OVERVIEW OF THE WESTERN AND CENTRAL PACIFIC OCEAN TUNA FISHERIES, 2001

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INTRODUCTION

The tuna fishery in the western and central Pacific Ocean is 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 both the exclusive economic zones of Pacific states and on the high seas. The main species targetted by these fisheries are skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*) and albacore tuna (*T. alalunga*).

All catch statistics presented in this review have been compiled for an area termed the *western and central Pacific Ocean* (WCPO), being the area of the Pacific Ocean west of 150°W longitude. Catch estimates presented herein are available in Working Paper SWG–2 (*Estimates of annual catch of target species in the western and central Pacific Ocean*) and represent the best available for calendar year 2001 at the time of writing.

![Figure 1. Pacific Ocean showing the WCPO](image)

### TOTAL CATCH IN THE WESTERN AND CENTRAL PACIFIC OCEAN

Annual total catches of the four main tuna species (skipjack, yellowfin, bigeye and albacore) in the WCPO increased steadily during the 1980s as the purse seine fleet expanded, remained relatively stable during most of the 1990s, increased sharply in 1998 and has remained at this elevated level since (Figures 2 and 3). The provisional total WCPO catch of tunas during 2001 was estimated at **1,914,159 mt**, slightly higher than the 2000 catch of 1,908,910 mt and the third highest annual catch recorded after 1998 (2,038,584 mt). During 2001, the purse seine fishery accounted for an estimated 1,077,255 mt (56% of the total catch), with pole-and-line taking an estimated 329,901 mt (17%), the longline fishery an estimated 238,729 mt (13% and a record for this fishery), and the remainder (14%) taken by troll gear and a variety of artisanal gears, mostly in eastern Indonesia and the Philippines.

The WCPO tuna catch represented 75% of the total estimated Pacific Ocean catch of 2,564,213 mt in 2001, and 49% of the provisional estimate of world tuna catch (3,863,435 mt) of the four species. The Eastern Pacific Ocean (EPO) catch in 2001 (650,054 mt) was the second highest on record. The provisional global catch of the four main species for 2001 was the second highest ever (after 1999), and has increased by over half a million tonnes since 1996.
Figure 2. Catch (mt) of albacore, bigeye, skipjack and yellowfin in the WCPO, by longline, pole-and-line, purse seine and other gear types

The 2001 WCPO catch of skipjack (1,206,099 mt) was slightly lower than in 2000 and well below the 1998 record catch (1,317,736 mt). As usual, skipjack dominated the total species catch (63%). The WCPO yellowfin catch (475,501 mt; 25%) was the highest since the record catch in 1998 (494,447 mt), and continues to comprise 35–40% of the global catch. The bigeye (115,392 mt; 6%) and albacore1 (117,167 mt; 6%) catches were similar to 2000 levels, but not as high as the record catches for these species taken during 1999 (115,768 mt and 147,789 mt, respectively).

Figure 3. Catch (mt) of albacore, bigeye, skipjack and yellowfin in the WCPO.

This paper provides an overview of the WCPO tuna fisheries, in turn by gear and species, and makes some observations on recent developments in each fishery, with emphasis on 2001 catches relative to those of recent years, where information is currently available.

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1 includes catches of North and South Pacific albacore west of 150°W, which comprised 85% of the total Pacific Ocean albacore catch of 139,356t in 2001; the subsequent section, “Tuna Fishery Catch by Species - Albacore” is concerned only with catches of South Pacific albacore, which make up less than 40% of the WCPO catch.
1. PURSE SEINE

1.1 Historical Overview

The purse seine fishery has accounted for around 55–60% of the WCPO total catch by volume since the early 1990s, with annual catches in the range 790,000–1,200,000 mt. The majority of the WCPO purse seine catch is taken by the four main DWFN fleets – Japan, Korea, Taiwan and USA, which currently number around 140 vessels, but with an increasing contribution from the Pacific Islands domestic fleets (Figure 4) in recent years (40 vessels in 2000). The balance of the regional purse-seine fleet come from the Philippines fisheries and a variety of other fleets, including a small seasonally active Spanish fleet.

[Figure 4. Number of purse seine vessels operating in the WCPO (this does not include the Philippines purse seine/ringnet vessels which number over 400)]

The WCPO purse-seine fishery is essentially a skipjack fishery, unlike those of other ocean areas. Skipjack regularly account for 70–75% of the purse seine catch, with yellowfin accounting for 20–25% and bigeye accounting for only a small proportion (Figure 5). Features of the purse seine catch by species during the past decade have been:

- Annual skipjack catches fluctuating between 600,000 and 700,000 mt p.a. until the sharp increase with the 1998 catch which has since been maintained at around 800,000 mt and above;
- Annual yellowfin catches fluctuating considerably between 120,000 and 265,000 mt; increases in the proportion of yellowfin in the catch are often noted during El Niño years (Figure 5), with sharp reductions during La Niña years (1995/96 and to a lesser extent 1999/2000);
- Increased bigeye tuna purse seine catches, first in 1997 (30,819 mt) and then again in 1999 (34,282 mt and 2000 (30,629 mt), as a result of increased use of drifting FADs since 1996.

