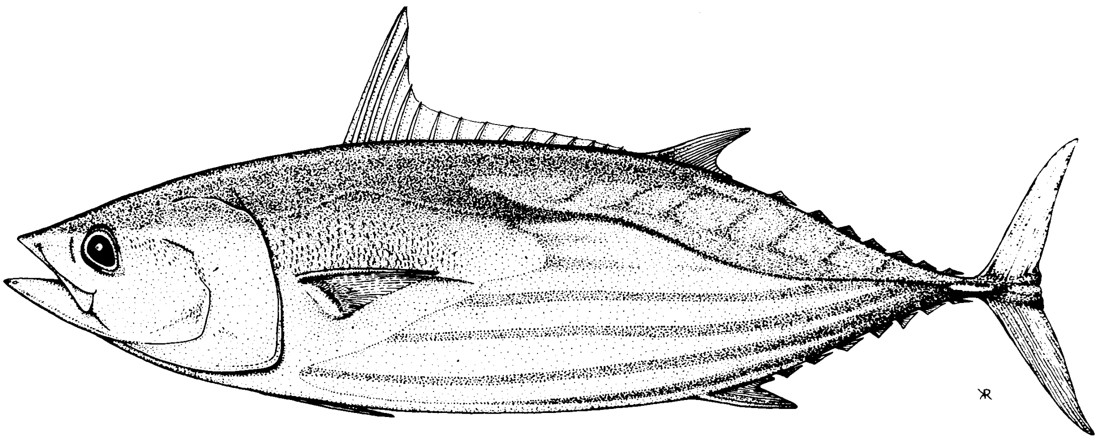
THE WESTERN AND CENTRAL PACIFIC TUNA FISHERY: 2001 OVERVIEW AND STATUS OF STOCKS

John Hampton and Peter Williams



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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.

Inquiries regarding this report or other aspects of the work programme of the OFP should be directed to:

The Oceanic Fisheries Programme Manager
Secretariat of the Pacific Community
B.P. D5
98848 Noumea Cedex
New Caledonia

For further information, including a complete online French version of this report, see the OFP web page: http://www.spc.int/oceanfish/.

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:

Directeur du programme Pêche hauturière
Secrétariat général de la Communauté du Pacifique
B.P. D5
98848 Nouméa Cédex
Nouvelle-Calédonie

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, increased significantly in 1998. The 2001 catch is estimated at 1,908,126 mt, the second highest annual catch recorded after 1998 (2,035,773 mt). The purse-seine fishery accounted for an estimated 57% of the total catch, pole-and-line 17%, and longline 12%, with the remainder (14%) taken by troll gear and a variety of artisanal gears, mostly in eastern Indonesia and the Philippines. The WCPO tuna catch represented 75% of the total estimated Pacific Ocean catch of 2,558,180 mt, and 49% of the provisional estimate of world tuna catch (3,857,402 mt).

The 2001 catch by species featured a continuation of high skipjack tuna catches (1,212,037 mt; 64% of the total). The yellowfin tuna catch (472,417 mt; 25%) was below the record 1998 level, but has now been over 400,000 mt for the past five years. The bigeye tuna catch (107,045 mt; 6%) was slightly below the record high of 1999. The albacore tuna (North and South Pacific) catch in 2001 (116,627 mt; 6%) was considerably less than the record catch of 1999.

The 2001 **purse-seine** catch of 1,089,270 mt was the fourth consecutive annual catch in excess of 1,000,000 mt. Skipjack tuna (843,412 mt; 77%) continued to be the basis of the fishery, but was down slightly from the 2000 catch. The yellowfin tuna catch (219,151 mt; 20%) showed a slight increase on the 2000 catch, although the bigeye tuna catch (26,707 mt; 3%) declined for the second successive year as a result of reduced FAD fishing. The Japanese, Korean and Taiwanese fleets all maintained approximately the same levels of catch as in 2000, while the United States fleet sustained a slight decrease. Pacific Island domestic purse-seine fleets contributed around 16% of the 2001 purse-seine catch, a big increase over the 2000 level of 10%.

