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THE WESTERN AND CENTRAL PACIFIC TUNA FISHERY: 2019 OVERVIEW AND STATUS OF STOCKS

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The western and central Pacific tuna fishery: 2019 overview and status of stocks

Tuna Fisheries Assessment
Report no. 20

FAME
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Preface

Tuna fisheries assessment reports provide current information on the tuna fisheries of the western and central Pacific Ocean (WCPO) and the fish stocks (mainly tuna) that are impacted by them. The information provided in this report is summary in nature, but a list of references (mostly accessible via the internet) is included for those seeking further details. This report is a smart PDF so if you click on a reference within the document it will take you to the figure/section; to return to the page you were on, press alt and the left arrow key.

This report focuses on the primary tuna stocks targeted by the main WCPO industrial fisheries – skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), bigeye (*T. obesus*) and South Pacific albacore tuna (*T. alalunga*).

The report is divided into three parts: the first section provides an overview of the fishery, with emphasis on developments over the past few years; the second summarises the most recent information on the status of the stocks; and the third summarises information concerning the interaction between the tuna fisheries, other associated and dependent species and their environment. The data used in compiling the report are those which were available to the Oceanic Fisheries Programme (OFP) at the time of publication, and are subject to change as improvements continue to be made to recent and historical catch statistics from the region. The fisheries statistics presented will usually be complete through the end of the year prior to publication. However, some minor revisions to statistics occasionally may be made for recent years. The stock assessment information presented is the most recent available at the time of publication.

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Further information, including a French version of this report, is available at the OFP webpage.

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1 The western and central Pacific tuna fishery

The tuna fisheries in the western and central Pacific Ocean (WCPO), encompassed by the Western and Central Pacific Fisheries Commission Convention Area (WCPFC-CA) (Figure 1), are diverse, ranging from small-scale, artisanal operations in the coastal waters of Pacific states, to large-scale, industrial purse seine, pole-and-line and longline operations in the exclusive economic zones (EEZs) of Pacific states and in international waters (high seas). The main species targeted by these fisheries are skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*) and albacore tuna (*T. alalunga*).

The current fishery characterisation includes updates to historical data, which show that 2019 was the highest catch year in history, with catches of the four target tuna species just under 3 million tonnes (t). We expect revisions to the 2019 catch estimates in next year's report, as estimates in the most recent year are preliminary.

Annual total catch of the four main tuna species in the WCPFC-CA increased steadily during the 1980s as the purse seine fleet expanded, and remained relatively stable during most of the 1990s until a sharp increase in catch in 1998. Since then, there has been an upward trend in total tuna catch, primarily due to increases in purse seine catch, with some stabilisation since 2012 (Figure 2 and Table 1). The provisional total WCPFC-CA tuna catch for 2019 was estimated at 2,997,309t – a record catch. In 2019, the purse seine fishery accounted for an estimated 2,108,012t (70% of the total catch), a record catch for this fishery. The pole-and-line fishery landed an estimated 191,135t (6% of the catch – a drop from the highest value (415,016t), recorded in 1984, a time of much greater pole-and-line vessel participation as discussed below). The longline fishery in 2019 accounted for an estimated 279,015t (9% of the catch) – a drop from the highest value (284,849t), recorded in 2004. Troll gear accounted for <1% of the total catch (8,116t), a drop from the highest value (25,845t), recorded in 2000. The remaining 14% (411,031t) was taken by a variety of artisanal gear, mostly in eastern Indonesia, the Philippines and Vietnam, which is a slight drop from the highest value (412,680t), recorded in 2018. The WCPFC-CA tuna catch for 2019 represented 81% of the total Pacific Ocean catch (3,696,933t) and 55% of the global tuna catch (the provisional estimate for 2019 being 5,443,488t, a record global catch).

The 2019 WCPFC-CA catch of skipjack (2,045,970t – 68% of the total catch) was a record catch, and an increase of 10% from 2018 (Table 2). The WCPFC-CA yellowfin catch for 2019 (696,797t – 23% of the total catch) is around 17,000t lower than the highest value (713,773t), recorded in 2017. The WCPFC-CA bigeye catch for 2019 (135,442t – 5% of the total catch) was a drop from the highest value (181,707t), recorded in 2004, and a 10% decrease over the 2018 catch. The WCPFC-CA albacore catch for 2019 (119,100t – 4% of the total catch) was a drop from the highest value (148,051t), recorded in 2002, and a 7% increase over the 2018 catch. As there are separate assessments for South Pacific albacore and North Pacific albacore, the WCPFC-CA catch of albacore (Table 2) is further divided into two summary tables (Table 7 and Table 8). South Pacific albacore in the WCPFC-CA, assessed by SPC[1], totalled a 2019 catch of 69,301t which is 4% greater than the average of the previous five years, but 11% lower than the highest value (77,884t), recorded in 2010. The albacore tuna catch in the WCPFC-CA north of the equator was 49,696t in 2019, which is 2% greater than the average of the past five years, but less than half the highest catch of 104,233t, taken in 1976; the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) is responsible for conducting assessments[2] of albacore tuna in the North Pacific Ocean.

Several indices of annual fishing effort for the major gears employed in the commercial tuna fisheries are summarised in Table 3, Figure 3 (purse seine), Figure 4 (longline) and Figure 5 (pole-and-line). For the purse seine fleet, excluding the Indonesian, Philippine and Vietnamese domestic vessels, the number of active vessels peaked in 2014 and 2015 at 313. The percentage of purse seiners flagged to Pacific Island states has steadily increased from 0 as late as 1979 to a high of 45% (125 out of 277) in 2018. The increase in number of purse seine sets and purse seine fishing days has mirrored the rise in number of vessels, although the peak in both measures of fishing effort, sets and days, occured a few years earlier

[1] The Pacific Community, formerly Secretariat of the Pacific Community.

[2] The ISC North Pacific albacore assessment covers the entire North Pacific, including the waters of the Inter-American Tropical Tuna Commission Convention Area (IATTC-CA). Catch in the IATTC-CA, which is not included in the tables and figures in this report, has averaged 25% of the total North Pacific albacore catch over the past five years.

(2011–2013) at around 65,000 (suggesting improvements in efficiency). Purse seine vessels can make more than one set per day, and a day of searching (with no sets made) is counted as a fishing day.

The 2019 purse seine skipjack catch (1,708,812t – 84% of the total skipjack catch) was 18% higher than the 2018 catch (Table 4). The 2019 purse seine catch of yellowfin tuna (349,358t) was an 8% decrease from 2018 (Table 5). The 2019 purse seine catch of bigeye tuna (46,740t) was a 28% decrease from 2018, and represented 35% of the total 2019 bigeye catch (Table 6). It is important to note that the purse seine species composition for 2019 will be revised once all observer data for 2019 have been received and processed, and the current estimate should therefore be considered preliminary.

The commercial longline fleet (excluding Vietnamese and Indonesian domestic and Japanese coastal longliners) peaked in size in 1994 at a total of 5,068 vessels (Table 2 and Figure 4). The fleet has steadily declined since then, and totalled 1,669 vessels in 2019. The percentage of longliners flagged to Pacific Island countries has steadily increased from 0 in the mid-1970s to around 30% in 2017–2019. While the number of longline vessels has declined over the history of the fishery, a more direct measure of effort – hooks fished – has shown a different trend. Total hooks fished in the WCPFC-CA varied around a level of 400 million from the mid 1970s to the late 1990s. Starting in 2001, hooks fished doubled to the 800 million level with the peak occurring in 2012 at 885 million hooks; 2019 was the second highest level on record at 838 million hooks.

The recent longline catch estimates are often uncertain and subject to revision due to delays in reporting. Nevertheless, the bigeye (72,391t) catch was on par with catches since 2010, while the yellowfin (107,656t) catch for 2019 was the third highest on record, trailing only the 1980 catch of 125,113t and 1979 catch of 108,910t.

The pole-and-line fleet has been contracting in size continuously since 1974, when the number of vessels peaked at 798, and totalled just 103 vessels in 2019 (Table 2 and Figure 5). Pole-and-line effort, measured in fishing days, has shown a similar decline, from a high of 88,567 days in 1978 to 10,805 days in 2019.

Skipjack accounts for the majority of the pole-and-line catch (89%), with yellowfin tuna (10%) making up the bulk of the remaining catch. The Japanese distant-water and offshore fleet and the Indonesian fleet account for most of the WCPFC-CA pole-and-line catch.

The 2019 troll catch in the WCPFC-CA was the highest catch since 2013, at 8,116t, most of which was albacore tuna. Skipjack and yellowfin tuna are also taken in significant quantities in tropical small-scale troll fisheries, but most of these catches are reported under "Other gears". Since 2007, New Zealand (average 2,338t catch per year) has had the most consistent effort in the South Pacific albacore troll fishery, with the United States landing a small catch (averaging 376t per year) from the South Pacific.

2 Status of tuna stocks

The sections below provide a summary of the recent developments in fisheries for each species, and the results from the most recent stock assessments. A summary of the important biological reference points for the four stocks is provided in Table 9. Bigeye and yellowfin tuna stocks were assessed in 2020, the skipjack tuna stock was assessed in 2019, and the South Pacific albacore stock was assessed in 2018. Due to uncertainty in the fisheries data for the most recent year, data from the year immediately preceding the assessment year is not included in the bigeye, yellowfin and albacore assessments. Thus, the bigeye and yellowfin tuna assessments include data through 2018, while South Pacific albacore currently includes data through 2016. Skipjack, with its shorter lifespan and importance of young fish to the fishery, includes the most recent year of data; thus the 2019 assessment included fisheries data through 2018. Information on the status of other oceanic fisheries resources (e.g. billfishes and sharks) is provided in 4.3 *Ecosystem Considerations*.

2.1 Skipjack tuna

The 2019 WCPFC-CA skipjack catch of 2,045,970t was a record catch (Figure 6 and Table 4). As in recent years, the main contributor to the overall catch of skipjack was that taken in the purse seine fishery (1,708,812t in 2019 – 84% of total skipjack catch). The next-highest proportion of the catch was by pole-and-line gear (153,869t – 8%). The longline fishery accounted for less than 1% of the total catch.

The vast majority of skipjack are taken in equatorial areas, and most of the remainder is taken in the seasonal domestic fishery off Japan (Figure 6).

The dominant size of the WCPFC-CA skipjack catch (by weight) typically ranges from 40cm to 60cm, corresponding to 1-2^{+} year-old fish (Figure 6). For pole-and-line, the fish typically range from 40cm to 55cm, while skipjack in the domestic fisheries of Indonesia and the Philippines are much smaller (20–40cm). In general, skipjack taken in unassociated (free-swimming) schools are larger than those taken in schools associated with Fish Aggregating Devices (FADs).

Stock assessment

The most recent assessment of skipjack in the WCPO was conducted in 2019, and included data from 1972 to 2018, using an eight region model (Vincent *et al.* 2019); readers are referred to that document for more details on model configuration and settings. The 2019 assessment included investigaton of alternative regional structures (five and eight regions), growth functions, length composition scalars, tag mixing periods, and levels of steepness in the stock-recruitment relationship. The Scientific Committee (SC) of the Western and Central Pacific Fisheries Commission (WCPFC) agreed to use the eight region model to describe the stock status of skipjack tuna because they considered that it better captured the biology of skipjack tuna. Stock status was determined over an uncertainty grid of 54 models where models with a steepness of 0.65 or 0.95 were down weighted by 20% and models with a length composition scalar of 50 were also down weighted by 20%, while all other models were given a weighting of 1. While estimates of fishing mortality for skipjack have increased over time, current fishing mortality rates for skipjack tuna are estimated to be about 0.45 times the level of fishing mortality associated with maximum sustainable yield (F_{MSY}). Therefore, overfishing is not occurring (i.e. $F_{recent} < F_{MSY}$). Spawning biomass is estimated to be at 44% of the level predicted in the absence of fishing. Recent spawning biomass levels are estimated to be well above the limit reference point of 20% of the level predicted in the absence of fishing ($SB/SB_{F=0} = 0.2$). Overall, the estimated recruitment shows an upward trend over time, but the spawning potential shows a long-term decline. Under status quo fishing conditions, where catch and effort levels are maintained at the average 2016–2018 levels, the stock is projected to have zero probability of dropping below the Limit Reference Point (LRP). A number of diagnostic plots on exploitation history, present status and future projections are shown in Figure 7.

The conclusions of the WCPFC SC at its 15th Regular Session (SC15), which were presented as recommendations to the WCPFC, are outlined below.

- The grid median spawning potential depletion level is $SB_{recent}/SB_{F=0} = 0.44$ with a likely range of 0.37 to 0.53 (80th percentile). There were no individual models where $SB_{recent}/SB_{F=0} < 0.2$, which indicated a zero probability that recent spawning biomass is below the LRP.
- The grid median F_{recent}/F_{MSY} is 0.45, with a likely range of 0.34 to 0.60 (80th percentile) and no values of F_{recent}/F_{MSY} in the grid exceed 1. Therefore, there is zero probability that overfishing is occurring.
- The largest uncertainty in the structural uncertainty grid is due to the assumed tag mixing period. SC15 acknowledged that further study is warranted to investigate the uncertainty surrounding the appropriate mixing period for the tagging data.
- The spatial extent of the Japanese pole-and-line fishery has decreased over the time period and the future use of this standardised catch-per-unit-effort (CPUE) index within future stock assessments is uncertain. Therefore, further study of alternative indices of abundance is warranted, such as investigation of standardising the purse seine fishery CPUE and evaluation of the feasibility of conducting fishery independent surveys.

2.2 Yellowfin tuna

The WCPC-CA yellowfin catch in 2019, of 696,797t, was lower than the highest value (713,773t), recorded in 2017 (Figure 8 and Table 5). The purse seine catch (349,358t) decreased by 8%, and the longline catch (107,656t) increased by 9%, from 2018 levels. The remainder of the yellowfin tuna catch comes from pole-and-line and troll, and the domestic fisheries in Indonesia, Vietnam and the Philippines. The purse seine catch of yellowfin tuna is typically around four times the size of the longline catch.

As with skipjack, most of the yellowfin catch is taken in equatorial areas by large purse seine vessels, and a variety of gears in the Indonesian and Philippines fisheries. The domestic surface fisheries of the

Philippines and Indonesia take large numbers of small yellowfin in the range 20–50cm (Figure 8). In the purse seine fishery, greater numbers of smaller yellowfin are caught in log and FAD sets than in unassociated sets. A major proportion (by weight) of the purse seine catch is adult (> 100cm) yellowfin tuna.

Stock assessment

The most recent assessment of yellowfin tuna in the WCPO was conducted in 2020 (Vincent *et al.* 2020) and included data from 1952 to 2018. The 2020 assessment included the incorporation of an index fishery for each of the nine regions, use of additional information on yellowfin growth, and enforcement of mixing periods in the tagging data. The analysis presented the results as a structural uncertainty grid from 72 model runs and those results were equally weighted when developing management advice. Across the range of model runs in this assessment, the key factor influencing estimates of stock status was growth, with the most optimistic stock status estimates those using a growth curve estimated externally from otolith data. Models where growth was estimated from modal size progression were the most pessimistic while a third method, where growth was estimated from both conditional age-at-length and size composition data, was intermediate although closer to the otolith growth curve models. Additional axes of uncertainty in the yellowfin grid included multiple values for steepness in the stock-recruitment relationship, a range of size scalars to weight size frequency data, and an assumed mixing period of either 1 or 2 quarters for tagged fish.

Fishing mortality on both juvenile and adult fish increased has steadily since the early days of the fishery, although juvenile mortality shows signs of leveling off. Current fishing mortality rates for yellowfin tuna, however, are estimated to be below F_{MSY} in all models, which indicates that overfishing is not occurring. Spawning potential showed a long continuous decline from the 1950s to the 2000s, but appears to have leveled off since around 2010. Recruitment has been variable throughout the assessment period, but somewhat lower in the past three decades relative to the 1950s and 1960s. Recent spawning biomass levels are uniformly (72 out of 72 runs) estimated to be above the SB_{MSY} level and the LRP of 20% of the level predicted in the absence of fishing. Under status quo fishing conditions, where effort and catch levels are maintained at the average 2016–2018 levels, the stock is projected to have zero probability of dropping below the LRP. A number of diagnostic plots on exploitation history, present status and future projections are shown in Figure 9.

The conclusions of the WCPFC at its 16^{th} Regular Session (SC16), which were presented as recommendations to the WCPFC in 2020, are outlined below.

- Based on the uncertainty grid adopted by SC16, the WCPO yellowfin tuna spawning biomass is above the biomass LRP and recent F is below F_{MSY}. The stock is not experiencing overfishing (0% probability F_{recent}>F_{MSY}) and is not in an overfished condition (0% probability $SB_{recent}/SB_{F=0}$<LRP). Additionally, stochastic projections predict there to be no risk of breaching the LRP (0% probability $SB_{2048}/SB_{F=0}$<LRP) under average 2016–2018 fishing conditions.
- Levels of fishing mortality and depletion differ between regions, and fishery impact was highest in the tropical region (Regions 3, 4, 7 and 8 in the stock assessment model), mainly due to the purse seine fisheries in the equatorial Pacific and the "other" fisheries within the western Pacific.
- WCPFC could consider reducing fishing mortality on yellowfin, from fisheries that take juveniles, with the goal to increase maximum fishery yields and reduce any further impacts on the spawning potential for this stock in the tropical regions.
- Although the structural uncertainty grid presents a positive indication of stock status, the high level of unresolved conflict amongst the data inputs used in the assessment suggests additional caution may be appropriate when interpreting assessment outcomes to guide management decisions.
- Recommend as a precautionary approach that the fishing mortality on yellowfin tuna stock should not be increased from the level that maintains spawning biomass at 2012–2015 levels until the WCPFC can agree on an appropriate target reference point.

2.3 Bigeye tuna

The 2019 WCPFC-CA bigeye tuna catch was 135,442t, which was a drop from the highest value (181,707t), recorded in 2004. A 18,017t decrease in purse seine catch and a 3,480t increase in the longline fishery

(Figure 10 and Table 6) has had the overall effect of a decrease in total bigeye catch relative to 2018. Of the total bigeye catch in 2019, 53% was caught by longline, 35% by purse seine, and the remainder was distributed across troll, pole and line, and other gears.

The majority of the WCPFC-CA catch is taken in equatorial areas, by both purse seine and longline, but with some longline catch in sub-tropical areas (e.g. east of Japan and off the east coast of Australia) (Figure 10). In the equatorial areas, much of the longline catch is taken in the central Pacific, contiguous with the important traditional bigeye longline area in the eastern Pacific.