[Figure 5. Purse seine catch (mt) of bigeye, skipjack and yellowfin in the WCPO]
1.2 The Year 2001 Fishery

1.2.1 Catch estimates and fleet size

The provisional 2001 purse-seine catch of 1,077,255 mt was the fourth consecutive annual catch in excess of 1,000,000 mt. This catch level was attained despite voluntary reductions in effort as a result of economic conditions (i.e. lower cannery-bound tuna prices) as existed in the fishery during 2000. The formation of World Tuna Purse Seine Organisation (WTPO) in recent years has led to a catch reduction programme in an effort to address the problems of over-supply and low prices. During the early months of 2001, the situation in the WCPO resulted in the unprecedented move by the entire US purse seine fleet to voluntarily forego fishing during the entire month of January and a part of February. A reduction in effort was also apparent with the Korean and Taiwanese fleets during this period but not to the extent seen with the US fleet. A positive trend in skipjack prices eventuated in the first quarter of 2001 and remained at this level leading into 2002. Not mentioned in the statistics at this stage was the introduction of a mainland Chinese purse seine vessel into the fishery during 2001.

The number of Pacific-island domestic vessels dropped from 40 vessels in 2000 to 35 vessels in 2001. The PNG purse seine fleet now constitutes the largest Pacific-island domestic fleet and is made up of 17 domestically-based vessels fishing in joint-venture arrangements in PNG waters and another five vessels that fish over a wider area under the FSM Arrangement. The number of vessels in the FSM and Kiribati fleets remained stable into 2001, while the Marshall Islands fleet (5 vessels re-flagged from Vanuatu during 2000), were well established and fished consistently throughout 2001. The Solomon Island fleet comprised only two active vessels during 2001.

The purse seine skipjack catch for 2001 (837,266 mt – 77%) was nearly 120,000 mt less than the 1998 catch (954,224 mt), but still much higher than pre-1998 levels, and the annual WCPO skipjack seems likely to stay at this new elevated level. The purse seine yellowfin catch for 2001 (215,856 mt – 21%) increased from the 2000 catch, which was considered low, but typical of what is expected in a La Nina period. The estimated purse seine bigeye catch for 2001 (24,133 mt – 2%) was down on the record 1999 catch (34,282 mt), primarily due to continued reduction in fishing effort on drifting FADs during 2001.

Figure 7 compares annual purse seine catches (skipjack and yellowfin) for the five main purse seine fleets operating in the tropical WCPO in recent years. During 2001, catches were similar to 2000 for most DWFN fleets, except the US fleet, which continues to reduce in vessel numbers. Taiwan has been the highest producer in the tropical purse seine fishery over this period. The steady increase in catch by the PNG fleet in recent years is noteworthy.

Figure 8 shows the time series of effort (in sets) by set type for the four major purse seine fleets operating in the WCPO. The percentage of sets on drifting FADs for all fleets dropped during 2001 and continued the
trend seen in 2000. Sets on unassociated schools were the predominant fishing method for the four main purse seine fleets for the first time since 1998.

Figure 8. Time series showing the percentage of total sets by school type for the major purse-seine fleets operating in the WCPO.
1.2.2 Geographic distribution

Catch distribution in the tropical areas of the WCPO is strongly influenced by ENSO events. Figure 9 demonstrates on a wider scale the effect of ENSO events on the spatial distribution of the purse-seine catch, with considerable variation over years and areas. In general, fishing effort is distributed further to the east during El Niño years, while a contraction westwards is typical during La Niña periods. The WCPO experienced an ENSO-transitional (or normal) period during 2001 compared to the La Nina conditions of recent years, and this is evident in the slight shift of activities eastwards during 2001 compared to activities during 2000. Indications in the eastern Pacific over the past six months show that the arrival of the next El Niño event should occur in the second half of 2002.

Figure 10 shows the distribution of effort (sets) by set type for the past six years, highlighting that log-associated and (to a lesser extent) free-swimming schools are perhaps not as readily available in the east in La Nina years relative to El Niño years. In the recent La Nina years (i.e. 1996, 1999 and 2000), associated sets east of 160°E were predominantly on drifting FADs, which is in contrast to the El Niño years (1997 and most of 1998) when there were a greater proportion of log sets east of 160°. During the recent La Nina period, it is known that purse seine fleets (predominantly US vessels) adopted a strategy of using drifting FADs in the east in order to target tuna more efficiently and reduce time in transit to their port of unloading (Pago Pago). This strategy was adopted in the absence of logs, which apparently are not as readily available in the east as in El Niño periods, when the more pronounced wind-generated westerly currents extend the range of natural debris (logs) beyond (and to the east of) the waters of Indonesia and Papua New Guinea.

The proportion of drifting FAD sets dropped during 2001 compared to previous years, a situation possibly related to the weakening of La Nina conditions and increased availability of logs in more eastern areas.

Figure 9. Distribution of purse-seine effort (all fleets), 1995–2001. ENSO periods are denoted by “+”: La Niña; “-”: El Niño; “--”: strong El Niño; “0”: transitional period.
Figure 10. Distribution of purse-seine effort (sets for all fleets) by set type, 1995–2001
(Solid–Unassociated; Grey–Log; Striped–Drifting FAD).
ENSO periods are denoted by “+”: La Niña; “−”: El Niño; “−−”: strong El Niño; “0”: transitional period.
2. **POLE-AND-LINE**

2.1 **Historical Overview**

The WCPO pole-and-line fishery has several components:
- the year-round tropical skipjack fishery, mainly involving the domestic fleets of Indonesia, Solomon Islands and French Polynesia, and the distant water fleet of Japan
- seasonal sub-tropical skipjack fisheries in the home waters of Japan and Australia
- a seasonal albacore/skipjack fishery east of Japan (largely a subset of the Japan homewater fishery).