The 2001 **pole-and-line** catch of 329,932 mt (preliminary estimate) constituted 17% 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 (88%); albacore tuna taken by the Japanese coastal and offshore fleets in the temperate waters of the North Pacific (6%), 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 (135,872 mt in 2000) and the Indonesian fleet (169,218 mt in 2000) are again expected to account for most of the catch; the Solomon Islands fleet (the only significant Pacific Islands fleet) resumed fishing in the second half of 2001 after a period of inactivity due to civil unrest, recording a catch of 4,710 mt.

The 2001 **longline** catch of 221,874 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 2001 catch represented an all-time high, just eclipling the record of the previous year. The species composition of the 2001 longline catch was 35% yellowfin tuna, 37% albacore tuna and 28% bigeye tuna. As in previous years, most of the 2001 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 approximately 15% of the WCPO longline catch.

The 2001 **troll** catch of South Pacific albacore tuna (5,547 mt) was slightly less than that in 2000. 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 to about 35% in 2001.

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 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. Preliminary modelling results and fishery indicators suggest a decline in abundance occurred from the early 1960s until the mid-1990s. Post-1995 biomass is estimated to have risen, but this requires confirmation by future analyses.

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 pêcheries 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 ont accusé une augmentation importante en 1998. Pour l'année 2001, les prises sont estimées à 1908 126 tonnes, deuxième chiffre le plus élevé après celui de 1998 (2 035 773). La pêche à la senne représente environ 57 pour cent du total des prises, celle à la canne 17 pour cent et celle à la palangre 12 pour cent, les 14 pour cent restants étant les produits de la pêche à la traîne et de divers types de pêche artisanale, principalement en Indonésie orientale et aux Philippines. Les prises de thon dans le Pacifique occidental et central constituent 75 pour cent du total estimé des prises dans l'océan Pacifique, qui atteignent 2558 180 tonnes, et 49 pour cent des prises mondiales de thon, estimées provisoirement à 3 857 402 tonnes.

Si l'on ventile les prises par espèce, on observe que les prises de bonite en 2001 demeurent à un niveau élevé et atteignent 1 212 037 tonnes, soit 64 pour cent du total des prises; les prises de thon jaune (472 417, 25%) accusent un léger recul par rapport au record de 1998 tout en se maintenant au-dessus de la barre des 400 000 tonnes depuis cinq ans, tandis que les prises de thon obèse sont de 107 045 tonnes (6 %), en légère baisse par rapport au record enregistré en 1999. Les prises de germon (Pacifique Nord et Sud) en 2001 (116 627, soit 6%) sont loin du record atteint en 1999.

En 2001, les prises des **senneurs** se sont élevées à 1 089 270 tonnes; c'est la quatrième année consécutive que les prises annuelles dépassent le million de tonnes. Cette pêche reste fondée sur la pêche de la bonite (843 412, 77%), malgré une diminution de par rapport au chiffre enregistré en 2000. Les prises de thon jaune (219 151, 20%) ont montré une légère amélioration par rapport à celles de 2000, mais celles de thon obèse (26 707, 3%) accusent une baisse pour la deuxième année consécutive en raison de la diminution de la pêche autour de DCP. Les flottilles japonaise, coréenne et taiwanaise ont eu des prises sensiblement identiques à celles de 2000, tandis que la production de celle des États-Unis d'Amérique a continué de baisser légèrement. Les prises des flottilles nationales océaniennes de senneurs ont représenté environ 16 pour cent des prises de senneurs de 2001, soit une augmentation considérable par rapport aux 10 pour cent enregistrés en 2000.

Les prises à la **canne** de 2001 sont estimées provisoirement à 329 932 tonnes, soit 17 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 réalisées en Indonésie. Comme les années précédentes, la bonite a représenté la grande majorité des prises (88%), le germon pris par les flottilles côtières et hauturières japonaises dans les eaux tempérées du Pacifique Nord (6%), 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 la flottille japonaise pratiquant la pêche hauturière et au large et la flottille indonésienne qui devraient encore une fois réaliser la majorité des prises, estimées à 135 872 et 169 218 tonnes, respectivement, en 2000; la flottille des Îles Salomon, seule flottille océanienne d'une certaine importance, n'a repris la pêche qu'au cours du deuxième semestre 2001, après une période d'inactivité causée par des troubles civils. Les prises enregistrées ont atteint 4 710 tonnes.

