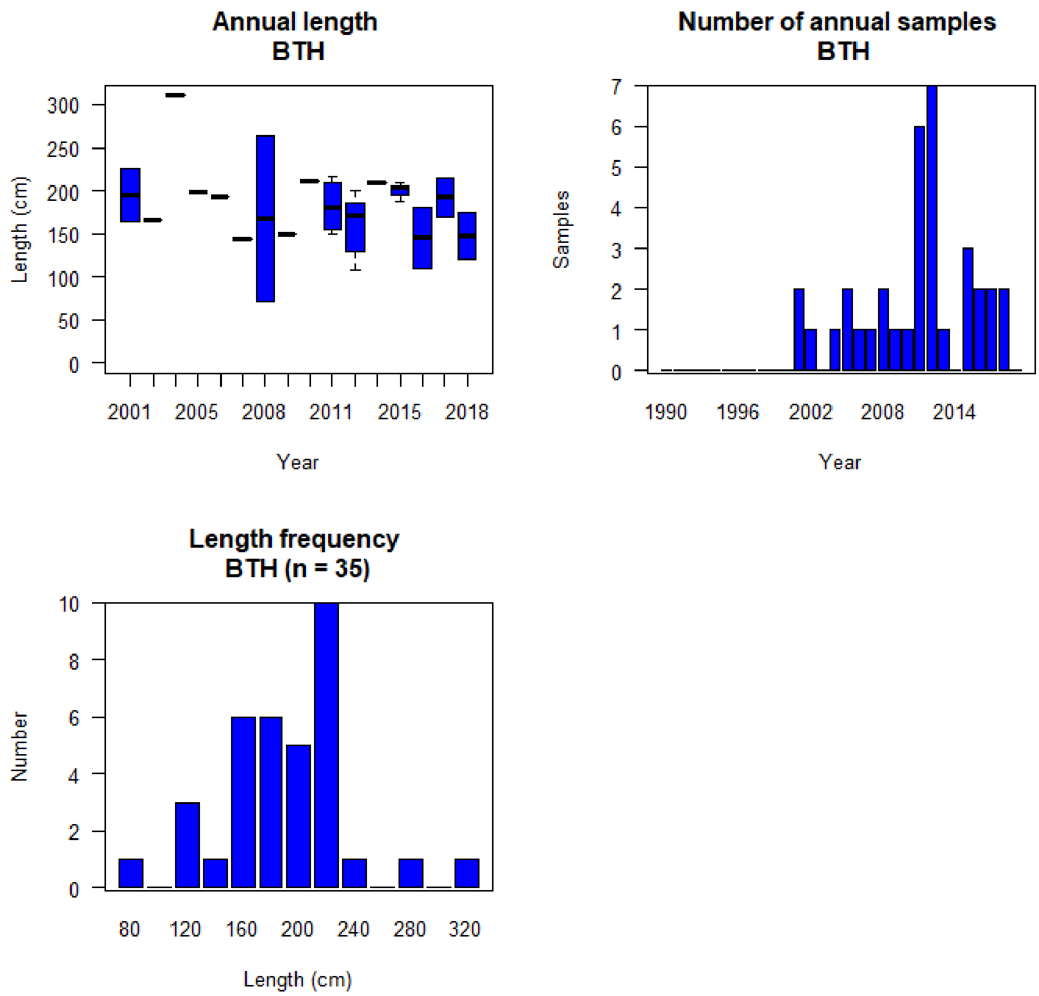


Figure 43: WCPFC observed purse seine length data for bigeye thresher sharks, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

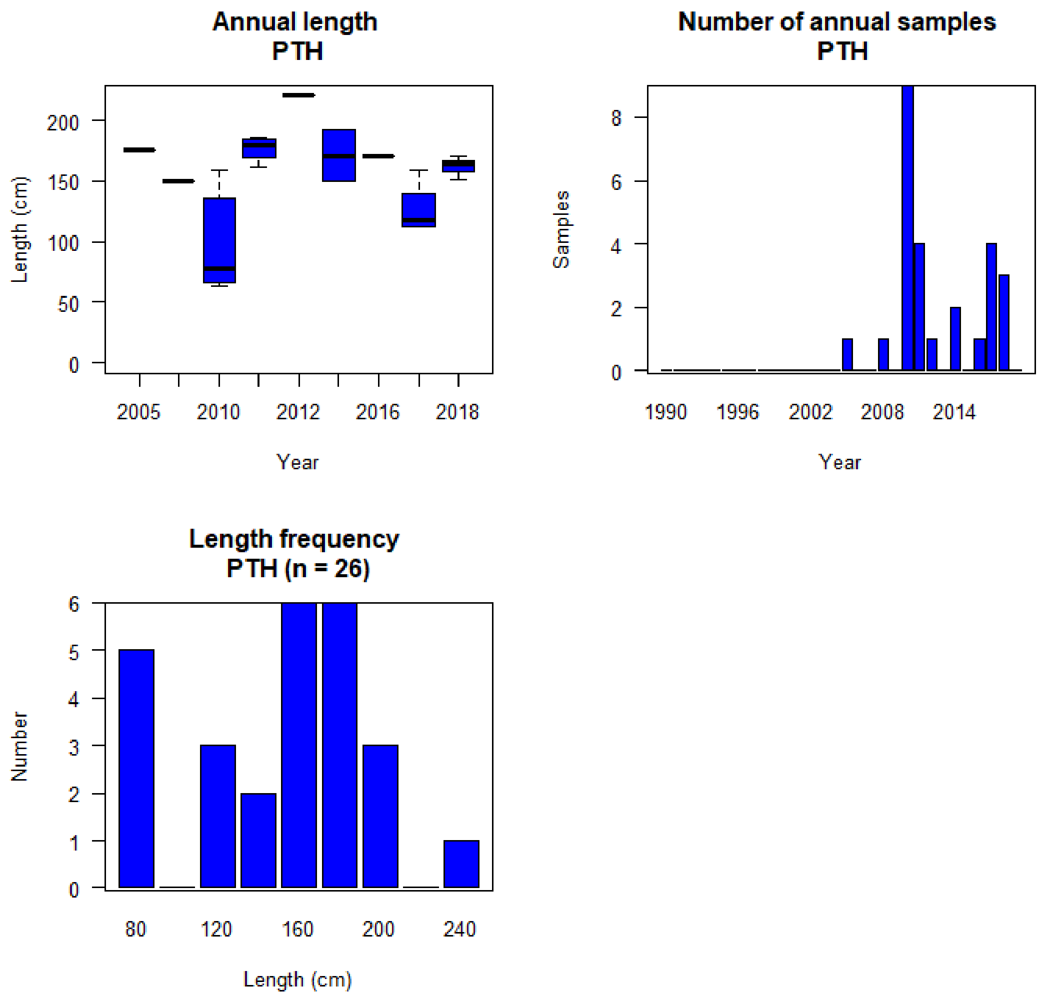


Figure 44: WCPFC observed purse seine length data for pelagic thresher sharks, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

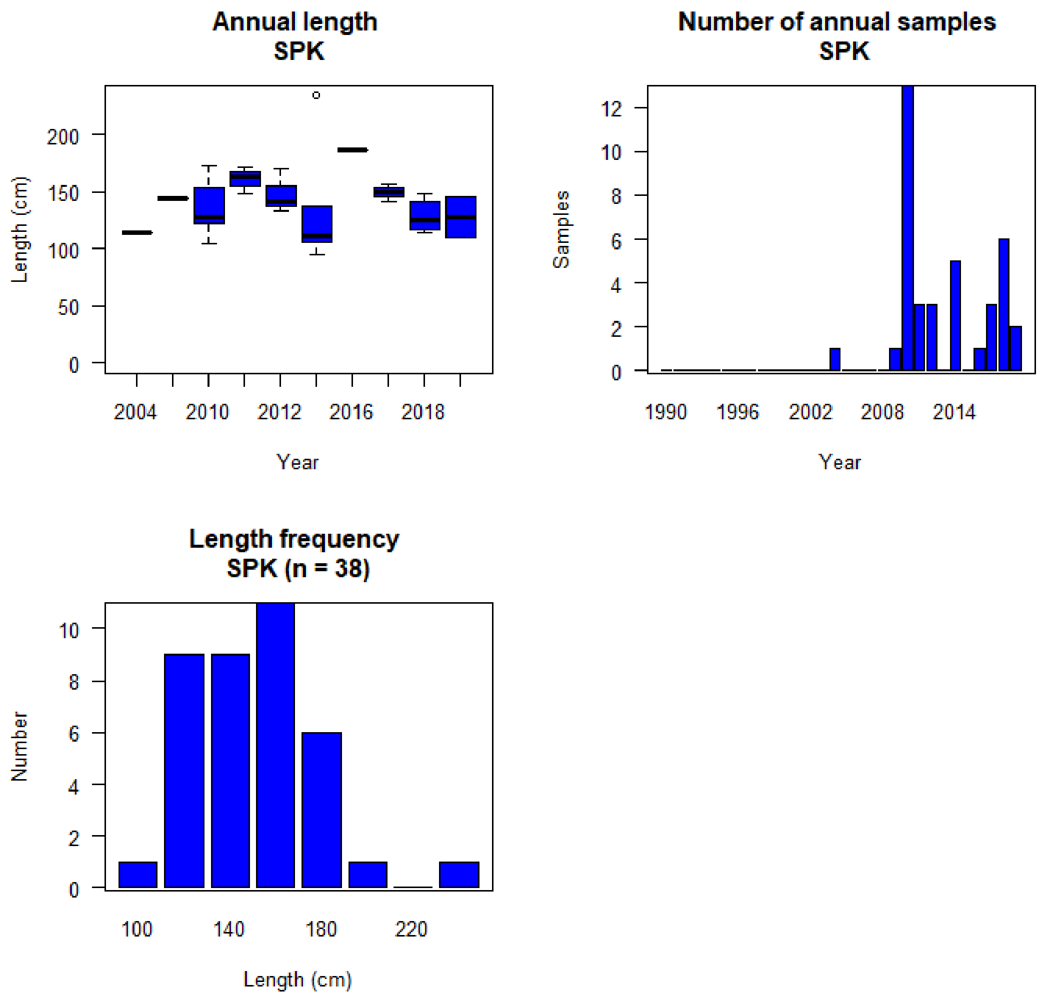


Figure 45: WCPFC observed purse seine length data for great hammerhead sharks, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

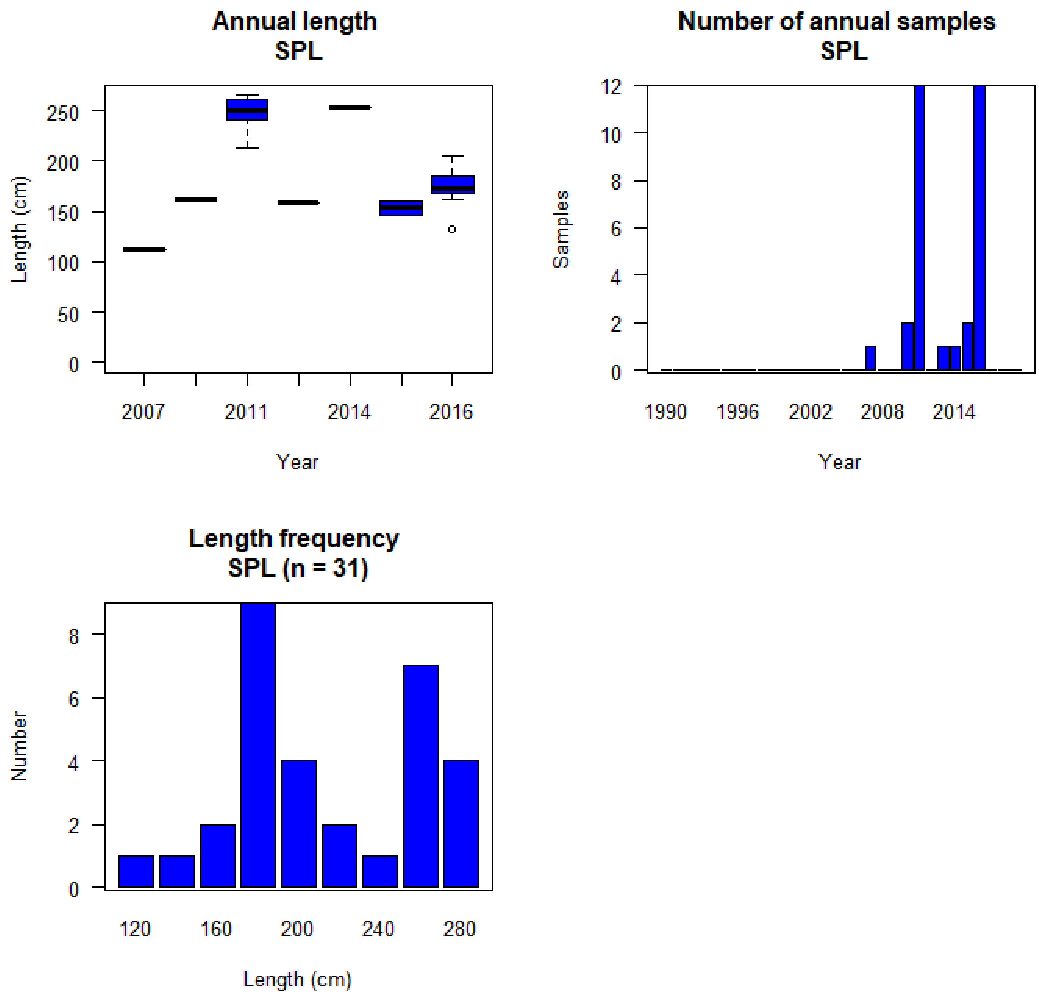


Figure 46: WCPFC observed purse seine length data for scalloped hammerhead sharks, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

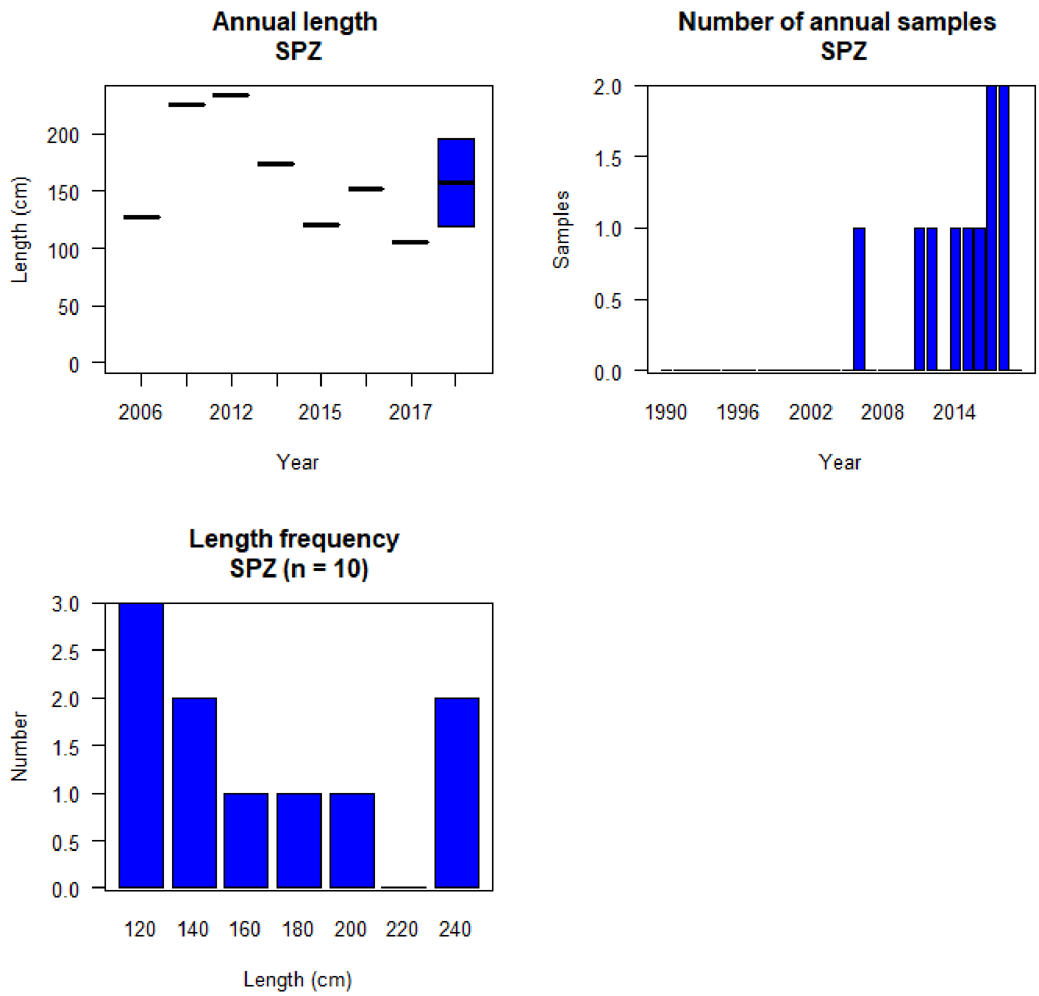


Figure 47: WCPFC observed purse seine length data for smooth hammerhead sharks, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

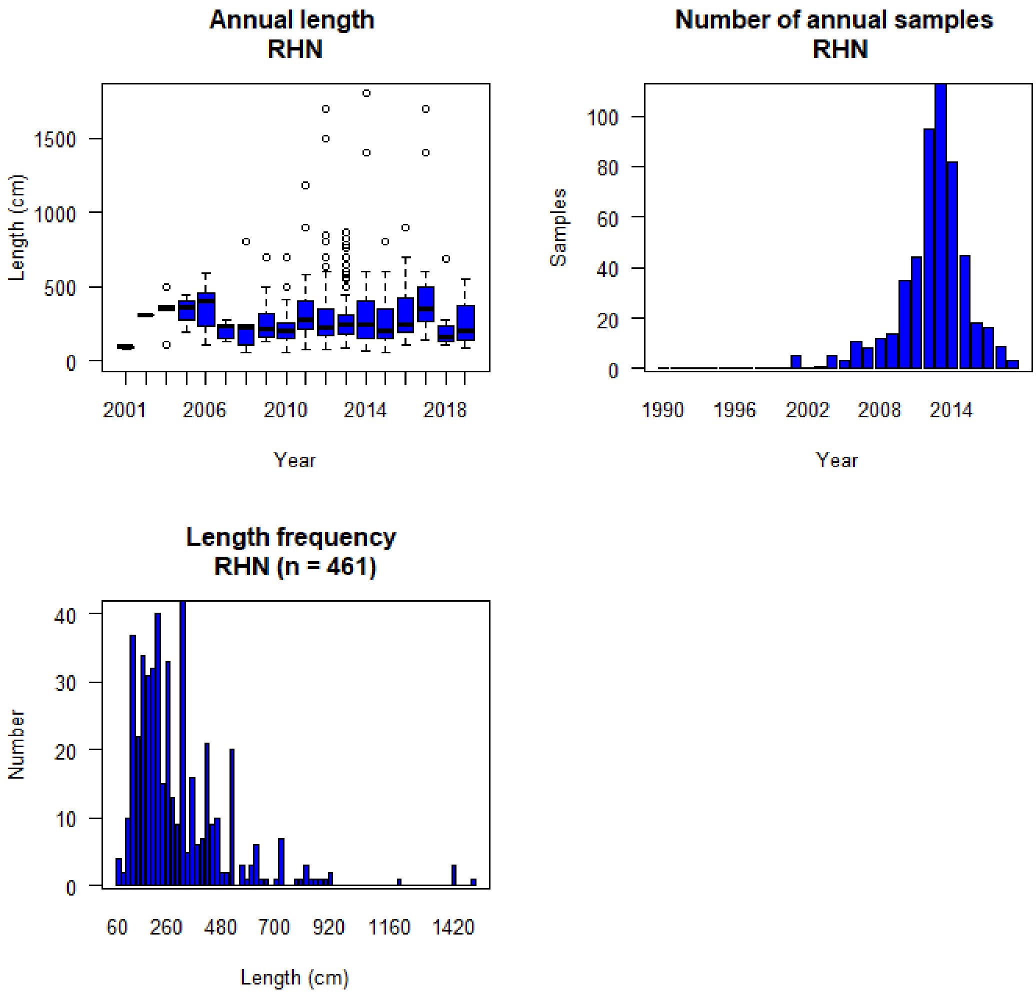


Figure 48: WCPFC observed purse seine length data for whale sharks, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25^{th} and upper 75^{th} percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

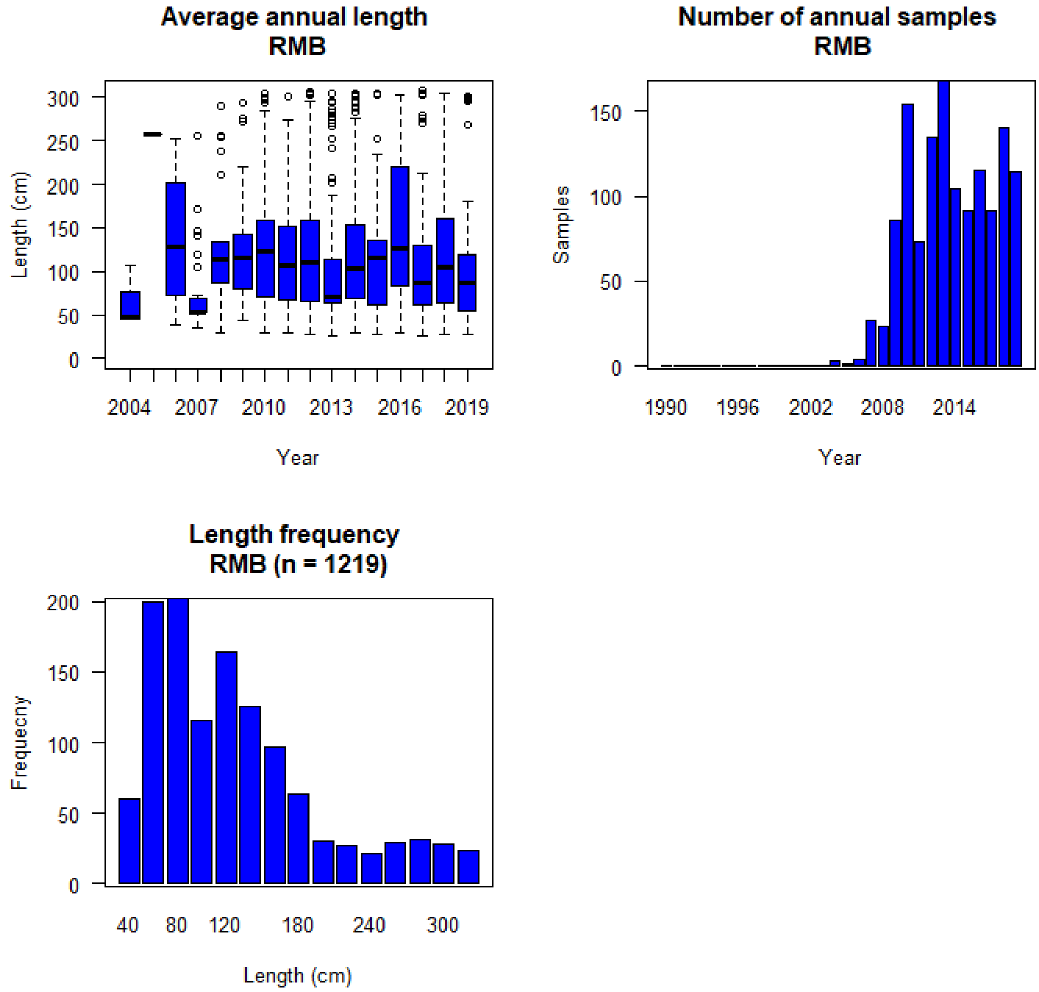


Figure 49: WCPFC observed purse seine length data for giant manta rays, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

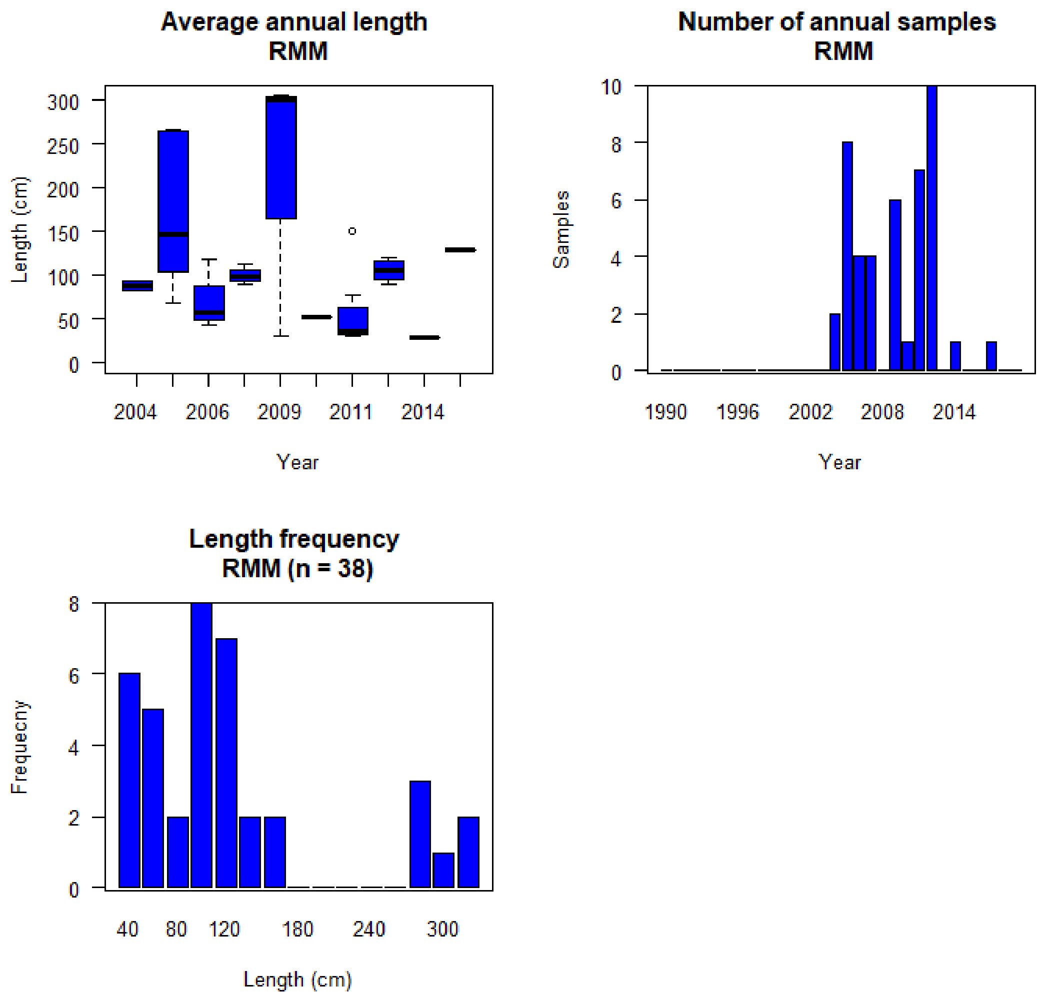


Figure 50: WCPFC observed purse seine length data for devilrays, showing the distribution of annual length measurements (top left); number of length sample from each year (top right); and the length frequency distribution (bottom left). The boxes show the median (black line), lower 25th and upper 75th percentile values of the distributions, the whiskers indicate the range in which most of the values fall and the points indicate outliers.

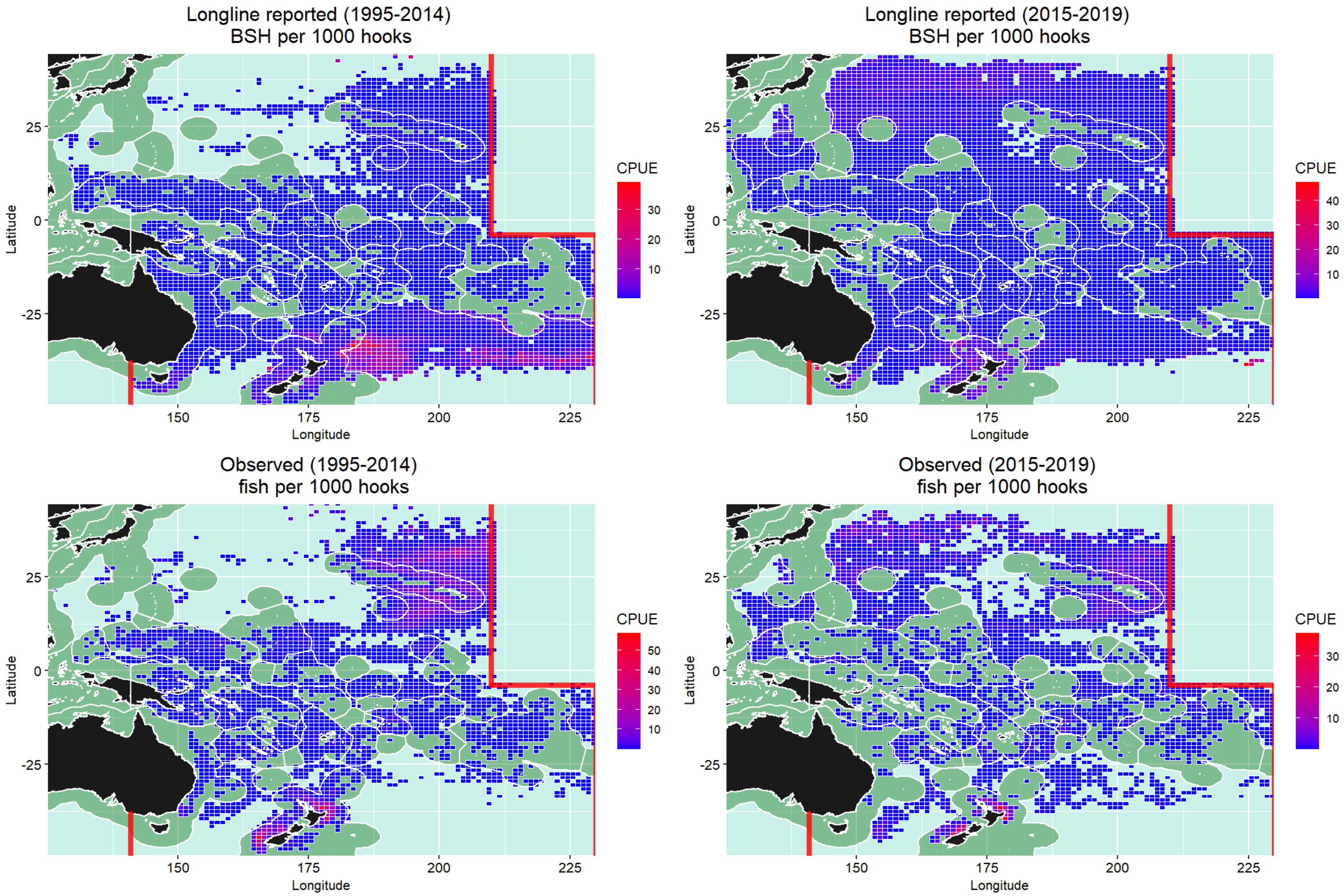


Figure 51: WCPFC distribution of the longline reported (top) and observed catch (bottom) for blue sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

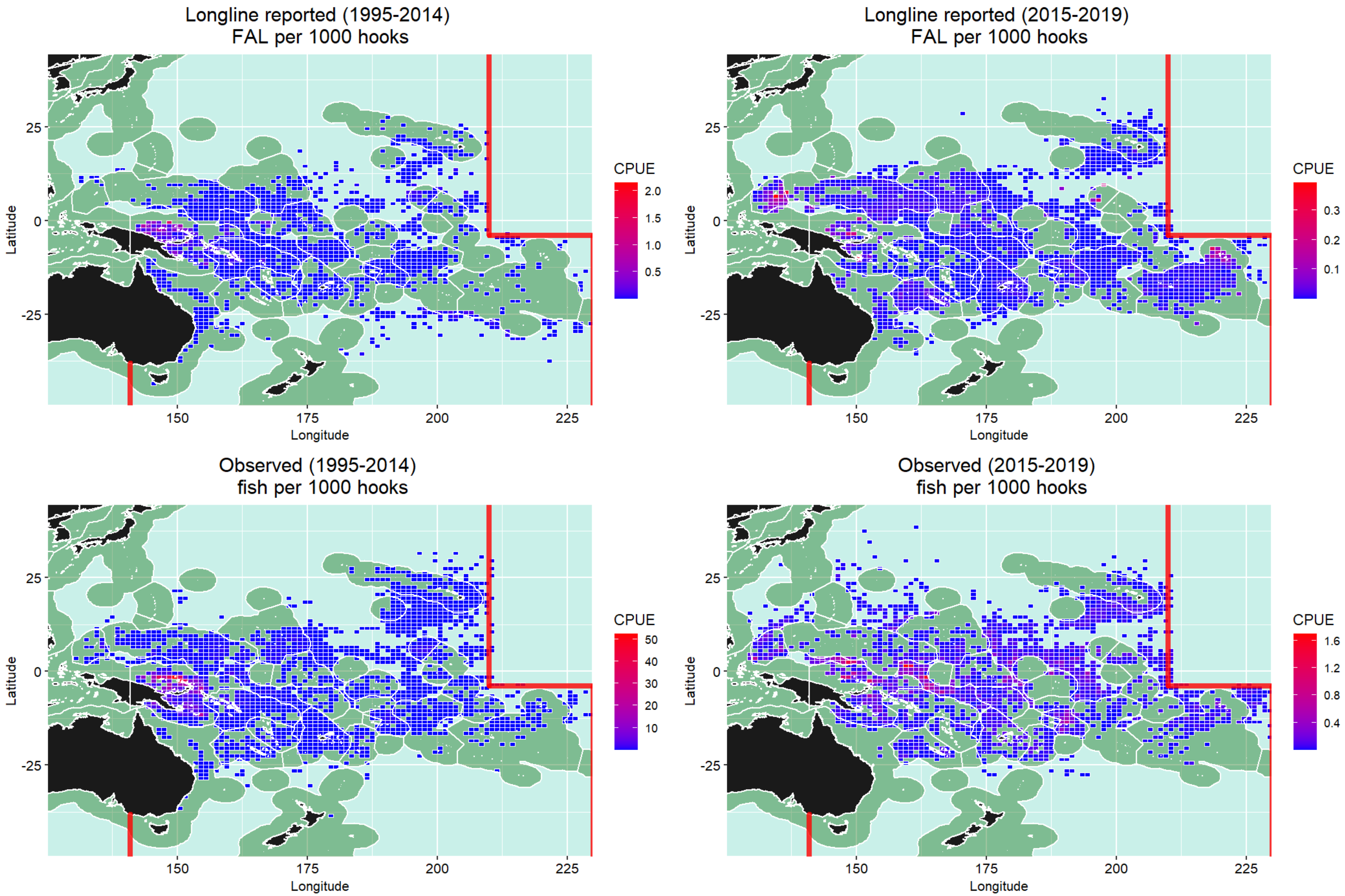


Figure 52: WCPFC distribution of the longline reported (top) and observed catch (bottom) for silky sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

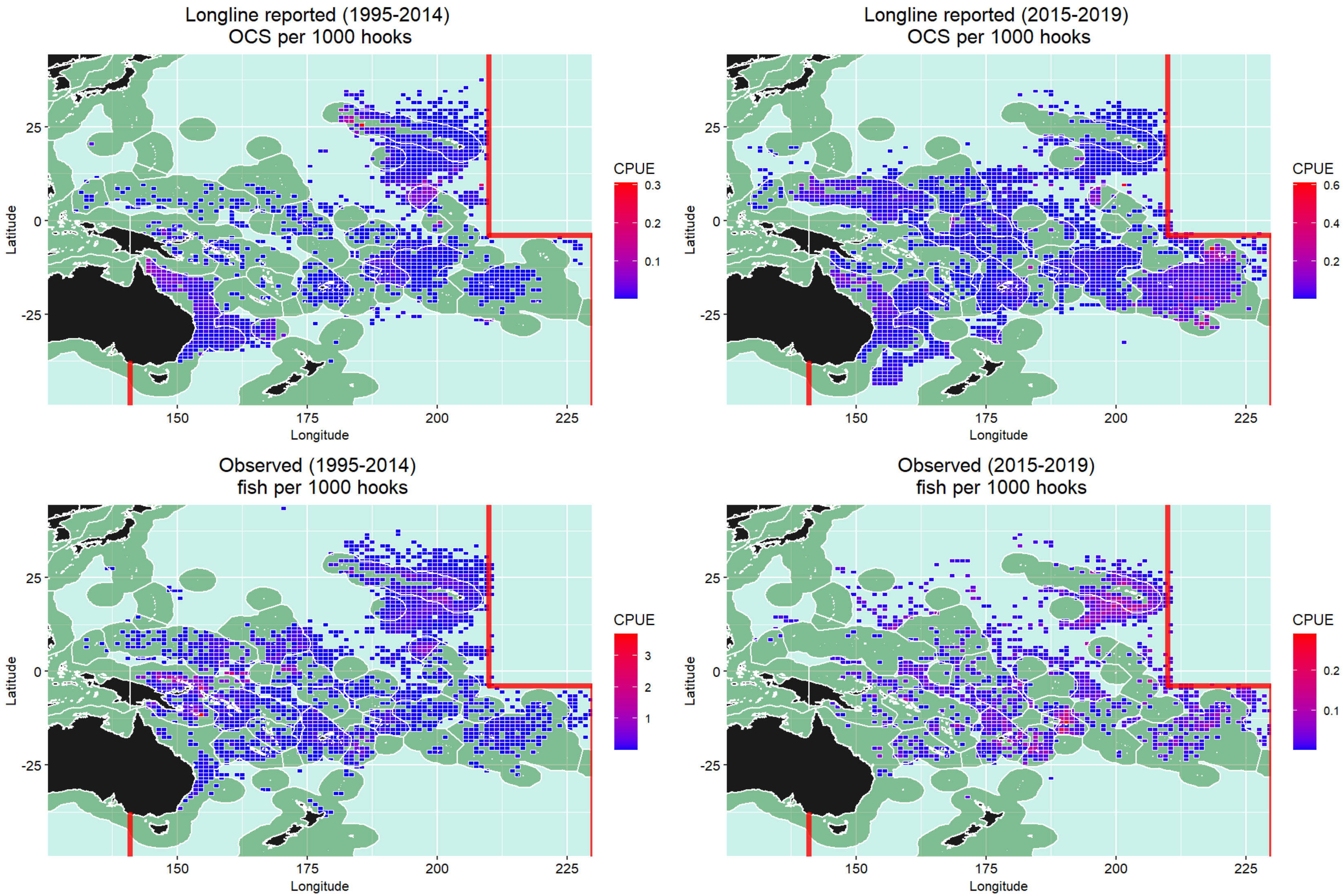


Figure 53: WCPFC distribution of the longline reported (top) and observed catch (bottom) for oceanic whitetip sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

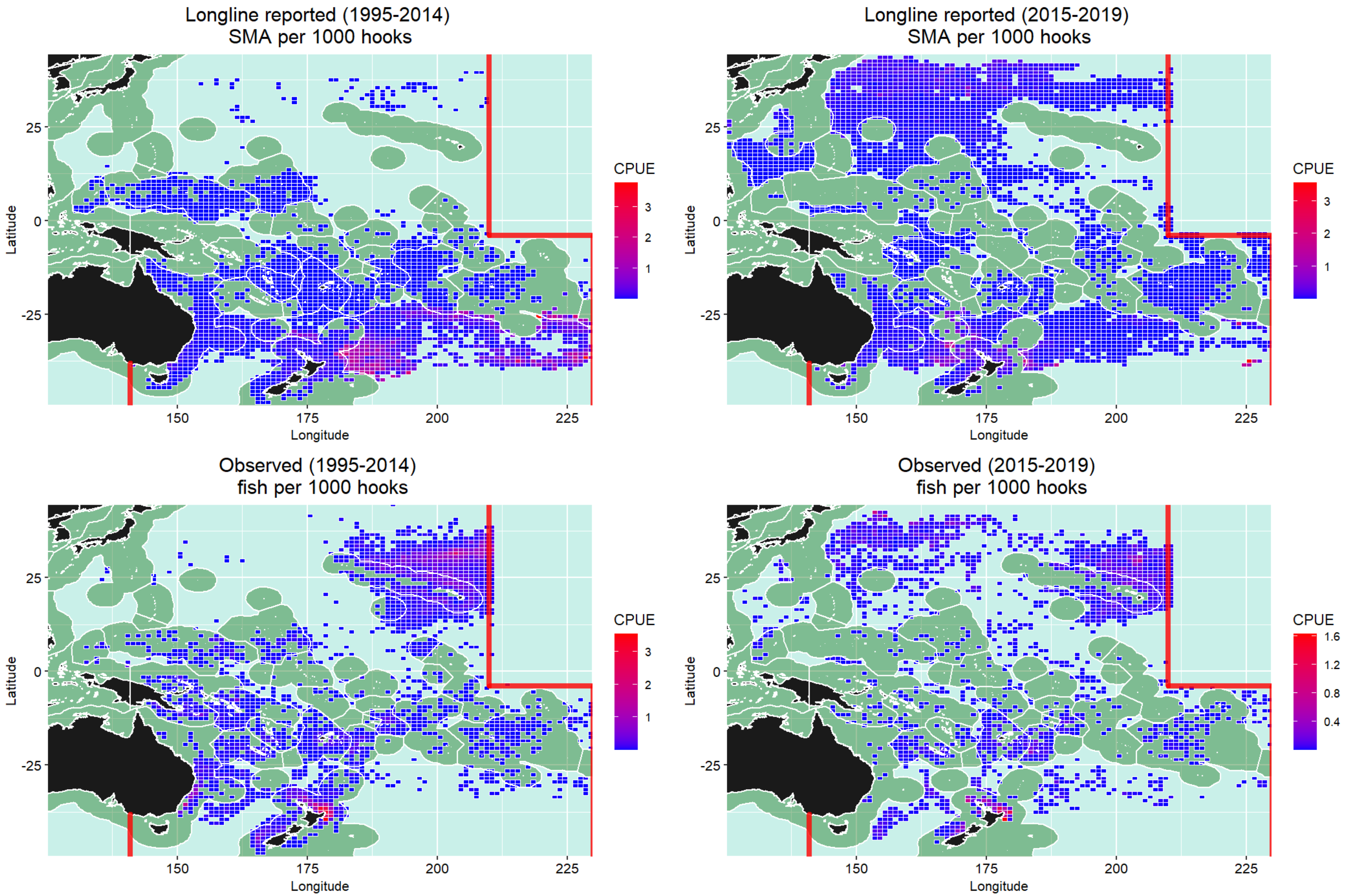


Figure 54: WCPFC distribution of the longline reported (top) and observed catch (bottom) for shortfin mako sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

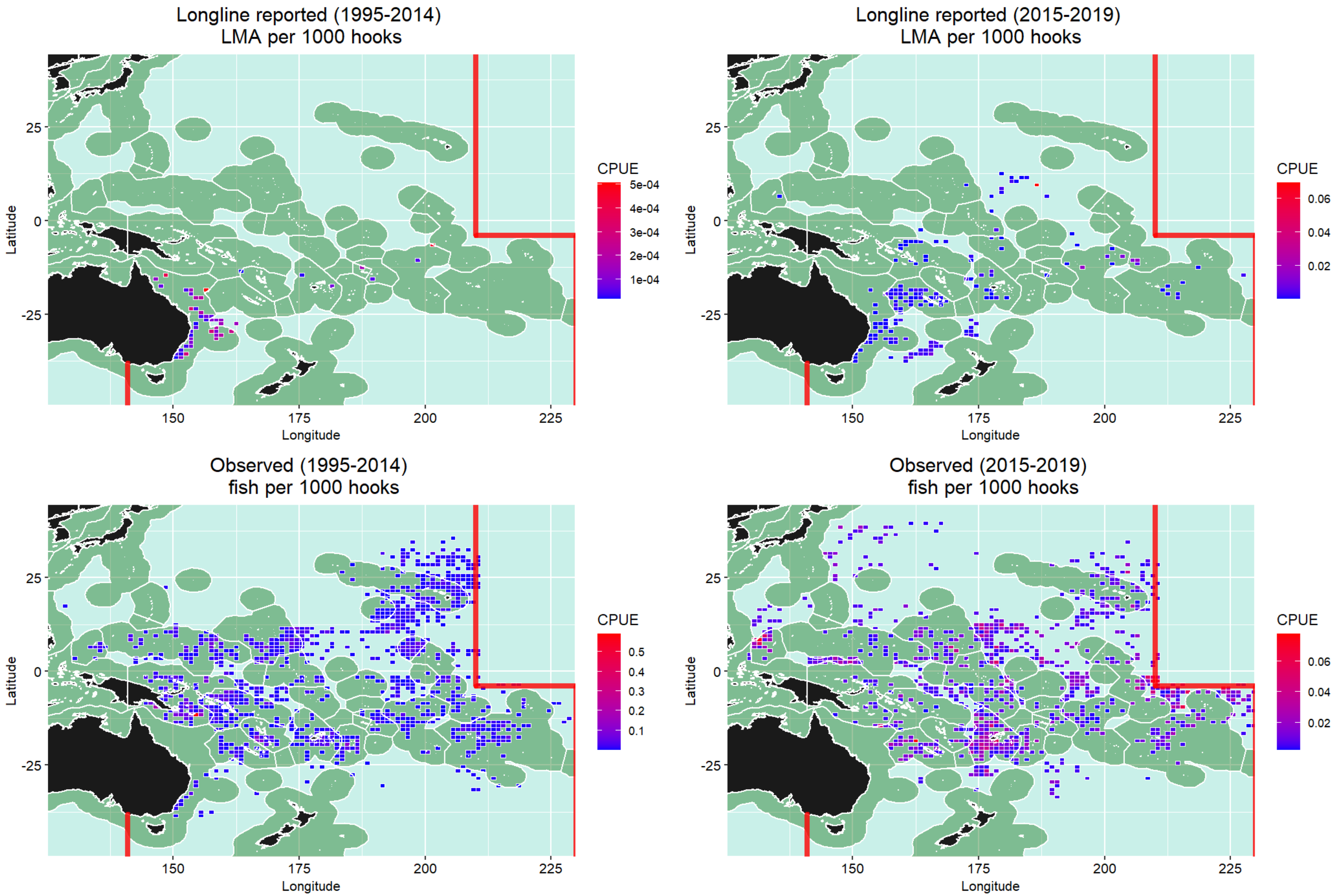


Figure 55: WCPFC distribution of the longline reported (top) and observed catch (bottom) for longfin mako sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

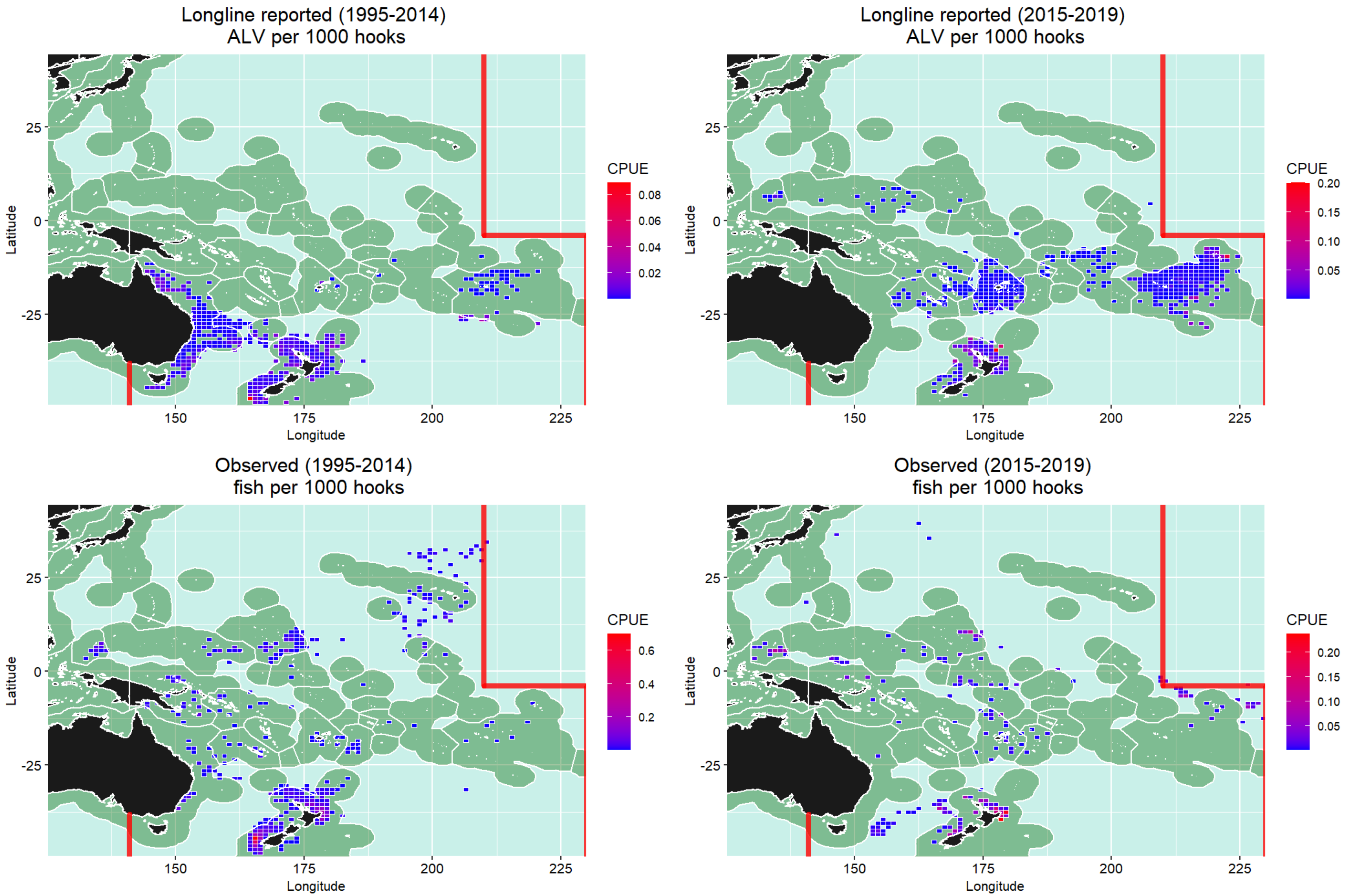


Figure 56: WCPFC distribution of the longline reported (top) and observed catch (bottom) for common thresher sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

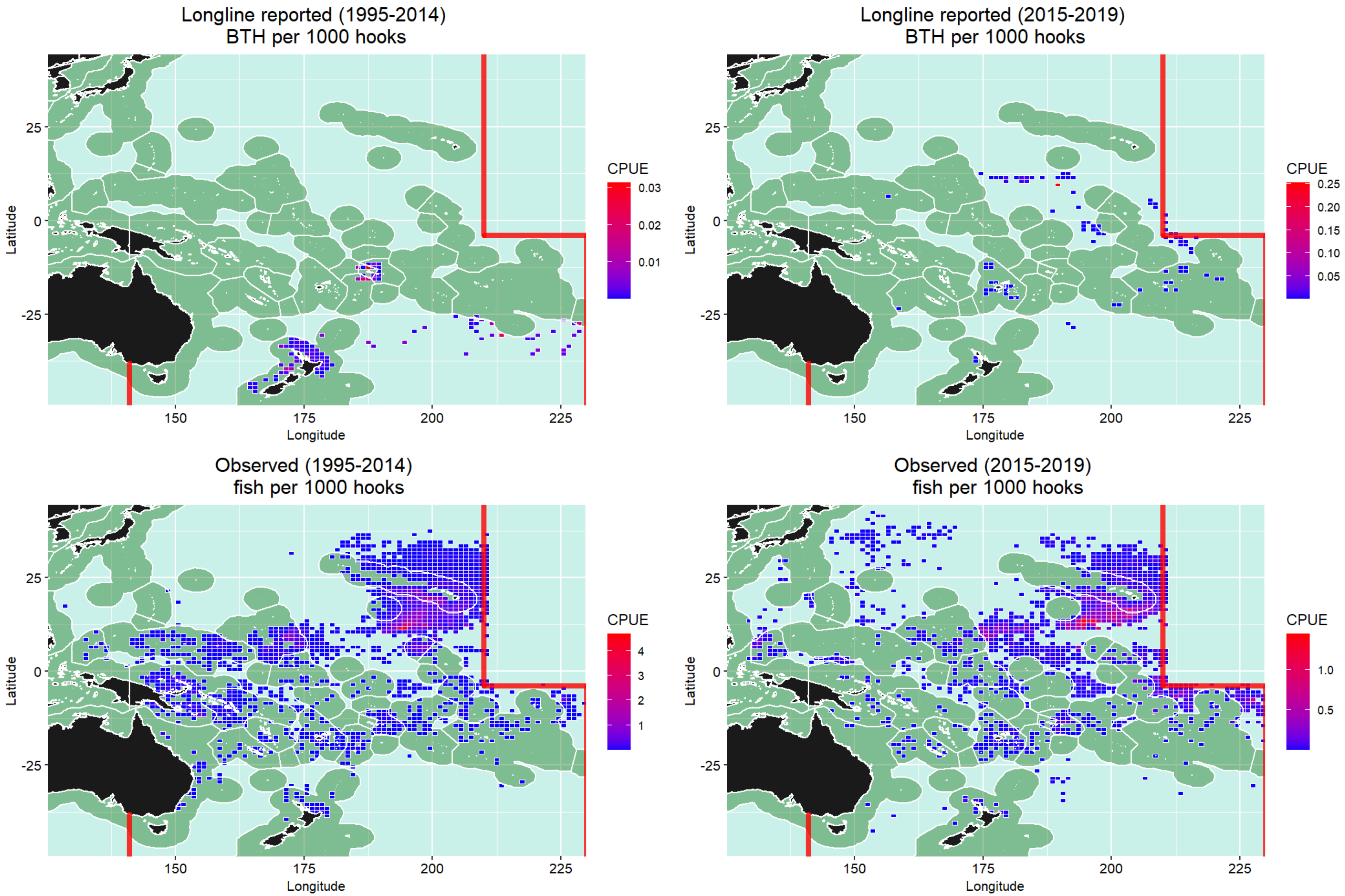


Figure 57: WCPFC distribution of the longline reported (top) and observed catch (bottom) for bigeye thresher sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

