The Western and Central Pacific Tuna Fishery 2000

Overview and Status of Stocks

John Hampton, Antony Lewis and Peter Williams

Oceanic Fisheries Programme

Tuna Fisheries Assessment Report N°3

Secretariat of the Pacific Community

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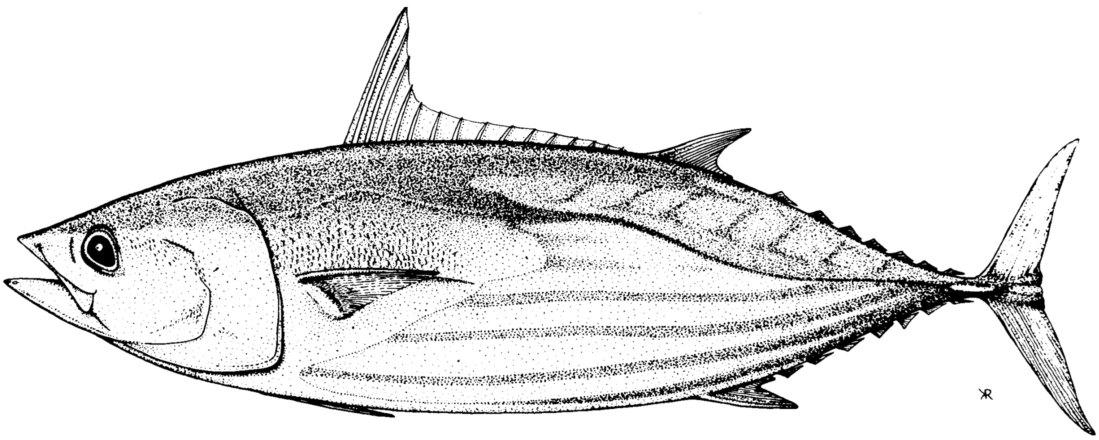

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Preface

Tuna Fisheries Assessment Reports provide current information on the tuna fishery of the western and central Pacific Ocean and the fish stocks, mainly tuna, which are impacted by them. 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 two main parts, the first providing an overview of the fishery, with emphasis on developments during the past few years, and the second providing the most recent information on the status of the stocks. The data used in compiling the report are those which were available to the Oceanic Fisheries Programme (OFP) at the time of publication. The fisheries statistics presented will usually be 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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Préface

Les rapports d'évaluation de la pêche thonière donnent des informations d'actualité sur la pêche thonière dans le Pacifique occidental et central et ses répercussions sur les stocks de poisson, principalement de thon. Le présent rapport braque le projecteur sur les principaux stocks de thon ciblés par cette activité : bonite (*Katsuwonus pelamis*), thon jaune (*Thunnus albacares*), thon obèse (*T. obesus*) et germon (*T. alalunga*).

Ce rapport comprend deux parties. La première fait un tour d'horizon de la pêche thonière et met l'accent sur l'évolution intervenue ces dernières années, et la seconde fait le point sur l'état des stocks. Les données utilisées pour établir ce rapport sont celles dont le programme Pêche hauturière avait connaissance au moment de la publication. Les statistiques halieutiques présentées sont généralement complétées à la fin de l'année qui précède la publication. Quelques modifications mineures peuvent parfois être apportées aux statistiques pour les années récentes. Les informations concernant l'évaluation des stocks qui sont présentées ici sont les plus récentes dont on dispose et sont actualisées périodiquement pour chaque espèce, au fur et à mesure que l'on procède à des analyses.

Pour toute question concernant ce rapport ou d'autres aspects des activités du programme Pêche hauturière, veuillez vous adresser au :

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Des informations complémentaires, notamment une version française intégrale de ce rapport, peuvent être consultées sur le site Web du programme Pêche hauturière: http://www.spc.int/oceanfish/.

Abstract

Overview of the Western and Central Pacific Tuna Fishery

The tuna fishery in the western and central Pacific Ocean (WCPO, west of 150°W) 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 both in the exclusive economic zones of Pacific states and on the 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 tuna catches, after being relatively stable since 1991, have increased significantly since 1998. The 2000 catch is estimated at 1,862,269 metric tonnes (mt), a very slight decrease from the 1999 catch. The purse-seine fishery accounted for an estimated 56% of the total catch, pole-and-line 19%, and longline 12%, with the remainder (13%) taken by troll gear and a variety of artisanal gears, mostly in eastern Indonesia and the Philippines. The WCPO tuna catch represented 76% of the total estimated Pacific Ocean catch of 2,461,526 mt, and 48% of the provisional estimate of world tuna catch (3,841,641 mt).

The 2000 catch by species featured a continuation of high skipjack tuna catches (1,163,417 mt; 62% of the total). The yellowfin tuna catch (426,909 mt; 23%) was below the all-time high 1997–1998 level, but has now been over 400,000 mt for the past four years; the bigeye tuna catch (115,264 mt; 6%) was slightly below the record high of the previous year. The albacore tuna (North and South Pacific) catch in 2000 (156,679 mt; 8%) was a record high.

The 2000 **purse-seine** catch of 1,034,209 mt was the second-highest ever — slightly higher than the 1999 catch and about 190,000 mt lower than the 1998 record catch. This was despite the prevailing unfavourable economic conditions in the fishery, with historically low prices for part of the year resulting in some voluntary effort reduction. Skipjack tuna (890,020 mt; 78%) continued to be the basis of the fishery, but was down approximately 130,000 mt from the record 1998 catch. The yellowfin tuna catch (196,346 mt; 19%) showed a slight decrease (20,000 mt) on the 1999 catch, as did the bigeye tuna catch (28,843 mt; 3%), the latter as a result of reduced FAD fishing. The Japanese, Korean and Taiwanese fleets all recorded substantial increases in catch in 2000, while the United States fleet sustained a significant decrease. Pacific Island domestic purse-seine fleets contributed around 10% of the 2000 purse-seine catch, slightly down from 1999, with the FSM fleet taking a record catch.

The 2000 **pole-and-line** catch of 359,246 mt constituted 19% of the total WCPO catch. The catch has steadily increased since 1997, primarily because of increased catches reported in Indonesia. As in previous years, skipjack tuna comprised the vast majority of the catch (84%); albacore tuna taken by the Japanese coastal and offshore fleets in the temperate waters of the North Pacific (10%), yellowfin tuna (5%) and a small component of bigeye tuna (1%) made up the remainder of the catch. By fleet, the Japanese distant-water and offshore fleet (128,344 mt) and the Indonesian fleet (160,000 mt reported) accounted for most of the catch; the Solomon Islands fleet took a much reduced catch of 2,692 mt as a result of civil unrest.

The 2000 **longline** catch of 217,240 mt accounted for 12% of the total western and central Pacific catch, but rivals the much larger purse-seine catch in terms of catch value. The 2000 catch represented an all-time high, surpassing the previous record catch taken in 1980. The species composition of the 2000 longline catch was 30% yellowfin tuna, 37% albacore tuna and 32% bigeye tuna. As in previous years, most of the 2000 catch was taken by the large-vessel, distant-water fleets of Japan, Korea and Taiwan, although this proportion is declining. Effort by these fleets is widespread as they target bigeye and yellowfin tuna for the frozen sashimi market, and albacore tuna in the more temperate waters for canning. The developing domestic longline fisheries of Pacific Island countries now provide over 10% of the WCPO longline catch; distant-water vessels from China have recently entered the fishery and there has been rapid development of a longline fishery in Vietnam.

The 2000 **troll** catch of South Pacific albacore tuna (5,750 mt) returned to more average levels, after the poor 1999 catch. As in previous years, catch and effort were concentrated in two main areas

— in coastal waters around New Zealand, and in the south central Pacific in the vicinity of the Sub-Tropical Convergence Zone.

Status of Tuna Stocks

Skipjack Tuna

The available fishery indicators suggest that, while skipjack tuna stock biomass in the WCPO shows considerable inter-annual variation, the fisheries have had little measurable impact on the stock. The application of the MULTIFAN-CL assessment model gave results generally consistent with the fishery indicators and previous tag-based assessments. While fishing mortality has increased significantly over time, the overall estimates of recent fishing mortality-at-age remain considerably less than the corresponding estimates of natural mortality-at-age. The percentage reduction in stock biomass attributable to the fishery has been 10–20% in recent years. Current levels of stock biomass are high and recent catch levels are easily sustainable under current stock productivity conditions.

Yellowfin Tuna

The various fishery indicators examined are mostly stable, indicating that fishery performance has been sustained over a long period of time. The longline catch and effective effort estimates have a considerable impact on the results of the MULTIFAN-CL analysis. In particular, the analysis suggests declines in biomass and recruitment in recent years consistent with the recent decline in longline CPUE. The impact of fishing on the stock is therefore estimated to have increased in recent years, from a 20% impact on biomass in the early 1990s to about 30% impact in 2000. The estimate of current impact on the stock is somewhat lower than the corresponding estimate (50%) from last year's report. This change is due in part to some refinements made to the estimates of standardised longline effort and the addition of new data to the model, but also reflects the inherent uncertainty associated with population estimates for the most recent years.

The overall conclusion regarding the status of the WCPO yellowfin tuna stock is similar to that in previous reports. The stock is at least moderately exploited, with recent average levels of age-specific fishing mortality probably somewhat less than the corresponding maximum sustainable yield (MSY) levels. Recent catch levels would therefore be sustainable at long-term average levels of recruitment, but the lower recruitment in recent years may indicate that the stock is shifting to a lower productivity regime. If this is the case, catch and CPUE may decline in coming years.

Bigeye Tuna

Bigeye tuna are demonstrably slower growing, longer lived, and, as a consequence, less resilient to fishing than skipjack and yellowfin tuna. The results of limited tagging in the early 1990s indicated that bigeye tuna exploitation rates at that time were at least as great as those for skipjack and yellowfin tuna. Preliminary modelling results and fishery indicators suggest a decline in abundance occurred from the early 1960s until the mid-1990s. This was related to a slight decline in recruitment over this period. Recent recruitment is estimated to be at a low level, although these estimates are subject to high uncertainty. Recent catches and fishing mortality of juvenile bigeye tuna in particular have increased significantly. The results at this stage suggest that recent catch levels may be close to the maximum sustainable with the present age-specific exploitation pattern.

The modelling results obtained to date are driven to a large extent by the estimates of standardised longline CPUE. These estimates are obtained from a habitat model in which the vertical distribution of bigeye tuna in relation to ambient temperature is a key input. Currently, this model input is based on a very limited number of observations of bigeye tuna tagged with sonic or archival tags. Additional archival tag data from various locations throughout the WCPO are required to improve these key estimates of bigeye tuna vertical distribution.

South Pacific Albacore Tuna

Fishery indicators and the MULTIFAN-CL analysis both suggest that the South Pacific albacore tuna stock declined moderately during the 1970s to early 1990s. This decline in stock biomass was mainly recruitment driven, as is the recovery in the mid-1990s. One hypothesis concerning the relationship between recruitment and oceanographic conditions predicts that recruitment may have been low in 1999–2000 but may increase over the next few years due to recent La Niña conditions. The impact of the fishery on the stock is estimated to be small, and higher levels of catch could likely be sustained.

Résumé

Tour d'horizon de la pêche thonière dans le Pacifique occidental et central

La pêche thonière dans l'océan Pacifique occidental et central (à l'ouest du 150° O) est très diversifiée; on y trouve à la fois de petites entreprises artisanales dans les eaux côtières des États et territoires océaniens et de grandes entreprises industrielles de pêche à la senne, à la canne et à la palangre, tant dans les zones économiques exclusives des États et territoires océaniens qu'en haute mer. Les principales espèces ciblées par ces flottilles sont la bonite (*Katsuwonus pelamis*), le thon jaune (*Thunnus albacares*), le thon obèse (*T. obesus*) et le germon (*T. alalunga*).

Après être demeurées relativement stables depuis 1991, les prises annuelles accusent une augmentation importante depuis 1998. Pour l'année 2000, la prise est estimée à 1 862 269 tonnes, soit une très légère diminution par rapport à la prise de 1999. La pêche à la senne représente environ 56 pour cent du total des prises, celle à la canne 19 pour cent et celle à la palangre 12 pour cent; les 13 pour cent qui restent sont réalisés à la traîne et par divers engins artisanaux, principalement en Indonésie orientale et aux Philippines. La prise de thon dans le Pacifique occidental et central constitue 76 pour cent du total estimé des prises dans l'océan Pacifique, qui atteignent 2 461 526 tonnes, et 48 pour cent de la prise mondiale de thon, estimée provisoirement à 3 841 641 tonnes.

Si l'on ventile la prise par espèce, on observe que la prise de bonite en 2000 demeure à un niveau élevé et atteint 1 163 417 tonnes, soit 62 pour cent du total des prises; la prise de thon jaune (426 909 tonnes, 23% du total) accuse un léger recul par rapport au record jamais égalé de 1997-1998 tout en se maintenant au-dessus de la barre des 400 000 tonnes depuis quatre ans, tandis que la prise de thon obèse n'est que de 115 264 tonnes, (6 %), soit une légère baisse par rapport au record de l'année précédente. La prise de germon (Pacifique Nord et Sud) atteint le chiffre record de 156 679 tonnes (8% du total).

En 2000, les prises des senneurs s'élèvent à 1 034 209 tonnes; elles dépassent légèrement la prise de 1999 mais sont inférieures d'environ 190 000 tonnes à la prise record de 1998, tout en restant en deuxième position malgré les conditions économiques défavorables qu'a subi la pêche. Les prix, qui n'ont jamais été aussi bas, pendant une partie de l'année, ont contraint les senneurs à réduire délibérément leur effort de pêche. Cette activité reste fondée sur la pêche de bonite (890 020 tonnes, 78% du total), malgré une diminution de 130 000 tonnes environ par rapport au chiffre record de 1998. La prise de thon jaune (196 346 tonnes, 19%) accuse une légère baisse (20 000 tonnes) par rapport à celle de 1999, de même que celle de thon obèse (28 843 tonnes, 3%) dont la baisse s'explique par le recul de la pêche à l'aide de DCP. Les flottilles japonaise, coréenne et taiwanaise ont connu de fortes augmentations des prises en 2000, tandis que la production de celle des États-Unis d'Amérique continue de chuter. Les prises des flottilles nationales océaniennes de senneurs représentent environ 10 pour cent des prises de senneurs de 2000, soit un léger recul par rapport à 1999; le record est battu par la flottille des États fédérés de Micronésie.

En 2000, les prises à la canne s'élèvent à 359 246 tonnes, soit 19 pour cent des prises totales dans le Pacifique occidental et central, poursuivant ainsi leur progression régulière, entamée en 1997, qui s'explique principalement par l'augmentation des prises signalée en Indonésie. Comme les années précédentes, la bonite représente la vaste majorité des prises (84%); le germon pris par les flottilles côtières et hauturières du Japon dans les eaux tempérées du Pacifique Nord (10%), le thon jaune (5%) et une faible proportion de thon obèse (1%) représentant le reste. Si l'on effectue la ventilation par flottille, ce sont les flottilles japonaises pratiquant la pêche hauturière et au large et la flottille indonésienne qui réalisent la majorité des prises, estimées provisoirement à 128 344 et 160 000 tonnes respectivement; la flottille des Îles Salomon enregistre des prises beaucoup plus faibles (2 692 tonnes) par suite des troubles civils.

Les prises de 2000 réalisées par les flottilles de palangriers, soit 217 240 tonnes, ne représentent que 12 pour cent du total dans le Pacifique occidental et central, mais, sur le plan de la valeur marchande, elles rivalisent avec celles des senneurs, pourtant bien plus importantes. Les prises de 2000 battent le record précédent de 1980. La composition par espèce des prises réalisées à la

palangre en 2000 est de 30 pour cent de thon jaune, 37 pour cent de germon et 32 pour cent de thon obèse. Comme les années passées, la majeure partie des prises de 2000 est réalisée par les flottilles du Japon, de la Corée et de Taiwan pratiquant la pêche hauturière et composées de navires de grande taille, bien que leur proportion soit en baisse. Ces flottilles font porter leur effort de pêche sur une vaste zone, car elles ciblent le thon obèse et le thon jaune pour le marché du sashimi congelé et le germon dans les eaux plus tempérées pour la conserverie. Les flottilles nationales des États et territoires océaniens représentent maintenant plus de 10 pour cent des prises à la palangre dans le Pacifique occidental et central; les flottilles de haute mer de la Chine continentale se sont mises depuis peu à pratiquer la pêche à la palangre, et cette activité est en plein essor au Vietnam.

En 2000, la prise à la traîne de germon du sud (5 750 tonnes) retrouve son niveau normal, après les médiocres résultats de 1999. Comme les années précédentes, les prises et l'effort se sont concentrés dans deux principales zones : les eaux côtières entourant la Nouvelle-Zélande et le Pacifique central et méridional, aux abords de la zone de convergence subtropicale.

État des stocks de thonidés

Bonite

Les indicateurs de pêche dont nous disposons laissent à penser que la biomasse des stocks de bonite dans le Pacifique occidental et central présente une variation interannuelle considérable, mais que la pêche n'a qu'une faible incidence mesurable sur ces stocks. L'évaluation préliminaire réalisée à l'aide du modèle MULTIFAN-CL a donné des résultats qui confirment généralement les indicateurs et les évaluations faites auparavant au moyen de marques. Si la mortalité due à la pêche a beaucoup augmenté au fil du temps, en revanche, les estimations globales récentes de la mortalité par âge due à la pêche sont de loin inférieures aux estimations correspondantes de la mortalité naturelle par âge. Le pourcentage de diminution de la biomasse des stocks imputable à la pêche a été de 10 à 20 pour cent, ces dernières années. Les niveaux actuels de biomasse des stocks sont élevés, et les niveaux de prises atteints récemment peuvent se maintenir aisément, dans les conditions actuelles de productivité des stocks.

Thon jaune

D'après les indicateurs de l'état de la pêcherie analysés, stables dans l'ensemble, le rendement de la pêche est resté constant pendant une longue période. Les estimations des prises et d'effort effectifs des palangriers influent considérablement sur les résultats de l'analyse au moyen de MULTIFAN-CL. Celle-ci fait en effet apparaître une diminution de la biomasse et du recrutement, au cours de ces dernières années, ce qui corrobore la récente baisse des PUE des palangriers. On estime donc que l'impact de la pêche sur les stocks a fortement augmenté ces dernières années, passant de 20 pour cent d'impact sur la biomasse au début des années 90 à 30 pour cent en 2000. Les estimations de l'impact actuel de la pêche sur le stock sont légèrement inférieures à l'estimation correspondante (50 pour cent) mentionnée dans le rapport de l'an dernier. Cette diminution s'explique en partie par l'affinement des estimations de l'effort normalisé de pêche à la palangre et par l'intégration de nouvelles données au modèle, mais elle reflète également l'incertitude intrinsèque liée aux estimations de population effectuées ces toutes dernières années.

Dans l'ensemble, l'état du stock de thon jaune dans le Pacifique occidental et central est identique à celui qui a été décrit dans les rapports précédents. Le stock est modérément exploité. Les niveaux moyens récents de mortalité par âge imputable à la pêche sont légèrement inférieurs aux niveaux correspondants de rendement maximal constant. Les niveaux de prise récents sont donc durables, à condition que le niveau moyen de recrutement perdure à long terme. La diminution du recrutement observée ces dernières années pourrait cependant indiquer que le stock évolue vers un régime de moindre productivité. Si tel est le cas, les prises et les prises par unité d'effort pourraient décliner au cours des prochaines années.

Thon obèse

Le thon obèse a sans conteste une croissance plus lente et une plus grande longévité et, par conséquent, il est plus vulnérable à la pêche que la bonite et le thon jaune. Les quelques marquages qui ont été faits au début des années 90 indiquent que les taux d'exploitation du thon obèse étaient à l'époque au moins aussi élevés que ceux de la bonite et du thon jaune. Les premières modélisations et les indicateurs de pêche indiquent qu'il y a eu diminution de l'abondance du début des années 60 jusqu'au milieu des années 90, ce qui s'explique par un léger déclin du recrutement pendant cette période. Les estimations récentes font apparaître un niveau de recrutement modeste, mais elles sont sujettes à caution. Les prises et la mortalité du fait de la pêche, celle du thon obèse juvénile en particulier, ont beaucoup augmenté ces derniers temps. À ce stade, ce résultat laisse à penser que le niveau des prises récentes approche probablement le maximum admissible dans les conditions actuelles d'exploitation en fonction de l'âge.

Les résultats obtenus jusqu'à présent par modélisation sont surtout influencés par les estimations de PUE normalisées de pêche à la palangre. Ces estimations sont obtenues sur la base d'un modèle d'habitat fondé principalement sur la répartition verticale du thon obèse en fonction de la température ambiante. À l'heure actuelle, cette information repose sur un nombre très limité d'observations de thons obèses portant des marques enregistreuses ou acoustiques. Il faudrait disposer d'autres données fournies par des marques enregistreuses et recueillies en divers sites du Pacifique occidental et central pour améliorer ces estimations fondamentales de la répartition verticale du thon obèse.

Germon du Sud

Les indicateurs de l'état de la pêcherie et les résultats de l'analyse MULTIFAN-CL donnent à penser que le stock de germon du sud a modérément décliné à partir du milieu des années 70 jusqu'au début des années 90. Cette diminution de la biomasse du stock s'explique principalement par la diminution du recrutement, de même que la reconstitution des stocks au milieu des années 90. Selon une hypothèse concernant les relations existant entre le recrutement et les conditions océanographiques, le recrutement, encore faible en 1999-2000, pourrait augmenter au cours des prochaines années sous l'effet du récent épisode La Niña. On estime que l'impact de la pêche sur le stock est très faible et que des niveaux supérieurs de prise pourraient probablement être supportés.

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List of Abbreviations

CPUE	catch per unit of fishing effort
ENSO	El Niño Southern Oscillation
EPO	eastern Pacific Ocean
FAD	fish aggregation device
GRT	gross registered tonnes
MSY	maximum sustainable yield
MULTIFAN-CL	a length-based, age-structured computer model used for fish stock assessment
OFP	Oceanic Fisheries Programme of the Secretariat of the Pacific Community
RTTP	Regional Tuna Tagging Project
SCTB	Standing Committee on Tuna and Billfish
SPC	Secretariat of the Pacific Community
STCZ	Sub-Tropical Convergence Zone
WCPO	western and central Pacific Ocean

1 Introduction

The tuna fishery in the western and central Pacific Ocean (WCPO) 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 both in the exclusive economic zones of Pacific states and on the 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*); a range of other species is taken incidentally in these fisheries but those species, including billfish, are not considered here.

In this report, we provide an overview of the tuna fisheries, with an emphasis on the year 2000, and current information on the status of the stocks of the target tuna species. The report draws on data and research results obtained by the SPC's Oceanic Fisheries Programme (OFP), particularly the 2000 Tuna Fishery Yearbook (Lawson 2001), and on material presented at the August 2001, 14th meeting of the Standing Committee on Tuna and Billfish (SCTB), held in Noumea, New Caledonia (see the SCTB homepage at http://www.spc.int/OceanFish).

2 Total Catch in the Western and Central Pacific Ocean

While each of the tuna stocks is distributed throughout the tropical and temperate waters of the Pacific Ocean, the tropical surface fisheries, which target skipjack, yellowfin and bigeye tuna and which dominate the total catch, tend to be concentrated in the western and eastern parts of the Pacific. Also, in the case of skipjack and yellowfin tuna, mixing of stocks between the western and eastern Pacific is believed to be low. For these reasons, when describing the tuna fisheries of the Pacific, we normally define the western and central Pacific Ocean and the eastern Pacific Ocean (EPO) as being separated by 150°W longitude (Figure 1). The WCPO as defined will also approximate the likely area of competence of the developing Western and Central Pacific Fisheries Commission.

