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A compendium of fisheries indicators for tuna stocks

WCPFC-SC15-2019/SA-WP-01 rev1[*]

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[*] **Rev 1, includes changes to Figures 17 and 26 where a correction was made to exclude the Japanese coastal fleet from the CPUE analysis.**

Contents

1 Executive Summary

The principal purpose of this paper is to provide empirical information on recent patterns in fisheries for the SC's consideration. For SC15, we present a compendium of fishery indicators for all 'key' target tuna species (skipjack, bigeye, yellowfin and South Pacific albacore tuna), with albacore, bigeye and yellowfin not having full stock assessments in 2019. Trends for South Pacific albacore tuna are also described in the regularly requested stand-alone paper Brouwer et al. (2019).

The indicators that are documented include: total catch by gear, nominal CPUE trends, spatial distribution of catch and associated trends, size composition of the catch and trends in average size. These include data loaded into the WCPFC databases as of 16 July 2019. Commentary provided in this paper typically relates to comparisons of the values of various indicators to previous years, in particular comparisons of 2018 values to 2017 and to the average over 2013-2017.

It is difficult to confidently interpret the stock status-related implications of trends in any indicators in isolation of other data sets and a population dynamics model. Therefore, short-term stochastic projections for WCPO albacore, bigeye and yellowfin stocks are also presented to assess potential stock status at the end of 2020 in light of recent catch and effort trends.

2 Introduction

Following development of stock indicators for key species not formally assessed (Scientific Committee's Work Programme for 2008-2010, Project 24), stock indicators were first reported to SC4 in 2008 by the paper of Hampton and Williams (2008). Indicators for all key tuna species were have been reported regularly since 2012 (Harley and Williams, 2012; Harley and Williams, 2013; Pilling et al., 2016; Pilling et al., 2017; Brouwer et al., 2018). The more recent papers addressed the request from SC9 for descriptive text to assist in interpreting the paper contents.

Stock indicators for skipjack, bigeye, yellowfin and South Pacific albacore tuna are presented here, with albacore, bigeye and yellowfin not having full stock assessments in 2019. Commentary provided in this paper compares the values of various indicators to previous years, in particular comparisons of 2018 values to 2017 and to the average over 2013-2017.

Short-term stochastic projections for albacore, bigeye and yellowfin specifically are also included for further information. For these, the stocks were projected forward from 2015 or 2016, using the most recent assessments (Tremblay-Boyer et al., 2017; Tremblay-Boyer et al., 2018; Vincent et al., 2018). Future recruitments were modeled as deviations around the stock recruitment relationship from the period over which the stock-recruitment relationship was estimated within the assessment model. For each stock, projections were performed over the grid of assessment runs defined by SC13 (yellowfin) and SC14 (bigeye, South Pacific albacore) as appropriate. Bigeye and yellowfin stocks were projected through 2016, 2017 and 2018 based upon the actual fishing level by each fleet in the assessments, and then through to 2020 based upon the assumption that levels of effort or catch would remain constant at the 2018 level. For South Pacific albacore, the stock was projected through 2017 and 2018 using actual catch/effort levels, and then through to 2020 assuming 2018 levels continued. We note that the near-future stock status will be influenced by recent recruitment levels defined within the stock assessment model, rather than the random recruitments sampled from the historical period. Those recruitments will take a number of years to reach the adult biomass.

3 Indicators and data sources

Indicators are based on annual catch estimates for the convention area, and aggregate catch and effort data for the gear specific analyses. In some instances, individual fleets have been used for particular indicators. Given the large number of indicators, the descriptive text is tabulated below for each stock.

Please note that the figures here may include or exclude specific fleets that are included in summaries made for other purposes (e.g. CMM tables) and therefore these numbers may not be identical to those produced elsewhere. Furthermore, these numbers will change as more data become available.

Acknowledgments

The authors would like to thank Sam McKechnie for useful comments on earlier drafts of this paper.

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Skipjack tuna

Figure	Indicator	Description
Figure 1	Total catch by gear	Total catch in 2018 was 1,795,048, a 10% increase from 2017 and a 1% decrease from 2013-2017. Purse seine catch in 2018 (1,469,520t) was a 15% increase from 2017 and a 2% increase from the 2013-2017 average. Pole and line catch (138,534t) was a 4% increase from 2017 and a 9% decrease from the average 2013-2017 catch. Catch by other gear (182,888t) was a 16% decrease from 2017 and 19% decrease from the average catch in 2013-2017.
Figure 2 - top	Tropical pole and line CPUE	Pole and line CPUE for the Japanese fleet in 2018 (7.54t per day) was a 55% increase from 2017 and a 14% increase from the 2013-2017 average. Pole and line CPUE for the Solomon Islands fleet in 2018 (1.16t per day) was a 42% decrease from 2017 and a 48% decrease from the 2013-2017 average. This high variability is likely caused but the small size of the fleet rather than an indication of stock abundance.
Figure 2 - bottom	Tropical purse seine CPUE	Free-school CPUE in 2018 (13.61t per day) was a 14% increase from 2017 and a 19% decrease from the 2013-2017 average. Log CPUE in 2018 (18.88t per day) was a 18% increase from 2017 and a 8% decrease from the 2013-2017 average. Drifting FAD CPUE in 2018 (22.6t per day) was a 13% increase from 2017 and a 20% decrease from the 2013-2017 average. Anchored FAD CPUE in 2018 (9.72t per day) was a 11% increase from 2017 and a 16% increase from the 2013-2017 average.
Figure 3	Maps of catch by gear	Compared to the longer time frame, the reduction in pole and line catch in recent years is notable, particularly in the equatorial zone. The easterly distribution of purse seine catches in 2014-2018) have been influenced by recent ENSO conditions.
Figure 4	Purse seine effort and CPUE maps	Purse seine CPUE has generally been higher in the central and eastern regions of the tropical WCPO, with some notably high catch rates achieved at the margins of this area. The easterly distribution of purse seine catches in 2014-2018 have been influenced by recent ENSO conditions.
Figure 5	Spatial distribution of catch	90% of the purse seine catch in 2018 was taken in 649 1x1 degree squares. This was a 10% decrease on 2017 and a 0% decrease on 2013-2017 average. 90% of the pole and line catch was taken in 259 1x1 degree squares. This was a 12% decrease on 2017 and a 20% decrease on 2013-2017 average.
Figure 6	Catch at length by gear type in both numbers and weight	The catch in numbers of fish was predominantly made up of small fish from the Indonesia/Philippines fisheries. Large fish are mostly caught in the purse seine unassociated sets. But catch by weight is mostly made up by fish from the purse seine fisheries.
Figure 7	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2018 (1.77kg) was 5% decrease from 2017 and a 14% decrease from the average in 2013-2017. The mean weight of pole and line caught fish (2.13kg) was 1% decrease from 2017 and a 21% decrease from the average in 2013-2017. The mean weight of Indonesia / Philippines domestic caught fish (0.52kg) was 16% decrease from 2017 and a 30% decrease from the average in 2013-2017. The mean weight of free-school caught purse seine fish (3.92kg) was 5% decrease from 2017 and a 1% decrease from the average in 2013-2017. The mean weight of FAD caught fish (2.09kg) was 17% decrease from 2017 and a 8% decrease from the average in 2013-2017.
NA	Stochastic stock projections	NA - as a new assessment has been undertaken in 2019, and final grid still to be selected by SC, no projection is presented for skipjack here, however (Vincent et al., 2019) will present some projections.

South Pacific albacore tuna

Figure	Indicator	Description
Figure 8	Total catch by gear	Total provisional South Pacific catch in 2018 was 68,454, a 27% decrease from 2017 and a 17% decrease from the average 2013-2017. Longline catch in 2018 (65,410t) was a 28% decrease from 2017 and a 18% decrease from the 2013-2017 average. Note the discussions in Williams (2019) and Williams and Reid (2019) on the catch reporting of albacore in the South Pacific ocean for more details. Catch by other gear - almost all troll - (3,018t) was a 15% increase from 2017 and 7% increase from the average catch in 2013-2017. For the southern WCPCA, total albacore catch was 65,949, a 14% decrease from 2017 and a 2% decrease from the average 2013-2017. Longline catch in 2018 (62,889t) was a 15% decrease from 2017 and a 2% decrease from the 2013-2017 average. Troll catch (3,034t) was a 15% increase from 2017 and 7% increase from the average catch in 2013-2017. Note that numbers will differ slightly to those tabulated in the albacore trends paper (Brouwer et al., 2019).
Figure 9	Southern longline CPUE (south of 10°S)	Japanese longline CPUE in 2018 (0.96 fish per 100 hooks) was a 29% decrease from 2017 and a 34% decrease from the 2013-2017 average. Fiji longline CPUE (1.14 fish per 100 hooks) was a 11% decrease from 2017 and a 3% decrease from the 2013-2017 average. Chinese longline CPUE (1.73 fish per 100 hooks) was a 14% decrease from 2017 and a 10% increase from the 2013-2017 average. Finally, Chinese Taipei longline CPUE in 2018 (1.94 fish per 100 hooks) was unchanged from 2017 and a 3% increase from the 2013-2017 average.
Figure 10	Maps of catch by gear	In recent years, catches have concentrated in the 10-20°S latitudinal band. While 2018 estimates remain provisional, slightly higher catch is seen in the high seas and around 170°E. Catch increased south of 20°S in the high seas east of 180° in 2018. Overall in 2018 the catch distribution is somewhat shifted towards the west.
Figure 11	Longline effort and CPUE maps	Over the whole period, catch rates have been highest south of 10°S, and the overall pattern is for increasing CPUE as you move from north to south. In the more recent period, catch rates have been relatively high within high seas areas and in the 15-20°S band.
Figure 12	Spatial distribution of catch	90% of the longline catch in 2018 was taken in 54 5x5 degree squares of the southern WCPO. This was a 8% increase from 2017 and a 8% increase from the 2013-2017 average.
Figure 13	Catch at length by gear type in both numbers and weight	The catch in numbers of fish and weight shows that the largest fish are caught in the longline fisheries and the troll catch is made up of small fish usually less than 80cm in length.
Figure 14	Mean weight by gear type	While the mean weight of individual fish taken across all gears is relatively stable over the long-term, in mean weight 2018 (14.18kg) was a 5% decrease from 2017 and a 2% increase from the 2013-2017 average. The mean weight of longline caught fish (16.08kg) was a 2% increase from 2017 and a 8% increase from the 2013-2017 average. The mean weight of fish caught in other gears (3.7kg), almost all troll, was a 28% decrease from 2017 and a 26% decrease from the 2013-2017 average.
Figure 15	Stochastic stock projections	Under recent fishery conditions, the albacore stock is initially projected to increase as recent estimated relatively high recruitments support adult stock biomass, then decline as future recruitment is sampled from the long-term historical estimates The projections indicate that, median $F_{2020}/F_{MSY} = 0.24$; median $SB_{2020}/SB_{F=0} = 0.43$; median $SB_{2019}/SB_{MSY} = 3.2$. The risk that $SB_{2020}/SB_{F=0} <$ LRP = 0%, $SB_{2020} < SB_{MSY} = 0\%$ and $F_{2020} > F_{MSY} = 0\%$.

Bigeye tuna

Figure	Indicator	Description
Figure 16	Total catch by gear	Total catch in 2018 was 145,402t, a 13% increase from 2017 and a 1% decrease from the average 2013-2017. Longline catch in 2018 (71,305t) was a 23% increase from 2017 and a 7% increase from the 2013-2017 average. Purse seine catch in 2018 (64,119t) was a 10% increase from 2017 and a 4% increase from the 2013-2017 average. Pole and line catch (1,677t) was a 3% increase from 2017 and a 60% decrease from the average 2013-2017 catch. Catch by other gear (8,301t) was a 25% decrease from 2017 and 45% decrease from the average catch in 2013-2017.
Figure 17 - top	Tropical pole and line CPUE	Japanese pole and line CPUE in 2018 (0.016t per day) was a 41% decrease from 2017 and 12% decrease from the average CPUE in 2013-2017.
Figure 17 - middle	Tropical purse seine CPUE	Free-school CPUE in 2018 (0.2t per day) was a 2% increase from 2017 and a 11% decrease from the 2013-2017 average. Log CPUE in 2018 (0.95t per day) was a 15% increase from 2017 and a 35% decrease from the 2013-2017 average. Drifting FAD CPUE in 2018 (1.71t per day) was a 9% decrease from 2017 and a 29% decrease from the 2013-2017 average. Anchored FAD CPUE in 2018 (0.31t per day) was a 16% increase from 2017 and a 35% decrease from the 2013-2017 average.
Figure 17 - bottom	Tropical longline CPUE (20^oN to 10^oS)	Japanese longline CPUE in 2018 (0.45 fish per 100 hooks) was a 16% increase from 2017 and 12% increase from the average CPUE in 2013-2017. Korean longline CPUE (0.57 fish per 100 hooks) was a 11% increase from 2017 and 1% decrease from the average CPUE in 2013-2017. US (Hawaiian) longline CPUE (0.33 fish per 100 hooks) was a 1% increase from 2017 and 10% decrease from the average CPUE in 2013-2017.
Figure 18	Maps of catch by gear	Compared to the longer time frame, a higher proportion of the catch in recent years has been taken by purse seine, and longline catches have concentrated more into the 10^oN-10^oS equatorial band.
Figure 19	Longline effort and CPUE maps	Longline CPUE in the recent period has generally been lower than that seen across the longer time frame. Higher catch rates are now generally limited to the equatorial eastern region of the WCPFC-CA.
Figure 20	Purse seine effort and CPUE maps	While areas of high bigeye catch rates have become more fragmented in recent years, higher catch rates in the tropical eastern region still expand further west in the tropical northern hemisphere (to 10^oN) and to the southeast of the tropical region.
Figure 21	Spatial distribution of catch	90% of the longline catch in 2018 was taken in 84 5x5 degree squares of the southern WCPO. This was a a 21% decrease from 2017 and a 17% decrease from the 2013-2017 average. 90% of the purse seine catch in 2018 was taken in 635 5x5 degree squares of the southern WCPO. This was a 7% decrease from 2017 and a 3% increase from the 2013-2017 average.
Figure 22	Catch at length by gear type in both numbers and weight	The catch in numbers of fish was predominantly made up of small fish (<50cm) in the most recent years from the Indonesia/Philippines fisheries. Large fish being caught in the longline fisheries.

Figure	Indicator	Description
Figure 23	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2018 (7.25kg) was a 12% increase from 2017 and a 2% increase from the average in 2013-2017. The mean weight of longline caught fish (43.25kg) was 5% decrease from 2017 and a 3% increase from the average in 2013-2017. The mean weight of Indonesia / Philippines domestic caught fish (1.3kg) was 21% increase from 2017 and a 18% increase from the average in 2013-2017. The mean weight of free-school caught purse seine fish (13.49kg) was 6% decrease from 2017 and a 4% increase from the average in 2013-2017. The mean weight of FAD caught fish (4.99kg) was 19% decrease from 2017 and a 18% decrease from the average in 2013-2017.
Figure 24	Stochastic stock projections	Under recent fishery conditions, the bigeye stock is initially projected to increase as recent estimated relatively high recruitments support adult stock biomass, declines slightly before again increasing. Median $F_{2020}/F_{MSY} = 0.62$; median $SB_{2020}/SB_{F=0} = 0.41$; median $SB_{2020}/SB_{MSY} = 1.79$. Risk that $SB_{2020} <$ LRP = 0%. Projections are from the updated model runs of Vincent et al. (2018).