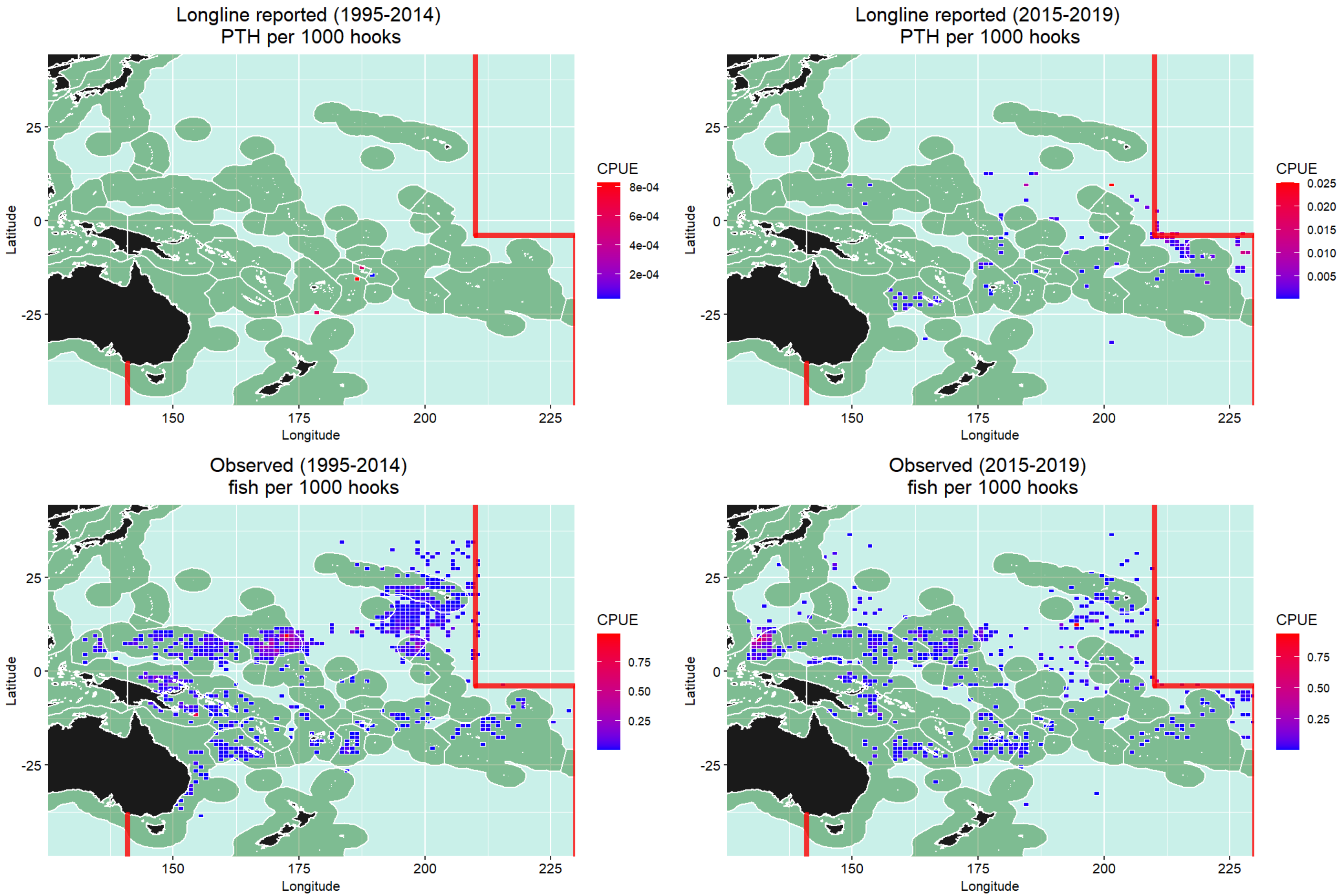


Figure 58: WCPFC distribution of the longline reported (top) and observed catch (bottom) for pelagic thresher sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

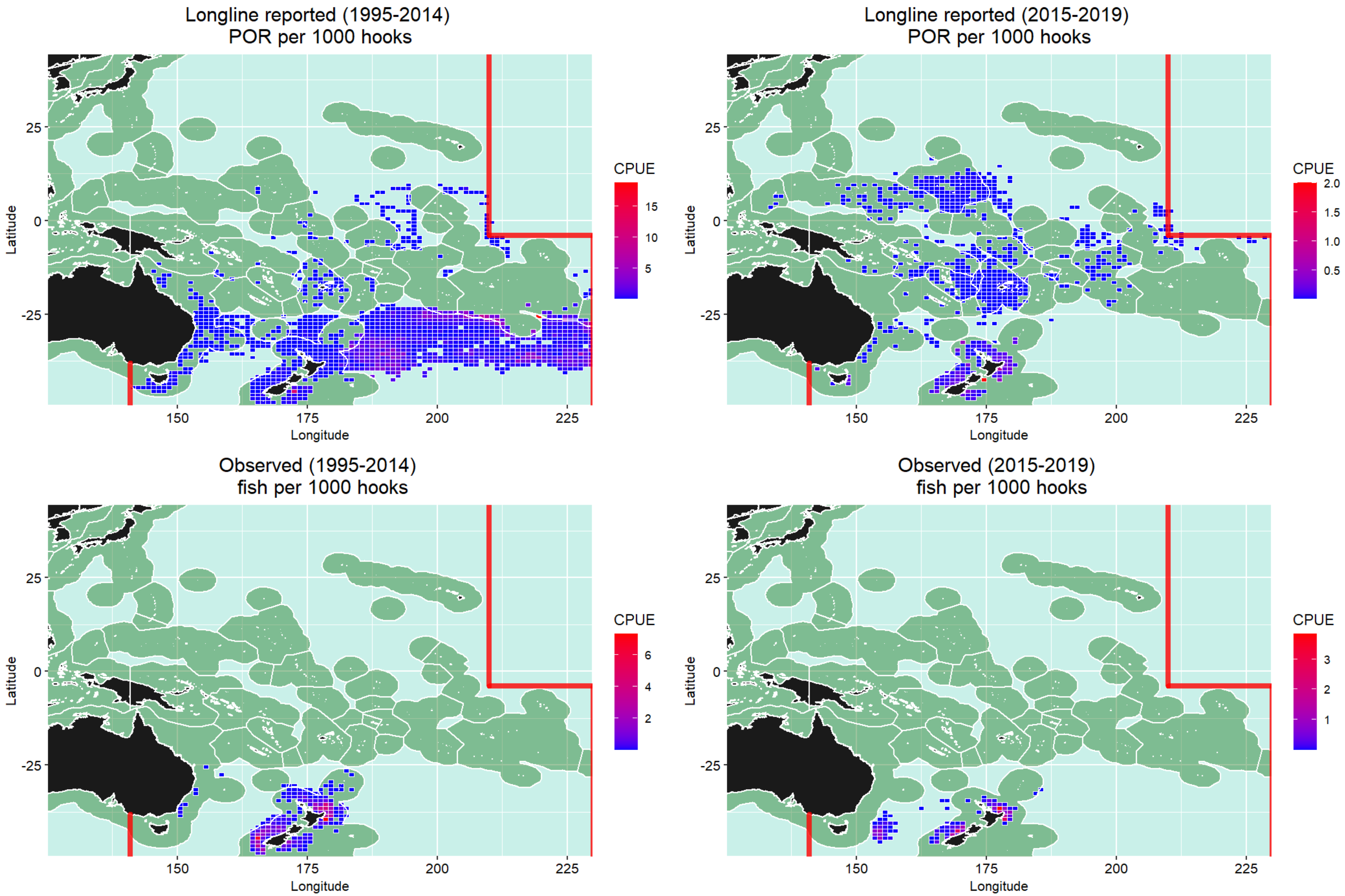


Figure 59: WCPFC distribution of the longline reported (top) and observed catch (bottom) for porbeagle sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

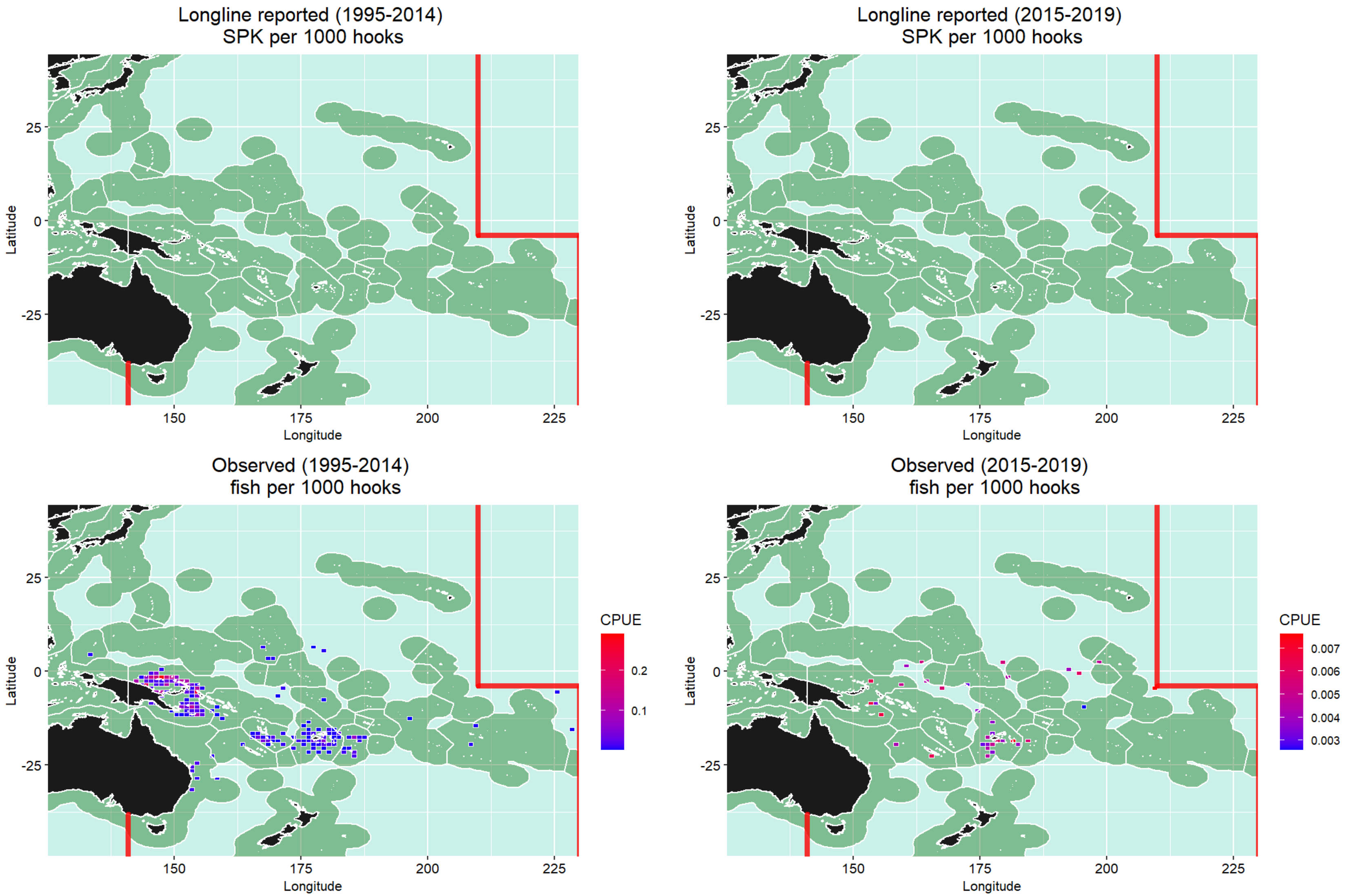


Figure 60: WCPFC distribution of the longline reported (top) and observed catch (bottom) for great hammerhead sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

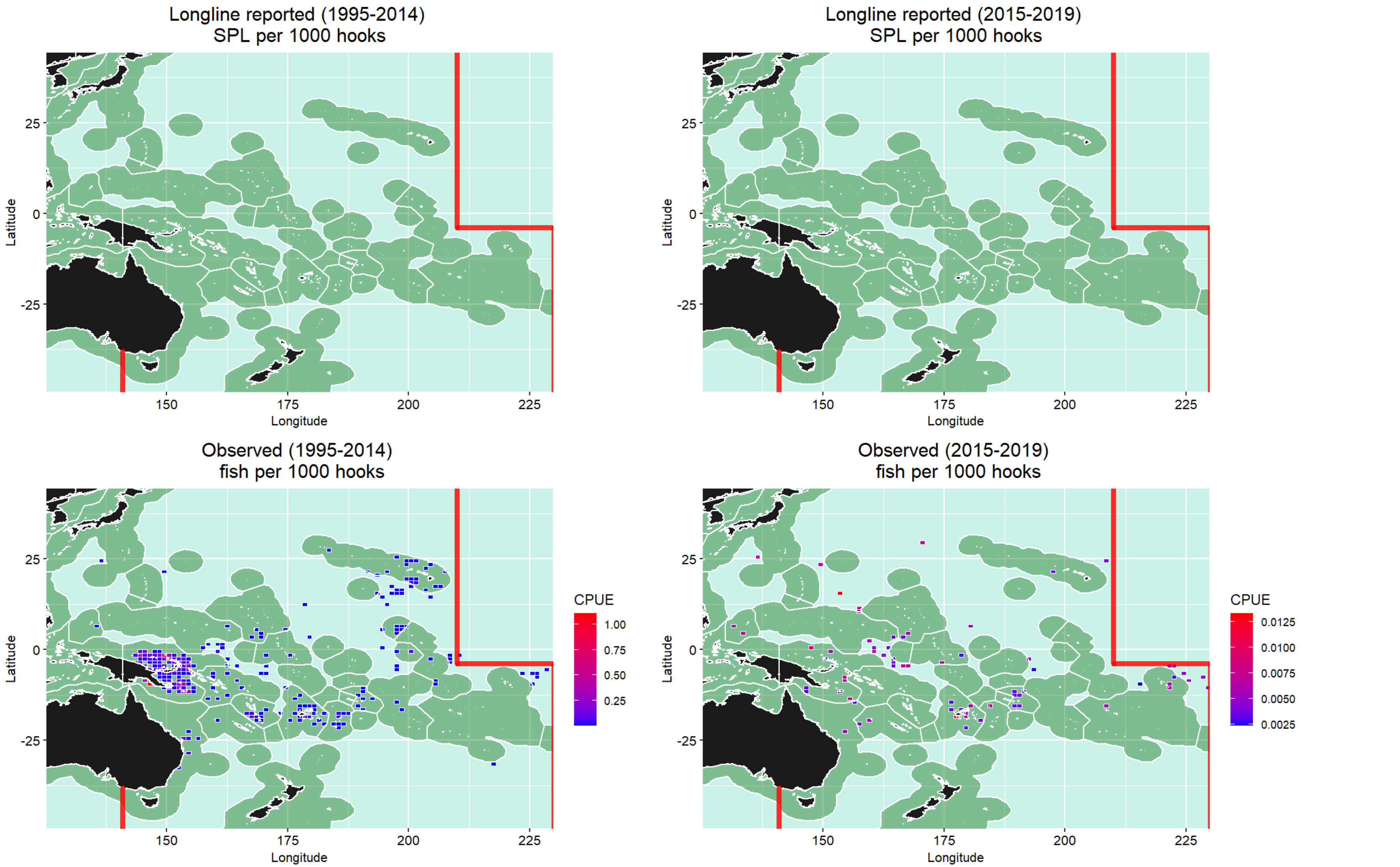


Figure 61: WCPFC distribution of the longline reported (top) and observed catch (bottom) for scalloped hammerhead sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

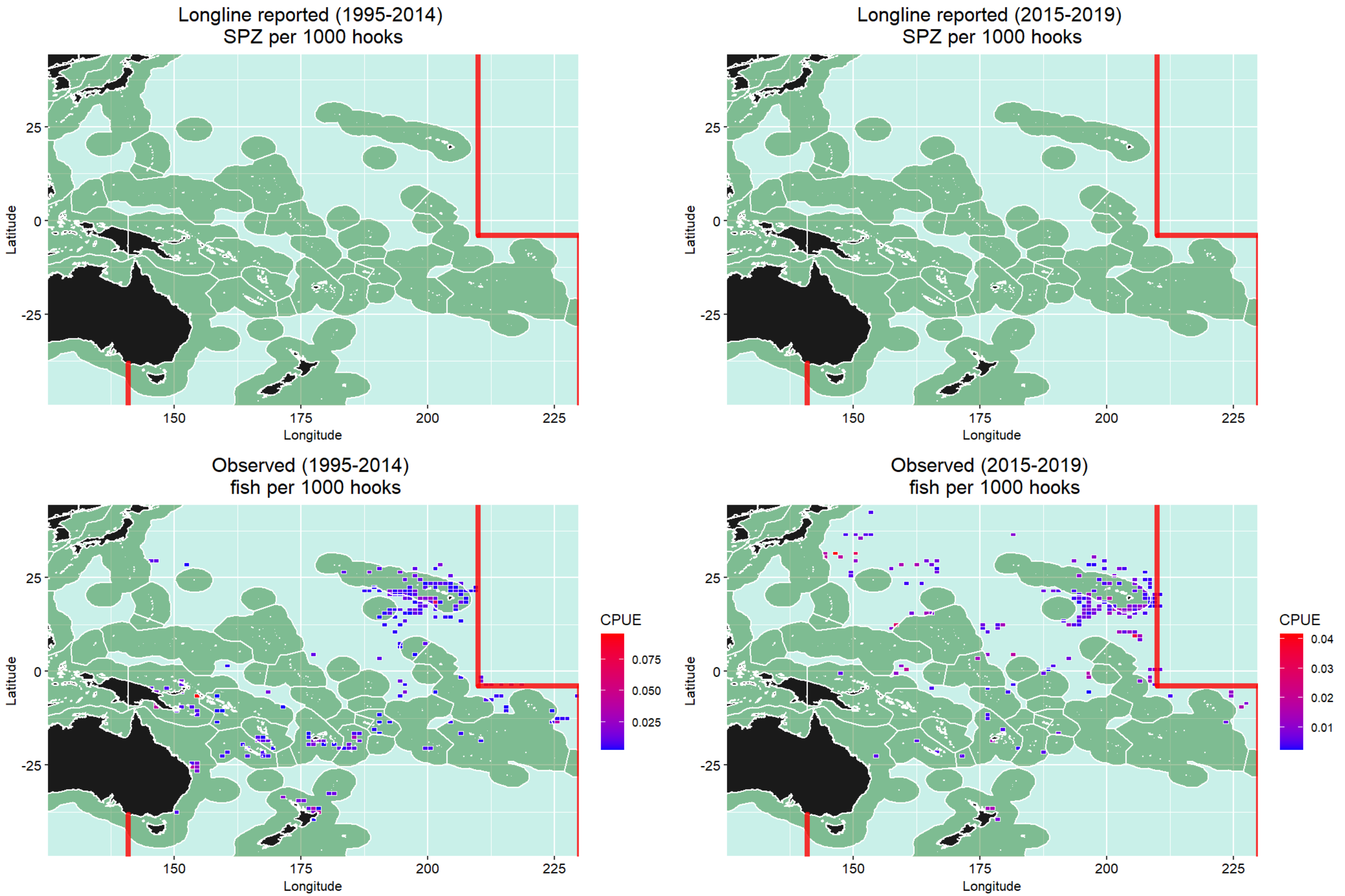


Figure 62: WCPFC distribution of the longline reported (top) and observed catch (bottom) for smooth hammerhead sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

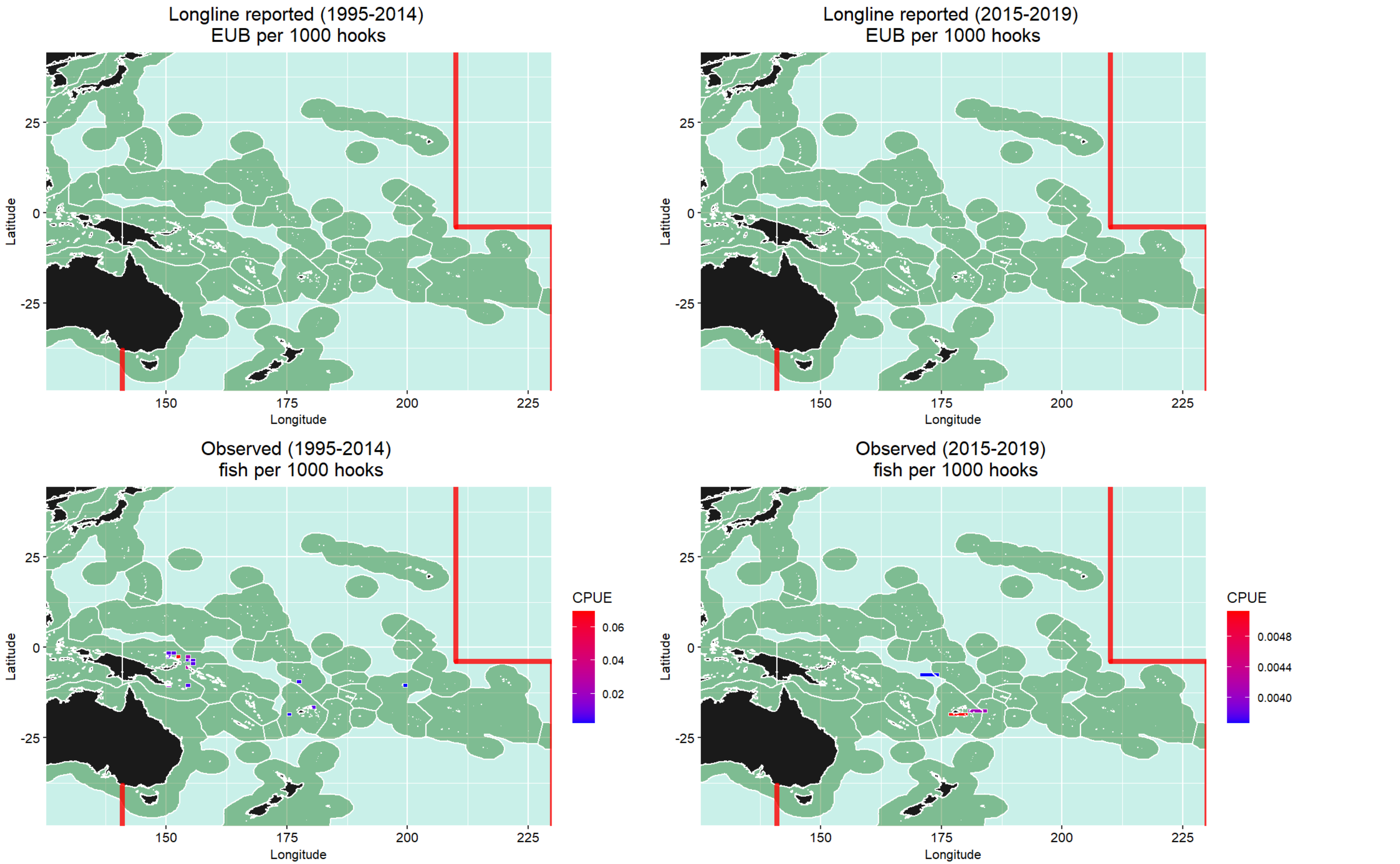


Figure 63: WCPFC distribution of the longline reported (top) and observed catch (bottom) for winghead sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

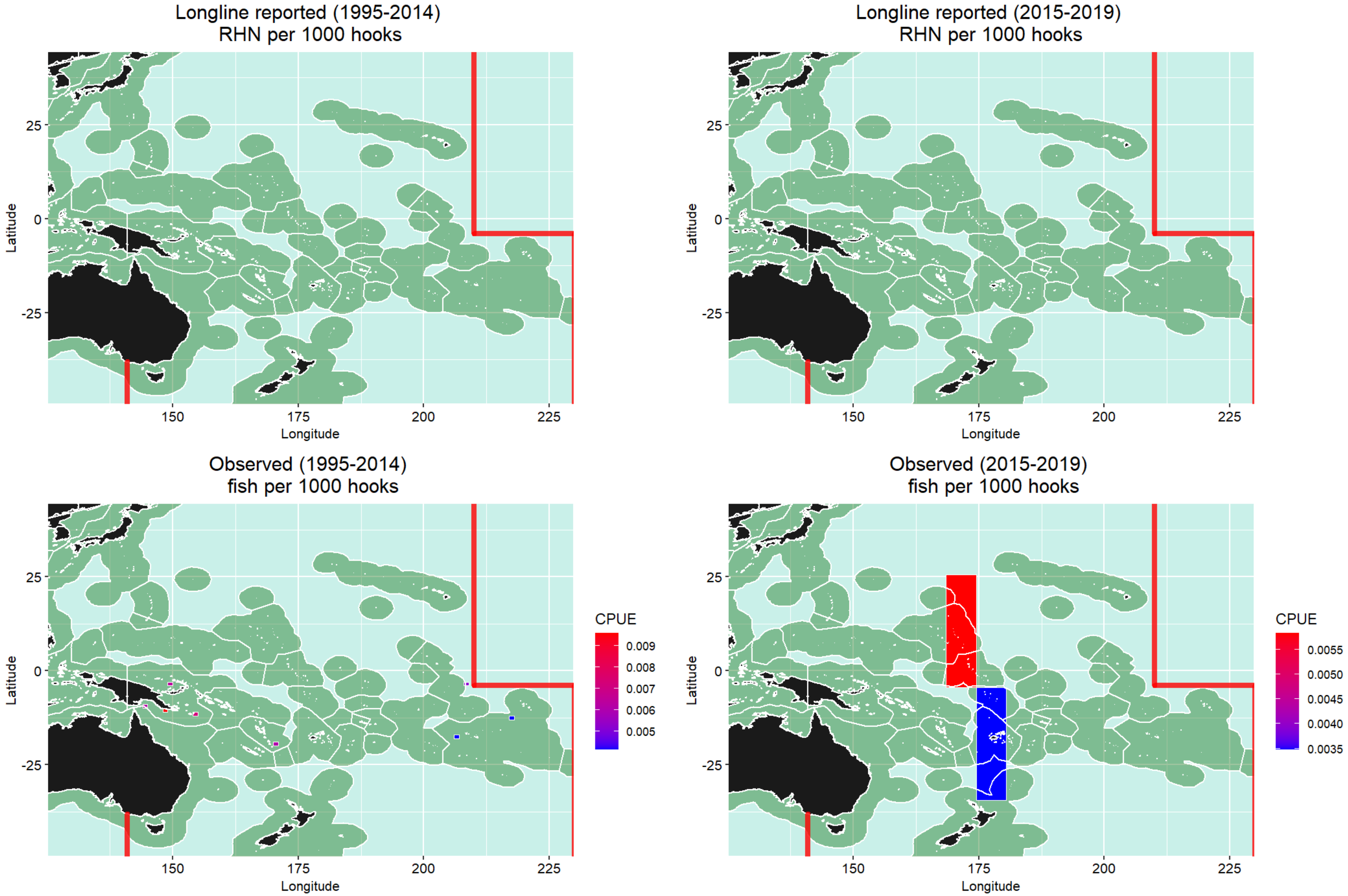
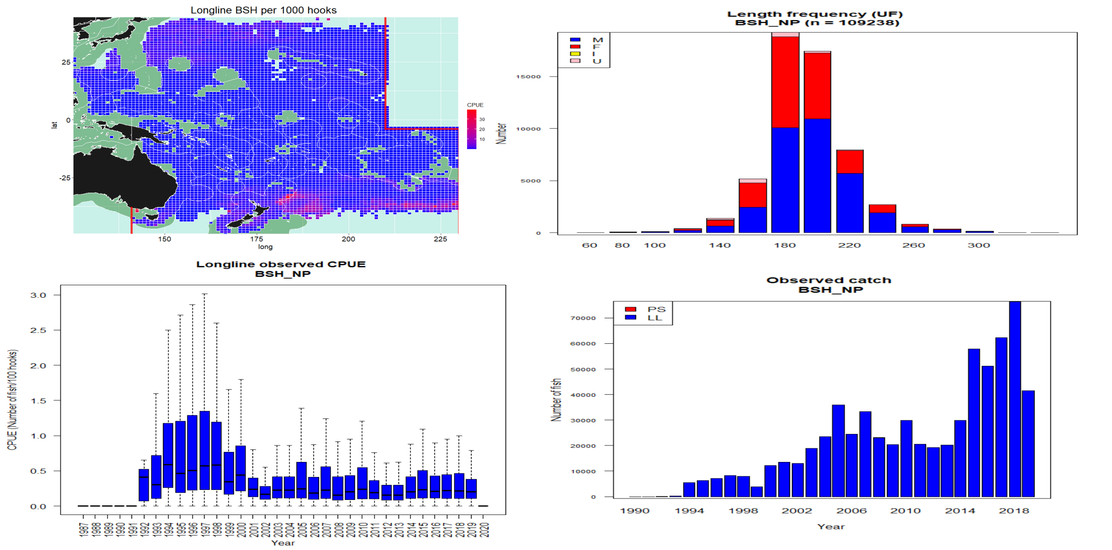


Figure 64: WCPFC distribution of the longline reported (top) and observed catch (bottom) for whale sharks from 1995-2019 presented as observed individuals per observed hooks set, shown for two time periods 1995-2014 (left) and 2015-2019 (right).

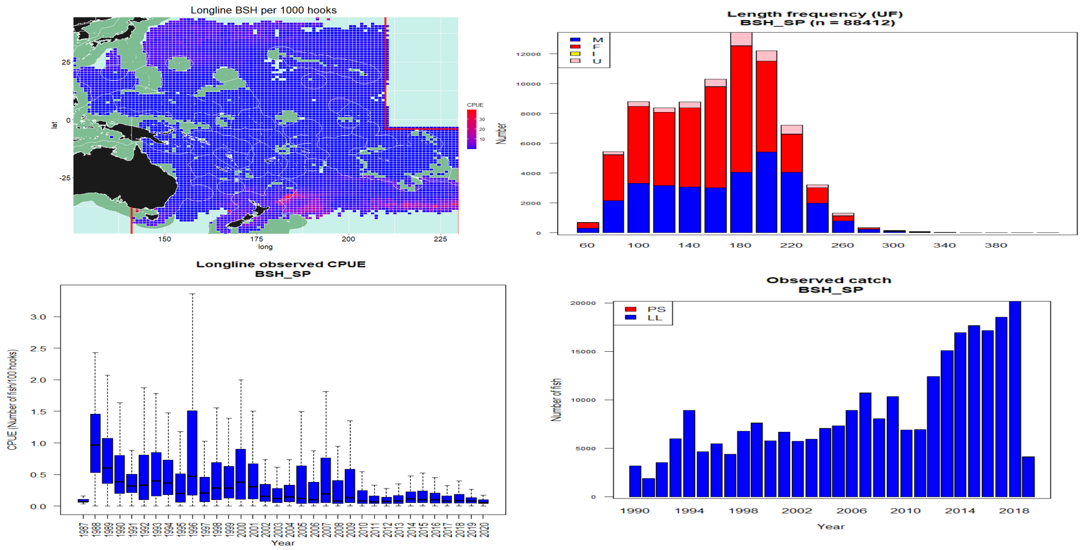
Blue shark − NP



Assessment Results							
Assessment Type				Stock Status			
Data rich (2017)				Not overfished, No overfishing			
Life History							
L max	290 − 380	Max age	16−28	Repro cycle	12 − 24	Spawning	May−Sept
k	0.094 − 0.251	Age recruit	0−1	Gestation	9 − 12	M	0.058−0.413
Len birth	35−60	Age mat	4−7	Litter size	1 − 112	r	0.34
L0	−1.554 − −0.759	Len mat	140−196 cm	Pupping	Feb−Mar	Conv factors	Various
Sex specific parameters		Yes		Steepness		0.459−0.622	
Stock delineation		Equator north		Release mortality (%)		17−24 (LL)	
International conventions							
CITES				NA			
CMS				Appendix II			
IUCN Red list				Near threatened			
WCPFC CMMs							
CMM2014−05; CMM2010−07; CMM2019−04							

Figure 65: WCPFC research information summary sheet for blue shark in the north Pacific. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019), Fujinami et al. (2017), ISC (2017) and Fujinami et al. (2019).

Blue shark − SP



Assessment Results	
Assessment Type	Stock Status
Data rich (2016)	Unknown due to ambiguous results

Life History							
L max	312 − 377	Max age	16−27	Repro cycle	Unknown	Spawning	Unknown
k	0.088 − 0.164	Age recruit	Unknown	Gestation	9−10	M	0.19−0.21
Len birth	Unknown	Age mat	7 − 9	Litter size	13−68	r	0.34
L0	−1.482 − −1.29	Len mat	190−199 cm	Pupping	Apr−Jun	Conv factors	Various

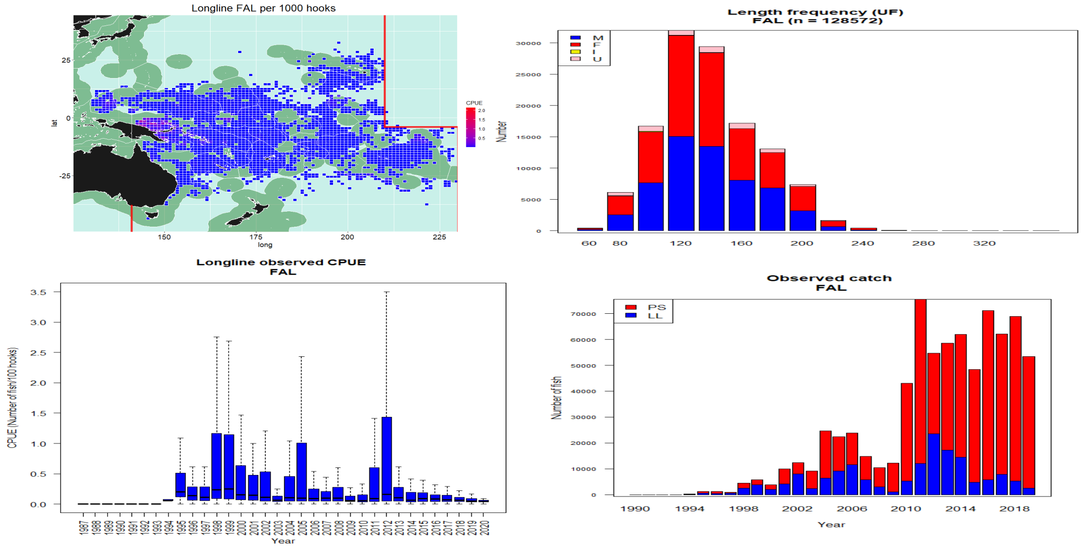
Sex specific parameters	Some	Steepness	0.4−0.8
Stock delineation	Equator south	Release mortality (%)	Unknown

International conventions	
CITES	NA
CMS	Appendix II
IUCN Red list	Near threatened

WCPFC CMMs
CMM2014−05; CMM2010−07; CMM2019−04

Figure 66: WCPFC research information summary sheet for South Pacific blue shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019), Joung et al., 2018 and Takeuchi et al., 2016.

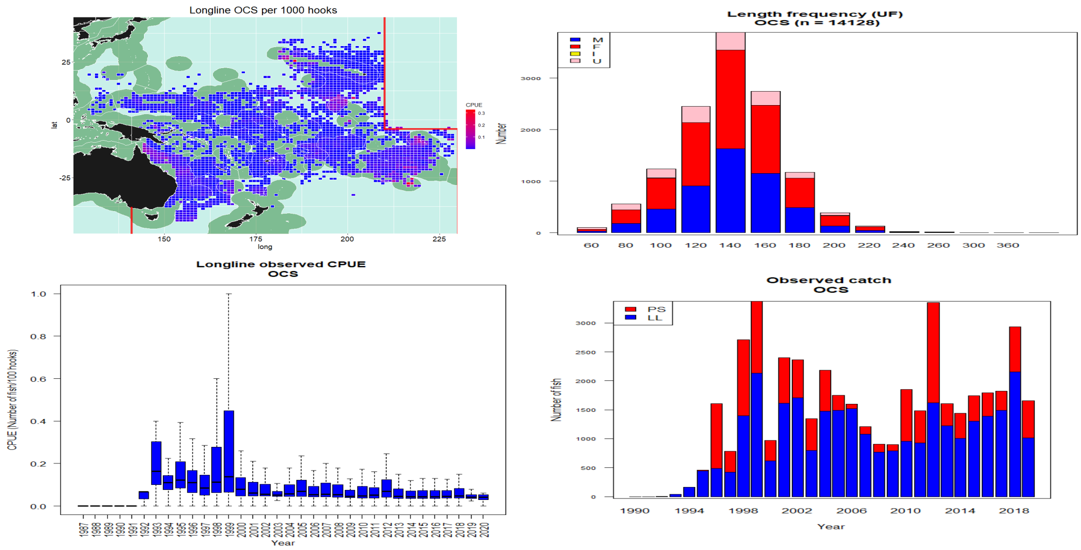
Silky shark



Assessment Results							
Assessment Type				Stock Status			
Data rich (2013 and 2018)				Not overfished, Overfishing taking place			
Life History							
L max	256−350	Max age	25−35	Repro cycle	24	Spawning	Year round
k	0.08−1.4	Age recruit	Unknown	Gestation	12	M	0.179−0.26
Len birth	48−87	Age mat	5−10	Litter size	2−18	r	0.163
L0	−2.98 − −1.76	Len mat	135−220	Pupping	Year round	Conv factors	Various
Sex specific parameters		Some		Steepness		0.401	
Stock delineation		WCPO		Release mortality (%)		20 (LL)	
International conventions							
CITES				Appendix II			
CMS				Appendix II			
IUCN Red list				Vulnerable			
WCPFC CMMs							
CMM2014−05; CMM2013−08; CMM2010−07; CMM2019−04							

Figure 67: WCPFC research information summary sheet for silky shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in ABNJ (2018a), Clarke et al. (2015), Chin and Simpfendorfer (2019) and Rice and Harley (2012d).

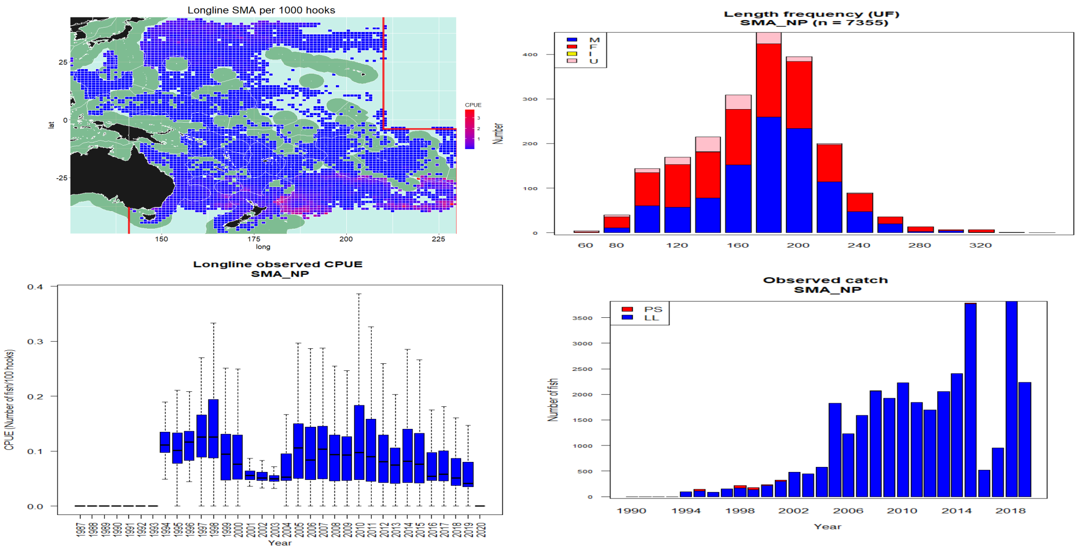
Oceanic whitetip shark



Assessment Results							
Assessment Type				Stock Status			
Data rich (2019)				Overfished and Overfishing taking place			
Life History							
L max	245−316	Max age	11−36	Repro cycle	Annual	Spawning	Summer
k	0.04−0.103	Age recruit	Unknown	Gestation	9−12	M	0.1−0.26
Len birth	45−75	Age mat	4−8	Litter size	1−14	r	0.028−0.197
L0	−2.698	Len mat	120−200	Pupping	Feb−July (NP)	Conv factors	Various
Sex specific parameters		Some		Steepness		0.34−0.49	
Stock delineation		Unknown		Release mortality (%)		Unknown	
International conventions							
CITES				Appendix II			
CMS				Resolution 8.16			
IUCN Red list				Critically endangered			
WCPFC CMMs							
CMM2014−05, CMM2011−04, CMM2010−07; CMM2019−04							

Figure 68: WCPFC research information summary sheet for oceanic whitetip shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Tremblay-Boyer and Neubauer (2019).

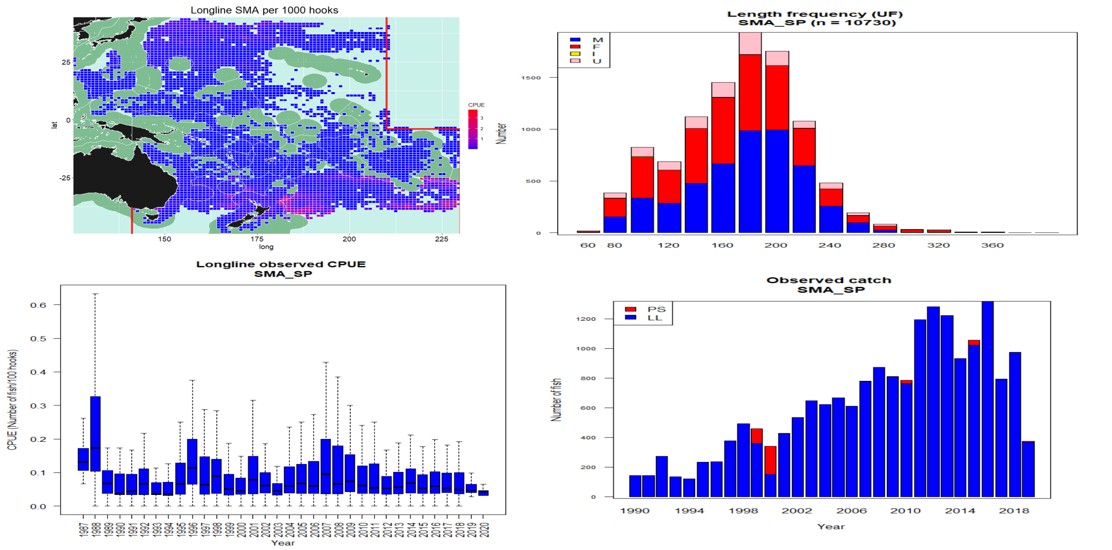
Shortfin mako − NP



Assessment Results							
Assessment Type				Stock Status			
Data rich				Not overfished, No overfishing			
Life History							
L max	231−375	Max age	13−30	Repro cycle	36	Spawning	Jan−Sep
k	0.05−0.25	Age recruit	0−1	Gestation	9−25	M	0.078−0.242
Len birth	59−74	Age mat	5−19	Litter size	4−17	r	1.047−1.088
L0	−6.08 − −3.65	Len mat	180−278	Pupping	Year round	Conv factors	Various
Sex specific parameters		Some		Steepness		Unknown	
Stock delineation		Unknown		Release mortality (%)		30 (LL)	
International conventions							
CITES				Appendix II			
CMS				Appendix II			
IUCN Red list				Endangered			
WCPFC CMMs							
CMM2014−05; CMM2010−07; CMM2019−04							

Figure 69: WCPFC research information summary sheet for shortfin mako shark in the north Pacific. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and ISC (2018b).

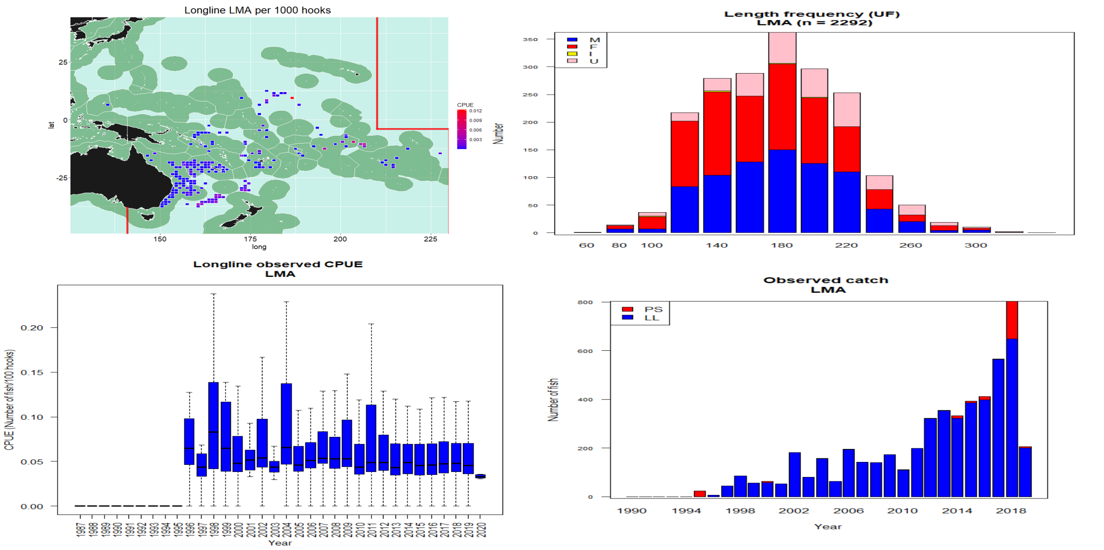
Shortfin mako − SP



Assessment Results							
Assessment Type				Stock Status			
None				Unknown			
Life History							
L max	270−347	Max age	>29	Repro cycle	Unknown	Spawning	Year round
k	Unknown	Age recruit	0−1	Gestation	Unknown	M	0.1−0.15
Len birth	61	Age mat	7−21	Litter size	Unknown	r	Unknown
L0	Unknown	Len mat	180−285	Pupping	Aug−Feb	Conv factors	Various
Sex specific parameters		Some		Steepness		Unknown	
Stock delineation		Tropics to warm temperate		Release mortality (%)		Unknown	
International conventions							
CITES				Appendix II			
CMS				Appendix II			
IUCN Red list				Endangered			
WCPFC CMMs							
CMM2014−05; CMM2010−07; CMM2019−04							

Figure 70: WCPFC research information summary sheet for shortfin mako shark in the south Pacific. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

Longfin mako



Assessment Results	
Assessment Type	Stock Status
None	Unknown

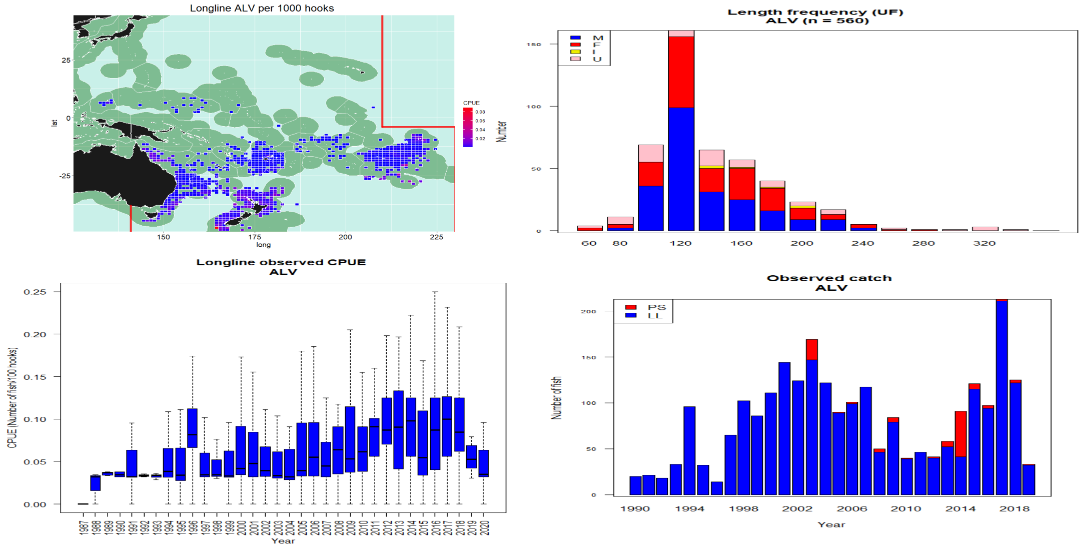
Life History							
L max	162	Max age	Unknown	Repro cycle	Unknown	Spawning	Winter
k	Unknown	Age recruit	0−1	Gestation	Unknown	M	Unknown
Len birth	60−122	Age mat	Unknown	Litter size	3−14	r	Unknown
L0	Unknown	Len mat	178−245	Pupping	May−Oct	Conv factors	Some
Sex specific parameters		No		Steepness		Unknown	
Stock delineation		Tropics to warm temperate		Release mortality (%)		40 (LL)	

International conventions	
CITES	Appendix II
CMS	Appendix II
IUCN Red list	Endangered

WCPFC CMMs
CMM2014−05; CMM2010−07; CMM2019−04

Figure 71: WCPFC research information summary sheet for longfin mako shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

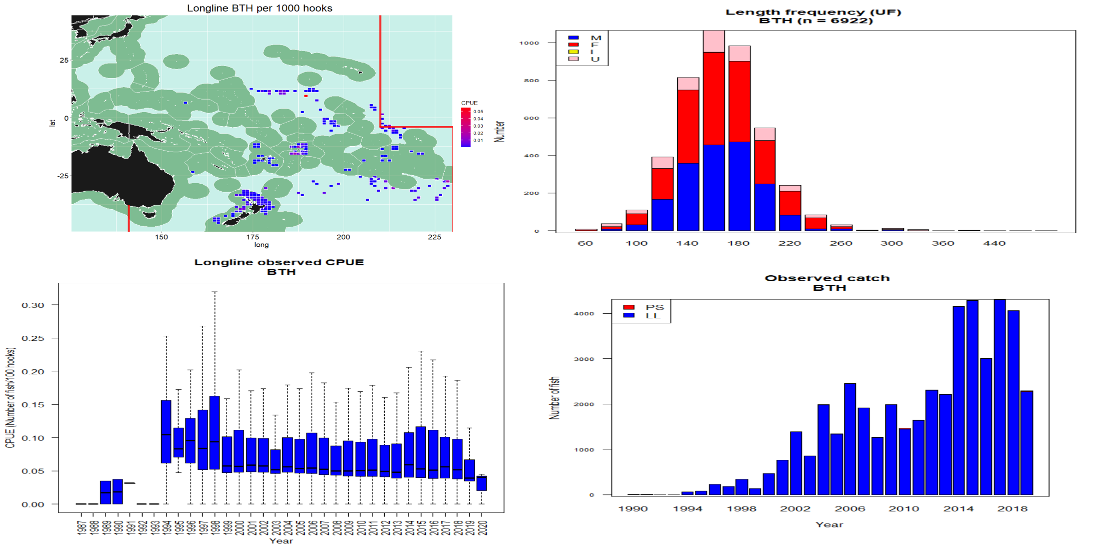
Common thresher



Assessment Results							
Assessment Type				Stock Status			
None				Unknown			
Life History							
L max	610−760	Max age	38−50	Repro cycle	Annual	Spawning	Unknown
k	0.108−0.129	Age recruit	Unknown	Gestation	9	M	0.176
Len birth	111−158	Age mat	3−9	Litter size	2−4	r	1.078−1.178
L0	−2.88	Len mat	260−400	Pupping	Jun−Apr (NA)	Conv factors	Some
Sex specific parameters		No		Steepness		Unknown	
Stock delineation		Unknown		Release mortality (%)		Unknown	
International conventions							
CITES				Appendix II			
CMS				Appendix II			
IUCN Red list				Vulnerable			
WCPFC CMMs							
CMM2014−05; CMM2010−07; CMM2019−04							

Figure 72: WCPFC research information summary sheet for common thresher shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

Bigeye thresher



Assessment Results

Assessment Type	Stock Status
Risk assessment (MIST)	Wide range of sustainability risk − status unknown

Life History

L max	460−488	Max age	19−21	Repro cycle	Unknown	Spawning	Year round
k	0.088−0.092	Age recruit	Unknown	Gestation	12	M	0.223
Len birth	64−140	Age mat	9−13	Litter size	2−4	r	0.996
L0	−4.24 − −4.21	Len mat	208−355	Pupping	Year round	Conv factors	Various

Sex specific parameters	Some	Steepness	Unknown
Stock delineation	Unknown	Release mortality (%)	Unknown

International conventions

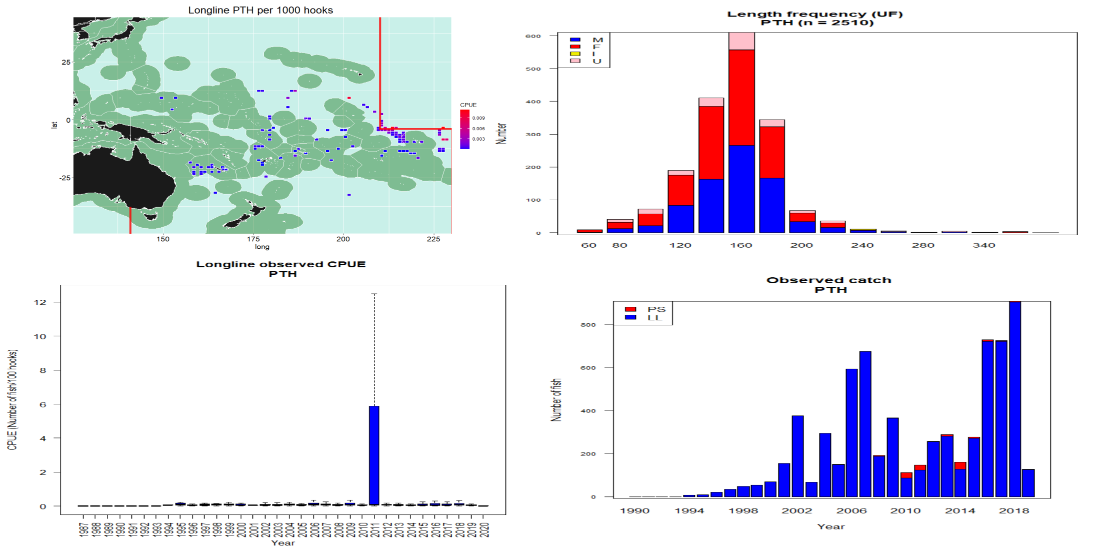
CITES	Appendix II
CMS	Appendix II
IUCN Red list	Vulnerable

WCPFC CMMs

CMM2014−05; CMM2010−07; CMM2019−04

Figure 73: WCPFC research information summary sheet for bigeye thresher shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Fu et al. (2016).