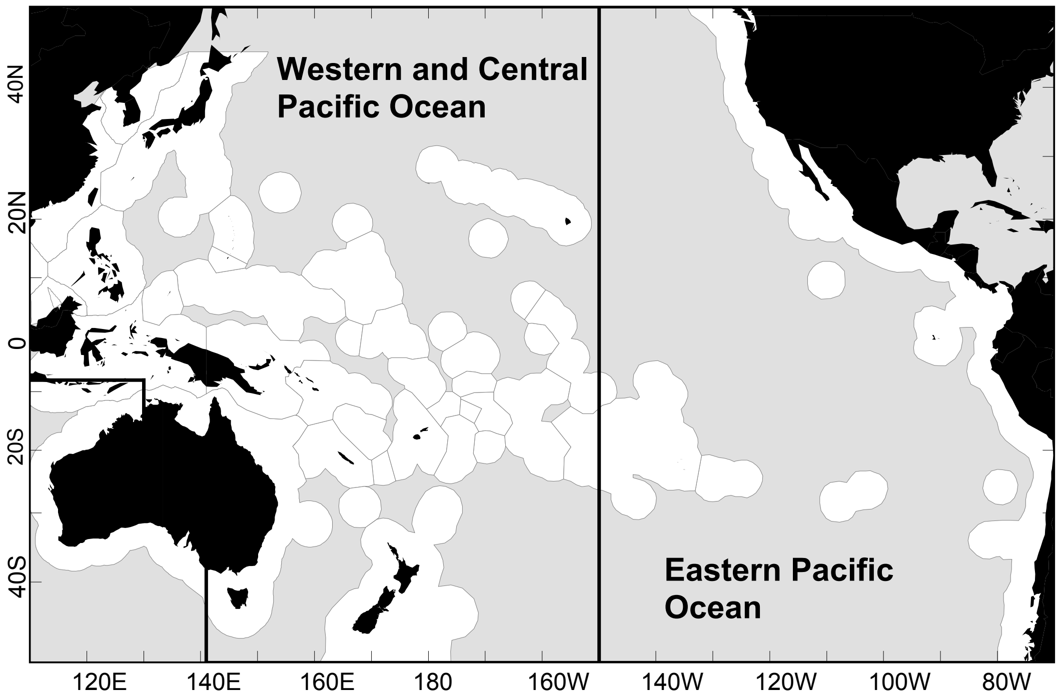


Figure 1. The western and central Pacific Ocean and the eastern Pacific Ocean.

Total annual catches of the four main tuna species (skipjack, yellowfin, bigeye and albacore tuna) in the WCPO, after having been relatively stable since 1991, have increased significantly since 1998 (Figures 2 and 3). The total WCPO tuna catch during 2000 was estimated at 1,862,269 mt, the third highest annual catch recorded after 1998 (2,014,106 mt). The purse-seine fishery accounted for an estimated 1,034,209 mt (56% of the total catch), the pole-and-line fishery an estimated 359,246 mt (19%), and the longline fishery an estimated 217,240 mt (12%), with the remainder (13%) taken by troll gear and a variety of artisanal gears, mostly in eastern Indonesia and the Philippines (Figure 2). The year 2000 WCPO tuna catch represented 76% of the total estimated Pacific Ocean catch of 2,461,526 mt in 2000, and 48% of the provisional estimate of world catch (3,841,641 mt) of the four tuna species.

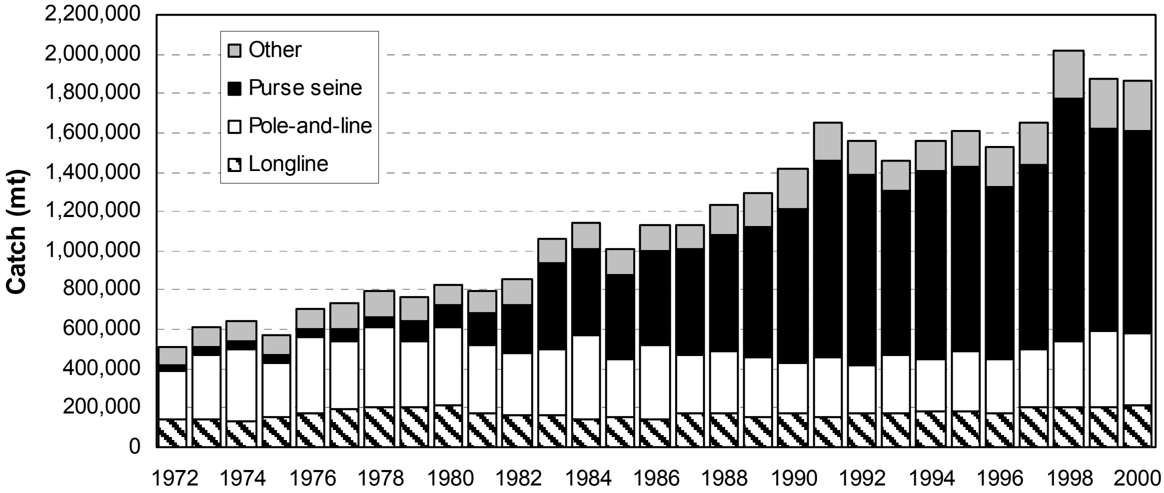


Figure 2. Annual total catch of skipjack, yellowfin, bigeye and albacore tuna, by fishing method, in the WCPO.

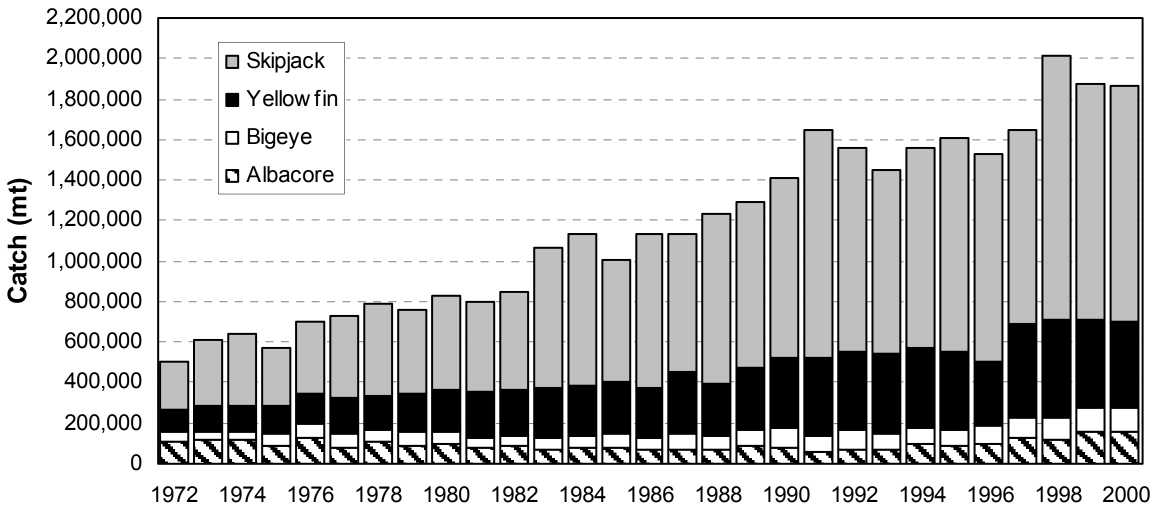


Figure 3. Annual total catch, by species, in the WCPO.

The 2000 catch by species (Figure 3) was dominated, as usual, by skipjack tuna (1,163,417 mt; 62% of the total tuna catch), down from the 1998 record level (1,306,671 mt) but similar to 1999. Yellowfin tuna (426,909 mt; 23%) catches were also below the all-time high 1997/1998 levels, but have been above 400,000 mt for the past four years. The albacore tuna catch[1] (156,679 mt; 8%) was a record high, and the bigeye tuna catch (115,264 mt; 6%) just below the historical high (117,121 mt) of 1999..

[1] Includes catches of North and South Pacific albacore tuna west of 150°W, which comprised 90% of the total Pacific Ocean albacore tuna catch of 173,586 mt in 2000.

3 Tuna Fishery by Gear Type

3.1 Purse Seine

3.1.1 Historical Overview

The purse-seine fishery has accounted for around 55–60% of the WCPO total catch since the early 1990s, with annual catches in the range 790,000–1,200,000 mt. The majority of the WCPO purse-seine catch (>70%) is taken by the four main distant-water fishing fleets (Japan, Korea, Taiwan and USA), which currently number around 140 vessels.

There has been an increasing contribution from the growing number of Pacific Island domestic vessels (Figure 4) in recent years (10%), with the balance from Philippines fisheries and a variety of other fleets, including a small seasonally active Spanish fleet.

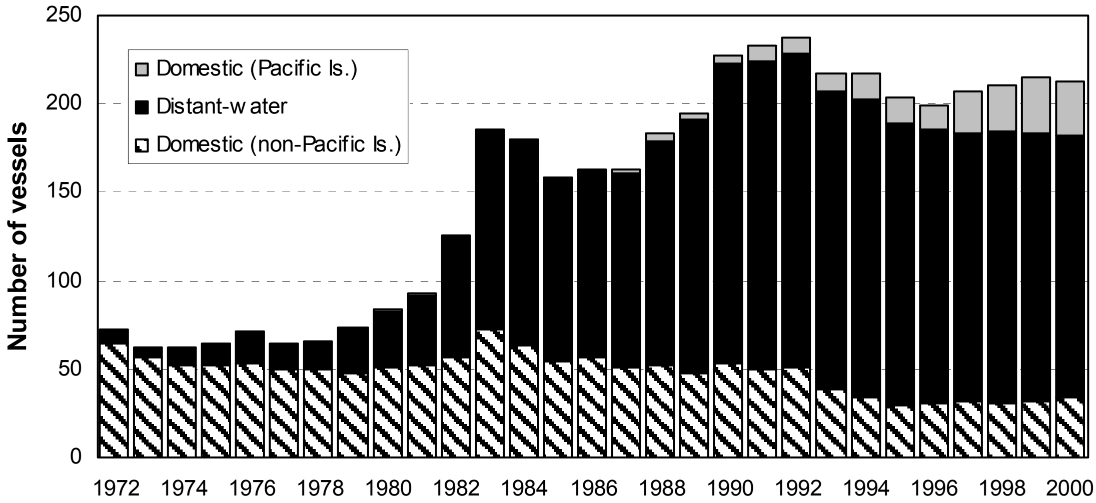


Figure 4. Number of purse-seine vessels operating in the WCPO. Domestic (non-Pacific Is.) includes vessels based in Australia, Japan and New Zealand, but not Philippines domestic vessels.

The WCPO purse-seine fishery is essentially a skipjack fishery, unlike those of other ocean areas. Skipjack tuna regularly account for 70–80% of the purse-seine catch, with yellowfin accounting for 20-25% and bigeye accounting for only a small proportion. Purse-seine catches in recent years have been the highest ever — the WCPO historical high catch was in 1998 (1,226,722 mt), with the second highest taken in 2000 (1,034,209 mt), despite the prevailing unfavourable economic conditions in the fishery, with historically low prices for part of the year, and some voluntary effort reduction.

Features of the purse-seine fishery during the past decade include::

- Annual skipjack tuna catches fluctuating between 600,000 and 770,000 mt until the recent sharp increases, starting with the 1998 catches and maintained since that time;
- Annual yellowfin catches fluctuating considerably between 120,000 and 265,000 mt; increases in the proportion of yellowfin tuna 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 (31,337 mt) and then again in 1999 (34,937 mt) and 2000 (28,843 mt), as a result of the increased use of drifting FADs since 1996.

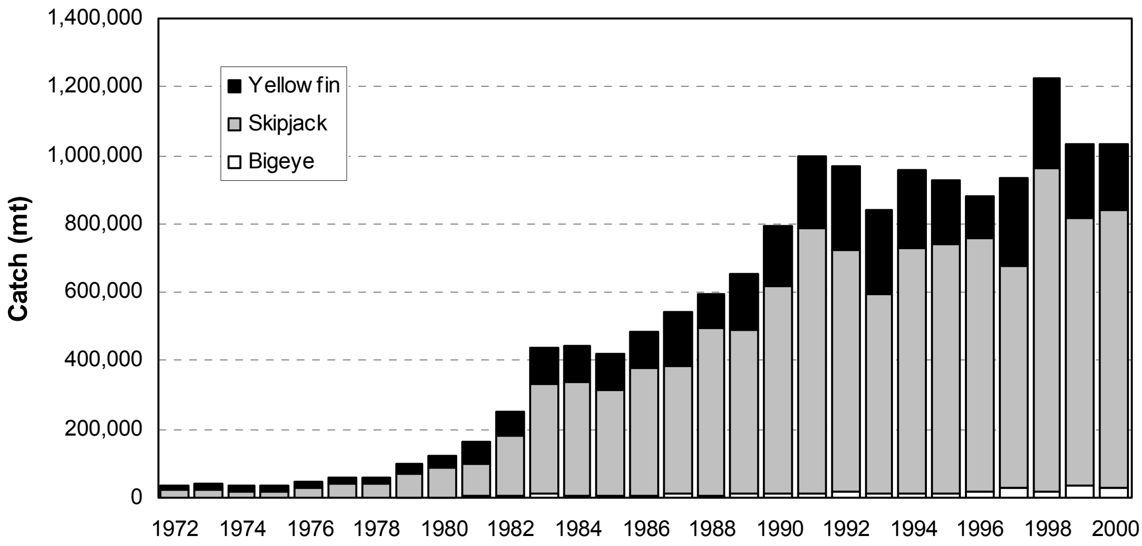


Figure 5. Purse-seine catch of skipjack, yellowfin and bigeye tuna in the WCPO.

3.1.2 The Year 2000 Fishery

The 2000 purse-seine catch of 1,034,209 mt was the third consecutive annual catch to exceed 1,000,000 mt, despite some voluntary reductions in effort in response to declining prices. Overall fleet size remained similar, except for the continuing reduction of the USA fleet; there was some redistribution of domestically-based vessels in the Pacific Islands.

The purse-seine skipjack tuna catch for 2000 (809,020 mt; 78%) was more than 130,000 mt less than the record 1998 catch (942,907 mt). The purse-seine yellowfin tuna catch for 2000 (196,346 mt; 19%) continued declining from the record 1998 catch, and is believed to reflect the prevailing La Niña situation. With the reduced incidence of setting on drifting FADs during 2000, the estimated purse-seine bigeye tuna catch for 2000 (28,843 mt; 3%) was down from 1999.

The total catches for three of the four main purse-seine fleets operating in the WCPO (Japan, Korea and Taiwan) increased during 2000, in association with improved catch rates. The catch from the USA fleet, however, declined sharply, with fewer vessels fishing and because of reduced catch rates. The Pacific Island domestic purse-seine fleets continued to take a significant proportion of the WCPO purse-seine catch, but this declined slightly, to around 10% of the total purse-seine catch in 2000. The major Pacific Islands domestic fleets are from Federated States of Micronesia (FSM), Marshall Islands, Papua New Guinea, Solomon Islands and Vanuatu. The 2000 Solomon Islands catch (8,751 mt) was much reduced as a result of the prevailing civil unrest and its impact on fishing operations, whereas the catch by the FSM fleet (25,638 mt) was the highest on record.

The percentage of sets on drifting FADs decreased for two of the major fleets during 2000 (USA and Taiwan) and increased for Japan, whereas the Korean fleet continued to make minimal use of FADs (Figure 6). Drifting FAD sets accounted for close to 90% of all sets made by the USA purse-seine fleet during 1999 (up from about 20% of sets in 1998) but fell to around 60% during 2000.

Geographical distribution

Catch distribution in these tropical areas is strongly influenced by ENSO events. Figure 7 demonstrates on a wider scale the effect of ENSO events on the spatial distribution of the purse-seine catch. Fishing effort is distributed farther to the east during El Niño years and contracting westward during La Niña periods. There is, however, some indication that the use of drifting FADs has dampened these effects, with more fishing in areas farther east during recent La Niña periods, typically involving FAD sets, than in past La Niña events (Figure 8). This may, however, be accompanied by somewhat reduced catch rates, as was the case for the US fleet during 2000. Fishing in eastern areas during El Niño periods (1997–98), on the other hand, involves mostly unassociated and log sets.

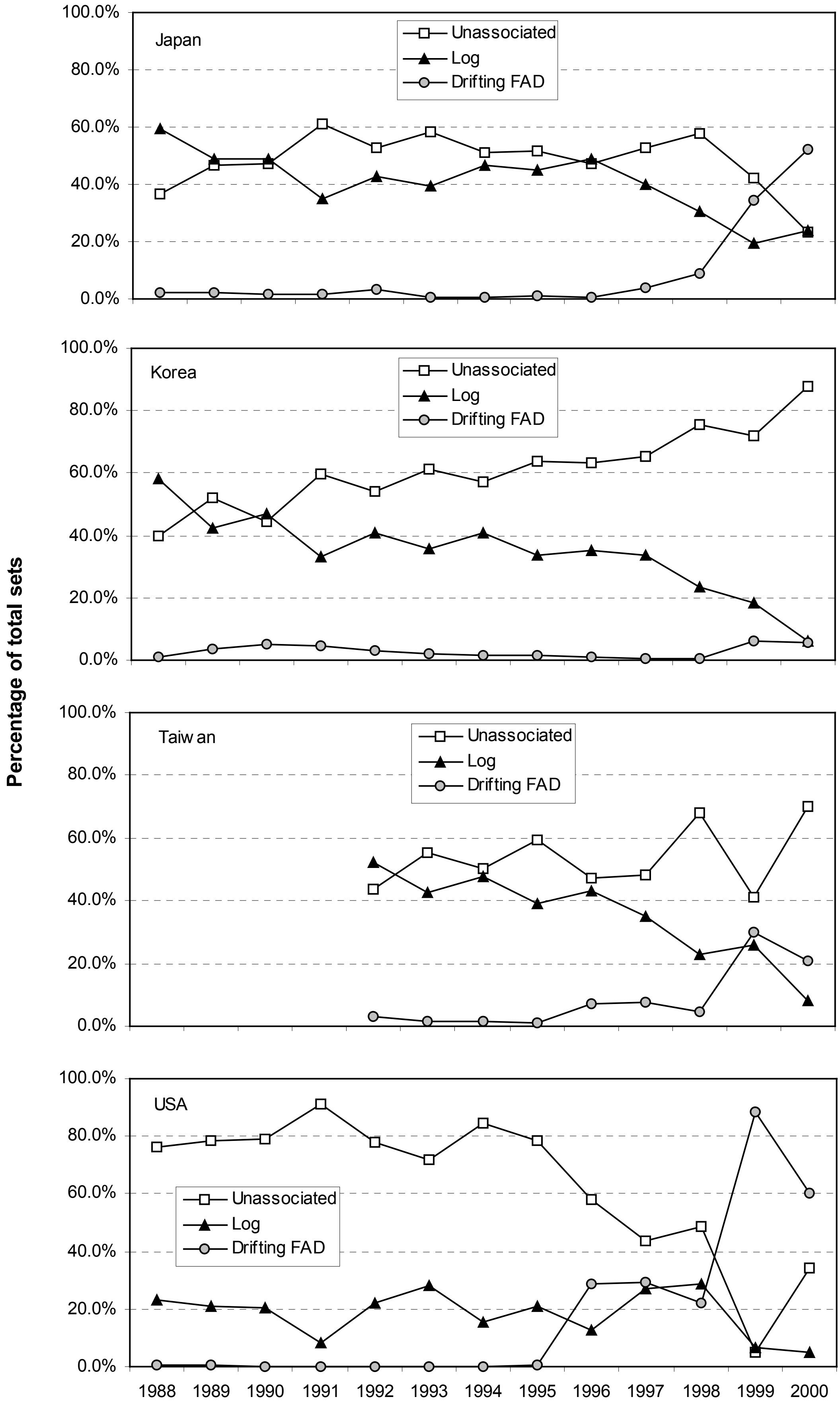


Figure 6. The percentage of total sets by set type for the major purse-seine fleets operating in the WCPO.

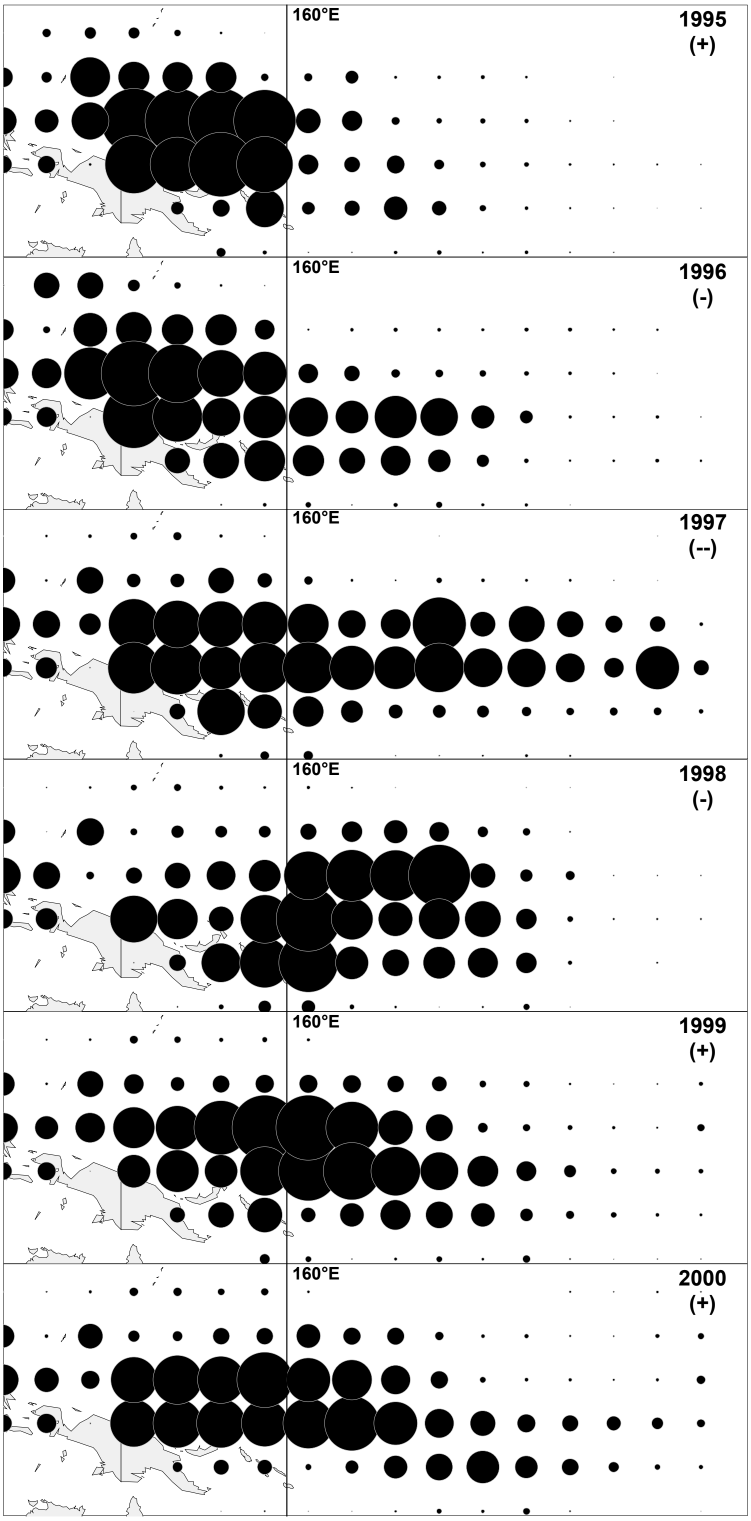


Figure 7. Distribution of purse-seine effort (days fishing and searching), 1995–2000. ENSO periods are denoted by: '+' = La Niña; '-' = El Niño; '--' = strong El Niño.