As with skipjack and yellowfin tuna, the domestic surface fisheries of the Philippines and Indonesia take large numbers of small bigeye in the range of 20–50cm. In addition, large numbers of 25–75cm bigeye are taken in purse seine fishing on FADs (Figure 10) which, along with the fisheries of the Philippines and Indonesia, account for the bulk of the catch by number. The longline fishery, which lands bigeye mostly above 100cm, accounts for most of the catch by weight in the WCPFC-CA. This contrasts with large yellowfin tuna, which (in addition to the longline gear) are also taken in significant amounts from unassociated schools in the purse seine fishery and in the Philippines handline fishery. Large bigeye are very rarely taken in the WCPO purse seine fishery, and only a relatively small amount comes from the handline fishery in the Philippines. Bigeye sampled in the longline fishery are predominantly adult fish, with a mean size of approximately 130cm with most between 80 and 160cm.

Stock assessment

The most recent assessment of bigeye tuna in the WCPO was conducted in 2020 (Ducharme-Barth *et al.* 2020), and included data from 1952 to 2018. This assessment utilised only the new growth estimates first introduced in the 2017 assessment (McKechnie *et al.* 2017) but also incorporated additional age-at-length information from tag recaptures and implemented the Richards growth model. Additionally, only the 10^{o}N spatial structure was considered; an "index fishery" approach with utilisation of spatiotemporal model standardised CPUE indices was implemented for the nine regions, and updates were incorporated for tag data models, purse seine catch estimates, size composition data, and biological parameters for the length-weight relationship and reproductive potential. Management advice was formulated from the results of an uncertainty grid of 24 models that addressed several key model uncertainties. The most influential factor contributing to uncertainty around estimated stock status was the level of data weighting given to the size-frequency data. Assessment outcomes became increasingly optimistic as greater weight was placed on the size-frequency data. Additional model uncertanties addressed in the grid included natural mortality and steepness in the stock-recruitment relationship.

Fishing mortality is estimated to have increased over time, particularly on juveniles over the last two decades, although juvenile mortality shows signs of leveling off. Current fishing mortality rates for bigeye tuna, however, are estimated to be below F_{MSY} in 21 of the 24 models in the grid, which indicates that overfishing is likely not occurring. Spawning potential showed a long continuous decline from the 1950s to the 2000s, but appears to have leveled off since around 2010. Recruitment has been variable throughout the assessment period, but somewhat higher in the past two decades relative to the 1950s and 1960s. Recent spawning biomass levels are uniformly (24 out of 24 runs) estimated to be above both the SB_{MSY} level and the LRP of 20% of the level predicted in the absence of fishing. Under status quo fishing conditions, where effort and catch levels are maintained at the average 2016–2018 levels and relatively positive recent (2007–2016) recruitment patterns continue, the stock is projected to have zero probability of dropping below the LRP. A number of diagnostic plots on exploitation history, present status and future projections are shown in Figure 11.

The conclusions of WCPFC SC16, which were based on placing equal weight on all 24 model runs, were presented as recommendations to the WCPFC, and are outlined below.

- The median catch in the last year of the assessment (2018) was 159,288t which was greater than the median MSY (140,720t).
- Based on the uncertainty grid, WCPO bigeye tuna spawning biomass is above the biomass LRP and F_{recent} is very likely below F_{MSY}.
- It was concluded that the stock is not overfished (0% probability $SB/SB_{F=0}$<LRP) and likely not experiencing overfishing (87.5% probability $F_{recent}<F_{MSY}$).

- Levels of fishing mortality and depletion differ among regions, and that fishery impact was higher in the tropical regions (Regions 3, 4, 7 and 8 in the stock assessment model), with particularly high fishing mortality on juvenile bigeye tuna in these regions. There is also evidence that the overall stock status is buffered with biomass kept at a more elevated level overall by low exploitation in the temperate regions (1, 2, 6 and 9).
- Based on these results, it was recommended as a precautionary approach that the fishing mortality on bigeye tuna stock should not be increased from the level that maintains spawning biomass at 2012–2015 levels until the WCPFC can agree on an appropriate target reference point.

2.4 South Pacific albacore tuna

The total South Pacific albacore catch in 2019 (69,987t) represented a drop from the highest value (75,135t), recorded in 2017 (Figure 12 and Table 7). Longline fishing has accounted for most of the catch of this stock (81% in the 1990s, but 96% in the most recent 10 years). The troll catch, covering a season spanning November to April, has generally been in the range of 3,000–8,000t, however it has averaged 2,674t over the past five years. Note that the albacore assessment presented here is for the albacore stock that occurs south of the equator within the WCPFC-CA and the catch data is presented in Table 7. We also provide the catch data for the albacore stock north of the equator (Table 8, thus the tables together total the numbers in Table 2); the northern albacore stock is presently assessed by the ISC (ALBWG, 2020).

The longline catch is widely distributed across the South Pacific (Figure 12), with the largest catches from the western region. Much of the increase in catch is attributed to that taken by vessels fishing north of latitude 20°S. The Pacific Island domestic longline fleet catch is restricted to latitudes 10°–25°S. Troll catch is distributed in New Zealand's coastal waters, mainly off the South Island, and along the sub-tropical convergence zone (STCZ). In the past, less than 20% of the overall South Pacific albacore catch was taken east of 150°W but, in the most recent five years, this has increased to over 25%.

The longline fishery takes mainly larger adult albacore, mostly in the narrow size range of 90–105cm, and the troll fishery takes juvenile fish in the range of 45–80cm. Juvenile albacore also occasionally appear in the longline catch in more southern latitudes.

Stock assessment

The most recent stock assessment for South Pacific albacore tuna was undertaken in 2018 (Tremblay-Boyer *et al.* 2018), and was based on data from 1960 to 2016. This analysis presented the results from a structural uncertainty grid based on 72 model runs for developing management advice. All plausible combinations of the most important axes of uncertainty were included with equal weighting in the grid.

The assessment indicates that fishing mortality has generally been increasing over time, with F_{recent} (2012–2015 average) estimated to be 0.2 times the fishing mortality that will support the MSY. Across the grid F_{recent}/F_{MSY} ranged from 0.06–0.53. This indicates that overfishing is not occurring (Figure 13). Spawning biomass levels are above both the level that will support the MSY (SB_{recent}/SB_{MSY} = 3.3 for the diagnostic case and range 1.45–10.74 across the grid) and the adopted LRP of $0.2SB_{F=0}$ ($SB_{recent}/SB_{F=0} = 0.52$ for the median and range 0.32–0.72 across the grid) indicating that the stock is not overfished. Under status quo fishing conditions, where catch levels are maintained at recent 2019 levels, the stock is projected to have a probability of dropping below the LRP as early as 2020 and this increases to a level of >30% by 2048. A number of diagnostic plots on exploitation history, present status and future projections are shown in Figure 13.

The SC also considered an index of economic conditions in the South Pacific albacore fishery (Williams and Reid 2018). This index, which integrates fishing costs, catch rates and fish prices, estimates a strong declining trend in economic conditions, reaching an historical low in 2013. While the economic conditions remain relatively poor, there was a slight recovery in 2017 due to high CPUE for South Pacific albacore.

The conclusions of the WCPFC SC at its 14^{th} Regular Session (SC14), which were based on 72 model runs, were presented as recommendations to the WCPFC, and are outlined below.

- The median spawning biomass depletion level ($SB_{recent}/SB_{F=0}$) was 0.52 with an upper and lower bound of 0.37 to 0.63 respectively.
- There was a 0% probability that the recent spawning biomass had breached the adopted LRP.

- The median fishing impact (F_{recent}/F_{MSY}) was 0.2 with a 0% probability that recent fishing mortality was above F_{MSY}.
- For several years, SC has noted that any increases in catch or effort in sub-tropical longline fisheries are likely to lead to declines in catch rates in some regions (10°S–30°S), especially for longline catch of adult albacore, with associated impacts on vessel profitability.
- The assessment results show that, while the stock has exhibited a long-term decline, the stock is not in an overfished state and overfishing is not taking place.

2.5 Summary across target tuna stocks

To summarise the most recent stock assessments for the four target tuna stocks, stock status for all four species are plotted together on a single Majuro plot, along with grid model uncertainties (Figure 14). All four are considered to be in a healthy, sustainable status as none are considered to be overfished. Yellowfin, skipjack and albacore are estimated to have a 0% probability of currently experiencing overfishing, while bigeye is estimated to have a 12.5% probability. To place these results in context, a summary of stock status for these same four stocks assessed in other ocean basins by the three other tuna Regional Fisheries Management Organizations (RFMOs) are illustrated in Figure 14. As most of the other tuna RFMOs report stock status relative to MSY-based reference points (i.e., SB/SB_{MSY} and F/F_{MSY}), we based the WCPFC status on the same criteria.

2.6 Tuna tagging

Large-scale tagging experiments are required to provide the level of information (fishery exploitation rates and population size) that is necessary to enable stock assessments of tropical tunas in the WCPO. Tagging data have the potential to provide significant information of relevance to stock assessment, either by way of stand-alone analyses or, preferably, through their integration with other data directly in the stock assessment model. Tuna tagging has been a core activity of the Oceanic Fisheries Programme over the last 30 years, with tagging campaigns occurring in the 1970s, 1990s and, most recently, since 2006. This most recent campaign has now tagged and released 452,489 tuna in the equatorial WCPO, including over 1,800 archival tag releases, with 81,591 reported recaptures (Figure 15). A summary of tag releases and recoveries is provided in Table 10.

3 Ecosystem and bycatch issues

3.1 Catch composition

The tuna fisheries of the WCPO principally target four main tuna species: skipjack; yellowfin; bigeye; and albacore tuna. However, the fisheries also catch a range of other species in association with these. Some of the associated species (bycatch) are of commercial value (by-products), while many others are discarded. There are also incidents of the capture of species of ecological and/or social significance, including marine mammals, sea birds, sea turtles and some species of shark (e.g. whale sharks).

The information concerning the catch composition of the main tuna fisheries in the WCPO comes largely from the various observer programmes operating in the region. Overall, catch (in weight) from unassociated and associated purse seine sets are dominated by tuna species (99.7% and 97.9%, respectively), with anchored FAD sets having a slightly higher bycatch rate (99.5% tuna) than drifting FADs (Figure 16). Historically, associated sets have accounted for the majority of bycatch of finfish and shark species, although there is some variation from year to year due to changes in the proportions of sets by association type (Peatman *et al.* 2018).

Species composition of the catch has also been estimated for three main longline fisheries operating in the WCPO: the western tropical Pacific (WTP) shallow-setting longline fishery; the WTP deep-setting longline fishery; and the western South Pacific (WSP) albacore fishery. While estimates are uncertain due to the low level of observer coverage, some general conclusions are possible. The main tuna species account for 60.9%, 79.8% and 67.4% of the total catch (by weight) of the shallow-set, deepset and albacore target longline fisheries respectively (Figure 17). The WTP shallow-set fishery has a higher proportion of non-tuna species in the catch, principally shark and billfish species, while mahi mahi (*Coryphaena* *hippurus*) and opah (*Lampris guttatus*) represent a significant component of the WSP albacore longline catch. There are also considerable differences in the species composition of the billfish catch in the longline fisheries as follows: the WTP shallow and WSP albacore fisheries catch a higher proportion of surface-orientated species than does the WTP deep-setting fishery. Blue sharks (*Prionace glauca*) are the most common shark in the deep set fishery (Figure 17).

3.2 Species of special interest

A range of conservation and management measures have been introduced by WCPFC to reduce impacts of fisheries on species of special interest, including whale shark (*Rhincodon typus*), silky shark (*Carcharhinus falciformis*)and oceanic whitetip shark (*Carcharhinus longimanus*), sea turtles, whales and seabirds. Spatially and temporally disaggregated summaries of observer bycatch data are publicly available, including observed longline and purse seine effort and interaction rates for species of special interest.

There are limited interactions between the purse seine fishery and protected species, such as whale sharks and manta rays (*Mobula birostris*) (Figure 16). Historically, some vessels deliberately set around whale sharks associated with tuna schools, but this practice has been prohibited since 2014 in the WCPO. In a very small percentage of cases of free school sets, a whale shark is encountered; in these instances, the whale shark was not seen before the set was made. Observed interaction rates between the purse seine fishery and sea turtles are low ($<$ 1 interaction per 100 sets), and interactions with seabirds are very rare.

Interactions with seabirds and marine mammals are very low in all three longline fisheries (although the probability of detecting rare events with low observer coverage means that the estimates of very low interaction rates are very uncertain). Catch of five species of marine turtles has been observed in the equatorial longline fishery, although the observed encounter rate was particularly low, and most of the turtles caught were alive at the time of release.

3.3 Catch and status of billfish and sharks

In addition to the main tuna species, annual catch estimates for the WCPO in 2019 are available for the main species of billfish (swordfish (*Xiphias gladius*) [16,830t], blue marlin (*Makaira nigricans*) [15,856t], striped marlin (*Kajikia audax*) [3,637t] and (*Istiompax indica*) black marlin [1,748t]). For all of these species current catch is around the average for the past decade. Catch of associated species cannot be accurately quantified using logsheet data, but estimates should be possible in the future when longline observer coverage increases. (See Peatman *et al.* (2018) for more details.) Observer coverage is already sufficiently high to estimate catch of bycatch species for large-scale purse seiners operating in equatorial and tropic waters.

The status of silky and oceanic whitetip sharks is of concern as assessments have shown that stocks are subject to overfishing and, in the case of oceanic whitetip, severely overfished. A WCPFC ban on the use of either shark lines or wire traces in longline sets is in place, which is hoped will reduce the catch of silky and oceanic whitetip sharks. Over the past several years stock assessments have been undertaken for several billfish and shark species, in addition to the main tuna species. The SC recommendations to the WCPFC are broadly outlined below.

- Stabilise stock size or catch/ensure no increase in fishing pressure
  - Southwest Pacific swordfish
  - Pacific blue marlin
- Reduce catch and/or rebuild the stock and/or reduce effort and/or enhance data collection efforts
  - Pacific bluefin tuna
  - Southwest Pacific striped marlin
  - Western and central north Pacific striped marlin
  - Blue shark
  - Silky shark
  - Oceanic whitetip shark

Two shark (oceanic whitetip and sillky) and two billfish (Southwest Pacific striped marlin and Southwest Pacific swordfish) species have been assessed by SPC staff in recent years (Figure 18). Stock status for these species is based on the Kobe plot, where overfished status is judged relative to spawning stock size at MSY[3]. There is considerable uncertainty in the estimates of F/F_{MSY} and SB/SB_{MSY} for all four species. Based on the assessment model grid medians, Southwest Pacific striped marlin and oceanic whitetip are likely in an overfished state, while overfishing is likely occurring for silky shark as well as oceanic whitetip.

3.4 El Niño Southern Oscillation forecast

One of the major factors influencing the distribution of tuna species, perhaps mostly notably for skipjack, is the El Niño Southern Oscillation (ENSO) (Lehodey *et al.* 1997). The two extremes of the oscillation, El Niño and La Niña, result in very different distributions of purse seine fishing effort (Figure 19). At the time this report went to press, a medium-strength La Niña event was in progress and forecast to continue across the Pacific from November 2020 to June 2021. Typically, this results in a pooling of warm water in the western Pacific, a relative decrease in sea surface temperature in the eastern Pacific, and a concentration of skipjack in the western Pacific, although we note that every ENSO event differs in its magnitude, range and impact.

3.5 Climate change

The Spatial Ecosystem And Population Dynamics (SEAPODYM, Lehodey *et al.* 2014) modelling framework was used to investigate how climate change could affect the distribution and abundance of skipjack, yellowfin, bigeye tuna and South Pacific albacore, at the Pacific basin scale, and within the EEZs of Pacific Island countries (Senina *et al.* 2018). The analysis formed two parts, firstly, a model parameterisation phase over the historical period (1980–2010) using an analysis of historic ocean conditions, and then projections of an ensemble of simulations to explore key sources of uncertainty in climate models. Second, five different atmospheric forcing datasets from Earth System models projected under the ("business as usual") Intergovernmental Panel on Climate Change (IPCC) Regional Concentration Pathways 8.5 (RCP8.5) emissions scenario were used to drive physical-biogeochemical models through the 21^{st} century. Additional scenarios were included to explore uncertainty associated with future primary production and dissolved oxygen concentration, as well as possible adaptation through phenotypic plasticity of these tuna species to warmer spawning grounds. The impact of ocean acidification was also included for yellowfin tuna based on results from laboratory experiments.

The historical simulations (Figure 20) reflect key features of the ecology and behaviour of the four tuna species and match the total historical catch in terms of both weight and size frequency distributions. The projections show an eastern shift in the biomass of skipjack and yellowfin tuna over time, with a large and increasing uncertainty for the second half of the century, especially for skipjack tuna. The impact is weaker for bigeye tuna and albacore, which predicts a wider and warmer range of favorable spawning habitat. For albacore, a strong sensitivity to sub-surface oxygen conditions resulted in a very wide range of projected stock sizes. Historical fishing pressure was estimated to have reduced the adult stocks of all four tuna species by 30–55% by the end of 2010. The effects of fishing on biomass strongly outweighed the decreases attributed to climate change in the short- to medium-term. Thus, fishing pressure is expected to be the dominant driver of tuna population status until the mid-century. The projected changes in abundance and redistribution of these tuna associated with climate change could have significant implications for the economic development of Pacific Island countries and territories, and the management of tuna resources, at basin scale. In particular, larger proportions of the catch of each species is increasingly expected to be made in international waters.

[3] Because the WCPFC has not agreed upon LRPs for billfish or shark, the Kobe plot, rather than the depletion-based Majuro plot, is the default.

4 For further information[4]

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5 Tables

Table 1: Catch (metric tonnes) by gear for the western and central Pacific region, 1960 to 2019. Note: Data for 2019 are preliminary.

