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THE WESTERN AND CENTRAL PACIFIC TUNA FISHERY:

2007–2008 OVERVIEW AND STATUS OF STOCKS

Shelton Harley, Peter Williams, Simon Nicol, and John Hampton

Tuna Fisheries Assessment Report N° 9

Secretariat of the Pacific Community

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back to contents page

Preface

Tuna Fisheries Assessment Reports provide current information on the tuna fishery of the western and central Pacific Ocean, the fish stocks, mainly tuna, that are impacted by them and their environment. The information provided in this document is a summary, but a list of references (mostly accessible via the internet) is included for those seeking further details.

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

The report is in three main parts. The first section provides an overview of the fishery, with emphasis on developments during the past few years. The second summarises the most recent information on the status of the stocks, and the third summarises information on the interaction between the tuna fisheries and the environment. The data used in compiling the report are those that were available to the Oceanic Fisheries Programme (OFP) at the time of publication. The fisheries statistics presented are usually complete to the end of the year prior to publication. However, some minor revisions to statistics may be made for recent years from time to time. The stock assessment information presented is the most recent available, and is updated periodically for each species as new analyses are completed.

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Contents

Preface

1 The western and central Pacific tuna fishery 1

2 Status of tuna stocks 2

2.1 Skipjack tuna 2

2.1.1 Stock assessment 2

2.2 Yellowfin tuna 3

2.2.1 Stock assessment 3

2.3 Bigeye tuna 3

2.3.1 Stock assessment 4

2.4 South Pacific albacore tuna 4

2.4.1 Stock assessment 5

3 Ecosystem considerations 5

3.1 Catch composition 5

3.2 Impact of catches 6

3.3 Trophic structure and ecology 6

3.4 Oceanographic and climate effects 7

For further information 27

1 The western and central Pacific tuna fishery

The tuna fishery in the western and central Pacific Ocean (WCPO), encompassed by the Convention Area of the Western and Central Pacific Fisheries Commission (WCP–CA) (Figure 1), is a diverse fishery 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 both in the exclusive economic zones 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*).

Annual total catches of the four main tuna species (skipjack, yellowfin, bigeye and albacore) in the WCP–CA increased steadily during the 1980s as the purse seine fleet expanded. They then remained relatively stable during most of the 1990s until the sharp increase in catch during 1998. Over the past 7 years, there has been an increasing trend in total tuna catch, primarily due to increases in purse-seine fishery catches (Figure 2 and (Table 1). The provisional total WCP–CA tuna catch for 2008 was estimated at 2,426,195 mt, the highest annual catch recorded, but only 6,000 mt higher than the previous record in 2007 (2,420,082 mt). During 2008, the purse-seine fishery accounted for an estimated 1,783,669 mt (74% of the total catch, and a record for this fishery), with pole-and-line taking an estimated 170,805 mt (7%), the longline fishery an estimated 231,003 mt (10%), and the remainder (10%) taken by troll gear and a variety of artisanal gear, mostly in eastern Indonesia and the Philippines. The WCP–CA tuna catch (2,426,195 mt) for 2008 represented 81% of the total Pacific Ocean catch of 3,009,477 mt, and 56% of the global tuna catch (the provisional estimate for 2008 is just over 4.3 million mt).

The 2008 WCP–CA catch of skipjack (1,634,617 mt – 67% of the total catch) was the second highest ever, and 74,000 mt less than the record catch of 2007 (1,708,605 mt) (Table 2). The WCP–CA yellowfin catch for 2008 (539,481 mt – 22%) was easily the highest on record and nearly 77,000 mt (17%) higher than the previous record in 1998 (462,786 mt). The WCP–CA bigeye catch for 2008 (157,054 mt – 6%) was the second highest on record (slightly lower than the record catch of 157,173 mt taken in 2004), mainly due to a relatively high estimated bigeye catch from the purse-seine fishery. The 2008 WCP–CA albacore catch (95,043 mt – 4%) was the lowest for over 10 years, with reduced catches experienced in both the South and North Pacific fisheries in 2008 compared to recent years.

The 2008 purse-seine catch of 1,783,669 mt was the fifth consecutive record for this fishery but only 23,000 mt higher than the previous record in 2007 (Figure 3 and Table 1). The 2008 purse-seine skipjack catch (1,409,921 mt – 79% of the total catch) was clearly lower than the record catch of 2007, although the purse-seine skipjack catch has now increased by more than 500,000 mt (or 59%) since 2001 (919,410 mt), at an average of about 70,000 mt per year. The 2008 purse-seine catch of yellowfin tuna (325,904 mt – 18%) was clearly the highest on record, with a 40% increase (95,000 mt) on the 2007 catch and 65,000 mt (25%) higher than the previous record taken in 1998. The provisional catch estimate for bigeye tuna for 2008 (46,811 mt –3%) was also the highest on record.

The WCP–CA longline catch (231,003 mt) for 2008 was the lowest since 2000 and around 12% lower than the highest on record which was attained in 2004 (262,584 mt) (Figure 4 and Table 1). The WCP–CA albacore longline catch (69,920 mt – 30%) for 2008 was the lowest since 2000. The provisional bigeye catch (87,504 mt – 38%) for 2008 was higher than the average for the period 2000–2008, and the yellowfin catch (69,516 mt – 30%) was similar to the 2007 catch, but the lowest since 1999.

The 2008 catch estimates for the key pole-and-line fleets operating in the WCP–CA have yet to be provided, although the total catch estimate is expected to show a further decline on levels in recent years. Carrying over the 2007 catch estimates for these key fleets provides a provisional catch for 2008 of 170,805 mt, which is the lowest annual catch for this fishery since the mid-1960s (Figure 5 and Table 1). The Japanese distant-water and offshore fleet (118,907 mt in 2007) and the Indonesian fleet (60,415 mt in 2007) account for most of the WCP–CA pole-and-line catch.

back to contents page

The 2008 troll albacore catch (3,497 mt) was the highest since 2004, mainly due to good catches experienced in the New Zealand domestic fishery. The New Zealand troll fleet (168 vessels caught 3,349 mt in 2008) and USA vessels (4 vessels caught 148 mt 2008) typically account for most of the albacore troll catch, with minor contributions from the Canadian, Cook Island and French Polynesian fleets.

2 Status of tuna stocks

The sections below provide a summary of recent developments in the fisheries for each species and the results from the latest stock assessments.

2.1 Skipjack tuna

The 2008 WCP–CA skipjack catch of 1,634,617 mt was the second highest on record (74,000 mt less than the record in 2008) (Figure 6 and Table 3). As has been the case in recent years, the main determinant of the overall catch of skipjack is catch taken in the purse-seine fishery (1,409,921 mt in 2008 – 86%). The balance of the catch was taken by the pole-and-line gear (125,367 mt – 8%) and the "unclassified" gear used in the domestic fisheries of Indonesia, the Philippines and Japan (~80,000 mt – 6%), while the longline fishery accounted for less than 1% of the total catch.

The majority of the skipjack catch is taken in equatorial areas, and most of the remainder is taken in the seasonal home-water fishery of Japan. The domestic fisheries of Indonesia (purse-seine, pole-and-line and unclassified gear) and the Philippines (e.g. ring-net and purse seine) account for the majority of the skipjack catch in the western equatorial portion of the WCP–CA.

The dominant size of the WCP–CA skipjack catch (by weight and numbers) typically falls in the 40–60 cm range, corresponding to 1–2+ year-old fish. There was a greater proportion of medium-large (60–80 cm) skipjack caught in the purse-seine fishery during 2002 and 2005 (unassociated, free swimming school sets account for most of the large skipjack). In contrast, the WCP–CA skipjack purse-seine catch in 2004 and 2006 comprised younger fish, mainly from associated schools. Skipjack from both associated and unassociated sets during 2008 were mostly in the range 50–65 cm, with very few fish over 70 cm evident in the sampled catch.

2.1.1 Stock assessment

The most recent assessment of skipjack in the WCPO was conducted in 2008 and included data from 1972 to 2007.

While estimates of fishing mortality for skipjack have increased over time, current fishing mortality rates for skipjack tuna are estimated to be well below the F_{MSY} reference point and, therefore, overfishing is not occurring (i.e. $F_{CURRENT} < F_{MSY}$) (Figure 7). Estimates of recruitment and total biomass of skipjack have increased over time, though it is not known if these estimates represent the true situation, perhaps as a result of a decreased abundance of predators, or instead reflect a bias in the assessment, e.g. underestimating increases in the efficiency of the key fleets. Nevertheless, recent biomass levels are estimated to be well above the B_{MSY} level. Based on these results, the WCPFC Scientific Committee noted that the stock is not in an overfished state and that exploitation is modest relative to the stock's biological potential. However, it was further noted that any increases in purse-seine catches of skipjack may result in a corresponding increase in fishing mortality for yellowfin and bigeye tunas.

2.2 Yellowfin tuna

The 2008 WCP–CA yellowfin tuna catch (539,481 mt) was clearly a record and primarily due to the record catch in the purse-seine fishery (325,904 mt – 60% of the total catch) (Figure 8 and Table 4). The purse-seine catch of yellowfin tuna is now more than four times the longline catch (69,516 mt in 2008 –13%), with the remainder coming from the "other" gear category of the Indonesian and Philippines domestic fisheries. The 2008 yellowfin tuna purse-seine catch was more than 64,000 mt (25%) higher than the previous record. In recent years, the yellowfin longline catch has ranged from 75,000 to 82,000 mt, which is well below catches taken in the late 1970s to early 1980s (90,000–120,000 mt). This decline is presumably related to changes in targeting practices by some of the large fleets and the gradual reduction in the number of distant-water vessels. The WCP–CA longline catch for 2008 was the lowest since 1999.

As with skipjack, the great majority of the catch is taken in equatorial areas by large purse-seine vessels, and a variety of gear in the Indonesian and Philippine fisheries. The domestic surface fisheries of the Philippines and Indonesia take large numbers of small yellowfin in the 20–50 cm range. In the purse-seine fishery, smaller yellowfin are caught in log and FAD sets than in unassociated sets. A major portion of the purse-seine catch is adult (> 100 cm) yellowfin tuna, to the extent that the purse-seine catch (by weight) of adult yellowfin tuna is usually higher than the longline catch. This was clearly the case in 2008, where exceptional catches of large yellowfin in the size range 120–130 cm occurred in the purse-seine fishery.

2.2.1 Stock assessment

The most recent assessment of yellowfin tuna in the WCPO was conducted in 2009 and included data from 1952 to 2008.

Fishing mortality has increased in recent years, but is still estimated to be below FMSY, indicating that overfishing is not occurring (Figure 9). Both biomass and recruitment have declined gradually over the duration of the fishery, but biomass levels are estimated to still be above BMSY so the stock is not considered to be in an overfished state. This optimism at the stock level must be tempered by the patterns observed at the subregional level within the stock assessment. Patterns of exploitation and fishery impacts are not the same across the entire modelled region, with much high fishery impacts estimated for Region 3, the western equatorial Pacific. This region, from which 95% of catches are taken, is at least fully exploited with no potential for increased catches. The 'optimistic' overall stock status is due to the estimated buffering due to lower fishery impacts in other subregions. The WCPFC Scientific Committee reiterated earlier advice that there should be no increase in fishing mortality in the western equatorial Pacific.

2.3 Bigeye tuna

The WCP–CA 2008 bigeye tuna catch was 157,054 mt. Longline bigeye catches have fluctuated between 70,000–98,000 mt since 1999, with the 2008 catch (87,504 mt) being the third highest on record (Figure 10 and Table 5). The provisional WCP–CA purse seine bigeye catch for 2008 was estimated to be 46,811 mt which is the highest on record. However, this estimate may change since there is a substantial amount of 2008 observer data, which is used to estimate the purse-seine bigeye catch, yet to be received and processed. The WCP–CA pole-and-line fishery has generally accounted for between 2,000 and 4,000 mt of bigeye catch annually over the past decade, although recent revisions to the estimates for the Indonesian fishery have resulted in an increase (to 6,000–11,000 mt) since 2004. The "other" category, representing various types of gear in the Philippine, Indonesian and Japanese domestic fisheries, has accounted for an estimated 11,000–20,000 mt (9–13% of the total WCP–CA bigeye catch) in recent years.

The majority of the WCP–CA catch is taken in equatorial areas, both by purse seine and longline, but with some longline catch in subtropical areas (e.g. east of Japan and off the east coast of Australia). In the equatorial areas, much of the longline catch is taken in the central Pacific, continuous with the important traditional bigeye longline area in the eastern Pacific.

As with skipjack and yellowfin tuna, the domestic surface fisheries of the Philippines and Indonesia take large numbers of small bigeye in the 20–60 cm range. The longline fishery clearly accounts for most of the catch (by weight) of large bigeye in the WCP–CA. This is in contrast to large yellowfin tuna, which (in addition to the longline gear) are also taken in significant amounts from unassociated (free-swimming) schools in the purse-seine fishery and in the Philippines handline fishery. Large bigeye are very rarely taken in the WCPO purse-seine fishery and only a relatively small amount comes from the handline fishery in the Philippines. Bigeye sampled in the longline fishery are predominantly adult fish with a mean size of ~130 cm FL (range 80–160 cm FL).

2.3.1 Stock assessment

The most recent assessment of bigeye tuna in the WCPO was conducted in 2009 and included data from 1952 to 2008.

Fishing mortality is estimated to have increased over time, particularly in recent years. Current levels are far in excess of F_{MSY} level ($F_{CURRENT} > F_{MSY}$) and therefore, overfishing is occurring (Figure 11). The biomass of spawners is estimated to have declined over the duration of the fishery and is now approaching BMSY, indicating that the stock is either in a slightly overfished state or will be in the near future. The model estimates that recent catches have been sustained by higher-than-average levels of recruitment, which have also maintained biomass above the B_{MSY} level. Although this increasing trend is compatible with the existing data (which show increasing catches of both small and large bigeye tuna in recent years), it represents an area of uncertainty in the current assessment that will be examined in detail in the next assessment scheduled for 2010.

Based on the results of the assessment, and an evaluation of the potential impacts of the new WCPFC Conservation and Management Measure for bigeye and yellowfin tuna (CMM2008-01), the Scientific Committee of the WCPFC noted the continued decline in the stock and that CMM2008-01 was unlikely to achieve its objective of a 30% reduction in fishing mortality. The Committee thus recommended that further actions should be identified and implemented to ensure the achievement of these objectives.

2.4 South Pacific albacore tuna

The south Pacific albacore catch in 2008 (51,672 mt,) was clearly lower than the record catch in 2006 (65,798 mt), but still within the higher range (51,000–66,000 mt) established since 2001 (Figure 12 and Table 6). In the post-driftnet era, longline has accounted for most (> 75%) of the south Pacific albacore catch, while the troll catch, for a season spanning November – April has been in the range 3,000–8,000 mt.

The longline catch is widely distributed in the south Pacific, but with catches concentrated in the western part of the Pacific. The Chinese-Taipei distant-water longline fleet catch is taken in all three regions, while the Pacific Island domestic longline fleet catch is restricted to the latitudes 10°–25°S. Troll catches are distributed in New Zealand's coastal waters, mainly off the South Island, and along the SCTZ. Less than 20% of the overall south Pacific albacore catch is usually taken east of 150°W.

The longline fishery takes adult albacore generally in the narrow size range 90–105 cm and the troll fishery takes juvenile fish in the range 45–80 cm. Juvenile albacore also appear in the longline catch from time to time (e.g. fish in the range 60–70 cm sampled in the longline catch during 2004 and 2006).

2.4.1 Stock assessment

The most recent stock assessment for south Pacific albacore tuna was undertaken in 2009 based on data from 1960 to 2008.

The assessment indicates fishing mortality on adult fish has increased considerably over the past decade. Despite this, overall estimates of fishing mortality are well below F_{MSY} and therefore overfishing is not occurring (Figure 13). Biomass levels have declined over the last decade due to a decline in recruitment; however, current biomass levels remain well above BMSY and therefore the stock is not in an overfished state. Nevertheless, the current level of longline catch is estimated to be having a considerably higher impact on the portion of the stock vulnerable to the longline fishery. The assessment indicates that the current level of impact is about 50% for those larger fish taken in the northern longline fisheries, having increased sharply in recent years. Based on the results of the assessment, the WCPFC Scientific Committee concluded that current levels of catch are sustainable with low risk of recruitment overfishing. However, current levels of fishing mortality may be affecting longline catch rates for adult albacore.