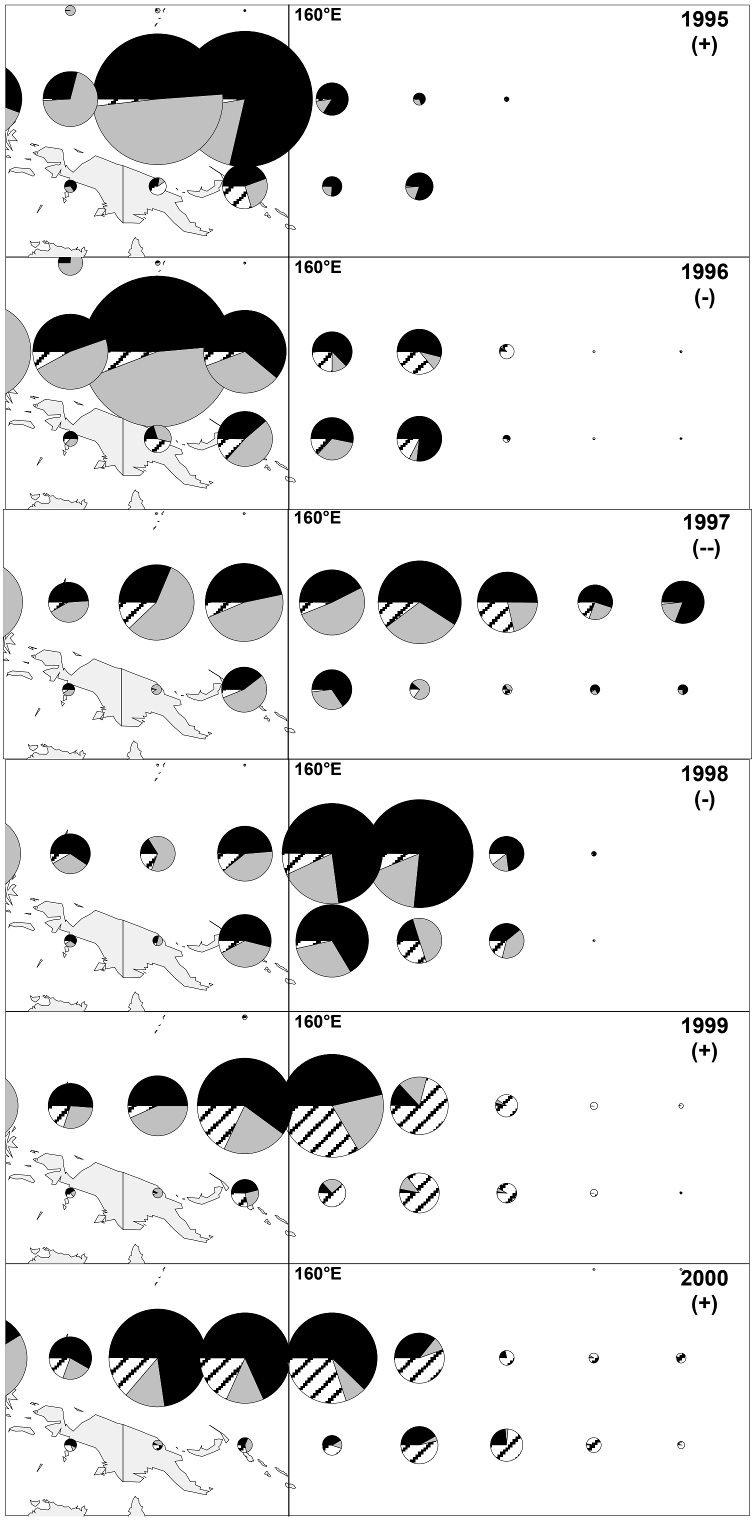


Figure 8. Distribution of purse-seine effort (sets) by set type, 1995–2000. (Solid–Unassociated; Grey–Log; Striped–Drifting FAD). ENSO periods are denoted by: '+' = La Niña; '-' = El Niño; '--' = strong El Niño.

3.2 *Pole and Line*

3.2.1 Historical Overview

The WCPO pole-and-line fishery includes:

- the year-round tropical skipjack tuna fishery, mainly involving the domestic fleets of Indonesia, Solomon Islands and French Polynesia, and the distant-water fleet of Japan;
- seasonal subtropical skipjack tuna fisheries in the home waters of Japan and Australia;
- a seasonal albacore/skipjack tuna fishery east of Japan (largely an extension of the Japan home-water 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 9) and stabilisation in the annual pole-and-line catch during the past decade (Figure 10; note that distinction between troll and pole-and-line gears in the Japanese coastal fleet was not possible for years prior to 1995). The gradual reduction in the number 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, and only one vessel was operating in Fiji Islands in 2000. Several vessels continue to fish in Hawaii, and the French Polynesian *bonitier* fleet remains active, but with more vessels turning to longlining activity. Against this trend, there has been a reported recent increase in Indonesian catches (since 1999), apparently as a result of technological advances and increased demand for the catch.

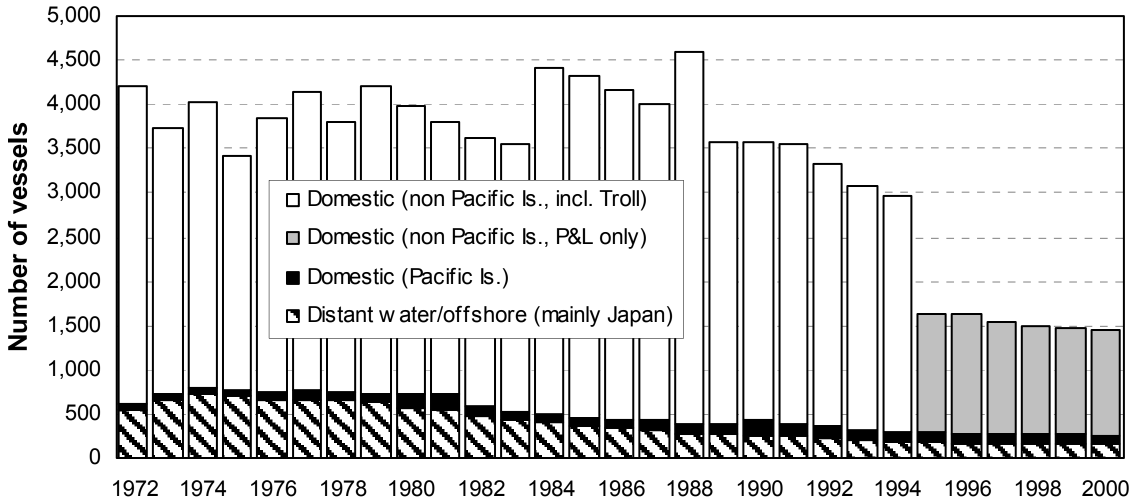


Figure 9. Pole-and-line vessels operating in the WCPO.

3.2.2 The Year 2000 Fishery

The pole-and-line catch estimate for 2000 (359,246 mt) includes Indonesian data, which report elevated catches for recent years. The estimate indicates the pole-and-line catch is at levels not seen since the mid-1980s. It is a slight decrease from the 1999 catch (386,831 mt) and represents about 19% of the total WCPO catch (Figure 10). As in previous years, skipjack tuna account for the vast majority (84%) of the pole-and-line catch. Albacore tuna taken by the Japanese coastal and offshore fleets in the temperate waters of the North Pacific (10%), yellowfin tuna (5%) and a small component of bigeye tuna (1%) make up the remainder of the catch. The Japanese distant-water and offshore fleet (128,344 mt of skipjack and yellowfin tuna in 1999) and the Indonesian domestic fleet (~160,000 mt) account for the bulk of the catch. Pole-and-line albacore catches in the North Pacific were at record levels in 1999–2000. The Solomon Islands pole-and-line fleet recorded a much reduced catch of 2,692 mt during 2000, down from the usual 20,000 mt per year, as a result of the civil unrest.

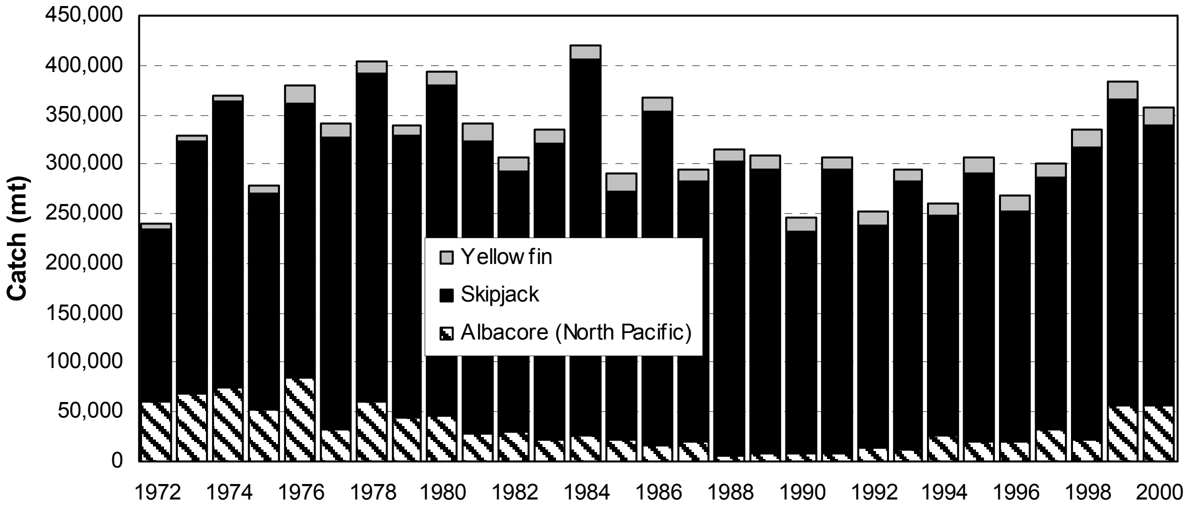


Figure 10. Pole-and-line catch in the WCPO.

Geographical distribution

Figure 11 shows the average distribution of pole-and line effort for the period 1995–1998, with most effort in tropical areas year-round (domestic and distant water fisheries), and seasonal effort in the Japan home-water fishery and along the Australian southeast coast.

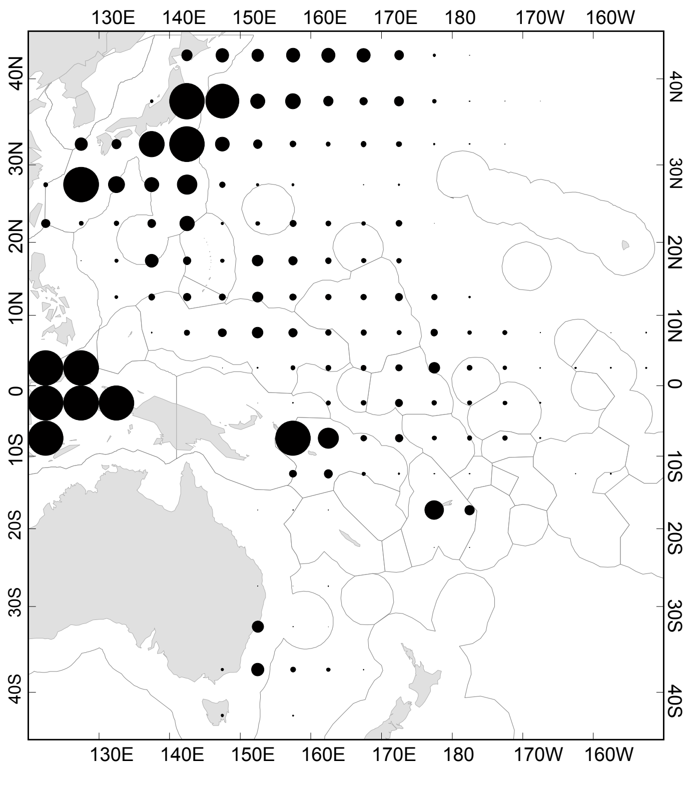


Figure 11. Average distribution of WCPO pole-and-line effort, 1995–1998.

3.3 Longline

3.3.1 Historical Overview

The longline fishery provides the longest catch history for the WCPO, with catch information available since the early 1950s. The total number of vessels involved in the fishery has fluctuated between 4,000 and 5,000 for much of this period (Figure 12).

The fishery involves two main types of operation:

- Large (typically >250 GRT) freezer vessels, which undertake long voyages (months) and operate over large areas of the region (distant-water vessels). These vessels may target either tropical (yellowfin and bigeye tuna) or subtropical (albacore tuna) species, and continue to produce the majority of the WCPO longline catch. Some voluntary reduction in vessel numbers by one major fleet (Japan) has occurred in recent years.
- Smaller (typically <100 GRT) vessels, usually domestically based, with ice or chilling capacity, and serving fresh or air-freight sashimi markets. These vessels operate mostly in tropical areas.

Additionally, small artisanal vessels in Indonesia and the Philippines (not included in Figure 12) take quantities of large yellowfin and bigeye tuna by handlining and small vertical longlines.

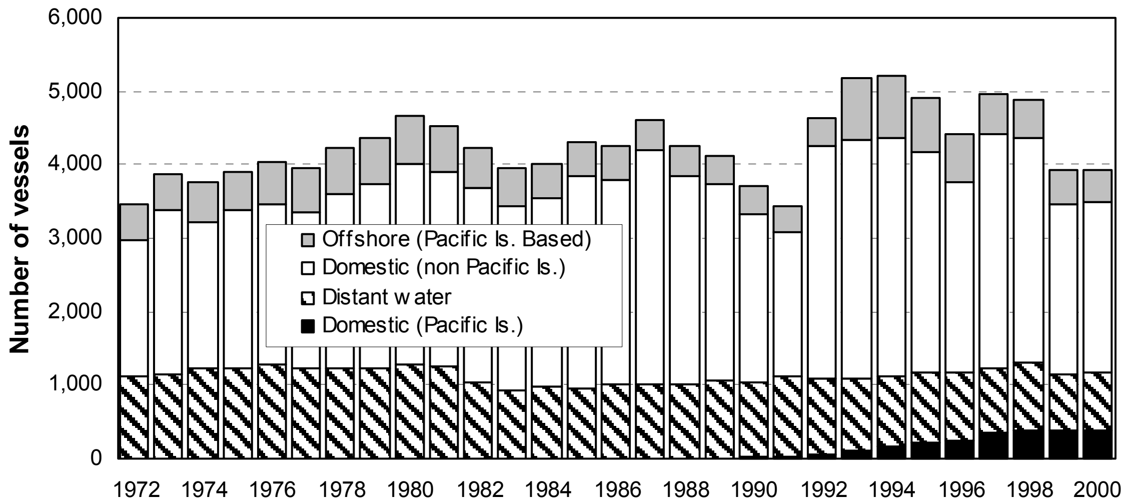


Figure 12. Longline vessels operating in the WCPO.

There have been significant changes in fleet operations and composition 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 water) in order to capitalise on the higher price of bigeye tuna compared to that of yellowfin tuna. The 1990s saw the gradual development of domestic fleets in the Pacific Islands, such as those of Samoa, Fiji Islands, French Polynesia, New Caledonia and Solomon Islands; these are mostly in subtropical areas, with albacore the main species taken, and now provide over 10% of the total WCPO longline 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 (Figure 12) 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 high seas areas of the South Pacific, and there has been rapid development of the longline fishery in at least one Southeast Asian state (Vietnam).

The annual total longline catch, after declining from high levels at the end of the 1970s, was relatively stable during the 1980s (Figure 13), but has again steadily increased during the 1990s. Total catches during this time have generally ranged between 140,000 and 210,000 mt. There have however been considerable changes in the species composition of the catch over this period, as well as changes in operation and structure of the fleet, as noted above.

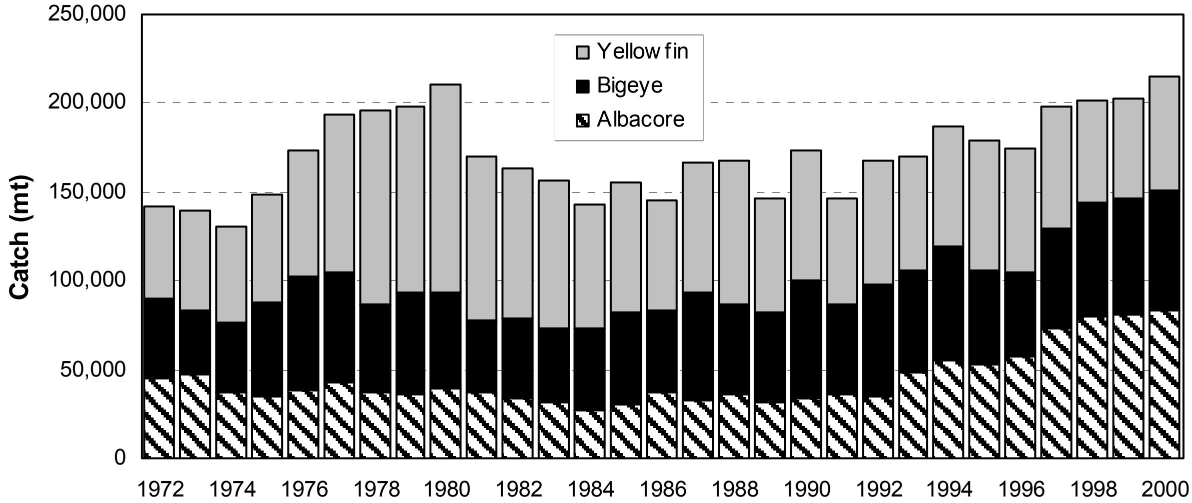


Figure 13. Longline catch in the WCPO.

3.3.2 The Year 2000 Fishery

The longline catch in the WCPO in 2000 of 217,240 mt accounted for 12% of the total WCPO catch, but rivals the much larger purse-seine catch in value. The year 2000 catch was an all-time high for the fishery, surpassing the previous record catch taken in 1980. The overall species composition of the 2000 catch was 30% yellowfin, 37% albacore and 32% bigeye, in contrast to 1981, when yellowfin dominated the catch (117,423 mt; 55%). The 2000 yellowfin catch of 64,735 mt represented a recovery from two years of low catches (< 60,000 mt) in 1998/99. The longline catch of bigeye (67,792 mt) was the highest recorded, following steady increases since 1996. The South Pacific albacore longline catch (41,436 mt) was also the highest recorded, as the result of increased growth in Pacific Island domestic fisheries (Fiji Islands, French Polynesia), and may be higher with probable under-reporting in several of these fisheries.

Geographical distribution

Figure 14 shows the geographical distribution of effort by category of fleet for 1999, which are the most recent data. As in previous years, most of the 2000 WCPO catch was still taken by the large-vessel distant-water fleets of Japan, Korea and Taiwan, although their overall proportion of the catch is declining. Effort 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 of the offshore fleets (Taiwan and China primarily shown, as no effort data are available for Japanese offshore vessels) occurs mainly in tropical areas, and shows limited overlap with the distant-water effort. The growth in domestic vessel fleets in the South Pacific has been noted, as has the arrival of distant-water Chinese longliners in the region in 1999 (effort data not available).Figure 15 shows the species composition by area for 1999 (most recent data). 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 distribution of the bigeye catch is similar: the majority of the catch is taken primarily from tropical areas, but with significant catches in temperate/subtropical areas (east of Japan, Australia, New Zealand). The albacore catch, in contrast, is taken in subtropical and temperate waters in both hemispheres.

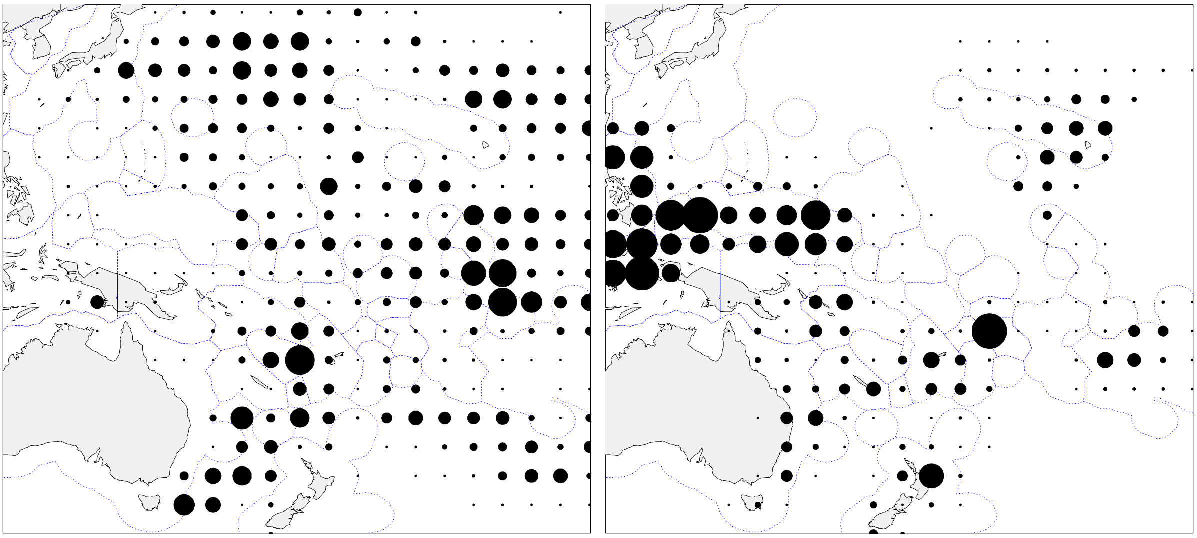


Figure 14. Distribution of distant-water (left) and offshore and domestic longline effort (right–excludes Japanese domestic fishery) during 1999.

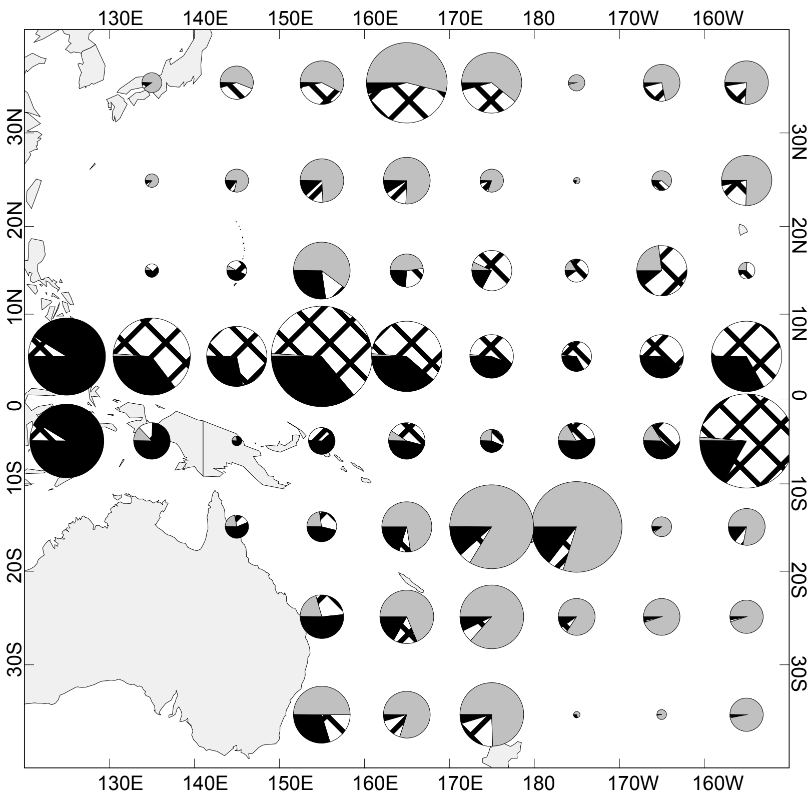


Figure 15. Distribution of longline catch, by species, during 1999 (black = yellowfin tuna; hatching = bigeye tuna; grey = albacore tuna).

3.4 Troll

3.4.1 Historical Overview

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

The fishery expanded following the development of the SCTZ fishery after 1986 (Figure 16), with the largest annual catch (around 9,000 mt) taken in 1989. Since then, annual catches have varied between about 4,000 and 8,000 mt. The level of effort expended by the troll fleets each year tends to reflect the price of albacore tuna for canning and expectations concerning likely fishing success.

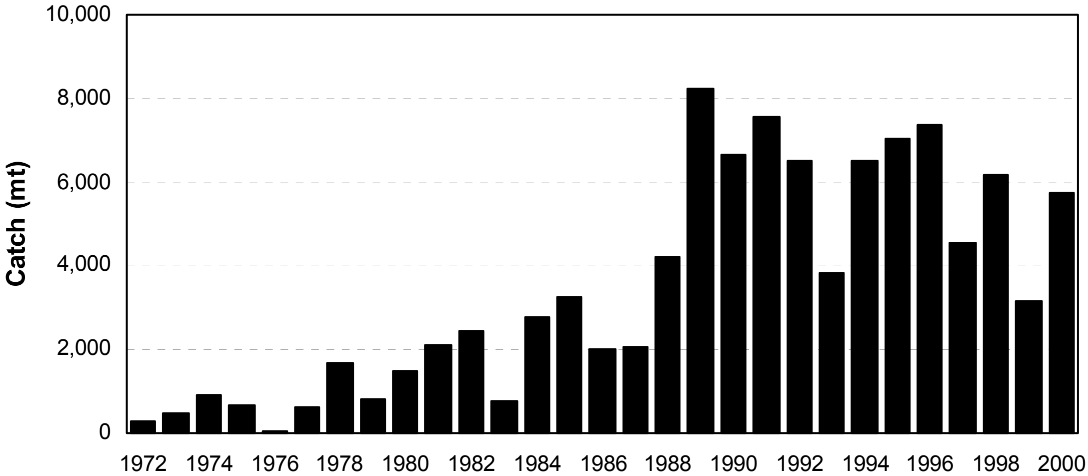


Figure 16. Troll catch of albacore tuna in the South Pacific Ocean.

