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A compendium of fisheries indicators for target tuna stocks in the WCPFC Convention Area

WCPFC-SC17-2021/SA-IP-15

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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 SC17, we present a compendium of fishery indicators for all 'key' target tuna species (skipjack, bigeye, yellowfin and South Pacific albacore tuna), Full stock assessments were not conducted for bigeye, yellowfin, and skipjack in 2021. Trends for South Pacific albacore tuna are also described in the regularly requested stand-alone paper: *Trends in the South Pacific albacore longline and troll fisheries* (McKechnie et al., 2021).

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 available from the WCPFC databases as of 19 July 2021. It is difficult to confidently interpret the stock status-related implications of trends in any indicators in isolation from other data sets and a population dynamics model. Therefore, short-term stochastic projections for WCPO skipjack, bigeye and yellowfin stocks are also presented to assess potential stock status at the end of 2021 in light of recent catch and effort trends.

2 Data and Methods

To track developments in key target tuna species not formally assessed in the current year, a formal request was made to develop stock indicators (Scientific Committee's Work Programme for 2008-2010, Project 24), and these were first reported to SC4 in 2008 (Hampton and Williams, 2008). More recent versions of this now-annual SC paper have 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. South Pacific albacore had a full assessment conducted this year, differing from previous assessments in that the assessment was for the Pacific-wide population and involved a joint effort between SPC and IATTC scientists (Castillo-Jordan et al., 2021). Bigeye and yellowfin tuna were assessed in 2020 (Ducharme-Barth et al., 2020 and Vincent et al., 2020, respectively). Skipjack was last assessed in 2019 (Vincent et al., 2019). Commentary provided in this paper compares the values of various indicators to previous years, in particular comparisons of 2020 values to 2019 and to the average from 2015-2019.

Short-term stochastic projections for WCPO skipjack, bigeye and yellowfin are included for further information; projections for South Pacific albacore are not provided as an assessment is being conducted in 2021 and the final model uncertainty grid has not yet been approved by SC (though some projections will likely be provided in the assessment presentations). For all three stocks, projections were from 2018, using the most recent assessments (Vincent et al., 2019, Ducharme-Barth et al., 2020, Vincent et al., 2020). Future recruitments were modelled 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 SC15 (skipjack) and SC16 (bigeye and yellowfin) and results were weighted as appropriate. All three stocks were projected through 2019 using actual catch and effort levels in that year, and then through to 2022 assuming 2020 catch and effort levels remained constant. We note that the near-future stock status of bigeye and yellowfin in particular will largely be influenced by recent recruitment levels estimated 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, dependent on the species.

Indicators are based on annual catch estimates for the WCPFC 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.

3 Note on reduced observer coverage in 2020

Observer coverage levels were greatly reduced in 2020 due to the impacts of COVID-19. To estimate the potential errors associated with lower observer sampling rates, Peatman et al. (2021) conducted a sub-sampling exercise to assess the potential impact on purse seine species composition estimates. They determined that catch estimates of bigeye, and to a lesser extent yellowfin, were most sensitive to reduced observer coverage.

Regarding the figures presented and discussed in this paper, the indicators potentially most affected by the reduced observer coverage are the 2020 values for the total purse seine catch and CPUE estimates for bigeye, yellowfin and skipjack. Longline catch and CPUE are less affected, as are summaries of length and weight by gear type.

Acknowledgments

The authors would like to thank Tiffany Vidal for quite 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 2020 was 1,769,202t, a 13% decrease from 2019 and a 3% decrease from the 2015-2019 average. Purse seine catch in 2020 (1,447,342t) was a 15% decrease from 2019 and a 1% increase from the 2015-2019 average. Pole and line catch (121,530t) was a 23% decrease from 2019 and a 21% decrease from the 2015-2019 average catch. Catch by other gears (see Williams and Ruaia (2021) for descriptions) totaled 197,944t; an 11% increase from 2019 and 10% decrease from the average catch in 2015-2019. In 2020, percentage catch by gear was: purse seine - 82%, other gear - 11%, pole-and-line - 7%, longline - <1%.
Figure 2 - top	Tropical pole and line CPUE	Pole and line CPUE for the Japanese fleet in 2020 (5.15t per day) decreased by 25% from 2019 and decreased by 19% from the 2015-2019 average. Pole and line CPUE for the Solomon Islands fleet in 2020 (1.94t per day) increased by 6% from 2019 and increased by 13% from the 2015-2019 average. The Solomon Islands fleet CPUE has been relatively steady around 2 mt/day for the past 5 years; CPUE generally varied between 3 and 5 mt/day from 1990 to 2014.
Figure 2 - bottom	Tropical purse seine CPUE	Free-school CPUE in 2020 (23.64t per day) decreased by 25% from 2019 and decreased by 5% from the 2015-2019 average. Log-associated CPUE in 2020 (24.37t per day) decreased by 20% from 2019 and decreased by 12% from the 2015-2019 average. Drifting FAD CPUE in 2020 (36.47t per day) decreased by 18% from 2019 and decreased by 5% from the 2015-2019 average. Anchored FAD CPUE in 2020 (10.73t per day) decreased by 22% from 2019 and decreased by 18% from the 2015-2019 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. A relatively strong La Niña event in the second half of the year shifted purse seine catches in 2020 westward from the distribution during 2016-2020); a period that saw a preponderance of El Niño 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, particularly towards the WCPFC-CA northeast equatorial region.
Figure 5	Spatial concentration of catch	90% of the purse seine catch in 2020 was taken in 664 1^ox 1^o squares. This was a 13% increase from 2019 and a 3% increase from the 2015-2019 average. Over the longer term (25 years), the minimum number of 1^ox 1^o squares in which 90% of the purse seine catch has been taken has slowly, but steadily, increased from a range of 550-600 to a range of 600-650. 90% of the pole and line catch was taken in 253 1^ox 1^o degree squares. This was an 18% decrease from 2019 and an 18% decrease from the 2015-2019 average. After experiencing a sharp contraction between 1980 and 2000 (from 800+ to less than 400 cells), the pole-and-line fishery has been relatively steady over the past 20 years, in terms of how many 1^ox 1^o cells (between 250 and 350) from which 90% of the catch has been taken.
Figure 6	Catch at length by gear type in both numbers and weight	In most years, the catch at length in numbers of fish is broadly bimodal. One peak comprises small fish, generally smaller than 40 cm, taken in the Indonesia/Philippines fisheries; the other peak is comprised of larger fish, generally between 45 and 70 cm, mostly caught in the purse seine fisheries. While numbers of skipjack caught is roughly equal between the two fisheries, catch by weight is dominated by the purse seine fisheries. In 2020, the purse seine associated catch included an unusually large number of skipjack under 45 cm, essentially removing the appearance of a bimodal distribution in catch numbers. The resultant impact on weight distribution for the associated catch is also apparent.

Figure	Indicator	Description
Figure 7	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2020 (1.66kg) decreased by 23% from 2019 and decreased by 13% from 2015-2019 average. The mean weight of pole and line caught fish (2.01kg) decreased by 16% from 2019 and decreased by 15% from the 2015-2019 average. The mean weight of Indonesia / Philippines domestic caught fish (0.49kg) decreased by 2% from 2019 and decreased by 8% from the average in 2015-2019. The mean weight of skipjack from free-school (unassociated) purse seine sets (3.78kg) decreased by 3% from 2019 and showed no change from the 2015-2019 average. The mean weight of skipjack from FAD sets (1.81kg) decreased by 28% from 2019 and decreased by 19% from the 2015-2019 average.
Figure 8	Stochastic stock projections	Under recent fishery conditions, the skipjack stock is projected to increase slightly from recent assessed depletion levels. The projections indicate that median $F_{2018-2021}/F_{MSY} = 0.49$; median $SB_{2022}/SB_{F=0} = 0.43$; median $SB_{2022}/SB_{MSY} = 1.58$. The risk that $SB_{2022}/SB_{F=0} < LRP = 0\%$, $SB_{2022} < SB_{MSY} = 0\%$ and $F_{2018-2021} > F_{MSY} = 5\%$. Note the Limit Reference Point (LRP) is 20% $SB_{F=0}$.

South Pacific albacore tuna

Figure	Indicator	Description
Figure 9	Total catch by gear	Total provisional South Pacific catch in 2020 was 69,931t, an 18% decrease from 2019 and a 16% decrease from the 2015-2019 average. Longline catch in 2020 (64,963t) decreased by 21% from 2019 and decreased by 20% from the 2015-2019 average. Note the discussions in Williams (2021) and Williams and Ruaia (2021) on the catch reporting of albacore in the South Pacific Ocean for more details. Catch by other gear - mostly troll - (4,944t) increased by 63% from 2019 and increased by 76% from the 2015-2019 average. For the southern WCPFC-CA, total albacore catch was 60,305t, a 14% decrease from 2019 and a 12% decrease from the 2015-2019 average. Longline catch in 2020 (55,321t) decreased by 18% from 2019 and decreased by 15% from the 2015-2019 average. Catch by other gear (mostly troll catch) (4,956t) increased by 63% from 2019 and increased by 72% from the 2015-2019 average. In 2020, percentage catch by gear was: longline - 74%, pole-and-line - 14%, other gear - 5%, purse seine - 3%. Note that numbers may differ slightly to those tabulated in the albacore trends paper (McKechnie et al., 2021).
Figure 10	Southern longline CPUE (south of 10^{o}S)	Japanese longline CPUE in 2020 (1.53 fish per 100 hooks) increased by 53% from 2019 and increased by 32% from the 2015-2019 average. Korean longline CPUE (0.47 fish per 100 hooks) decreased by 39% from 2019 and decreased by 33% from the 2015-2019 average. Chinese longline CPUE (1.03 fish per 100 hooks) decreased by 7% from 2019 and decreased by 35% from the 2015-2019 average. Finally, Chinese Taipei longline CPUE in 2020 (1.63 fish per 100 hooks) increased by 6% from 2019 and decreased by 11% from the 2015-2019 average. The Combined CPUE time series is a weighted average of the other time series; as there is only CPUE data for the Japanese fleet prior to 1963, the Combined CPUE trend is the same as the Japanese CPUE for those years.
Figure 11	Maps of catch by gear	In recent years, catches have concentrated in the 10^{o}S-20^{o}S latitudinal band. While 2020 estimates remain provisional, the spatial distribution of the longline catch is similar to the distribution of catches seen over the preceding 5-year period. The troll catch of the preceding five years has contracted from the long-term pattern, when notable catches were taken east of 170^o W.
Figure 12	Longline effort and CPUE maps	Over the entire time series, catch rates have been highest south of 10^{o}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 highest in the high seas areas between 30^{o}S and 40^{o}S. CPUE in the region around southern Melanesia (Vanuatu, New Caledonia, Fiji) shows a decline over time, with 2020 values notably lower than the preceding five years.
Figure 13	Spatial concentration of catch	90% of the longline catch in 2020 was taken in 54 5^{o}x 5^o degree squares of the southern WCPO. This was a 4% decrease from 2019 and a 3% increase from the 2015-2019 average. Despite the 2020 decrease, the trend over the past decade has been a steady increase in the minimum fished area to capture 90% of the catch, increasing from around 40 to around 55 5^{o}x 5^o degree squares.
Figure 14	Catch at length by gear type in both numbers and weight	The catch in numbers of fish and weight (t) shows that the largest fish are caught in the longline fisheries and the troll catch is made up of small fish, typically less than 80cm in length. There is little apparent trend in the peak of the length mode from the longline fishery, but there has been an increase in the numbers, and total catch weight, of albacore in the 50-70cm size range over the previous three years landed by the 'Other' fishery sector.

Figure	Indicator	Description
Figure 15	Mean weight by gear type	While the mean weight of individual fish taken across all gears is relatively stable over the long-term, 2020 (13.82kg) was a 6% decrease from 2019 and a 5% decrease from the 2015-2019 average. The mean weight of longline caught fish (16.46kg) increased by 3% from 2019 and increased by 6% from the 2015-2019 average. The mean weight of fish caught in other gears (4.31kg), almost all troll, showed no change from 2019 and decreased by 6% from the 2015-2019 average.
NA	Stochastic stock projections	NA - as a new assessment has been undertaken in 2021, and final grid still to be selected by SC, no projection is presented for South Pacific albacore here, however Castillo-Jordan et al. (2021) will aim to present some projections based on the new assessment.

Bigeye tuna

Figure	Indicator	Description
Figure 16	Total catch by gear	Total catch in 2020 was 150,180t, a 10% increase from 2019 and was equal to the 2015-2019 average. Longline catch in 2020 (58,560t) decreased by 16% from 2019 and decreased by 12% from the 2015-2019 average. Purse seine catch in 2020 (74,145t) increased by 46% from 2019 and increased by 13% from the 2015-2019 average. Pole and line catch (1,030t) decreased by 32% from 2019 and decreased by 71% from the 2015-2019 average. Catch by other gears (see Williams and Ruaia (2021) for descriptions) totaled 16,445t and was a 11% increase from 2019 and 11% increase from the 2015-2019 average. In 2020, percentage catch by gear was: purse seine - 49%, longline - 39%, other gear - 6%, pole-and-line - 1%.
Figure 17 - top	Tropical pole and line CPUE	Japanese pole and line CPUE in 2020 (0.002t per day) decreased by 86% from 2019 and decreased by 86% from the 2015-2019 average.
Figure 17 - middle	Tropical purse seine CPUE	Free-school CPUE in 2020 (0.2t per day) decreased by 41% from 2019 and decreased by 51% from the 2015-2019 average. Log-associated CPUE in 2020 (1.68t per day) decreased by 3% from 2019 and decreased by 25% from the 2015-2019 average. Drifting FAD CPUE in 2020 (4.17t per day) increased by 53% from 2019 and increased by 33% from the 2015-2019 average. Anchored FAD CPUE in 2020 (0.14t per day) decreased by 3% from 2019 and decreased by 64% from the 2015-2019 average.
Figure 17 - bottom	Tropical longline CPUE (20^{o}N to 10^{o}S)	Japanese longline CPUE in 2020 (0.54 fish per 100 hooks) increased by 29% from 2019 and increased by 16% from the 2015-2019 average. Korean longline CPUE (0.63 fish per 100 hooks) increased by 3% from 2019 and increased by 9% from the 2015-2019 average. US (Hawaiian) longline CPUE (0.32 fish per 100 hooks) increased by 7% from 2019 and decreased by 6% from the 2015-2019 average.
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^{o}N-10^{o}S 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 extend further west in the tropical northern hemisphere (to 10^{o}N) and to the southeast of the tropical region. A couple of purse seine bigeye “hotspots” are noted for 2020, at around 155^{o}W and 170^{o}W, along the equator.
Figure 21	Spatial concentration of catch	90% of the longline catch in 2020 was taken in 91 5^{o}x 5^o degree squares of the southern WCPO. This was a 14% decrease from 2019 and a 12% decrease from the 2015-2019 average. There has been little or no trend in longline catch concentration over the past 40 years, with around 100 cells accounting for 90% of the catch. 90% of the purse seine catch in 2020 was taken in 564 1^{o}x 1^o degree squares of the southern WCPO. This was a 6% increase from 2019 and a 3% decrease from the 2015-2019 average. The spatial concentration of bigeye purse seine catch has shown little trend since leveling off at around 550 cells in the early 2000s.