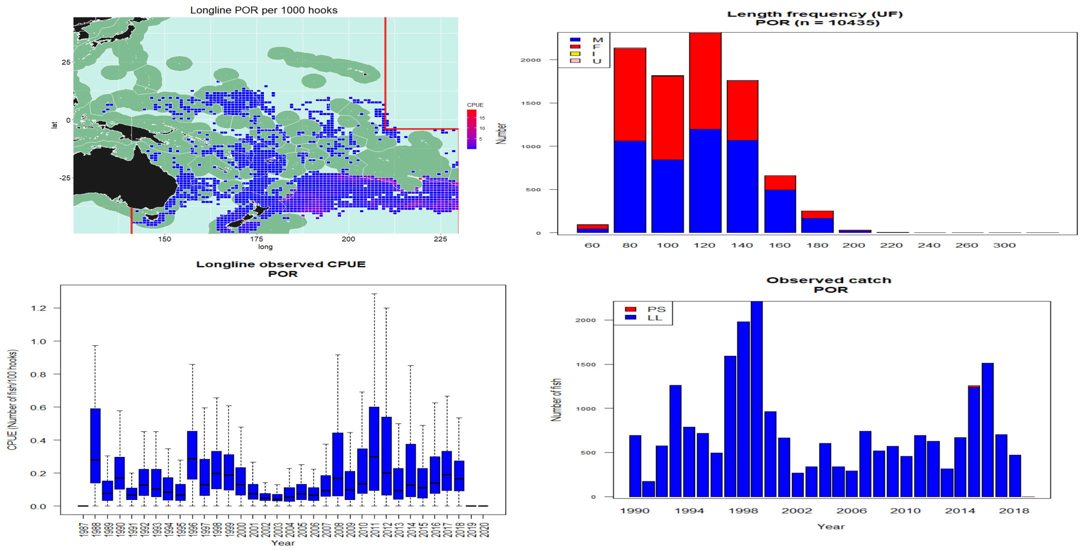
Pelagic thresher



Assessment Results							
Assessment Type				Stock Status			
ERA/PSA (2007)				PSA medium			
Life History							
L max	383	Max age	14−29	Repro cycle	Unknown	Spawning	Unknown
k	0.085−0.12	Age recruit	Unknown	Gestation	9	M	0.132−0.155
Len birth	130−190	Age mat	7−9	Litter size	2	r	0.055−0.064
L0	−7.67 − −5.48	Len mat	144−292	Pupping	Unknown	Conv factors	Various
Sex specific parameters		Some		Steepness		Unknown	
Stock delineation		Separate E and W Pacific		Release mortality (%)		Unknown	
International conventions							
CITES				Appendix II			
CMS				Appendix II			
IUCN Red list				Endangered			
WCPFC CMMs							
CMM2014−05; CMM2010−07; CMM2019−04							

Figure 74: WCPFC research information summary sheet for pelagic thresher shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

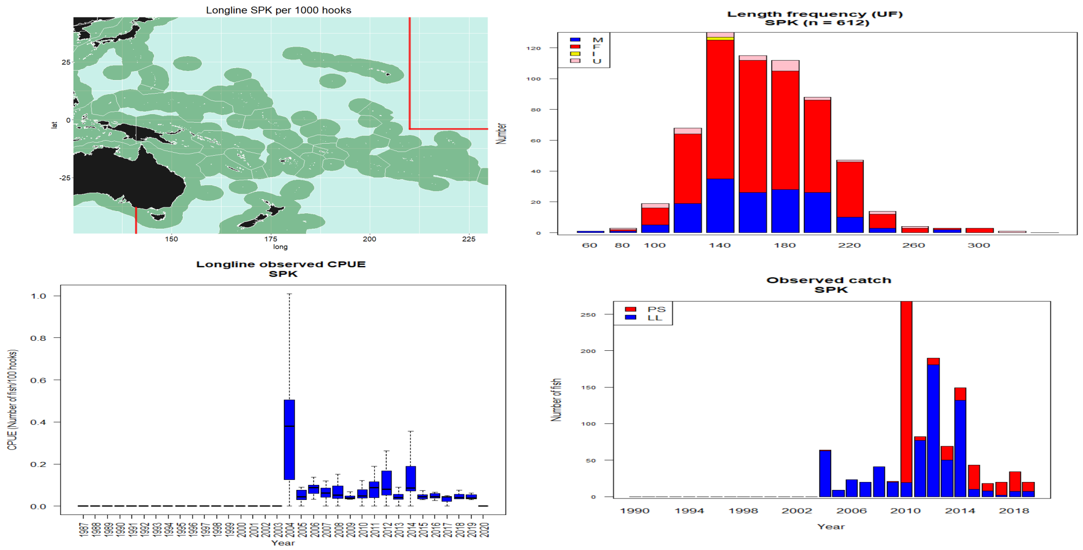
Porbeagle shark



Assessment Results							
Assessment Type				Stock Status			
Risk assessment (2017)				Unknown, but very low risk of overfishing			
Life History							
L max	185−210	Max age	65	Repro cycle	Annual	Spawning	Oct−Dec
k	0.086−0.133	Age recruit	0−1	Gestation	8−9	M	<0.1
Len birth	58−80	Age mat	6−16	Litter size	1−5	r	Unknown
L0	−4.22 − −6.86	Len mat	140−202	Pupping	Apr−Sep	Conv factors	Some
Sex specific parameters		Some		Steepness		Unknown	
Stock delineation		South Pacific		Release mortality (%)		30 (LL)	
International conventions							
CITES				Appendix II			
CMS				Appendix II			
IUCN Red list				Vulnerable			
WCPFC CMMs							
CMM2014−05; CMM2010−07; CMM2019−04							

Figure 75: WCPFC research information summary sheet for porbeagle shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

Great hammerhead



Assessment Results	
Assessment Type	Stock Status
ERA/PSA (2007)	PSA medium

Life History							
L max	550−610	Max age	42−45	Repro cycle	24	Spawning	Spring
k	0.079	Age recruit	Unknown	Gestation	11	M	Unknown
Len birth	50−70	Age mat	7−9	Litter size	6−42	r	Unknown
L0	Unknown	Len mat	214−243	Pupping	Summer	Conv factors	Some

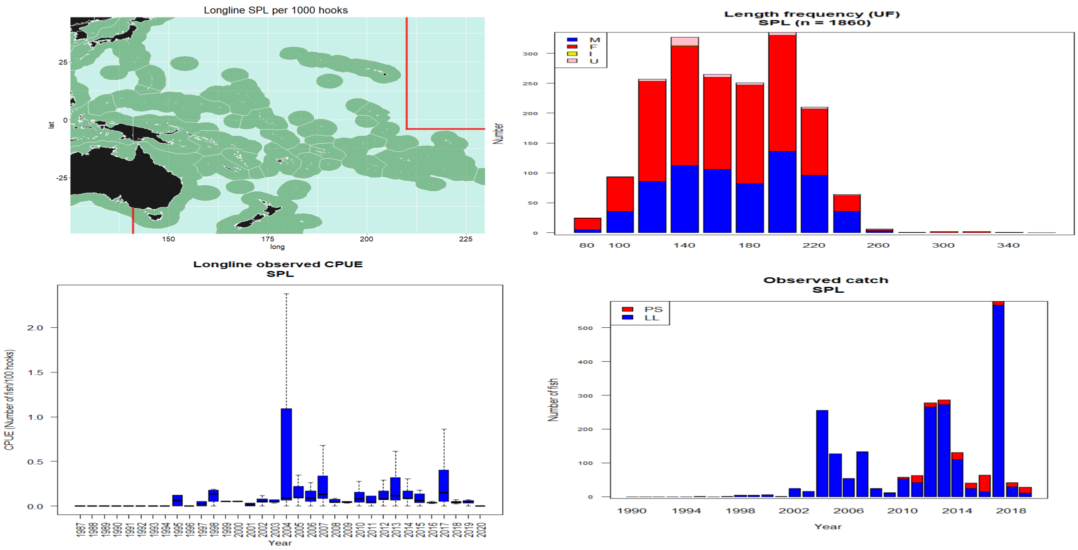
Sex specific parameters	Some	Steepness	Unknown
Stock delineation	Unknown	Release mortality (%)	Unknown

International conventions	
CITES	Appendix II
CMS	Appendix II
IUCN Red list	Critically endangered

WCPFC CMMs
CMM2014−05; CMM2010−07; CMM2019−04

Figure 76: WCPFC research information summary sheet for great hammerhead shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

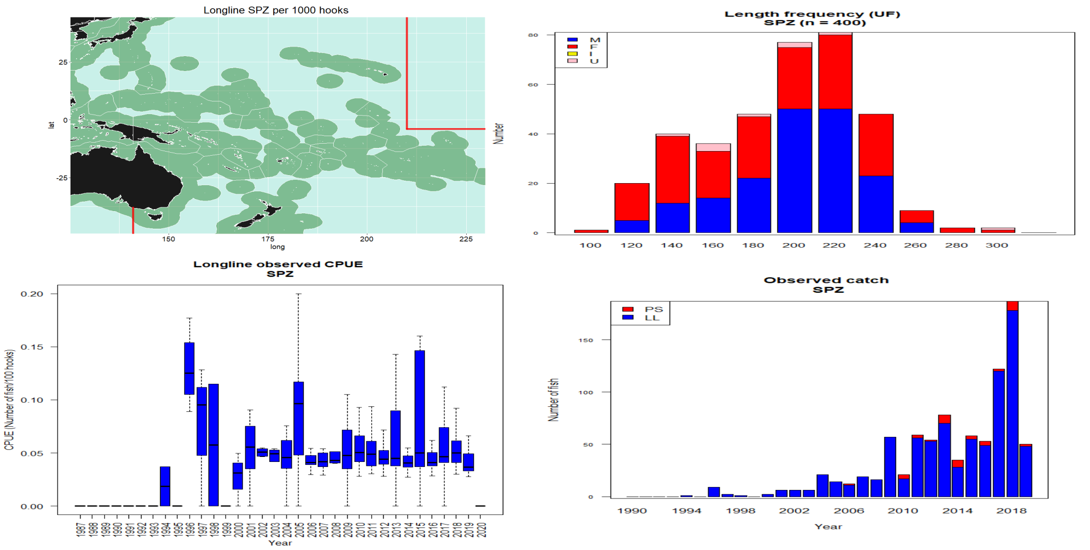
Scalloped hammerhead



Assessment Results							
Assessment Type				Stock Status			
ERA/PSA (2007)				PSA high to medium			
Life History							
L max	370−420	Max age	21−35	Repro cycle	24	Spawning	Summer
k	0.222−0.249	Age recruit	Unknown	Gestation	9−10	M	0.107
Len birth	42−57	Age mat	4−13	Litter size	12−38	r	0.086
L0	0.413−0.746	Len mat	198−250	Pupping	Summer	Conv factors	Some
Sex specific parameters		Some		Steepness		Unknown	
Stock delineation		Unknown		Release mortality (%)		Unknown	
International conventions							
CITES				Appendix II			
CMS				Appendix II			
IUCN Red list				Critically endangered			
WCPFC CMMs							
CMM2014−05; CMM2010−07; CMM2019−04							

Figure 77: WCPFC research information summary sheet for scalloped hammerhead shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

Smooth hammerhead



Assessment Results			
Assessment Type		Stock Status	
ERA/PSA (2007)		PSA medium	

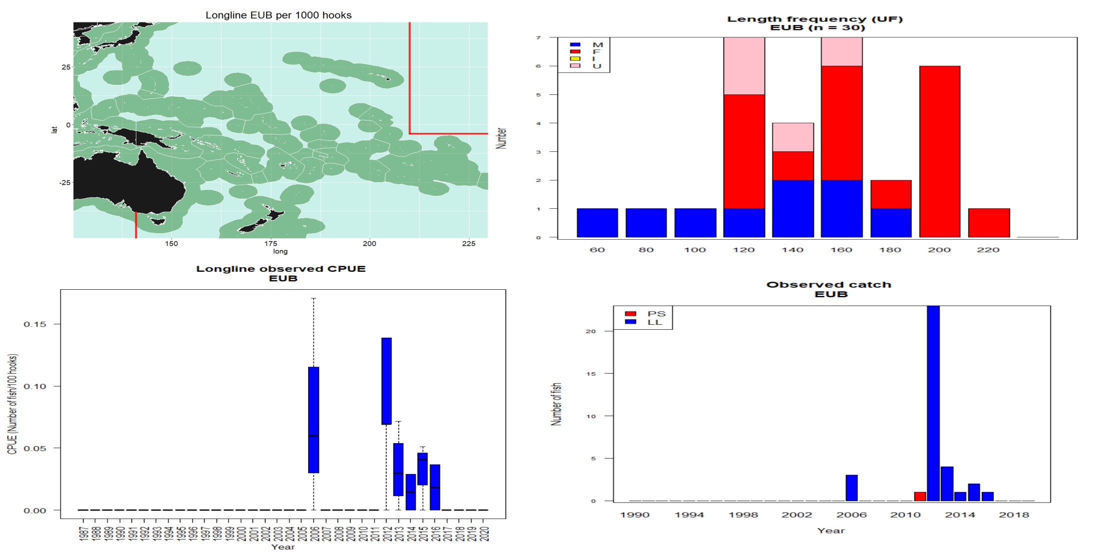
Life History							
L max	359−400	Max age	20−25	Repro cycle	Unknown	Spawning	Summer
k	0.09−0.128	Age recruit	Unknown	Gestation	10−11	M	Unknown
Len birth	50−65	Age mat	15−22	Litter size	20−49	r	Unknown
L0	−1.31 − −0.72	Len mat	222−304	Pupping	Summer	Conv factors	Some
Sex specific parameters		Some		Steepness		Unknown	
Stock delineation		Separate E and W Pacific		Release mortality (%)		Unknown	

International conventions	
CITES	Appendix II
CMS	Resolution 8.16
IUCN Red list	Vulnerable

WCPFC CMMs
CMM2014−05; CMM2010−07; CMM2019−04

Figure 78: WCPFC research information summary sheet for smooth hammerhead shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

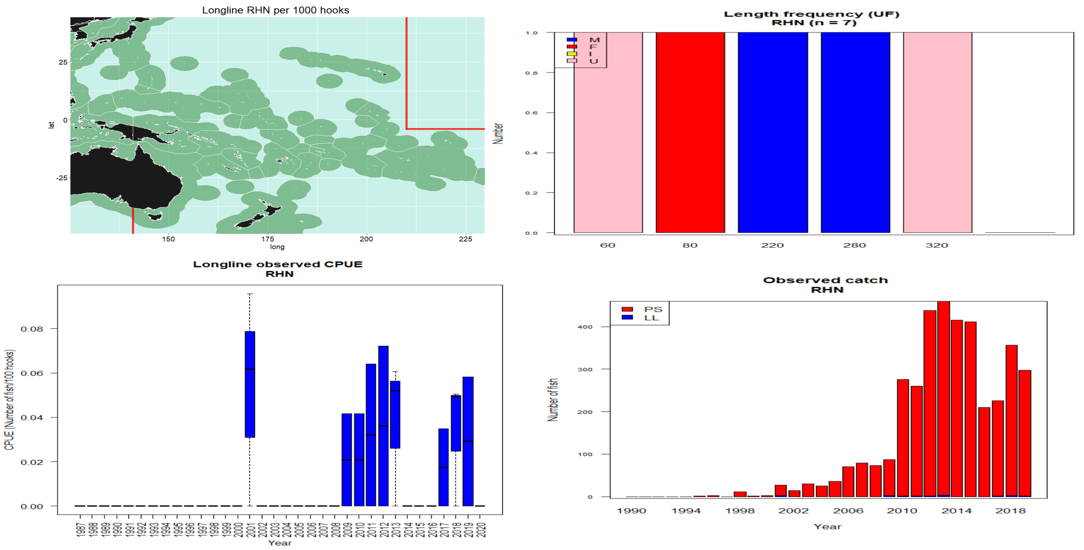
Winghead shark



Assessment Results							
Assessment Type				Stock Status			
None				Unknown			
Life History							
L max	172	Max age	21	Repro cycle	Annual	Spawning	Summer
k	0.12	Age recruit	Unknown	Gestation	10−11	M	Unknown
Len birth	48−50	Age mat	7	Litter size	6−25	r	Unknown
L0	Unknown	Len mat	108−120	Pupping	Summer	Conv factors	Some
Sex specific parameters		No		Steepness		Unknown	
Stock delineation		Unknown		Release mortality (%)		Unknown	
International conventions							
CITES				NA			
CMS				NA			
IUCN Red list				Endangered			
WCPFC CMMs							
CMM2014−05; CMM2010−07; CMM2019−04							

Figure 79: WCPFC research information summary winghead shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

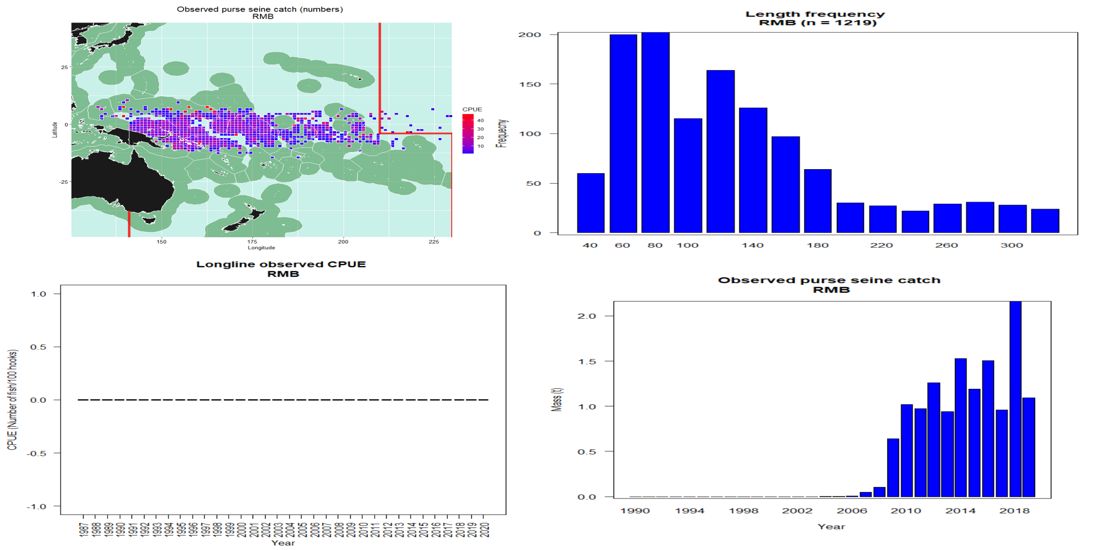
Whale shark							



Assessment Results							
Assessment Type				Stock Status			
Risk (2018)				Low risk from purse seining			
Life History							
L max	1200−2000	Max age	25−130	Repro cycle	Unknown	Spawning	Unknown
k	0.021−0.037	Age recruit	Unknown	Gestation	Unknown	M	Unknown
Len birth	46−78	Age mat	17−25	Litter size	300	r	Unknown
L0	Unknown	Len mat	5700−9500	Pupping	Unknown	Conv factors	Various
Sex specific parameters		No		Steepness		Unknown	
Stock delineation		Unknown		Release mortality (%)		0 (PS)	
International conventions							
CITES				Appendix II			
CMS				Appendix I			
IUCN Red list				Endangered			
WCPFC CMMs							
CMM2014−05; CMM2012−04; CMM2010−14; CMM2019−04							

Figure 80: WCPFC research information summary sheet for whale shark. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

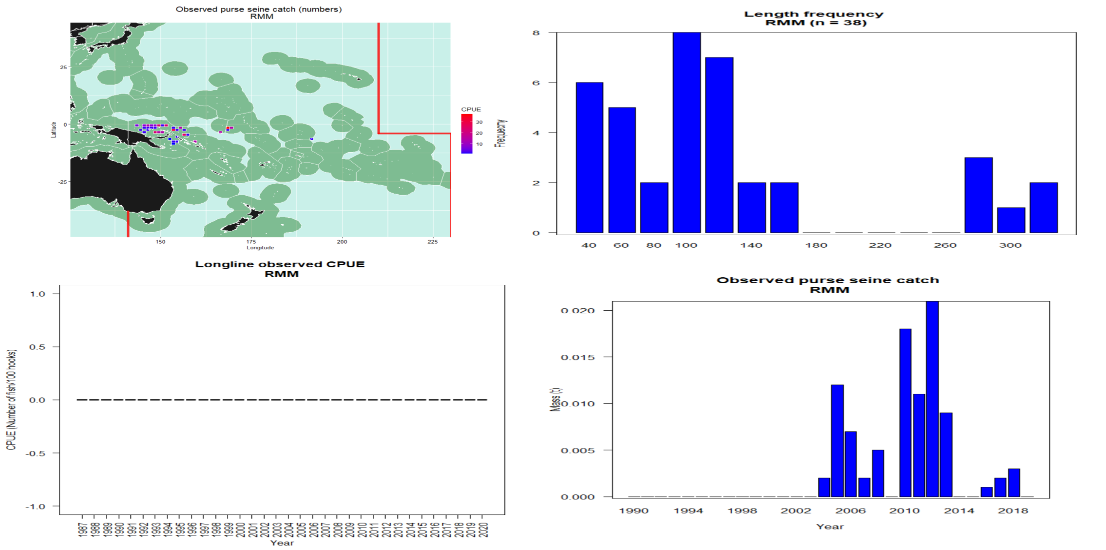
Giant manta



Assessment Results							
Assessment Type				Stock Status			
ERA/PSA (2007)				PSA high to medium			
Life History							
L max	520−910	Max age	20	Repro cycle	Unknown	Spawning	Unknown
k	Unknown	Age recruit	Unknown	Gestation	Unknown	M	Unknown
Len birth	122−127	Age mat	Unknown	Litter size	2	r	Unknown
L0	Unknown	Len mat	400	Pupping	Unknown	Conv factors	None
Sex specific parameters		No		Steepness		Unknown	
Stock delineation		Unknown		Release mortality (%)		Unknown	
International conventions							
CITES				Appendix II			
CMS				Appendix I			
IUCN Red list				Vulnerable			
WCPFC CMMs							
CMM2014−05; CMM2010−07; CMM2019−05							

Figure 81: WCPFC research information summary sheet for giant manta ray. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

Giant devilray



Assessment Results							
Assessment Type				Stock Status			
ERA/PSA (2007)				PSA high to medium			
Life History							
L max	250	Max age	15−20	Repro cycle	12−24	Spawning	Unknown
k	Unknown	Age recruit	Unknown	Gestation	Unknown	M	0.087
Len birth	Unknown	Age mat	Unknown	Litter size	1	r	Unknown
L0	Unknown	Len mat	Unknown	Pupping	Unknown	Conv factors	None
Sex specific parameters		No		Steepness		Unknown	
Stock delineation		Unknown		Release mortality (%)		57 (PS)	
International conventions							
CITES				Appendix II			
CMS				Appendix I			
IUCN Red list				Endangered			
WCPFC CMMs							
CMM2014−05; CMM2010−07; CMM2019−05							

Figure 82: WCPFC research information summary sheet for giant devilray. This table presents the observed CPUE distribution (top left); length data by sex (top right); unstandardised CPUE (bottom left); and catch by gear (bottom right) where PS = purse seine and LL = longline. Definitions of the terms used in the sheet can be found in Table 5. Most data derived from the figures presented in Clarke et al. (2015), Chin and Simpfendorfer (2019) and Coelho et al. (2019).

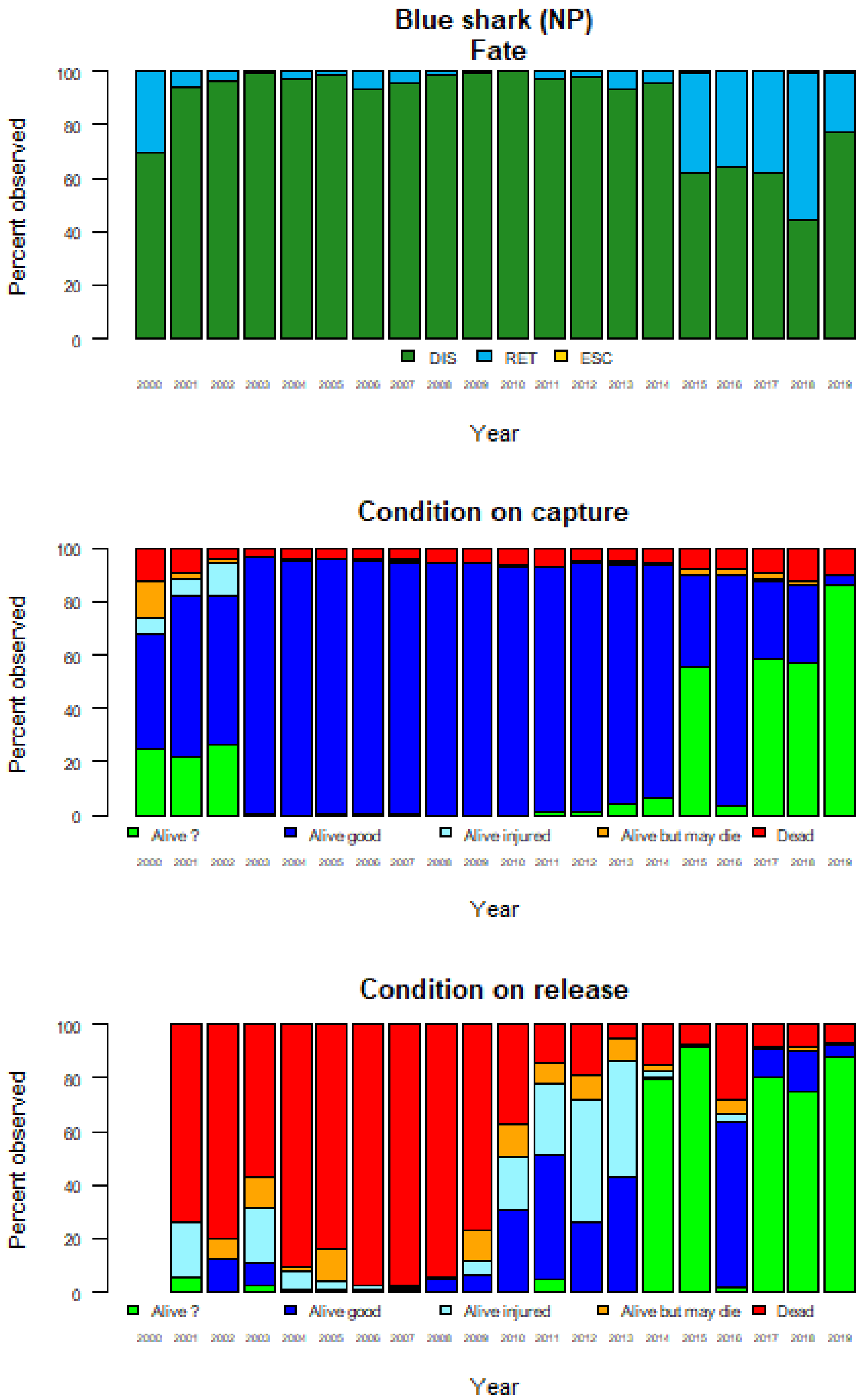


Figure 83: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught blue sharks in the north Pacific. DIS = Discarded; RET = Retained; ECS = Escaped.

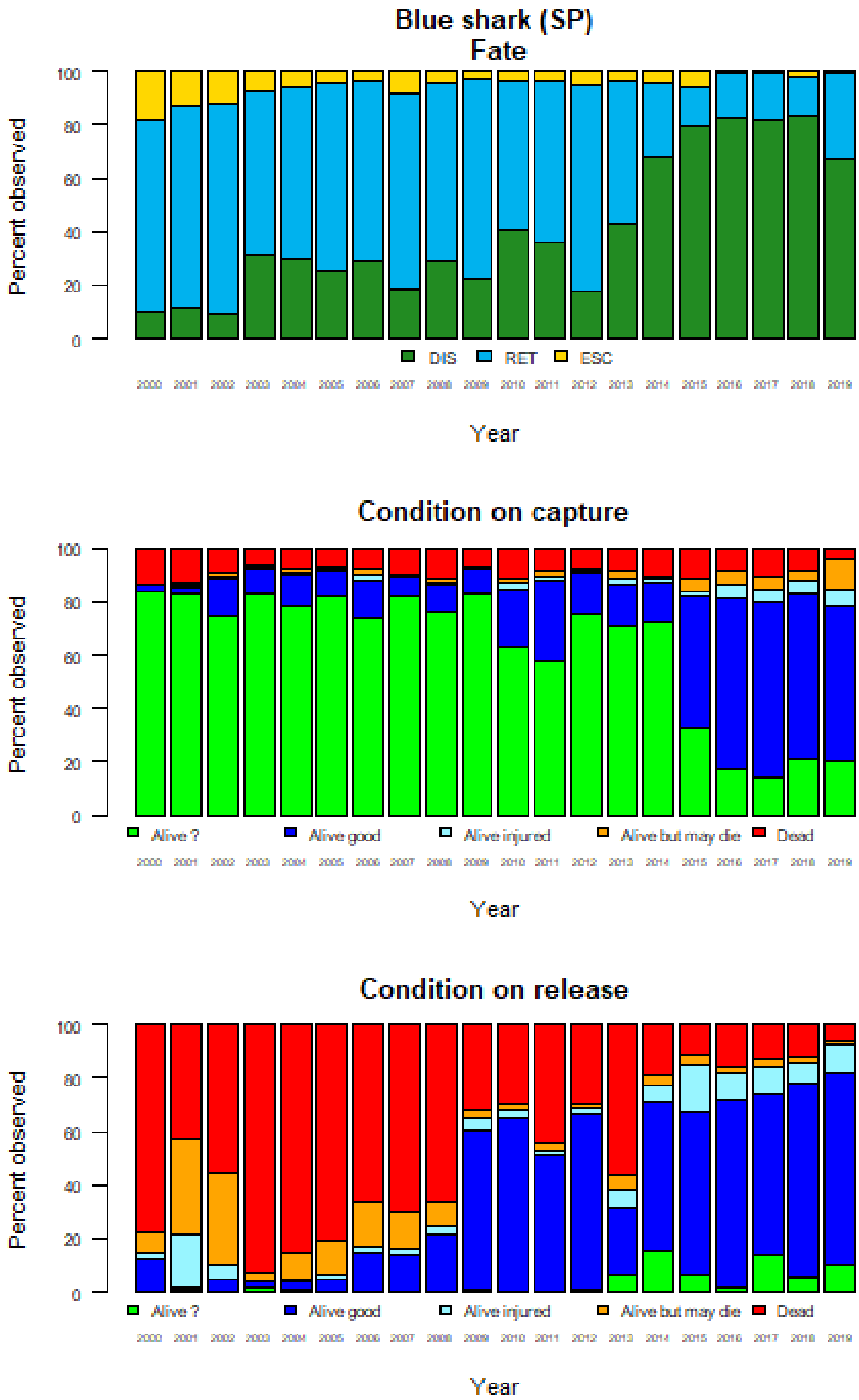


Figure 84: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught South Pacific blue sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

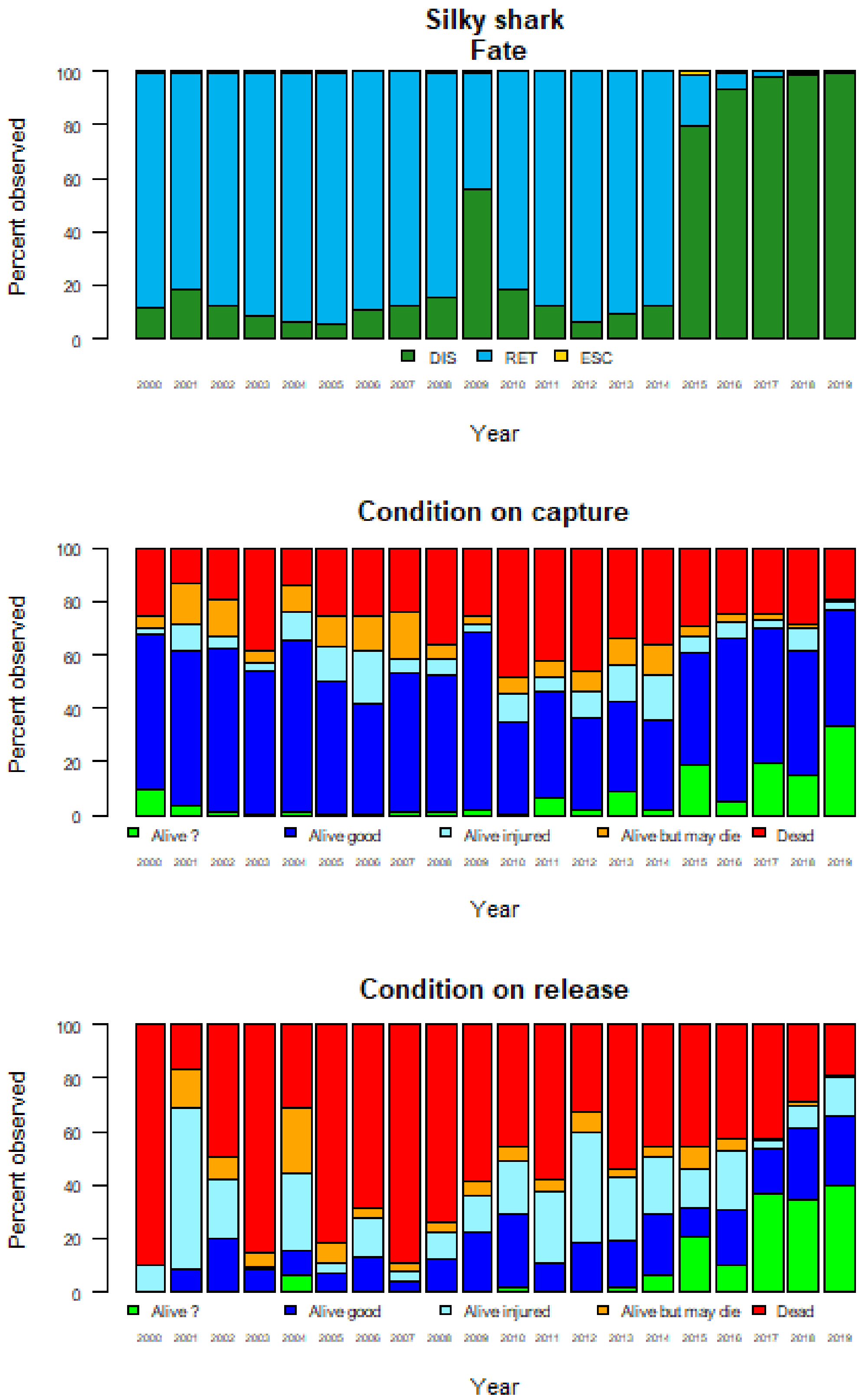


Figure 85: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught silky sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

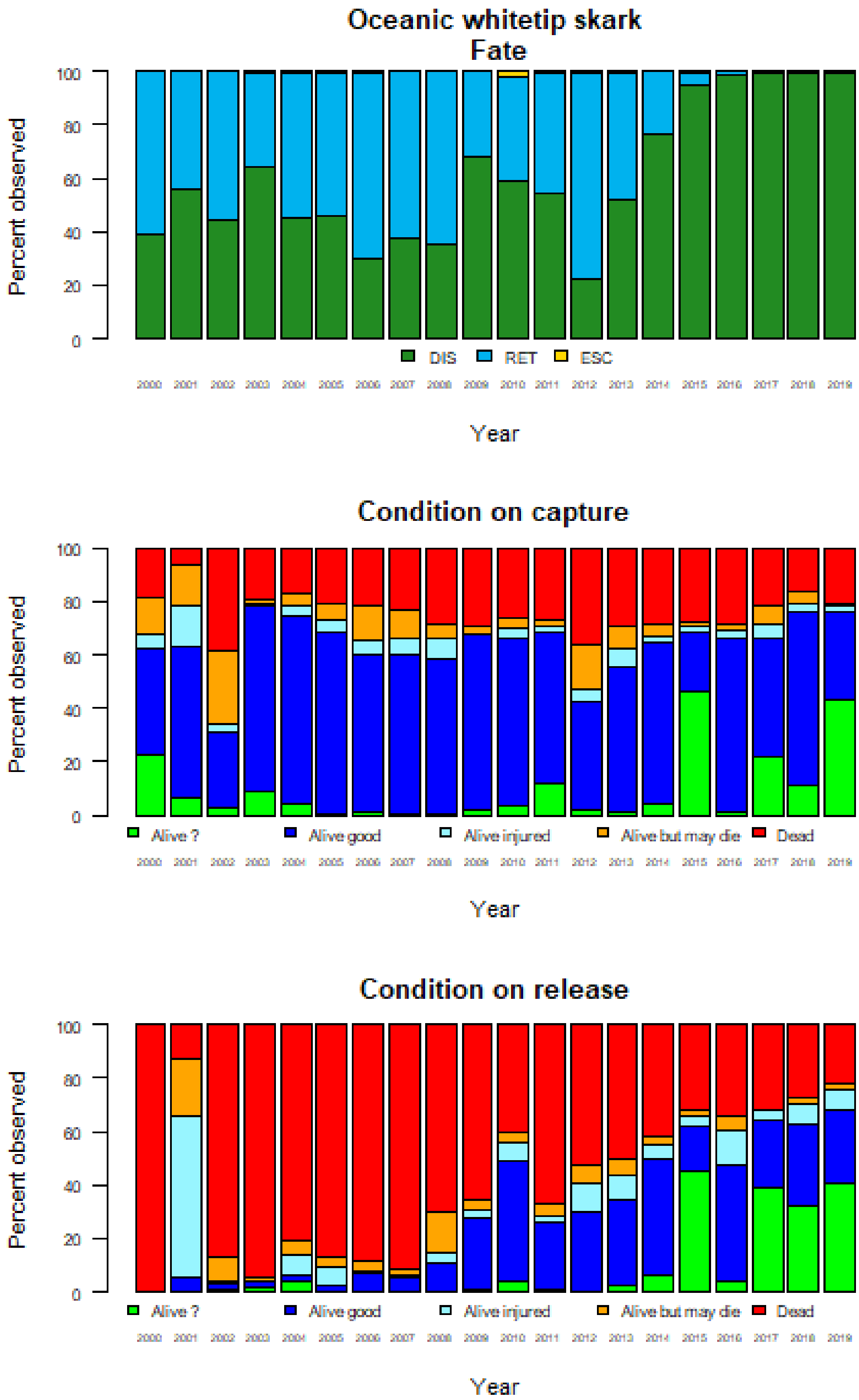


Figure 86: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught oceanic whitetip sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

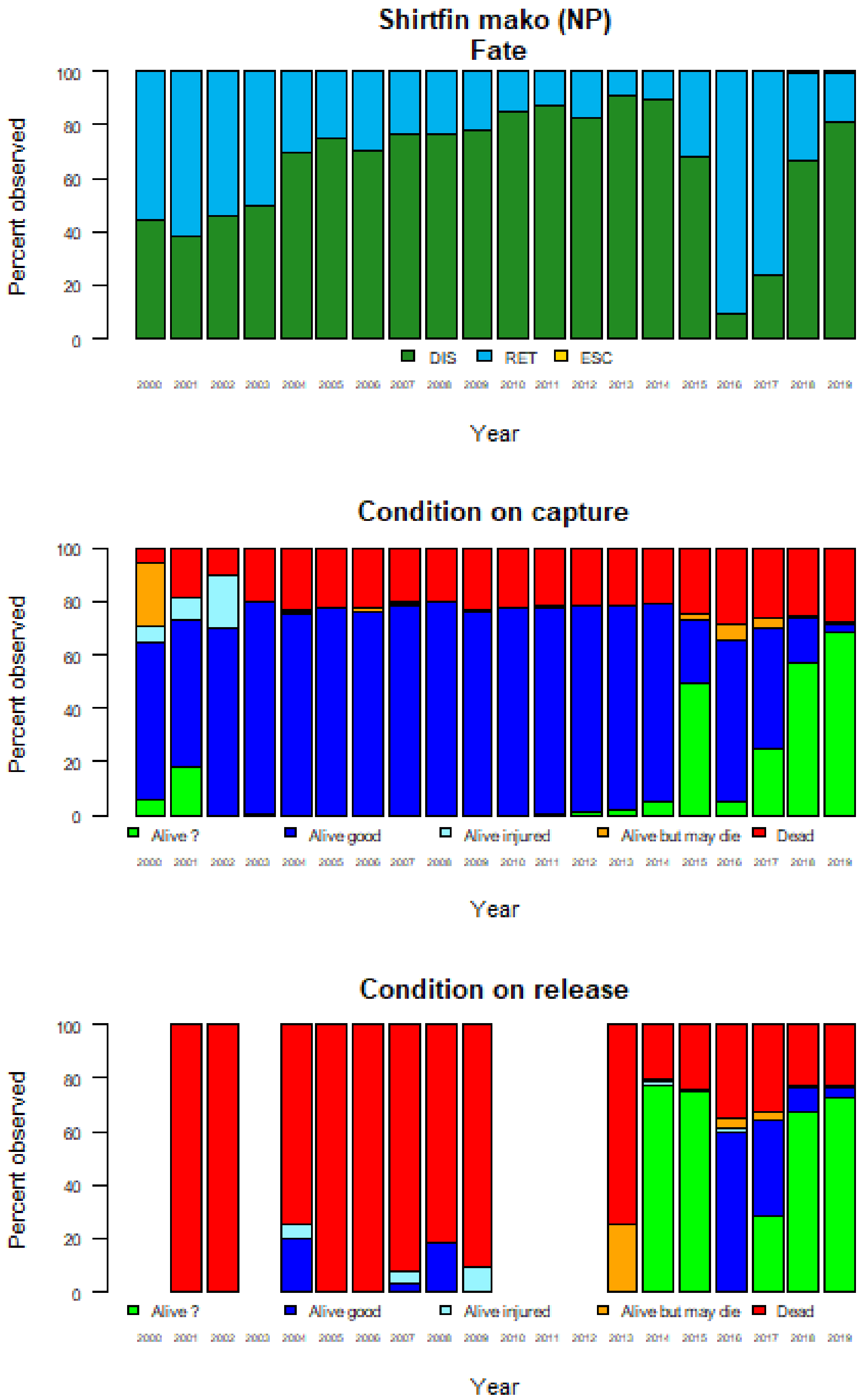


Figure 87: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught shortfin mako sharks in the north Pacific. DIS = Discarded; RET = Retained; ECS = Escaped.

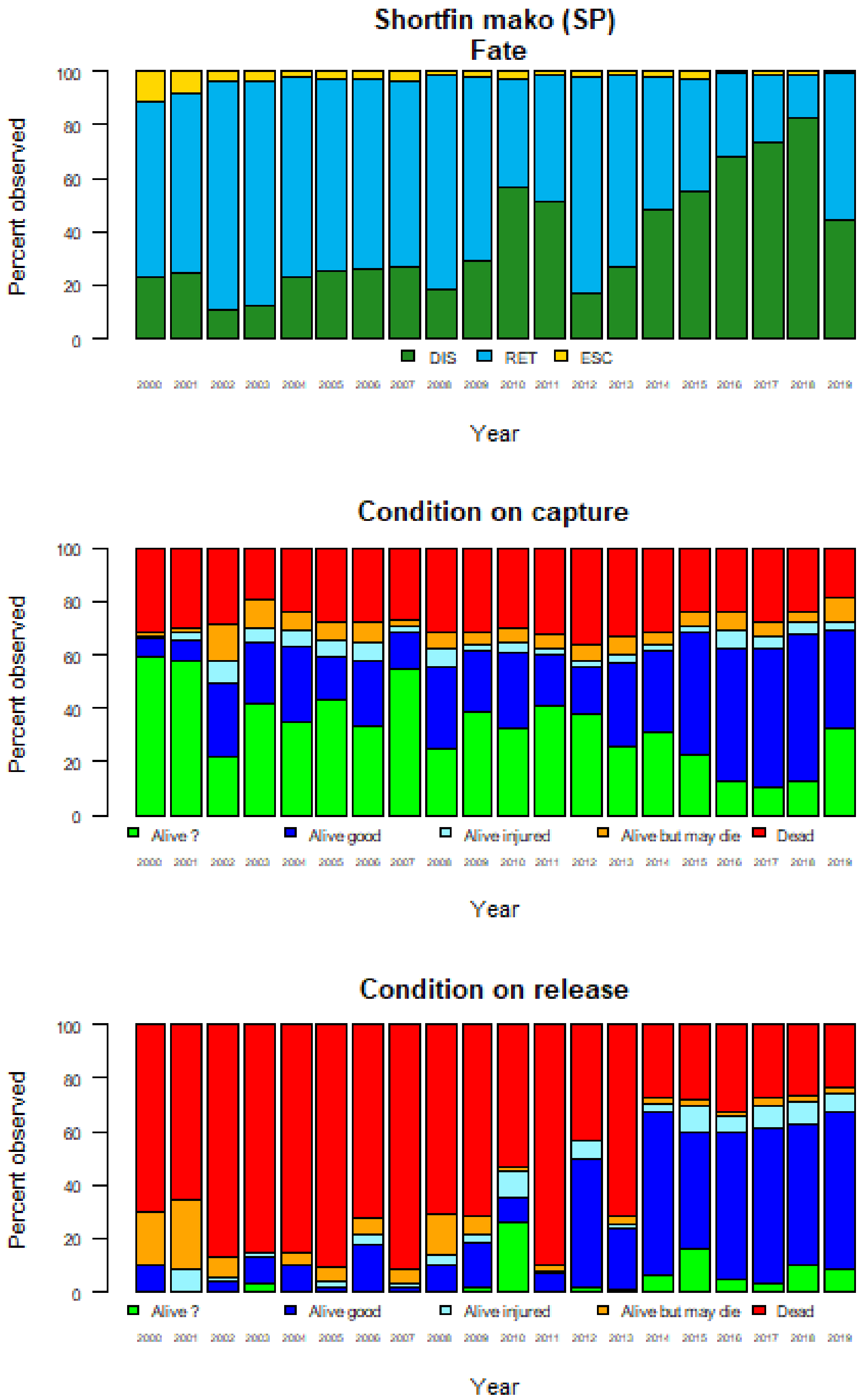


Figure 88: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught shortfin mako sharks in the south Pacific. DIS = Discarded; RET = Retained; ECS = Escaped.

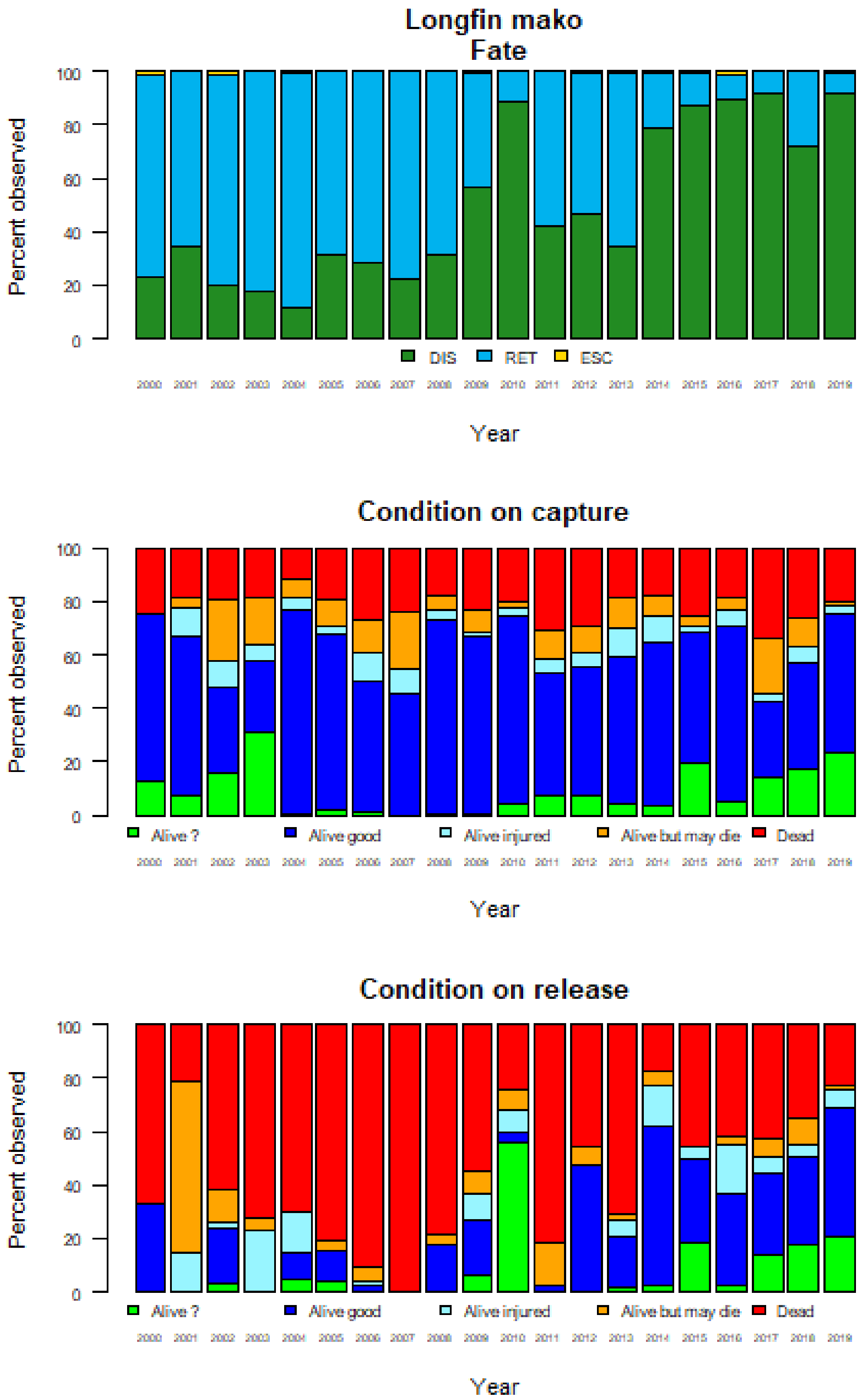


Figure 89: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught longfin mako sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

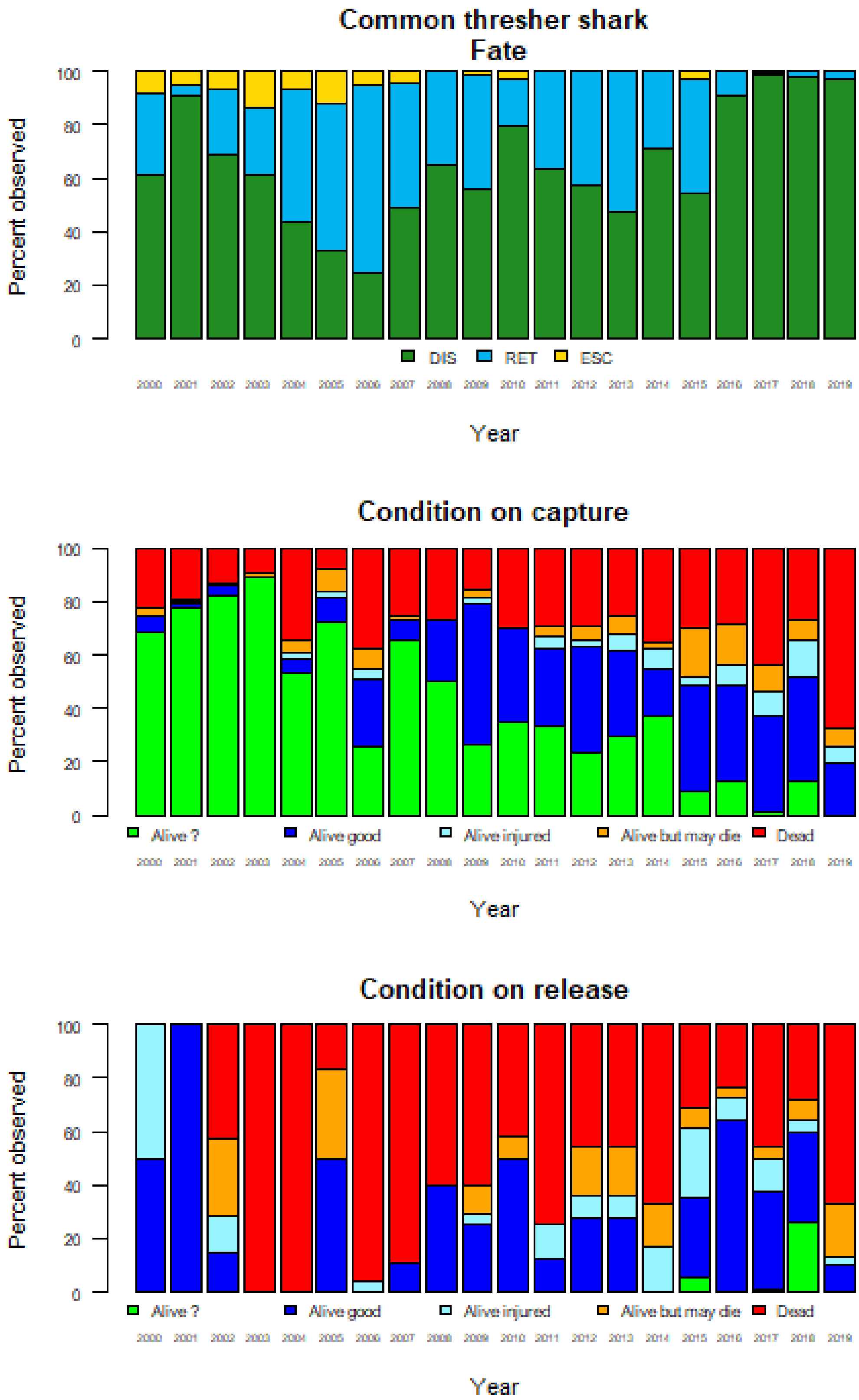


Figure 90: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught common thresher sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

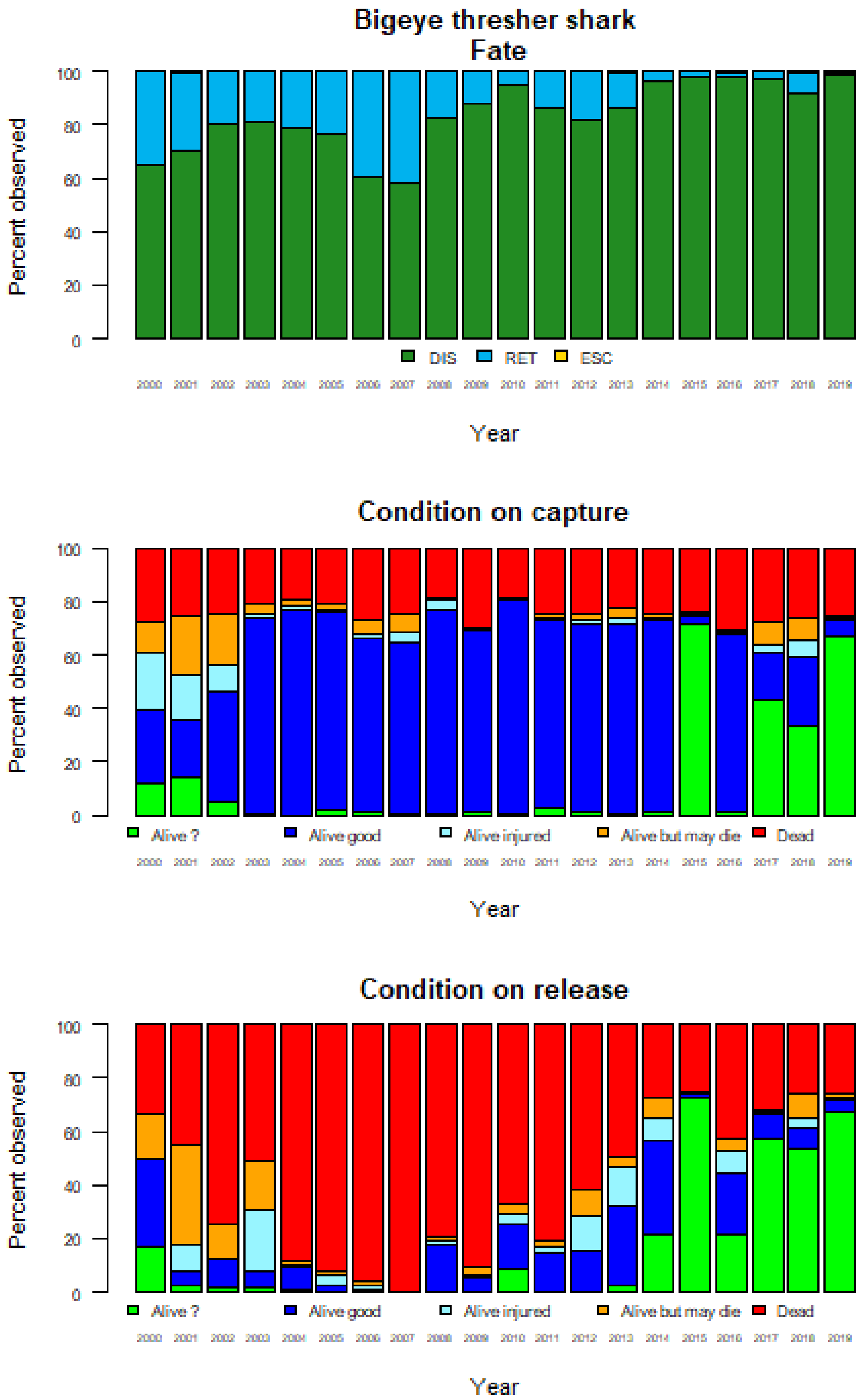


Figure 91: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline bigeye thresher sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

