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A compendium of fisheries indicators for tuna stocks

WCPFC-SC13-2017/SA-WP-02

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Abstract

The principle purpose of this paper is to provide empirical information on recent patterns in fisheries for the SC's consideration. For SC13, we present a compendium of fishery indicators for all 'key' target tuna species (skipjack, bigeye, yellowfin and south Pacific albacore tuna), with skipjack and south Pacific albacore 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 (WCPFC-2017-SC13/SA-WP-08).

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 30 June 2017. Commentary provided in this paper typically relates to comparisons of the values of various indicators to previous years, in particular comparisons of 2016 values to 2015 and to the average over 2011-15.

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 and south Pacific albacore stocks are also presented to assess potential stock status at the end of 2018 in light of recent catch and effort trends.

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 et al., 2012), 2013 (Harley and Williams, 2013) and 2016 (Pilling et al., 2016a). The last two 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 south Pacific albacore being the two stocks not assessed in 2017. Commentary provided in this paper compare the values of various indicators to previous years, in particular comparisons of 2016 values to 2015 and to the average over 2011-15. Short-term stochastic projections for skipjack and south Pacific albacore specifically are also included for further information. For these, the stocks were projected forward from 2013 and 2015, respectively, using the most recent assessments (Harley et al., 2015; McKechnie et al., 2016). 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 south Pacific albacore, projections were performed across the weighted grid of nine assessment runs (e.g. Pilling et al., 2016b), with the stock projected through 2014 and 2015 based upon the effort data available. Given current uncertainty in the data available for 2016, 2015 effort levels were assumed to continue through 2016 to 2018. For skipjack, projections were performed over the grid of skipjack assessment runs defined by SC12. All skipjack axes of uncertainty were equally weighted (weighting = 1), with the exception of the steepness axis, where runs assuming steepness of 0.65 or 0.9 were down-weighted to 0.8, consistent with the approach used for all other stocks. The skipjack stock was projected through 2016 based upon the actual fishing levels by fleet, and then through 2017 to 2018 based upon the assumption that levels of effort or catch would remain constant at 2016 levels.

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.

Skipjack tuna		
Figure	**Indicator**	**Description**
Figure 1	Total catch by gear	Total catch in 2016 (1,816,762t) was comparable to that in 2015 and a 2% increase over 2011-15. Other catches (251,470t) were 2% higher than in 2015 and 26% higher than 2011-15. Pole and line catch (151,441t) was a 1% decrease on 2015 and an 11% decrease on 2011-15. Purse seine catch (1,408,110t) was comparable to both 2015 and the 2011-15 average.
Figure 2 - top	Tropical pole and line CPUE	Pole and line CPUE for the Japanese fleet in 2016 (6.52t per day) was comparable to 2015 but 9% lower than the 2011-15 average. For the Solomon Islands fleet, the CPUE (1.75t per day) was 42% higher than in 2015, but 42% lower than the 2011-15 average.
Figure 2 – bottom	Tropical purse seine CPUE	Free-school CPUE in 2016 (15.22t per day) was 21% lower than in 2015 and 11% lower than the 2011-15 average. Log CPUE (21.26t per day) was a 4% increase on 2015 but a 1% decrease on the 2011-15 average. Drifting FAD CPUE (23.77t per day) was a 32% decrease on 2015 and a 17% decrease on 2011-15. Anchored FAD CPUE (8.42t per day) was a 43% increase on 2015 but a 5% decrease on 2011-15.
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 2016 (and to a lesser extent, over 2012-2016) 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 catches	90% of the purse seine catch in 2016 was taken in 661 1x1 degree squares. This was a 6% increase on 2015 and a 9% increase on 2011-15. 90% of the pole and line catch was taken in 169 1x1 degree squares; a 39% decrease on 2015 and a 43% decrease on 2011-15.
Figure 6	Catch at length by gear type in both numbers and weight	-
Figure 7	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2016 (2.17kg) was 4% higher than in 2015 and a 1% increase on 2011-15. The mean weight of pole and line caught fish (2.21kg) was a 38% decrease on 2015 and a 21% decrease on 2011-15. The mean weight of Indonesia / Philippines domestic caught fish (0.63kg) was a 3% decrease on 2015 and a 32% decrease on 2011-15. A simple linear regression suggests a significant declining slope over the period ($p < 0.05$). The mean weight of free-school caught purse seine fish (4.06kg) was a 2% decrease on 2015 but a 10% increase on 2011-15. A simple linear regression suggests a significant increasing slope over the period ($p < 0.05$). The mean weight of FAD caught fish (2.99kg) was a 15% increase on 2015 and a 32% increase on 2011-15.
Figure 8	Stochastic stock projections	Under recent fishery conditions, the skipjack stock was initially projected to decline as recent relatively high recruitments move through the stock. Median F_{2018}/F_{MSY} = 0.37; median $SB_{2018}/SB_{F=0}$ = 0.47. In the longer-term (not shown), under recent conditions and the assumption of long term recruitment patterns, the stock was projected to recover above the interim TRP: median $SB_{2028}/SB_{F=0}$ = 0.57.

South Pacific albacore tuna		
Figure	**Indicator**	**Description**
Figure 9	Total catch by gear	Total South Pacific catch in 2016 (68,682t) was a 16% decrease over 2015 and a 15% decrease over 2011-15. Longline catch (66,311t) was 16% lower both than in 2015 and 14% lower than the 2011-15 average. Catches from other gears (2,345t) were 17% lower than in 2015 and 25% lower than the 2011-15 average. For the southern WCPCA, the total catch in 2016 (58,033t) was an 8% decrease from 2015 and a 13% decrease over 2011-15. Longline catch (55,635t) was also an 8% decrease from 2015 and a 13% decrease over 2011-15. Troll catch (2,372t) was a 17% decrease on 2015 and a 24% decrease over 2011-15. Note that numbers will differ slightly to those tabulated in the albacore trends paper (SC13-SA-WP-07)
Figure 10	Southern longline CPUE (south of 10°S)	Japanese longline CPUE in 2016 (1.27 fish per 100 hooks) was 1% lower than in 2015, and a 16% decrease on 2011-15. Korean longline CPUE (0.68 fish per 100 hooks) was a 23% decrease on 2015 but a 77% increase on 2011-15. Chinese longline CPUE (1.67 fish per 100 hooks) was a 15% increase on 2015, and a 27% increase on 2011-15. Finally, Chinese Taipei longline CPUE in 2016 (1.84 fish per 100 hooks) was 3% higher than in 2015, and 15% higher than the 2011-15 average.
Figure 11	Maps of catch by gear	In recent years, catches have concentrated in the 10-20°S latitudinal band. While 2016 estimates remain provisional, slightly higher catch in the high seas are seen.
Figure 12	Longline effort and CPUE maps	Over the whole period, catch rates have been highest south of 10°S. In the more recent period, catch rates have been relatively high within high seas areas and in the 15-20°S band. Catch rates in 2016 appear lower than across previous years.
Figure 13	Spatial distribution of catches	90% of the longline catch in 2016 was taken in 52 5x5 degree squares of the southern WCPO. This was a 4% increase on 2015 and a 9% increase on 2011-15.
Figure 14	Catch at length by gear type in both numbers and weight	-
Figure 15	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2016 (14.93kg) was a 1% increase on 2015 and an 8% increase on 2011-15. The mean weight of longline caught fish (16.06kg) was a 1% increase on 2015 and an 8% increase on 2011-15. The mean weight of fish caught in other gears (4.62kg) was a 1% increase on 2015 but a 2% decrease on 2011-15.
Figure 16	Stochastic stock projections	The south Pacific albacore stock was projected to continue to decline under recent (2015) conditions, and had a 17% change of falling below the LRP by 2018. Median F_{2018}/F_{MSY} = 0.43; $SB_{2018}/SB_{F=0}$ = 0.32, risk $SB_{2018}/SB_{F=0} < 20\%$ = 17%.

Bigeye tuna		
Figure	**Indicator**	**Description**
Figure 17	Total catch by gear	Total catch in 2016 (154,045t) was 9% higher than in 2015, but a 2% decrease over 2011-15. Longline catch (65,371t) was 5% lower than in 2015 and 11% lower than 2011-15. Pole and line catch (3,700t) was 35% lower than in 2015 and a 26% decrease on 2011-15. Purse seine catch (63,304t) was 22% higher than in 2015, but a 5% decrease on the 2011-15 average. Catches from other gears (21,670t) were 44% higher than in 2015 and 76% higher than the 2011-15 average.
Figure 18 - top	Tropical pole and line CPUE	Japanese pole and line CPUE in 2016 (0.003t per day) was down 50% on 2015 and 84% on the 2011-15 average.
Figure 18 – middle	Tropical purse seine CPUE	Free-school CPUE in 2016 (0.27t per day) was comparable to that in 2015 and 33% higher than the 2011-15 average. Log CPUE (1.53t per day) was a 25% decrease on 2015 and a 13% decrease on the 2011-15 average. Drifting FAD CPUE (2.04t per day) was comparable to that in 2015 and a 20% decrease on 2011-15. Anchored FAD CPUE (0.41t per day) was a 5% increase on 2015 but a 27% reduction on 2011-15.
Figure 18 – bottom	Tropical longline CPUE (20°N-10°S)	Japanese longline CPUE in 2016 (0.43 fish per 100 hooks) was a 22% decrease on 2015, and a 15% decrease on 2011-15. Korean longline CPUE (0.53 fish per 100 hooks) was a 21% decrease on 2015 and a 4% decrease on 2011-15. US (Hawaiian) longline CPUE (0.34 fish per 100 hooks) was a 12% decrease on both 2015 and on 2011-15.
Figure 19	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°N-10°S equatorial band.
Figure 20	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 21	Purse seine effort and CPUE maps	While areas of high bigeye catch rates have become more fragmented, higher catch rates in the tropical eastern region still expand further west in the tropical northern hemisphere (to 10°N) and to the southeast of the tropical region in recent years.
Figure 22	Spatial distribution of catches	90% of the longline catch in 2016 was taken in 100 5x5 degree squares. This was a 1% decrease on 2015 but a 2% increase on 2011-15. 90% of the purse seine catch was taken in 592 1x1 degree squares; a 3% increase on 2015 but comparable to that over 2011-15.
Figure 23	Catch at length by gear type in both numbers and weight	-
Figure 24	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2016 (6.71kg) was a 12% decrease on 2015 and an 8% decrease on 2011-15. The mean weight of longline caught fish (41.12kg) was a 1% decrease on 2015 and a 6% decrease on 2011-15. A simple linear regression suggests a significant declining slope over the period ($p < 0.05$). The mean weight of Indonesia / Philippines domestic caught fish (0.89kg) was a 24% decrease on 2015 and a 19% decrease on 2011-15. The mean weight of free-school caught fish (13.66kg) was a 5% decrease on 2015 but a 13% increase on 2011-15. The mean weight of FAD caught fish (6.53kg) was a 2% decrease on 2015 but a 13% increase on 2011-15.