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3 Ecosystem considerations

The Convention on the Conservation and Management of Highly Migratory Fish Stocks in the WCPO has identified ecosystem issues as an important element of the principles for conservation and management of the tuna resource in the WCP–CA. This section of the report provides a brief summary of the information available from the WCP–CA tuna fishery concerning associated and dependent species, including information on the species composition of the catch from the tuna fisheries and an assessment of the impact of the fishery on these species. It is important to note that most of these species have received limited attention to date and consequently it is only possible to provide an assessment of the impact of the fishery for a few species. The section also includes a summary of the biophysical conditions in the WCPO and a review of recent and current research on the relationship between the main tuna species and the pelagic ecosystem.

3.1 Catch composition

The tuna fisheries of the WCPO principally target four main tuna species: skipjack, yellowfin, bigeye and albacore tuna. However, the fisheries also catch a range of other species in association with these main species. Some of the associated species are of commercial value (by-product), while many others are of no value and are discarded. There are also incidents of the capture of species of importance based on their ecological and/or social significance ('protected species'), including marine mammals, sea turtles and some species of shark (e.g. whale sharks).

The information available concerning the catch composition of the main tuna fisheries in the WCPO, is largely gained from the various observer programmes operating in the region. Overall, catches from unassociated and associated purse-seine sets are dominated by the tuna species (99.9% and 98.6%, respectively) and there has been limited interaction with protected species (Figure 14). Most of the observed interactions involved unidentified species of marine mammals and few mortalities have been recorded.

Species composition of the catch has also been estimated for three main longline fisheries operating in the WCPO: the western tropical Pacific (WTP) shallow-setting longline fishery, the WTP deep-setting longline fishery, and the western south Pacific (WSP) albacore fishery. While estimates are uncertain due to the low level of observer coverage, some general conclusions can be made. The main tuna species account for 46%, 72% and 72% of the total catch (by weight) of the three fisheries, respectively (Figure 14). Blue shark was the third-ranked species in the catch composition of all three fisheries. The WTP shallow fishery has a higher proportion of non-tuna species in the catch, principally shark and billfish species, while opah (moonfish) represents a significant component of the WSP albacore longline catch. There are also considerable differences in the species composition of the billfish catch between the three fisheries, while overall the WTP shallow and WSP albacore fisheries catch a higher proportion of surface-orientated species compared to the WTP deep-setting fishery.

Interactions with seabirds and marine mammals were very low in all three longline fisheries. Catches of five species of marine turtles were observed in the equatorial longline fishery, although the observed encounter rate was very low and most of the turtles caught were alive at the time of release.

3.2 Impact of catches

In addition to the main tuna species, annual catch estimates for the WCPO are available for the main species of billfish (swordfish, blue marlin, striped marlin and black marlin). However, the catches of other associated species have not been accurately quantified. For the billfish species, preliminary stock assessments have been undertaken (Pacific-wide blue marlin, North Pacific swordfish, southwest Pacific swordfish, and southwest striped marlin), although they are hampered by limited information concerning species biology and stock structure. Nevertheless, the assessments generally indicate that these stocks are not overexploited at current levels of fishing effort.

To evaluate current exploitation rates and the impacts of FAD fishing methods on tuna stocks, over 250,000 tuna have been tagged and released in the equatorial western and central Pacific Ocean (Figure 15). Preliminary analysis supports the current estimates of stock status for the tuna species with exploitation rates higher for bigeye and yellowfin than for skipjack. Information on movement demonstrates higher mobility in skipjack in comparison to yellowfin and bigeye. Analysis of electronic tag data has identified the shallow depth behaviour exhibited by all three species when associating with FADs and consequently the increased vulnerability of juvenile bigeye to capture by purse-seine fishing methods on FADs. Residency time on the FADs was shorter than reported in other oceans and in the eastern Pacific Ocean. Scientific observer sampling of purse-seine catches from FAD sets has identified that past estimates of juvenile bigeye catches on these sets may have underestimated the bigeye catch by 5–15%.

3.3 Trophic structure and ecology

Recent analyses comparing the trophic structure of the pelagic ecosystems in the equatorial Pacific suggested distinct differences in the trophic structure of the western and eastern regions. The western Pacific tuna were characterised by a fish-dominated diet while tuna in the eastern Pacific were eating squids in high proportion. Specific prey were found in the eastern and western parts of the equatorial Pacific, such as mantis shrimps (Stomatopoda), anchovies, and juveniles of reef-associated fish (surgeonfish, butterflyfish) in the west, and the swimming crab (*Callinectes* sp.) and 14 squid species, particularly the jumbo squid (*Dosidicus gigas*), in the east. Food-web modelling using this dietary information identified spatial heterogeneity in the structure of the Pacific ecosystems. In the eastern Pacific, there was a large influence of squids and of bullet/frigate tuna (*Auxis* spp.), while in the western Pacific skipjack had a key role in the ecosystem.

A database has been established to curate data on the location and physical description of seamounts in the western and central Pacific Ocean. Twenty datasets on seamounts and bathymetry from different sources and scales (from individual cruises to worldwide satellite data) were gathered and cross-validated to remove any atolls and islands incorrectly classified as seamounts. The screening of all the potential seamounts produced a final list of 4023 underwater features with accurate position and information (Figure 16).

Tuna longline observer data were then used with the seamount database to investigate the role of seamounts in aggregating large pelagic biodiversity, and to identify which pelagic species are associated with seamounts.

The analysis indicates that seamounts are hotspots of pelagic biodiversity. Higher species richness was detected in association with seamounts than with coastal or oceanic areas. Seamounts were found to have higher species diversity within 30–40 km of the summit, while for sets close to coastal habitat the diversity was lower and fairly constant with distance. The study supports hypotheses that seamounts may be areas of special interest for management of marine pelagic predator species, such as blue shark, oceanic whitetip shark, swordfish, skipjack, moonfish, sunfish, albatross and dolphins.

Preliminary analysis of sex ratio and growth data has detected evidence of spatial variation in the growth and reproductive biology of bigeye, yellowfin and south Pacific albacore with slower growth observed in the western Pacific and an earlier onset of maturity than that observed in the central Pacific. Biological samples are now being collected for each species to help address this question.

3.4 Oceanographic and climate effects

Ocean-climate systems have been shown to strongly influence tuna fisheries in the Western and Central Pacific Ocean (WCPO) The physical oceanography of the WCPO strongly influences the tuna fisheries at various spatio-temporal scales and in different ways. Climate related changes in oceanic conditions (e.g. currents, primary production and temperature,) influence tuna vertical and horizontal movements, larval survival and recruitment strength, and may lead to changes in fishery distribution and catch rates. Understanding oceanographic spatio-temporal variability and its impact on fisheries remains a key issue for fishery management.

Movement of water masses linked to wind-driven surface currents largely influences the distribution, abundance and migration of tunas. Surface water circulation in the WCPO is dominated by two large, closed circular gyres centred at approximately 30° North and South (Figure 17). Between these gyres lies the Pacific equatorial current system, which consists of two westward-flowing currents — the North Equatorial Current (NEC) and South Equatorial Current (SEC) — and two eastward-flowing counter-currents — the North Equatorial Counter Current (NECC) and South Equatorial Counter Current (SECC). Along the Philippine coast, the NEC bifurcates and turns into the northward-flowing Kuroshio Current (KUR), which becomes the western boundary of the north Pacific subtropical gyre. The equatorial branch of the SEC enters the Coral Sea south of the Solomon Islands and becomes the East Australian Current (EAC), which defines the western boundary of the south Pacific subtropical gyre. Areas of divergence or convergence of currents induce physical phenomena (e.g. upwellings, thermal fronts and eddies) that enhance local productivity and create zones of forage availability for tuna. Therefore, seasonal and annual variations in current patterns and the associated variation in the location and timing of productive areas are of major importance for fishermen as they affect tuna distribution and availability.

Tuna movement is also linked to the horizontal displacement of surface isotherms and vertical change in mixed layer depth that determine their surface habitat. The northern arm of the SEC is driven westward along the equator by the southeast trade winds, creating an upwelling of cooler, nutrient-rich waters extending westward from the coast of South America. This cooler water mass is characterised by high primary productivity and is frequently referred to as the “cold tongue”. In contrast, the western equatorial Pacific is characterised by low primary production and warmer surface waters (>28°C) that typically show little seasonal variability (<1°C). This water mass is referred to as the “warm pool” (Figure 17). The largest proportion of the tuna catch (mainly skipjack) in the Pacific Ocean is taken within the warm pool area. Surface tuna fisheries, particularly purse-seine fisheries targeting skipjack, appear to respond to the seasonality of the warm pool. Large-scale movements of tropical tuna in the western central equatorial Pacific have been correlated with the position of the oceanic convergence zone, produced where the warm pool meets the cold tongue. This nutrient-rich zone supports high concentrations of secondary productivity (small fishes) in a band several hundred kilometres wide along the eastern edge of the warm-water pool. Tuna are likely to seasonally follow this convergence zone to remain in waters with relatively high concentrations of prey species in conditions suitable for reproduction. Variations in tuna catches are reported at regional and domestic scales both seasonally and inter-annually and are related to east-west migration of the warm pool–cold tongue pelagic ecosystem.

El Niño Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) events are the dominant source of environmental variability in the WCPO on inter-annual and decadal scales respectively. While ENSO and PDO patterns are clearly related, PDO phases seem to last for 20–30 yrs, with some interannual variability, while ENSO events tend to last for only 6–18 months, with high monthly variability, at least in some indicators such as the Southern Oscillation Index (SOI) (Figure 17). El Niño events dominate ENSO during the positive (warm) phase of the PDO, and La Niña events prevail during the negative (cold) PDO phase. Analyses have demonstrated that inter-annual variability in the environmental conditions linked to the El Niño Southern Oscillation (ENSO) is evident in the operation of the main tuna fisheries and the population dynamics of the tuna species. During El Niño conditions, the distribution of purse-seine catch in the WCPO is generally displaced eastwards, indicating a spatial shift in the distribution of skipjack tuna. For longline fisheries, the vertical change in the thermal structure during El Niño (La Niña) events results in the rising (deepening) and vertical extension (contraction) of the temperature habitats of yellowfin and bigeye, thereby affecting the catchability of the species. Recruitment in tuna populations is also influenced by ENSO variability, although the conditions favouring recruitment vary between species. El Niño events appear to result in higher recruitment for skipjack and yellowfin, while south Pacific albacore recruitment is higher under La Niña conditions. It is hypothesised that the cold regime of PDO (1947–1977) would benefit subtropical species, while the warm regime of PDO (1977–1998) would favour tropical tuna recruitment.

To explore the mechanisms by which climate and environmental variability affect the pelagic ecosystem and tuna populations, a spatial ecosystem and population dynamics model (SEAPODYM) has been developed. The model has been applied to bigeye, yellowfin, skipjack and south Pacific albacore. Climate change impacts have been simulated for skipjack and bigeye using forcing datasets of oceanic conditions under the IPCC scenario, SRES A2 (i.e. atmospheric CO_2 concentrations reaching 850 ppm in the year 2100) and historical data between 1860 and 2000. The simulations demonstrate clear expansion of the spawning habitat and density of larvae for both species, especially in the eastern tropical Pacific (Figure 18). This phenomenon occurs in correlation with the temperature warming but also with the changes in productivity and circulation that interact together through the larvae prey-predator interactions in the model. Despite the large increase in larval density, the ensuing adult biomass of both species is predicted to decrease in the western Pacific and to remain stable or slightly increase in the eastern Pacific.

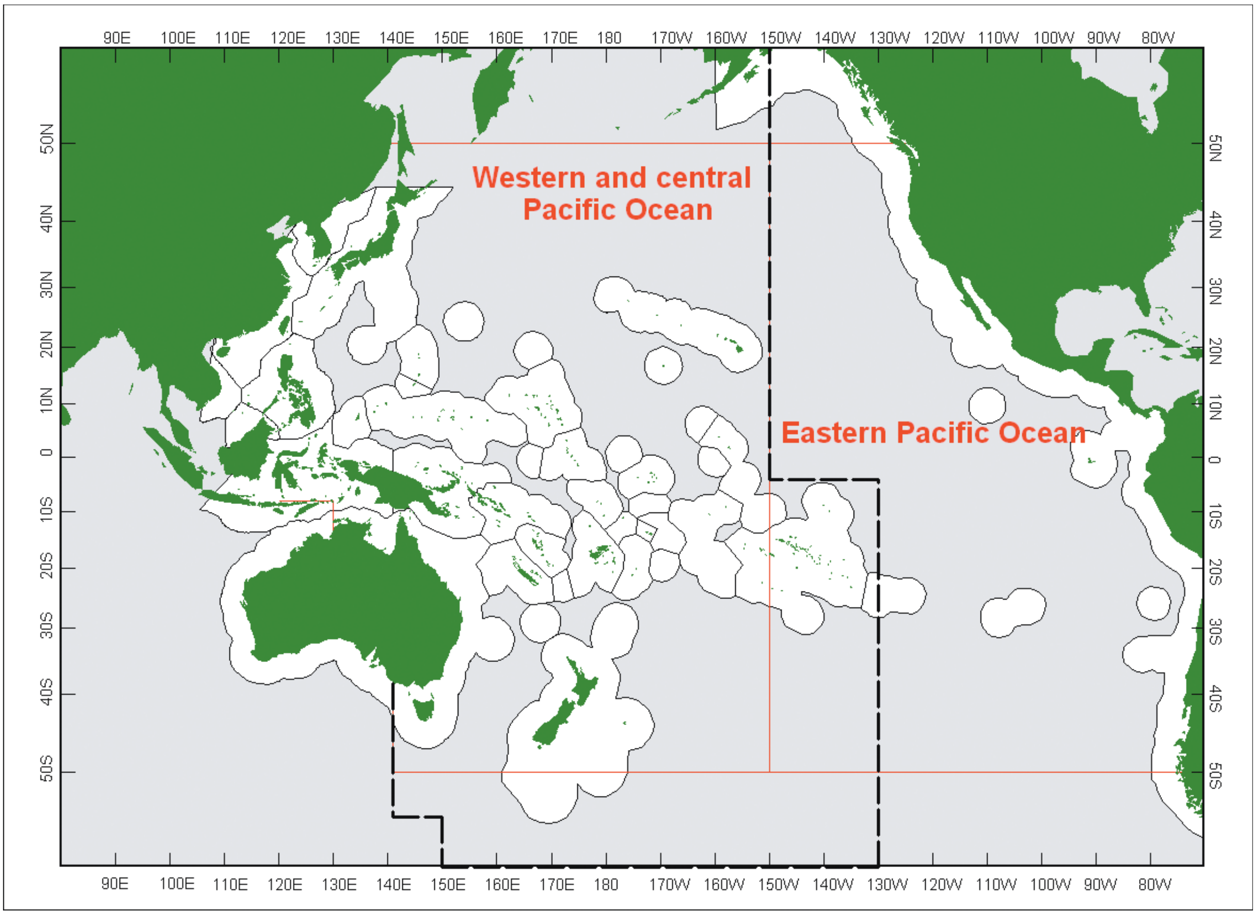
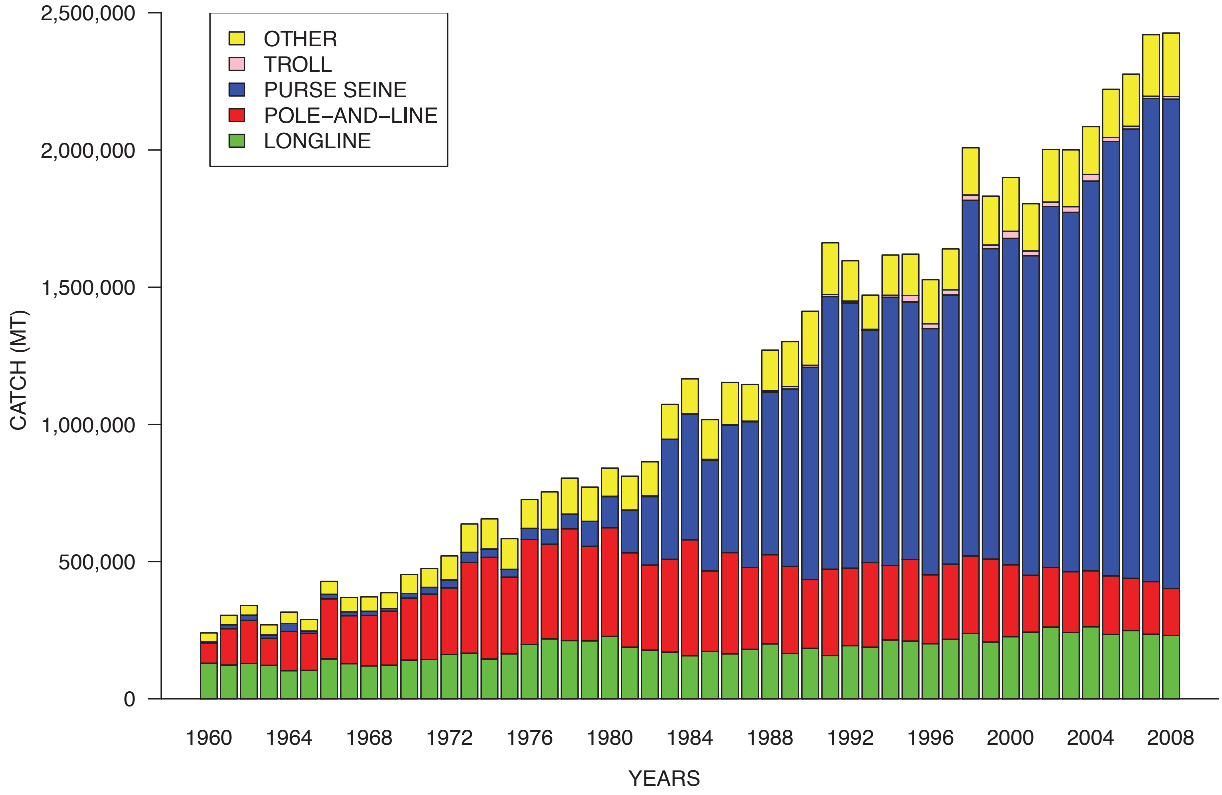