Figure	Indicator	Description
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. Larger fish (>100cm), as well as the majority of the total catch, are generally caught in the longline fisheries. Intermediate sized fish (40cm-80cm) are taken in the purse seine fisheries. In 2020, the number of small bigeye caught in the Indonesia/Philippines fisheries, in the 10-30 cm range, continued a trend of increasing numbers since 2017 and a return to 2016 levels, noting the 2020 bigeye catch estimate for Indonesia is provisional at this stage. Additionally there were fewer bigeye <70cm taken in FAD sets.
Figure 23	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2020 (3.43kg) decreased by 19% from 2019 and decreased by 31% from the 2015-2019 average. The mean weight of longline caught fish (40.13kg) decreased by 2% from 2019 and decreased by 7% from the 2015-2019 average. The mean weight of Indonesia / Philippines domestic caught fish (0.54kg) decreased by 21% from 2019 and decreased by 33% from the 2015-2019 average. The mean weight of free-school caught purse seine fish (9.83kg) decreased by 3% from 2019 and decreased by 23% from the 2015-2019 average. The mean weight of FAD caught fish (5.93kg) increased by 6% from 2019 and increased by 3% from the 2015-2019 average.
Figure 24	Stochastic stock projections	Under recent fishery conditions and **long-term recruitment assumptions**, the bigeye stock is projected to remain around recent assessed depletion levels. The projections indicate that median $F_{2018-2021}/F_{MSY} = 1.01$; median $SB_{2022}/SB_{F=0} = 0.38$; median $SB_{2022}/SB_{MSY} = 1.58$. The risk that $SB_{2022}/SB_{F=0} < LRP = 0\%, SB_{2022} < SB_{MSY} = 0\%$ and $F_{2018-2021} > F_{MSY} = 52\%$. Under recent fishery conditions and **recent recruitment assumptions**, the bigeye stock is projected to increase slightly from recent assessed depletion levels. The projections indicate that median $F_{2018-2021}/F_{MSY} = 1.00$; median $SB_{2022}/SB_{F=0} = 0.40$; median $SB_{2022}/SB_{MSY} = 1.59$. The risk that $SB_{2022}/SB_{F=0} < LRP = 0\%, SB_{2022} < SB_{MSY} = 0\%$ and $F_{2018-2021} > F_{MSY} = 51\%$. Note the Limit Reference Point (LRP) is 20% $SB_{F=0}$. MSY metrics are strongly influenced by the shift in gear composition of the tropical fleet in 2020.

Yellowfin tuna

Figure	Indicator	Description
Figure 25	Total catch by gear	Total catch in 2020 was 643,251t, a 7% decrease from 2019 and a 4% decrease from the 2015-2019 average. Purse seine catch in 2020 (391,250t) increased by 13% from 2019 and increased by 1% from the 2015-2019 average. Longline catch in 2020 (72,357t) decreased by 32% from 2019 and decreased by 26% from the 2015-2019 average. Pole and line catch (11,600t) decreased by 34% from 2019 and decreased by 55% from the 2015-2019 average. Catch by other gear (see Williams and Ruaia (2021) for descriptions) totaled 168,044t and was a 24% decrease from 2019 and a 4% increase from the average catch in 2015-2019. This is mainly due to the large fluctuations in estimates for the other gears in Indonesia in recent years. In 2020, percentage catch by gear was: purse seine - 61%, other gear - 26%, longline - 11%, pole-and-line - 2%.
Figure 26 - top	Tropical pole and line CPUE	Japanese pole and line CPUE in 2020 (0.045t per day) increased by 47% from 2019 and increased by 5% from the 2015-2019 average. 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 2020 (7.03t per day) was a 1% decrease and decreased by 7% from the 2015-2019 average. Log-associated CPUE in 2020 (8.49t per day) increased by 18% from 2019 and increased by 10% from the 2015-2019 average. Drifting FAD CPUE in 2020 (7.91t per day) increased by 26% from 2019 and increased by 32% from the 2015-2019 average. Anchored FAD CPUE in 2020 (8t per day) decreased by 21% from 2019 and decreased by 24% from the 2015-2019 average.
Figure 26 - bottom	Tropical longline CPUE (20^{o}N to 10^{o}S)	Japanese longline CPUE in 2020 (0.72 fish per 100 hooks) decreased by 23% from 2019 and decreased by 11% from the 2015-2019 average. Korean longline CPUE (0.87 fish per 100 hooks) decreased by 8% from 2019 and increased by 22% from the 2015-2019 average.
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 the purse seine fishery within the 10^{o}N-10^{o}S equatorial band, with catches higher in the mid-tropical WCPO band, mirroring skipjack. Catch in the Indonesian/Philippines region remains notably high.
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 WCPFC-CA. There is a strong contraction in the high CPUE area compared to the long-term.
Figure 29	Purse seine effort and CPUE maps	Areas of high CPUE have fragmented over time, across the tropical WCPFC-CA, and were concentrated in the west of the tropical region in 2020, with some localised high CPUE achieved in other areas.
Figure 30	Spatial concentration of catch	90% of the longline catch in 2020 was taken in 87 5^{o}x 5^o degree squares of the southern WCPO. This was a 15% decrease from 2019 and a 6% decrease from the 2015-2019 average. 90% of the purse seine catch in 2020 was taken in 503 1^{o}x 1^o degree squares of the southern WCPO. This was an 8% increase from 2019 and a 3% decrease from the 2015-2019 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 (>90cm) 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. The total number of yellowfin taken in the Indonesia/Philippines fisheries was down slightly from the high numbers seen in the 2018 and 2019 catches.

Figure	Indicator	Description
Figure 32	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2020 (2.2kg) increased by 1% from 2019 and decreased by 23% from the 2015-2019 average. The mean weight of longline caught fish (24.16kg) decreased by 16% from 2019 and decreased by 21% from the 2015-2019 average. The mean weight of Indonesia / Philippines domestic caught fish (0.8kg) decreased by 8% from 2019 and decreased by 14% from the 2015-2019 average. The mean weight of free-school caught purse seine fish (15.82kg) increased by 1% from 2019 and decreased by 7% from the 2015-2019 average. The mean weight of FAD caught fish (3.55kg) decreased by 26% from 2019 and decreased by 15% from the 2015-2019 average.
Figure 33	Stochastic stock projections	Under recent fishery conditions, the yellowfin stock is projected to increase increase from recent assessed depletion levels. The projections indicate that median $F_{2018-2021}/F_{MSY} = 0.33$; median $SB_{2022}/SB_{F=0} = 0.64$; median $SB_{2022}/SB_{MSY} = 2.60$. The risk that $SB_{2022}/SB_{F=0} < LRP = 0\%$, $SB_{2022} < SB_{MSY} = 0\%$ and $F_{2018-2021} > F_{MSY} = 1\%$. Note the Limit Reference Point (LRP) is 20% $SB_{F=0}$.

5 Figures

Skipjack

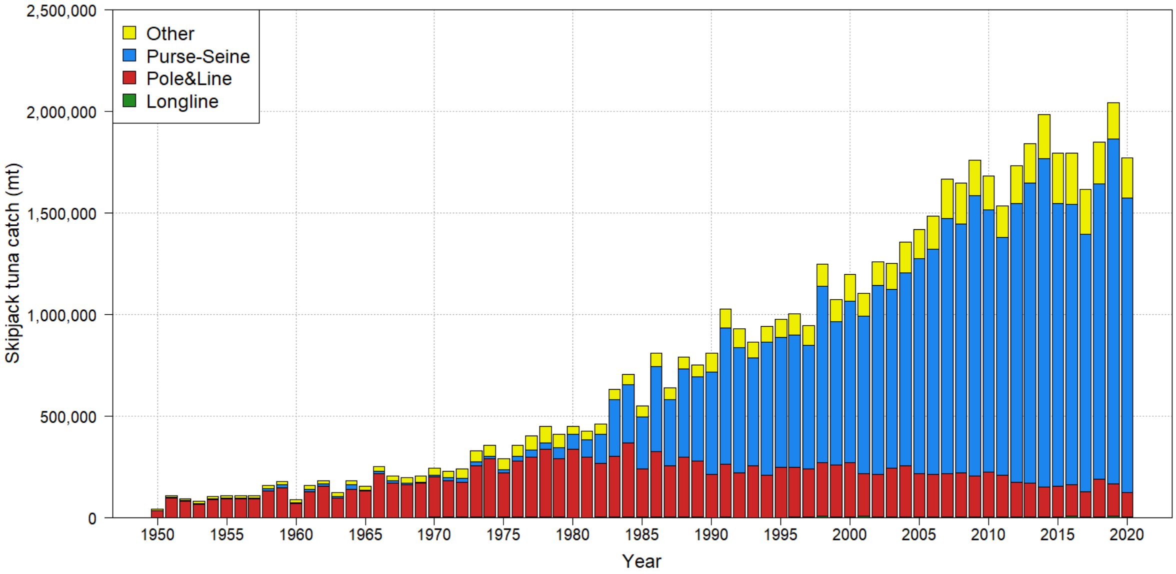


Figure 1: Skipjack tuna catch (mt) by gear type and year for the WCPFC-Convention Area.

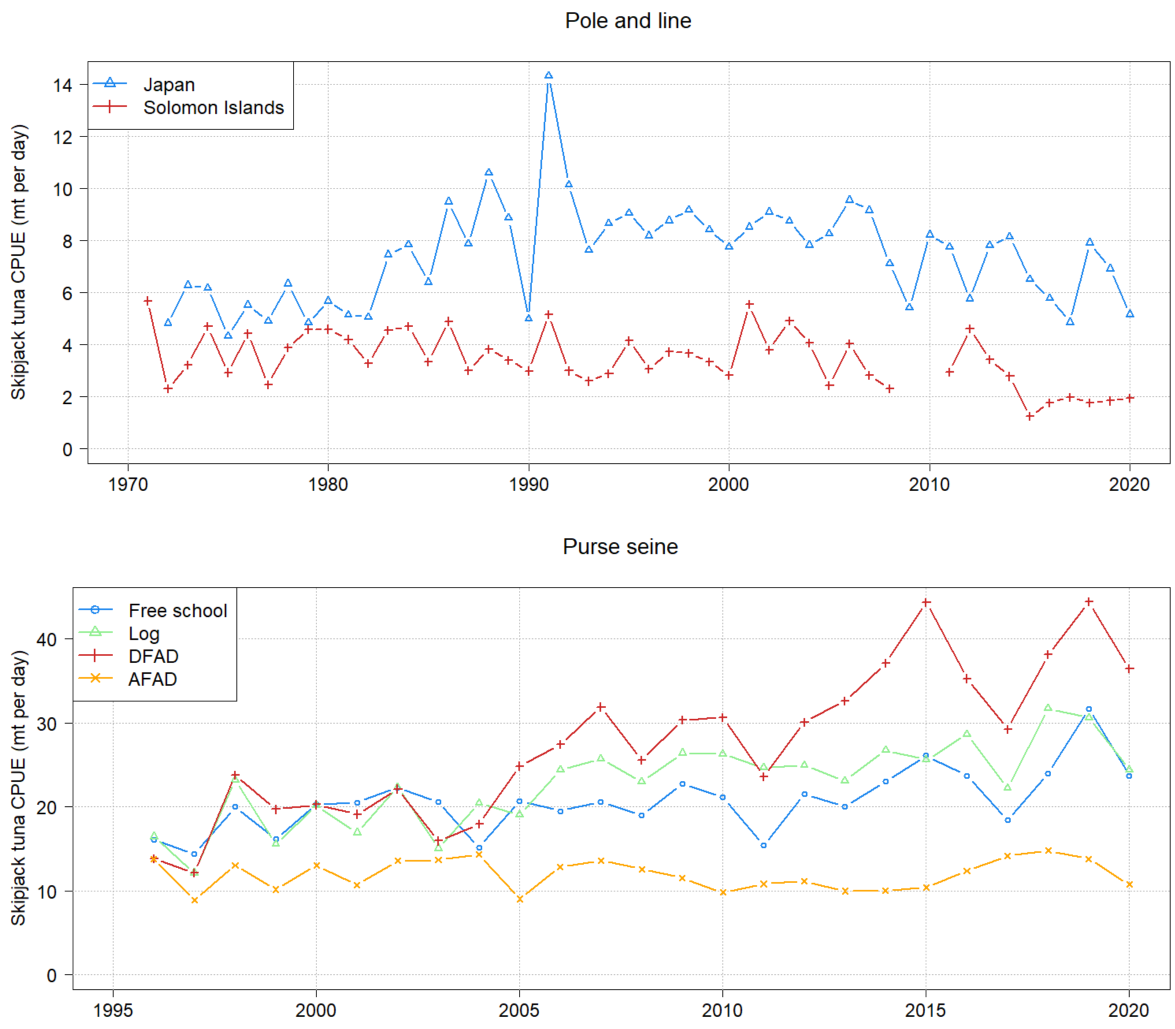


Figure 2: Skipjack tuna catch per unit effort in the tropical WCPO by year for major pole and line fishing fleets (top), and purse seine (all fleets combined) for the major set types (bottom). Note different time series lengths.

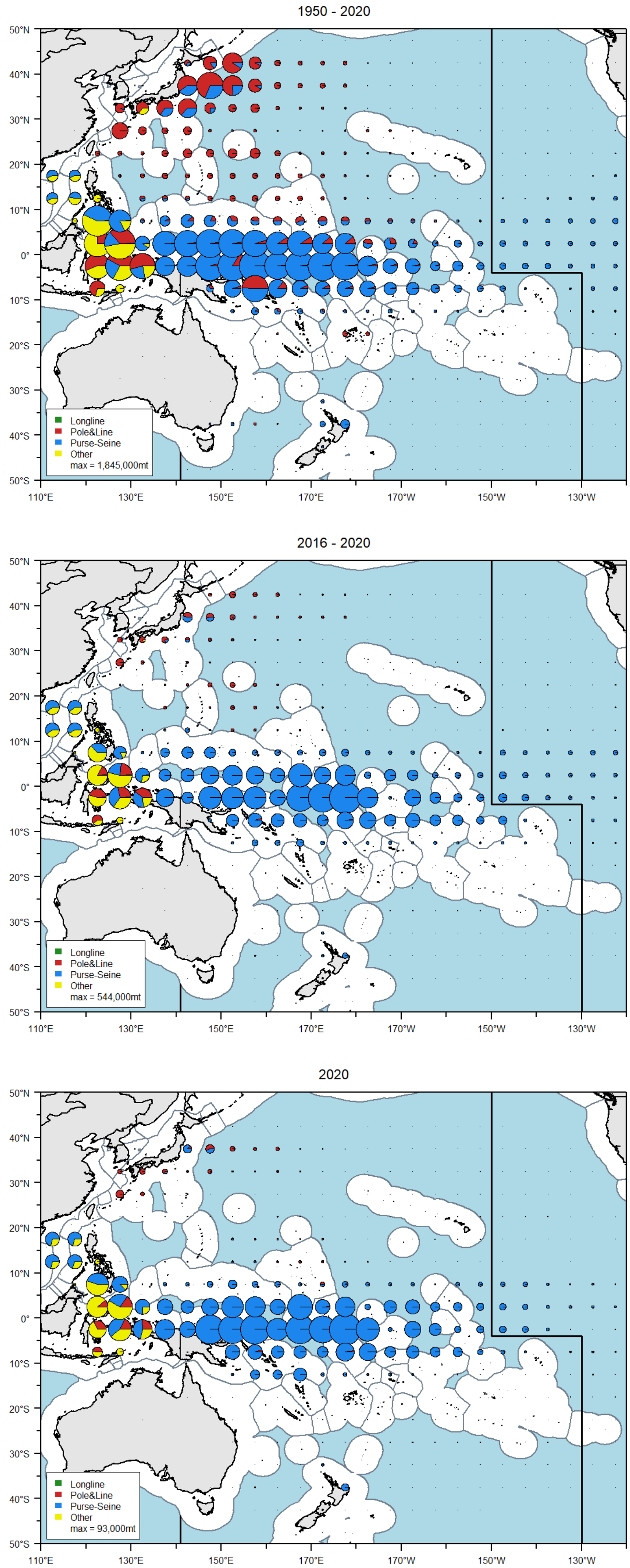


Figure 3: Skipjack tuna catch distribution by gear type and 5^ox 5^o region for the Pacific Ocean for the period 1950-2020 (top), 2016-2020 (middle) and 2020 (bottom). Note that the scale differs between panels and the figure legends provide the catch associated with each maximum circle size.