Yellowfin tuna		
Figure	**Indicator**	**Description**
Figure 25	Total catch by gear	Total catch in 2016 (651,575t) was a 12% increase over 2015 and a 14% increase over 2011-15. Longline catch (91,635t) was 10% lower than in 2015 and 1% lower than the 2011-15 average. Pole and line catch (23,074t) was 36% lower than in 2015 and 25% lower than 2011-15. Purse seine catch (394,756t) was 29% higher than in 2015, and 17% higher than 2011-15. Catches from other gears (142,110t) were 2% higher than in 2015 and 26% higher than the 2011-15 average.
Figure 26 - top	Tropical pole and line CPUE	Japanese CPUE in 2016 (0.01t per day) was a 10% decrease on 2015 and 62% lower than the 2011-15 average. Solomon Island CPUE in 2016 (0.35t per day) was a 36% increase on 2015 but 32% lower than the 2011-15 average.
Figure 26 – middle	Tropical purse seine CPUE	Free-school CPUE in 2016 (4.95t per day) was a 14% increase on 2015 and a 17% increase on 2011-15. Log CPUE (5.38t per day) was 15% lower than in 2015 and a 1% decrease on 2011-15. Drifting FAD CPUE (4.16t per day) was a 13% decrease on 2015, and a 20% decrease on the 2011-15 average. Anchored FAD CPUE (6.85t per day) was a 43% increase on 2015 and a 28% increase on 2011-15.
Figure 26 – bottom	Tropical longline CPUE (20°N to 10°S)	Japanese longline CPUE in 2016 (0.66 fish per 100 hooks) was a 30% increase on 2015 and a 40% increase on 2011-15. Korean longline CPUE (0.61 fish per 100 hooks) was a 40% decrease on 2015 but a 7% increase on 2011-15.
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°N-10°S equatorial band, with catches higher in the mid-tropical WCPO band, mirroring skipjack. Catch in the Indonesian/Philippines region remain 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 2016.
Figure 30	Spatial distribution of catches	90% of the longline catch in 2016 was taken in 91 5x5 degree squares which was a 20% increase on 2015 and a 13% increase on 2011-15. 90% of the purse seine catch was taken in 539 1x1 degree squares, which was 2% less than in 2015 but 7% more than the 2011-2015 average.
Figure 31	Catch at length by gear type in both numbers and weight	-
Figure 32	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2016 (4.38kg) was a 4% decrease on 2015 but an 8% increase on 2011-15. The mean weight of longline caught fish (31.21kg) was a 1% increase on 2015 but a 3% decrease on the average over 2011-15. The mean weight of Indonesia / Philippines domestic caught fish (1.10kg) was a 24% decrease on 2015 but comparable to the average over 2011-15. The mean weight of free-school caught fish (16.57kg) was a 10% decrease on 2015 and a 16% decrease on the 2011-15 average. The mean weight of FAD caught fish (7.29kg) was a 13% increase on 2015 and a 20% increase on 2011-15.

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McKechnie, S., Hampton, J., Pilling, G.M. and Davies, N. (2016). Stock assessment of skipjack tuna in the western and central Pacific Ocean. WCPFC-SC12-2016/SA-WP-04.

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Skipjack tuna

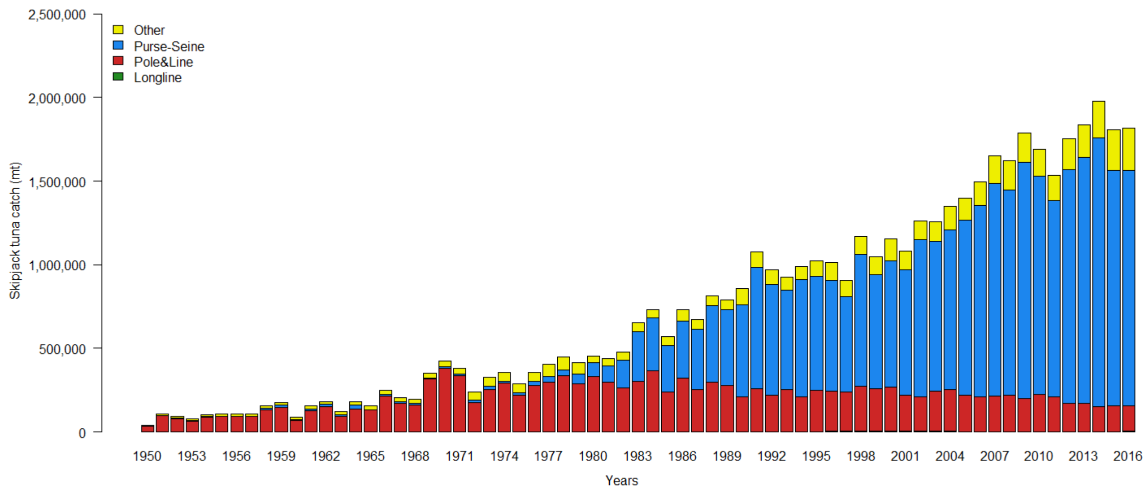


Figure 1. Skipjack tuna catch by gear type and year for the WCPFC-Convention Area.

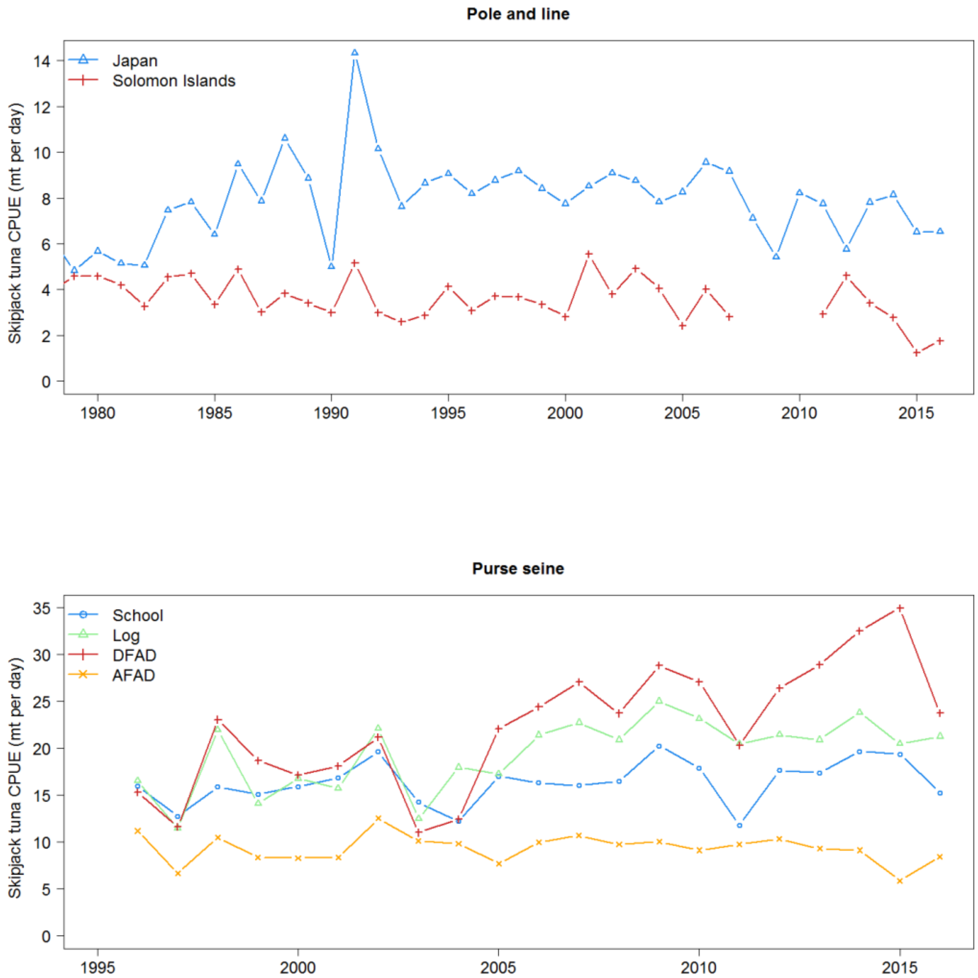


Figure 2. Skipjack tuna catch per unit effort in the tropical WCPO by year for major pole and line fishing fleets (top) and purse seine fleets for the major set types (bottom). Note different time series lengths; purse seine series limited to 1996 onwards, given approach to adjusting species composition through observer sampling.

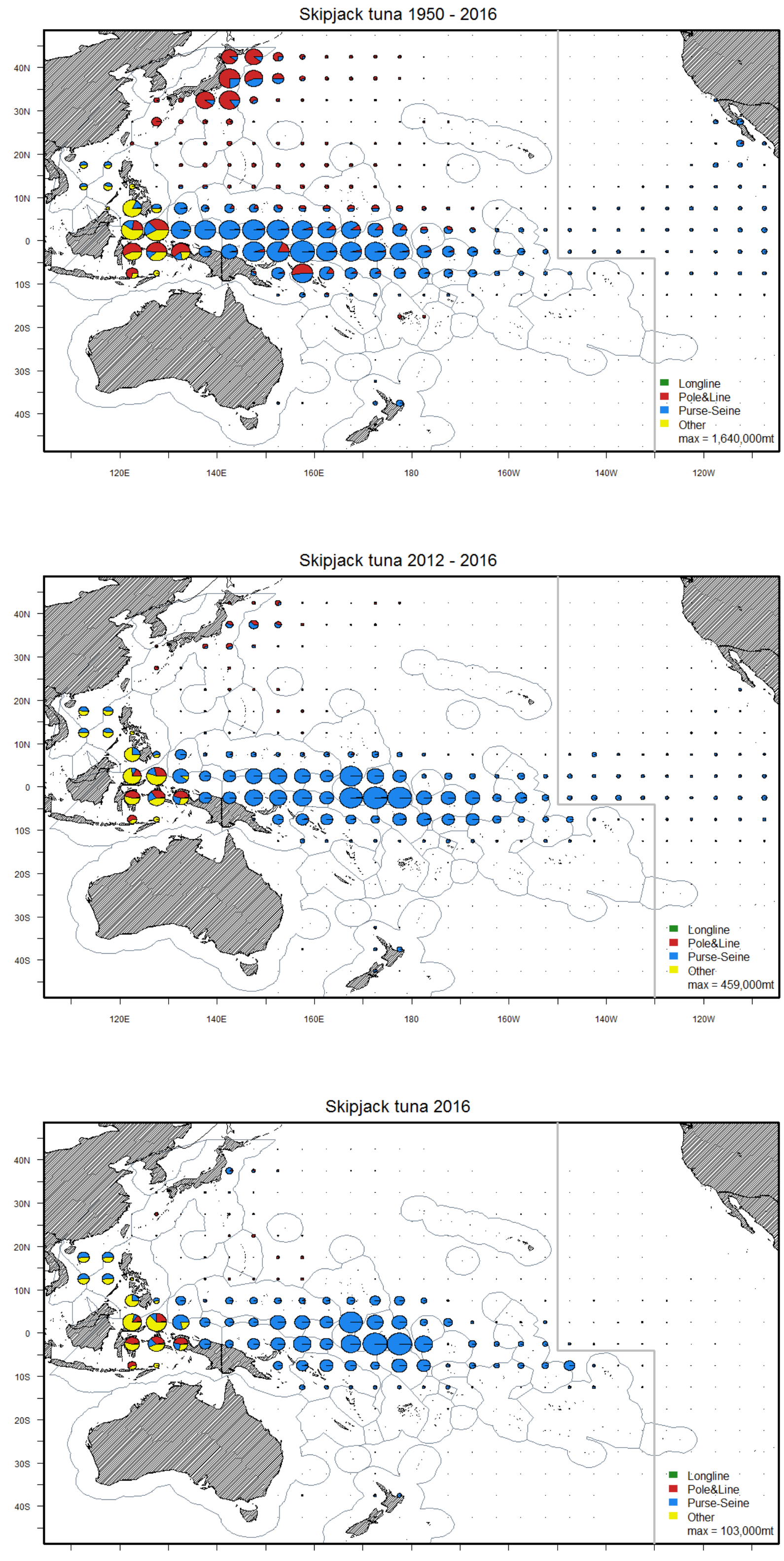


Figure 3. Skipjack tuna catch distribution by gear type and 5x5° region for the entire Pacific Ocean for the period 1950-2016 (top), 2012-2016 (middle) and 2016 (bottom). The figure legend provides the catch associated with the maximum circle size.

