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A compendium of fisheries indicators for tuna stocks

WCPFC-SC14-2018/ SA-WP-02

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Contents

1 Executive Summary

The principle purpose of this paper is to provide empirical information on recent patterns in fisheries for the SC's consideration. For SC14, we present a compendium of fishery indicators for all 'key' target tuna species (skipjack, bigeye, yellowfin and south Pacific albacore tuna), with skipjack and yellowfin being the target tuna species for which full stock assessments have not been conducted this year. Trends for south Pacific albacore tuna are also described in the regular requested stand-alone paper Brouwer et al. (2018).

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 13 July 2018. Commentary provided in this paper typically relates to comparisons of the values of various indicators to previous years, in particular comparisons of 2017 values to 2016 and to the average over 2012-2016.

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 skipjack, bigeye and yellowfin stocks are also presented to assess potential stock status at the end of 2019 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: Development and reporting of stock indicators for those key species not formally assessed), stock indicators were first reported to SC4 in 2008 by the paper of Hampton and Williams (2008). Indicators for all key tuna species were reported in 2012 (Harley and Williams, 2012); 2013 (Harley and Williams, 2013); 2016 (Pilling et al., 2016); and 2017 (Pilling et al., 2017). 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 skipjack and yellowfin being the two stocks not assessed in 2018. Commentary provided in this paper compares the values of various indicators to previous years, in particular comparisons of 2017 values to 2016 and to the average over 2012-2016. Short-term stochastic projections for skipjack, bigeye and yellowfin specifically are also included for further information. For these, the stocks were projected forward from 2015, using the most recent assessments (McKechnie et al., 2016; Tremblay-Boyer et al., 2017; (Vincent et al., 2018)). 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 SC12 and SC13 as appropriate. For skipjack and yellowfin all axes of uncertainty were equally weighted (weighting = 1), and for bigeye runs were weighted with a 3:1 weighting consistent with the decisions of SC13. Stocks were projected through to 2016 (bigeye and yellowfin) or 2016 to 2017 (skipjack) based upon the actual fishing levels by fleet, and then through to 2019 based upon the assumption that levels of effort or catch would remain constant at that level. For both bigeye and yellowfin, we note that the near-future stock status will largely be determined 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

A range of indicators are provided in the following series of plots, which are based upon an equally wide range of data extracts. 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 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 Steven Hare 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 2017 was 1,624,162, a 9% decrease from 2016 and comparable to the average from 2012-2016. Purse seine catch in 2017 (1,280,311t) was a 7% decrease from 2016 and a 12% decrease from the 2012-2016 average. Pole and line catch (123,132t) was a 21% decrease from 2016 and a 23% decrease from the average 2012-2016 catch. Catch by other gear (218,175t) was a 13% decrease from 2016 and 1% decrease from the average catch in 2012-2016.
Figure 2 - top	Tropical pole and line CPUE	Pole and line CPUE for the Japanese fleet in 2017 (4.49t per day) was a 22% decrease from 2016 and a 34% decrease from the 2012-2016 average. At the time of writing this report, we had no 2017 data for the Solomon Islands.
Figure 2 - bottom	Tropical purse seine CPUE	Free-school CPUE in 2017 (12.32t per day) was a 19% decrease from 2016 and a 31% decrease from the 2012-2016 average. Log CPUE in 2017 (15.92t per day) was a 23% decrease from 2016 and a 26% decrease from the 2012-2016 average. Drifting FAD CPUE in 2017 (20.09t per day) was a 16% decrease from 2016 and a 31% decrease from the 2012-2016 average. Anchored FAD CPUE in 2017 (10.27t per day) was a 19% increase from 2016 and a 18% increase from the 2012-2016 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 2017 (and to a lesser extent, over 2013-2017) 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.
Figure 5	Spatial distribution of catch	90% of the purse seine catch in 2017 was taken in 717 1x1 degree squares. This was a 7% increase on 2016 and a 15% increase on 2012-2016 average. 90% of the pole and line catch was taken in 175 1x1 degree squares. This was a 36% decrease on 2016 and a 41% decrease on 2012-2016 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.
Figure 7	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2017 (1.99kg) was 9% decrease from 2016 and a 7% decrease from the average in 2012-2016. The mean weight of pole and line caught fish (2.12kg) was 4% decrease from 2016 and a 22% decrease from the average in 2012-2016. The mean weight of Indonesia / Philippines domestic caught fish (0.66kg) was 4% increase from 2016 and a 20% decrease from the average in 2012-2016. The mean weight of free-school caught purse seine fish (4.04kg) was 2% decrease from 2016 and a 5% increase from the average in 2012-2016. The mean weight of FAD caught fish (2.9kg) was 4% decrease from 2016 and a 25% increase from the average in 2012-2016.
Figure 8	Stochastic stock projections	Under recent fishery conditions, the skipjack stock was initially projected to decline as recent relatively high recruitments move out of the stock. Median $F_{2019}/F_{MSY} = 0.47$; median $SB_{2019}/SB_{F=0} = 0.45$; median $SB_{2019}/SB_{MSY} = 1.67$. In the longer-term (not shown), under recent conditions and the assumption of long-term recruitment patterns, the stock was projected to recover to around the interim TRP ($SB/SB_{F=0} = 0.5$): median $SB_{2029}/SB_{F=0} = 0.49$.

South Pacific albacore tuna

Figure	Indicator	Description
Figure 9	Total catch by gear	Total south Pacific catch in 2017 was 92,291, a 35% increase from 2016 and a 14% increase from the average 2012-2016. Longline catch in 2017 (89,388t) was a 36% increase from 2016 and a 14% increase from the 2012-2016 average. Catch by other gear - almost all troll - (2,875t) was a 17% increase from 2016 and 2% decrease from the average catch in 2012-2016. For the southern WCPCA, was 75,707, a 33% increase from 2016 and a 13% increase from the average 2012-2016. Longline catch in 2017 (72,785t) was a 34% increase from 2016 and a 14% increase from the 2012-2016 average. Troll catch (2,896t) was a 17% increase from 2016 and 1% decrease from the average catch in 2012-2016. Note that numbers will differ slightly to those tabulated in the albacore trends paper (Brouwer et al., 2018).
Figure 10	Southern longline CPUE (south of 10^{o}S)	Japanese longline CPUE in 2017 (1.36 fish per 100 hooks) was a 13% increase from 2016 and a 8% decrease from the 2012-2016 average. Korean longline CPUE (0.33 fish per 100 hooks) was a 51% decrease from 2016 and a 27% decrease from the 2012-2016 average. Chinese longline CPUE (2 fish per 100 hooks) was a 20% increase from 2016 and a 41% increase from the 2012-2016 average. Finally, Chinese Taipei longline CPUE in 2017 (1.93 fish per 100 hooks) was a 1% increase from 2016 and a 9% increase from the 2012-2016 average.
Figure 11	Maps of catch by gear	In recent years, catches have concentrated in the 10-20^{o}S latitudinal band. While 2017 estimates remain provisional, slightly higher catch is seen in the high seas.
Figure 12	Longline effort and CPUE maps	Over the whole period, catch rates have been highest south of 10^{o}S. In the more recent period, catch rates have been relatively high within high seas areas and in the 15-20^{o}S band. Catch rates in 2017 appear lower than across previous years.
Figure 13	Spatial distribution of catch	90% of the longline catch in 2017 was taken in 48 5x5 degree squares of the southern WCPO. This was a 9% decrease from 2016 and a 2% decrease from the 2012-2016 average.
Figure 14	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 15	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2017 (15.14kg) was a 4% increase from 2016 and a 9% increase from the 2012-2016 average. The mean weight of longline caught fish (16.03kg) was a 3% increase from 2016 and a 9% increase from the 2012-2016 average. The mean weight of fish caught in other gears (5.08kg), almost all troll, was a 4% increase from 2016 and a 4% increase from the 2012-2016 average.
NA	Stochastic stock projections	NA - as a new assessment has been undertaken in 2018, and final grid still to be selected by SC, no projection is presented for albacore this year.

Bigeye tuna

Figure	Indicator	Description
Figure 16	Total catch by gear	Total catch in 2017 was 126,929, a 17% decrease from 2016 and a 19% decrease from the average 2012-2016. Longline catch in 2017 (58,164t) was a 8% decrease from 2016 and a 19% decrease from the 2012-2016 average. Purse seine catch in 2017 (56,194t) was a 12% decrease from 2016 and a 13% decrease from the 2012-2016 average. Pole and line catch (1,411t) was a 65% decrease from 2016 and a 70% decrease from the average 2012-2016 catch. Catch by other gear (11,160t) was a 48% decrease from 2016 and 28% decrease from the average catch in 2012-2016.
Figure 17 - top	Tropical pole and line CPUE	Japanese pole and line CPUE in 2017 (0.034t per day) was a 169% increase from 2016 and 108% increase from the average catch in 2012-2016.
Figure 17 - middle	Tropical purse seine CPUE	Free-school CPUE in 2017 (0.2t per day) was a 20% decrease from 2016 and a 16% decrease from the 2012-2016 average. Log CPUE in 2017 (0.85t per day) was a 45% decrease from 2016 and a 50% decrease from the 2012-2016 average. Drifting FAD CPUE in 2017 (1.79t per day) was a 17% decrease from 2016 and a 29% decrease from the 2012-2016 average. Anchored FAD CPUE in 2017 (0.17t per day) was a 60% decrease from 2016 and a 69% decrease from the 2012-2016 average.
Figure 17 - bottom	Tropical longline CPUE (20^{o}N to 10^{o}S)	Japanese longline CPUE in 2017 (0.5 fish per 100 hooks) was a 26% increase from 2016 and 2% increase from the average catch in 2012-2016. Korean longline CPUE (0.51 fish per 100 hooks) was a 5% decrease from 2016 and 12% decrease from the average catch in 2012-2016. US (Hawaiian) longline CPUE (0.33 fish per 100 hooks) was a 4% decrease from 2016 and 12% decrease from the average catch in 2012-2016.
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 timeframe. 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^{o}N) and to the southeast of the tropical region.
Figure 21	Spatial distribution of catch	90% of the longline catch in 2017 was taken in 106 5x5 degree squares of the southern WCPO. This was a a 2% increase from 2016 and a 7% increase from the 2012-2016 average. 90% of the purse seine catch in 2017 was taken in 664 5x5 degree squares of the southern WCPO. This was a 11% increase from 2016 and a 10% increase from the 2012-2016 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) from the Indonesia/Philippines fisheries. Large fish are mostly caught in the longline fisheries.
Figure 23	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2017 (6.66kg) was a 2% decrease from 2016 and a 6% decrease from the average in 2012-2016. The mean weight of longline caught fish (50.5kg) was 19% increase from 2016 and a 19% increase from the average in 2012-2016. The mean weight of Indonesia / Philippines domestic caught fish (1.07kg) was 18% increase from 2016 and a 4% decrease from the average in 2012-2016. The mean weight of free-school caught purse seine fish (15.27kg) was 9% increase from 2016 and a 18% increase from the average in 2012-2016. The mean weight of FAD caught fish (6.41kg) was 6% decrease from 2016 and a 10% increase from the average in 2012-2016.

Figure	Indicator	Description
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, then decline slightly. When assessment run projection results were weighted as per SC13 decisions ('updated new growth' weighted three times higher than 'old growth'), median $F_{2019}/F_{MSY} = 0.96$; median $SB_{2019}/SB_{F=0} = 0.40$; median $SB_{2019}/SB_{MSY} = 1.50$. Weighted risk that $SB_{2019} < LRP = 10\%$. 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 2017 was 670,890, a 4% increase from 2016 and a 12% increase from the average 2012-2016. Purse seine catch in 2017 (472,279t) was a 22% increase from 2016 and a 33% increase from the 2012-2016 average. Longline catch in 2017 (83,399t) was a 6% decrease from 2016 and a 9% decrease from the 2012-2016 average. Pole and line catch (12,219t) was a 48% decrease from 2016 and a 56% decrease from the average 2012-2016 catch. Catch by other gear (102,993t) was a 28% decrease from 2016 and 17% decrease from the average catch in 2012-2016.
Figure 26 - top	Tropical pole and line CPUE	Japanese pole and line CPUE in 2017 (0.086t per day) was a 106% increase from 2016 and 144% increase from the average catch in 2012-2016. At the time of writing this report we had no 2017 data for the Solomon Islands.
Figure 26 - middle	Tropical purse seine CPUE	Free-school CPUE in 2017 (5.25t per day) was a 9% increase from 2016 and a 16% increase from the 2012-2016 average. Log CPUE in 2017 (5.54t per day) was a 2% increase from 2016 and a 1% decrease from the 2012-2016 average. Drifting FAD CPUE in 2017 (4.15t per day) was a 0% decrease from 2016 and a 19% decrease from the 2012-2016 average. Anchored FAD CPUE in 2017 (7.36t per day) was a 1% increase from 2016 and a 24% increase from the 2012-2016 average.
Figure 26 - bottom	Tropical longline CPUE (20^oN to 10^oS)	Japanese longline CPUE in 2017 (0.64 fish per 100 hooks) was a 9% decrease from 2016 and 26% increase from the average catch in 2012-2016. Korean longline CPUE (0.62 fish per 100 hooks) was a 2% increase from 2016 and 0% decrease from the average catch in 2012-2016.
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 timeframe. Relatively high catch rates are now found in the tropical western region of the WCP-CA.
Figure 29	Purse seine effort and CPUE maps	Purse seine CPUE in the recent period has generally been lower than that seen across the longer timeframe. Areas of high CPUE have fragmented over time, across the tropical WCP-CA, and were concentrated in the west of the tropical region in 2017, with some localised high CPUE achieved in other areas.
Figure 30	Spatial distribution of catch	90% of the longline catch in 2017 was taken in 100 5x5 degree squares of the southern WCPO. This was a a 8% increase from 2016 and a 22% increase from the 2012-2016 average. 90% of the purse seine catch in 2017 was taken in 538 5x5 degree squares of the southern WCPO. This was a 1% decrease from 2016 and a 5% increase from the 2012-2016 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.

