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The western and central Pacific tuna fishery: 2023 overview and status of stocks

Tuna Fisheries Assessment Report no. 24

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Fisheries, Aquaculture and Marine Ecosystems Division

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Preface

The Tuna Fisheries Assessment Report (TFAR) provides 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. As this report is a smart PDF, you may click on a reference within the document and it will take you to the figure or section; to return to the page you were on, press alt and the left arrow key (command key and left arrow on a Mac).

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 (*T. alalunga*).

The report is divided into three parts: the first section provides an overview of the fishery, with an 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 that 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 are typically complete through the end of the year prior to publication. However, some minor revisions to statistics may occasionally 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 FAME 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 the 2023 catch of 2,623,966 metric tonnes (hereafter abbreviated as "t") was the 12th highest catch year in history, and represented a minor decrease of 1.3% from 2022. We expect revisions to the 2023 catch estimates in next year's report, as estimates in the most recent year are preliminary. The WCPFC-CA tuna catch for 2023 represented 53% of the global tuna catch (Figure 2, the provisional estimate for 2023 being 4,997,242 t, a decrease of 6.9% from the 2019 record global catch of 5,367,301 t).

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 occured in 1998. Total tuna catches continued to increase until 2012, primarily due to increases in purse-seine catches, and have been relatively stable over the past decade (Figure 3, and Table 1), at a total catch level of 2.6 to 3.0 million t. The provisional total WCPFC-CA tuna catch for 2023 was estimated at approximately 2,623,966 t, which was 11.8% less than the record high of 2,974,314 t estimated in 2019, and a decrease of 1.3% from 2022. In 2023, the purse-seine fishery accounted for an estimated 1,837,030 t (70% of the total catch), which was 12.5% less than the record high of 2,100,135 t estimated in 2019 for this fishery. The pole-and-line fishery landed an estimated 111,670 t (4% of the catch), which is just 27% of the high of 415,016 t recorded in 1984, a time of much greater pole-and-line fishery participation. The longline fishery in 2023 accounted for an estimated 227,646 t (9% of the catch) – also lower than the highest value of 284,849 t recorded in 2004, and represented a 1% decrease over the 2022 longline catch. Troll gear accounted for <1% of the total catch (6925 t), well below the highest value (25,750 t) recorded in 2000. The remaining 17% (440,695 t) was taken by a variety of artisanal gear, mostly in eastern Indonesia, the Philippines and Vietnam, and is now the highest value on record, exceeding the previous high of 419,579 t recorded in 2021.

Box 1 – Summary of the 2023 WCPFC-CA tuna catch by gear type.

Gear type	Catch (1000 t)	% of total gear catch	Change from 2022	Notes
Purse-seine	1837	70%	-2%	4% below 5 yr avg.
Longline	228	9%	-1%	3% below 5 yr avg.
Pole-Line	112	4%	-28%	lowest since 1960
Troll	7	<1%	-27%	44% below 5 yr avg.
Other	441	17%	+14%	8% above 5 yr avg.
Total	2624	100%	-1%	5% below 5 yr avg.

The 2023 WCPFC-CA skipjack catch (1,635,659 t – 62% of the total catch) was 20% less than the highest value (2,044,779 t in 2019), and a decrease of 5% from 2022 (Figure 3 and Table 2). The WCPFC-CA yellowfin catch for 2023 (745,773 t – 28% of the total catch) was 1% below the highest value (754,331 t), which was achieved in 2021. The WCPFC-CA bigeye catch for 2023 (146,181 t – 6% of the total catch) was 25% below the highest value (195,052 t) achieved in 2004, and a 1% decrease over the 2022 catch. The WCPFC-CA albacore catch for 2023 (96,353 t – 4% of the total catch) was also well below the highest value (148,051 t) recorded in 2002, but a 3% increase from the 2022 catch.

Total tuna catch within the WCPFC-CA is also presented by the exclusive economic zone (EEZ) of individual countries EEZ (and on the high seas) and by flag nation, for the period of 1990–2023 (Figure 4). In 2023, the top 10 EEZs (one of which is the high seas area) in terms of catches accounted for 94% of the total catch while the top 10 flag states accounted for 83% of the total catch. In 2023, Kiribati was the top EEZ, supplanting Papua New Guinea from 2022. As has been the case for the past decade, Indonesia remained the top flag nation in catch. Tuna catches in the high seas comprised approximately 15% of the total, a sharp rise from the 2022 total of 10%, but still down considerably from the period 1990–2007 when high seas catches accounted for at least 25% of the annual total WCPFC-CA tuna catch.

Within the WCPFC-CA, South Pacific and North Pacific albacore are assessed separately; SPC[1] conducts the South Pacific albacore assessment while the ISC[2] conducts the North Pacific albacore assessment, which covers the entire North Pacific, including the waters of the Inter-American Tropical Tuna Commission Convention Area (IATTC-CA). The albacore tuna catch in the WCPFC-CA north of the equator was 31,295 t in 2023, which is 23% lower than the average of the previous five years, and less than one third of the highest catch of 104,798 t, taken in 1976 (Table 11). North Pacific albacore is not discussed further in this report; details of the latest assessment can be found in the ISC ALBWG (2023).

Box 2 – Summary of 2023 WCPFC-CA tuna catch by species.

Species	Catch (1000 t)	% of total tuna catch	Change from 2022	Notes
Albacore	96	4%	+3%	8% below 5 yr avg
Bigeye	146	6%	-1%	1% below 5 yr avg
Skipjack	1636	62%	-5%	9% below 5 yr avg
Yellowfin	746	28%	+7%	4% above 5 yr avg
Total	2624	100%	-1%	5% below 5 yr avg.

In 2021, for the first time, a South Pacific-wide albacore stock assessment was conducted jointly by SPC and IATTC, utilising data from both convention areas (Table 8, Table 9, Table 10). The South Pacific albacore catch in the WCPFC-CA totalled 66,334 t in 2023, which was nearly 3% higher than the average of the previous five years, and 18% lower than the highest value (80,986 t), recorded in 2010. Note that these values include catch within the overlap area with the IATTC-CA. For the eastern Pacific Ocean (EPO), exclusive of the overlap region, South Pacific albacore catch was just 1,921 t in 2023, although this total is provisional and likely to increase. Average catches in the EPO over the period 2019–2023 were 13,209 t.

Several indices of annual fishing effort for the major gear types employed in the commercial tuna fisheries are summarised in Table 3, Figure 5 (purse-seine), Figure 6 (longline) and Figure 7 (pole-and-line). For the purse-seine fleet, excluding the domestic fleets of Indonesia, the Philippines and Vietnam, the number of active vessels peaked in 2014 and 2015 at 313. The percentage of purse-seine vessels flagged to, or chartered by, Pacific Island countries and territories has steadily increased from 0 as late as 1979 to a high of 60% (145 out of 259) in 2023. The increase in number of purse-seine sets and purse-seine fishing days has mirrored the rise in the number of vessels, although the peak in both measures of fishing effort, sets and days, occurred a decade earlier (2011 for days and 2014 for sets) at around 65,000 days (or sets). While, on average, around one purse-seine set is conducted in a fishing day, 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 2023 purse-seine skipjack catch (1,358,582 t – 83% of the total skipjack catch) was 5.8% lower than

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

[2] The International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean, and the Albacore Working Group.

the 2022 catch (Table 4). The 2023 purse-seine catch of yellowfin tuna (420,523 t) increased 13.7% from 2022 and represented 56% of the total yellowfin catch (Table 5). The 2023 purse-seine catch of bigeye tuna (57,030 t) was an 11.8% decrease from 2022 and represented 39% of the total 2023 bigeye catch (Table 6). It is important to note that the purse-seine species composition for 2023 will be revised once all observer data for 2023 have been received and processed and, therefore, the current estimate should be considered preliminary. Note, however, that due to lingering COVID-19-related[3] reductions in trained observers and, therefore, observer placements, coverage levels were only around 60%. While this represents a sharp increase from coverage levels of the prior three years, the revised estimates are expected to be correspondingly imprecise relative to the pre-pandemic years (Peatman and Nicol 2021). Observer coverage of the purse-seine and longline fleets is further discussed in subsection 3.1 Observer coverage.

The commercial longline fleet (excluding Vietnamese and Indonesian domestic vessels and Japanese coastal longline vessels) peaked in size in 1994 at 5130 vessels (Table 3 and Figure 6). The fleet has steadily declined since then, and totalled 2,227 vessels in 2023 which was, however, an increase of 122 vessels from 2022. The percentage of longliners flagged to Pacific Island countries and territories has steadily increased from zero in the mid-1970s to just over 23% in 2018, and has fluctuated between 17% and 20% since; in 2023, 376 of the 2227 longline vessels (17%) were flagged to Pacific Island countries and territories. 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 increased from 400 million in the mid-1970s to 600 million in the early 2000s, to 800 million in the early 2010s. The peak year in hooks fished was 2012 at 888 million hooks reducing to 602 million hooks in 2023, a decline of 5% from 2022, and more than 14% below the average of the previous five years.

Box 3 – Summary of the 2023 commercial fishing effort in the WCPFC-CA.

Gear	Unit	Number	Change from 2022	Notes
Purse-seine	vessels	259	+3%	4% lower than 5 yr avg
Purse-seine	days	47,623	-1%	3% lower than 5 yr avg
Purse-seine	sets	52,245	-4%	6% lower than 5 yr avg
Longline	vessels	2227	-6%	2% lower than 5 yr avg
Longline	hooks	602,200,000	-5%	lowest since 2001
Pole-and-line	vessels	87	-10%	lowest on record
Pole-and-line	days	6918	-32%	lowest on record

The recent longline catch estimates are often uncertain and subject to revision due to delays in reporting. Nevertheless, the bigeye catch of 54,190 t was down by just over 1,000 t from the 2023 catch and was the

[3] Coronaviridae Study Group of the International Committee on Taxonomy of Viruses. Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. *Nat Microbiol* **5**, 536–544 (2020). https://doi.org/10.1038/s41564-020-0695-z

second lowest since 1983, while the yellowfin catch (83,876 t) for 2023 was a 5% decrease from the 2022 catch.

The pole-and-line fleet has been contracting in size continuously since 1974, when the number of vessels peaked at 798, to just 87 vessels in 2023, down from 97 in 2022 (Table 3 and Figure 7). Pole-and-line effort, measured in fishing days, has shown a similar decline, from a high of 88,567 days in 1977 to 6918 days in 2023, noting, however, that 2023 numbers are subject to revision.

Skipjack accounts for the majority of the pole-and-line tuna catch (80%), with yellowfin tuna (14%) 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 2023 troll catch in the WCPFC-CA was 6925 t, a decline of 27% from 2022, and 23% below the average of the previous five years. In recent years, albacore has comprised roughly half the troll catch, mainly by the New Zealand fleet (average 2262 t of catch per year over 2019–2023) but with a small catch by the United States (average 682 t per year). While skipjack and yellowfin tuna are usually taken in smaller quantities, there was greater catch of both species (2,564 t and 2,657 t respectively) than of albacore (1192 t) in 2023. Note also that much of the tropical small-scale troll fisheries catch is reported under “Other gear types”.

2 Status of tuna stocks

The sections below provide a summary of the recent developments in fisheries for each tuna 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 12. The skipjack tuna stock was assessed in 2022 (Castillo Jordán et al. 2022); bigeye and yellowfin tuna stocks were assessed in 2023 (Day et al. 2023 and Magnusson et al. 2023, respectively); the South Pacific albacore stock was most recently assessed in 2024 (Teears et al. 2024). 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 2021, while South Pacific albacore currently includes data through 2022. Skipjack, with its shorter lifespan and importance of young fish to the fishery, includes the most recent year of data (which is mostly purse-seine logsheet data that are available on a more timely basis than longline data); thus the 2022 assessment included fisheries data through 2021. Information on the status of other oceanic fisheries resources (e.g. billfish and sharks) is provided in subsection 3.4 Catch and status of billfish and sharks.

2.1 Skipjack tuna

The 2023 WCPFC-CA skipjack catch of 1,635,659 t was considerably lower than the highest value (2,044,799 t) recorded in 2019 (Table 4 and Figure 8). As in recent years, the main contributor to the overall skipjack catch was the purse-seine fishery (1,358,582 t in 2023 – 83% of total skipjack catch). The next-highest proportion of the catch was by "other" fishery (182,856 t – 11%), which includes small-scale and miscellaneous gear types such as handlines, ringnets and coastal trolling. The longline fishery accounted for less than 1% of the total catch. The vast majority of skipjack are taken in equatorial areas, including Indonesia and the Philippines, and most of the remainder is taken by the seasonal domestic fishery off Japan (Figure 8).

The dominant size of the WCPFC-CA skipjack catch (by weight) typically ranges from 40 cm to 60 cm, corresponding to fish that are 1–2+ years old (Figure 8). Pole-and-line-caught skipjack typically range in size from 40 cm to 55 cm, while skipjack caught by the domestic fisheries of Indonesia and the Philippines are much smaller, ranging from 20 cm to 40 cm. In general, skipjack taken in "unassociated" (i.e. 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 2022 and included data from 1972 to 2021, using the same eight-region model structure developed for the 2019 assessment (Castillo Jordán et al. 2022); readers are referred to that assessment for more details on model configuration and settings. The 2022 assessment featured several new model developments, including changes to the approaches for estimating fishing mortality and effective sample sizes for size composition data, use of variable tag mixing periods, and the development of new catch-per-unit-effort (CPUE) indices for the equatorial purse-seine fishery. At the Eighteenth Regular Session of the Scientific Committee (SC18) of the Western and Central Pacific Fisheries Commission (WCPFC), the assessment model was approved and equal weighting was applied to the 18 models in the structural uncertainty grid used for management advice. The grid comprised three axes; one related to tag mixing, one to growth estimation, and one to steepness of the stock-recruitment relationship. Median values from the 18 models for key reference points are discussed below.

While estimates of fishing mortality for skipjack have increased over time, current fishing mortality rates for skipjack tuna are estimated to be about 0.32 times the level of fishing mortality associated with maximum sustainable yield (F_{MSY}). Therefore, overfishing is not occurring (i.e. $F_{recent} < F_{MSY}$). Median spawning biomass[4] is estimated to be at 51% of the level predicted in the absence of fishing. Recent spawning biomass levels are estimated to be well above the limit reference point (LRP) of 20% of the level predicted in the absence of fishing ($SB/SB_{F=0} > 0.2$). Overall, spawning biomass and recruitment have shown a recent declining trend since peaks in the late 2000s. Fishing mortality continues to increase and remains higher for adults than juveniles. Depletion ($SB/SB_{F=0}$) continues to trend downwards, although

[4] As key tuna stock assessments generally incorporate the pattern of fecundity at size within the calculation of adult biomass (skipjack being the exception at present), this is more accurately called "spawning potential". However, we have used the term "spawning biomass" throughout this document, for simplicity.

the trend is mostly influenced by the long-term increasing trend in the estimates of unfished spawning biomass ($SB_{F=0}$) rather than the declining trend in the estimated spawning biomass (SB). The trends in spawning biomass and depletion vary among model regions, with declining trends more prevalent in the equatorial regions. In terms of stock status, the 2022 stock assessment of skipjack tuna for the WCPO indicated that, according to WCPFC reference points, the stock is neither overfished nor undergoing overfishing. Under status quo fishing conditions, where catch and effort levels are maintained at the average 2018–2021 levels, the stock is projected to have zero probability of dropping below the LRP. A number of illustrative plots on exploitation history, present status and future projections are shown in Figure 9.

While SC18 approved the 2022 assessment as the best available science on skipjack stock status, they could not agree on a management advice statement to provide to the WCPFC. A summary of the key assessment outcomes is provided below.

- The median spawning biomass depletion level for the structural uncertainty grid is $SB_{recent}/SB_{F=0}$ = 0.51 with a likely range of 0.43–0.64 (80^{th} percentile). This level of depletion is consistent with the target reference point (TRP) for skipjack as specified in the recently adopted WCPFC skipjack conservation and management procedure (CMM2022-01). There were no individual models where $SB_{recent}/SB_{F=0} < 0.2$, which indicates a zero probability that recent spawning biomass is below the LRP.
- The median F_{recent}/F_{MSY} for the model grid is 0.32, with a likely range of 0.18 to 0.45 (80th percentile) and no grid models with values of $F_{recent}/F_{MSY} > 1$. Therefore, there is zero probability that overfishing is occurring.
- The largest uncertainty in the structural uncertainty grid relates to how the tag mixing periods are assigned, followed by the choice of growth models.
- SC18 noted that the skipjack assessment continues to show that the stock is currently moderately exploited and the level of fishing mortality is sustainable.
- SC18 noted that the stock was assessed to be above the adopted LRP and fished at rates below F_{MSY} with 100% probability. Therefore, the skipjack stock is not overfished, nor subject to overfishing. At the same time, it was also noted that fishing mortality is continuously increasing for both adult and juvenile stages while the estimated spawning potential has shown a declining trend since the mid- to late-2000s, and spawning potential depletion reached historically low levels in recent years.
- SC18 noted that levels of fishing mortality and depletion differ between regions, and that fishery impact was highest in the tropical region (regions 5, 6, 7 and 8 in the stock assessment model), mainly due to the purse-seine fisheries in the equatorial Pacific and "other" fisheries within the western Pacific.

A number of recommendations were provided to be considered for future assessments, and these can be found in the SC18 Summary Report (WCPFC Secretariat 2022). Briefly, the key recommendations were to: 1) develop strategies for more timely provision of assessment papers for review prior to the Scientific Committee (SC); 2) enhance model diagnostics explore data conflicts; 3) investigate and include effort creep scenarios for CPUE indices; 4) conduct further work on tag mixing and tag reporting rates; 5) make improvements to the modelling of CPUE; and 6) explore evidence for an increase in recruitment over time.

Follow-up work has been conducted on the 2022 skipjack assessment to improve aspects of the model performance and was presented to the WCPFC SC at its Nineteenth Regular Session (SC19) (Castillo Jordán et al. 2023). The additional work made some notable improvements that will be carried into the next assessment due in 2025. While follow-up work is ongoing, to date it does not have any implications for stock status, which remains as reported in the 2022 assessment (Castillo Jordán et al. 2022).

2.2 Yellowfin tuna

The total WCPFC-CA yellowfin catch in 2023 (745,773 t) was just 1% less than the highest value (754,331 t) recorded in 2021 (Table 5 and Figure 10). The purse-seine catch (420,523 t) increased by 24%, and the longline catch (83,876 t) decreased by 5%, from 2022 levels. The remainder of the yellowfin tuna catch comes from pole-and-line and troll fisheries, 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 with a variety of gear types in the Indonesian and Philippines fisheries. The domestic surface fisheries of the Philippines and Indonesia take large numbers of small yellowfin in the range of 20–50 cm (Figure 10). 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 (> 100 cm) yellowfin tuna.

Stock assessment

The most recent assessment of yellowfin tuna in the WCPO was conducted in 2023 (Magnusson et al. 2023) and included data from 1952 to 2021. The 2023 assessment had five regions and was less complex than the nine-region structure used in the previous assessment. The 2023 assessment used a catch-errors modelling framework including a likelihood component for the CPUE from the index fisheries, estimated natural mortality internally using a Lorenzen functional form, and estimated growth internally using conditional age-at-length data using a von Bertalanffy growth formulation. Additional size composition filtering was applied with changes to the size data weighting, and with revisions to assumptions on non-decreasing selectivity and tagger effect modelling. The analysis presented the results as a structural uncertainty grid comprising 54 model runs that were equally weighted by SC19 when developing management advice. The structural uncertainty grid addressed several key model uncertainties in addition to estimation uncertainty. The most influential factors contributing to uncertainty around estimated stock status were the assumed tag mixing period and steepness. Additional model uncertainties addressed in the grid included weighting of the age and size composition data.

Fishing mortality on both juvenile and adult fish has increased since the early years of the fishery, although adult mortality has shown signs of levelling off in recent years. In contrast, juvenile fishing mortality is estimated to have increased rapidly in the last few years, from 0.22 in 2015 to 0.46 in 2021. This increase matches the rapidly increasing catches in fishery 23, which consists of miscellaneous gear types used by the Indonesian domestic small-scale fishery that targets juvenile fish at ages 0.5 and 0.75 years (i.e. two and three quarters, respectively). The annual catches in fishery 23 have increased from 58,000 in 2015 to 169,000 t in 2021. 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 biomass showed a continuous decline from the 1950s to the 2000s but appears to have levelled off after around 2010. Absolute recruitment has been variable throughout the assessment period, with no apparent long-term trend. Recent spawning biomass levels are uniformly (in all models) 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 fishing levels are maintained at the average 2019–2021 levels, the stock is projected to have zero probability of dropping below the LRP. A number of illustrative plots on exploitation history, present status and future projections are shown in Figure 11.

The conclusions of SC19, which were presented as recommendations to the Twentieth Regular Meeting of the WCPFC (WCPFC20) in 2023, are outlined below.

- Based on the uncertainty grid adopted by SC19, 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 is no risk of breaching the LRP (0% probability $SB_{2048}/SB_{F=0} < 0.2$) under average 2019–2021 fishing conditions.
- Levels of fishing mortality and depletion differ between regions, and fishery impact was highest in the tropical region (regions 2, 3, and 4 in the stock assessment model), mainly due to the purse-seine fisheries in the equatorial Pacific and "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 biomass 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 among the data inputs used in the assessment suggests additional caution may be appropriate when interpreting assessment outcomes to guide management decisions.
- SC19 recommends as a precautionary approach that the fishing mortality on the 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 TRP.

2.3 Bigeye tuna

The 2023 WCPFC-CA bigeye tuna catch was 146,181 t, which was well below the highest value (195,052 t) recorded in 2004. A sizable (7615 t) decrease in purse-seine catch was mostly offset by a similar (7264 t) increase in the catch by "other" gear types (Table 6 and Figure 12), but a decrease of 1100 t in the longline catch resulted in an overall decrease of about 1300 t in total bigeye catch relative to 2022. Of the total bigeye catch in 2023, 37% was caught by longline, 40% by purse-seine, and the remainder was distributed across troll, pole-and-line, and other gear types.

The majority of the WCPFC-CA catch is taken in equatorial areas, by both purse-seine and longline fisheries, but with some longline catch in sub-tropical areas (e.g. east of Japan) (Figure 12). In equatorial areas, much of the longline catch is taken in the central Pacific, contiguous with the important traditional bigeye longline area in the EPO.

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 20–50 cm. In addition, large numbers of small 25–75 cm bigeye are taken by purse-seine fishing on FADs (Figure 12) 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 larger than 100 cm, accounts for most of the catch by weight in the WCPFC-CA. Large bigeye are very rarely taken by the WCPO purse-seine fishery, and only a relatively small amount is taken by the handline fishery in the Philippines. Bigeye sampled in the longline fishery are predominantly adult fish, with a mean size of approximately 130 cm, with most between 80 cm and 160 cm.

Stock assessment

The most recent assessment of bigeye tuna in the WCPO was conducted in 2023 (Day et al. 2023) and included data from 1952 to 2021. This assessment used a catch-errors modelling framework, including a likelihood component for the CPUE from the index fisheries, estimated natural mortality internally using a Lorenzen functional form and estimated growth internally using conditional age-at-length data using a von Bertalanffy growth formulation. Additional size composition filtering was applied with changes to the size data weighting and with revisions to assumptions on non-decreasing selectivity and tagger effect modelling. Management advice was formulated from the results of an uncertainty grid of 54 models that addressed several key model uncertainties in addition to estimation uncertainty. The most influential factors contributing to uncertainty around estimated stock status were the assumed tag mixing period and steepness. Additional model uncertainties addressed in the grid included weighting of the age and size composition data.

Fishing mortality is estimated to have increased over time since 1970, particularly on juveniles, although mortality shows signs of levelling off in the last 20 years. Current fishing mortality rates for bigeye tuna, however, are estimated to be below F_{MSY} in all models in the uncertainty grid, which indicates that overfishing is likely not occurring. Spawning biomass shows a long continuous decline from the 1950s to the 2000s but appears to have levelled off since around 2010. Absolute recruitment has been variable throughout the assessment period, with no long-term trend, although with a tendency for some higher recruitments in the recent decade. All models in the structural uncertainty grid estimated spawning biomass 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 2019–2021 levels and the relatively positive recent (2010–2019) recruitment patterns are assumed to continue, the stock is projected to have zero probability of dropping below the LRP. A number of illustrative plots on exploitation history, present status and future projections are shown in Figure 13.

The conclusions of WCPFC SC19, which were based on placing equal weight on all 54 model runs, were presented as recommendations to the WCPFC20 and are outlined below.

- The preliminary estimate of the 2022 catch was 140,664 t, which is less than the median MSY (164,640 t).
- Based on the uncertainty grid, WCPO bigeye tuna spawning biomass is above the biomass LRP and F_{recent} is below F_{MSY} for all models in the uncertainty grid.
- It was concluded that the stock is not overfished and not experiencing overfishing.
- Levels of fishing mortality and depletion differ among regions, and the 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 estimated at a more elevated level overall due to low exploitation in the temperate regions (regions 1, 2, 5, 6 and 9).
- The interim objective of bigeye tuna stock under CMM 2021-01 is to maintain the depletion level of the stock at or above the average depletion level for 2012–2015. The recent depletion level of bigeye tuna is close to this interim objective.

2.4 South Pacific albacore tuna

The total WCPFC-CA South Pacific albacore catch in 2023 (66,334 t) decreased by roughly 5% from the 2022 catch, and well below the historical high of 80,986 t in 2010 (Table 7 and Figure 14). Longline fishing has accounted for most of the catch of this stock (79% in the 1990s, but 95% in the most recent 10 years). The troll catch, mostly taken from November to April, has generally been in the range of 3000–8000 t, although it has averaged less than 3500 t over the past five years.

The longline catch is widely distributed across the South Pacific (Figure 14), with the largest catches taken from the western region. Much of the increase in catch in the early 2000s 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 catches are distributed mostly in New Zealand's coastal waters, mainly off the South Island, and along the sub-tropical convergence zone. In the past, less than 20% of the overall South Pacific albacore catch was taken east of 150°W but, in the last five years, this has increased to over 25%, largely due to increased catches by the Chinese fleet in the high seas.

The longline fishery takes mainly larger adult albacore, mostly in the narrow size range of 90–105 cm, and the troll fishery takes juvenile fish in the range of 45–80 cm. 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 2024 (Teears et al. 2021). Similar to the previous assessment (Castillo-Jordán et al. 2021), the assessment included the entire South Pacific region (south of the equator) incorporating both the WCPFC-CA and the IATTC-CA. The assessment was a collaborative effort by SPC and IATTC scientists, and data covered the period 1954–2022. Based on recommendations from SC17 and the 2024 pre-assessment workshop, there was a strong focus on simplifying the 2024 assessment compared to previous versions.