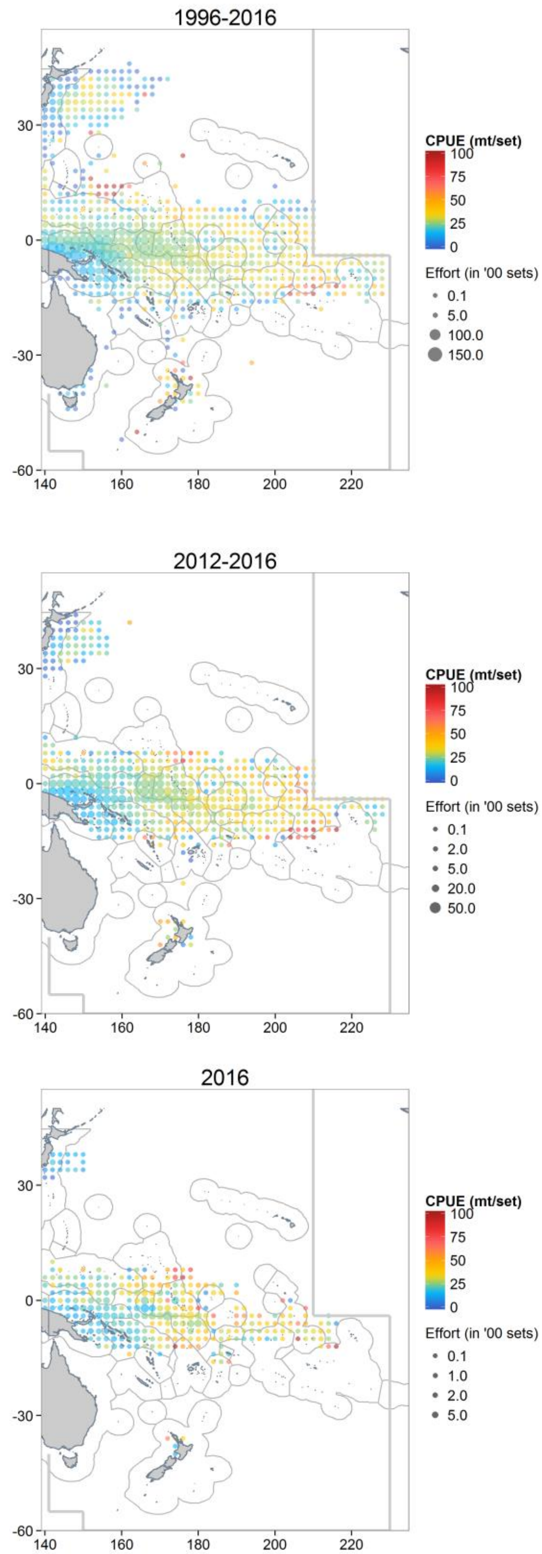


Figure 4. Distribution of purse seine effort (represented by circle size) and skipjack tuna CPUE (represented by colour) for the period 1996-2016 (top), 2012-2016 (middle) and 2016 (bottom). Note the differences in scales between plots.

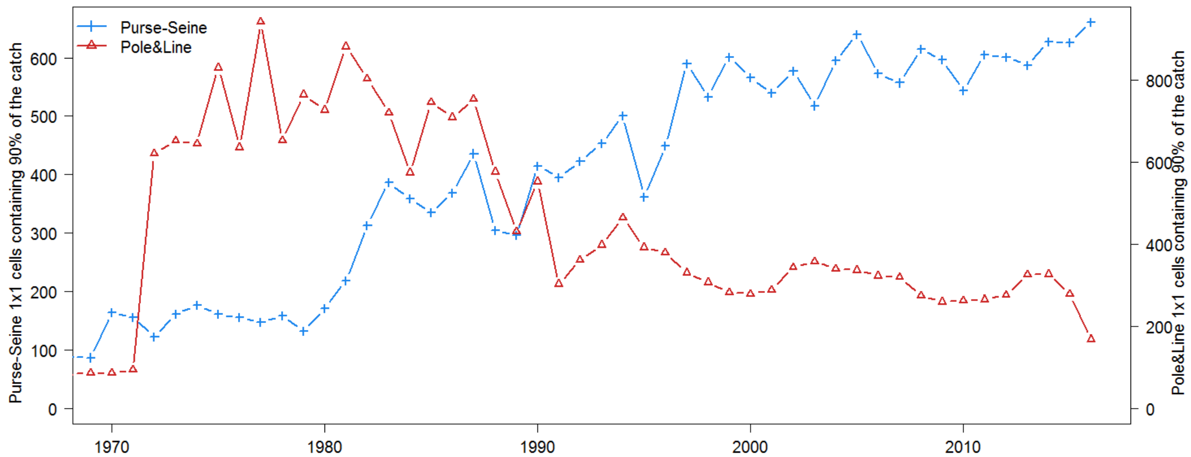


Figure 5. Spatial distribution of skipjack tuna catch for purse seine and pole and line by year for the WCPO.

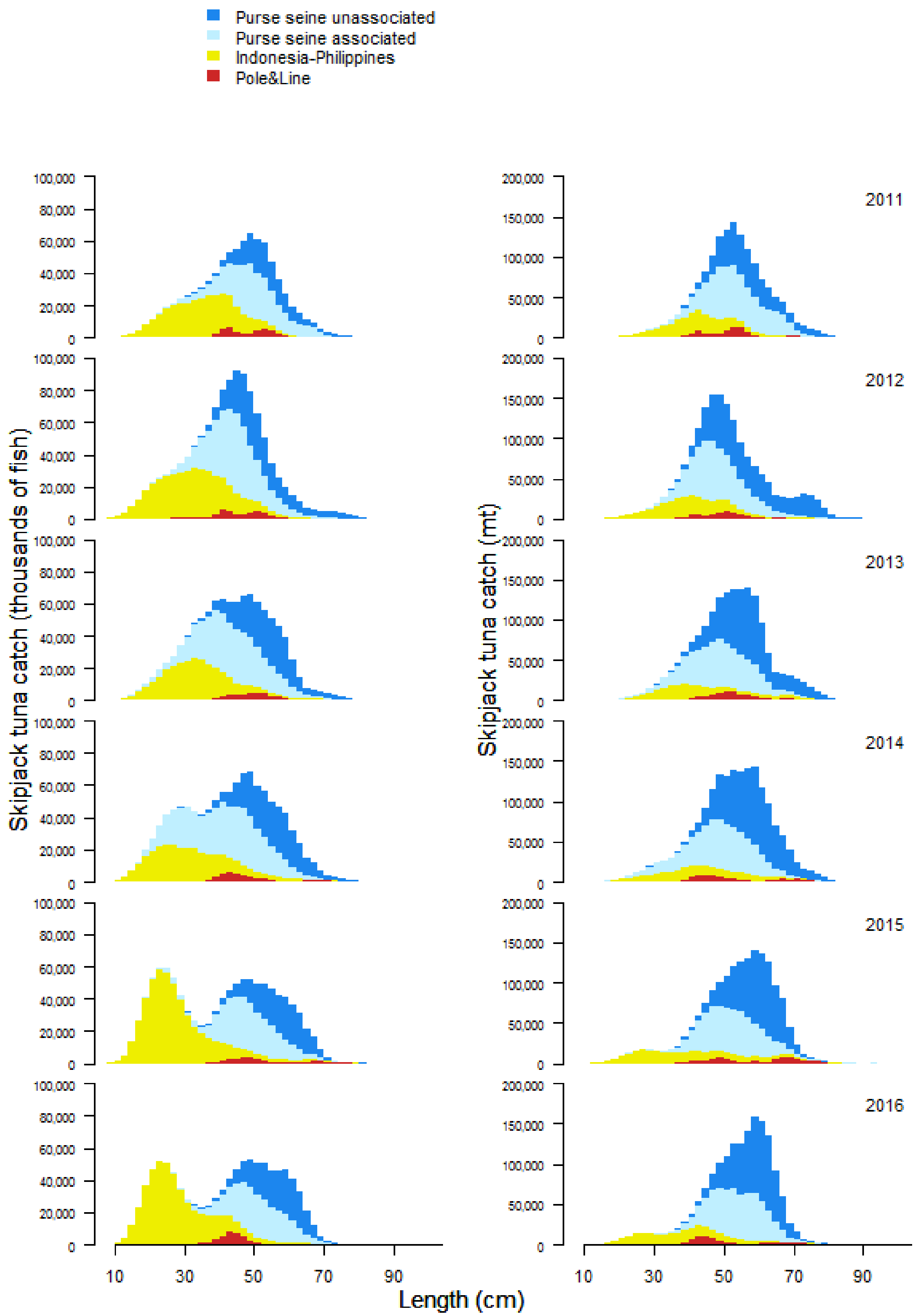


Figure 6. Catch-at-size of skipjack tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right).

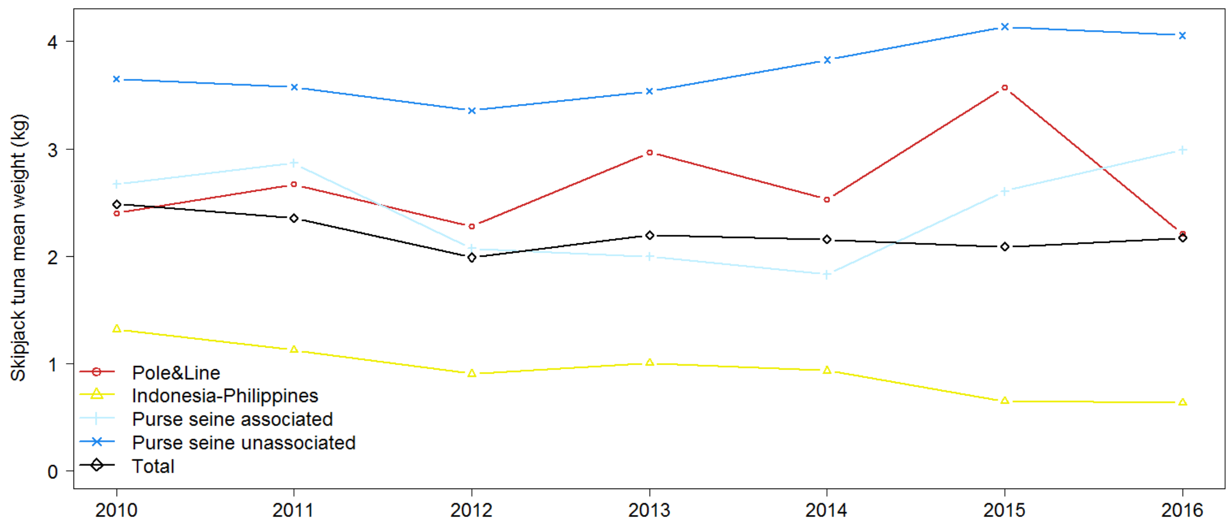


Figure 7. Mean weight of individual skipjack tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.

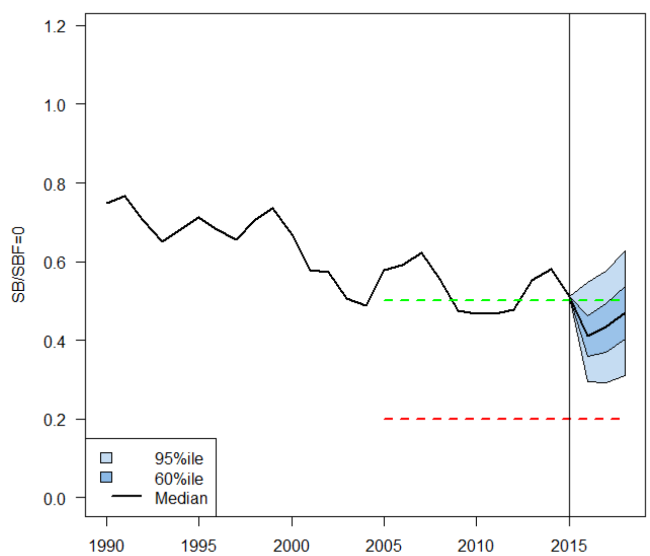
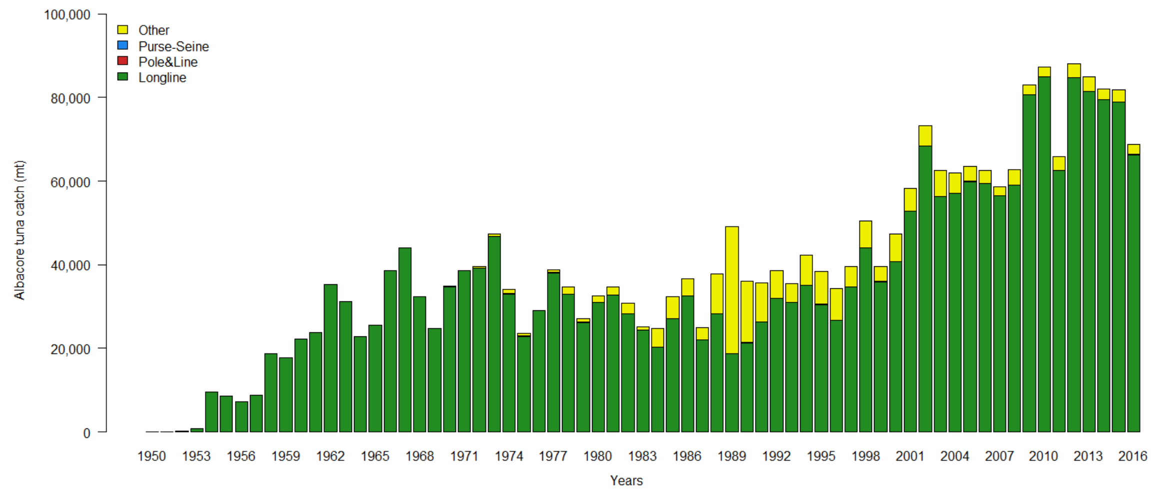


Figure 8. Stochastic projection results of skipjack spawning biomass ($SB/SB_{F=0}$) from 2015 using actual catch and effort levels in 2016, and through 2017/2018. Line prior to 2015 represents the weighted median across the uncertainty grid of assessment models. Levels of recruitment variability estimated for the period used to estimate the stock-recruitment relationship (1982-2014) assumed to continue in the future.