Les prises de 2001 réalisées par les flottilles de **palangriers**, soit 221 874 tonnes, ne représentent que 12 pour cent du total des prises réalisées dans le Pacifique occidental et central, mais, sur le plan de la valeur marchande, elles rivalisent avec celles des senneurs, pourtant bien plus importantes. D'un niveau légèrement plus élevé que celui de 2000, elles constituent d'ailleurs un record sans précédent. La composition par espèce des prises réalisées à la palangre en 2001 a été de 35 pour cent de thon jaune, 37 pour cent de germon et 28 pour cent de thon obèse. Comme les années passées, la majeure partie des prises de 2001 a été réalisée par les gros bateaux du Japon, de la Corée et de Taiwan pratiquant la pêche hauturière, 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 environ 15 pour cent des prises à la palangre dans le Pacifique occidental et central.

En 2001, les prises à la traîne de germon du sud (5 547 tonnes) ont atteint un niveau légèrement inférieur à celui de 2000. Comme les années précédentes, les prises et l'effort se sont concentrés sur 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, 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 prise 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 l'effort effectif 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 à 35 pour cent environ en 2001.

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 premières modélisations et les indicateurs de pêche laissent apparaître qu'il y a eu diminution de l'abondance du début des années 60 jusqu'au milieu des années 90. Selon les estimations, la biomasse postérieure à 1995 devrait avoir augmenté ; cette hypothèse ne pourra toutefois être confirmée que par des analyses ultérieures.

Les résultats obtenus jusqu'à présent par modélisation sont surtout influencés par les estimations des PUE normalisées de la 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

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 2001, 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 2001 Tuna Fishery Yearbook (Lawson 2002), and on material presented at the July 2002, 15th meeting of the Standing Committee on Tuna and Billfish (SCTB), held in Honolulu, Hawaii (see the SCTB homepage at http://www.spc.int/OceanFish).

1 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.

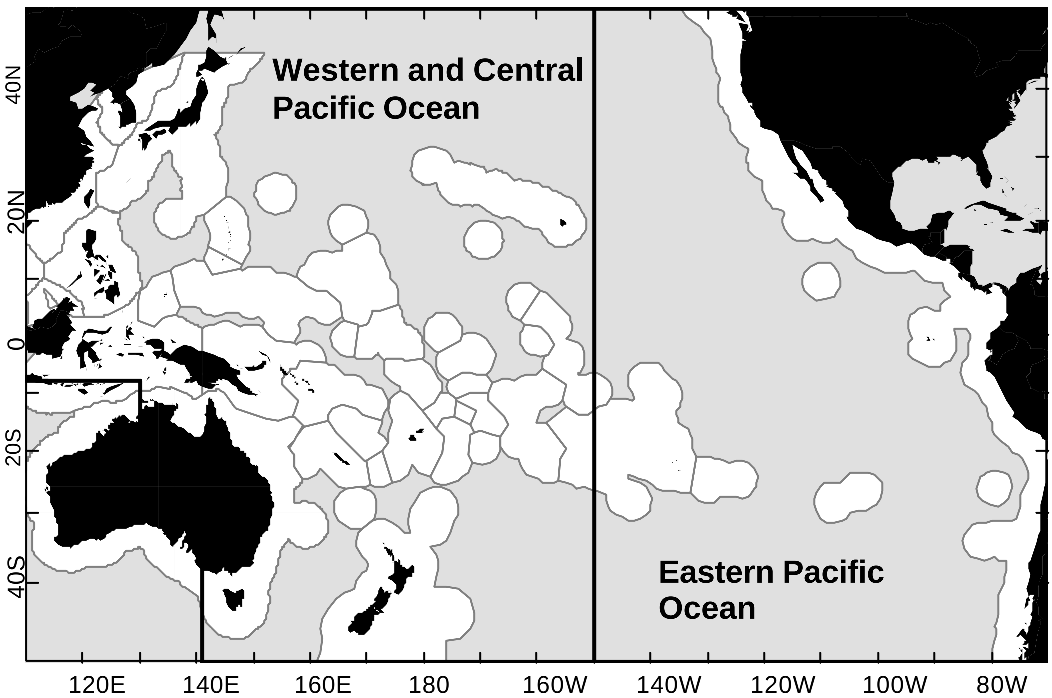

Figure 1. The western and central Pacific Ocean and the eastern Pacific Ocean.