The assessment presented the results from an ensemble model approach in which 100 models incorporated uncertainty in average natural mortality, stock-recruitment steepness and estimation error. The 2021 assessment was the first to include both convention areas modelled jointly in a spatially structured South Pacific wide assessment. The 2024 assessment also includes both convention areas however, an areas-as fleets approach was implemented in each of the convention areas in lieu of the explicit regional spatial structure used in 2021. Other changes from the 2021 assessment included: 1) conversion from a catch-errors to a catch-conditioned modelling framework; 2) inclusion of a likelihood component for the CPUE from the index fisheries; 3) application of a time-varying coefficient of variation for index fisheries; 4) effective sample sizes for size composition data (calculated using the Francis weighting approach), and movement; and 5) recruitment distribution fixed to values derived from SEAPODYM. Management advice was provided for the entire South Pacific region, and separately for the WCPFC-CA and IATTC-CA. Here, we focus on South Pacific-wide outcomes.

Consistent with the findings of the previous south Pacific albacore assessment (Castillo Jordan et al., 2021), the spawning biomass shows a sharp decline from the start of the model period until the mid-1970s after which it stabilises. The stock status, as indicated by the spawning biomass depletion ($SB_{recent}/SB_{F=0}$), shows a more gradual long-term decline from the start of the model period. Based on the ensemble set of models accepted at the Twentieth Regular Session of the SC (SC20), the South Pacific albacore stock is not considered to be overfished, and there was zero estimated risk of the stock being below the LRP of 20% $SB_{F=0}$. Stock depletion (years 2019–2022) including estimation uncertainty, across models had a median value of 0.48 (10^{th} to 90^{th} percentile interval 0.36–0.62). Fishing mortality has generally been increasing over time, most notably for the adult component of the stock. The median F_{recent} (2018–2021 average) was estimated to be 0.18 times the fishing mortality that would support MSY (10^{th} to 90^{th} percentile interval 0.06–0.44). Similarly, median SB_{recent}/SB_{MSY} was estimated at 3.02 (10^{th} to 90^{th} percentile interval 2.04–5.21). These estimates indicate that, according to WCPFC reference points, the stock is not overfished or currently undergoing overfishing. The addition of the IATTC region into the South Pacific albacore assessment did not notably alter the main assessment outcomes, and similar trajectories and terminal depletion levels were estimated in both the WCPFC-CA and IATTC-CA (Teears et al. 2024).

Stock projections (Teaars et al. 2024), with stochastic recruitment variation, suggest that under status quo fishing conditions, where catch levels are maintained at the average for 2020–2022, the stock is projected to increase in the short term but stabilise over the long term near a median depletion ($SB/SB_{F=0}$) of 0.50, with a small ($< 10\%$) risk of being below the LRP of 20% $SB_{F=0}$. A number of illustrative plots on exploitation history, present status and future projections are shown in Figure 15.

The conclusions of the WCPFC SC20, based on the ensemble of 100 models were presented as recommendations to the WCPFC, and are outlined below.

- Spawning biomass shows a sharp decline from the beginning of the model period until the mid-1970s after which it stabilises. The stock status, as indicated by the spawning biomass depletion ($SB/SB_{F=0}$), shows a more gradual long-term decline from the beginning of the model period.
- The median value of relative recent (2019–2022) spawning biomass depletion for South Pacific albacore ($SB_{recent}/SB_{F=0}$) was 0.48 with a 10^{th}–90^{th} percentile interval of 0.36–0.62, which is close to, but just below, the 0.5 re-calibrated interim target reference point (iTRP) for South Pacific albacore based on the 2024 assessment.
- There was 0% probability (0 out of 100 ensemble models, including estimation uncertainty) that the recent (2019–2022) spawning biomass had breached the adopted LRP.
- Fishing mortality on adults continues to increase, while fishing mortality on juveniles remains low. Fishing mortality has increased sharply in the EPO since 2010 as longline catches have increased but has remained stable in the WCPFC-CA over a similar period.
- The median of relative recent fishing mortality for South Pacific albacore (F_{recent}/F_{MSY}) was 0.18 with a 10^{th}–90^{th} percentile interval of 0.06–0.44.
- There was 0% probability (0 out of 100 ensemble models) that the recent (2018–2021) fishing mortality was above F_{MSY}.
- Spawning biomass shows a sharp decline from the beginning of the model period until the mid-1970s after which it stabilizes. The stock status, as indicated by the spawning biomass depletion, shows a more gradual long-term decline from the beginning of the model period.

2.5 Summary across target tuna stocks

To summarise the most recent stock assessments for the four target tuna stocks, the stock status for all four species is plotted on a single Majuro plot, along with the associated uncertainty from their respective model grids with weightings applied where required by SC (Figure 16). All four stocks are considered to be in a healthy, sustainable status as none are considered to be overfished. Yellowfin, skipjack and South Pacific albacore are estimated to have a 0% probability of currently experiencing overfishing, while bigeye is estimated to have a 12.5% probability of undergoing overfishing. To place these results in context, a summary of stock status for these same four species assessed in other ocean basins by the three other tuna regional fisheries management organizations is illustrated in Figure 16. As most of the other regional tuna fisheries management organizations 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. The classification of stock status used in Figure 16 (bottom plot) is based on the medians of multiple models (weighted if required by SC) for each assessment. However, stock status estimates often carry a large uncertainty, which is not evident in plots showing only medians. The pie charts at the bottom of Figure 16 present a summary of the fraction of models for each assessment that estimated stock status in each of the four Kobe quadrants.

2.6 Progress in harvest strategy development

WCPFC CMM 2022-03 - *Conservation and Management Measure on Establishing a Harvest Strategy for key fisheries and stocks in the Western and Central Pacific Ocean* establishes the requirement that "...the Commission shall develop and implement a harvest strategy approach for each of the key fisheries or stocks under the purview of the Commission". Progress in developing and implementing the harvest strategy elements varies across the four key tuna stocks, as summarised in Box 4.

Box 4 – Summary of progress in implementing harvest strategy elements for key WCPFC tuna stocks and fisheries.

Stock:	Skipjack	SP Albacore	Bigeye	Yellowfin
Key gear	Tropical purse-seine	Southern longline	Tropical longline	-
Management objectives	TRP adopted*	iTRP identified	Candidate TRPs identified	Noted
Management procedure	MP adopted*	Developing		
Performance indicators	Identified	Identified	Identified	Identified
Mixed fishery	Developing			
Monitoring strategy	Adopted	Developing		

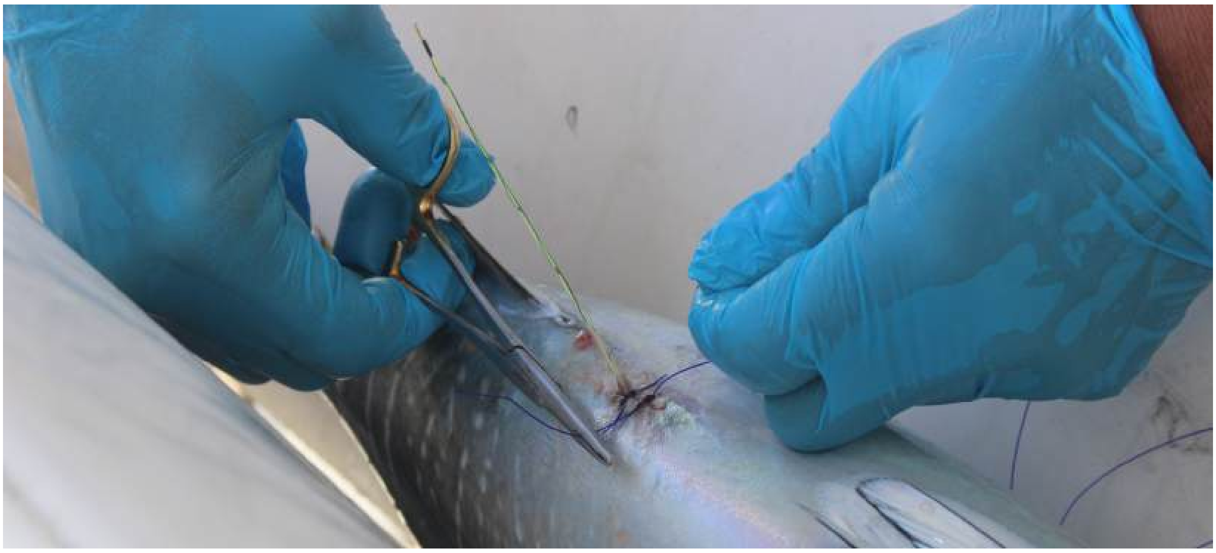
* *WCPFC CMM 2022-01. Conservation and Management Measure on a Management Procedure for WCPO Skipjack Tuna*

A major step was made at the Nineteenth Regular Session of the WCPFC (WCPFC19) meeting in Da Nang, Vietnam where WCPFC CMM 2022–01 - *"Conservation and Management Measure on a Management Procedure for WCPO Skipjack Tuna"* - was adopted. This CMM sets out the specifications of an interim management procedure (MP) for skipjack tuna, including the definition of a harvest control rule and a target reference point (TRP). The skipjack tuna MP was run for the first time in 2023. The output of the MP provides recommendations for the overall effort and catch levels for the WCPFC skipjack fisheries to apply for the next three years (i.e. 2024–2026), which was incorporated within CMM 2023–01 - *"Conservation and Management Measure for Bigeye, Yellowfin and Skipjack Tuna in the Western and Central Pacific Ocean"* - at WCPFC20 in Cook Islands. WCPFC21 adopted the monitoring strategy for WCPO skipjack tuna, which supports the process for the Commission and its subsidiary bodies to routinely evaluate the performance of the MP to check that it is working as expected.

Technical progress was made on South Pacific albacore at WCPFC20, where an interim TRP was identified, while evaluations of the implications of a range of alternative TRP values were also requested. Candidate management procedures based on these values were developed and evaluation results presented to the WCPFC's second Science Management Dialogue meeting and to WCPFC21 in 2024. The adoption of an MP is scheduled for 2025. In 2024, WCPFC21 identified three candidate TRPs for WCPO bigeye tuna for evaluation within MPs for this stock, with the potential adoption of an MP scheduled for 2025. WCPFC21 also noted that the interim management objectives for yellowfin and bigeye in CMM 2023-01 are not compatible. As part of the mixed fishery framework, development of MPs for South Pacific albacore, WCPO bigeye and the adopted WCPO skipjack MP will allow the outcomes for WCPO yellowfin to be evaluated. A selection of papers documenting the latest developments and timetables for future work are listed with other cited references in subsection 4.3 Harvest strategies.

2.7 Tuna tagging

Large-scale tagging experiments are important to enhance the level of information (fishery exploitation rates and population size) that is necessary to inform 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 OFP over the last 30 years, with tagging campaigns occurring in the 1970s, 1990s and, most recently, since 2006. This most recent campaign has tagged and released 497,051 tunas in the equatorial WCPO, including over 1,800 archival tag releases, with 69,667 reported recaptures (Figure 17). A summary of tag releases and recoveries for all historical tuna tagging programs is provided in Table 13, and a breakdown by species and EEZ for the ongoing Pacific Tuna Tagging Programme is provided in Table 14.



3 Ecosystem considerations

3.1 Observer coverage

Observer-collected data are critical to characterising bycatch in the commercial fisheries, as well as observing and documenting operational fishing practices onboard vessels. The placement and protection of observers onboard vessels has been codified in a series of WCPFC conservation and management measures (CMMs). At present, coverage of purse-seine fishing activities is mandated at 100% (since 2010), while longline fishing activities are mandated at 5% (since 2012). In practice, neither of these coverage levels is being routinely met. However, coverage levels of both fleets have increased steadily since 2010 (Figure 18). Observer coverage of the purse-seine fleet, measured as fishing days effectively observed onboard, peaked in 2018 at just over 90%; longline coverage peaked in 2023 at just over 6%. The COVID-19 pandemic had a significant impact on observer coverage, with 2021 coverage rates declining to less than 10% and 4% for the purse-seine and longline fleets, respectively. Coverage rates improved sharply in the purse-seine fishery attaining nearly 60% coverage in 2023 while longline coverage was the highest on record. More detailed breakdowns of observer coverage by fleet and EEZ, as well as discussion on the barriers to achieving higher coverage rates, can be found in Panizza et al. (2024).

3.2 Purse-seine set characterisation

Two forms of purse-seine fishing occur: fishing on anchored and drifting FADs, which along with drifting logs are referred to as associated, and fishing on free schools, referred to as unassociated. Catch and size composition differ between the two fishing methods and the use of FADs is regulated by several WCPFC CMMs. Between 1990 and 2009, the number of associated and unassociated sets were roughly equal with total catch slightly higher for associated sets (Figure 19). Beginning in 2010, coinciding with implementation of the Parties to the Nauru Agreement (PNA) Vessel Day Scheme, there was a sharp increase in the number of unassociated sets, while the number of associated sets has remained roughly at a constant level over the past decade. Despite the difference in set numbers, total catch over the past decade has remained relatively equal between the two set types, indicating a much lower average catch for unassociated sets. However, free school purse-seine fishing results in a much higher proportion of "skunk" sets where very low catches (< 1 t) are made, typically due to the failure of a set to encircle a tuna school (Figure 19, top figure) – 42% compared with less than 5% for associated sets over the past five years.

The information concerning the non-target 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 (96.2% tuna) than drifting FADs (Figure 20). 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 the relative proportions of unassociated and associated sets (Peatman et al. 2021).

3.3 Species of special interest

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

A range of CMMs have been introduced by the WCPFC to reduce the impacts of fisheries on species of special interest, including marine turtles, whales and seabirds (sharks are discussed in subsection 3.4 Catch and status of billfish and sharks). Spatially and temporally disaggregated summaries of observer bycatch data are publicly available[5], including observed longline and purse-seine effort and interaction rates for species of special interest.

[5] See: https://www.wcpfc.int/public-domain-bycatch

There are limited interactions between the purse-seine fishery and protected species, such as whale sharks and manta rays (*Mobula birostris*). 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 apparently not seen before the set was made. Observed interaction rates between the purse-seine fishery and marine turtles are low (< 1 interaction per 100 sets), and interactions with seabirds are very rare.

Interactions with seabirds and marine mammals are low for the three major gear types (i.e. purse-seine longline, pole-and-line), although the probability of detecting rare events with low observer coverage means that the estimates of interaction rates are uncertain. Catches of five species of marine turtles has been observed in the equatorial longline fishery, although the observed encounter rate was particularly low and mortality rates vary between turtle species.

3.4 Catch and status of billfish and sharks

In addition to the main tuna species, annual catch estimates for the WCPFC-CA in 2023 are available for the main species of billfish: swordfish (*Xiphias gladius*) at 14,859 t, blue marlin (*Makaira nigricans*) at 10,542 t, striped marlin (*Kajikia audax*) at 3772 t and black marlin (*Istiompax indica*) at 9231 t. Note that these bycatch estimates are generally based on catch reported in logsheets and may represent an underestimate of actual bycatch, although most of the billfish catch is retained.

Estimates of total billfish and shark catches, for both the purse-seine (associated and unassociated sets) and longline fisheries, based on observer data, have been produced for the period 2003–2022 (Figure 21, Peatman and Nicol 2023, Peatman et al. 2024). These estimates show that shark and billfish catches in the longline fishery is at least one order of magnitude greater than in the purse-seine fishery. Over the past 20 years, total annual longline fishery billfish catches have remained relatively steady between 0.5 and 1.0 million individuals, and generally around 5000 individuals in the purse-seine fishery, with roughly equal numbers in associated and unassociated sets.

Five species of WCPFC-CA billfish have been formally assessed over the past decade: Southwest Pacific swordfish (last assessed in 2021) and Southwest Pacific striped marlin (2019) by SPC; North Pacific swordfish (2023), North Pacific striped marlin (2023) and blue marlin (2021) by ISC. Stock status for these species is based on the Kobe plot, where the overfished status is judged relative to spawning stock size at MSY.[6] There is considerable uncertainty in the estimates of F/F_{MSY} and SB/SB_{MSY} for all five species. Based on the assessment model grid medians, Southwest Pacific striped marlin and North Pacific striped marlin are likely in an overfished state, while overfishing is also occurring for North Pacific striped marlin.

Similar to billfish, the bycatch of sharks (sharks, in this context, refers to sharks and rays) is much greater in the longline fishery (1.5–2.0 million individuals) than in the purse-seine fishery (50–100,000 individuals). Purse-seine associated set catch of sharks is generally higher than unassociated set shark catches, although in recent years the numbers have been similar. A detailed species composition of the longline shark catch, based on an analysis of observer data, was reported to WCPFC SC at its Nineteenth Regular Session (SC19) (Peatman and Nicol 2023). Blue shark (*Prionace glauca*) and silky shark (*Carcharhinus falciformis*) are the most common shark species taken by the longline fisheries, with sizable numbers of shortfin mako (*Isurus oxyrinchus*), oceanic whitetip (*Carcharhinus longimanus*) and bigeye thresher (*Alopias superciliosus*) also being taken (Figure 22). The decline in the total longline shark catch noted earlier is primarily due to a decrease in blue shark catches from more than 1 million individuals in the early 2000s to around 0.7 million after 2015. The pelagic stingray (*Pteroplatytrygon violacea*) is the most common non-shark elasmobranch species taken by the longline fishery and is surpassed only by blue shark in total numbers caught.

The status of silky and oceanic whitetip sharks is of particular concern because assessments have shown that these stocks are subject to overfishing and, in the case of oceanic whitetip, is severely overfished. A WCPFC ban on the use of either shark lines or wire traces in longline sets is in place, and it is hoped this will reduce the catch of silky and oceanic whitetip sharks. Over the past several years, stock assessments have also been undertaken for five WCPFC-CA shark species (Figure 23, bottom plot): South Pacific blue shark (2022), oceanic whitetip (2019) and silky shark (2024) by SPC; North Pacific blue shark (2017) and North Pacific shortfin mako shark (2024) by ISC. Even more so than with the billfish assessments, there is considerable uncertainty in the estimates of the biological reference points, F/F_{MSY} and SB/SB_{MSY}, for all five species. Based on the assessment model grid medians, the oceanic whitetip is considered to be both overfished and experiencing overfishing while the silky shark is likely in an overfished state. Encouragingly, southwest Pacific blue shark has improved in status in recent years and is likely neither overfished nor experiencing overfishing. Similarly, the recent assessment of silky shark concludes that overfishing of the stock has likely ended, although the stock biomass likely remains below the biological reference point, although this is more uncertain than the conclusion regarding overfishing.

Links to the stock assessments for the billfish and shark species listed above are given in subsection 4.2.

The SC recommendations on billfish and sharks to the WCPFC are broadly outlined below.

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

- Stabilise stock size or catch to ensure there is no increase in fishing pressure on:
  - southwest Pacific swordfish; and
  - Pacific blue marlin.
- Reduce catch and/or rebuild the stock and/or reduce effort and/or enhance data collection efforts for:
  - southwest Pacific striped marlin;
  - western and central North Pacific striped marlin;
  - southwest Pacific blue shark;
  - silky shark; and
  - oceanic whitetip shark.

3.5 Ecosystem and climate indices

WCPFC, primarily through the work of its SC, has been considering the application of ecosystem indicators to assist with advice on the impacts of fisheries targeting tuna and tuna-like species on the broader pelagic ecosystem since the Eleventh Regular Session of the SC (SC11) in 2015. At SC18, a set of candidate ecosystem and climate indicators was presented for consideration for adoption (SPC-OFP 2022a). Several recommendations concerning the reporting of ecosystem and bycatch issues were made. In particular, SC18 recommended that available information and updates on the impacts of climate change be included or combined with status of stocks reporting. Further, SC18 recommended that "Ecosystem and Bycatch Indicators" be presented annually to the SC as a standing agenda item, and the identification of their implications and subsequent triggers be developed.

Beginning in 2022, a new section has been added to the TFAR, to present a summary of a select number of the important ecosystem and climate indicators. Note that many of the indicators in the SPC-OFP (2022a) report are already covered elsewhere in the TFAR; those included here are non-repetitive. The indicators are illustrated in Figure 24 and are briefly described below. For additional detail, refer to SPC-OFP (2023).

Mean fish condition, abbreviated as K_{rel}, is a relative measure of the average "fatness" of a tuna. Values greater than 1.0 K_{rel} indicate fatter tuna than expected, given the fish length and may be indicative of good feeding conditions.

Climate indices are defined within Figure 24; only a brief description is provided here[7].
Sea surface temperature (SST) anomalies. Three different measures of SST anomalies are presented, generally for the tropical Pacific region.

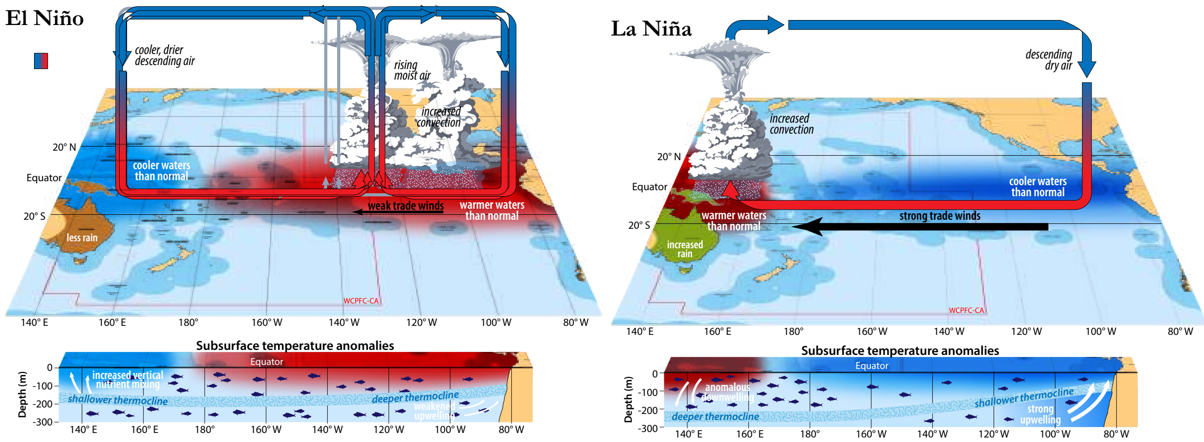
[7] Until 2024, climate indices have been developed using output generated by a CSIRO reanalysis project, the BRAN (Bluelink ReANalaysis 2020) which has not been updated beyond 2021. We anticipate moving to a new platform (Copernicus) next year to annually upate these time series

Warm pool indices. Three different indices measuring the size, eastern extent and depth of the tropical Pacific warm pool are presented.

Climate indices. Two well-known climate indices are identified as useful monitors of the large-scale oceanic environment.

3.6 El Niño–Southern Oscillation forecast

One of the major factors influencing the distribution of tuna species, perhaps most notably for skipjack, is the El Niño–Southern Oscillation (ENSO, Figure 25) (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. The WCPO experienced nearly three years of La Niña conditions from July 2020 to January 2023, a duration unheralded in the modern climatological record. El Niño conditions arose by May 2023 and a short, but intense, event lasted until April 2024. At the time this report went to press, a La Niña watch was in effect, with several meteorological agencies forecasting an event of moderate strength developing in early 2025. The United States NOAA Climate Prediction Center projects January 2024 as the peak of the event (Figure 25), with a relatively quick return to neutral conditions before mid-2025.



Typically, La Niña events result in a pooling of warm water in the western Pacific with a deepening of the warmer surface layer, a relative decrease in sea surface temperature in the eastern Pacific, and a greater concentration of skipjack in the western Pacific; El Niño events result in a broader swath of warm surface waters extending from the central American coast to as far west as 170°E. It is important to note that every ENSO event differs in its magnitude, range and impact. The response of the purse-seine fleet to fishing conditions influenced by the ENSO cycle is illustrated for the past decade in Figure 26. In 2015, a year with a very strong El Niño event, purse-seine fishing was widely distributed across the tropical Pacific, with the geographic centre of fishing activity located around 170°E. In neutral or La Niña conditions (as in 2020–2022), the geographic centre of fishing can be as much as much as 20° of longitude to the west, a distance of more than 2000 km. To illustrate the contraction of the fishing grounds, we computed the amount of oceanic area comprising 90% of the purse-seine sets (Figure 25, lower right figure). Between 2014 and 2019, the fleet occupied between 8 and 10 million km^2 of ocean; the area occupied dropped to just 6 million km^2 in 2022. There is one confounding factor that appears to counter the tendency of skipjack movement, and the purse-seine fishery, to the west in times of La Niña, and that is the use of drifting FADs. The centres of the unassociated and associated fleets are illustrated in Figure 25 by large blue and red dots, respectively. In most years, unassociated effort is highest to the west of the centre of the associated effort.

3.7 Climate change

The SEAPODYM (Lehodey et al. 2014) modelling framework was used to investigate how climate change could affect the distribution and abundance of skipjack, yellowfin, bigeye and South Pacific albacore, on a Pacific–basin scale, and within the EEZs of Pacific Island countries and territories (Senina et al. 2018; Bell et al. 2021). The analysis formed two parts: 1) a model parameterisation phase over the historical period (1979–2010) using an analysis of historic ocean conditions, and then projections of an ensemble of simulations to explore key sources of uncertainty in climate models; and 2) four different atmospheric forcing datasets from earth system models (ESMs) projected under the ("business as usual")

Intergovernmental Panel on Climate Change (IPCC) Regional Concentration Pathways 8.5 (RCP8.5) emissions scenario (Figure 27) were used to drive physical-biogeochemical models through the 21st century. To study the impact of moderate emission scenario RCP 4.5 on tuna population distributions, additional projections were generated by simulating the lower rate of warming from available ocean forcings (see details in Methods section of Bell et al., 2021). The impact of ocean acidification was also studied for yellowfin tuna based on results from laboratory experiments (Nicol et al. 2022).

The estimations of historical tuna abundance and spatial distributions (Figure 28 and Figure 29, left column) 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. Historical fishing pressure was estimated to have reduced the adult stocks of all four tuna species by 30–55% by the end of 2010, with the lowest estimate for skipjack tuna and the highest for bigeye, and yellowfin and South Pacific albacore adult stocks estimated to be depleted to 50% of their unfished populations. 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. In addition, tuna stocks were projected to shift towards the central and eastern Pacific Ocean. However, despite the gradual shift, western stocks will still reside within the WCPO convention area until the early 2040s, which is reflected by the stable biomass levels illustrated in Figure 28. Later on, the biomass trends become negative. A spatial depiction of the projected redistribution of biomass for all four target tunas is illustrated in Figure 29. Two sets of projections are shown, representing a medium greenhouse gas emissions scenario (RCP4.5) and the more extreme scenario (RCP8.5). Qualitatively, the impacts are similar, albeit more enhanced under the RCP8.5 scenario. The agreement between the projections under four ESMs forcings indicate that the distributional shifts are very likely to occur. Quantitatively, these estimations have considerable uncertainty due to coarse spatial resolution and model sensitivities to biases in environmental variables.

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 on an ocean–basin scale. In particular, larger proportions of the catch of each tuna species are increasingly expected to be made in international waters (Bell et al. 2021).