South Pacific albacore tuna



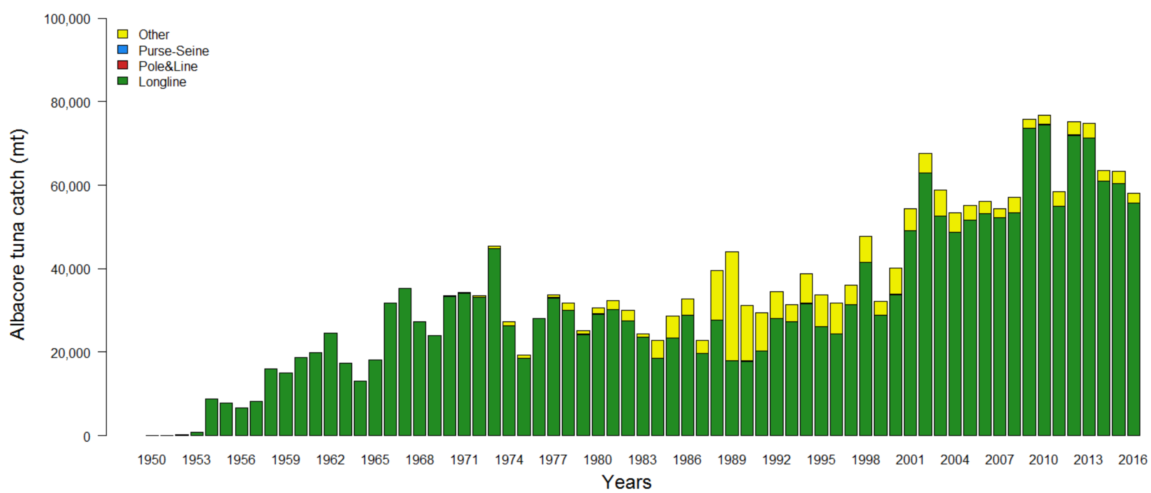


Figure 9. South Pacific albacore tuna catch by gear type and year for the south Pacific as a whole (top) and southern WCPCA (bottom). Note: 'Other' gear here is primarily troll gear, but includes driftnet catches in the 1980s and early 1990s.

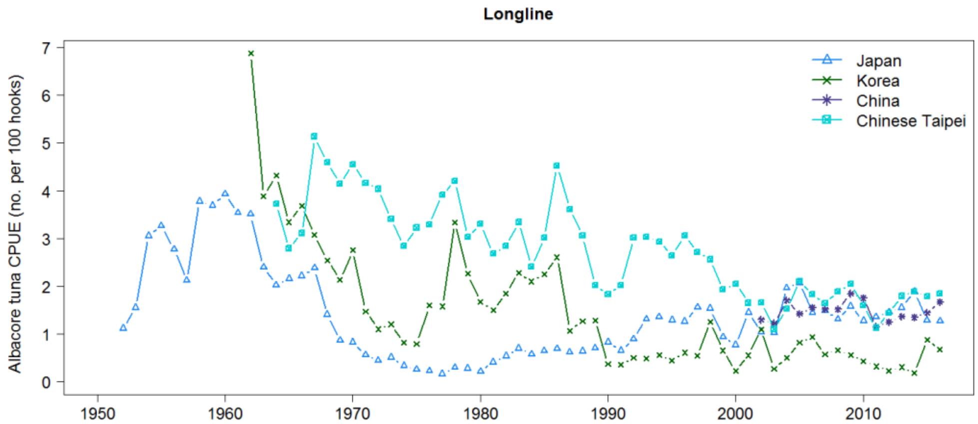


Figure 10. South Pacific albacore tuna catch per unit effort in the southern WCP-CA (south of 10°S) by year for major longline fleets.

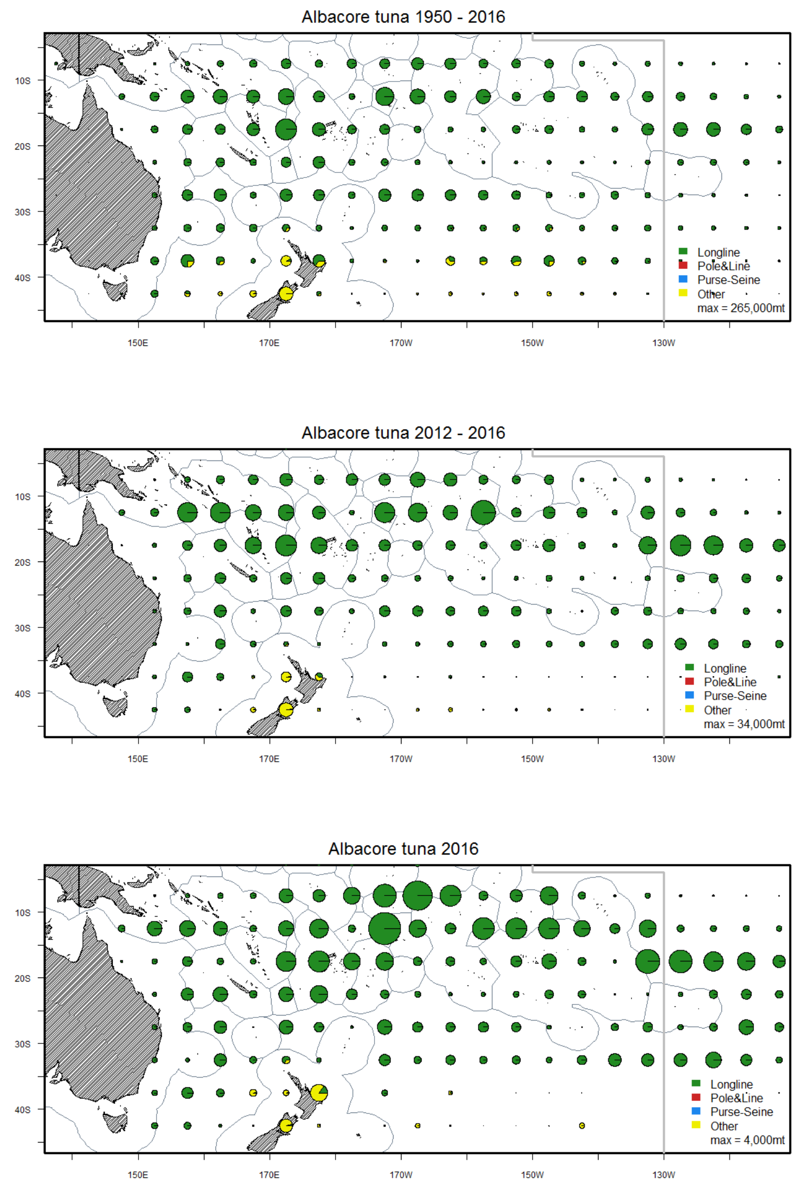


Figure 11. South Pacific albacore tuna catch distribution by gear type and 5x5° region for the southern Pacific Ocean for the period 1950-2016 (top), 2012-2016 (middle) and 2016 (bottom). The figure legend provides the catch associated with the maximum circle size.

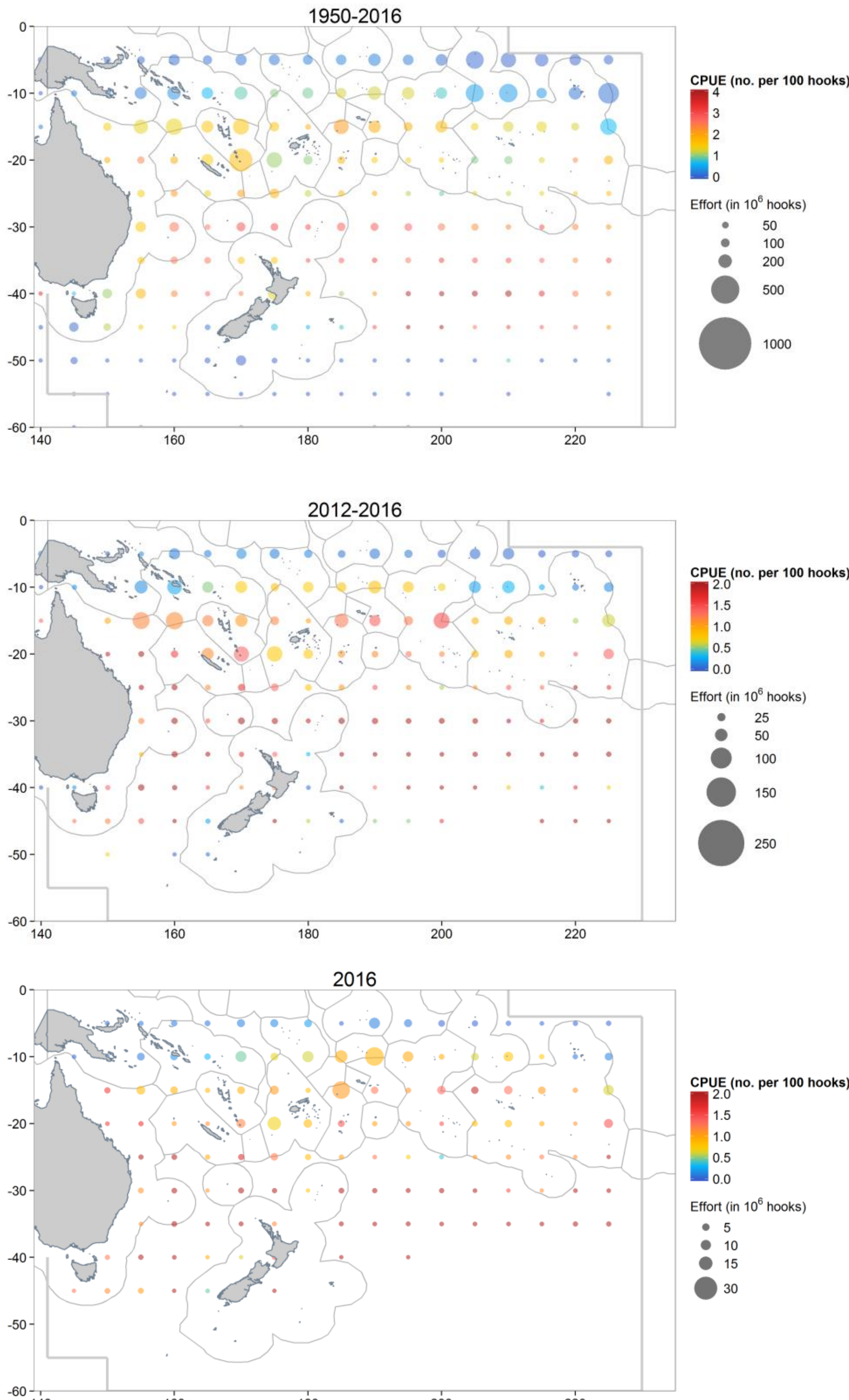


Figure 12. Distribution of longline effort (represented by circle size) and south Pacific albacore tuna CPUE (represented by colour) for the period 1950-2016 (top), 2012-2016 (middle) and 2016 (bottom). Note the differences in scales between plots.