Yellowfin tuna

Figure	Indicator	Description
Figure 25	Total catch by gear	Total catch in 2018 was 666,971, a 2% decrease from 2017 and a 9% increase from the average 2013-2017. Purse seine catch in 2018 (374,062t) was a 22% decrease from 2017 and a 1% increase from the 2013-2017 average. Longline catch in 2018 (94,509t) was a 11% increase from 2017 and a 4% increase from the 2013-2017 average. Pole and line catch (12,201t) was a 1% decrease from 2017 and a 48% decrease from the average 2013-2017 catch. Catch by other gear (186,199t) was a 79% increase from 2017 and 51% increase from the average catch in 2013-2017. This is mainly due to the large fluctuations in estimates for the other gears in Indonesia in recent years.
Figure 26 - top	Tropical pole and line CPUE	Japanese pole and line CPUE in 2018 (0.038t per day) was a 56% decrease from 2017 and 16% decrease from the average catch in 2013-2017. At the time of writing this report the Solomon Islands CPUE is too variable to be informative, probably due to the small size of that fishery.
Figure 26 - middle	Tropical purse seine CPUE	Free-school CPUE in 2018 (3.93t per day) was a 25% decrease from 2017 and a 12% decrease from the 2013-2017 average. Log CPUE in 2018 (5.34t per day) was a 8% increase from 2017 and a 3% decrease from the 2013-2017 average. Drifting FAD CPUE in 2018 (3.38t per day) was a 16% decrease from 2017 and a 32% decrease from the 2013-2017 average. Anchored FAD CPUE in 2018 (7.23t per day) was a 25% increase from 2017 and a 20% increase from the 2013-2017 average.
Figure 26 - bottom	Tropical longline CPUE (20^oN to 10^oS)	Japanese longline CPUE in 2018 (0.79 fish per 100 hooks) was a 1% decrease from 2017 and 13% increase from the average CPUE in 2013-2017. Korean longline CPUE (0.39 fish per 100 hooks) was a 38% decrease from 2017 and 42% decrease from the average catch in 2013-2017.
Figure 27	Maps of catch by gear	Compared to the longer time frame, a slightly higher proportion of the catch in recent years has been taken by purse seine within the 10^oN-10^oS equatorial band, with catches higher in the mid-tropical WCPO band, mirroring skipjack. Catch in the Indonesian/Philippines region remains notable.
Figure 28	Longline effort and CPUE maps	Longline CPUE in the recent period has generally been lower than that seen across the longer time frame. Relatively high catch rates are now found only in the tropical western region of the WCP-CA. There is a strong contraction in the high CPUE area compared to both long-term and medium-term.
Figure 29	Purse seine effort and CPUE maps	Areas of high CPUE have fragmented over time, across the tropical WCP-CA, and were concentrated in the west of the tropical region in 2018, with some localised high CPUE achieved in other areas.
Figure 30	Spatial distribution of catch	90% of the longline catch in 2018 was taken in 83 5x5 degree squares of the southern WCPO. This was a a 17% decrease from 2017 and a 3% decrease from the 2013-2017 average. 90% of the purse seine catch in 2018 was taken in 575 5x5 degree squares of the southern WCPO. This was a 4% increase from 2017 and a 8% increase from the 2013-2017 average.
Figure 31	Catch at length by gear type in both numbers and weight	The catch in numbers of fish was predominantly made up of small fish (<50cm) from the Indonesia/Philippines fisheries. Large fish are mostly caught in the longline and unassociated purse seine fisheries and larger yellowfin dominate the catch by weight, in contrast to catch in number.

Figure	Indicator	Description
Figure 32	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2018 (3.36kg) was a 18% decrease from 2017 and a 20% decrease from the average in 2013-2017. The mean weight of longline caught fish (31.25kg) was 3% increase from 2017 and a 2% increase from the average in 2013-2017. The mean weight of Indonesia / Philippines domestic caught fish (0.97kg) was 6% decrease from 2017 and a 19% decrease from the average in 2013-2017. The mean weight of free-school caught purse seine fish (17.6kg) was 6% decrease from 2017 and a 6% decrease from the average in 2013-2017. The mean weight of FAD caught fish (3.97kg) was 18% decrease from 2017 and a 22% decrease from the average in 2013-2017.
Figure 33	Stochastic stock projections	Under recent fishery conditions, the yellowfin stock is initially projected to increase as recent estimated relatively high recruitments support adult stock biomass, then decline slightly. Median $F_{2020}/F_{MSY} = 0.74$; median $SB_{2020}/SB_{F=0} = 0.32$; median $SB_{2020}/SB_{MSY} = 1.33$. Risk that $SB_{2020} <$ LRP = 8%.

Figures

Skipjack

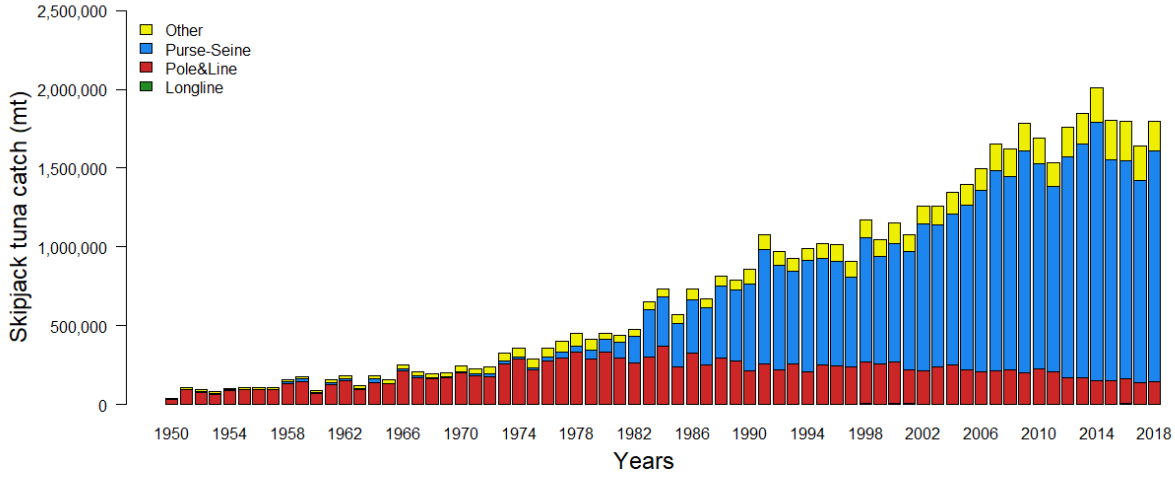


Figure 1: Skipjack tuna catch by gear type and year for the WCPFC-Convention Area.

Figure 2: Skipjack tuna catch per unit effort in the tropical WCPO by year for major pole and line fishing fleets (top), purse seine for the major set types (bottom). Note different time series lengths.

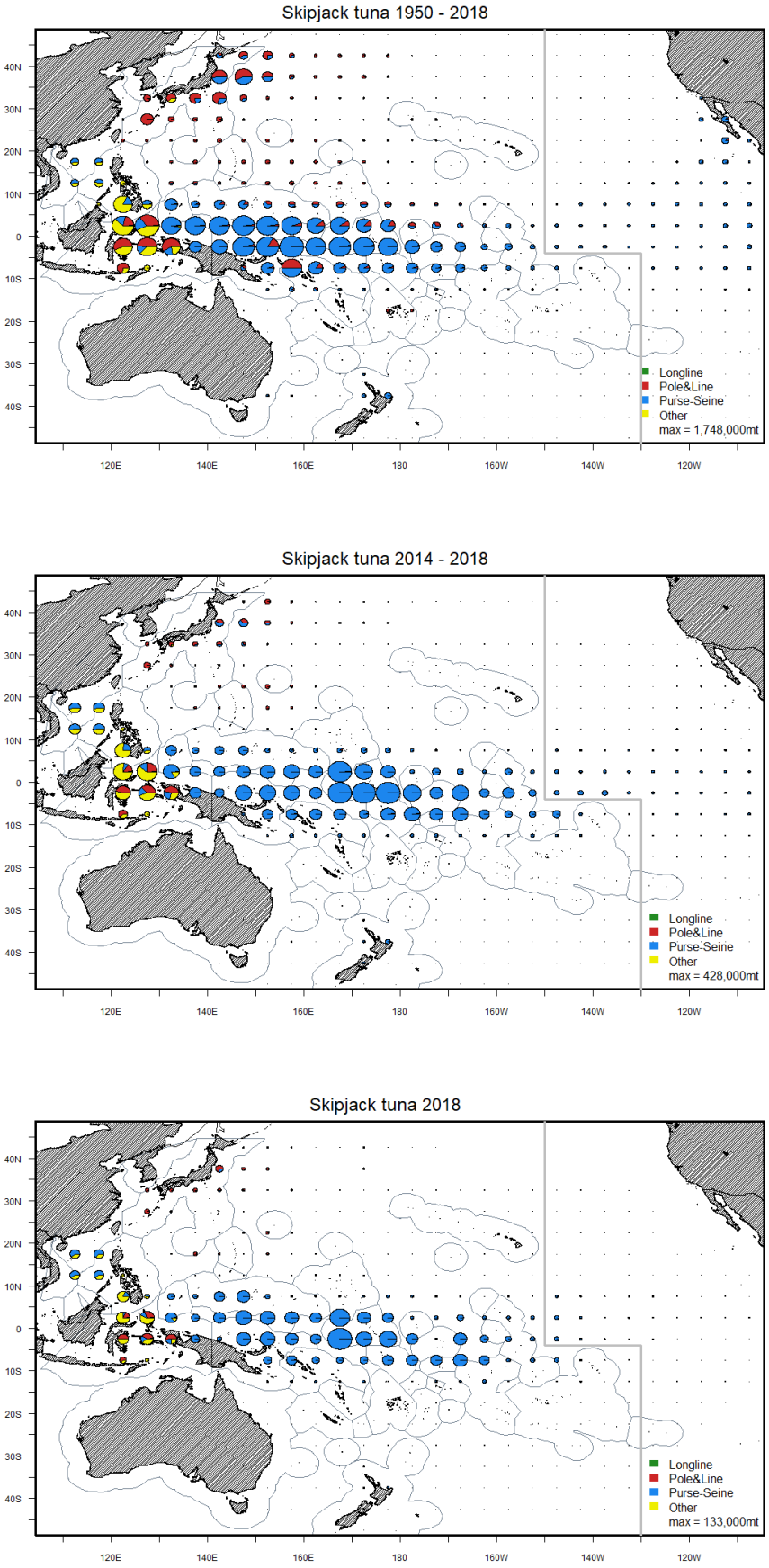


Figure 3: Skipjack tuna catch distribution by gear type and 5x5^o region for the entire Pacific Ocean for the period 1950-2018 (top), 2014-2018 (middle) and 2018 (bottom). The figure legend provides the catch associated with this maximum circle size.

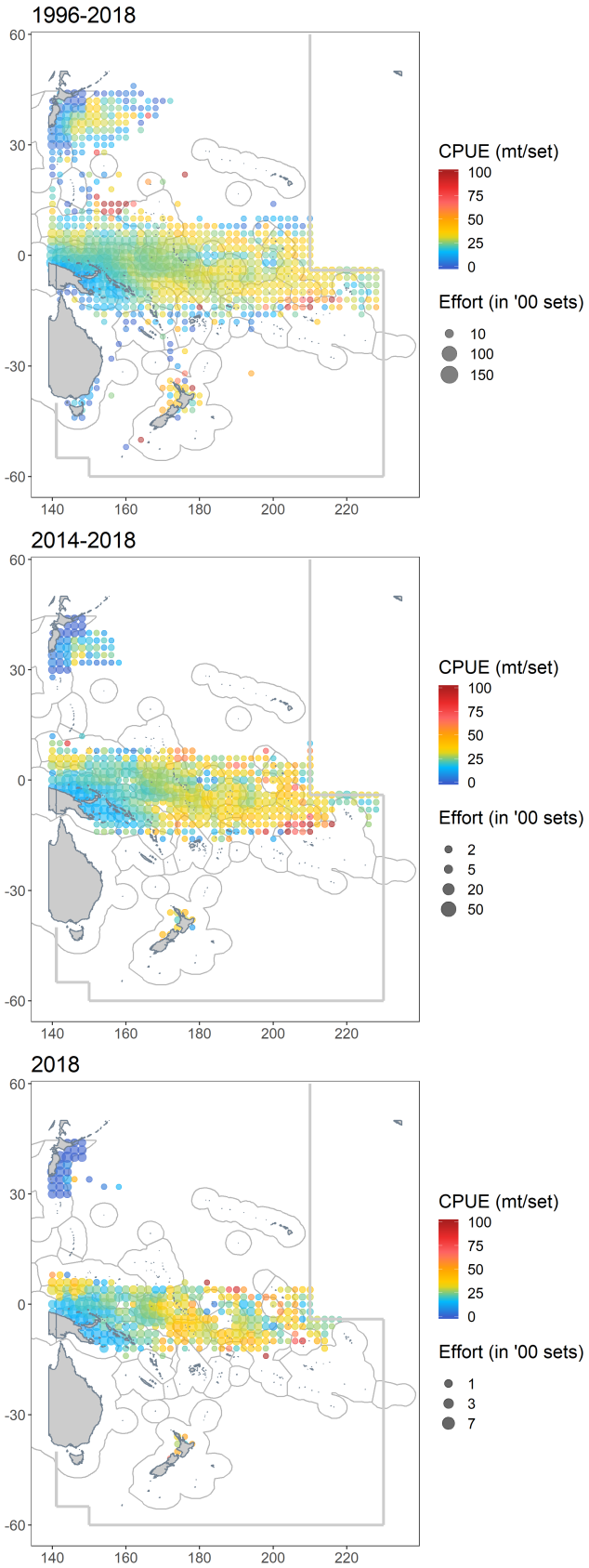


Figure 4: Distribution of purse seine effort (represented by circle size) and skipjack tuna CPUE (represented by colour) for the period 1950-2018 (top), 2014-2018 (middle) and 2018 (bottom). Note the differences in scales between plots.

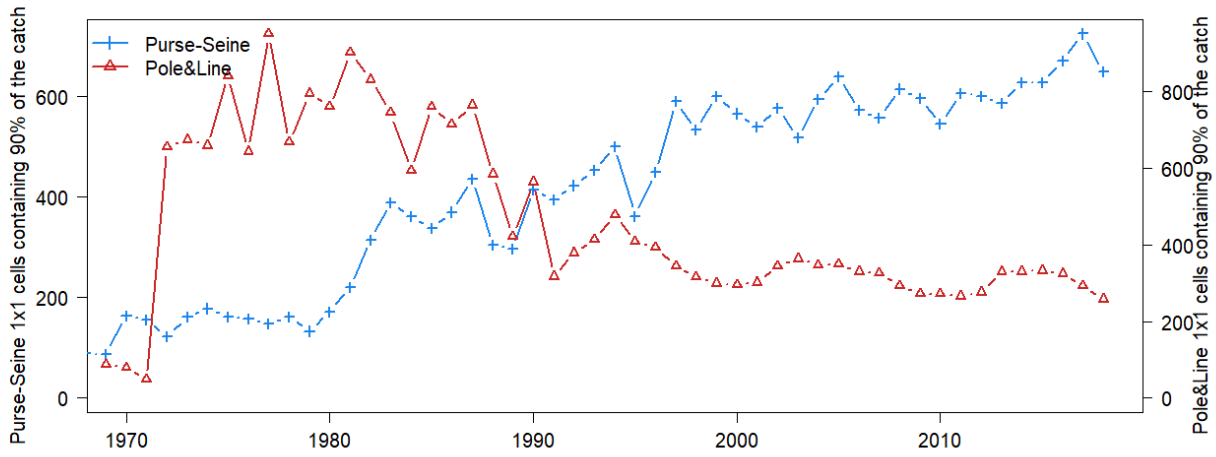


Figure 5: Spatial distribution of skipjack tuna catch for purse seine and pole and line fisheries by year for the WCPO.