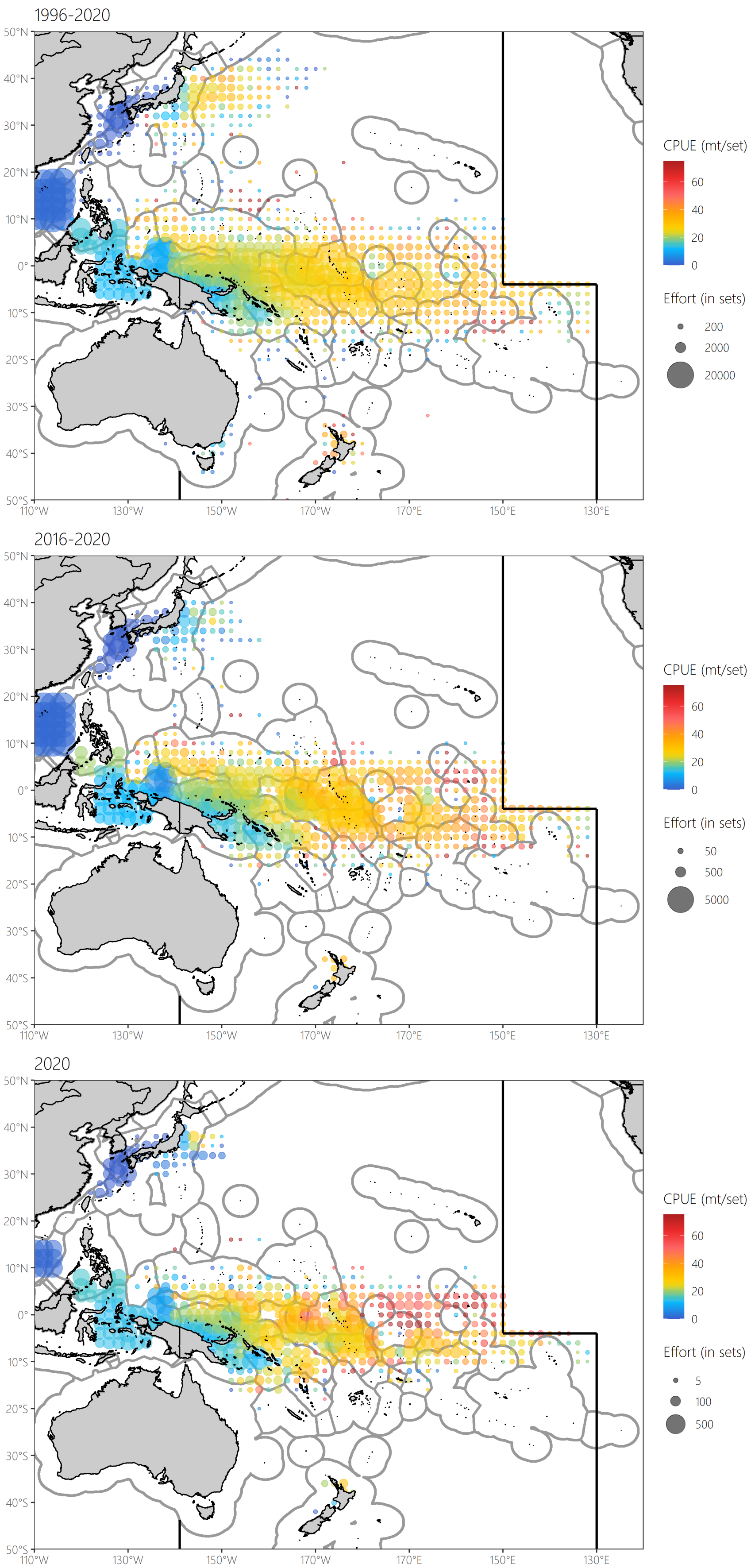


Figure 4: Distribution of 2°x 2° purse seine effort (represented by circle size) and skipjack tuna CPUE (represented by colour) for the period 1950-2020 (top), 2016-2020 (middle) and 2020 (bottom). Note the differences in scales between plots.

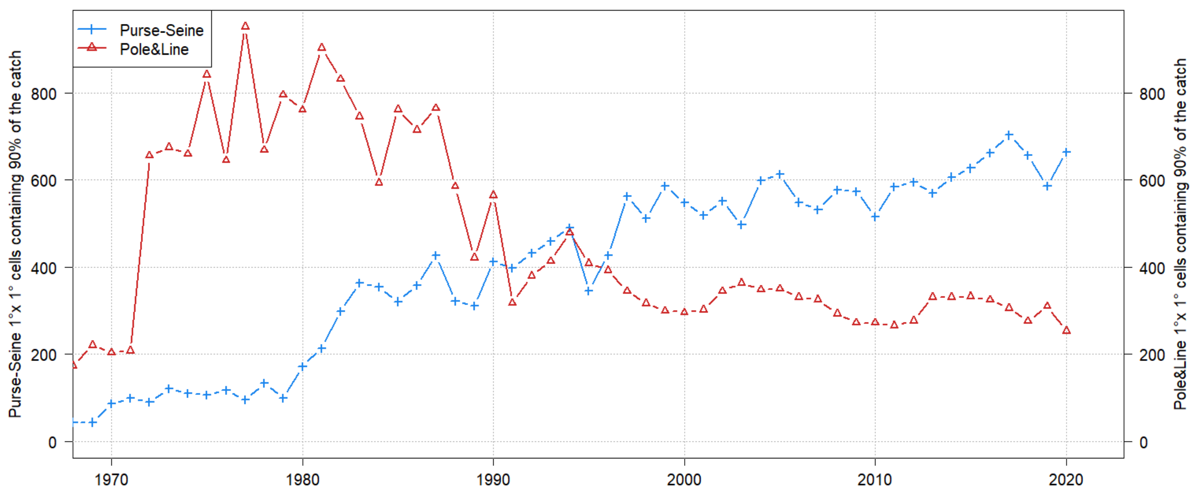


Figure 5: Spatial concentration of skipjack tuna catch for purse seine and pole and line fisheries by year for the WCPO.

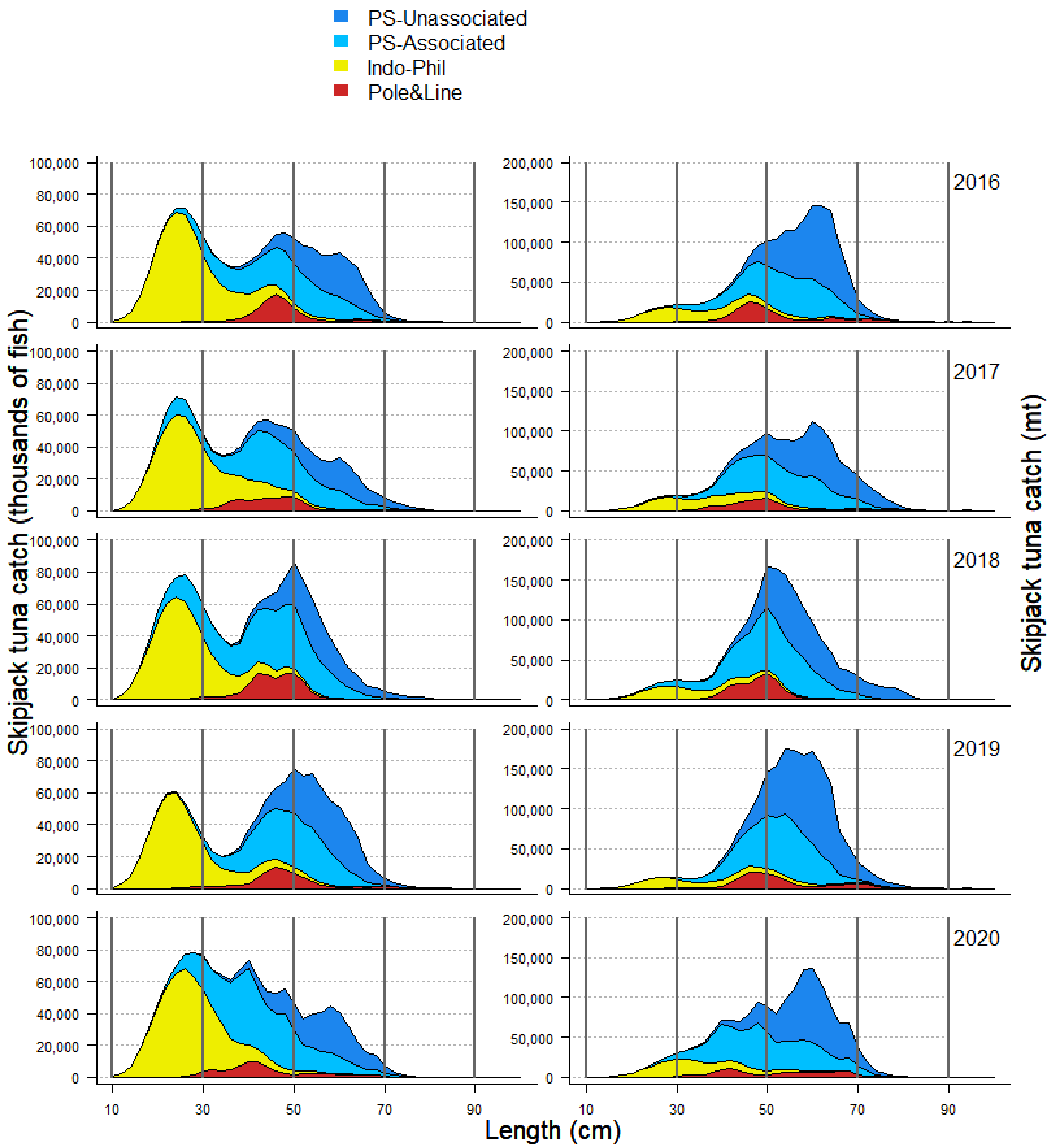


Figure 6: Catch-at-size of skipjack tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). The grey vertical lines are guides to aid interpretation.

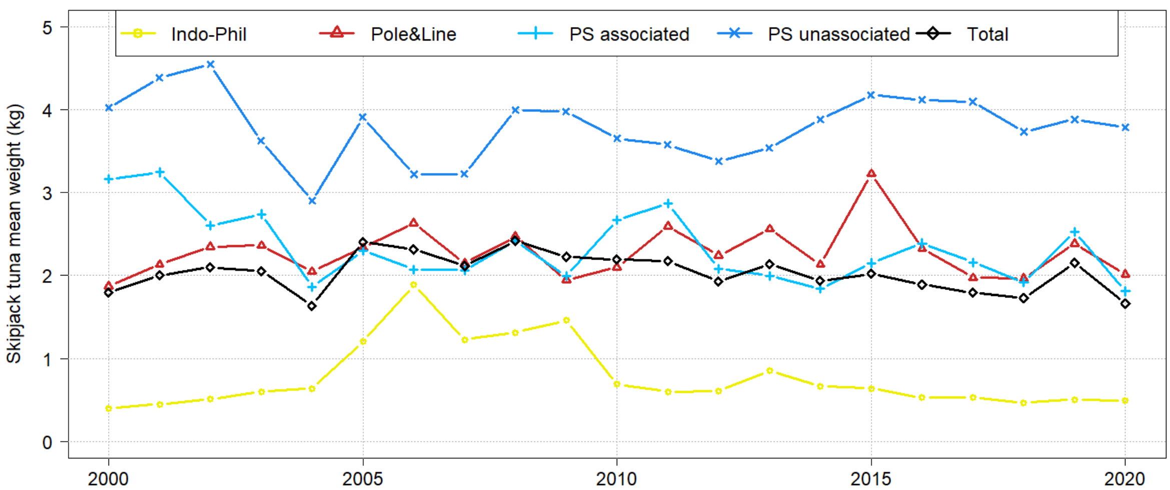


Figure 7: Mean weight of individual skipjack tuna taken by gear and year for the WCPO. The 'total' line represents the mean skipjack weight for the total catch.