Economic factors and technological advances in the purse seine fishery (primarily targeting the same species, skipjack) have seen a gradual decline in the number of vessels in the pole-and-line fishery (Figure 10) and stabilisation in the annual pole-and-line catch during the past decade (Figure 11; note that distinction between troll and pole-and-line gears in the the Japanese coastal fleet was not possible for years prior to 1995). The gradual reduction in numbers of vessels has occurred in all pole-and-line fleets over the past decade. Pacific Island domestic fleets have declined in recent years – fisheries formerly operating in Palau, Papua New Guinea and Kiribati are no longer active, only one or two vessels are now operating in Fiji, and there have been problems in the Solomons fishery over the past 2 years. Several vessels continue to fish in Hawai’i, and the French Polynesian bonitier fleet remains active, but more vessels are turning to longlining activity. Against this trend, there has been a reported increase in Indonesian catches since 1999, apparently as a result of increased demand for catch and possibly technological advances.

![Figure 10. Pole-and-line vessels operating in the WCPO](image1)

![Figure 11. Pole-and-line catch in the WCPO](image2)
2.2 The Year 2001 Fishery (provisional)

The preliminary pole-and-line catch estimate for 2001 (329,901 mt) is a slight increase on the 2000 level (327,632 mt), but is essentially the same as 2000 since the estimates for the two fleets (Japan and Indonesia) taking most of this catch have not yet been provided for 2001. As in 2000, this catch represents about 17% of the total WCPO tuna catch. As in previous years, skipjack accounts for the vast majority of the catch (88%); albacore taken by the Japanese coastal and offshore fleets in the temperate waters of the north Pacific (6%), yellowfin (5%) and a small component of bigeye (1%) make up the remainder of the catch. Catch estimates for some fleets have not been provided for recent years, but the Japanese distant-water and offshore (150,049 mt in 1999) and the Indonesian fleets (154,850 mt in 2000) are expected to once again account for most of the catch. The trend of low catches by the Solomon Islands fleet continued during 2001 with a total catch of only 4,710 mt (up from 2,692 mt in 2000), with fishing only conducted during the second half of the year.

Figure 12 shows the average distribution of pole-and-line effort for the period 1995–2000. Effort in tropical areas is usually year-round and includes the domestic fisheries in Indonesia and the Solomon Islands and the Japanese distant-water fishery. The pole-and-line effort in the vicinity of Japan by both offshore and distant-water fleets is seasonal (highest effort and catch in the 2nd and 3rd quarters). The effort in French Polynesian waters is essentially the bonitier fleet.

![Figure 12. Average distribution of WCPO pole-and-line effort (1995–2000).](image-url)
3. LONGLINE

3.1 Overview

The longline fishery continues to account for around 10–12% of the total WCPO catch (Lawson, 2002), but rivals the much larger purse seine catch in landed value. It provides the longest time series of catch estimates for the WCPO, with estimates available since the early 1950s (Lawson, 2002).

The fishery involves two main types of operation –
- large (typically >250 GRT) distant-water freezer vessels which undertake long voyages (months) and operate over large areas of the region. These vessels may target either tropical (yellowfin, bigeye) or subtropical (albacore) species. Some voluntary reduction by one major fleet (Japan distant-water) has occurred in recent years;
- smaller (typically <100 GRT) offshore vessels which are usually domestically-based, with ice or chill capacity, and serving fresh or air-freight sashimi markets. These vessels operate mostly in tropical areas.

Additionally, small vessels in Indonesia and Philippines (not included in Figure 13) target yellowfin and bigeye by handlining and small vertical longlines, usually around the numerous arrays of anchored FADs in these waters. These fisheries have similar species composition as longliners operating in the same area.

![Figure 13. Longline vessels operating in the WCPO](image)

There have been significant changes in fleet operations during the past two decades. For example, a feature of the 1980s was a change in targeting practices (fishing deeper to catch bigeye in cooler waters) in order to capitalise on a higher price for bigeye compared to yellowfin. There has been a gradual increase in the number of Pacific-Islands domestic vessels, such as those from Samoa, Fiji, French Polynesia, New Caledonia and Solomon Islands over the past decade. These fleets mainly operate in subtropical waters, with albacore the main species taken and now provide over 10% of the total WCPO catch. The entrance into the fishery and subsequent decline of the smaller “offshore” sashimi longliners of Taiwan and mainland-China, based in Micronesia, during the past decade is also noteworthy. There has also been a trend towards flexibility in species targeting in some fleets, notably those with ultra-low temperature freezing capacity. In recent years, large Chinese longliners have been targeting albacore in the high seas areas of the South Pacific, and there has been rapid development of the longline fishery in at least one southeast Asian country (Vietnam, but for which catch estimates are not yet available).

The annual total longline tuna catch has been relatively stable during the past 25 years (Figure 14), with total catches generally between 130,000 and 200,000 mt. and comprised almost entirely of yellowfin, bigeye and albacore (Lawson, 2002).
3.2 **The Year 2001 Fishery (provisional)**

3.2.1 *Catch estimates and fleet sizes*

The 2001 longline catch (238,729 mt) was a record for the WCPO, eclipsing the previous high (218,363 mt) in 2000. The overall species composition of the 2001 WCPO longline catch was 35% yellowfin, 35% albacore and 30% bigeye. The bigeye (71,643 mt) and albacore (WCPO–82,573 mt; south Pacific–46,248 mt) catches for 2001 were records for this fishery. The 2001 yellowfin catch (82,870 mt) was the highest catch in nearly 20 years and continued the significant recovery from the lowest catch (56,520 mt) recorded for nearly 30 years in 1999, only two years earlier.

Domestic fleet sizes continue to increase at the expense of foreign-offshore and distant-water fleets (Figure 14), although the Taiwanese distant-water longline fleet increased by 30% (to 101 vessels) during 2001. This increase was primarily due to several vessels shifting activities to the Pacific Ocean from the Indian and Atlantic Oceans (Dr. Shyh-bin Wang, pers. comm.). Most of these vessels are "super-cold" longline vessels targeting bigeye and yellowfin tunas, and now contribute to a more diverse fleet that previously only concentrated on targeting albacore.