Figure 1: The western and central Pacific Ocean (WCPO), the eastern Pacific Ocean (EPO) and the WCPFC Convention Area boundary (WCP–CA in dashed lines).



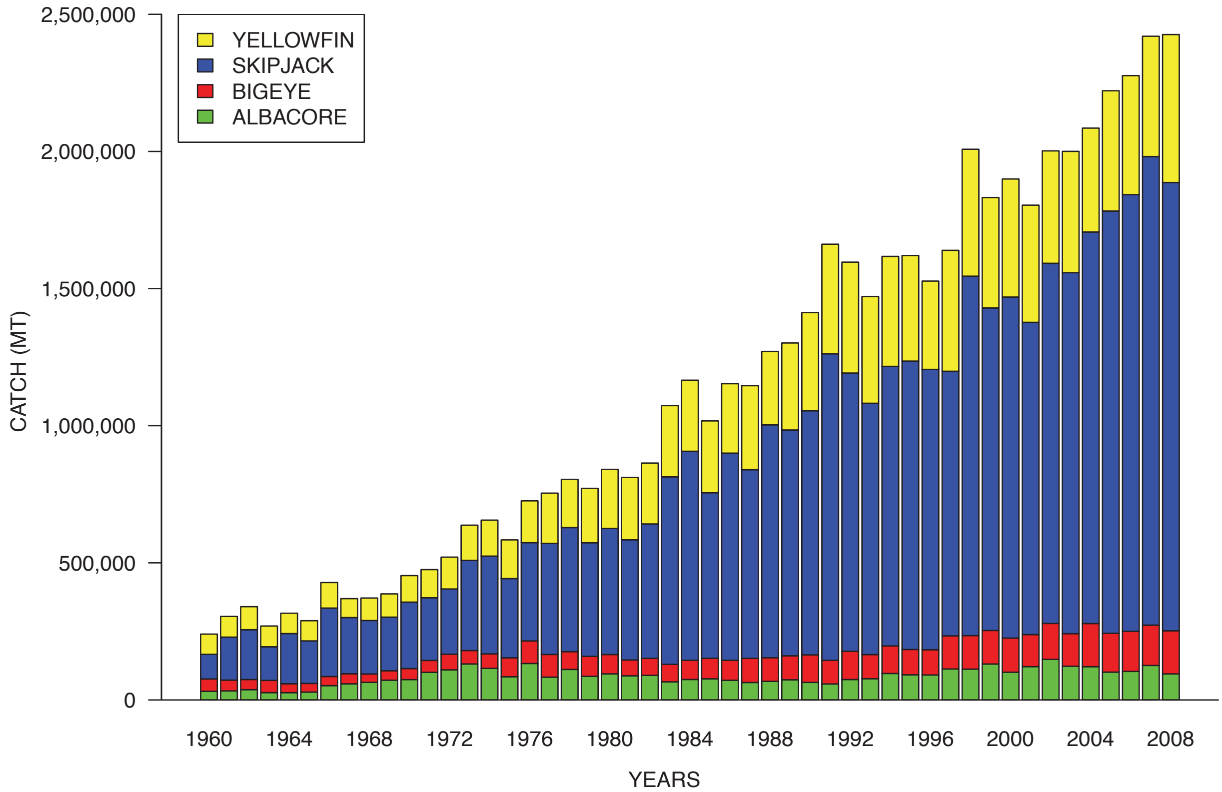


Figure 2: Catch (metric tonnes) by gear type (top) and species (bottom) for the western and central Pacific region, 1960–2008. (Note: data for 2008 are preliminary

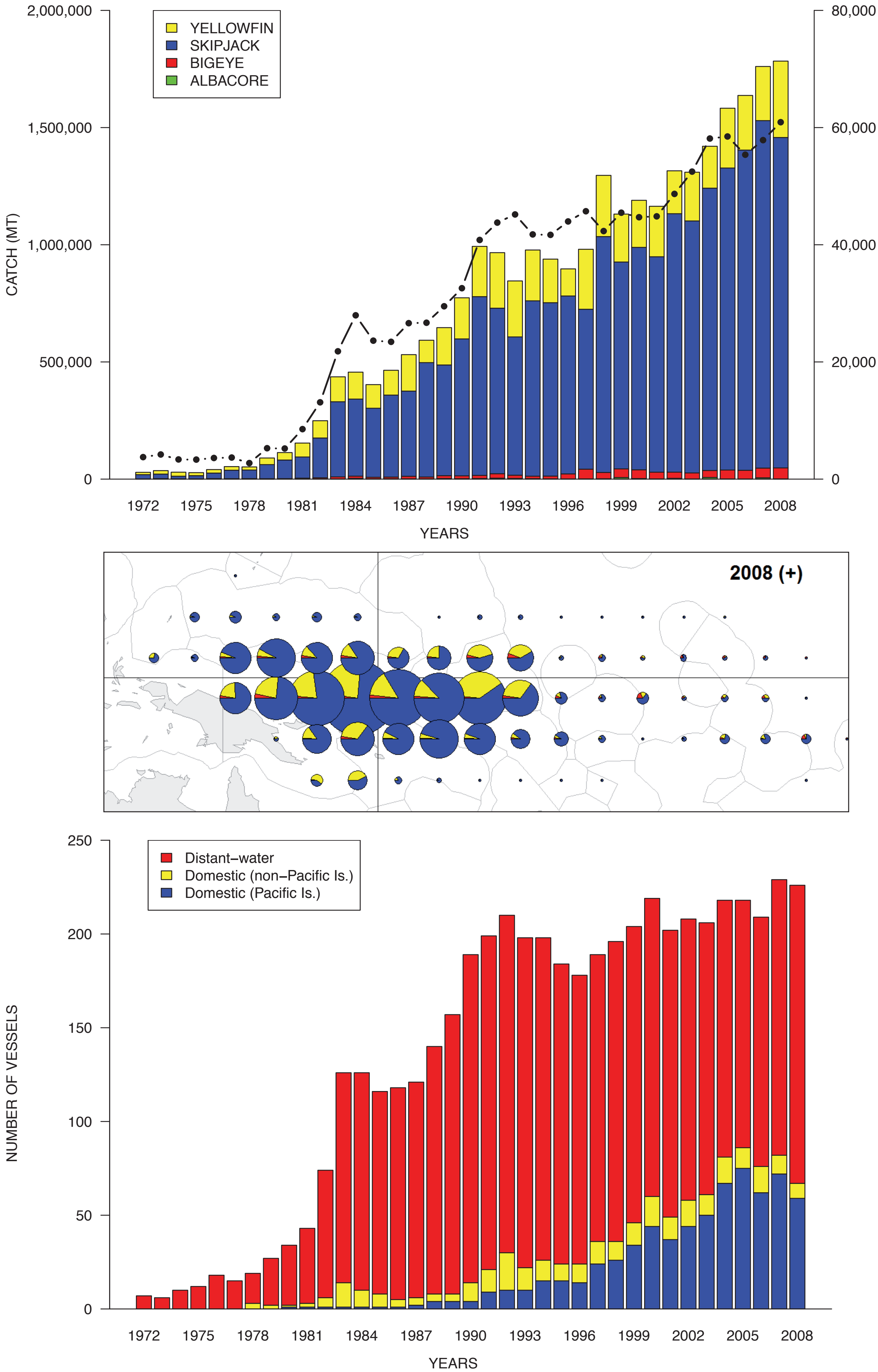


Figure 3: Time series of catch (mt) and effort (top), recent spatial distribution of catches (middle), and fleet sizes (bottom) for the purse-seine fishery in the western and central Pacific Ocean (WCPO).

back to contents page

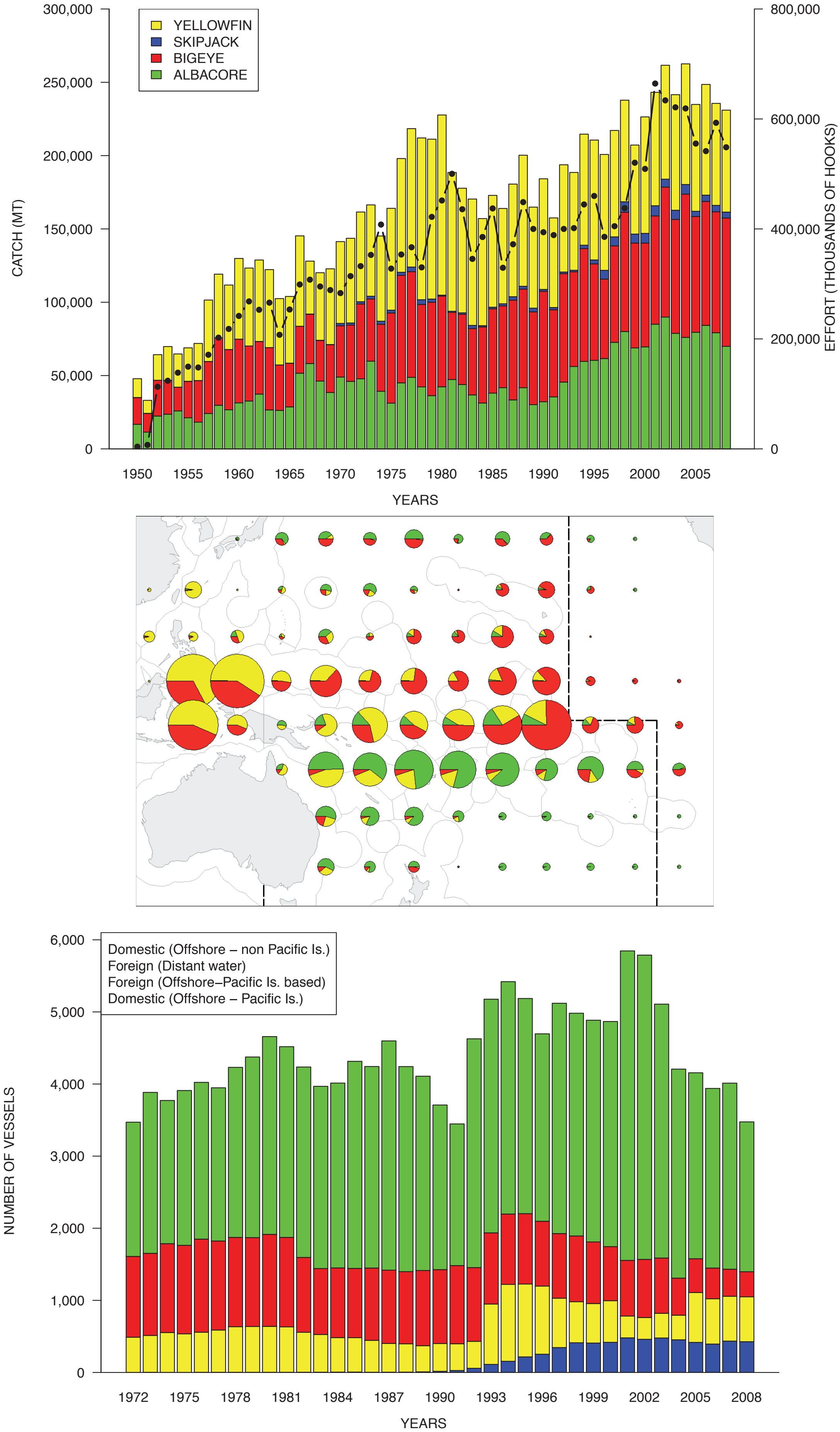


Figure 4: Time series of catch (mt) and effort (top), recent spatial distribution of catches (middle), and fleet sizes (bottom), for the longline fishery in the western and central Pacific Ocean (WCPO).

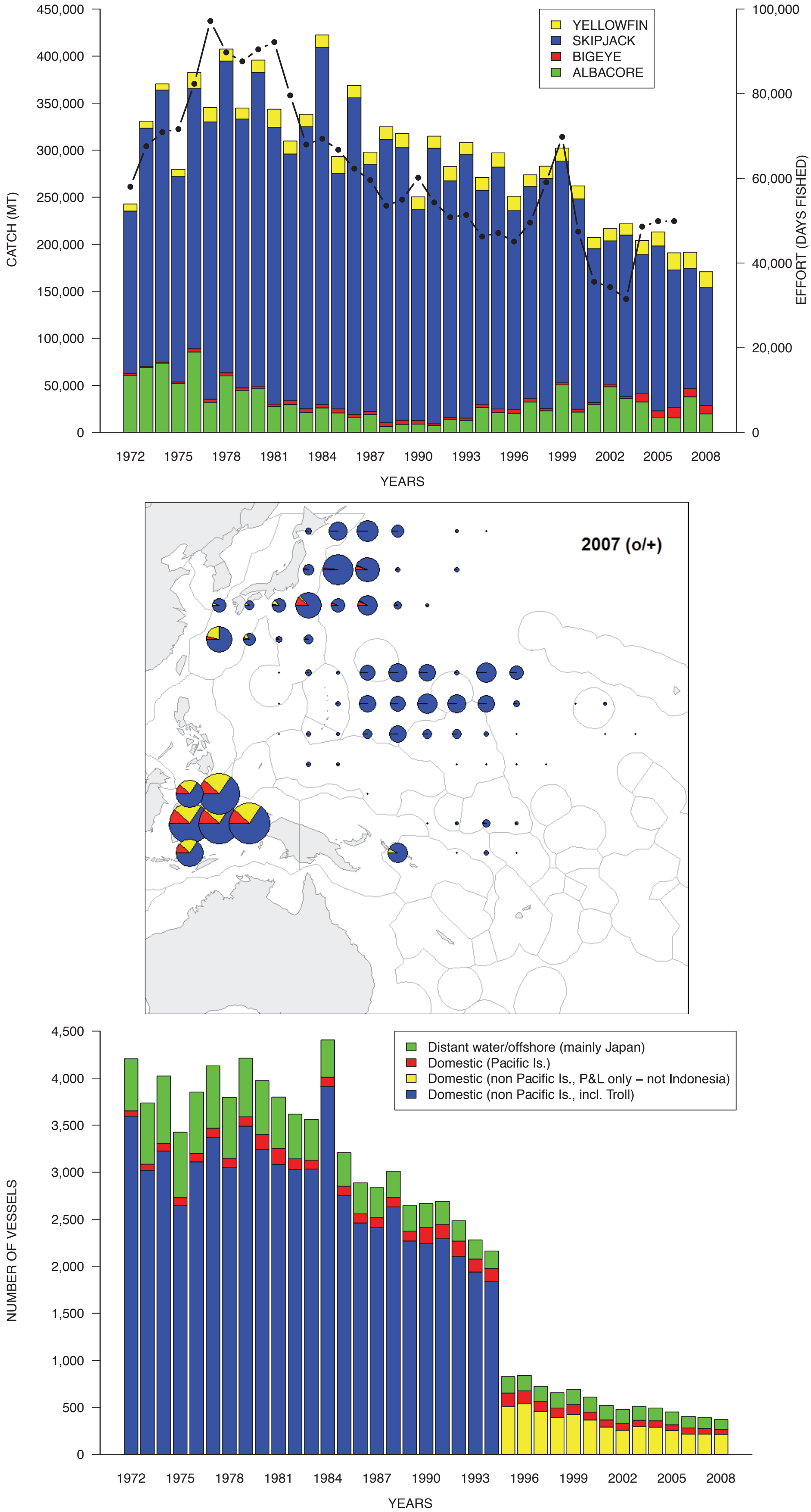


Figure 5: Time series of catch (mt) and effort (top), recent spatial distribution of catches (middle), and fleet sizes (bottom), for the pole and line fishery in the western and central Pacific Ocean (WCPO).