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5 Tables

Table 1. Catch (in metric tonnes) of the four target tuna species (skipjack, yellowfin, bigeye and South Pacific albacore) by gear for the WCPFC-CA, 1960–2023. Note: Data for 2023 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	9,482	0	57,703	398,739
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	29,030	268	87,209	520,785
1973	166,399	330,841	36,269	484	103,281	637,274
1974	145,192	370,499	29,547	898	109,578	655,714
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	53,492	621	136,322	754,105
1978	212,059	407,482	52,041	1,686	131,084	804,352
1979	211,221	344,799	90,103	814	124,684	771,621
1980	230,625	398,498	116,755	1,489	89,969	837,336
1981	191,732	348,917	158,559	2,118	107,884	809,210
1982	179,575	316,457	255,491	2,552	107,990	862,065
1983	175,498	342,287	442,152	946	109,381	1,070,264
1984	162,111	415,016	462,277	3,124	118,478	1,161,006
1985	177,722	287,892	409,536	3,465	136,815	1,015,430
1986	169,129	360,864	474,838	2,270	146,887	1,153,988
1987	179,966	294,879	543,980	2,323	131,876	1,153,024
1988	200,774	327,997	608,996	4,649	151,215	1,293,631
1989	170,876	311,981	664,660	8,646	165,205	1,321,368
1990	188,842	247,104	795,530	7,181	203,546	1,442,203
1991	160,889	290,006	1,006,764	7,969	203,164	1,668,792
1992	199,688	259,762	975,738	6,786	163,594	1,605,568
1993	195,377	293,014	846,114	4,438	145,436	1,484,379
1994	221,367	262,721	971,563	7,411	162,932	1,625,994
1995	217,417	298,301	927,491	23,490	168,157	1,634,856
1996	215,466	301,279	896,443	17,708	208,131	1,639,027
1997	226,375	298,666	959,218	18,637	178,294	1,681,190
1998	251,197	323,645	1,257,392	19,004	213,874	2,065,112
1999	219,024	338,480	1,068,956	13,381	211,995	1,851,836
2000	248,474	319,854	1,143,294	25,750	235,765	1,973,137
2001	264,340	272,483	1,118,917	17,234	212,029	1,885,003
2002	281,627	286,202	1,265,452	16,026	222,616	2,071,923
2003	261,636	303,905	1,265,758	19,777	251,042	2,102,118
2004	284,849	322,179	1,354,239	23,347	290,764	2,275,378
2005	250,698	266,735	1,484,881	13,173	228,682	2,244,169
2006	255,653	257,594	1,524,791	9,985	255,759	2,303,782
2007	245,130	284,661	1,691,082	9,120	304,655	2,534,648
2008	247,755	269,551	1,737,348	11,707	312,938	2,579,299
2009	280,374	264,350	1,800,944	9,850	277,334	2,632,852
2010	278,577	270,123	1,707,563	11,284	260,046	2,527,593

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Table 1. *(continued)*

Year	Longline	Pole-and-line	Purse-seine	Troll	Other	Total
2011	261,756	275,070	1,575,357	9,144	242,160	2,363,487
2012	275,053	242,960	1,851,274	10,659	302,350	2,682,296
2013	242,833	229,560	1,934,752	9,202	313,341	2,729,688
2014	264,682	206,939	2,079,879	6,348	348,113	2,905,961
2015	270,007	214,041	1,772,737	7,261	396,971	2,661,017
2016	240,729	198,398	1,862,822	6,677	411,945	2,720,571
2017	246,325	171,570	1,833,284	7,529	332,224	2,590,932
2018	257,247	232,216	1,910,337	7,016	413,140	2,819,956
2019	267,784	186,021	2,100,135	8,812	411,562	2,974,314
2020	211,933	228,506	1,885,310	9,441	399,821	2,735,011
2021	205,424	200,086	1,834,206	9,968	419,579	2,669,263
2022	230,038	154,241	1,876,558	9,540	387,351	2,657,728
2023	227,646	111,670	1,837,030	6,925	440,695	2,623,966

Table 2. Catch (in metric tonnes) by species for the four main tuna species taken in the WCPFC-CA, 1960–2023. Note: Data for 2023 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	36,750	204,829	68,939	399,821
1968	64,213	30,427	194,990	81,944	371,574
1969	72,106	36,032	203,329	87,272	398,739
1970	74,350	41,702	242,366	98,989	457,407
1971	100,737	44,142	228,722	104,966	478,567
1972	109,655	57,163	238,082	115,885	520,785
1973	131,149	48,889	329,050	128,186	637,274
1974	115,162	52,758	356,557	131,237	655,714
1975	84,651	69,314	288,468	141,279	583,712
1976	132,947	83,110	356,862	153,098	726,017
1977	83,171	84,055	401,708	185,171	754,105
1978	111,161	66,964	448,039	178,188	804,352
1979	86,007	74,557	408,847	202,210	771,621
1980	95,156	73,355	448,633	220,192	837,336
1981	88,095	66,352	426,215	228,548	809,210
1982	89,496	76,730	459,614	236,225	862,065
1983	65,988	82,856	629,453	291,967	1,070,264
1984	74,540	89,648	703,988	292,830	1,161,006
1985	77,060	90,508	547,717	300,145	1,015,430
1986	71,757	97,580	690,369	294,282	1,153,988
1987	63,645	113,979	638,743	336,657	1,153,024
1988	67,948	110,236	789,843	325,604	1,293,631
1989	73,533	110,967	749,978	386,890	1,321,368
1990	63,872	134,376	809,942	434,013	1,442,203
1991	58,322	119,886	1,025,148	465,436	1,668,792
1992	74,452	143,145	928,151	459,820	1,605,568
1993	77,496	121,643	864,459	420,781	1,484,379
1994	96,461	135,473	939,534	454,526	1,625,994
1995	91,750	119,681	977,514	445,911	1,634,856
1996	91,140	115,273	1,003,276	429,338	1,639,027
1997	112,900	141,099	943,070	484,121	1,681,190
1998	112,465	161,641	1,248,763	542,243	2,065,112
1999	131,066	170,450	1,072,197	478,123	1,851,836
2000	101,672	160,442	1,197,535	513,488	1,973,137
2001	121,561	147,535	1,104,396	511,511	1,885,003
2002	148,051	169,452	1,257,444	496,976	2,071,923
2003	123,239	157,258	1,250,353	571,268	2,102,118
2004	122,399	195,052	1,357,372	600,555	2,275,378
2005	105,371	163,189	1,418,111	557,498	2,244,169
2006	105,257	171,132	1,481,612	545,781	2,303,782
2007	126,857	170,448	1,665,759	571,584	2,534,648
2008	105,109	178,622	1,647,814	647,754	2,579,299
2009	135,622	174,660	1,760,249	562,321	2,632,852
2010	129,223	148,261	1,679,879	570,230	2,527,593
2011	115,766	176,070	1,534,529	537,122	2,363,487
2012	143,792	177,326	1,733,338	627,840	2,682,296
2013	138,396	167,323	1,840,855	583,114	2,729,688

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Table 2. *(continued)*

Year	Albacore	Bigeye	Skipjack	Yellowfin	Total
2014	121,719	176,901	1,985,679	621,662	2,905,961
2015	116,364	155,008	1,792,612	597,033	2,661,017
2016	101,268	162,635	1,790,256	666,412	2,720,571
2017	126,541	138,473	1,610,457	715,461	2,590,932
2018	110,893	161,871	1,844,530	702,662	2,819,956
2019	104,393	136,676	2,044,779	688,466	2,974,314
2020	127,303	153,886	1,721,880	731,942	2,735,011
2021	90,013	139,610	1,685,309	754,331	2,669,263
2022	93,115	147,448	1,719,189	697,976	2,657,728
2023	96,353	146,181	1,635,659	745,773	2,623,966

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, 1960–2022. Note: For vessels, the abbreviations are: DPI: domestic (Pacific Island); DNPI: domestic (non-Pacific Island); DWFN: distant-water fishing nation. For longline effort, the abbreviation Mhks refers to millions of hooks. Effort totals exclude the following: Japan coastal, Indonesia, Philippines and Vietnam domestic purse-seine vessels; Vietnam and Indonesia domestic longline vessels; Japanese coastal and Indonesian domestic vessels for pole-and-line. Longline effort data prior to 1970 is deemed unreliable and, therefore, have been removed; the same is true of pole-and-line data prior to 1972.The table begins at 1960 solely to maintain consistency with the years present in the catch tables.

	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	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	8	13	0	0	0	0	0	0	0	0
1968	0	0	51	77	0	0	0	0	0	0	0	0
1969	0	4	17	22	0	0	0	0	0	0	0	0
1970	0	6	99	120	0	1,743	1,658	342.1	0	0	0	0
1971	0	6	1,939	2,654	0	1,794	1,684	378.9	0	0	0	0
1972	0	7	2,465	3,433	0	1,862	1,609	342.2	554	56	0	54,754
1973	0	6	2,657	3,591	2	2,232	1,650	364.8	650	66	0	65,381
1974	0	10	1,942	2,337	0	1,986	1,786	407.4	716	82	0	66,810
1975	0	12	2,197	2,629	0	2,147	1,763	354.2	696	81	0	66,314
1976	0	18	2,534	3,159	2	2,174	1,847	367.9	653	89	9	74,787
1977	0	15	2,253	2,721	2	2,125	1,821	363.7	662	100	20	88,567
1978	0	19	2,491	2,994	2	2,358	1,871	360.5	645	100	14	83,754
1979	0	27	3,639	4,463	2	2,505	1,868	471.0	625	98	10	79,590
1980	1	33	3,798	4,961	2	2,743	1,913	498.1	572	160	9	79,191
1981	1	42	7,763	8,115	2	2,645	1,871	461.8	548	168	18	80,060
1982	1	73	11,770	11,560	3	2,641	1,592	409.1	475	108	23	68,126
1983	8	118	18,993	16,062	4	2,527	1,437	351.3	434	91	16	58,692
1984	6	120	25,08	21,471	5	2,563	1,445	376.4	396	98	8	59,279
1985	6	110	20,819	18,418	6	2,844	1,437	386.8	356	98	0	53,866
1986	5	113	20,805	18,160	3	2,732	1,445	332.0	330	97	5	51,413
1987	5	116	24,329	19,823	4	3,100	1,415	363.7	314	112	5	48,305
1988	8	132	24,261	19,441	5	2,774	1,393	441.7	277	102	18	42,862
1989	5	152	27,110	22,115	9	2,557	1,405	401.0	269	105	15	43,480
1990	13	176	30,060	23,081	16	2,132	1,410	391.9	255	166	20	42,075
1991	15	184	37,134	31,075	27	1,820	1,455	384.6	242	154	19	32,256
1992	17	193	40,825	30,618	59	3,032	1,396	506.2	216	163	13	32,447
1993	15	183	42,751	31,219	113	3,186	1,570	393.9	203	138	19	32,113
1994	22	176	38,072	29,233	158	3,285	1,687	444.9	185	137	23	31,233
1995	21	163	36,967	28,486	217	3,057	1,624	461.8	174	145	33	31,229
1996	20	158	37,723	29,951	259	2,726	1,428	385.8	165	139	33	29,449
1997	31	158	39,336	30,687	349	3,262	1,231	377.6	163	108	26	33,060
1998	32	164	36,517	31,736	415	3,077	1,223	453.2	163	102	16	33,995
1999	40	164	38,520	27,260	405	3,063	1,151	513.9	163	103	16	33,600
2000	52	174	37,727	30,707	422	3,113	1,089	515.6	160	83	15	28,622
2001	46	161	37,906	30,339	490	3,358	1,118	592.1	155	75	11	25,809
2002	55	158	41,598	33,256	463	3,380	1,149	675.2	151	70	11	27,327
2003	59	152	44,017	33,639	482	2,165	1,139	718.9	144	69	9	22,759
2004	78	147	47,191	35,280	476	2,062	910	712.2	127	67	9	22,122
2005	86	142	48,946	40,347	475	2,124	763	650.0	128	60	11	22,122
2006	76	148	44,976	36,188	433	2,182	639	640.6	113	65	6	18,424

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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
2007	83	162	48,145	39,349	458	1,959	518	716.0	106	58	5	18,413
2008	80	175	52,246	44,750	432	1,773	604	733.8	98	50	3	16,887
2009	80	187	52,811	47,059	401	1,734	589	764.6	96	48	6	16,002
2010	87	196	55,045	54,311	509	1,751	632	774.8	95	50	2	16,150
2011	94	191	65,860	60,737	608	1,873	660	819.9	91	56	2	14,835
2012	100	191	61,516	64,763	540	1,806	645	887.6	87	54	1	15,286
2013	104	199	62,395	64,759	380	1,884	744	725.1	80	49	2	13,786
2014	109	204	60,244	64,872	540	1,849	656	738.0	80	47	0	11,361
2015	118	195	49,193	55,331	538	1,976	705	767.6	76	47	0	12,817
2016	138	160	50,191	53,374	373	1,936	701	691.8	76	45	0	14,464
2017	136	152	53,399	57,178	547	1,638	633	731.7	80	46	0	13,307
2018	132	145	50,326	57,189	609	1,402	631	741.1	70	40	0	13,980
2019	138	148	47,896	58,676	454	1,174	619	799.5	67	37	0	13,177
2020	141	131	50,671	54,462	414	1,147	608	702.7	60	34	1	11,802
2021	146	119	48,846	52,594	387	1,200	596	633.4	65	34	1	11,156
2022	140	111	48,063	54,173	360	1,118	627	632.4	62	34	1	10,209
2023	145	114	47,623	52,245	376	1.223	628	602.4	61	26	0	6,918

Table 4. Skipjack tuna catch (in metric tonnes) by gear type for the WCPFC-CA, 1960–2023. Note: Data for 2023 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	10,929	0	24,930	204,829
1968	83	162,379	7,599	0	24,929	194,990
1969	130	168,084	5,045	0	30,070	203,329
1970	1,608	197,873	7,670	0	35,215	242,366
1971	1,475	180,945	13,873	0	32,429	228,722
1972	1,544	172,827	18,343	0	45,368	238,082
1973	1,861	253,217	19,537	0	54,435	329,050
1974	2,124	289,202	11,209	0	54,022	356,557
1975	1,919	218,271	13,259	0	55,019	288,468
1976	2,096	276,582	22,077	0	56,107	356,862
1977	3,127	294,641	32,700	0	71,240	401,708
1978	3,233	331,401	32,176	0	81,229	448,039
1979	2,179	285,859	54,667	0	66,142	408,847
1980	632	333,597	76,108	12	38,284	448,633
1981	756	296,065	85,153	17	44,224	426,215
1982	972	264,726	145,814	64	48,038	459,614
1983	2,144	298,928	278,721	154	49,506	629,453
1984	870	366,811	287,899	284	48,124	703,988
1985	1,108	238,932	253,771	146	53,760	547,717
1986	1,439	322,665	301,300	211	64,754	690,369
1987	2,329	252,142	325,570	154	58,548	638,743
1988	1,937	295,325	434,004	286	58,291	789,843
1989	2,507	275,088	413,702	229	58,452	749,978
1990	363	211,573	503,247	158	94,601	809,942
1991	885	259,778	672,760	126	91,599	1,025,148
1992	432	218,765	617,897	125	90,932	928,151
1993	573	255,152	530,677	105	77,952	864,459
1994	379	209,636	652,327	187	77,005	939,534
1995	598	247,744	638,531	12,244	78,397	977,514
1996	3,935	242,486	651,106	6,456	99,293	1,003,276
1997	4,070	236,999	606,523	9,164	86,314	943,070
1998	5,030	266,772	866,959	8,262	101,740	1,248,763
1999	4,208	255,330	706,421	5,606	100,632	1,072,197
2000	4,559	264,407	797,991	14,951	115,627	1,197,535
2001	5,059	212,668	774,718	7,482	104,469	1,104,396
2002	3,450	207,488	932,334	6,737	107,435	1,257,444
2003	3,824	238,179	882,074	9,665	116,611	1,250,353
2004	4,051	249,936	950,066	15,062	138,257	1,357,372
2005	1,084	216,715	1,054,924	6,235	139,153	1,418,111
2006	1,528	208,731	1,109,716	3,920	157,717	1,481,612
2007	1,175	213,010	1,257,359	3,521	190,694	1,665,759
2008	803	218,570	1,225,679	4,553	198,209	1,647,814
2009	1,220	201,323	1,383,392	4,227	170,087	1,760,249
2010	1,192	223,409	1,291,770	4,685	158,823	1,679,879
2011	1,124	206,843	1,172,705	2,188	151,669	1,534,529
2012	2,004	170,538	1,372,607	3,885	184,304	1,733,338
2013	1,254	169,025	1,475,711	3,058	191,807	1,840,855

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Table 4. *(continued)*

Year	Longline	Pole-and-line	Purse-seine	Troll	Other	Total
2014	1,879	148,684	1,616,536	1,338	217,242	1,985,679
2015	1,879	151,317	1,393,137	1,647	244,632	1,792,612
2016	5,642	156,603	1,376,372	1,645	249,994	1,790,256
2017	2,571	123,466	1,263,312	2,014	219,094	1,610,457
2018	4,162	183,935	1,450,201	1,712	204,520	1,844,530
2019	5,593	158,225	1,703,032	1,901	176,028	2,044,779
2020	2,312	159,440	1,406,884	1,315	151,929	1,721,880
2021	2,847	165,480	1,366,956	2,690	147,336	1,685,309
2022	2,575	130,233	1,441,816	2,532	142,033	1,719,189
2023	2,631	89,026	1,358,582	2,564	182,856	1,635,659

Table 5. Yellowfin tuna catch (in metric tonnes) by gear type for the WCPFC-CA, 1960–2023. Note: Data for 2023 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	3,428	0	26,303	68,939
1968	46,070	2,706	7,083	0	26,085	81,944
1969	51,627	5,166	3,867	0	26,612	87,272
1970	55,806	4,606	7,644	0	30,933	98,989
1971	57,766	5,248	9,058	0	32,894	104,966
1972	61,175	7,465	9,739	0	37,506	115,885
1973	62,291	7,458	14,609	0	43,828	128,186
1974	58,116	6,582	17,098	0	49,441	131,237
1975	69,462	7,801	12,987	0	51,029	141,279
1976	77,570	17,186	15,576	0	42,766	153,098
1977	94,414	15,257	17,430	0	58,070	185,171
1978	110,202	12,767	15,818	0	39,401	178,188
1979	108,910	11,638	32,097	0	49,565	202,210
1980	125,113	15,142	36,502	9	43,426	220,192
1981	97,114	22,044	61,398	16	47,976	228,548
1982	86,149	17,123	90,099	54	42,800	236,225
1983	90,259	17,184	136,317	48	48,159	291,967
1984	76,988	17,633	143,930	67	54,212	292,830
1985	79,973	22,717	134,057	66	63,332	300,145
1986	68,999	17,970	141,884	56	65,373	294,282
1987	75,407	19,044	182,212	35	59,959	336,657
1988	88,855	20,566	144,529	67	71,587	325,604
1989	73,306	22,133	215,964	47	75,440	386,890
1990	79,300	20,769	247,028	48	86,868	434,013
1991	63,512	19,182	285,775	38	96,929	465,436
1992	77,739	23,043	296,814	83	62,141	459,820
1993	72,055	20,486	267,646	37	60,557	420,781
1994	82,184	21,378	273,986	60	76,918	454,526
1995	88,306	23,209	250,865	2,529	81,002	445,911
1996	91,887	30,551	205,833	2,595	98,472	429,338
1997	81,065	22,845	293,618	2,797	83,796	484,121
1998	81,077	27,506	328,241	2,765	102,654	542,243
1999	71,023	26,787	275,091	3,121	102,101	478,123
2000	96,908	26,957	276,615	3,302	109,706	513,488
2001	95,569	24,443	289,725	3,675	98,099	511,511
2002	95,644	24,133	268,839	3,129	105,231	496,976
2003	95,712	24,304	325,493	3,059	122,700	571,268
2004	104,066	30,640	323,660	2,664	139,525	600,555
2005	87,417	27,007	357,404	2,455	83,215	557,498
2006	85,016	23,653	343,373	2,561	91,178	545,781
2007	82,516	26,570	353,104	2,802	106,592	571,584
2008	84,200	22,705	431,280	2,889	106,680	647,754
2009	99,373	23,918	334,629	3,005	101,396	562,321
2010	98,523	20,112	351,274	3,595	96,726	570,230
2011	97,778	36,838	315,175	2,999	84,332	537,122
2012	87,666	34,705	398,145	2,926	104,398	627,840
2013	77,346	21,924	372,649	2,348	108,847	583,114

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Table 5. *(continued)*

Year	Longline	Pole-and-line	Purse-seine	Troll	Other	Total
2014	100,375	24,082	379,904	2,104	115,197	621,662
2015	104,375	35,719	317,558	2,572	136,809	597,033
2016	91,870	23,387	408,705	2,551	139,899	666,412
2017	86,227	24,935	500,506	2,443	101,350	715,461
2018	97,727	26,225	379,664	2,421	196,625	702,662
2019	104,426	17,706	343,875	2,712	219,747	688,466
2020	74,191	30,622	399,044	2,503	225,582	731,942
2021	75,528	20,997	404,498	2,687	250,621	754,331
2022	88,448	17,676	369,916	2,710	219,226	697,976
2023	83,876	16,169	420,523	2,657	222,548	745,773

Table 6. Bigeye tuna catch (in metric tonnes) by gear type for the WCPFC-CA, 1960–2023. Note: Data for 2023 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	62	0	253	36,750
1968	27,757	2,272	194	0	204	30,427
1969	32,571	3,350	49	0	62	36,032
1970	34,965	3,178	591	0	2,968	41,702
1971	38,359	1,862	678	0	3,243	44,142
1972	51,040	1,762	671	0	3,690	57,163
1973	42,412	1,258	770	0	4,449	48,889
1974	45,653	1,039	1,079	0	4,987	52,758
1975	61,488	1,334	1,280	0	5,212	69,314
1976	73,325	3,423	2,008	0	4,354	83,110
1977	72,083	3,325	2,693	0	5,954	84,055
1978	56,364	3,337	2,932	0	4,331	66,964
1979	63,837	2,540	3,214	0	4,966	74,557
1980	62,537	2,916	3,816	0	4,086	73,355
1981	46,590	3,382	11,756	0	4,624	66,352
1982	48,578	4,993	19,017	0	4,142	76,730
1983	46,311	5,077	26,764	0	4,704	82,856
1984	52,976	4,557	27,068	0	5,047	89,648
1985	58,629	5,529	20,175	0	6,175	90,508
1986	56,989	4,133	30,112	0	6,346	97,580
1987	68,832	4,602	34,993	0	5,552	113,979
1988	68,288	5,890	29,255	0	6,803	110,236
1989	64,916	6,131	32,473	0	7,447	110,967
1990	77,009	5,985	43,260	0	8,122	134,376
1991	61,033	3,929	45,577	0	9,347	119,886
1992	75,966	4,055	56,923	0	6,201	143,145
1993	66,566	4,505	44,902	0	5,670	121,643
1994	79,175	5,251	43,224	0	7,823	135,473
1995	68,125	6,228	36,918	145	8,265	119,681
1996	58,054	7,940	38,923	432	9,924	115,273
1997	68,597	6,563	58,009	412	7,518	141,099
1998	85,048	6,405	60,638	507	9,043	161,641
1999	74,959	5,856	80,572	316	8,747	170,450
2000	76,924	6,838	66,280	397	10,003	160,442
2001	78,690	5,905	53,500	408	9,032	147,535
2002	92,381	6,109	60,976	712	9,274	169,452
2003	83,016	5,296	57,564	142	11,240	157,258
2004	99,709	9,238	73,313	232	12,560	195,052
2005	78,892	6,851	71,703	220	5,523	163,189
2006	83,592	9,781	71,338	157	6,264	171,132
2007	81,113	7,296	74,937	187	6,915	170,448
2008	83,428	9,204	79,564	212	6,214	178,622
2009	80,507	7,916	80,846	174	5,217	174,660
2010	72,721	7,027	64,189	275	4,049	148,261
2011	77,567	5,655	86,997	251	5,600	176,070
2012	83,971	3,934	76,329	273	12,819	177,326
2013	65,637	5,009	84,404	266	12,007	167,323

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Table 6. *(continued)*

Year	Longline	Pole-and-line	Purse-seine	Troll	Other	Total
2014	75,434	4,714	81,430	303	15,020	176,901
2015	73,397	5,687	60,970	199	14,755	155,008
2016	63,077	3,933	74,056	174	21,395	162,635
2017	58,126	2,264	66,810	157	11,116	138,473
2018	68,911	4,165	77,448	108	11,239	161,871
2019	68,237	1,514	52,081	146	14,698	136,676
2020	57,686	1,773	73,040	88	21,299	153,886
2021	54,640	2,123	62,191	94	20,562	139,610
2022	55,289	2,039	64,645	92	25,383	147,448
2023	54,190	2,230	57,030	84	32,647	146,181

Table 7. Albacore tuna catch (in metric tonnes) by gear type for the WCPFC-CA (including the overlap region with the IATTC-CA), south of the equator, 1960–2023. Note: Data for 2023 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	39	24,342
1984	18,541	0	0	2,773	1,589	22,903
1985	23,413	0	0	3,253	1,937	28,603
1986	28,765	0	0	2,003	1,946	32,714
1987	19,750	0	0	2,134	930	22,814
1988	27,617	0	0	4,061	5,283	36,961
1989	17,887	0	0	8,135	21,968	47,990
1990	17,671	245	0	6,740	7,538	32,194
1991	20,303	14	0	7,570	1,489	29,376
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	3,431	137	57,497
2006	55,923	23	0	2,749	188	58,883
2007	52,847	17	0	1,987	60	54,911
2008	54,200	12	0	3,502	160	57,874
2009	72,813	21	0	2,031	211	75,076
2010	78,643	14	0	2,139	190	80,986
2011	55,275	21	0	3,189	233	58,718
2012	71,814	26	0	2,962	248	75,050
2013	72,091	26	0	3,226	248	75,591

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Table 7. *(continued)*

Year	Longline	Pole-and-line	Purse-seine	Troll	Other	Total
2014	61,494	26	0	2,403	248	64,171
2015	62,089	24	0	2,602	263	64,978
2016	58,512	33	10	2,158	333	61,046
2017	75,671	12	10	2,418	199	78,310
2018	65,386	16	17	2,685	380	68,484
2019	67,403	43	2	3,507	263	71,218
2020	59,684	27	4	4,732	331	64,778
2021	44,598	21	7	4,068	342	49,036
2022	65,542	17	1	3,777	270	69,607
2023	64,461	17	0	1,192	664	66,334

Table 8. Albacore tuna catch (in metric tonnes) by gear type for the for the WCPFC-CA (excluding the overlap region with the IATTC-CA), south of the equator, 1960–2023. Note: Data for 2023 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	16,387	0	0	0	0	16,387
1964	13,023	0	0	0	0	13,023
1965	18,046	0	0	0	0	18,046
1966	31,682	0	0	0	0	31,682
1967	31,873	0	0	5	0	31,878
1968	24,498	0	0	14	0	24,512
1969	23,055	0	0	0	0	23,055
1970	30,431	100	0	50	0	30,581
1971	29,504	100	0	0	0	29,604
1972	30,121	100	0	268	0	30,489
1973	43,123	100	0	484	0	43,707
1974	23,944	100	0	898	0	24,942
1975	17,711	100	0	646	0	18,457
1976	26,697	100	0	25	0	26,822
1977	29,244	100	0	621	0	29,965
1978	24,554	100	0	1,686	0	26,340
1979	23,051	100	0	814	0	23,965
1980	28,039	100	0	1,468	0	29,607
1981	28,555	0	0	2,085	5	30,645
1982	24,850	0	0	2,434	6	27,290
1983	21,683	0	0	744	39	22,466
1984	17,453	0	0	2,773	1,589	21,815
1985	22,387	0	0	3,253	1,937	27,577
1986	28,053	0	0	2,003	1,946	32,002
1987	16,730	0	0	2,134	930	19,794
1988	22,183	0	0	3,826	5,283	31,292
1989	14,538	0	0	7,900	21,968	44,406
1990	15,023	245	0	6,505	7,538	29,311
1991	18,665	14	0	7,335	1,489	27,503
1992	16,335	11	0	6,108	65	22,519
1993	21,696	62	0	3,826	70	25,654
1994	27,143	65	0	6,694	89	33,991
1995	24,372	139	0	7,246	104	31,861
1996	22,171	30	0	7,138	156	29,495
1997	28,596	9	0	4,381	133	33,119
1998	36,914	9	0	5,946	85	42,954
1999	26,042	38	0	2,941	74	29,095
2000	31,665	80	0	5,753	139	37,637
2001	48,593	19	0	4,841	199	53,652
2002	57,778	7	0	4,373	150	62,308
2003	40,659	5	0	5,984	130	46,778
2004	44,298	1	0	4,488	116	48,903
2005	51,914	11	0	3,359	129	55,413
2006	53,881	4	0	2,614	188	56,687
2007	48,312	17	0	1,977	60	50,366
2008	50,247	0	0	3,502	0	53,749
2009	68,317	0	0	2,031	0	70,348
2010	69,940	0	0	2,139	0	72,079
2011	47,608	0	0	3,189	0	50,797
2012	64,909	0	0	2,962	0	67,871
2013	62,564	0	0	3,226	0	65,790

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Table 8. *(continued)*

Year	**Longline**	**Pole-and-line**	**Purse-seine**	**Troll**	**Other**	**Total**
2014	53,156	0	0	2,403	0	55,559
2015	52,832	0	0	2,602	0	55,434
2016	45,363	0	10	2,158	0	47,531
2017	66,528	0	10	2,363	0	68,901
2018	57,439	0	17	2,685	161	60,302
2019	57,893	3	2	3,507	103	61,508
2020	51,540	18	4	4,732	250	56,544
2021	34,010	2	7	4,068	142	38,229
2022	57,249	2	1	3,777	120	61,149
2023	51,103	1	0	1,192	505	52,801

Table 9. Albacore tuna catch (in metric tonnes) by gear type for the overlap region between the WCPFC-CA and IATTC-CA, south of the equator, 1960–2023. Note: Data for 2023 are preliminary.