Figure	Indicator	Description
Figure 32	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2017 (4.33kg) was a 1% decrease from 2016 and a 3% increase from the average in 2012-2016. The mean weight of longline caught fish (32.9kg) was 1% increase from 2016 and a 3% increase from the average in 2012-2016. The mean weight of Indonesia / Philippines domestic caught fish (1.04kg) was 6% decrease from 2016 and a 11% decrease from the average in 2012-2016. The mean weight of free-school caught purse seine fish (16.68kg) was 4% decrease from 2016 and a 16% decrease from the average in 2012-2016. The mean weight of FAD caught fish (7.81kg) was 4% increase from 2016 and a 30% increase from the average in 2012-2016.
Figure 33	Stochastic stock projections	Under recent fishery conditions, the yellowfin stock was initially projected to increase as recent estimated relatively high recruitments support adult stock biomass, then decline slightly. Median $F_{2019}/F_{MSY} = 0.63$; median $SB_{2019}/SB_{F=0} = 0.37$; median $SB_{2019}/SB_{MSY} = 1.51$. Risk that $SB_{2019} < LRP = 6\%$.

Figures

Skipjack

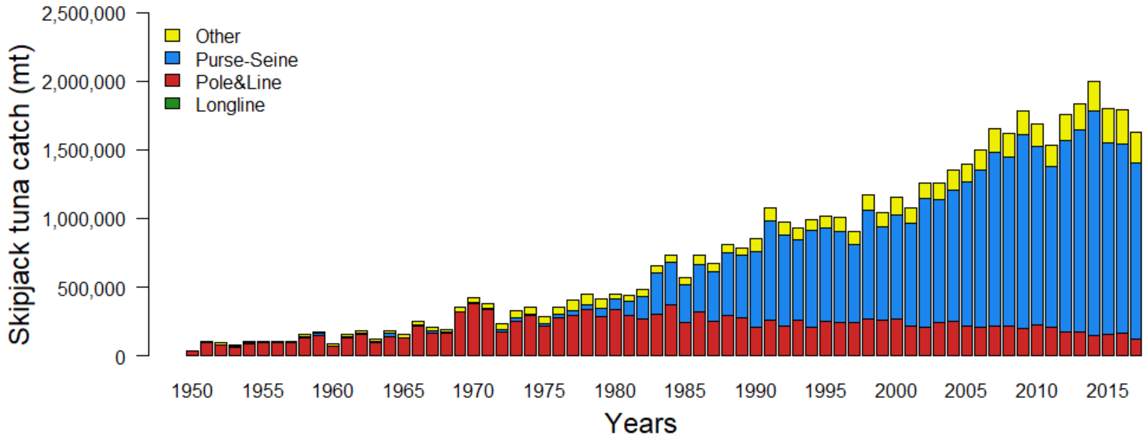


Figure 1: Skipjack tuna catch by gear type and year for the WCPFC-Convention Area.

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.

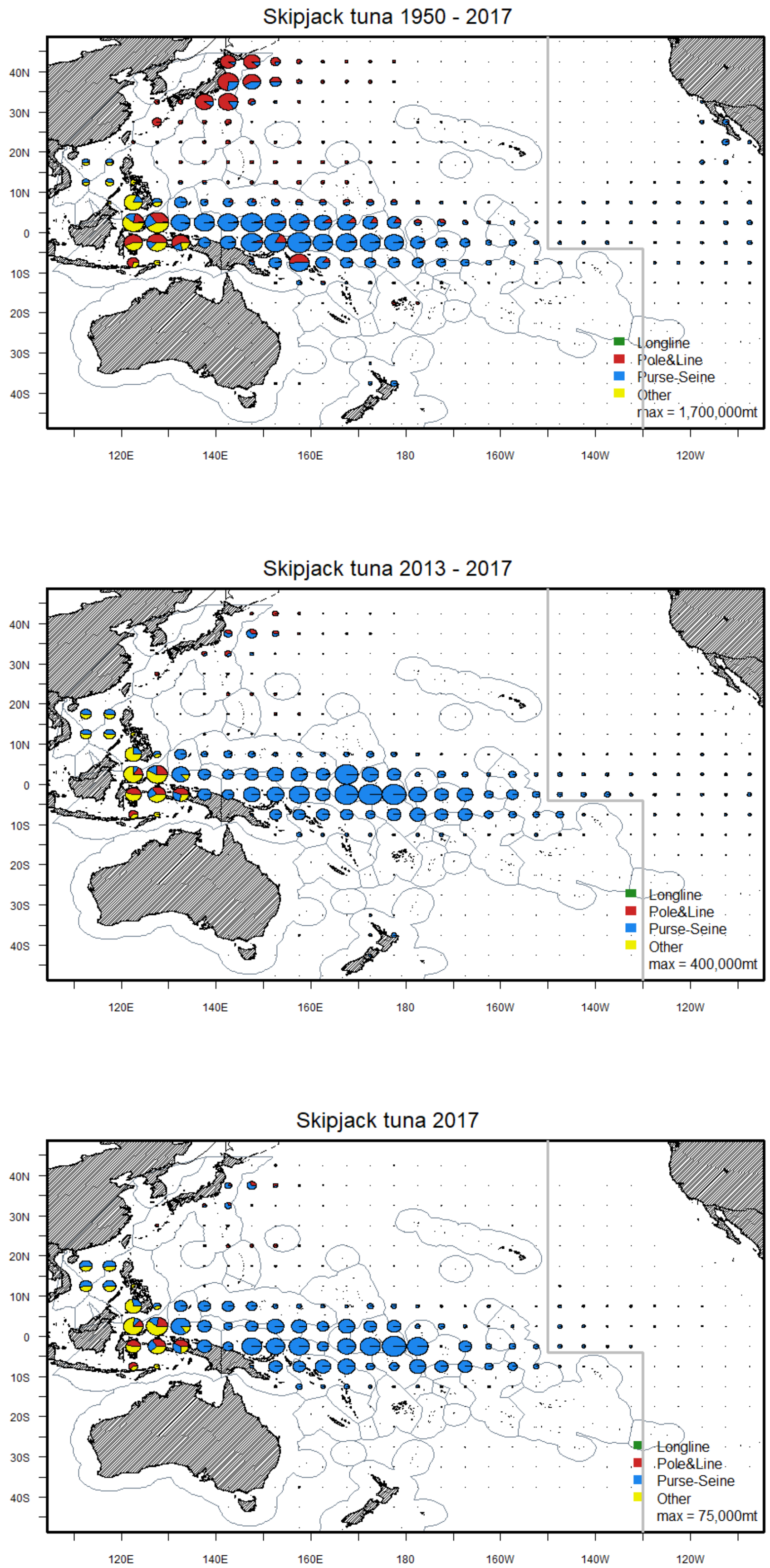


Figure 3: Skipjack tuna catch distribution by gear type and 5x5^o region for the entire Pacific Ocean for the period 1950-2017 (top), 2013-2017 (middle) and 2017 (bottom). The figure legend provides the catch associated with this maximum circle size.

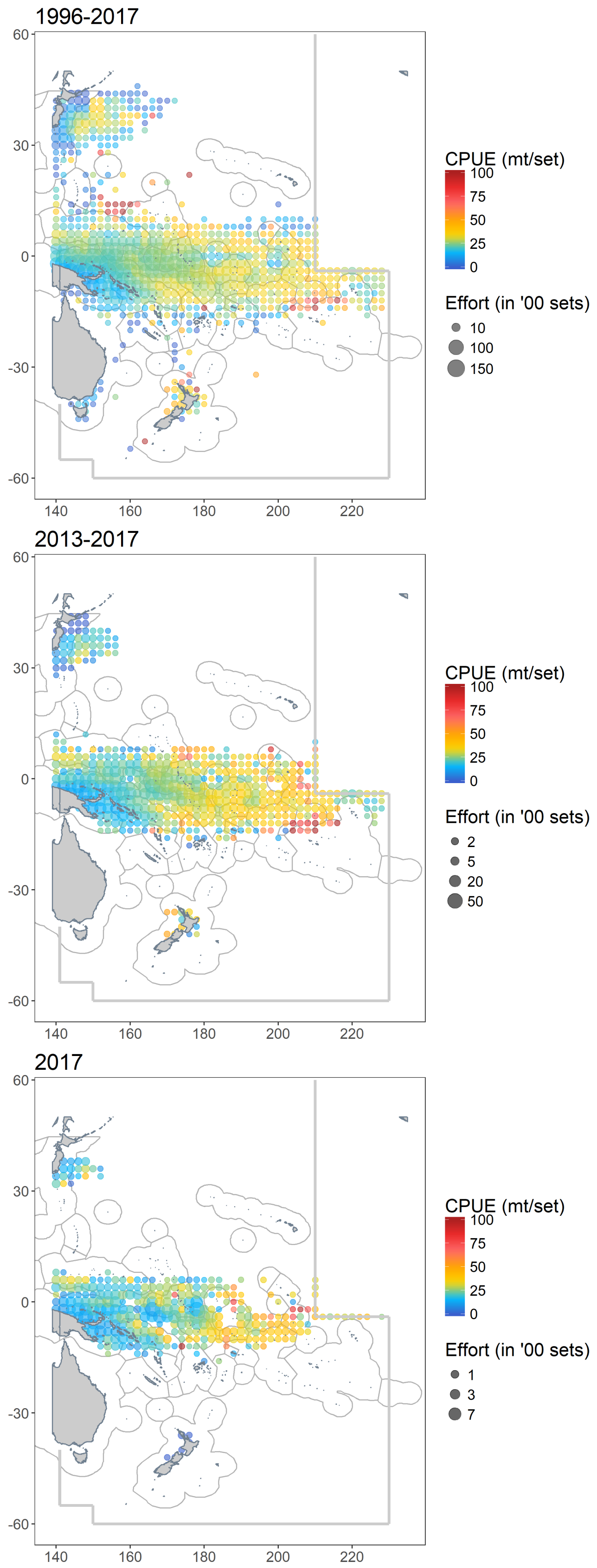


Figure 4: Distribution of purse seine effort (represented by circle size) and skipjack tuna CPUE (represented by colour) for the period 1950-2017 (top), 2013-2017 (middle) and 2017 (bottom). Note the differences in scales between plots.

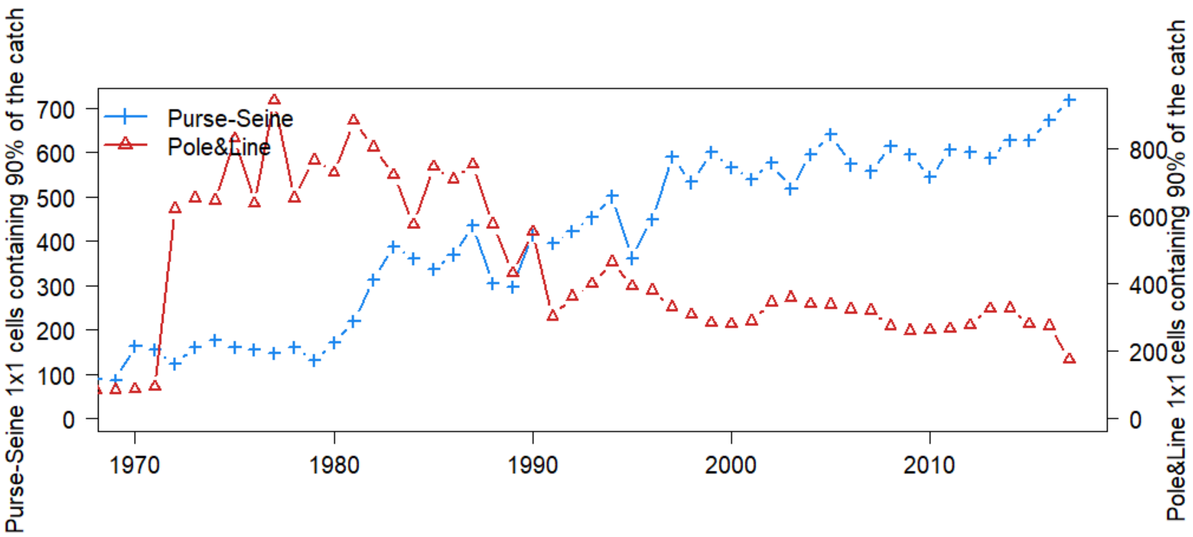


Figure 5: Spatial distribution of skipjack tuna catch for purse seine and pole and line fisheries by year for the WCPO.

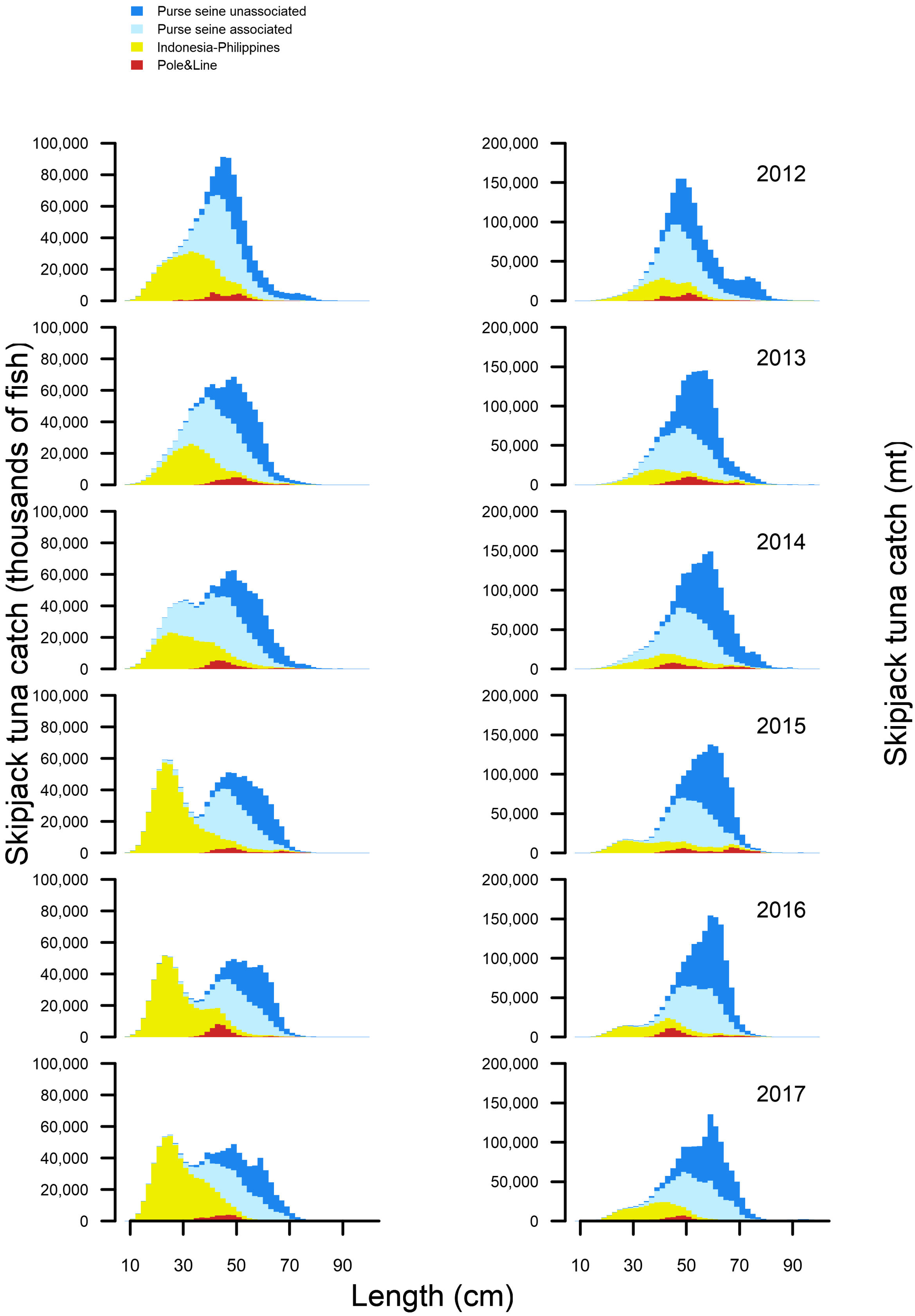


Figure 6: Catch-at-size of skipjack tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right).