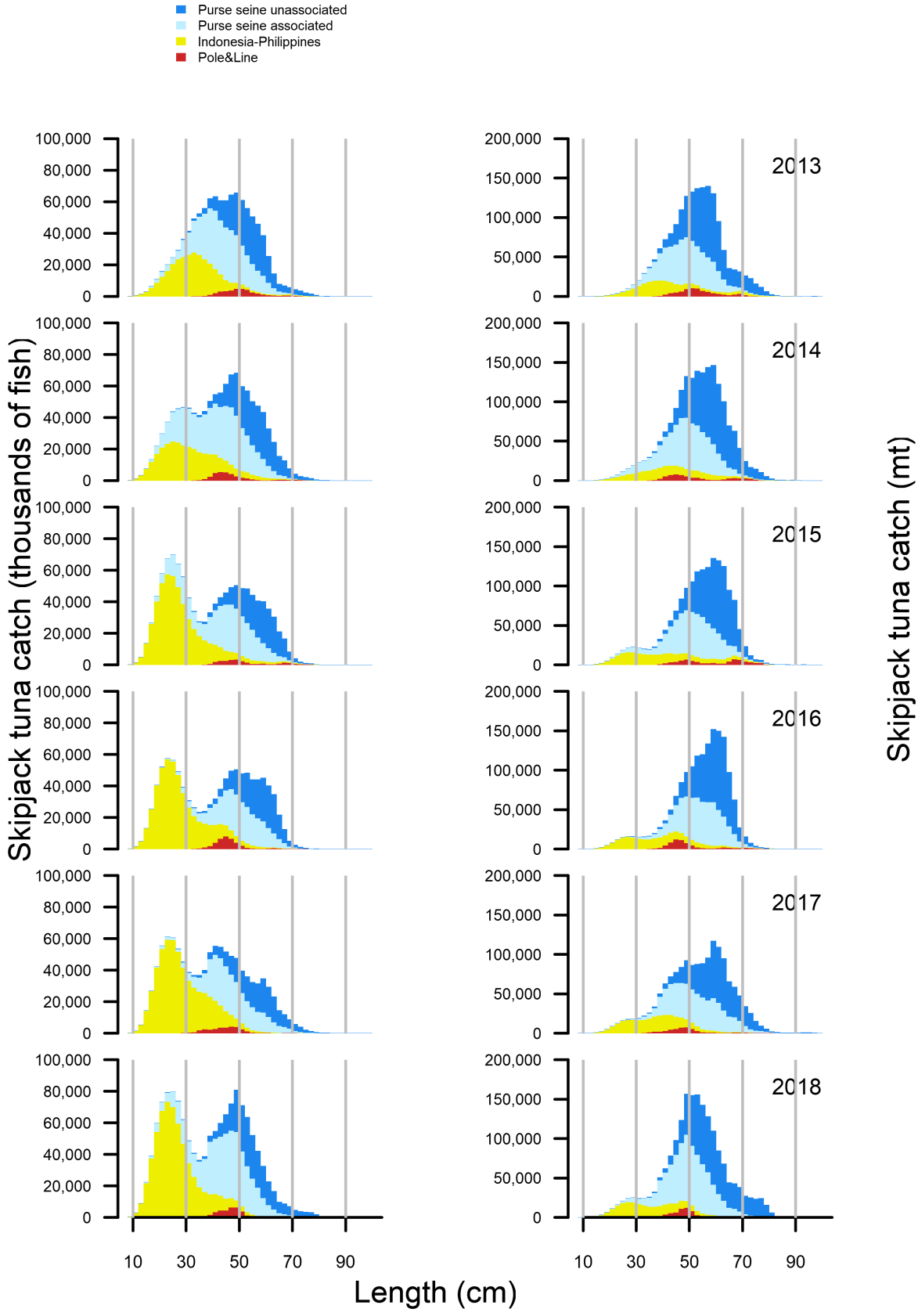


Figure 6: Catch-at-size of skipjack tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). The grey vertical lines are guides to aid interpretation.

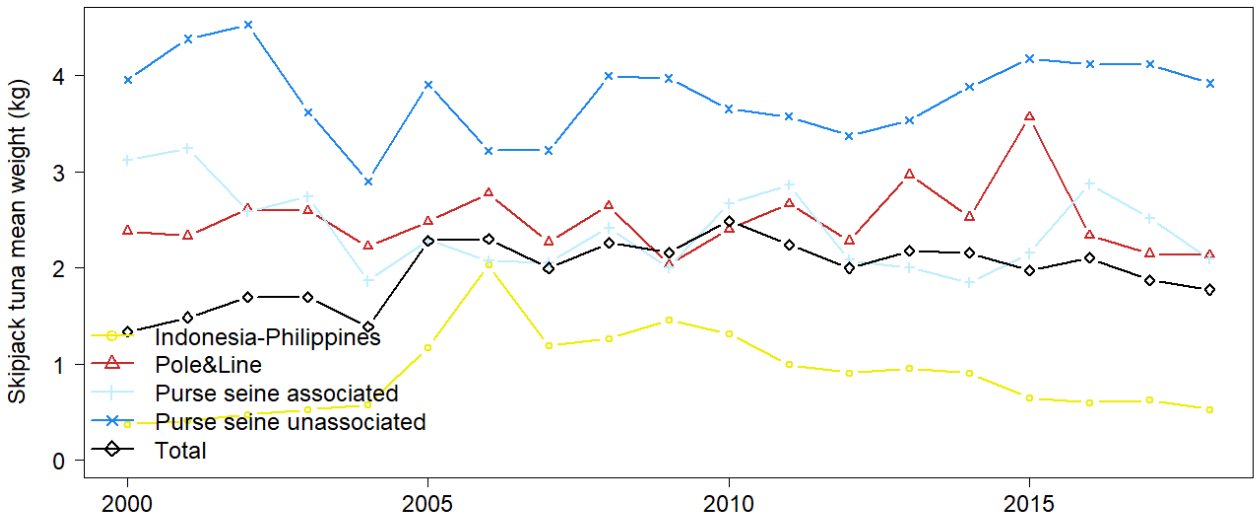


Figure 7: Mean weight of individual skipjack tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number. Note: previous iterations of this paper only showed the most recent seven years, this time series has been extended back to 2000 due to a request from SC14.

South Pacific albacore

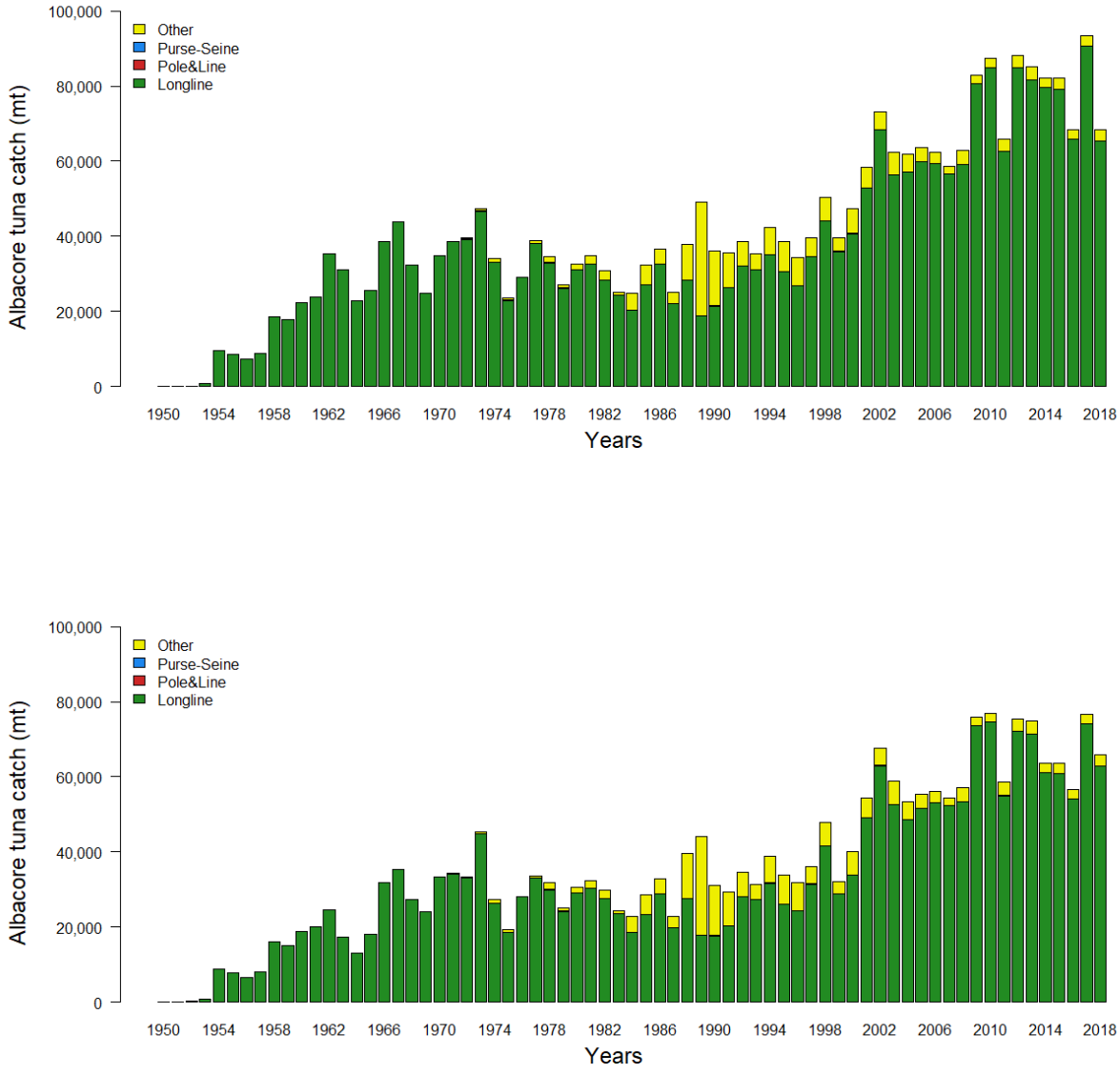


Figure 8: South Pacific albacore tuna catch by gear type and year for the South Pacific as a whole (top) and WCPFC-CA south of the equator (bottom). Note: 'Other' gear here is primarily troll gear, but includes driftnet catches in the 1980s and early 1990s.

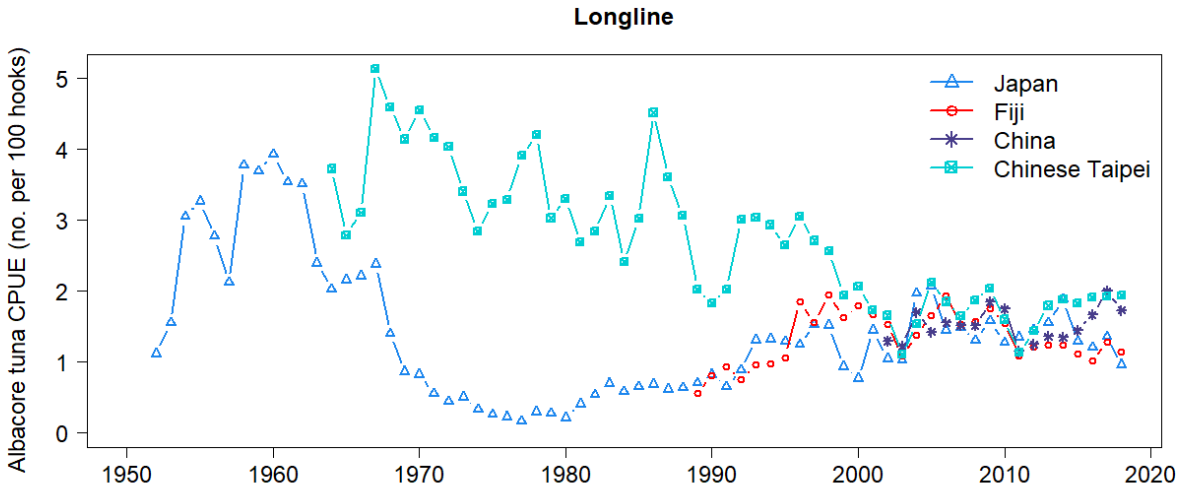


Figure 9: South Pacific albacore tuna catch per unit effort in the southern WCP-CA (south of 10°S) by year for major longline fleets.

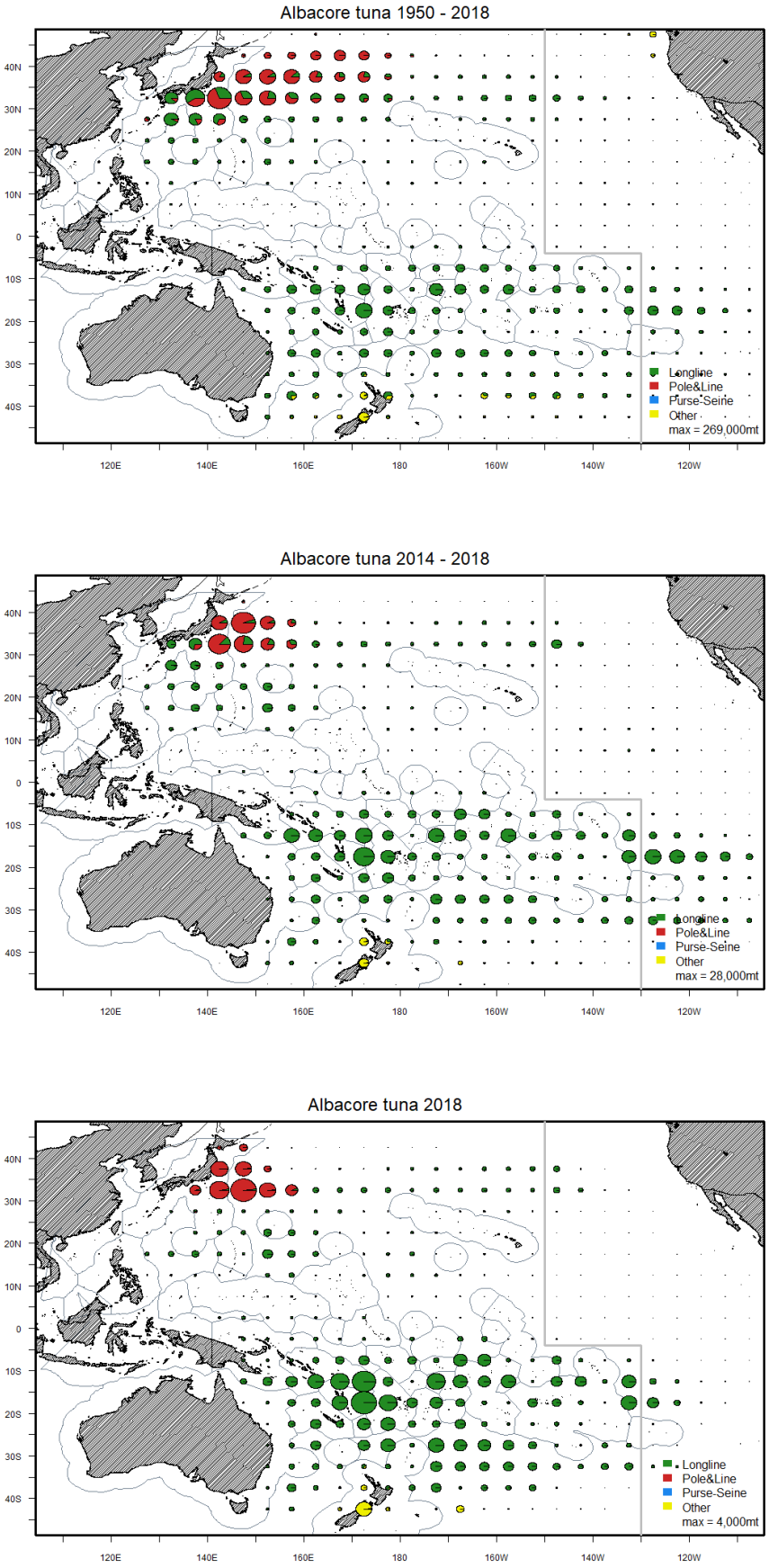


Figure 10: South Pacific albacore tuna catch distribution by gear type and 5x5^o region for the entire Pacific Ocean for the period 1950-2018 (top), 2014-2018 (middle) and 2018 (bottom). The figure legend provides the catch associated with this maximum circle size.