Year	Longline	Pole-and-line	Purse-seine	Troll	Other	Total
1960	0	0	0	0	0	0
1961	0	0	0	0	0	0
1962	0	0	0	0	0	0
1963	440	0	0	0	0	440
1964	35	0	0	0	0	35
1965	11	0	0	0	0	11
1966	104	0	0	0	0	104
1967	3,419	0	0	0	0	3,419
1968	2,834	0	0	0	0	2,834
1969	969	0	0	0	0	969
1970	2,854	0	0	0	0	2,854
1971	4,612	0	0	0	0	4,612
1972	2,958	0	0	0	0	2,958
1973	1,611	0	0	0	0	1,611
1974	2,335	0	0	0	0	2,335
1975	787	0	0	0	0	787
1976	1,327	0	0	0	0	1,327
1977	3,735	0	0	0	0	3,735
1978	5,390	0	0	0	0	5,390
1979	1,129	0	0	0	0	1,129
1980	1,033	0	0	0	0	1,033
1981	1,710	0	0	0	0	1,710
1982	2,649	0	0	0	0	2,649
1983	1,876	0	0	0	0	1,876
1984	1,088	0	0	0	0	1,088
1985	1,026	0	0	0	0	1,026
1986	712	0	0	0	0	712
1987	3,020	0	0	0	0	3,020
1988	5,434	0	0	235	0	5,669
1989	3,349	0	0	235	0	3,584
1990	2,648	0	0	235	0	2,883
1991	1,638	0	0	235	0	1,873
1992	11,734	0	0	235	0	11,969
1993	5,533	0	0	235	0	5,768
1994	4,530	0	0	235	0	4,765
1995	1,664	0	0	235	0	1,899
1996	2,130	0	0	136	0	2,266
1997	2,853	0	0	149	0	3,002
1998	4,818	0	0	167	0	4,985
1999	2,746	0	0	253	0	2,999
2000	2,775	0	0	351	0	3,126
2001	5,425	0	0	206	0	5,631
2002	5,820	0	0	144	0	5,964
2003	11,439	0	0	0	0	11,439
2004	5,662	5	0	63	7	5,737
2005	2,003	1	0	72	8	2,084
2006	2,042	19	0	135	0	2,196
2007	4,535	0	0	10	0	4,545
2008	3,953	12	0	0	160	4,125
2009	4,496	21	0	0	211	4,728
2010	8,703	14	0	0	190	8,907
2011	7,667	21	0	0	233	7,921
2012	6,905	26	0	0	248	7,179
2013	9,527	26	0	0	248	9,801

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Table 9. *(continued)*

Year	Longline	Pole-and-line	Purse-seine	Troll	Other	Total
2014	8,338	26	0	0	248	8,612
2015	9,257	24	0	0	263	9,544
2016	13,149	33	0	0	333	13,515
2017	9,143	12	0	55	199	9,409
2018	7,947	16	0	0	219	8,182
2019	9,510	40	0	0	160	9,710
2020	8,144	9	0	0	81	8,234
2021	10,588	19	0	0	200	10,807
2022	8,293	15	0	0	150	8,458
2023	13,358	16	0	0	159	13,533

Table 10. Albacore tuna catch (in metric tonnes) by gear type south of the equator, 1960–2023. Note: Data for 2023 are preliminary.

Year	Longline	Pole-and-line	Purse-seine	Troll	Other	Total
1960	22,248	45	0	0	0	22,293
1961	23,742	0	0	0	0	23,742
1962	35,219	0	0	0	0	35,219
1963	31,095	16	0	0	0	31,111
1964	22,824	0	0	0	0	22,824
1965	25,455	0	0	0	0	25,455
1966	38,661	0	0	0	0	38,661
1967	43,952	0	0	5	0	43,957
1968	32,368	0	0	14	0	32,382
1969	24,805	0	0	0	0	24,805
1970	34,775	100	0	50	0	34,925
1971	38,530	100	0	0	0	38,630
1972	39,131	122	0	268	0	39,521
1973	46,705	141	0	484	0	47,330
1974	33,039	112	0	898	0	34,049
1975	22,849	105	0	646	0	23,600
1976	28,957	100	0	25	0	29,082
1977	38,019	100	0	621	0	38,740
1978	32,890	100	0	1,686	0	34,676
1979	26,162	100	0	814	0	27,076
1980	30,972	101	0	1,468	0	32,541
1981	32,694	0	0	2,085	5	34,784
1982	28,347	1	0	2,434	6	30,788
1983	24,309	0	0	744	39	25,092
1984	20,340	2	0	2,773	1,589	24,704
1985	27,138	0	0	3,253	1,937	32,328
1986	32,641	0	0	2,003	1,946	36,590
1987	21,979	9	0	2,134	930	25,052
1988	28,288	0	0	4,296	5,283	37,867
1989	18,738	0	0	8,370	21,968	49,076
1990	21,304	245	0	6,975	7,538	36,062
1991	26,292	14	0	7,805	1,489	35,600
1992	32,014	11	0	6,578	65	38,668
1993	30,998	74	0	4,296	70	35,438
1994	34,998	67	0	7,164	89	42,318
1995	30,508	139	0	7,716	104	38,467
1996	26,763	30	0	7,410	156	34,359
1997	34,802	21	0	4,679	133	39,635
1998	44,333	36	0	6,280	85	50,734
1999	37,124	138	0	3,447	74	40,783
2000	43,508	102	0	6,455	139	50,204
2001	60,201	37	0	5,253	199	65,690
2002	73,148	18	0	4,661	150	77,977
2003	59,364	12	0	5,984	130	65,490
2004	60,830	110	0	4,614	123	65,677
2005	63,347	29	0	3,503	137	67,016
2006	64,540	29	0	2,884	188	67,641
2007	58,108	17	0	2,014	60	60,199
2008	59,903	12	0	3,502	160	63,577
2009	82,425	21	0	2,031	211	84,688
2010	89,813	14	0	2,139	190	92,156
2011	63,416	30	0	3,190	233	66,869
2012	84,486	41	0	2,962	248	87,737
2013	84,482	26	0	3,226	248	87,982

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Table 10. *(continued)*

Year	Longline	Pole-and-line	Purse-seine	Troll	Other	Total
2014	80,144	26	0	2,403	248	82,821
2015	80,720	24	0	2,602	263	83,609
2016	73,237	40	0	2,158	333	75,768
2017	91,868	14	0	2,418	199	94,499
2018	80,271	16	0	2,685	380	83,352
2019	76,602	68	0	3,507	263	80,440
2020	69,236	32	0	4,733	331	74,332
2021	67,454	350	0	4,068	342	72,214
2022	87,666	65	0	3,777	270	91,778
2023	66,382	17	0	1,192	664	68,255

Table 11. Albacore tuna catch (in metric tonnes) by gear type for the WCPFC-CA, north of the equator, 1960–2023. Note: Data for 2023 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	4,179	64,522
1981	17,007	27,426	252	0	11,071	55,756
1982	16,377	29,615	561	0	13,117	59,670
1983	13,225	21,098	350	0	7,206	41,879
1984	12,737	26,015	3,380	0	10,022	52,154
1985	14,599	20,714	1,533	0	12,187	49,033
1986	12,937	16,096	1,542	0	9,194	39,769
1987	13,649	19,091	1,205	0	10,218	44,163
1988	14,077	6,216	1,208	235	17,656	39,392
1989	12,260	8,629	2,521	235	17,276	40,921
1990	14,499	8,532	1,995	235	24,034	49,295
1991	15,156	7,103	2,652	235	8,050	33,196
1992	17,482	13,888	4,104	235	12,392	48,101
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	534	76,780
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	289	60,908
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	360	65,021
2004	27,063	32,359	7,200	838	299	67,759
2005	29,388	16,150	850	743	654	47,785
2006	29,596	15,406	364	596	412	46,374
2007	27,480	37,768	5,682	549	394	71,873
2008	25,124	19,060	825	550	1,675	47,234
2009	26,462	31,172	2,076	413	423	60,546
2010	27,498	19,561	330	590	258	48,237
2011	30,013	25,713	480	448	326	56,980
2012	29,598	33,757	4,193	613	581	68,742
2013	26,505	33,576	1,988	304	432	62,805

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Table 11. *(continued)*

Year	Longline	Pole-and-line	Purse-seine	Troll	Other	Total
2014	25,500	29,433	2,009	200	406	57,548
2015	28,267	21,294	1,072	241	512	51,386
2016	21,627	14,442	3,679	149	324	40,221
2017	23,730	20,893	2,646	497	465	48,231
2018	21,062	17,875	3,001	90	341	42,369
2019	22,124	8,533	1,143	545	826	33,171
2020	18,039	36,644	6,335	803	680	62,501
2021	27,747	11,465	554	460	718	40,944
2022	17,750	4,276	180	429	439	23,074
2023	23,887	4,228	744	428	2,008	31,295

Table 12. Biological reference points (BRPs) and stock status from the latest stock assessments (assessment year shown in parentheses) for South Pacific albacore, bigeye, skipjack and yellowfin tunas. Note: Biomass is in metric tonnes. SB_{recent} is the average spawning biomass over the last four years of the assessment; $SB_{F=0}$ is the average spawning biomass (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 from one year prior to the last year of the assessment) fishing mortality to that which will support the MSY; No. of models in the grid indicates the number of models that were included in the assessment uncertainty grid that was approved by the Scientific Committee. Values represent the medians, or weighted medians, where relevant, across the model grids.

BRP	**Albacore (2021)**	**Bigeye (2023)**	**Skipjack (2022)**	**Yellowfin (2023)**
SB_{recent}	341,308	672,600	3,978,300	2,633,535
$SB_{F=0}$	711,059	1,921,715	7,616,930	5,603,267
MSY	101,100	164,640	2,648,400	700,400
F_{recent}/F_{MSY}	0.18	0.59	0.32	0.5
$SB_{recent}/SB_{F=0}$	0.48	0.35	0.51	0.47
No. models in grid	100	54	18	54

Table 13. Total numbers of albacore, 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. Also, as releases and recoveries occur independently and fish move from where they were tagged, it is possible for the number recovered of a species in a particular EEZ to exceed the number released in that EEZ. With respect to the abbreviations, SSAP: Skipjack Survey and Assessment Programme (1977-1981), RTTP: Regional Tuna Tagging Programme (1989-1992), PTTP: Pacific Tuna Tagging Programme (2006-2023).

	PTTP		**RTTP**		**SSAP**	
EEZ	**Releases**	**Recoveries**	**Releases**	**Recoveries**	**Releases**	**Recoveries**
FJ	0	6	5,197	528	28,980	2,659
FM	33,824	3,255	11,711	1,779	8,791	330
ID	40,418	5,053	13,740	2,653		37
IW	32,815	4,014				
KI	53,521	5,348	14,754	851	5,212	449
NZ	2,863	8		2	15,020	1,000
PF	0	1		1	29,693	128
PG	218,466	29,241	44,502	3,677	9,079	1,077
PW	14,369	214	7,495	142	8,663	114
SB	95,220	19,175	15,226	2,372	7,870	597
Other	5,555	3,352	39,042	6,925	48,976	1,077
TOTAL	497,051	69,667	151,667	18,930	162,284	7,468

Table 14. PTTP tagging totals for the four target tuna species.

	Releases				**Recoveries**			
EEZ	**Albacore**	**Bigeye**	**Skipjack**	**Yellowfin**	**Albacore**	**Bigeye**	**Skipjack**	**Yellowfin**
FJ	0	0	0	0	3	0	1	2
FM	0	1,552	25,367	6,905	0	253	2,519	483
ID	0	506	31,548	8,364	3	67	4,295	688
IW	0	25,865	2,023	4,927	3	2,122	1,468	421
KI	0	32,167	13,028	8,326	0	2,865	1,783	700
NZ	2,863	0	0	0	6	0	2	0
PF	0	0	0	0	1	0	0	0
PG	0	4,488	151,629	62,349	3	764	20,355	8,119
PW	0	45	11,509	2,815	0	1	185	28
SB	0	581	69,952	24,687	2	92	15,339	3,742
Other	14	1,286	3,303	952	3	1,875	1,041	433
TOTAL	2,877	66,490	308,359	119,325	24	8,039	46,988	14,616

EEZ abbreviations: FJ: Fiji, FM: Federated States of Micronesia, ID: Indonesia, IW: International Waters (high seas), KI: Kiribati, NZ: New Zealand, PF: French Polynesia, PG: Papua New Guinea, PW: Palau, SB: Solomon Islands, Other: Pacific Island countries and territories with low numbers of releases and/or recoveries.

6 Figures

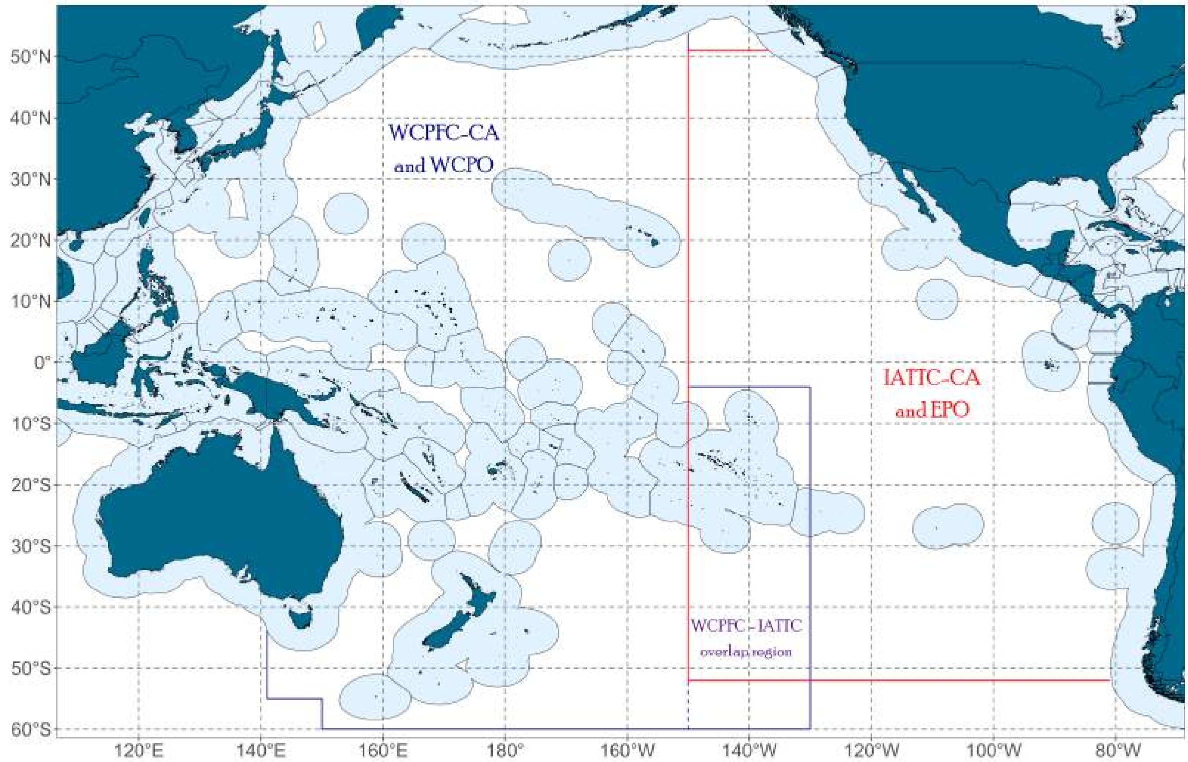


Figure 1. Important national and regional management zones in the Pacific. The WCPFC-CA is outlined in dark blue, the IATTC-CA area is outlined in red. The western and central Pacific Ocean (WCPO) includes all of the WCPFC-CA, minus the overlap with the IATTC-CA; the eastern Pacific Ocean (EPO) is coincident with the IATTC-CA. The EEZs of Pacific Island countries and territories are shaded light blue and high seas areas are white.

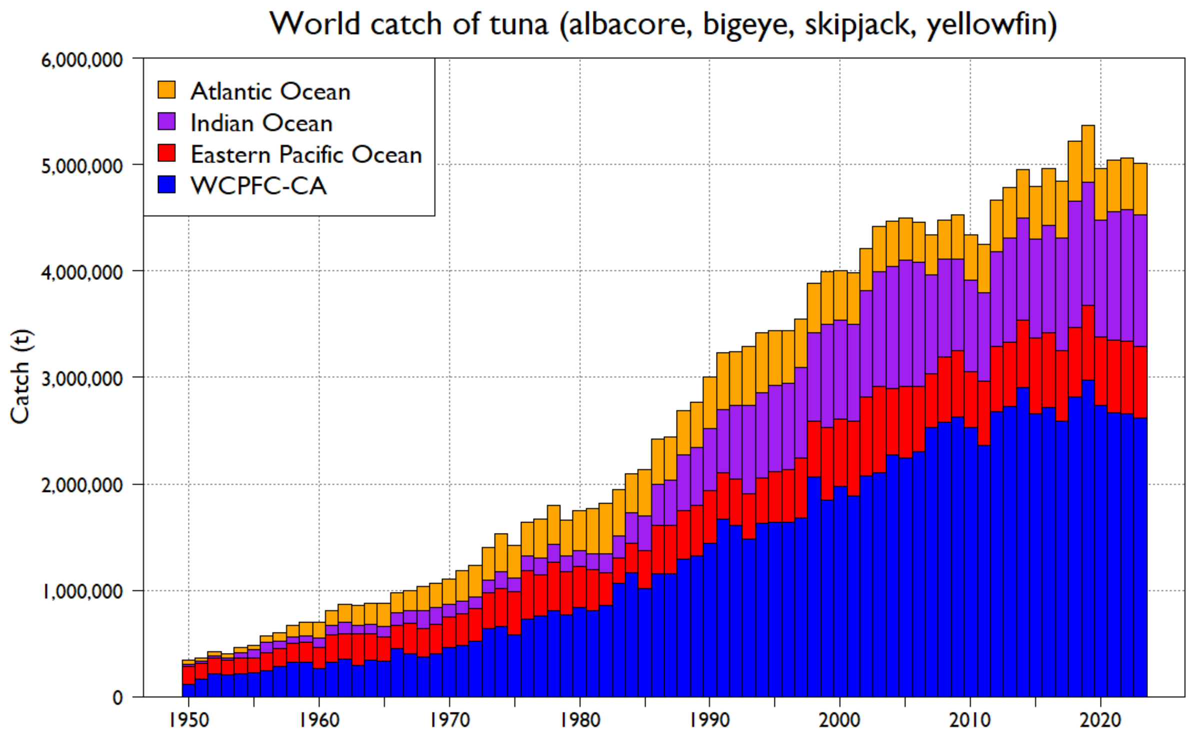


Figure 2. World catch of target tuna (albacore, bigeye, skipjack, yellowfin), 1950–2023. The WCPFC-CA total includes catch in the overlap region with the IATTC; therefore, the eastern Pacific Ocean total does not include that catch. Data for 2023 is provisional for all areas.

Total WCPFC-CA target tuna catch plots

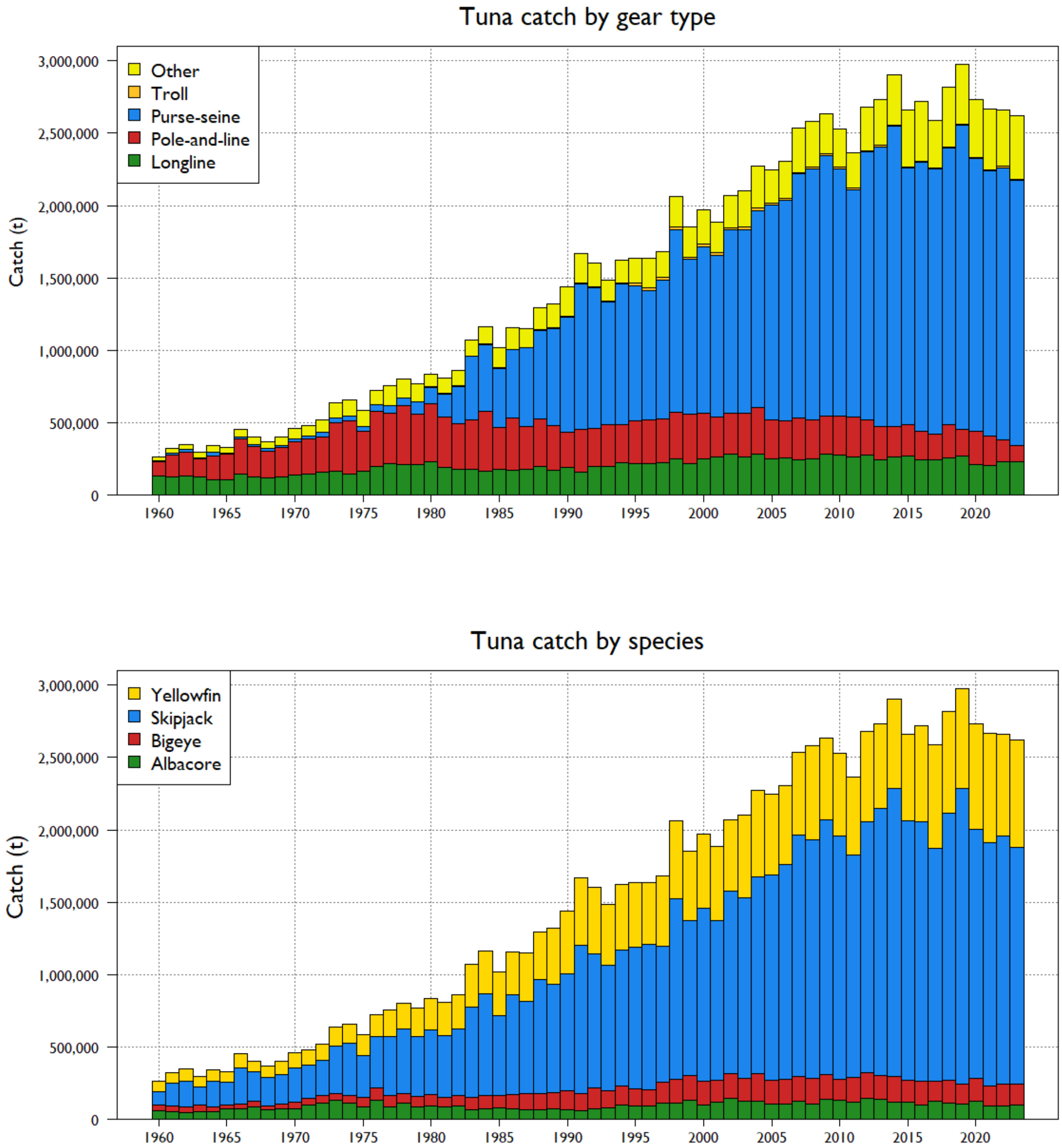
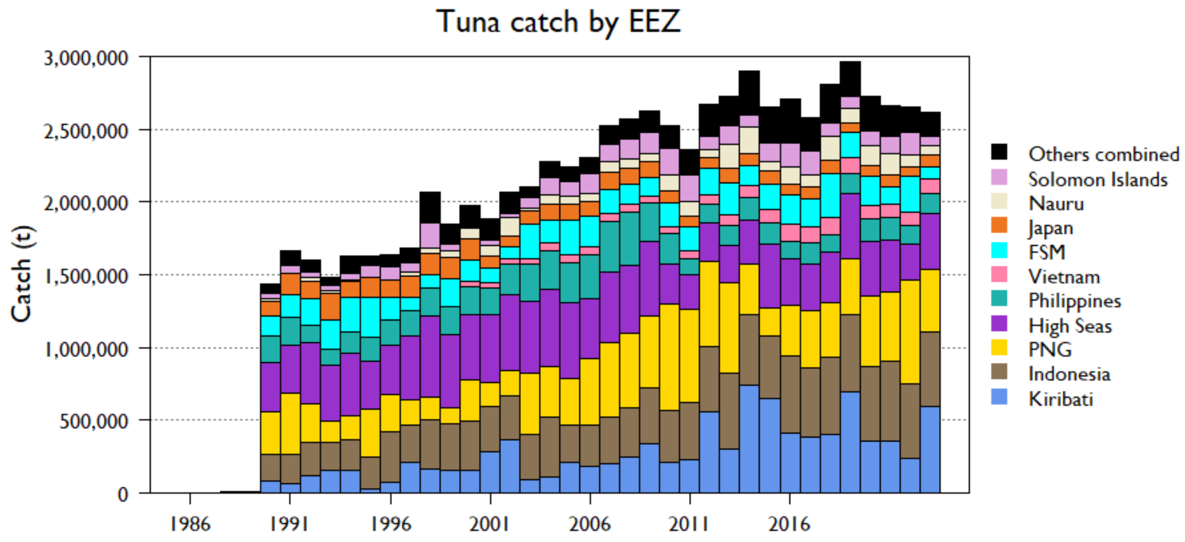


Figure 3. Catch (in metric tonnes) by gear type (top) and species (bottom) for the western and central Pacific region, 1960–2023. Note: data for 2023 are preliminary.