3.4.2 The Year 2000 Fishery

The 2000 troll albacore tuna catch (5,750 mt) was about average, and almost twice that of the poor 1999 catch (Figure 16). Figure 17 shows the distribution of effort for the South Pacific troll fleets for 1998, which is expected to also approximate the distribution of fishing effort for 1999 and 2000 (i.e. mainly off the coast New Zealand and along the STCZ).

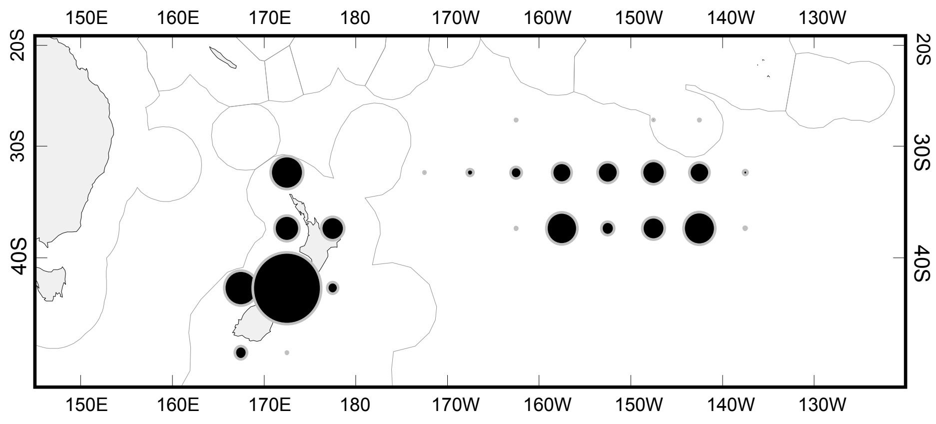


Figure 17. Distribution of South Pacific albacore tuna troll fishery effort during 1998.

4 Status of Tuna Stocks

In this section, we review the status of skipjack, yellowfin, bigeye and South Pacific albacore tuna stocks. The reference area used for skipjack and yellowfin tuna is the WCPO as earlier defined. For bigeye tuna, previous reports have considered both the WCPO and the EPO in an integrated Pacific-wide model. This year, the report focuses on the WCPO, although research on the Pacific-wide bigeye tuna model is ongoing. For albacore tuna, we continue the past practice of considering the entire Pacific Ocean south of the equator.

In each section, the catch history for that species is briefly summarised. Two types of 'fishery indicators' of stock status are then reviewed — trends in catch per unit of effort and the size composition of catches. In some circumstances, measures based on these variables can provide useful, albeit approximate, indications of the impact of fishing on the stocks. Finally, the results of stock assessment analyses are reviewed. In previous reports, information from tagging experiments and from the application of length-based, age-structured models (using the MULTIFAN-CL software) have been presented separately. In this report, the tagging-based stock assessment indicators have not been re-stated (they are unchanged from previous reports) and we focus on the results of the MULTIFAN-CL analyses (which integrate information from the tagging data as well as catch, effort and size data).

It should be stressed that these analyses are still evolving and may change over the next few years as additional data become available and new insights into the statistical properties of the models are obtained. Nevertheless, the results presented represent the 'best available' information on the current status of WCPO tuna stocks.

4.1 Skipjack Tuna

4.1.1 Catch

Skipjack tuna are taken primarily by purse-seine and pole-and-line gear, with smaller catches by artisanal gears in eastern Indonesia and the Philippines. Catches in the WCPO have increased steadily since 1970, more than doubling during the 1980s. The catch has been relatively stable during the 1990s (range 800,0001,300,000 mt), with catches of more than a million metric tonnes occurring in 1991, 1992, 1995, 1996, 1998, 1999 and 2000 (Figure 18). 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 steadily for economic reasons. Skipjack tuna catch increased during the 1980s due to growth in the international purse-seine fleet, combined with increased catches by domestic fleets from the Philippines and Indonesia (which have made up to 20–25% of the total skipjack tuna catch in WCPO in recent years).

The 2000 catch of 1,163,417 mt comprised:

- Purse seine — 809,020 mt (70% of the total), of which most was taken by the four main distant-water fleets (568,000 mt) and the Philippine purse-seine and ringnet fleet (estimated 120,000 mt);
- Pole-and-line — 283,000 mt (24%), of which around 130,000 mt was taken by Japanese fleets, an estimated 147,000 mt by Indonesia, following significantly increased catches in recent years, and a much reduced 2,200 mt by Solomon Islands;
- Other gears — 70,000 mt (6%), mostly unclassified gears in Indonesia, the Philippines and Japan.

The majority of the skipjack tuna catch is taken in equatorial areas, and a lesser amount in the seasonal home-water fishery of Japan (Figure 19). The distribution (and catch) of skipjack tuna in equatorial areas east of Papua New Guinea is strongly influenced by ENSO events.

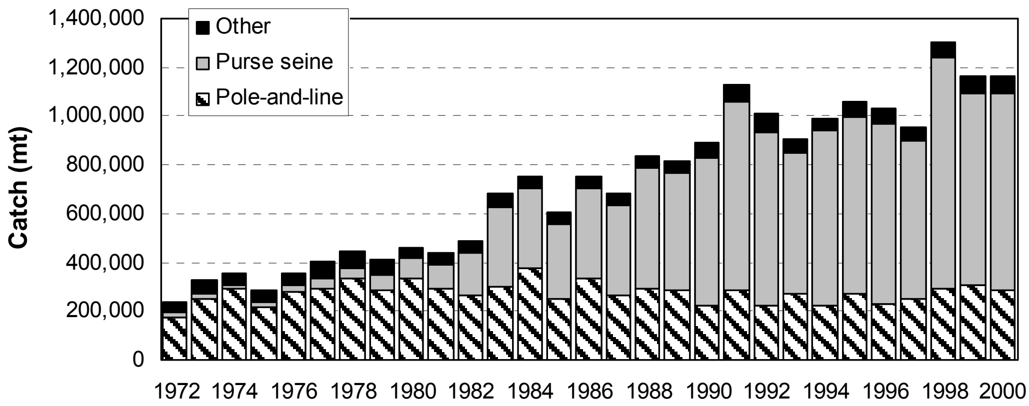


Figure 18. WCPO skipjack tuna catch, by gear.

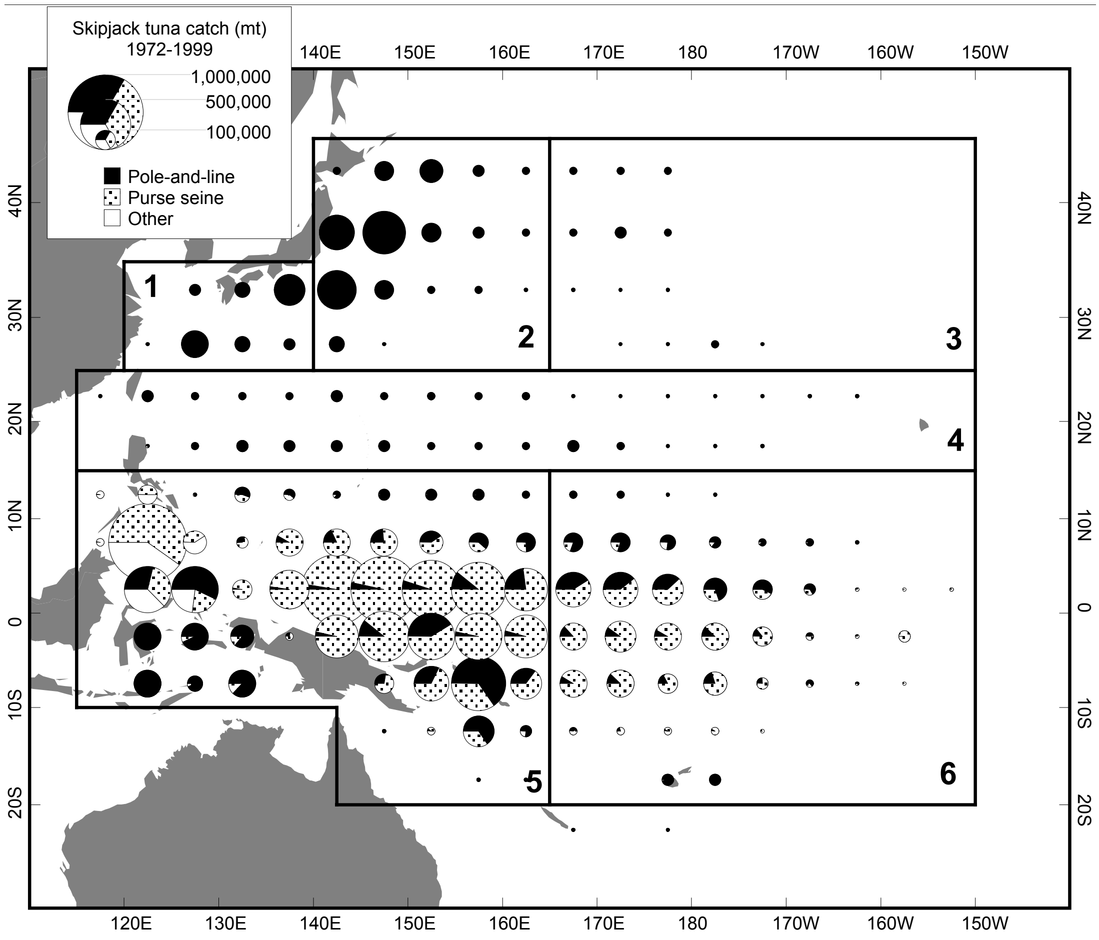


Figure 19. Distribution of skipjack tuna catch, 1972–1999. The six-region spatial stratification used in stock assessment is shown.

4.1.2 Catch Per Unit of Effort

Various skipjack tuna CPUE time series can be examined for evidence of fishery impacts. Nominal CPUE series (i.e. simply catch divided by reported effort) for Japanese, USA, Korean and Taiwanese purse seiners by major set types are shown in Figure 20. These fleets are the major purse-seine fleets fishing in the WCPO.

Skipjack tuna CPUE was fairly stable during the period 1988–1997 for all fleets and set types. For log and FAD sets, CPUE was substantially higher in 1998, 1999 (USA fleet) and 2000. These increases may be due to higher skipjack stock levels, an increase in the effectiveness of purse seine effort, or both.

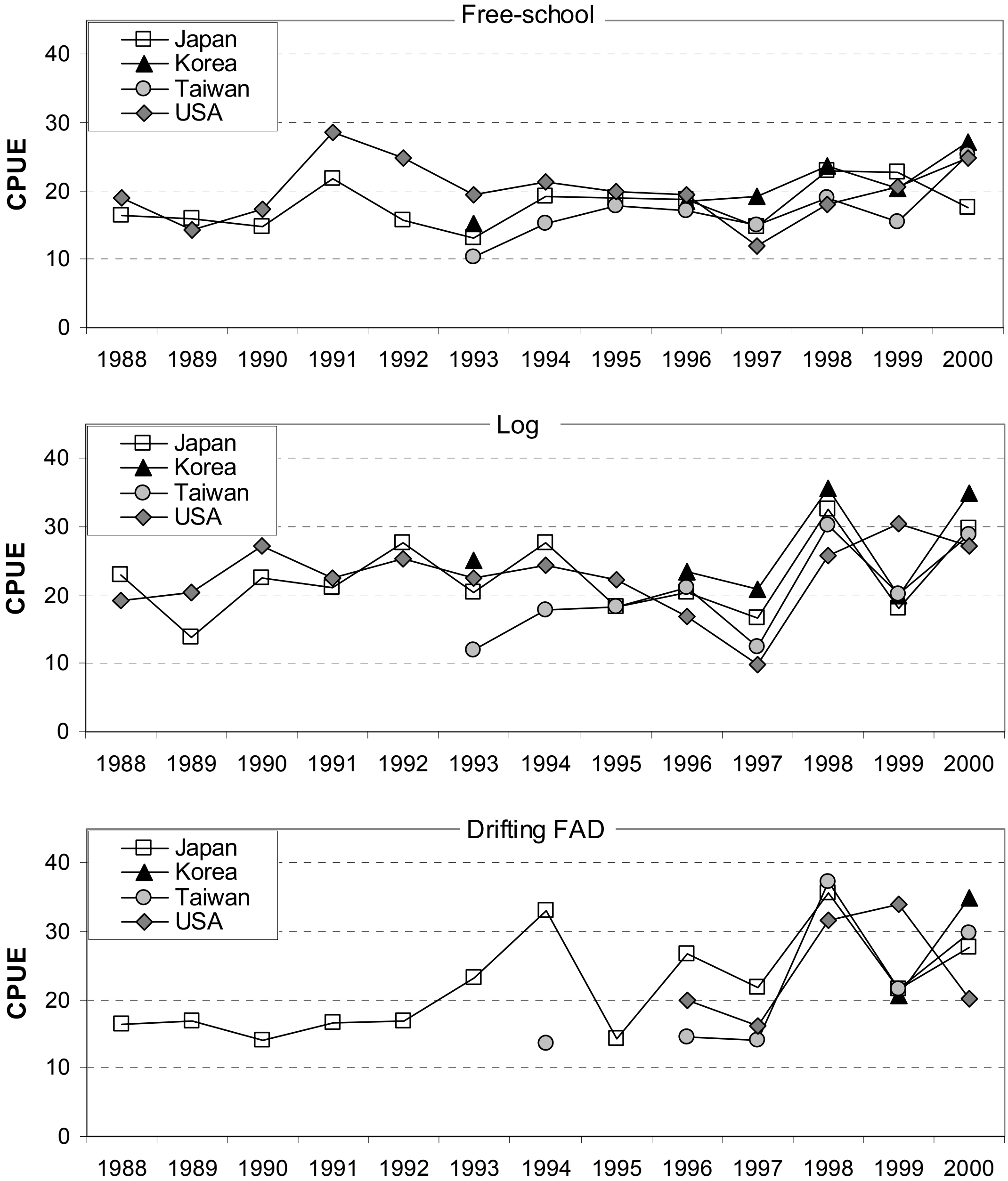


Figure 20. Skipjack tuna CPUE (mt per day) by major set type categories (free-school, log and drifting FAD sets) for Japanese, Korean, Taiwanese and USA purse seiners fishing in the WCPO. Effort and CPUE were partitioned by set type according to the proportions of total sets attributed to each set type.

In contrast to the industrial purse-seine fleets, the Solomon Islands pole-and-line fleet has been operating in the region for many years using fairly consistent fishing practices and technology (although catches were much reduced during 2000 due to political unrest.). Therefore, the nominal CPUE of this fleet (Figure 21) may provide a better index of skipjack tuna abundance than the purse-seine fleets (at least in the area around Solomon Islands, where these vessels fish). Nominal CPUE was marginally higher in the 1980s (average of 3.9 mt per day) than in the 1990s (average of 3.5 mt per day). Such a modest decline does not suggest a serious depletion of the skipjack tuna resource, either locally or in the WCPO.

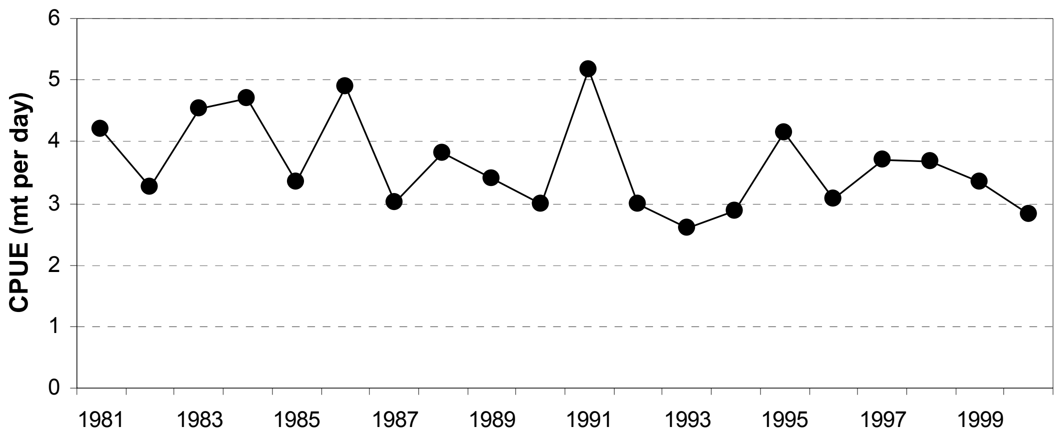


Figure 21. Nominal skipjack tuna CPUE for Solomon Islands pole-and-line vessels.

The Japanese distant-water, pole-and-line fleet has operated over a wide area of the WCPO for many years, and its CPUE may also be useful for interpreting trends in skipjack tuna abundance. However, in contrast to the Solomon Islands fleet, the Japanese fleet has changed considerably over the years, with smaller, less-efficient vessels dropping out of the fleet as it reduced in size, and the remaining vessels adopting new technology as it became available. Ogura and Shono (1999) have estimated the effects of a range of vessel characteristics on skipjack tuna CPUE, resulting in estimates of CPUE that have been adjusted for the factors found to be significant. Both the nominal and standardised CPUE (updated from this study) show generally increasing CPUE, although there is some decline in the standardised index in the early 1990s (Figure 22). On the basis of these time series, we would conclude that the skipjack tuna stock in the WCPO remains healthy.

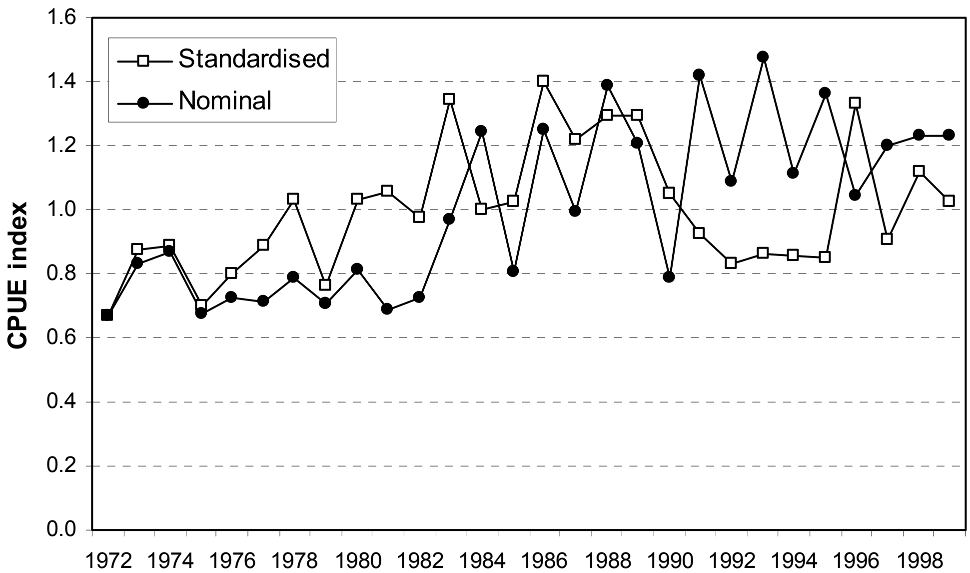


Figure 22. Nominal and standardised skipjack tuna CPUE (relative to the average of each series) for Japanese distant-water, pole-and-line vessels.

4.1.3 Size of Fish Caught

As fisheries become heavily exploited, the size distribution of fish caught often changes (usually with a decline in the proportion of large fish). It is therefore useful to monitor the size composition of the catch as another potential indicator of the impact of fishing. Other factors, however, such as variable recruitment and changes in fishing methods, may also impact the catch size composition.

Estimates of catch-at-size for pole-and-line and purse-seine fleets during different time periods are shown in Figure 23. The size composition of the catch broadened considerably in the 1980s with the commencement of purse seining. Purse-seine log sets tend to catch smaller skipjack, while FAD and school sets tend to catch slightly larger fish. The incidence of skipjack < 40 cm appears to have been lower in 1999–2000 compared with earlier years.

4.1.4 Stock Assessment

An integrated, length-based, age- and spatially-structured model known as MULTIFAN-CL (Fournier et al. 1998; Hampton and Fournier 2001a) is now routinely applied to tuna stock assessment in the WCPO. During 2001, the application to skipjack tuna was considerably enhanced by a collaborative study between SPC and the Japan National Research Institute of Far Seas Fisheries. The previous analysis was restricted to the tropical region of the WCPO (15°N–20°S), with a simple two-region spatial structure (a longitudinal boundary along 165°E). This year, the geographical scope of the analysis was extended to include the northwestern Pacific and the Japanese pole-and-line fisheries that occur in this region. A considerable amount of tagging data for this region was also added to the analysis. The entire WCPO is therefore considered in the new analysis, and a six-region stratification (see Figure 19) similar to that employed by Ogura and Shono (1999) is used.

The data cover the period 1972–1999 using a quarterly time stratification. Catch, effort and size data for 24 fisheries (12 pole-and-line, Philippine and Indonesian domestic, 7 purse-seine and 3 research longline fisheries) were used in the analysis, with the purse-seine fisheries classified by set type (log, FAD and unassociated sets) in each region. Tagging data from SPC tagging experiments in the tropical WCPO and from Japanese experiments in the subtropical WCPO (215,997 releases, 17,052 returns) were incorporated into the analysis. The skipjack tuna population is assumed to comprise 16 quarterly age classes (the last being a cumulative age class), which are exploited by the 24 fisheries with estimated age-specific selection patterns and time-varying catchability.

Complete details of the data, model structure and results are given in Hampton and Fournier (2001b) (see http://www.spc.int/OceanFish/Html/SCTB/SCTB14/skj-1.pdf); only the subset of results of direct importance to stock assessment is given here.

Annual fishing mortality rates have increased steadily over time and are highest for adult skipjack tuna (< 45 cm) where they are approximately 0.4–0.5 per year in recent years (Figure 24). Juvenile skipjack tuna are relatively lightly exploited. Despite the recent increases, overall fishing mortality rates remain considerably less than the corresponding natural mortality rates (which are around 2.0 per year).

Recruitment estimates show considerable low- and high-frequency variation (Figure 25). Recruitment appears to be higher following El Niño episodes (e.g. during 1990–91 and 1997–98), which is consistent with hypotheses currently advanced regarding the impact of ENSO events on tropical tuna productivity (Lehodey 2000). There was an upward shift in recruitment in the mid-1980s, which may be related to decadal-scale changes in biological productivity.

Population biomass trends are driven by the recruitment variability as expected in a short-lived species such as skipjack tuna (Figure 26). Large peaks are observed in 1988, 1991 and 1998, following the large recruitments in those years or immediately before. Recent levels of total skipjack tuna biomass are above their long-term average levels.

The impact of the fishery on the stock is summarised in Figure 27, which compares the estimated biomass trajectory with the trajectory that would have resulted (based on the model parameters) in the absence of fishing, assuming that the fishery has had no effect on recruitment. There is little difference in the two trajectories for skipjack tuna, indicating that the fishery has had minimal effect on the stock. The highest levels of impact occurred in the 1990s, when the fishery was estimated to have reduced its biomass by 10–20% from the level it would otherwise have attained.