Year	Longline	Pole-and-line	Purse seine	Troll	Other	Total
1960	129,874	98,956	5,224	0	31,195	265,249
1961	123,330	150,709	14,540	0	34,536	323,115
1962	128,804	166,141	18,875	0	34,947	348,767
1963	122,703	125,048	11,934	0	36,795	296,480
1964	102,481	167,181	29,012	0	41,334	340,008
1965	103,955	176,112	8,621	0	41,727	330,415
1966	145,278	241,730	16,913	0	46,993	450,914
1967	128,047	205,255	14,508	5	52,006	399,821
1968	120,136	183,954	15,143	14	52,327	371,574
1969	122,806	208,748	9,483	0	57,703	398,740
1970	141,360	230,142	16,222	50	69,633	457,407
1971	143,625	241,506	24,511	0	68,925	478,567
1972	161,533	242,745	29,031	268	87,209	520,786
1973	166,399	330,841	36,269	484	103,281	637,274
1974	145,192	370,499	29,548	898	109,578	655,715
1975	164,049	279,663	27,685	646	111,669	583,712
1976	198,013	382,627	40,770	25	104,582	726,017
1977	218,413	345,257	53,491	621	136,322	754,104
1978	212,059	407,482	52,040	1,686	131,084	804,351
1979	211,221	344,799	90,102	814	124,684	771,620
1980	230,625	398,498	116,754	1,489	89,969	837,335
1981	191,732	348,917	158,558	2,118	107,884	809,209
1982	179,575	316,457	255,491	2,552	107,990	862,065
1983	175,498	342,287	442,154	949	109,378	1,070,266
1984	162,111	415,016	462,275	3,124	118,478	1,161,004
1985	177,722	287,892	409,536	3,468	136,812	1,015,430
1986	169,129	360,864	474,837	2,284	146,873	1,153,987
1987	179,966	294,879	543,979	2,350	131,849	1,153,023
1988	200,774	327,997	608,998	4,671	151,193	1,293,633
1989	170,876	311,981	664,658	8,687	165,164	1,321,366
1990	188,842	247,104	795,528	7,219	203,508	1,442,201
1991	160,889	290,006	1,006,764	8,004	203,129	1,668,792
1992	199,688	259,762	975,738	6,844	163,536	1,605,568
1993	195,377	293,014	846,115	4,612	145,262	1,484,380
1994	221,367	262,721	971,566	7,493	162,850	1,625,997
1995	217,417	298,301	927,490	23,585	168,062	1,634,855
1996	215,466	301,279	896,443	17,807	208,032	1,639,027
1997	226,375	298,666	959,216	18,732	178,199	1,681,188
1998	251,197	323,645	1,257,392	19,099	213,779	2,065,112
1999	219,024	338,480	1,068,959	13,476	211,900	1,851,839
2000	248,474	319,854	1,143,294	25,845	235,670	1,973,137
2001	264,340	272,483	1,118,919	17,329	211,934	1,885,005
2002	281,627	286,202	1,265,454	16,129	222,513	2,071,925
2003	261,636	303,905	1,258,226	19,875	250,944	2,094,586
2004	284,849	322,179	1,354,241	23,445	290,666	2,275,380
2005	250,693	266,735	1,479,328	13,293	228,562	2,238,611
2006	255,650	257,594	1,512,944	10,098	255,646	2,291,932
2007	245,130	284,661	1,655,498	9,249	304,526	2,499,064
2008	247,675	269,551	1,709,351	11,740	312,905	2,551,222
2009	280,374	264,350	1,785,789	9,898	277,286	2,617,697
2010	275,135	270,123	1,703,133	11,320	260,010	2,519,721

Continued on next page

Table 1: *(continued)*

Year	Longline	Pole-and-line	Purse seine	Troll	Other	Total
2011	261,756	275,070	1,550,492	11,973	239,331	2,338,622
2012	275,053	242,960	1,844,078	14,018	298,991	2,675,100
2013	242,834	229,560	1,897,359	9,484	313,059	2,692,296
2014	264,683	206,939	2,059,006	6,677	347,784	2,885,089
2015	271,113	214,041	1,752,755	7,552	396,702	2,642,163
2016	240,729	198,398	1,850,479	7,206	411,414	2,708,226
2017	246,325	171,062	1,831,891	7,978	331,806	2,589,062
2018	257,247	231,555	1,902,340	7,462	412,680	2,811,284
2019	279,015	191,135	2,108,012	8,116	411,031	2,997,309

Table 2: Catch (metric tonnes) by species for the four main tuna species taken in the western and central Pacific region, 1960 to 2019. Note: Data for 2019 are preliminary.

Year	Albacore	Bigeye	Skipjack	Yellowfin	Total
1960	56,619	45,025	89,938	73,667	265,249
1961	51,561	39,380	156,736	75,438	323,115
1962	46,331	36,868	181,624	83,944	348,767
1963	53,675	44,346	122,703	75,756	296,480
1964	50,545	32,391	182,918	74,154	340,008
1965	70,226	31,333	155,221	73,635	330,415
1966	75,114	33,187	249,514	93,099	450,914
1967	89,303	36,749	204,837	68,932	399,821
1968	64,213	30,426	195,027	81,908	371,574
1969	72,106	36,033	203,327	87,274	398,740
1970	74,350	41,689	242,261	99,107	457,407
1971	100,737	44,144	228,632	105,054	478,567
1972	109,655	57,151	237,856	116,124	520,786
1973	131,149	48,853	328,823	128,449	637,274
1974	115,162	52,757	356,498	131,298	655,715
1975	84,651	69,269	288,824	140,968	583,712
1976	132,947	82,742	357,629	152,699	726,017
1977	83,171	83,388	403,079	184,466	754,104
1978	111,161	66,226	450,083	176,881	804,351
1979	86,007	73,568	412,548	199,497	771,620
1980	95,156	72,301	451,805	218,073	837,335
1981	88,095	64,348	433,322	223,444	809,209
1982	89,496	73,149	470,705	228,715	862,065
1983	65,988	79,470	638,797	286,011	1,070,266
1984	74,540	86,637	716,941	282,886	1,161,004
1985	77,060	87,595	561,292	289,483	1,015,430
1986	71,757	93,066	713,338	275,826	1,153,987
1987	63,645	110,987	653,893	324,498	1,153,023
1988	67,948	107,005	806,864	311,816	1,293,633
1989	73,533	107,401	768,567	371,865	1,321,366
1990	63,872	127,162	836,704	414,463	1,442,201
1991	58,322	115,274	1,047,969	447,227	1,668,792
1992	74,452	138,530	946,799	445,787	1,605,568
1993	77,496	116,151	889,312	401,421	1,484,380
1994	96,461	129,919	960,941	438,676	1,625,997
1995	91,750	111,080	998,729	433,296	1,634,855
1996	91,140	106,000	1,030,648	411,239	1,639,027
1997	112,900	138,555	949,551	480,182	1,681,188
1998	112,465	152,312	1,272,715	527,620	2,065,112
1999	131,066	152,748	1,093,492	474,533	1,851,839
2000	101,672	148,108	1,224,246	499,111	1,973,137
2001	121,561	139,166	1,127,520	496,758	1,885,005
2002	148,051	157,879	1,288,776	477,219	2,071,925
2003	123,239	146,705	1,272,039	552,603	2,094,586
2004	122,399	181,707	1,385,190	586,084	2,275,380
2005	105,366	151,662	1,436,605	544,978	2,238,611
2006	105,254	157,082	1,493,739	535,857	2,291,932
2007	126,857	154,043	1,666,272	551,892	2,499,064
2008	105,029	165,545	1,646,588	634,060	2,551,222
2009	135,622	158,431	1,764,294	559,350	2,617,697
2010	125,781	141,568	1,680,533	571,839	2,519,721
2011	115,766	162,923	1,524,890	535,043	2,338,622
2012	143,792	165,203	1,739,439	626,666	2,675,100
2013	138,397	153,882	1,826,981	573,036	2,692,296

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Table 2: *(continued)*

Year	Albacore	Bigeye	Skipjack	Yellowfin	Total
2014	121,720	164,545	1,978,927	619,897	2,885,089
2015	117,470	145,314	1,779,730	599,649	2,642,163
2016	101,245	151,163	1,789,530	666,288	2,708,226
2017	125,157	129,897	1,620,235	713,773	2,589,062
2018	110,915	149,181	1,846,344	704,844	2,811,284
2019	119,100	135,442	2,045,970	696,797	2,997,309

Table 3: Several indices of fishing effort for the three main gears used in commercial fishing of tuna in the western and central Pacific region, 1960–2019. For vessels, the abbreviations are: DPI – domestic (Pacific Island); DNPI – domestic (non-Pacific Island), DWFN – distant water fishing nation. Longline effort (Mhks) is millions of hooks. Effort totals exclude the following: Japan coastal, Indonesia, Philippine and Vietnam domestic purse seine vessels; Vietnam and Indonesia domestic longline vessels; Japanese coastal and Indonesian domestic vessels for pole-and-line.

	Purse seine				Longline				Pole-and-line			
	Vessels		Effort		Vessels			Effort	Vessels			Effort
Year	DPI	DWFN	Days	Sets	DPI	DNPI	DWFN	Mhks	Japan	DPI	DNPI	Days
1960	0	0	0	0	0	881	1845	241.7	0	0	0	0
1961	0	0	0	0	0	730	1937	268.2	0	0	0	0
1962	0	0	0	0	0	695	1848	253.0	0	0	0	0
1963	0	0	0	0	0	806	1911	266.0	0	0	0	0
1964	0	0	0	0	0	641	1821	207.5	0	0	0	0
1965	0	0	0	0	0	726	1752	253.4	0	0	0	0
1966	0	0	0	0	0	175	1861	299.1	0	0	0	0
1967	0	0	8	13	0	173	1831	308.5	0	0	0	0
1968	0	0	51	77	0	253	1845	296.3	0	0	0	0
1969	0	4	17	22	0	918	1739	289.6	0	0	0	0
1970	0	6	99	120	0	1743	1658	284.6	0	0	0	0
1971	0	6	1939	2654	0	1794	1684	316.2	0	0	0	0
1972	0	7	2465	3433	0	1862	1609	333.5	554	56	0	54754
1973	0	6	2657	3591	2	2232	1650	352.7	650	66	0	65381
1974	0	10	1942	2337	0	1986	1786	408.0	716	82	0	66810
1975	0	12	2197	2629	0	2147	1763	327.8	696	81	0	66314
1976	0	18	2534	3159	2	2174	1847	353.6	653	89	9	74787
1977	0	15	2253	2721	2	2125	1821	368.9	662	100	20	88567
1978	0	19	2491	2994	2	2358	1871	330.8	645	100	14	83754
1979	0	27	3639	4463	2	2505	1868	421.8	625	98	10	79590
1980	1	33	3798	4961	2	2743	1913	451.8	572	160	9	79191
1981	1	42	7763	8114	2	2645	1871	500.0	548	168	18	80060
1982	1	73	11770	11560	3	2641	1592	435.7	475	108	23	68126
1983	8	118	18993	16062	4	2527	1437	345.5	434	91	16	58692
1984	6	120	25083	21471	5	2563	1445	385.9	396	98	8	59279
1985	6	110	20819	18418	6	2872	1437	438.1	356	98	0	53866
1986	5	113	20805	18160	3	2795	1445	330.3	330	97	5	51413
1987	5	116	24329	19823	4	3179	1415	372.1	314	112	5	48305
1988	8	132	24261	19441	5	2844	1393	445.5	277	102	18	42862
1989	5	152	27111	22115	9	2695	1405	392.9	269	105	15	43480
1990	13	176	30060	23081	16	2283	1410	390.0	255	166	20	42075
1991	15	184	37153	31093	27	1965	1455	385.2	242	154	19	32256
1992	17	193	40825	30618	59	3173	1396	400.6	216	163	13	32447
1993	15	183	42751	31219	113	3241	1570	398.8	203	138	19	32113
1994	22	176	38091	29254	158	3223	1687	451.5	185	137	23	31233
1995	21	163	37015	28526	217	2984	1624	463.6	174	145	33	31229
1996	20	158	37758	29971	259	2599	1428	389.6	165	139	33	29449
1997	31	158	39328	30681	349	3194	1231	413.6	163	108	26	33060
1998	32	164	36532	31750	415	3089	1223	466.6	163	102	16	33995
1999	40	164	38521	27260	405	3075	1151	543.4	163	103	16	33600
2000	52	174	37790	30754	422	1426	1089	533.7	160	83	15	28622
2001	46	161	37977	30398	490	2312	1118	702.7	155	75	11	25809
2002	55	158	41777	33415	463	2245	1149	726.0	151	70	11	27327
2003	59	152	44031	33646	482	1622	1139	725.6	144	69	9	22759
2004	78	147	47264	35340	476	1515	910	718.7	127	67	9	22122
2005	86	142	49123	40486	475	1473	763	649.7	128	60	11	22122
2006	76	148	45095	36280	433	1313	639	641.5	113	65	6	18424
2007	83	162	48256	39430	458	1163	518	716.5	106	58	5	18413

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Table 3: *(continued)*

	Purse seine				Longline				Pole-and-line			
	Vessels		Effort		Vessels			Effort	Vessels			Effort
Year	DPI	DWFN	Days	Sets	DPI	DNPI	DWFN	Mhks	Japan	DPI	DNPI	Days
2008	80	175	52363	44849	432	1147	604	734.7	98	50	3	16887
2009	80	187	52946	47191	401	1148	589	765.8	96	48	6	16001
2010	87	196	55067	54372	509	1165	632	772.2	95	50	2	16153
2011	94	191	65971	60814	608	1131	660	819.5	91	56	2	14833
2012	100	191	61671	64896	540	630	645	885.5	87	54	1	15241
2013	104	199	63047	65330	380	738	744	722.3	80	49	2	13786
2014	109	204	60658	65318	540	724	656	737.9	80	47	0	11348
2015	118	195	49429	55501	538	820	705	766.4	76	47	0	12817
2016	138	160	50640	53682	373	783	701	689.5	76	45	0	14464
2017	136	152	54269	57773	547	709	633	705.0	80	46	0	13169
2018	132	145	50887	57524	609	706	631	726.2	69	40	0	13768
2019	138	152	52835	61740	452	592	625	837.8	66	37	0	10805

Table 4: Skipjack tuna catch (metric tonnes) by gear type for the western and central Pacific region, 1960 to 2019. Note: Data for 2019 are preliminary.

Year	Longline	Pole-and-line	Purse seine	Troll	Other	Total
1960	0	70,428	3,728	0	15,782	89,938
1961	0	127,011	11,693	0	18,032	156,736
1962	4	152,387	11,674	0	17,559	181,624
1963	0	94,757	9,592	0	18,354	122,703
1964	5	137,106	25,006	0	20,801	182,918
1965	11	129,933	4,657	0	20,620	155,221
1966	52	215,600	10,949	0	22,913	249,514
1967	124	168,846	10,937	0	24,930	204,837
1968	83	162,379	7,636	0	24,929	195,027
1969	130	168,084	5,043	0	30,070	203,327
1970	1,608	197,873	7,565	0	35,215	242,261
1971	1,475	180,945	13,783	0	32,429	228,632
1972	1,544	172,827	18,117	0	45,368	237,856
1973	1,861	253,217	19,310	0	54,435	328,823
1974	2,124	289,202	11,150	0	54,022	356,498
1975	1,919	218,271	13,615	0	55,019	288,824
1976	2,096	276,582	22,844	0	56,107	357,629
1977	3,127	294,641	34,071	0	71,240	403,079
1978	3,233	331,401	34,220	0	81,229	450,083
1979	2,179	285,859	58,368	0	66,142	412,548
1980	632	333,597	79,280	12	38,284	451,805
1981	756	296,065	92,260	17	44,224	433,322
1982	972	264,726	156,905	64	48,038	470,705
1983	2,144	298,928	288,065	154	49,506	638,797
1984	870	366,811	300,852	284	48,124	716,941
1985	1,108	238,932	267,346	146	53,760	561,292
1986	1,439	322,665	324,269	219	64,746	713,338
1987	2,329	252,142	340,720	168	58,534	653,893
1988	1,937	295,325	451,025	299	58,278	806,864
1989	2,507	275,088	432,291	244	58,437	768,567
1990	363	211,573	530,009	176	94,583	836,704
1991	885	259,778	695,581	148	91,577	1,047,969
1992	432	218,765	636,545	168	90,889	946,799
1993	573	255,152	555,530	175	77,882	889,312
1994	379	209,636	673,734	228	76,964	960,941
1995	598	247,744	659,746	12,298	78,343	998,729
1996	3,935	242,486	678,478	6,514	99,235	1,030,648
1997	4,070	236,999	613,004	9,218	86,260	949,551
1998	5,030	266,772	890,911	8,316	101,686	1,272,715
1999	4,208	255,330	727,716	5,660	100,578	1,093,492
2000	4,559	264,407	824,702	15,005	115,573	1,224,246
2001	5,059	212,668	797,842	7,536	104,415	1,127,520
2002	3,450	207,488	963,666	6,796	107,376	1,288,776
2003	3,824	238,179	903,760	9,721	116,555	1,272,039
2004	4,051	249,936	977,884	15,118	138,201	1,385,190
2005	1,084	216,715	1,073,418	6,302	139,086	1,436,605
2006	1,528	208,731	1,121,843	3,987	157,650	1,493,739
2007	1,175	213,010	1,257,872	3,598	190,617	1,666,272
2008	803	218,570	1,224,453	4,572	198,190	1,646,588
2009	1,220	201,323	1,387,437	4,252	170,062	1,764,294
2010	1,192	223,409	1,292,424	4,705	158,803	1,680,533
2011	1,124	206,843	1,163,066	4,214	149,643	1,524,890
2012	2,004	170,538	1,378,708	6,235	181,954	1,739,439
2013	1,254	169,025	1,461,837	3,223	191,642	1,826,981

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Table 4: *(continued)*

Year	Longline	Pole-and-line	Purse seine	Troll	Other	Total
2014	1,879	148,684	1,609,784	1,567	217,013	1,978,927
2015	1,879	151,317	1,380,255	1,776	244,503	1,779,730
2016	5,642	156,603	1,375,647	1,918	249,720	1,789,530
2017	2,571	123,013	1,273,543	2,251	218,857	1,620,235
2018	4,162	183,267	1,452,866	1,945	204,104	1,846,344
2019	5,470	153,869	1,708,812	1,918	175,901	2,045,970

Table 5: Yellowfin tuna catch (metric tonnes) by gear type for the western and central Pacific region, 1960 to 2019. Note: Data for 2019 are preliminary.