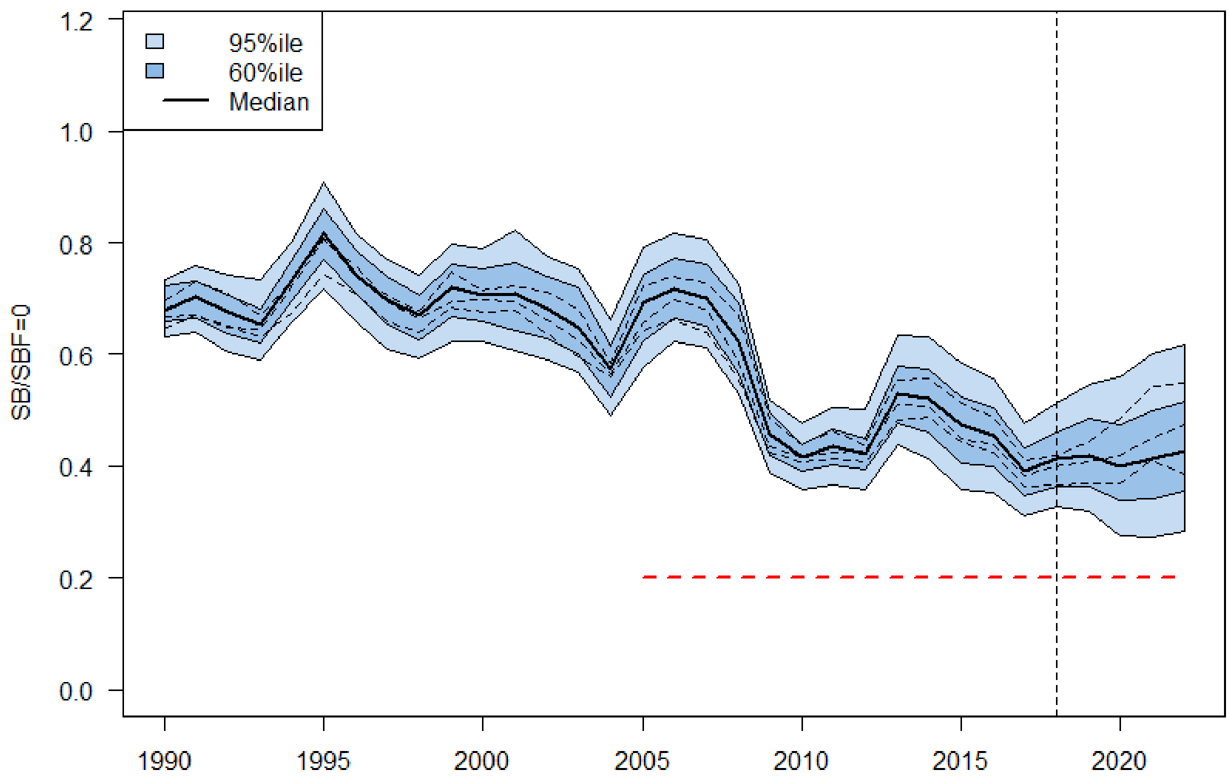
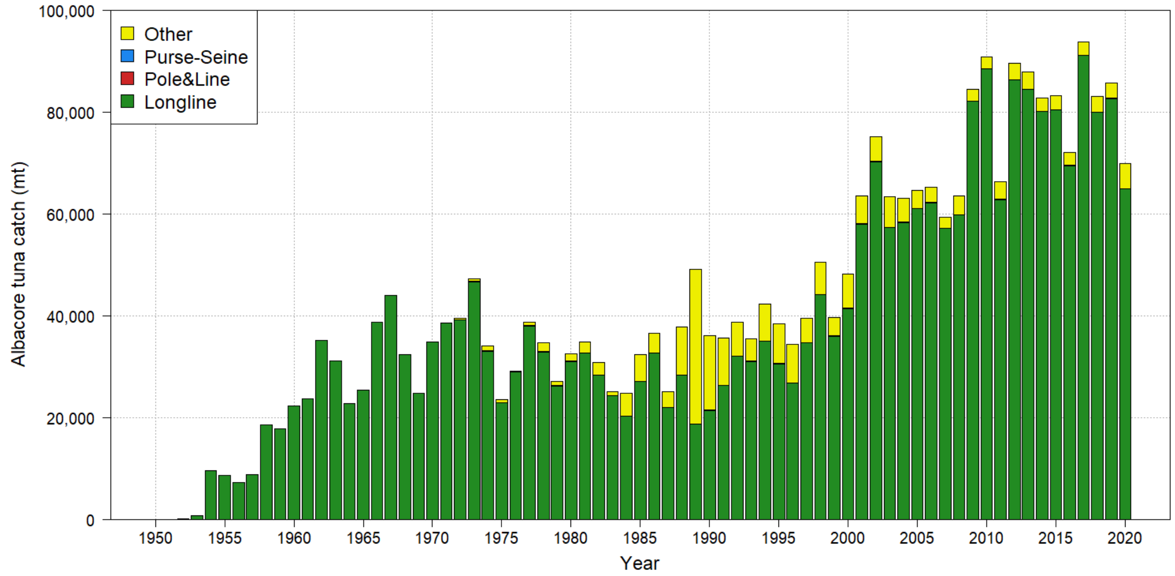


Figure 8: Skipjack spawning biomass depletion (SB/SB$_{F=0}$) from the uncertainty grid of assessment model runs for the period 1990 to 2018 (the vertical line at 2018 represents the last year of the assessment), and stochastic projection results for the period 2019 to 2022 assuming actual catch and effort levels in 2019 and 2020, and that 2020 fishing levels continued until 2022. During the projection period (2019-2022) levels of recruitment variability are assumed to match those over the time period used to estimate the stock-recruitment relationship (1982-2017). The solid black line shows the median annual depletion values (for grid model estimates prior to 2019 and for grid model projections for 2019-2022). The dashed lines indicate three example trajectories (chosen randomly out of 5400) from the model grid; the dark and light blue areas contain 60 and 95%, respectively, of depletion estimates for each year. The red dashed line represents the agreed limit reference point of 20%SB$_{F=0}$.

South Pacific albacore



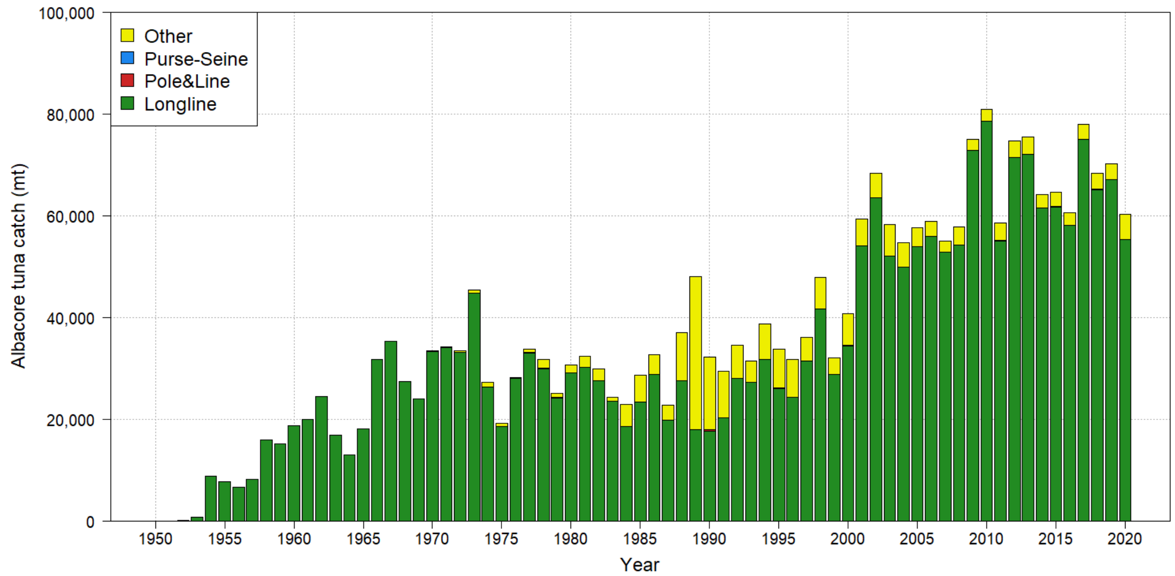


Figure 9: South Pacific albacore tuna catch (mt) by gear type and year for the South Pacific as a whole (top) and WCPFC-CA south of the equator (bottom). Note: 'Other' gear here is primarily troll gear, but includes driftnet catches in the 1980s and early 1990s.

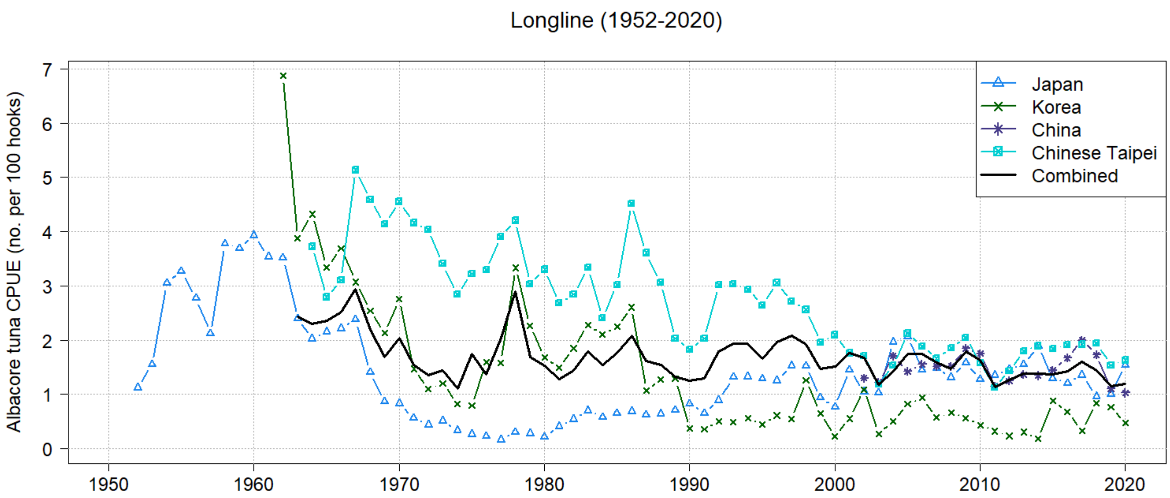


Figure 10: South Pacific albacore tuna catch per unit effort in the southern WCPFC-CA (south of 10°S) by year for major longline fleets.

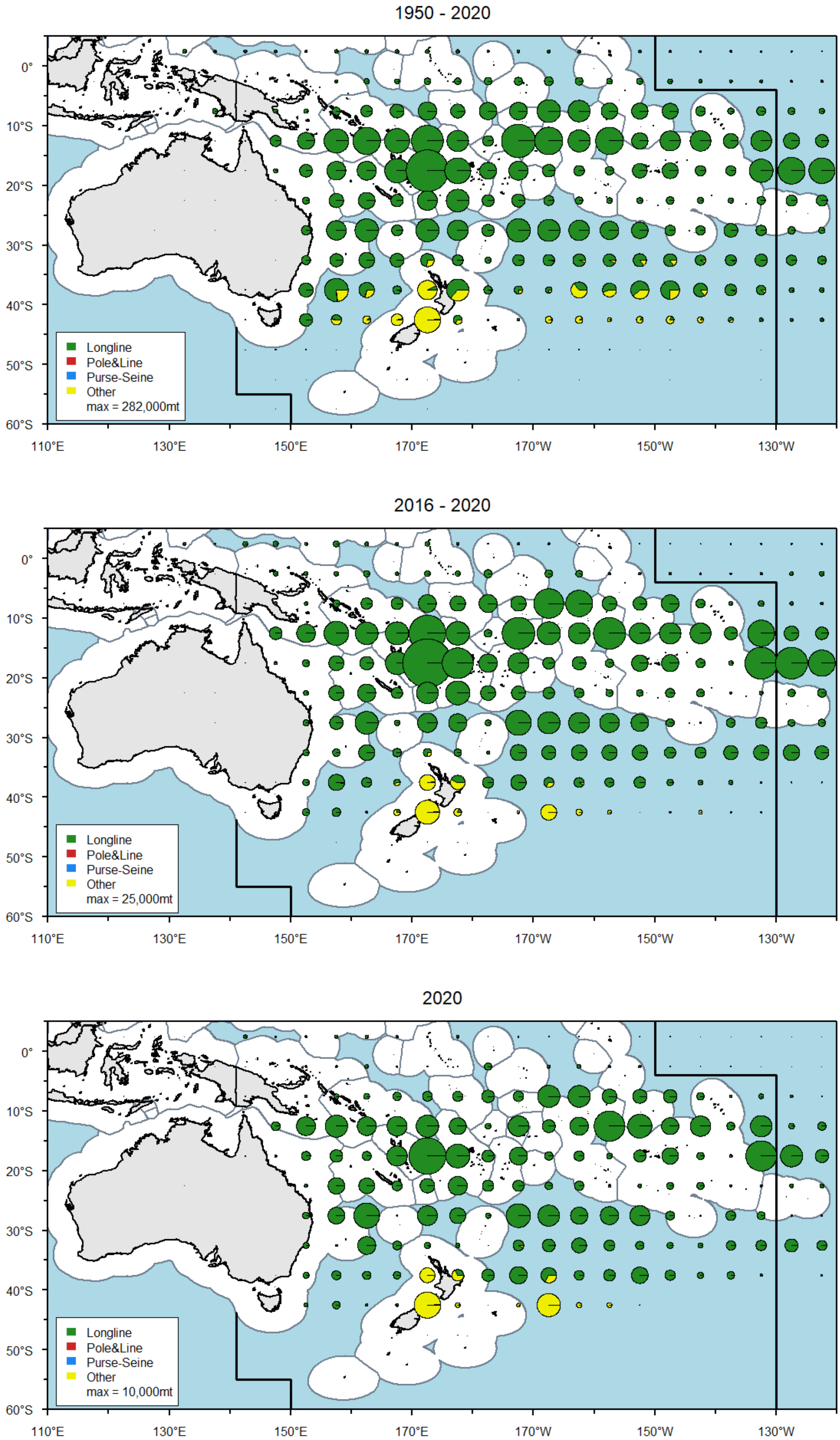


Figure 11: South Pacific albacore tuna catch distribution by gear type and 5^{o}x 5^o region for the Pacific Ocean for the period 1950-2020 (top), 2016-2020 (middle) and 2020 (bottom). Note that the scale differs between panels and the figure legends provide the catch associated with each maximum circle size.

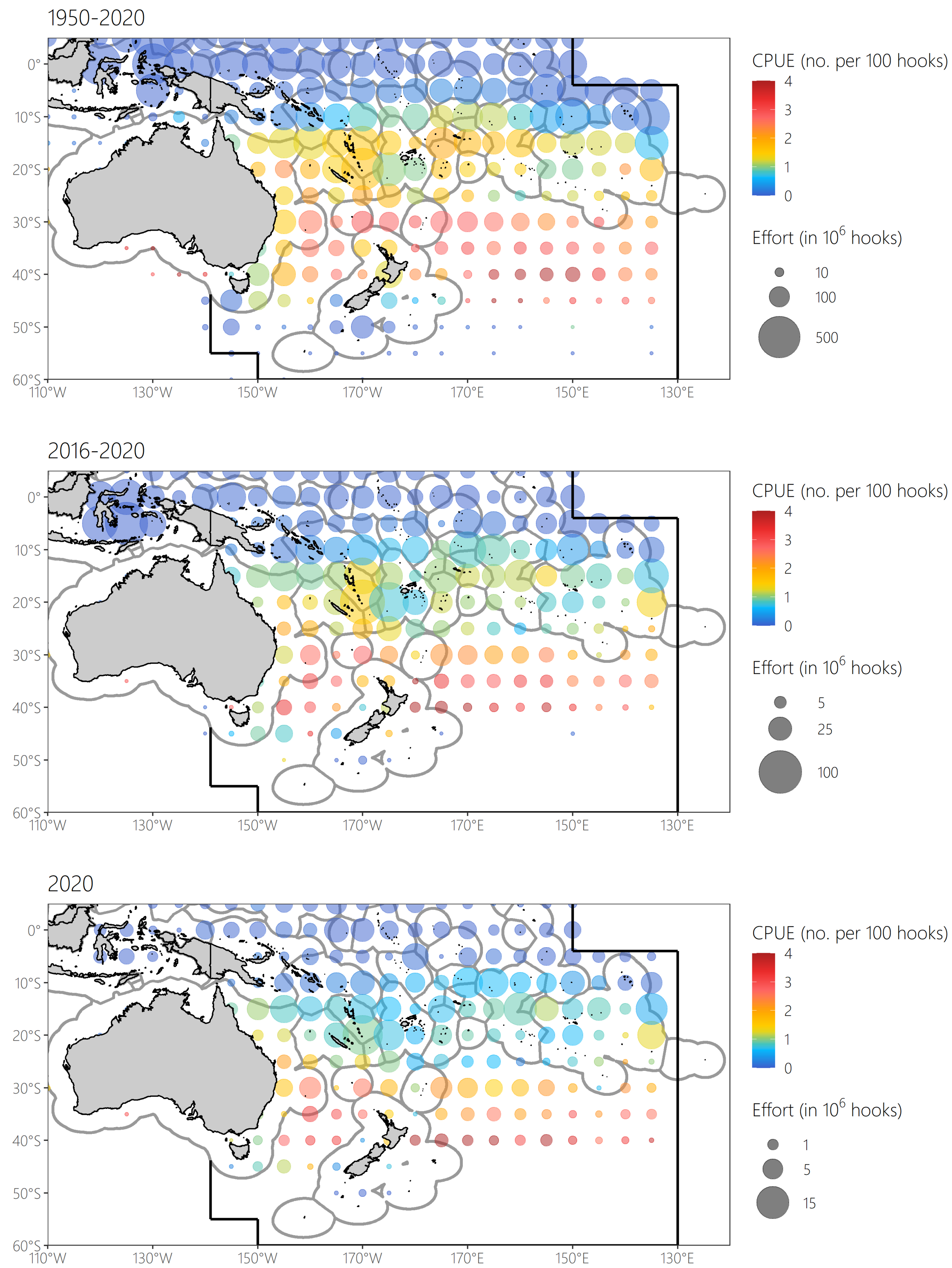


Figure 12: Distribution of 5°x 5° longline effort (represented by circle size) and South Pacific albacore tuna CPUE (represented by colour) for the period 1950-2020 (top), 2016-2020 (middle) and 2020 (bottom). Note the differences in scales between plots.