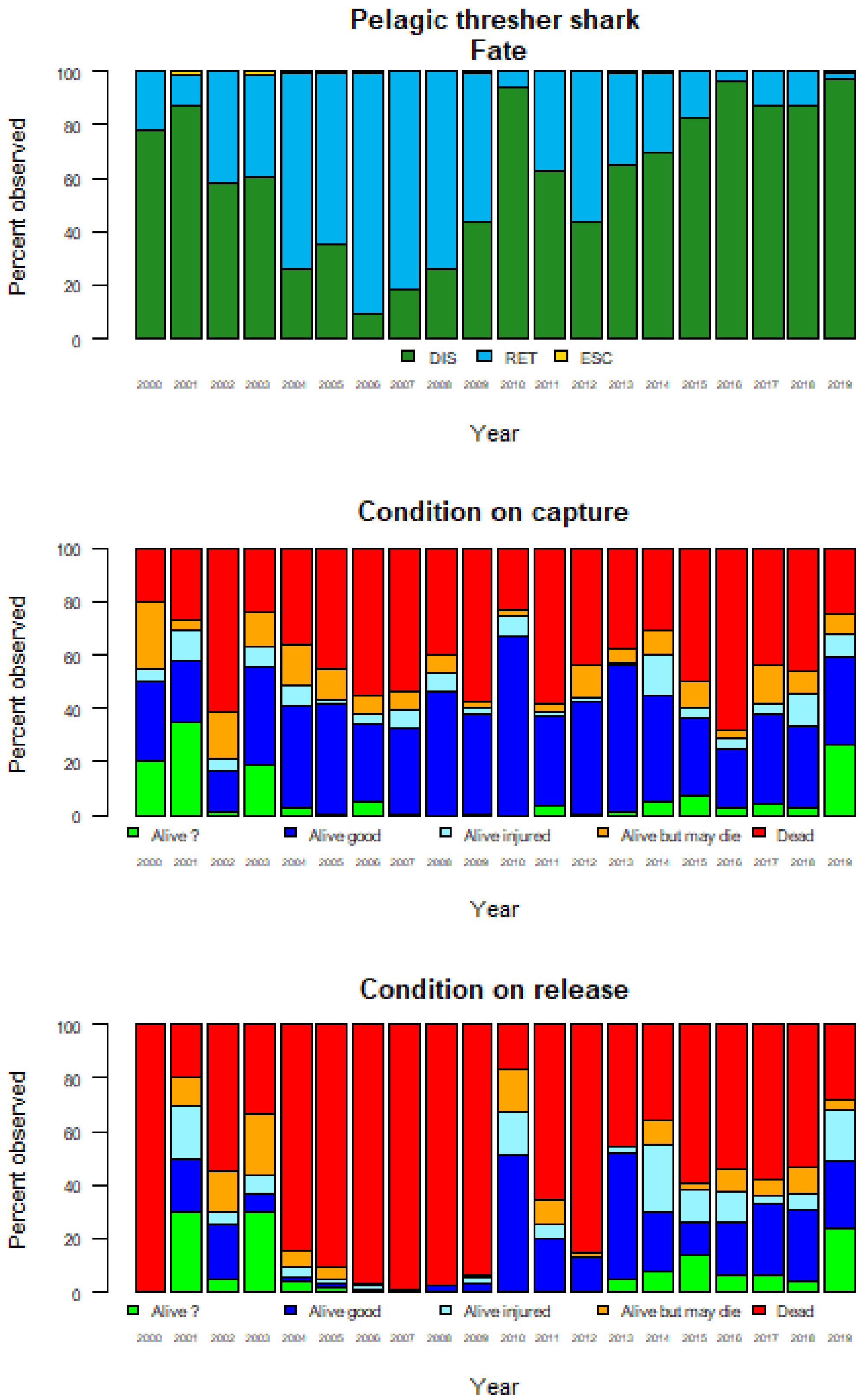


Figure 92: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught pelagic thresher sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

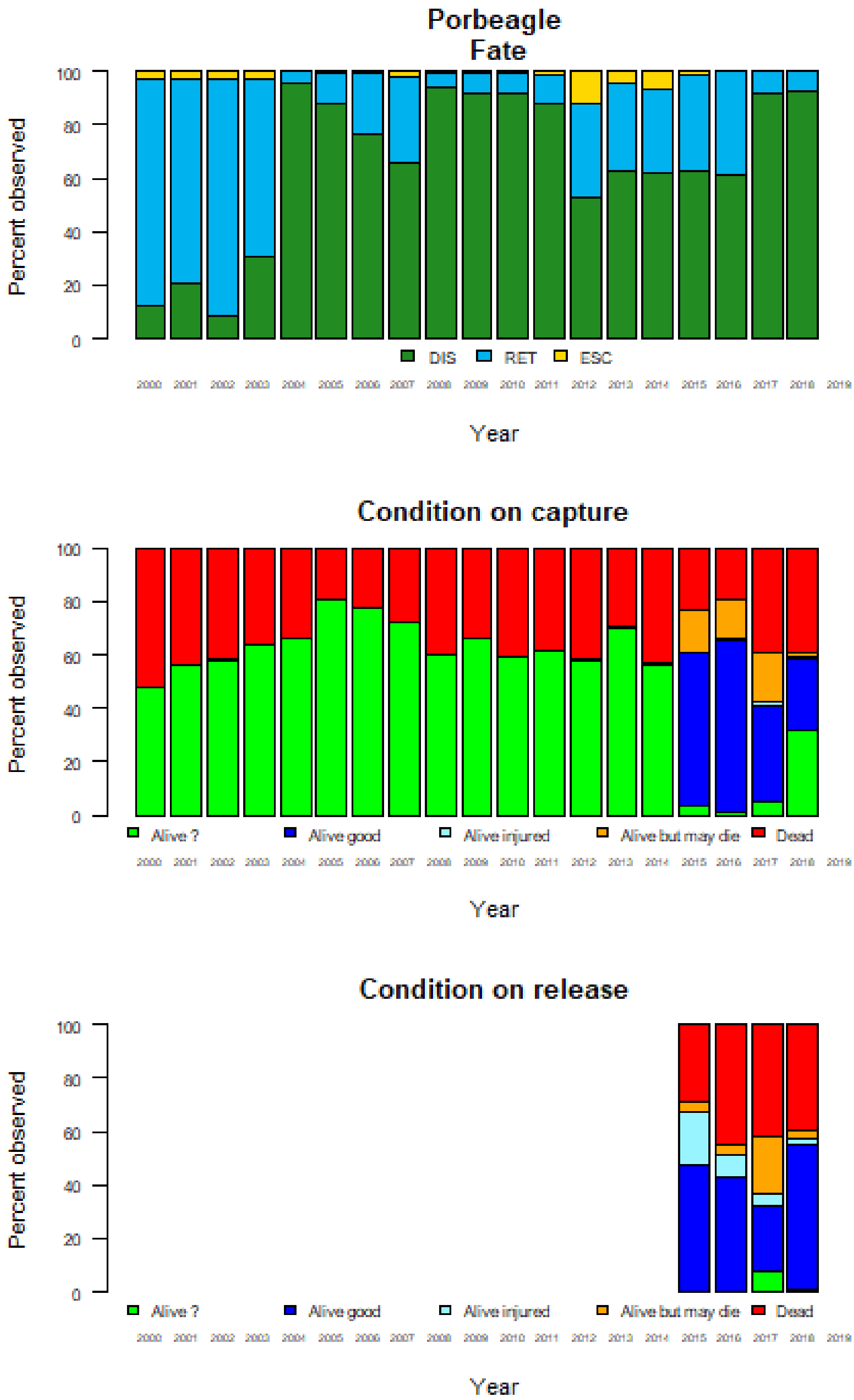


Figure 93: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught porbeagle sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

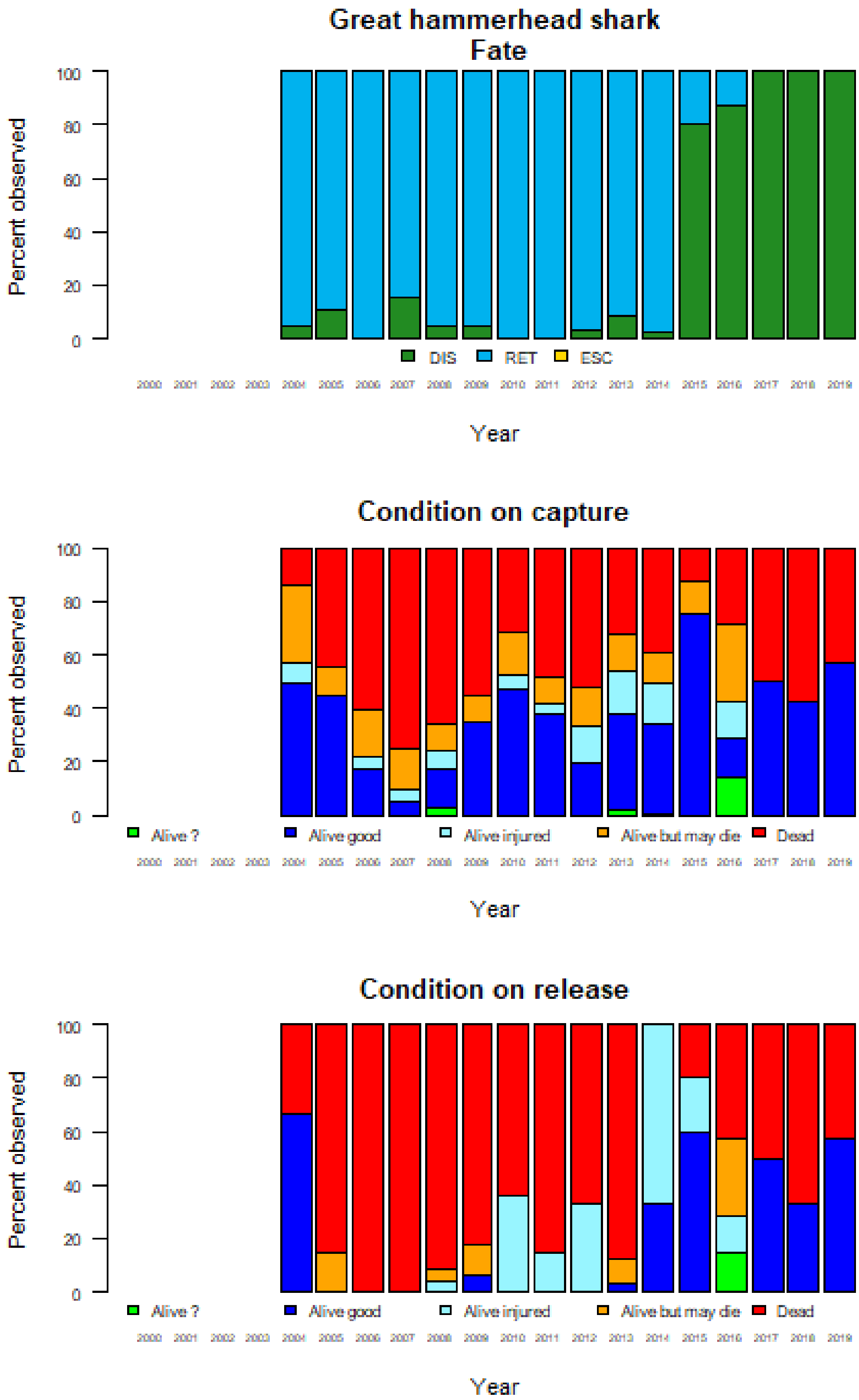


Figure 94: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught great hammerhead sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

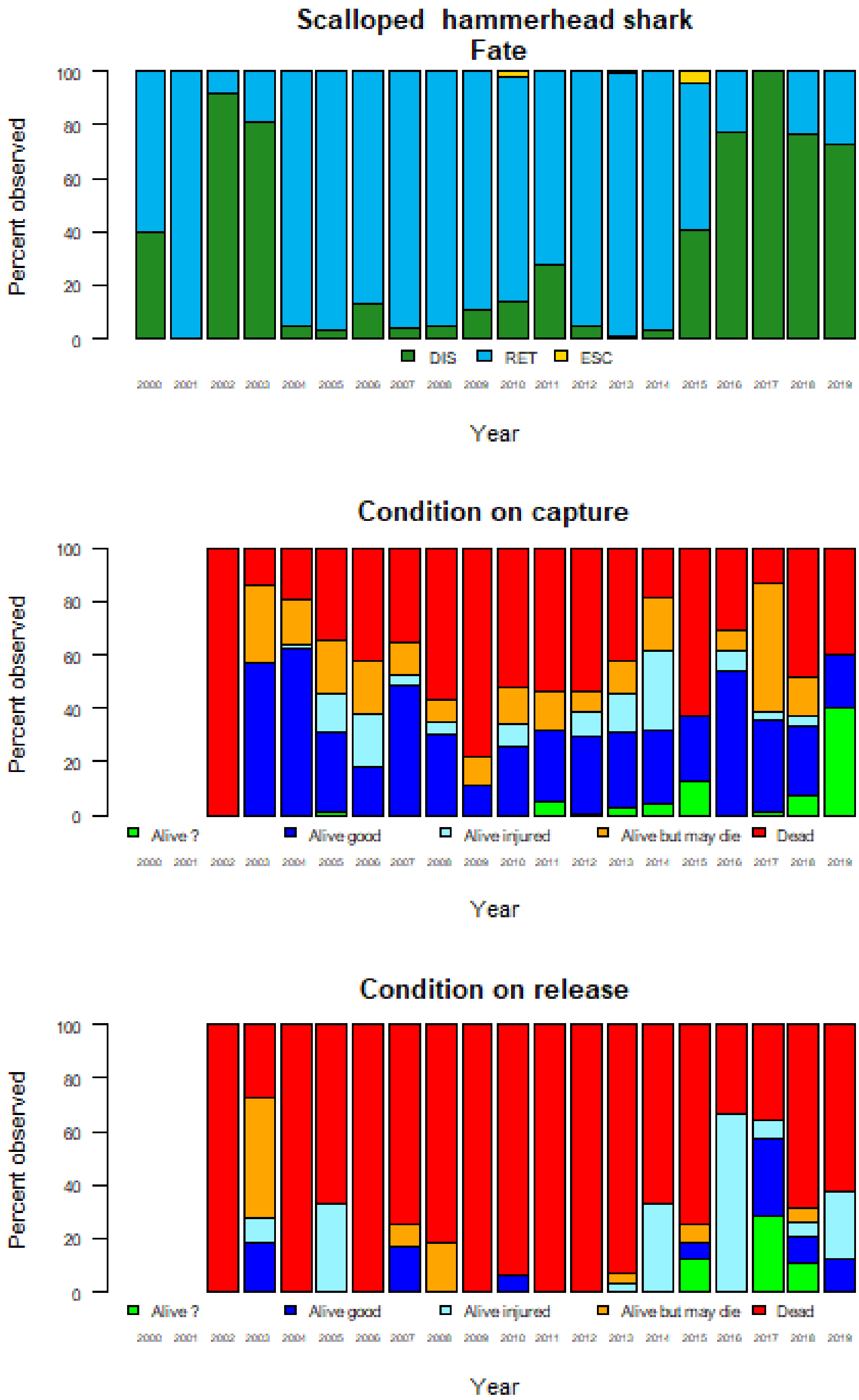


Figure 95: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught scalloped hammerhead sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

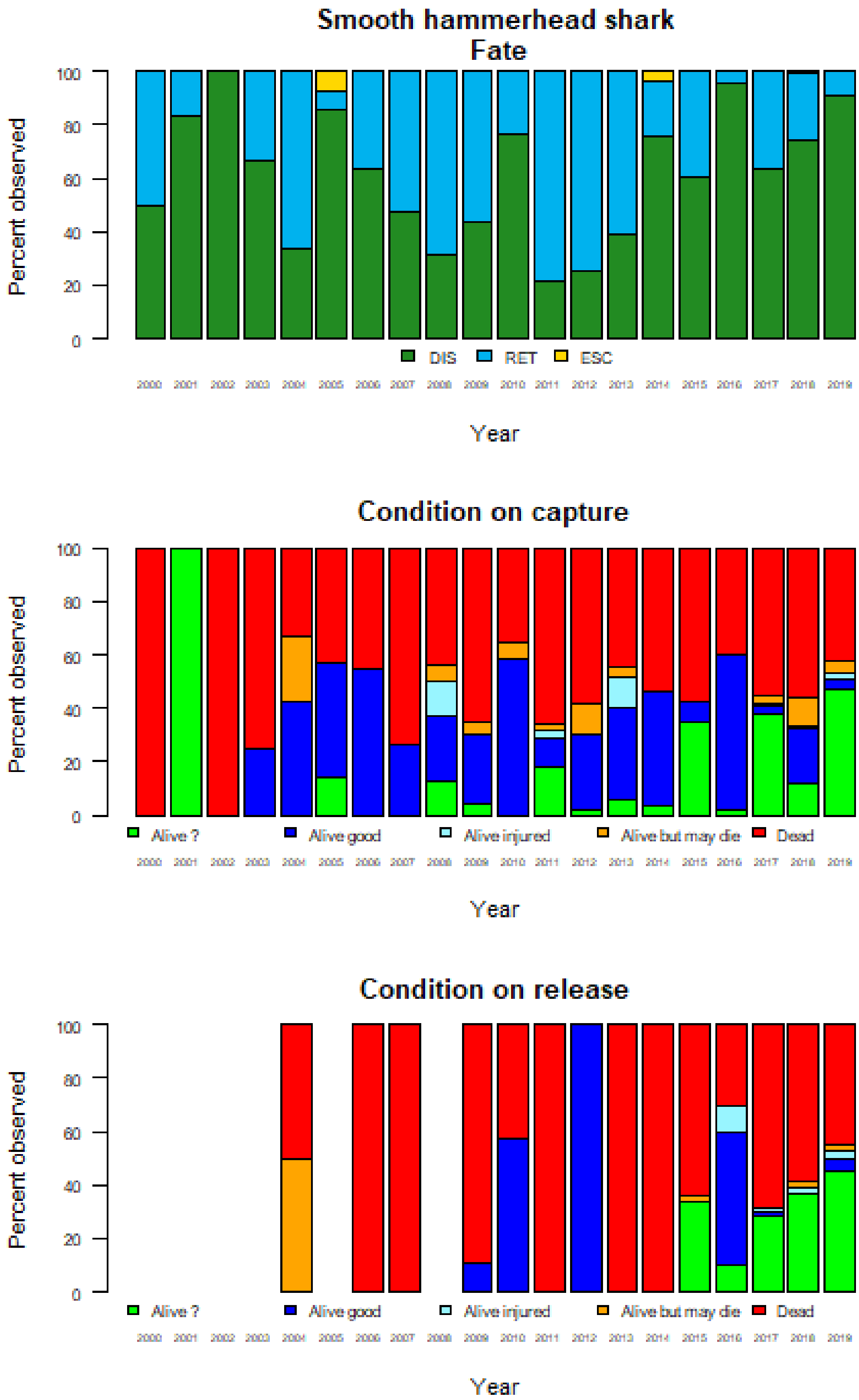


Figure 96: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught smooth hammerhead sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

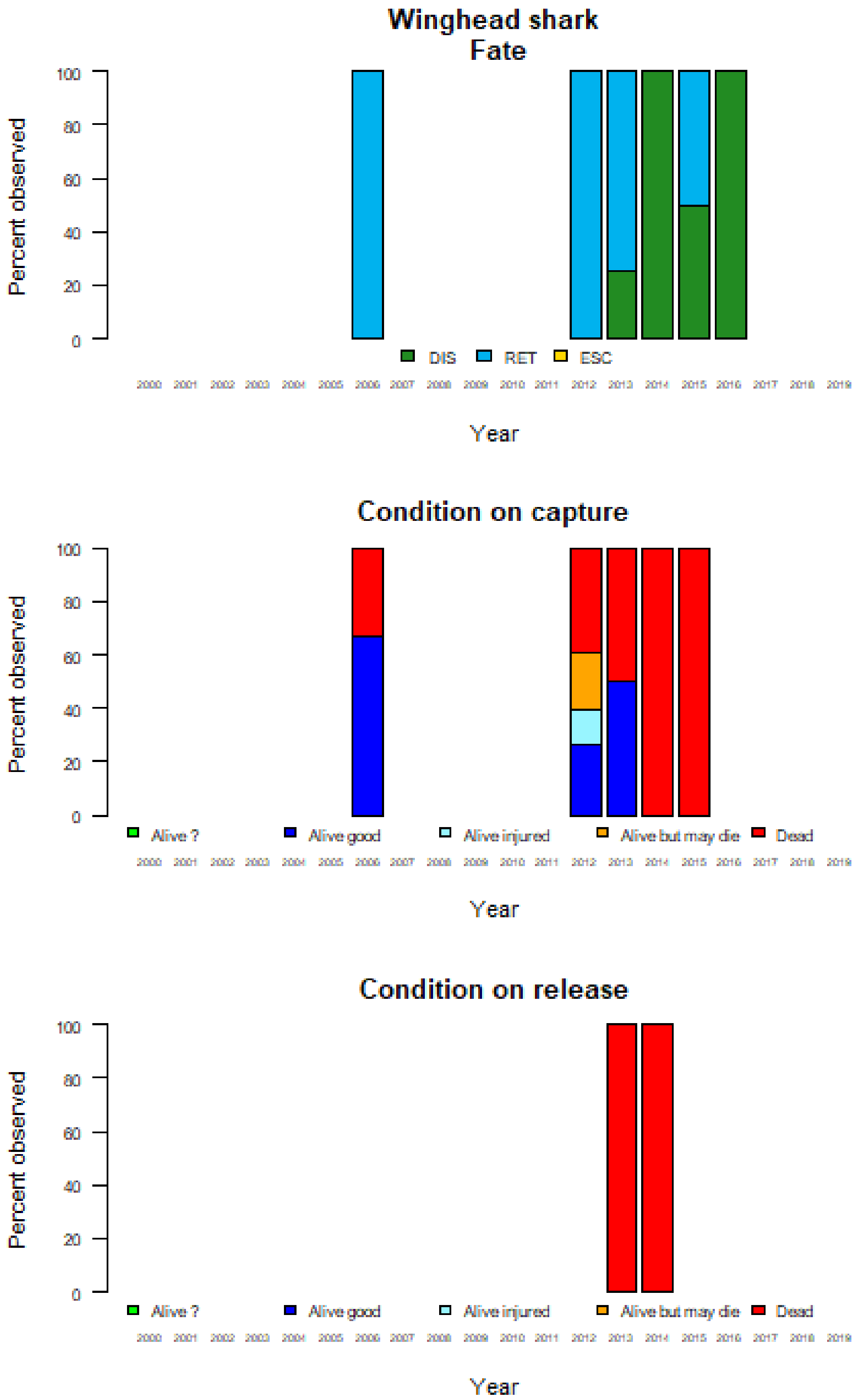


Figure 97: The fate (top); condition at capture (middle); and the condition at release (bottom) of longline caught winghead sharks. DIS = Discarded; RET = Retained; ECS = Escaped.

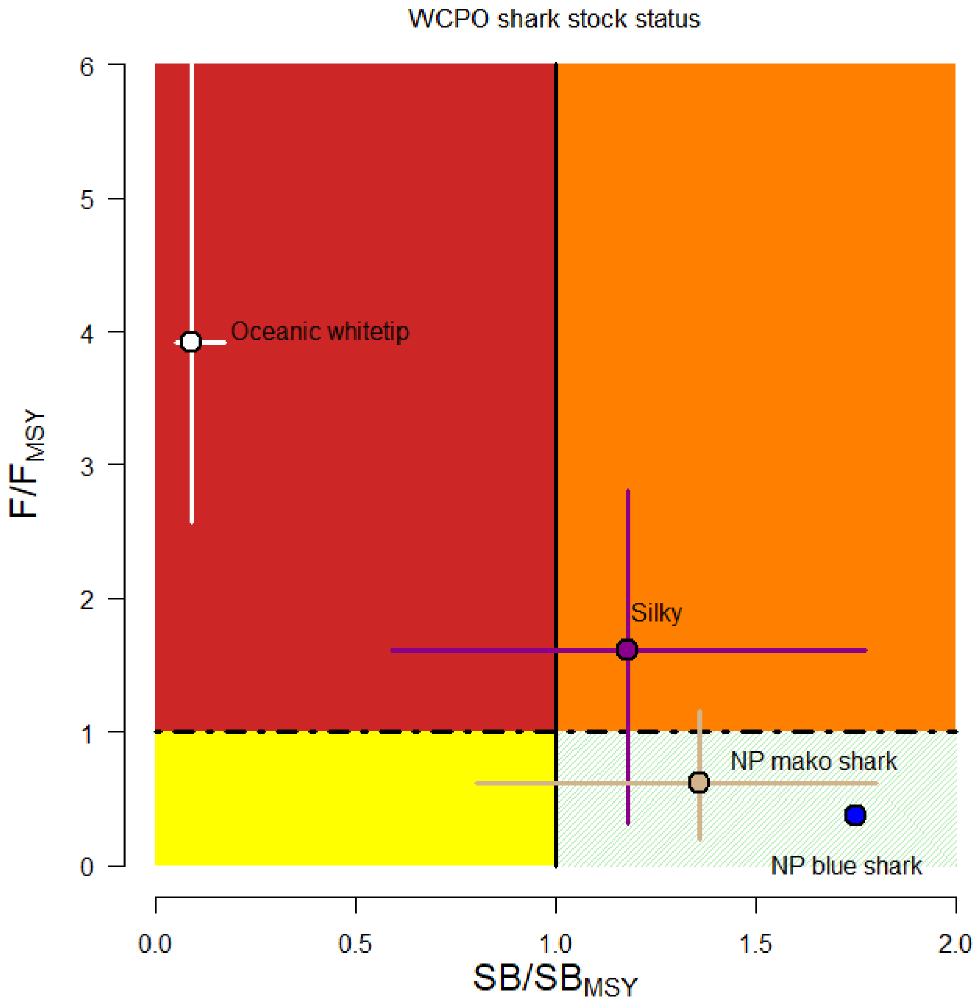


Figure 98: Kobe plot showing the agreed stock status for WCPFC stocks assessed with Data Rich assessments.

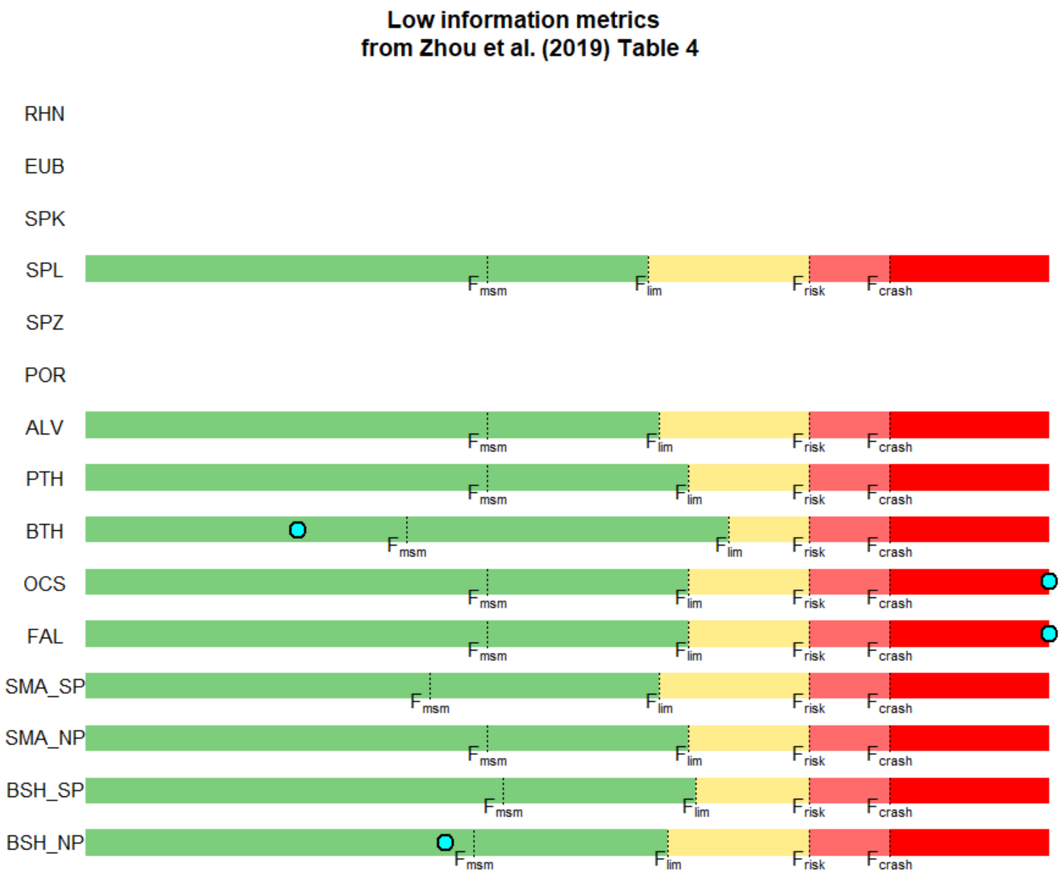


Figure 99: Zoom plot showing the productivity and Fishing Mortality metrics rescaled from Zhou et al. (2019) as a ratio relative to F_{crash} for WCPFC stocks for medium and data assessments. F_{risk} is not reported in Zhou et al. (2019) but simply shown here as 10% below F_{crash}. The cyan points are estimated F converted to F/F_{risk}. Note as yet these metrics have not been agreed by the WCPFC nor the SC, but are shown here for illustrative purposes as a potential means to illustrate stock status for medium and data assessments.

Name (Species name) colour coded for high, medium and low as per SC15 priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	This coulum describes whether or not we have the data required for this type of assesment.	How reliable are these data based on the criteria specified in Table 5.	Can we do an assessment with level of data? If yes, should we do it? Or would a lower level of information be appropriate?
		Marurity	Marurity schedule			
		Structure	Understand Structure			
		M	Reliable M			
	Fisheries	Catch	Catch history >=20 yr			
		Effort	Effort data			
		Length	Length from fisheries			
		Weight	Weight from fisheries			
Medium data	Biology	Growth	Reliable age-length			
		Maturity	Marurity schedule			
		Structure	Understand Structure			
	Fisheries	Catch/effort	Catch/effort >=10 yr			
		Length	Length			
		Weight	Weight			
Poor data	Risk	Catch obs.	Catch location			
		Exp. advice	Prod. & sust. estimates			
Research needs	List of the top 3 or 4 research needs					

Figure 100: WCPFC research report card explanatory card. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Blue shark (NP) (Prionace glauca) high priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	High	Can de done
		Marurity	Marurity schedule	Yes	High	SC13-SA-WP-10
		Structure	Understand Structure	No	Medium	Should be repeated
		M	Reliable M	Yes	High	Gaps in observer data
	Fisheries	Catch	Catch history >=20 yr	Yes	High	inhibit accurate catch
		Effort	Effort data	Yes	High	history estimation.
		Length	Length from fisheries	Yes	High	
		Weight	Weight from fisheries	Yes	High	
Medium data	Biology	Growth	Reliable age-length	Yes	High	Can de done
		Maturity	Marurity schedule	Yes	High	Should include medium
		Structure	Understand Structure	No	Medium	information metrics
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	High	if data rich assessment
		Length	Length	Yes	High	done.
		Weight	Weight	Yes	High	
Poor data	Risk	Catch obs.	Catch location	Yes	High	Not required if above
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	done
Research needs	Spatio-temporal representative observer coverage, refine stock structure information					
	Develop catch history throughout range in WCPO. Collect length-weight and length-length data					
	Resolve uncertainties in reproductive schedule					

Figure 101: WCPFC research report card for blue shark in the north Pacific. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Blue shark (SP) (Prionace glauca) high priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	High	Can be done if data Improves
		Marurity	Marurity schedule	Yes	High	
		Structure	Understand Structure	No	Medium	
		M	Reliable M	Yes	Medium	Gaps in observer data inhibit accurate catch history estimation.
	Fisheries	Catch	Catch history >=20 yr	Yes	Medium	
		Effort	Effort data	Yes	High	
		Length	Length from fisheries	Yes	Medium	
		Weight	Weight from fisheries	Yes	Medium	
Medium data	Biology	Growth	Reliable age-length	Yes	High	Can de done Estimates of Flim and Fcrash or Surplus production model
		Maturity	Marurity schedule	Yes	Medium	
		Structure	Understand Structure	No	Medium	
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Medium	
		Length	Length	Yes	High	
		Weight	Weight	Yes	Medium	
Poor data	Risk	Catch obs.	Catch location	Yes	High	Not required if above done
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	
Research needs	Develop catch history throughout range in WCPO Collect length-weight and length-length data, and age data throughout the range Resolve uncertainties in reproductive schedule					

Figure 102: WCPFC research report card for South Pacific blue shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Silky shark (Carcharhinus falciformis) high priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	Medium	Can de done
		Marurity	Marurity schedule	Yes	High	SC9-SA-WP-03
		Structure	Understand Structure	No	Medium	Should be repeated
		M	Reliable M	Yes	Medium	Gaps in observer data
	Fisheries	Catch	Catch history >=20 yr	Yes	High	inhibit accurate catch
		Effort	Effort data	Yes	High	history estimation.
		Length	Length from fisheries	Yes	Medium	
		Weight	Weight from fisheries	Yes	Medium	
Medium data	Biology	Growth	Reliable age-length	Yes	High	Can de done
		Maturity	Marurity schedule	Yes	High	Should include medium
		Structure	Understand Structure	Yes	High	information metrics
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	High	if data rich assessment
		Length	Length	Yes	High	done.
		Weight	Weight	Yes	high	
Poor data	Risk	Catch obs.	Catch location	Yes	High	Not required if above
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	done
Research needs	Spatio-temporal representative observer coverage, release mortality estimates Develop catch history throughout range in WCPO. Determine the reproductive schedule and periodicity Collect length-weight and length-length data, and age data throughout the range					

Figure 103: WCPFC research report card for silky shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Oceanic whitetip shark (Carcharhinus longimanus) high priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	Medium	Can de done
		Marurity	Marurity schedule	Yes	Medium	SC15-SA-WP-06
		Structure	Understand Structure	No	Medium	Should be repeated
		M	Reliable M	Yes	Medium	Gaps in observer data
	Fisheries	Catch	Catch history >=20 yr	Yes	Medium	inhibit accurate catch
		Effort	Effort data	Yes	High	history estimation.
		Length	Length from fisheries	Yes	High	
		Weight	Weight from fisheries	Yes	High	
Medium data	Biology	Growth	Reliable age-length	Yes	High	Can de done
		Maturity	Marurity schedule	Yes	High	Should include medium
		Structure	Understand Structure	No		information metrics
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Medium	if data rich assessment
		Length	Length	Yes	High	done.
		Weight	Weight	Yes	High	
Poor data	Risk	Catch obs.	Catch location	Yes	High	Not required if above
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	done
Research needs	Spatio-temporal representative observer coverage, refine stock structure information Develop catch history throughout range in WCPO. Collect region-specific life history parameters Collect length-weight and length-length data					

Figure 104: WCPFC research report card for oceanic whitetip shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Shortfin mako - NP (Isurus oxyrinchus) high priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	Medium	Can de done
		Marurity	Marurity schedule	Yes	Medium	SC14-SA-WP-11
		Structure	Understand Structure	No	Medium	Should be repeated
		M	Reliable M	Yes	Low	Gaps in observer data
	Fisheries	Catch	Catch history >=20 yr	Yes	Medium	inhibit accurate catch
		Effort	Effort data	Yes	High	history estimation.
		Length	Length from fisheries	Yes	Medium	
		Weight	Weight from fisheries	Yes	Medium	
Medium data	Biology	Growth	Reliable age-length	Yes	Medium	Can de done
		Maturity	Marurity schedule	Yes	Medium	Should include medium
		Structure	Understand Structure	No	Medium	information metrics
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	High	if data rich assessment
		Length	Length	Yes	Medium	done.
		Weight	Weight	Yes	Medium	
Poor data	Risk	Catch obs.	Catch location	Yes	Medium	Not required if above
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	done
Research needs	Spatio-temporal representative observer coverage, refine stock structure information					
	Develop catch history throughout range in WCPO. Collect length-weight and length-length data					
	Resolve uncertainties in the biology including age, growth, and reproductive parameters					

Figure 105: WCPFC research report card for shortfin mako shark in the north Pacific. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Shortfin mako - SP (Isurus oxyrinchus) high priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	Medium	Can be done if data Improves
		Marurity	Marurity schedule	Yes	Medium	
		Structure	Understand Structure	No	Medium	
		M	Reliable M	Yes	Low	Gaps in observer data inhibit accurate catch history estimation.
	Fisheries	Catch	Catch history >=20 yr	Yes	Medium	
		Effort	Effort data	Yes	High	
		Length	Length from fisheries	Yes	Medium	
		Weight	Weight from fisheries	Yes	Medium	
Medium data	Biology	Growth	Reliable age-length	Yes	Medium	YES Should be done
		Maturity	Marurity schedule	Yes	Medium	
		Structure	Understand Structure	No	Medium	
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Medium	Could be done as indicator analysis
		Length	Length	Yes	Medium	
		Weight	Weight	Yes	Medium	
Poor data	Risk	Catch obs.	Catch location	Yes	Medium	Not required if above done
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	
Research needs	Spatio-temporal representative observer coverage, refine stock structure information Develop catch history throughout range in WCPO. Collect region-specific life history parameters Collect length-weight and length-length data					

Figure 106: WCPFC research report card for shortfin mako shark in the south Pacific. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Longfin mako (Isurus paucus) low priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	No		NO
		Marurity	Marurity schedule	No		
		Structure	Understand Structure	No		
		M	Reliable M	No		
	Fisheries	Catch	Catch history >=20 yr	Yes	Low	
		Effort	Effort data	Yes	High	
		Length	Length from fisheries	Yes	Low	
		Weight	Weight from fisheries	Yes	Low	
Medium data	Biology	Growth	Reliable age-length	No		NO
		Maturity	Marurity schedule	No		
		Structure	Understand Structure	No		
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Low	
		Length	Length	Yes	Medium	
		Weight	Weight	Yes	Low	
Poor data	Risk	Catch obs.	Catch location	Yes	Medium	EASI-Fish, SAFE
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	or similar
Research needs	Spatio-temporal representative observer coverage, refine stock structure information					
	Develop catch history throughout range in WCPO, improve biological estimates					
	Collect length-weight and length-length data					

Figure 107: WCPFC research report card for longfin mako shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Common thresher (Alopias vulpinus) low priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	Medium	No
		Marurity	Marurity schedule	Yes	Low	
		Structure	Understand Structure	No	Low	
		M	Reliable M	Yes	Low	
	Fisheries	Catch	Catch history >=20 yr	Yes	Low	
		Effort	Effort data	Yes	High	
		Length	Length from fisheries	Yes	Low	
		Weight	Weight from fisheries	Yes	Low	
Medium data	Biology	Growth	Reliable age-length	Yes	High	Can de done
		Maturity	Marurity schedule	Yes	Low	Estimates of Flim
		Structure	Understand Structure	No	Low	and Fcrash
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Medium	
		Length	Length	Yes	Low	
		Weight	Weight	Yes	Medium	
Poor data	Risk	Catch obs.	Catch location	Yes	Medium	EASI-Fish, SAFE
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	or similar
Research needs	Spatio-temporal representative observer coverage, refine stock structure information					
	Develop catch history throughout range in WCPO. Collect region-specific life history parameters					
	Collect length-weight and length-length data					

Figure 108: WCPFC research report card for common thresher shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Bigeye thresher (Alopias superciliosus) medium priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	Medium	NO
		Marurity	Marurity schedule	Yes	Medium	
		Structure	Understand Structure	No		
		M	Reliable M	No	Low	
	Fisheries	Catch	Catch history >=20 yr	Yes	Medium	
		Effort	Effort data	Yes	High	
		Length	Length from fisheries	Yes	Medium	
		Weight	Weight from fisheries	Yes	Low	
Medium data	Biology	Growth	Reliable age-length	Yes	Low	Can de done
		Maturity	Marurity schedule	Yes	Low	Estimates of Flim
		Structure	Understand Structure	No		and Fcrash or
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Medium	Surplus production model
		Length	Length	Yes	High	SC13-SA-WP-11
		Weight	Weight	Yes	Medium	
Poor data	Risk	Catch obs.	Catch location	Yes	High	Not required if above
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	done
Research needs	Spatio-temporal representative observer coverage, refine stock structure information Develop catch history throughout range in WCPO. Collect region-specific life history parameters Collect length-weight and length-length data					

Figure 109: WCPFC research report card for bigeye thresher shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Pelagic thresher (Alopias pelagicus) low priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	Medium	NO
		Marurity	Marurity schedule	Yes	Medium	
		Structure	Understand Structure	No	Low	
		M	Reliable M	No		
	Fisheries	Catch	Catch history >=20 yr	Yes	Medium	
		Effort	Effort data	Yes	High	
		Length	Length from fisheries	Yes	Low	
		Weight	Weight from fisheries	Yes	Low	
Medium data	Biology	Growth	Reliable age-length	Yes	Medium	Can de done
		Maturity	Marurity schedule	Yes	Medium	Estimates of Flim
		Structure	Understand Structure	No	Low	and Fcrash
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Low	
		Length	Length	Yes	Medium	
		Weight	Weight	Yes	Medium	
Poor data	Risk	Catch obs.	Catch location	Yes	Medium	EASI-Fish, SAFE
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	or similar
Research needs	Spatio-temporal representative observer coverage, refine stock structure information					
	Develop catch history throughout range in WCPO, improve biological estimates					
	Collect length-weight and length-length data					

Figure 110: WCPFC research report card for pelagic thresher shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Porbeagle shark (Lamna nasus) low priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	High	NO
		Marurity	Marurity schedule	Yes	High	
		Structure	Understand Structure	Yes	Medium	
		M	Reliable M	Yes	Medium	
	Fisheries	Catch	Catch history >=20 yr	Yes	High	
		Effort	Effort data	Yes	High	
		Length	Length from fisheries	Yes	Medium	
		Weight	Weight from fisheries	Yes	Medium	
Medium data	Biology	Growth	Reliable age-length	Yes	High	Can de done
		Maturity	Marurity schedule	Yes	High	Estimates of Flim
		Structure	Understand Structure	Yes	High	and Fcrash or
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Medium	Surplus production model
		Length	Length	Yes	High	
		Weight	Weight	Yes	Medium	
Poor data	Risk	Catch obs.	Catch location	Yes	Medium	Not required if above
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	done
Research needs	Spatio-temporal representative observer coverage					
	Develop catch history throughout range in WCPO					
	Resolve life history, reproductive biology, and stock structure					

Figure 111: WCPFC research report card for porbeagle shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Great hammerhead (Sphyrna mokarran) low priority						
Assessment type	**Inputs**		**Data needs**	**Do we have it**	**Data certainty**	**Can we do it? If yes, should we?**
Rich data	Biology	Age	Reliable age-length	Yes	Low	NO
		Marurity	Marurity schedule	Yes	Low	
		Structure	Understand Structure	No	Low	
		M	Reliable M	No	Low	
	Fisheries	Catch	Catch history >=20 yr	Yes	Low	
		Effort	Effort data	Yes	Medium	
		Length	Length from fisheries	Yes	Low	
		Weight	Weight from fisheries	Yes	Low	
Medium data	Biology	Growth	Reliable age-length	No		Can de done
		Maturity	Marurity schedule	No		Estimates of Flim
		Structure	Understand Structure	No	Low	and Fcrash
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Low	
		Length	Length	Yes	Low	
		Weight	Weight	Yes	Low	
Poor data	Risk	Catch obs.	Catch location	Yes	Low	EASI-Fish, SAFE
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	or similar
Research needs	Spatio-temporal representative observer coverage, refine stock structure information					
	Develop catch history throughout range in WCPO. Collect region-specific life history parameters					
	Collect length-weight and length-length data, improve biological estimates					

Figure 112: WCPFC research report card for great hammerhead shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Scalloped hammerhead (Sphyrna lewini) low priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	Low	NO
		Marurity	Marurity schedule	Yes	Low	
		Structure	Understand Structure	No	Low	
		M	Reliable M	Yes	Medium	
	Fisheries	Catch	Catch history >=20 yr	Yes	Low	
		Effort	Effort data	Yes	Medium	
		Length	Length from fisheries	Yes	Low	
		Weight	Weight from fisheries	Yes	Low	
Medium data	Biology	Growth	Reliable age-length	No		Can de done
		Maturity	Marurity schedule	No		Estimates of Flim
		Structure	Understand Structure	No		and Fcrash
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Medium	
		Length	Length	Yes	Medium	
		Weight	Weight	Yes	Medium	
Poor data	Risk	Catch obs.	Catch location	Yes	Medium	EASI-Fish, SAFE
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	or similar
Research needs	Spatio-temporal representative observer coverage, refine stock structure information					
	Develop catch history throughout range in WCPO. Collect region-specific life history parameters					
	Collect length-weight and length-length data, improve biological estimates					

Figure 113: WCPFC research report card for scalloped hammerhead shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Smooth hammerhead (Sphyrna zygaena) low priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	Low	NO
		Marurity	Marurity schedule	Yes	Low	
		Structure	Understand Structure	Yes	Low	
		M	Reliable M	No	Low	
	Fisheries	Catch	Catch history >=20 yr	Yes	Low	
		Effort	Effort data	Yes	Medium	
		Length	Length from fisheries	Yes	Low	
		Weight	Weight from fisheries	Yes	Low	
Medium data	Biology	Growth	Reliable age-length	No		Can de done
		Maturity	Marurity schedule	No		Estimates of Flim
		Structure	Understand Structure	No		and Fcrash
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Medium	
		Length	Length	Yes	Low	
		Weight	Weight	Yes	Low	
Poor data	Risk	Catch obs.	Catch location	Yes	Low	EASI-Fish, SAFE
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	or similar
Research needs	Spatio-temporal representative observer coverage, refine stock structure information					
	Develop catch history throughout range in WCPO, improve coastal fishery catch estimates					
	Collect length-weight and length-length data, improve biological estimates					

Figure 114: WCPFC research report card for smooth hammerhead shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Winghead shark (Eusphyra blochii) low priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	Low	NO
		Marurity	Marurity schedule	Yes	Low	
		Structure	Understand Structure	No	Low	
		M	Reliable M	No	Low	
	Fisheries	Catch	Catch history >=20 yr	Yes	Low	
		Effort	Effort data	Yes	Medium	
		Length	Length from fisheries	Yes	Low	
		Weight	Weight from fisheries	Yes	Low	
Medium data	Biology	Growth	Reliable age-length	No		NO
		Maturity	Marurity schedule	No		
		Structure	Understand Structure	No		
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Low	
		Length	Length	Yes	Low	
		Weight	Weight	Yes	Low	
Poor data	Risk	Catch obs.	Catch location	Yes	Low	EASI-Fish, SAFE
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	or similar
Research needs	Spatio-temporal representative observer coverage, refine stock structure information Develop catch history throughout range in WCPO. Collect region-specific life history parameters Collect length-weight and length-length data, improve biological estimates					

Figure 115: WCPFC research report card for winghead shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Whale shark (Rhincodon typus) low priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	Yes	Low	NO
		Marurity	Marurity schedule	Yes	Low	
		Structure	Understand Structure	Yes	Low	
		M	Reliable M	Yes	Low	
	Fisheries	Catch	Catch history >=20 yr	Yes	Medium	
		Effort	Effort data	Yes	High	
		Length	Length from fisheries	Yes	Low	
		Weight	Weight from fisheries	No		
Medium data	Biology	Growth	Reliable age-length	Yes	Low	NO
		Maturity	Marurity schedule	Yes	Low	
		Structure	Understand Structure	Yes	Low	
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	High	
		Length	Length	Yes	Low	
		Weight	Weight	No		
Poor data	Risk	Catch obs.	Catch location	Yes	High	EASI-Fish, SAFE
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	or similar
Research needs	Refine stock structure information					
	Improve biological estimates					
	Quantify the post release survival of released whale sharks in the WCPO purse seine fishery					

Figure 116: WCPFC research report card for whale shark. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Giant manta (Manta birostris) medium priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	No		NO
		Marurity	Marurity schedule	No		
		Structure	Understand Structure	No		
		M	Reliable M	No		
	Fisheries	Catch	Catch history >=20 yr	Yes	Low	
		Effort	Effort data	Yes	High	
		Length	Length from fisheries	No		
		Weight	Weight from fisheries	No		
Medium data	Biology	Growth	Reliable age-length	No		NO
		Maturity	Marurity schedule	No		
		Structure	Understand Structure	No		
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Low	
		Length	Length	Yes	Low	
		Weight	Weight	No		
Poor data	Risk	Catch obs.	Catch location	Yes	Low	EASI-Fish, SAFE
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	or similar
Research needs	Assess species composition of generic codes, develop catch histories					
	Improve biological estimates					
	Quantify the post release survival of releases in the WCPO purse seine fishery					

Figure 117: WCPFC research report card for giant manta ray. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Spinetail devil ray (Mobula mobula) medium priority						
Assessment type	Inputs		Data needs	Do we have it	Data certainty	Can we do it? If yes, should we?
Rich data	Biology	Age	Reliable age-length	No		NO
		Marurity	Marurity schedule	No		
		Structure	Understand Structure	No		
		M	Reliable M	No		
	Fisheries	Catch	Catch history >=20 yr	Yes	Low	
		Effort	Effort data	Yes	Medium	
		Length	Length from fisheries	No		
		Weight	Weight from fisheries	No		
Medium data	Biology	Growth	Reliable age-length	No		NO
		Maturity	Marurity schedule	No		
		Structure	Understand Structure	No		
	Fisheries	Catch/effort	Catch/effort >=10 yr	Yes	Low	
		Length	Length	Yes	Low	
		Weight	Weight	No		
Poor data	Risk	Catch obs.	Catch location	Yes	Low	EASI-Fish, SAFE
		Exp. advice	Prod. & sust. estimates	Yes	SC3-EB SWG/WP-01	or similar
Research needs	Assess species composition of generic codes, develop catch histories					
	Improve biological estimates					
	Quantify the post release survival of releases in the WCPO purse seine fishery					

Figure 118: WCPFC research report card for giant devilray. The colour bar at the top shows the research priority as agreed at SC15: red = high; gold = medium; blue = low; and the definitions for the data certainty criteria can be found in Table 6.

Appendix I - Country specific plots

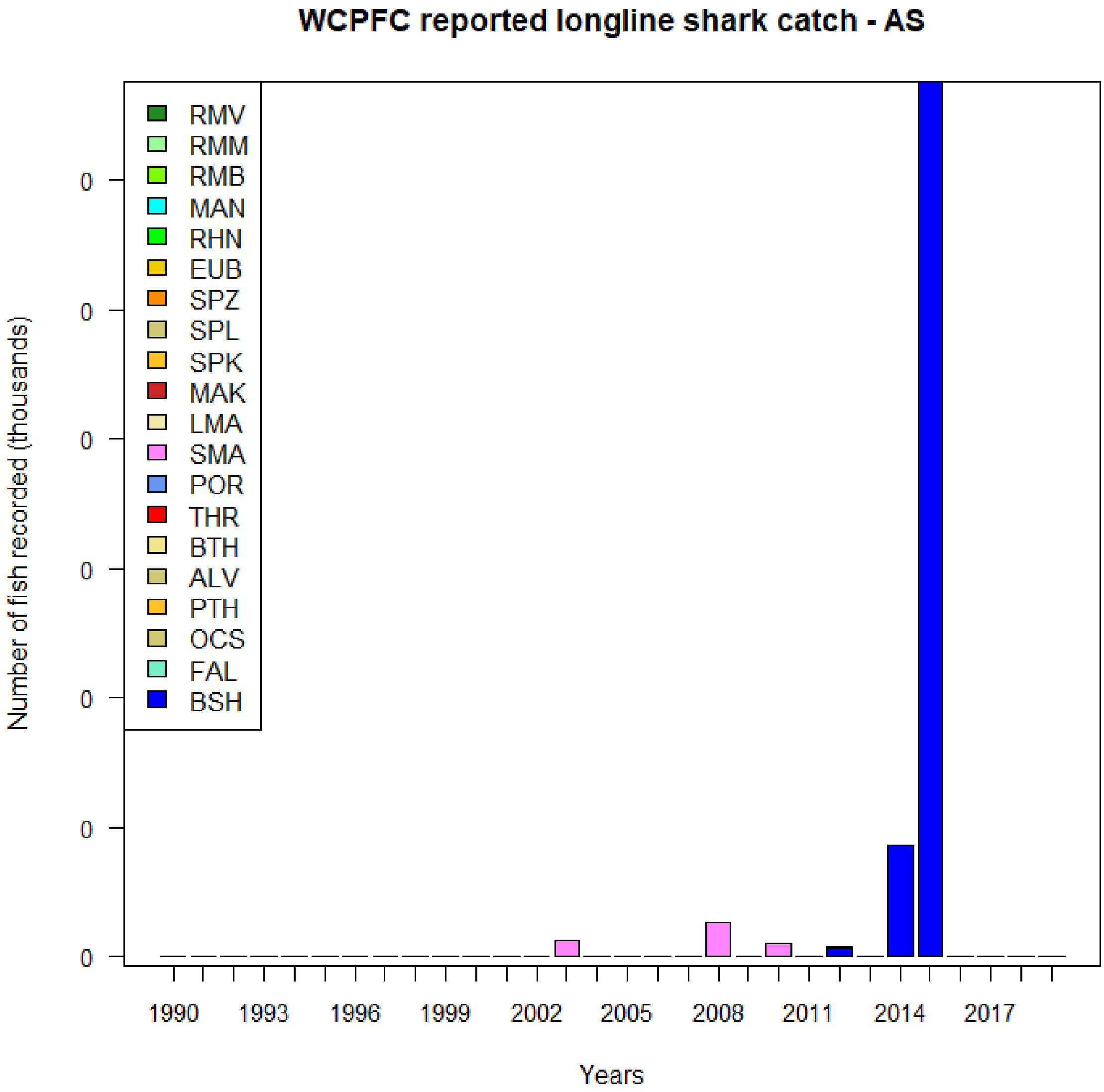


Figure AI - 1: Longline logsheet reporting data for American Samoan flagged vessels showing the number of sharks reported by species and species group.