Year	Longline	Pole-and-line	Purse seine	Troll	Other	Total
1960	55,020	1,872	1,438	0	15,337	73,667
1961	53,166	3,259	2,777	0	16,236	75,438
1962	55,547	4,225	6,975	0	17,197	83,944
1963	53,185	2,071	2,277	0	18,223	75,756
1964	45,247	5,074	3,647	0	20,186	74,154
1965	45,493	3,434	3,752	0	20,956	73,635
1966	61,654	2,192	5,844	0	23,409	93,099
1967	36,083	3,125	3,421	0	26,303	68,932
1968	46,070	2,706	7,047	0	26,085	81,908
1969	51,627	5,166	3,869	0	26,612	87,274
1970	55,806	4,606	7,762	0	30,933	99,107
1971	57,766	5,248	9,146	0	32,894	105,054
1972	61,175	7,465	9,978	0	37,506	116,124
1973	62,291	7,458	14,872	0	43,828	128,449
1974	58,116	6,582	17,159	0	49,441	131,298
1975	69,462	7,801	12,676	0	51,029	140,968
1976	77,570	17,186	15,177	0	42,766	152,699
1977	94,414	15,257	16,725	0	58,070	184,466
1978	110,202	12,767	14,511	0	39,401	176,881
1979	108,910	11,638	29,384	0	49,565	199,497
1980	125,113	15,142	34,383	9	43,426	218,073
1981	97,114	22,044	56,294	16	47,976	223,444
1982	86,149	17,123	82,589	54	42,800	228,715
1983	90,259	17,184	130,361	51	48,156	286,011
1984	76,988	17,633	133,986	67	54,212	282,886
1985	79,973	22,717	123,395	69	63,329	289,483
1986	68,999	17,970	123,428	62	65,367	275,826
1987	75,407	19,044	170,053	48	59,946	324,498
1988	88,855	20,566	130,741	76	71,578	311,816
1989	73,306	22,133	200,939	73	75,414	371,865
1990	79,300	20,769	227,478	68	86,848	414,463
1991	63,512	19,182	267,566	51	96,916	447,227
1992	77,739	23,043	282,781	98	62,126	445,787
1993	72,055	20,486	248,286	141	60,453	401,421
1994	82,184	21,378	258,136	101	76,877	438,676
1995	88,306	23,209	238,250	2,570	80,961	433,296
1996	91,887	30,551	187,734	2,636	98,431	411,239
1997	81,065	22,845	289,679	2,838	83,755	480,182
1998	81,077	27,506	313,618	2,806	102,613	527,620
1999	71,023	26,787	271,501	3,162	102,060	474,533
2000	96,908	26,957	262,238	3,343	109,665	499,111
2001	95,569	24,443	274,972	3,716	98,058	496,758
2002	95,644	24,133	249,082	3,172	105,188	477,219
2003	95,712	24,304	306,828	3,101	122,658	552,603
2004	104,066	30,640	309,189	2,706	139,483	586,084
2005	87,417	27,007	344,884	2,508	83,162	544,978
2006	85,016	23,653	333,449	2,607	91,132	535,857
2007	82,516	26,570	333,412	2,854	106,540	551,892
2008	84,200	22,705	417,586	2,903	106,666	634,060
2009	99,373	23,918	331,658	3,027	101,374	559,350
2010	98,523	20,112	352,883	3,611	96,710	571,839
2011	97,778	36,838	313,096	3,802	83,529	535,043
2012	87,666	34,705	396,971	3,935	103,389	626,666
2013	77,346	21,924	362,571	2,460	108,735	573,036

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Table 5: *(continued)*

Year	Longline	Pole-and-line	Purse seine	Troll	Other	Total
2014	100,375	24,082	378,139	2,195	115,106	619,897
2015	104,375	35,719	320,171	2,729	136,655	599,649
2016	91,870	23,387	408,578	2,803	139,650	666,288
2017	86,227	24,929	498,822	2,617	101,178	713,773
2018	97,727	26,215	381,693	2,589	196,620	704,844
2019	107,656	17,813	349,358	2,550	219,420	696,797

Table 6: Bigeye tuna catch (metric tonnes) by gear type for the western and central Pacific region, 1960 to 2019. Note: Data for 2019 are preliminary.

Year	Longline	Pole-and-line	Purse seine	Troll	Other	Total
1960	43,467	1,500	58	0	0	45,025
1961	37,517	1,800	63	0	0	39,380
1962	35,895	800	173	0	0	36,868
1963	42,540	1,800	6	0	0	44,346
1964	30,989	1,143	231	0	28	32,391
1965	29,848	1,254	201	0	30	31,333
1966	31,984	1,108	9	0	86	33,187
1967	33,632	2,803	61	0	253	36,749
1968	27,757	2,272	193	0	204	30,426
1969	32,571	3,350	50	0	62	36,033
1970	34,965	3,178	578	0	2,968	41,689
1971	38,359	1,862	680	0	3,243	44,144
1972	51,040	1,762	659	0	3,690	57,151
1973	42,412	1,258	734	0	4,449	48,853
1974	45,653	1,039	1,078	0	4,987	52,757
1975	61,488	1,334	1,235	0	5,212	69,269
1976	73,325	3,423	1,640	0	4,354	82,742
1977	72,083	3,325	2,026	0	5,954	83,388
1978	56,364	3,337	2,194	0	4,331	66,226
1979	63,837	2,540	2,225	0	4,966	73,568
1980	62,537	2,916	2,762	0	4,086	72,301
1981	46,590	3,382	9,752	0	4,624	64,348
1982	48,578	4,993	15,436	0	4,142	73,149
1983	46,311	5,077	23,378	0	4,704	79,470
1984	52,976	4,557	24,057	0	5,047	86,637
1985	58,629	5,529	17,262	0	6,175	87,595
1986	56,989	4,133	25,598	0	6,346	93,066
1987	68,832	4,602	32,001	0	5,552	110,987
1988	68,288	5,890	26,024	0	6,803	107,005
1989	64,916	6,131	28,907	0	7,447	107,401
1990	77,009	5,985	36,046	0	8,122	127,162
1991	61,033	3,929	40,965	0	9,347	115,274
1992	75,966	4,055	52,308	0	6,201	138,530
1993	66,566	4,505	39,410	0	5,670	116,151
1994	79,175	5,251	37,670	0	7,823	129,919
1995	68,125	6,228	28,317	145	8,265	111,080
1996	58,054	7,940	29,650	432	9,924	106,000
1997	68,597	6,563	55,465	412	7,518	138,555
1998	85,048	6,405	51,309	507	9,043	152,312
1999	74,959	5,856	62,870	316	8,747	152,748
2000	76,924	6,838	53,946	397	10,003	148,108
2001	78,690	5,905	45,131	408	9,032	139,166
2002	92,381	6,109	49,403	713	9,273	157,879
2003	83,016	5,296	47,011	142	11,240	146,705
2004	99,709	9,238	59,968	232	12,560	181,707
2005	78,892	6,851	60,176	220	5,523	151,662
2006	83,592	9,781	57,288	157	6,264	157,082
2007	81,113	7,296	58,532	187	6,915	154,043
2008	83,428	9,204	66,487	212	6,214	165,545
2009	80,507	7,916	64,617	175	5,216	158,431
2010	72,721	7,027	57,496	275	4,049	141,568
2011	77,567	5,655	73,850	251	5,600	162,923
2012	83,971	3,934	64,206	273	12,819	165,203
2013	65,637	5,009	70,963	271	12,002	153,882

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Table 6: *(continued)*

Year	Longline	Pole-and-line	Purse seine	Troll	Other	Total
2014	75,434	4,714	69,074	312	15,011	164,545
2015	73,397	5,687	51,257	204	14,769	145,314
2016	63,077	3,933	62,565	201	21,387	151,163
2017	58,126	2,215	58,265	184	11,107	129,897
2018	68,911	4,143	64,757	135	11,235	149,181
2019	72,391	1,496	46,740	143	14,672	135,442

Table 7: Albacore tuna catch (metric tonnes) by gear type for the western and central Pacific region, south of the equator, 1960 to 2019. Note: Data for 2019 are preliminary.

Year	Longline	Pole-and-line	Purse seine	Troll	Other	Total
1960	18,750	0	0	0	0	18,750
1961	19,979	0	0	0	0	19,979
1962	24,492	0	0	0	0	24,492
1963	16,827	0	0	0	0	16,827
1964	13,058	0	0	0	0	13,058
1965	18,057	0	0	0	0	18,057
1966	31,786	0	0	0	0	31,786
1967	35,292	0	0	5	0	35,297
1968	27,332	0	0	14	0	27,346
1969	24,024	0	0	0	0	24,024
1970	33,285	100	0	50	0	33,435
1971	34,116	100	0	0	0	34,216
1972	33,079	100	0	268	0	33,447
1973	44,734	100	0	484	0	45,318
1974	26,279	100	0	898	0	27,277
1975	18,498	100	0	646	0	19,244
1976	28,024	100	0	25	0	28,149
1977	32,979	100	0	621	0	33,700
1978	29,944	100	0	1,686	0	31,730
1979	24,180	100	0	814	0	25,094
1980	29,072	100	0	1,468	0	30,640
1981	30,265	0	0	2,085	5	32,355
1982	27,499	0	0	2,434	6	29,939
1983	23,559	0	0	744	7	24,310
1984	18,541	0	0	2,773	8	21,322
1985	23,413	0	0	3,253	9	26,675
1986	28,765	0	0	2,003	10	30,778
1987	19,750	0	0	2,134	11	21,895
1988	27,617	0	0	4,061	12	31,690
1989	17,887	0	0	8,135	13	26,035
1990	17,671	245	0	6,740	112	24,768
1991	20,303	14	0	7,570	95	27,982
1992	28,069	11	0	6,343	65	34,488
1993	27,229	62	0	4,061	70	31,422
1994	31,673	65	0	6,929	89	38,756
1995	26,036	139	0	7,481	104	33,760
1996	24,301	30	0	7,274	156	31,761
1997	31,449	9	0	4,530	133	36,121
1998	41,732	9	0	6,113	85	47,939
1999	28,788	38	0	3,194	74	32,094
2000	34,440	80	0	6,104	139	40,763
2001	54,018	19	0	5,047	199	59,283
2002	63,598	7	0	4,517	150	68,272
2003	52,098	5	0	5,984	130	58,217
2004	49,960	6	0	4,551	123	54,640
2005	53,917	12	0	3,520	137	57,586
2006	55,923	23	0	2,751	188	58,885
2007	52,847	17	0	2,061	60	54,985
2008	54,200	12	0	3,503	160	57,875
2009	72,813	21	0	2,031	211	75,076
2010	75,135	14	0	2,139	190	77,478
2011	55,075	21	0	3,258	233	58,587
2012	71,264	26	0	2,962	248	74,500
2013	70,592	26	0	3,226	248	74,092

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Table 7: *(continued)*

Year	Longline	Pole-and-line	Purse seine	Troll	Other	Total
2014	60,531	26	0	2,403	248	63,208
2015	60,142	24	0	2,602	263	63,031
2016	56,119	33	10	2,135	333	58,630
2017	74,583	12	10	2,764	199	77,568
2018	64,612	16	17	2,715	380	67,740
2019	66,253	43	2	3,426	263	69,987

Table 8: Albacore tuna catch (metric tonnes) by gear type for the western and central Pacific region, north of the equator, 1960 to 2019. Note: Data for 2019 are preliminary.

Year	Longline	Pole-and-line	Purse seine	Troll	Other	Total
1960	12,637	25,156	0	0	76	37,869
1961	12,668	18,639	7	0	268	31,582
1962	12,866	8,729	53	0	191	21,839
1963	10,151	26,420	59	0	218	36,848
1964	13,182	23,858	128	0	319	37,487
1965	10,546	41,491	11	0	121	52,169
1966	19,802	22,830	111	0	585	43,328
1967	22,916	30,481	89	0	520	54,006
1968	18,895	16,597	267	0	1,109	36,868
1969	14,454	32,148	521	0	959	48,082
1970	15,696	24,385	317	0	517	40,915
1971	11,909	53,351	902	0	359	66,521
1972	14,695	60,591	277	0	645	76,208
1973	15,101	68,808	1,353	0	569	85,831
1974	13,020	73,576	161	0	1,128	87,885
1975	12,682	52,157	159	0	409	65,407
1976	16,998	85,336	1,109	0	1,355	104,798
1977	15,810	31,934	669	0	1,058	49,471
1978	12,316	59,877	1,115	0	6,123	79,431
1979	12,115	44,662	125	0	4,011	60,913
1980	13,271	46,743	329	0	4,173	64,516
1981	17,007	27,426	252	0	11,055	55,740
1982	16,377	29,615	561	0	13,004	59,557
1983	13,225	21,098	350	0	7,005	41,678
1984	12,737	26,015	3,380	0	11,087	53,219
1985	14,599	20,714	1,533	0	13,539	50,385
1986	12,937	16,096	1,542	0	10,404	40,979
1987	13,649	19,091	1,205	0	7,806	41,751
1988	14,077	6,216	1,208	235	14,522	36,258
1989	12,260	8,629	2,521	235	23,853	47,498
1990	14,499	8,532	1,995	235	13,843	39,104
1991	15,156	7,103	2,652	235	5,194	30,340
1992	17,482	13,888	4,104	235	4,255	39,964
1993	28,954	12,809	2,889	235	1,187	46,074
1994	27,956	26,391	2,026	235	1,097	57,705
1995	34,352	20,981	1,177	1,091	389	57,990
1996	37,289	20,272	581	951	286	59,379
1997	41,194	32,250	1,068	1,734	533	76,779
1998	38,310	22,953	1,554	1,357	352	64,526
1999	40,046	50,469	6,872	1,144	441	98,972
2000	35,643	21,572	2,408	996	290	60,909
2001	31,004	29,448	974	622	230	62,278
2002	26,556	48,465	3,303	931	526	79,781
2003	26,986	36,121	627	927	361	65,022
2004	27,063	32,359	7,200	838	299	67,759
2005	29,383	16,150	850	743	654	47,780
2006	29,593	15,406	364	596	412	46,371
2007	27,480	37,768	5,682	549	394	71,873
2008	25,044	19,060	825	550	1,675	47,154
2009	26,462	31,172	2,076	413	423	60,546
2010	27,564	19,561	330	590	258	48,303
2011	30,213	25,713	480	449	326	57,181
2012	30,148	33,757	4,193	613	581	69,292
2013	28,005	33,576	1,988	304	432	64,305

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Table 8: *(continued)*

Year	**Longline**	**Pole-and-line**	**Purse seine**	**Troll**	**Other**	**Total**
2014	26,464	29,433	2,009	200	406	58,512
2015	31,320	21,294	1,072	241	512	54,439
2016	24,018	14,442	3,679	149	324	42,612
2017	24,818	20,893	1,251	162	465	47,589
2018	21,838	17,914	3,001	78	341	43,172
2019	27,247	17,914	3,098	79	775	49,113

Table 9: BRPs and stock status from the latest stock assessments (assessment year shown in parentheses) for South Pacific albacore, bigeye, skipjack, and yellowfin tunas. All biomasses are in metric tonnes. SB_{recent} is the average spawning biomass over the last 4 years of the assessment; $SB_{F=0}$ is the average spawning potential (over the recent 10-year period) predicted to occur in the absence of fishing; MSY is the maximum sustainable yield based on recent patterns of fishing; F_{recent}/F_{MSY} is the ratio of recent (using a window one year earlier than for SB) fishing mortality to that which will support the MSY; $SB_{recent}/SB_{F=0}$ Spawning potential in the recent time period relative to that predicted to occur in the absence of fishing.

BRP	**Albacore (2018)**	**Bigeye (2020)**	**Skipjack (2019)**	**Yellowfin (2020)**
SB_{recent}	240,569	590,311	2,576,701	1,994,655
$SB_{F=0}$	462,633	1,353,367	6,299,363	3,603,980
MSY	98,080	140,720	2,294,024	1,091,200
F_{recent}/F_{MSY}	0.2	0.72	0.45	0.36
$SB_{recent}/SB_{F=0}$	0.52	0.41	0.44	0.58

Table 10: Total of bigeye, skipjack, and yellowfin tuna tagged during the three major tropical tuna tagging projects in the western and central Pacific region. Note: Separate EEZ results are provided for any region with more than 10,000 releases in any single programme; SSAP = Skipjack Survey and Assessment Programme (1977–1981); RTTP = Regional Tuna Tagging Programme (1989–1992); PTTP = Pacific Tuna Tagging Programme (2006–2019).

	PTTP		**RTTP**		**SSAP**	
EEZ	**Releases**	**Recoveries**	**Releases**	**Recoveries**	**Releases**	**Recoveries**
FJ		9	5,197	528	28,980	2,659
FM	32,744	2,879	11,711	1,779	8,791	330
ID	40,416	6,627	13,740	2,653		37
IW	19,648	4,245				
KI	40,642	5,043	14,754	851	5,212	449
NZ	2,863	9		2	15,020	1,000
PG		1	44,502	3,677	9,079	1,077
PF	218,465	31,089		1	29,693	128
PW	14,367	276	7,495	142	8,663	114
SB	78,235	13,960	15,226	2,372	7,870	597
Other	5,109	17,453	39,042	6,925	48,976	1,077
TOTAL	452,489	81,591	151,667	18,930	162,284	7,468

6 Figures

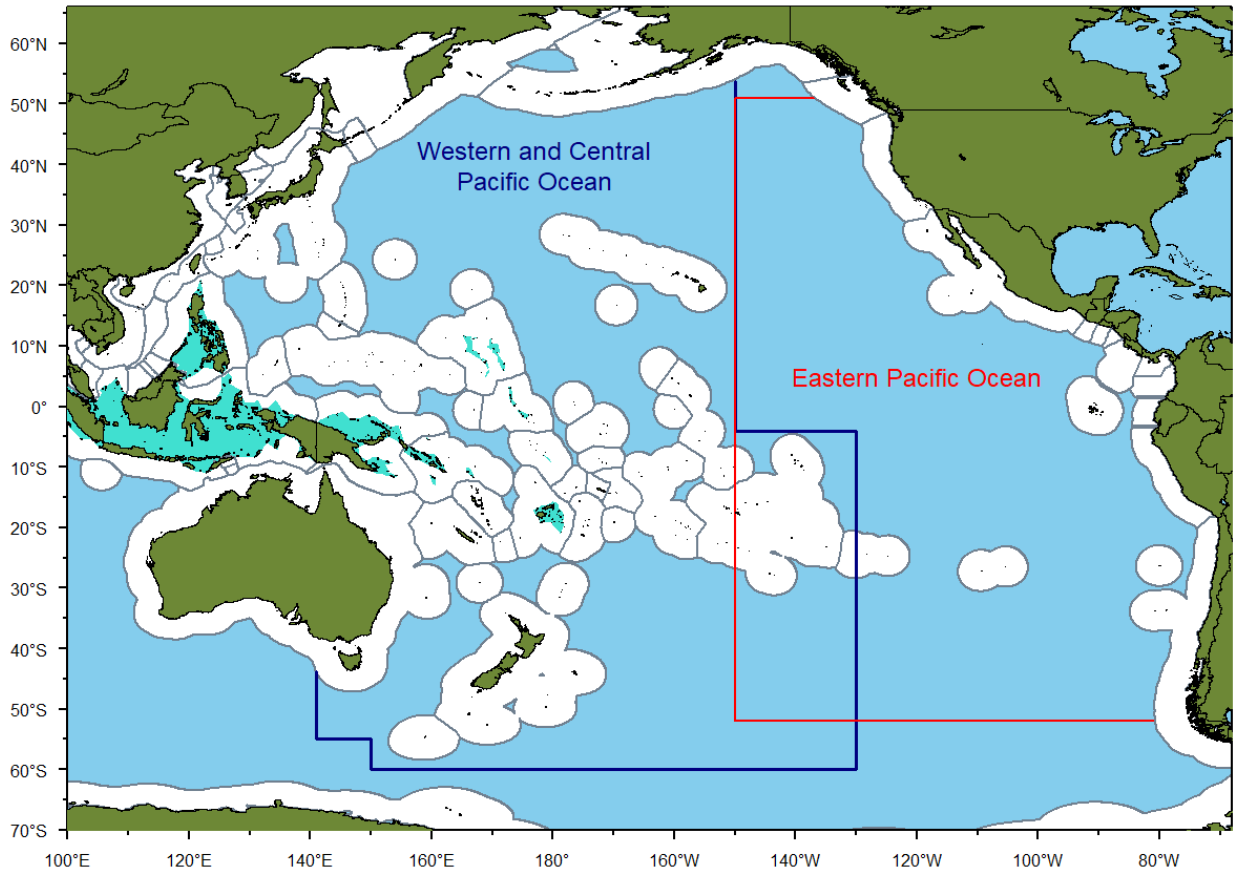

Figure 1: The WCPO, the eastern Pacific Ocean and the WCPFC-CA boundary. Note: WCPFC-CA is outlined in dark blue. Pacific nation EEZs are outlined in grey and archipelagic waters are shaded turquoise.