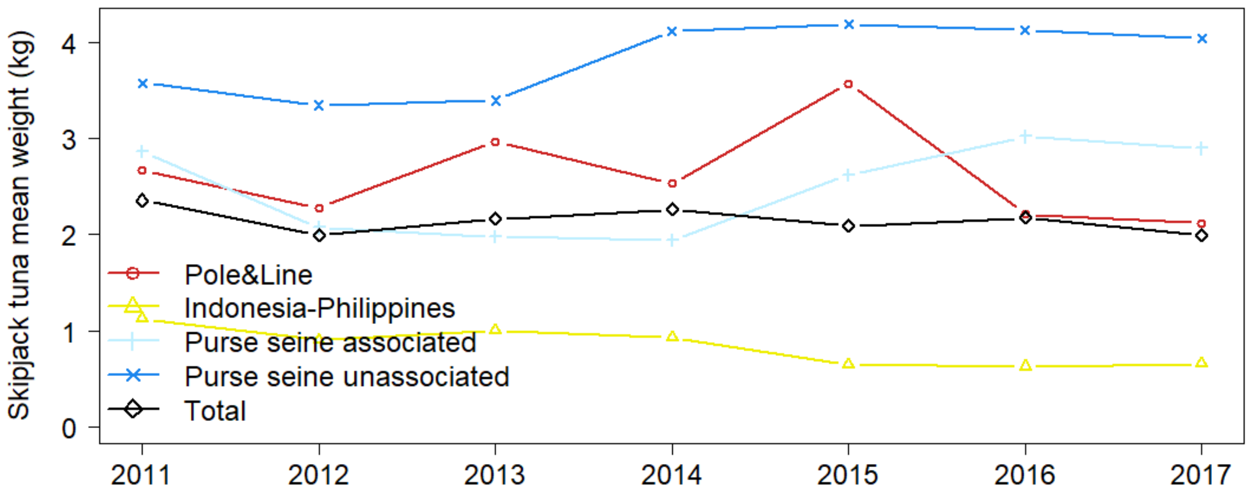


Figure 7: Mean weight of individual skipjack tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.

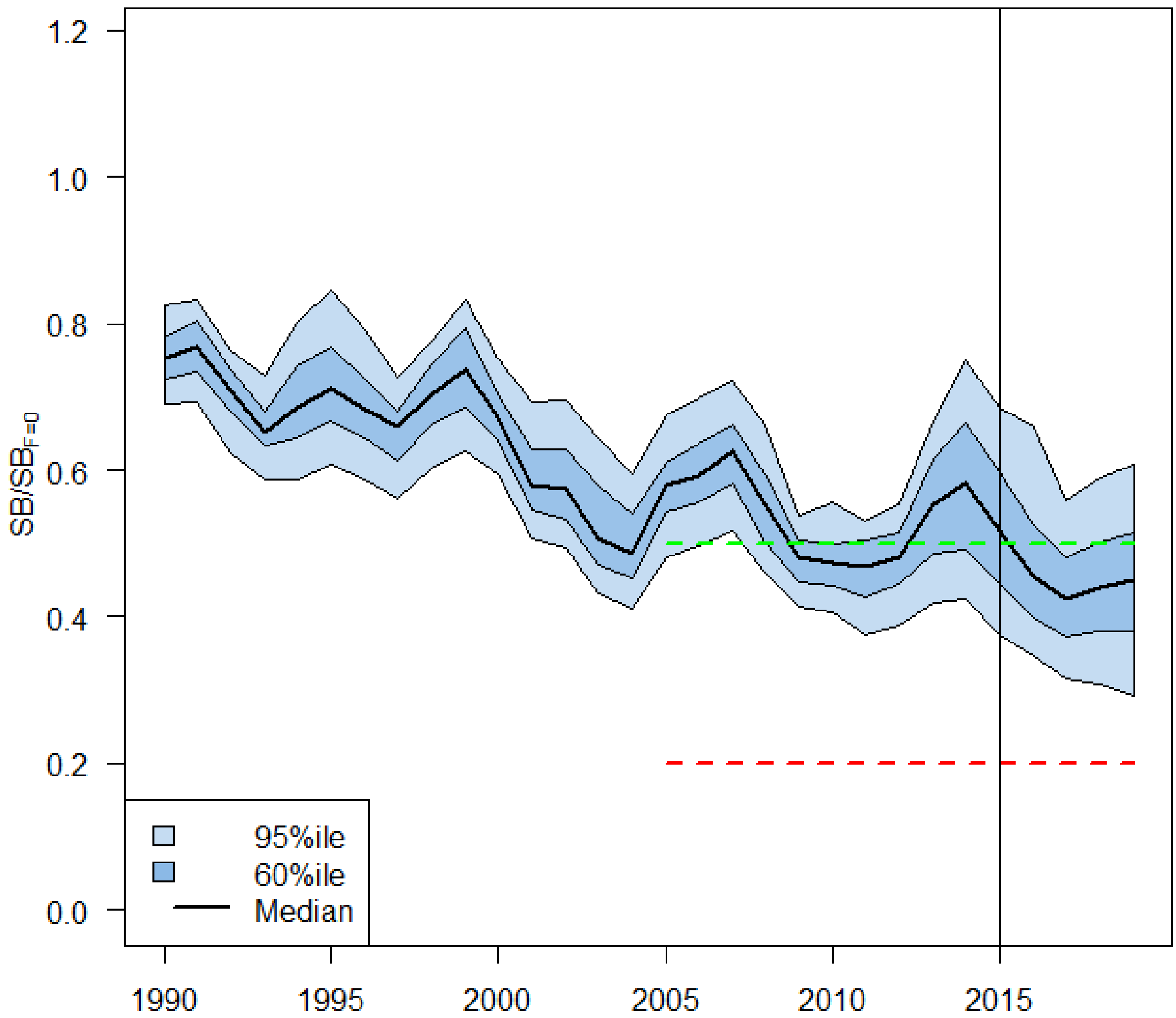
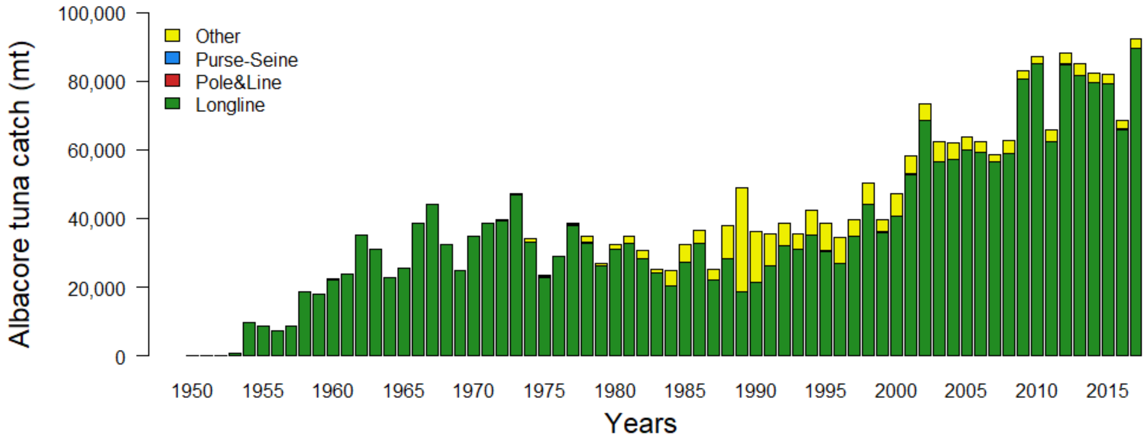


Figure 8: Skipjack spawning biomass (SB/SB$_{F=0}$) from the uncertainty grid of assessment model runs for the period 1990 to 2015 (the vertical line at 2015 represents the last year of the assessment), and stochastic projection results for the period 2016 to 2019 assuming actual catch and effort levels in 2016, and that 2017 catch and effort levels were fixed from 2017 to 2019. During the projection period (2016-2019) levels of recruitment variability are assumed to match those over the time period used to estimate the stock-recruitment relationship (1982-2014). The green and red dashed lines represent the agreed target and limit reference points respectively.

South Pacific albacore



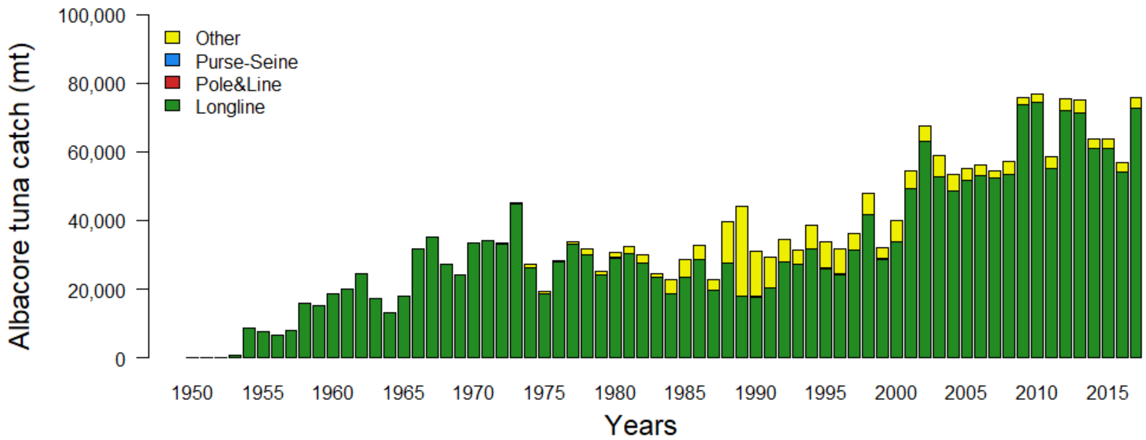


Figure 9: South Pacific albacore tuna catch by gear type and year for the south Pacific as a whole (top) and WCPFC-CA south of the equator (bottom). Note: 'Other' gear here is primarily troll gear, but includes driftnet catches in the 1980s and early 1990s.

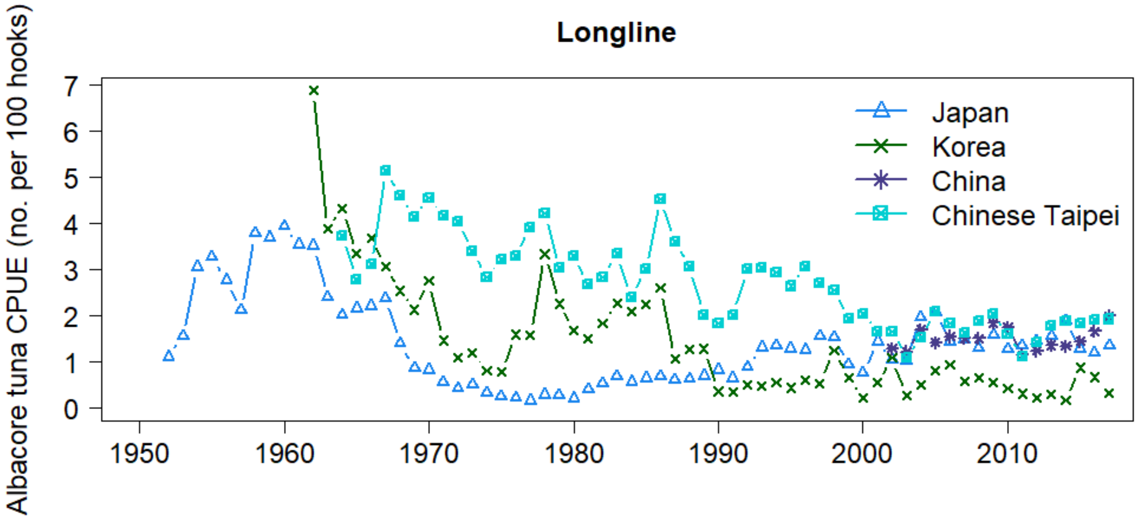


Figure 10: South Pacific albacore tuna catch per unit effort in the southern WCP-CA (south of 10^{o}S) by year for major longline fleets.