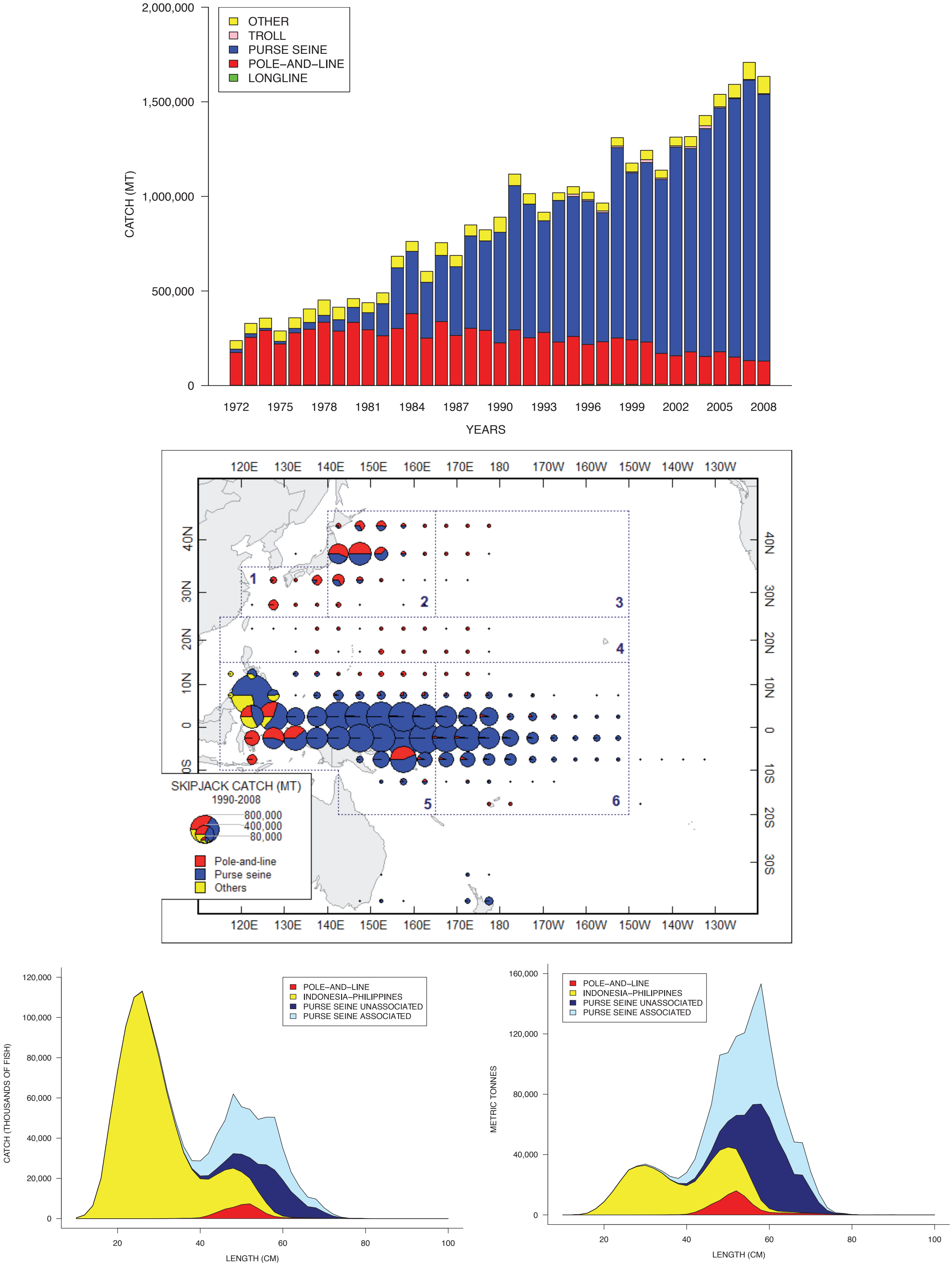


Figure 6: Time series (top), recent spatial distribution (middle), and size composition (bottom) of skipjack tuna catches (mt) by gear for the western and central Pacific Ocean (WCPO).

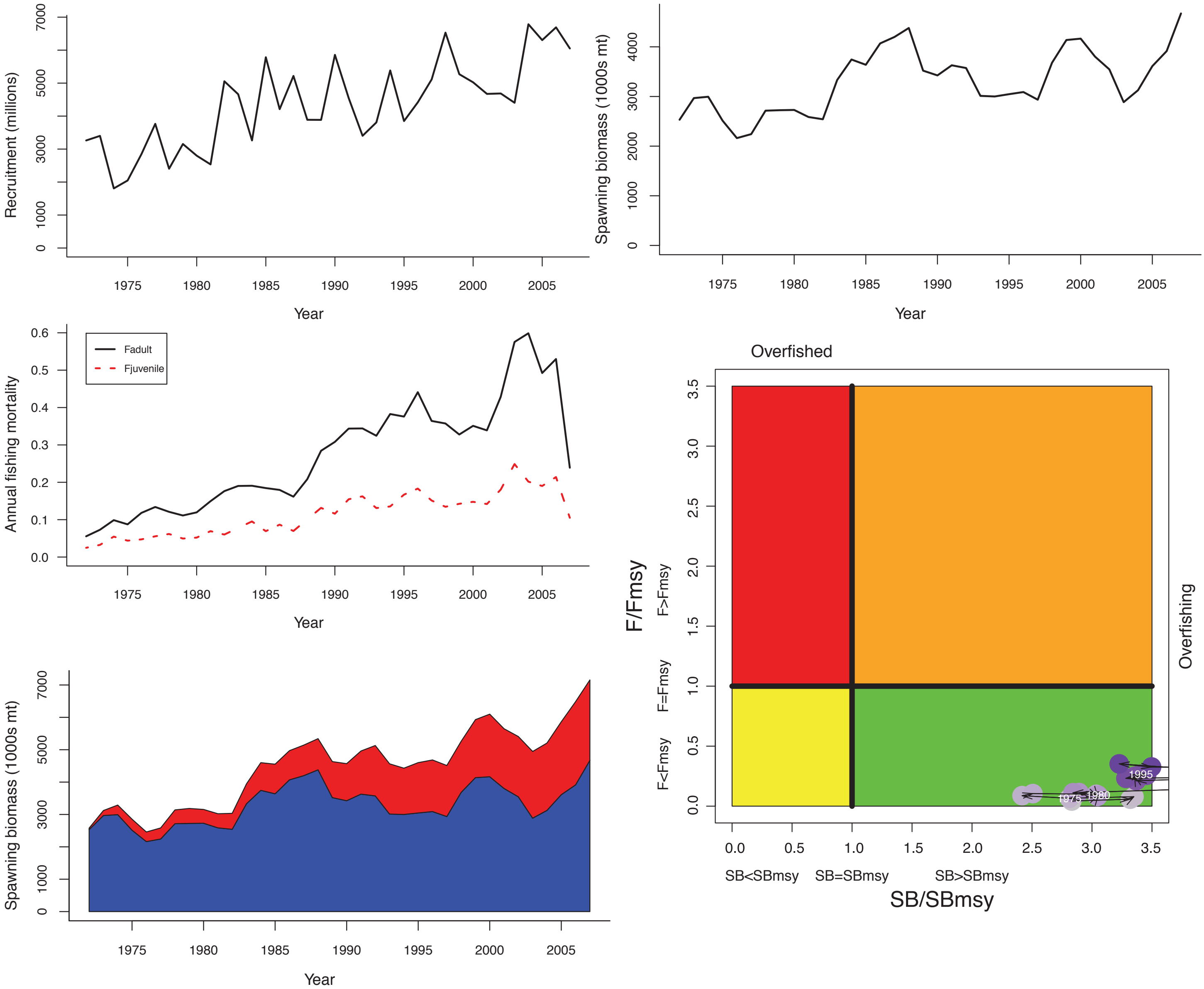


Figure 7: Estimated recruitment (top left), spawning biomass (top right), fishing mortality (middle left), stock status (middle right), and estimated spawning biomass with [blue] and without [red] fishing (bottom left) from the 2008 skipjack tuna stock assessment.

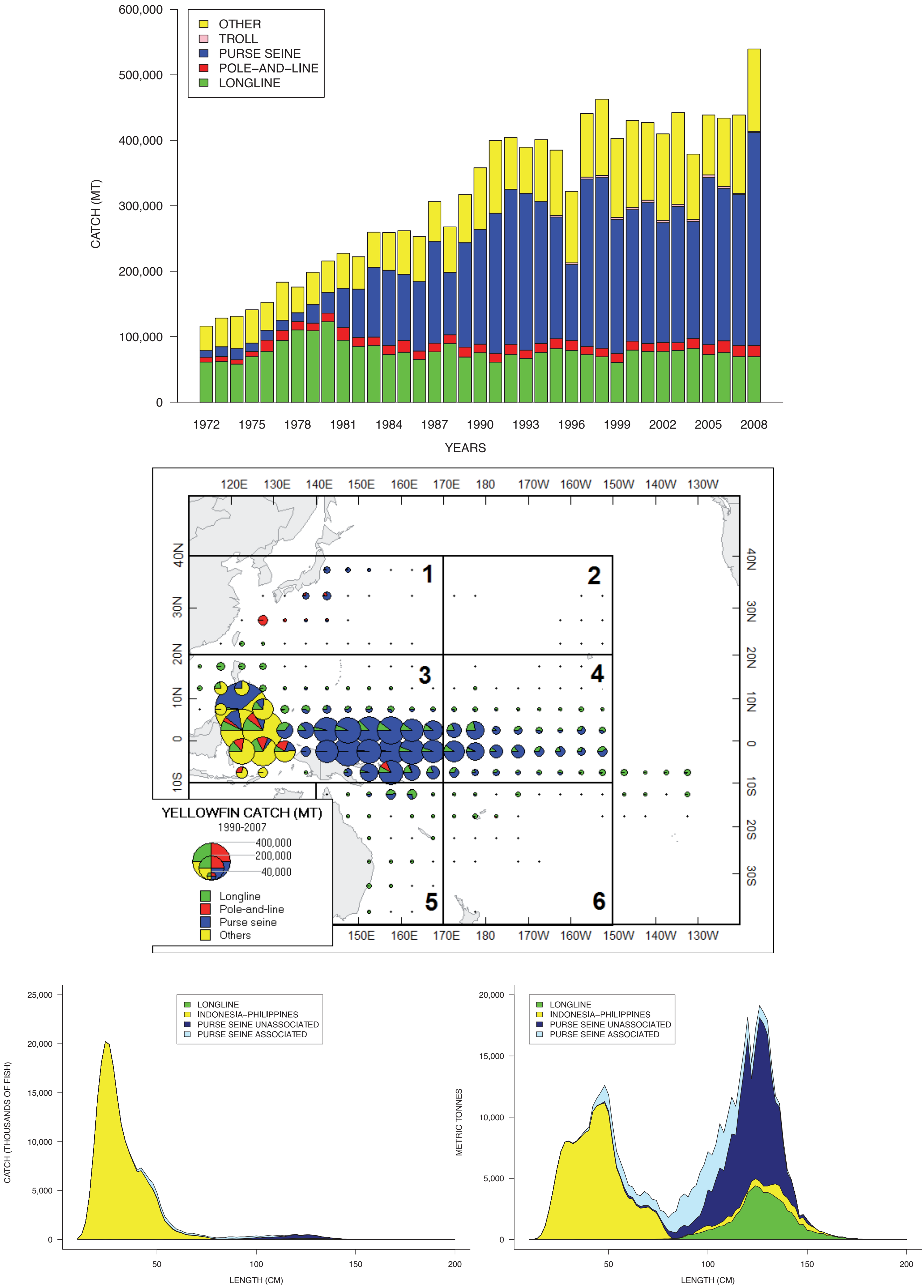


Figure 8: Time series (top), recent spatial distribution (middle), and size composition (bottom) of yellowfin tuna catches (mt) by gear type for the western and central Pacific Ocean (WCPO).

back to contents page

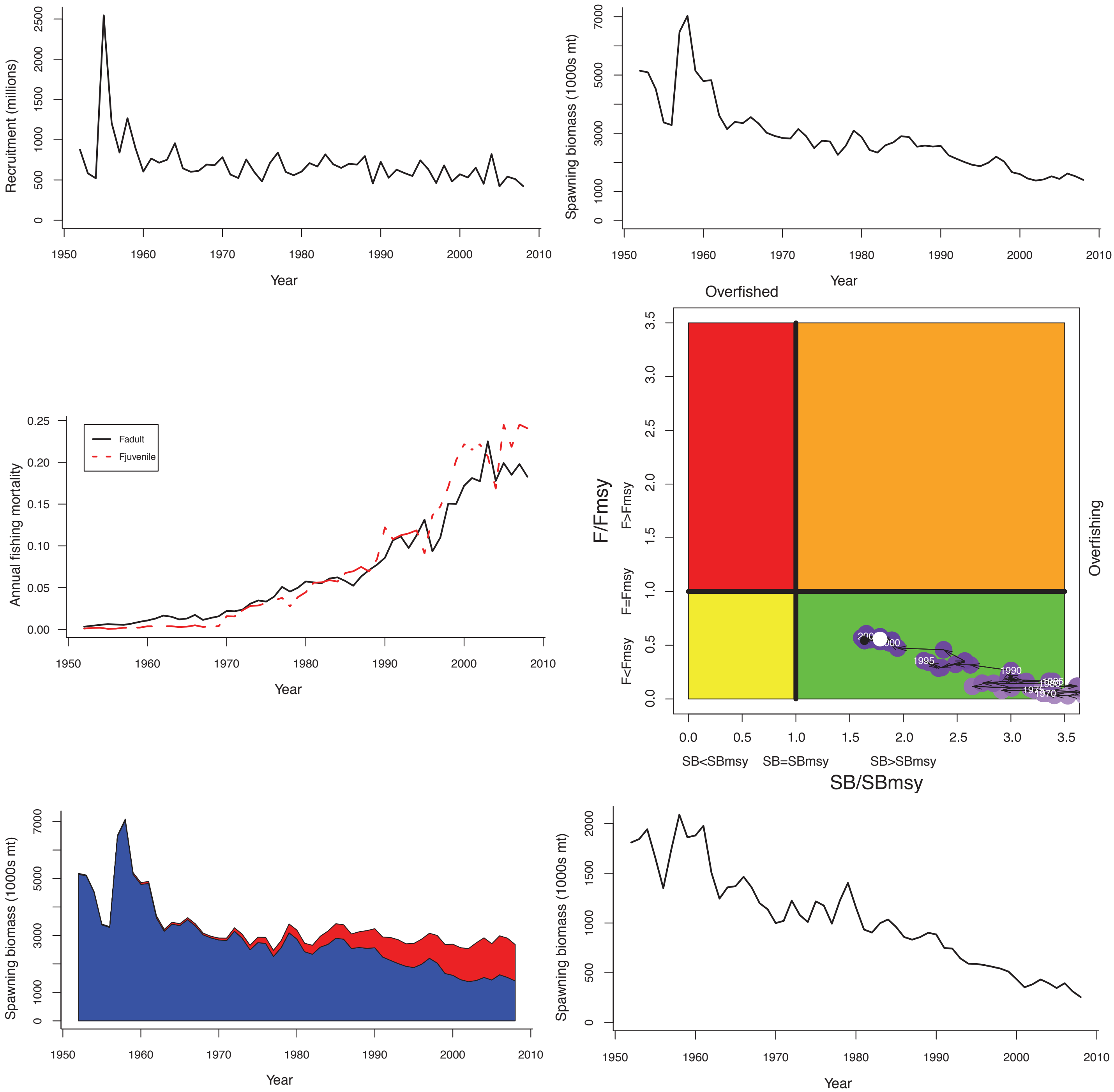


Figure 9: Estimated recruitment (top left), spawning biomass (top right), fishing mortality (middle left), stock status (middle right), estimated spawning biomass with [blue] and without [red] fishing (bottom left), and spawning biomass for the western equatorial region (bottom right) from the 2009 yellowfin tuna stock assessment.