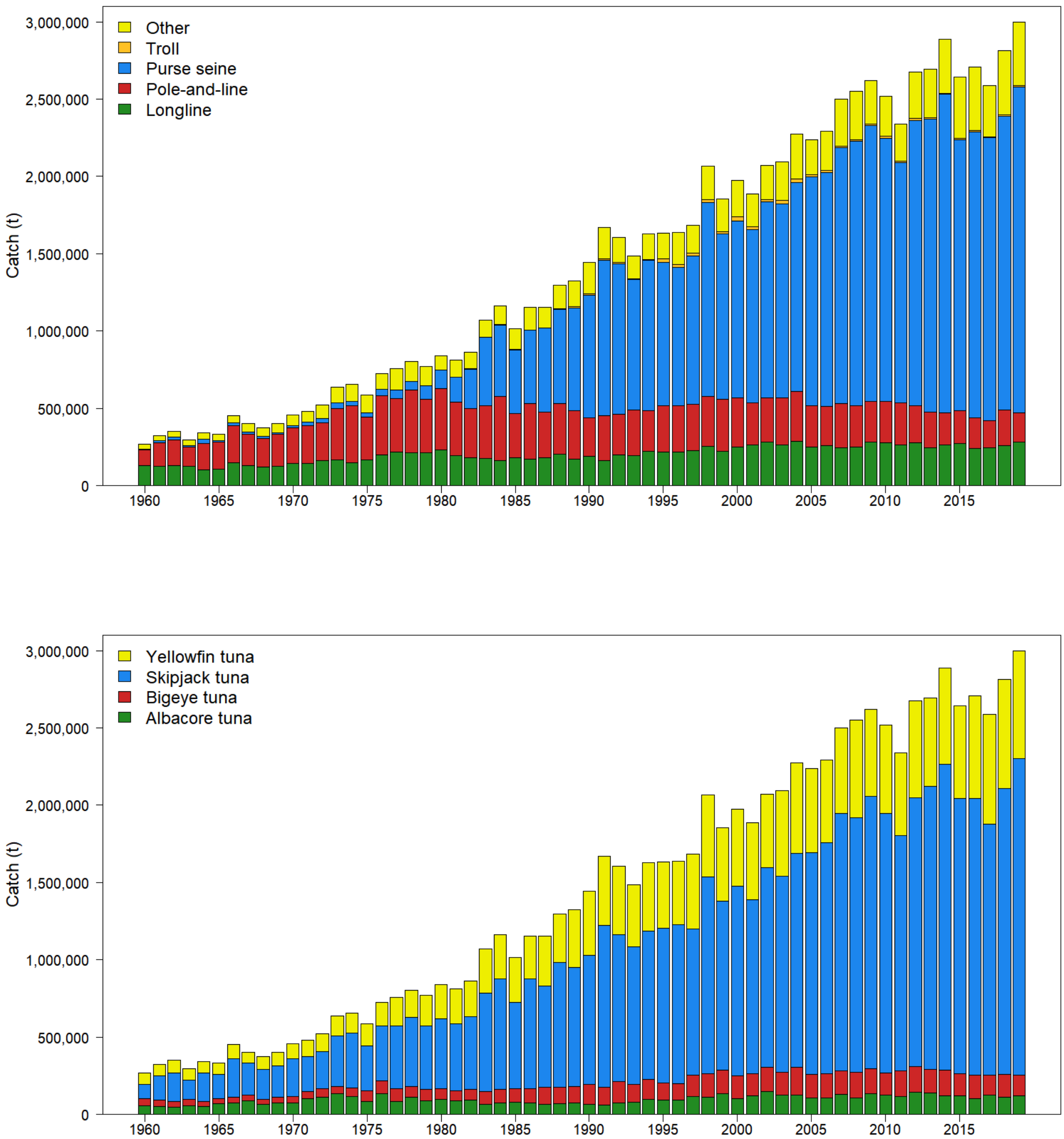

Figure 2: Catch (metric tonnes) by gear (top) and species (bottom) for the western and central Pacific region, 1960–2019. Note: data for 2019 are preliminary.

Purse seine catch and effort plots

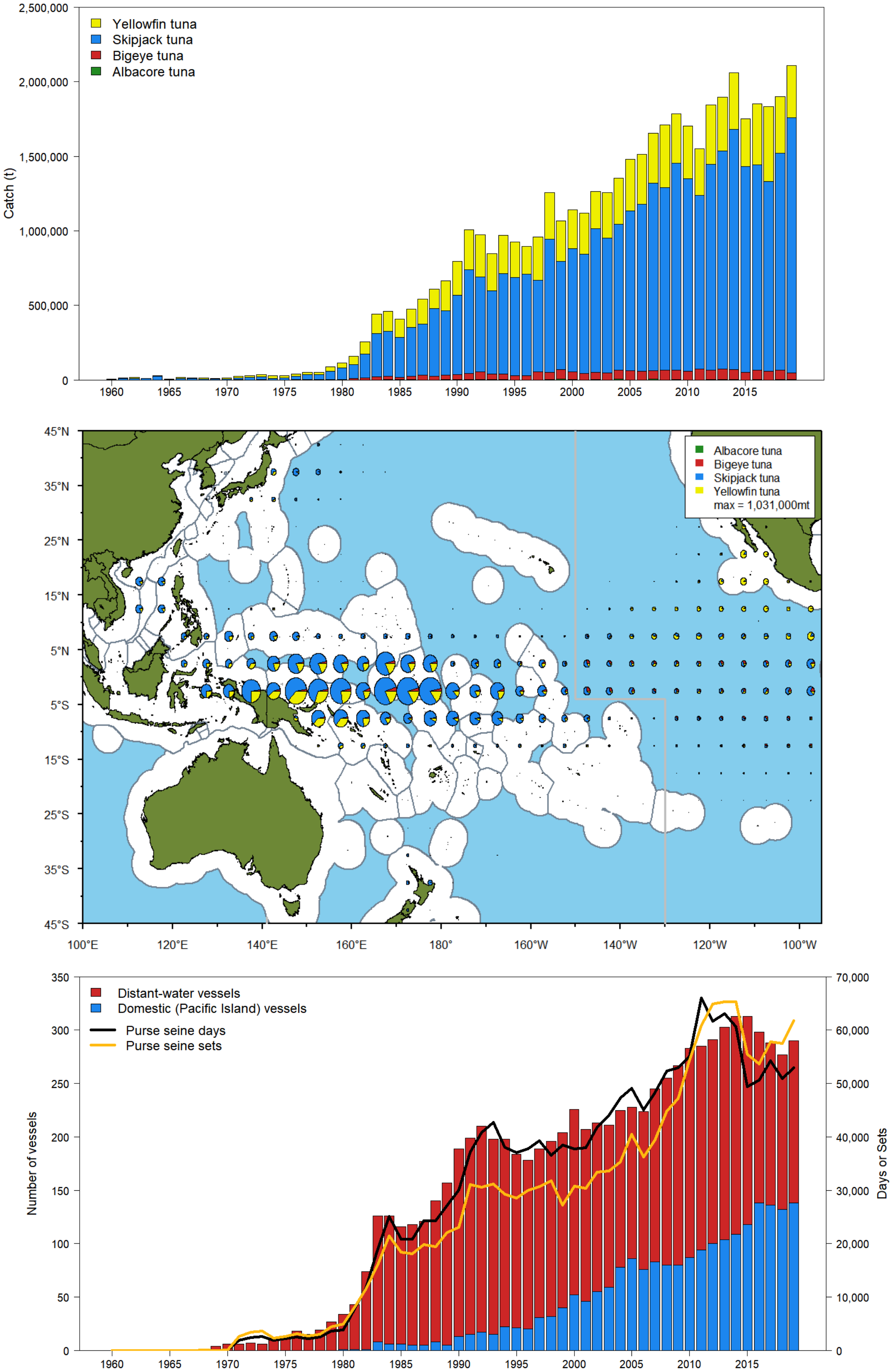

Figure 3: Time series of catch (top), recent (2015–2019) spatial distribution of catch (middle), and indices of fishing effort, in fleet sizes and number of sets and days (bottom), for the purse seine fishery in the WCPO.

Longline catch and effort plots

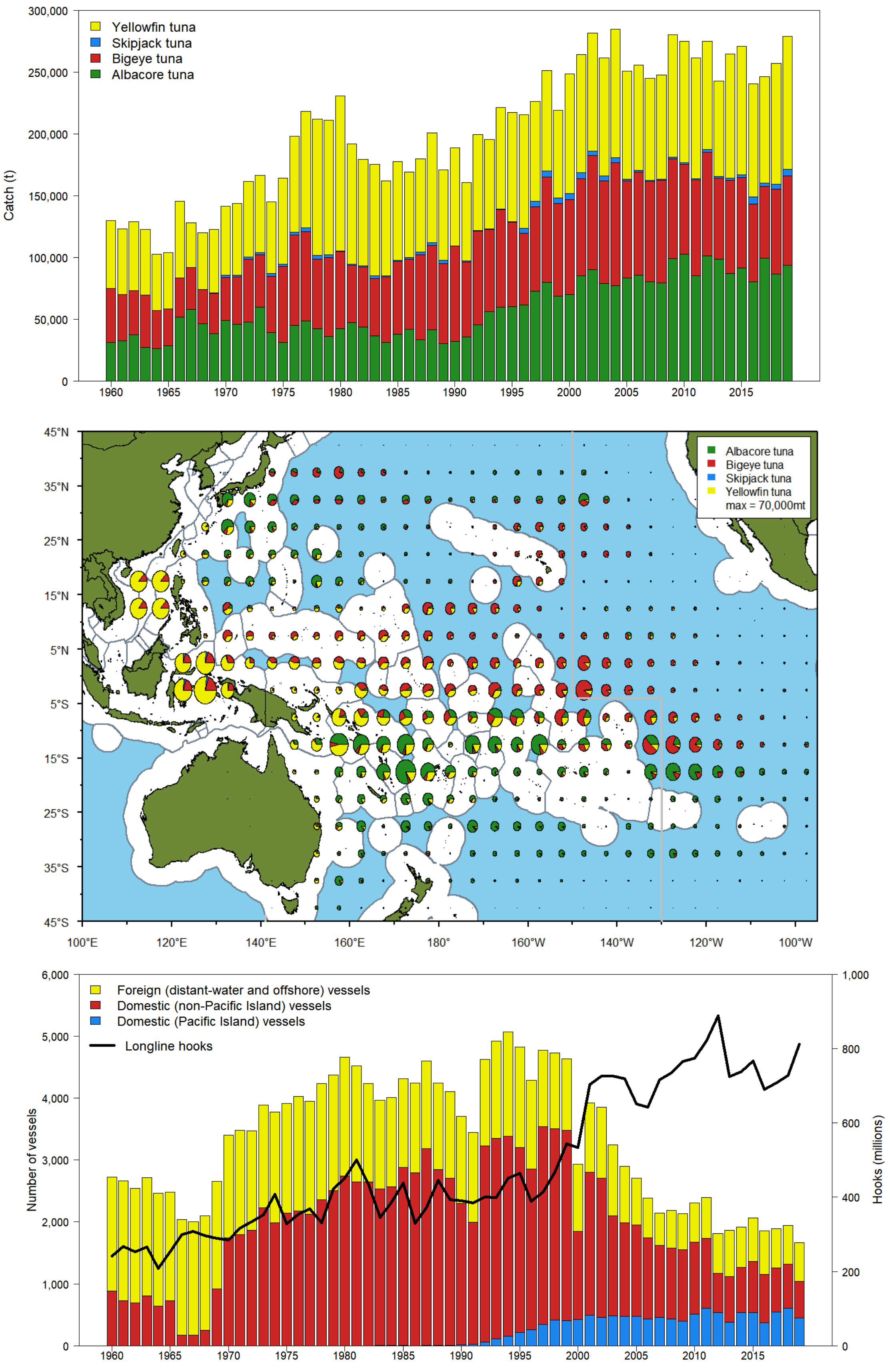

Figure 4: Time series of catch (top), recent (2015–2019) spatial distribution of catch (middle), and indices of fishing effort, in fleet sizes and number of hooks fished (bottom), for the longline fishery in the WCPO.

Pole-and-line catch and effort plots

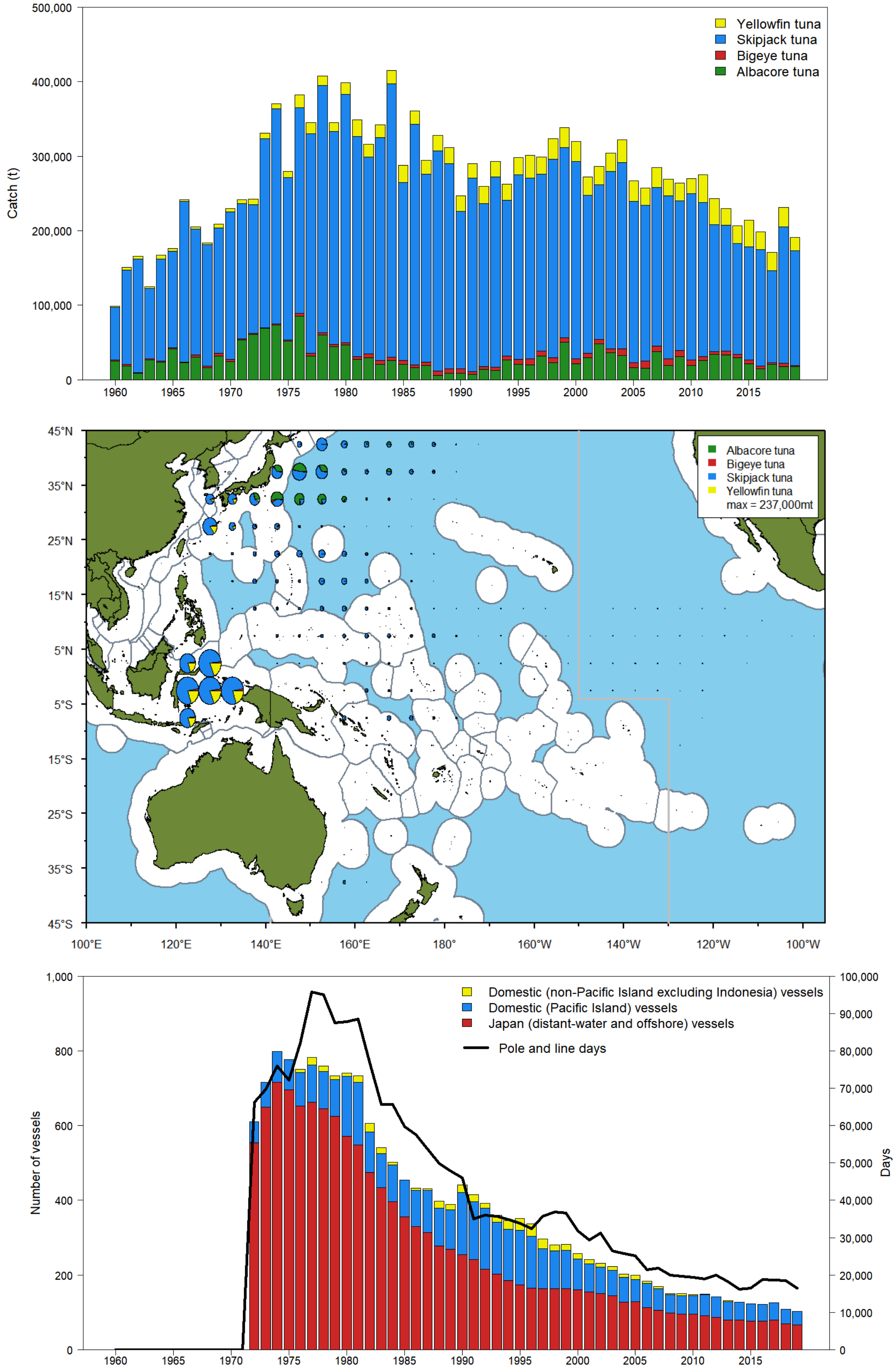

Figure 5: Time series of catch (top), recent (2015–2019) spatial distribution of catch (middle), and indices of fishing effort in fleet sizes and number of days (bottom), for the pole-and-line fishery in the WCPO. Note that vessel numbers and fishing days are not available prior to 1972.

Skipjack catch data

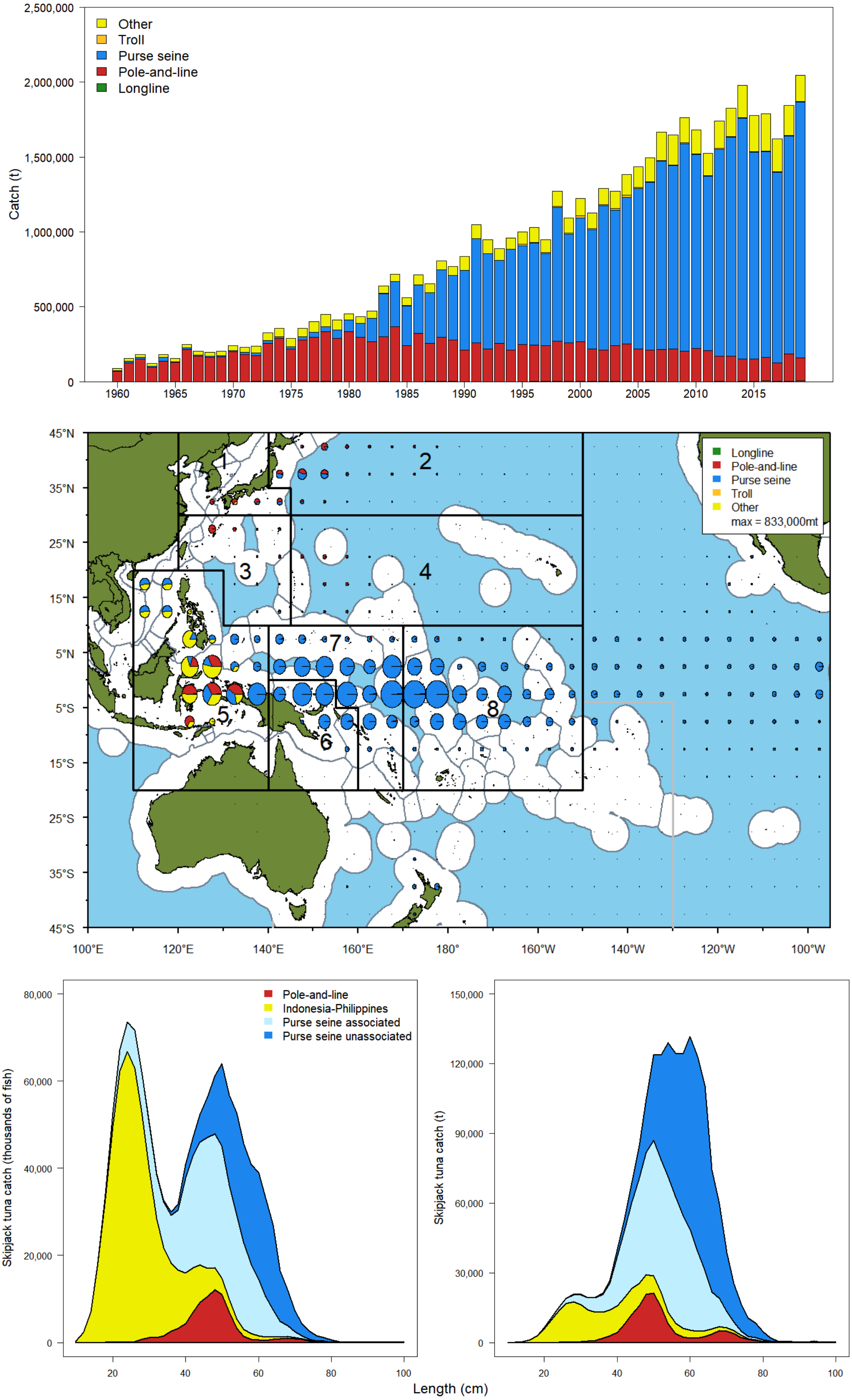

Figure 6: Time series (top), recent (2015–2019) spatial distribution and assessment regions (middle), and size composition (average for last five years; bottom) of skipjack tuna catch by gear for the WCPO.