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 2001 was estimated at 1,908,126 mt, the second highest annual catch recorded after 1998 (2,035,773,602 mt). The purse-seine fishery accounted for an estimated 1,089,270 mt (57% of the total catch), the pole-and-line fishery an estimated 329,932 mt (17%), and the longline fishery an estimated 221,874 mt (12%), with the remainder (14%) taken by troll gear and a variety of artisanal gears, mostly in eastern Indonesia and the Philippines (Figure 2). The year 2001 WCPO tuna catch represented 75% of the total estimated Pacific Ocean catch of 2,558,180 mt in 2001, and 49% of the provisional estimate of world catch (3,857,402 mt) of the four tuna species.

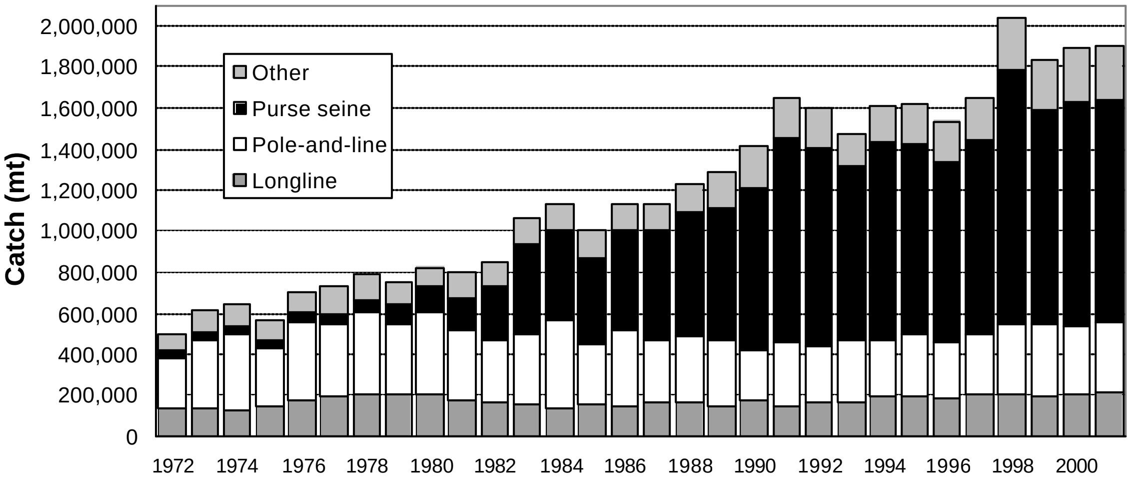

Figure 2. Annual total catch of skipjack, yellowfin, bigeye and albacore tuna, by fishing method, in the WCPO.

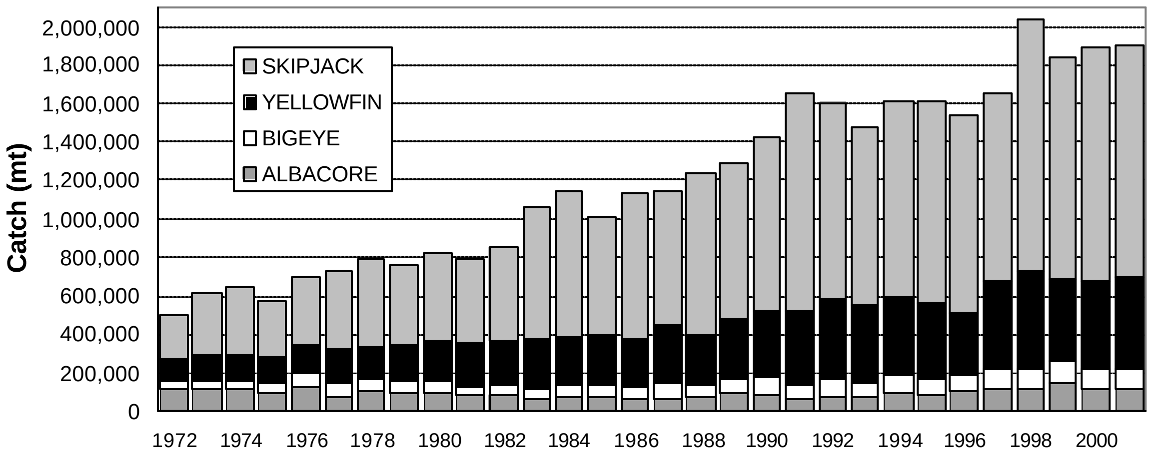

Figure 3. Annual total catch, by species, in the WCPO.