3.2.2 *Geographic distribution*

Figure 15 shows the distribution of effort by category of fleet for 2000 activities (representing the most recently available data for all fleets, but reflecting the likely distributions for 2001).

As in previous years, most of the 2001 WCPO catch was taken by the large-vessel, distant-water fleets of Japan, Korea and Taiwan although the overall proportion of the catch is declining. Effort by these fleets is widespread as sectors of these fleets target bigeye and yellowfin for the frozen sashimi market, and albacore in the more temperate waters for canning. Activity by the offshore fleets from Japan, mainland China and Taiwan are restricted to the tropical waters, targeting bigeye and yellowfin for the fresh sashimi market; these fleets have limited overlap with the distant-water fleets. The substantial "offshore" effort in the west of the region is primarily by Indonesian and Taiwanese domestic fleets targeting yellowfin and bigeye. The growth in domestic fleets in the South Pacific over recent years has been noted; the most significant examples are the increase in the Fijian fleet, and the establishment of the domestic Samoan and French Polynesian fleets.
Figure 15. Distribution of distant-water longline effort (left), and offshore and domestic fleet effort (right—excludes Japanese coastal fishery) during 2000

Figure 16 shows species composition by area for 2000 (2001 data incomplete). The majority of the yellowfin catch is taken in tropical areas, especially in the western parts of the region, with smaller amounts in often seasonal subtropical fisheries. The majority of the bigeye catch is also taken primarily from tropical areas, but in contrast to yellowfin, mainly in the eastern parts of the WCPO, adjacent to the traditional EPO bigeye fishing grounds. The albacore catch, in contrast, is taken in subtropical and temperate waters in both hemispheres.

Figure 16. Distribution of longline tuna catch by species during 2000 (Black—yellowfin; hatched—bigeye; grey—albacore)
4. TROLL

4.1 Overview

The South Pacific troll fishery is based in the coastal waters of New Zealand, and along the Sub-Tropical Convergence Zone (STCZ, east of NZ waters located near 40°S). The fleets of New Zealand and United States have historically accounted for the great majority of the catch, which in turn consists almost exclusively of albacore tuna.

The fishery expanded following the development of the STCZ fishery after 1986, with the largest annual catch (around 8,200 mt) taken in 1989 (Figure 17; Lawson, 2002). Since then, annual catches have varied between 3,000 and 8,000 mt. The level of effort expended by the troll fleets each year tends to reflect the price commanded for the product (albacore for canning) to some extent, and by expectations concerning likely fishing success.

![Figure 17. Troll catch (mt) of albacore in the south Pacific Ocean](image)

4.2 The Year 2001 Fishery

The preliminary 2001 troll albacore catch (5,547 mt) was a slight drop on the 2000 level, and essentially made up of the NZ (3,254 mt) and US (2,218 mt) fleet catches. Figure 18 shows the distribution of effort for troll fleets for 2000, which is expected to be a likely distribution of fishing effort for 2001 (i.e. off the coast of New Zealand and in the STCZ).

![Figure 18. Distribution of South Pacific troll effort during 2000](image)
5. SKIPJACK

5.1 Catch

Skipjack, the dominant species in the western and central Pacific Ocean (WCPO) tuna catch, are taken primarily by purse seine and pole-and-line gear, with smaller catches by other artisanal gears in eastern Indonesia and Philippines. Catches in the WCPO have increased steadily since 1970, more than doubling during the 1980s, and relatively stable since then (range 800,000–1,200,000 mt), with catches of more than one million mt in 1991, 1992, 1995, 1998–2001 (Figure 19). Pole-and-line fleets, primarily Japanese, initially dominated the fishery, with the catch peaking at 380,000 mt in 1984. The relative importance of this fishery, however, has declined over the years primarily due to economic constraints. The skipjack catch increased during the 1980s due to growth in the international purse seine fleet, combined with increased catches by domestic fleets from Philippines and Indonesia (which now make up 20-25% of the total skipjack catch in WCPO in recent years).

The 2001 estimated catch of 1,206,099 mt, the second highest on record, by gear was as follows:
- Purse seine - 837,266 mt (69%), of which most was taken by the four main DWFN fleets (576,199 mt) and Philippines purse seine and ringnet fisheries;
- Pole-and-line - provisional estimate of 291,858 mt (24%), primarily comprising catches by Japanese (~120,000 mt) and Indonesian (~150,000 mt) fleets, but a continuing reduced contribution (4,508 mt) by Solomon Islands fleet compared with catches in the 1990s;
- Other gears – ~75,000 mt (7%) representing mostly unclassified gears in Indonesia, Philippines and Japan.

Figure 19. WCPO skipjack catch (mt) by gear

Figure 20 shows the average spatial distribution of skipjack catch in the WCPO for the period 1990–2000, with the great majority of the catch taken in equatorial areas, and a lesser amount in the seasonal home-water fishery of Japan. The distribution (and catch) of skipjack in equatorial areas east of Papua New Guinea is strongly influenced by ENSO events, as noted earlier.

5.2 Catch per unit of effort

Purse seine sets are made on two main school types – associated (floating object) and unassociated (free-swimming). Associated (log) sets initially accounted for most of the catch as the fishery developed in the WCPO, but as experience was acquired and gear technology improved, unassociated (free) schools become more important. In recent years (1999 in particular), several fleets concentrated fishing on associated sets,
and primarily drifting man-made FADs (Figure 8). This has had some implications for the species (and size) composition of the catch.