Skipjack diagnostic plots

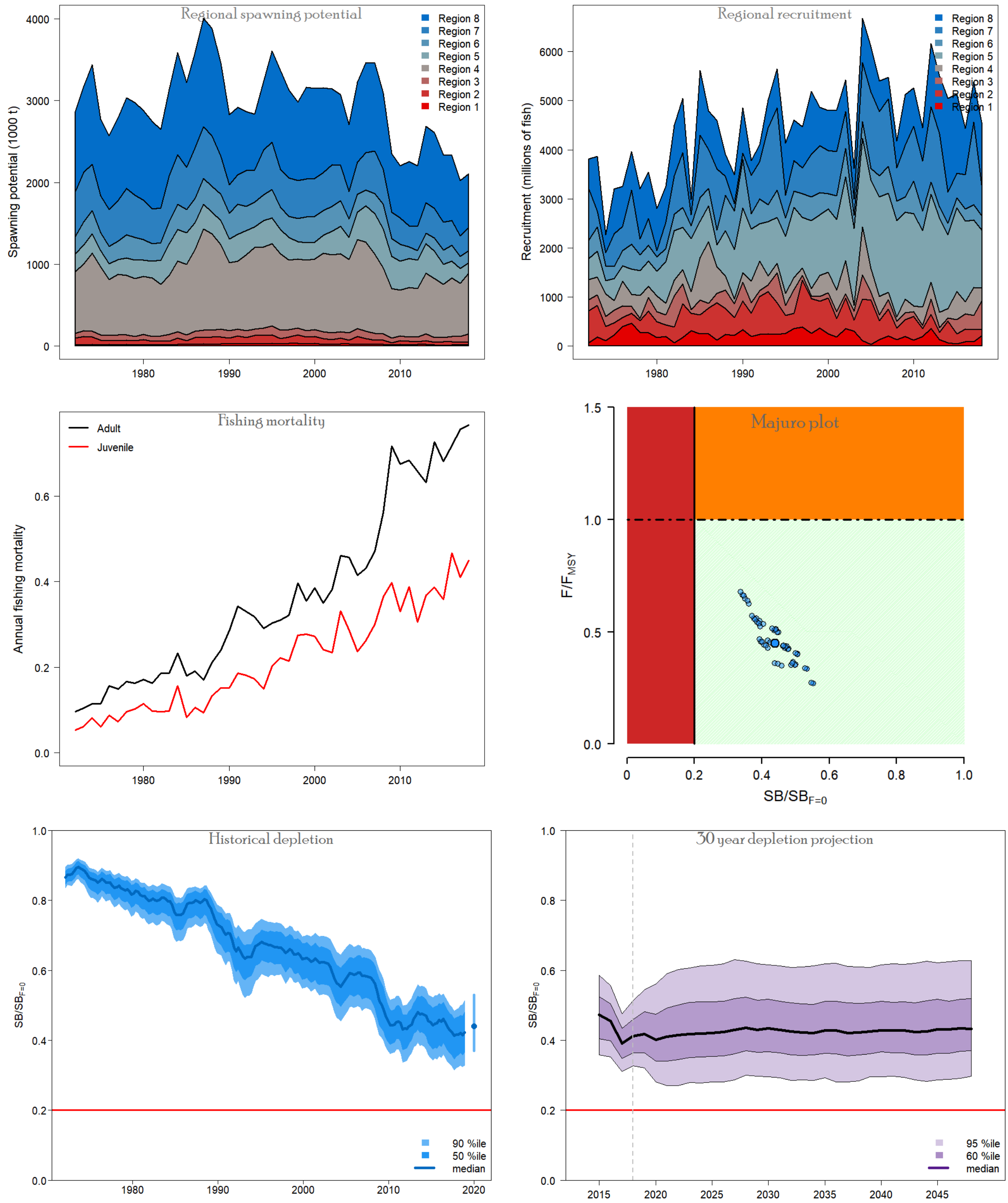

Figure 7: Estimated spawning biomass (top left), recruitment (top right), fishing mortality (middle left) from the diagnostic case; stock status displayed using a Majuro Plot, the large blue point is the diagnostic model and the other points indicate the runs in the sensitivity grid of 54 models (middle right), estimated level of depletion across the grid (bottom left), and 30-year projected depletion based on status quo (2016–2018 catch/effort levels) fishing (bottom right).

Yellowfin catch data

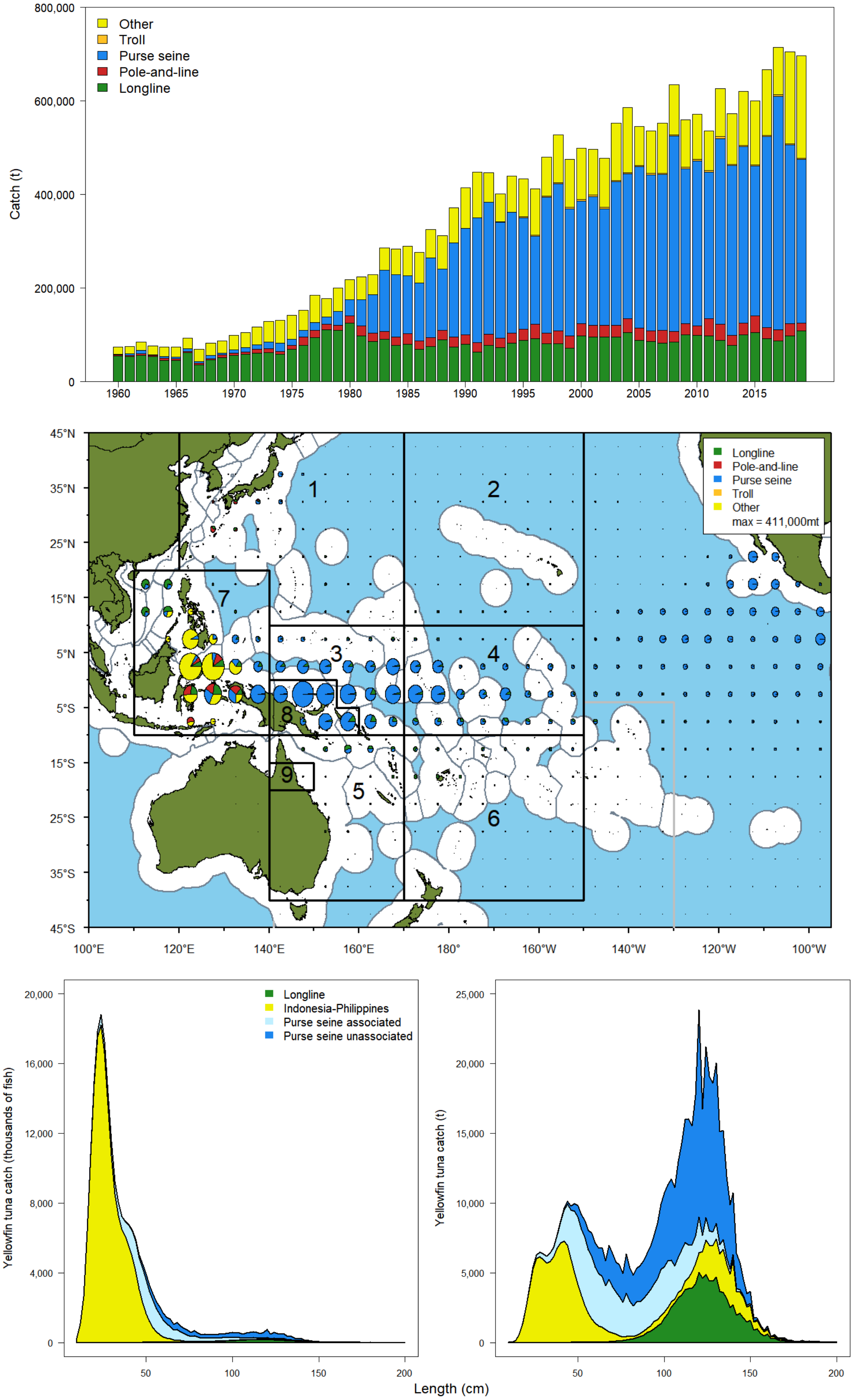

Figure 8: Time series (top), recent (2015–2019) spatial distribution and assessment regions (middle), and size composition (average for last five years, bottom) of yellowfin tuna catch by gear for the WCPO.

Yellowfin diagnostic plots

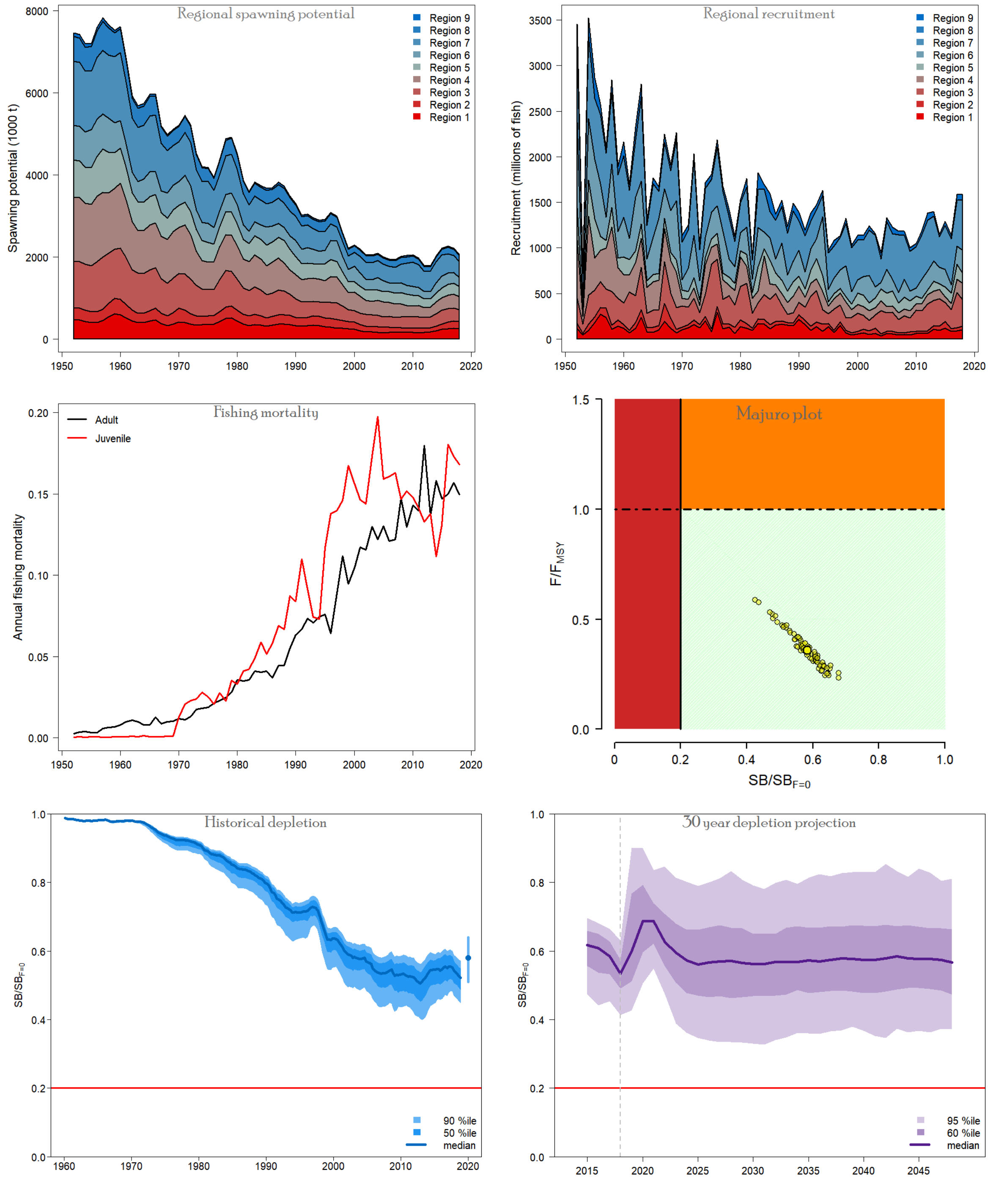

Figure 9: Estimated spawning biomass (top left), recruitment (top right), fishing mortality (middle left) from the diagnostic case; stock status displayed using a Majuro Plot, the large blue point is the diagnostic model and the other points indicate the runs in the sensitivity grid of 72 models (middle right), estimated level of depletion across the grid (bottom left), and 30-year projected depletion based on status quo (2016–2018 catch/effort levels) fishing (bottom right).

Bigeye catch data

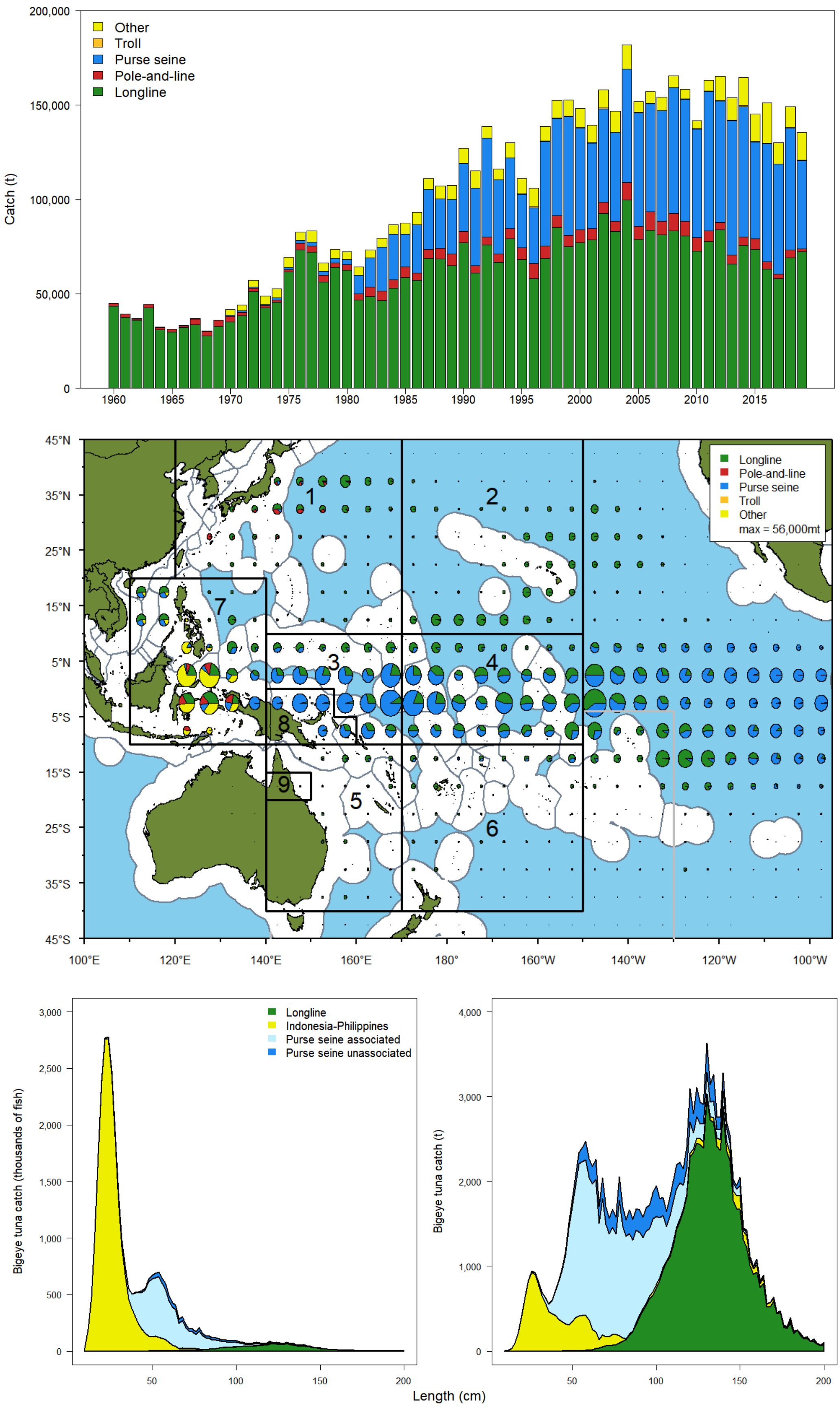

Figure 10: Time series (top), recent (2015–2019) spatial distribution and assessment regions (middle), and size composition (average for last five years; bottom) of bigeye tuna catch by gear for the WCPO.