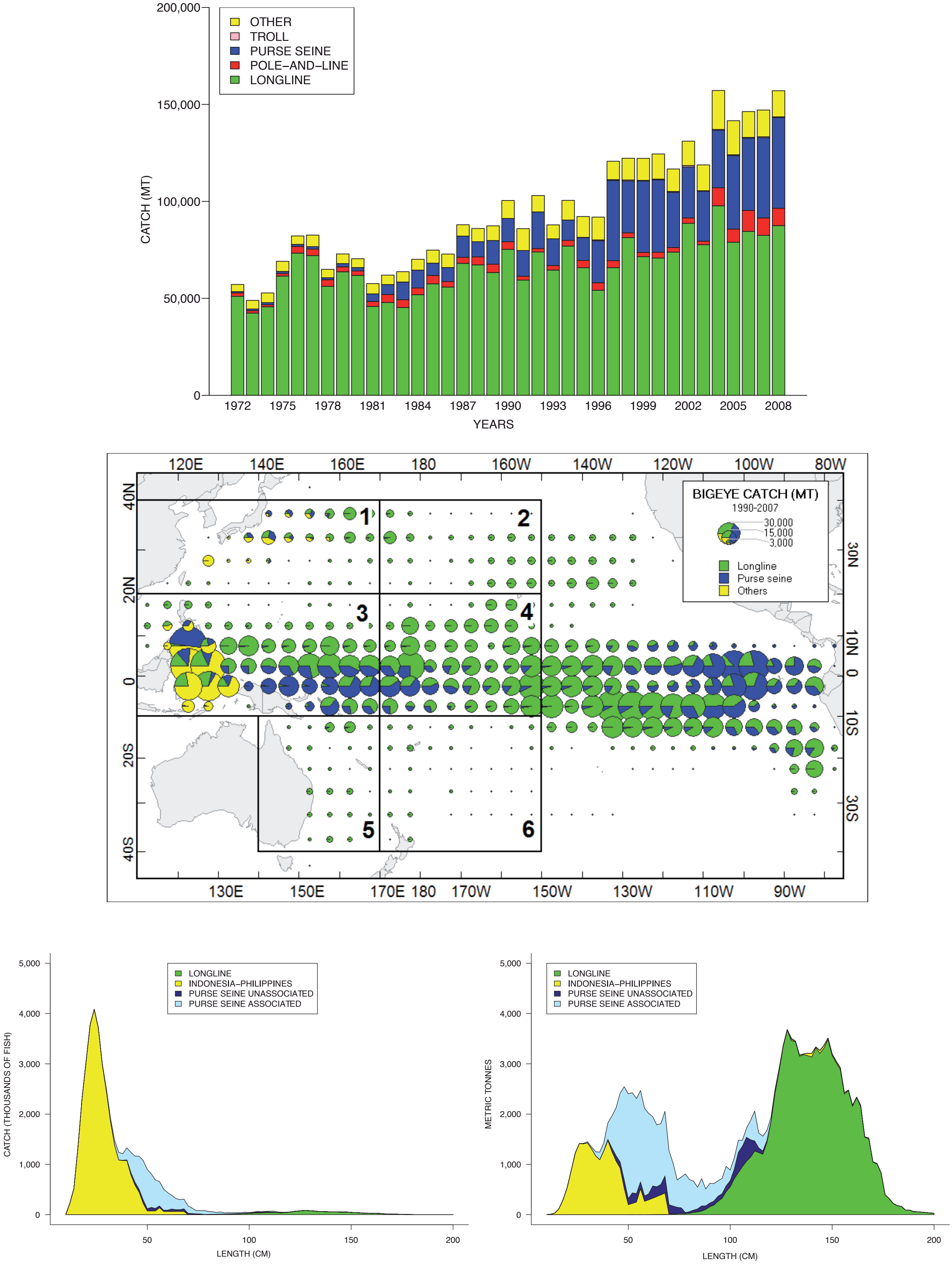


Figure 10: Time series (top), recent spatial distribution (middle), and size composition (bottom) of bigeye tuna catches (mt) by gear type for the western and central Pacific Ocean (WCPO).

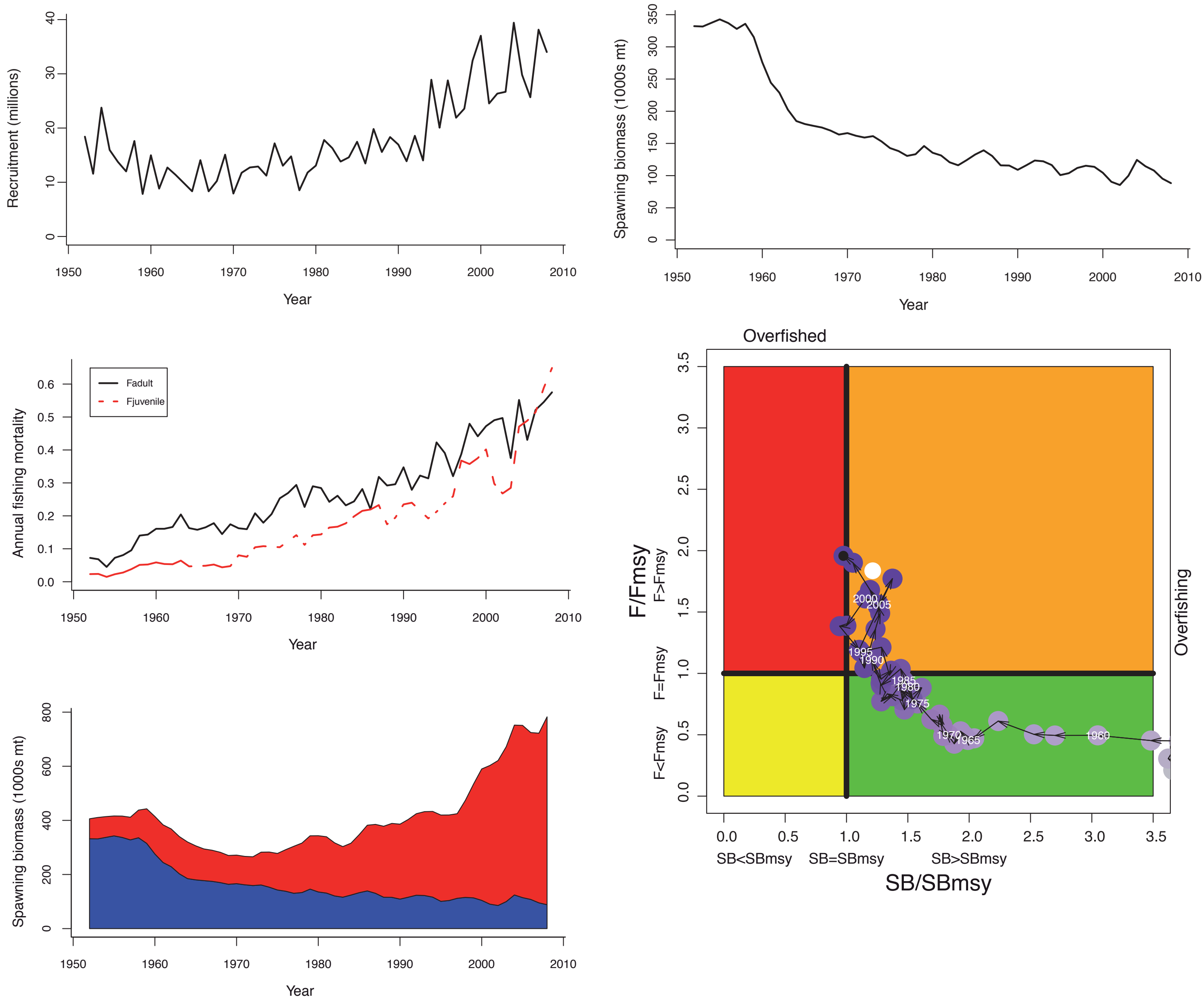


Figure 11: Estimated recruitment (top left), spawning biomass (top right), fishing mortality (middle left), stock status (middle right), and estimated spawning biomass with [blue] and without [red] fishing (bottom left) from the 2009 bigeye tuna stock assessment.

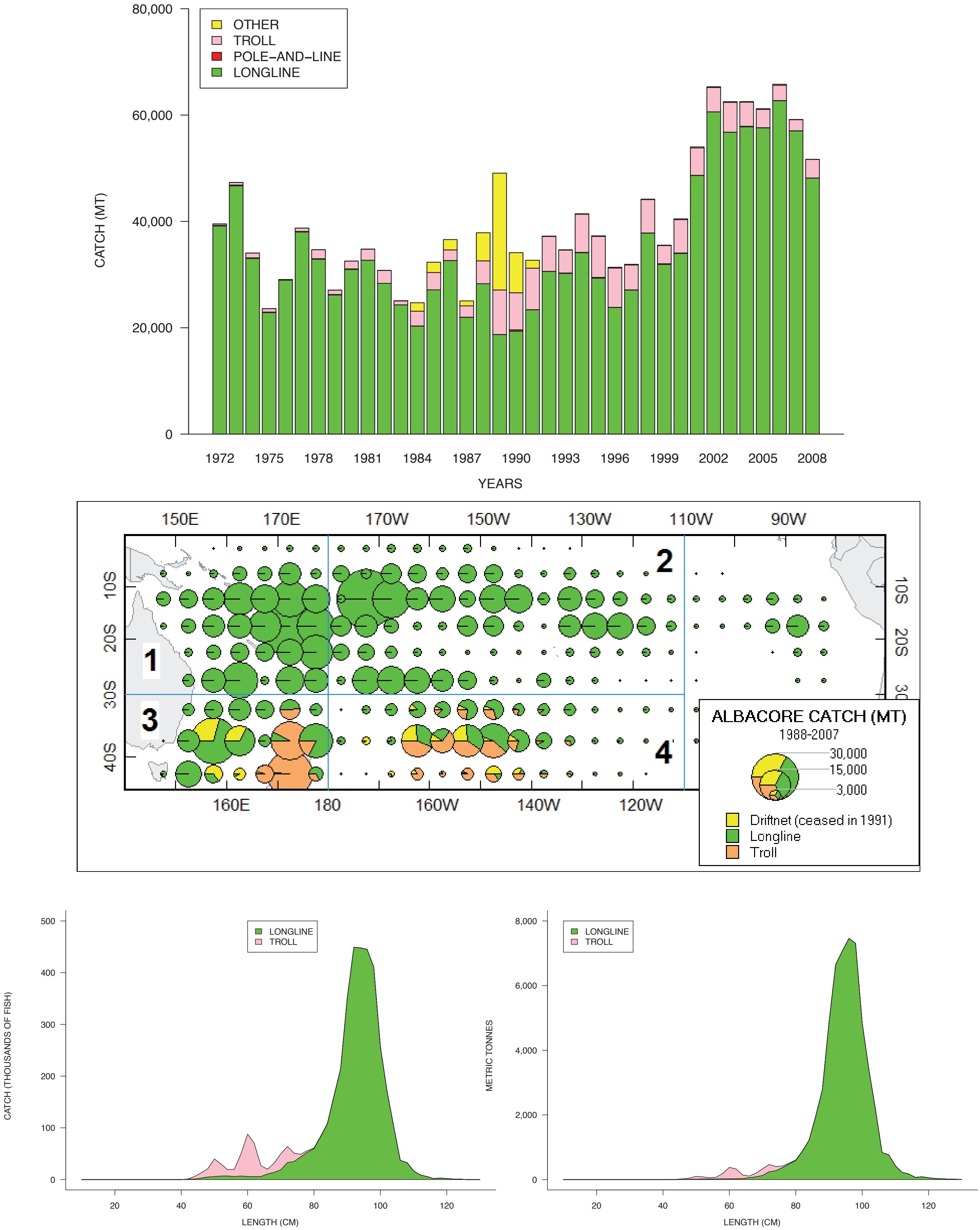


Figure 12: Time series (top), recent spatial distribution (middle), and size composition (bottom) of south Pacific albacore tuna catches (mt) by gear type for the western and central Pacific Ocean (WCPO).

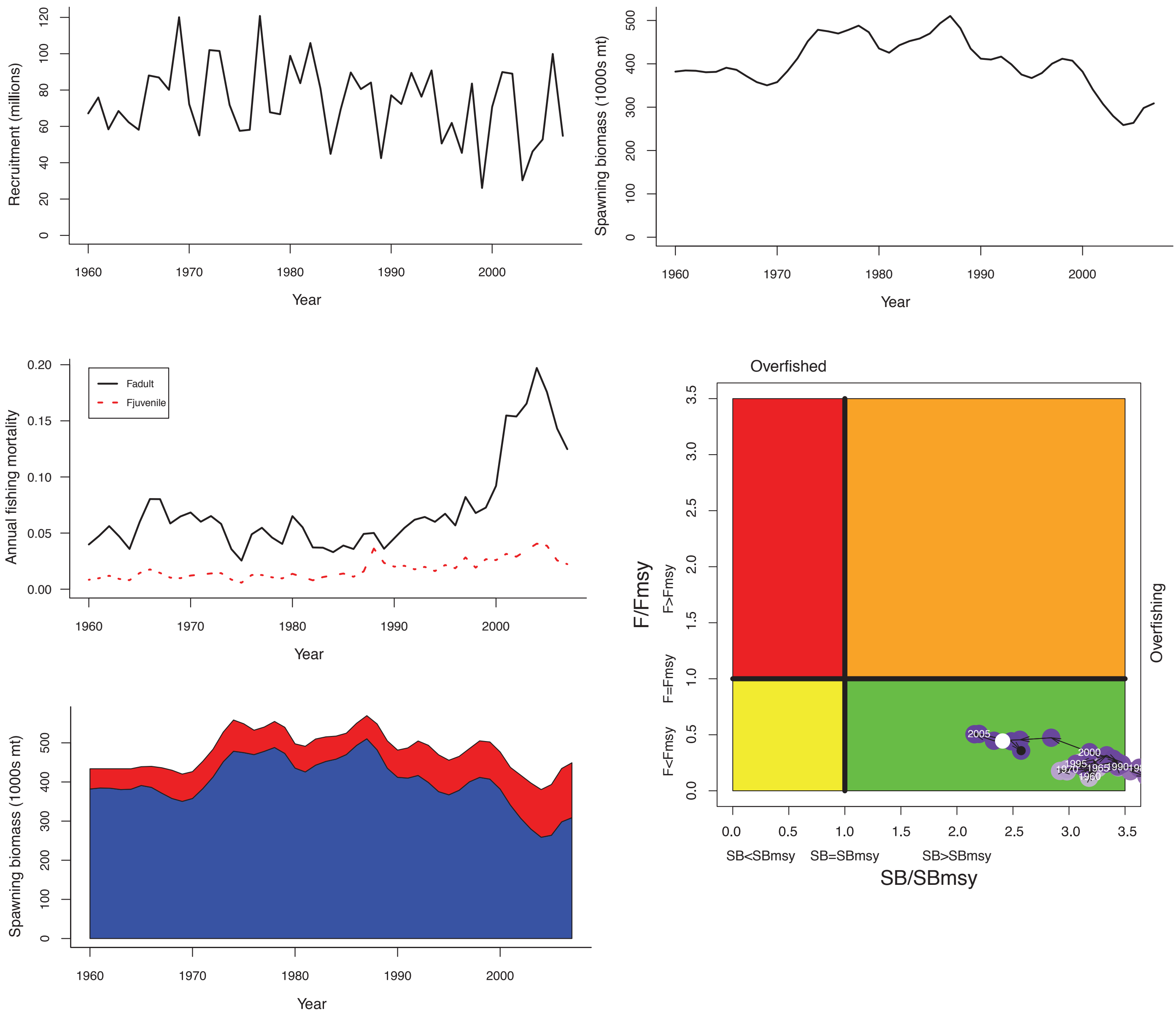


Figure 13: Estimated recruitment (top left), spawning biomass (top right), fishing mortality (middle left), stock status (middle right), and estimated spawning biomass with [blue] and without [red] fishing (bottom left) from the 2009 south Pacific albacore tuna stock assessment.