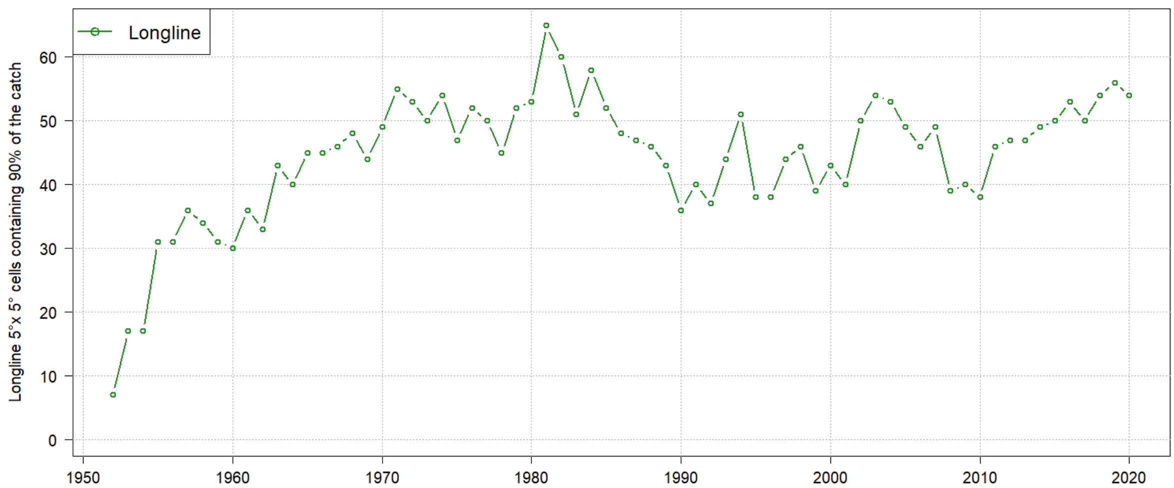


Figure 13: Spatial concentration of South Pacific albacore tuna catch for the longline fishery by year for the WCPO.

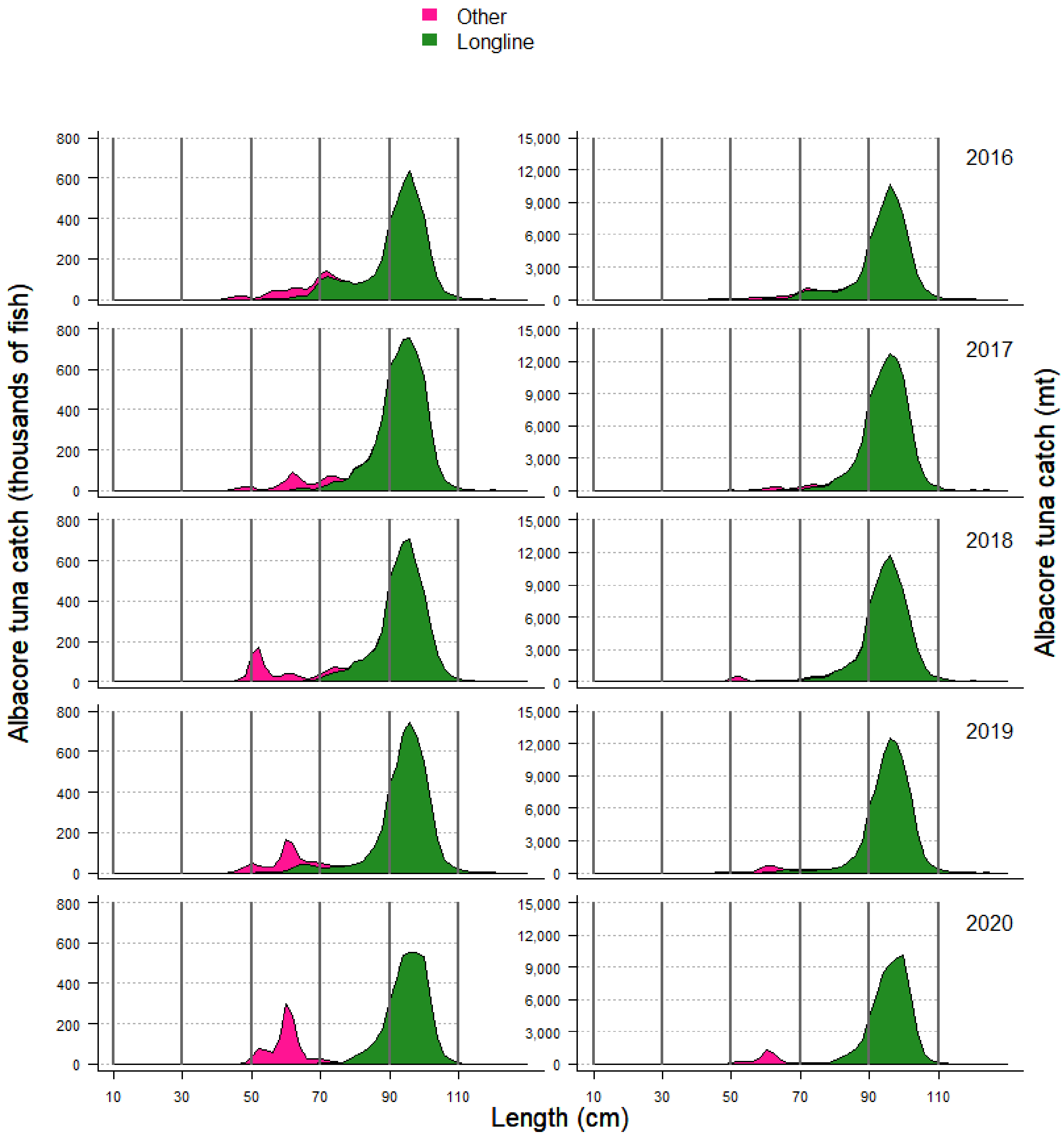


Figure 14: Catch-at-size of South Pacific albacore tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). "Other" gear is almost entirely troll caught albacore. The grey vertical lines are guides to aid interpretation.

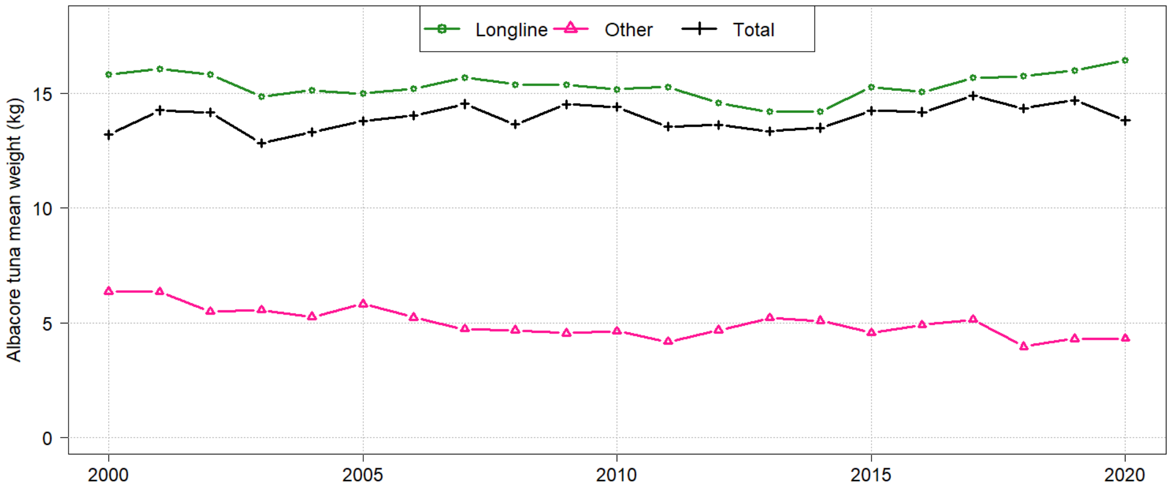


Figure 15: Mean weight of individual South Pacific albacore tuna taken by gear and year for the WCPO. The 'total' line represents the mean albacore weight for the total catch.

Bigeye

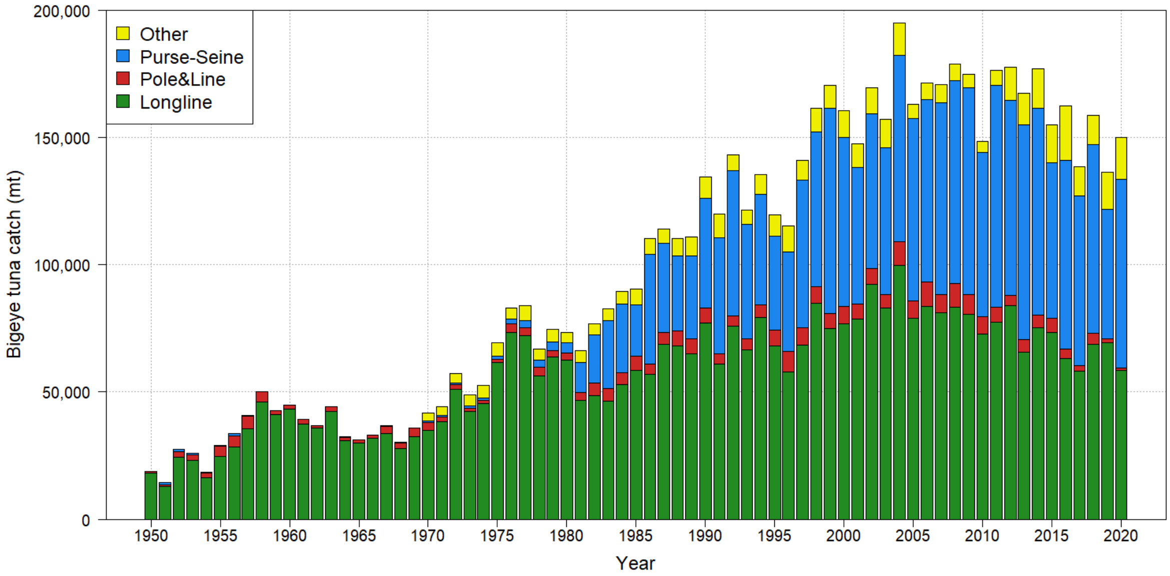


Figure 16: Bigeye tuna catch by gear type and year for the WCPFC-Convention Area.

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.

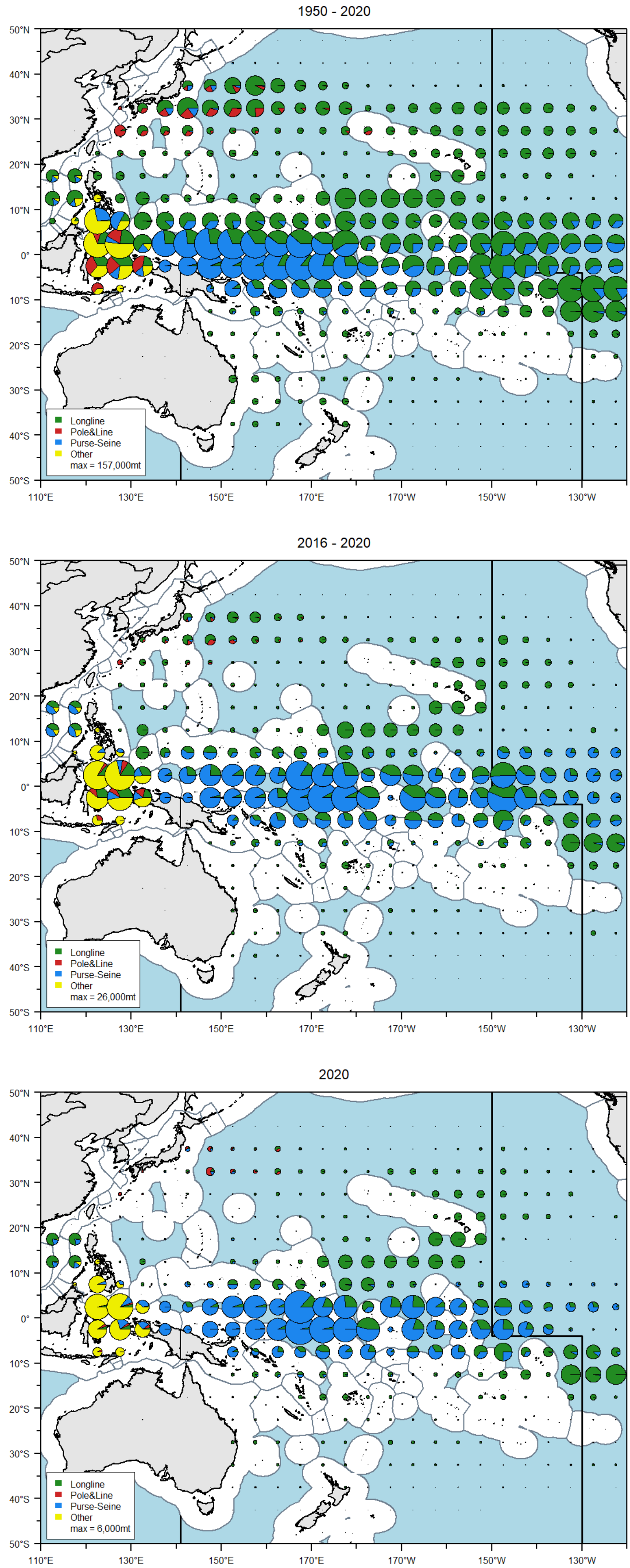


Figure 18: Bigeye tuna catch distribution by gear type and 5^ox 5^o region for the Pacific Ocean for the period 1950-2020 (top), 2016-2020 (middle) and 2020 (bottom). Note that the scale differs between panels and the figure legends provide the catch associated with each maximum circle size.