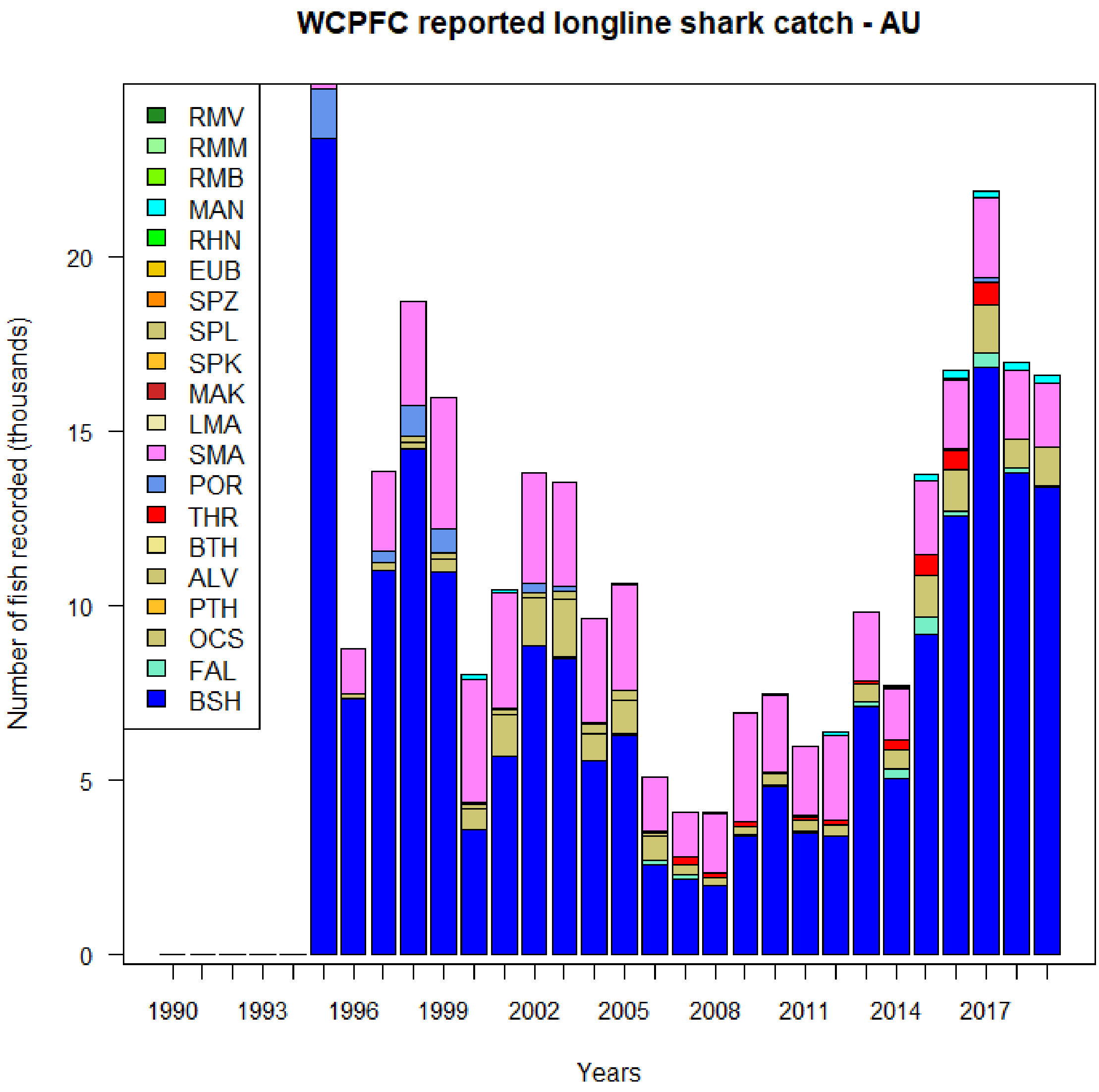


Figure AI - 2: Longline logsheet reporting data for Australian flagged vessels showing the number of sharks reported by species and species group.

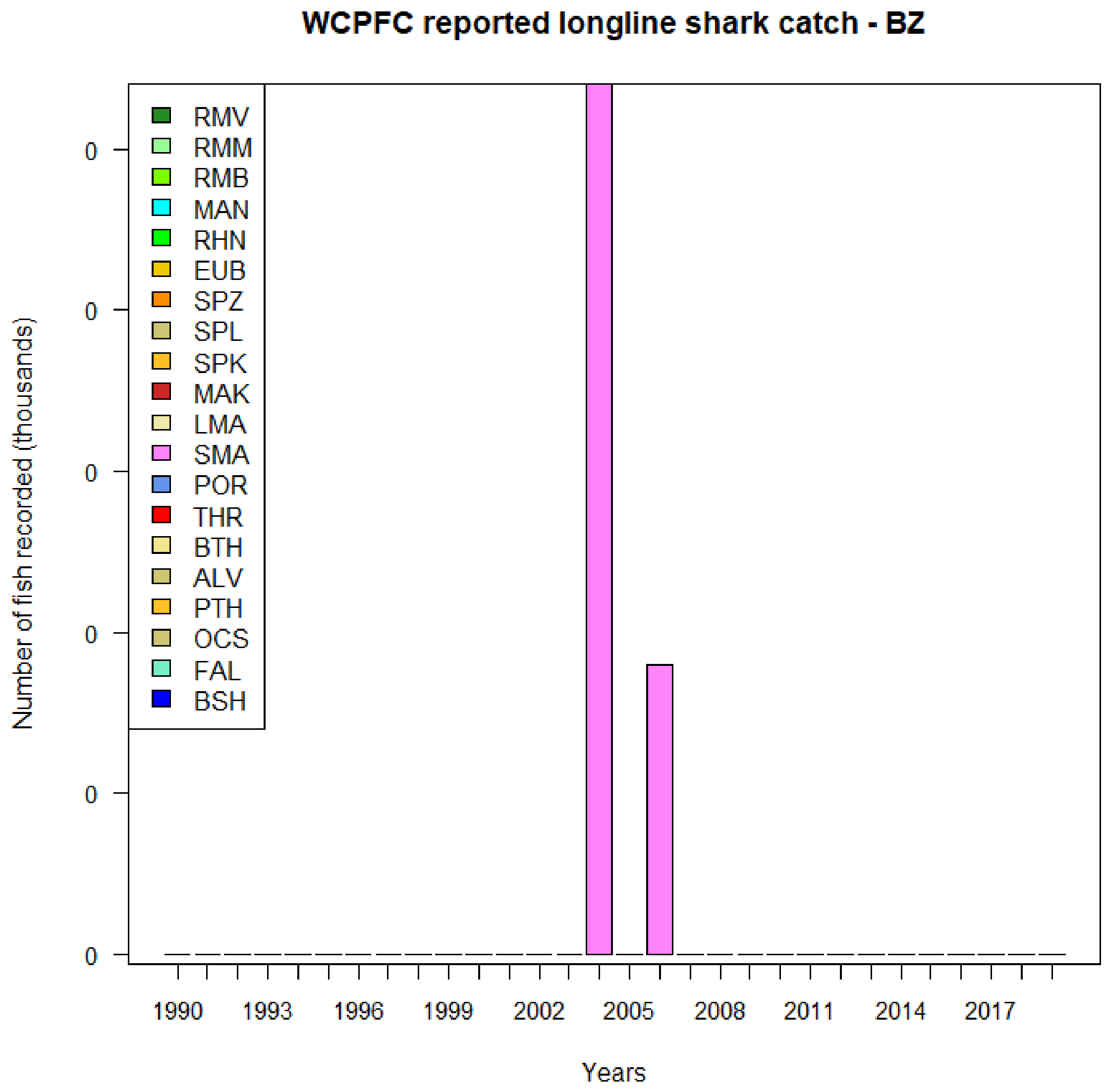


Figure AI - 3: Longline logsheet reporting data for Belize flagged vessels showing the number of sharks reported by species and species group.

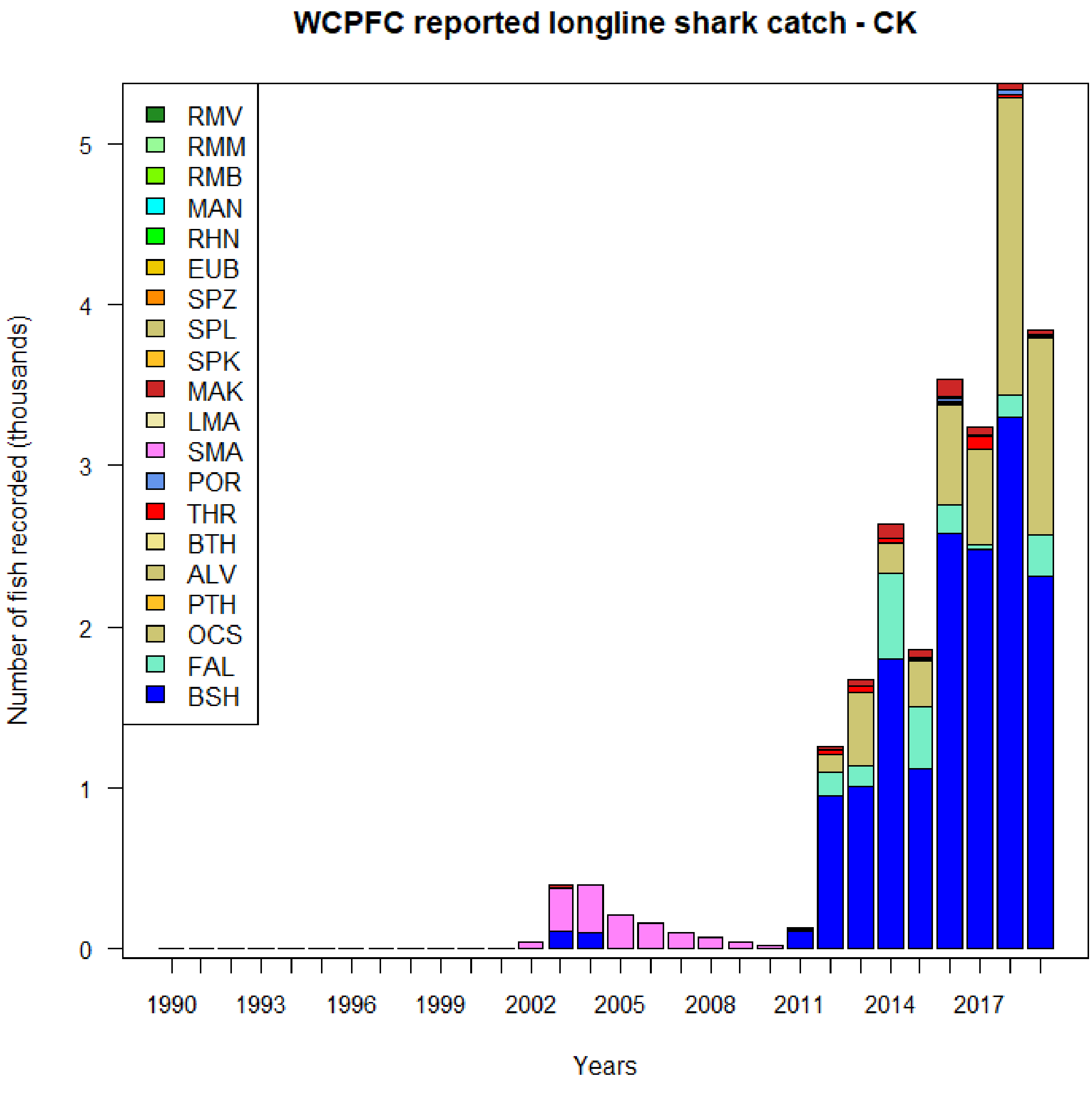


Figure AI - 4: Longline logsheet reporting data for the Cook Islands flagged vessels showing the number of sharks reported by species and species group.

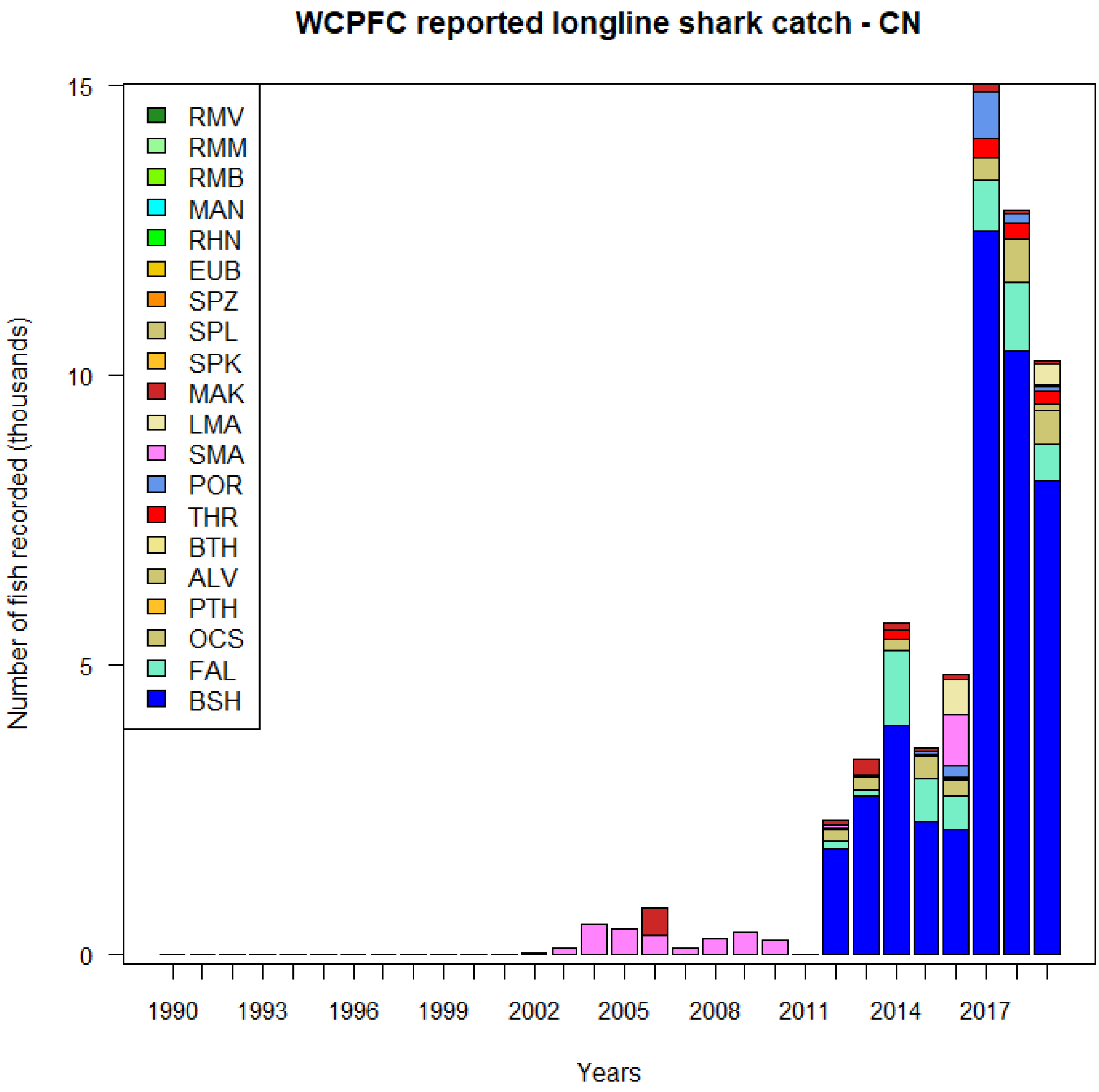


Figure AI - 5: Longline logsheet reporting data for Chinese flagged vessels showing the number of sharks reported by species and species group.

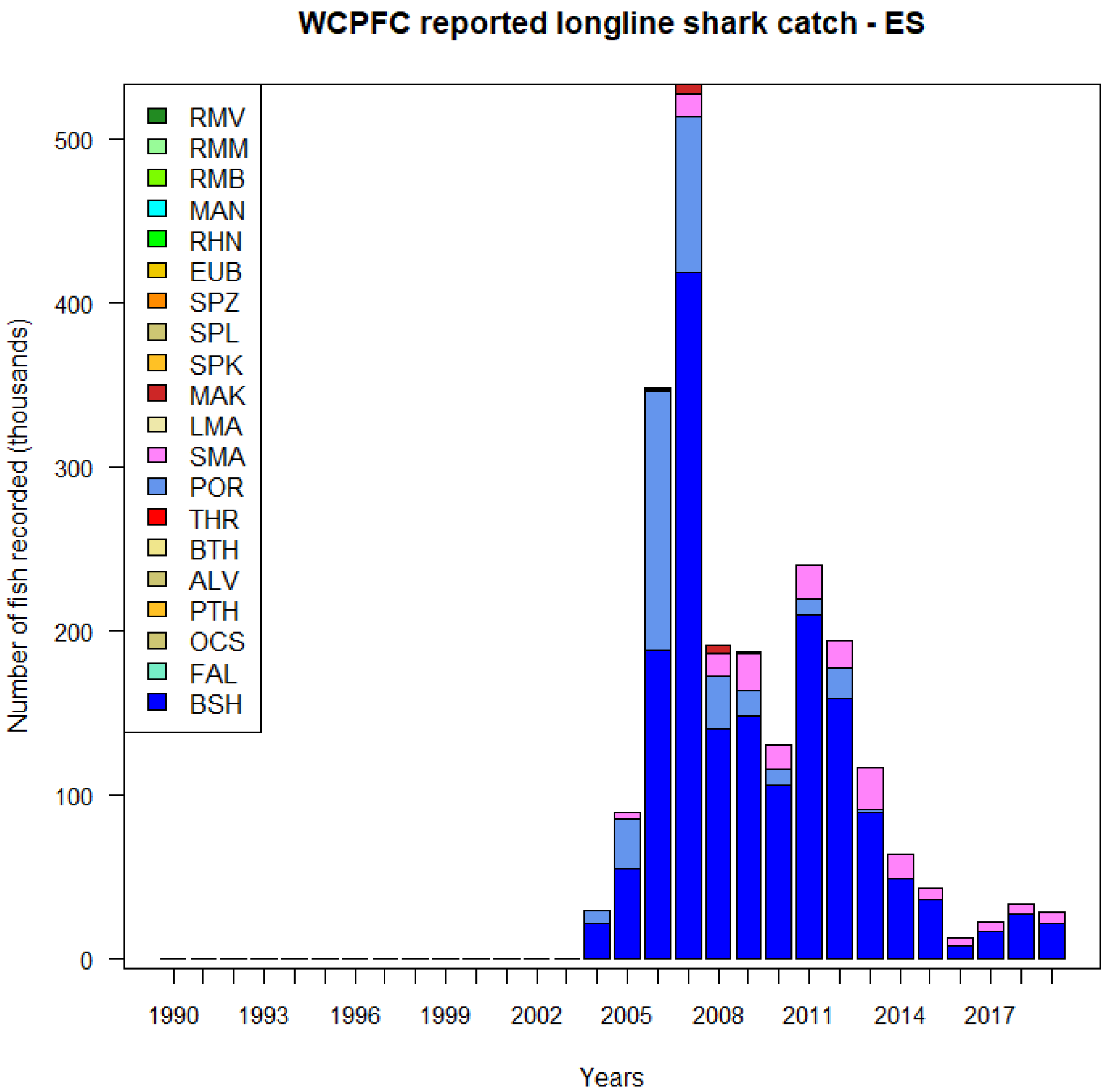


Figure AI - 6: Longline logsheet reporting data for EC - Spanish flagged vessels showing the number of sharks reported by species and species group.

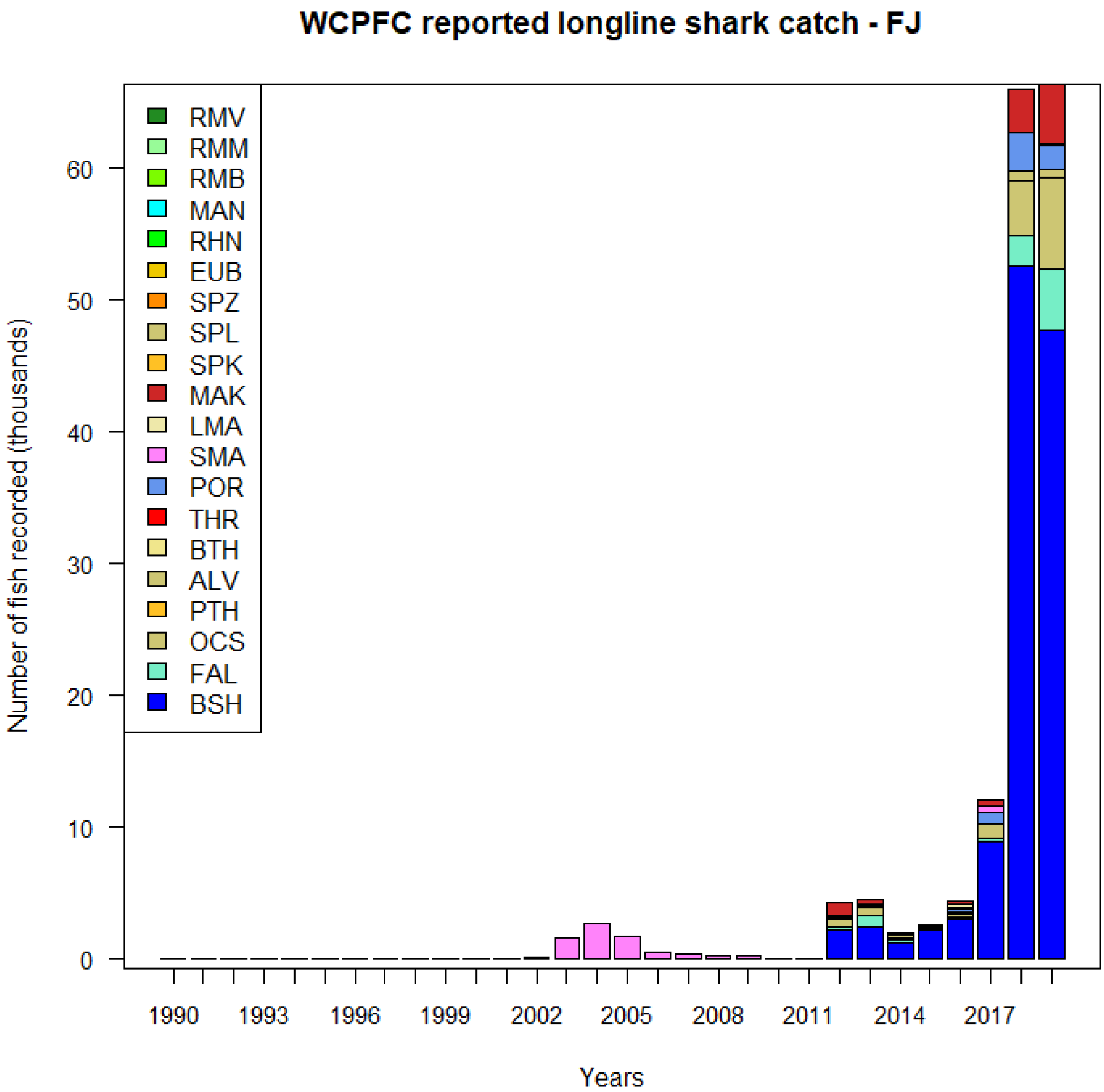


Figure AI - 7: Longline logsheet reporting data for Fijian flagged vessels showing the number of sharks reported by species and species group.

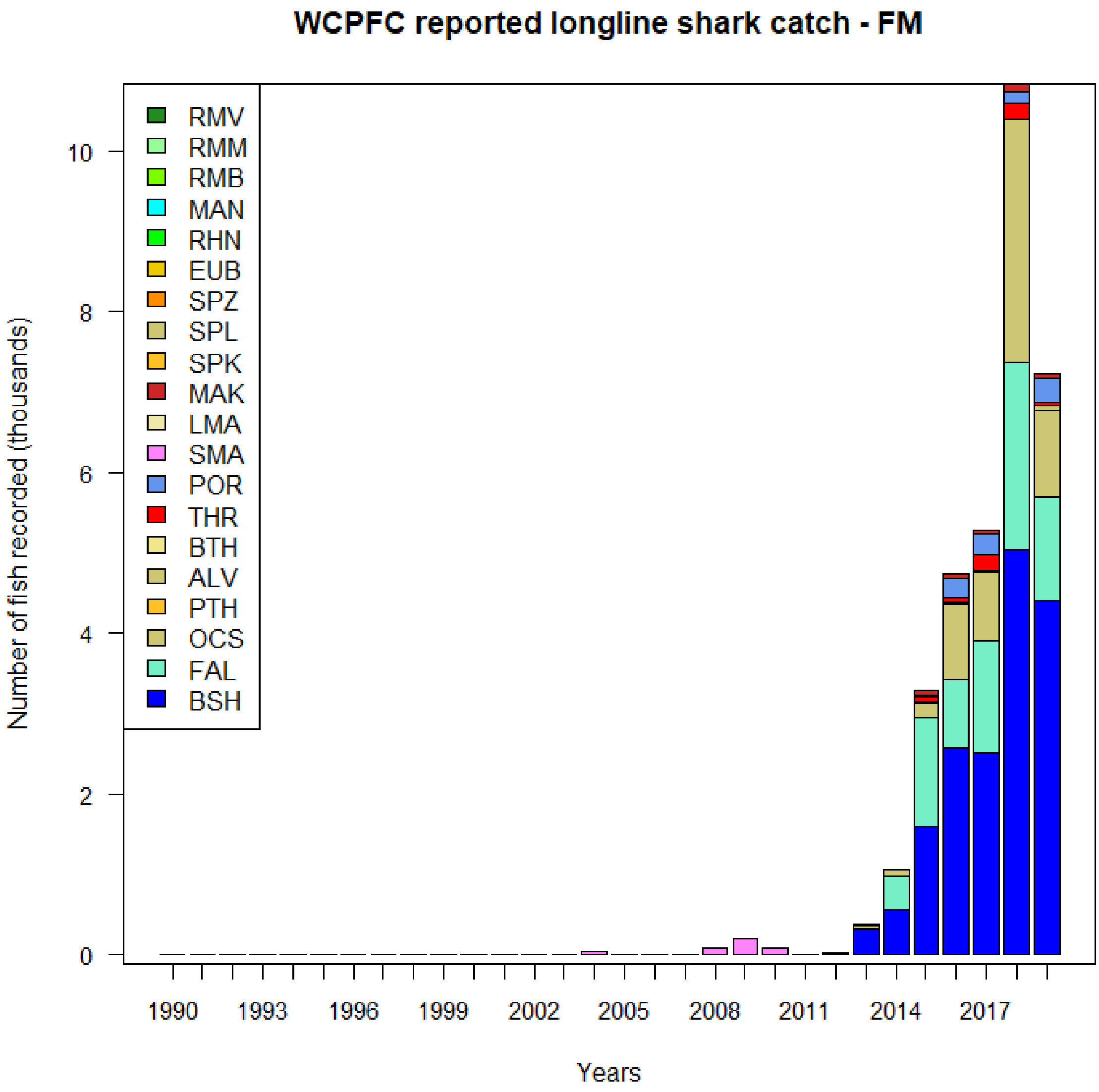


Figure AI - 8: Longline logsheet reporting data for the Federated States of Micronesian flagged vessels showing the number of sharks reported by species and species group.

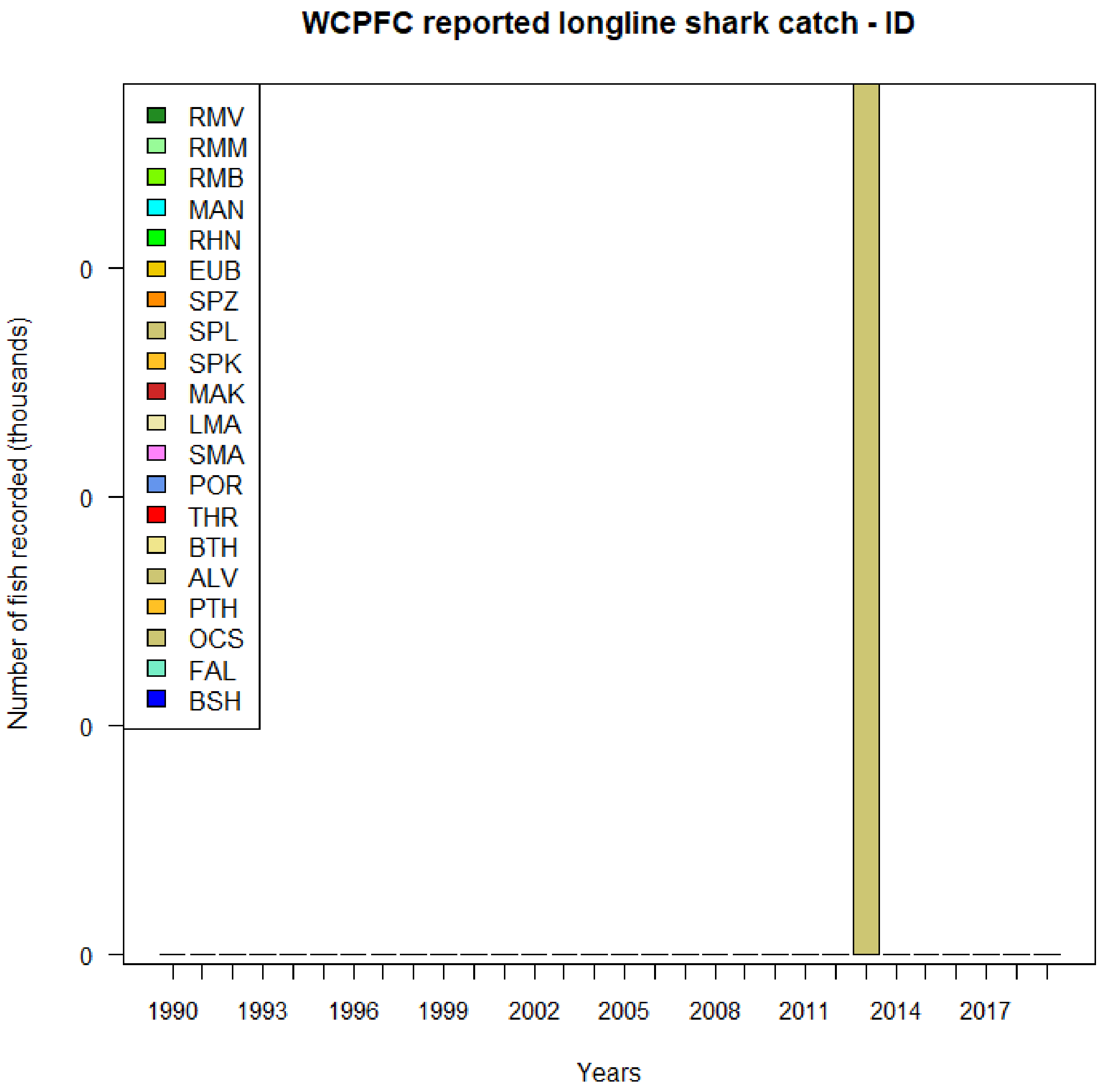


Figure AI - 9: Longline logsheet reporting data for Indonesian flagged vessels showing the number of sharks reported by species and species group.

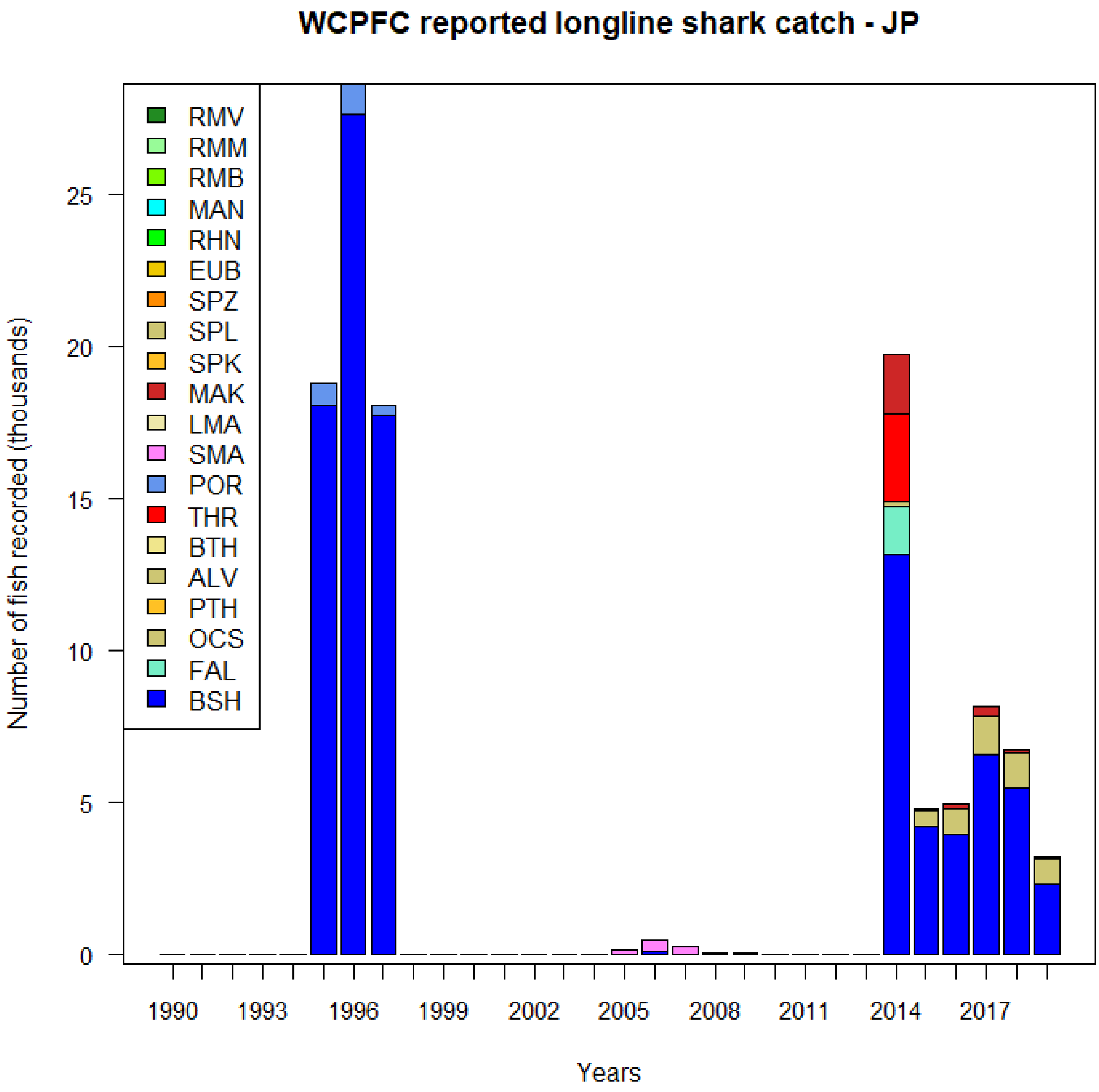


Figure AI - 10: Longline logsheet reporting data for Japanese flagged vessels showing the number of sharks reported by species and species group.

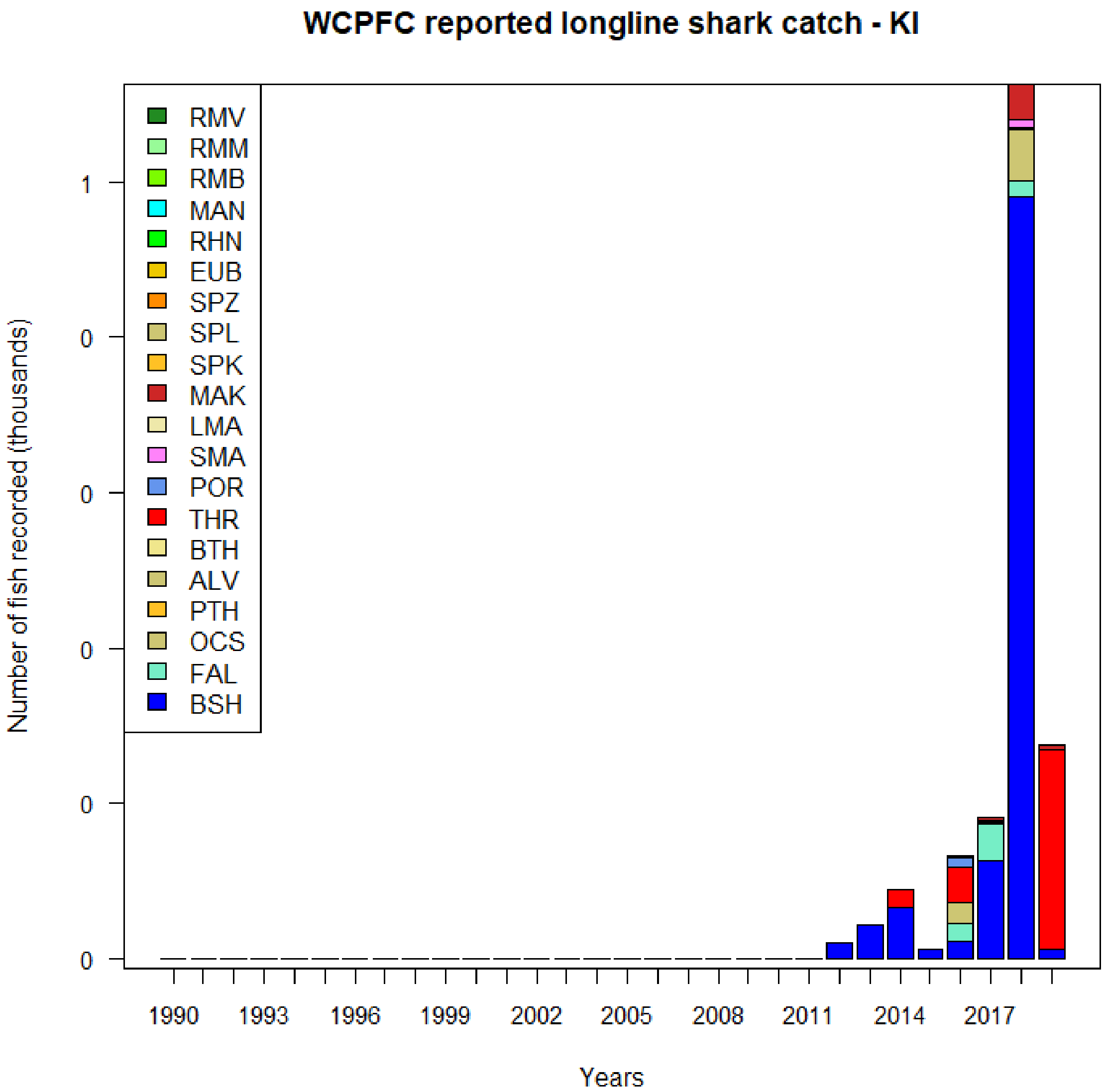


Figure AI - 11: Longline logsheet reporting data for Kiribati flagged vessels showing the number of sharks reported by species and species group.

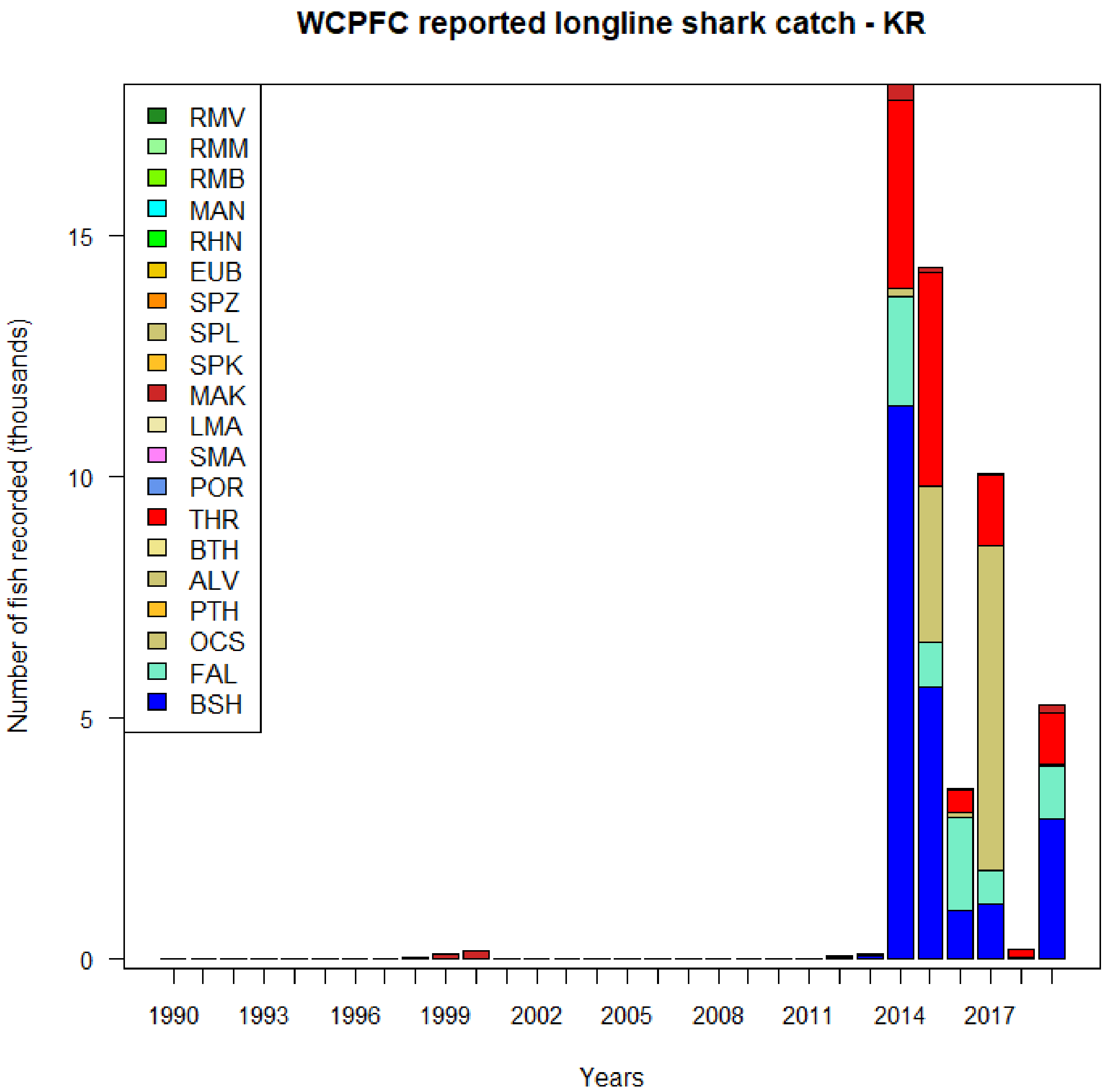


Figure AI - 12: Longline logsheet reporting data for the Republic of Korean flagged vessels showing the number of sharks reported by species and species group.

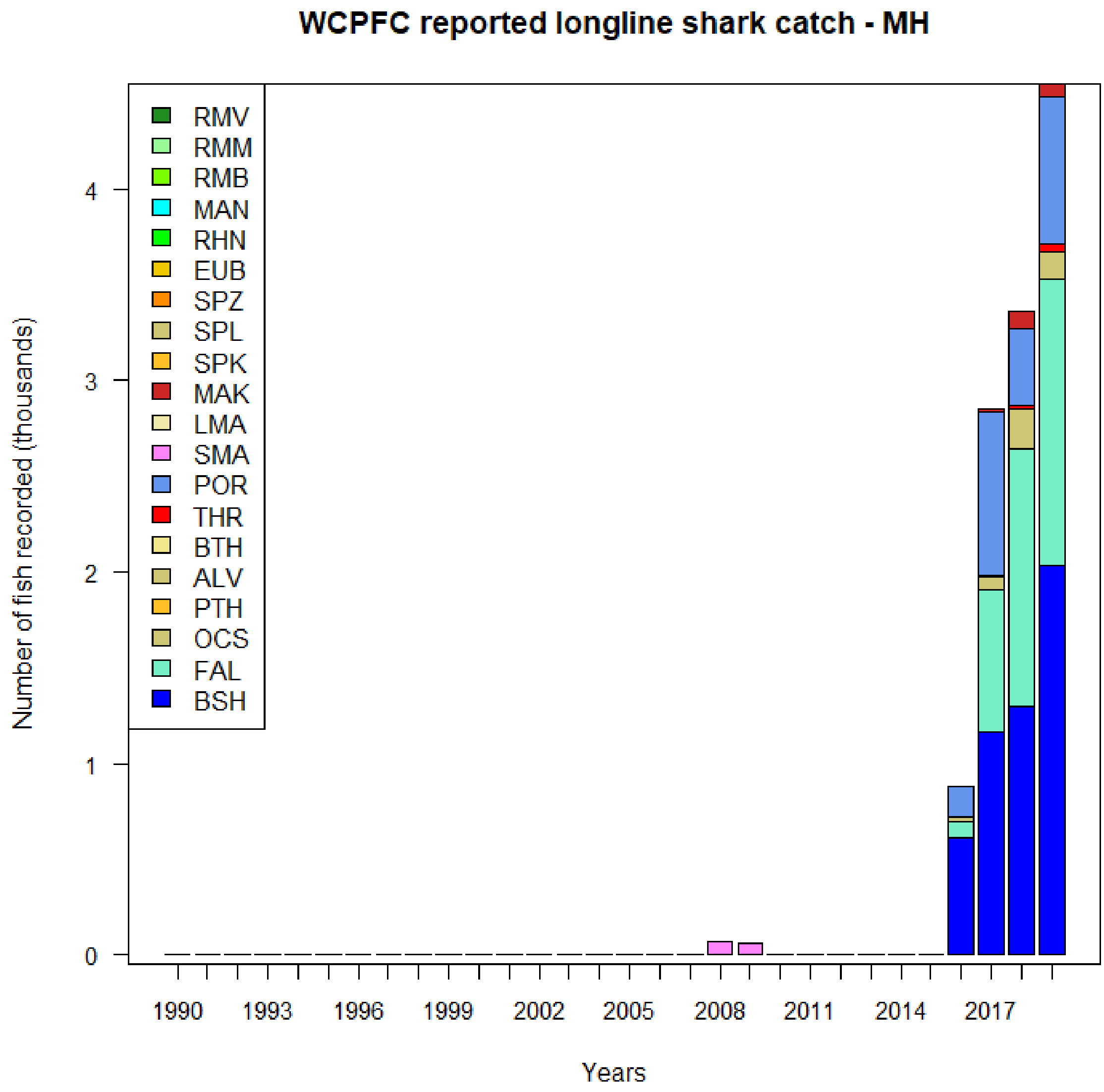


Figure AI - 13: Longline logsheet reporting data for the Republic of the Marshall Islands flagged vessels showing the number of sharks reported by species and species group.

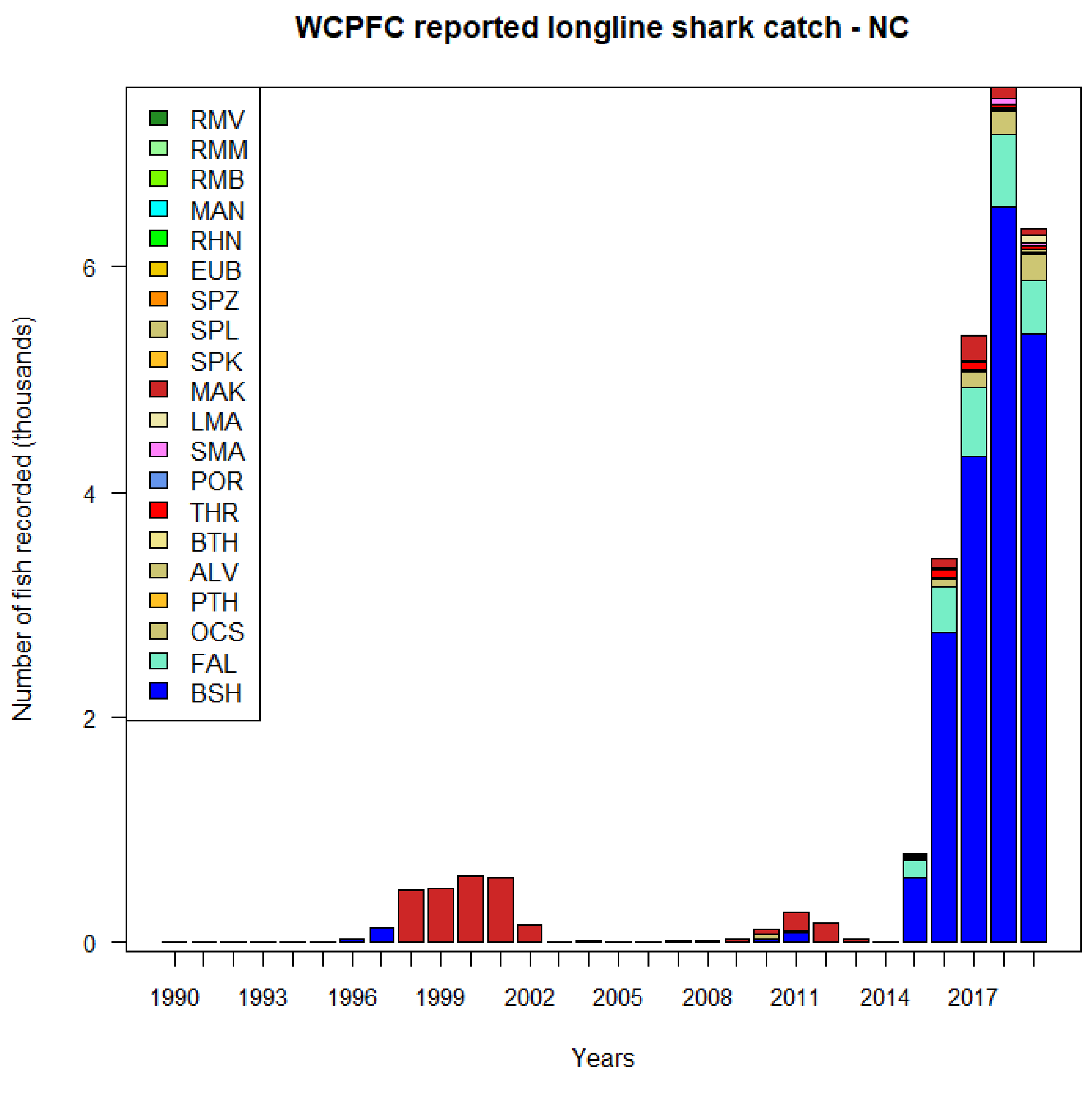


Figure AI - 14: Longline logsheet reporting data for New Caledonian flagged vessels showing the number of sharks reported by species and species group.

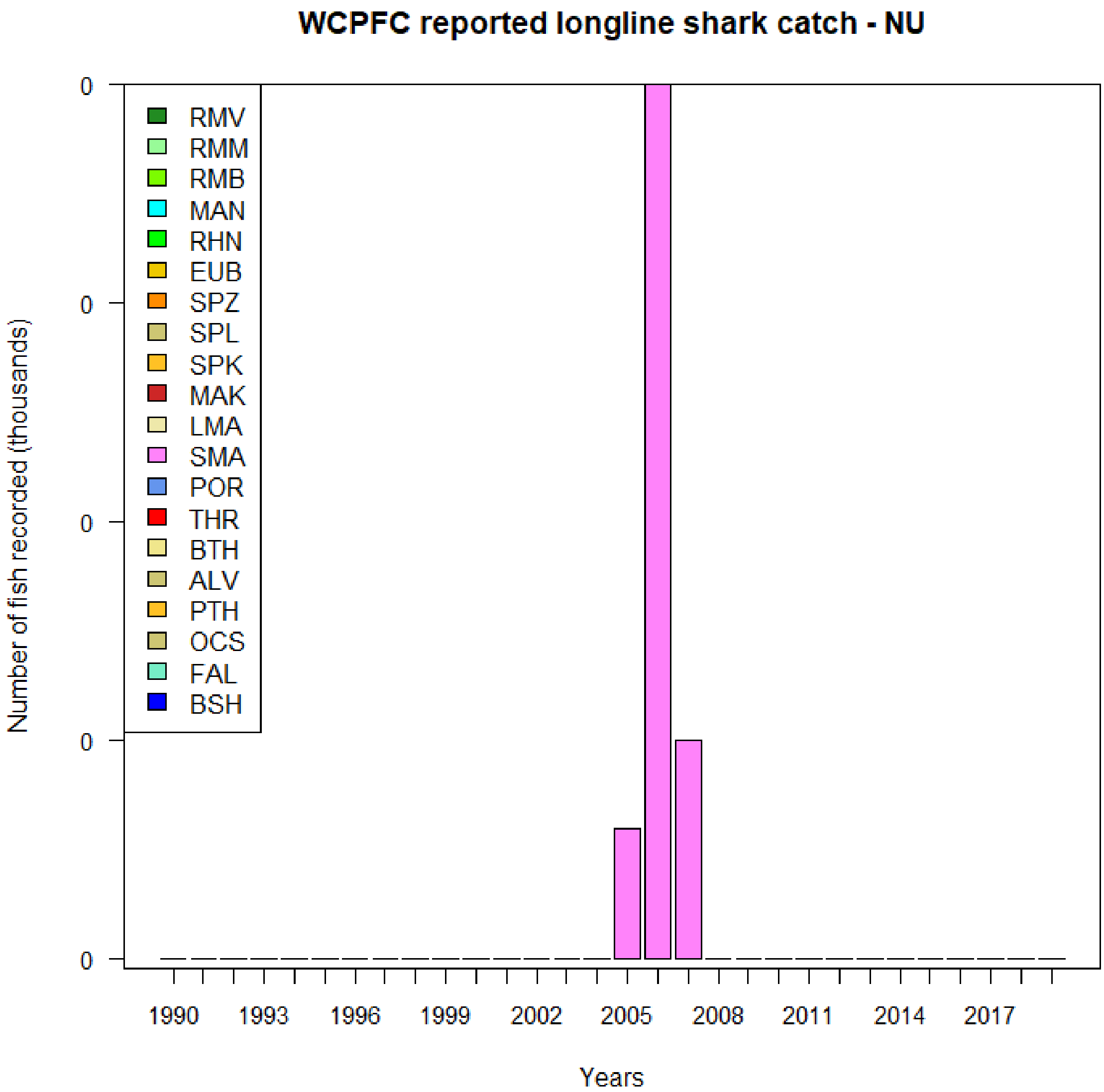


Figure AI - 15: Longline logsheet reporting data for Niue flagged vessels showing the number of sharks reported by species and species group.

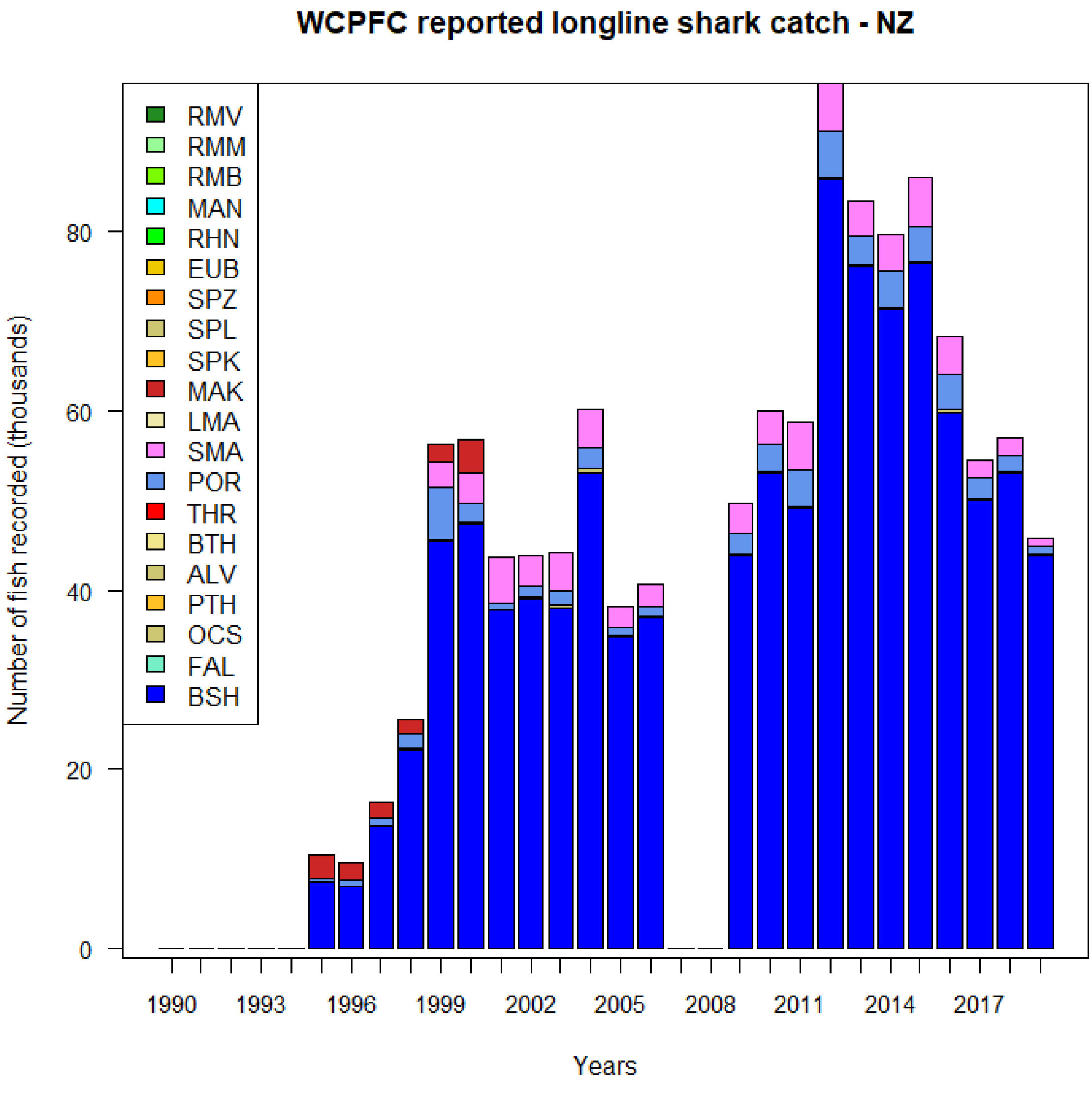


Figure AI - 16: Longline logsheet reporting data for New Zealand flagged vessels showing the number of sharks reported by species and species group.