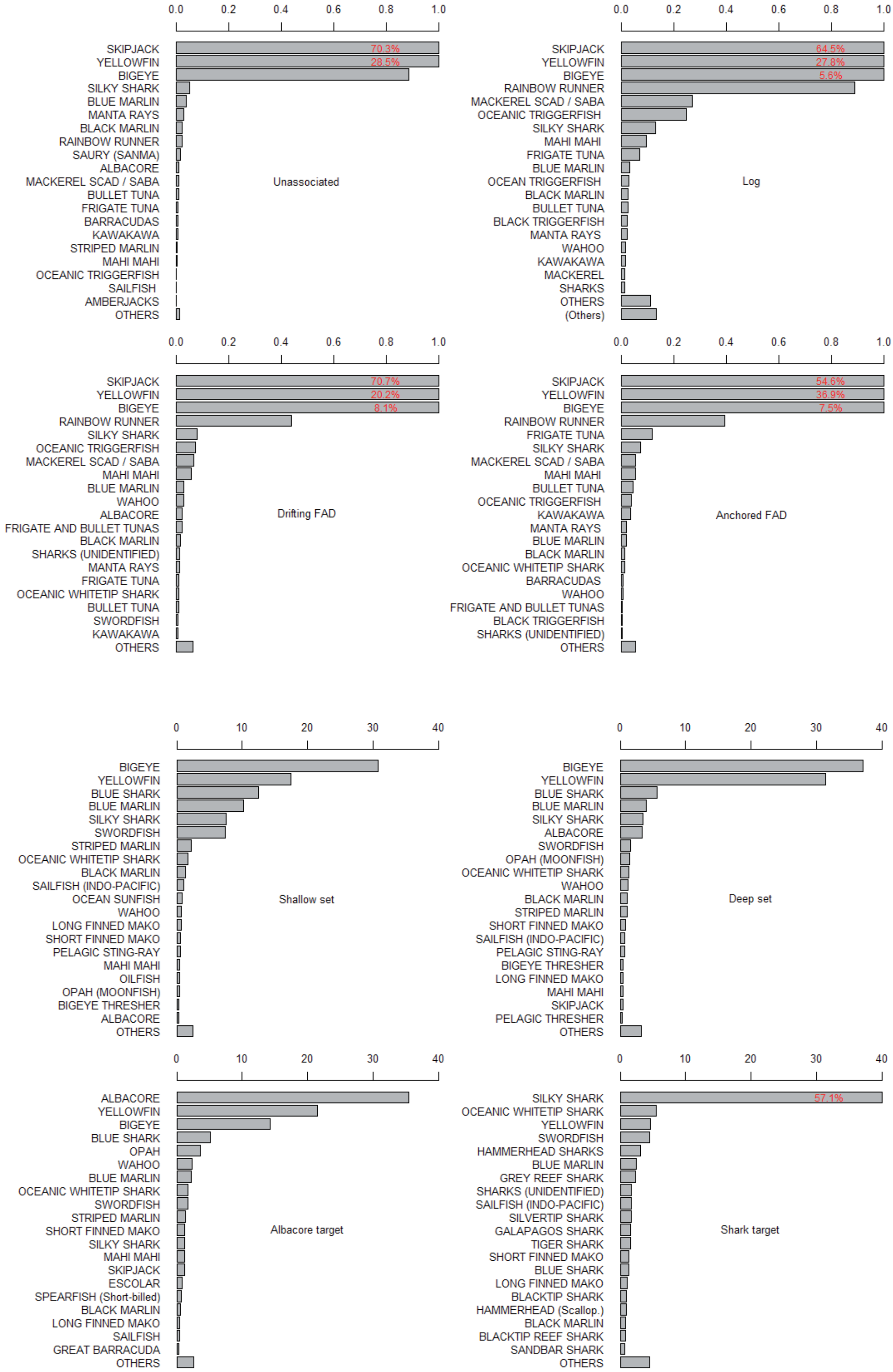


Figure 14: Catch composition of the various categories of purse seine (top) and longline (bottom) fisheries operating in the WCPO.

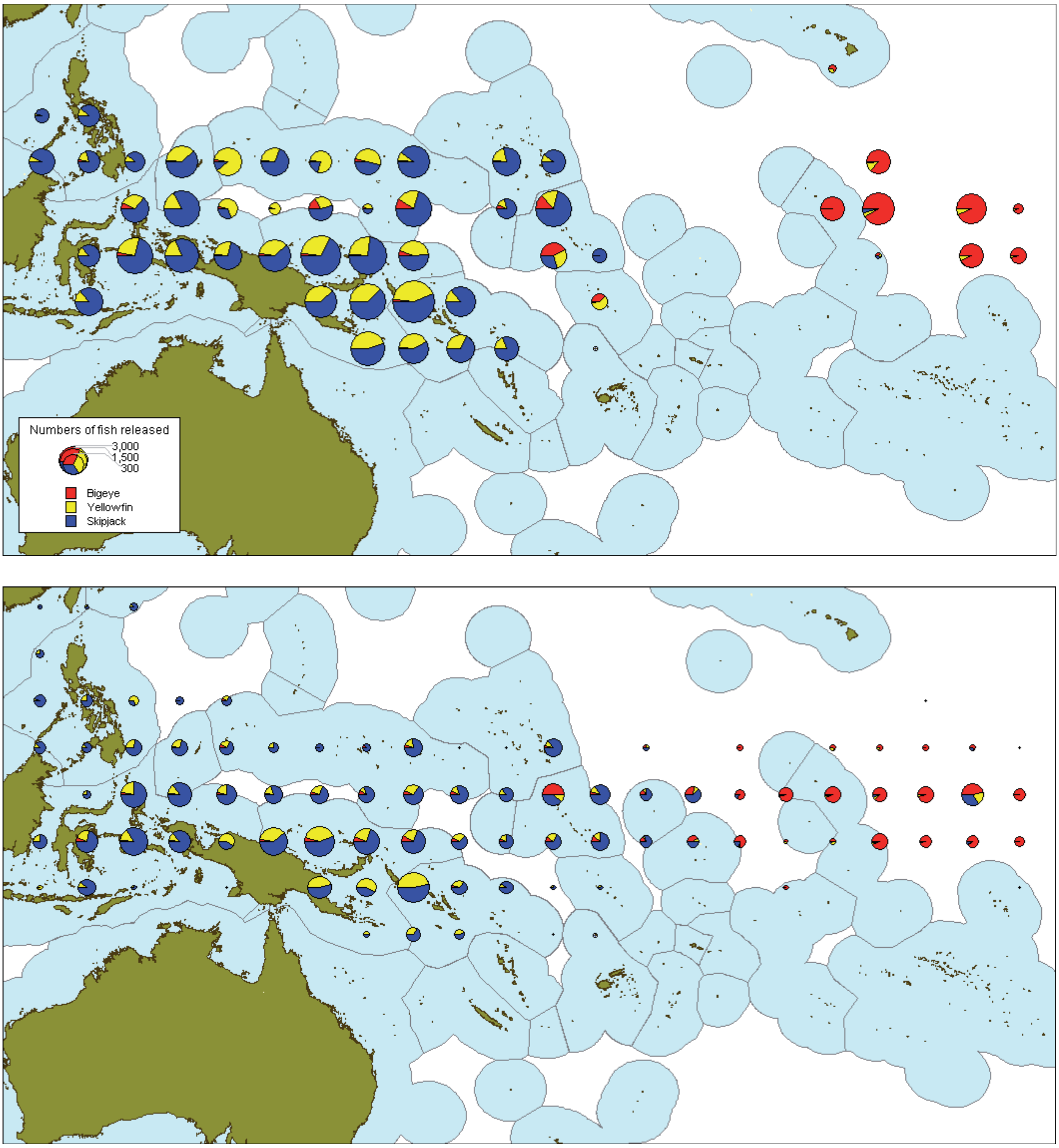


Figure 15: Tag releases (top) and recaptures (bottom) by species from the recent Pacific Tuna Tagging Programme (PTTP).

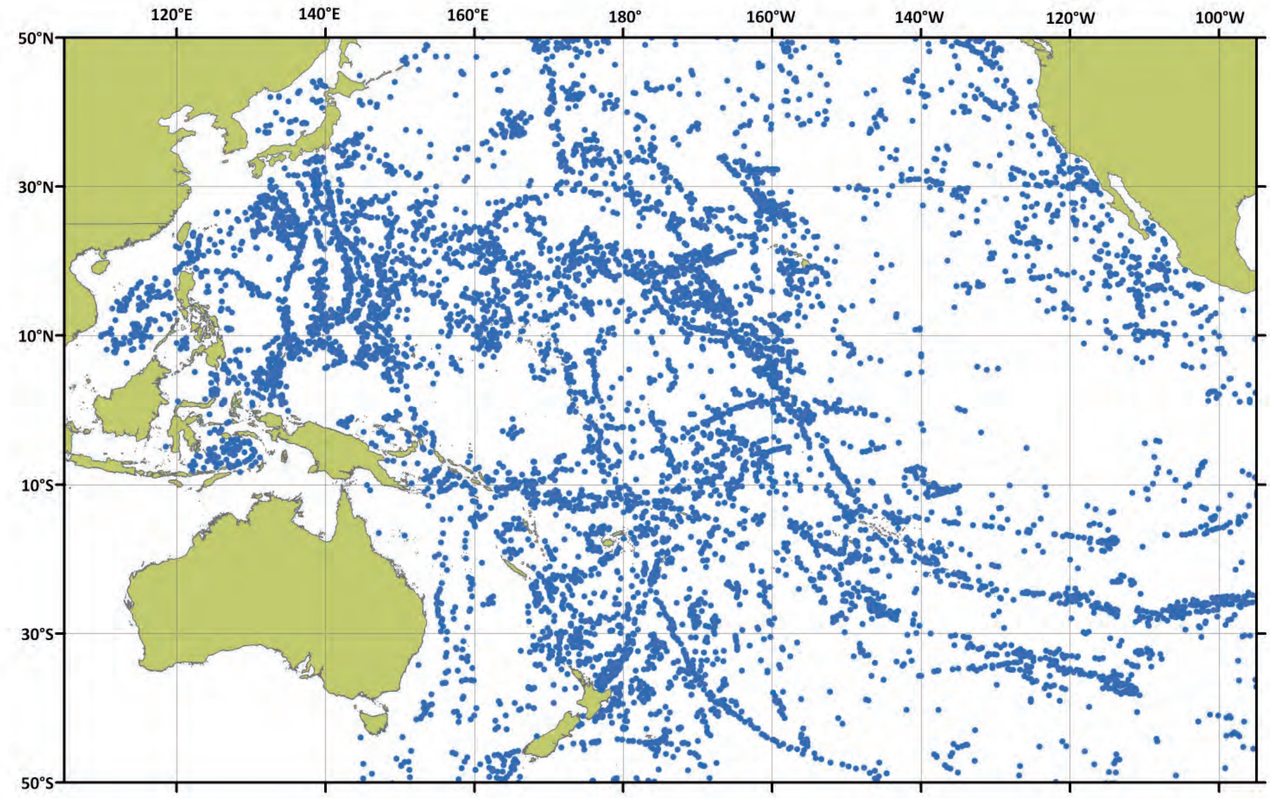


Figure 16: Locations of known seamounts in the Pacific Ocean.

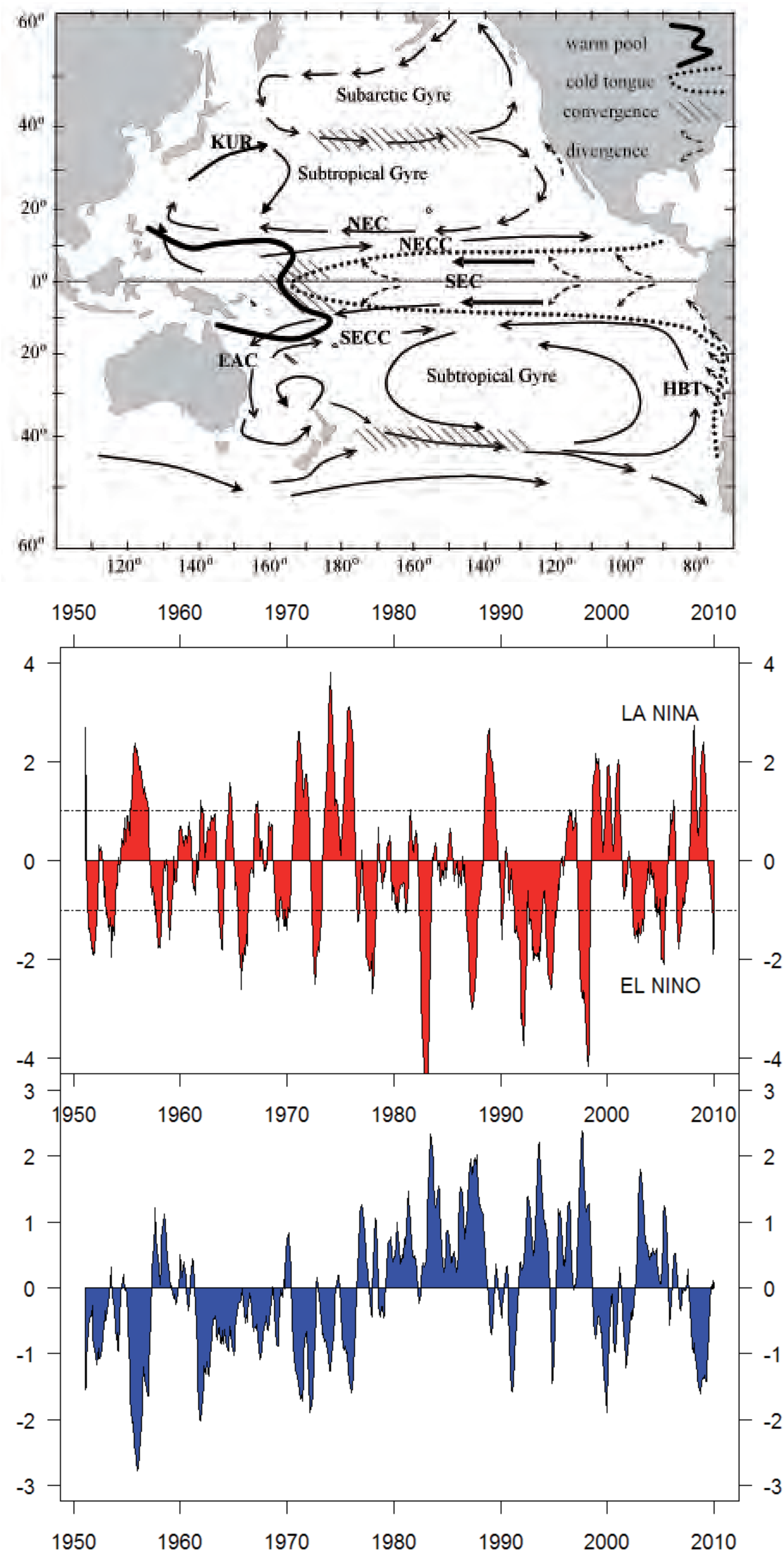


Figure 17: Key currents and water masses of the Pacific Ocean (top) and monthly trends in the Southern Oscillation Index (middle) and Pacific Decadal Oscillation (bottom).