Total WCPFC-CA target tuna catch plots, cont.



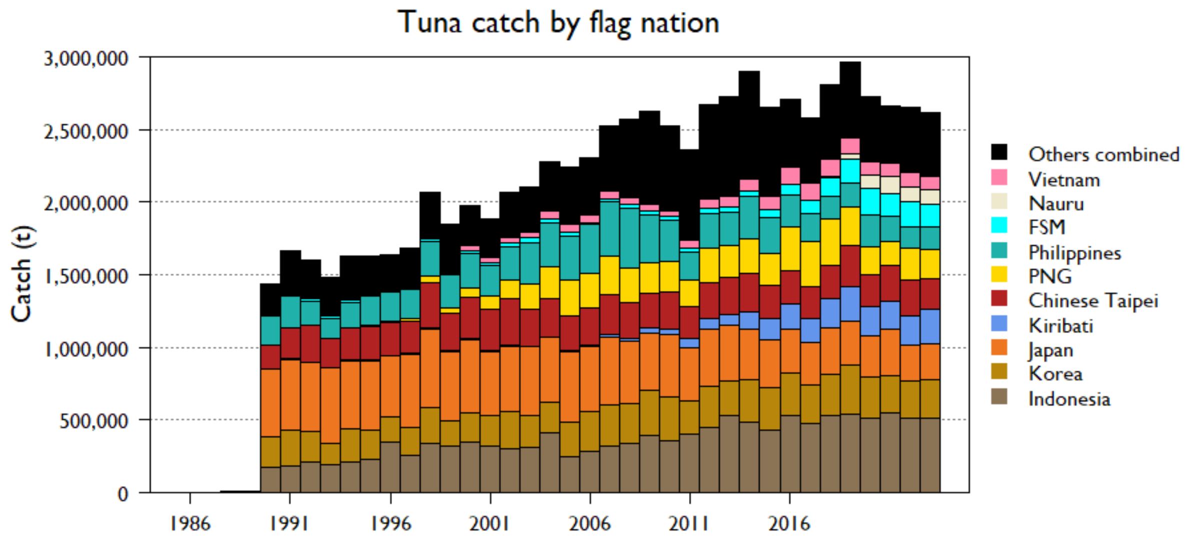


Figure 4. Catch (in metric tonnes) by EEZ (top) and flag (bottom) for the western and central Pacific region, 1990–2023. Note: The top 10 individual EEZs or flags are shown, as determined by total target tuna catch in 2023.

Purse-seine catch and effort plots

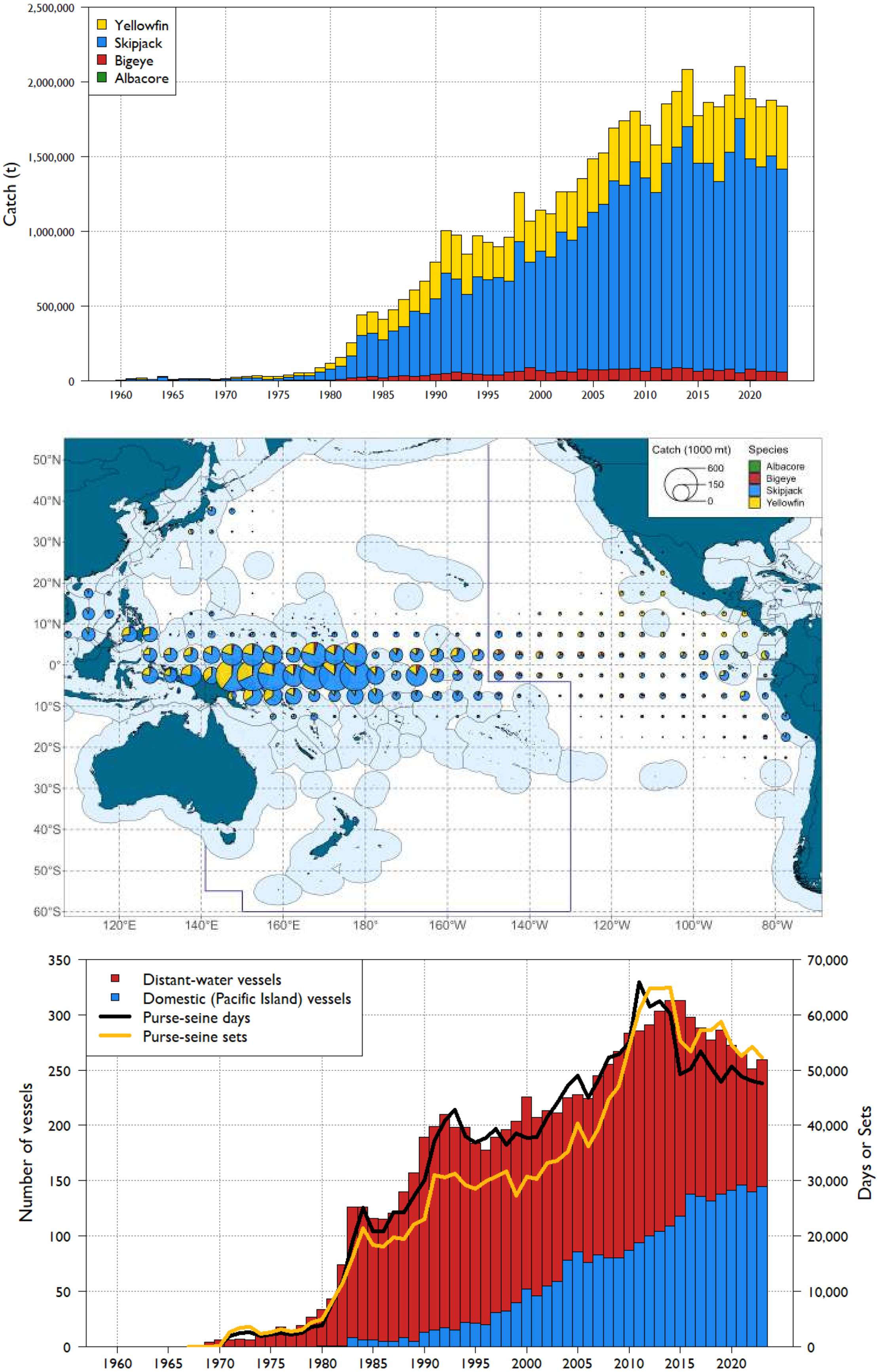


Figure 5. Time series of catch (top), recent (2019–2023) spatial distribution of catch (middle), and indices of fishing effort, in fleet sizes and number of sets and days (bottom), for the purse-seine fishery in the WCPO. Note: Effort totals exclude Japan coastal, Indonesia, the Philippines and Vietnam domestic purse-seine vessels.

Longline catch and effort plots

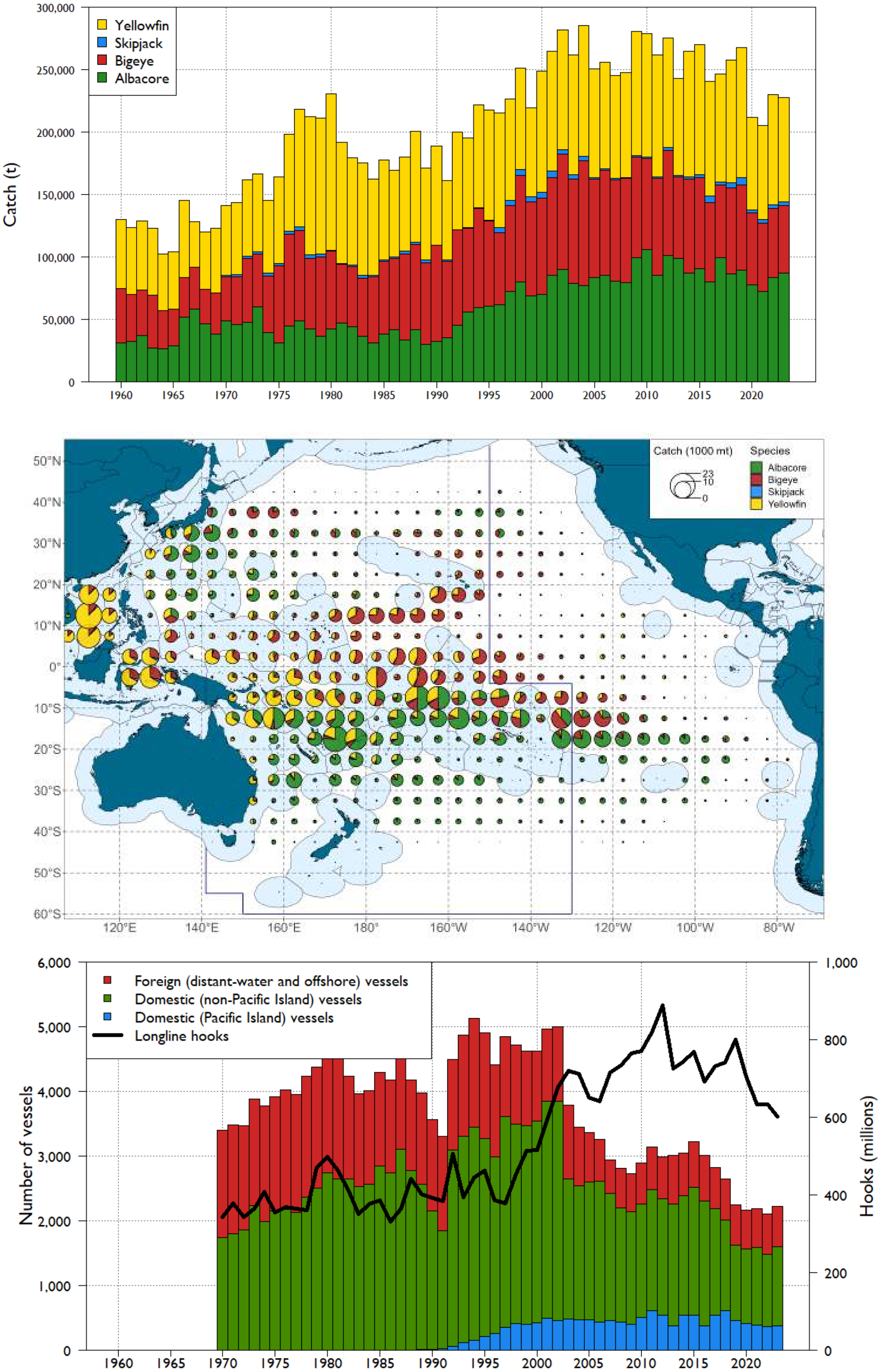


Figure 6. Time series of catch (top), recent (2019–2023) spatial distribution of catch (middle), and indices of fishing effort, in fleet sizes and number of hooks fished (bottom), for the longline fishery in the WCPFC-CA. Note: vessel numbers and hook estimates are considered unreliable prior to 1970.

Pole-and-line catch and effort plots

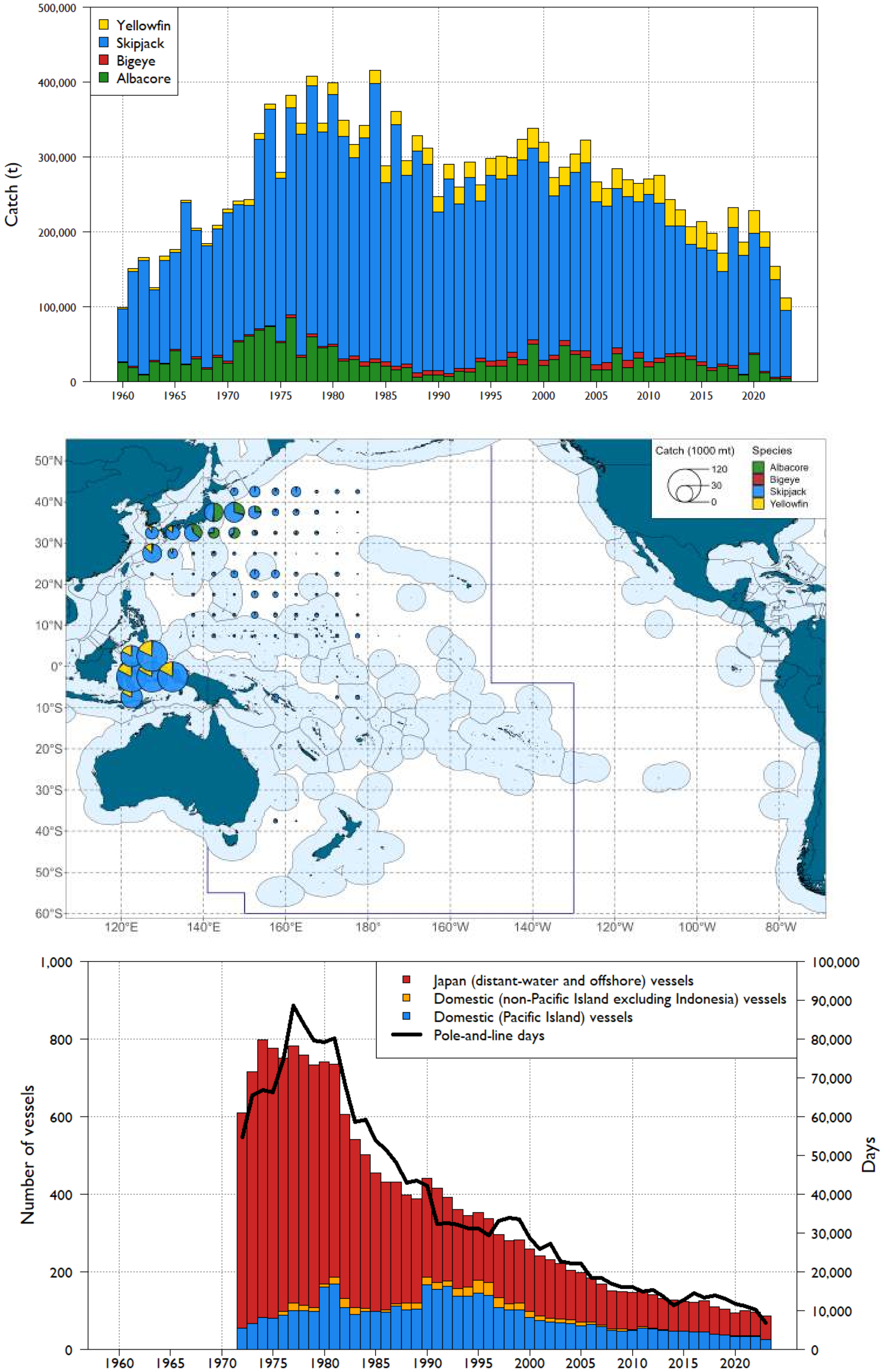


Figure 7. Time series of catch (top), recent (2019–2023) spatial distribution of catch (middle), and indices of fishing effort in fleet sizes and number of days (bottom), for the pole-and-line fishery in the WCPFC-CA. Note: vessel numbers and fishing days are not available prior to 1972.

Skipjack catch data

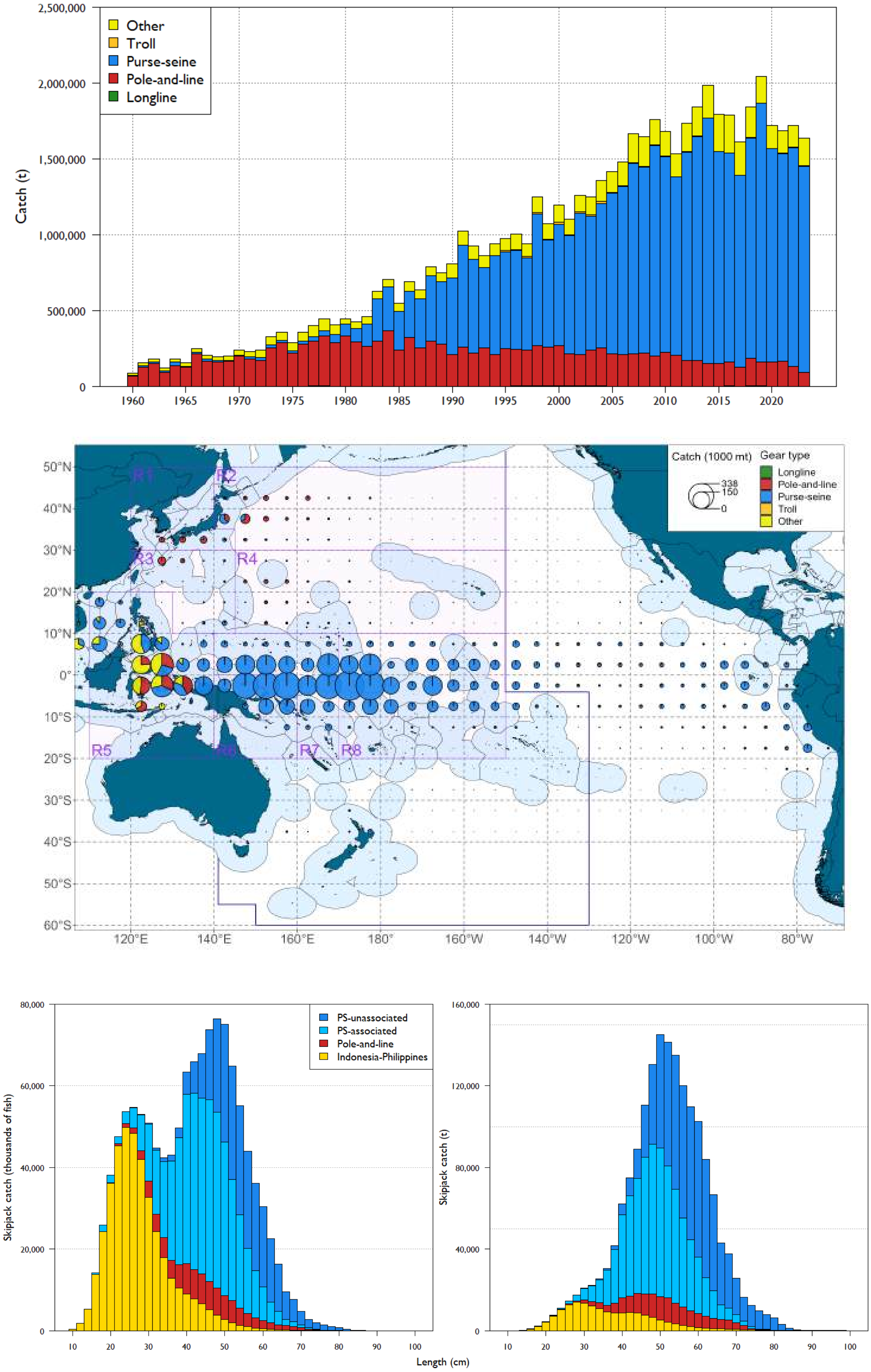


Figure 8. Time series (top), recent (2019–2023) spatial distribution and assessment regions outlined in purple (middle), and size composition (average for last five years, bottom) of skipjack tuna catch by gear type for the WCPFC-CA.

Skipjack stock status plots

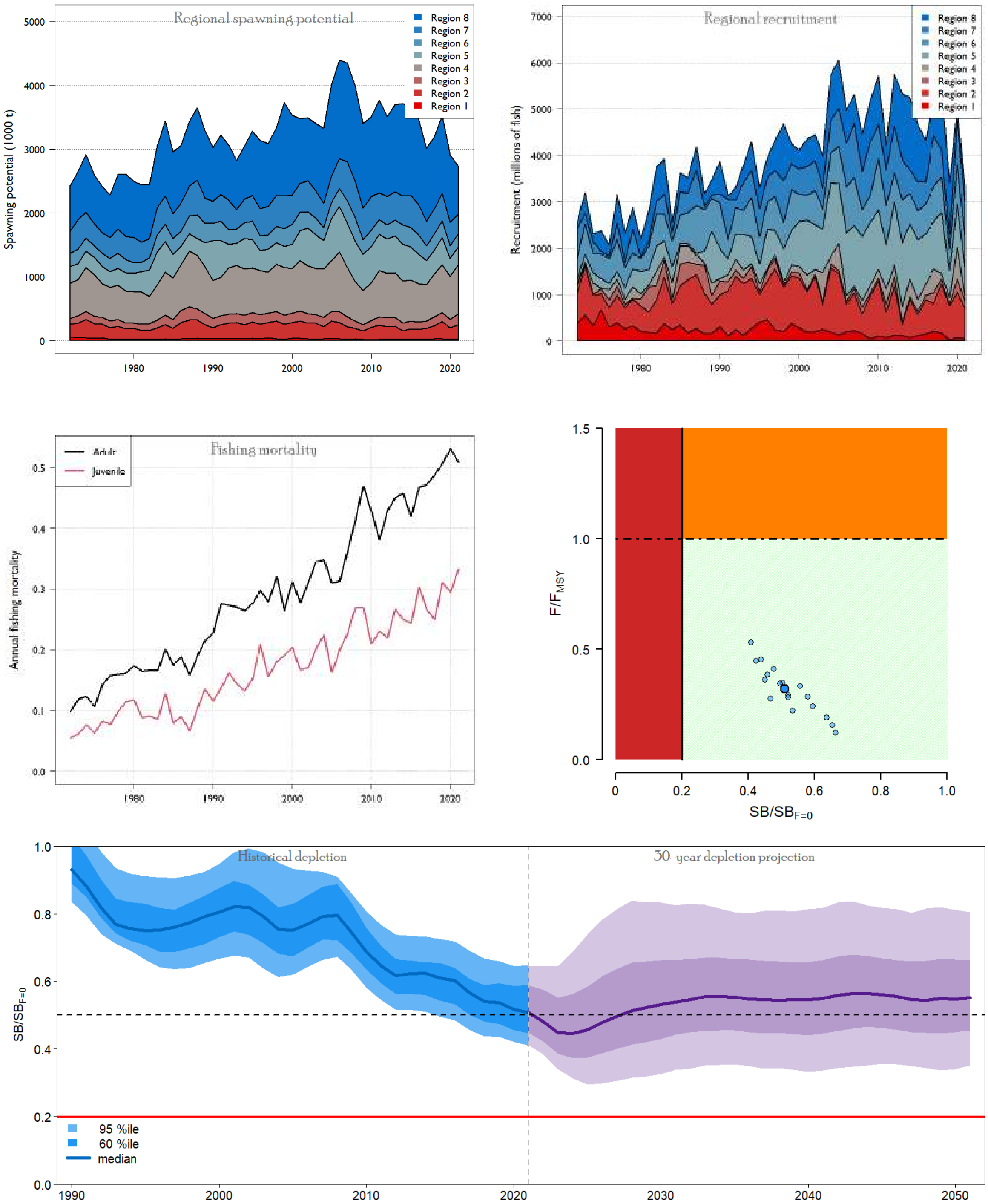


Figure 9. Estimated spawning biomass (SB) time series by model region (top left), recruitment by model region (top right), and fishing mortality for adults and juveniles (middle left) from the skipjack diagnostic case model; stock status displayed on a Majuro plot as the end points (recent values) from the uncertainty grid of 18 models (middle right) with the median value illustrated by the large blue point. Estimated historical depletion since 1990 (from the stock assessment) and projected 30-year depletion under status quo conditions (2023 catch/effort levels) are shown in the bottom plot. The vertical line represents the final year of data in the most recent assessment and, thus, marks the transition to projection estimates. All depletion estimates (historical and projected) are computed in the same manner as $SB_{recent}/SB_{F=0}$. Spawning biomass in the absence of fishing is computed as a 10-year average lagged by one year relative to each of the three years used in the "recent" SB calculation. The red horizontal line is the LRP (at 0.2 $SB_{recent}/SB_{F=0}$). The dashed horizontal line (at 0.5 $SB_{recent}/SB_{F=0}$) is the interim TRP objective described in the skipjack MP CMM 2022-01.

Yellowfin catch data

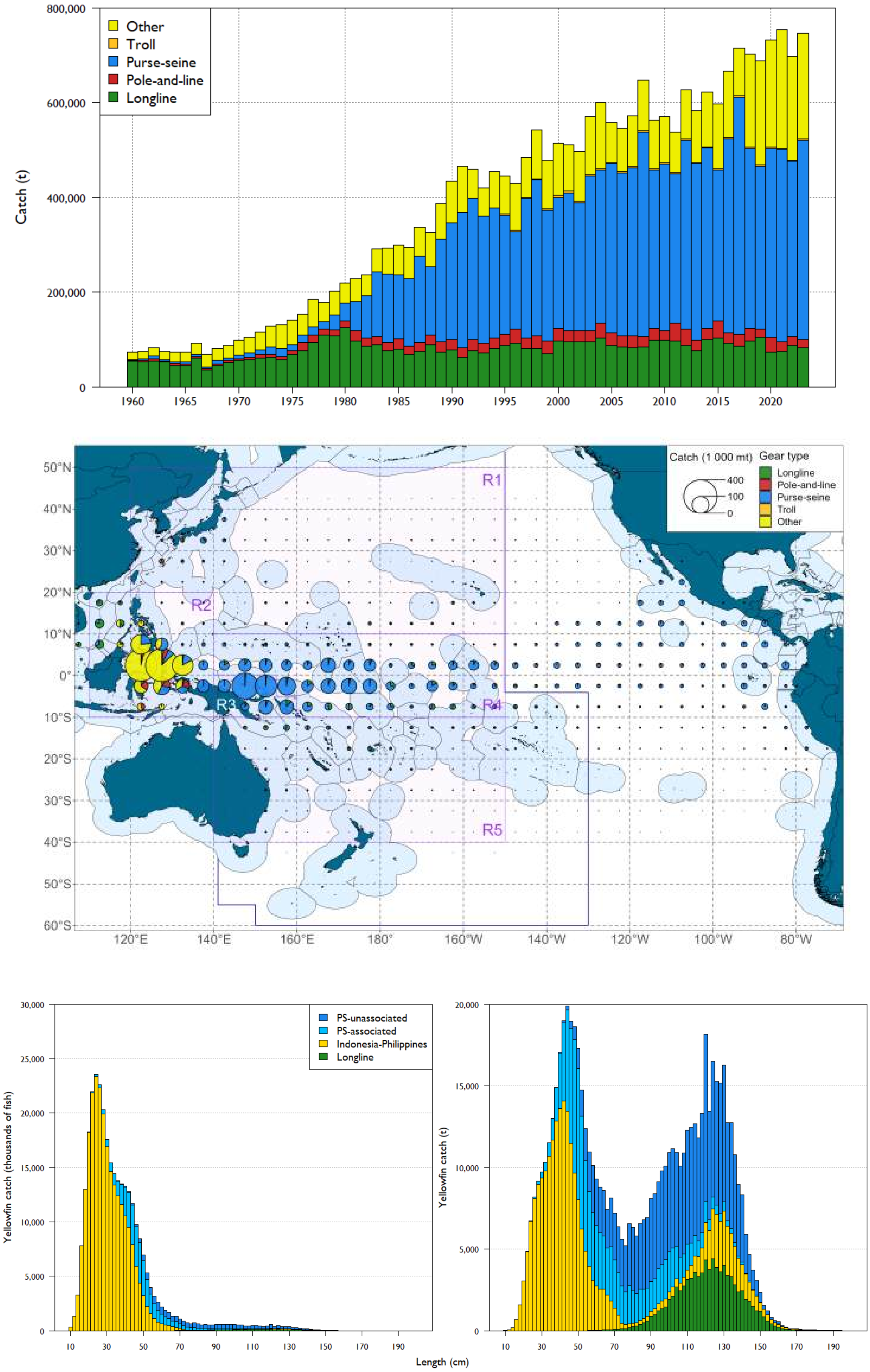


Figure 10. Time series (top), recent (2019–2023) spatial distribution and assessment regions (middle), and size composition (average for last five years, bottom) of yellowfin tuna catch by gear type for the WCPFC-CA.