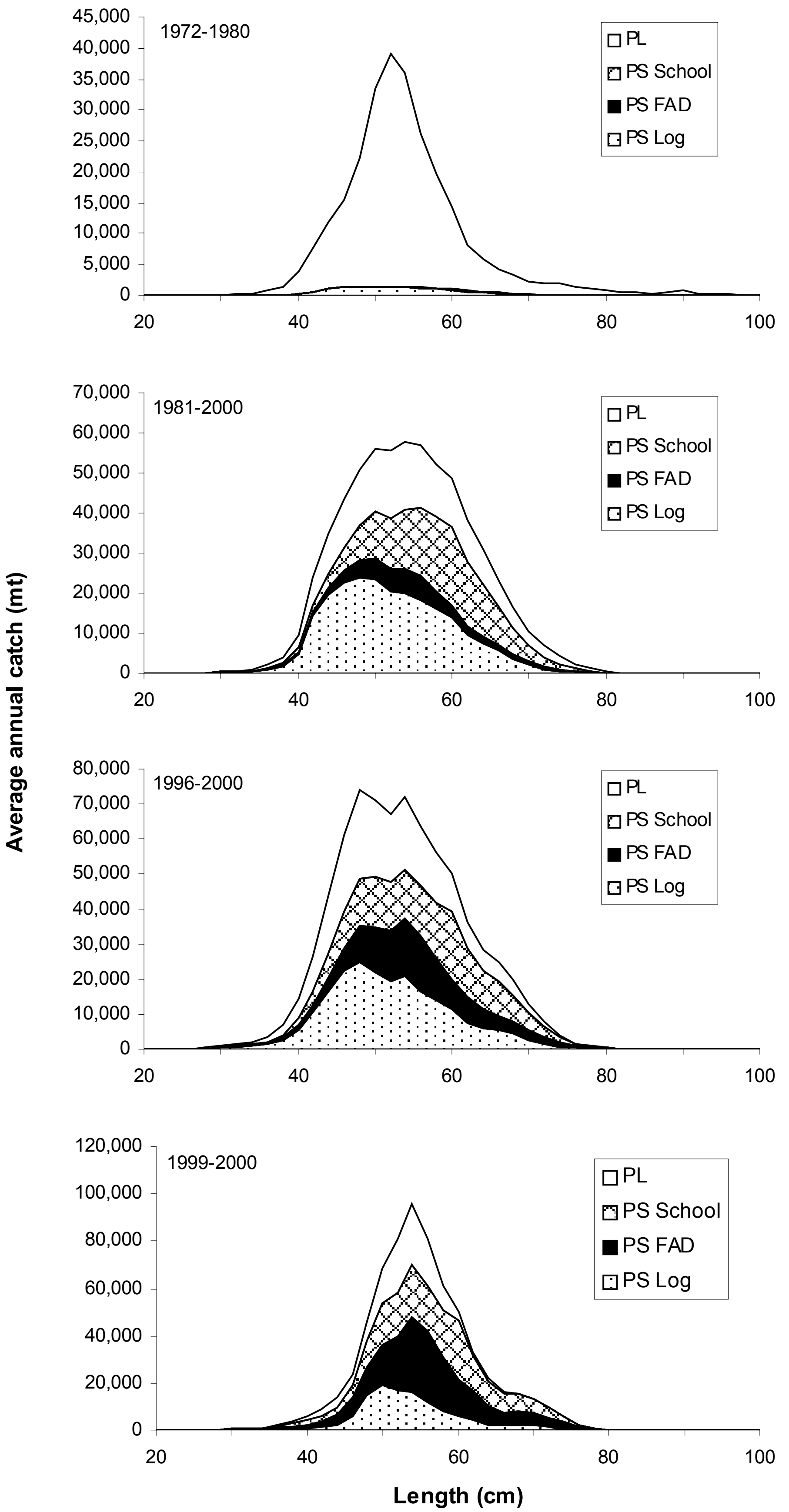


Figure 23. Skipjack tuna catch-at-size for pole-and-line (PL) and purse-seine (PS) fleets operating in the WCPO during different periods.

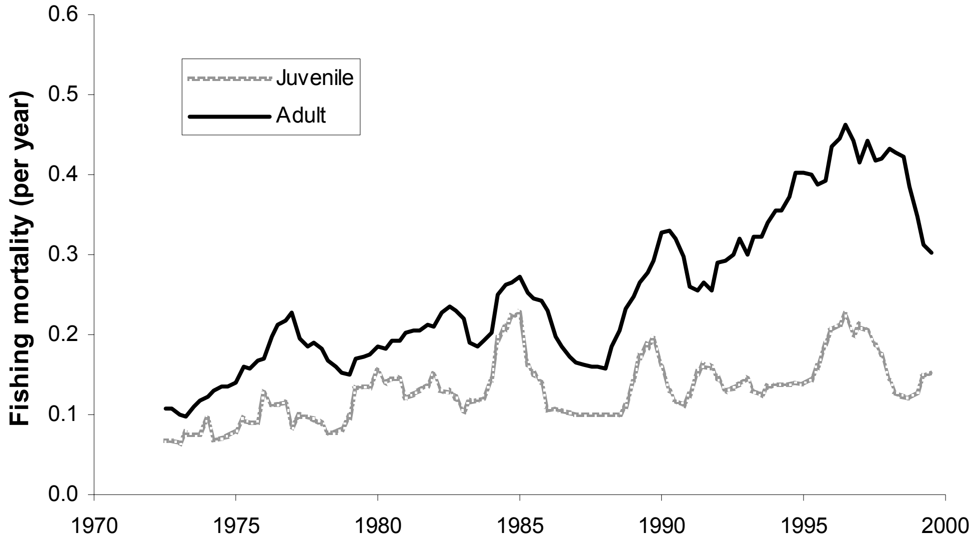


Figure 24. Estimated annual fishing mortality rates for juvenile (< 45 cm) and adult skipjack tuna.

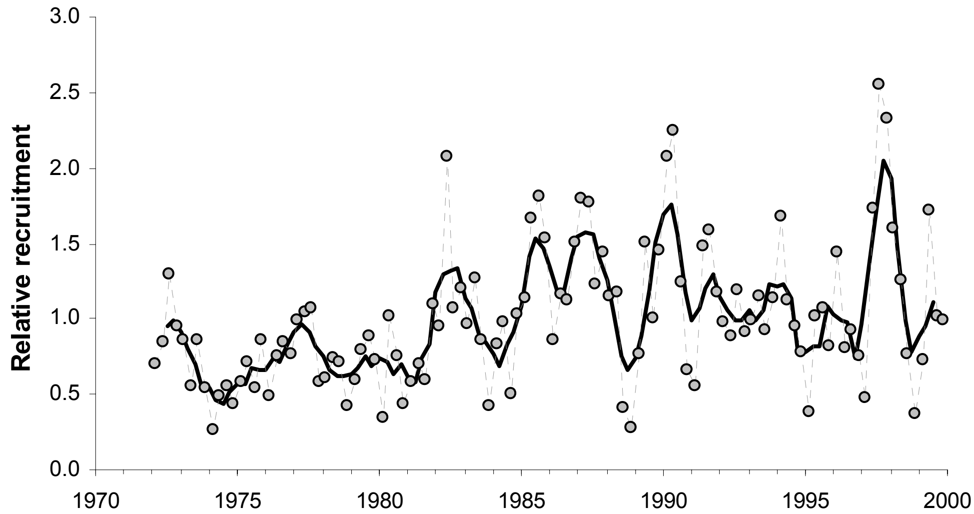


Figure 25. Estimated relative (scaled to the average) quarterly skipjack tuna recruitment with a four-quarter moving average (solid line).

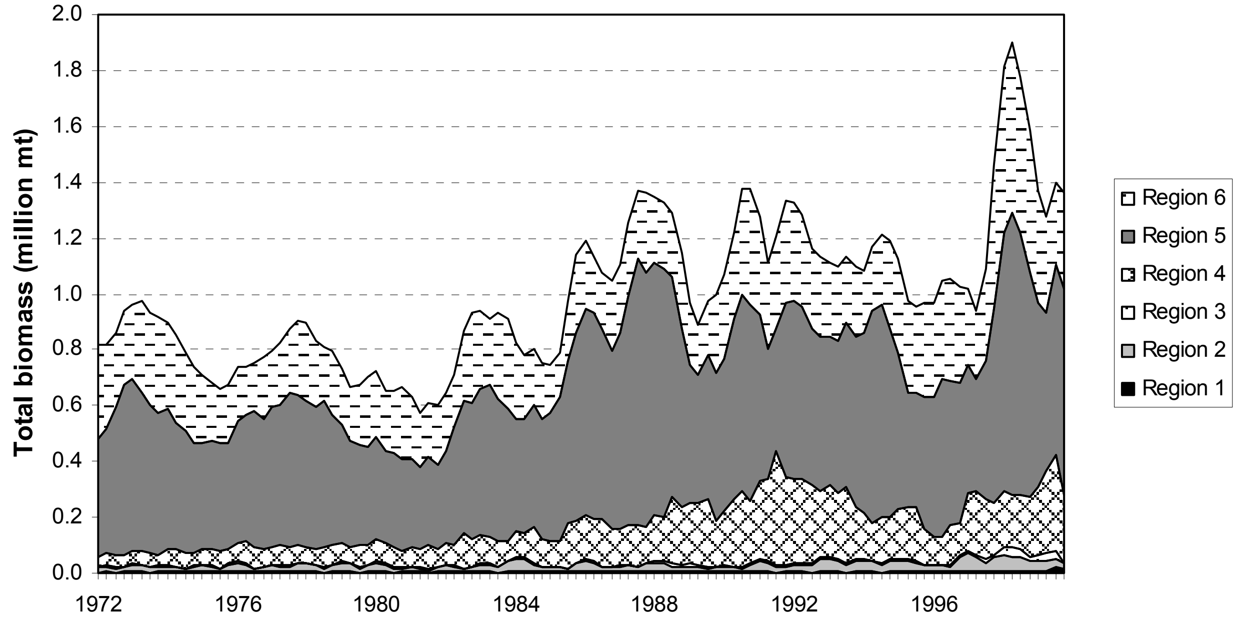


Figure 26. Estimated relative total skipjack tuna biomass, by region. Estimates are scaled to the average spatially aggregated biomass.

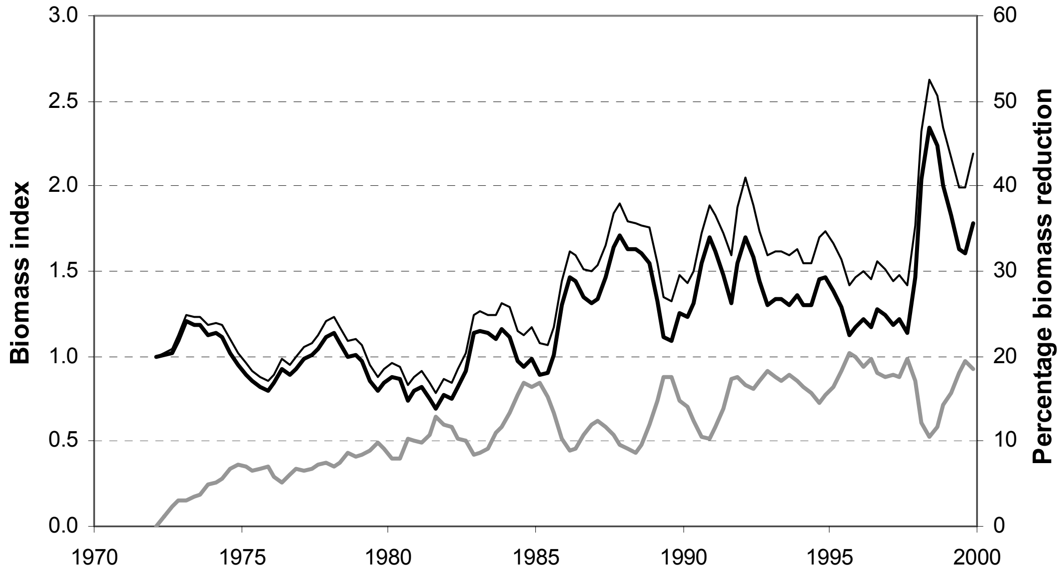


Figure 27. The estimated impact of fishing on skipjack tuna biomass. The lower biomass trajectory (darkest line) represents the model estimates of total biomass. The upper trajectory is the estimated biomass that would have occurred in the absence of fishing assuming that recruitment was unaffected by fishing. The lower line is the percentage biomass reduction due to fishing and is an index of fishery impact.

Conclusion

The available fishery indicators suggest that, while skipjack tuna stock biomass in the WCPO shows considerable inter-annual variation, the fisheries have had little measurable impact on the stock. The application of the MULTIFAN-CL assessment model gave results generally consistent with the fishery indicators and previous tag-based assessments. While fishing mortality has increased significantly over time, the overall estimates of recent fishing mortality-at-age remain considerably less than the corresponding estimates of natural mortality-at-age. The percentage reduction in stock biomass attributable to the fishery has been 10–20% in recent years. Current levels of stock biomass are high and recent catch levels are easily sustainable under current stock productivity conditions.

4.2 Yellowfin Tuna

4.2.1 Catch

Yellowfin tuna, an important component of tuna fisheries throughout the WCPO, are harvested with a diverse variety 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 and tropical waters. Purse seiners catch a wide size range of yellowfin tuna, whereas the longline fishery takes mostly adult fish.

Since 1990, the estimated yellowfin tuna catch in the WCPO has varied between 319,000 and 485,000 mt (Figure 28). The elevated total catches since 1997 followed the lowest catch for ten years in 1996, a result of greatly reduced purse-seine catches. Purse seiners harvest the majority of the yellowfin tuna catch (52% by weight in 1997–2000), with the longline and pole-and-line fisheries comprising 14% and 4% of the total catch, respectively. Catches by other gears (various artisanal gears mostly in Indonesia and the Philippines) are reported to have increased significantly in recent years and contributed 35% of the catch in 2000. Yellowfin tuna usually represent approximately 20–25% of the overall purse-seine catch and may contribute higher percentages of the catch in individual sets. Yellowfin tuna are often directly targeted by purse seiners, especially as unassociated schools.

Longline catches in recent years (56,000–73,000 mt) are well below catches in the late 1970s to early 1980s (which peaked at 117,000 mt), presumably because of changes in targeting practices by some of the larger fleets. Catches in the ‘Other’ category in Figure 28 are largely composed of yellowfin tuna from the Philippines and eastern Indonesia. These catches come from a variety of gear types (e.g. ringnet, bagnet, gillnet, handline and seine net) and have increased steadily over the past decade, and as noted, particularly in the past three years in Indonesia.

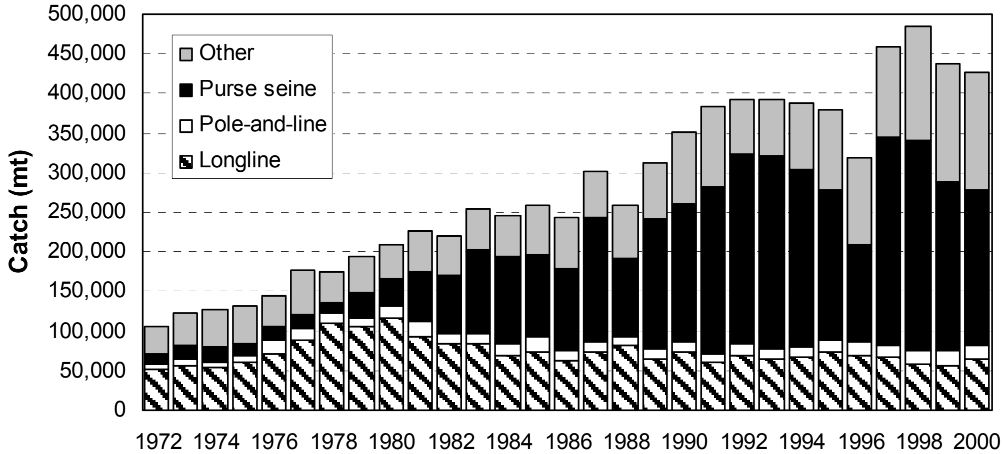


Figure 28. WCPO yellowfin tuna catch, by gear.

Figure 29 shows the spatial distribution of the yellowfin tuna catch in the WCPO for the past ten years. As for skipjack tuna, the majority of the catch is taken in equatorial areas, with declines in both purse-seine and longline catch towards the east. 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.

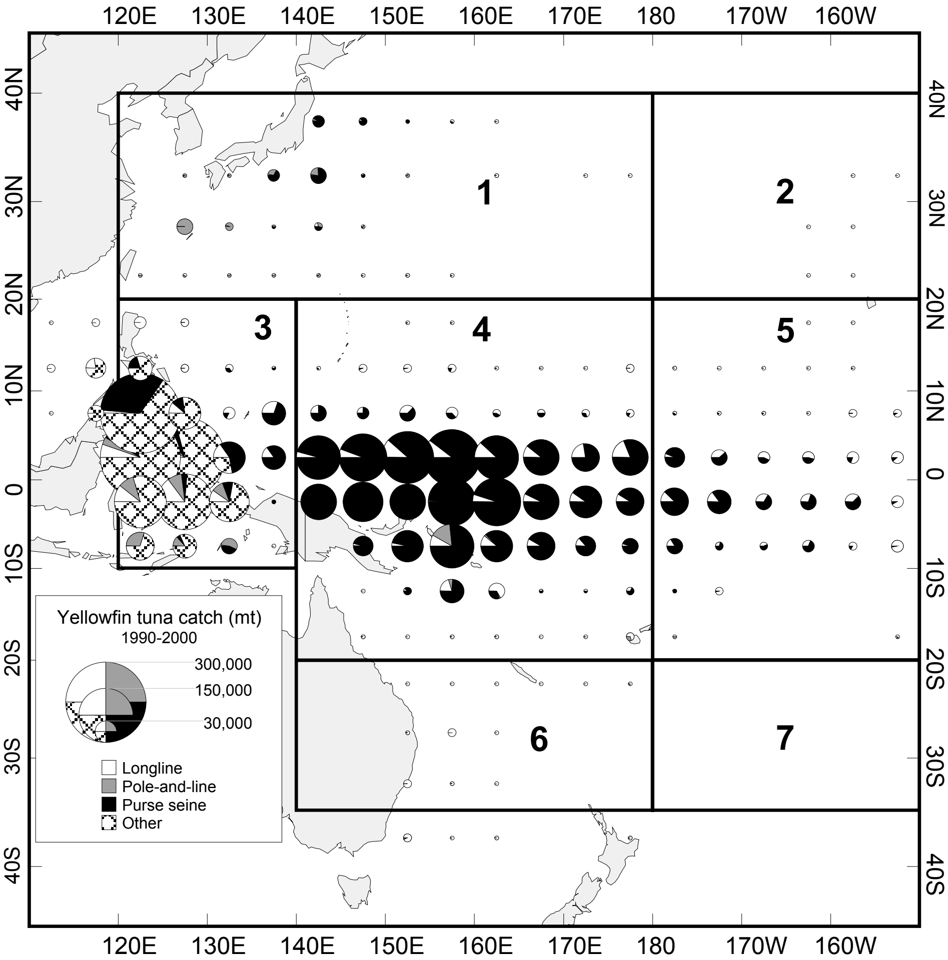


Figure 29. Distribution of yellowfin tuna catch, 1990–2000. The seven-region spatial stratification used in stock assessment is shown.

4.2.2 Catch Per Unit of Effort

Yellowfin tuna purse-seine CPUE is characterised by strong inter-annual variability, particularly for sets on free-swimming schools (Figure 30). 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.

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.

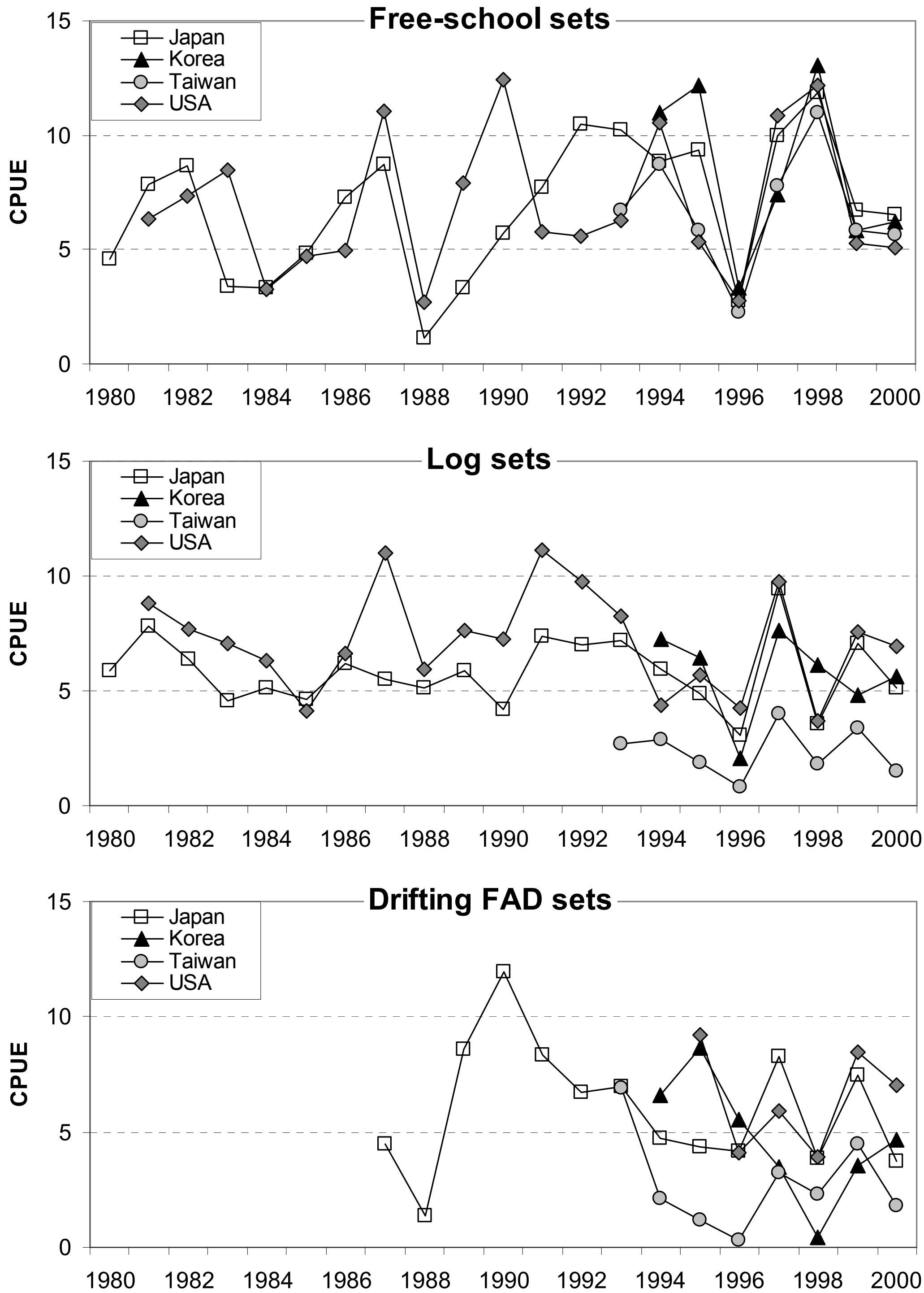


Figure 30. Yellowfin tuna CPUE (mt per day) by major set type categories (free-school, log and drifting FAD sets) for Japanese, Korean, Taiwanese and USA purse seiners fishing in the WCPO. Effort and CPUE were partitioned by set type according to the proportions of total sets attributed to each set type.

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. They calculated 'effective' longline effort as an estimate of the numbers of longline hooks fishing in the mixed layer above the thermocline, which is believed to define yellowfin tuna habitat. The estimates take into account the time and spatial variability in the depth of the mixed layer (using oceanographic databases) and variation in the fishing depth of longliners as indicated by distributions of the numbers of hooks between floats. The effective effort estimates were derived at 5°-month resolution for the Japanese distant-water longline fleet. The estimates were then raised to represent the total longline catch by 5°-month. Time series of nominal CPUE and standardised CPUE (catch per unit of 'effective' effort) are shown in Figure 31. 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 1998–1999. While these most recent points are the lowest observed standardised CPUEs for about 25 years, they are not much lower than those observed in the early 1970s. Nevertheless, this indicator suggests that the portion of the yellowfin tuna population available to the longline fishery is currently at a relatively low level. It should also be noted that these 'effective' effort estimates do not account for any technological advances (e.g. in fish location) that may have been adopted by the longline fleet. If such advances have occurred, then the standardised CPUE in Figure 31 may err on the optimistic side to some extent.