back to contents page

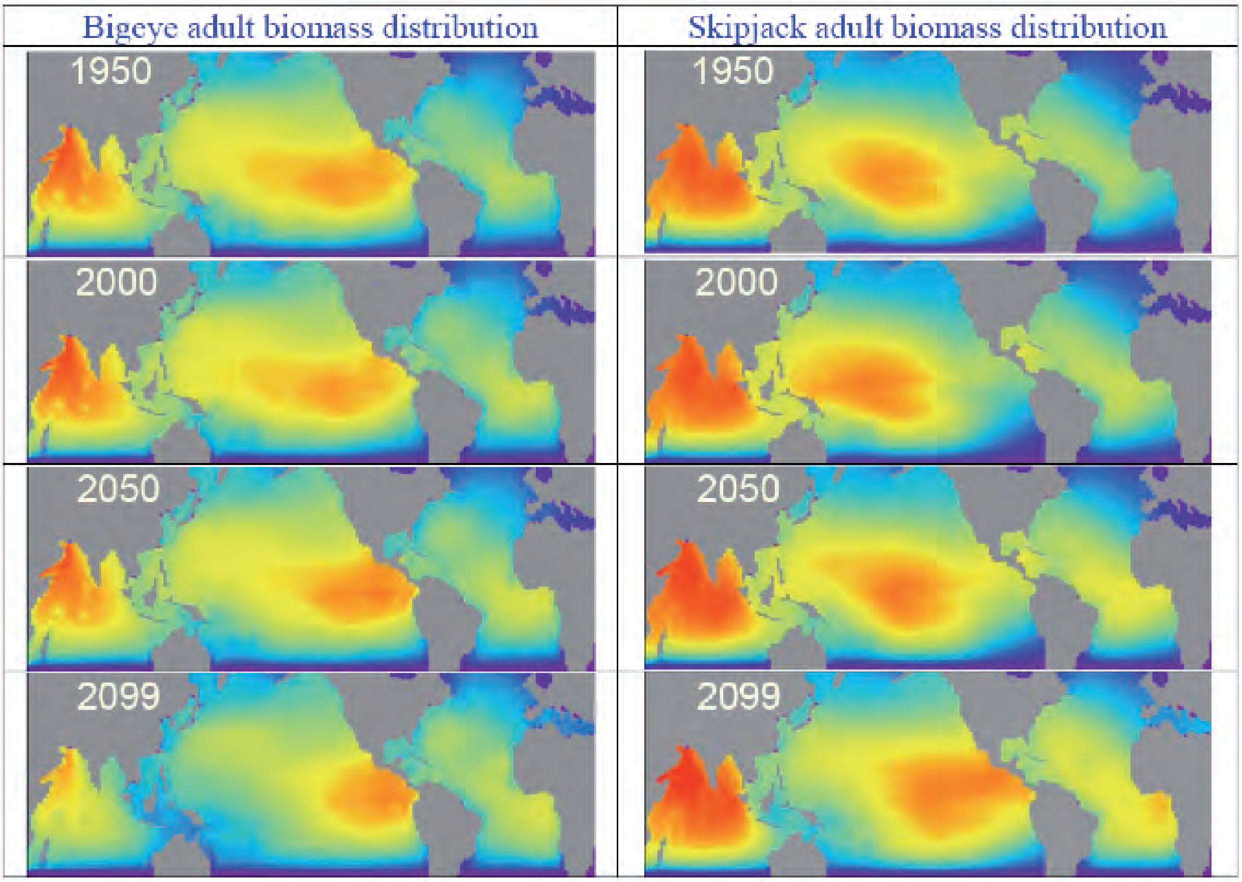


Figure 18: Change in spatial distribution of bigeye and skipjack adult biomass under the IPCC (SRES A2) scenario. (From Lehodey et al. 2008. SEAPODYM. V2: A Spatial ecosystem and population dynamics model with parameter optimization providing a new tool for tuna management. EB-WP-10. 4th Regular Session of the WPCFC Scientific Committee, Port Moresby, August 11–22.)

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back to contents page

Table 1: Catch (metric tonnes) by gear type for the western and central Pacific region, 1960–2008. (Note: data for 2008 are preliminary.)

YEAR	LONGLINE		POLE-AND-LINE		PURSE SEINE		TROLL		OTHER		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1960	129,874	54	73,800	31	5,224	2	0	0	31,195	13	240,093
1961	123,330	41	132,070	43	14,540	5	0	0	34,536	11	304,476
1962	128,804	38	157,412	46	18,875	6	0	0	34,947	10	340,038
1963	122,263	45	98,628	37	11,934	4	0	0	36,795	14	269,620
1964	102,481	32	143,323	45	29,012	9	0	0	41,334	13	316,150
1965	103,955	36	134,621	47	8,621	3	0	0	41,727	14	288,924
1966	145,278	34	218,900	51	16,913	4	0	0	46,993	11	428,084
1967	128,047	35	174,774	47	14,508	4	5	0	52,006	14	369,340
1968	120,136	32	183,954	50	15,143	4	14	0	52,327	14	371,574
1969	122,806	32	196,749	51	9,483	2	0	0	57,703	15	386,741
1970	141,360	31	226,088	50	16,222	4	50	0	69,633	15	453,353
1971	143,625	30	238,182	50	24,511	5	0	0	68,925	15	475,243
1972	161,533	31	242,745	47	29,030	6	268	0	87,209	17	520,785
1973	166,399	26	330,841	52	36,269	6	484	0	103,281	16	637,274
1974	145,192	22	370,499	57	29,548	5	898	0	109,578	17	655,715
1975	164,049	28	279,663	48	27,685	5	646	0	111,669	19	583,712
1976	198,013	27	382,627	53	40,770	6	25	0	104,582	14	726,017
1977	218,413	29	345,257	46	53,492	7	621	0	136,322	18	754,105
1978	212,059	26	407,482	51	52,040	6	1,686	0	131,084	16	804,351
1979	211,221	27	344,799	45	90,102	12	814	0	124,684	16	771,620
1980	227,707	27	395,746	47	113,264	13	1,489	0	102,645	12	840,851
1981	188,516	23	343,584	42	153,907	19	2,118	0	123,315	15	811,440
1982	177,765	21	309,802	36	249,233	29	2,552	0	124,409	14	863,761
1983	170,385	16	338,181	32	436,509	41	949	0	127,088	12	1,073,112
1984	157,072	13	422,512	36	456,467	39	3,124	0	126,690	11	1,165,865
1985	172,886	17	293,206	29	403,252	40	3,468	0	144,604	14	1,017,416
1986	163,964	14	368,730	32	464,460	40	2,284	0	153,694	13	1,153,132
1987	180,581	16	297,935	26	531,142	46	2,350	0	133,813	12	1,145,821
1988	200,281	16	324,805	26	592,611	47	4,671	0	148,481	12	1,270,849
1989	164,878	13	317,802	24	646,441	50	8,687	1	163,829	13	1,301,637
1990	184,185	13	250,390	18	773,730	55	7,219	1	196,934	14	1,412,458
1991	157,518	9	314,979	19	993,149	60	8,004	0	188,156	11	1,661,806
1992	193,757	12	282,598	18	966,314	61	6,844	0	146,840	9	1,596,353
1993	188,514	13	307,966	21	845,646	57	4,612	0	124,526	8	1,471,264
1994	214,641	13	271,071	17	977,650	60	7,493	0	146,461	9	1,617,316
1995	210,605	13	297,106	18	938,748	58	23,577	1	150,516	9	1,620,552
1996	200,802	13	251,053	16	897,123	59	17,807	1	160,521	11	1,527,306
1997	217,166	13	273,844	17	980,797	60	18,732	1	148,947	9	1,639,486
1998	237,803	12	282,965	14	1,296,103	65	19,099	1	172,022	9	2,007,992
1999	207,209	11	302,239	16	1,130,946	62	13,476	1	178,130	10	1,832,000
2000	226,416	12	261,937	14	1,189,731	63	25,845	1	195,557	10	1,899,486
2001	243,183	13	207,307	11	1,164,238	65	17,332	1	172,075	10	1,804,135
2002	261,629	13	216,945	11	1,315,645	66	16,121	1	191,684	10	2,002,024
2003	241,556	12	221,676	11	1,309,657	65	20,490	1	206,973	10	2,000,352
2004	262,584	13	203,903	10	1,420,387	68	24,207	1	174,014	8	2,085,095
2005	234,909	11	213,054	10	1,582,689	71	15,204	1	175,478	8	2,221,334
2006	248,550	11	190,767	8	1,637,169	72	10,133	0	189,897	8	2,276,516
2007	235,612	10	191,457	8	1,760,737	73	8,176	0	224,100	9	2,420,082
2008	231,003	10	170,805	7	1,783,669	74	9,446	0	231,272	10	2,426,195

Table 2: Catch (metric tonnes) by species for the four main tuna species taken in the western and central Pacific region, 1960–2008. (Note: data for 2008 are preliminary.)

YEAR	ALBACORE		BIGEYE		SKIPJACK		YELLOWFIN		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1960	31,463	13	45,025	19	89,938	37	73,667	31	240,093
1961	32,922	11	39,380	13	156,736	51	75,438	25	304,476
1962	37,602	11	36,868	11	181,624	53	83,944	25	340,038
1963	26,815	10	44,346	16	122,703	46	75,756	28	269,620
1964	26,687	8	32,391	10	182,918	58	74,154	23	316,150
1965	28,735	10	31,333	11	155,221	54	73,635	25	288,924
1966	52,284	12	33,187	8	249,514	58	93,099	22	428,084
1967	58,822	16	36,748	10	204,831	55	68,939	19	369,340
1968	64,213	17	30,416	8	194,978	52	81,967	22	371,574
1969	72,106	19	34,356	9	195,469	51	84,810	22	386,741
1970	74,350	16	40,082	9	242,230	53	96,691	21	453,353
1971	100,737	21	43,223	9	228,618	48	102,665	22	475,243
1972	109,655	21	57,164	11	237,818	46	116,148	22	520,785
1973	131,149	21	48,966	8	328,784	52	128,375	20	637,274
1974	115,162	18	52,800	8	356,484	54	131,269	20	655,715
1975	84,651	15	69,088	12	288,788	49	141,185	24	583,712
1976	132,947	18	82,183	11	358,389	49	152,498	21	726,017
1977	83,171	11	82,622	11	405,040	54	183,272	24	754,105
1978	111,161	14	64,956	8	452,387	56	175,847	22	804,351
1979	86,007	11	72,890	9	414,303	54	198,420	26	771,620
1980	95,156	11	70,437	8	459,608	55	215,650	26	840,851
1981	88,095	11	57,605	7	438,261	54	227,479	28	811,440
1982	89,496	10	61,983	7	490,244	57	222,038	26	863,761
1983	65,988	6	63,754	6	683,685	64	259,685	24	1,073,112
1984	74,540	6	70,140	6	762,093	65	259,092	22	1,165,865
1985	77,060	8	74,881	7	603,632	59	261,843	26	1,017,416
1986	71,757	6	72,840	6	755,407	66	253,128	22	1,153,132
1987	63,645	6	87,954	8	687,889	60	306,333	27	1,145,821
1988	67,948	5	86,034	7	849,161	67	267,706	21	1,270,849
1989	73,533	6	87,380	7	823,473	63	317,251	24	1,301,637
1990	63,872	5	100,452	7	890,150	63	357,984	25	1,412,458
1991	58,322	4	85,926	5	1,117,849	67	399,709	24	1,661,806
1992	74,452	5	103,011	6	1,014,574	64	404,316	25	1,596,353
1993	77,496	5	87,887	6	916,475	62	389,406	26	1,471,264
1994	96,461	6	100,522	6	1,019,372	63	400,961	25	1,617,316
1995	91,742	6	92,187	6	1,051,640	65	384,983	24	1,620,552
1996	91,140	6	91,904	6	1,022,298	67	321,964	21	1,527,306
1997	112,900	7	120,702	7	964,913	59	440,971	27	1,639,486
1998	112,465	6	122,240	6	1,310,501	65	462,786	23	2,007,992
1999	131,066	7	122,185	7	1,176,069	64	402,680	22	1,832,000
2000	101,161	5	124,445	7	1,243,471	65	430,409	23	1,899,486
2001	121,550	7	116,704	6	1,138,680	63	427,201	24	1,804,135
2002	147,782	7	131,045	7	1,313,361	66	409,836	20	2,002,024
2003	122,938	6	118,809	6	1,316,159	66	442,446	22	2,000,352
2004	121,393	6	157,173	8	1,427,664	68	378,865	18	2,085,095
2005	101,493	5	141,605	6	1,539,586	69	438,650	20	2,221,334
2006	103,972	5	146,313	6	1,592,338	70	433,893	19	2,276,516
2007	125,743	5	147,092	6	1,708,605	71	438,642	18	2,420,082
2008	95,043	4	157,054	6	1,634,617	67	539,481	22	2,426,195

Table 3: Skipjack tuna catch (metric tonnes) by gear type for the western and central Pacific region, 1950–2008. (Note: data for 2008 are preliminary.)