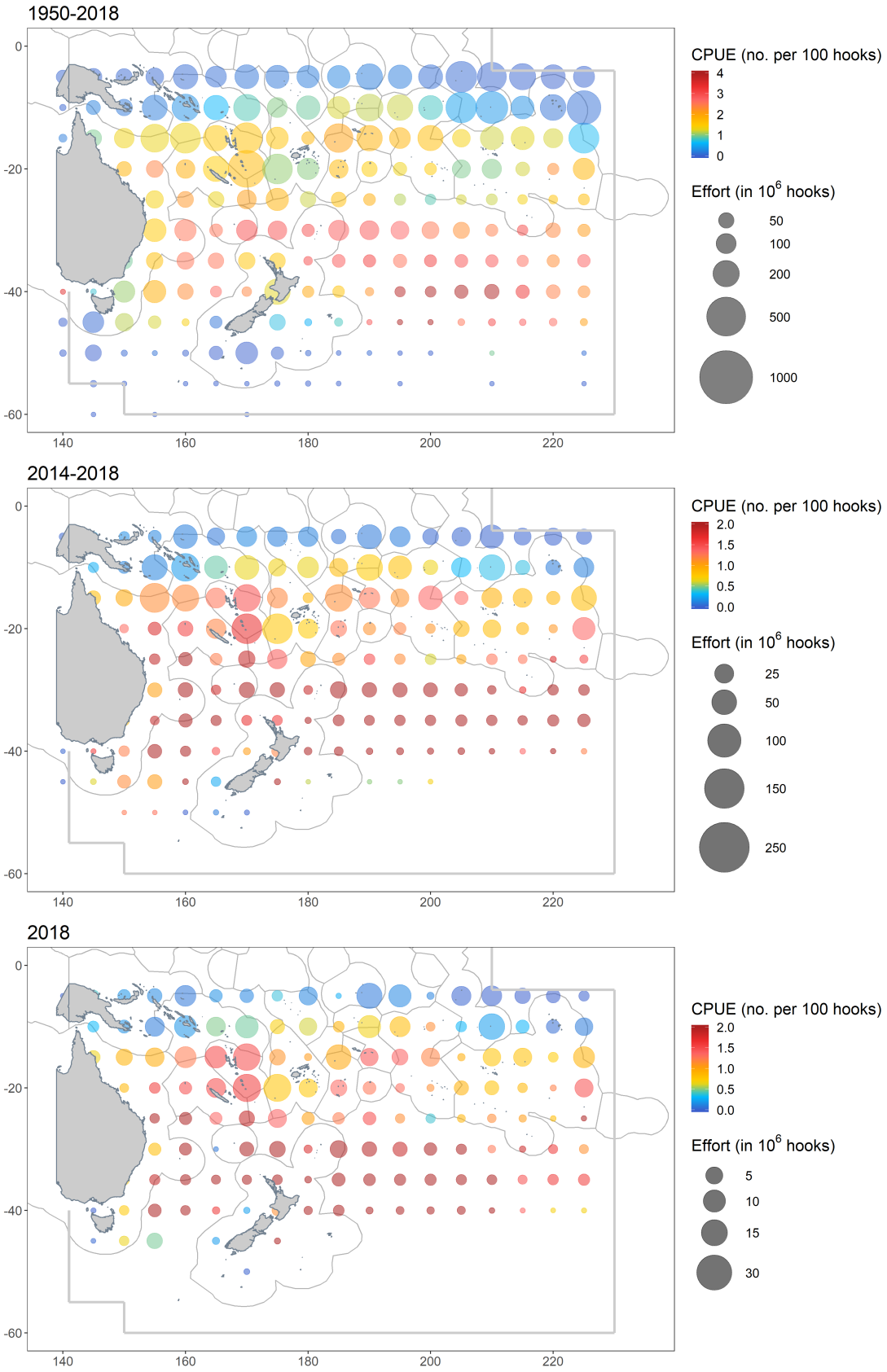


Figure 11: Distribution of longline effort (represented by circle size) and South Pacific albacore tuna CPUE (represented by colour) for the period 1950-2018 (top), 2014-2018 (middle) and 2018 (bottom). Note the differences in scales between plots.

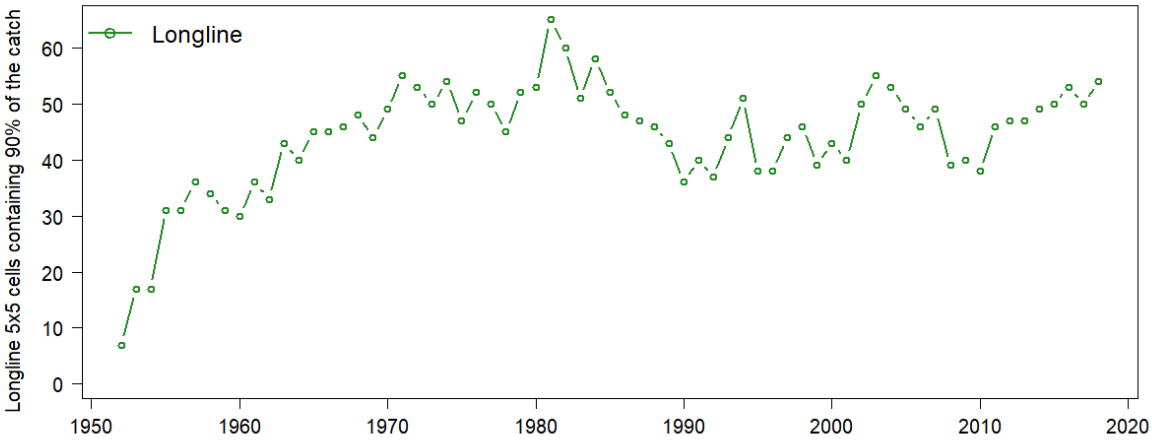


Figure 12: Spatial distribution of South Pacific albacore tuna catch for the longline fishery by year for the WCPO.

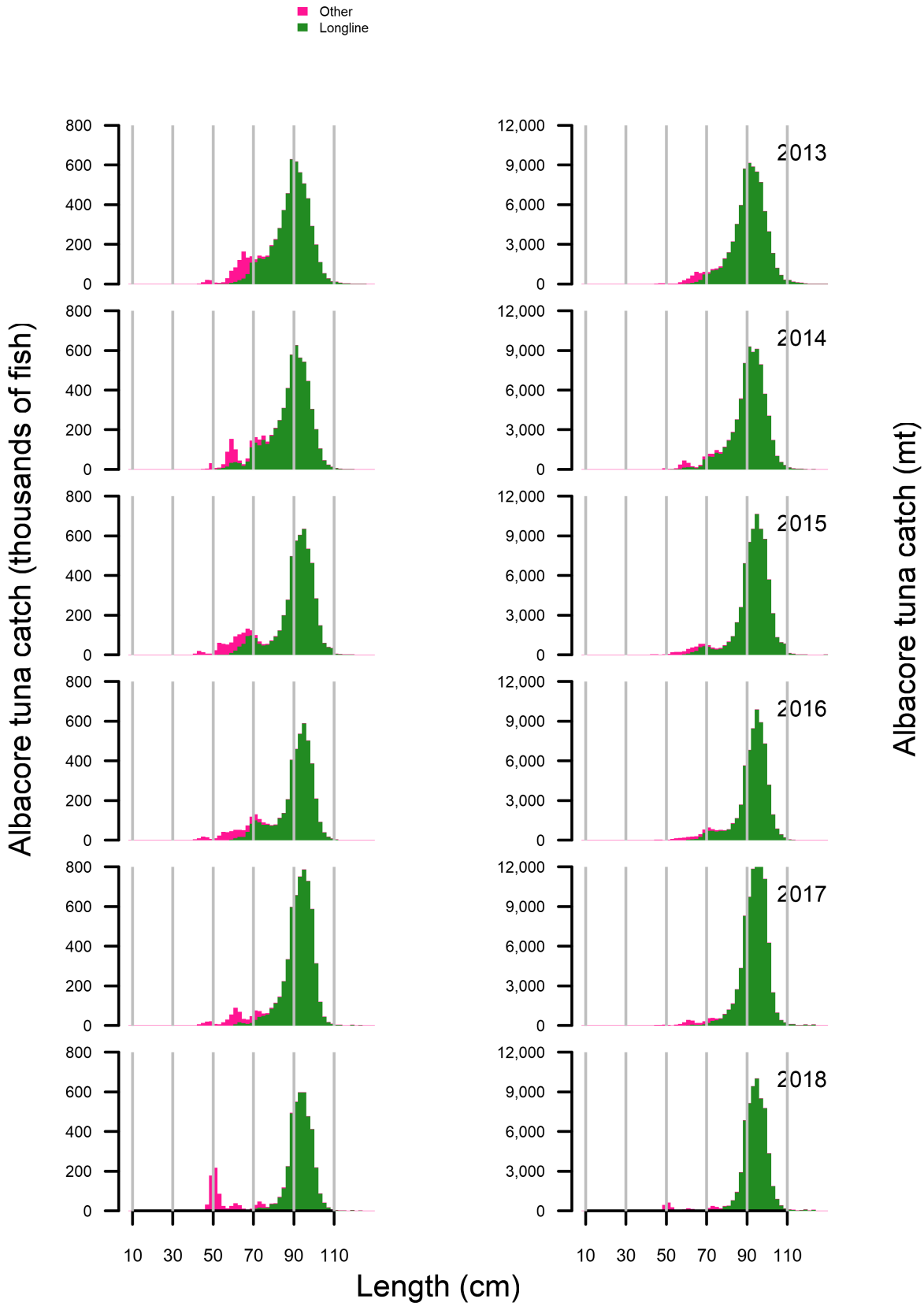


Figure 13: Catch-at-size of South Pacific albacore tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). The grey vertical lines are guides to aid interpretation.

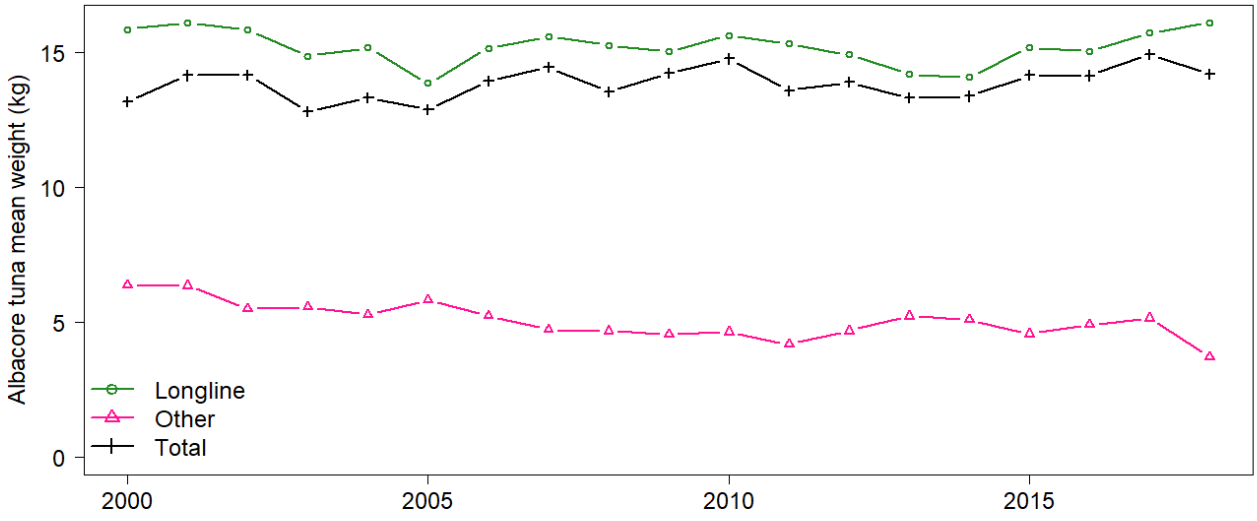


Figure 14: Mean weight of individual South Pacific albacore tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.