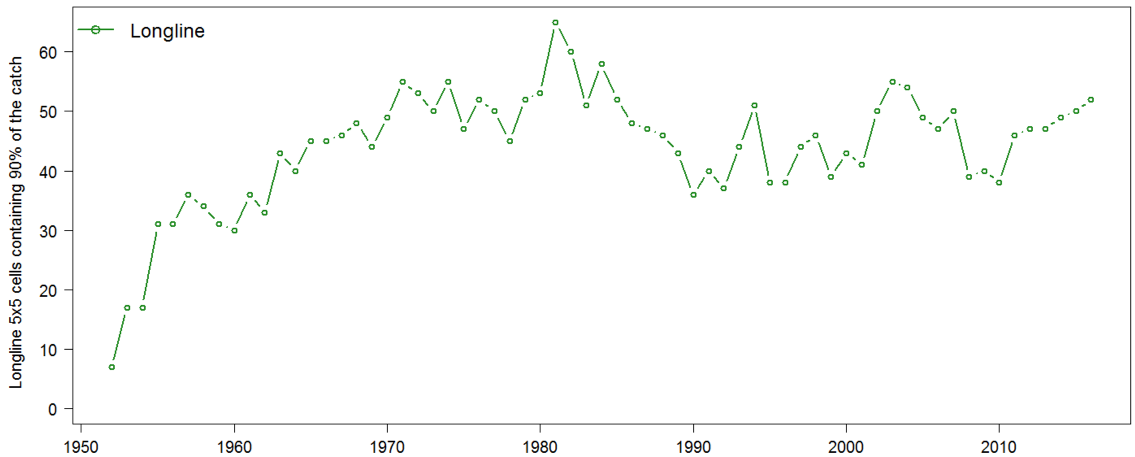


Figure 13. Spatial distribution of south Pacific albacore tuna catch for longline by year in the southern WCPO.

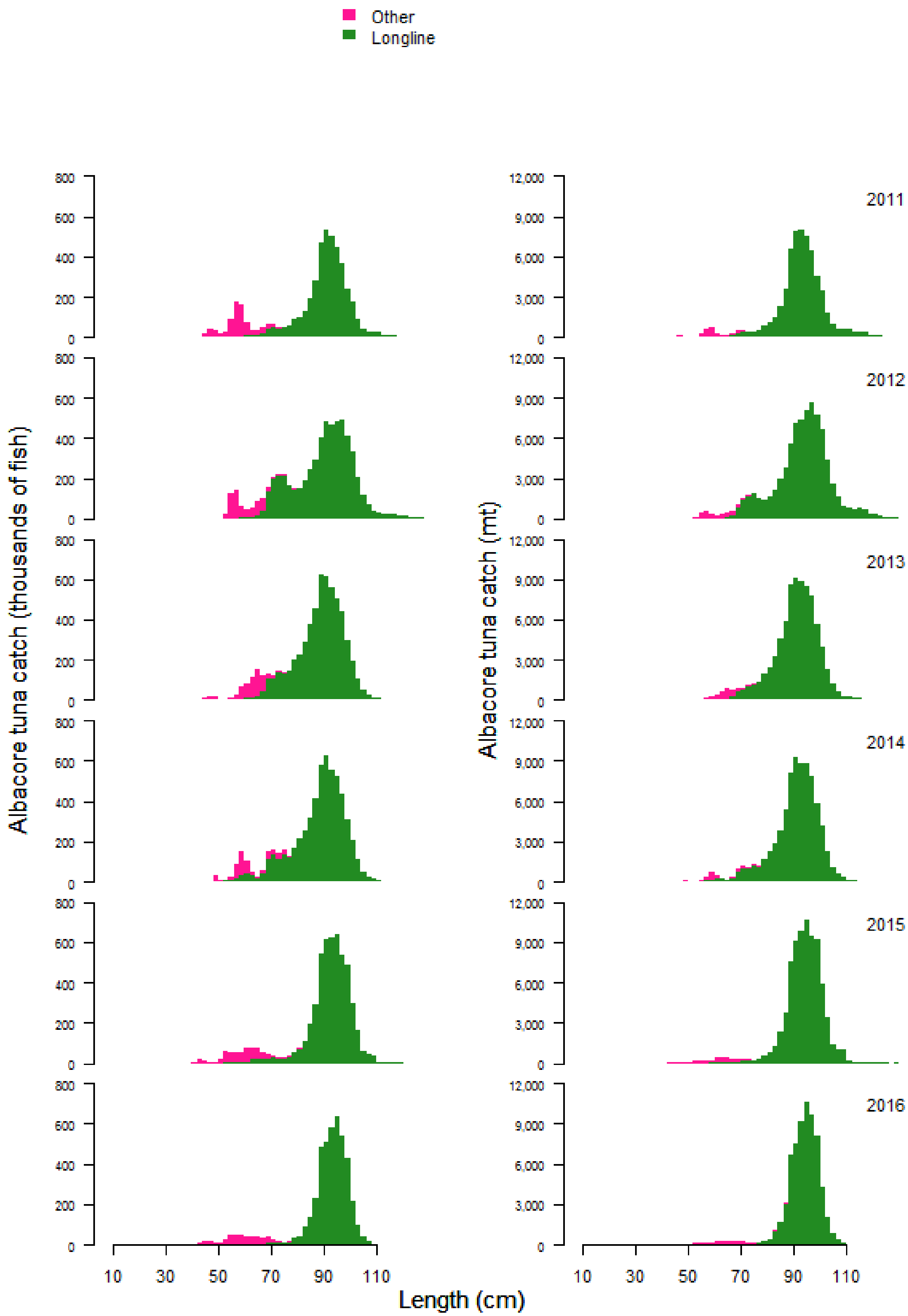


Figure 14. Weighted catch-at-size of south Pacific albacore tuna by gear type and year for the southern WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right).

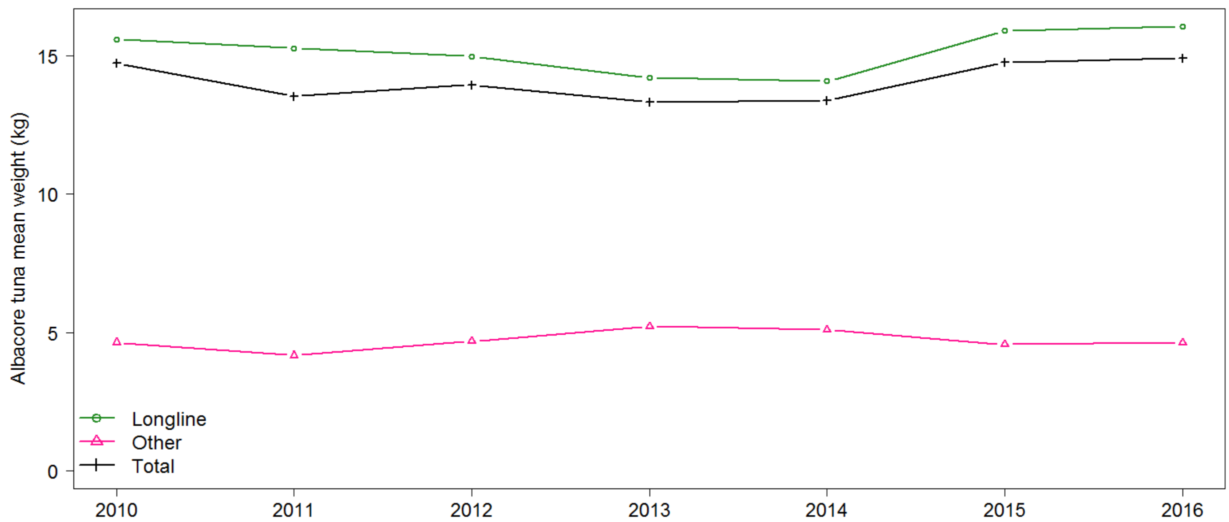


Figure 15. Mean weight of individual south Pacific albacore tuna taken by gear and year for the southern WCPO. The 'total' line represents the overall mean catch-at-size by number.

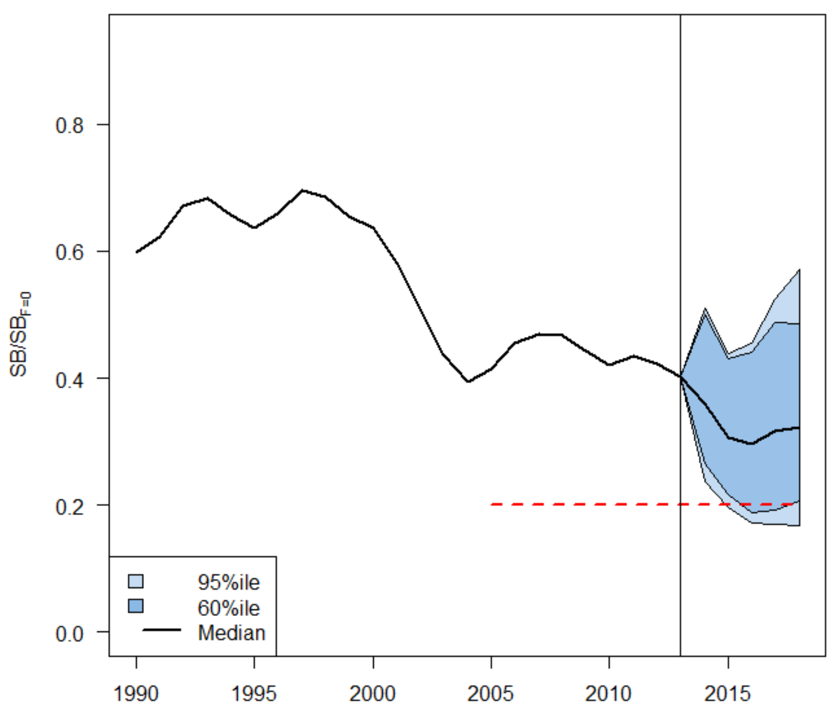


Figure 16. Stochastic projection results of south Pacific albacore spawning biomass ($SB/SB_{F=0}$) from 2013 using actual catch and effort levels in 2014 and 2015, with 2015 conditions assumed through 2018. Long-term levels of variability in estimated recruitment assumed to continue in the future.

Bigeye tuna

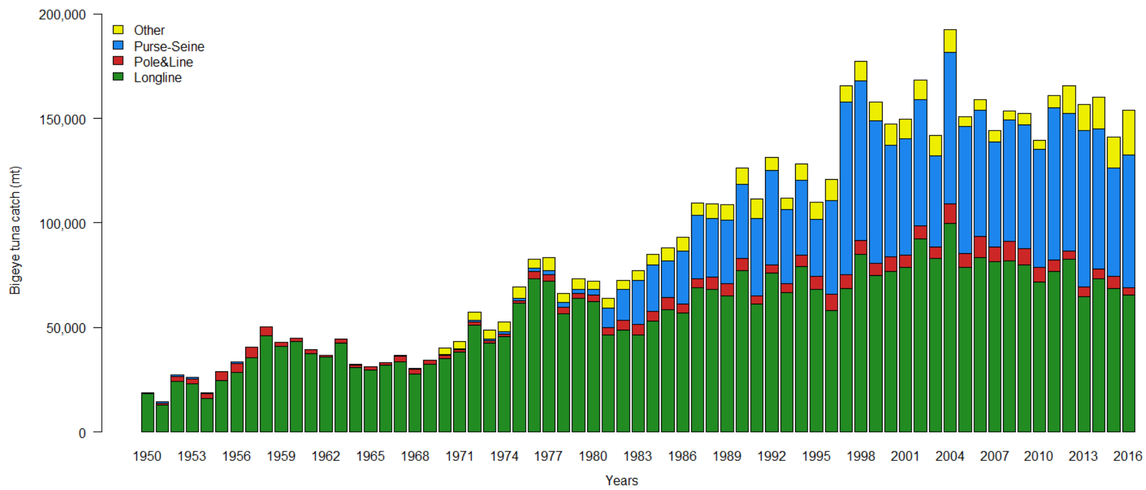


Figure 17. Bigeye tuna catch by gear type and year for the WCPFC-Convention Area.

Figure 18. 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.