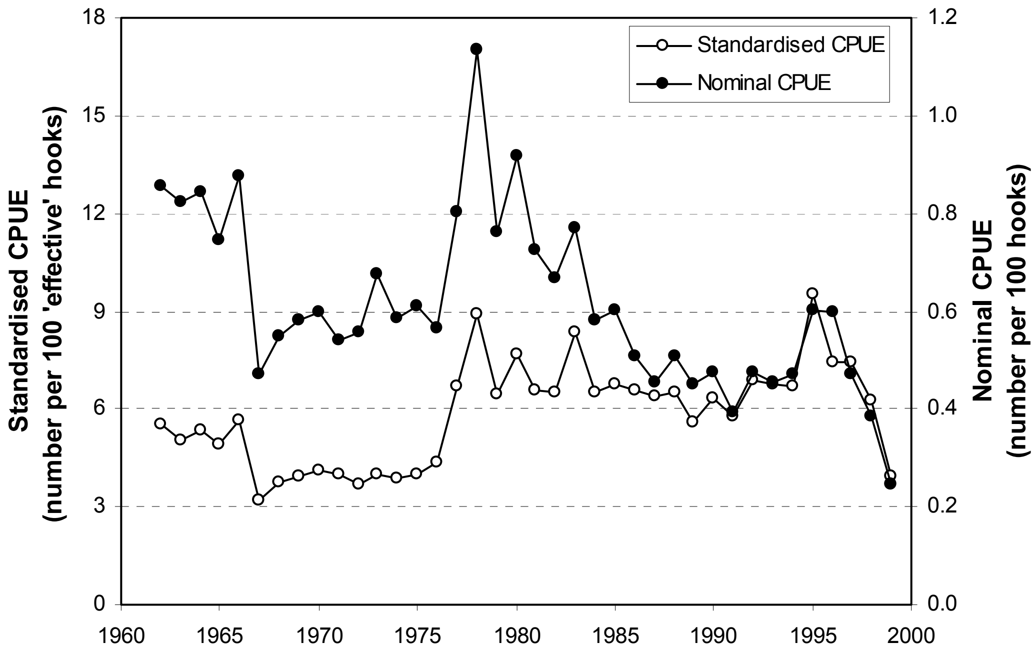


Figure 31. Nominal and standardised yellowfin tuna CPUE for Japanese distant-water longline vessels in the WCPO.

4.2.3 Size of Fish Caught

Estimates of catch-at-size of yellowfin tuna in the WCPO are shown in Figure 32. Prior to 1981, yellowfin tuna larger than about 80 cm were caught mainly by longline. Subsequently, smaller fish as well as "longline-sized" fish were caught by purse seine. The largest purse-seine-caught yellowfin tuna are caught in school sets, with smaller fish caught in school and FAD sets. FAD-set catches have increased markedly in recent years. Despite the widely held belief that purse seiners catch mainly juvenile yellowfin, a major portion of the purse seine catch in weight is also of adult (> 100 cm) yellowfin tuna. The purse-seine catch of adult yellowfin tuna is in fact considerably higher than the longline catch.

Apart from changes in size composition relating to differences between gear and purse seine set types, other changes are also evident. The main change in recent years is a decline in the amount of small yellowfin tuna caught. The mode at around 60 cm, evident in mainly log-set catches (see 1981–2000 panel of Figure 32), is much reduced in recent years, and particularly so in the last two years. Unless purse seiners have changed their targeting or fish retention practices (i.e. are avoiding the capture of or are discarding the smaller yellowfin tuna), the reduction in the incidence of smaller yellowfin tuna in size-composition samples may be indicative of low recruitment in recent years. Also, there appears to have been some contraction in the size range of longline-caught yellowfin tuna in recent years. The maximum size has contracted slightly in recent years and the proportion of fish < 100 cm has also declined, particularly in 1999–2000. The latter may reflect the recent lower recruitments entering the exploitable longline population.

4.2.4 Stock Assessment

The application of the MULTIFAN-CL model to yellowfin tuna in the WCPO is similar to that presented in previous reports. The spatial structure used in the analysis consists of the seven areas of the WCPO shown in Figure 29. The time period covered by the analysis is 1962–2000. Catch, effort and size data, stratified by quarter, for 19 fisheries (7 longline, 2 Philippine domestic, 1 Indonesian domestic, and 9 purse-seine fisheries classified by log, FAD and school sets) were used in the analysis. Tagging data from the RTTP were also incorporated into the analysis. The model structure adopted included: quarterly recruitment, 20 quarterly age classes, independent mean lengths for the first 8 age classes with von Bertalanffy growth constraining the mean lengths for the remaining age classes, structural time-series variation in catchability for all non-longline fisheries, age-specific natural mortality and age-specific movement among the model regions. A more detailed description of the data, the model structure employed for the analysis and the complete set of results is given in Hampton and Fournier (2001c) (http://www.spc.int/OceanFish/Html/SCTB/SCTB14/yft1.pdf).

Annual average fishing mortality rates for juvenile (< 100 cm) and adult yellowfin tuna for the WCPO as a whole are shown in Figure 33. Juvenile fishing mortality appears to have increased strongly in recent years (but the most recent estimates are poorly determined and may be unreliable). Fishing mortality rates for adult yellowfin tuna have increased more steadily throughout the time series. Fishing mortality rates for both juvenile and adult yellowfin tuna are still considerably less than the corresponding average natural mortality rates for both groups (around 0.8 per year) and therefore overfishing is unlikely to have occurred to date.

Recruitment estimates display considerable low- and high-frequency variation (Figure 34). The low frequency variation might be correlated with decadal-scale environmental variation and some of the higher frequency variation to the El Niño – La Niña cycle, although these hypotheses have not yet been examined in detail. Recruitment is estimated to have increased strongly during the late 1970s, and has remained at a high level until recently. The most recent recruitment estimates are considerably lower than average, consistent with the decline in the catch of small yellowfin tuna evident in size composition samples.

The time series of estimated relative total and adult **biomass**, by area, is shown in Figure 35. Most of the biomass is estimated to occur in the tropical regions 3, 4 and 5. Biomass increased strongly in the late 1970s and remained at a high level until recently, when a strong decline began. Most of the recent decline is attributable to regions 3 and 4. Despite these recent declines, current total biomass is estimated to be at similar levels to the mid-1970s. The biomass of adult yellowfin tuna shows similar trends and spatial distribution to the total biomass.

The impact of fishing on the total biomass has increased over time, and catches and fishing mortality have increased (Figure 36). In the early 1990s, the biomass is estimated to have been reduced by about 20% compared with the level it would have been in the absence of fishing. In recent years, the estimated impact of fishing has increased to 30%.

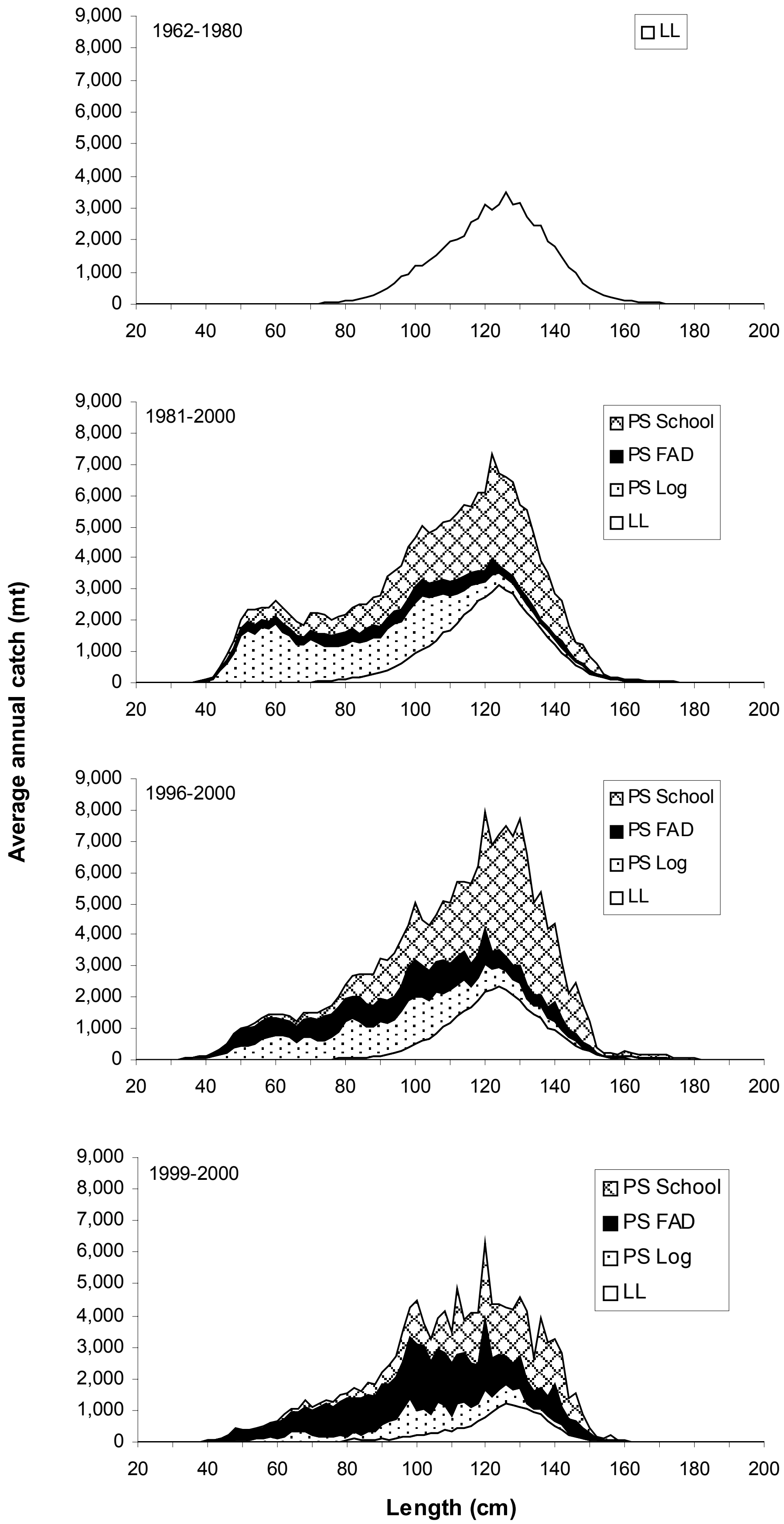


Figure 32. Yellowfin tuna catch-at-size for longline (LL) and purse-seine (PS) fleets operating in the WCPO during different periods.

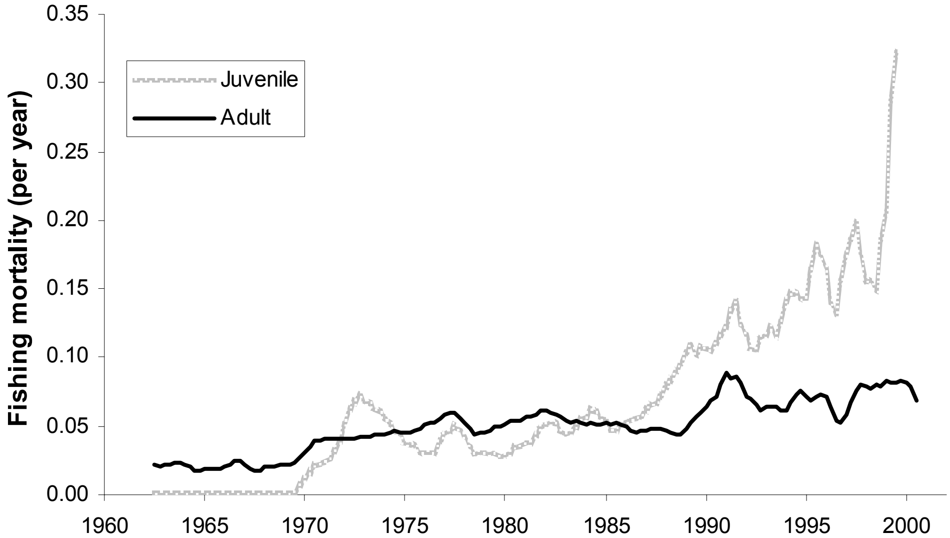


Figure 33. Estimated average annual fishing mortality rates for juvenile (< 100 cm) and adult yellowfin tuna.

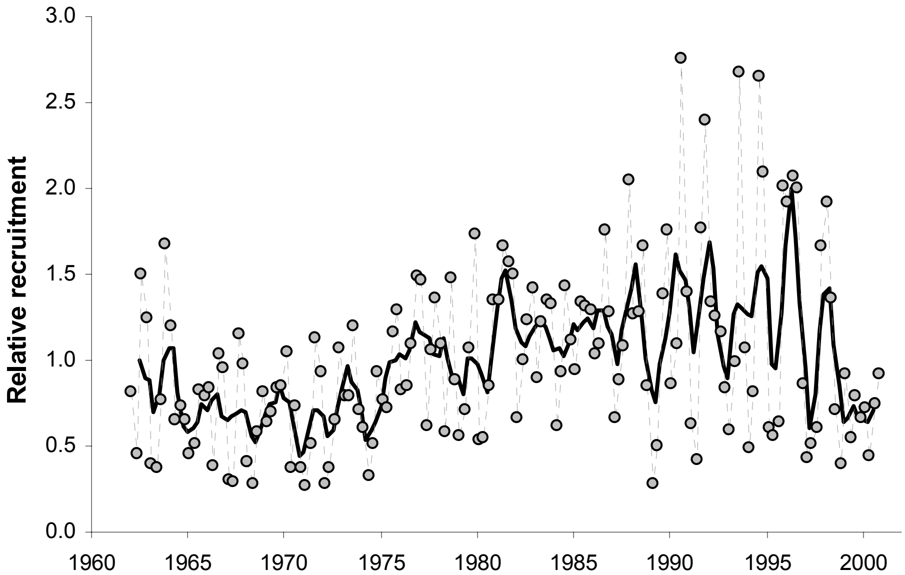


Figure 34. Estimated relative (scaled to the average) quarterly yellowfin tuna recruitment with a four-quarter moving average (solid line).

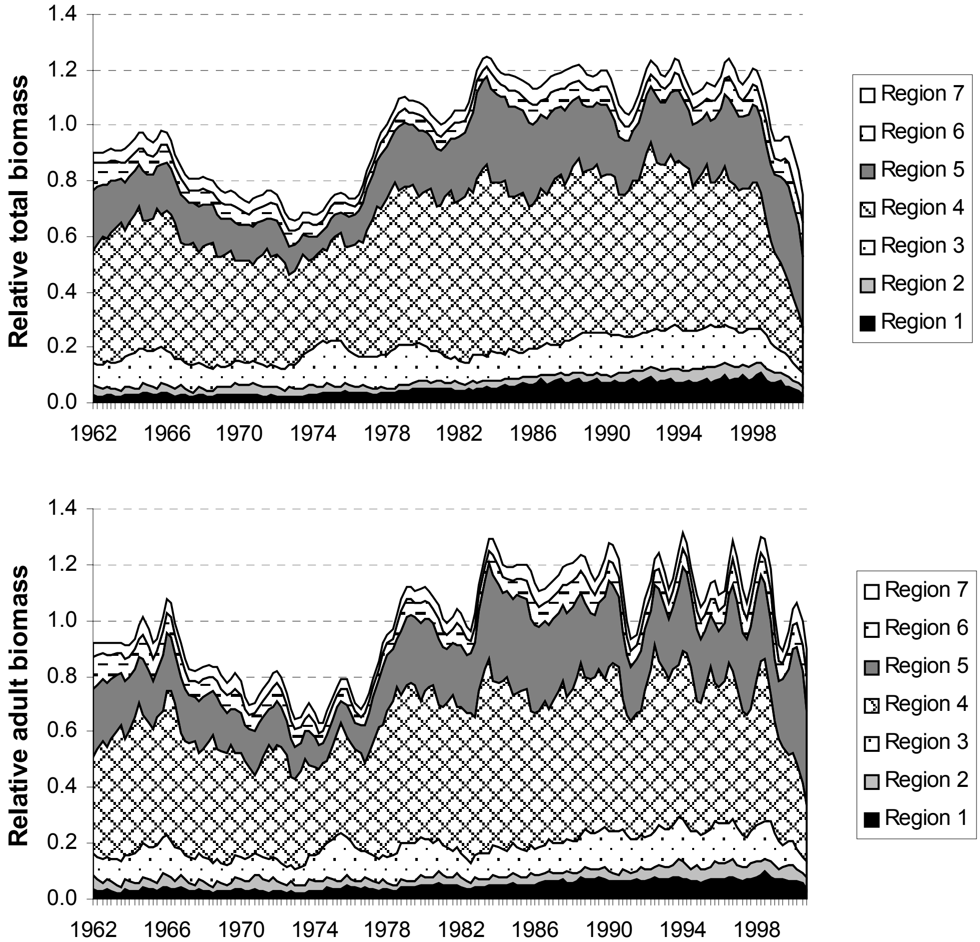


Figure 35. Estimated relative total (upper) and adult (lower) yellowfin tuna biomass, by region. Estimates are scaled to the average spatially aggregated biomass.

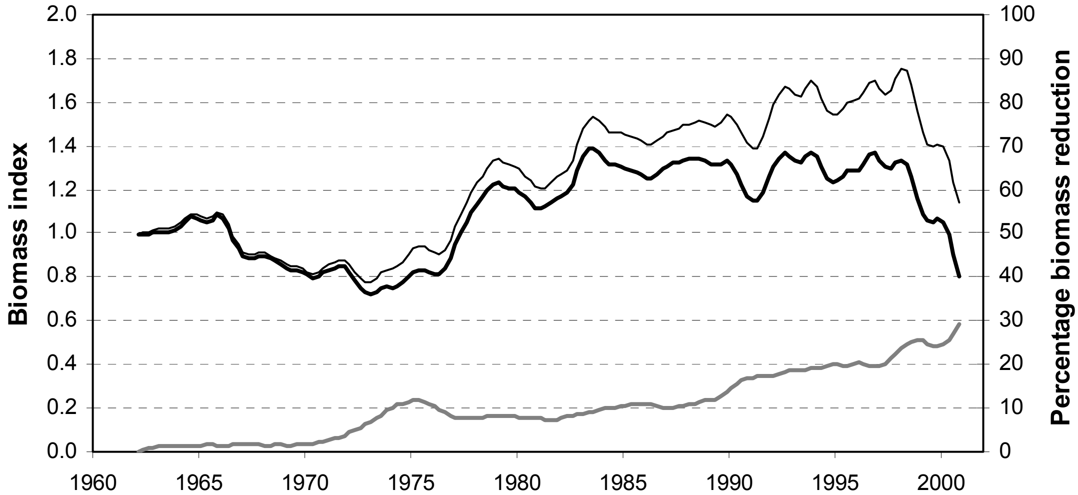


Figure 36. The estimated impact of fishing on yellowfin tuna biomass. The lower biomass trajectory (darkest line) represents the model estimates of total biomass. The upper trajectory is the estimated biomass that would have occurred in the absence of fishing assuming that recruitment was unaffected by fishing. The lower line plots the percentage biomass reduction due to fishing.

Conclusion

The various fishery indicators examined are mostly stable, indicating that fishery performance has been sustained over a long period of time. The longline catch and effective effort estimates have a considerable impact on the results of the MULTIFAN-CL analysis. In particular, the analysis suggests declines in biomass and recruitment in recent years consistent with the recent decline in longline CPUE. The impact of fishing on the stock is, therefore, estimated to have increased in recent years, from a 20% impact on biomass in the early 1990s to about 30% impact in 2000. The estimate of current impact on the stock is somewhat lower than the corresponding estimate (50%) from last year's report. This change is due in part to some refinements made to the estimates of standardised longline effort and the addition of new data to the model, but also reflects the inherent uncertainty associated with population estimates for the most recent years.

The overall conclusion regarding the status of the WCPO yellowfin tuna stock is similar to that in previous reports. The stock is at least moderately exploited, with recent average levels of age-specific fishing mortality probably somewhat less than the corresponding MSY levels. Recent catch levels would therefore be sustainable at long-term average levels of recruitment, but the lower recruitment in recent years may indicate that the stock is shifting to a lower productivity regime. If this is the case, catch and CPUE may decline in coming years.

4.3 Bigeye Tuna

4.3.1 Catch

Bigeye tuna are an important component of tuna fisheries throughout the Pacific Ocean. Bigeye tuna are taken by both surface gears (mostly as juveniles), and longline gear (as valuable adult fish). They are a principal target species of both the large, distant-water longliners from Japan and Korea and 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 cornerstone of the tropical longline fishery in the western and central Pacific Ocean; the catch in the SPC area had a landed value in 1996 of approximately US$800 million.

Since 1980, the Pacific-wide longline catch of bigeye tuna has varied between 88,000 and 158,000 mt (Figure 37), with Japanese longline vessels generally contributing over 80% of the catch. Longline catch in the EPO, the area east of 150°W and historically the primary bigeye tuna longline fishing area, has varied in the range 40,000–102,000 mt since 1980, exceeding 100,000 mt during 1986 and 1987, but has fallen to below 40,000 mt in recent years (23,000 mt in 1999). In contrast, the longline catch has been typically 40,000–65,000 mt in the WCPO, the area west of 150°W, reaching a record high of 68,000 mt in 2000 (Figure 37).

Since about 1994, there has been a rapid increase in purse-seine catches of juvenile bigeye tuna, first in the EPO and since 1996, to a lesser extent, in the WCPO. Purse-seine catches in the EPO increased from typical levels of less than 10,000 mt per year to more than 50,000 mt in 1996 and 1997, then to nearly 70,000 mt in 2000. The increases in the EPO catch resulted from fishing in largely new or previously lightly fished areas, with different fishing methods, i.e. the use of drifting FADs to aggregate tuna and deeper purse-seine nets to catch the tuna, mostly bigeye tuna, located deeper in the water column. In the WCPO, purse-seine catches of bigeye tuna are estimated to have been less than 20,000 mt per year up to 1996, mostly from sets on natural floating objects (Hampton et al. 1998). In 1999, that catch was the highest ever, almost 35,000 mt, but decreased to 28,800 mt in 2000 with reduced fishing on drifting FADs.

The total WCPO bigeye tuna catch in 1999 was a record 117,121 mt, and was only slightly less in 2000 (115,264 mt). The estimated total Pacific catch in 2000 was an all-time high 208,173 mt, just above the previous high 1997 catch (202,500 mt). The spatial distribution of Pacific-wide bigeye tuna catch during the 1990s is shown in Figure 38. The majority of the catch is taken in equatorial areas, by both purse seine and longline, but with significant longline catch in some sub-tropical areas (east of Japan, northeast of Hawaii and the east coast of Australia). An important longline fishing area occurs in the equatorial zone at about 110–160°W, an area which overlaps the location of increased purse-seine catches in recent years.

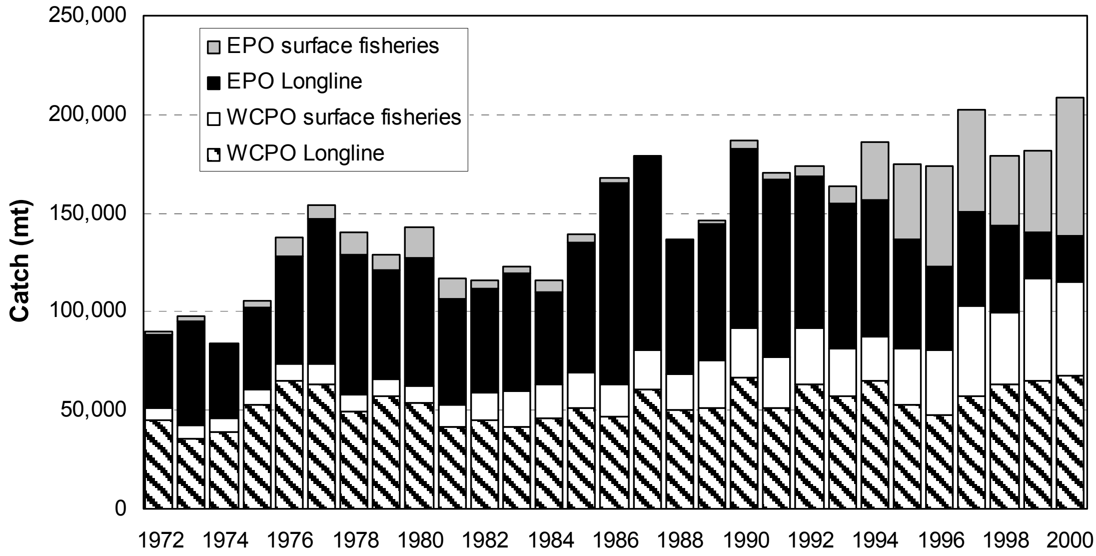


Figure 37. Bigeye tuna catch in the Pacific Ocean.