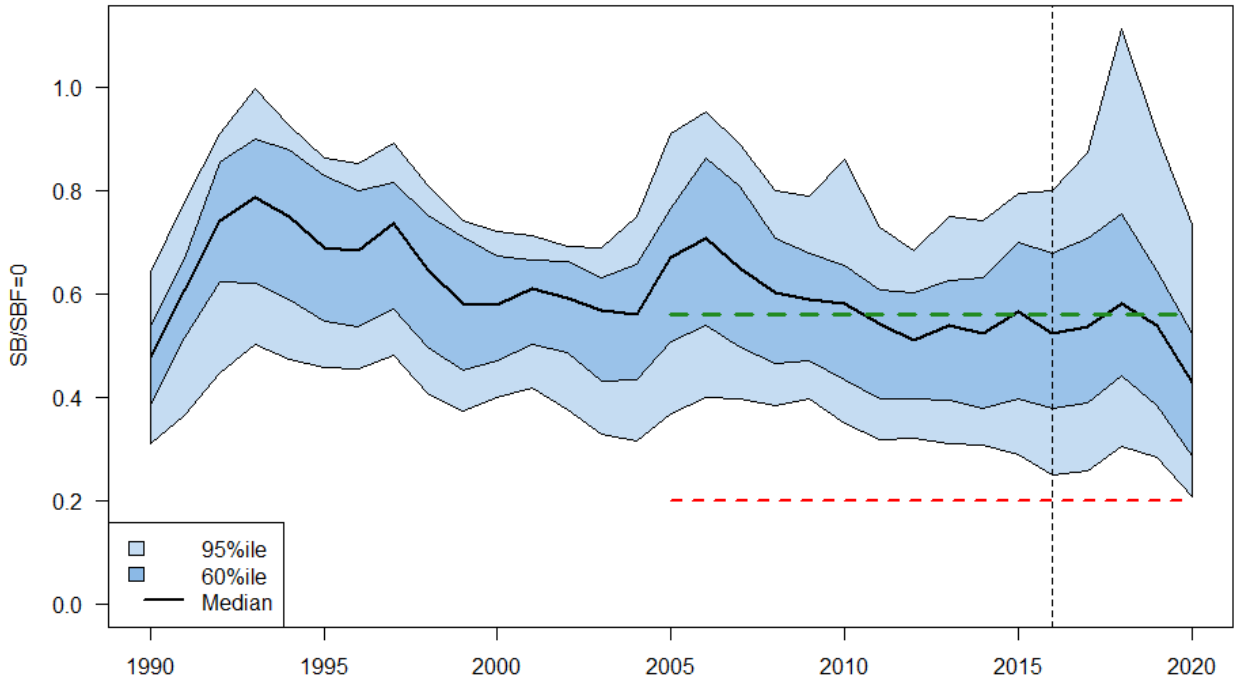


Figure 15: Stochastic projection results of albacore tuna spawning biomass ($SB/SB_{F=0}$) from 2016 using actual catch and effort levels in 2017 and 2018 and 2018 continues through to 2020. Prior to 2016 the data represent the 60th and 95th percentiles of the uncertainty grid from the assessment models and the median. Levels of recruitment variability estimated for the period used to estimate the stock-recruitment relationship (1962-2016) assumed to continue in the future. Projections are from the model runs of Tremblay-Boyer (2018). The red dashed line represents the WCPFC agreed limit reference point, and the green dashed line the target reference point.

Bigeye

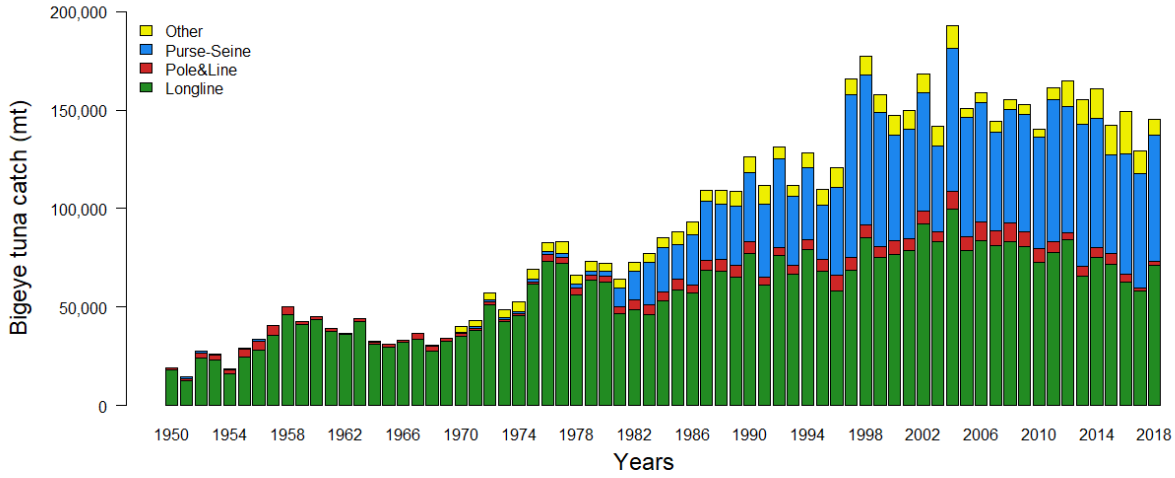
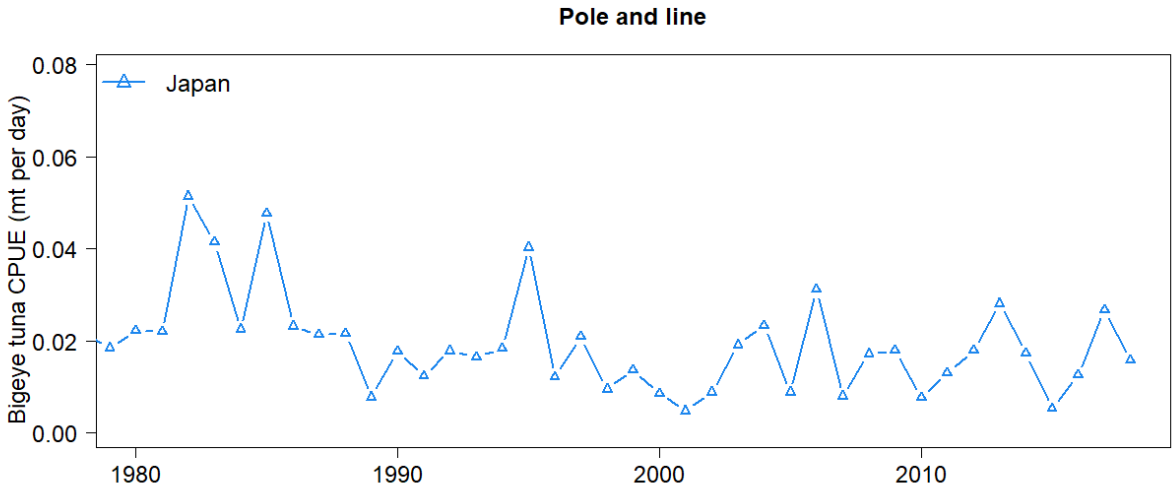
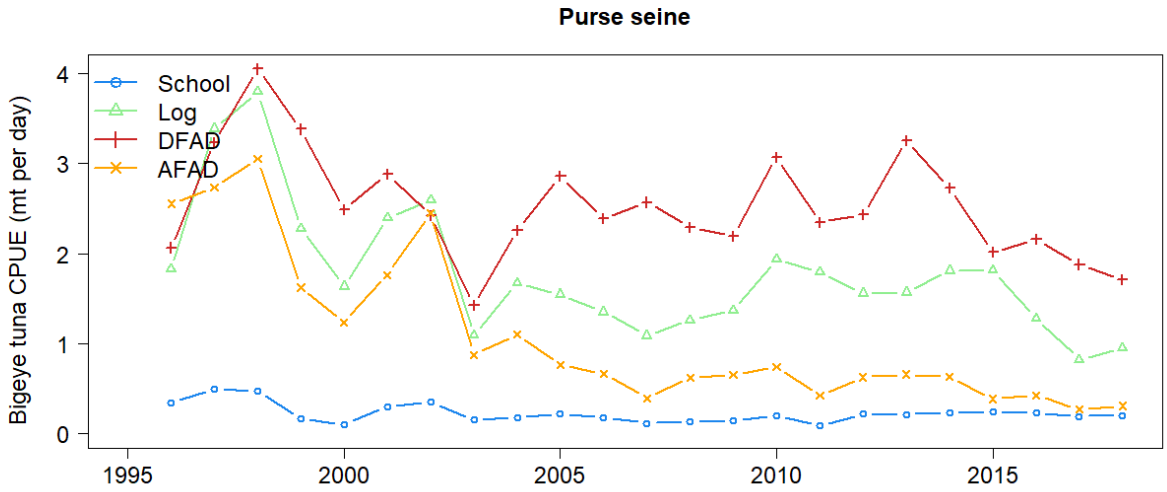


Figure 16: Bigeye tuna catch by gear type and year for the WCPFC-Convention Area.





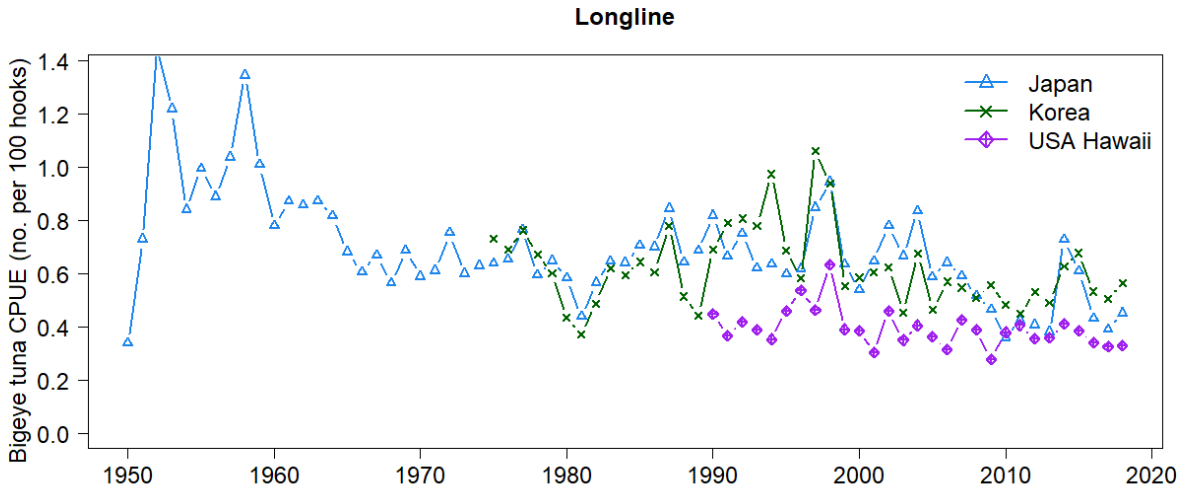


Figure 17: Bigeye tuna catch per unit effort in the tropical WCPO by year for major pole and line fishing fleets (top), purse seine for the major set types (middle), and tropical longline for three fleets (bottom; 20°N to 10°S, WCP-CA). Note different time series lengths.

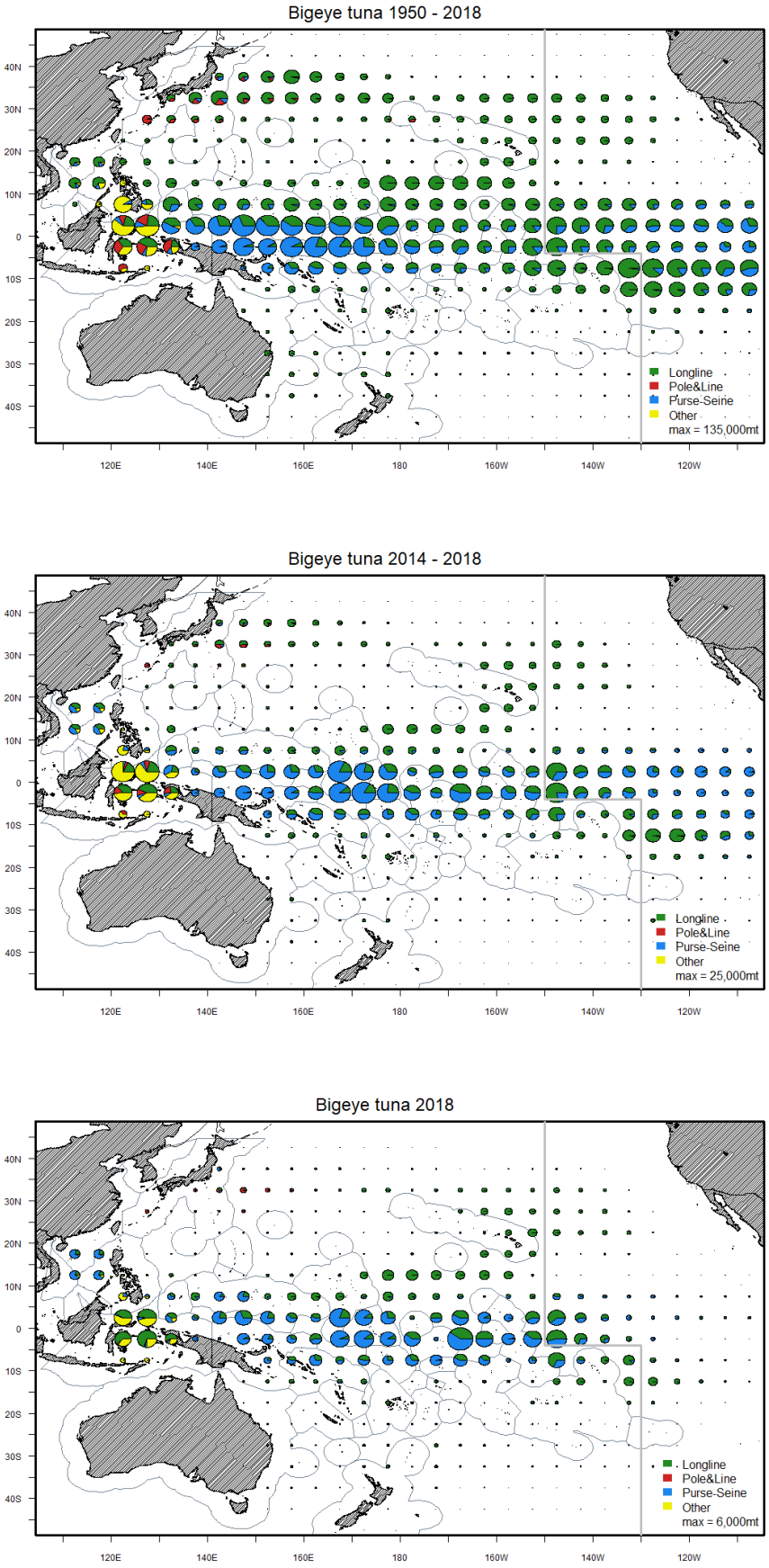


Figure 18: Bigeye tuna catch distribution by gear type and 5x5^o region for the entire Pacific Ocean for the period 1950-2018 (top), 2014-2018 (middle) and 2018 (bottom). The figure legend provides the catch associated with this maximum circle size.