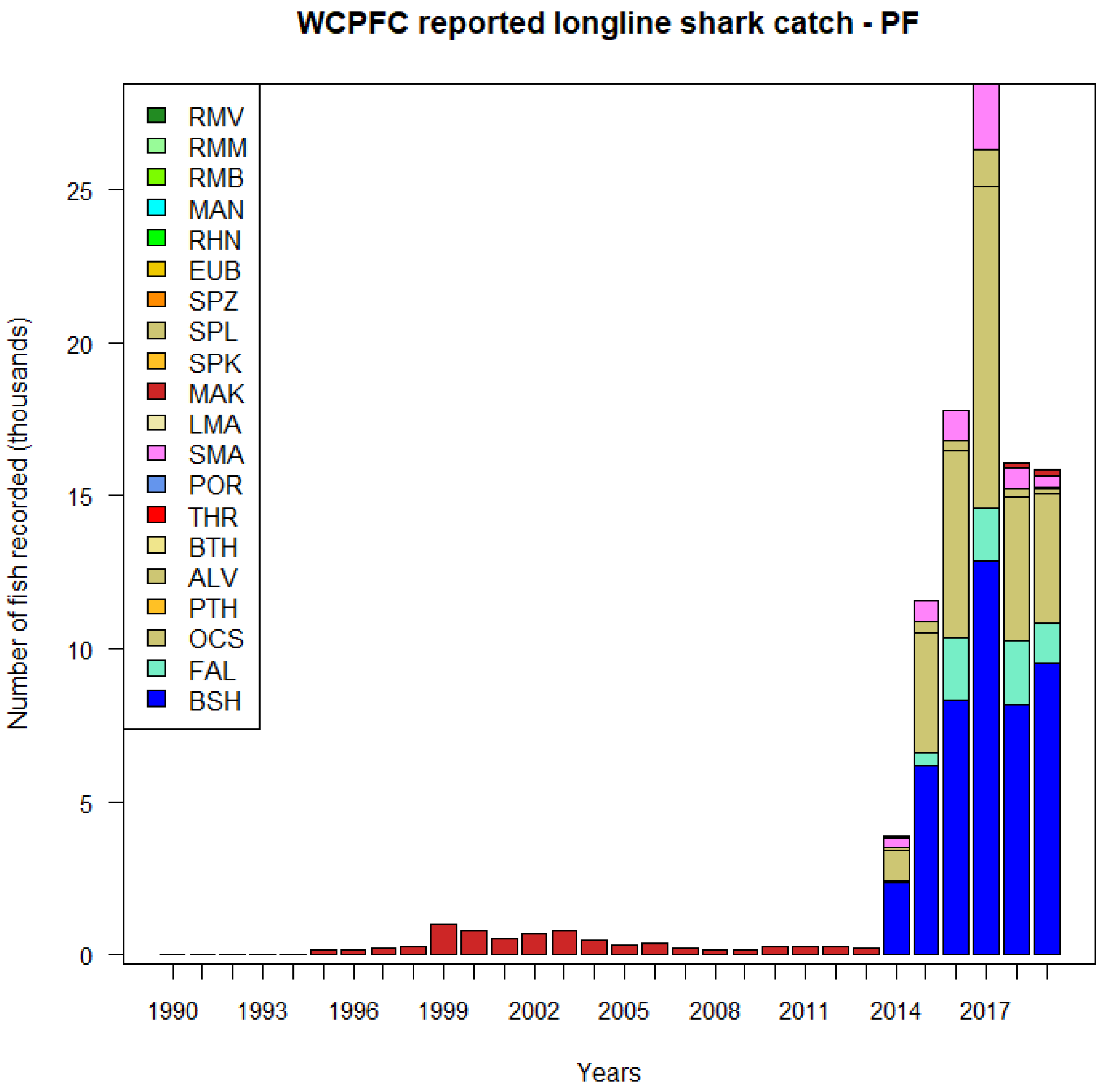


Figure AI - 17: Longline logsheet reporting data for French Polynesian flagged vessels showing the number of sharks reported by species and species group.

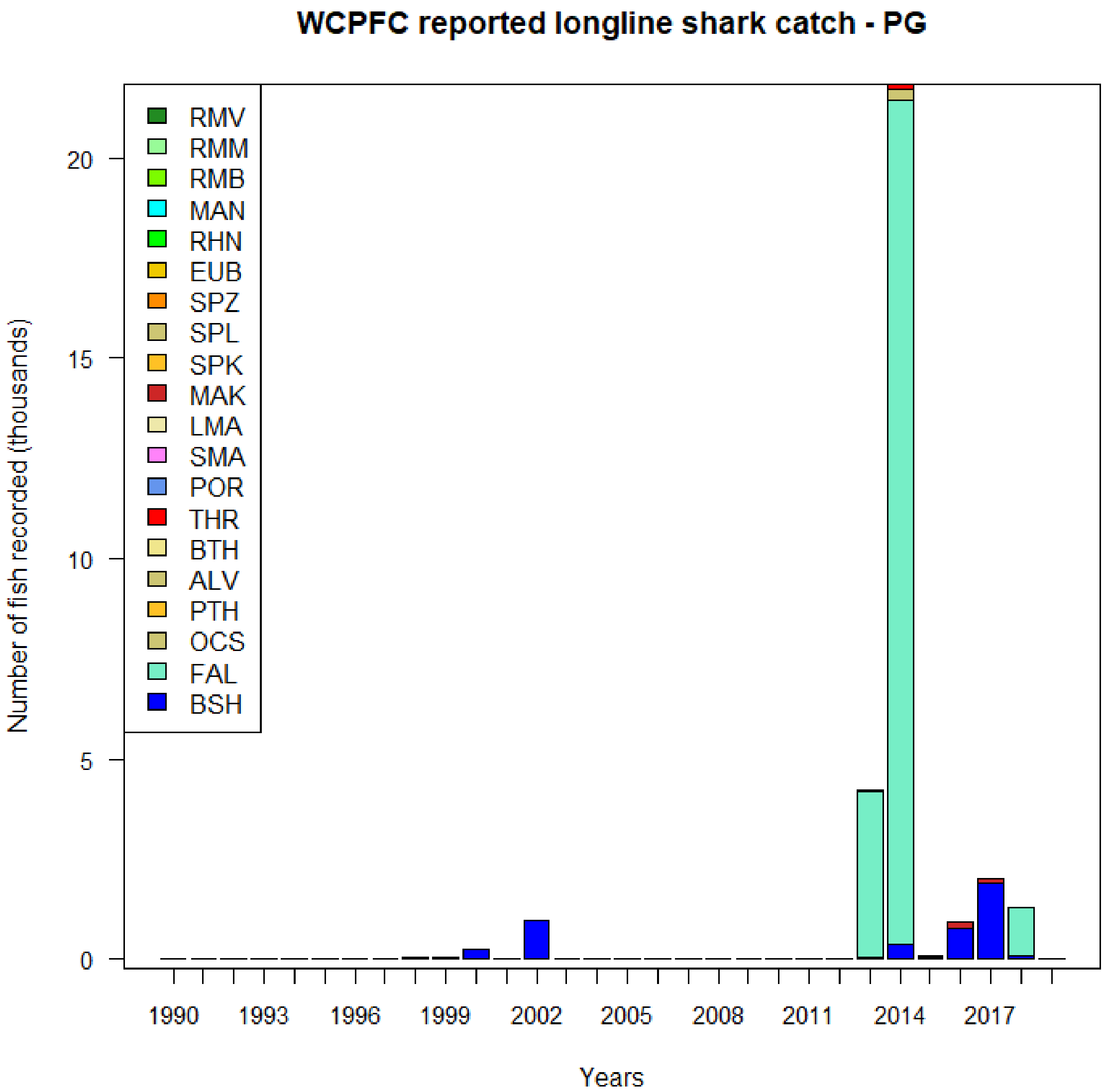


Figure AI - 18: Longline logsheet reporting data for Papua New Guinea flagged vessels showing the number of sharks reported by species and species group.

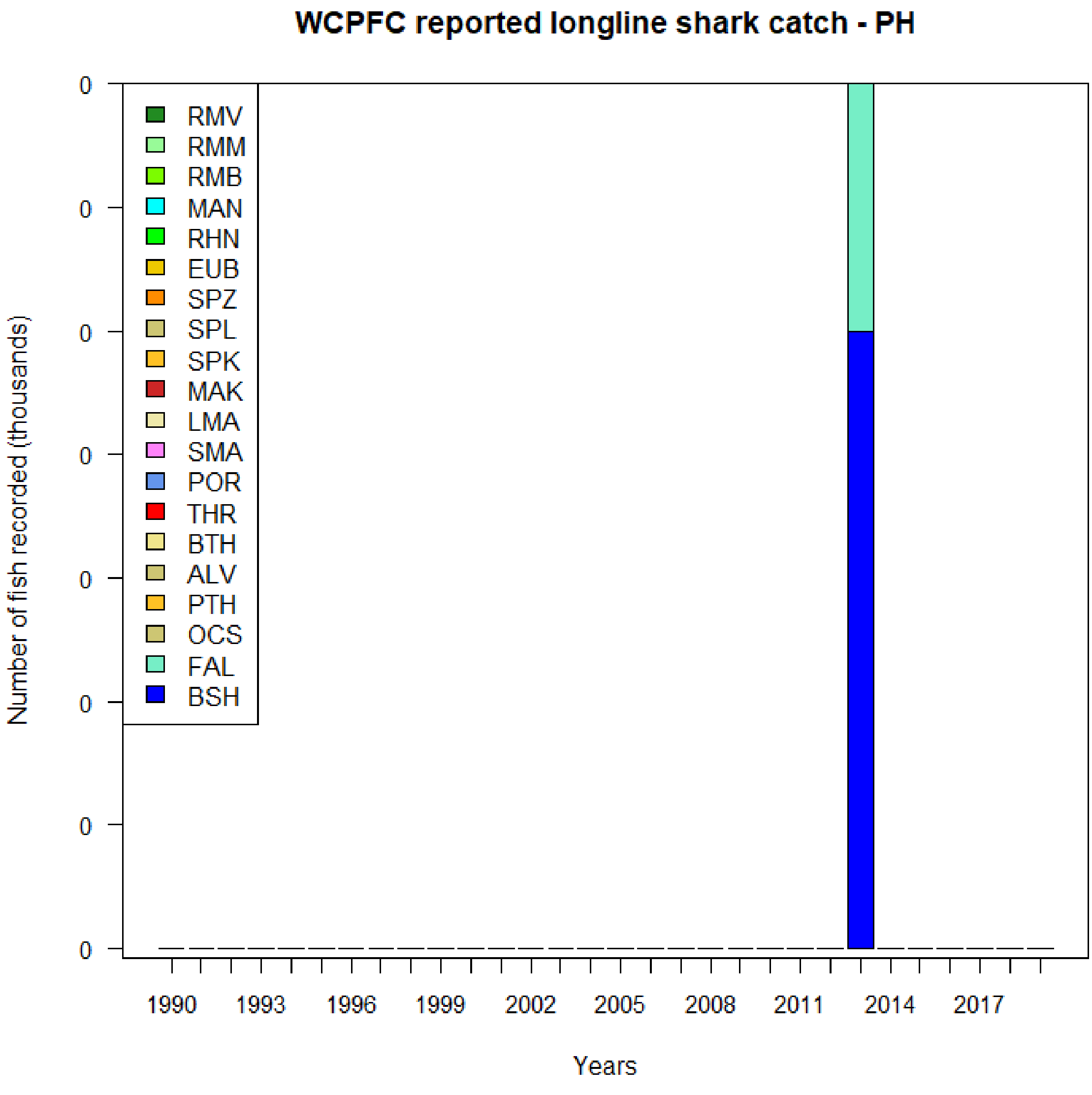


Figure AI - 19: Longline logsheet reporting data for Philippine flagged vessels showing the number of sharks reported by species and species group.

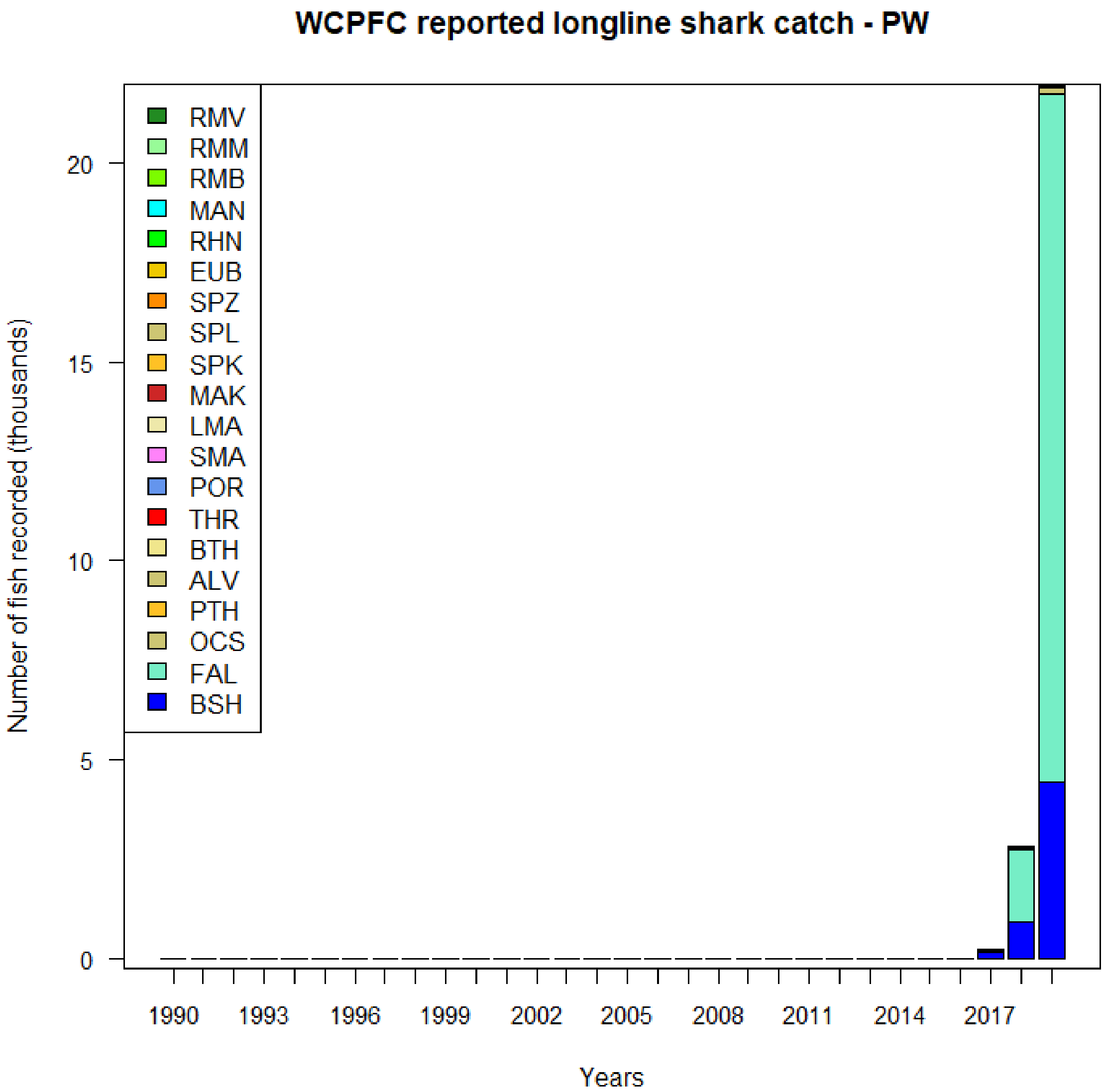


Figure AI - 20: Longline logsheet reporting data for Palau flagged vessels showing the number of sharks reported by species and species group.

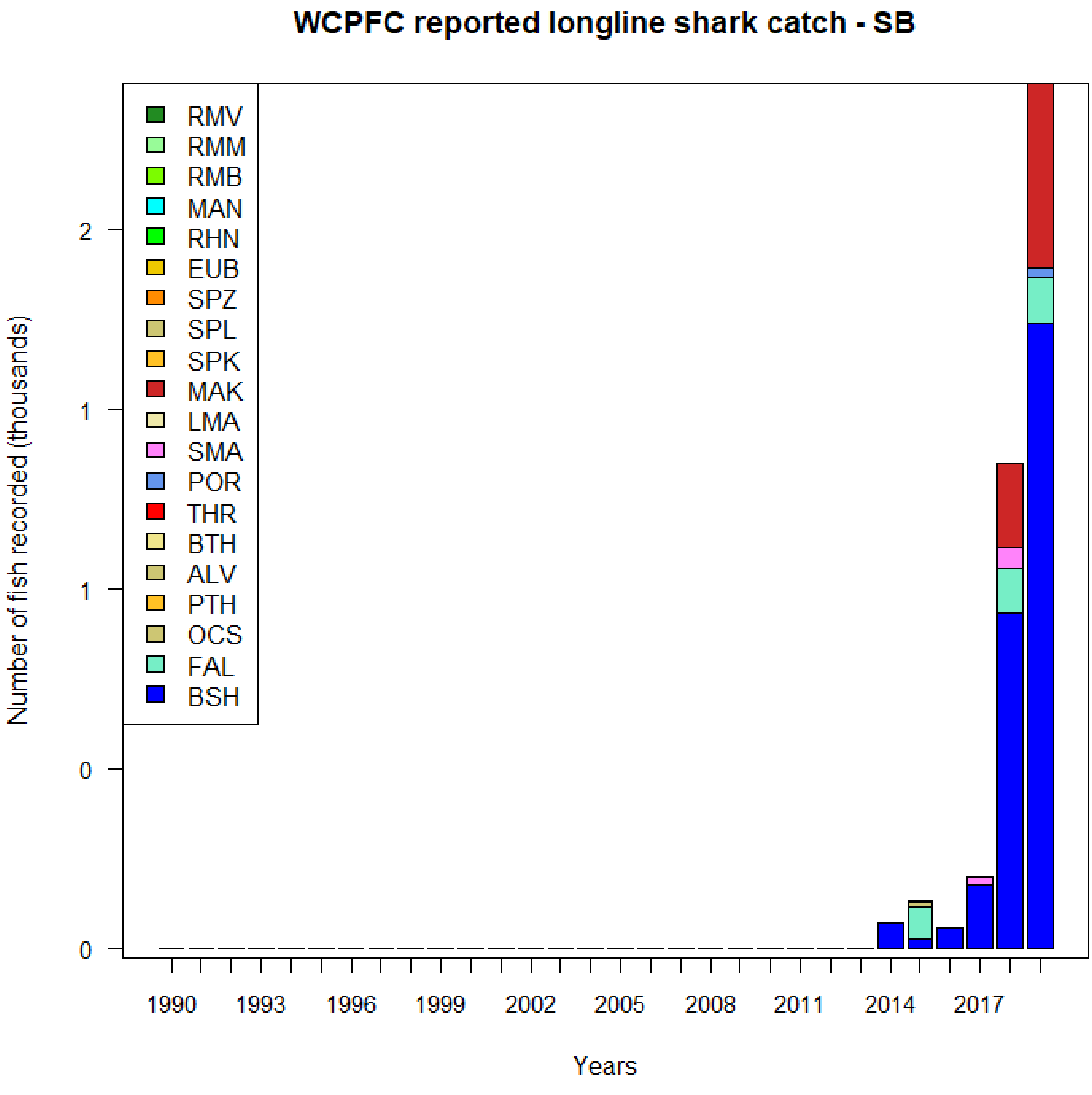


Figure AI - 21: Longline logsheet reporting data for the Solomon Islands flagged vessels showing the number of sharks reported by species and species group.

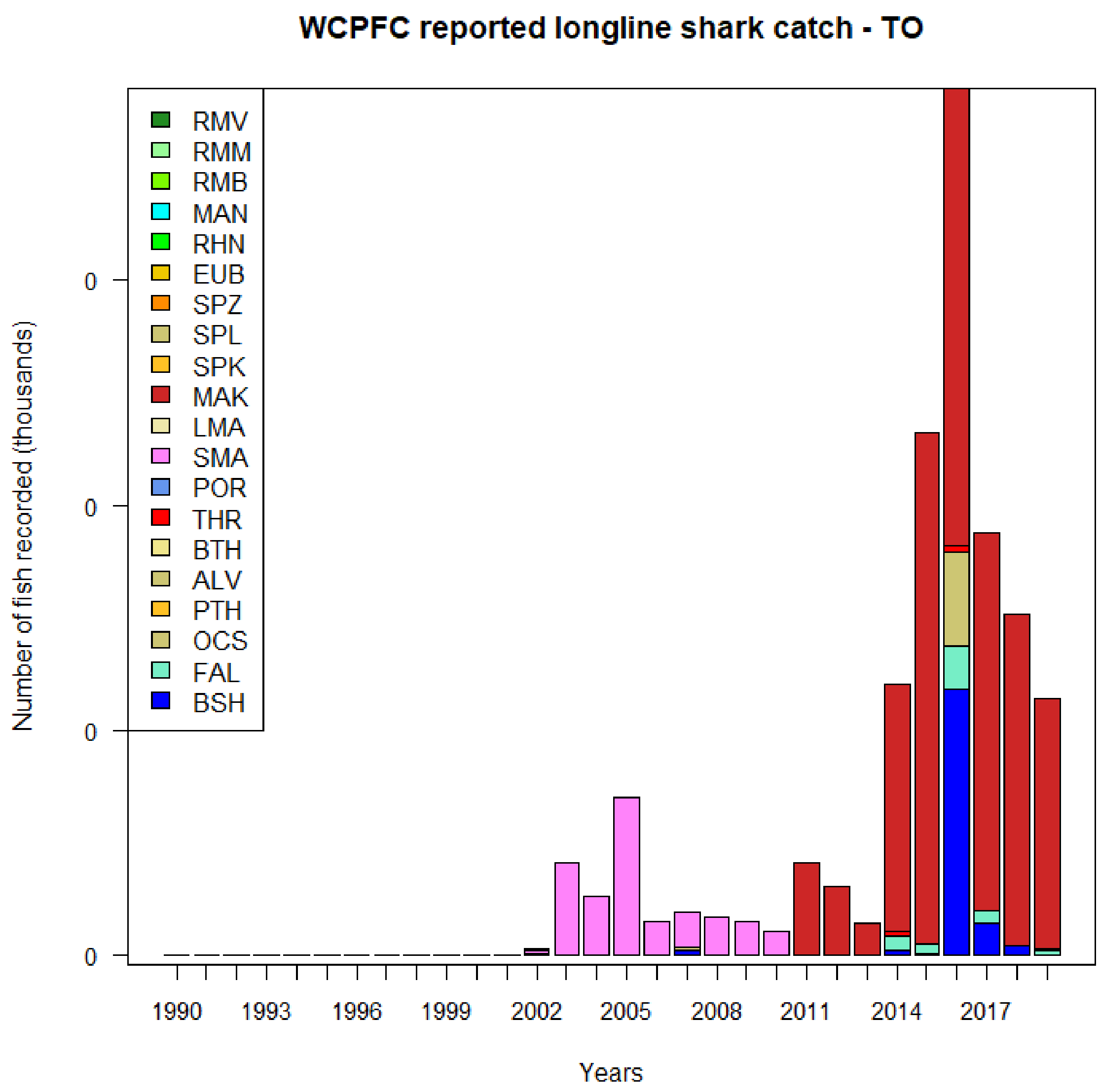


Figure AI - 22: Longline logsheet reporting data for Tongan flagged vessels showing the number of sharks reported by species and species group.

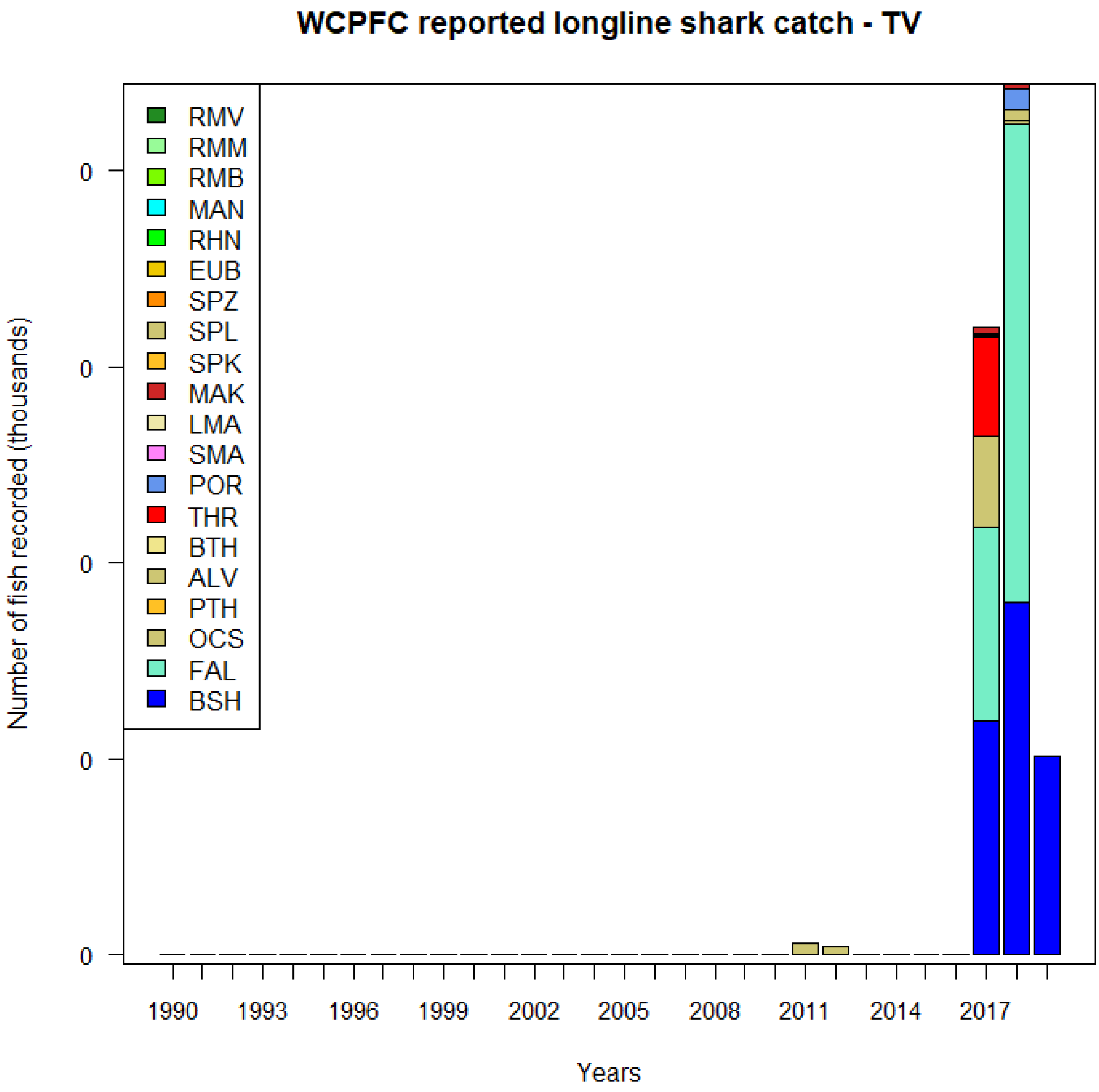


Figure AI - 23: Longline logsheet reporting data for Tuvalu flagged vessels showing the number of sharks reported by species and species group.

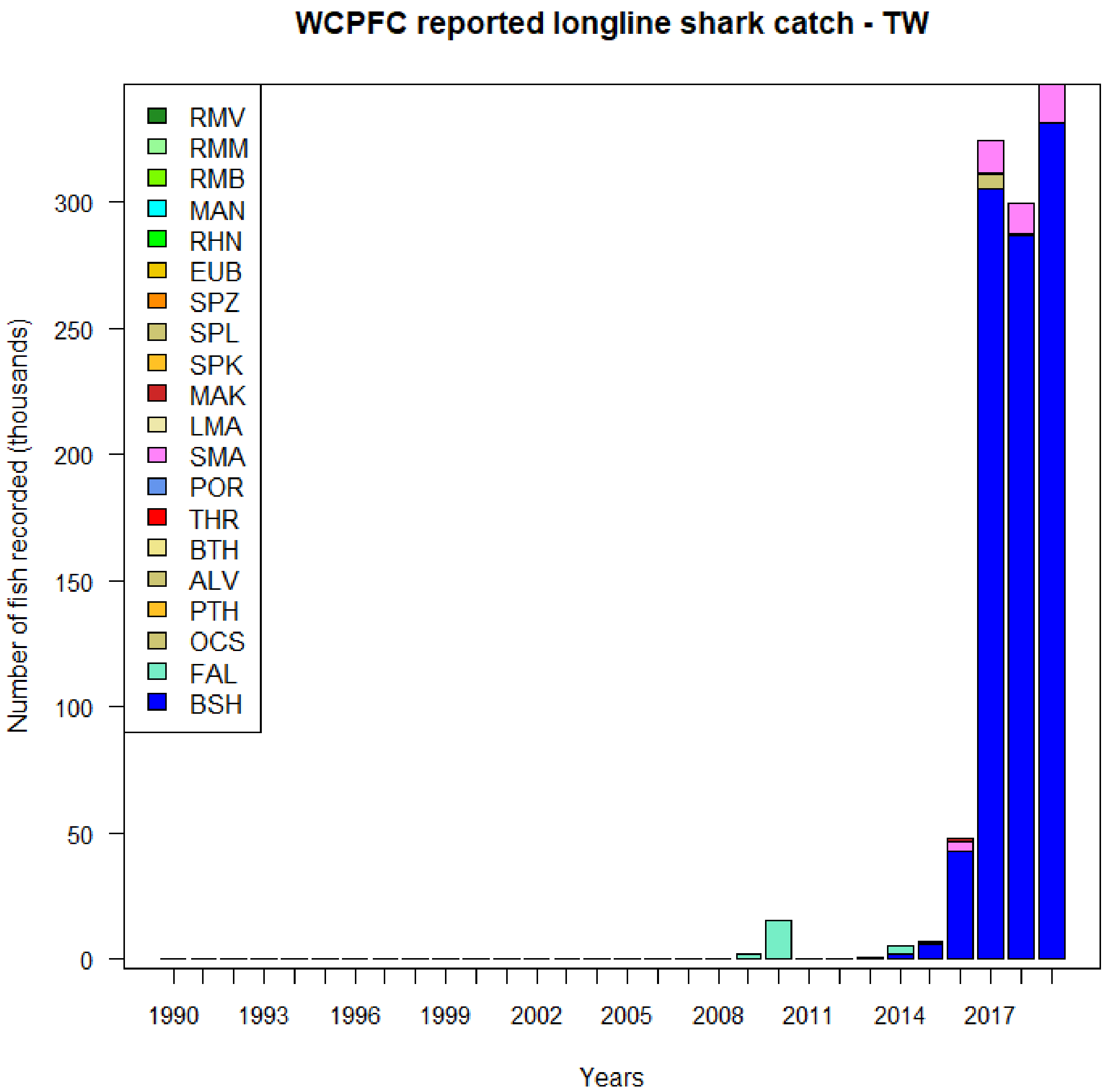


Figure AI - 24: Longline logsheet reporting data for Chinese Taipei flagged vessels showing the number of sharks reported by species and species group.

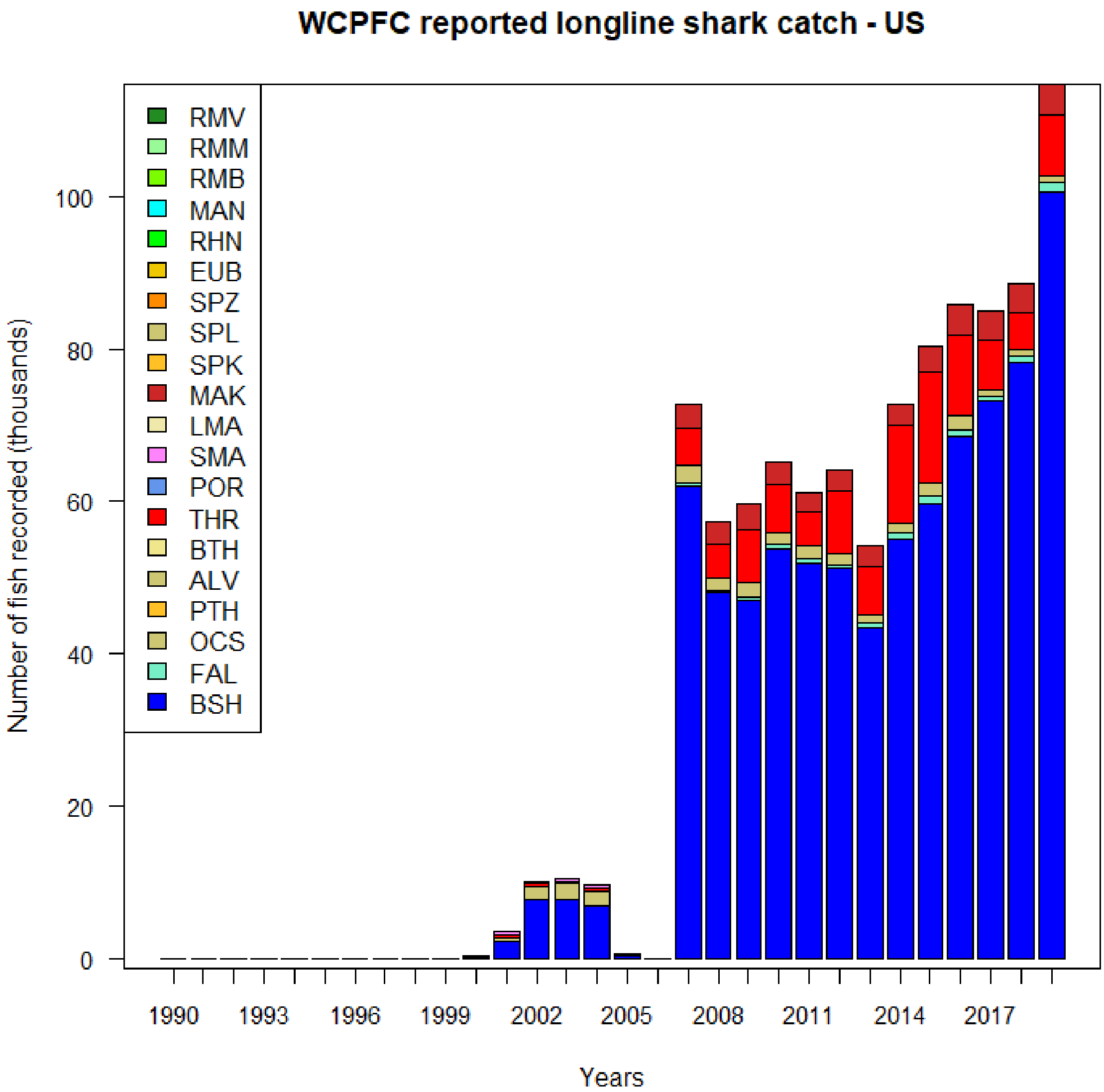


Figure AI - 25: Longline logsheet reporting data for the United States of America flagged vessels showing the number of sharks reported by species and species group.

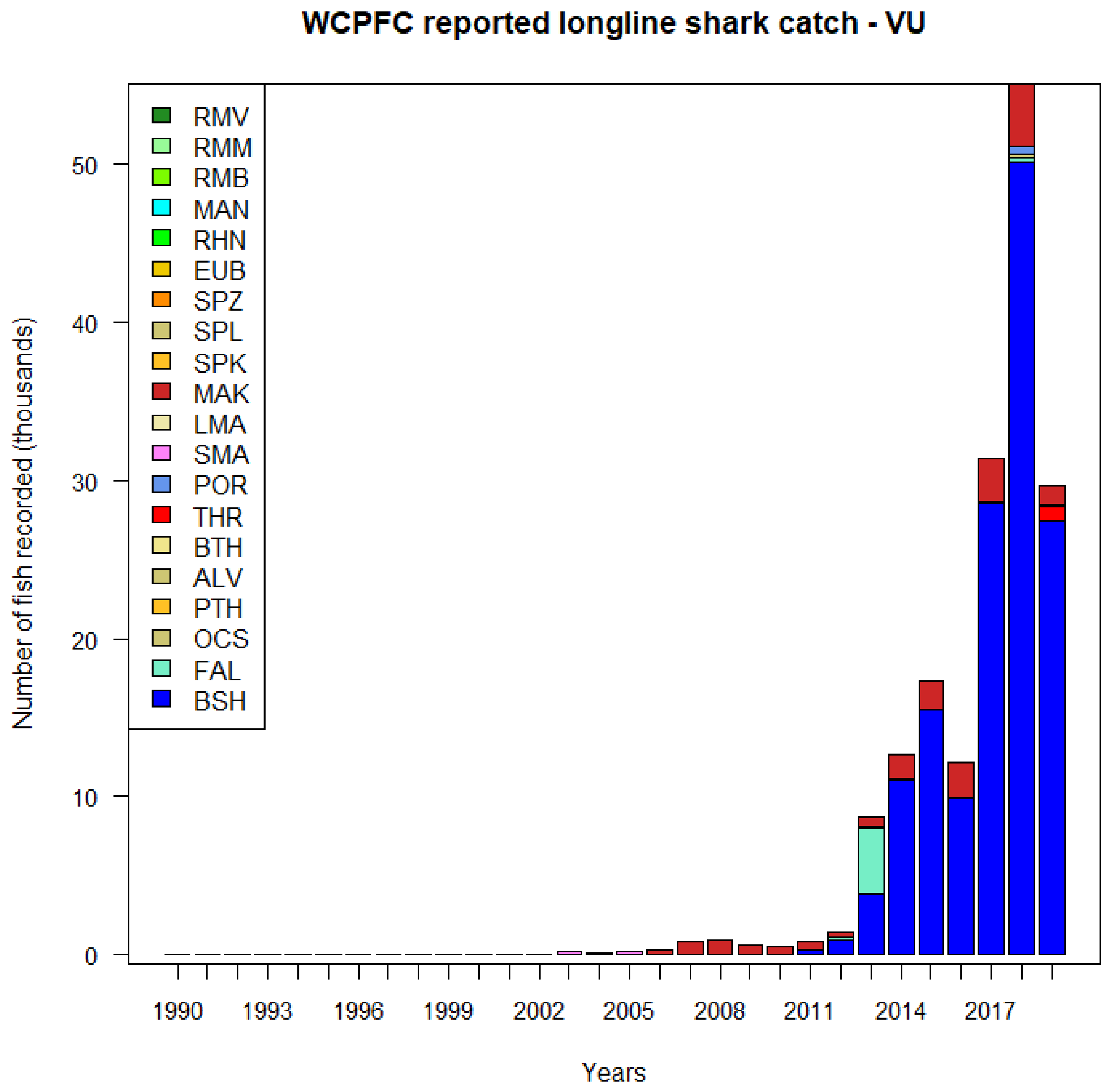


Figure AI - 26: Longline logsheet reporting data for Vanautu flagged vessels showing the number of sharks reported by species and species group.

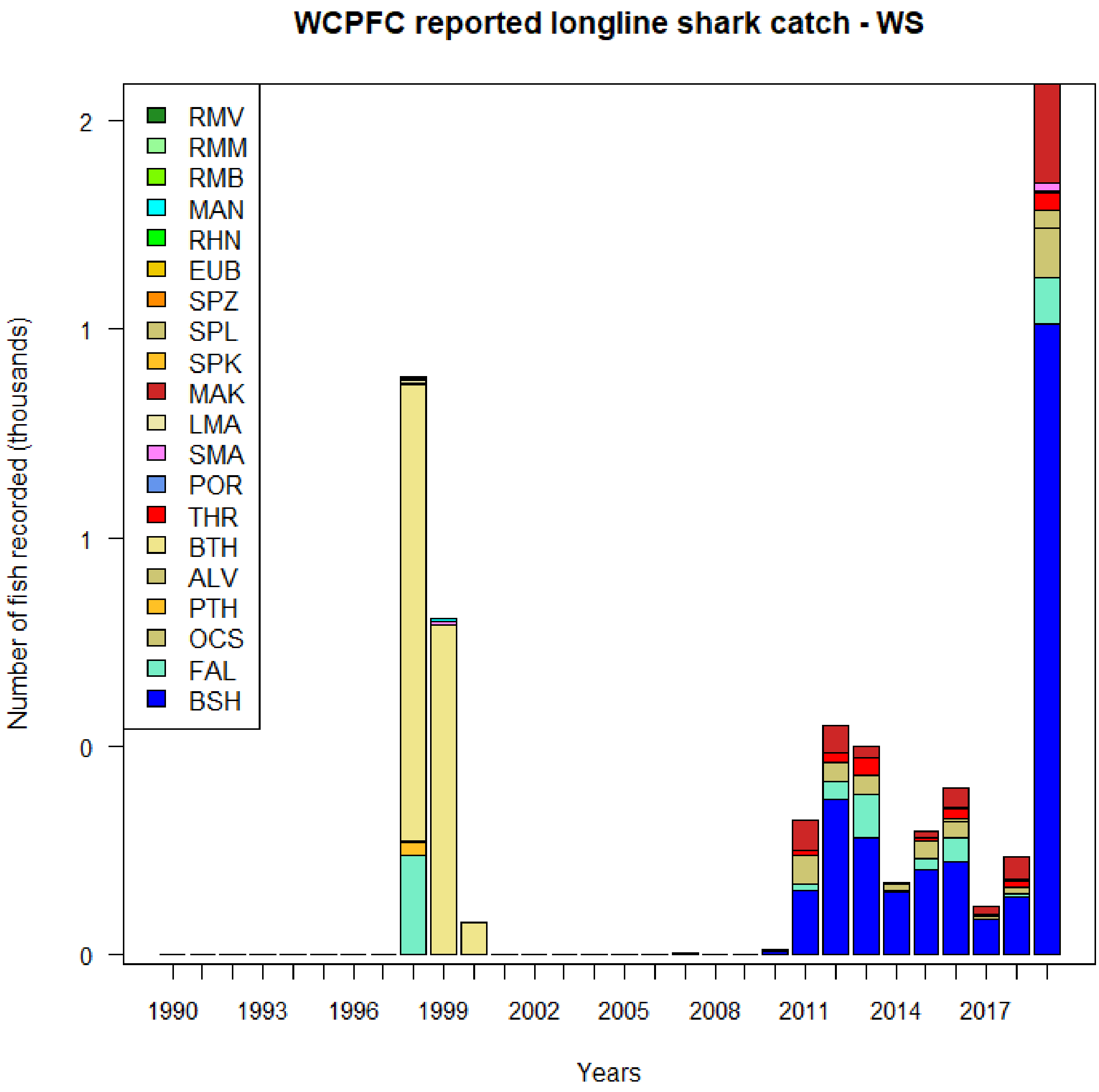
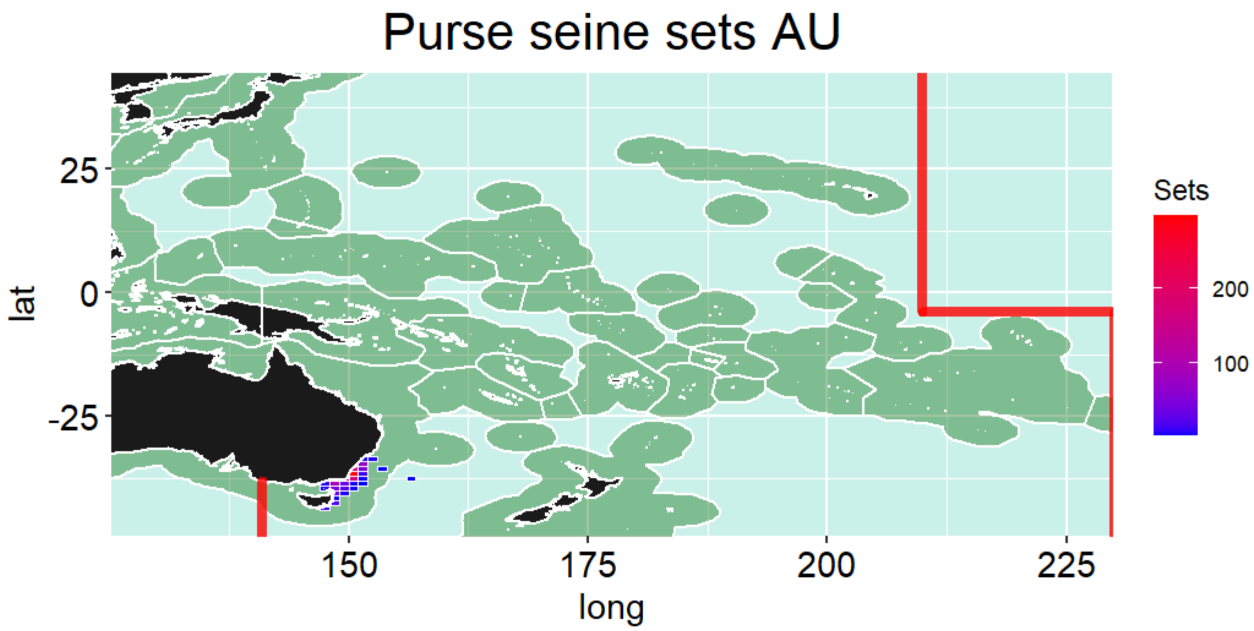


Figure AI - 27: Longline logsheet reporting data for Samoan flagged vessels showing the number of sharks reported by species and species group.



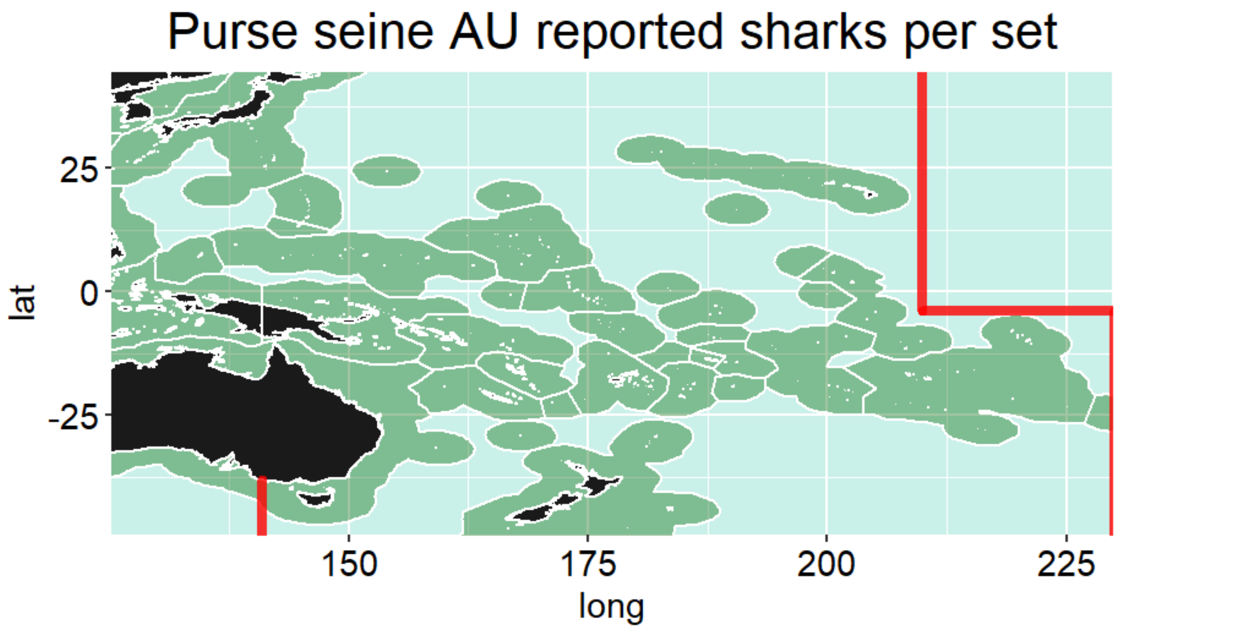


Figure AI - 28: Purse seine logsheet reporting data for Australian flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

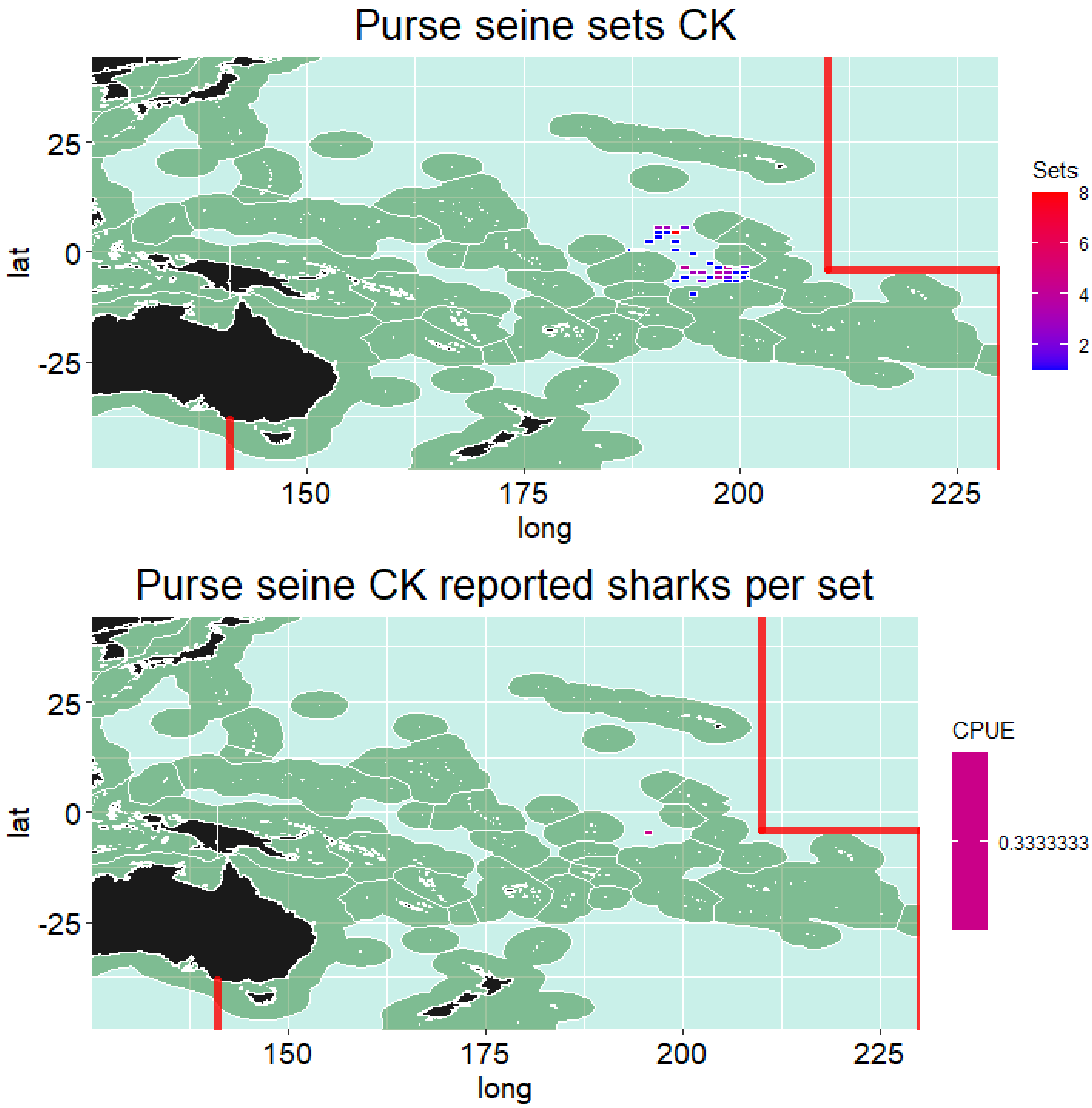


Figure AI - 29: Purse seine logsheet reporting data for the Cook Islands flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

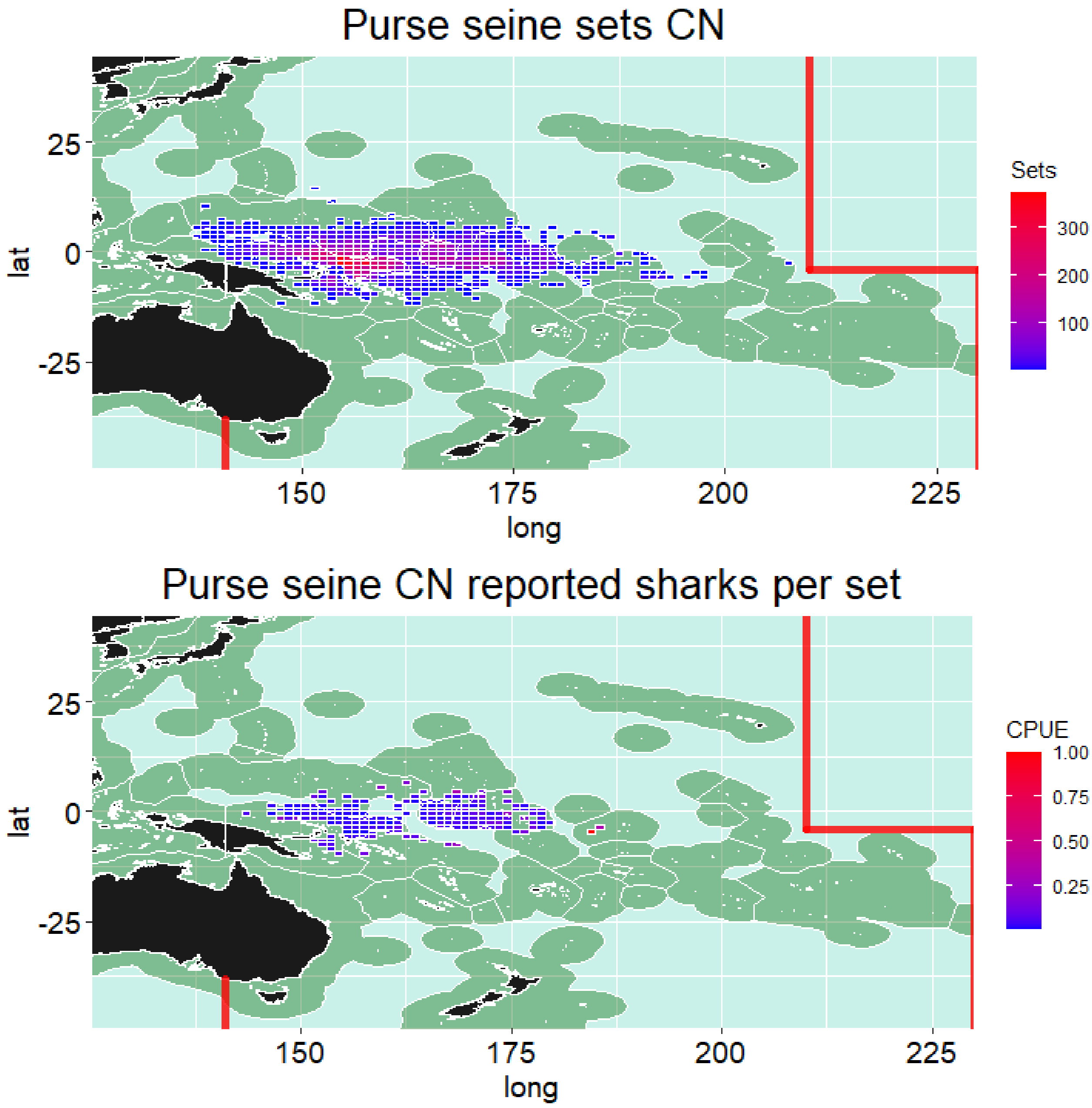


Figure AI - 30: Purse seine logsheet reporting data for Chinese flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