Bigeye diagnostic plots

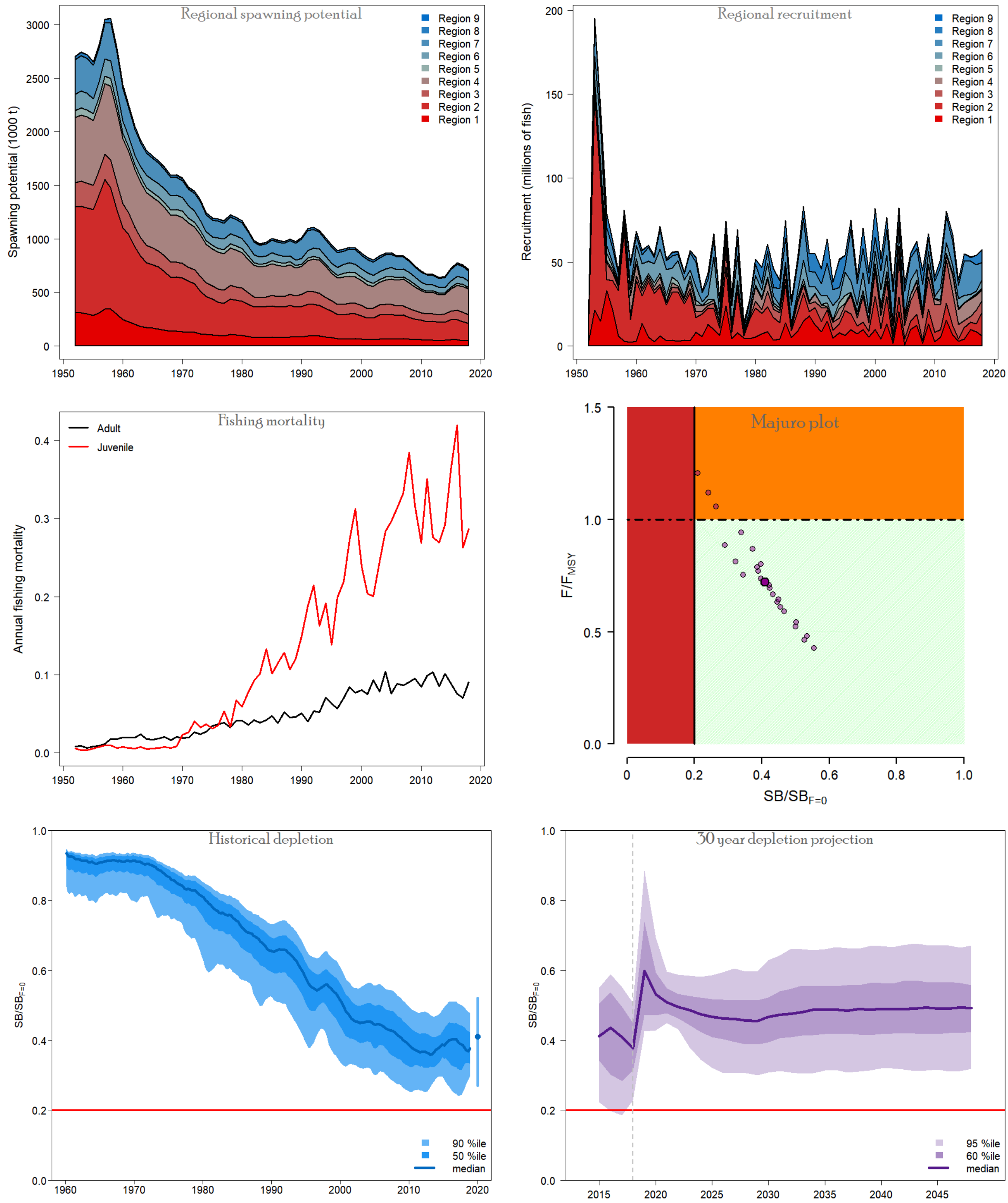

Figure 11: Estimated spawning biomass (top left), recruitment (top right), fishing mortality (middle left) from the diagnostic case; stock status displayed using a Majuro Plot, the large blue point is the diagnostic model and the other points indicate the runs in the sensitivity grid of 24 models (middle right), estimated level of depletion across the grid (bottom left), and 30-year projected depletion, under the "recent recruitment" (2007–2016) assumption, based on status quo (2016–2018 catch/effort levels) fishing (bottom right).

Albacore catch data

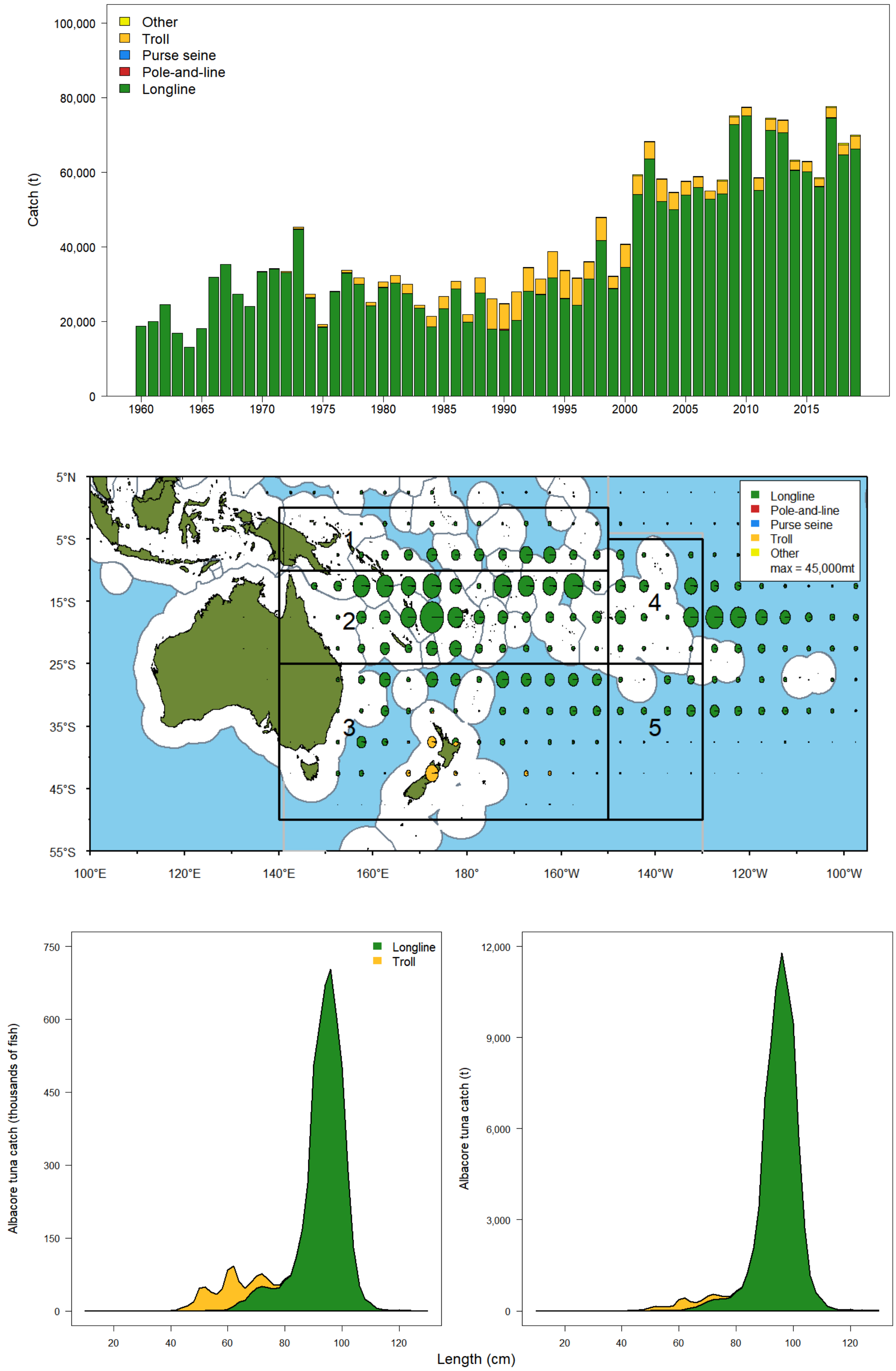

Figure 12: Time series (top), recent (2015–2019) spatial distribution and assessment regions (middle), and size composition (average for last five years, bottom) of South Pacific albacore tuna catch by gear for the WCPO south of the Equator.

Albacore diagnostic plots

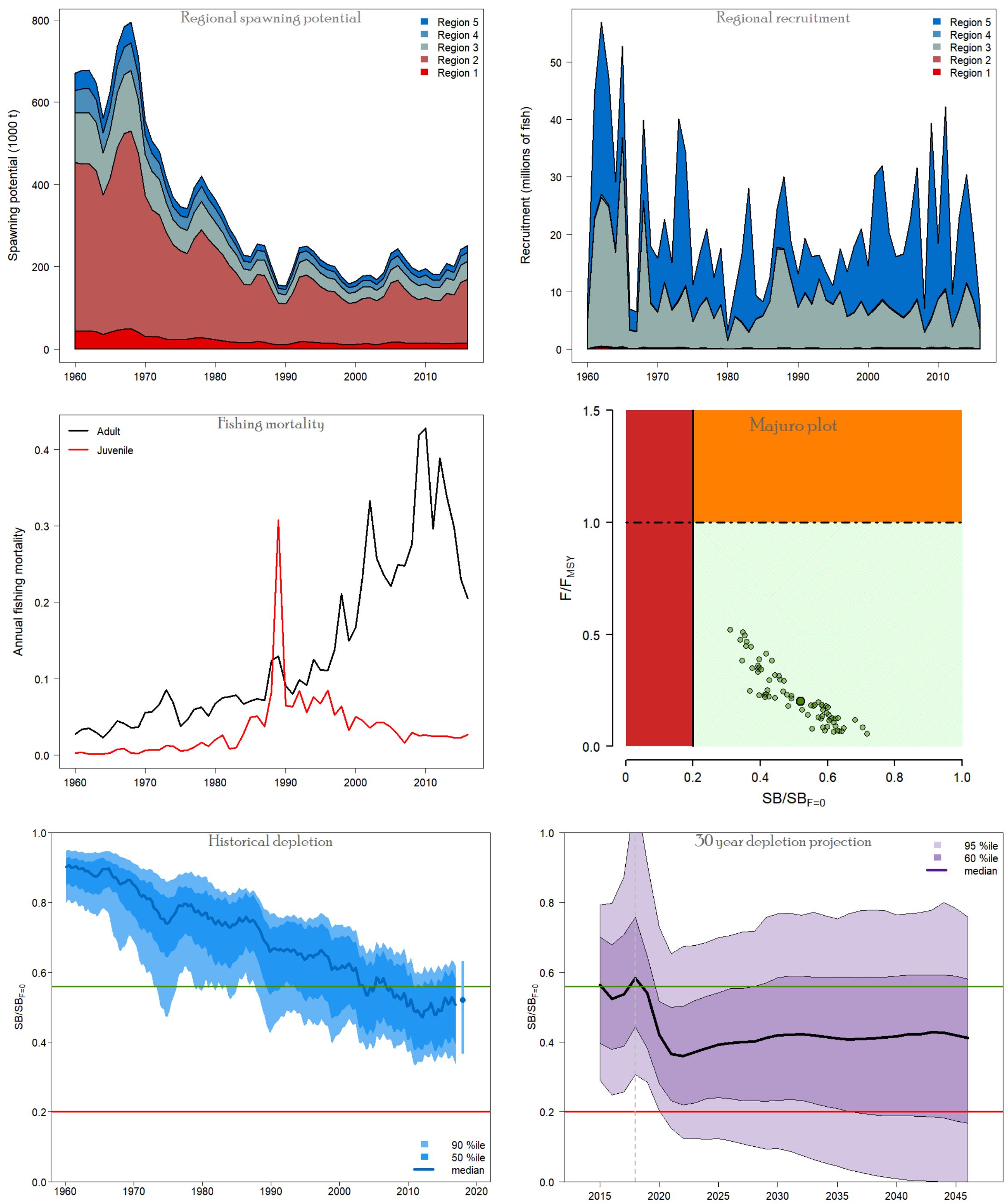

Figure 13: Estimated spawning biomass (top left), recruitment (top right), fishing mortality (middle left) from the diagnostic case; stock status displayed using a Majuro Plot, the large blue point is the diagnostic model and the other points indicate the runs in the sensitivity grid of 72 models (middle right), estimated level of depletion across the grid (bottom left), and 30-year projected depletion based on status quo (2019 catch levels) fishing (bottom right). The depletion target reference point is shown as a green line in the bottom plots.

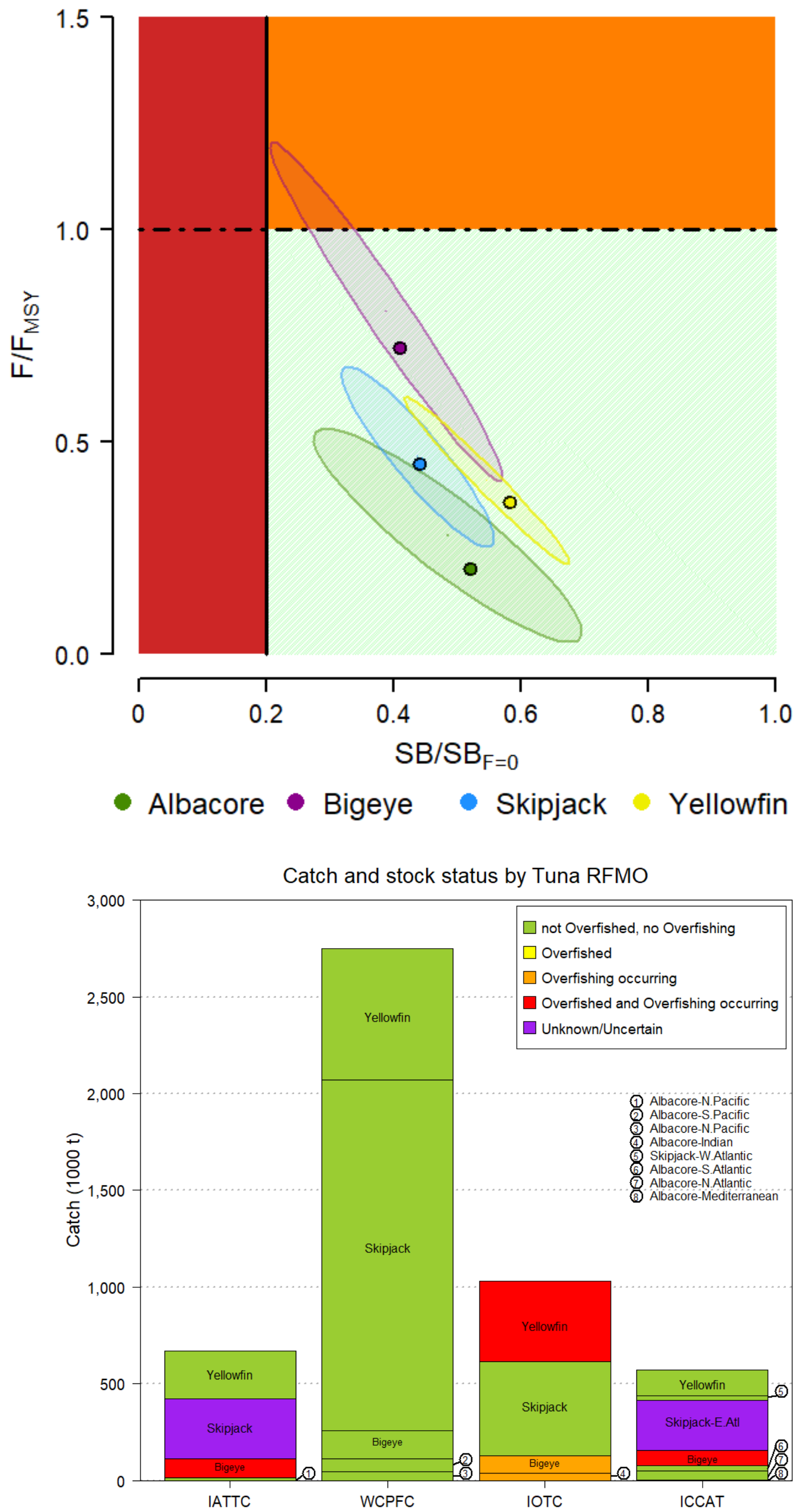

Figure 14: Majuro plot stock status summary for the four WCPO target tuna stocks (top) and a comparison of stock status for the same four tuna species in the other major ocean basins (bottom). In the Majuro plot, the grid median value is shown as a large dot, the ellipses closely approximate the distribution of values from grid models. Readers are referred to the individual species plots in earlier sections for more precise information on stock status from individual models in the uncertainty grid. The stock status comparison across basins is based on spawning biomass and fishing mortality relative to their MSY values. Data are current as of October 2020 and stock status assessments were obtained directly from documents produced by the responsible tuna RFMO. Catch is average catch over the five most recent years available. The "Unknown/Uncertain" classification was used when the reliability of the reference points was stated to be uncertain or unreliable. Note that North Pacific albacore is co-managed in the Pacific by both WCPFC and the Inter-American Tropical Tuna Commission (IATTC) and is, therefore, included for both organisations with the catch levels reflecting the split between the two convention areas.

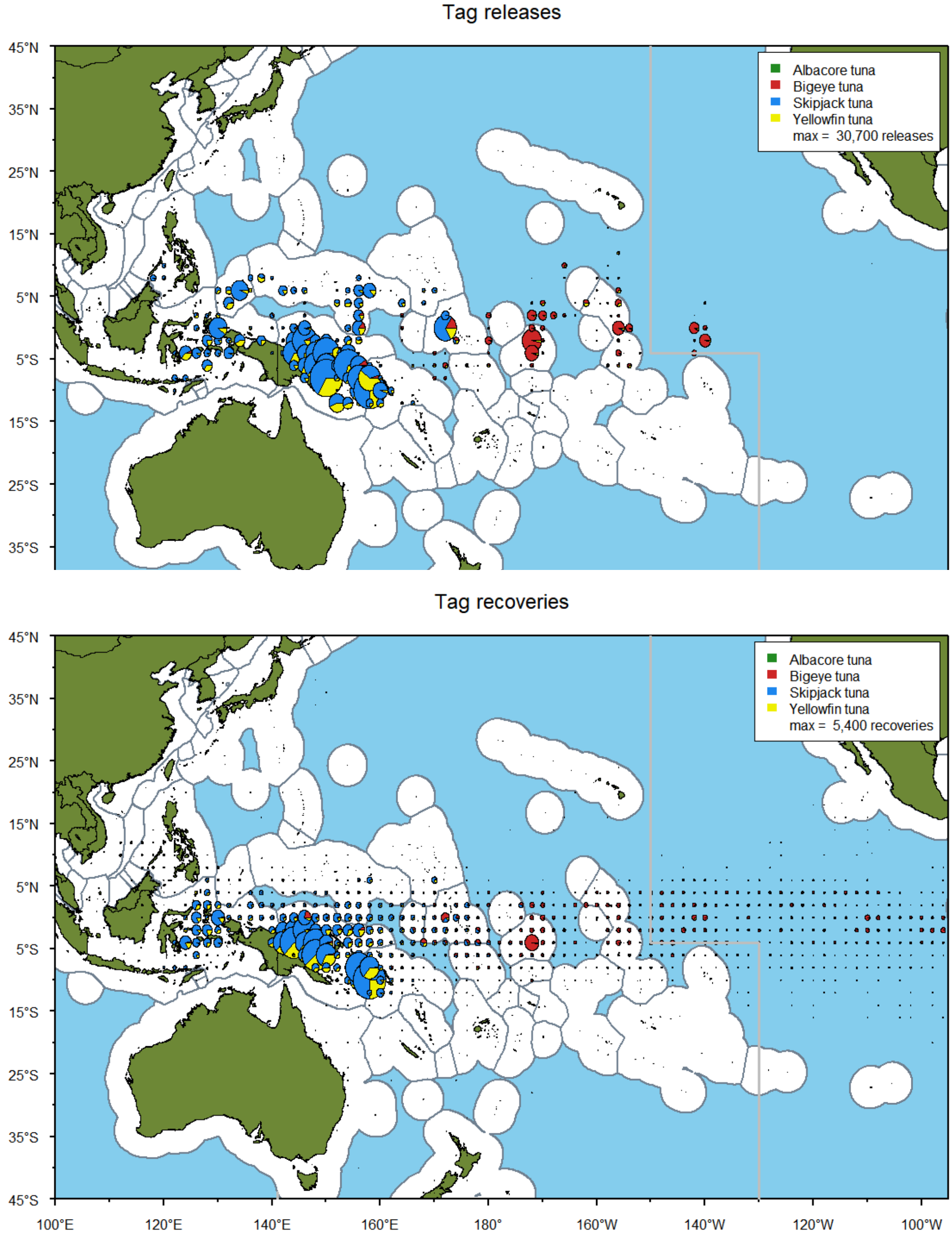

Figure 15: Tag releases (top) and recaptures (bottom) by species from the recent Pacific Tuna Tagging Programme (PTTP). Release and recovery locations have been aggregated to a 2^ox 2^o grid resolution for visual clarity.