**Figure 20. Distribution of WCPO skipjack catch, 1990–2000. The six-region spatial stratification used in stock assessment is shown.**

Figure 21 shows the annual time series of skipjack CPUE by vessel nation and set type. The 2001 skipjack CPUE for free-school sets is consistent for all fleets and equal to or slightly higher than corresponding levels experienced during 2000. The gradual increase in skipjack CPUE for free-school sets over the past 5 years is possibly related to technological advances enabling better detection of free-swimming schools.

The decline of skipjack CPUE for drifting FAD sets continued for the US fleet during 2001, although the drifting FAD CPUE for other fleets increased. This difference could be due to differences in areas fished by each fleet, noting that the ranking of each fleet for log-associated CPUE is identical to the ranking for drifting-FAD CPUE for 2001. The relatively poor catch rates for drifting FAD sets (< 20mt/set) appear to have resulted in a distinct change in strategy by the US purse seine fleet during 2001 to (seeking and) setting on more free-school sets.

Nominal skipjack CPUE for the offshore and distant-water Japanese **pole-and-line** fleets show no clear trend since 1994 (Figure 22). The skipjack CPUE for the offshore fleet, active in and around the Japanese home fishery, shows an oscillating pattern (between 4–6 mt/day) for most of the 1990s. In contrast, the distant-water fleet, primarily active in tropical waters, consistently accounted for a higher CPUE (between 6–8 mt/day) over this period. Skipjack CPUE in the Solomon Islands domestic pole-and-line fishery tend to be stable but lower than the Japanese fleets. There were significant reductions in effort by the Solomon Island fleet during recent years, no doubt contributing to a slight decline in CPUE. Nominal skipjack CPUE for the Japanese and Solomon Island fleets tend to follow a similar pattern from year to year, suggesting that stock-wide effects are involved. Some increases in CPUE have coincided with substantial effort reduction and the departure of less competitive boats from the fishery, as well as the acquisition of improved technology, e.g. bird radar. Ogura and Shono (1999) considered several of these factors in estimating the standardised CPUE for the Japanese pole-and-line fleets (Figure 23). The importance in considering these factors is demonstrated when comparing nominal (Figure 22) and standardised (Figure 23) CPUE for the Japanese distant-water fleet where, for example, standardised CPUE shows a more accentuated decline than nominal CPUE in recent years.
Figure 21. Skipjack tuna CPUE (mt per day) by major set-type categories (free-school, log and drifting FAD sets) for Japanese, Korean, Taiwanese and US purse seiners fishing in the WCPO. Effort and CPUE were partitioned by set type according to the proportions of total sets attributed to each set type.

Figure 22. Nominal skipjack tuna CPUE (mt/day) for selected pole-and-line fleets
5.3 Size of fish caught

In the WCPO, skipjack size composition data are available from fishery observers and port sampling activity, mostly involving the international fleet fishing east of 140°E. Monthly skipjack size in the purse seine fishery is illustrated for both associated and unassociated sets from January 1999 to December 2001 (Figure 24). Skipjack were usually between 30 and 70 cm FL and there were only small differences in the length composition between associated and unassociated sets. However, there are instances when unassociated sets also capture skipjack of a greater size range than associated sets, and this is apparent for several months during 2000 and 2001.
6. YELLOWFIN

6.1 Catch

Yellowfin tuna, an important component of tuna fisheries throughout the western and central Pacific Ocean (WCPO) and over 30% of the global catch of the species, are harvested with a diverse range of gear types, from small-scale artisanal fisheries in Pacific Island and southeast Asian waters to large ‘distant-water’ longliners and purse seiners that operate widely in equatorial/tropical waters. Purse seiners take a wide size range of yellowfin, whereas the longline fishery takes mostly adult fish. Yellowfin usually represent ~20–25% of the overall purse seine catch and may contribute a higher percentage of the catch in individual sets. Yellowfin are often directly targetted by purse seiners, especially as unassociated schools.

Since 1990, yellowfin catch in the WCPO has varied between 320,000–500,000 mt (Figure 25). The 1998 catch in the WCPO was the largest on record (494,447 mt). The elevated total catch in this year (and in 1997) followed the lowest catch for ten years in 1996 as a result of greatly reduced purse seine catches. Purse seine harvests the majority of the yellowfin catch (215,856 mt – 45% by weight during 2001), while longline and pole-and-line fisheries caught 17% (82,870 mt) and 3% (16,359 mt), respectively, and various assorted gears 34% (mostly eastern Indonesia and the Philippines).

The eastern Pacific (EPO) purse seine catch of yellowfin (391,379 mt) for 2001 was an all-time record and nearly 100,000 mt higher than the previous record in 1999. The 2001 Pacific-wide yellowfin catch of 885,012 mt was also a record, exceeding the previous record in 1998 by nearly 110,000 mt.

Catches in the ‘Other’ category in Figure 25 are largely composed of yellowfin from the Philippines and eastern Indonesia. These catches come from a variety of gear types (e.g. ring net, bagnet, gillnet, handline and seine net) and have increased steadily over the past decade.

The WCPO longline catch in recent years (53,000–82,000 mt) is well below catches in the late 1970s to early 1980s (90,000–120,000 mt), presumably related to changes in targetting practices by some of the large fleets and the gradual reduction in the number of distant-water vessels. The 1999 yellowfin catch of 56,520 mt was the lowest for nearly 30 years, but has recovered significantly in the past two years.

Figure 25. WCPO yellowfin catch (mt) by gear

Figure 26 shows the average spatial distribution of yellowfin catch in the WCPO for the period 1990–2000 (since longline catch by area is not complete for 2001). As with skipjack, the great majority of the catch is taken in equatorial areas by large purse seine vessels, and vessels in the Indonesian and Philippine fisheries.
Also, the east–west distribution of catch is strongly influenced by ENSO events, with larger catches taken east of 160°E during El Niño episodes.