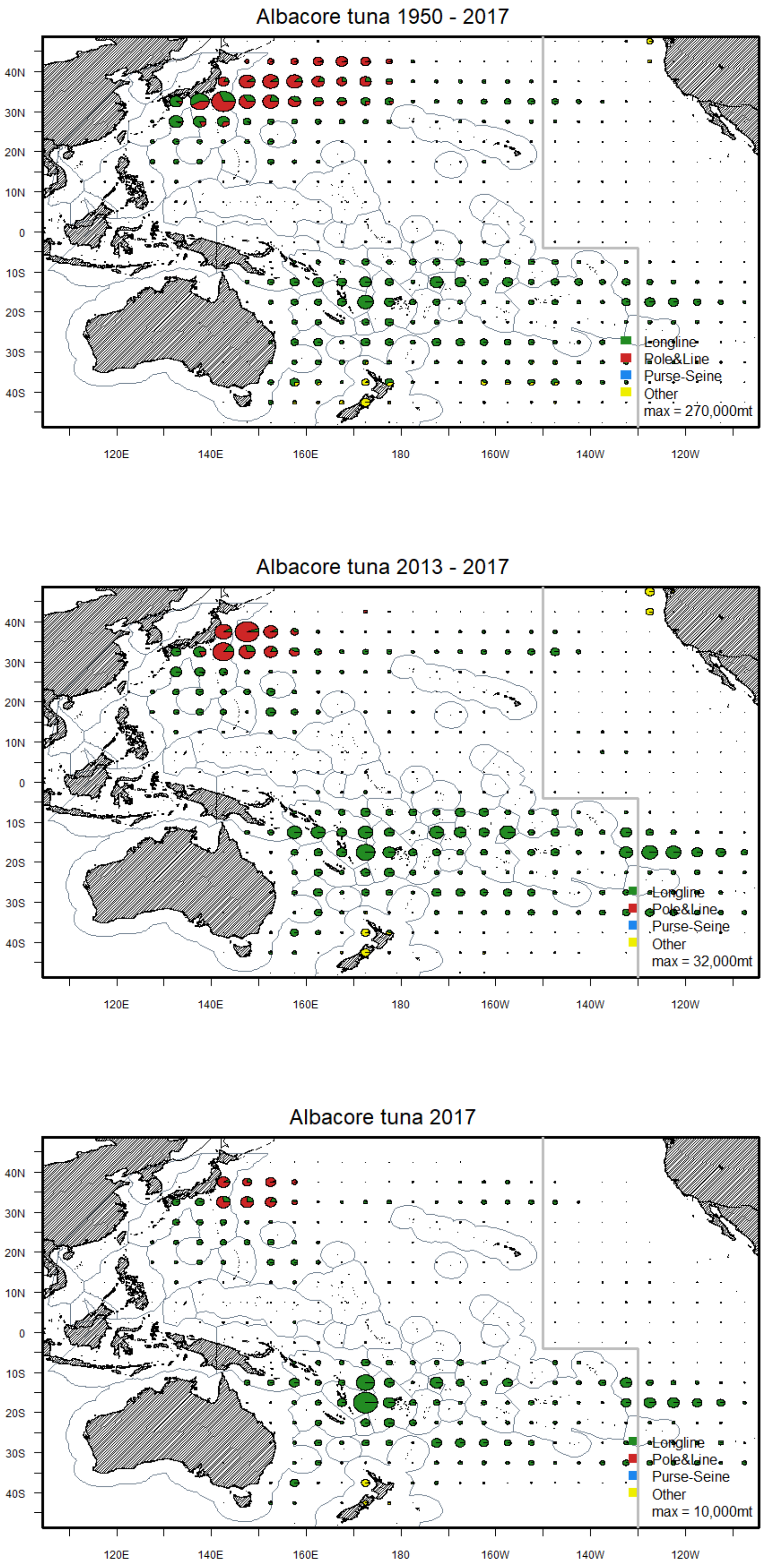


Figure 11: South Pacific albacore tuna catch distribution by gear type and 5x5^{o} region for the entire Pacific Ocean for the period 1950-2017 (top), 2013-2017 (middle) and 2017 (bottom). The figure legend provides the catch associated with this maximum circle size.

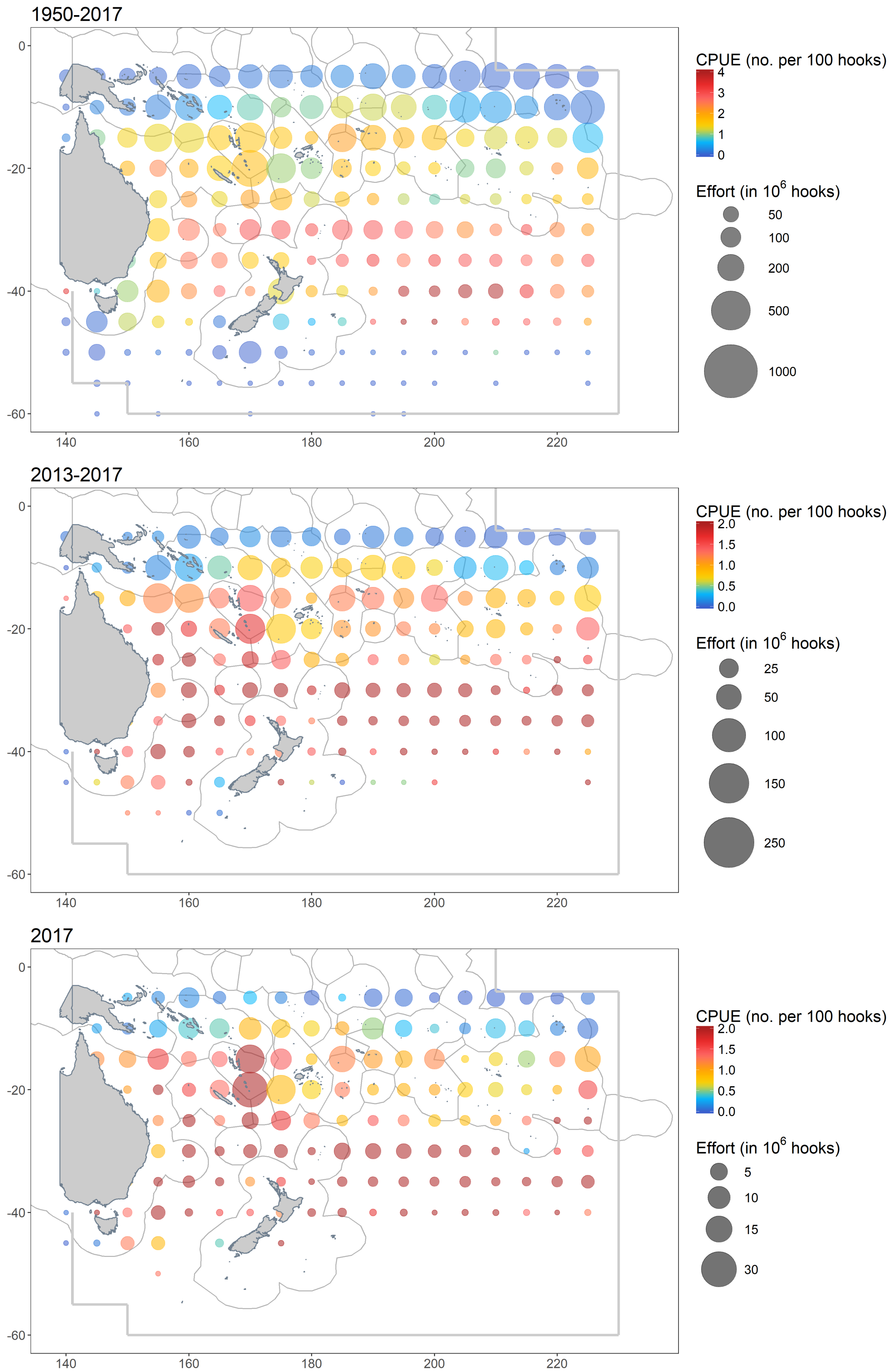


Figure 12: Distribution of longline effort (represented by circle size) and south Pacific albacore tuna CPUE (represented by colour) for the period 1950-2017 (top), 2013-2017 (middle) and 2017 (bottom). Note the differences in scales between plots.

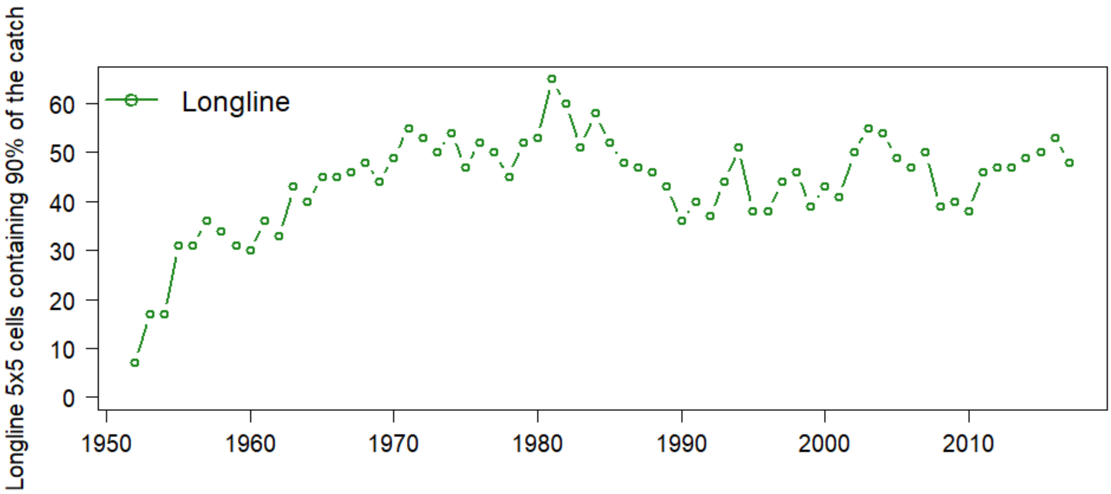


Figure 13: Spatial distribution of south Pacific albacore tuna catch for the longline fishery by year for the WCPO.

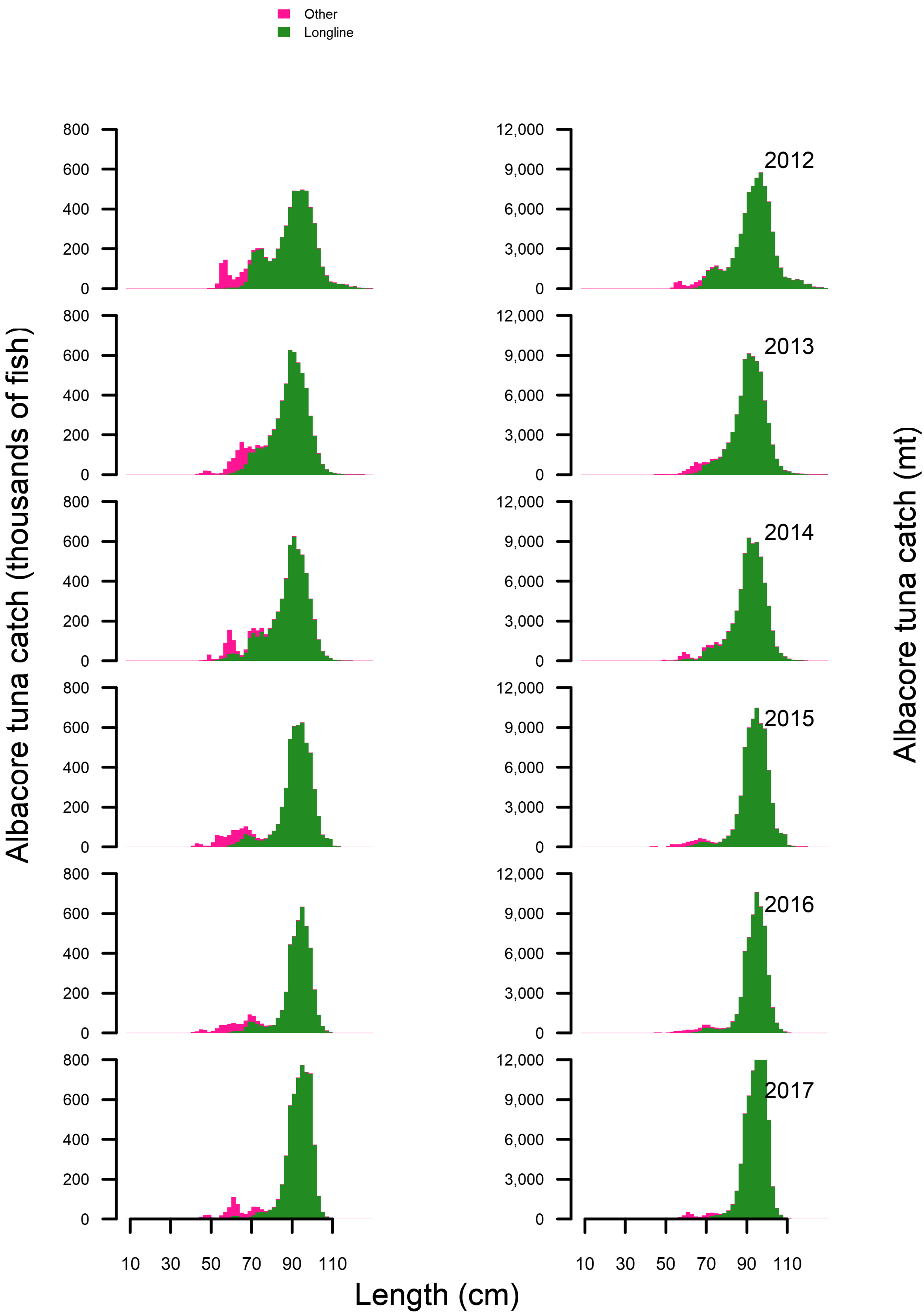


Figure 14: Catch-at-size of south Pacific albacore tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right).

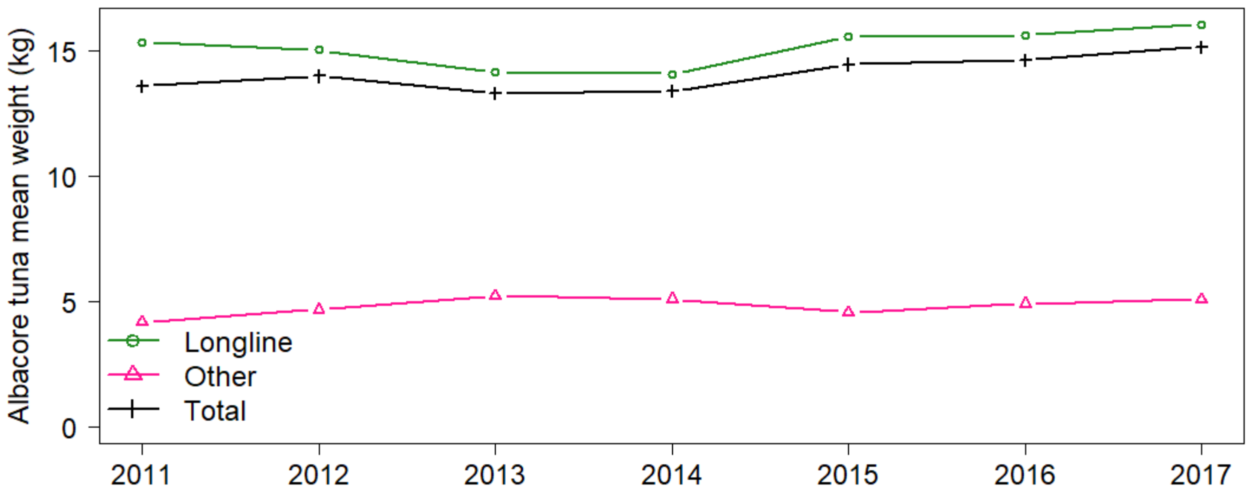


Figure 15: Mean weight of individual south Pacific albacore tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.