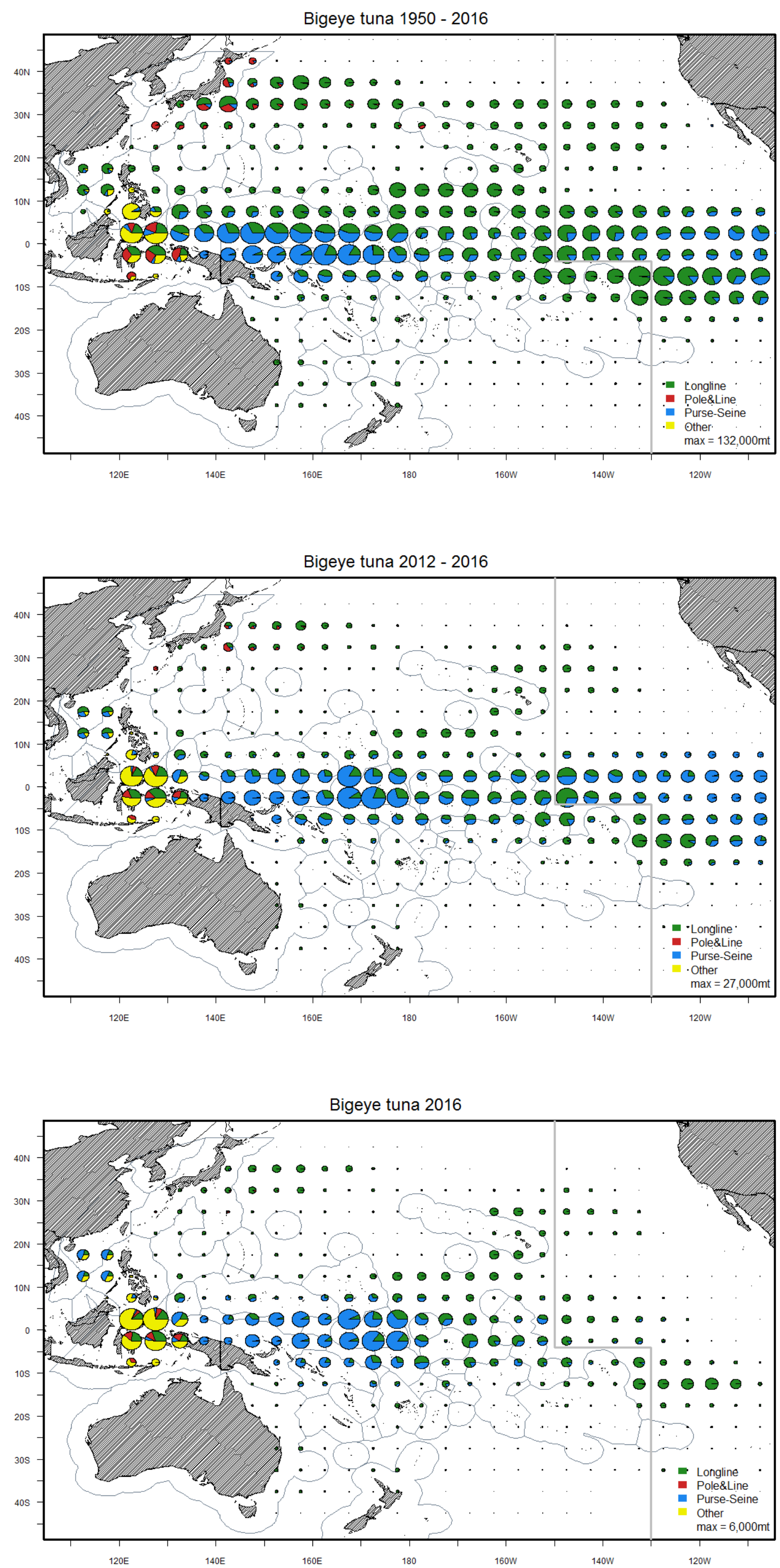


Figure 19. Bigeye tuna catch distribution by gear type and 5x5° region for the entire Pacific Ocean for the period 1950-2016 (top), 2012-2016 (middle) and 2016 (bottom). The figure legend provides the catch associated with this maximum circle size.

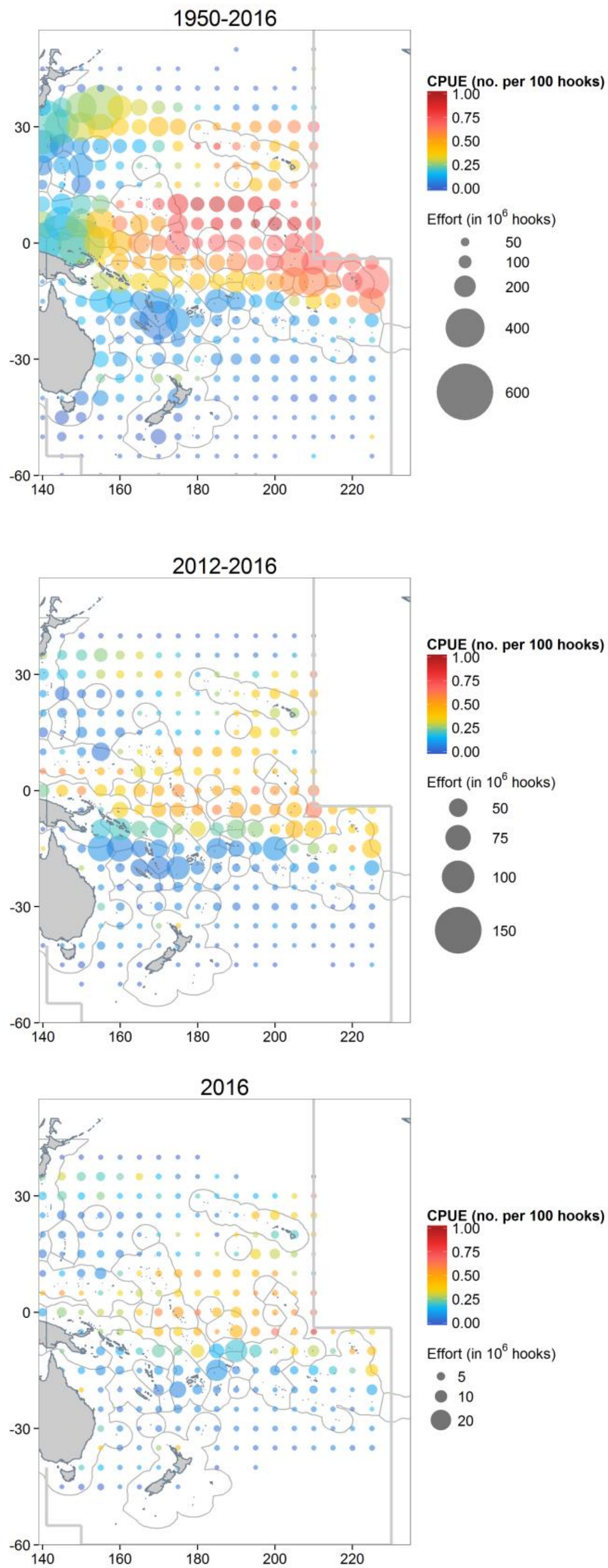


Figure 20. Distribution of longline effort (represented by circle size) and bigeye tuna CPUE (represented by colour) for the period 1950-2016 (top), 2012-2016 (middle) and 2016 (bottom). Note the differences in scales between plots.

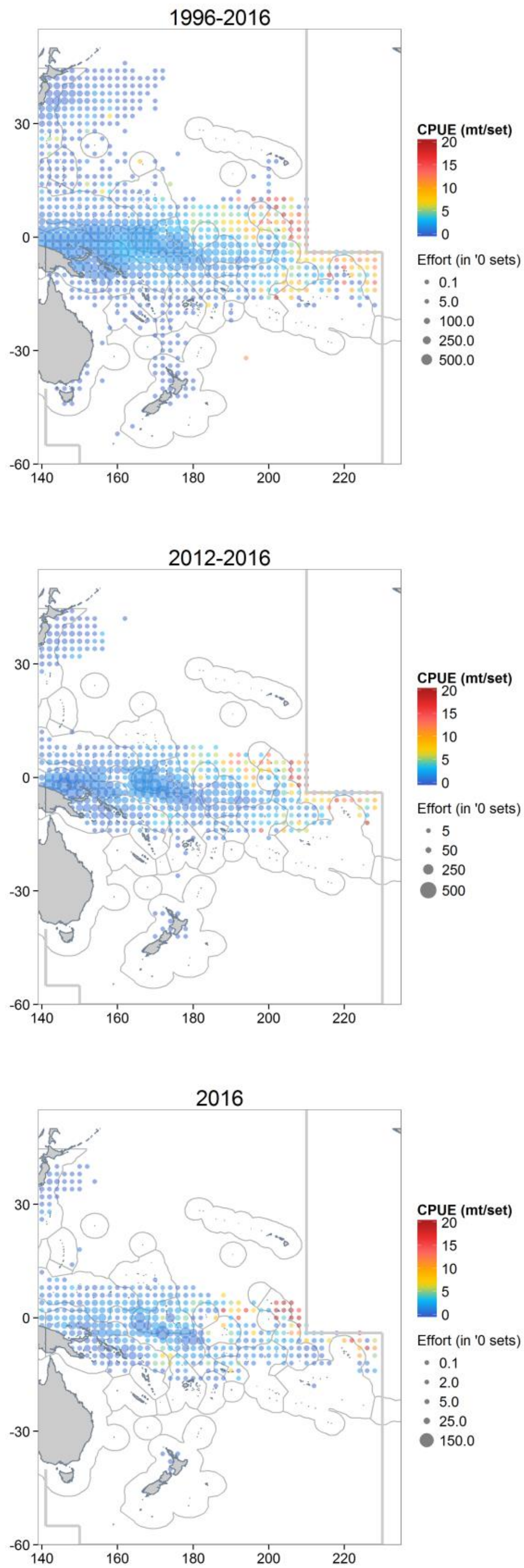


Figure 21. Distribution of 2° by 2° purse seine effort (represented by circle size) and bigeye tuna CPUE (represented by colour) for the period 1996-2016 (top), 2012-2016 (middle) and 2016 (bottom). Note the differences in circle size scale between plots.

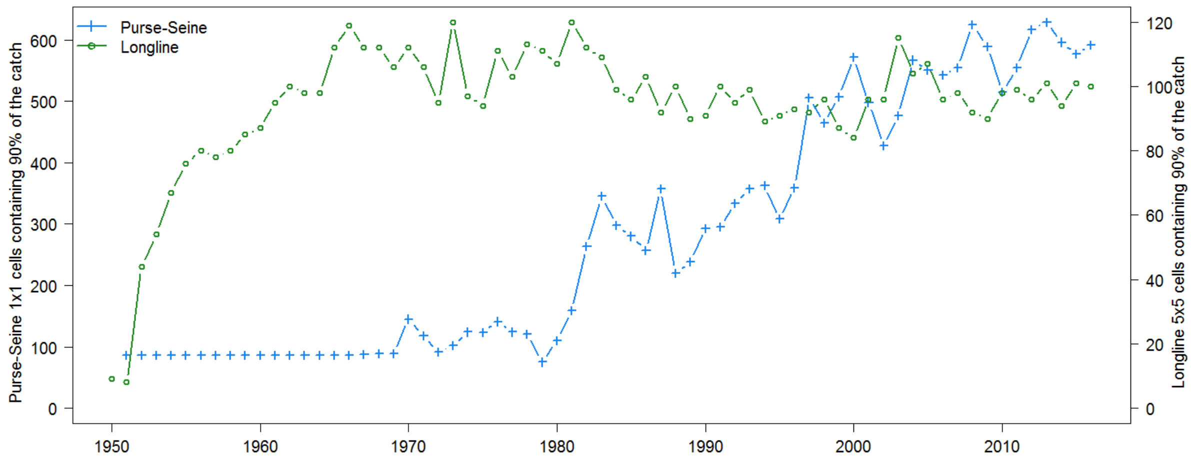


Figure 22. Spatial distribution of bigeye tuna catch for purse seine and longline by year for the WCPO.