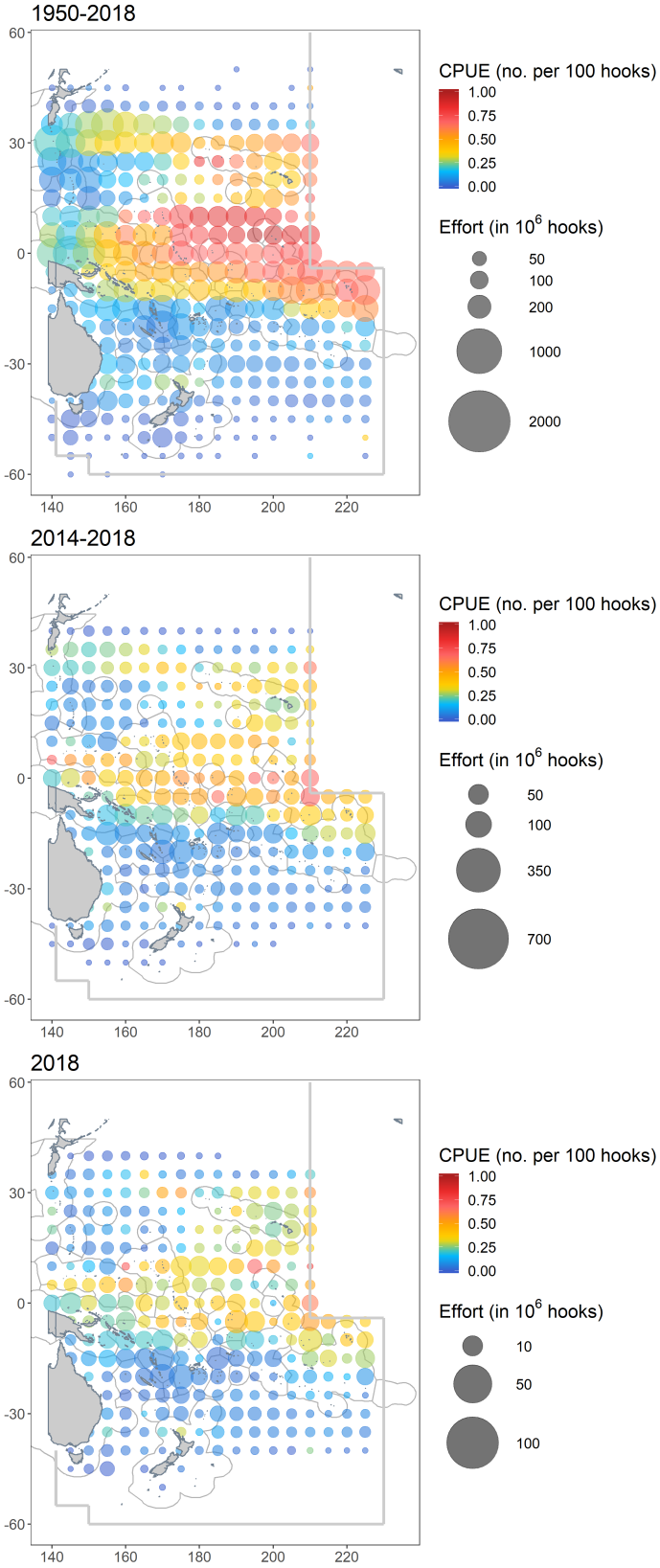


Figure 19: Distribution of longline effort (represented by circle size) and bigeye tuna CPUE (represented by colour) for the period 1950-2018 (top), 2014-2018 (middle) and 2018 (bottom). Note the differences in scales between plots.

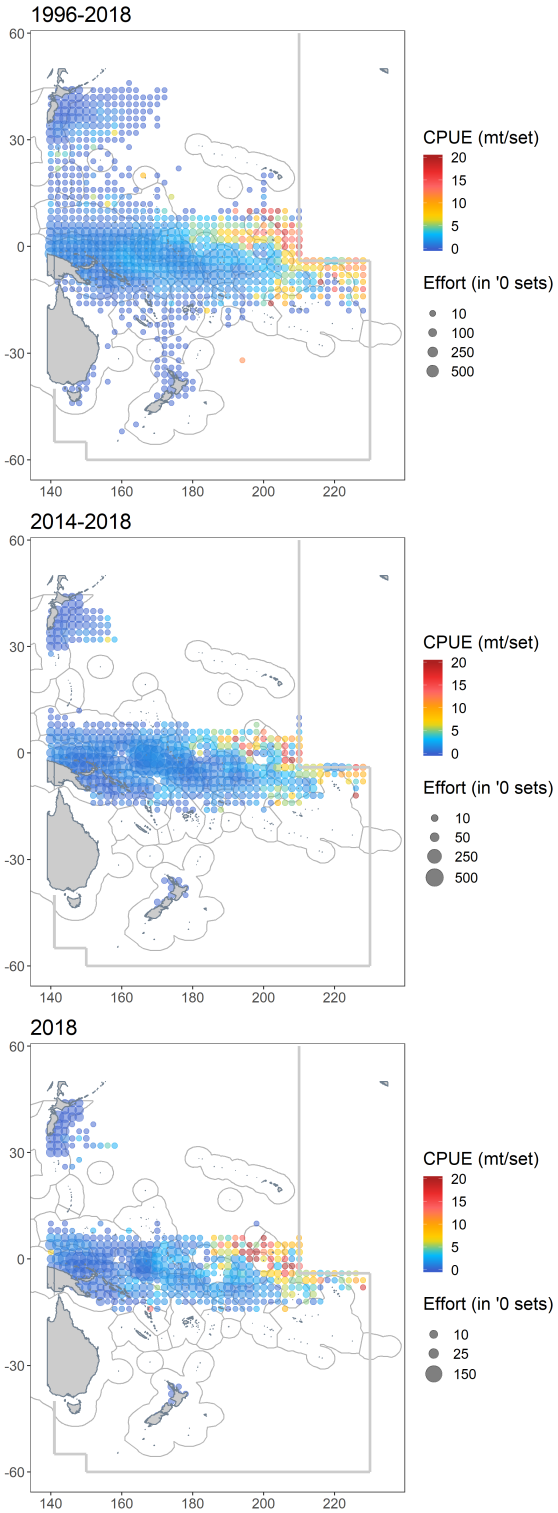


Figure 20: Distribution of 2^o by 2^o purse seine effort (represented by circle size) and bigeye tuna CPUE (represented by colour) for the period 1996-2018 (top), 2014-2018 (middle) and 2018 (bottom). Note the differences in circle size scale between plots.

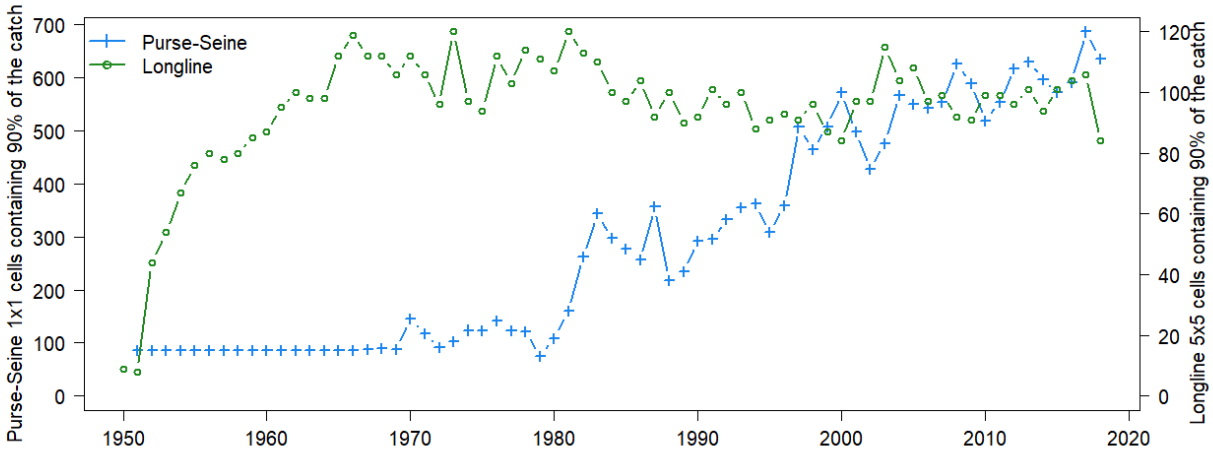


Figure 21: Spatial distribution of bigeye tuna catch for purse seine and longline by year for the WCPO.

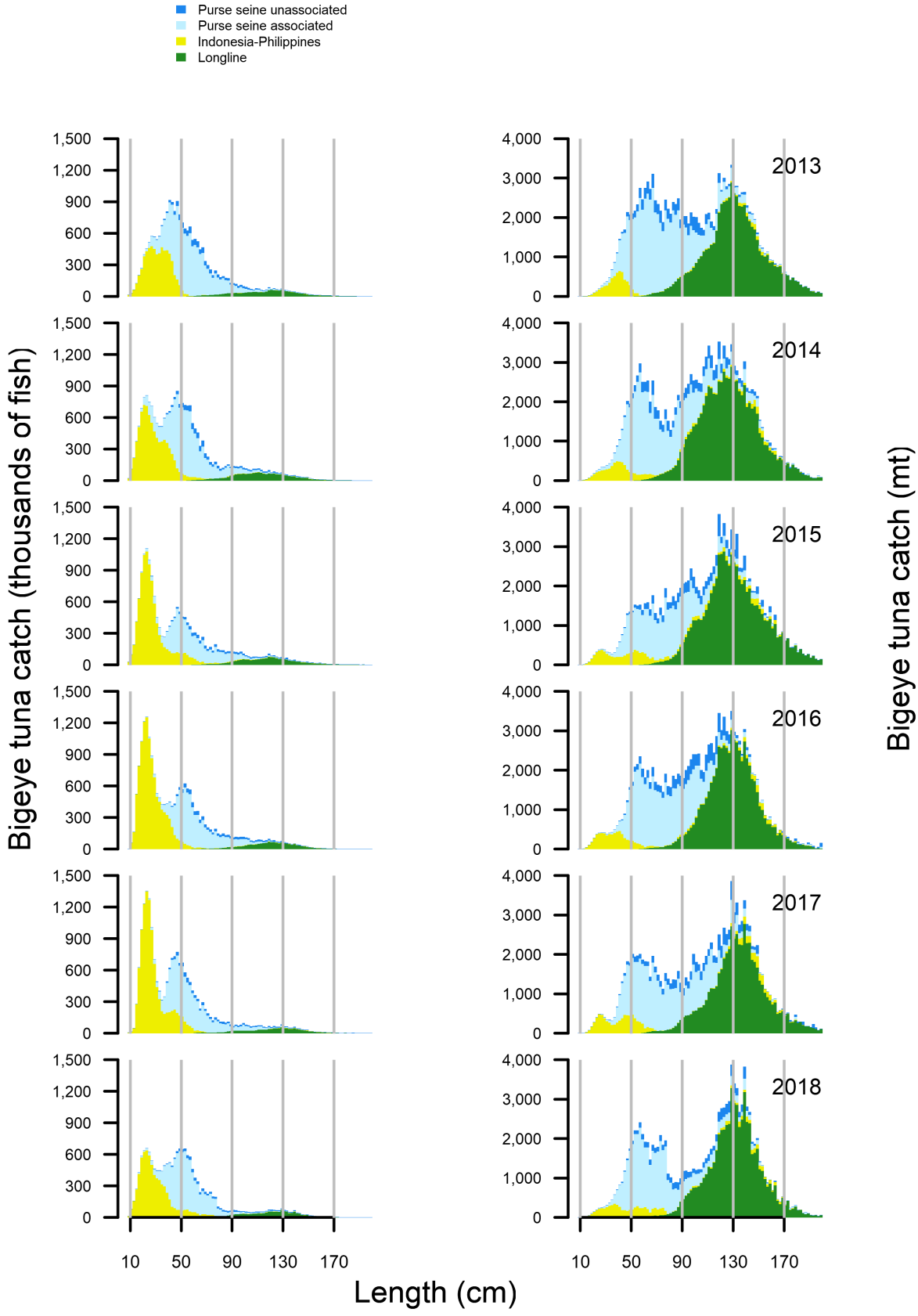


Figure 22: Catch-at-size of bigeye tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). The grey vertical lines are guides to aid interpretation.

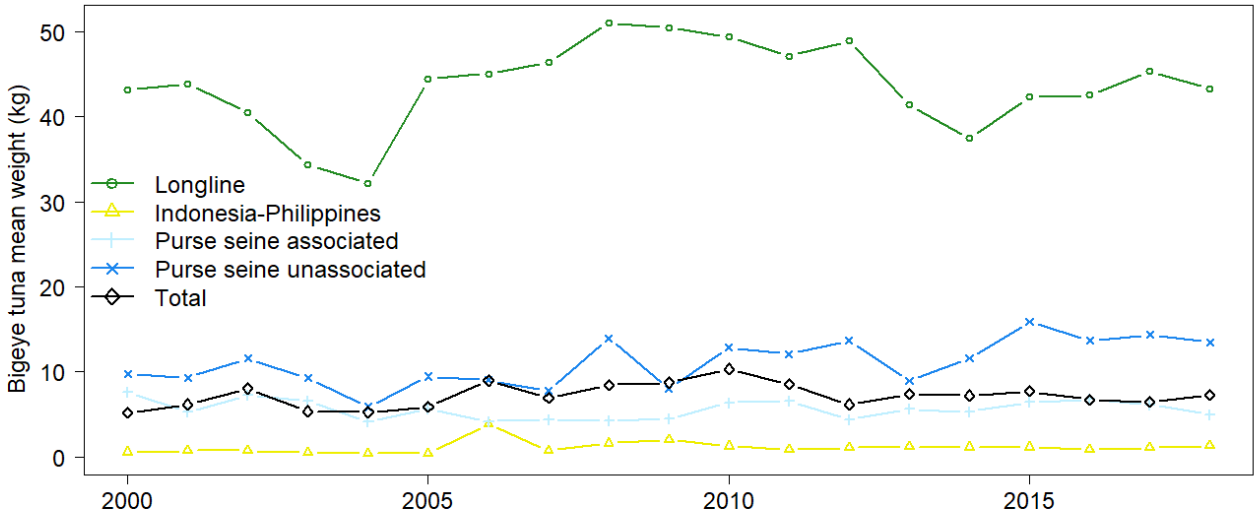


Figure 23: Mean weight of individual bigeye tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.

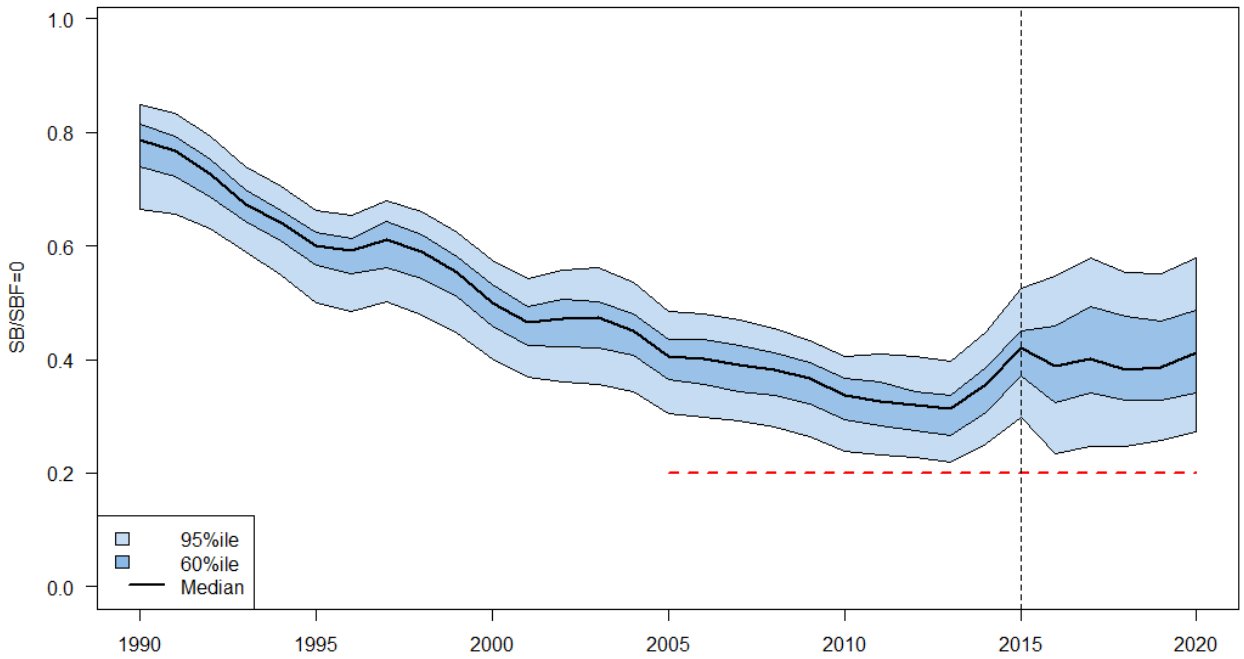


Figure 24: Stochastic projection results of bigeye tuna spawning biomass ($SB/SB_{F=0}$) from 2015 assuming actual catch and effort levels in 2018 continue through to 2020. Prior to 2015 the data represent the percentiles of the uncertainty grid from the assessment models. Levels of recruitment variability estimated for the period used to estimate the stock-recruitment relationship (1962-2014) assumed to continue in the future. Projections are from the 'updated' model runs of (Vincent et al., 2018). The red dashed line represents the WCPFC agreed limit reference point.