YEAR	LONGLINE		POLE-AND-LINE		PURSE SEINE		TROLL		OTHER		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1950	34	0	33,386	84	0	0	0	0	6,483	16	39,903
1951	12	0	96,214	90	1,748	2	0	0	8,602	8	106,576
1952	54	0	78,518	85	3,716	4	0	0	10,014	11	92,302
1953	1	0	65,546	82	3,371	4	0	0	11,403	14	80,321
1954	0	0	88,073	85	4,534	4	0	0	11,554	11	104,161
1955	157	0	92,524	85	2,906	3	0	0	12,664	12	108,251
1956	0	0	91,950	86	2,145	2	0	0	13,094	12	107,189
1957	17	0	92,156	86	2,813	3	0	0	11,955	11	106,941
1958	0	0	131,441	84	10,698	7	0	0	15,244	10	157,383
1959	33	0	145,447	82	16,941	10	0	0	14,853	8	177,274
1960	0	0	70,428	78	3,728	4	0	0	15,782	18	89,938
1961	0	0	127,011	81	11,693	7	0	0	18,032	12	156,736
1962	4	0	152,387	84	11,674	6	0	0	17,559	10	181,624
1963	0	0	94,757	77	9,592	8	0	0	18,354	15	122,703
1964	5	0	137,106	75	25,006	14	0	0	20,801	11	182,918
1965	11	0	129,933	84	4,657	3	0	0	20,620	13	155,221
1966	52	0	215,600	86	10,949	4	0	0	22,913	9	249,514
1967	124	0	168,846	82	10,931	5	0	0	24,930	12	204,831
1968	83	0	162,379	83	7,587	4	0	0	24,929	13	194,978
1969	130	0	160,212	82	5,057	3	0	0	30,070	15	195,469
1970	1,608	1	197,873	82	7,534	3	0	0	35,215	15	242,230
1971	1,475	1	180,945	79	13,769	6	0	0	32,429	14	228,618
1972	1,544	1	172,827	73	18,079	8	0	0	45,368	19	237,818
1973	1,861	1	253,217	77	19,271	6	0	0	54,435	17	328,784
1974	2,124	1	289,202	81	11,136	3	0	0	54,022	15	356,484
1975	1,919	1	218,271	76	13,579	5	0	0	55,019	19	288,788
1976	2,096	1	276,582	77	23,604	7	0	0	56,107	16	358,389
1977	3,127	1	294,641	73	36,032	9	0	0	71,240	18	405,040
1978	3,233	1	331,401	73	36,524	8	0	0	81,229	18	452,387
1979	2,179	1	285,859	69	60,123	15	0	0	66,142	16	414,303
1980	632	0	333,457	73	79,349	17	12	0	46,158	10	459,608
1981	756	0	294,292	67	90,304	21	17	0	52,892	12	438,261
1982	1,015	0	262,244	53	169,820	35	64	0	57,101	12	490,244
1983	2,144	0	299,762	44	320,690	47	154	0	60,935	9	683,685
1984	870	0	379,474	50	328,933	43	284	0	52,532	7	762,093
1985	1,108	0	250,010	41	294,654	49	146	0	57,714	10	603,632
1986	1,439	0	336,695	45	349,795	46	219	0	67,259	9	755,407
1987	2,329	0	262,467	38	363,392	53	168	0	59,533	9	687,889
1988	1,937	0	301,031	35	488,046	57	299	0	57,848	7	849,161
1989	2,507	0	289,706	35	472,376	57	244	0	58,640	7	823,473
1990	1,295	0	224,592	25	584,302	66	176	0	79,785	9	890,150
1991	1,542	0	292,950	26	762,738	68	148	0	60,471	5	1,117,849
1992	1,149	0	251,717	25	706,413	70	168	0	55,127	5	1,014,574
1993	1,036	0	280,066	31	590,078	64	175	0	45,120	5	916,475
1994	2,314	0	227,921	22	748,284	73	228	0	40,625	4	1,019,372
1995	2,675	0	257,147	24	739,901	70	12,298	1	39,619	4	1,051,640
1996	6,008	1	211,408	21	759,232	74	6,514	1	39,136	4	1,022,298
1997	6,118	1	225,612	23	682,423	71	9,218	1	41,542	4	964,913
1998	7,169	1	244,447	19	1,006,585	77	8,316	1	43,984	3	1,310,501
1999	6,146	1	235,739	20	882,640	75	5,660	0	45,884	4	1,176,069
2000	6,584	1	223,552	18	949,201	76	15,005	1	49,129	4	1,243,471
2001	6,951	1	163,328	14	919,410	81	7,539	1	41,452	4	1,138,680
2002	5,386	0	152,311	12	1,103,022	84	6,791	1	45,851	3	1,313,361
2003	6,254	0	171,796	13	1,075,364	82	9,719	1	53,026	4	1,316,159
2004	6,571	0	147,276	10	1,204,744	84	15,116	1	53,957	4	1,427,664
2005	3,579	0	175,247	11	1,288,710	84	6,289	0	65,761	4	1,539,586
2006	4,274	0	146,380	9	1,366,404	86	3,974	0	71,306	4	1,592,338
2007	4,361	0	127,590	7	1,482,712	87	3,583	0	90,359	5	1,708,605
2008	4,063	0	125,367	8	1,409,921	86	3,793	0	91,473	6	1,634,617

back to contents page

Table 4: Yellowfin tuna catch (metric tonnes) by gear type for the western and central Pacific region, 1950–2008. (Note: data for 2008 are preliminary.)

YEAR	LONGLINE		POLE-AND-LINE		PURSE SEINE		TROLL		OTHER		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1950	12,844	57	799	4	0	0	0	0	8,919	40	22,562
1951	8,862	44	900	4	938	5	0	0	9,395	47	20,095
1952	17,453	54	2,595	8	2,565	8	0	0	9,901	30	32,514
1953	23,139	58	5,228	13	1,260	3	0	0	10,440	26	40,067
1954	22,662	54	4,268	10	4,001	10	0	0	11,013	26	41,944
1955	22,800	55	3,983	10	2,944	7	0	0	11,624	28	41,351
1956	25,336	59	4,399	10	724	2	0	0	12,274	29	42,733
1957	41,911	72	1,669	3	1,496	3	0	0	12,967	22	58,043
1958	43,421	68	2,934	5	3,338	5	0	0	13,705	22	63,398
1959	43,965	66	4,119	6	4,316	6	0	0	14,495	22	66,895
1960	55,020	75	1,872	3	1,438	2	0	0	15,337	21	73,667
1961	53,166	70	3,259	4	2,777	4	0	0	16,236	22	75,438
1962	55,547	66	4,225	5	6,975	8	0	0	17,197	20	83,944
1963	53,185	70	2,071	3	2,277	3	0	0	18,223	24	75,756
1964	45,247	61	5,074	7	3,647	5	0	0	20,186	27	74,154
1965	45,493	62	3,434	5	3,752	5	0	0	20,956	28	73,635
1966	61,654	66	2,192	2	5,844	6	0	0	23,409	25	93,099
1967	36,083	52	3,125	5	3,428	5	0	0	26,303	38	68,939
1968	46,070	56	2,706	3	7,106	9	0	0	26,085	32	81,967
1969	51,627	61	2,714	3	3,857	5	0	0	26,612	31	84,810
1970	55,806	58	2,141	2	7,811	8	0	0	30,933	32	96,691
1971	57,766	56	2,855	3	9,150	9	0	0	32,894	32	102,665
1972	61,175	53	7,465	6	10,002	9	0	0	37,506	32	116,148
1973	62,291	49	7,458	6	14,798	12	0	0	43,828	34	128,375
1974	58,116	44	6,582	5	17,130	13	0	0	49,441	38	131,269
1975	69,462	49	7,801	6	12,893	9	0	0	51,029	36	141,185
1976	77,570	51	17,186	11	14,976	10	0	0	42,766	28	152,498
1977	94,414	52	15,257	8	15,531	8	0	0	58,070	32	183,272
1978	110,329	63	12,767	7	13,350	8	0	0	39,401	22	175,847
1979	109,043	55	11,638	6	28,174	14	0	0	49,565	25	198,420
1980	122,875	57	13,168	6	31,849	15	9	0	47,749	22	215,650
1981	94,665	42	19,270	8	59,463	26	16	0	54,065	24	227,479
1982	84,988	38	13,835	6	73,738	33	54	0	49,423	22	222,038
1983	86,187	33	13,266	5	106,360	41	51	0	53,821	21	259,685
1984	73,036	28	13,558	5	114,961	44	67	0	57,470	22	259,092
1985	76,265	29	18,156	7	100,736	38	69	0	66,617	25	261,843
1986	65,019	26	13,074	5	105,901	42	62	0	69,072	27	253,128
1987	76,812	25	13,243	4	155,619	51	48	0	60,611	20	306,333
1988	89,400	33	13,433	5	95,536	36	76	0	69,261	26	267,706
1989	68,908	22	15,169	5	159,350	50	73	0	73,751	23	317,251
1990	75,448	21	13,103	4	175,435	49	68	0	93,930	26	357,984
1991	61,115	15	12,921	3	214,496	54	51	0	111,126	28	399,709
1992	73,138	18	15,225	4	236,915	59	98	0	78,940	20	404,316
1993	66,711	17	12,698	3	238,905	61	141	0	70,951	18	389,406
1994	75,745	19	13,743	3	216,871	54	101	0	94,501	24	400,961
1995	81,749	21	15,063	4	185,933	48	2,570	1	99,668	26	384,983
1996	79,032	25	15,479	5	115,645	36	2,636	1	109,172	34	321,964
1997	72,587	16	12,362	3	255,935	58	2,838	1	97,249	22	440,971
1998	69,272	15	13,110	3	261,192	56	2,806	1	116,406	25	462,786
1999	60,718	15	13,817	3	204,607	51	3,162	1	120,376	30	402,680
2000	79,463	18	13,745	3	200,804	47	3,343	1	133,054	31	430,409
2001	77,361	18	12,163	3	215,364	50	3,716	1	118,597	28	427,201
2002	77,691	19	13,357	3	183,006	45	3,170	1	132,612	32	409,836
2003	78,813	18	11,976	3	207,975	47	3,462	1	140,220	32	442,446
2004	82,286	22	14,949	4	178,817	47	3,084	1	99,729	26	378,865
2005	72,856	17	14,889	3	255,220	58	4,142	1	91,543	21	438,650
2006	75,511	17	18,145	4	233,162	54	2,316	1	104,759	24	433,893
2007	69,552	16	17,112	4	230,970	53	1,378	0	119,630	27	438,642
2008	69,516	13	16,911	3	325,904	60	1,262	0	125,888	23	539,481

back to contents page

Table 5: Bigeye tuna catch (metric tonnes) by gear type for the western and central Pacific region, 1950–2008. (Note: data for 2008 are preliminary.)

YEAR	LONGLINE		POLE-AND-LINE		PURSE SEINE		TROLL		OTHER		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1950	18,244	97	646	3	0	0	0	0	0	0	18,890
1951	12,808	88	729	5	1,095	7	0	0	0	0	14,632
1952	24,355	89	2,100	8	1,039	4	0	0	0	0	27,494
1953	23,025	88	2,400	9	619	2	0	0	0	0	26,044
1954	16,204	87	2,100	11	360	2	0	0	0	0	18,664
1955	24,749	85	4,000	14	285	1	0	0	0	0	29,034
1956	28,342	84	4,400	13	908	3	0	0	0	0	33,650
1957	35,463	87	5,200	13	49	0	0	0	0	0	40,712
1958	45,994	92	4,200	8	48	0	0	0	0	0	50,242
1959	41,067	96	1,700	4	36	0	0	0	0	0	42,803
1960	43,467	97	1,500	3	58	0	0	0	0	0	45,025
1961	37,517	95	1,800	5	63	0	0	0	0	0	39,380
1962	35,895	97	800	2	173	0	0	0	0	0	36,868
1963	42,540	96	1,800	4	6	0	0	0	0	0	44,346
1964	30,989	96	1,143	4	231	1	0	0	28	0	32,391
1965	29,848	95	1,254	4	201	1	0	0	30	0	31,333
1966	31,984	96	1,108	3	9	0	0	0	86	0	33,187
1967	33,632	92	2,803	8	60	0	0	0	253	1	36,748
1968	27,757	91	2,272	7	183	1	0	0	204	1	30,416
1969	32,571	95	1,675	5	48	0	0	0	62	0	34,356
1970	34,965	87	1,589	4	560	1	0	0	2,968	7	40,082
1971	38,359	89	931	2	690	2	0	0	3,243	8	43,223
1972	51,040	89	1,762	3	672	1	0	0	3,690	6	57,164
1973	42,412	87	1,258	3	847	2	0	0	4,449	9	48,966
1974	45,653	86	1,039	2	1,121	2	0	0	4,987	9	52,800
1975	61,488	89	1,334	2	1,054	2	0	0	5,212	8	69,088
1976	73,325	89	3,423	4	1,081	1	0	0	4,354	5	82,183
1977	72,083	87	3,325	4	1,260	2	0	0	5,954	7	82,622
1978	56,237	87	3,337	5	1,051	2	0	0	4,331	7	64,956
1979	63,704	87	2,540	3	1,680	2	0	0	4,966	7	72,890
1980	61,857	88	2,278	3	1,737	2	0	0	4,565	6	70,437
1981	45,823	80	2,596	5	3,888	7	0	0	5,298	9	57,605
1982	47,886	77	4,108	7	5,114	8	0	0	4,875	8	61,983
1983	45,270	71	4,055	6	9,109	14	0	0	5,320	8	63,754
1984	51,889	74	3,465	5	9,193	13	0	0	5,593	8	70,140
1985	57,501	77	4,326	6	6,329	8	0	0	6,725	9	74,881
1986	55,804	77	2,865	4	7,222	10	0	0	6,949	10	72,840
1987	68,042	77	3,134	4	10,926	12	0	0	5,852	7	87,954
1988	67,250	78	4,125	5	7,821	9	0	0	6,838	8	86,034
1989	63,316	72	4,298	5	12,194	14	0	0	7,572	9	87,380
1990	75,272	75	3,918	4	11,998	12	0	0	9,264	9	100,452
1991	59,402	69	1,991	2	13,263	15	0	0	11,270	13	85,926
1992	73,919	72	1,757	2	18,882	18	0	0	8,453	8	103,011
1993	64,584	73	2,331	3	13,774	16	0	0	7,198	8	87,887
1994	76,953	77	2,951	3	10,469	10	0	0	10,149	10	100,522
1995	65,793	71	3,776	4	11,737	13	145	0	10,736	12	92,187
1996	54,172	59	3,864	4	21,665	24	432	0	11,771	13	91,904
1997	65,818	55	3,611	3	41,371	34	412	0	9,490	8	120,702
1998	81,320	67	2,446	2	26,772	22	507	0	11,195	9	122,240
1999	71,511	59	2,176	2	36,827	30	316	0	11,355	9	122,185
2000	70,797	57	2,988	2	37,318	30	397	0	12,945	10	124,445
2001	73,860	63	2,349	2	28,490	24	408	0	11,597	10	116,704
2002	88,669	68	2,805	2	26,314	20	712	1	12,545	10	131,045
2003	77,706	65	1,778	1	25,691	22	318	0	13,316	11	118,809
2004	97,703	62	9,313	6	29,626	19	464	0	20,067	13	157,173
2005	78,949	56	6,757	5	37,909	27	430	0	17,560	12	141,605
2006	84,531	58	10,813	7	37,239	25	404	0	13,326	9	146,313
2007	82,481	56	8,967	6	41,373	28	510	0	13,761	9	147,092
2008	87,504	56	8,930	6	46,811	30	346	0	13,463	9	157,054

back to contents page

Table 6: Pacific albacore tuna catch (metric tonnes) by gear type for the south Pacific Ocean, 1960–2008. (Note: data for 2008 are preliminary.)

YEAR	SOUTH PACIFIC OCEAN				
	LONGLINE	POLE-AND-LINE	TROLL	OTHER	TOTAL
1960	22,248	45	0	0	22,293
1961	23,742	0	0	0	23,742
1962	35,219	0	0	0	35,219
1963	31,095	16	0	0	31,111
1964	22,824	0	0	0	22,824
1965	25,455	0	0	0	25,455
1966	38,661	0	0	0	38,661
1967	43,952	0	5	0	43,957
1968	32,368	0	14	0	32,382
1969	24,805	0	0	0	24,805
1970	34,775	100	50	0	34,925
1971	38,530	100	0	0	38,630
1972	39,131	122	268	0	39,521
1973	46,705	141	484	0	47,330
1974	33,039	112	898	0	34,049
1975	22,849	105	646	0	23,600
1976	28,957	100	25	0	29,082
1977	38,019	100	621	0	38,740
1978	32,890	100	1,686	0	34,676
1979	26,162	100	814	0	27,076
1980	30,972	101	1,468	0	32,541
1981	32,694	0	2,085	5	34,784
1982	28,347	1	2,434	6	30,788
1983	24,309	0	744	39	25,092
1984	20,340	2	2,773	1,589	24,704
1985	27,138	0	3,253	1,937	32,328
1986	32,641	0	2,003	1,946	36,590
1987	21,979	9	2,134	930	25,052
1988	28,288	0	4,296	5,283	37,867
1989	18,738	0	8,370	21,968	49,076
1990	19,368	245	6,975	7,538	34,126
1991	23,385	14	7,805	1,489	32,693
1992	30,592	11	6,578	65	37,246
1993	30,229	74	4,296	70	34,669
1994	34,118	67	7,164	89	41,438
1995	29,332	139	7,716	104	37,291
1996	23,816	30	7,379	156	31,381
1997	27,103	21	4,679	133	31,936
1998	37,791	36	6,280	85	44,192
1999	31,909	138	3,419	74	35,540
2000	33,968	102	6,269	139	40,478
2001	48,638	37	5,142	199	54,016
2002	60,590	18	4,574	150	65,332
2003	56,769	12	5,612	130	62,523
2004	57,787	110	4,531	116	62,544
2005	57,597	28	3,451	129	61,205
2006	62,698	29	2,883	188	65,798
2007	57,028	20	2,082	50	59,180
2008	48,149	20	3,497	6	51,672