![Figure 26. Distribution of WCPO yellowfin catch, 1990–2000. The seven-region spatial stratification used in stock assessment is shown.](image)

### 6.2 Catch per unit of effort

Yellowfin purse seine CPUE is characterized by strong interannual variability and differences amongst the fleets (Figure 27). School-set CPUE is strongly related to ENSO variation in the WCPO, with CPUE generally higher during El Niño episodes. This is believed to be related to increased catchability of yellowfin tuna due to a shallower surface mixed layer during these periods. ENSO variability is also believed to impact the size of yellowfin and other tuna stocks through impacts on recruitment. In line with this hypothesis, and as seen in previous La Niña years (1995–96), the yellowfin CPUE for 1999–2000 generally declined from the highs experienced in the El Niño years of 1997–98 (Figure 27). During 2001, the CPUE increased in line with the weakening of La Niña. Note also the consistency in yellowfin CPUE trends for all purse seine fleets since 1996 (except perhaps the Japanese fleet in recent years).

The distant-water longline fishery, which has operated since the early 1950s, provides another means of monitoring changes in yellowfin tuna abundance. As longliners target larger fish, the CPUE time series should be more indicative of adult yellowfin tuna abundance. However, as with purse-seine CPUE, the interpretation of longline CPUE is confounded by various factors, such as the changes in fishing depth that occurred as longliners progressively switched from primarily yellowfin tuna targeting in the 1960s and early 1970s to bigeye tuna targeting from the late 1970s on. Such changes in fishing practices will have changed
the effectiveness of longline effort with respect to yellowfin tuna, and such changes need to be accounted for if the CPUE time series are to be interpreted as indices of relative abundance.

Figure 27. Yellowfin tuna CPUE (mt per day) by major set-type categories (free-school, log and drifting FAD sets) for Japanese, Korean, Taiwanese and US purse seiners fishing in the WCPO. Effort and CPUE were partitioned by set type according to the proportions of total sets attributed to each set type.

Bigelow et al. (1999) developed a procedure to account for the effects of changes in targeting as well as the variation in environmental parameters that define yellowfin tuna habitat. Time series of nominal CPUE and standardised CPUE (catch per unit of ‘effective’ effort) for the tropical WCPO are shown in Figure 28. Nominal CPUE declined sharply from 1978 to 1991, and at least part of this decline is attributable to the change in targeting behaviour of the longline fleet; the standardised CPUE therefore does not exhibit as strong a decline over this period. Over the entire time series, standardised CPUE had low points in the late 1960s to early 1970s, 1989–1991 and a decline from 1996 through 1999. While standardised CPUE for 1999 is the lowest observed for about 25 years, they are not much lower than those observed in the early-1970s. The significant decline then recovery in the purse seine CPUE during 1996 and 1997, respectively (Figure 27) anticipates the trend in longline CPUE during 1999 and 2000 (Figure 28), reflecting the growth and relative abundance of the main age class fished in each case.
6.3 **Size of fish caught**

Monthly yellowfin size (fork length, FL) is illustrated for both the longline and purse seine fleet from January 1999 to December 2001 (Figure 29). Most of the yellowfin measured from the purse seine fishery were sampled from the US fleet under the conditions of the multilateral treaty (USMLT). Note that there are no size composition data available from the Philippine and Indonesian fisheries for recent years, where small fish in considerable quantities are normally taken. Yellowfin from associated sets show two clear size modes during 1999, the second clearly overlapping with the mode in the longline fishery by September of that year. Unassociated sets comprise yellowfin mixed with skipjack of similar size or just large yellowfin. There is often overlap in the sizes of yellowfin taken in unassociated and associated sets.

Yellowfin sampled in the longline fishery by observers and port samplers at various locations in the WCPO are predominantly adult fish (range 80–160 cm FL). Mean size is ~120 cm FL and the progression of length modes showing recruitment into the longline fishery is clearly visible (Figure 29). Note the relative absence of medium-sized (60-100cm) yellowfin in the catches from both the longline and purse seine fisheries during 2000 and 2001 compared to 1999.

Figure 28. Nominal and standardised yellowfin tuna CPUE for Japanese distant-water longline vessels in the areas 4 and 5 (refer to Figure 26).

Figure 29. Size comparison of yellowfin sampled from the WCPO longline and purse seine catch, 1999–2001

(Dark grey shading: Longline; Light grey shading: Unassociated schools catch; Black: Associated schools catch)
7. **BIGEYE**

7.1 **Catch**

Bigeye tuna are an important component of tuna fisheries throughout the Pacific Ocean. Bigeye are taken by both surface gears, mostly as juveniles, and by longline gear, as valuable adult fish. They are a principal target species of both the large ‘distant-water’ longliners from Japan and Korea and of the smaller ‘fresh sashimi’ longliners based in several Pacific Island countries. Prices paid for both frozen and fresh product on the Japanese sashimi market are the highest of all the tropical tunas. Bigeye tuna are the economic cornerstone of the tropical longline fishery in the western and central Pacific Ocean, the catch of which in the WCPO had a landed value in 2001 approaching US$ one billion.

Since 1980, the Pacific-wide total catch of bigeye (all gears) has varied between 100,000 and 210,000 mt (Figure 30), with Japanese longline vessels generally contributing over 80% of the catch until the early 1990s. *Longline* catch in the eastern Pacific Ocean (EPO), the area east of 150°W and historically the primary bigeye longline fishing area, has varied in the range 50,000–102,000 mt since 1980, surpassing 100,000 mt once in 1986, but has fallen to below 40,000 mt in recent years, and an historical low in 1999 (23,164 mt). In contrast, the longline catch has been typically 40,000–66,000 mt in the western and central Pacific Ocean (WCPO), the area west of 150°W (Figure 31), attaining what looks to be a record catch during 2001 (71,643 mt).