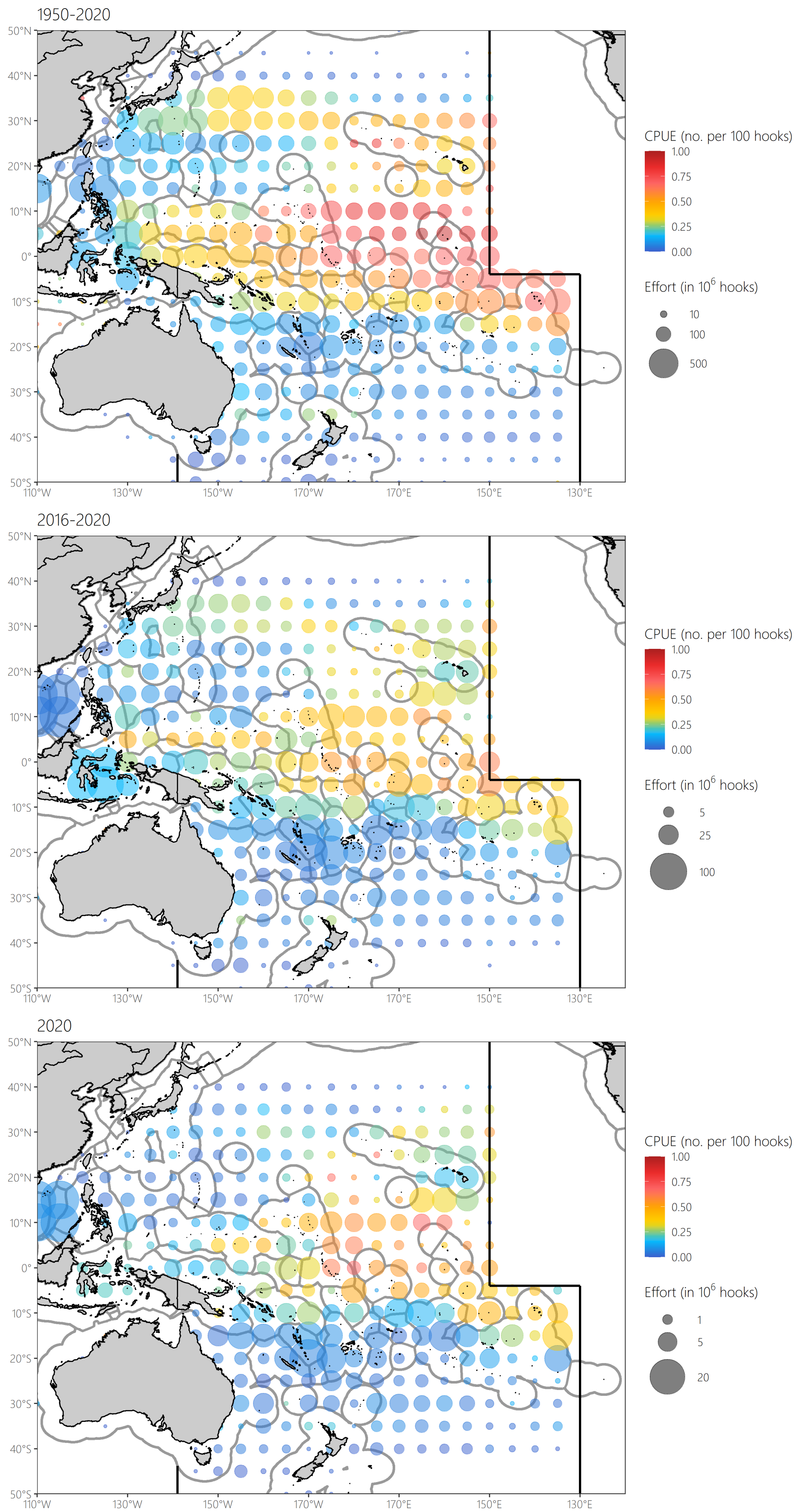


Figure 19: Distribution of 5^{o}x 5^o longline effort (represented by circle size) and bigeye tuna CPUE (represented by colour) for the period 1950-2020 (top), 2016-2020 (middle) and 2020 (bottom). Note the differences in scales between plots.

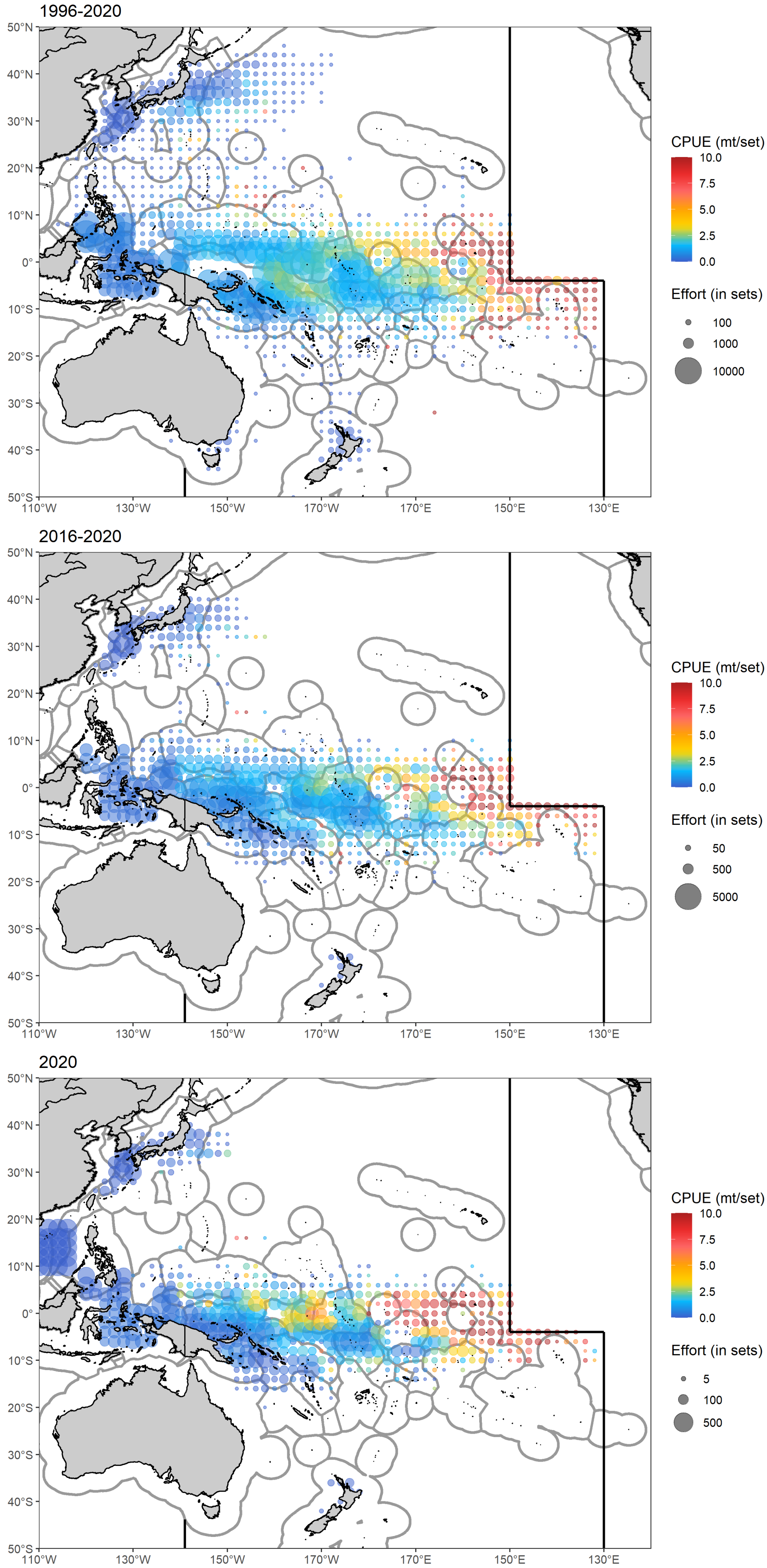


Figure 20: Distribution of 2°x 2° purse seine effort (represented by circle size) and bigeye tuna CPUE (represented by colour) for the period 1996-2020 (top), 2016-2020 (middle) and 2020 (bottom). Note the differences in circle size scale between plots.

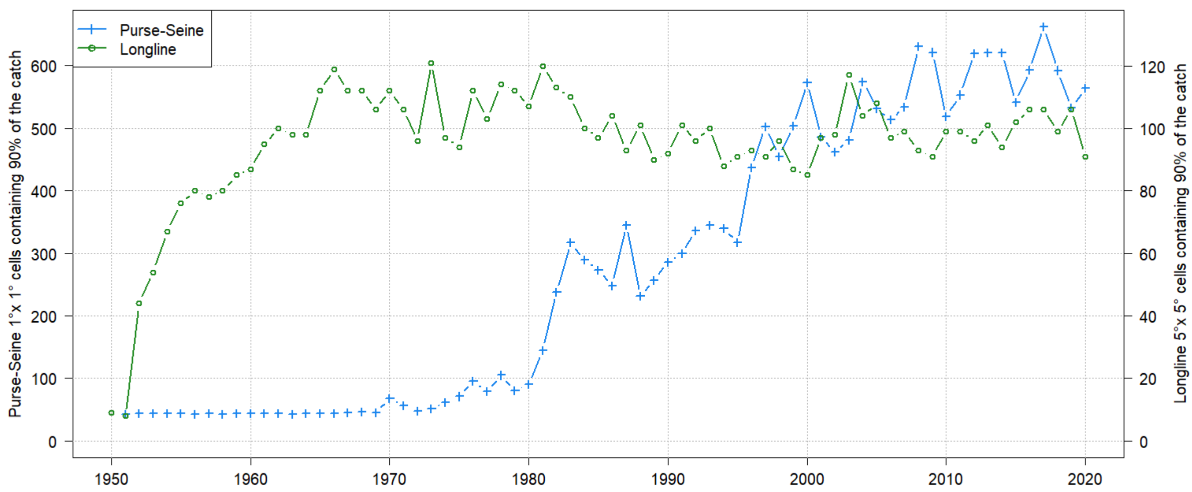


Figure 21: Spatial concentration of bigeye tuna catch for purse seine and longline by year for the WCPO.

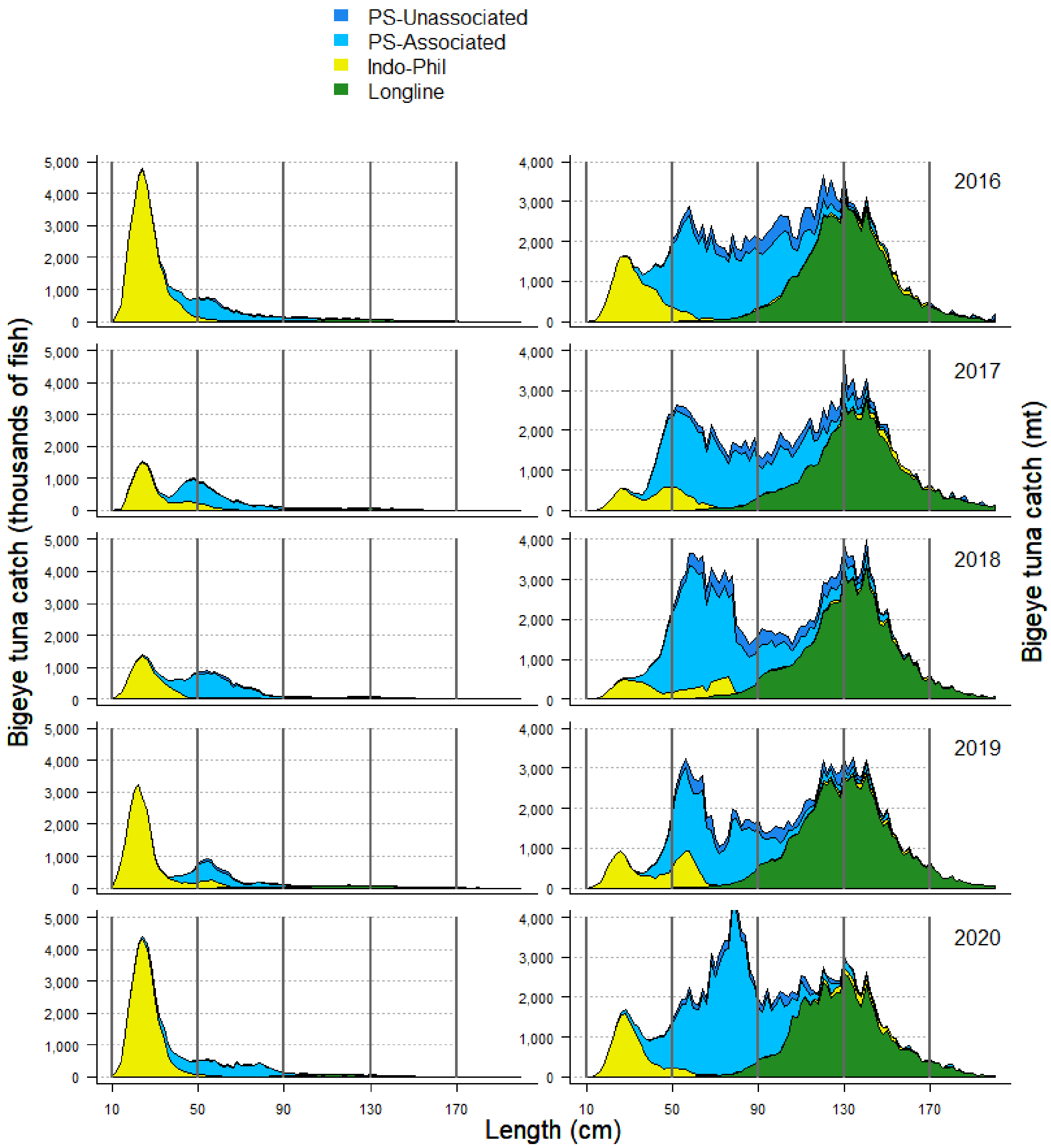


Figure 22: Catch-at-size of bigeye tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). The grey vertical lines are guides to aid interpretation.

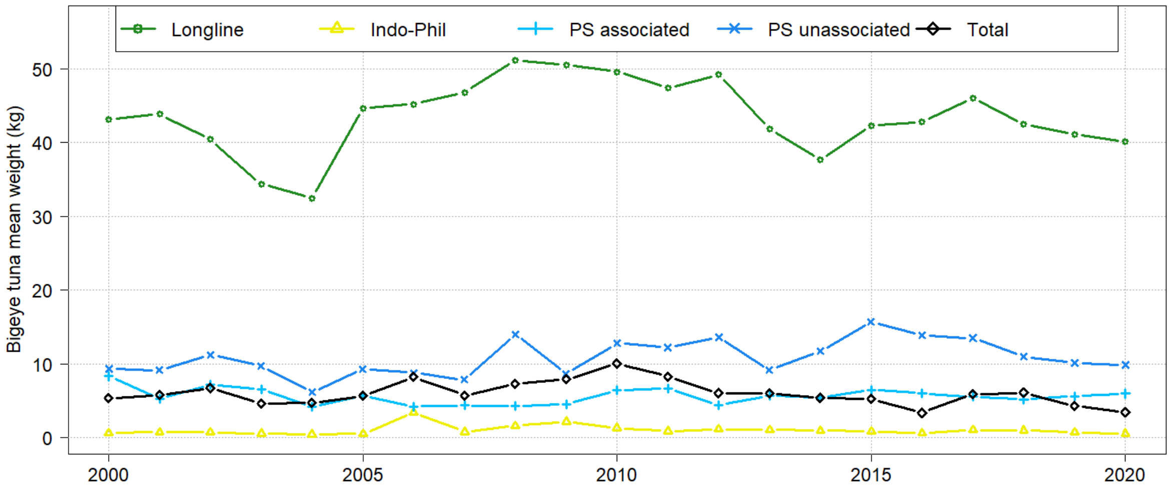


Figure 23: Mean weight of individual bigeye tuna taken by gear and year for the WCPO. The 'total' line represents the mean bigeye weight for the total catch.