Yellowfin

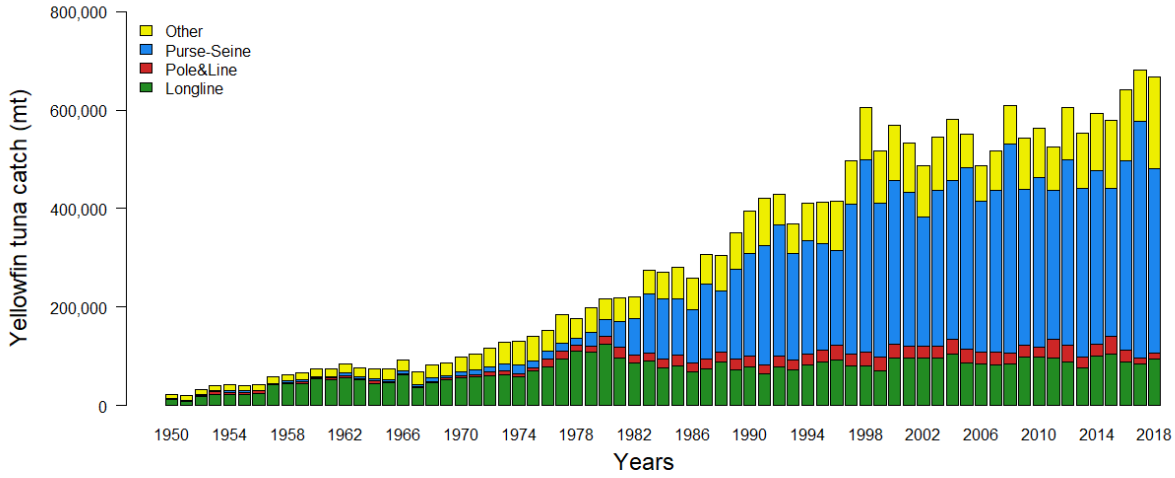
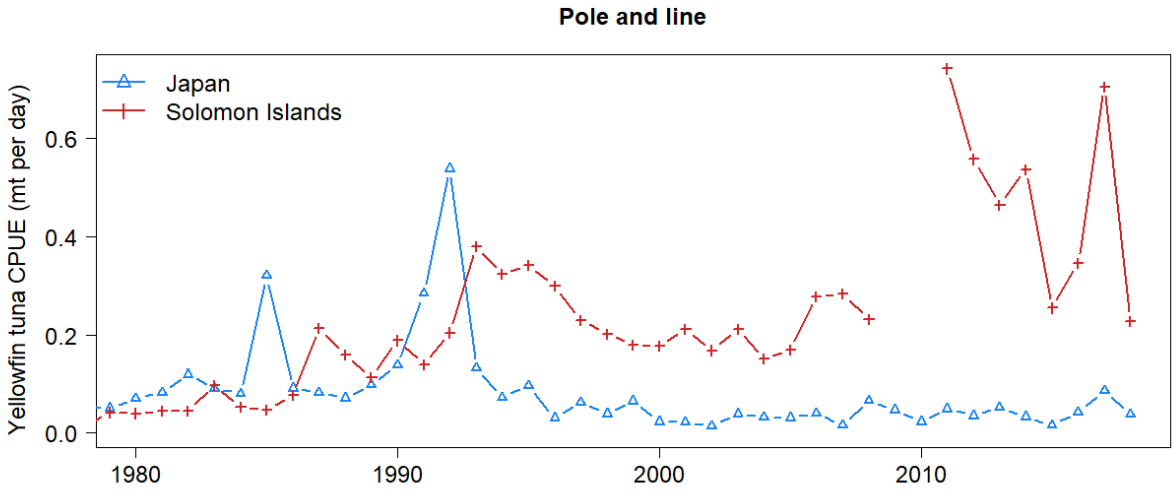
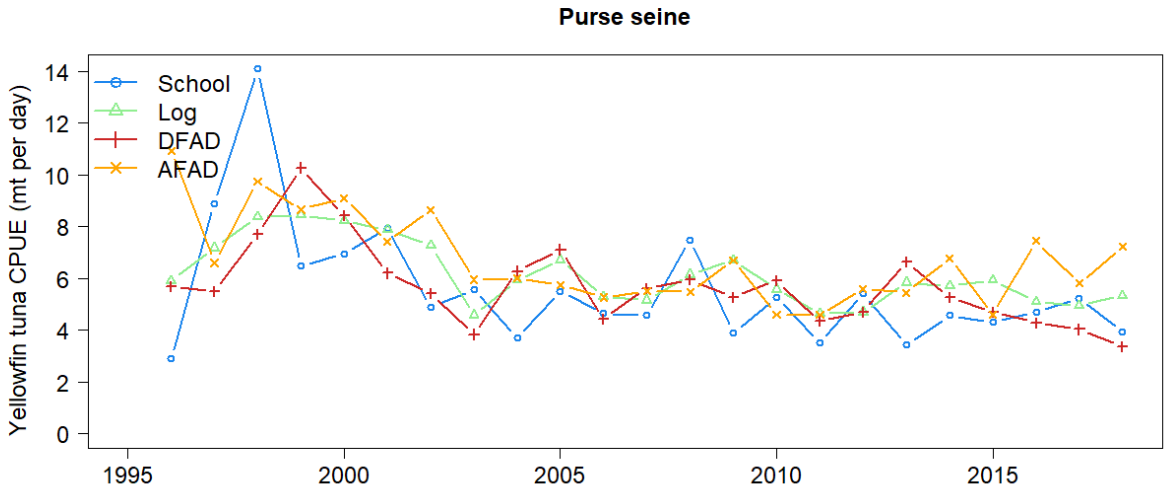


Figure 25: Yellowfin tuna catch by gear type and year for the WCPFC-Convention Area.





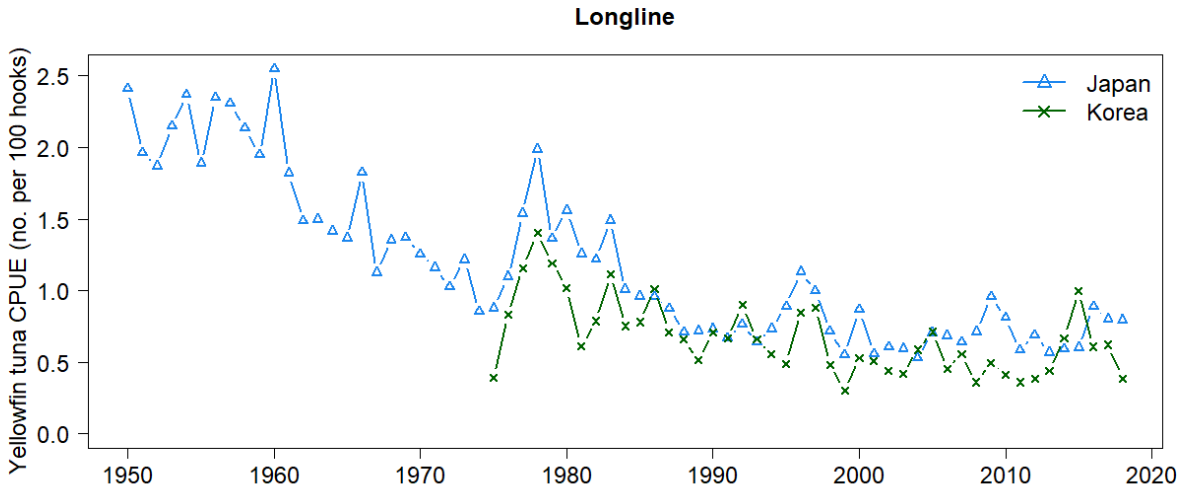
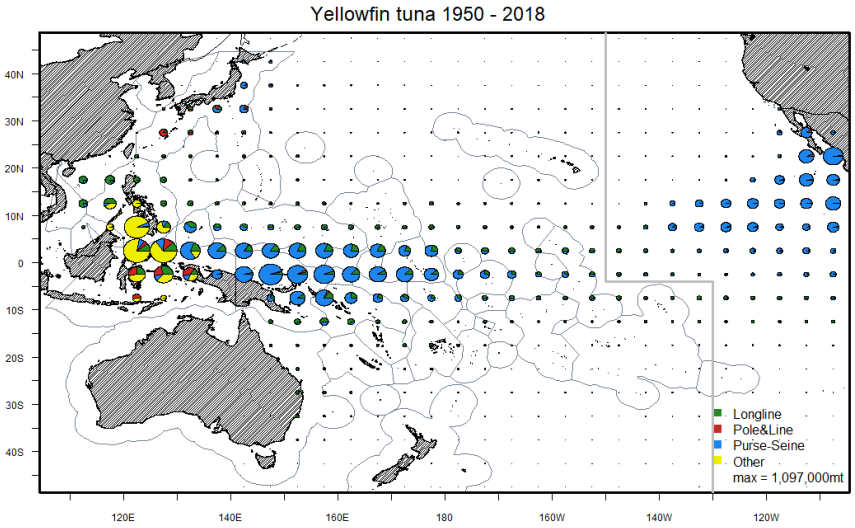
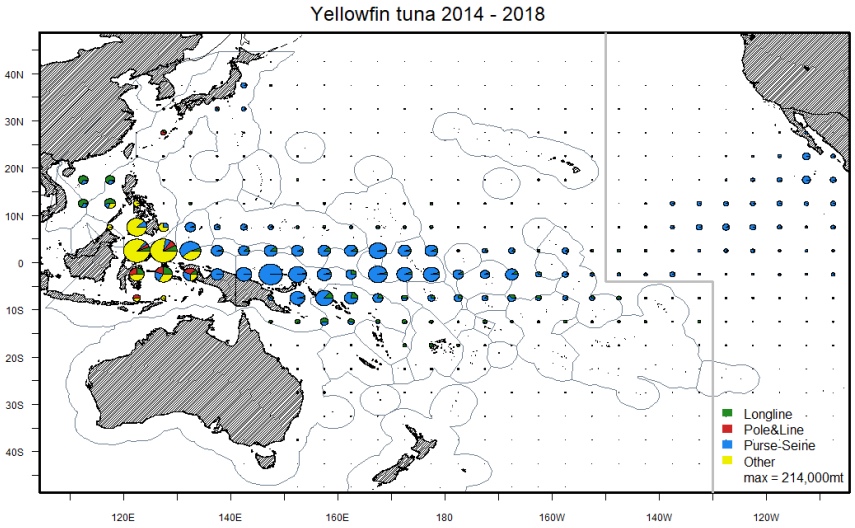


Figure 26: Yellowfin tuna catch per unit effort in the tropical WCPO by year for major pole and line fishing fleets (top), purse seine for the major set types (middle), and tropical longline for three fleets (bottom; 20°N to 10°S, WCP-CA). Note different time series lengths.





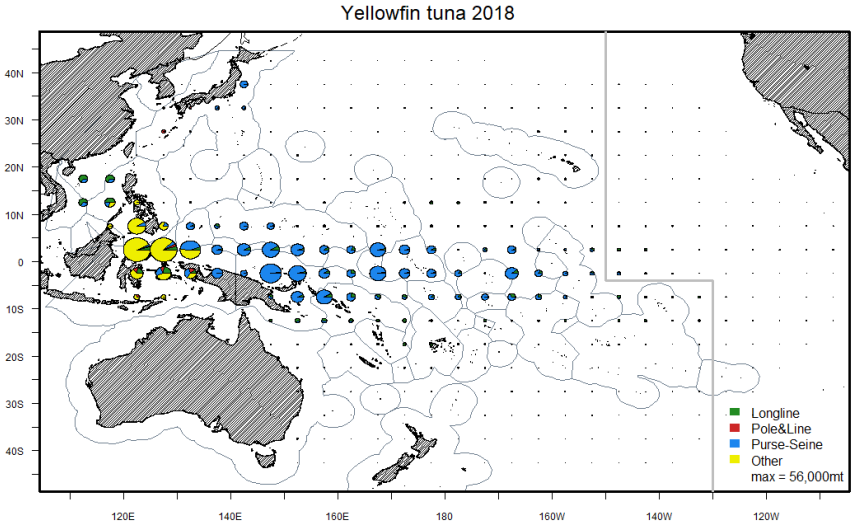


Figure 27: Yellowfin tuna catch distribution by gear type and 5x5^o region for the entire Pacific Ocean for the period 1950-2018 (top), 2014-2018 (middle) and 2018 (bottom). The figure legend provides the catch associated with this maximum circle size.

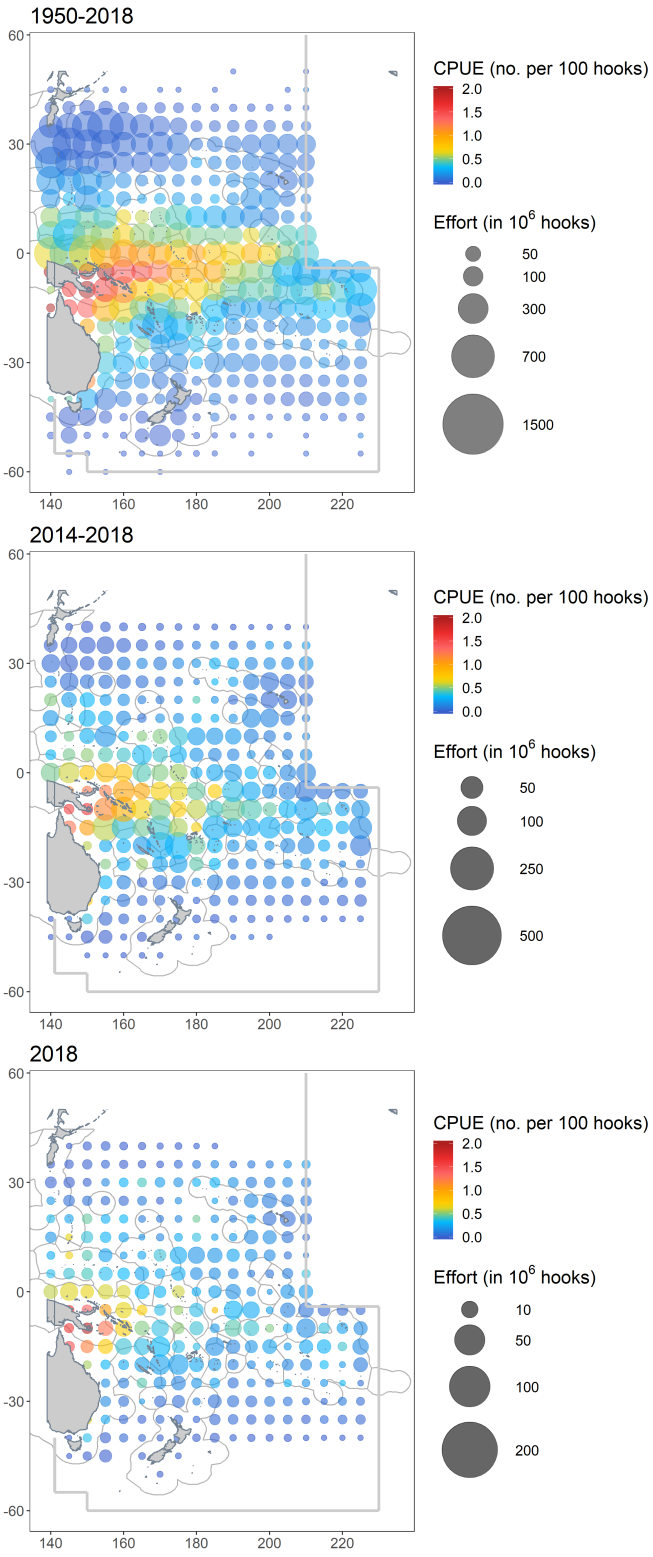


Figure 28: Distribution of longline effort (represented by circle size) and yellowfin tuna CPUE (represented by colour) for the period 1950-2018 (top), 2014-2018 (middle) and 2018 (bottom). Note the differences in scales between plots.