Since about 1994, there has been a rapid increase in *purse-seine* catches of juvenile bigeye, first in the EPO and since 1996, and to a lesser extent, in the WCPO. Purse-seine catches in the EPO increased from levels of less than 10,000 mt per year prior to 1994, to approximately 30,000 mt in 1994, then to around 50,000 mt in both 1996 and 1997 (Lawson, 2002). There was a decline in catches during 1998 (around 35,000 mt), but there have been increases in recent years to a record level in 2000 (70,098 mt; Lawson, 2002). The recent increases in the EPO catch resulted from fishing in largely new or previously lightly fished areas, with different fishing methods, that is, the use of drifting fish aggregating devices (FADs) to aggregate tuna and deeper purse-seine nets to catch those tuna, mostly bigeye, located deeper in the water column. In the WCPO, purse-seine catches of bigeye are estimated to have been less than 20,000 tonnes per year up to 1996 (Lawson, 2001). By 1997, this catch had increased to approximately 30,000 mt through the adoption of similar fishing techniques to those used in the EPO, before falling to 18,557 mt during 1998. The estimated 1999 WCPO purse seine catch reached a record level of 34,282 mt, mainly as a result of increased fishing on drifting FADs. The US fleet took an estimated 17,403 mt of bigeye in the WCPO during 1999, this catch easily exceeding the previous maximum annual catch of slightly over 10,000 mt, taken by this fleet during 1997. Since 1999, bigeye catches have reduced, probably due to reduced fishing on drifting FADs by several fleets.

![Figure 30. Pacific bigeye catch (mt) by gear](image-url)
The total WCPO bigeye catch (115,392 mt) for 2001 was similar to the level attained during 2000, and slightly lower than the record of 1999 (115,768 mt). The Pacific-wide bigeye catch (191,502 mt) for 2001 was around 20,000 mt less than the record attained in 2000, primarily due to significant decreases in the WCPO and EPO purse seine catches (Figure 30).

Figure 31 shows the spatial distribution of bigeye catch in the Pacific for the period 1990–2000 (2001 longline data for all fleets are not yet available). The majority of the WCPO catch is taken in equatorial areas, both by purse seine and longline, but with significant longline catch in some sub-tropical areas (east of Japan, east coast of Australia). In these 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, but just south of the Equator.

Figure 31. Distribution of bigeye catch, 1990–2000. The five-region spatial stratification used in stock assessment for the WCPO is shown.

7.2 Catch per unit of effort

Bigeye purse seine catches are rarely reported accurately on vessel logsheets and, in most cases, bigeye catch is reported with the yellowfin catch. Species composition data collected from the unloaded catch of purse seine vessels by port samplers are the sole source of information currently used to estimate the proportion of bigeye expected in the logsheet-reported catch of yellowfin. The annual estimated purse seine CPUE for bigeye in the WPCO was relatively stable until 1995, generally varying between 0.1 and 1 mt per day (Figure 32). The significant increase in the use of drifting FADs and technological changes has however seen increases in bigeye CPUE by several fleets, notably Japan and the US in recent years (Figure 32).

Figure 32. Estimated bigeye CPUE for the four main purse seine fleets in the WCPO
Bigelow et al. (2000) described an hypothesis for standardising effort in Pacific longline fisheries based on a bigeye habitat study in Tahiti. The standardised bigeye CPUE for the Japanese distant-water longline vessels for the tropical WCPO (presented in Figures 33) show that despite no obvious trends in nominal CPUE, standardised CPUE can be divided into two distinct periods — the pre-1980 period, where the CPUE index was generally above 9 per 100 "effective hooks", and the post-1980 period, where the CPUE index was generally below 9 per 100 "effective hooks". In the years prior to 1980 yellowfin was the preferred target species, in contrast to years after 1980, when bigeye-targeting became progressively more important. Both CPUE measures appear to oscillate from year to year at several points in this time series.

Figure 33. Standardised and nominal bigeye CPUE for distant-water and offshore Japanese longliners fishing in areas 2 and 3 (refer to Figure 31). Dashed lines represent the pre-1980 and post-1980 averages of standardised CPUE, respectively.

7.3 Size of fish caught

Monthly bigeye size (fork length, FL) is illustrated for both the longline and purse seine fleets from January 1999 to December 2001 (Figure 34). For the purse seine fleet, lengths are only illustrated for associated sets as fewer bigeye occur in, and are measured from unassociated sets. Most of the bigeye measured from the purse seine fishery were sampled from the US fleet under the conditions of the USMLT. Bigeye from associated sets comprised at least two size modes throughout this period. Bigeye sampled in the longline fishery are predominantly adult fish with a mean size of ~130 cm FL (range 80–160 cm FL). As with yellowfin (Figure 29), there was a general absence of medium-sized (60–100 cm) bigeye in the longline and purse seine catches during 2000 and 2001 compared with 1999. The progression of length modes of purse seine caught fish is clearly visible throughout the three-year time-series, as is the recruitment of medium-sized fish into the longline fishery in late 1999. The lack of clarity in the modal progression for associated purse seine sets during 2001 (compared to previous years) is possibly due to relatively fewer samples available as a result of less effort on drifting FAD sets during this period.
8. SOUTH PACIFIC ALBACORE

8.1 Catches

South Pacific albacore are exploited by a variety of longline fleets, by an international troll fleet operating seasonally in the region of the subtropical convergence zone (STCZ) and by a domestic troll fleet in New Zealand coastal waters. Throughout the 1990s, the longline catch in the South Pacific has been in the range of 23,000–40,000 mt, while the troll catch, for a season spanning November – April has been in the range 3,000–8,000 mt (Figure 35). The total catch during the 1990s ranged 33,000–46,000 mt which was well below the peak estimated catch of 52,414 mt in 1989, when driftnet fishing was in existence. In 2001, the
estimated total albacore catch jumped to 52,013 mt, which is slightly less than the record attained in 1989 and mainly attributable to a record longline catch (46,248 mt). Less than 15% of the south Pacific albacore catch is usually taken east of 150°W (Figure 36). The WCPO albacore catch (117,167 mt in 2001) includes north Pacific catches (from the longline, pole-and-line and troll fisheries) and typically contributes around 80–90% of the Pacific catch of albacore.