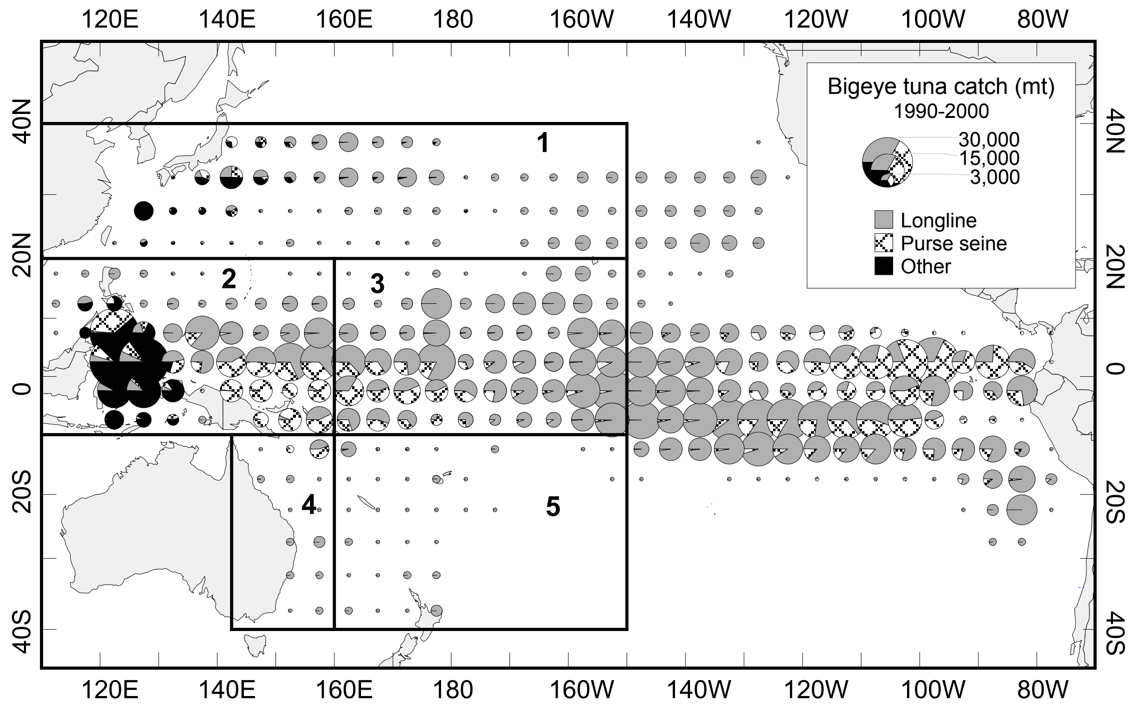


Figure 38. Distribution of bigeye tuna catch, 1990–2000. The five-region spatial stratification used in stock assessment for the WCPO is shown.

4.3.2 Catch Per Unit of Effort

The longline fishery provides the most potentially useful information on bigeye tuna relative abundance in the Pacific. The trend in nominal bigeye tuna CPUE for Japanese longliners has been relatively stable in the WCPO, despite increased targeting of that species since the mid-1970s (Figure 40). In the EPO, nominal CPUE for the Japanese fleet has been declining since the beginning of the fishery. Nominal CPUE has been significantly higher in the EPO than the WCPO, due largely to higher bigeye tuna vulnerability in the EPO where the cooler waters favoured by bigeye tuna are closer to the surface.

The changes in targeting behaviour of the Japanese and other longline fleets discussed in section 4.2.2 present similar problems for the interpretation of bigeye tuna CPUE. The changes in setting depth that began in the mid-1970s would be expected to have increased the effectiveness of longline effort for bigeye tuna, particularly in the WCPO where the cooler waters preferred by bigeye tuna are generally >200m. Bigelow et al. (2000b) therefore applied a similar procedure to the estimation of 'effective bigeye tuna' longline effort to that reported in section 2.2.2 for yellowfin tuna. For bigeye tuna, the vertical distribution was defined in relation to their temperature preferences (inferred from acoustical tracking studies carried out in French Polynesia by Dagorn et al. 2000) and dissolved oxygen requirements (inferred from laboratory and field observations). Information on gear configuration, gear depth distribution (including the shoaling effects of the equatorial currents on longline gear), and the spatial and temporal variability in thermal and dissolved oxygen profiles for the Pacific was then used to estimate the number of longline hooks fishing in bigeye tuna habitat. This 'effective bigeye tuna' effort forms the basis of the standardised CPUE series shown in Figure 39. The trends are somewhat different to those of the nominal CPUE — in particular, there is a declining trend for the WCPO since about 1990 that is not evident in the nominal CPUE series. The most recent standardised CPUE is about half of the levels recorded in the initial years of the fishery.

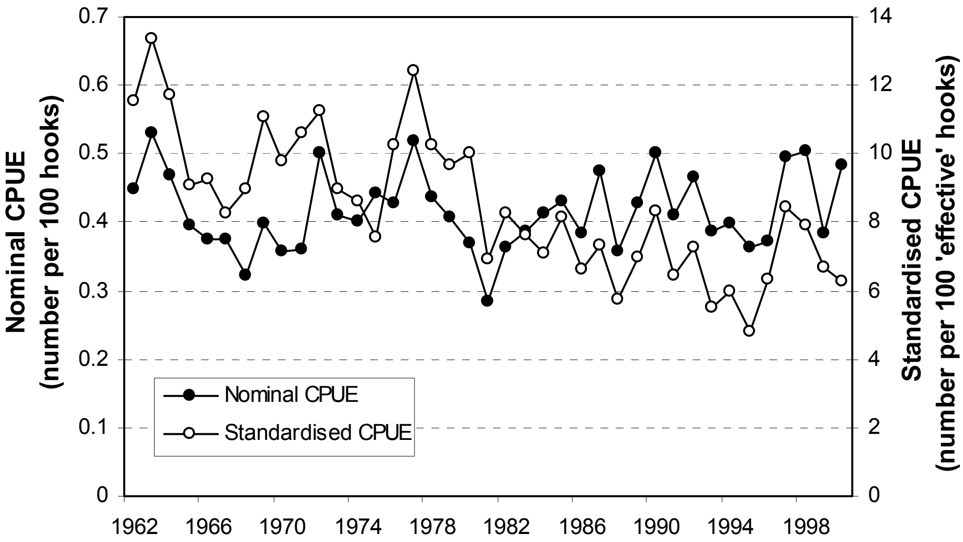


Figure 39. Standardised and nominal bigeye tuna CPUE by distant-water Japanese longliners in the WCPO.

4.3.3 Size of Fish Caught

Estimates of catch-at-size of bigeye tuna in the WCPO are shown in Figure 40. Prior to 1981, catches were mainly by longline and therefore primarily adult (> 100 cm) bigeye tuna were caught. Subsequently, mainly juvenile bigeye tuna were also caught by the purse seine fishery in FAD and log sets. In contrast to yellowfin tuna, few bigeye tuna are taken in purse seine school sets, and there is little overlap between the purse seine and longline size compositions.

Similarly to yellowfin tuna, some changes in the longline size composition are evident. In recent years, the incidence of very large bigeye tuna (> 160 cm) in size composition samples is lower compared with the pre-1981 period. Also, the incidence of smaller bigeye tuna (< 100 cm) in the longline catch has been considerably lower in the past two years compared with the earlier periods. Both of these changes could be the result of increased exploitation; however, the decline in the incidence of smaller-sized fish could have resulted from lower recruitment to the longline-exploitable population due to either increased purse seine catches (an interaction effect) or to reduced recruitment in general.

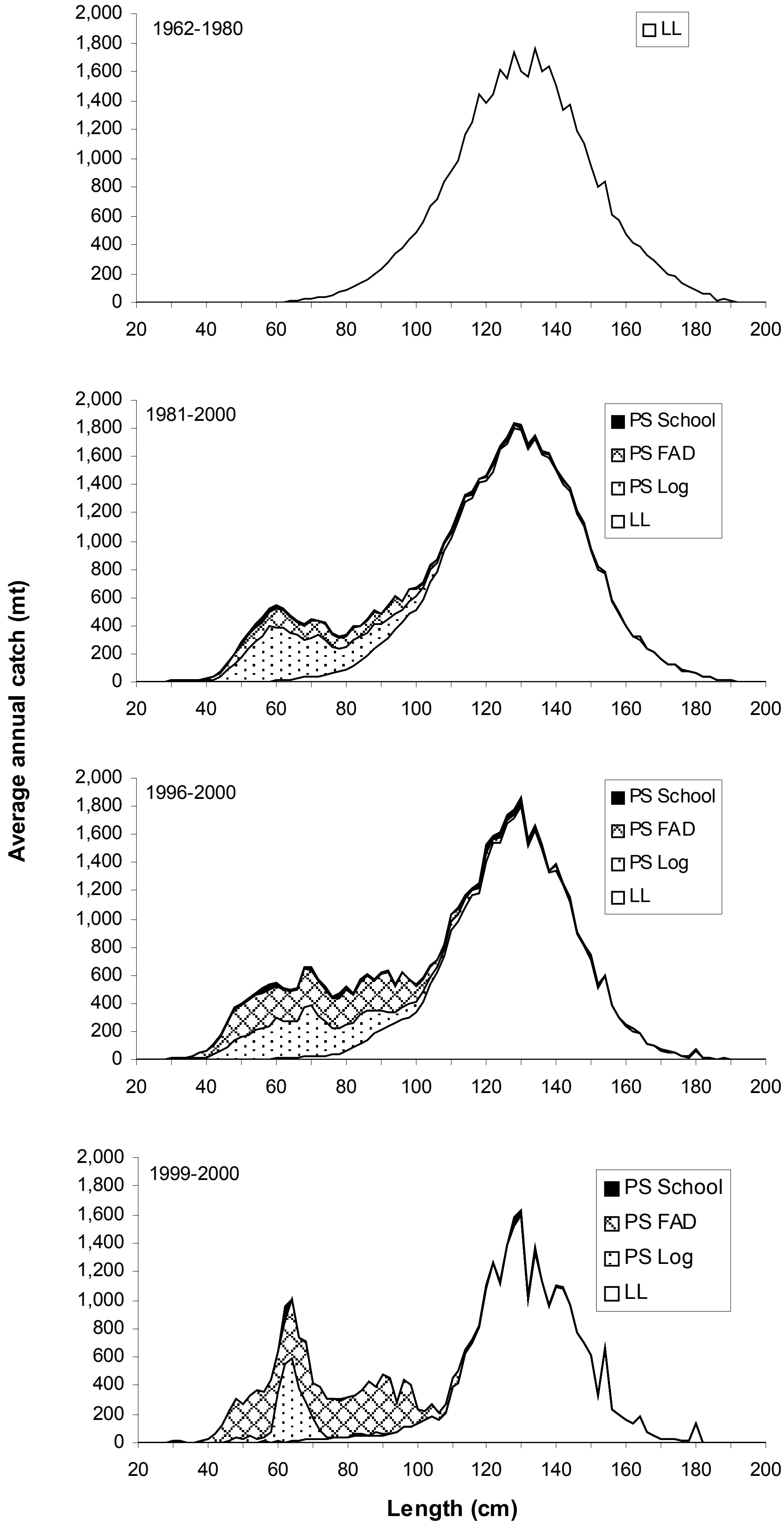


Figure 40. Bigeye tuna catch-at-size for longline (LL) and purse seine (PS) fleets operating in the WCPO during different periods.

4.3.4 Stock Assessment

As noted earlier, previous reports have presented the results of a MULTIFAN-CL analysis of bigeye tuna on a Pacific-wide basis. This work is ongoing and will be reported separately in due course. In the meantime, a new analysis has been developed that is restricted to the WCPO (i.e. west of 150°W) assuming that movement between the WCPO and the EPO is minimal. Catch, effort and size composition data covering the period 1962–2000 using a quarterly time stratification have been assembled. The spatial coverage of the model is the WCPO, within which a five-region spatial stratification (see Figure 38) has been adopted. Catch, effort and size data for 14 fisheries (5 longline, 2 Philippine domestic, 1 Indonesian domestic and 6 western Pacific purse-seine fisheries were used in the analysis. The limited amount of tagging data available from SPC's Regional Tuna Tagging Project was incorporated into the analysis. The model structure adopted thus far includes: quarterly recruitment, 28 quarterly age classes, independent mean lengths for the first 8 age classes with von Bertalanffy growth constraining the mean lengths for the remaining age classes, structural time-series variation in catchability for non-longline fisheries, age-specific natural mortality and age-specific movement among the model regions. A detailed description of the data, model structure and preliminary results will soon be available on the OFP website.

Annual average **fishing mortality rates** for juvenile (< 100 cm) and adult bigeye tuna for the WCPO as a whole are shown in Figure 41. Juvenile fishing mortality increased strongly with the development of the purse seine fishery and increased further in the past two years (but the most recent estimates are poorly determined and may be unreliable). Fishing mortality rates for adult bigeye tuna increased more steadily until about 1995 and have declined slightly since that time. The estimated fishing mortality rates are still considerably less than the corresponding average natural mortality rates for both groups (around 0.4–0.6 per year).

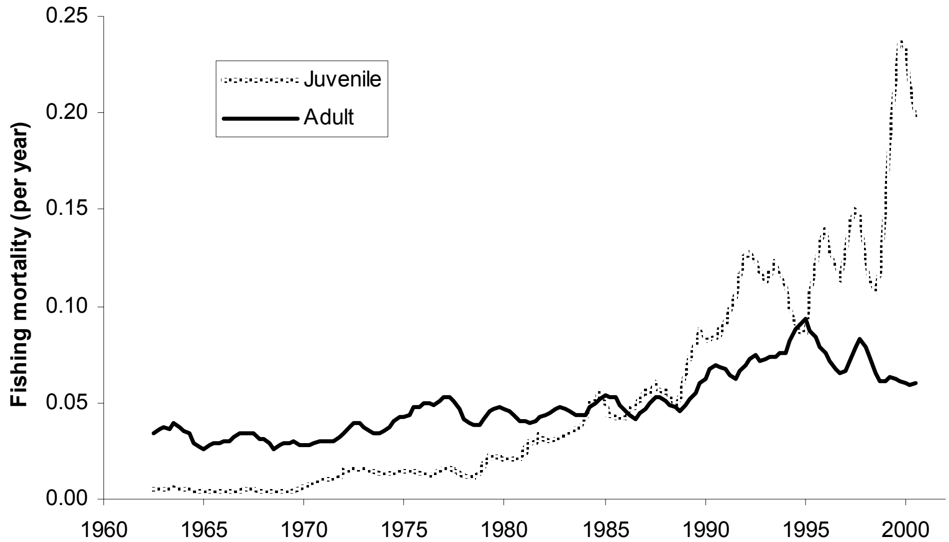


Figure 41. Estimated average annual fishing mortality rates for juvenile (< 100 cm) and adult bigeye tuna.

Recruitment estimates (Figure 42) show a seasonal signal in recruitment in the temperate North Pacific model region and a weaker seasonal pattern in the tropics. Average recruitment has been fairly constant, or decreasing slightly, over the time series, although the most recent estimates are historical lows. These estimates have high uncertainty, but if they are confirmed by future analyses, it may signal a period of reduced productivity of the bigeye tuna stock.

The time series of estimated relative total and adult **biomass** are shown in Figure 43. Both total and adult biomass have declined since the beginning of the time series, although some recovery is suggested since the mid-1990s.

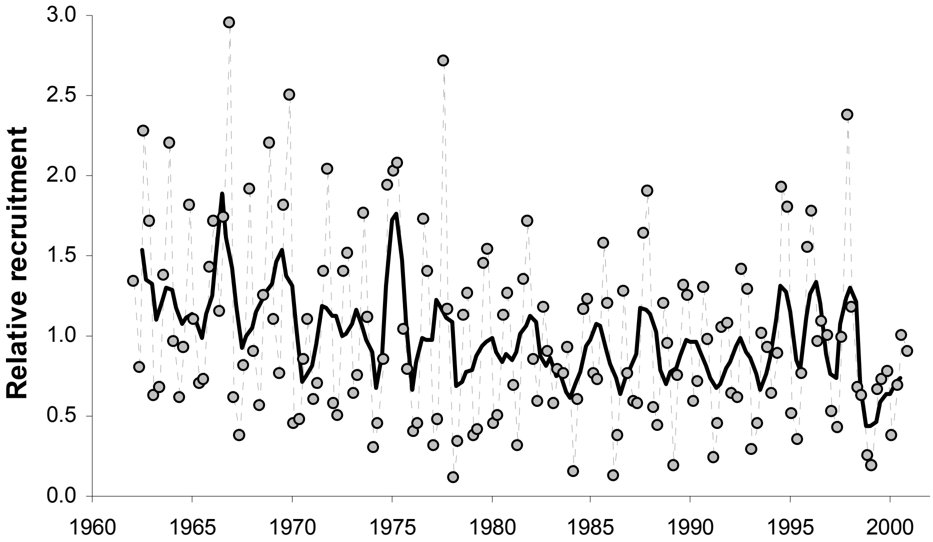


Figure 42. Estimated relative (scaled to the average) quarterly bigeye tuna recruitment with a four-quarter moving average (solid line).

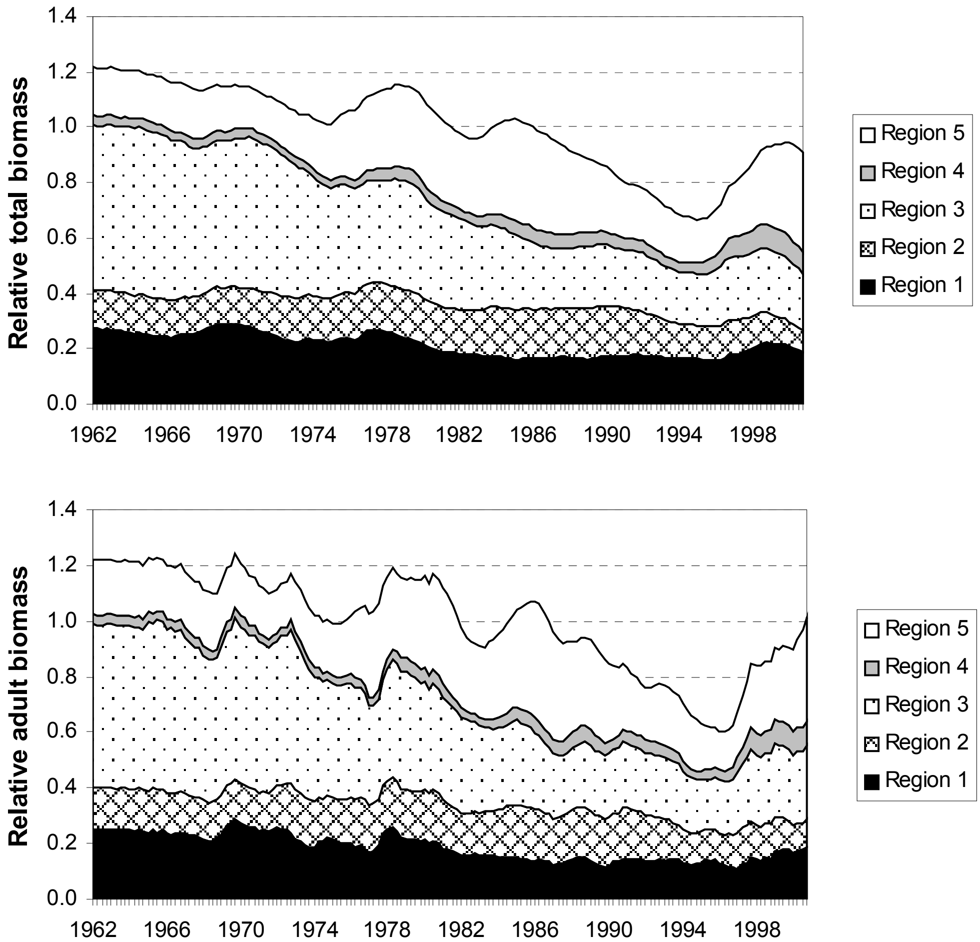


Figure 43. Estimated relative total (upper) and adult (lower) bigeye tuna biomass, by region. Estimates are scaled to the average spatially aggregated biomass.

The impact of fishing on the total biomass has increased over time as catches and fishing mortality have increased (Figure 44). The most recent biomass level is estimated to have been reduced by almost 30% compared to the level it would have been in the absence of fishing. This impact would be predicted to rise if recent low recruitment and fishery conditions continue.

Conclusion

Bigeye tuna are demonstrably slower growing, longer lived, and, as a consequence, less resilient to fishing than skipjack and yellowfin tuna. The results of limited tagging in the early 1990s indicated that bigeye tuna exploitation rates at that time were at least as great as those for skipjack and yellowfin tuna. Preliminary modelling results and fishery indicators suggest a decline in abundance occurred from the early 1960s until the mid-1990s. This was related to a slight decline in recruitment over this period. Recent recruitment is estimated to be at a low level, although these estimates are subject to high uncertainty. Recent catches and fishing mortality of juvenile bigeye tuna in particular have increased significantly. The results at this stage suggest that recent catch levels may close to the maximum sustainable with the present age-specific exploitation pattern.

The modelling results obtained to date are driven to a large extent by the estimates of standardised longline CPUE. These estimates are obtained from a habitat model in which the vertical distribution of bigeye tuna in relation to ambient temperature is a key input. Currently, this model input is based on a very limited number of observations of bigeye tuna tagged with sonic or archival tags. Additional archival tag data from various locations throughout the WCPO are required to improve these key estimates of bigeye tuna vertical distribution.

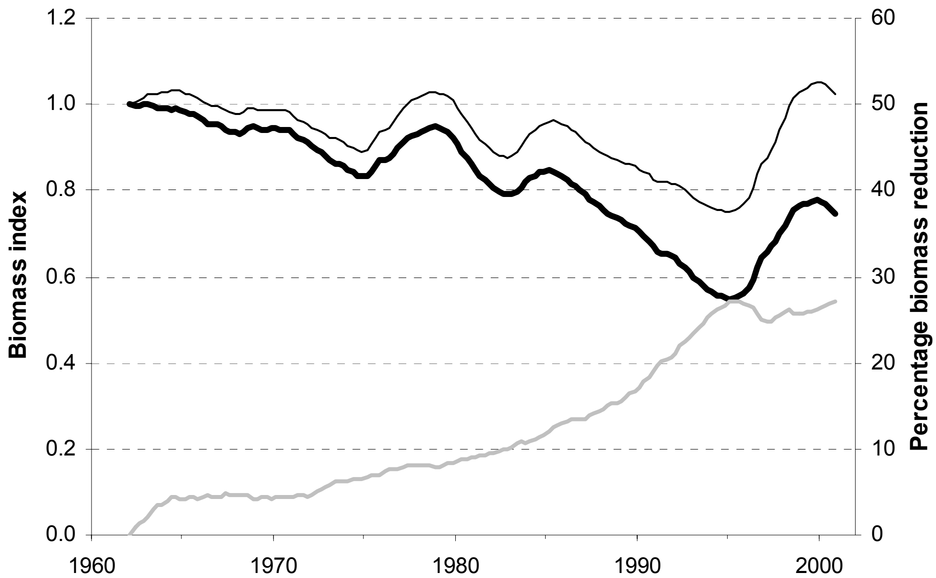


Figure 44. The estimated impact of fishing on bigeye tuna biomass in the WCPO. The lower biomass trajectory (darkest line) represent the model estimates of total biomass in each area. The upper trajectory is the estimated biomass that would have occurred in the absence of fishing assuming that recruitment was unaffected by fishing. The lower line plots the percentage biomass reduction due to fishing.

4.4 South Pacific Albacore Tuna

4.4.1 Catch

South Pacific albacore tuna are exploited by a variety of longline fleets, by an international troll fleet operating seasonally in the region of the STCZ, and by a domestic troll fleet in New Zealand's coastal waters. In the 1990s, the longline catch in the South Pacific was 23,000–40,000 mt, with the 2000 catch a record 41,400 mt, following the steady development of domestic longline fisheries in many Pacific Island countries and recent activity by large Chinese longliners. The troll fishery, with a season spanning November–April, has caught 3,000–7,500 mt annually (Figure 45). The total catches during most of the 1990s of 32,000–42,000 mt are well below the peak estimated catch of 52,400 mt in 1989, when driftnet fishing was occurring, although the estimated catch in 2000

(47,308 mt) is the second highest recorded. This was the result of increased domestic and Chinese longline catches, as noted, and an average year for the troll fishery.