Yellowfin stock status plots

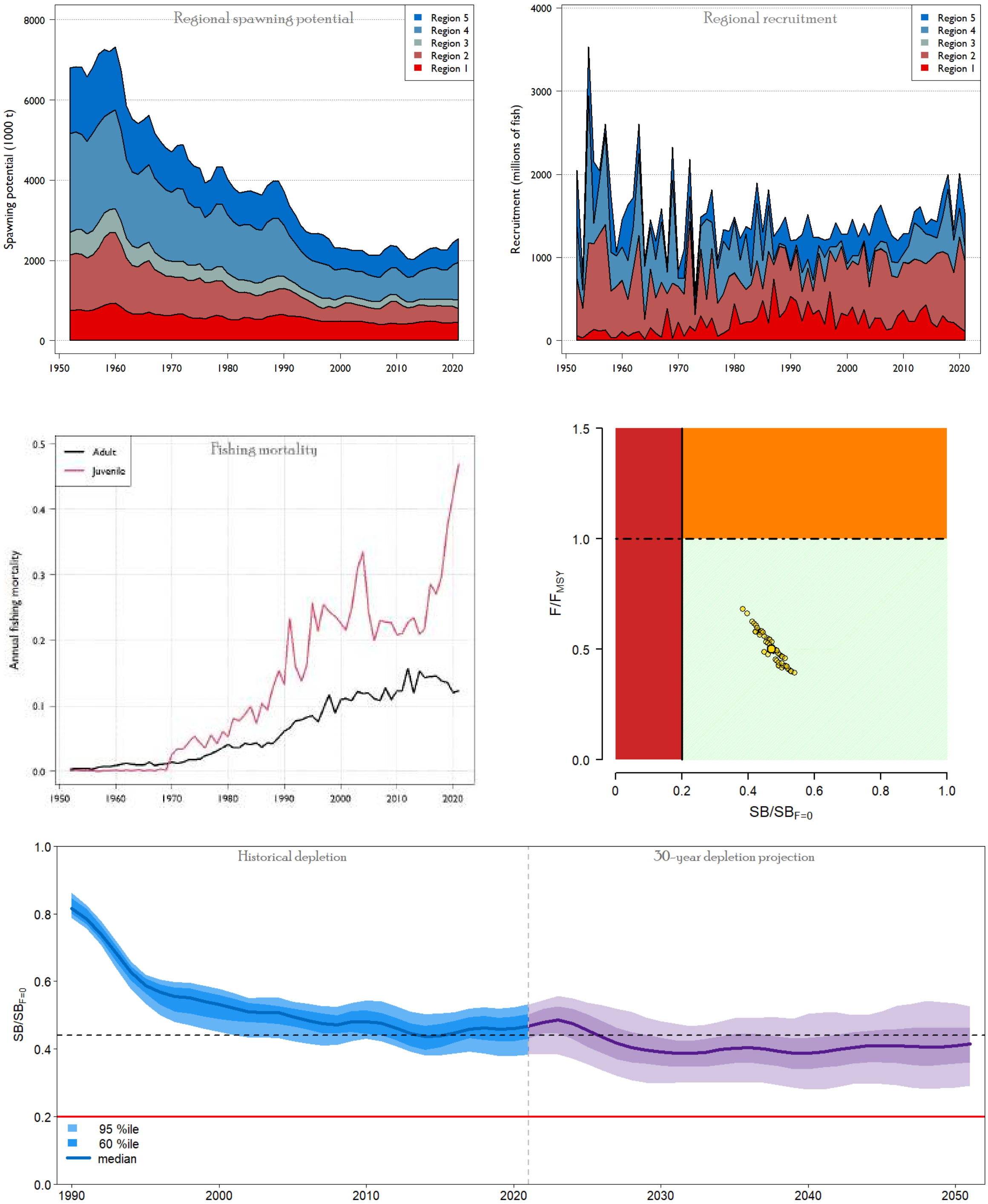


Figure 11. Estimated spawning biomass (SB) time series by model region (top left), recruitment by model region (top right), and fishing mortality for adults and juveniles (middle left) from the yellowfin diagnostic case model; stock status displayed on a Majuro Plot as the end points (recent values) from the uncertainty grid of 72 models (middle right) with the median value illustrated by the large yellow point. Estimated historical depletion since 1990 (from the stock assessment) and projected 30-year depletion under status quo conditions (2023 catch/effort levels) are shown in the bottom plot. The vertical line represents the final year of data in the most recent assessment and, thus, marks the transition to projection estimates. All depletion estimates (historical and projected) are computed in the same manner as $SB_{recent}/SB_{F=0}$. Spawning biomass in the absence of fishing is computed as a 10-year average lagged by one year relative to each of the three years used in the "recent" SB calculation. The red horizontal line is the LRP (at 0.2 $SB_{recent}/SB_{F=0}$). The dashed horizontal line represents the latest estimate of the average depletion ratio (at 0.44 $SB_{recent}/SB_{F=0}$) over the period 2012–2015, which is listed as the interim depletion objective in Tropical Tuna CMM 2023-01.

Bigeye catch data

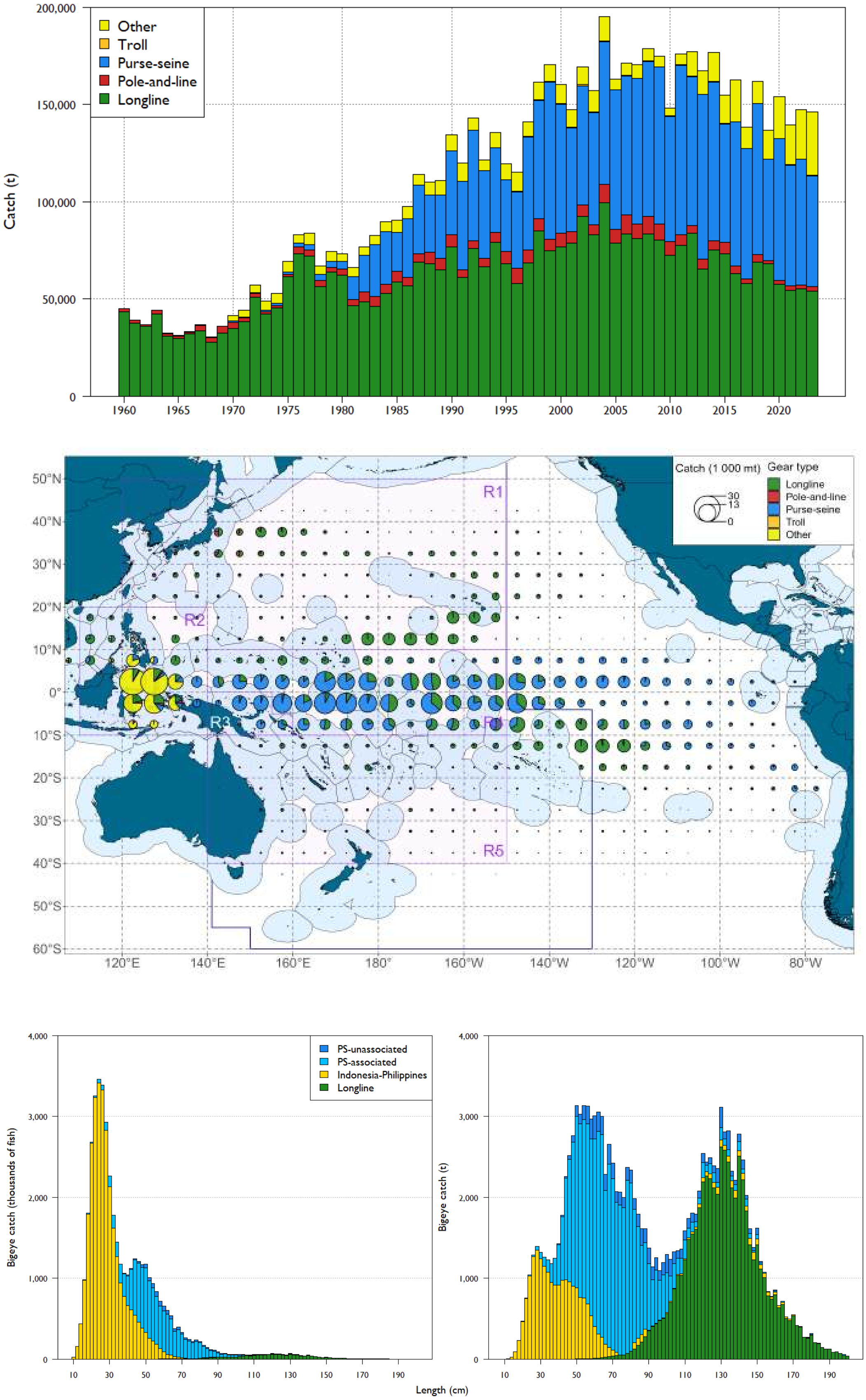


Figure 12. Time series (top), recent (2018–2022) spatial distribution and assessment regions (middle), and size composition (average for last five years, bottom) of bigeye tuna catch by gear for the WCPFC-CA.

Bigeye stock status plots

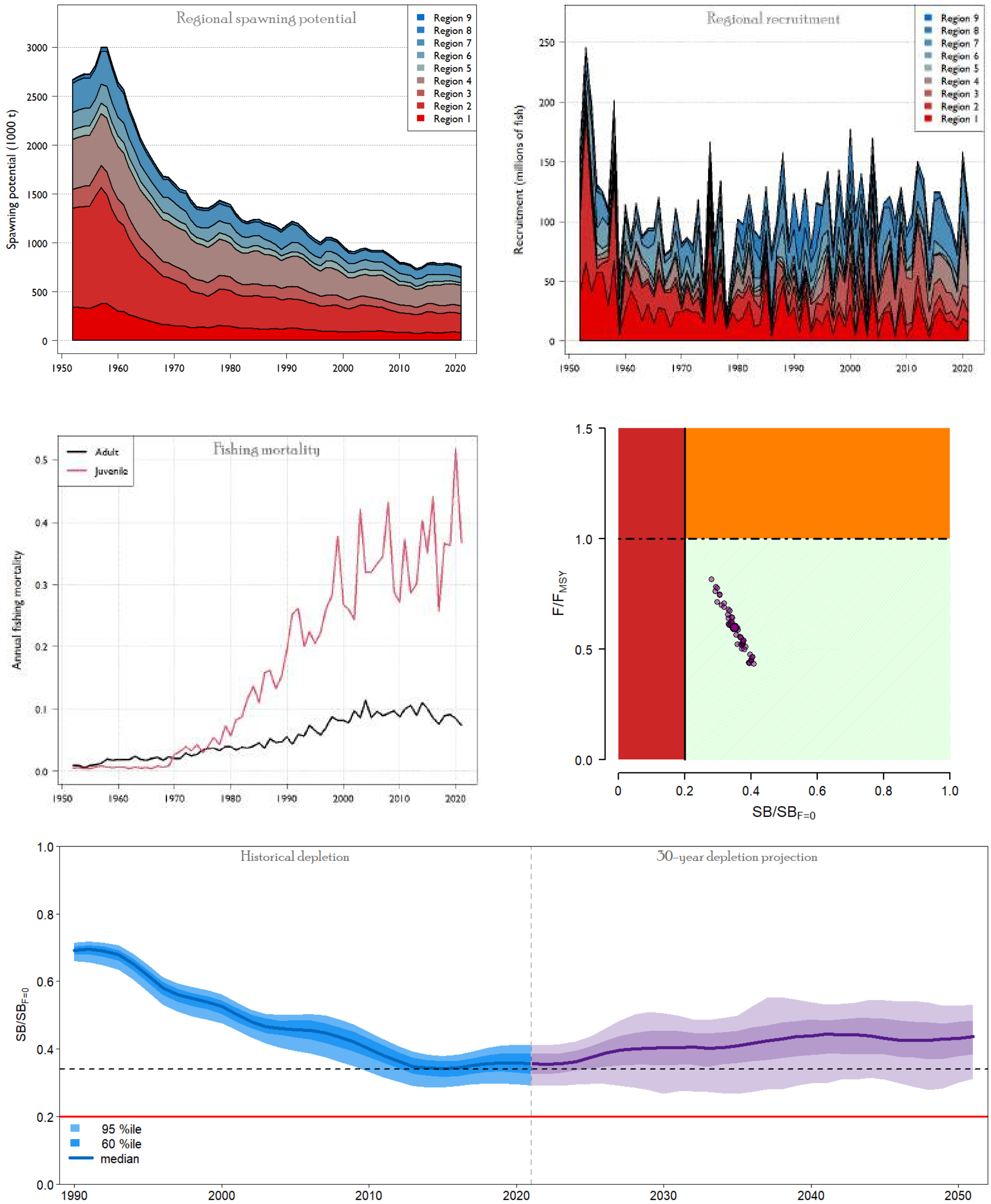


Figure 13. Estimated spawning biomass (SB) time series by model region (top left), recruitment by model region (top right), and fishing mortality for adults and juveniles (middle left) from the bigeye diagnostic case model; stock status displayed on a Majuro plot as the end points (recent values) from the uncertainty grid of 54 models (middle right) with the median value illustrated by the large purple point. Estimated historical depletion since 1990 (from the stock assessment) and projected 30-year depletion under status quo conditions (2023 catch/effort levels) are shown in the bottom plot. The vertical line represents the final year of data in the most recent assessment and, thus, marks the transition to projection estimates. All depletion estimates (historical and projected) are computed in the same manner as $SB_{recent}/SB_{F=0}$. Spawning biomass in the absence of fishing is computed as a 10-year average lagged by one year relative to each of the three years used in the "recent" SB calculation. The red horizontal line is the LRP (at 0.20 $SB_{recent}/SB_{F=0}$). The dashed horizontal line represents the latest estimate of the average depletion ratio (at 0.34 $SB_{recent}/SB_{F=0}$) over the period 2012–2015, which is listed as the interim depletion objective in Tropical Tuna CMM 2023D-01.

South Pacific albacore catch data

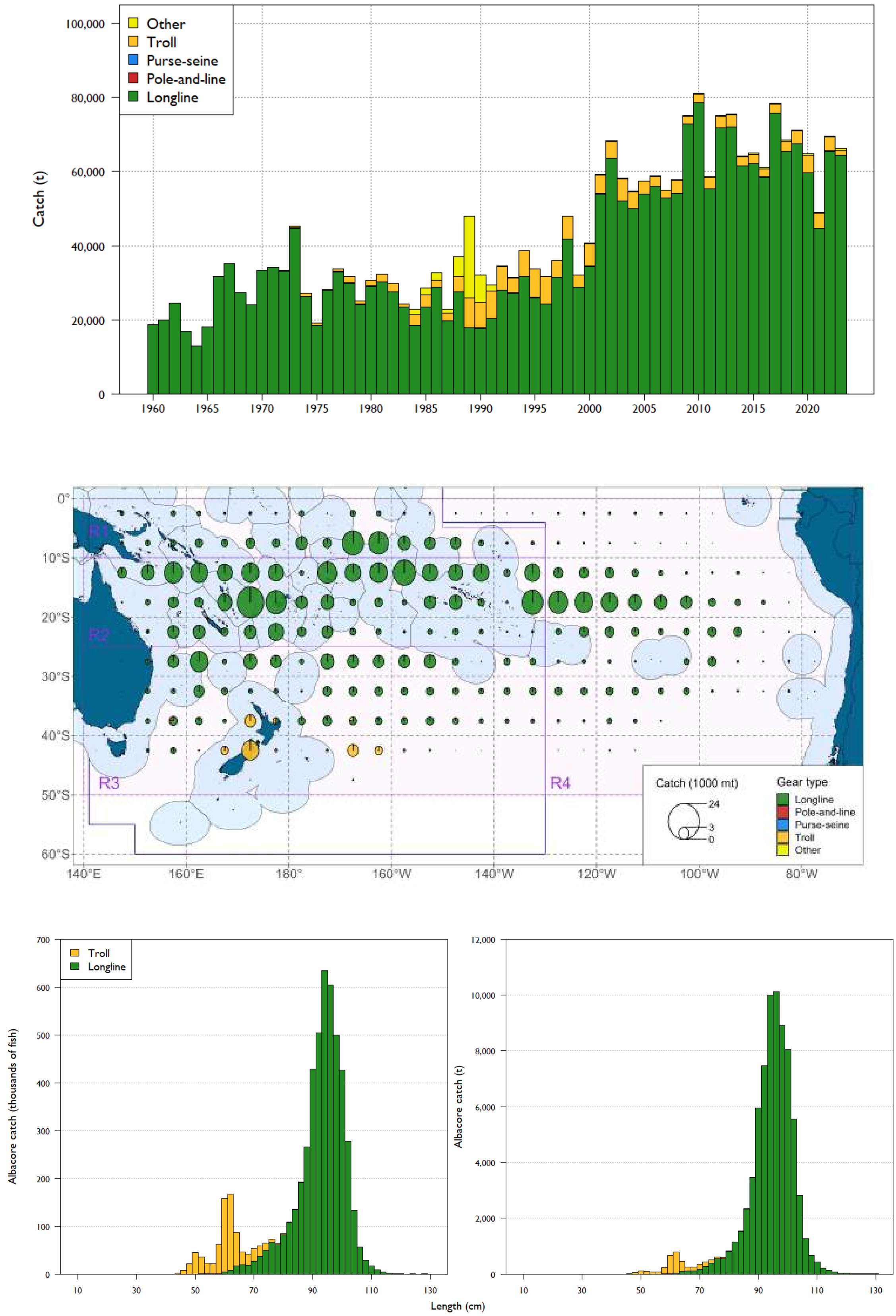


Figure 14. Time series (top), recent (2019–2023) spatial distribution and assessment regions (middle), and size composition (average for last five years, bottom) of South Pacific albacore tuna catch by gear type, Pacific-wide, south of the equator. Note: Size data represent only WCPFC-CA-caught albacore.

South Pacific albacore stock status plots

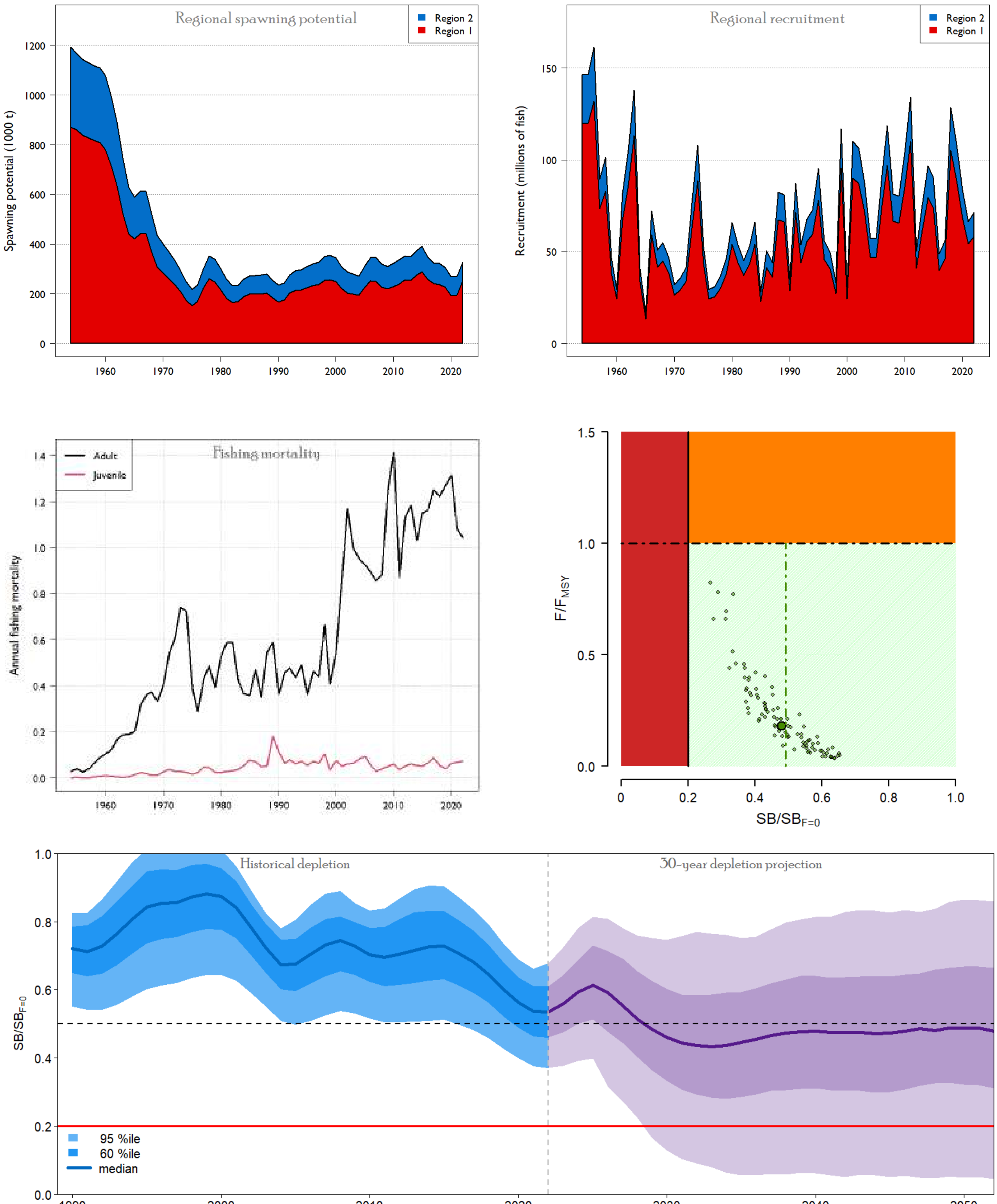


Figure 15. Estimated spawning biomass (SB) time series by model region (top left), recruitment by model region (top right), and fishing mortality for adults and juveniles (middle left) from the South Pacific albacore diagnostic case model; stock status displayed on a Majuro Plot as the end points (recent values) from the 100 ensemble model runs (middle right) with the median value illustrated by the large green point. Estimated historical depletion since 1990 (from the stock assessment) and projected 30-year depletion under status quo conditions (2023 catch/effort levels) are shown in the bottom plot. The vertical line represents the final year of data in the most recent assessment and, thus, marks the transition to projection estimates. All depletion estimates (historical and projected) are computed in the same manner as $SB_{recent}/SB_{F=0}$. Spawning biomass in the absence of fishing is computed as a 10-year average lagged by one year relative to each of the three years used in the "recent" SB calculation. The red horizontal line is the LRP (at 0.2 $SB_{recent}/SB_{F=0}$). The dashed horizontal line represents the 2024 recalibration to the interim TRP at an average depletion ratio of 0.5 $SB_{recent}/SB_{F=0}$) as agreed at the 20th Annual Meeting of the WCPFC.