Bigeye

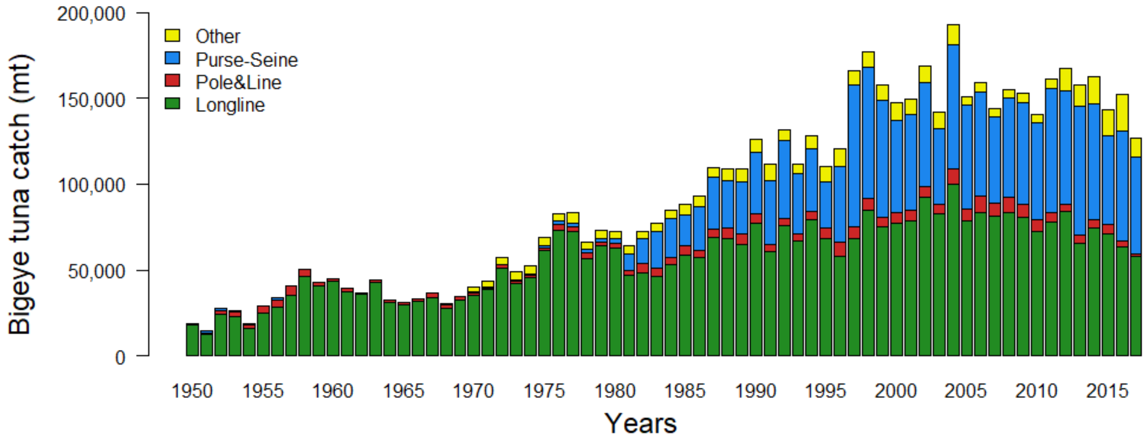


Figure 16: Bigeye tuna catch by gear type and year for the WCPFC-Convention Area.

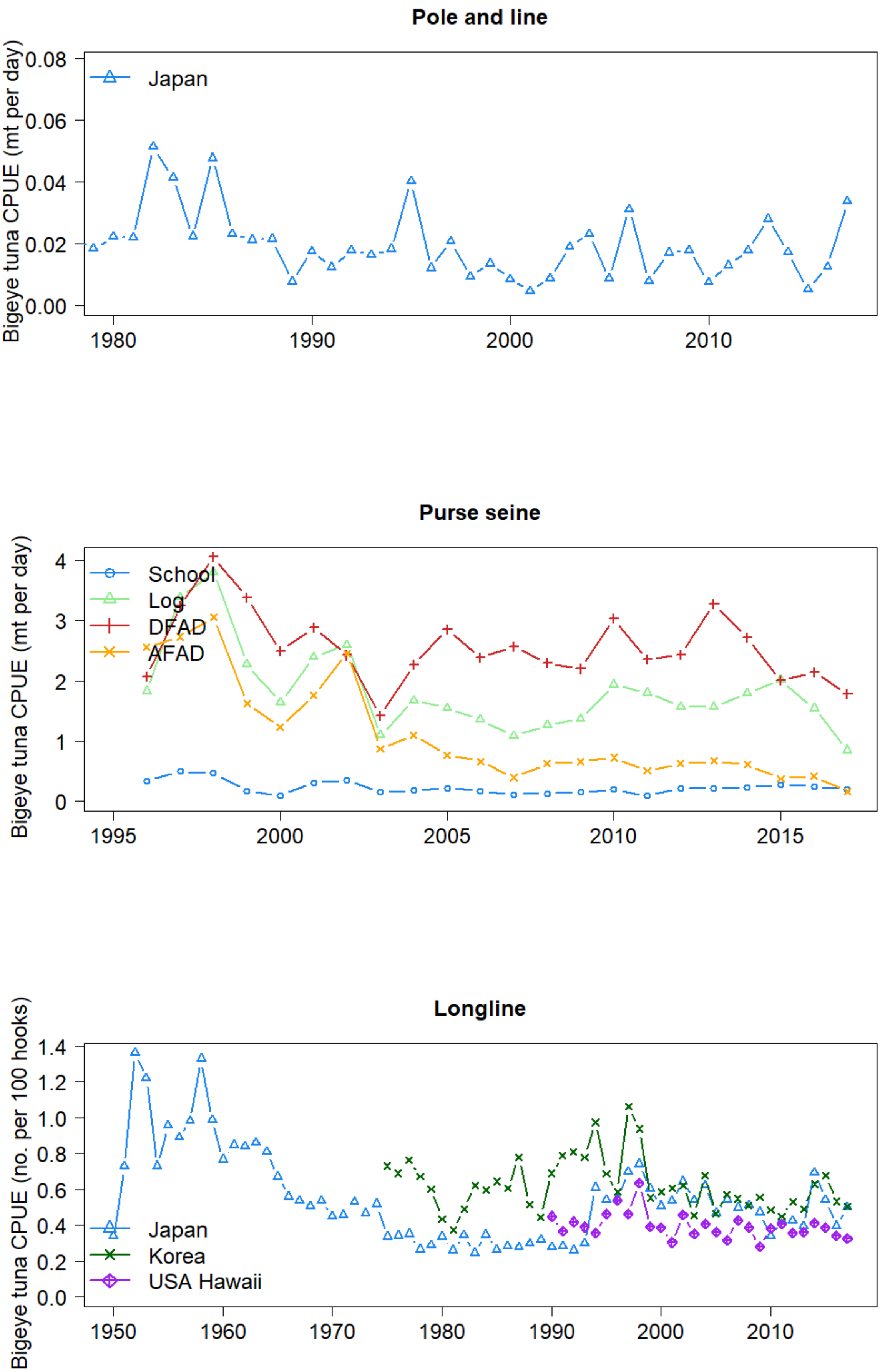


Figure 17: Bigeye tuna catch per unit effort in the tropical WCPO by year for major pole and line fishing fleets (top), purse seine for the major set types (middle), and tropical longline for three fleets (bottom; 20^{o}N to 10^{o}S, WCP-CA). Note different time series lengths.

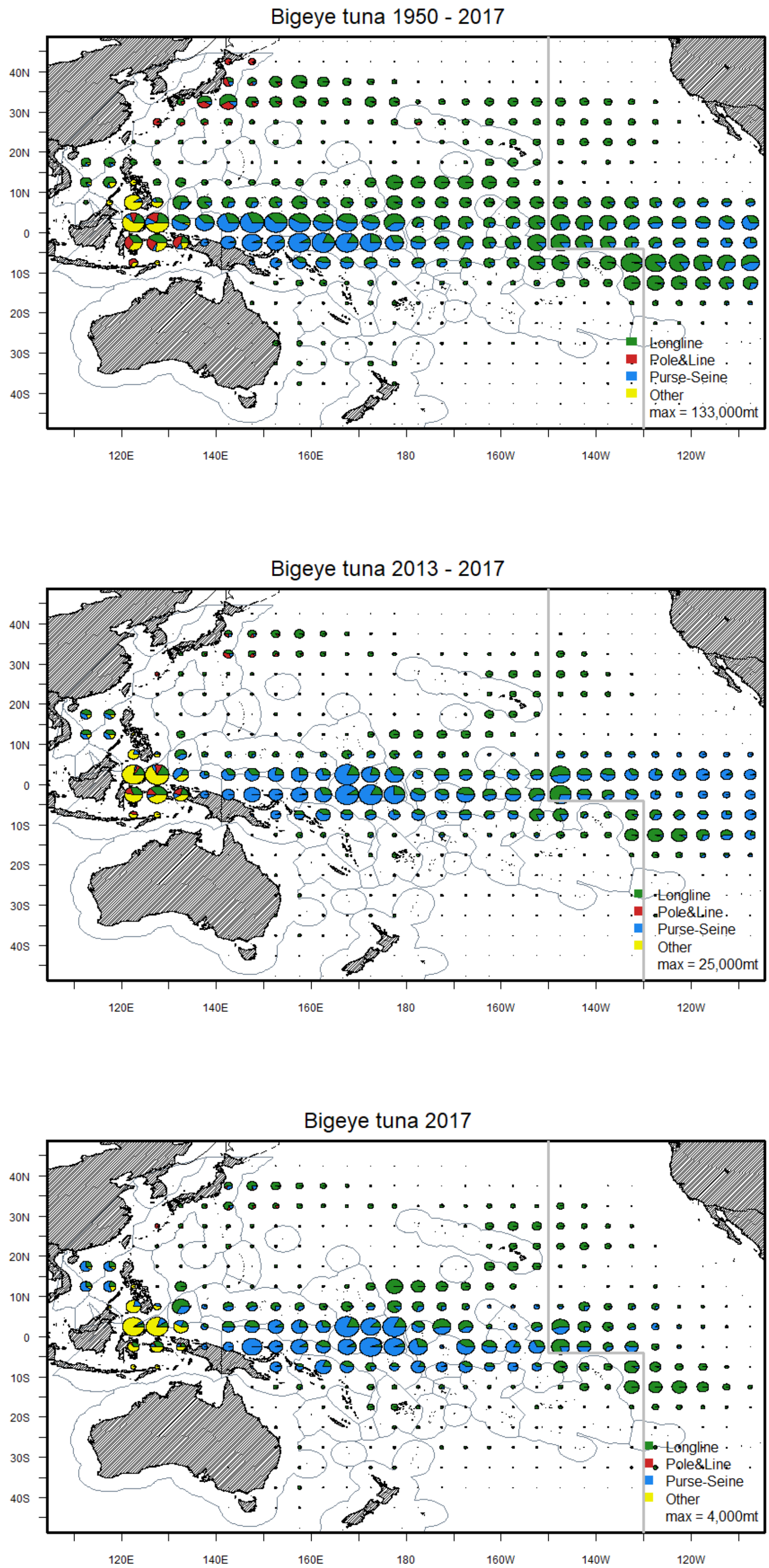


Figure 18: Bigeye tuna catch distribution by gear type and 5x5^o region for the entire Pacific Ocean for the period 1950-2017 (top), 2013-2017 (middle) and 2017 (bottom). The figure legend provides the catch associated with this maximum circle size.

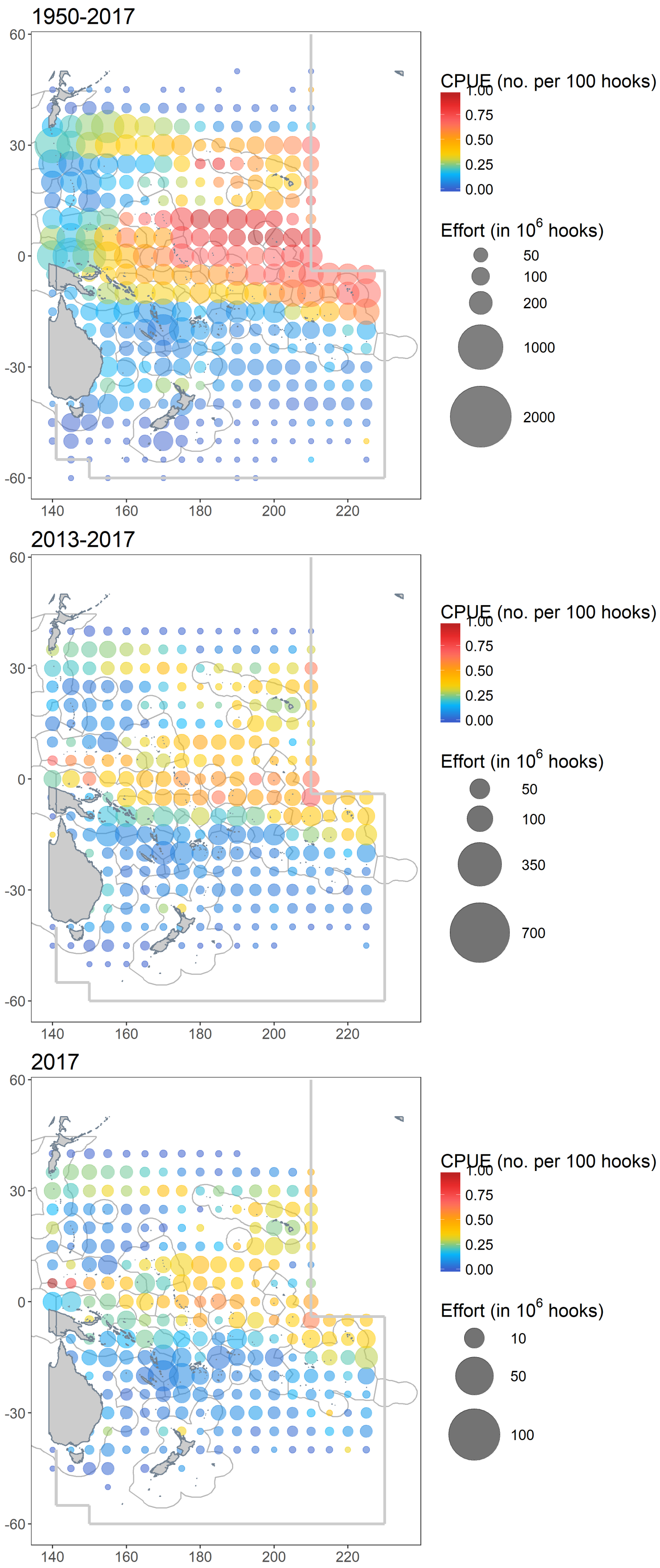


Figure 19: Distribution of longline effort (represented by circle size) and bigeye tuna CPUE (represented by colour) for the period 1950-2017 (top), 2013-2017 (middle) and 2017 (bottom). Note the differences in scales between plots.