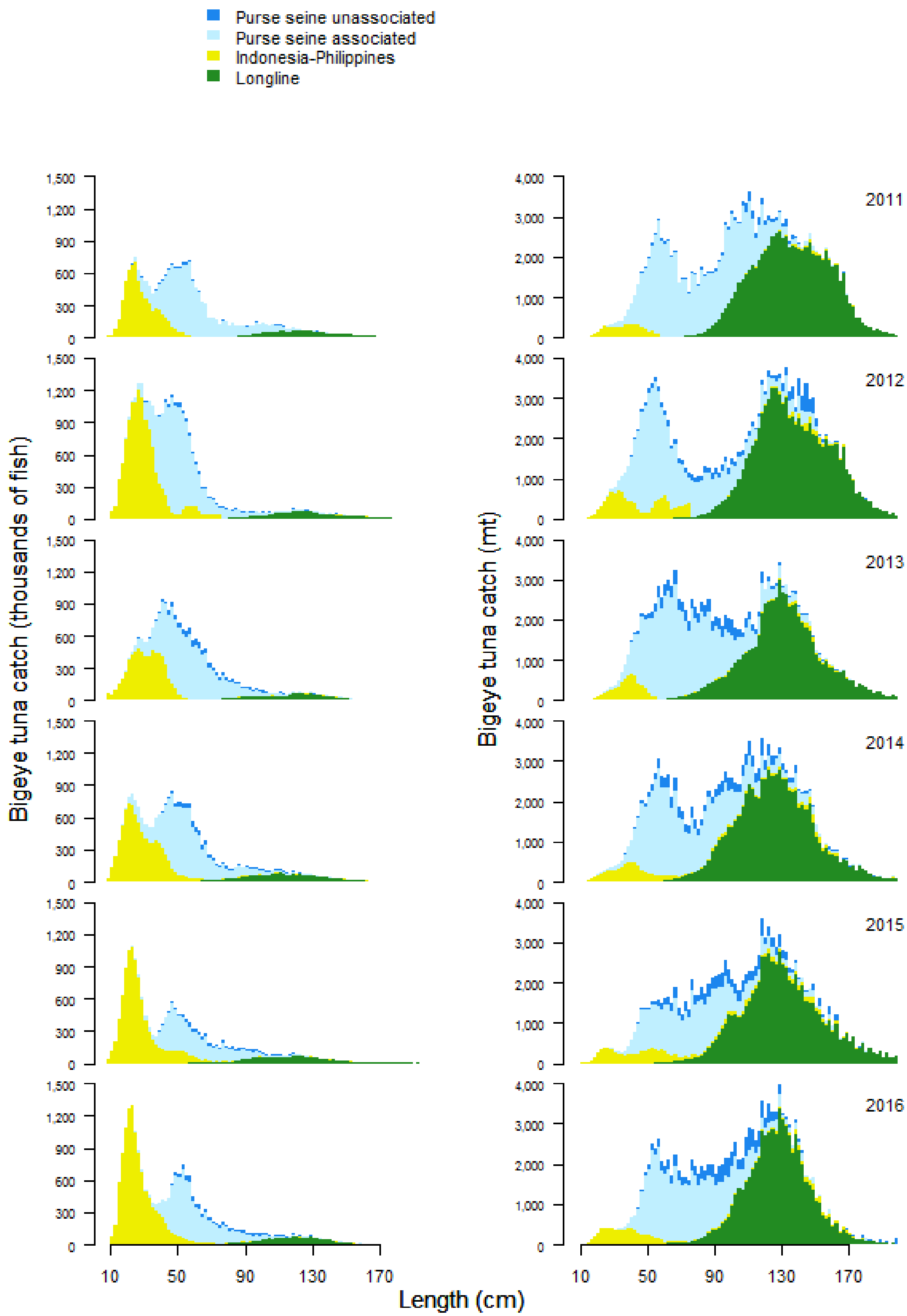


Figure 23. Catch-at-size of bigeye tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right).

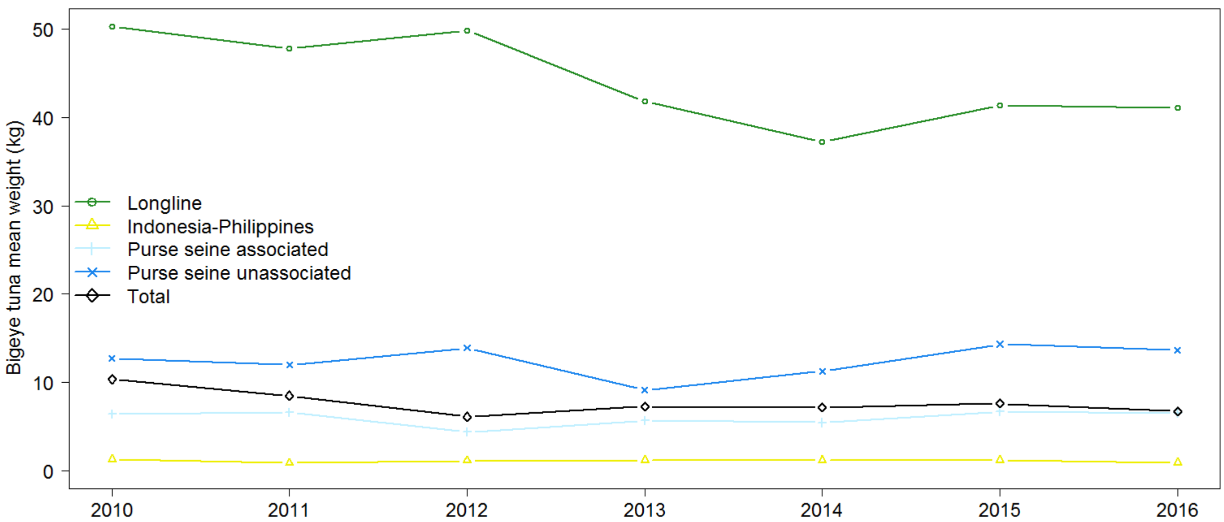


Figure 24. Mean weight of individual bigeye tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.

Yellowfin

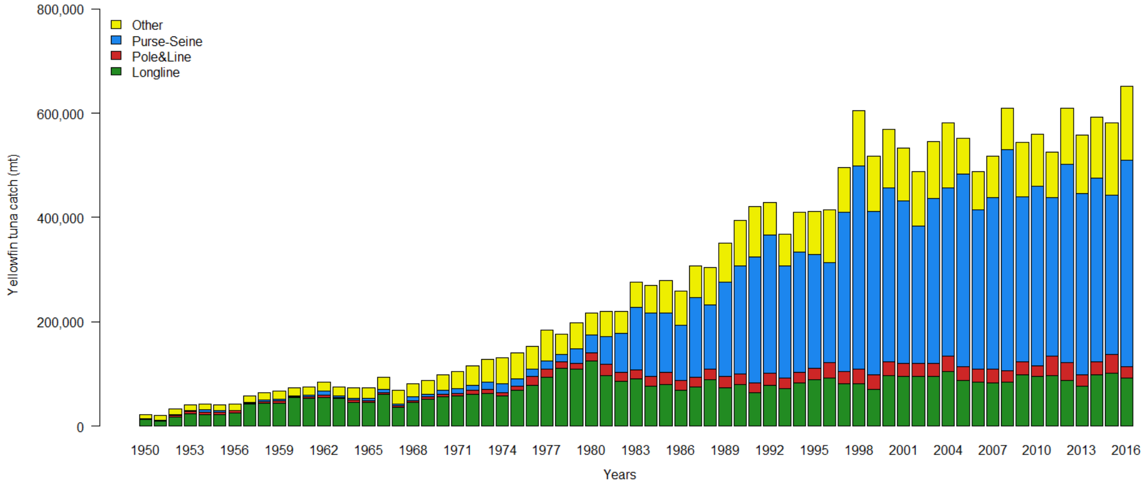


Figure 25. Yellowfin tuna catch by gear type and year for the WCPFC-Convention Area.

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

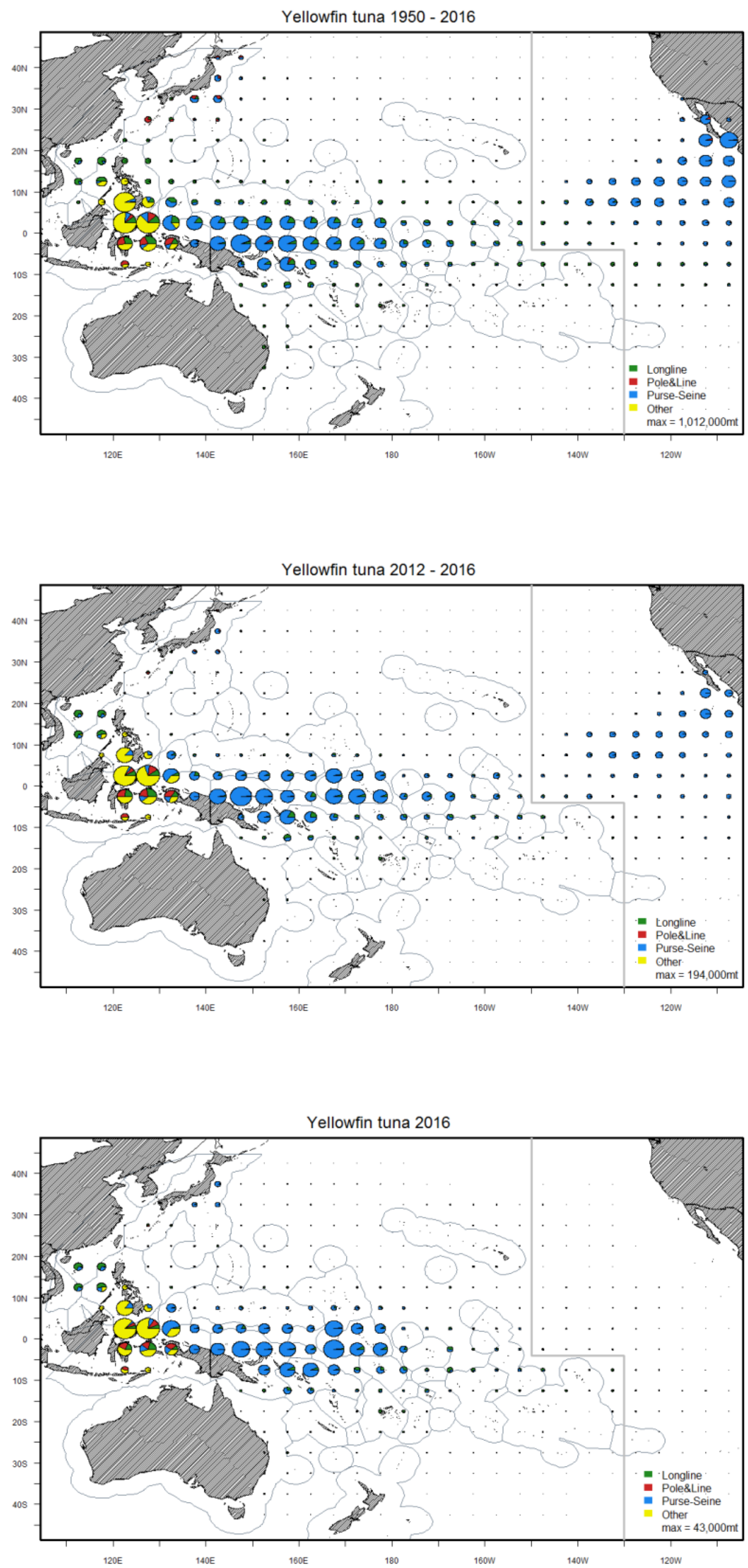


Figure 27. Yellowfin tuna catch distribution by gear type and 5x5° region for the entire Pacific Ocean for the period 1950-2016 (top), 2012-2016 (middle) and 2016 (bottom). The figure legend provides the catch associated with this maximum circle size.

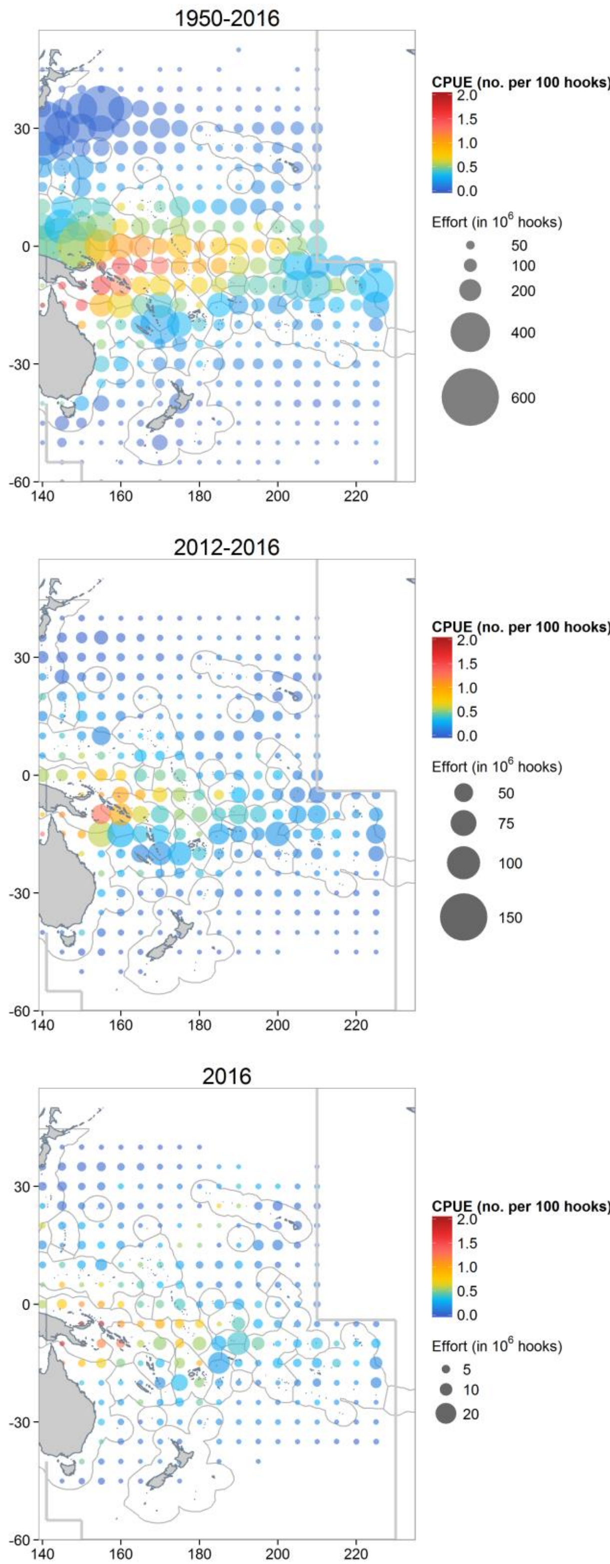


Figure 28. Distribution of longline effort (represented by circle size) and yellowfin tuna CPUE (represented by colour) for the period 1950-2016 (top), 2012-2016 (middle) and 2016 (bottom). Note the differences in scales between plots.