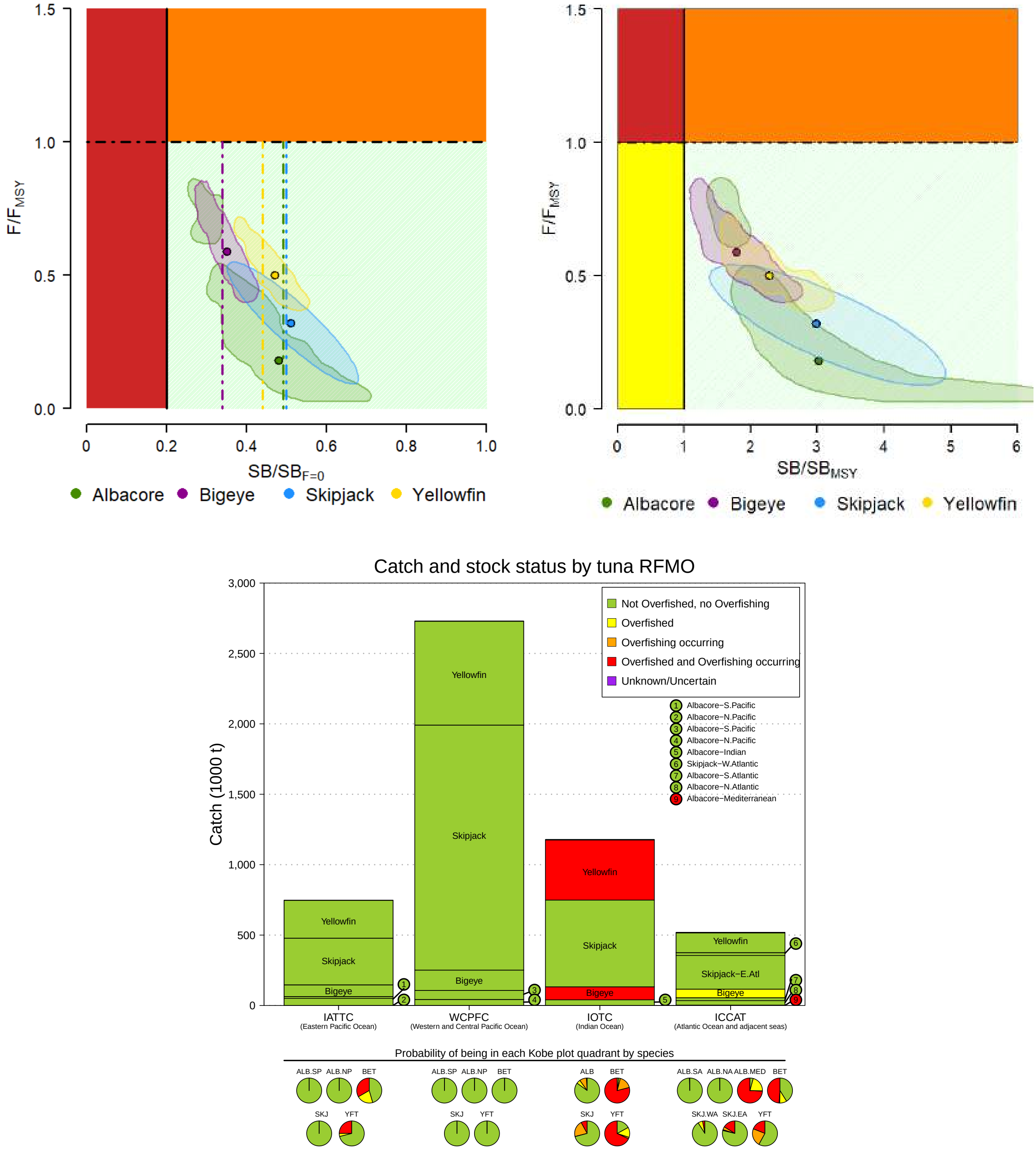
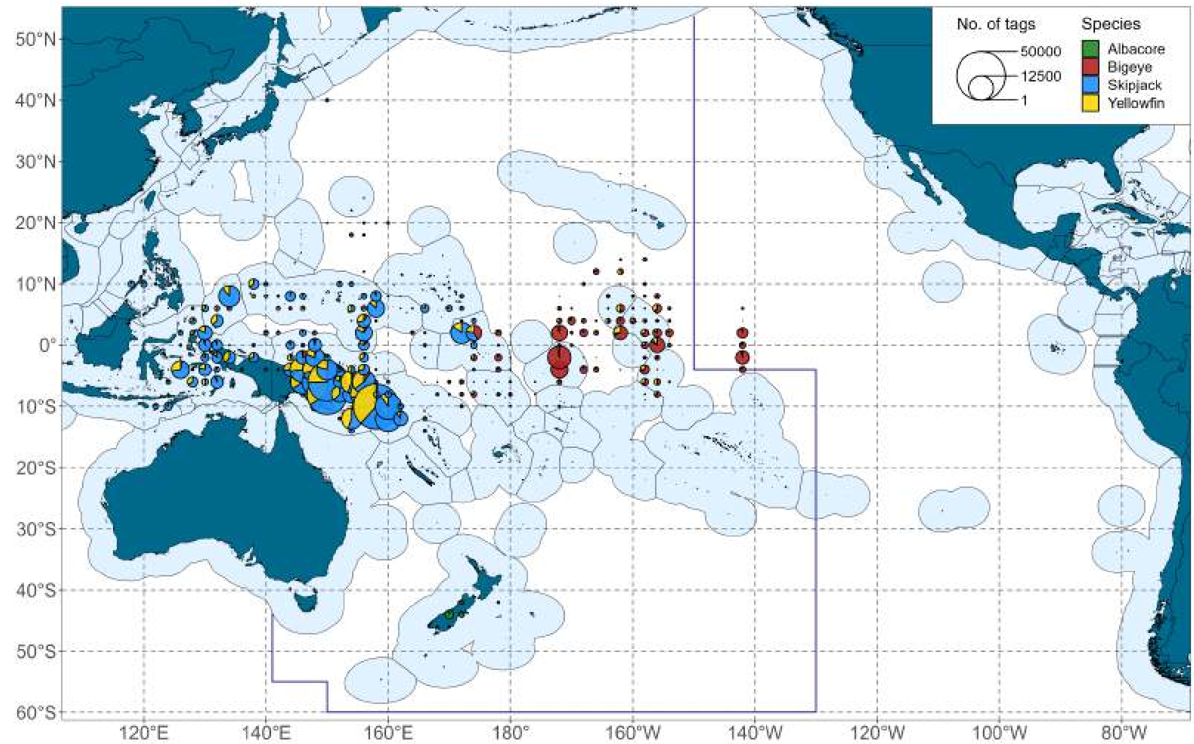


Figure 16. Majuro (top left) and Kobe (top right) plot stock status summary for the four WCPO target tuna stocks and a comparison of Kobe plot stock status for the same four tuna species in the other major ocean basins (bottom). In the Kobe and Majuro plots, the grid median value is shown as a large dot. For skipjack, uncertainty is illustrated by an ellipse closely approximating the distribution of point estimates from uncertainty grid models. For albacore, yellowfin, and bigeye, all assessed since 2023, the irregularly shaped regions represent the 95% confidence interval (kernel density estimate) of the grid model (for bigeye and yellowfin) and ensemble model (albacore) point estimates, incorporating estimation uncertainty (see text for additional detail). The vertical lines on the Majuro plot are interim TRPs (skipjack and South Pacific albacore) and management objectives (bigeye and yellowfin), and the colour corresponds to species. Both skipjack and albacore have interim TRPs of 0.5 and so their lines have been slightly jiggered. The stock status comparison across ocean basins is based on spawning biomass and fishing mortality relative to their MSY values. Data are current as of November 2024 and stock status assessments were obtained directly from documents produced by the responsible tuna regional fisheries management organization. See text for explanation of Kobe quadrant pie charts. Catch is average catch over the five most recent years available. Note that South and North Pacific albacore span both the WCPFC-CA and the IATTC-CA and, therefore, are included for both organisations, with the catch levels reflecting the split between the two convention areas.



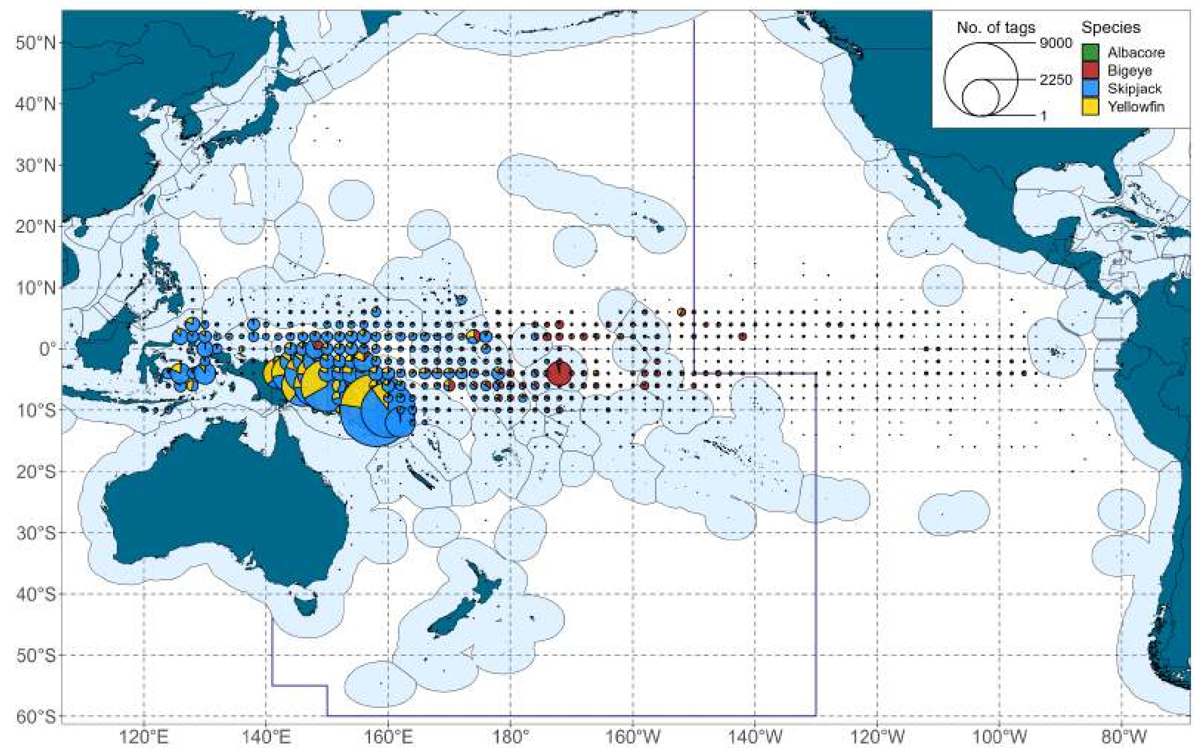
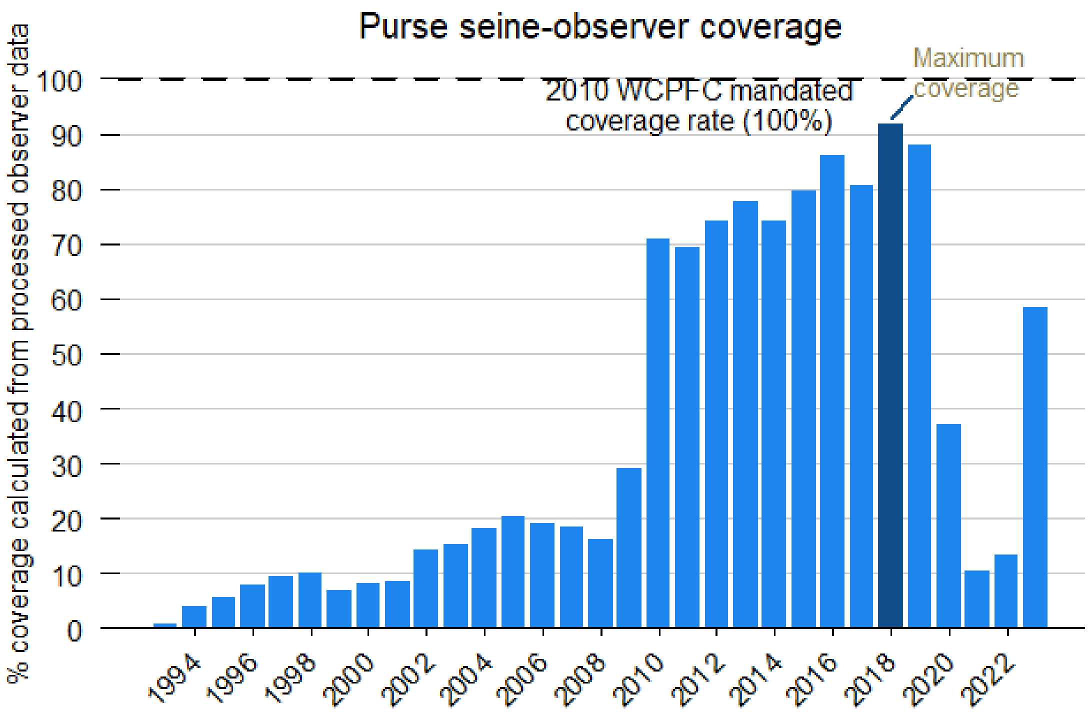


Figure 17. Tag releases (top) and recaptures (bottom) by species from the recent Pacific Tuna Tagging Programme. Note: Release and recovery locations have been aggregated to a 2°x2° grid resolution for visual clarity.



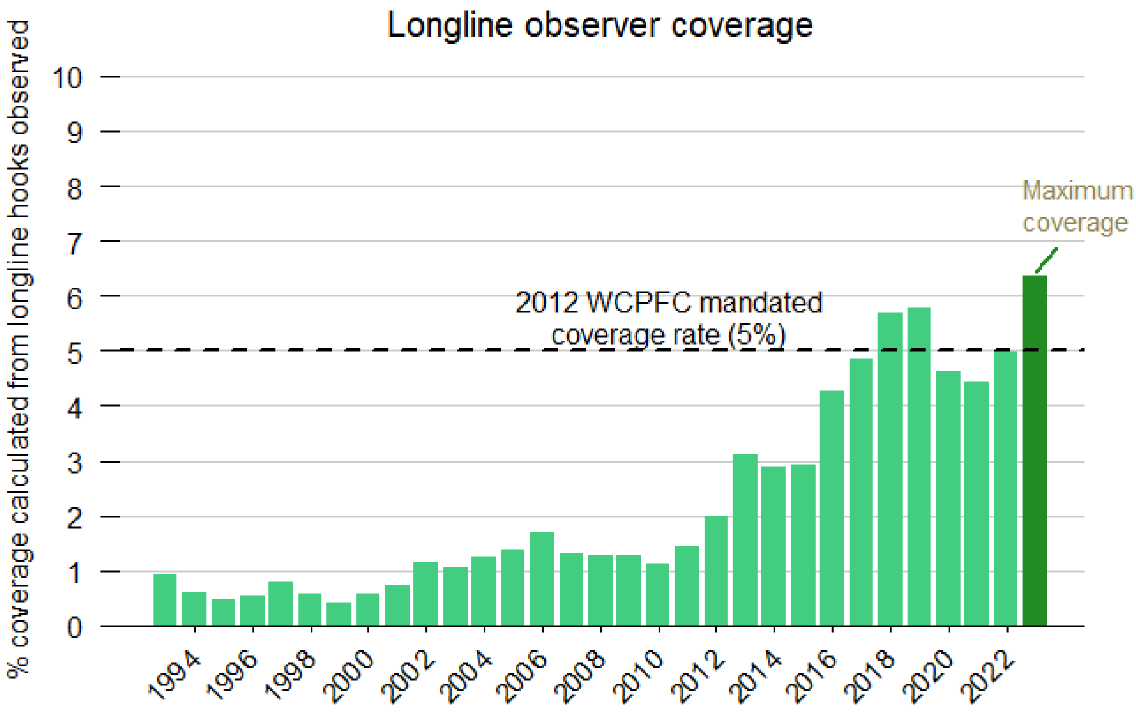


Figure 18. Observer coverage of the purse-seine (top) and longline fleets (bottom) operating within the EEZs of the WCPFC-CA, over the period 1993–2023. Note: Longline coverage is computed on the basis of hooks fished and includes fishing effort and observer coverage in both EEZs and the high seas. The Japan coastal longline fleet as well as the domestic longline fleets of Indonesia and Vietnam are excluded from effort summaries. Purse-seine coverage is based on processed observer data records and represents fishing days at sea. Purse-seine fishing days are computed from logsheets prior to 2010 and on VMS data for 2010–2023. Purse-seine data are between 10°N and 10°S, and exclude the domestic purse-seine fleets of Indonesia, the Philippines and Vietnam.

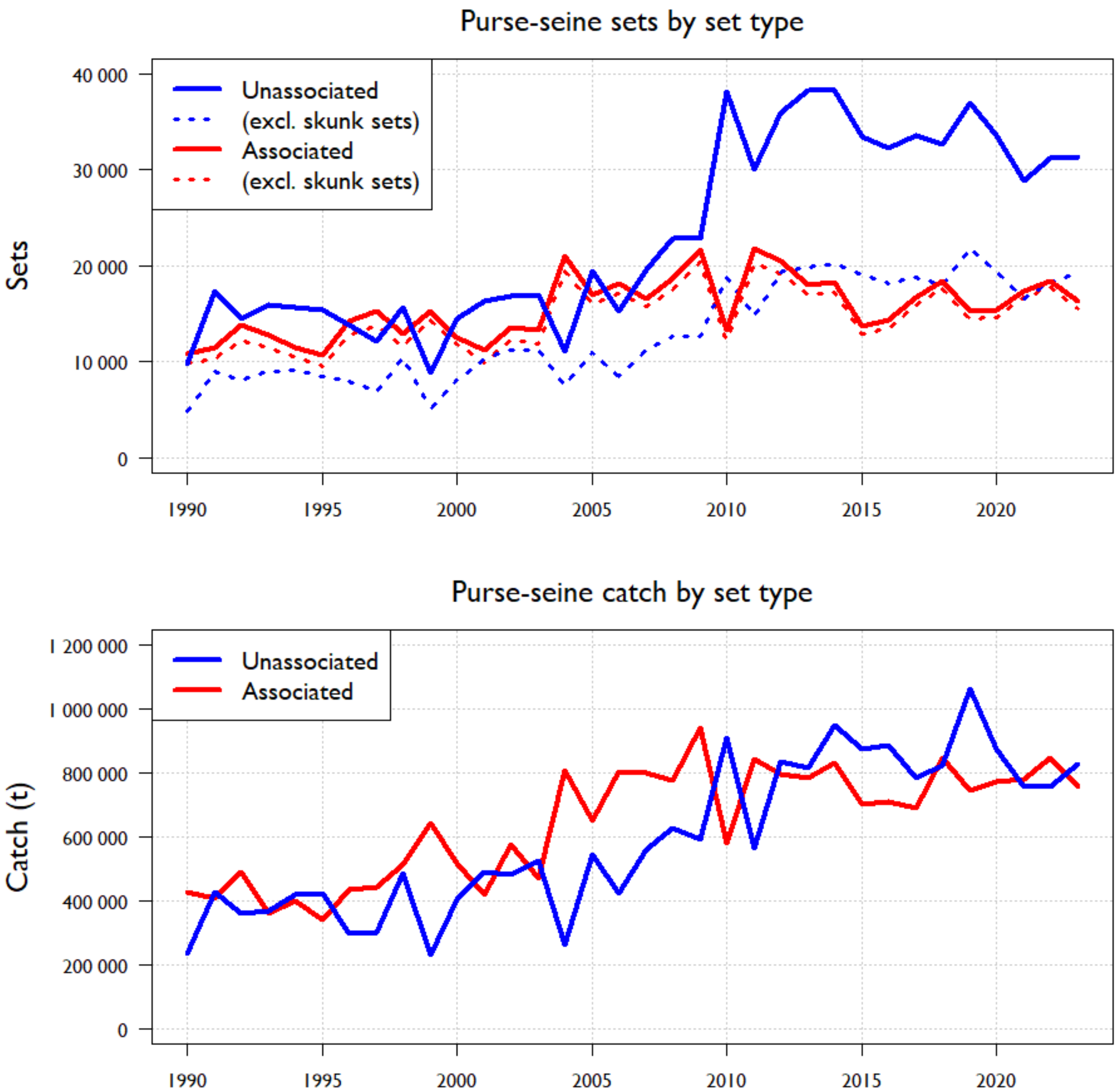


Figure 19. Illustration of the relative annual number of sets (top) and catch tonnage (bottom) by set association type (unassociated versus associated) over the period 1990–2023. The associated sets include all set association types, including FADs, logs, etc. Illustrated data are from raised logsheet data for the WCPFC tropical purse-seine fishery, excluding the domestic fleets of Indonesia, the Philippines and Vietnam.

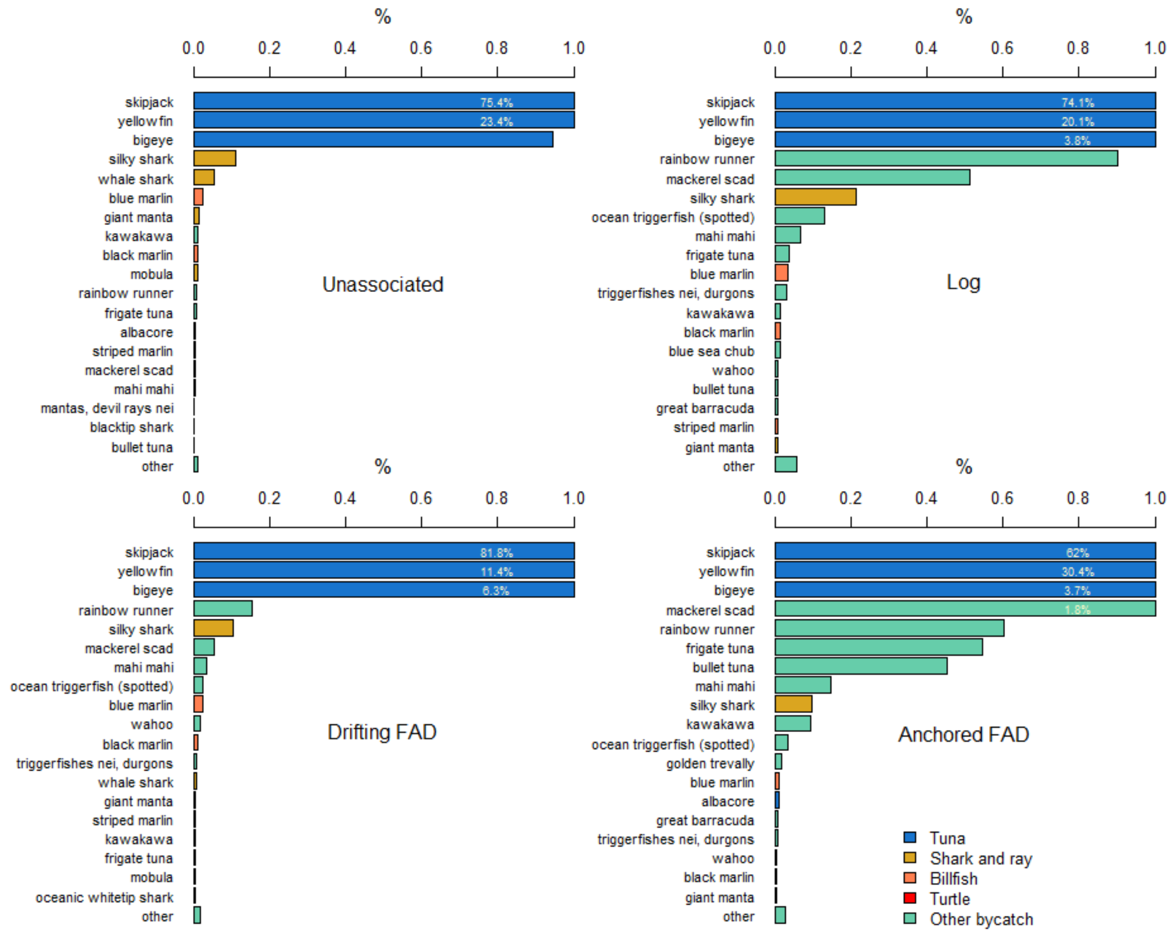


Figure 20. Catch composition of the various categories of purse-seine fisheries operating in the WCPFC-CA based on observer data from the last five years of data.

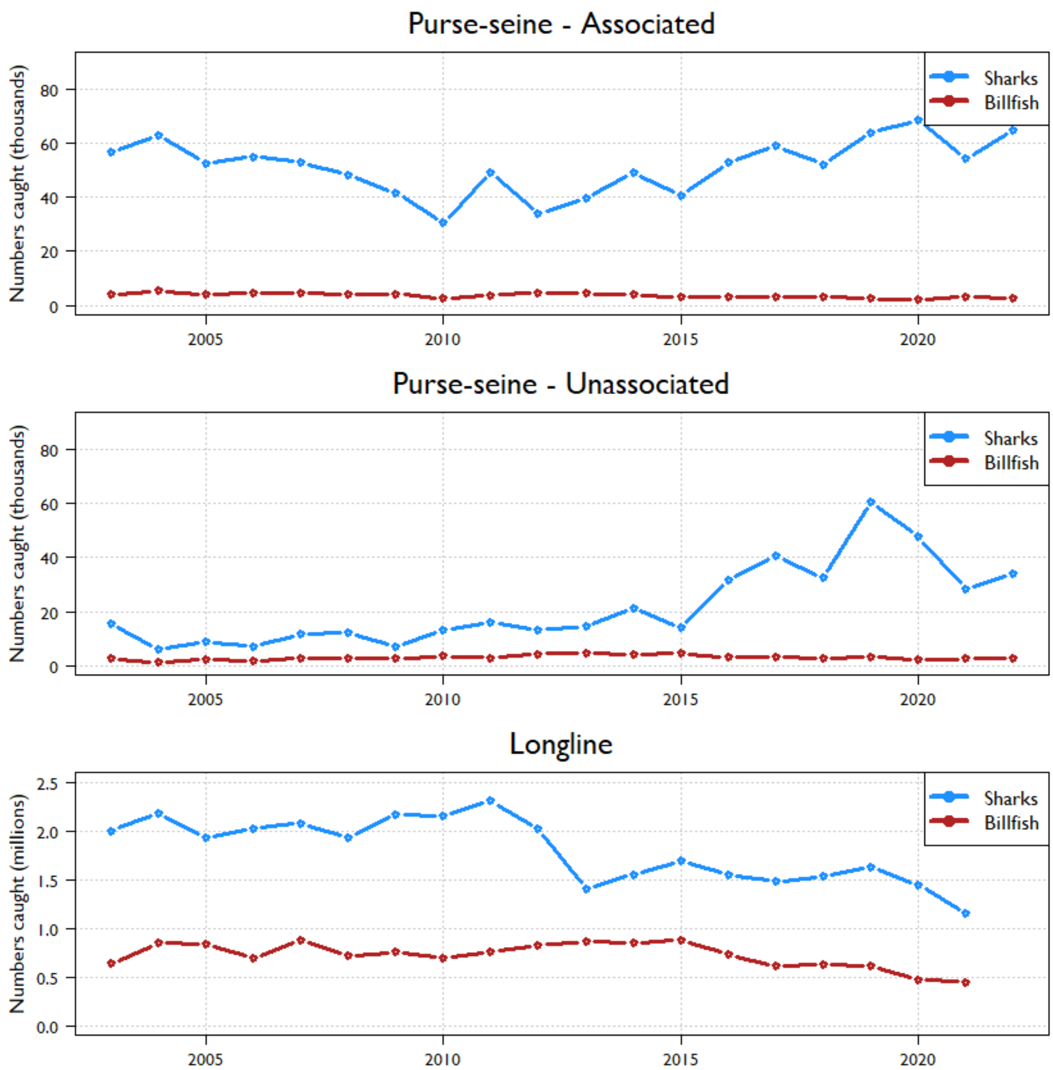


Figure 21. Estimated total catch (in numbers) of sharks and billfish in the purse-seine and longline fisheries operating in the WCPFC-CA. Note: Purse-seine estimates, for the period 2003–2020, are shown separately for associated sets (top figure) and unassociated sets (middle figure). Longline estimates cover the period 2003–2021 and are illustrated in the bottom figure. Note that the y-axis differs for the two gear types; numbers caught are in thousands for purse-seine gear and millions for longline gear.

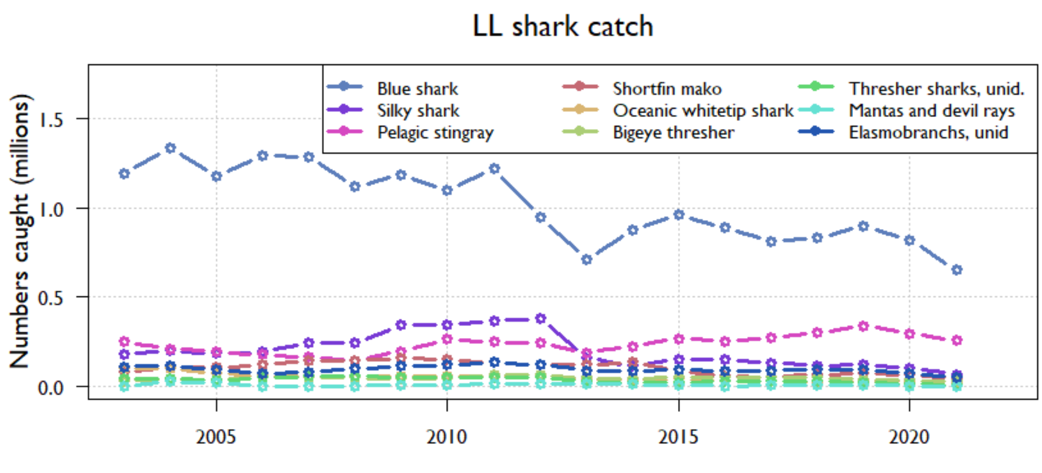
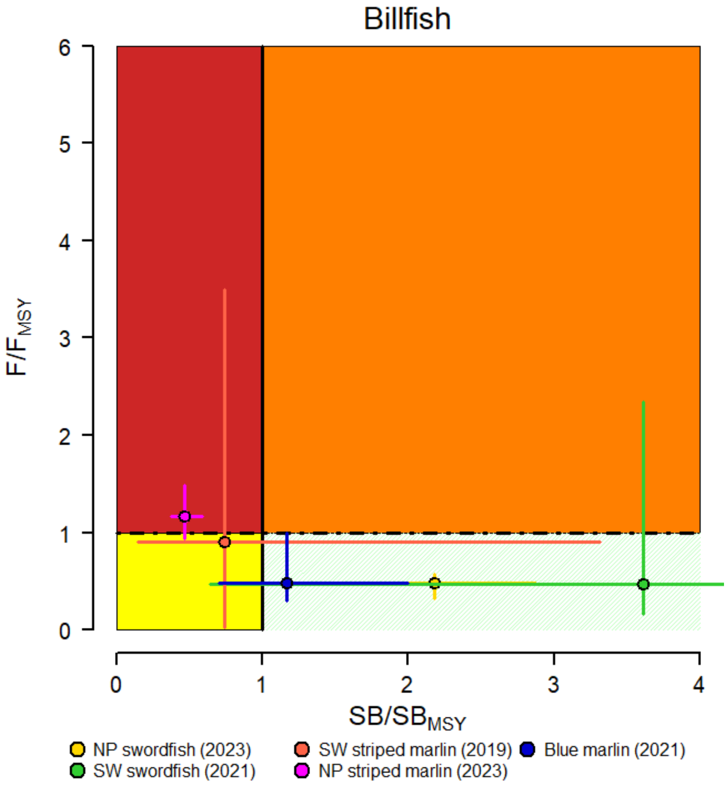


Figure 22. Estimated species composition of the longline shark catch in the WCPFC-CA, 2003–2021.