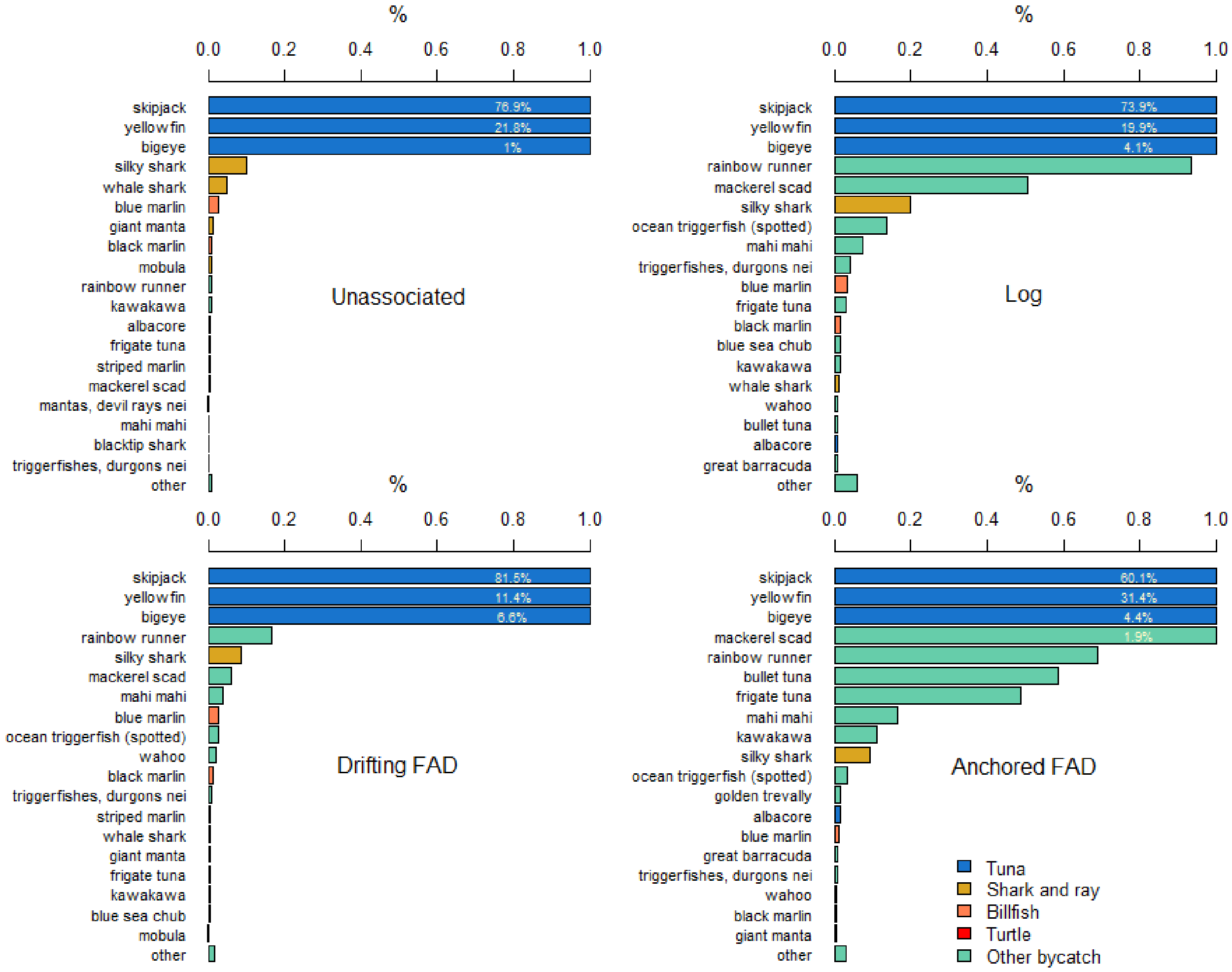

Figure 16: Catch composition of the various categories of purse seine fisheries operating in the WCPO based on observer data from the last five years' data. Note: Species comprising less than 0.01% of the catch are summed in the "other" category.

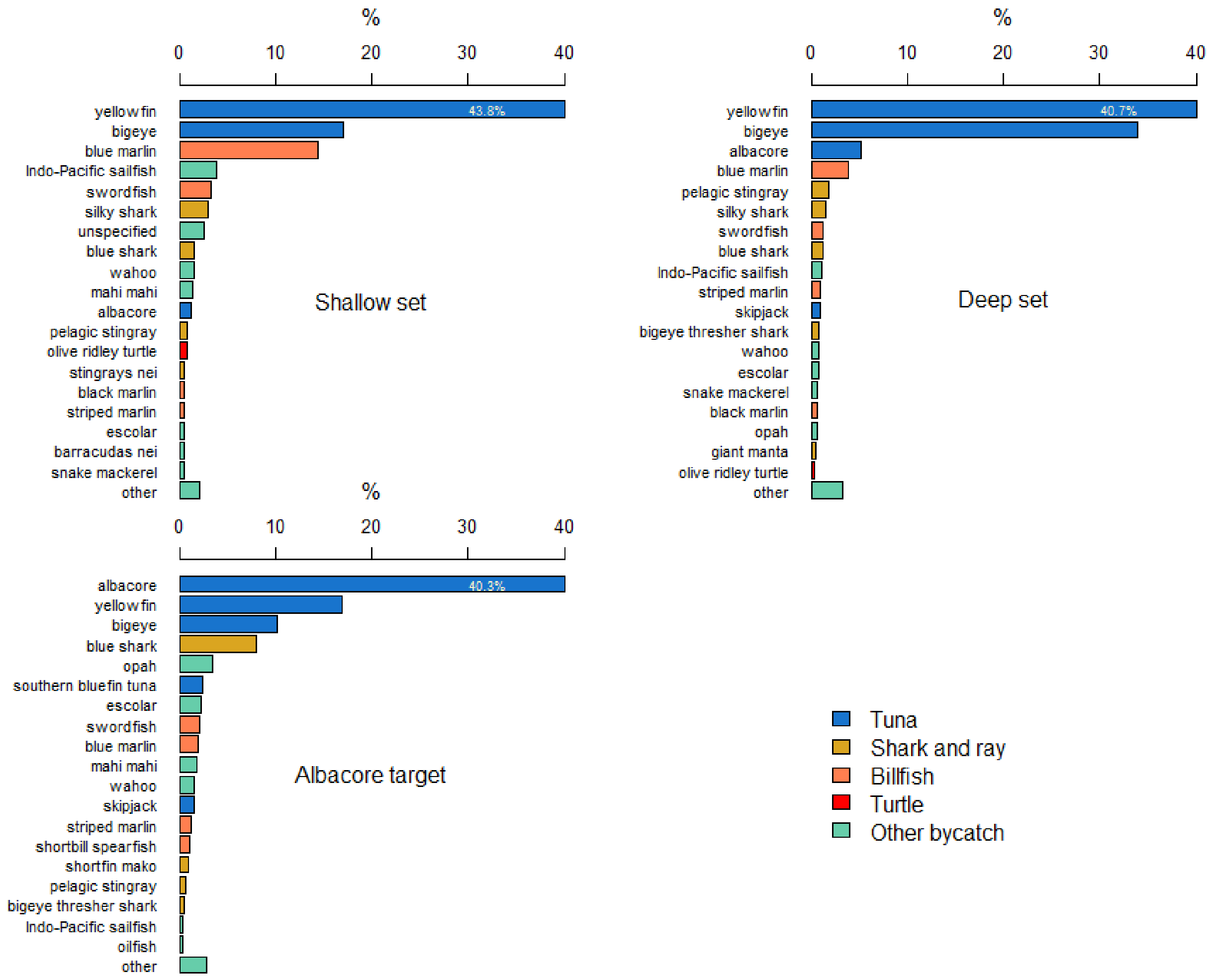

Figure 17: Catch composition of the various categories of longline fisheries operating in the WCPO based on observer data from the last five years' data.

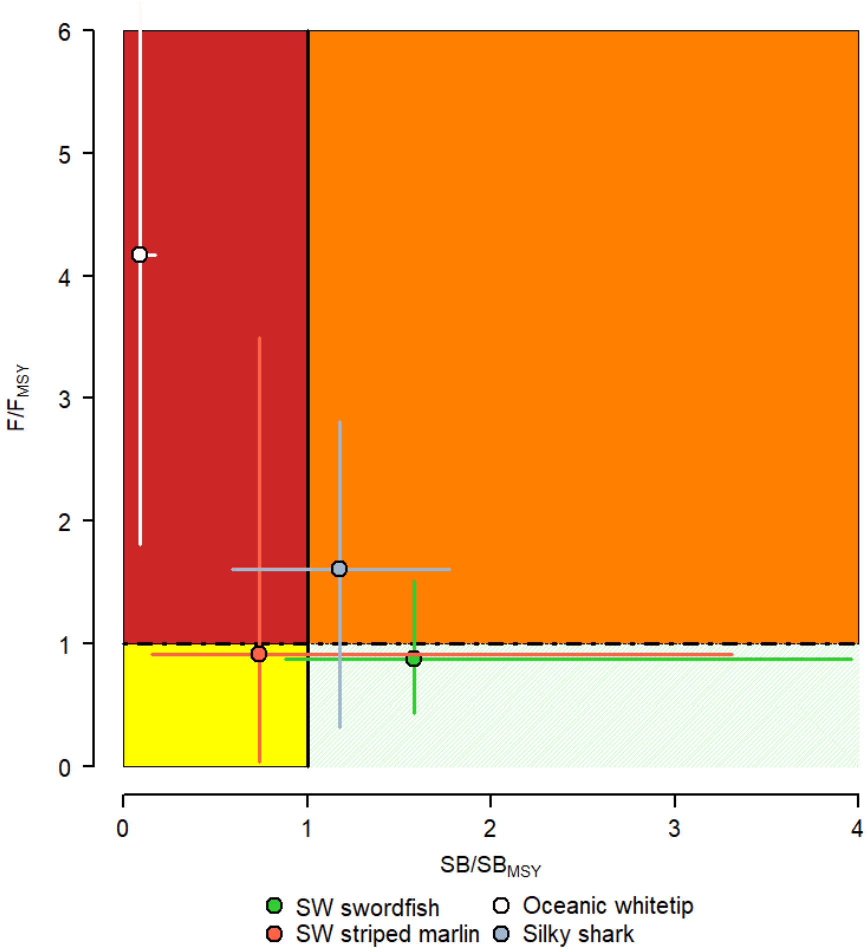

Figure 18: Kobe plot stock status summary for four species of billfishes and sharks assessed at SPC over the past decade and for which stock status has been determined. Note that this plot differs from that presented for the target tuna (the "Majuro" plot), because the WCPFC has not yet decided on LRPs for these species and therefore MSY-based reference points are used as a default.

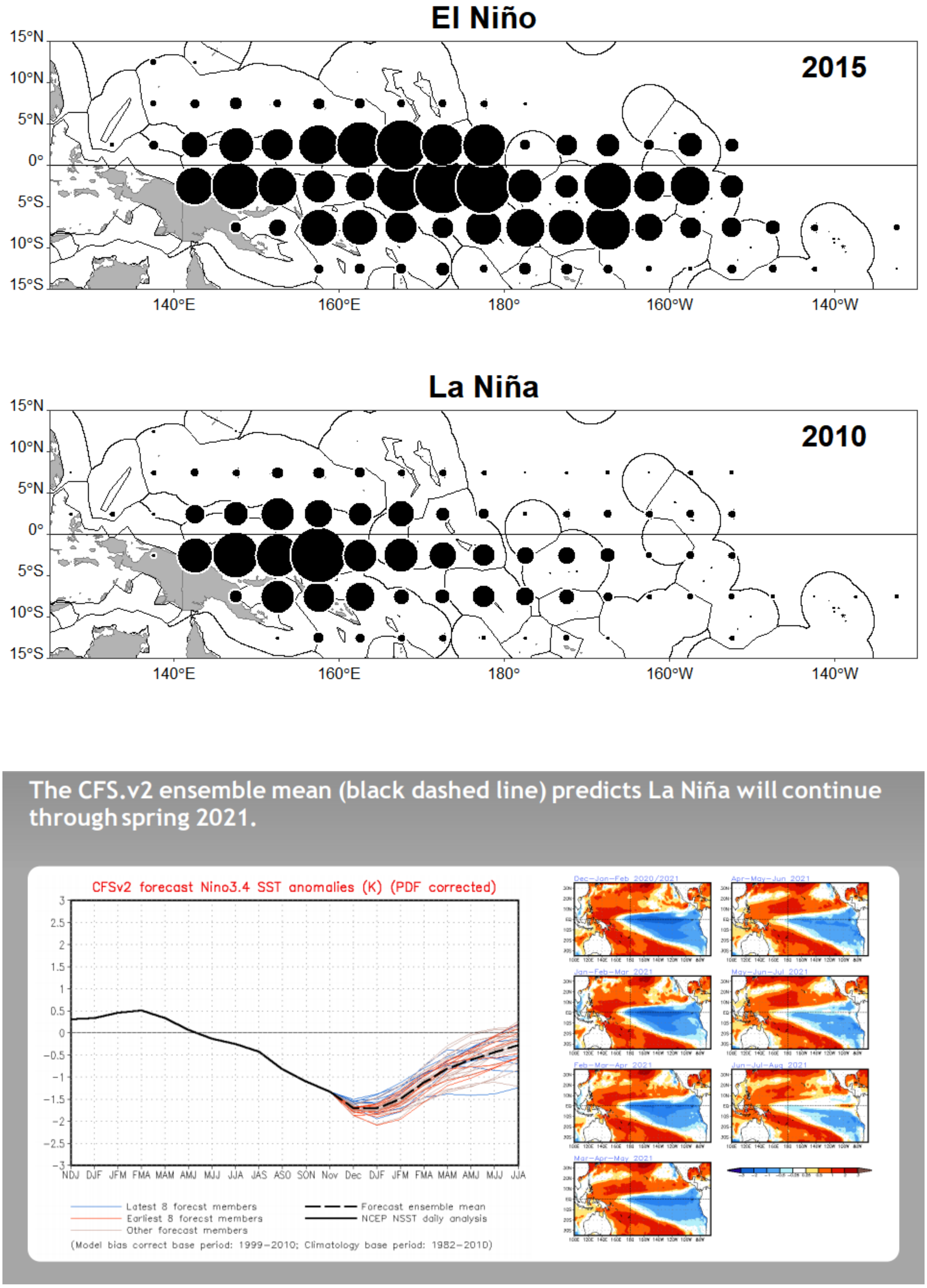

Figure 19: Illustration of difference in purse seine effort distribution between a strong El Niño (top) and strong La Niña event (middle). A medium strength La Niña event (overall negative sea surface temperature anomaly and westward extension of the "cold tongue" into the western Pacific) is forecasted to occur between the months of December 2020 and June 2021 (source: https://www.cpc.ncep.noaa.gov, forecast date: 16 November 2020).

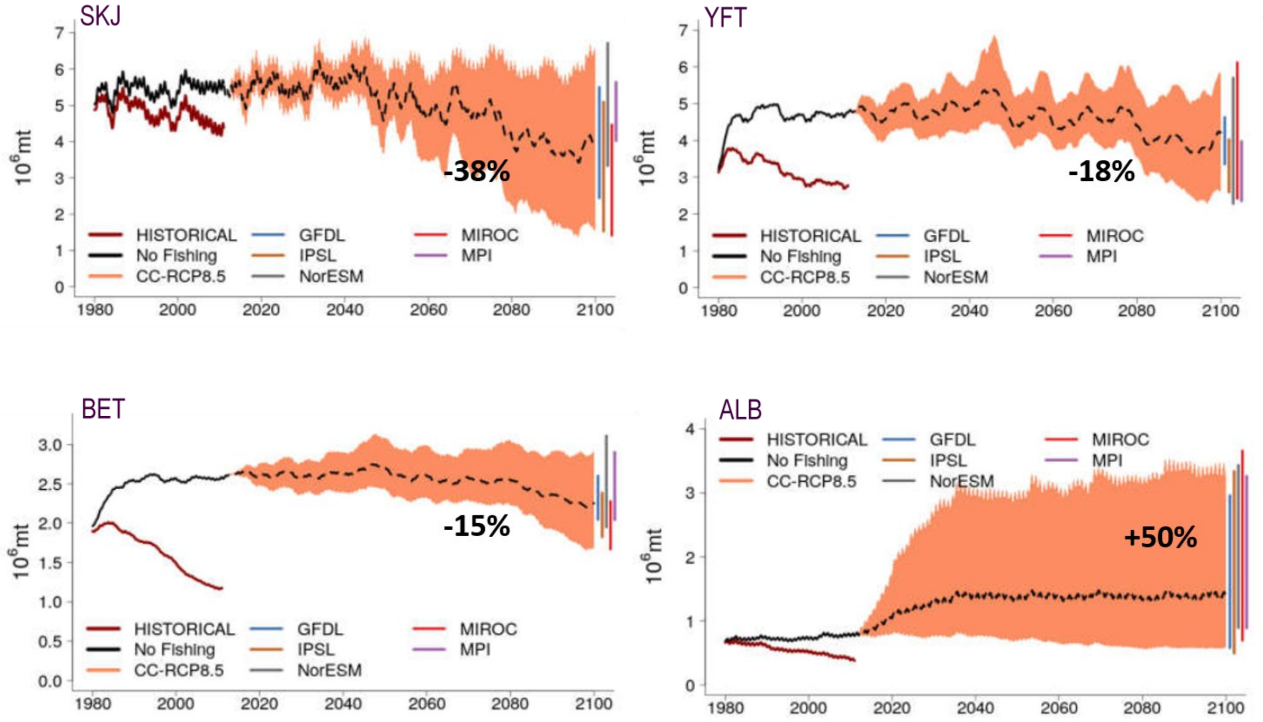

Figure 20: Envelope of predictions computed from simulation ensembles under IPCC RCP8.5 scenario for the WCPO. The change in total biomass is presented with the average (dotted line) and its envelope bounded by the 5% and 95% quantile values of the simulation ensembles. The percentage values represent the change in the mean biomass across runs in the 1990–2010 time window compared with 2090–2100. Modified from Senina *et al*. (2018).

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