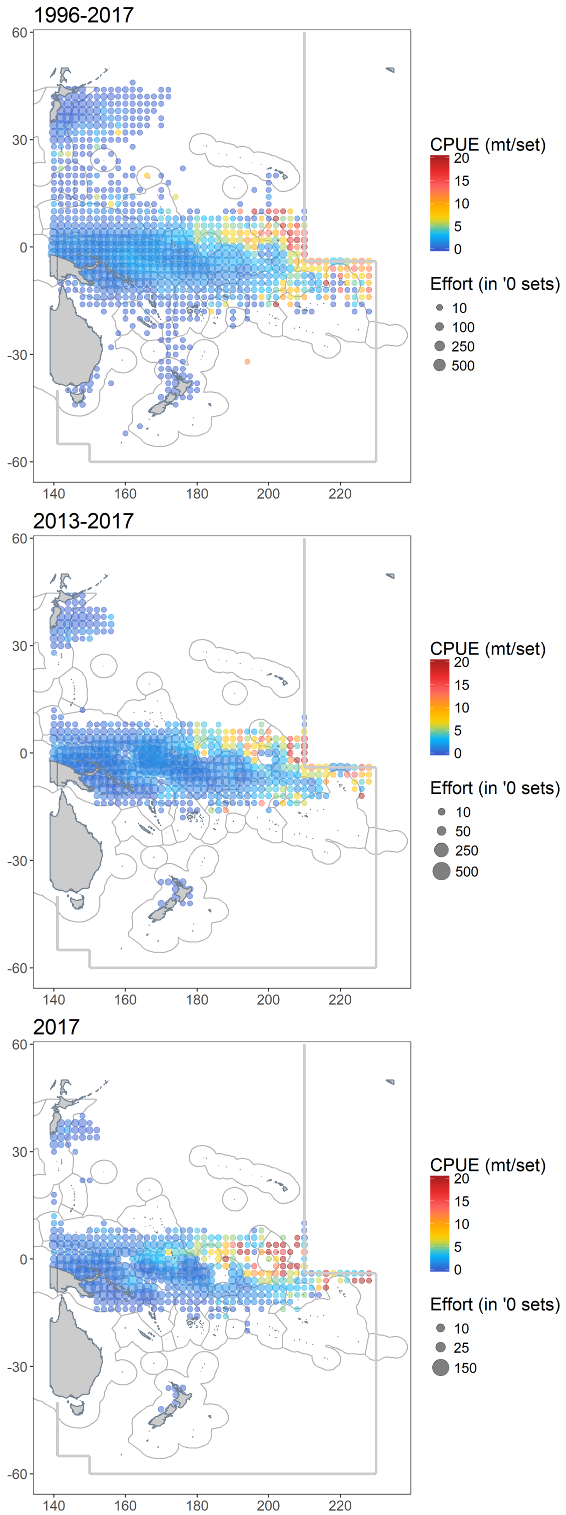


Figure 20: Distribution of 2^o by 2^o purse seine effort (represented by circle size) and bigeye tuna CPUE (represented by colour) for the period 1996-2017 (top), 2013-2017 (middle) and 2017 (bottom). Note the differences in circle size scale between plots.

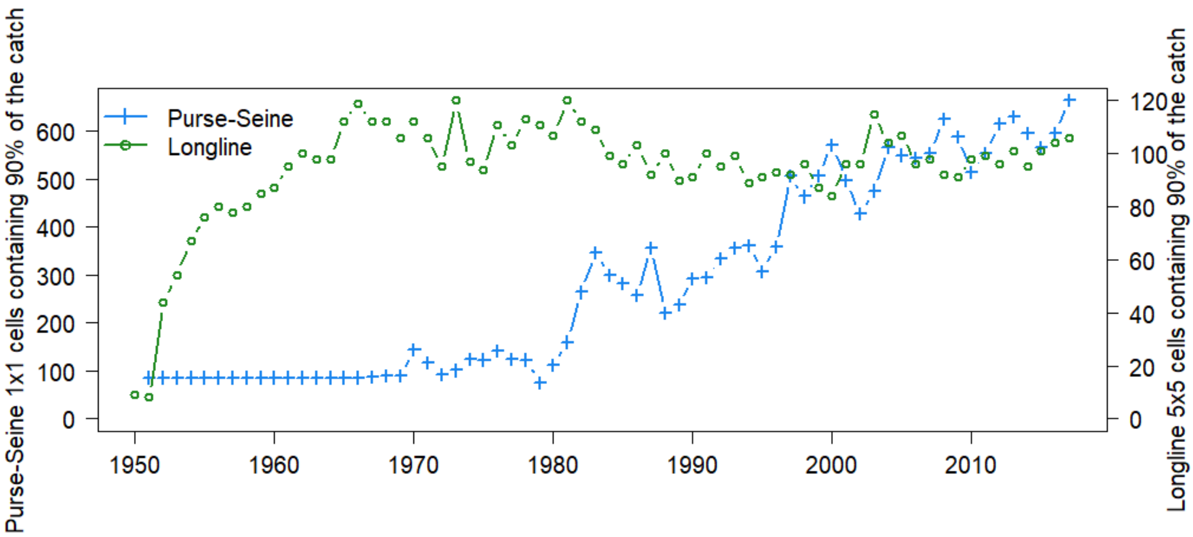


Figure 21: Spatial distribution of bigeye tuna catch for purse seine and longline by year for the WCPO.

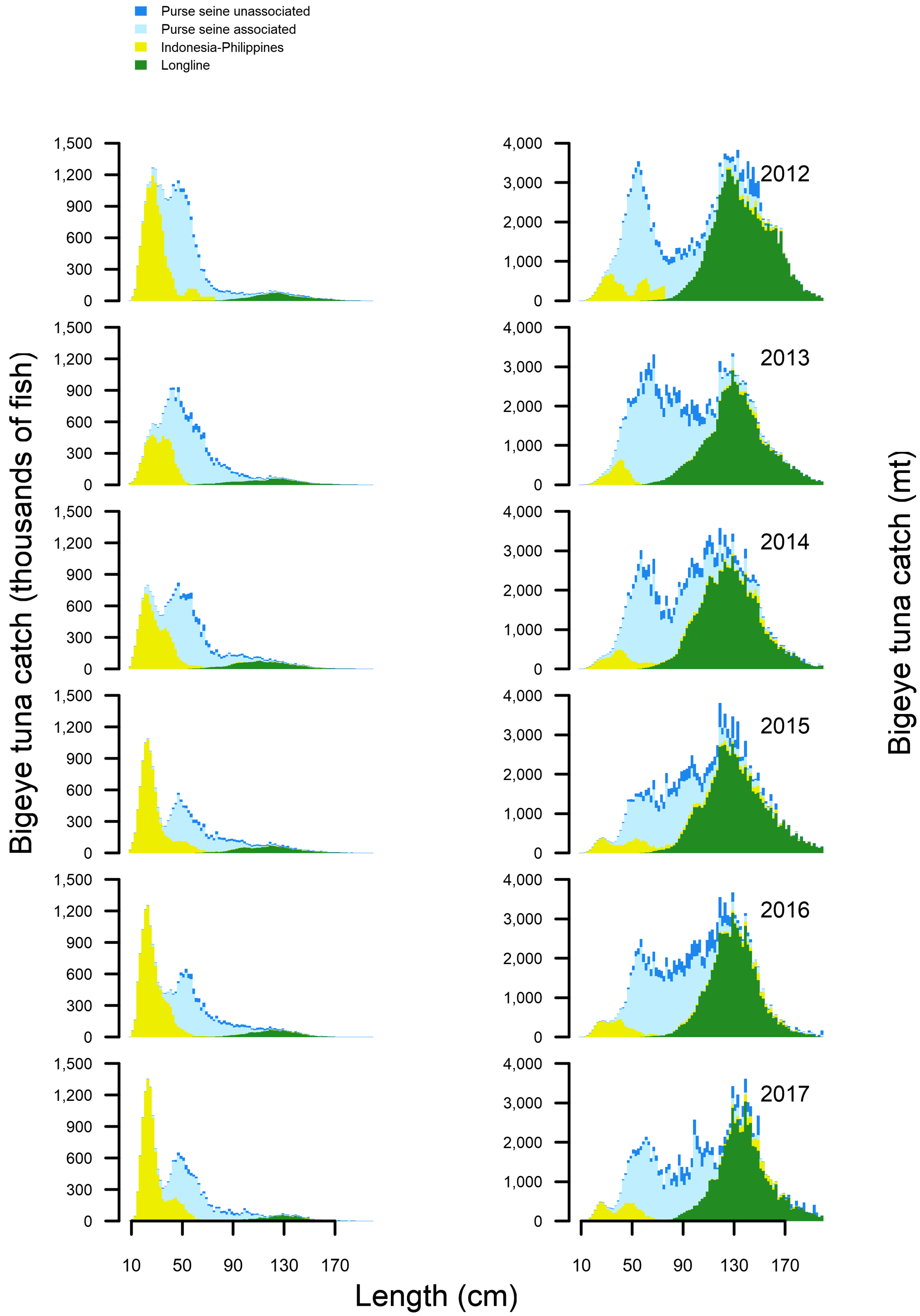


Figure 22: Catch-at-size of bigeye tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right).

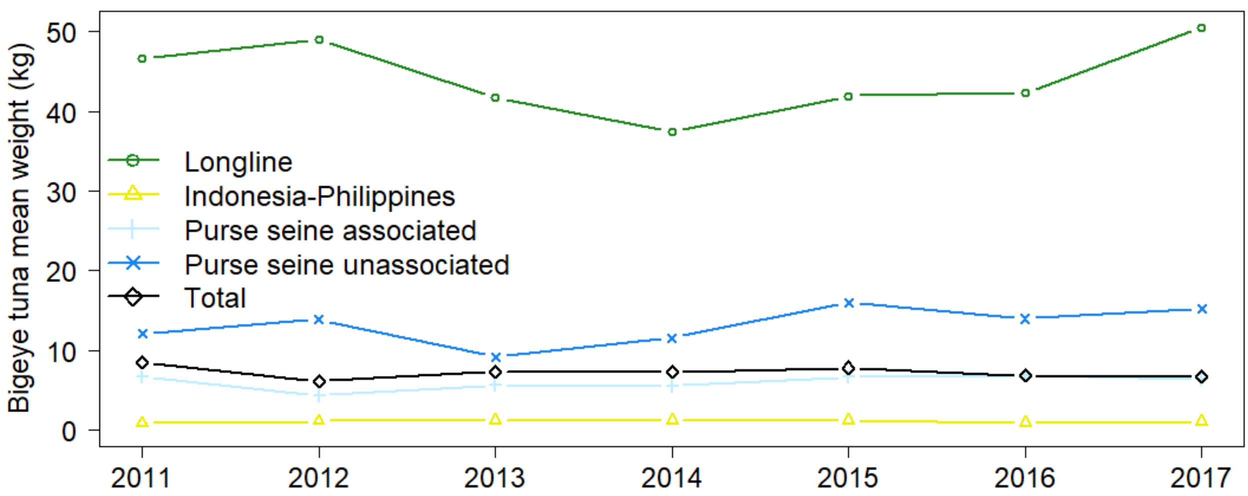


Figure 23: Mean weight of individual bigeye tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.

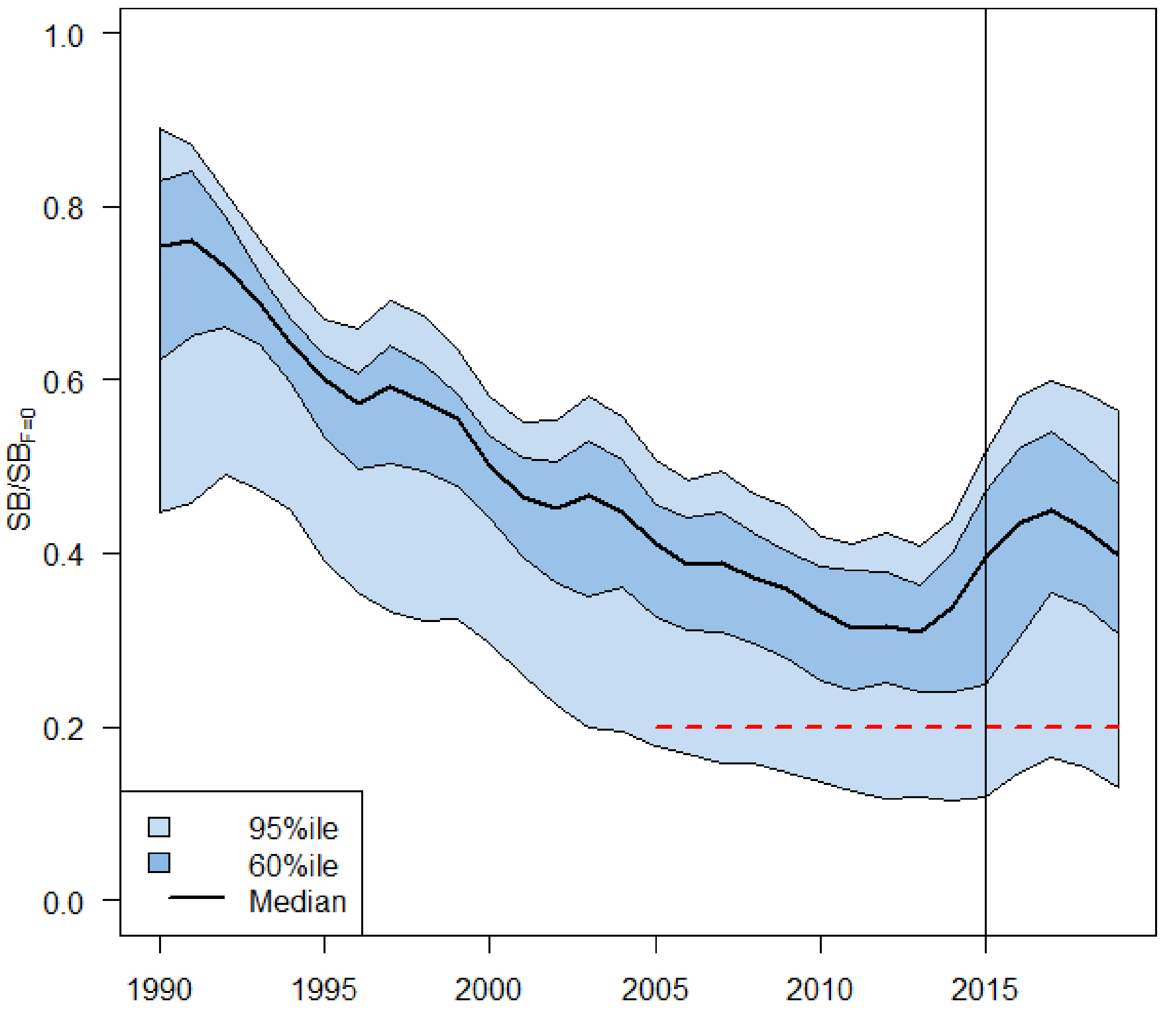


Figure 24: Stochastic projection results of bigeye tuna spawning biomass (SB/SB F=0) from 2015 assuming actual catch and effort levels in 2016 continue through to 2019. Prior to 2015 the data represent the 60th and 95th percentiles of the uncertainty grid from the assessment models and the weighted median (as per SC13 decisions, 'new' growth runs receive 3x weight of 'old' growth runs model runs). 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

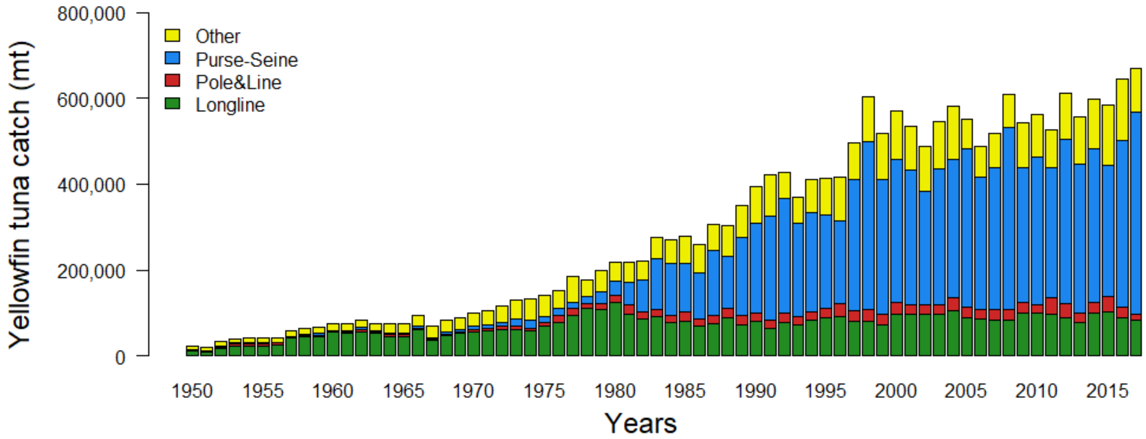


Figure 25: Yellowfin tuna catch by gear type and year for the WCPFC-Convention Area.