Albacore catch in several Pacific Island countries continue to increase in recent years. Fiji (7,791 mt), Samoa (4,820 mt), French Polynesia (4,261 mt) and American Samoa (3,253 mt) reported individual record catches of albacore during 2001. This catch level represents a large increase in albacore production compared to the early 1990s when albacore catch was less than 200 mt per year in French Polynesia and Fiji, and virtually non-existent in Samoa. The catch by these four Pacific-island countries alone represents around 45% of the total south Pacific albacore longline catch for 2001.

![Figure 35. South Pacific albacore catch (mt) by gear](image)

"Other" is primarily catch by the driftnet fishery.

The longline catch by DWFN fleets, primarily Taiwan and more recently several mainland Chinese vessels, is widely distributed in the South Pacific (Figure 36), but with catches concentrated in the western part of the region (west of 130°W). Catches by domestic longline fleets in Samoa, French Polynesia, Fiji, Solomon Islands, Tonga, and New Caledonia, and the Japanese fleet east of Australia, also contribute significantly to this wide geographical catch distribution. Troll catches are distributed in New Zealand coastal waters, mainly in the South Island, and along the STCZ.

![Figure 36. Distribution of south Pacific Albacore catch 1988–2000](image)

The three-region spatial stratification used in stock assessment for the WCPO is shown.
8.2 Catch per unit of effort

The key fishery indicators for south Pacific albacore are the nominal longline catch per unit effort (CPUE) and troll CPUE. For the longline fishery, data from the Taiwanese distant-water fleet (Figure 37) are generally used as this fleet has consistently targeted albacore over a long period of time. Longline CPUE (numbers of fish) is typically highest in the higher latitudes (STCZ and 30°–50°S), moderate in the tropics and subtropics (10°–30°S) and low near the equator (0°–10°S). For each of the two main latitudinal areas, longline CPUE has increased in the 1990s after a low point in 1989–1990. Nominal CPUE has tended to increase slightly in recent years in all areas after a low during 1999. The drop in CPUE in the northern area during recent years is related to the significant increase in effort targeting bigeye (and yellowfin), notably in the waters north of French Polynesia. The change in strategy by some vessels in this fleet will no doubt need to be considered in future stock assessment work on south Pacific albacore.

Several other longline fleets catch significant quantities of albacore while also targeting yellowfin and bigeye tuna, probably accounting for some of the variation in CPUE among these fleets. The established fleets in New Caledonian and Tongan had the highest albacore CPUE during the early 1990s, but recent years show general convergence in catch rates amongst the Pacific Islands fleets (Figure 38). Samoan data have not been included at this stage due to the short time period for which logsheet data are available.

![Figure 37. Nominal South Pacific albacore tuna CPUE (number/100 hooks) for Taiwanese distant-water longliners. South = 30°–50°S, central = 10°–30°S, north = 0°–10°S.](image)

Several other longline fleets catch significant quantities of albacore while also targeting yellowfin and bigeye tuna, probably accounting for some of the variation in CPUE among these fleets. The established fleets in New Caledonian and Tongan had the highest albacore CPUE during the early 1990s, but recent years show general convergence in catch rates amongst the Pacific Islands fleets (Figure 38). Samoan data have not been included at this stage due to the short time period for which logsheet data are available.

![Figure 38. Nominal albacore CPUE (number/100 hooks) by Pacific Islands longline fleets](image)
The troll fishery CPUE for the New Zealand domestic fleet tended to increase during the 1980s, but has been relatively stable during the 1990s (Figure 39). CPUE for the US fleet operating in the STCZ is generally higher, but more variable, indicating possibly a greater impact of environmental variation on the ability of this fleet to locate and catch albacore. There has been some convergence in the CPUE of these fleets in recent years.

Figure 39. Nominal South Pacific albacore CPUE (number/day) for the New Zealand troll fleet (operating in NZ coastal waters) and the USA troll fleet (operating east of 180° along the STCZ)

8.3 Size of fish caught

Size composition data of South Pacific albacore are derived primarily from port sampling. Monthly albacore length frequencies from the troll and longline fishery are illustrated from January 1999 to December 2001 (Figure 40). Albacore from the troll fishery were measured from the catch of US troll vessels fishing in the sub-tropic convergent zone (STCZ) east of New Zealand waters. The troll fishery usually operates during the summer (January – March) and typically lands albacore between 45 and 80 cm FL (Figure 39), with modal structure differing considerably between years.

Longline caught albacore are measured in various port in the SPC region (e.g. American Samoa, Fiji, French Polynesia, New Caledonia, Samoa and Tonga). Usually a single multiple-age class length mode is evident throughout the year. There is some evidence of overlap in the size composition of fish taken in both fisheries during the first three months of each year.
Figure 40. Size comparison of albacore sampled from the South Pacific longline and troll catch, 1999–2001
(Black: Longline; Grey: Troll)
REFERENCES