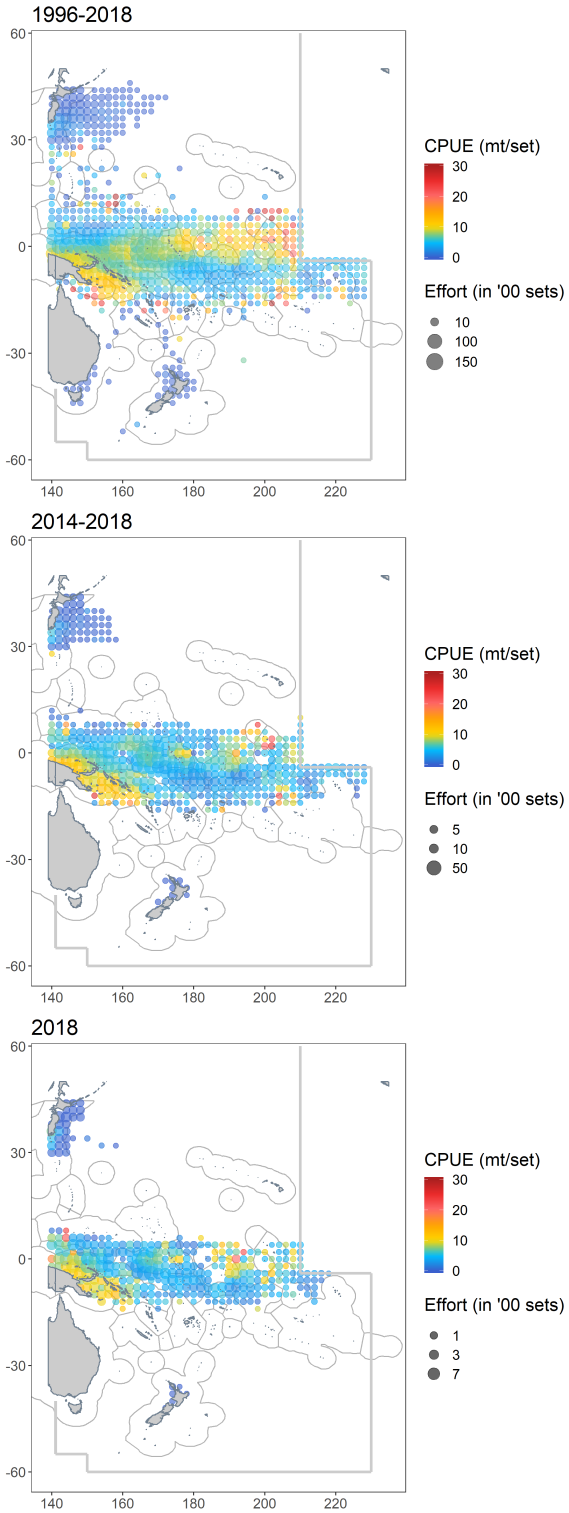


Figure 29: Distribution of 2^o by 2^o purse seine effort (represented by circle size) and yellowfin tuna CPUE (represented by colour) for the period 1996-2018 (top), 2014-2018 (middle) and 2018 (bottom). Note the differences in circle size scale between plots.

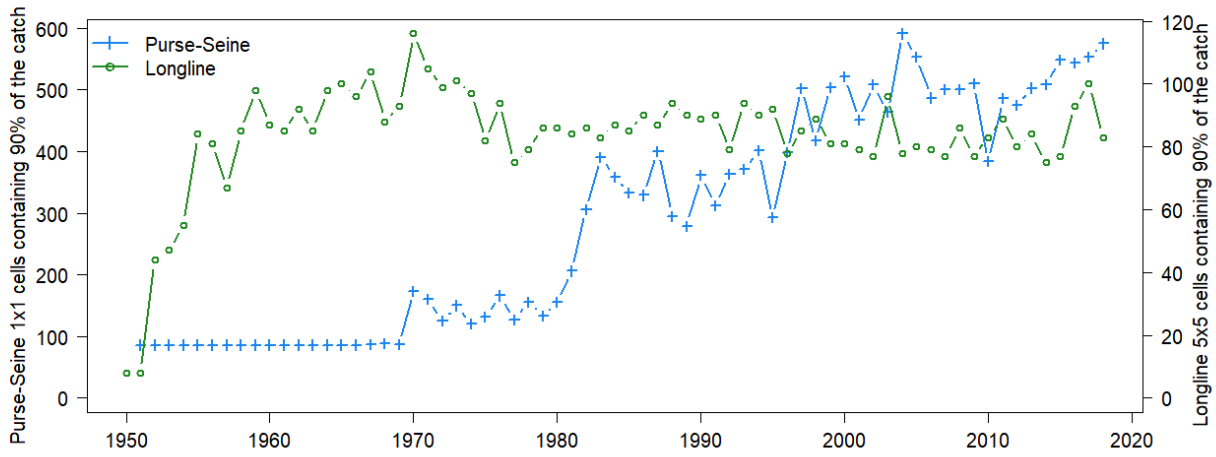


Figure 30: Spatial distribution of yellowfin tuna catch for purse seine and longline by year for the WCPO.

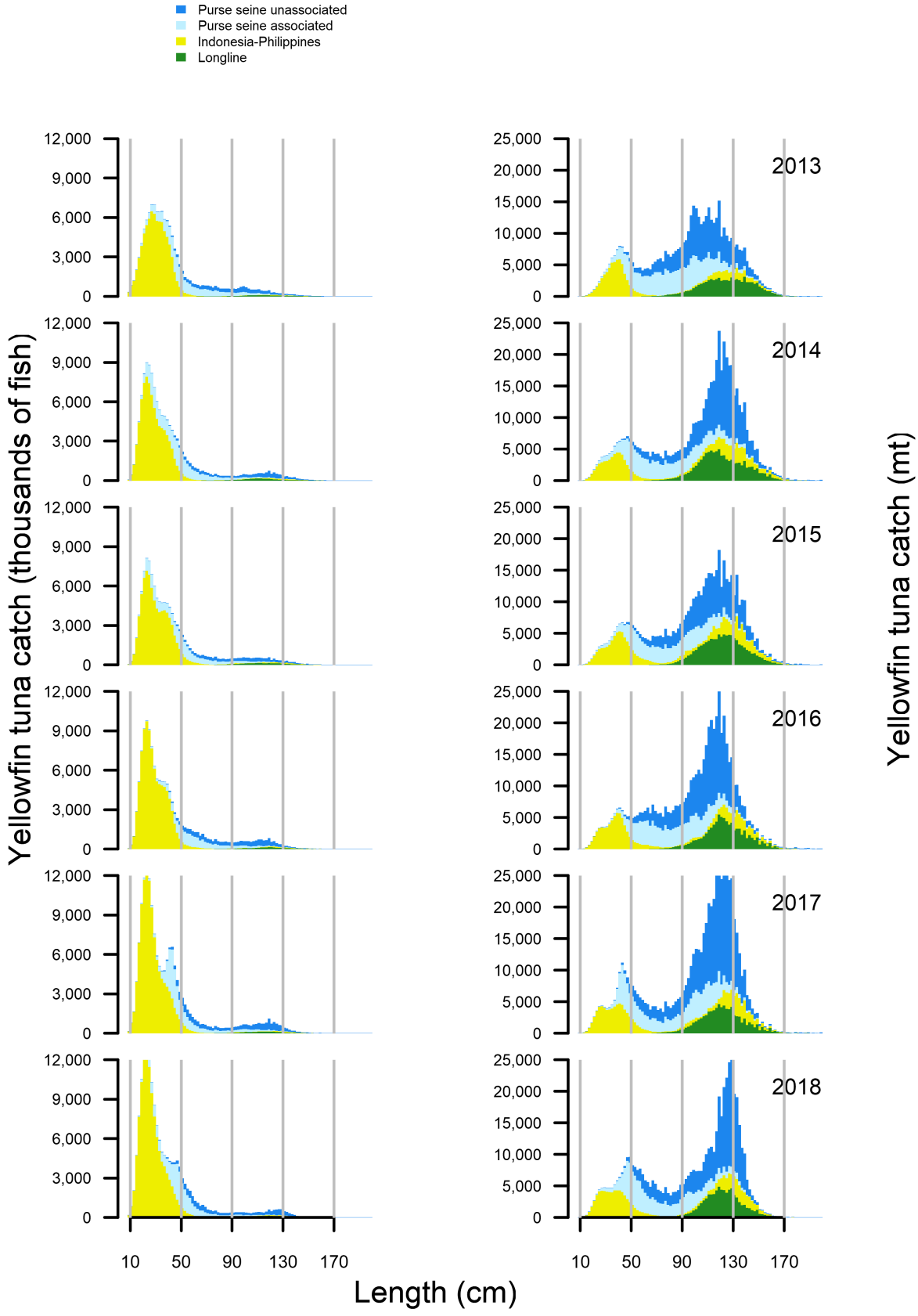


Figure 31: Catch-at-size of yellowfin tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). The grey vertical lines are guides to aid interpretation.

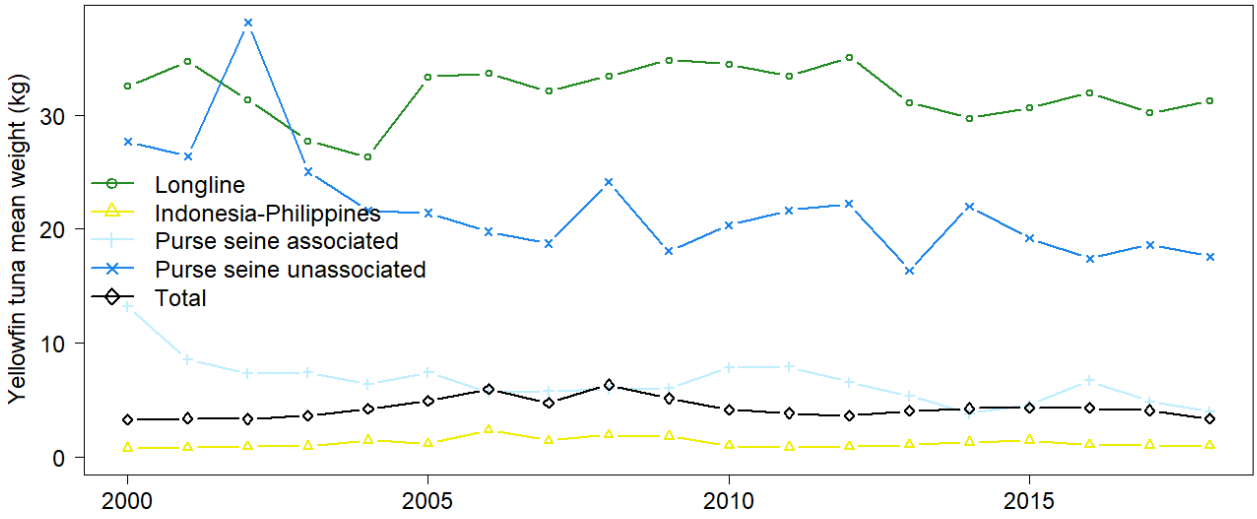


Figure 32: Mean weight of individual yellowfin tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.

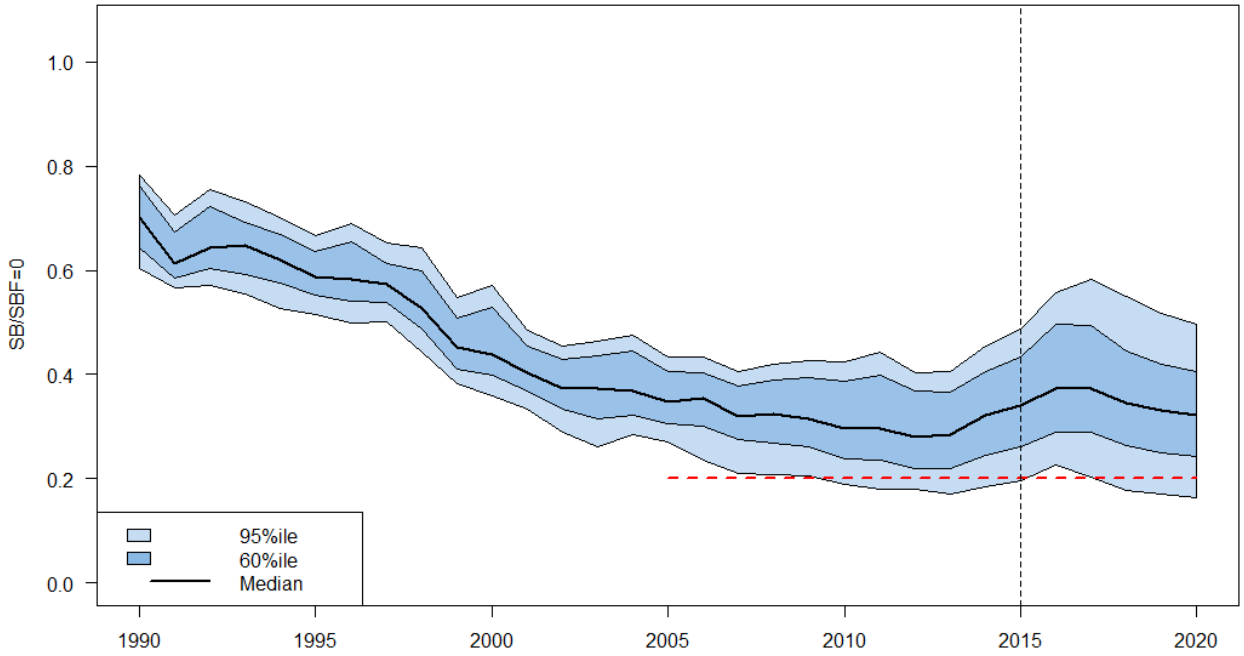


Figure 33: Stochastic projection results of yellowfin tuna spawning biomass ($SB/SB_{F=0}$) from 2015 assuming actual catch and effort levels in 2018 continue through to 2020. Prior to 2015 the data represent the 60^{th} and 95^{th} percentiles of the uncertainty grid from the assessment models and the median. Levels of recruitment variability estimated for the period used to estimate the stock-recruitment relationship (1962-2014) assumed to continue in the future. The red dashed line represents the WCPFC agreed limit reference point.