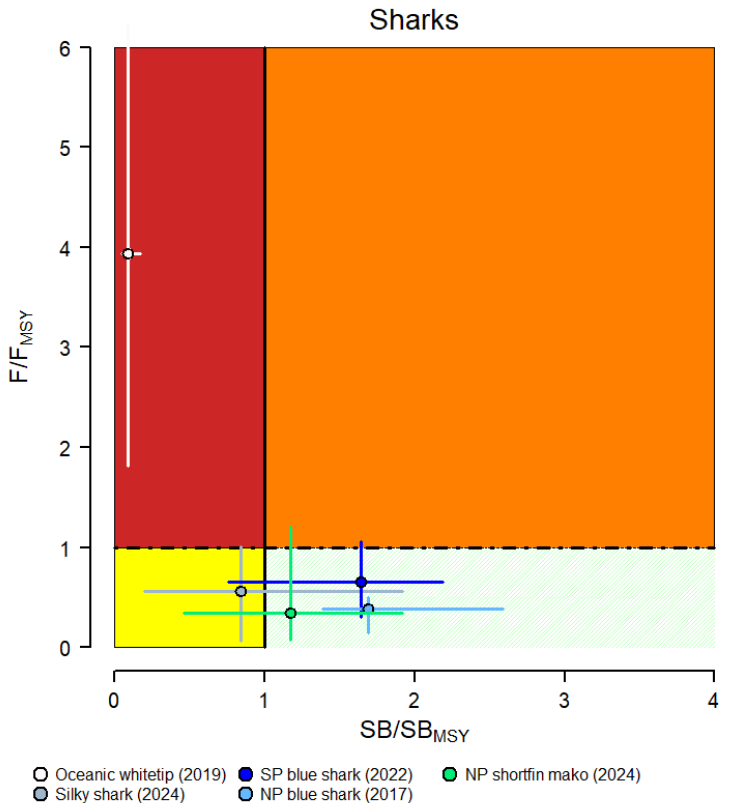
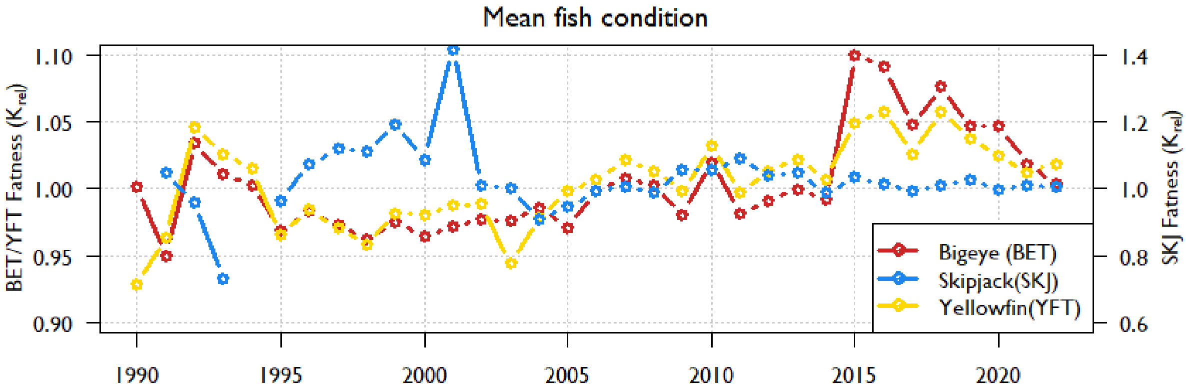


Figure 23. Kobe plot stock status summary for WCPFC-CA billfishes (top) and sharks (bottom) assessed over the past decade and for which stock status has been determined. Note: This plot differs from that presented for the target tuna (the Majuro plot), because the WCPFC has not yet decided on LRPs for these species and therefore MSY-based reference points are used as a default. The numbers in parentheses represent the year of the most recent stock assessment for that species.

Ecosystem and climate indices



Indicator	Description	Notes	Time-series
Sea Surface Temperature Anomalies			
Annual SST Anomaly	Mean annual SST anomaly (°C) across **WCPO area**	• Derived from ocean models • WCPO area western limit of 130°E • Anomaly from mean temperature 1993-2021	
	Mean annual SST anomaly (°C) across **WCPO equatorial zone**	• Derived from ocean models • Equatorial zone 5°S-5°N • Anomaly from mean temperature 1993-2021	
Nov-Apr Warm-pool SST Anomaly	Mean annual SST anomaly (°C) within warm-pool extent	• Derived from ocean models • Warm-pool defined by mean Nov-Apr temperature > 29°C	
Warm-pool Indices			
Mean Size of Warm-pool	Approximate size of warm-pool in millions of km^2	• Derived from ocean models • Warm-pool defined by mean Nov-Apr temperature > 29°C	
Eastern Limit of Warm-pool Boundary	Longitude of strongest sea surface salinity boundary	• Derived from ocean models • Boundary defined as largest change over 10° distance	
Mean Warm-pool Mixed Layer Depth	Mean depth (m) of the mixed layer within warm-pool	• Derived from ocean models • Layer over which water temperature is homogenous	
Climate Indices			
Oceanic Niño (ONI) and Interdecadal Pacific Oscillation (IPO) Index	ONI indicates SST anomalies in the Niño 3.4 region during Nov-Jan each year IPO represents long-term oscillation between El Niño favourable and La Niña favourable phases	• ONI values > 0.5 indicative of El Niño events, values < -0.5 indicative of La Niña • IPO values > 0 indicative of more El Niño events, < 0 indicative of more La Niña events • Time series from 1993-2021	

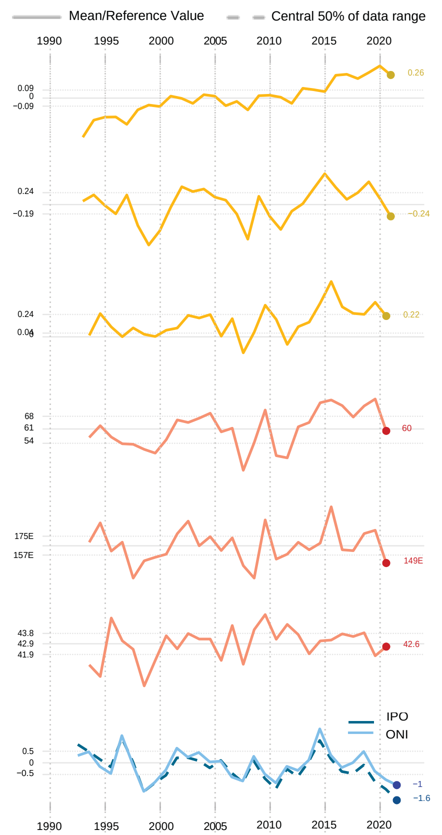
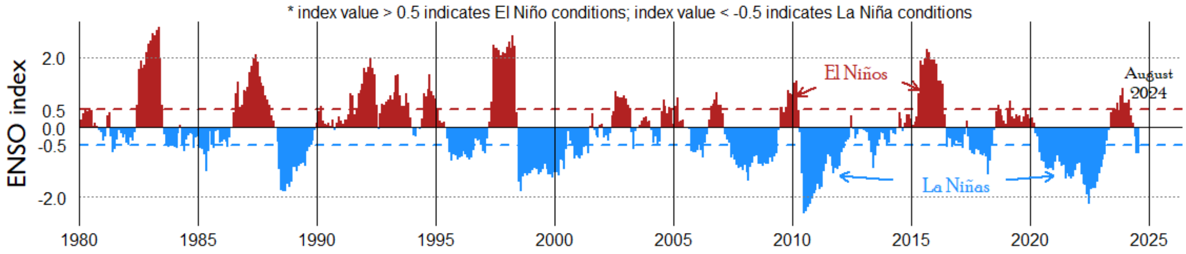


Figure 24. Ecosystem and climate indicators developed to monitor the oceanic environment of the WCPFC-CA. Note: Top - Mean fish condition of longline caught tuna; bottom - WCPO climate indices. See text for details.

El Niño Southern Oscillation figures



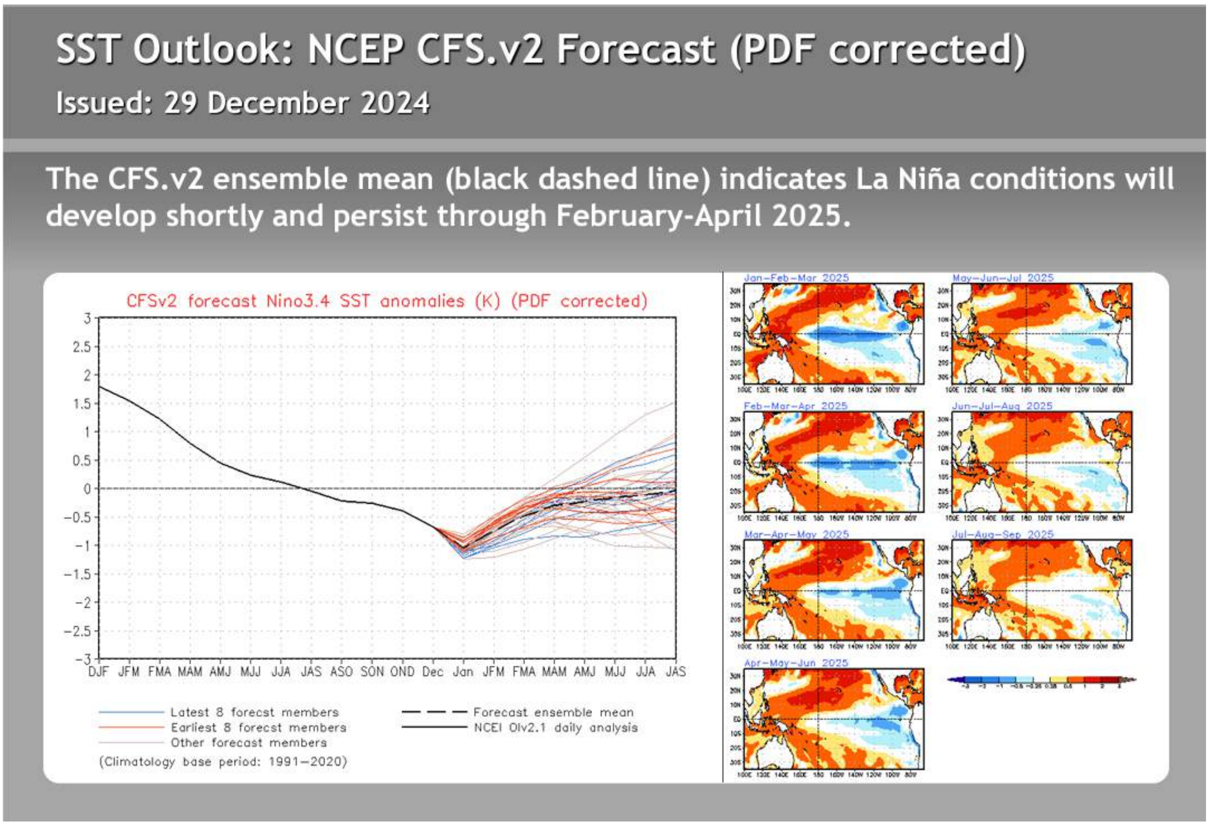


Figure 25. Top figure: The Multivariate Enso Index (MEI), over the period 1980–2024 (source: https://www.psl.noaa.gov/enso/mei). Note: The MEI provides a long-term perspective on the strength and duration of ENSO events; the ENSO gauges in Figure 26 were derived from this index. Bottom figure: The most recent ENSO forecast at the time this TFAR went to press. After three consecutive La Niña events, the tropical Pacific entered an El Niño phase in mid-2023 and is currently underway and is forecast to continue until May 2024. Source: https://www.cpc.ncep.noaa.gov, forecast date: 11 December 2023.

El Niño Southern Oscillation figures (cont.)

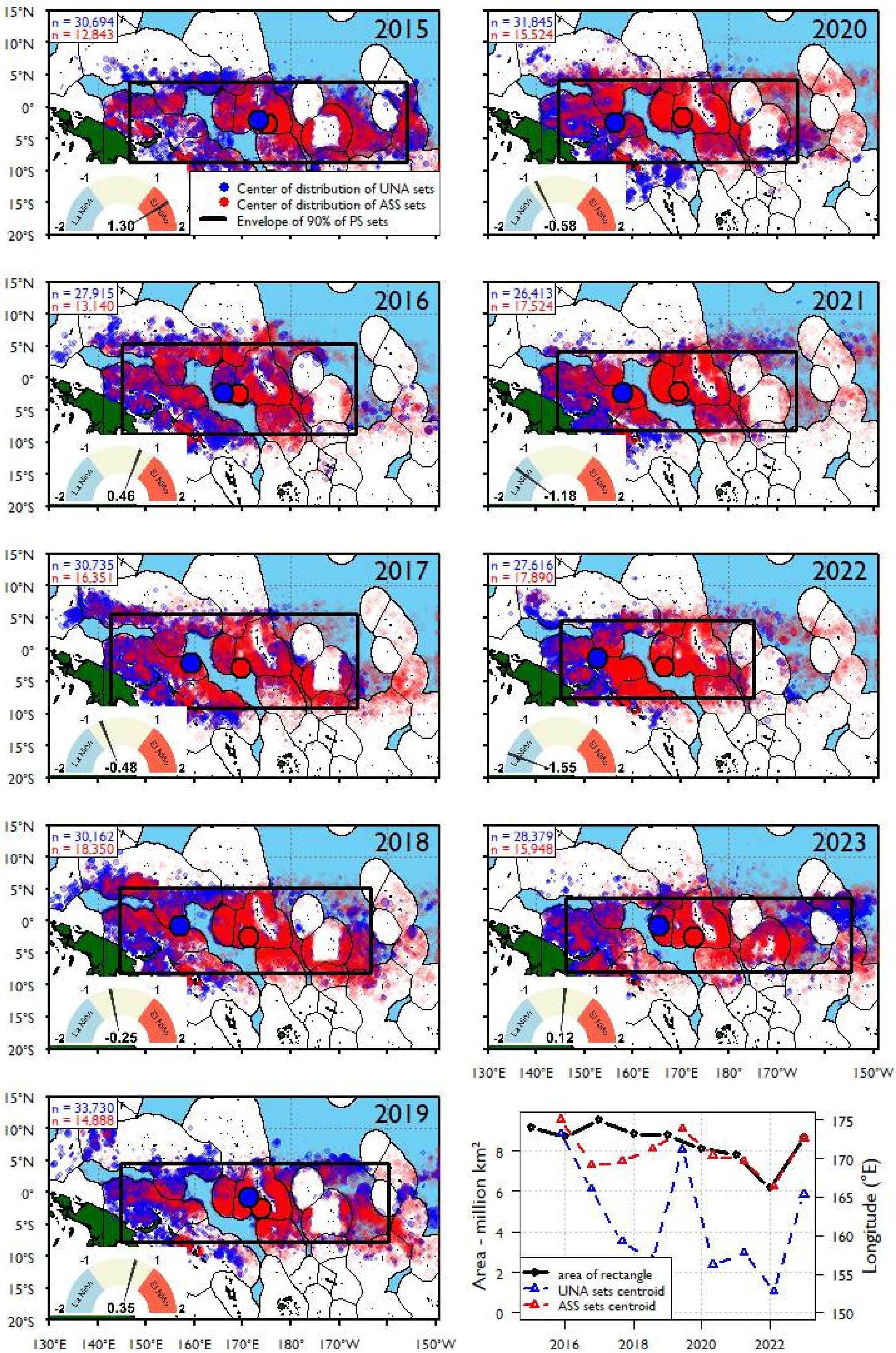


Figure 26. Illustration of the annual distribution of WCPO unassociated and associated sets over the period 2015–2023. Note: Each point is scaled relative to catch size and FAD-associated (ASS), and free school (UNA) sets are coloured differently. The large coloured dots show the centre of distribution for the two set types. The black box bounds 90% of all sets both north–south and east–west. The ENSO gauge in the lower left corner of each figure is the annual average of the Multivariate Enso Index (MEI), which is further described and illustrated in Figure 25. Illustrated data are from raised logsheet data for the WCPFC tropical purse-seine fishery, excluding the domestic fleets of Indonesia, the Philippines and Vietnam.

Climate change projections

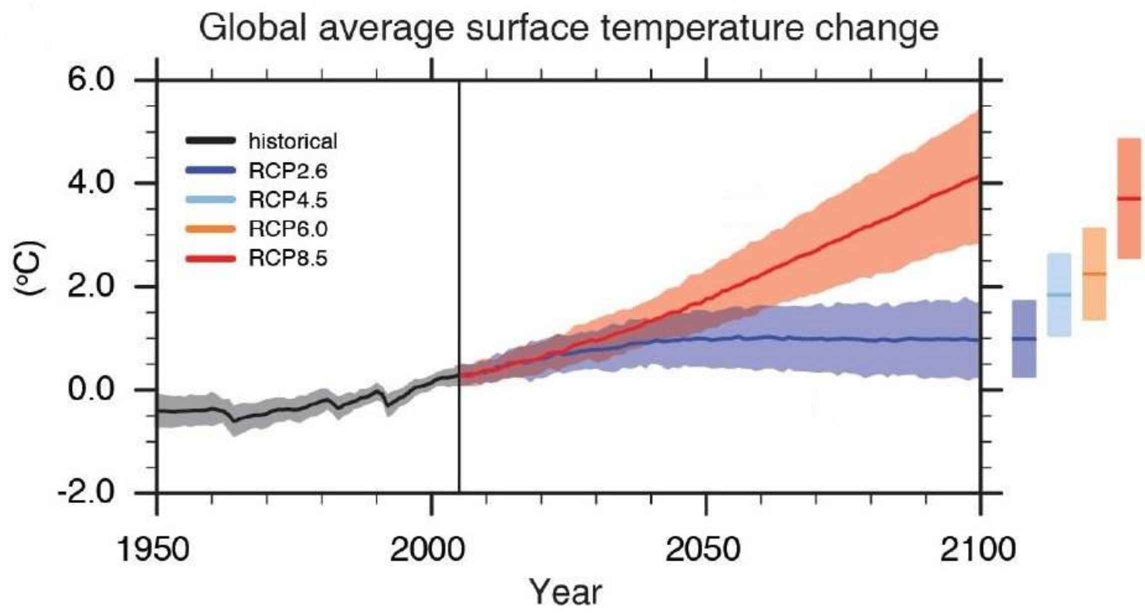


Figure 27. Two global temperature change projections developed for the Intergovernmental Panel on Climate Change 5th Assessment Report (AR5). Note: The illustrated trajectories represent two scenarios, termed Representative Carbon Pathways (RCP), reflecting different assumptions about human response to future greenhouse gas emissions. RCP2.6 and RCP8.5 reflect extremes between a strong coordinated effort to reduce emissions by 30% from baseline conditions by 2100 (RCP2.6) and a "no climate policy" response wherein emissions continue to increase at current levels (RCP8.5). The bars on the right show projected temperature increases in the year 2100, and include the two other scenarios (RCP4.5 and RCP6.0) listed in the legend, for which the full time series are not displayed. Source: IPCC 2014.

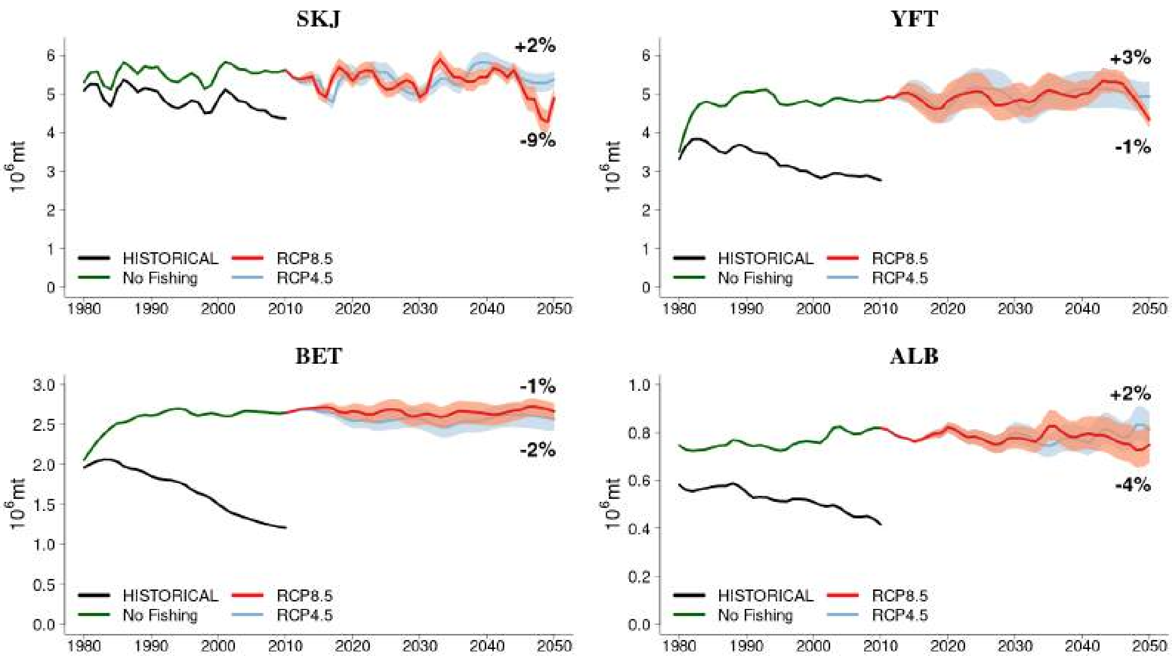


Figure 28. Envelope of predictions computed from four earth system models (IPSL, GFDL, MIROC and MPI) under IPCC RCP8.5 and RCP4.5 scenarios for the WCPO for skipjack (SKJ), yellowfin (YFT), bigeye (BET) and South Pacific albacore (ALB) tuna. Note: The change in total biomass is presented with the average 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 2011–2020 time window compared with 2044–2053. Modified and updated from Senina et al. 2018.

Climate change projections (cont.)

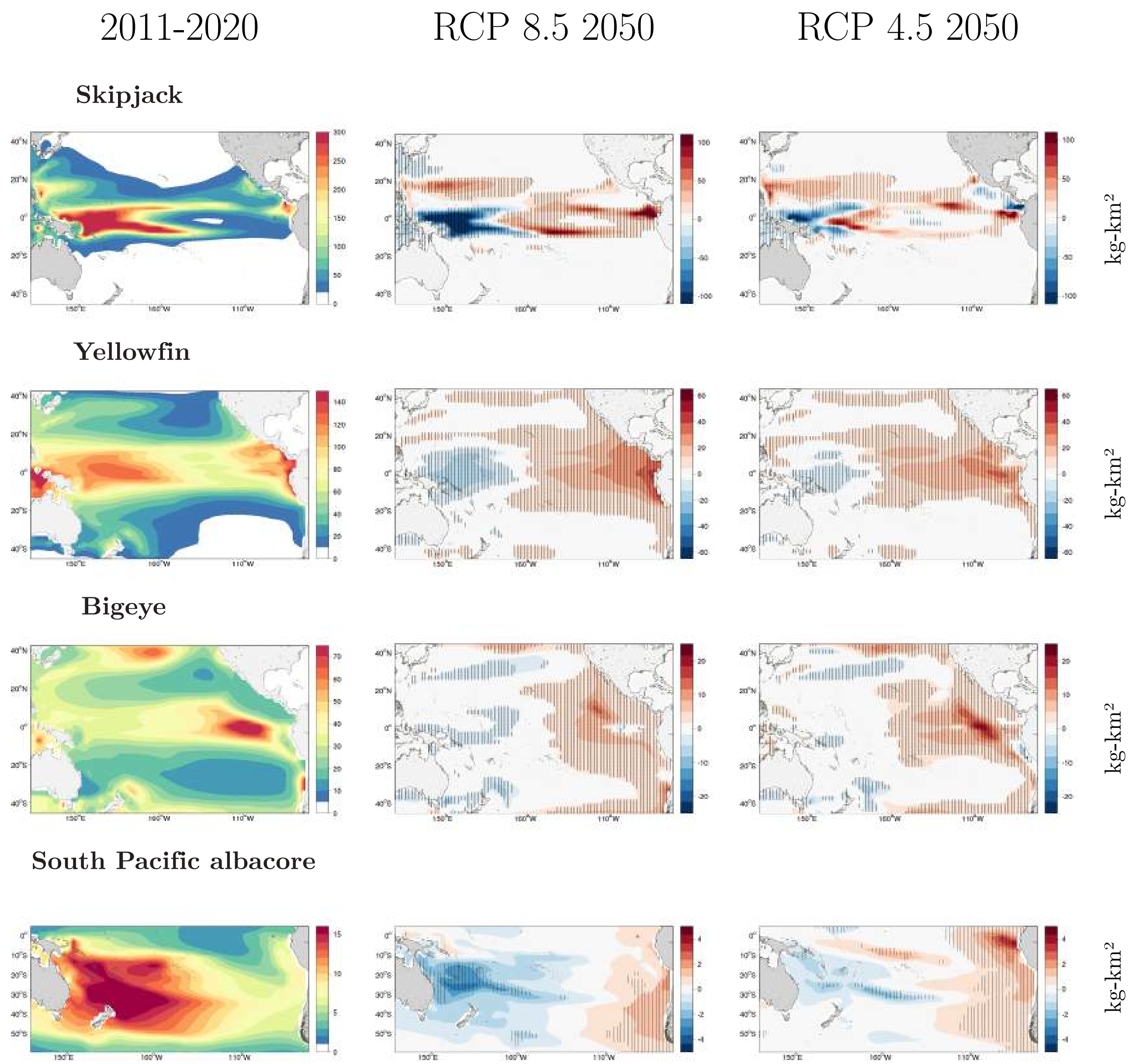


Figure 29. Average biomass distributions (kg-km²) of skipjack, yellowfin, bigeye and South Pacific albacore tuna in the Pacific Ocean basin for 2015 (averaged over 2011–2020) (left), and mean anomalies (kg-km²) from the average 2015 biomass distribution of each tuna species projected to occur by 2050 (averaged over 2044–2053) under the RCP 8.5 (middle) and RCP 4.5 (right) greenhouse gas emissions scenarios (right). Note: Shading indicates areas where projections from four Earth System Models agree in the sign of change. Source: Bell et al. (2021).

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