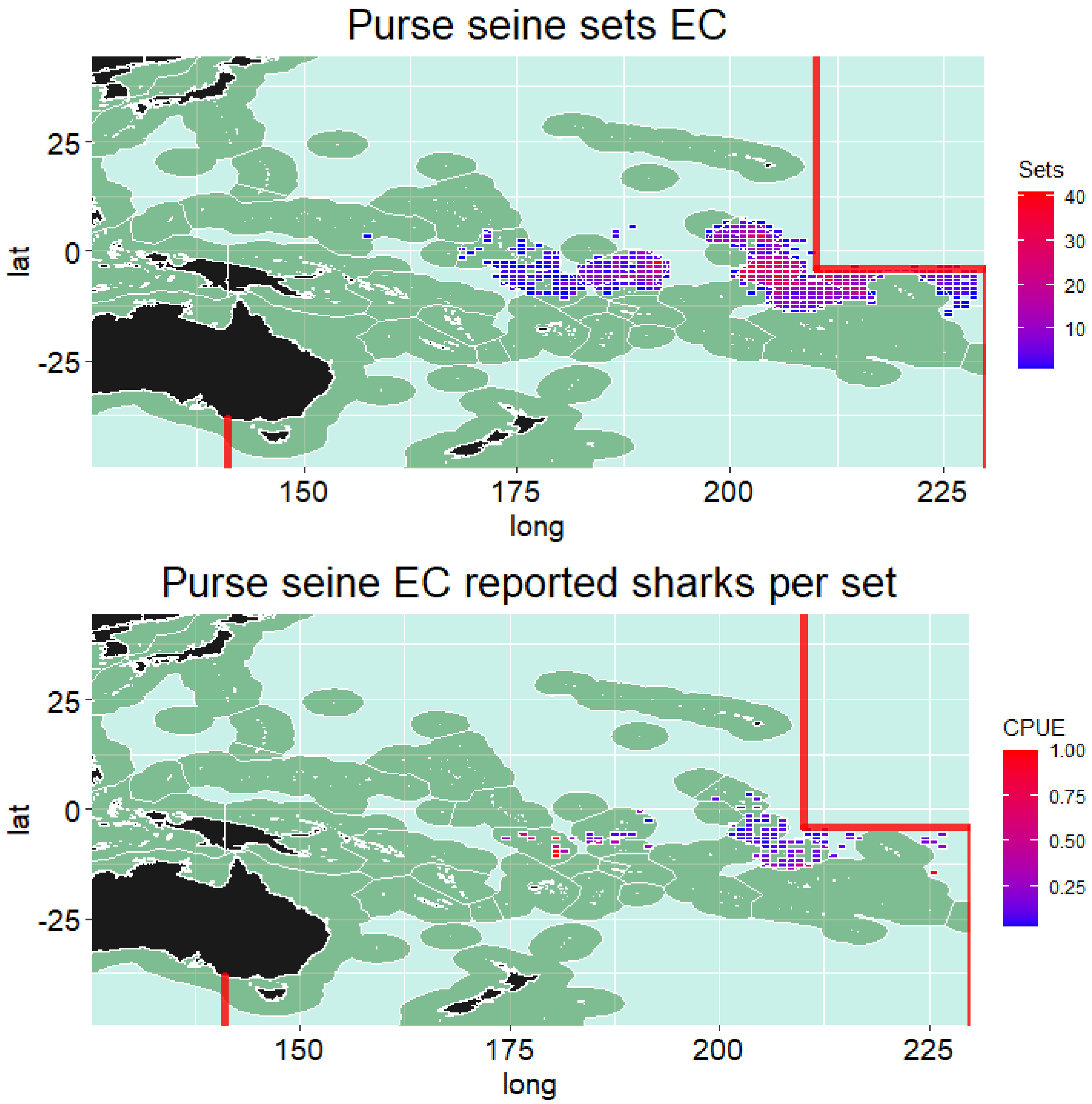


Figure AI - 31: Purse seine logsheet reporting data for Ecuador flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

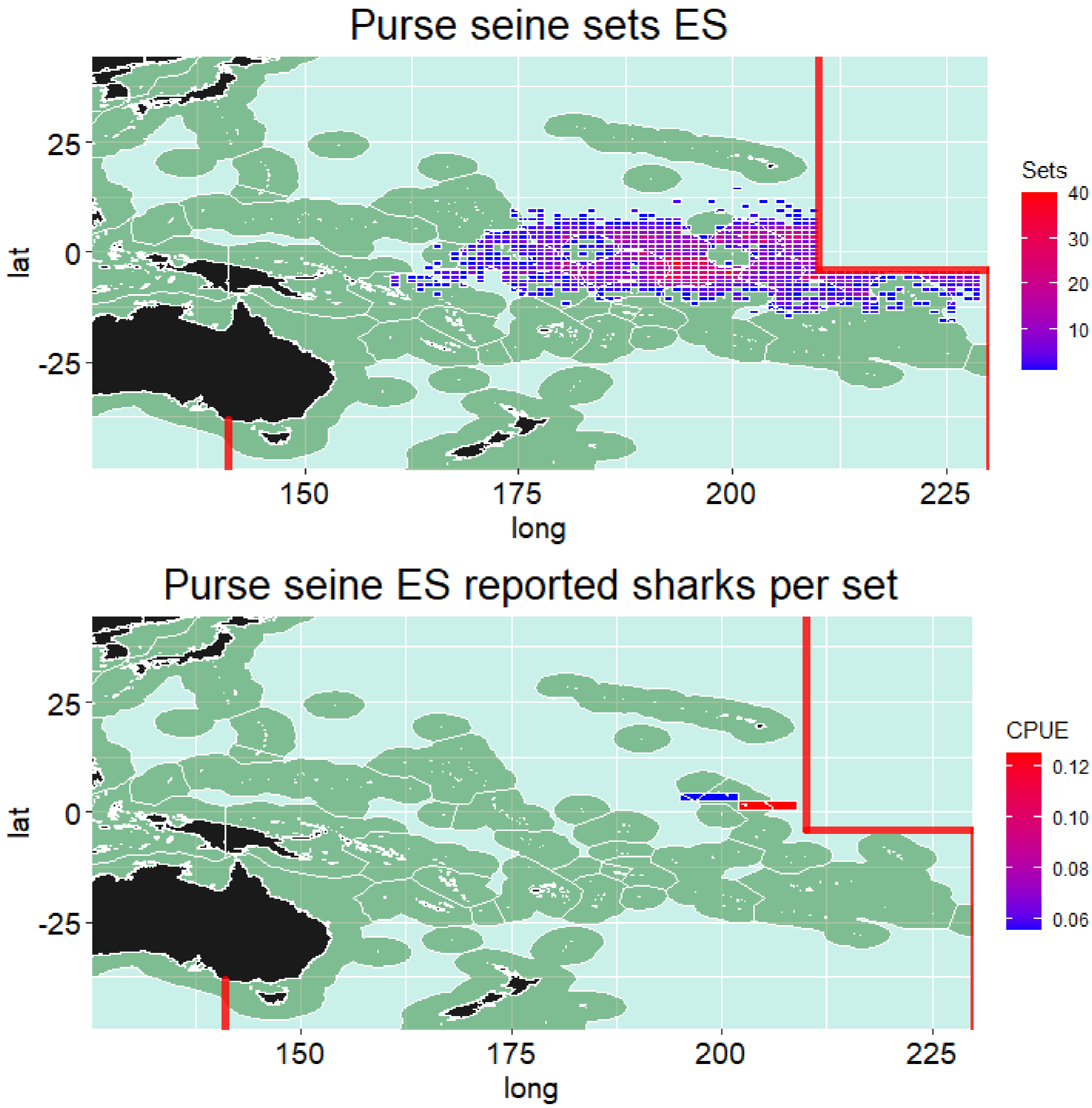
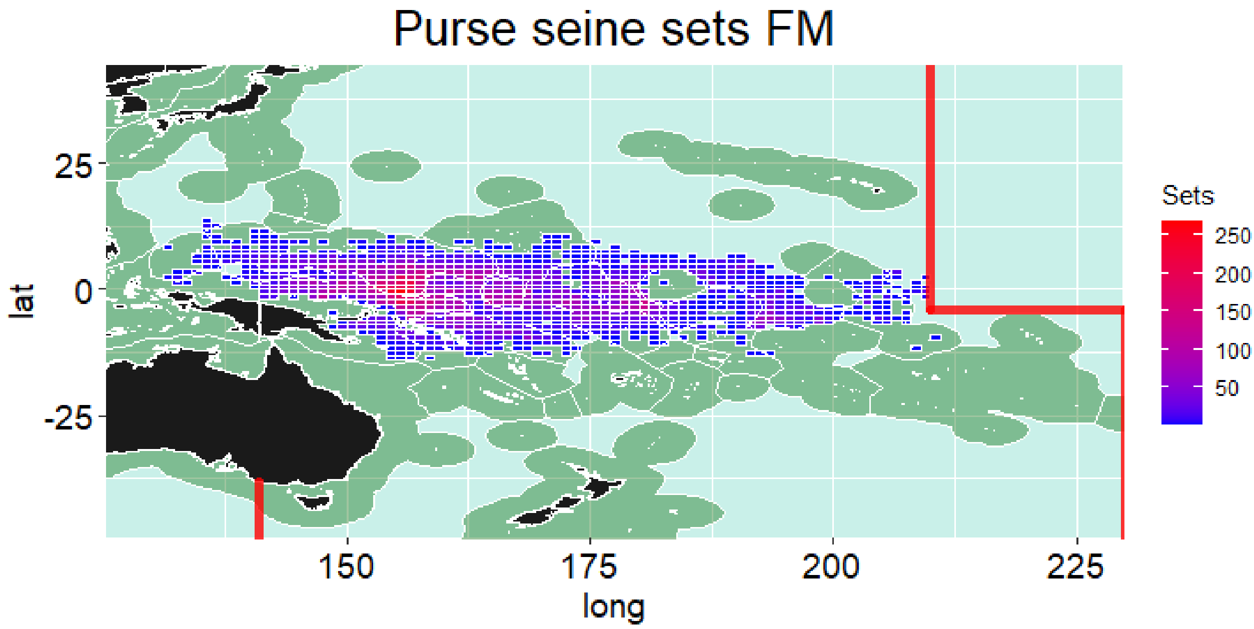


Figure AI - 32: Purse seine logsheet reporting data for EC - Spanish flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).



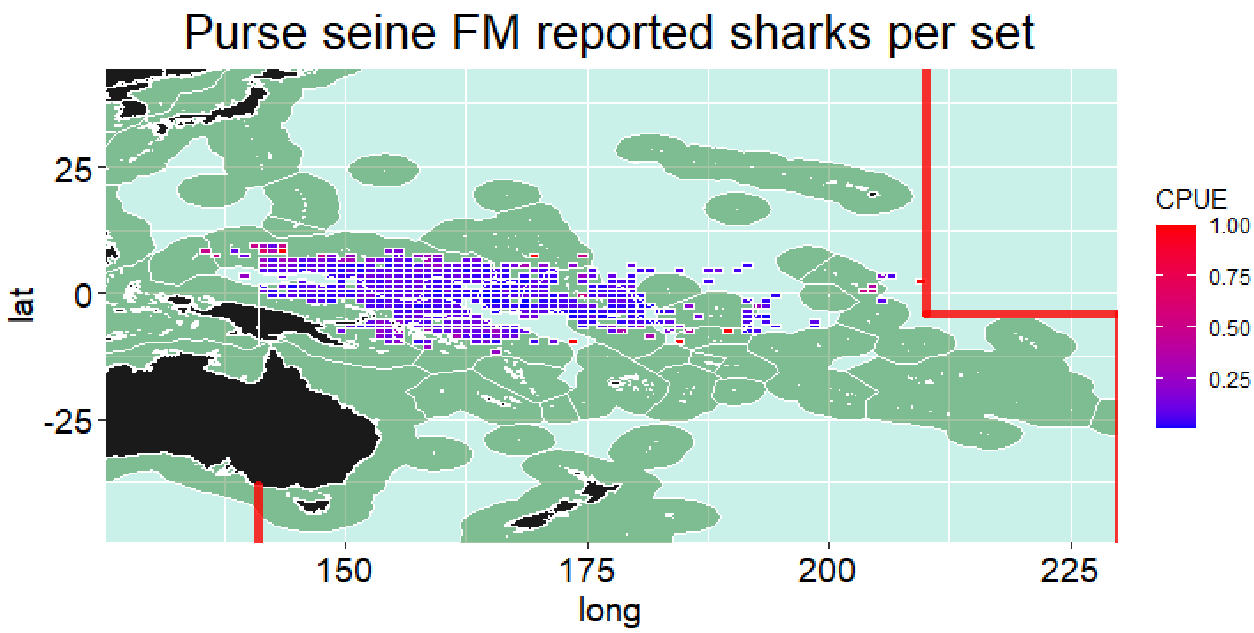


Figure AI - 33: Purse seine logsheet reporting data for the Federated States of Micronesia flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

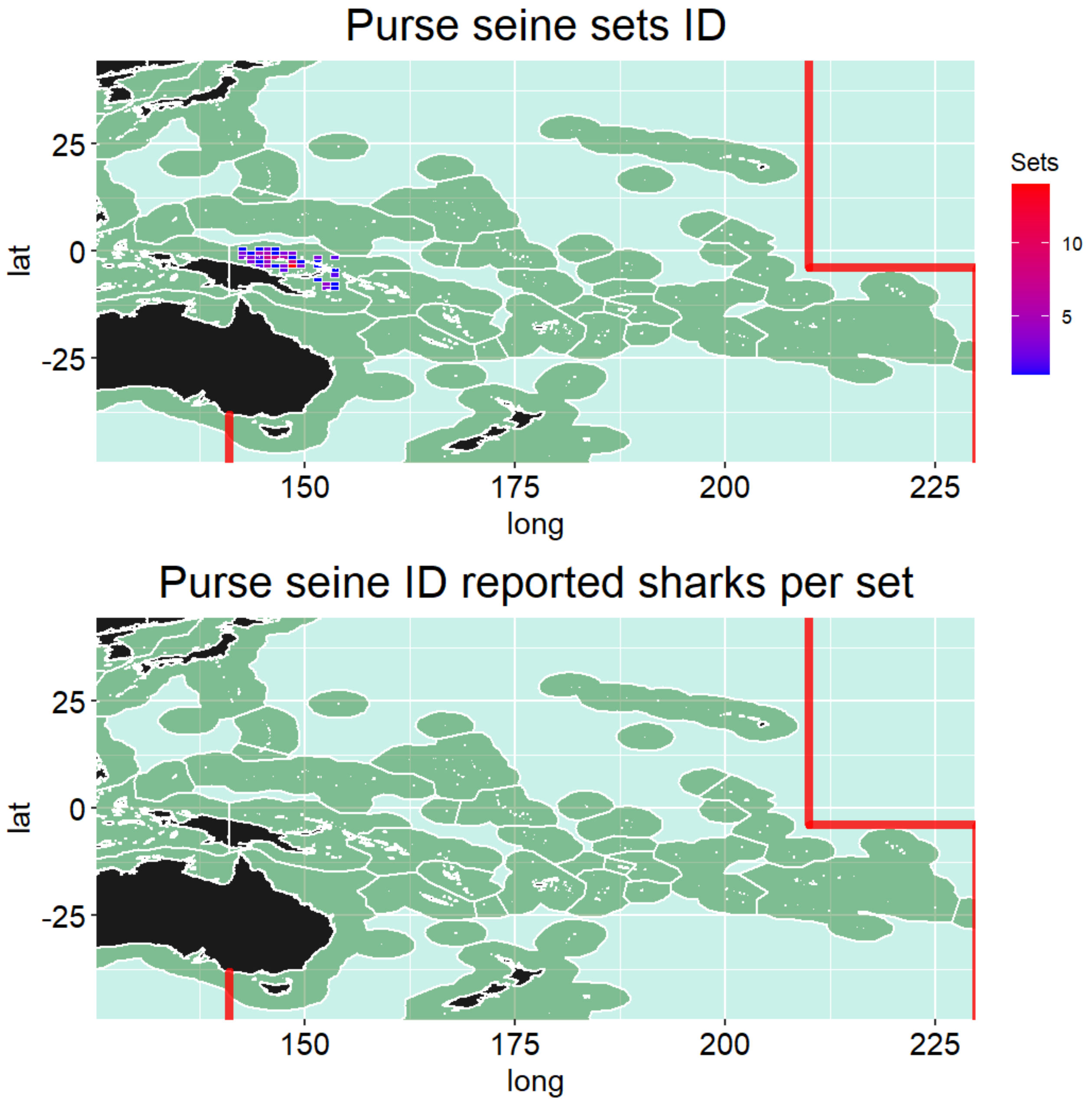


Figure AI - 34: Purse seine logsheet reporting data for Indonesian flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

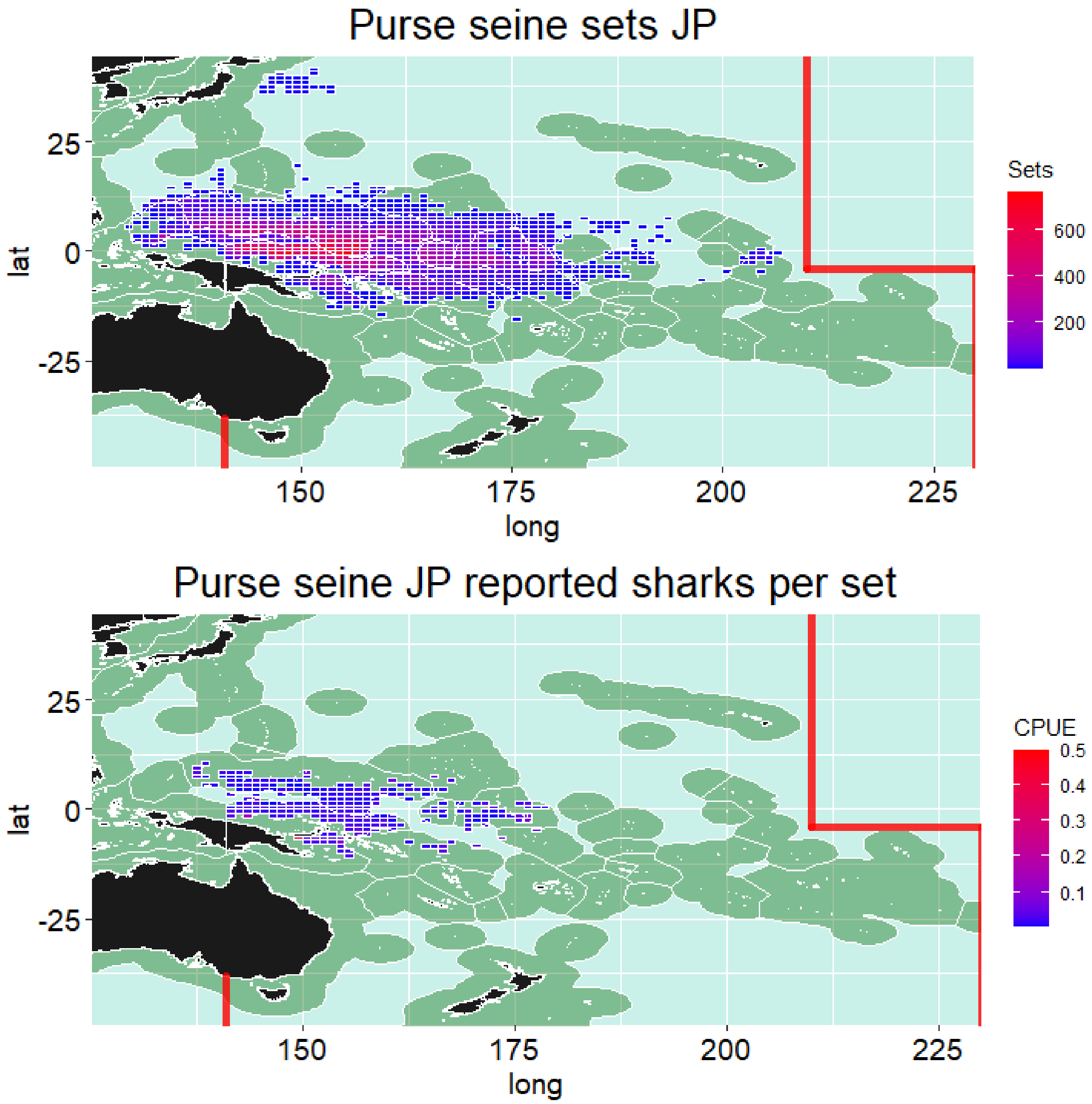


Figure AI - 35: Purse seine logsheet reporting data for Japanese flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

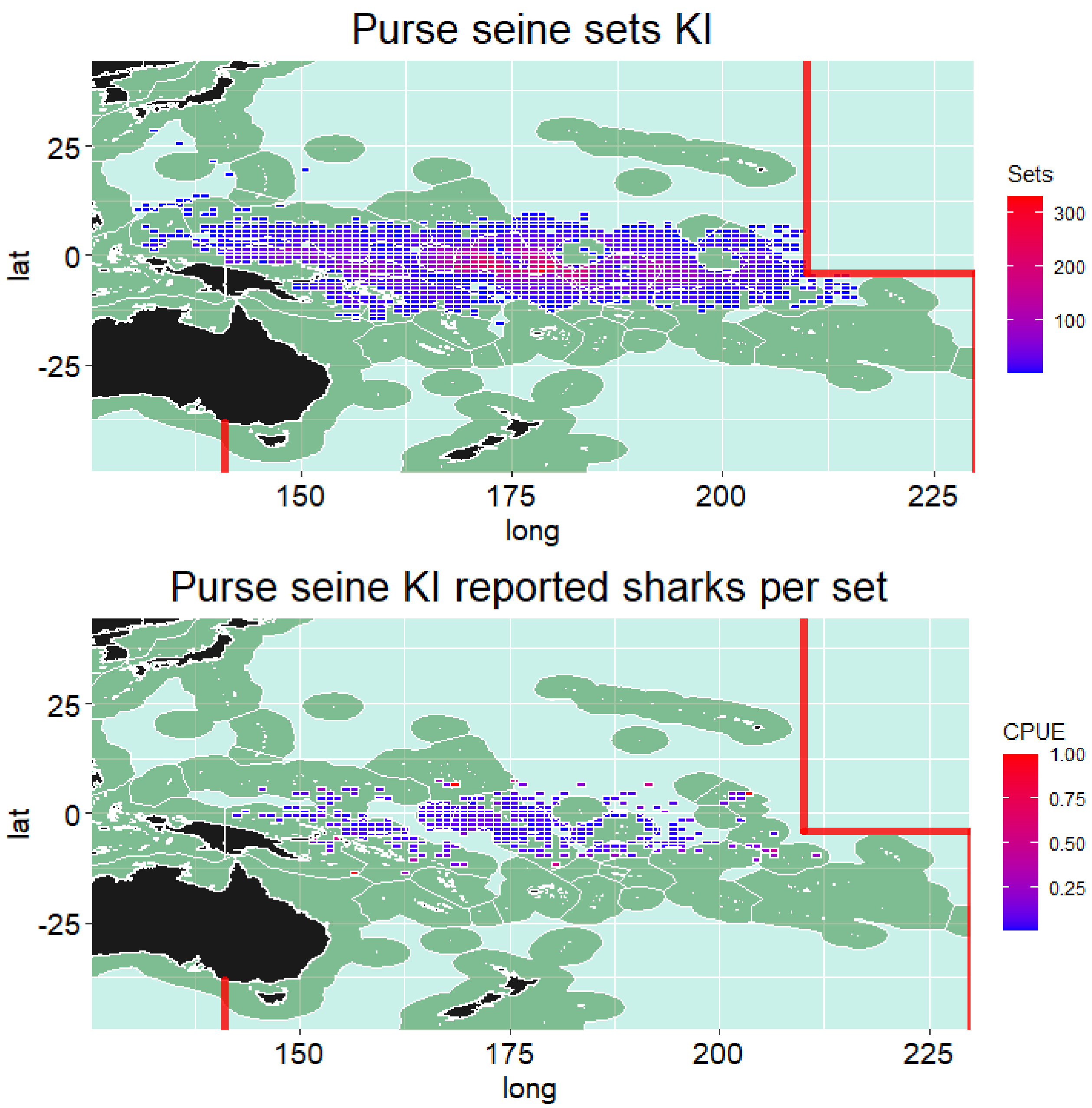


Figure AI - 36: Purse seine logsheet reporting data for Kiribati flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

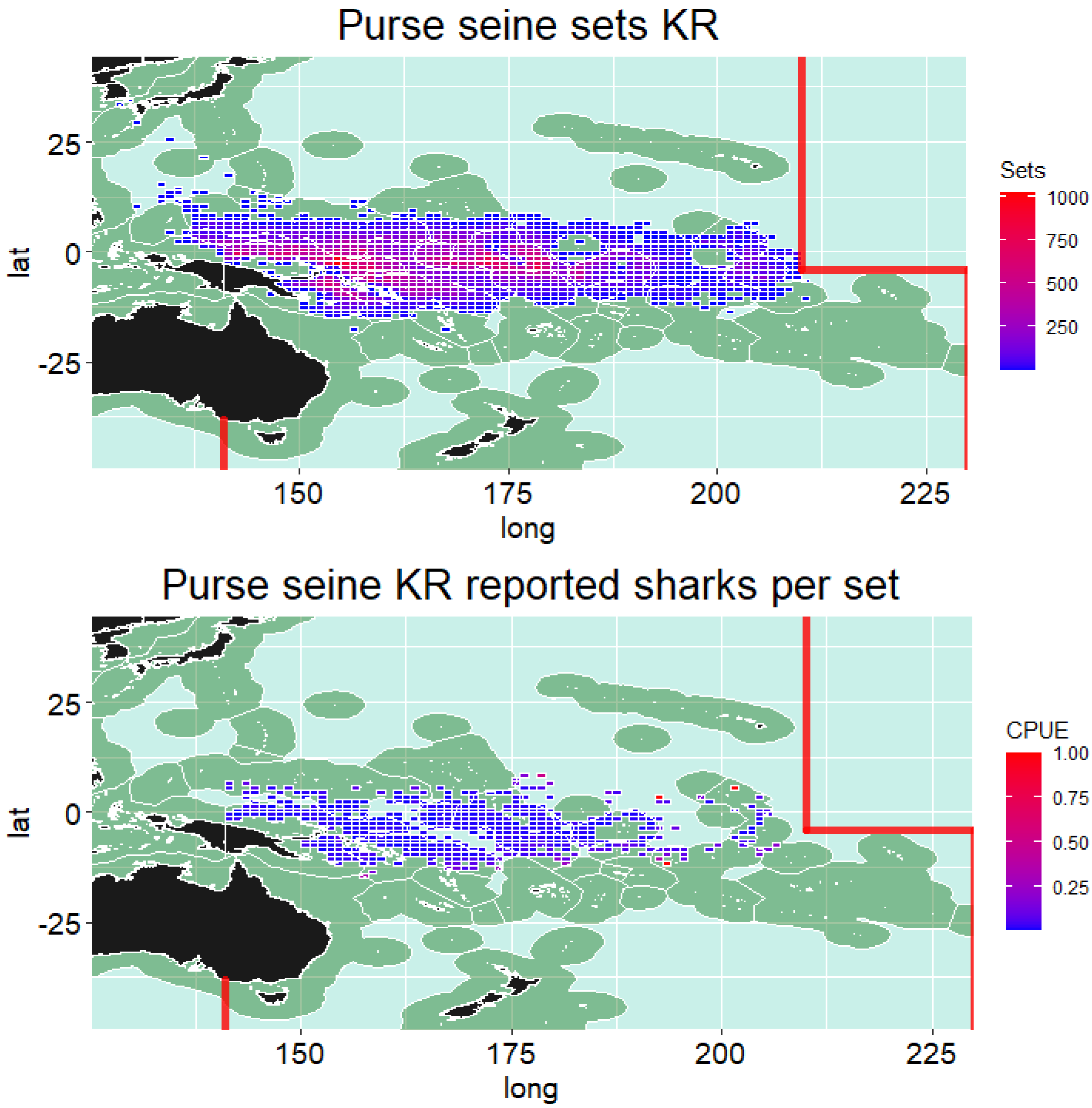
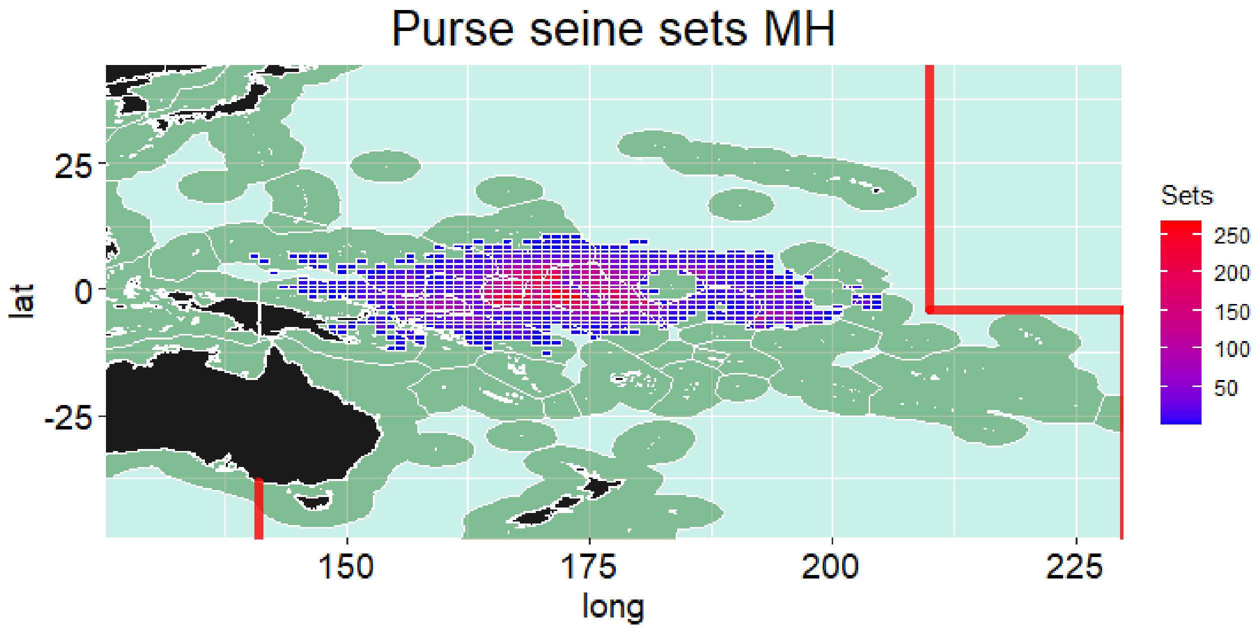


Figure AI - 37: Purse seine logsheet reporting data for the Republic of Korea flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).



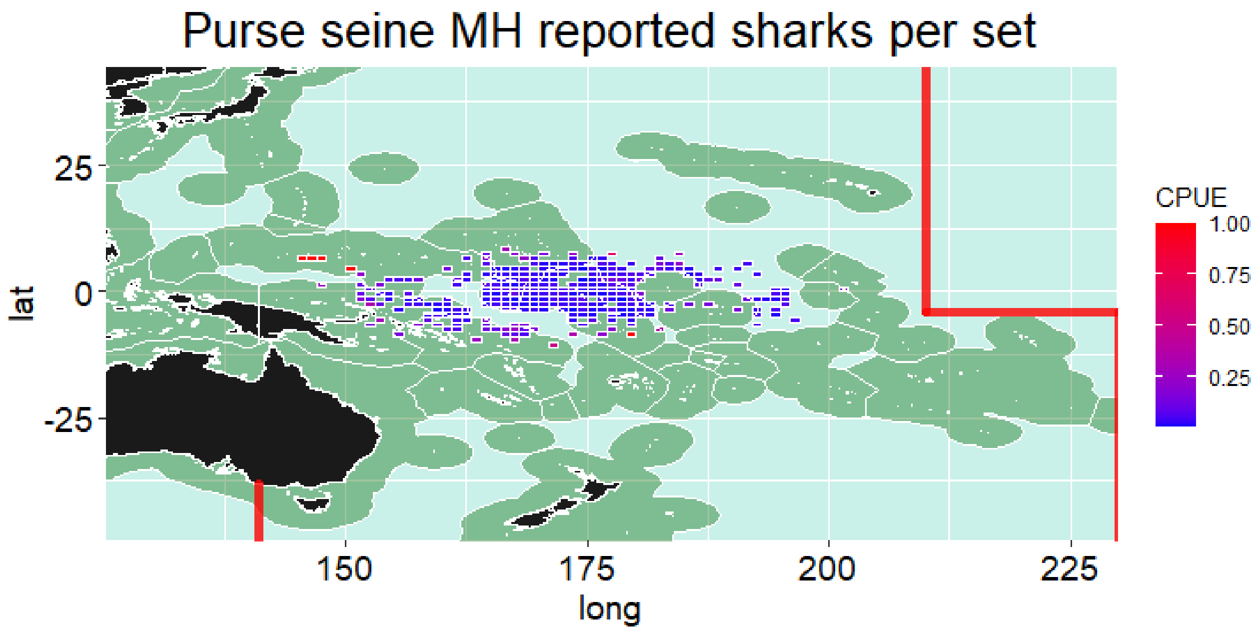


Figure AI - 38: Purse seine logsheet reporting data for the Marshall Islands flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

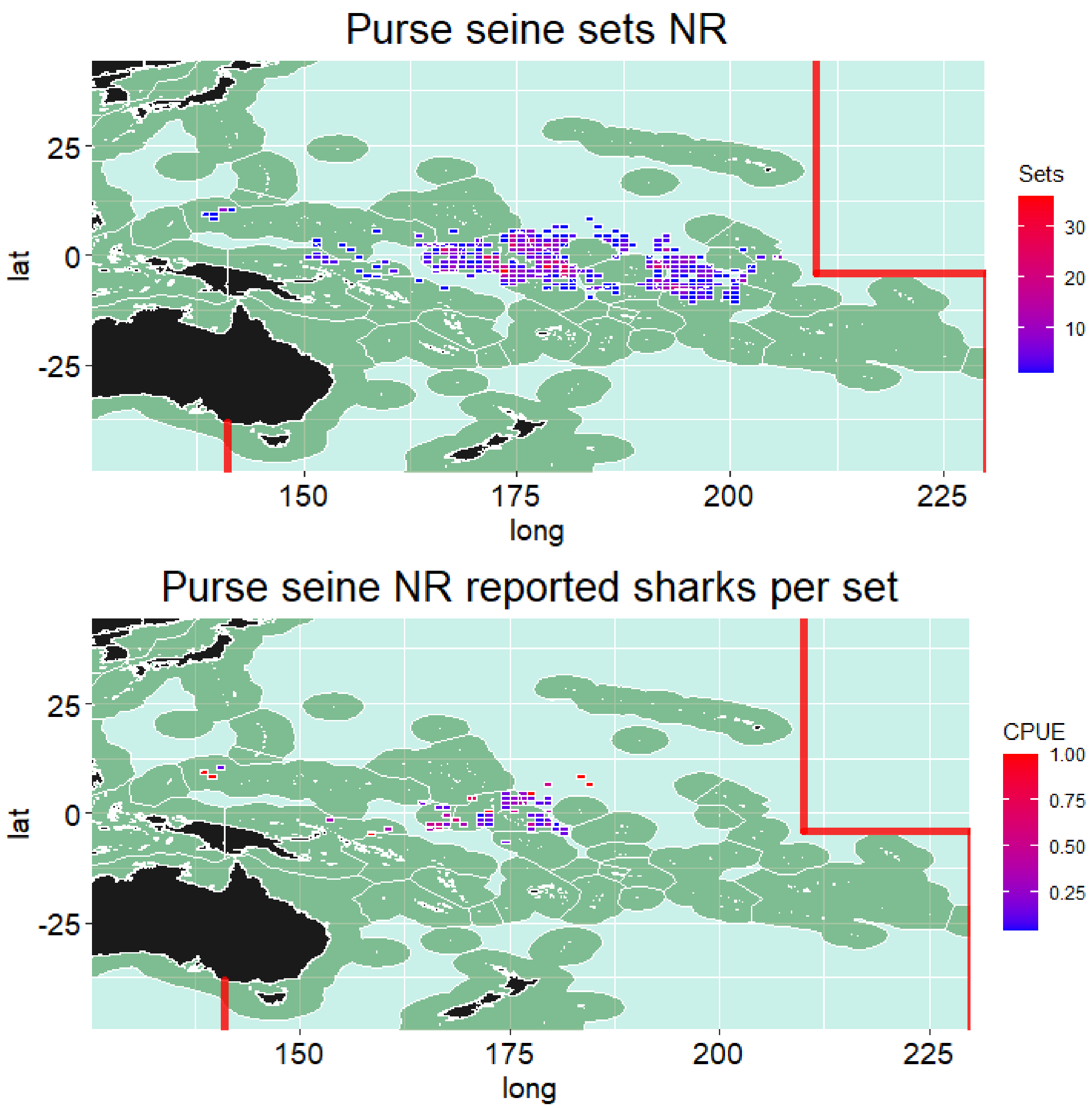


Figure AI - 39: Purse seine logsheet reporting data for Nauru flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

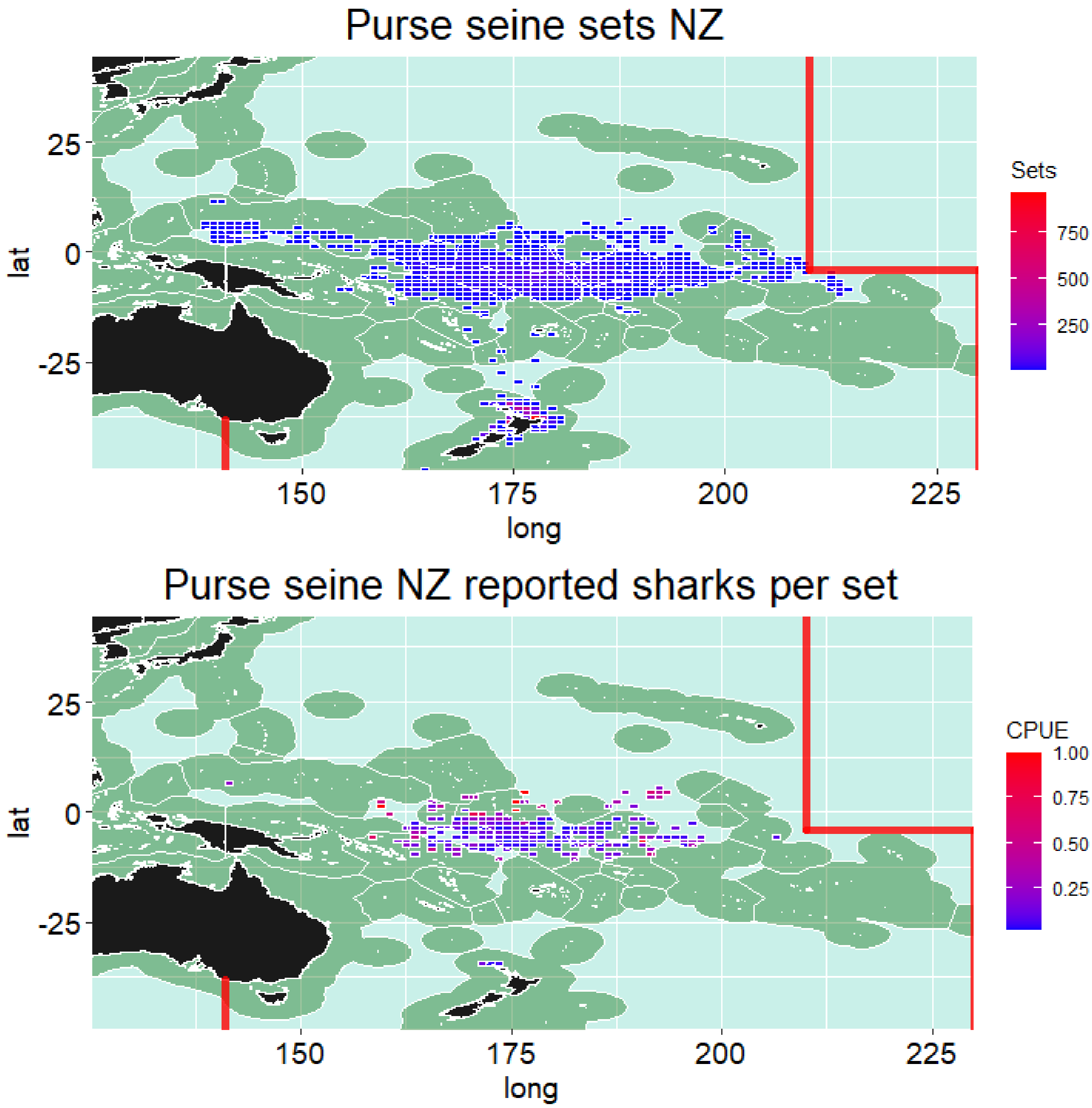


Figure AI - 40: Purse seine logsheet reporting data for New Zealand flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

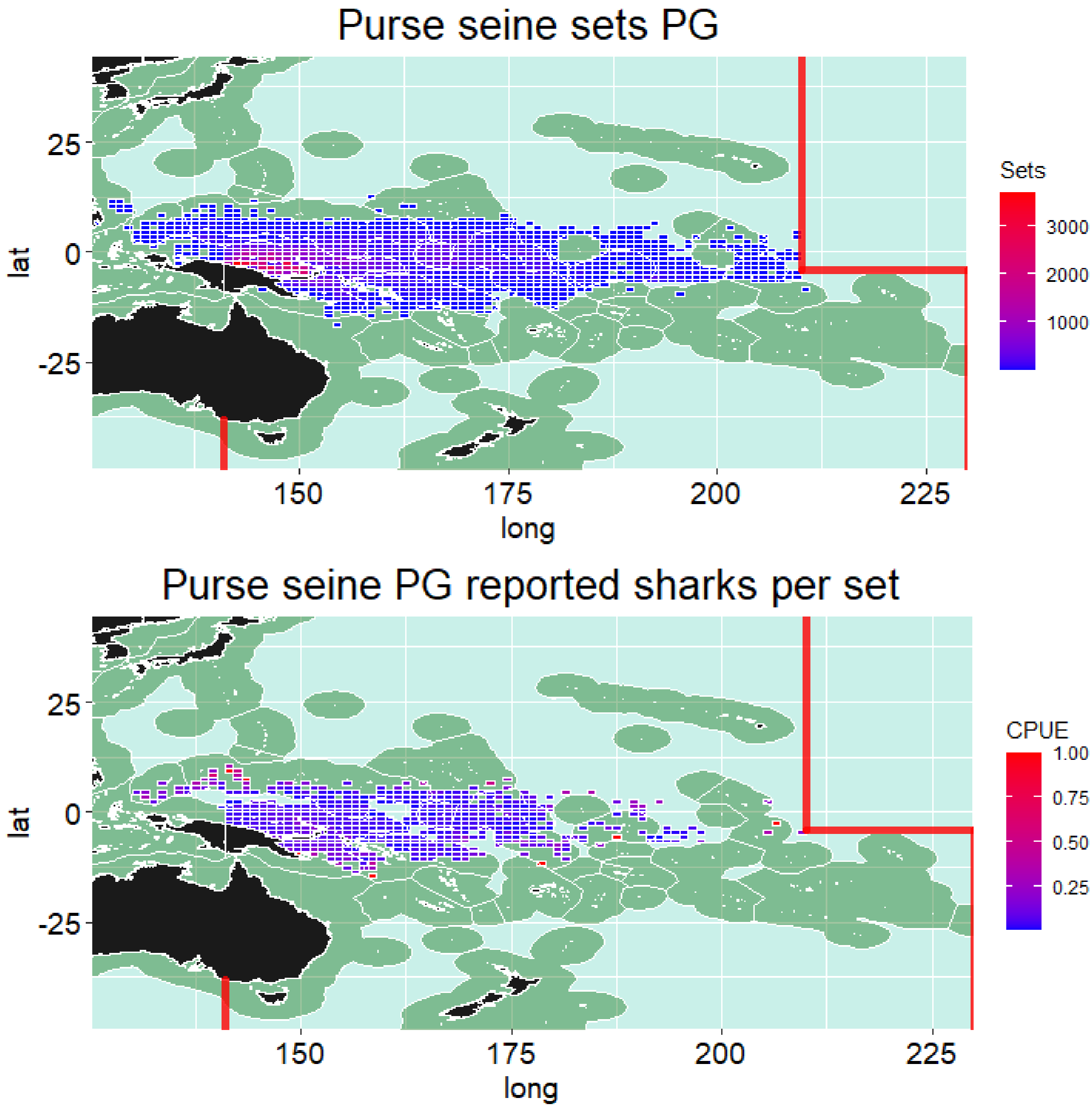


Figure AI - 41: Purse seine logsheet reporting data for Papua New Guinea flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

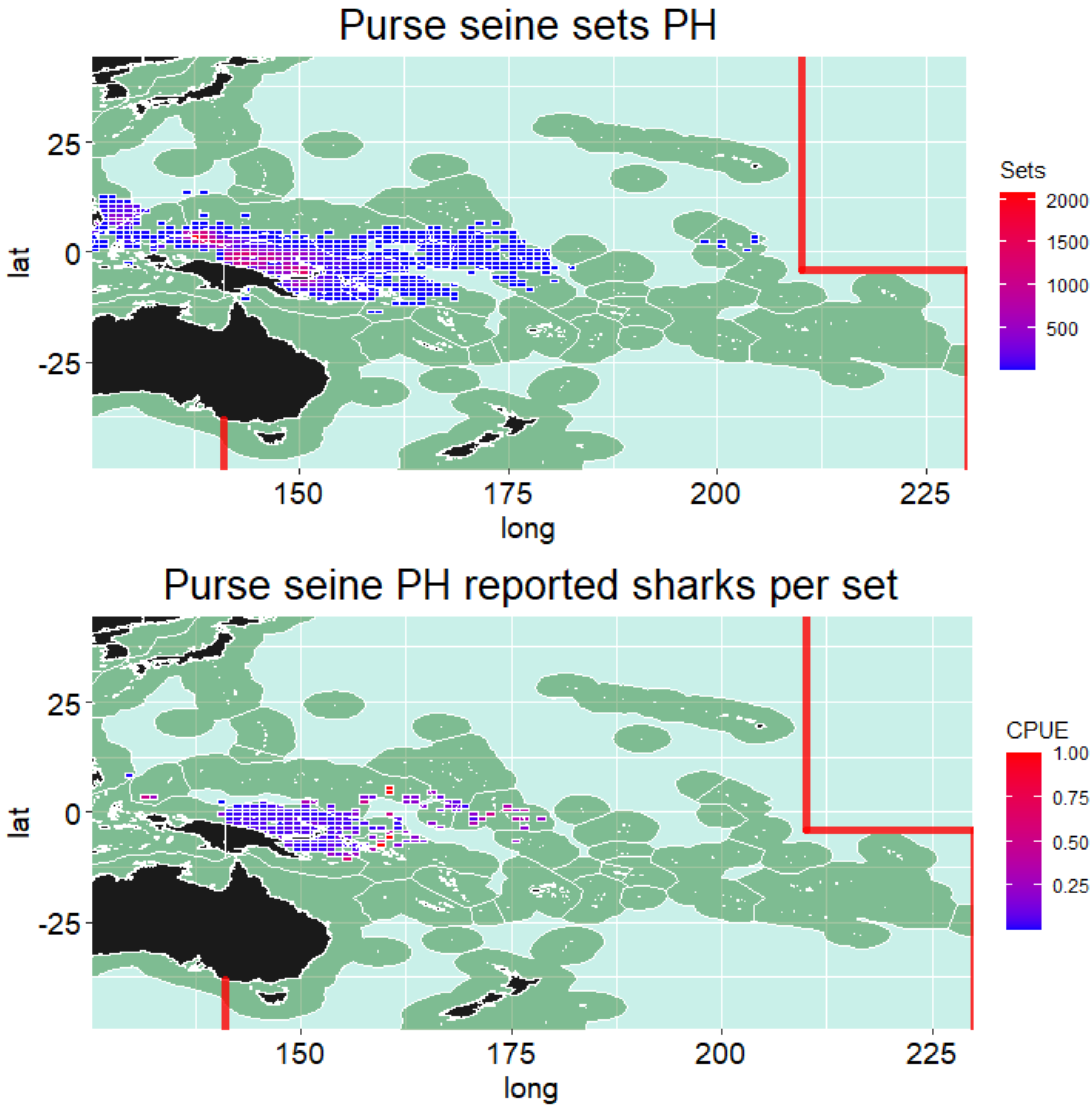


Figure AI - 42: Purse seine logsheet reporting data for Philippine flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

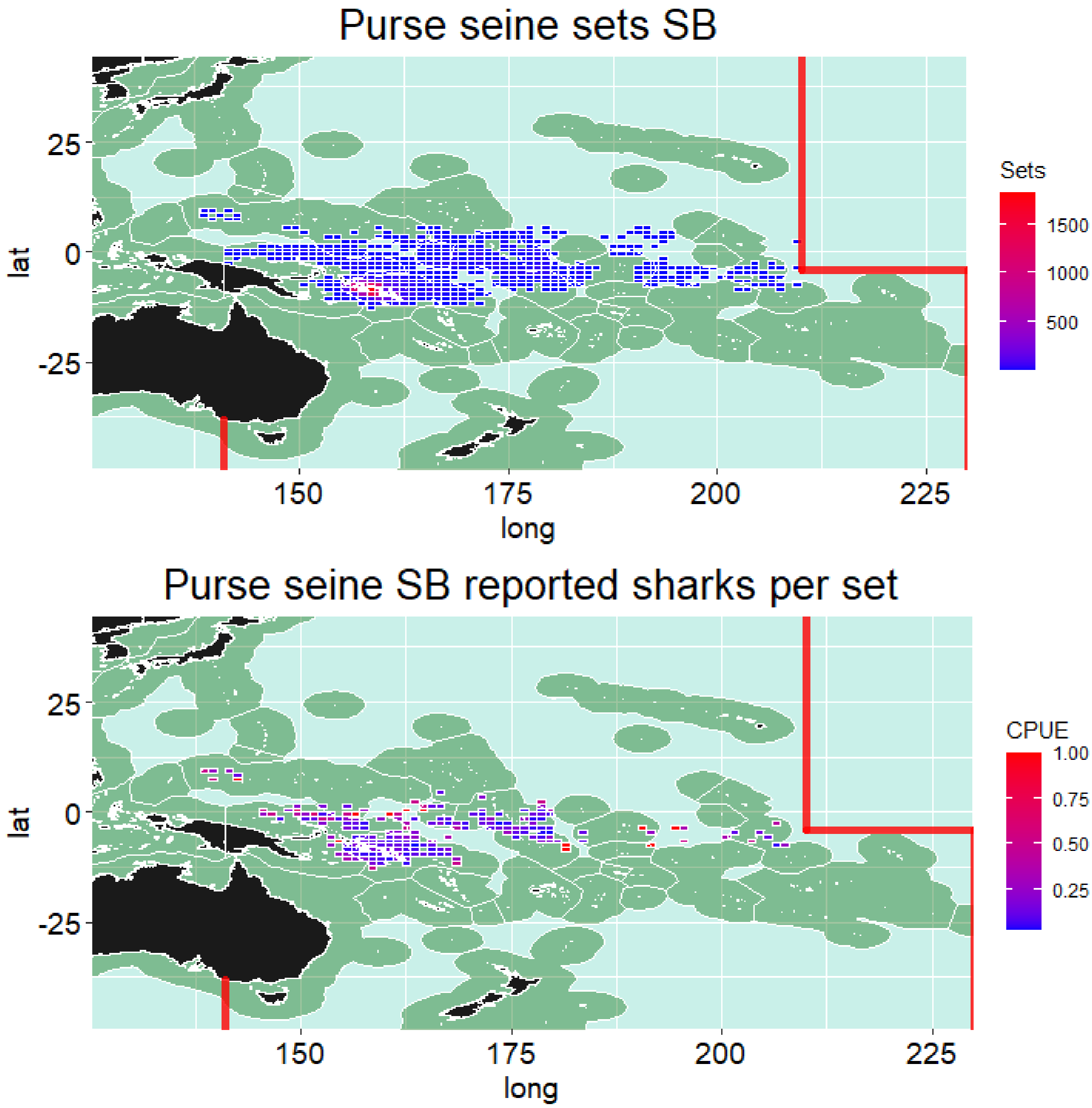


Figure AI - 43: Purse seine logsheet reporting data for the Solomon Islands flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

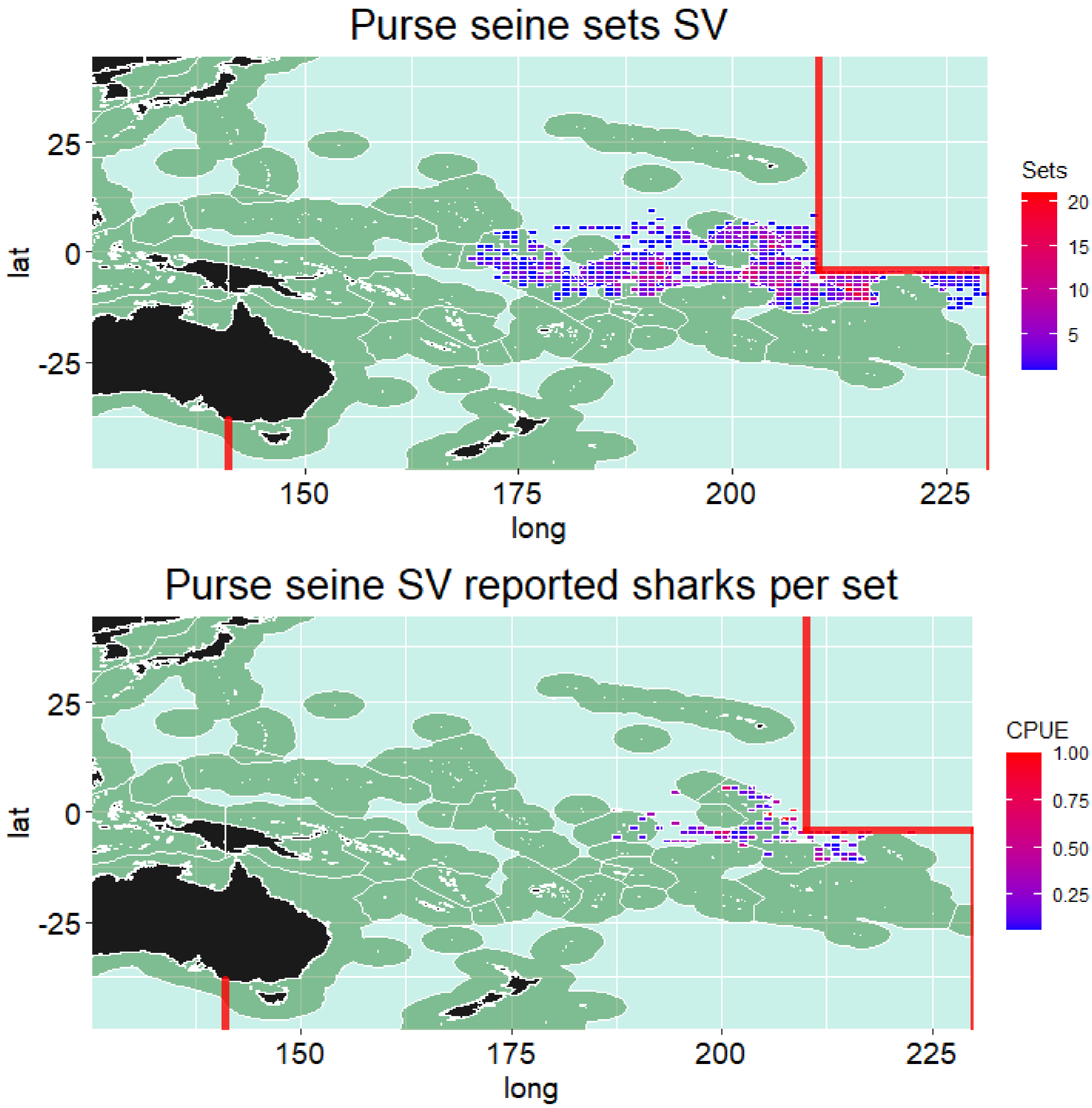
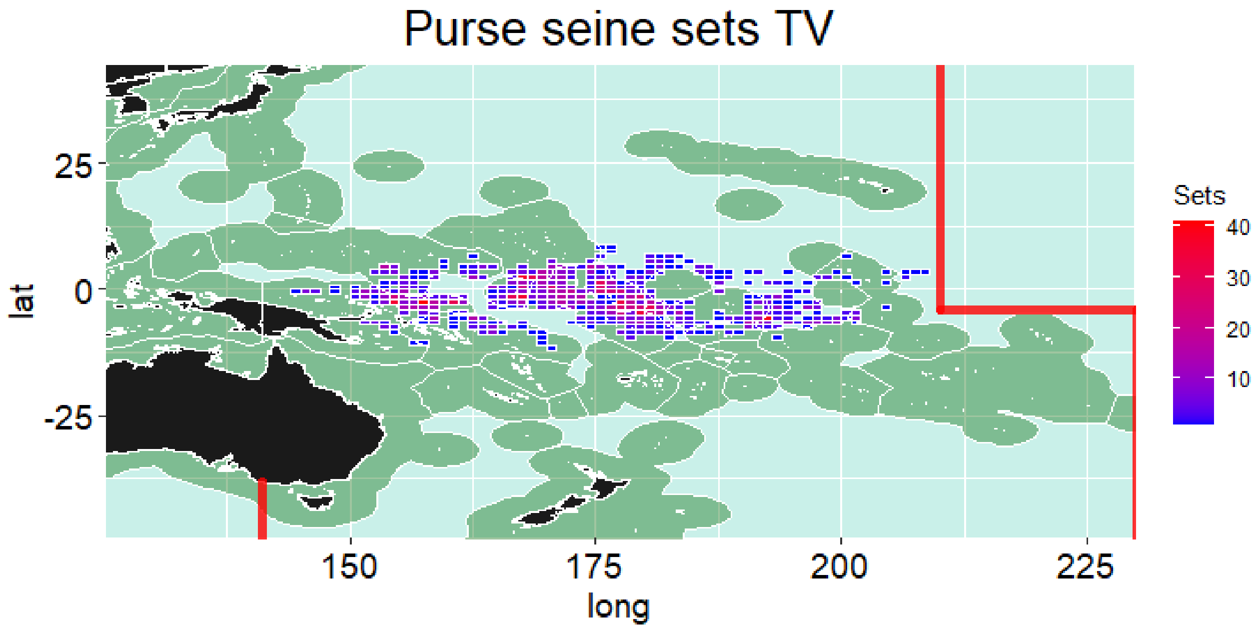


Figure AI - 44: Purse seine logsheet reporting data for El Salvador flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).