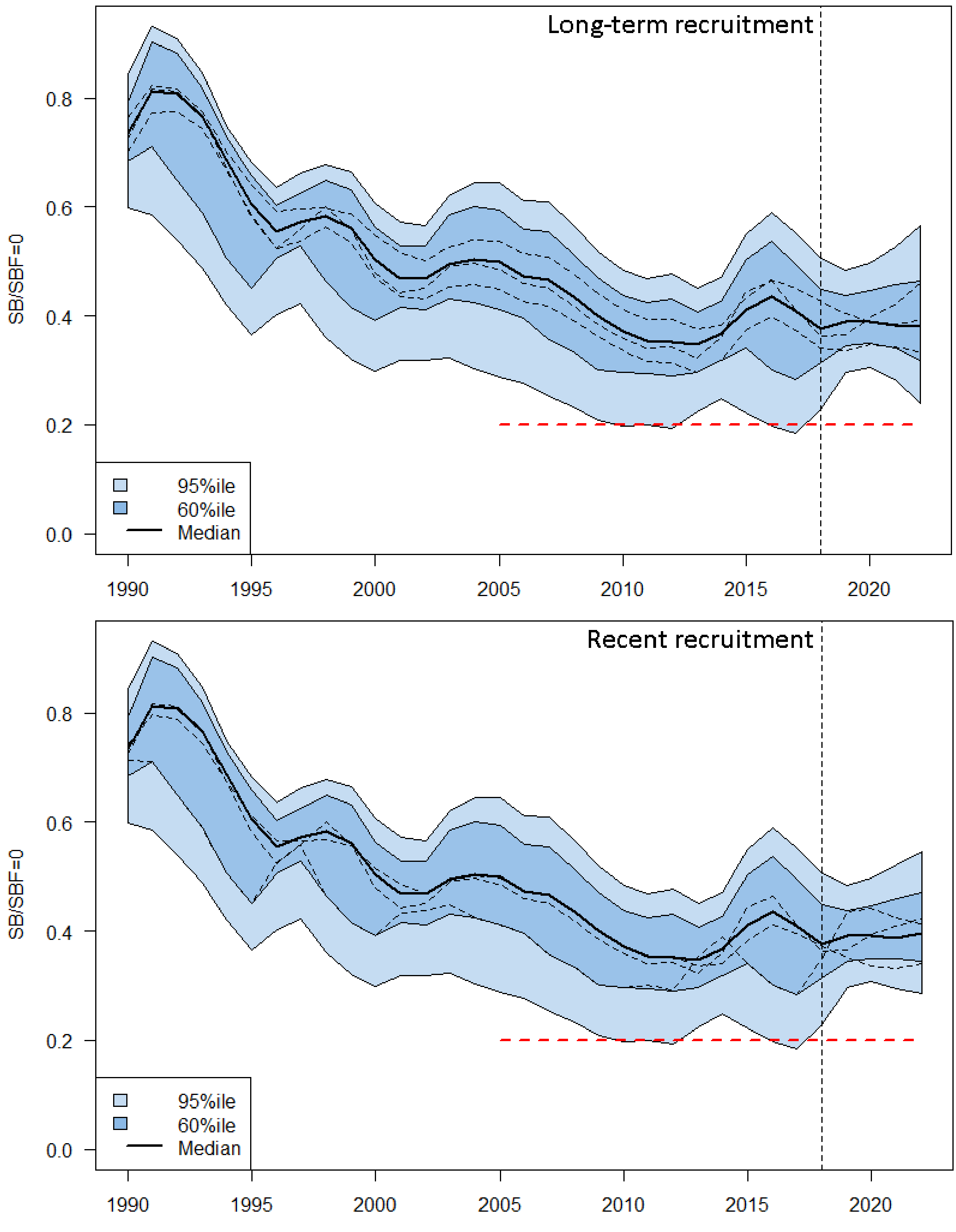


Figure 24: Bigeye spawning biomass depletion ($SB/SB_{F=0}$) from the uncertainty grid of assessment model runs for the period 1990 to 2018 (the vertical line at 2018 represents the last year of the assessment), and stochastic projection results for the period 2019 to 2022 assuming actual catch and effort levels in 2019 and 2020, and that 2020 fishing levels continued until 2022. During the projection period (2019-2022) levels of recruitment variability are assumed to match those over the time period used to estimate the "long-term" stock-recruitment relationship (1962-2016, top panel) and "recent" stock recruitment relationship (2007-2016, bottom panel). The solid black line shows the median annual depletion values (for grid model estimates prior to 2019 and for grid model projections for 2019-2022). The dashed lines indicate three example trajectories (chosen randomly out of 2400) from the model grid; the dark and light blue areas contain 60 and 95%, respectively, of depletion estimates for each year. The red dashed line represents the agreed limit reference point of $20\%SB_{F=0}$.

Yellowfin

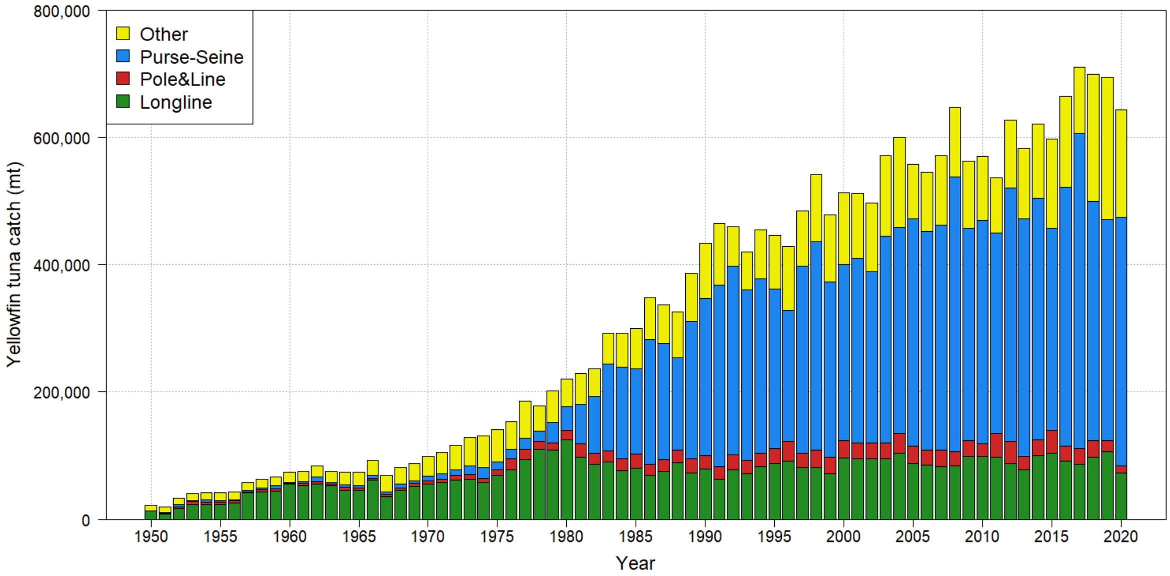


Figure 25: Yellowfin tuna catch (mt) by gear type and year for the WCPFC-Convention Area.

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.

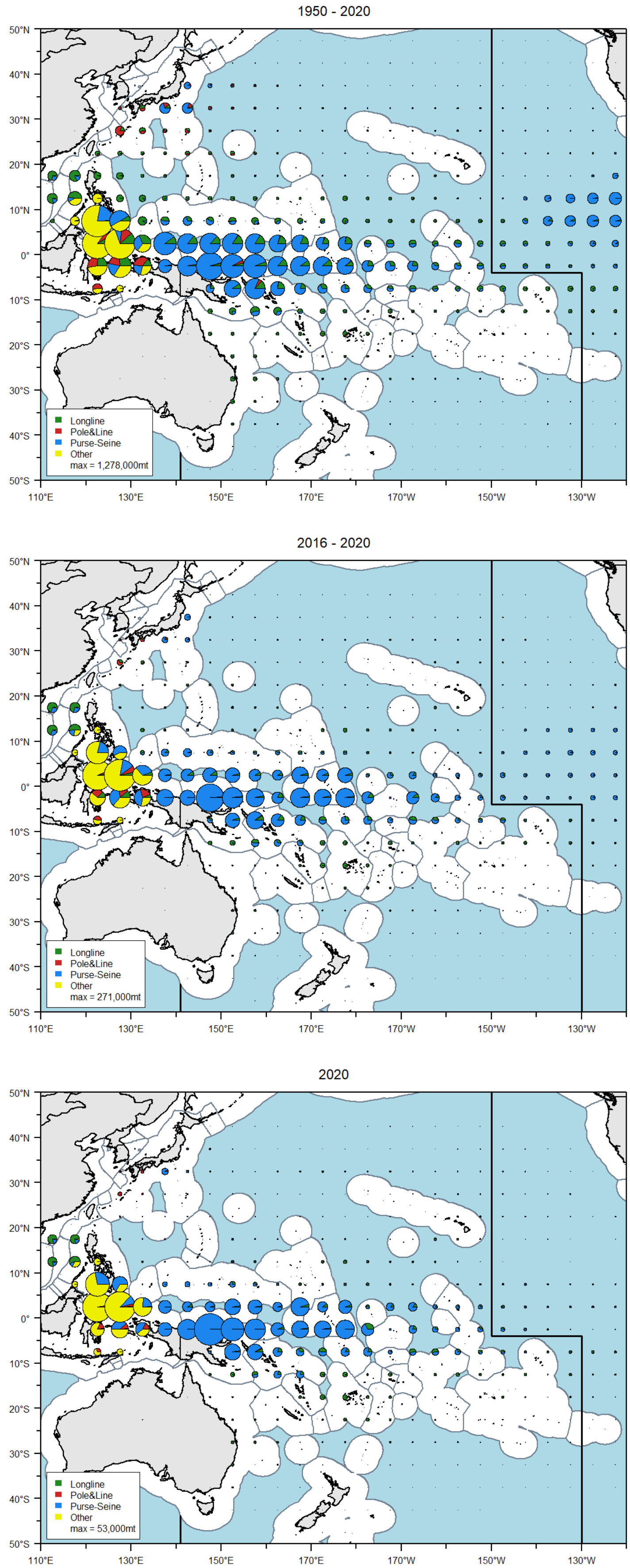


Figure 27: Yellowfin tuna catch distribution by gear type and 5^ox 5^o region for the Pacific Ocean for the period 1950-2020 (top), 2016-2020 (middle) and 2020 (bottom). Note that the scale differs between panels and the figure legends provide the catch associated with each maximum circle size.

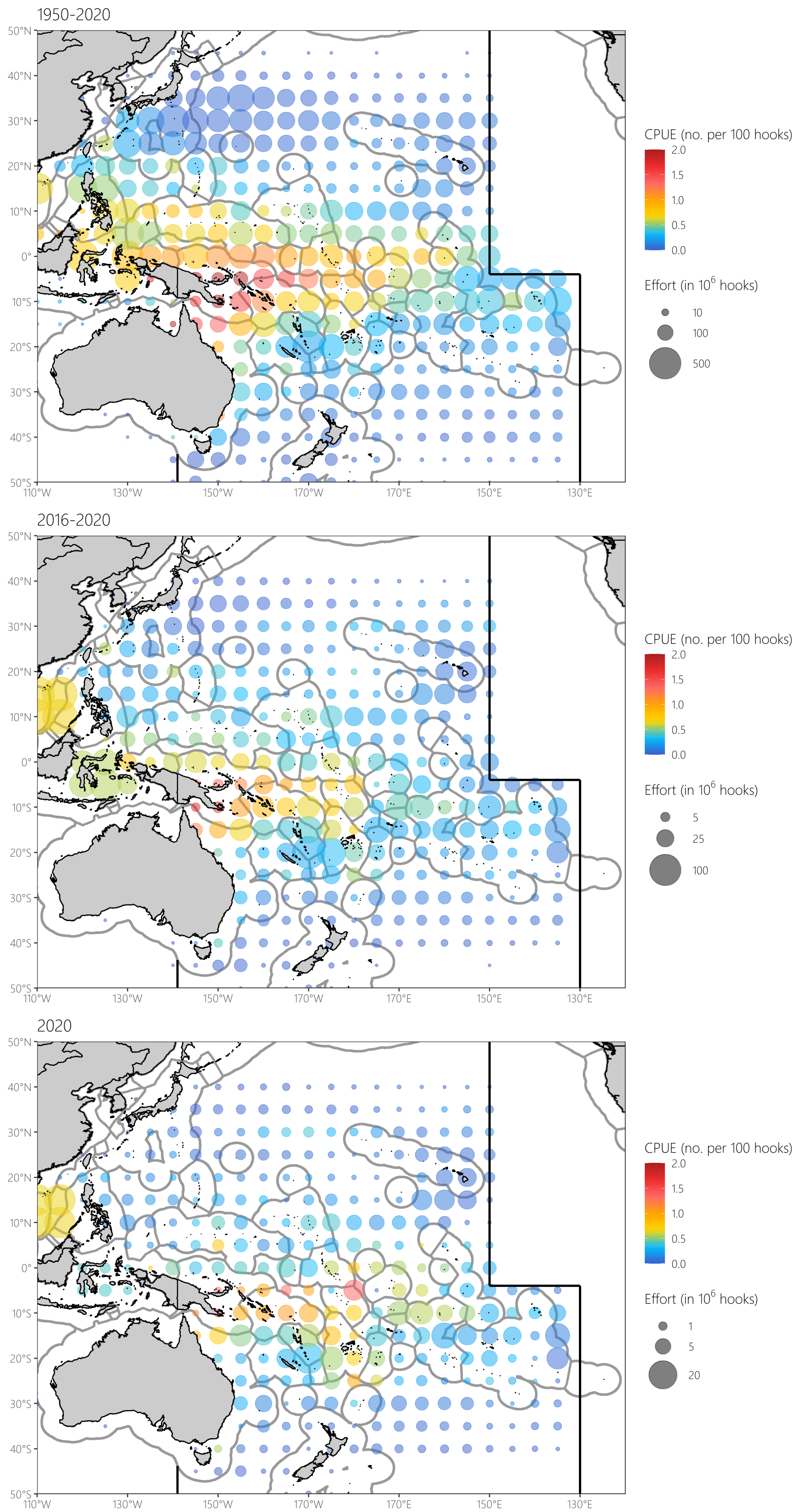


Figure 28: Distribution of 5°x5° longline effort (represented by circle size) and yellowfin tuna CPUE (represented by colour) for the period 1950-2020 (top), 2016-2020 (middle) and 2020 (bottom). Note the differences in scales between plots.