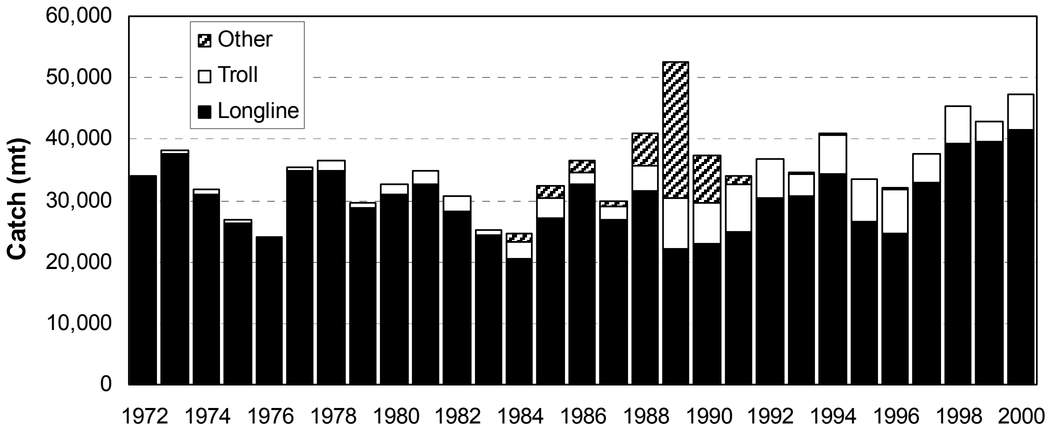


Figure 45. South Pacific albacore tuna catch, by gear. ('Other' is primarily catch by the driftnet fishery.)

The distant-water longline catch, primarily by Taiwanese longliners, is widely distributed in the South Pacific (Figure 46), but with catches concentrated in the western part of the region. Catches by domestic longline fleets in Fiji Islands, Samoa, French Polynesia, 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's coastal waters, mainly off the South Island, and along the SCTZ.

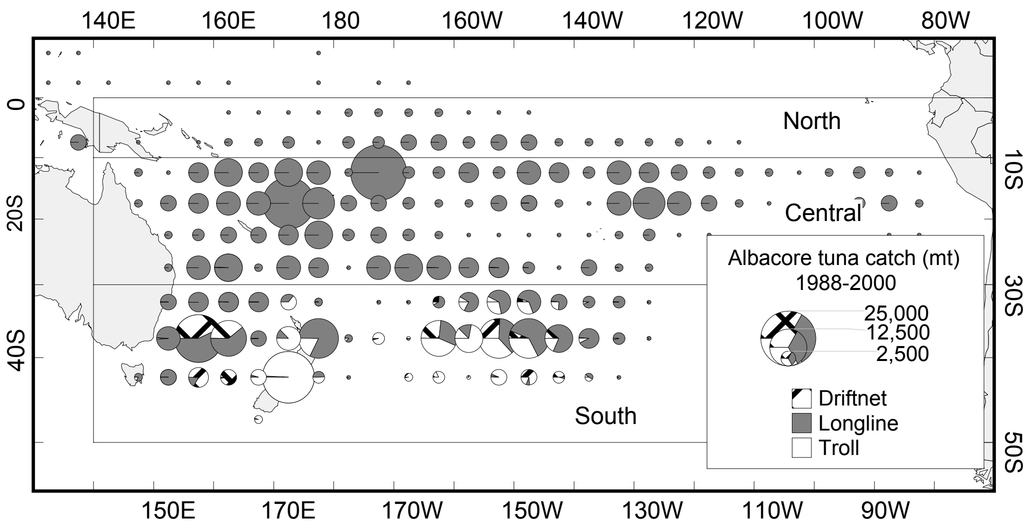


Figure 46. Distribution of South Pacific albacore tuna catch, 1988–2000. The three-region spatial stratification used in stock assessment is shown.

4.4.2 Catch Per Unit of Effort

The key fishery indicators for South Pacific albacore tuna are longline and troll fishery CPUE. For the longline fishery, data from the Taiwanese distant-water fleet are generally used as this fleet has consistently targeted albacore tuna over a long period of time. Longline CPUE (numbers of fish per hundred hooks) is typically highest in the higher latitudes (30–50°S), moderate in the tropics and subtropics (10–30°S) and low near the equator (0–10°S). Time series of CPUE for these latitudinal bands are plotted in Figure 47. Taiwanese longline CPUE declined from the late 1960s to the late 1980s in all areas, but has increased somewhat in the 1990s after a low point in 1990.

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 48). CPUE for the USA and New Zealand fleets operating in the STCZ is generally higher, but more variable, probably indicating a greater impact of environmental variation on the ability of this fleet to locate and catch albacore tuna.

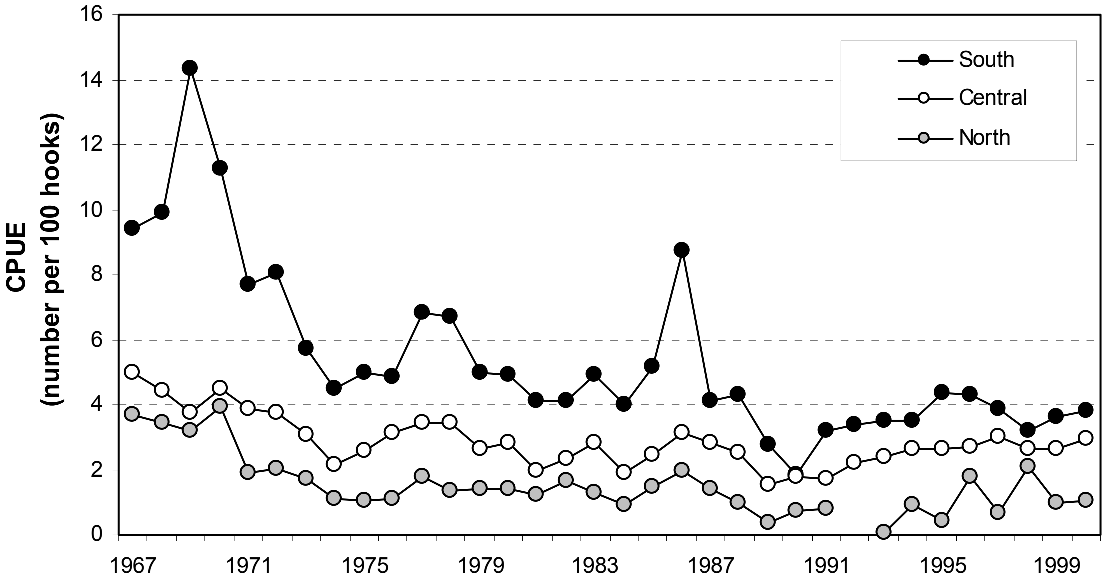


Figure 47. Nominal South Pacific albacore tuna CPUE for Taiwanese longliners. South = 30–50°S, central = 10–30°S, north = 0–10°S.

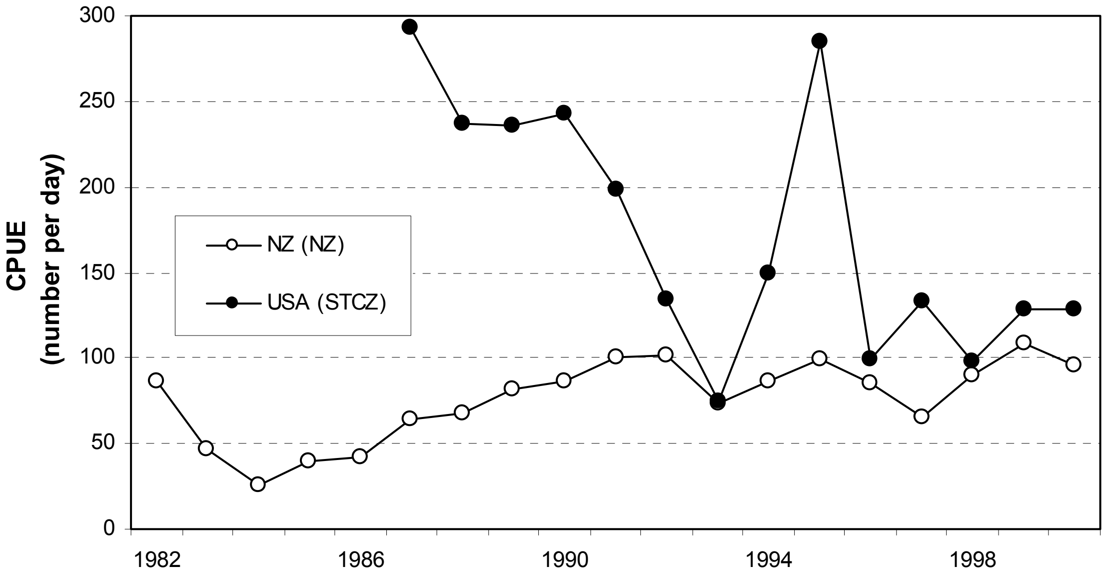


Figure 48. South Pacific albacore tuna CPUE for the New Zealand domestic troll fleet and the USA troll fleet operating east of 180° along the STCZ.

4.4.3 Size of Fish Caught

Estimated albacore tuna catch-at-size is shown in Figure 49 for several periods. There are no noteworthy changes in the size distributions for the longline or surface components of the fishery.

4.4.4 Stock Assessment

The MULTIFAN-CL analysis considered fishery data from 1962 to 2000, stratified by quarter for the longline fisheries and by month for the surface fisheries. A simple spatial structure was adopted, consisting of three latitudinal bands: 0–10°S; 10–30°S; and 30–50°S, spanning the entire South Pacific. Distant-water longline fisheries for Japan, Korea and Taiwan were defined for each of these regions, as well as Samoan and 'other domestic' longline fisheries in the central region. The surface fisheries, the New Zealand coastal troll fishery, the central South Pacific troll fishery and the driftnet fishery all occur in the southernmost region, giving a total of 14 region-specific fisheries. The model was fitted to catch, effort and length–frequency data for each fishery. The small amount of tagging data for South Pacific albacore were also incorporated into the model. A more detailed description of the data, the model structure employed for the analysis, and the complete set of results will soon be available on the OFP website.

Average annual **fishing mortality rates** for juvenile (< 85 cm) and adult albacore tuna are shown in Figure 50. Fishing mortality for juvenile fish (primarily taken by surface fisheries) was very low prior to the mid-1980s, but increased with the development of surface fisheries, particularly the driftnet fishery. With the cessation of driftnetting, juvenile albacore tuna fishing mortality fell to around one-third of its peak. For adult albacore tuna (primarily exploited by longliners), average fishing mortality increased in the mid-1980s. Fishing mortality rates for both juvenile and adult albacore remain low in comparison with estimates of natural mortality (0.4–0.6 per year over most of the exploited age classes).

The estimated **recruitment** time series (Figure 51) shows considerable variability, more so during the second half of the time series. Lehodey (2000) has hypothesised a negative effect of El Niño conditions on albacore recruitment, which may explain the relatively low recruitment around 1985, 1990 and in the mid-1990s (approximately two years following El Niño events). If Lehodey's hypothesis is correct, relatively low recruitment may also have occurred in 1999−2000 following the very strong 1997−1998 El Niño event (although this is not yet apparent in the analysis). Likewise, relatively high recruitment might be expected for 2001−2003 following protracted La Niña conditions.

Estimated trends in relative total and adult **biomass** are shown in Figure 52. Biomass declined to historic lows in the late 1980s and recovered to some extent during the 1990s. The estimated biomass ratio of the last three years to the first three years of the time period is around 0.70.

As expected from the low estimated fishing mortality rates, the estimated **impact of the fishery** on the South Pacific albacore population has been small (Figure 53). The percentage reduction in biomass due to fishing is currently estimated to be in the vicinity of 10%.

Conclusion

Fishery indicators and the MULTIFAN-CL analysis both suggest that the South Pacific albacore tuna stock declined moderately during the 1970s to early 1990s. This decline in stock biomass was mainly recruitment driven, as is the recovery in the mid-1990s. One hypothesis concerning the relationship between recruitment and oceanographic conditions predicts that recruitment may have been low in 1999−2000 but may increase over the next few years due to recent La Niña conditions. The impact of the fishery on the stock is estimated to be small, and higher levels of catch could likely be sustained.

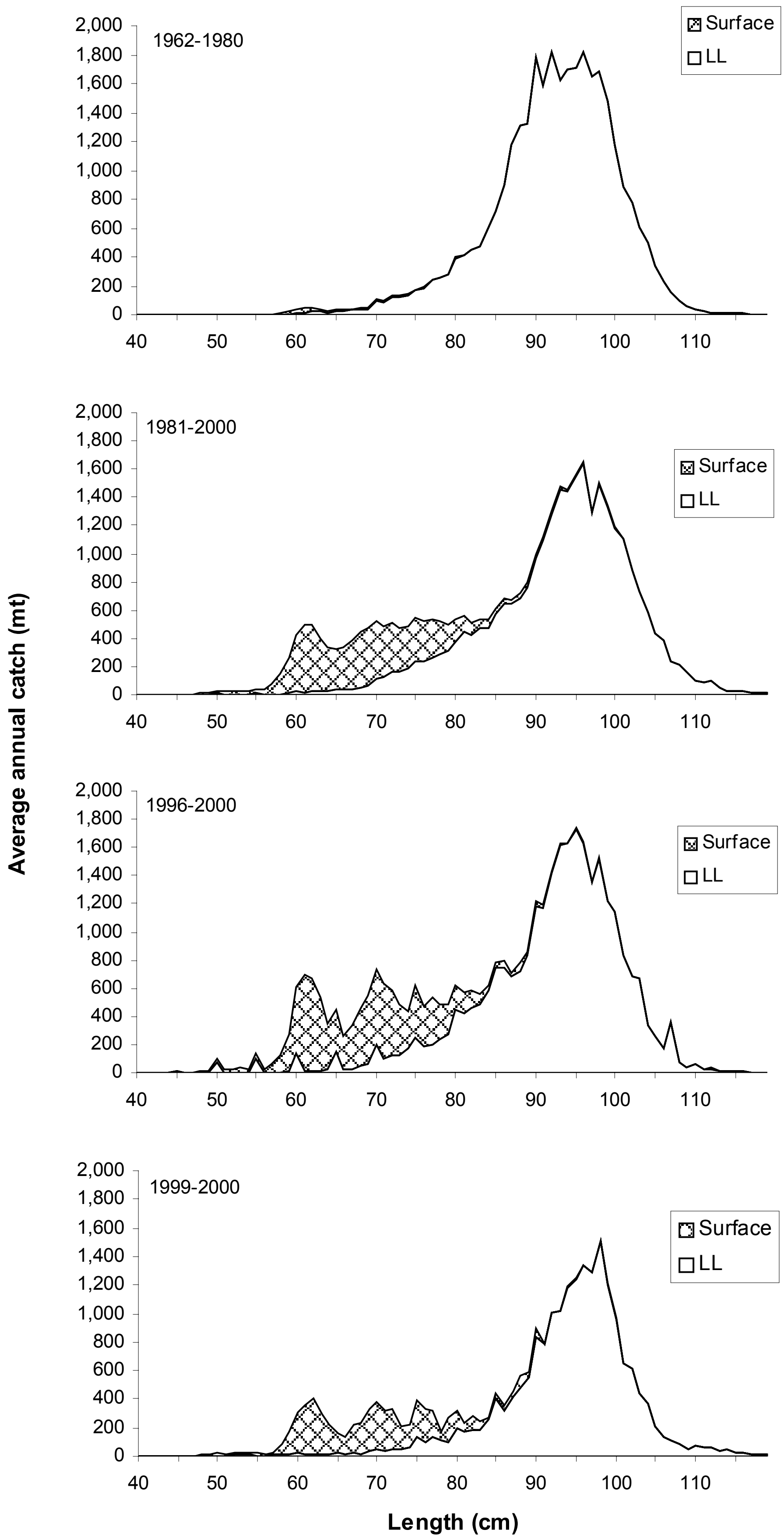


Figure 49. South Pacific albacore tuna catch-at-size for longline (LL) and surface (troll and driftnet) fleets during different periods.

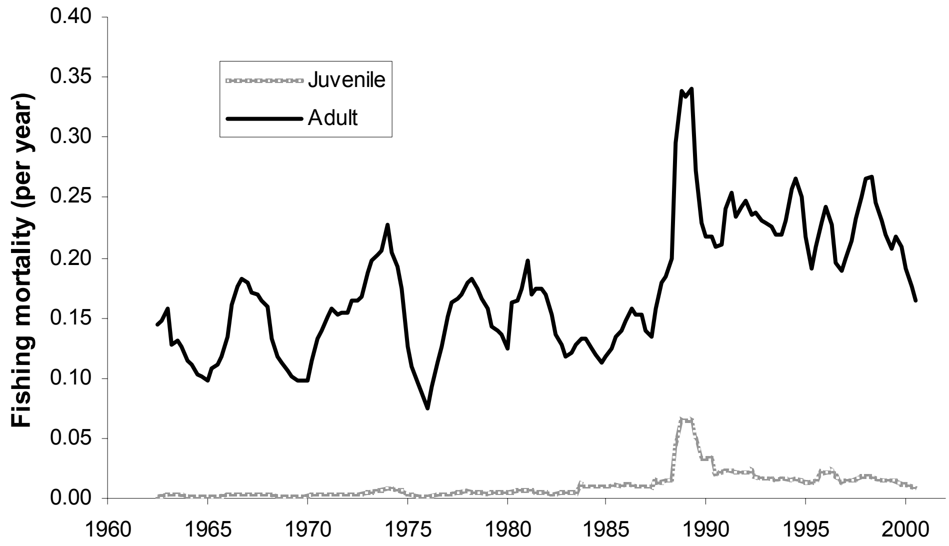


Figure 50. Estimated average annual fishing mortality rates for juvenile (< 85 cm) and adult South Pacific albacore tuna.

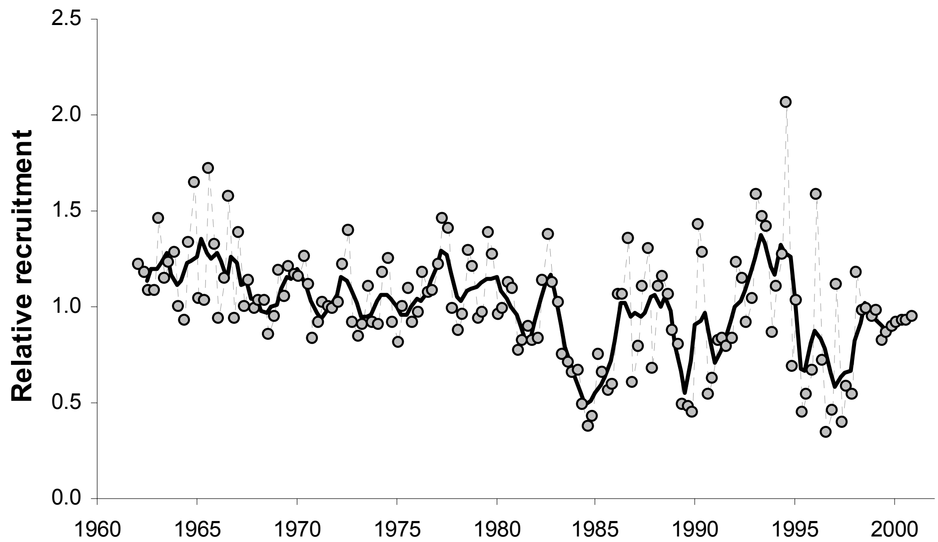
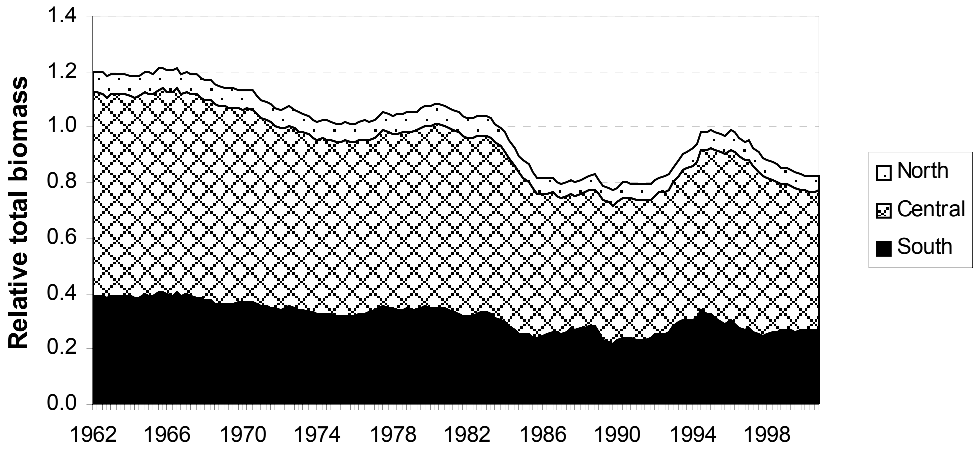


Figure 51. Estimated relative (scaled to the average) quarterly South Pacific albacore tuna recruitment with a four-quarter moving average (solid line).



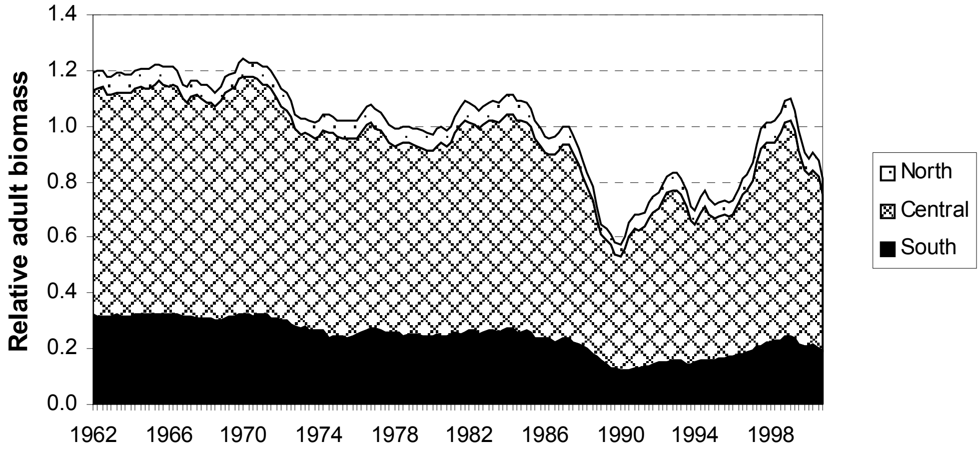


Figure 52. Estimated relative total (upper) and adult (lower) South Pacific albacore tuna biomass, by region. Estimates are scaled to the average spatially aggregated biomass.

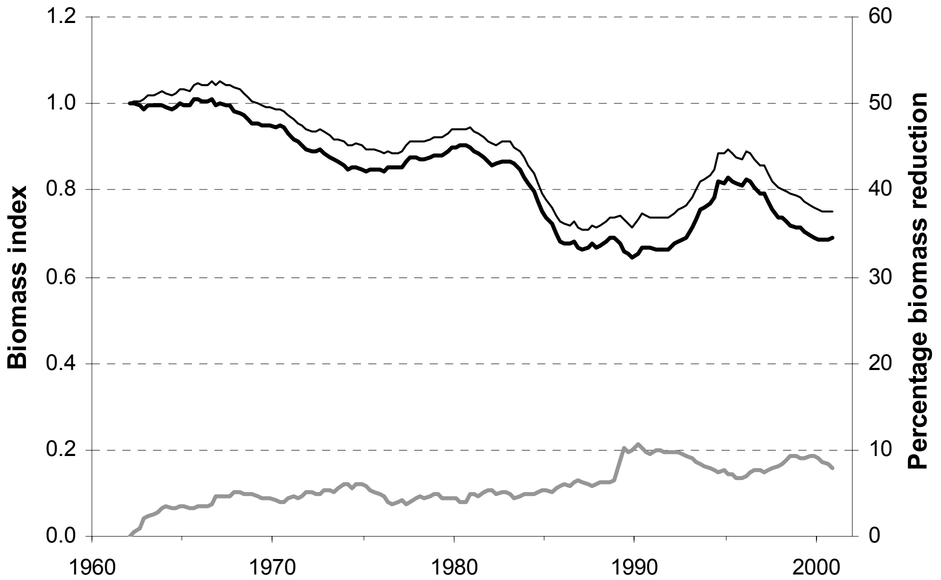


Figure 53. The estimated impact of fishing on South Pacific albacore tuna biomass. The lower biomass trajectory (darkest line) represents the model estimates of total biomass. The upper trajectory is the estimated biomass that would have occurred in the absence of fishing assuming that recruitment was unaffected by fishing. The lower line plots the percentage biomass reduction due to fishing.

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