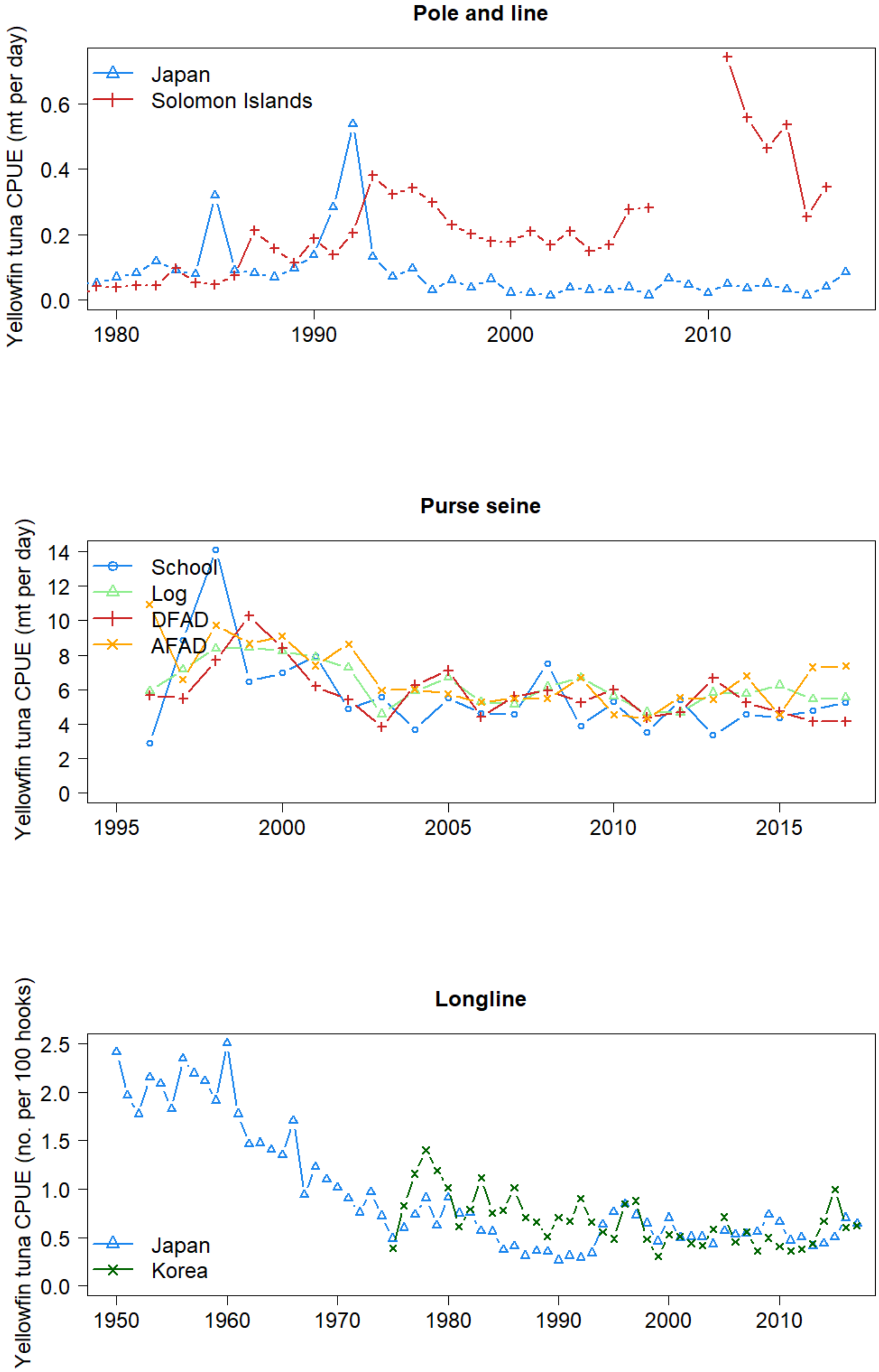


Figure 26: Yellowfin tuna catch per unit effort in the tropical WCPO by year for major pole and line fishing fleets (top), purse seine for the major set types (middle), and tropical longline for three fleets (bottom; 20°N to 10°S, WCP-CA). Note different time series lengths.

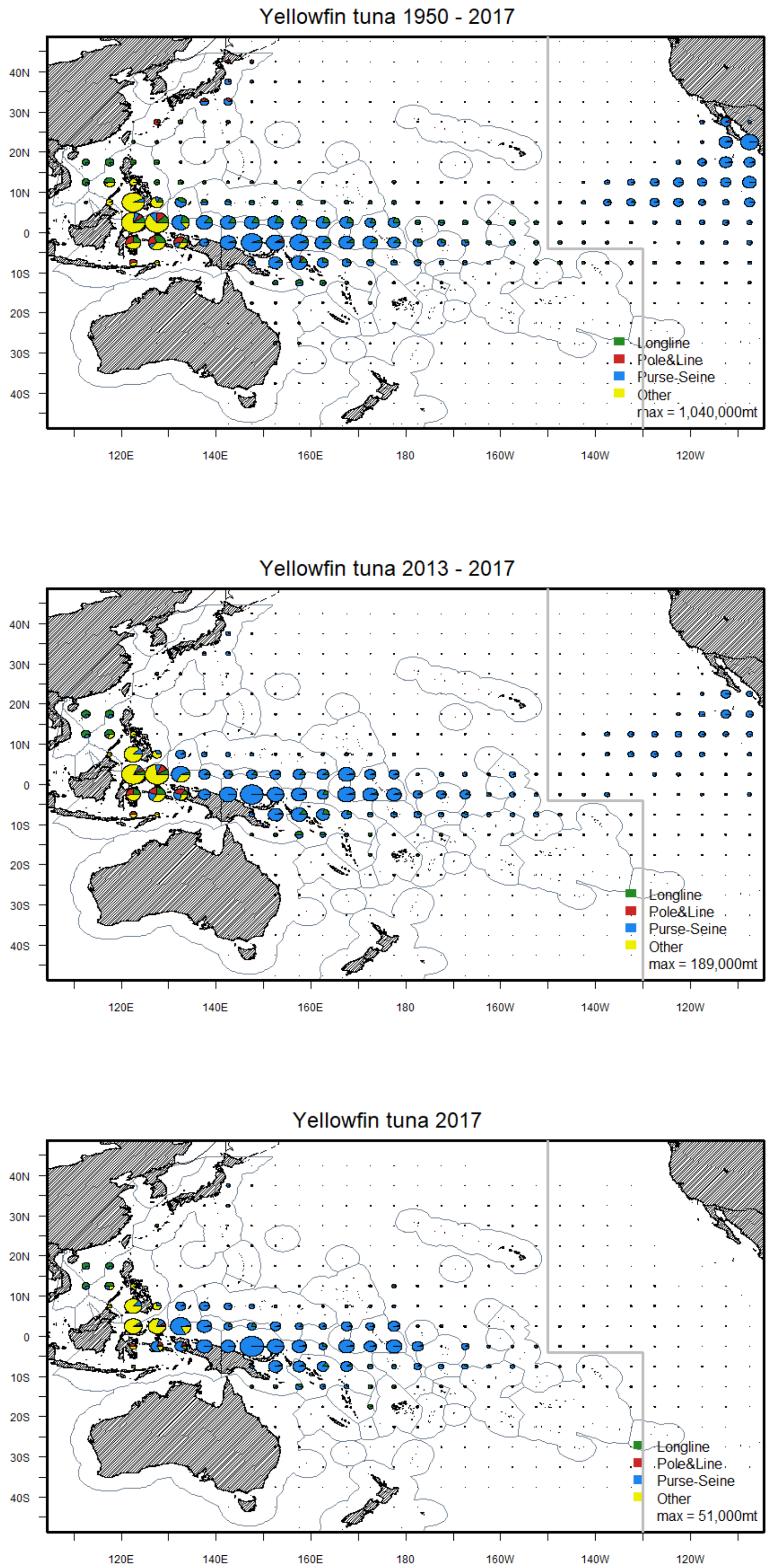


Figure 27: Yellowfin tuna catch distribution by gear type and 5x5^o region for the entire Pacific Ocean for the period 1950-2017 (top), 2013-2017 (middle) and 2017 (bottom). The figure legend provides the catch associated with this maximum circle size.

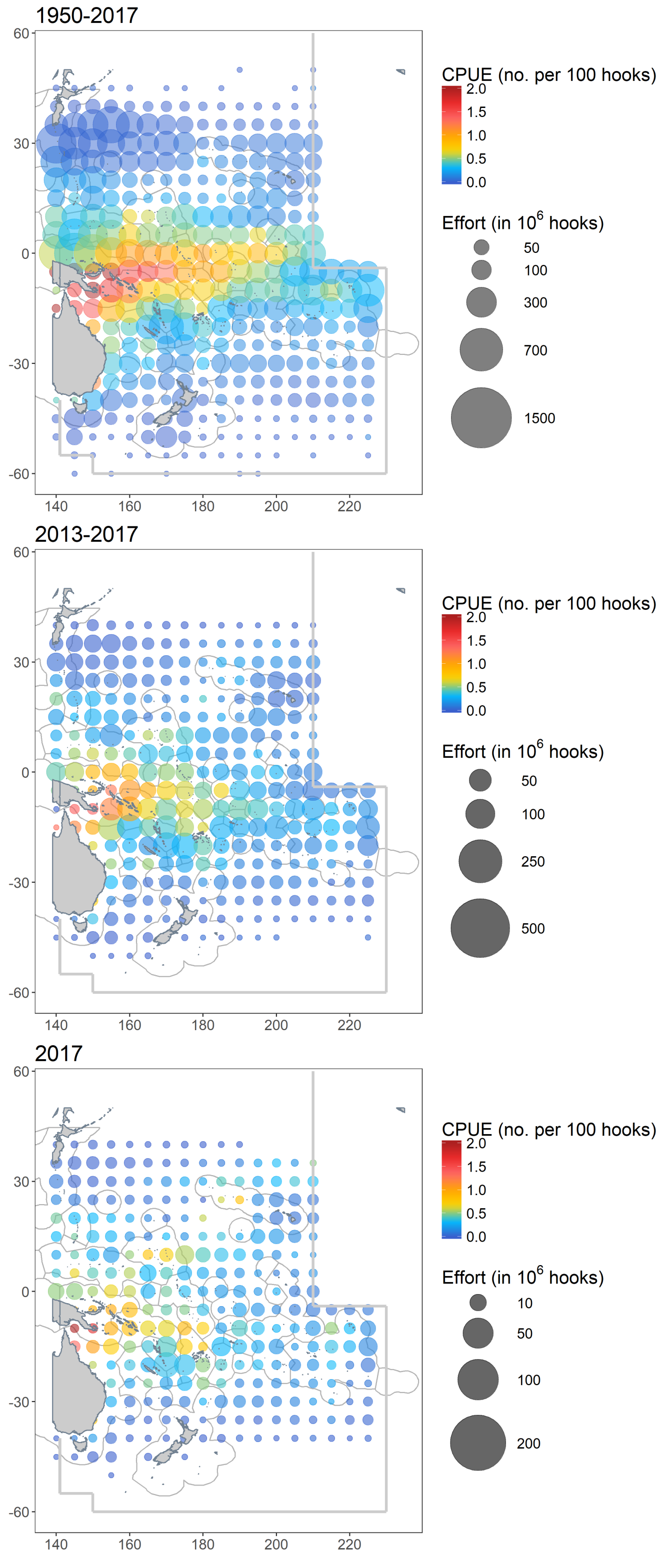


Figure 28: Distribution of longline effort (represented by circle size) and yellowfin tuna CPUE (represented by colour) for the period 1950-2017 (top), 2013-2017 (middle) and 2017 (bottom). Note the differences in scales between plots.