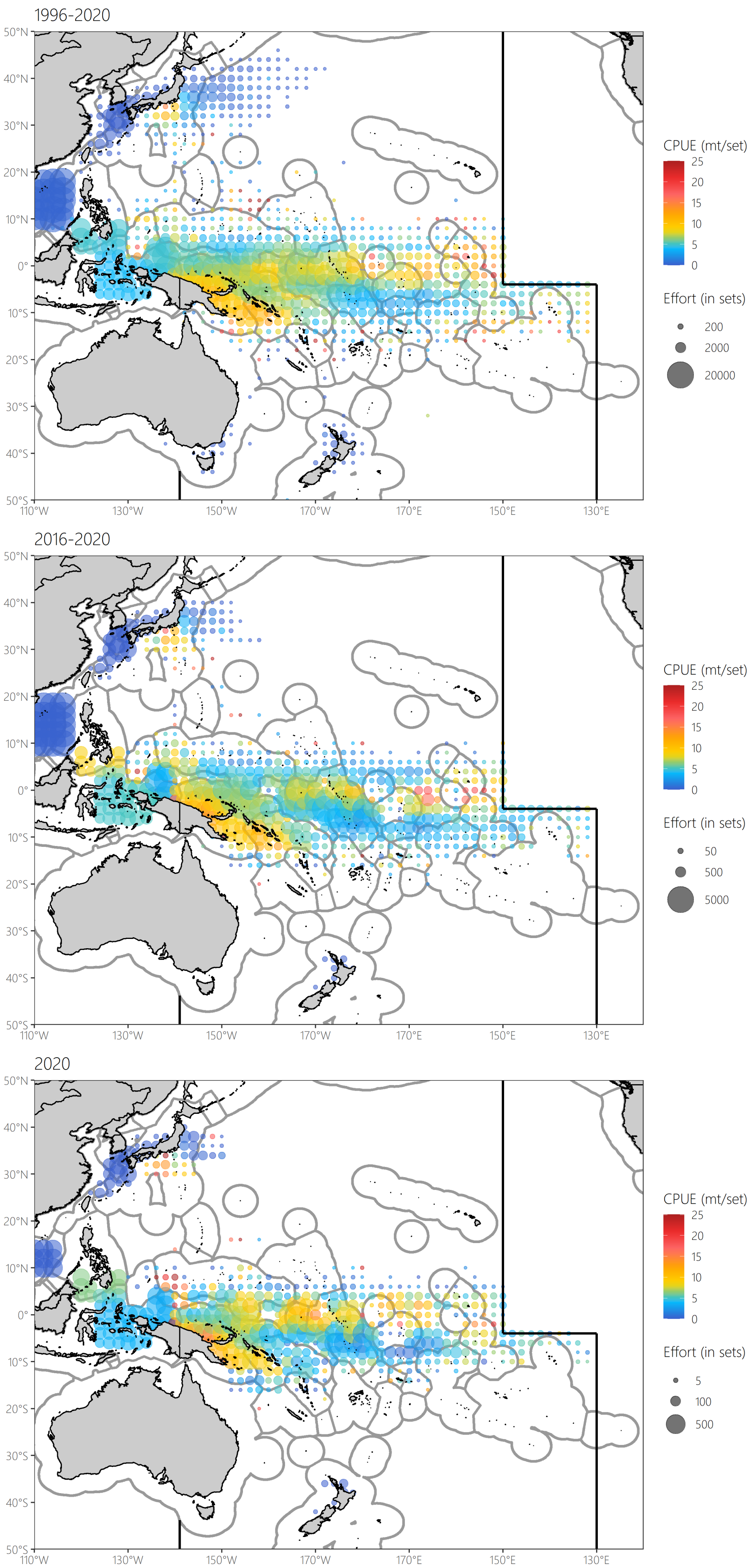


Figure 29: Distribution of 2^ox 2^o purse seine effort (represented by circle size) and yellowfin tuna CPUE (represented by colour) for the period 1996-2020 (top), 2016-2020 (middle) and 2020 (bottom). Note the differences in circle size scale between plots.

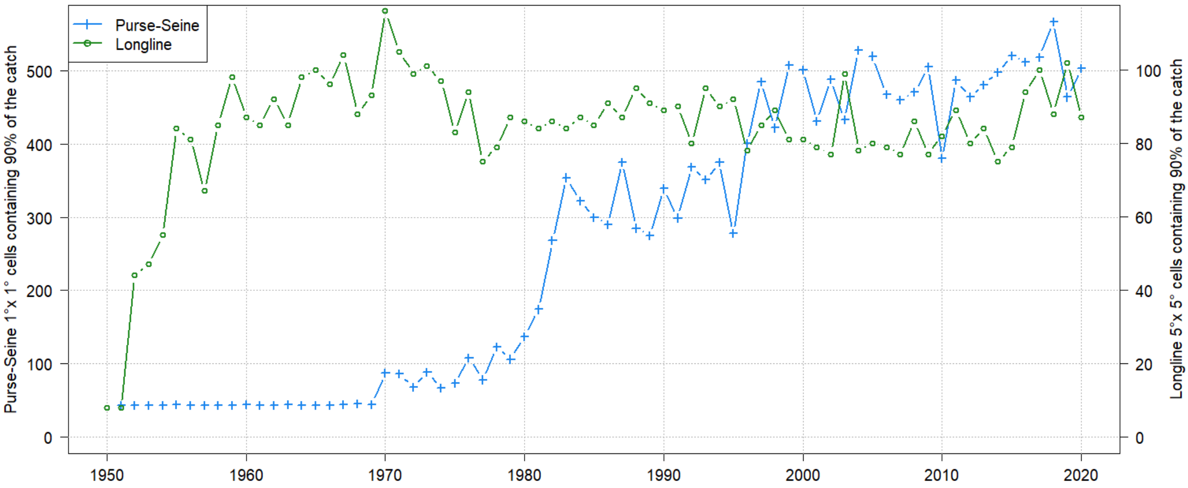


Figure 30: Spatial concentration of yellowfin tuna catch for purse seine and longline by year for the WCPO.

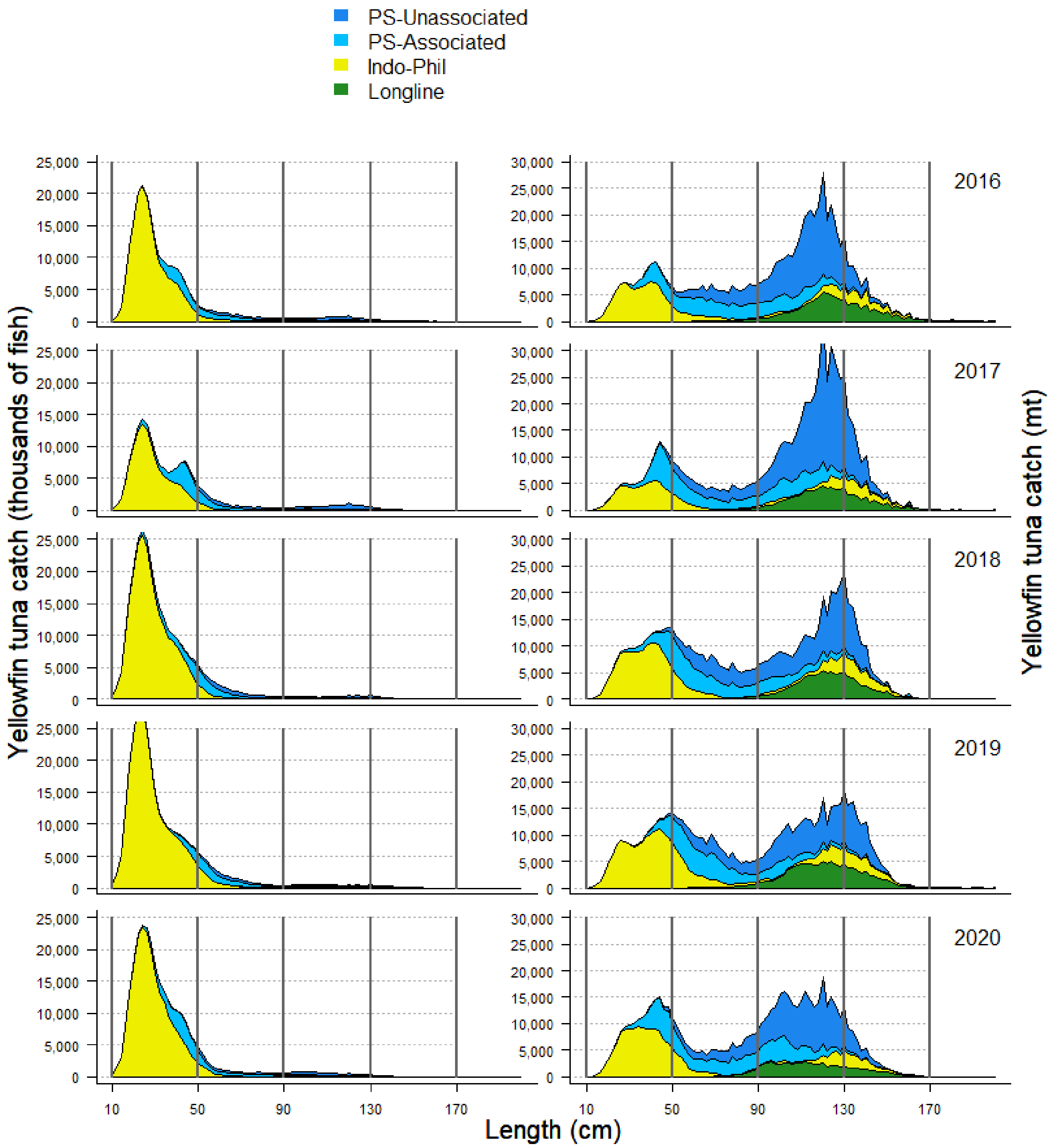


Figure 31: Catch-at-size of yellowfin tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). The grey vertical lines are guides to aid interpretation.

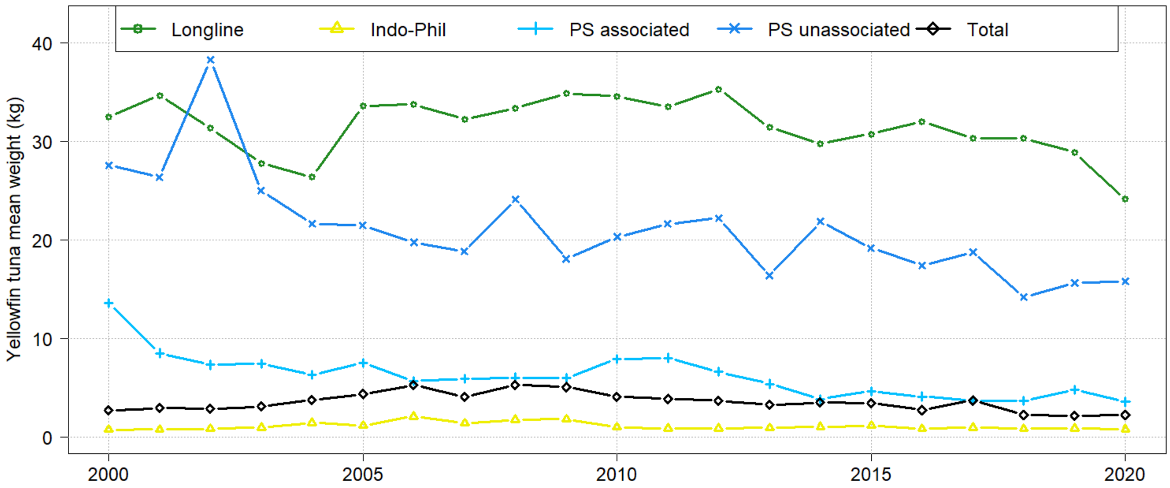


Figure 32: Mean weight of individual yellowfin tuna taken by gear and year for the WCPO. The 'total' line represents the mean yellowfin weight for the total catch.

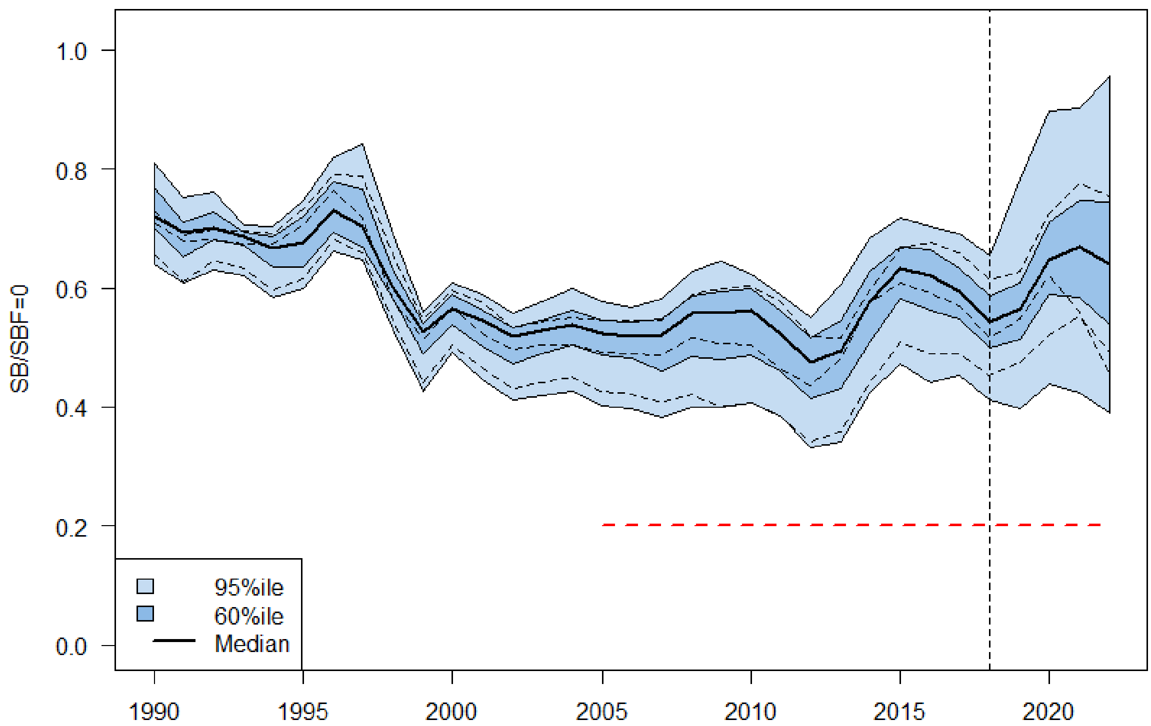


Figure 33: Yellowfin spawning biomass depletion ($SB/SB_{F=0}$) from the uncertainty grid of assessment model runs for the period 1990 to 2018 (the vertical line at 2018 represents the last year of the assessment), and stochastic projection results for the period 2019 to 2022 assuming actual catch and effort levels in 2019 and 2020, and that 2020 fishing levels continued until 2022. During the projection period (2019-2022) levels of recruitment variability are assumed to match those over the time period used to estimate the stock-recruitment relationship (1962-2017). The solid black line shows the median annual depletion values (for grid model estimates prior to 2019 and for grid model projections for 2019-2022). The dashed lines indicate three example trajectories (chosen randomly out of 5400) from the model grid; the dark and light blue areas contain 60 and 95%, respectively, of depletion estimates for each year. The red dashed line represents the agreed limit reference point of $20\%SB_{F=0}$.