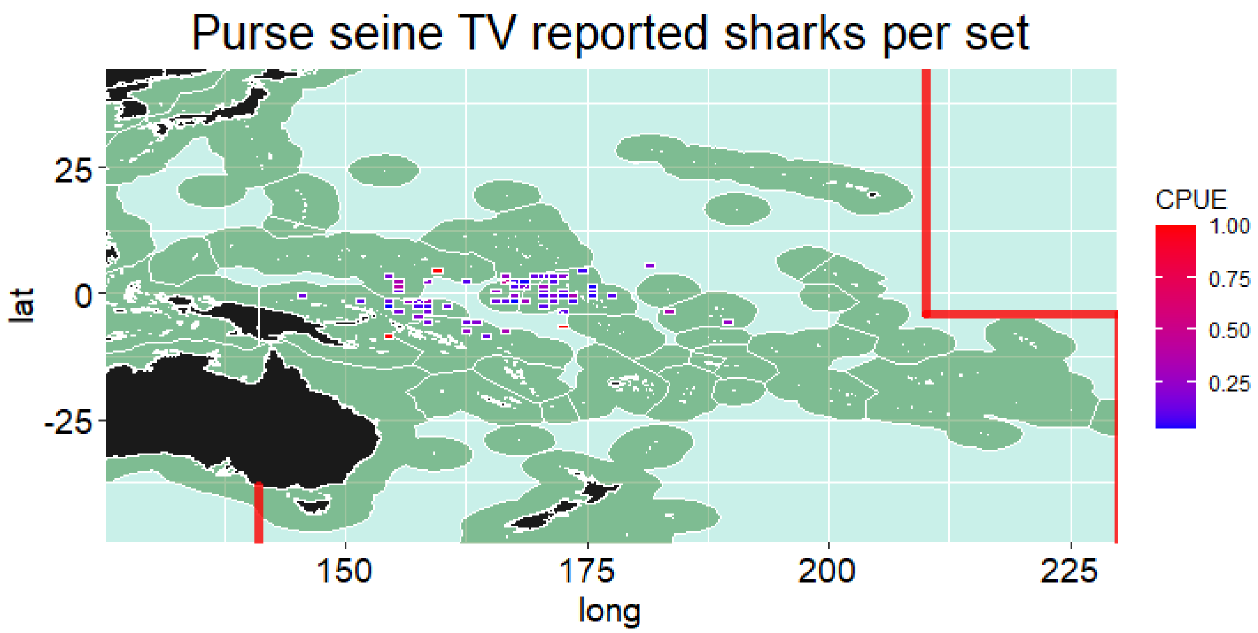


Figure AI - 45: Purse seine logsheet reporting data for Tuvalu flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

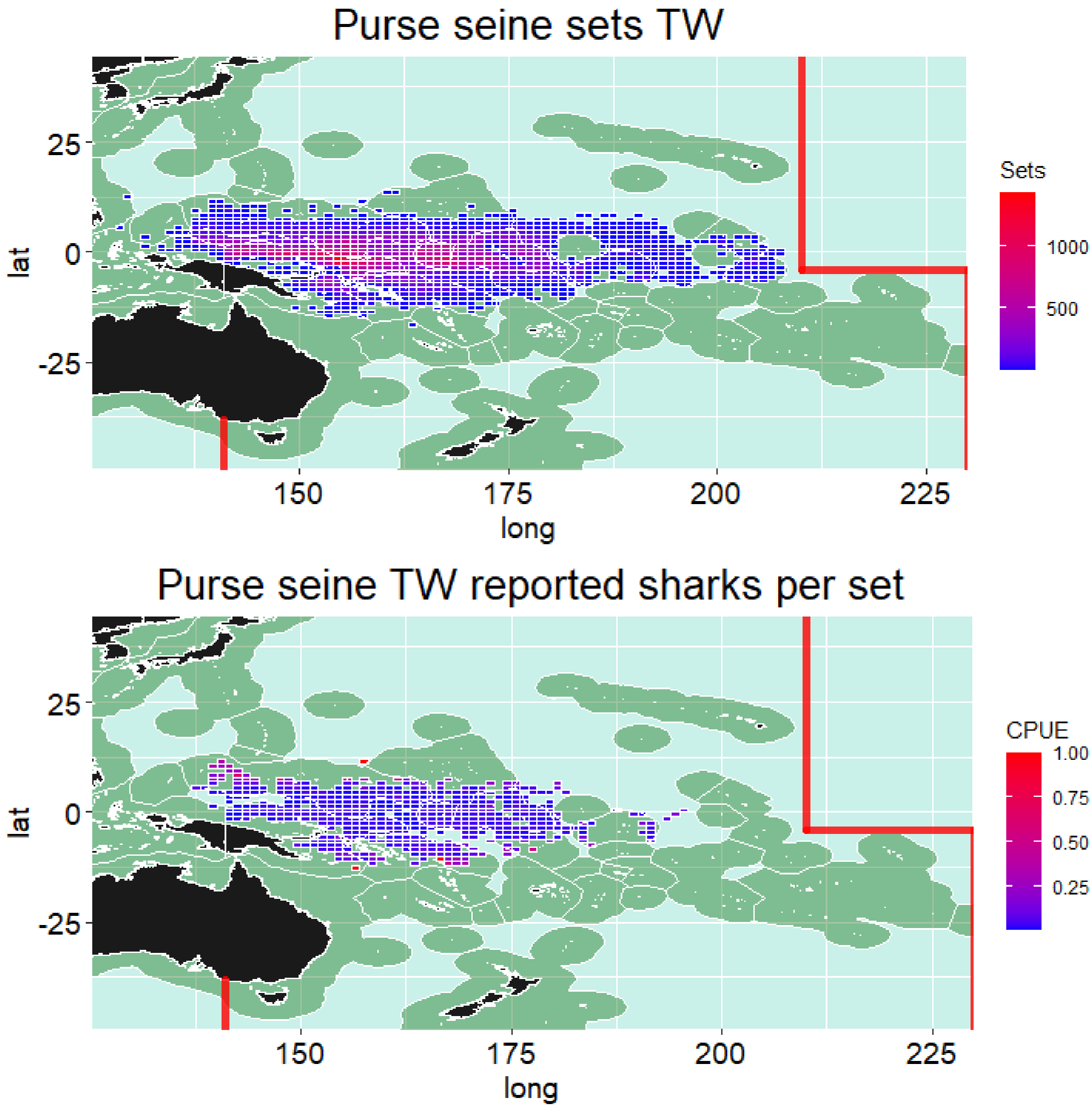


Figure AI - 46: Purse seine logsheet reporting data for Chinese Taipei flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

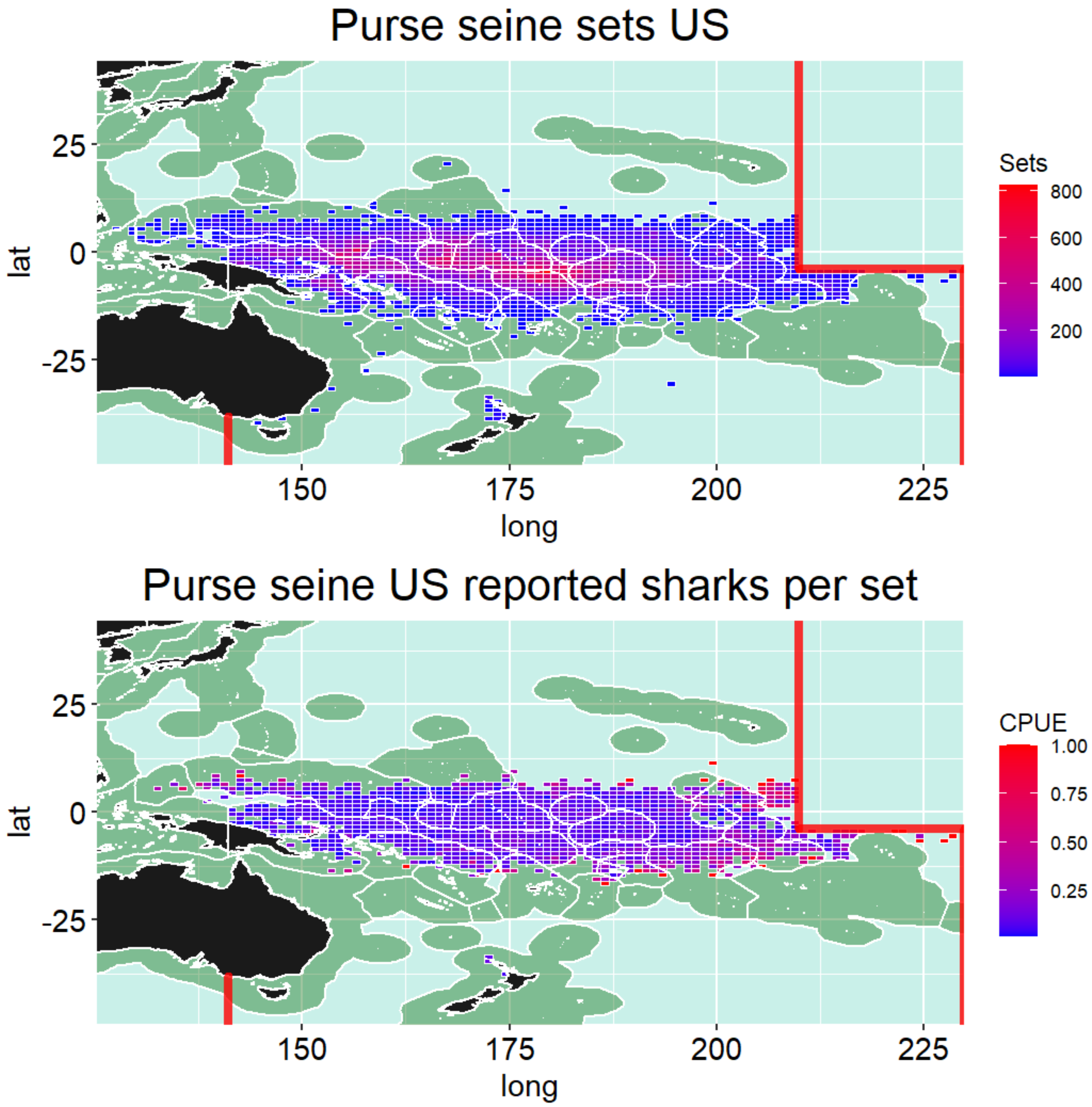
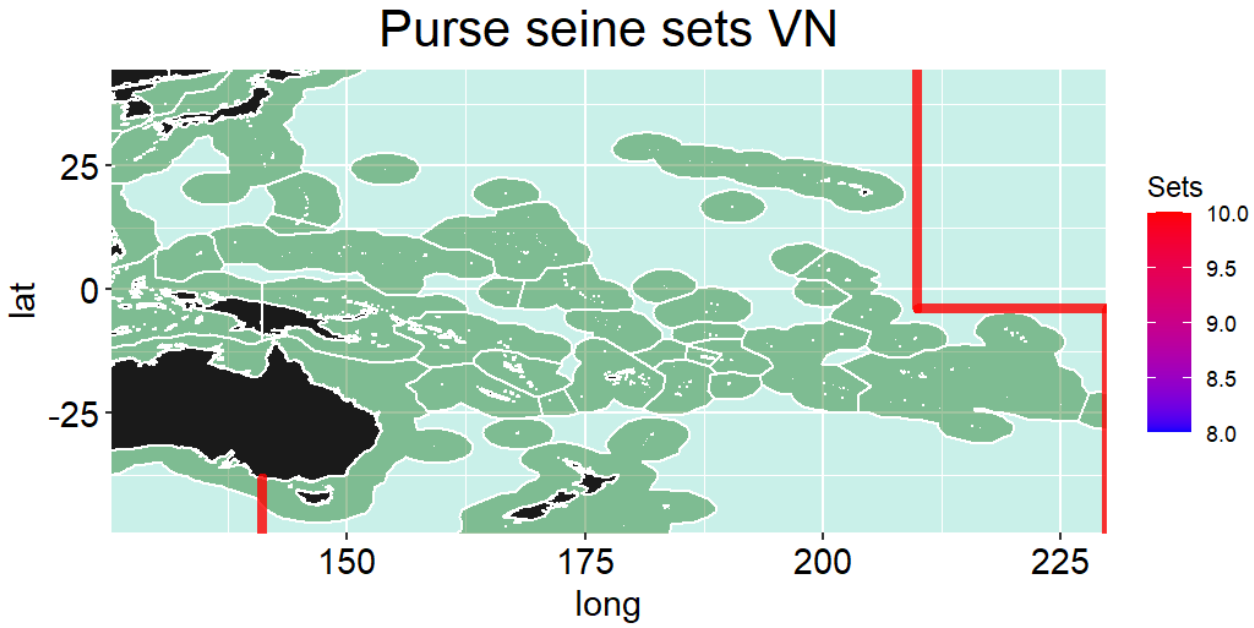


Figure AI - 47: Purse seine logsheet reporting data for the United States of America flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).



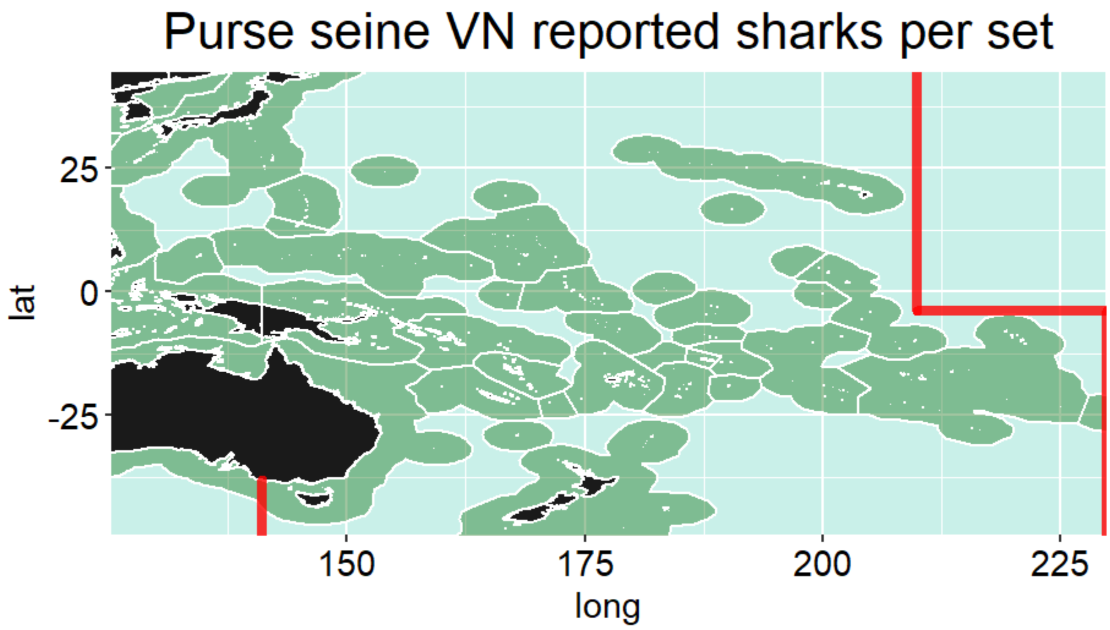


Figure AI - 48: Purse seine logsheet reporting data for Vietnamese flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

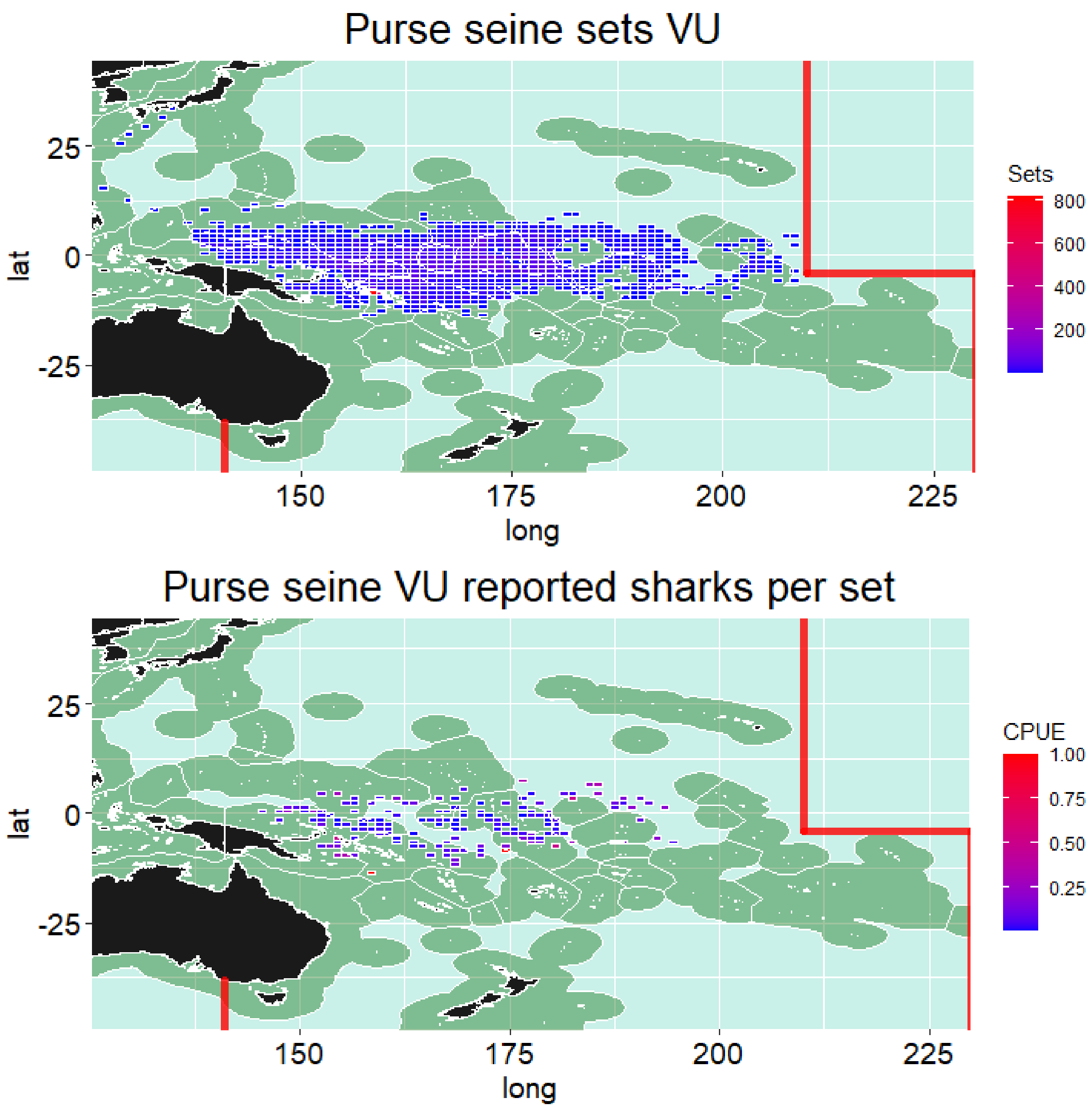


Figure AI - 49: Purse seine logsheet reporting data for Vanuatu flagged vessels showing the number of sets (top) and the number of sets reporting shark catch (Bottom).

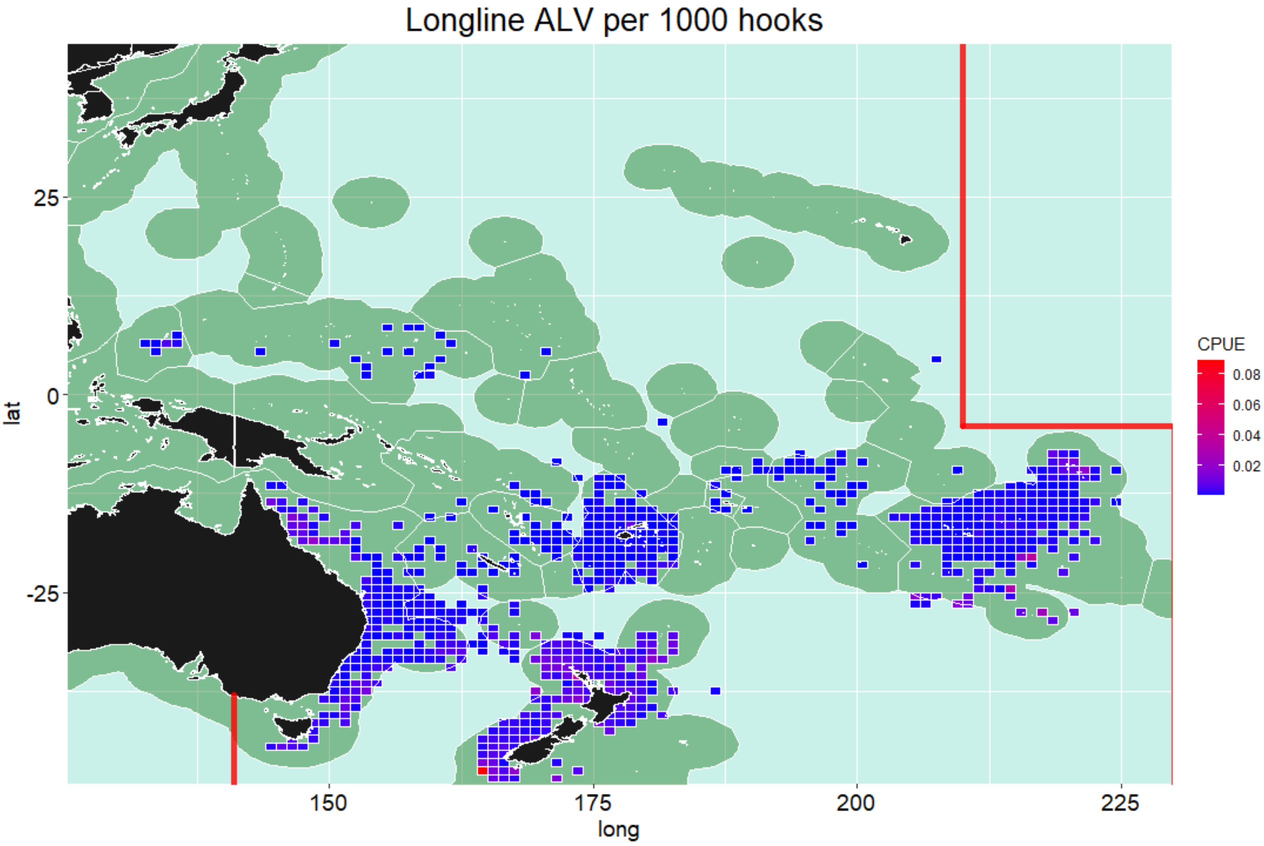


Figure AI - 50: Longline logsheet reported catch (numbers) of common thresher sharks between 2015 and 2019.

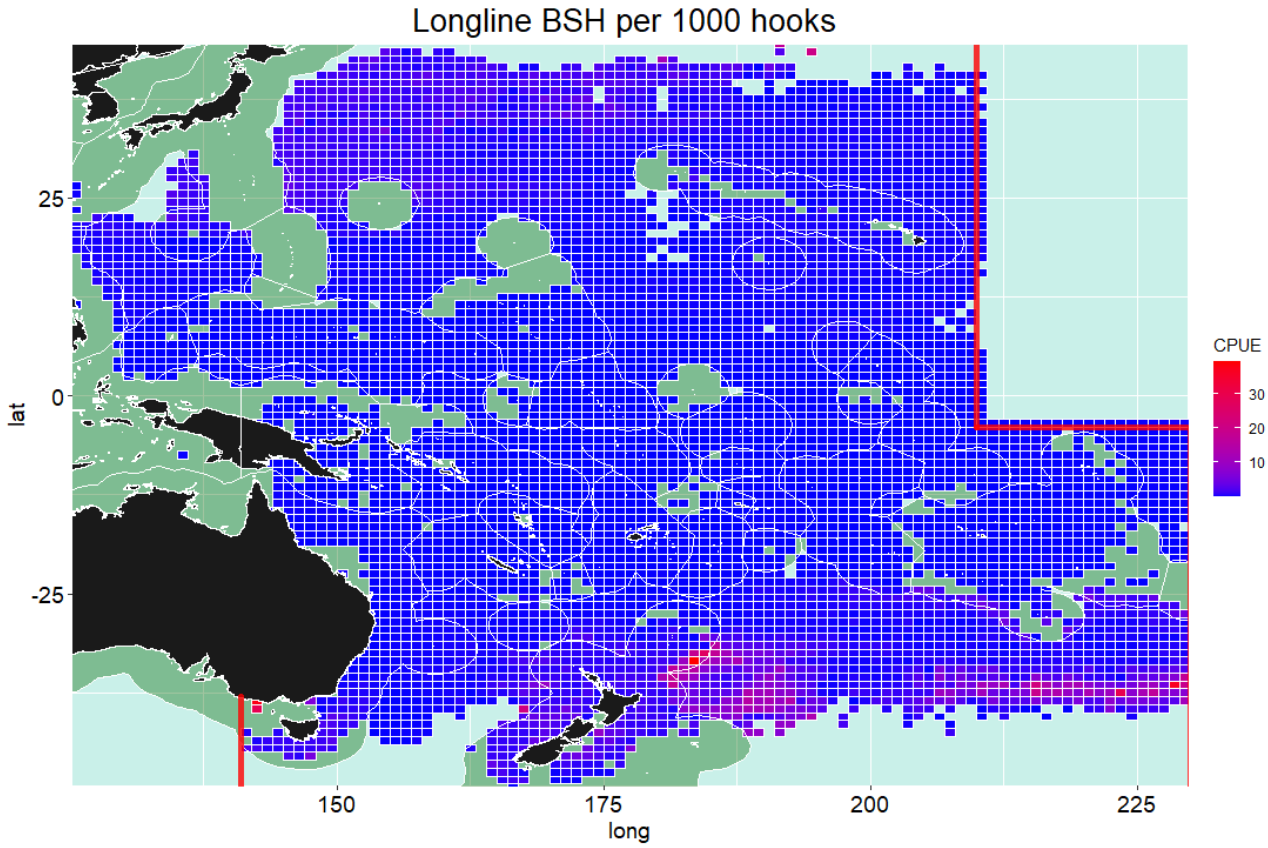


Figure AI - 51: Longline logsheet reported catch (numbers) of blue sharks between 2015 and 2019.

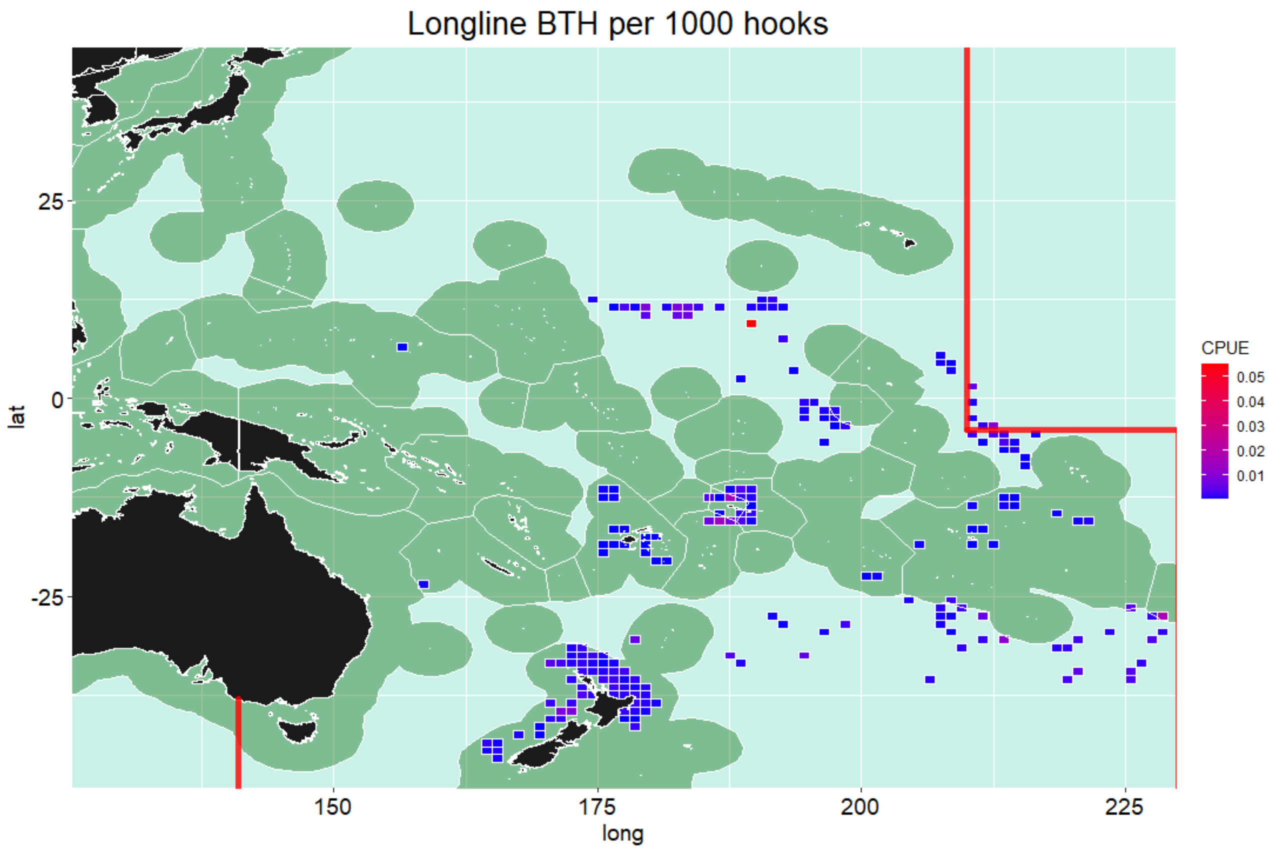


Figure AI - 52: Longline logsheet reported catch (numbers) of bigeye thresher sharks between 2015 and 2019.

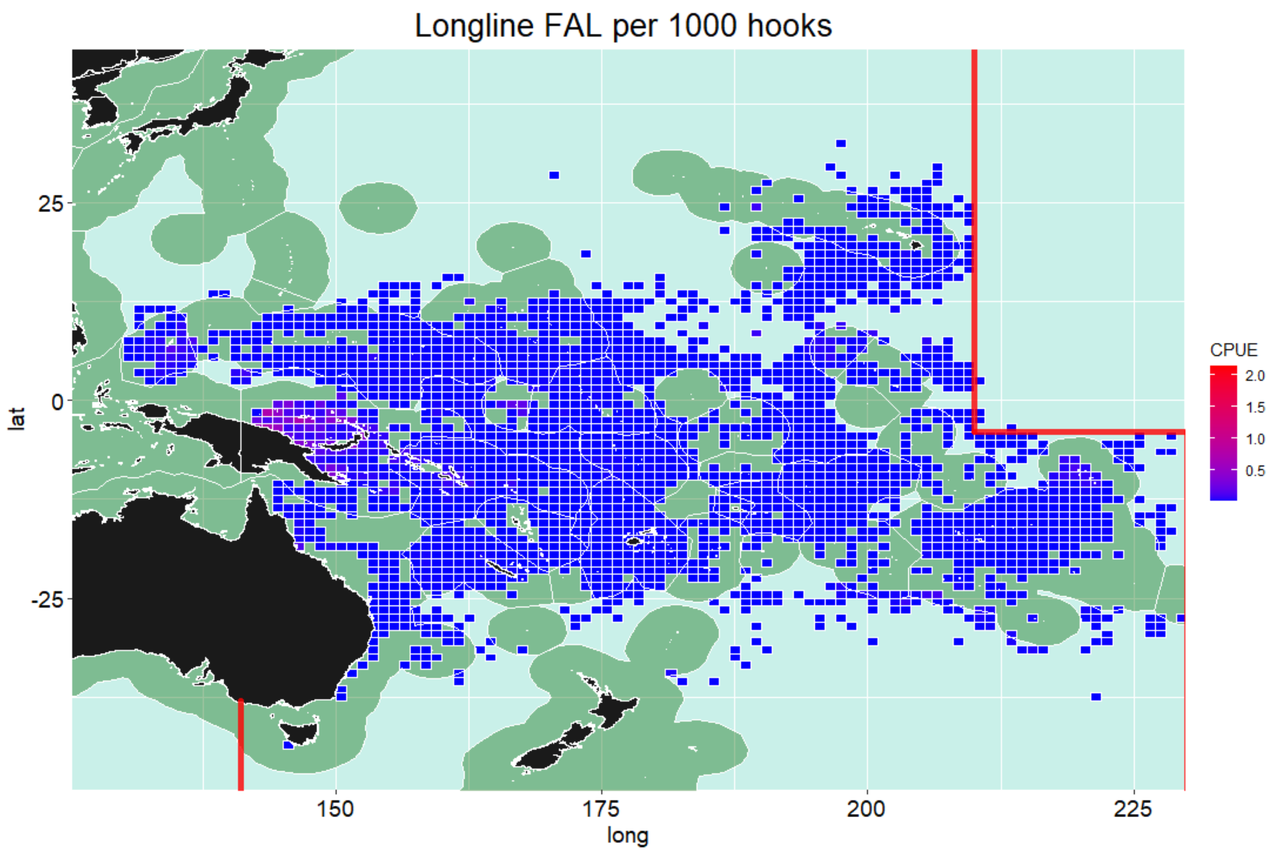


Figure AI - 53: Longline logsheet reported catch (numbers) of silky sharks between 2015 and 2019.

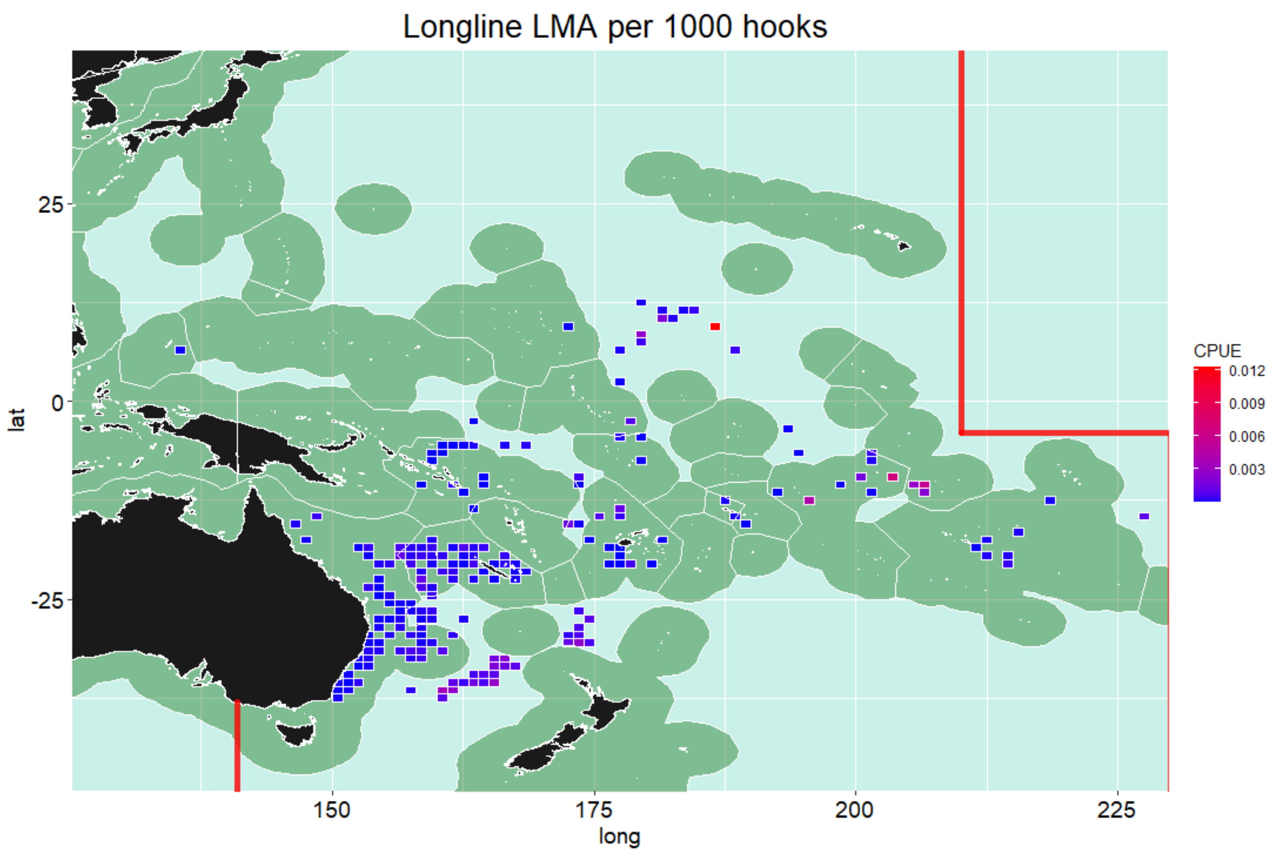


Figure AI - 54: Longline logsheet reported catch (numbers) of longfin mako sharks between 2015 and 2019.

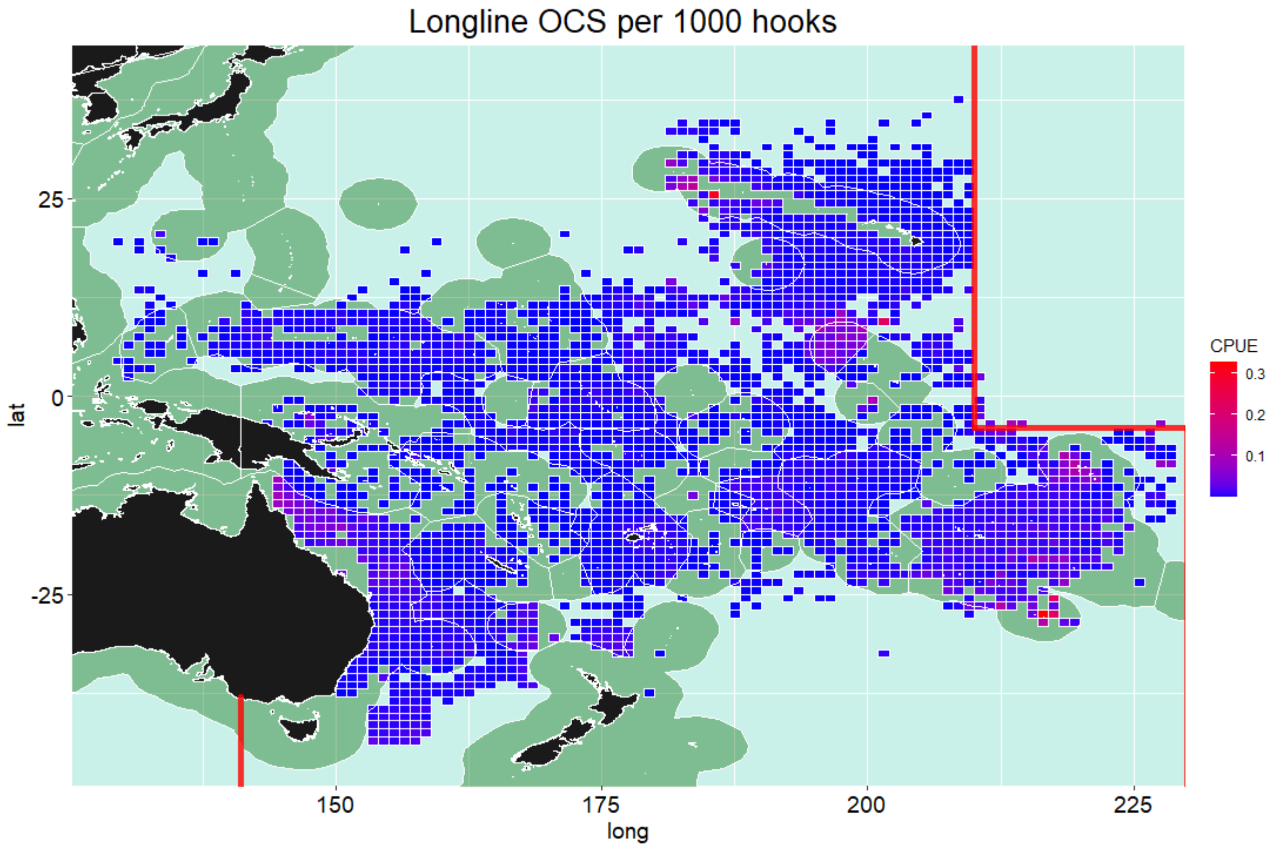


Figure AI - 55: Longline logsheet reported catch (numbers) of common oceanic whitetip sharks between 2015 and 2019.

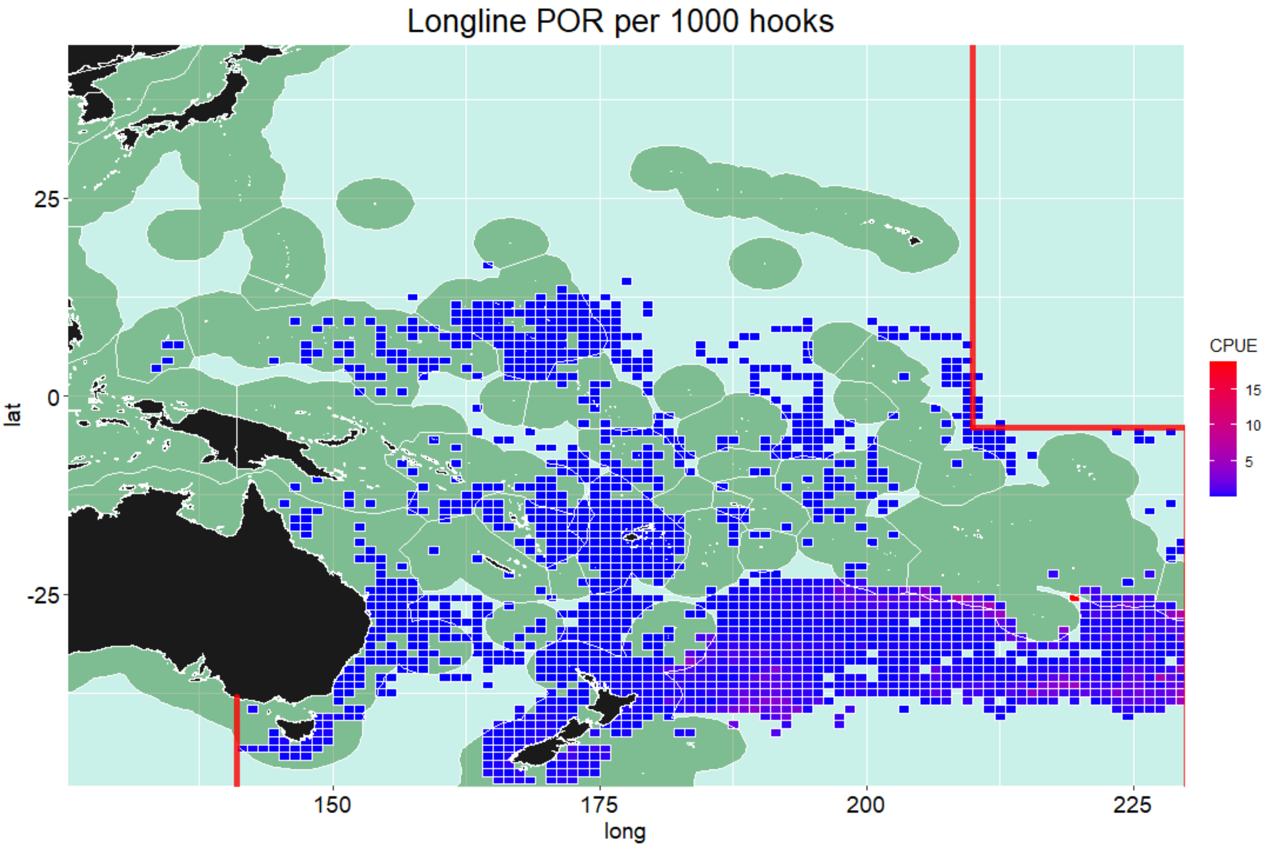


Figure AI - 56: Longline logsheet reported catch (numbers) of porbeagle sharks between 2015 and 2019.

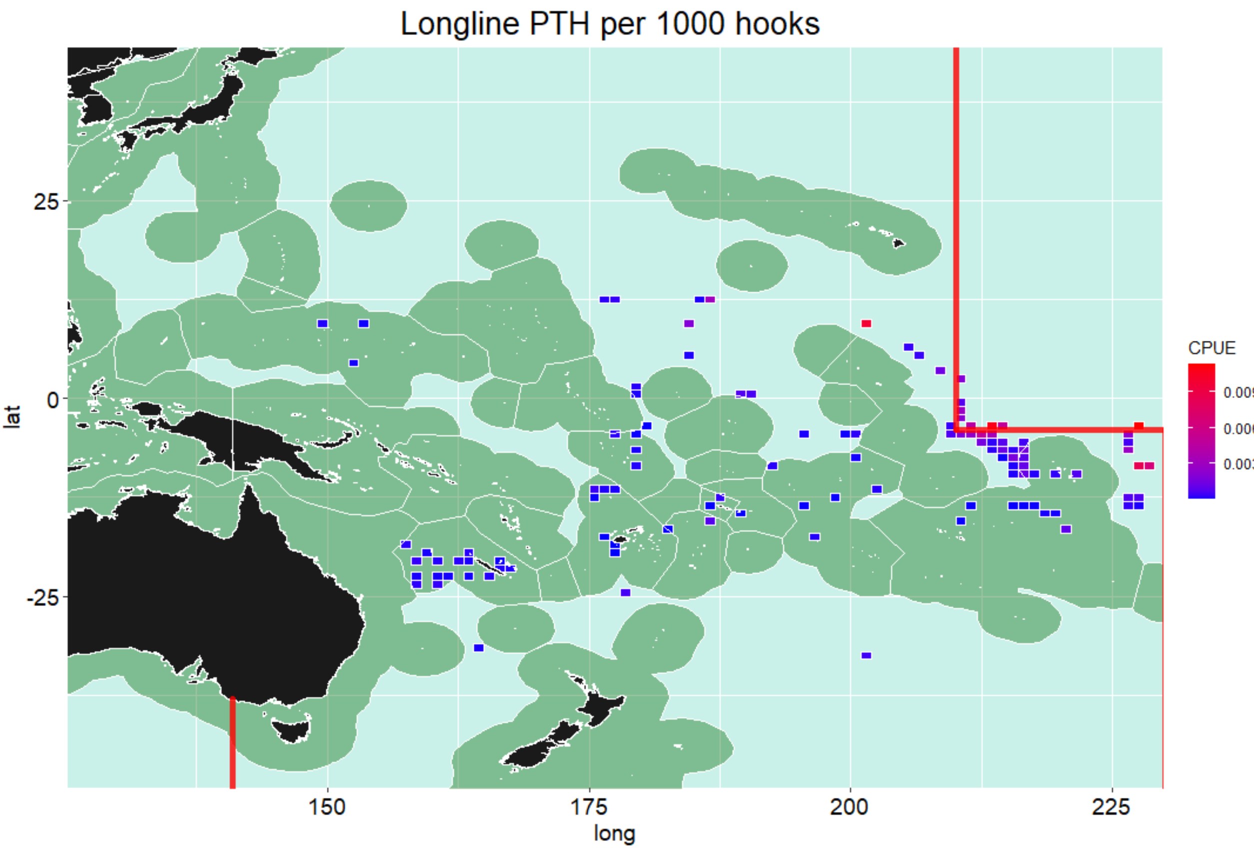


Figure AI - 57: Longline logsheet reported catch (numbers) of pelagic thresher sharks between 2015 and 2019.

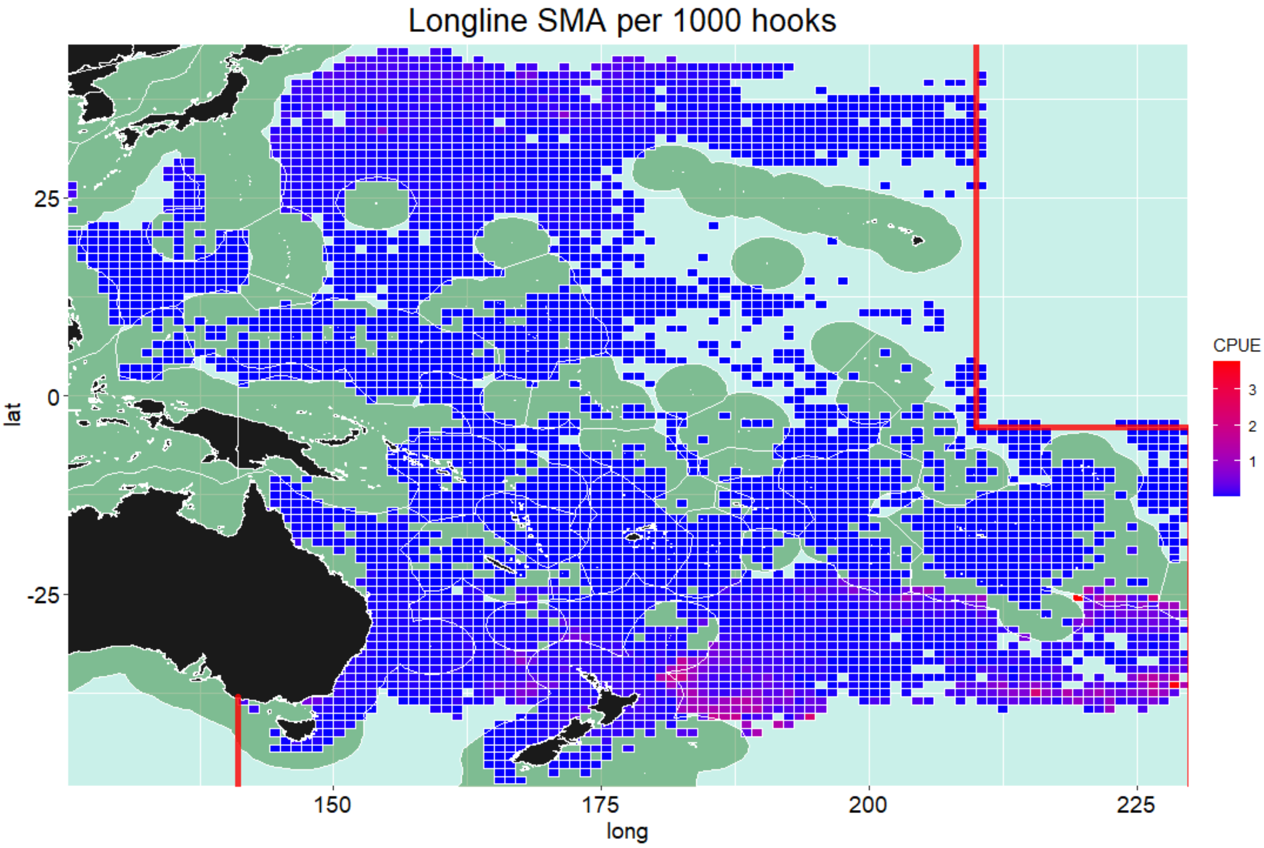


Figure AI - 58: Longline logsheet reported catch (numbers) of shortfin mako sharks between 2015 and 2019.

Appendix II - Review of the 2016-2020 SRP