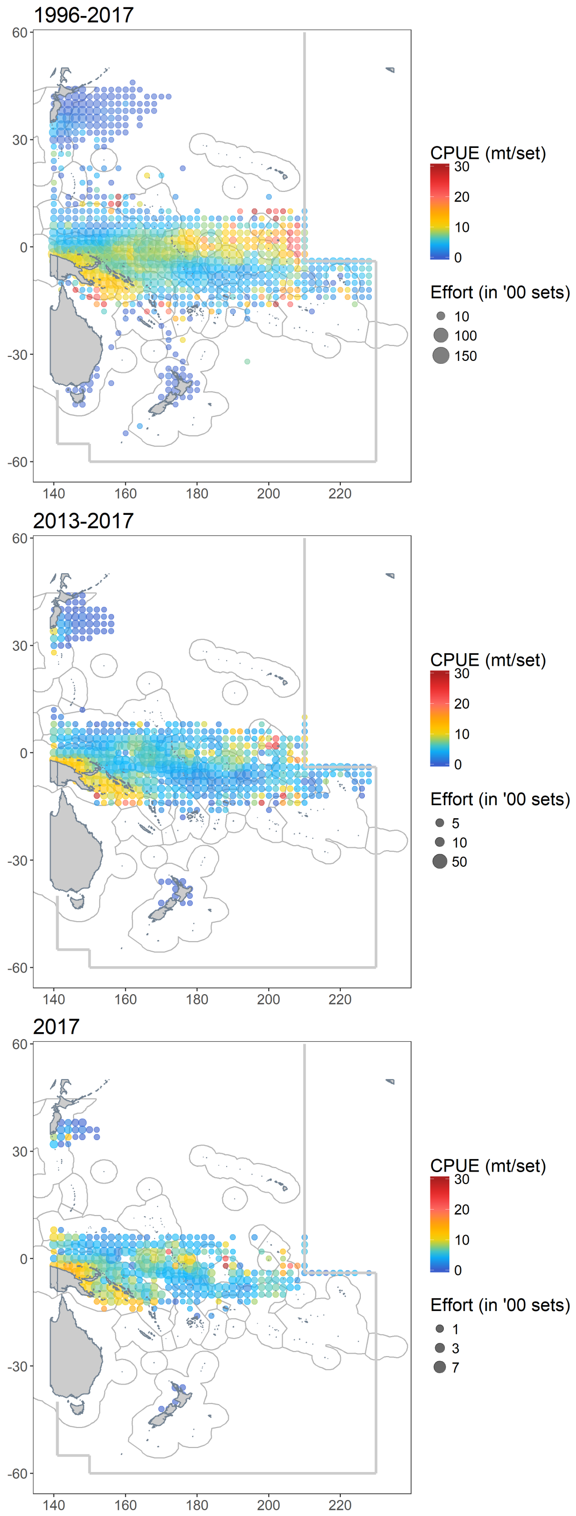


Figure 29: Distribution of 2^o by 2^o purse seine effort (represented by circle size) and yellowfin tuna CPUE (represented by colour) for the period 1996-2017 (top), 2013-2017 (middle) and 2017 (bottom). Note the differences in circle size scale between plots.

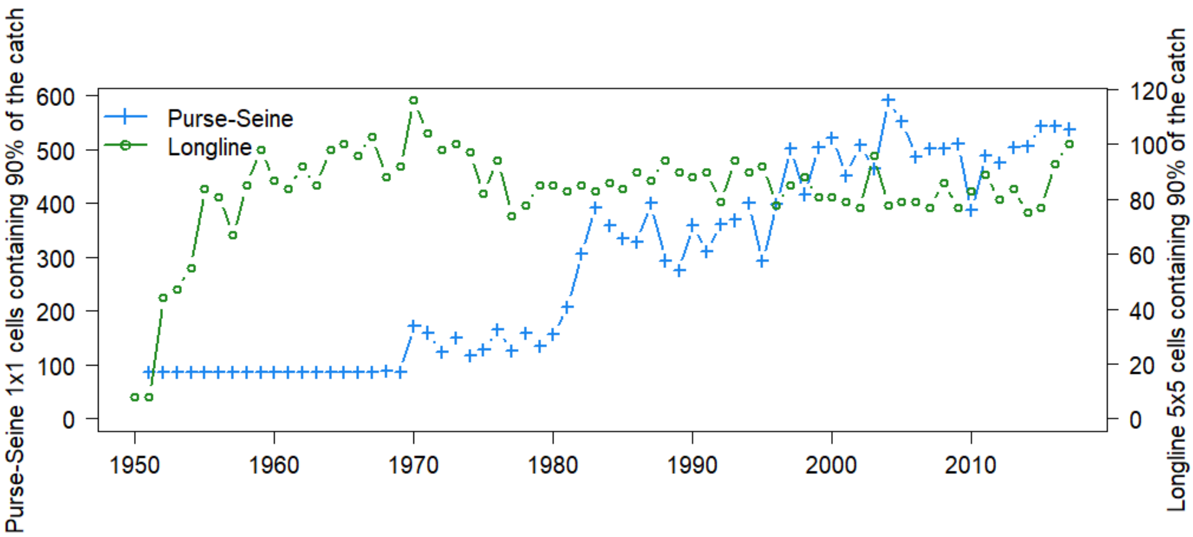


Figure 30: Spatial distribution of yellowfin tuna catch for purse seine and longline by year for the WCPO.

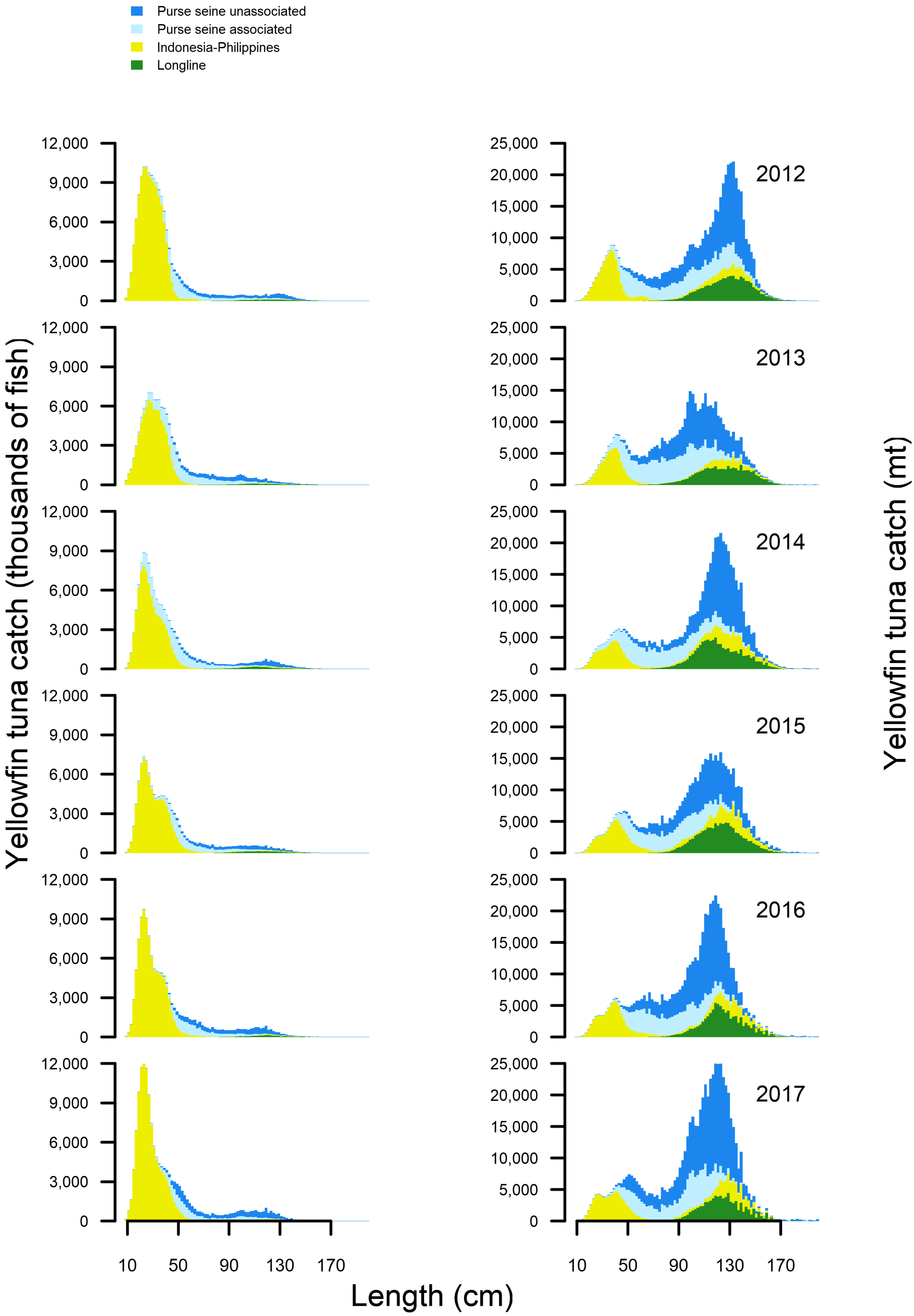


Figure 31: Catch-at-size of yellowfin tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right).

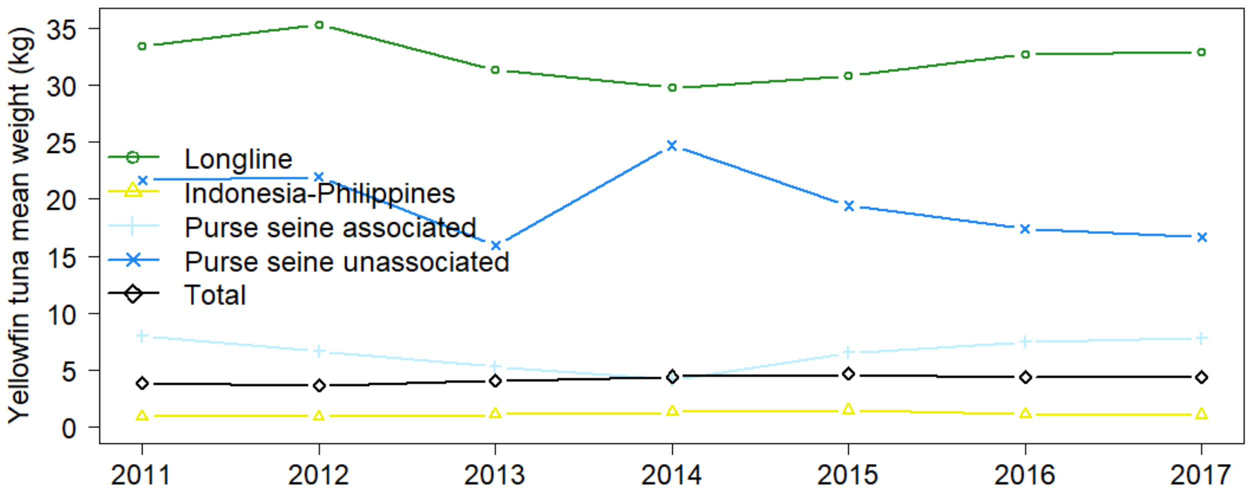


Figure 32: Mean weight of individual yellowfin tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.

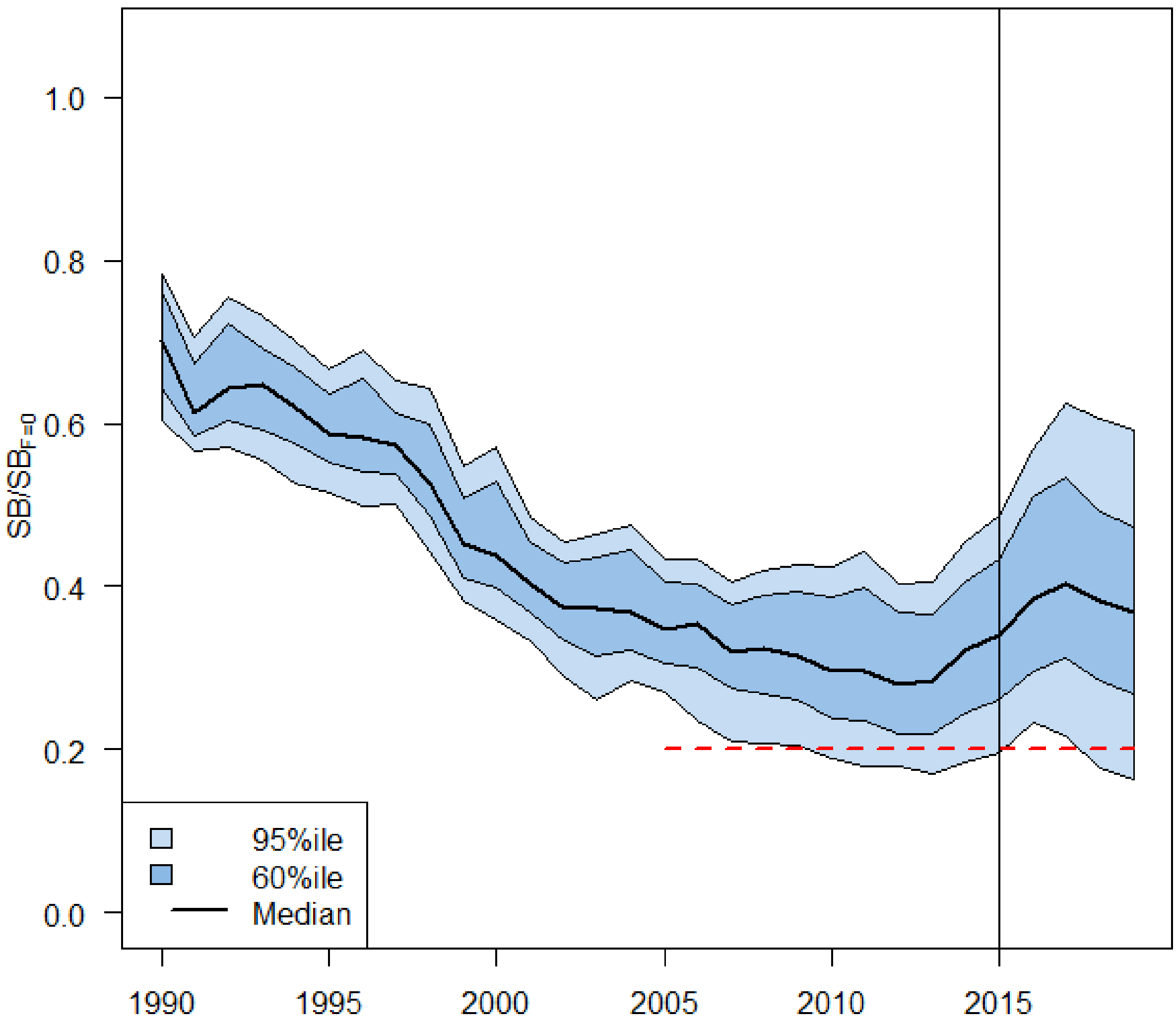


Figure 33: Stochastic projection results of yellowfin tuna spawning biomass (SB/SB$_{F=0}$) from 2015 assuming actual catch and effort levels in 2016 continue through to 2019. Prior to 2015 the data represent the 60th and 95th percentiles of the uncertainty grid from the assessment models and the median (model runs were not weighted by SC13). 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.