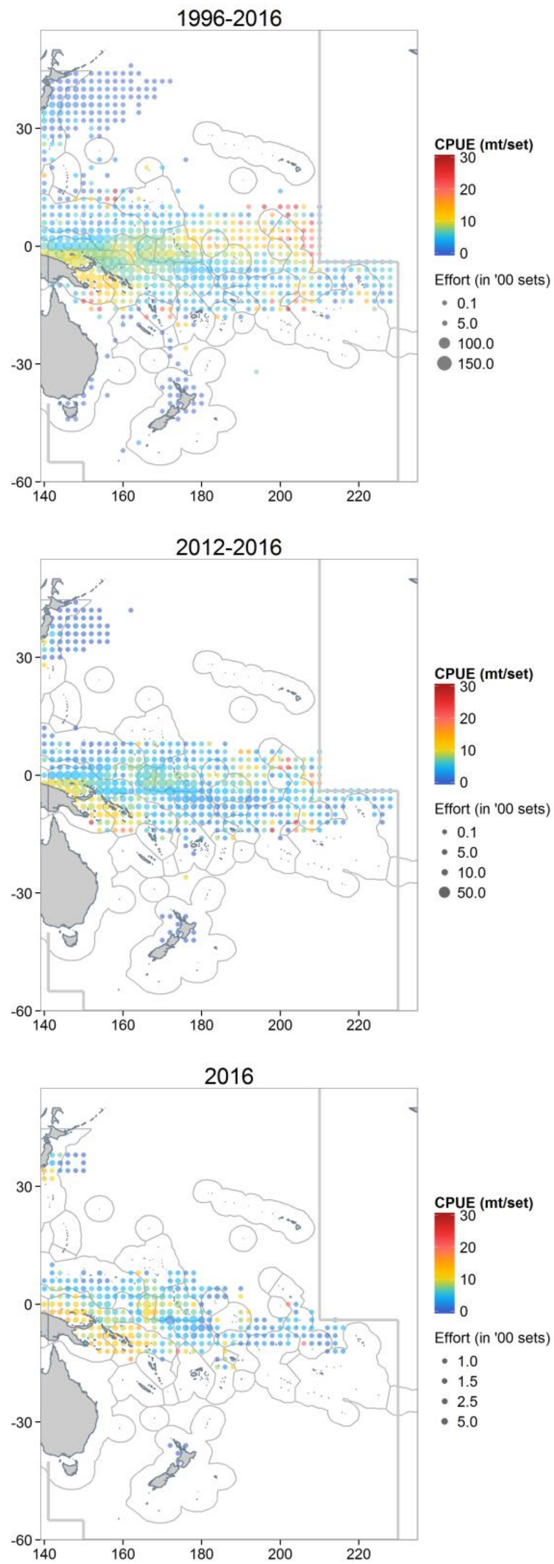


Figure 29. Distribution of 2° by 2° purse seine effort (represented by circle size) and yellowfin tuna CPUE (represented by colour) for the period 1996-2016 (top), 2012-2016 (middle) and 2016 (bottom). Note the differences in circle size scale between plots.

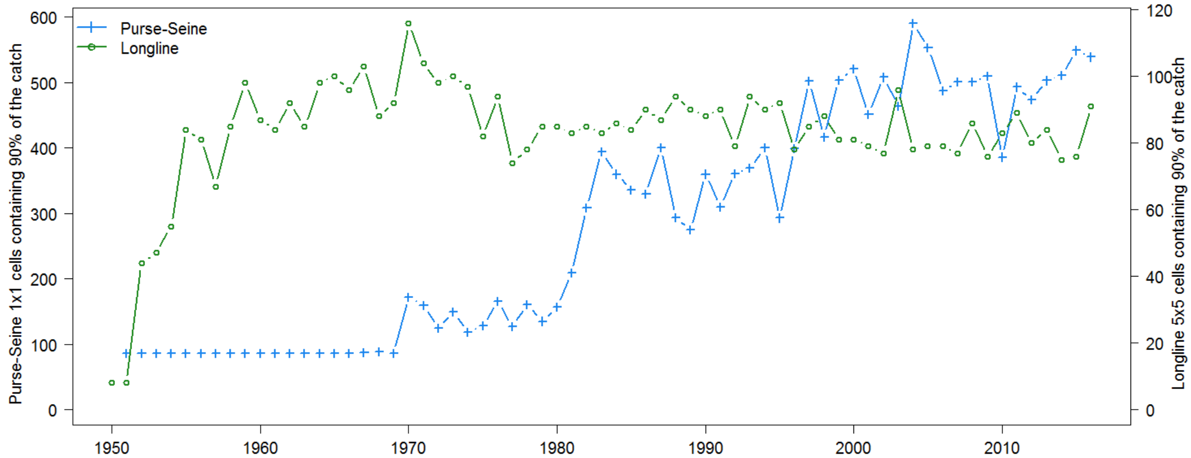


Figure 30. Spatial distribution of yellowfin tuna catch for purse seine and longline by year for the WCPO.

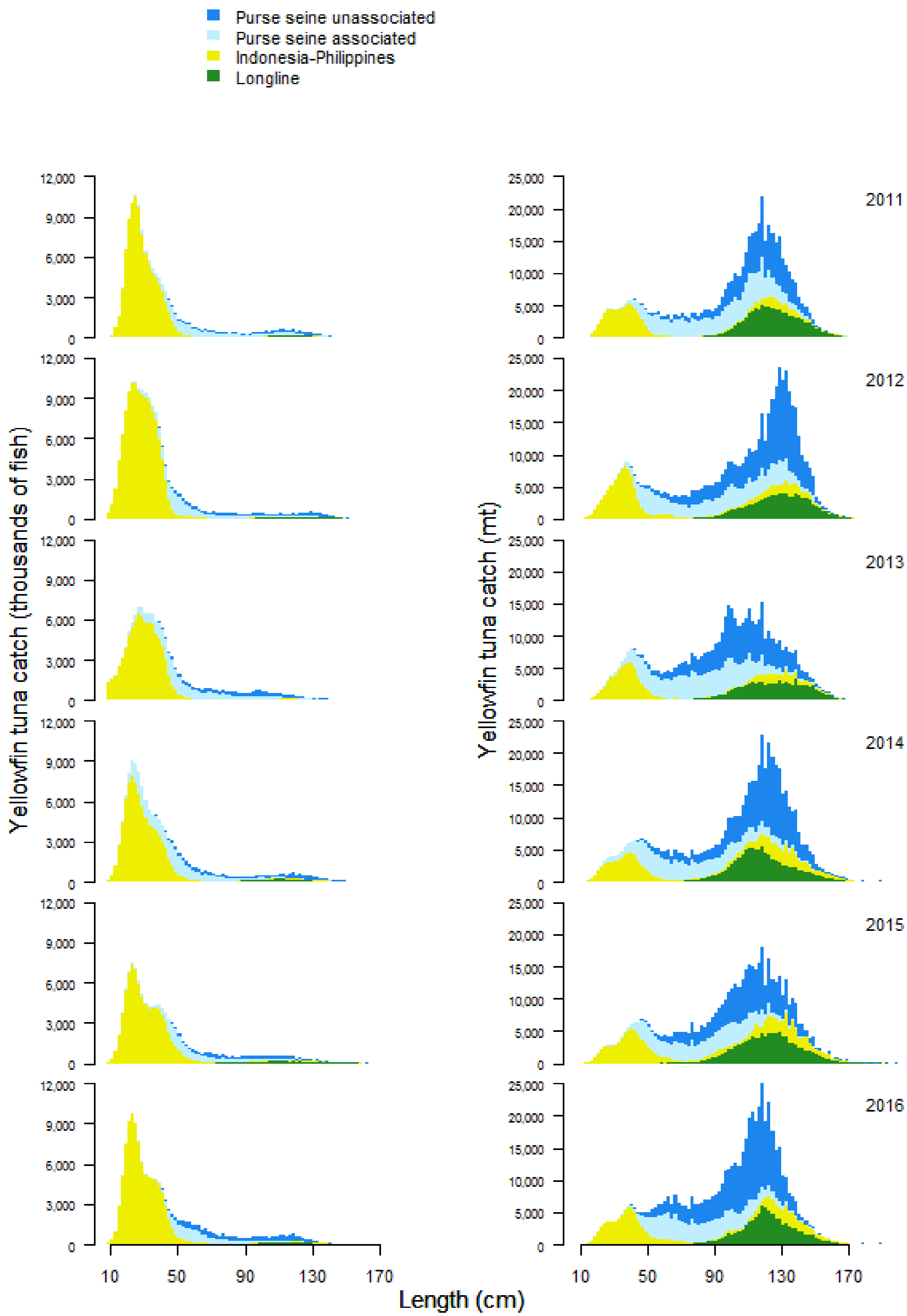


Figure 31. Catch-at-size of yellowfin tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right).

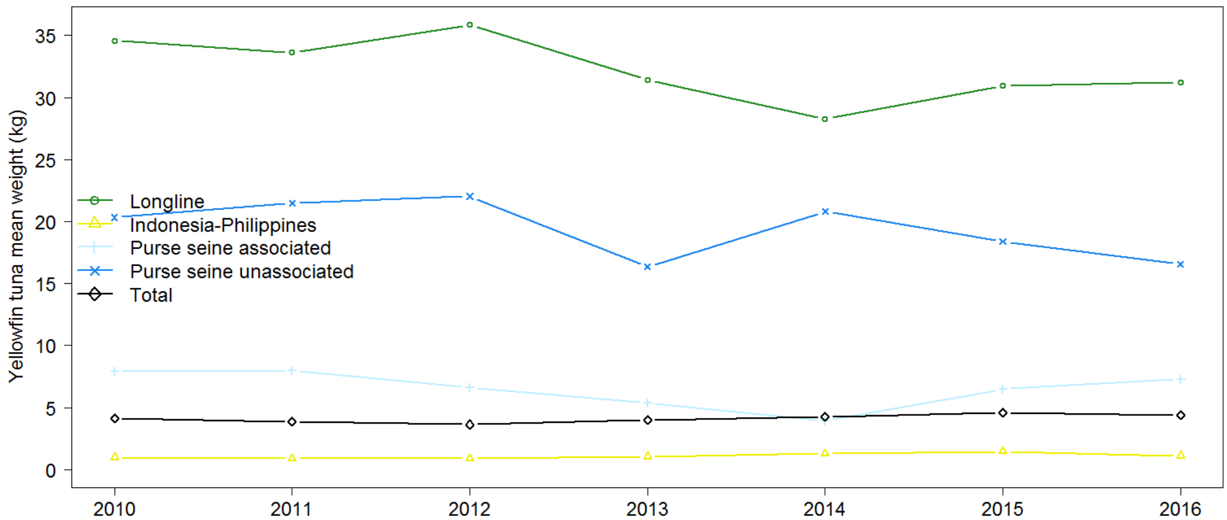


Figure 32. Mean weight of individual yellowfin tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.