The 2001 catch by species (Figure 3) was dominated, as usual, by skipjack tuna (1,212,037 mt; 64% of the total tuna catch), down from the 1998 record level (1,309,934 mt) and slightly lower than in 2000 (1,225,414 mt). The 2001 yellowfin tuna catch (472,417 mt; 25%) was the highest since the record catch in 1998 (498,518 mt) and continued the recent trend of catches above 400,000 mt for the past four years. The albacore tuna catch[1] (116,627 mt; 6%), and the bigeye tuna catch (107,045 mt; 6%) were similar to 2000 levels, but not as high as the record catches for these species taken during 1999 (147,770 mt and 110,522 mt, respectively).

[1] Includes catches of North and South Pacific albacore tuna west of 150°W, which comprised 84% of the total Pacific Ocean albacore tuna catch of 138,816 mt in 2001.

2 Tuna Fishery by Gear Type

2.1 Purse Seine

2.1.1 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 (40 vessels in 2000), with the balance from Philippines fisheries and a variety of other fleets, including a small seasonally active Spanish fleet.

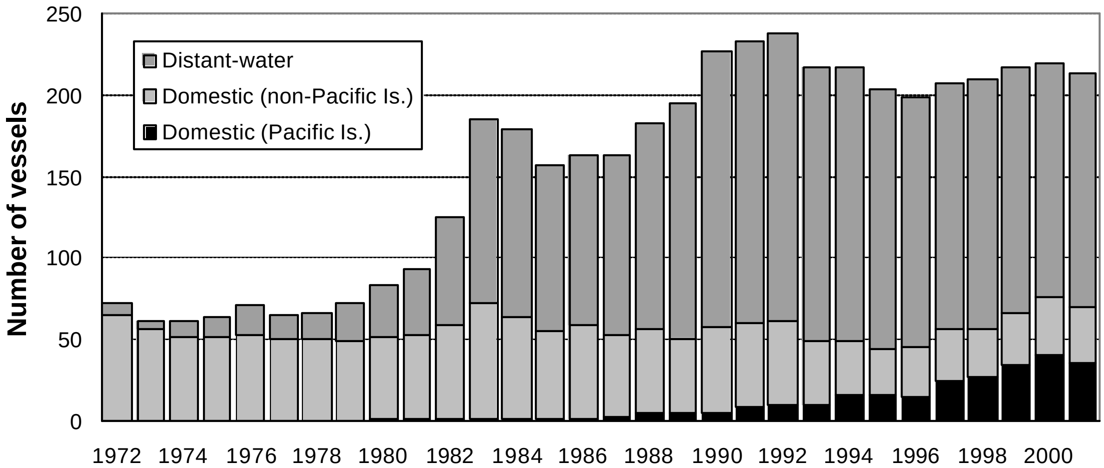

Figure 4. Number of purse-seine vessels operating in the WCPO. Domestic (non-Pacific Is.) includes vessels based in Australia, Japan and New Zealand, but not Philippines domestic vessels.

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 (1,238,242 mt), and catches have been over 1 million mt since, 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 (Figure 5) during the past decade include:

- Annual skipjack catches fluctuating between 600,000 and 700,000 mt p.a. until the sharp increase with the 1998 catch which has since been maintained at around 800,000 mt and above;
- Annual yellowfin catches fluctuating considerably between 120,000 and 272,000 mt; increases in the proportion of yellowfin in the catch are often noted during El Niño years, with sharp reductions during La Niña years (1995/96 and to a lesser extent 1999/2000);
- Increased bigeye tuna purse seine catches, first in 1997 (30,494 mt) and then again in 1999 (34,541 mt) and 2000 (30,665 mt), as a result of increased use of drifting FADs since 1996.

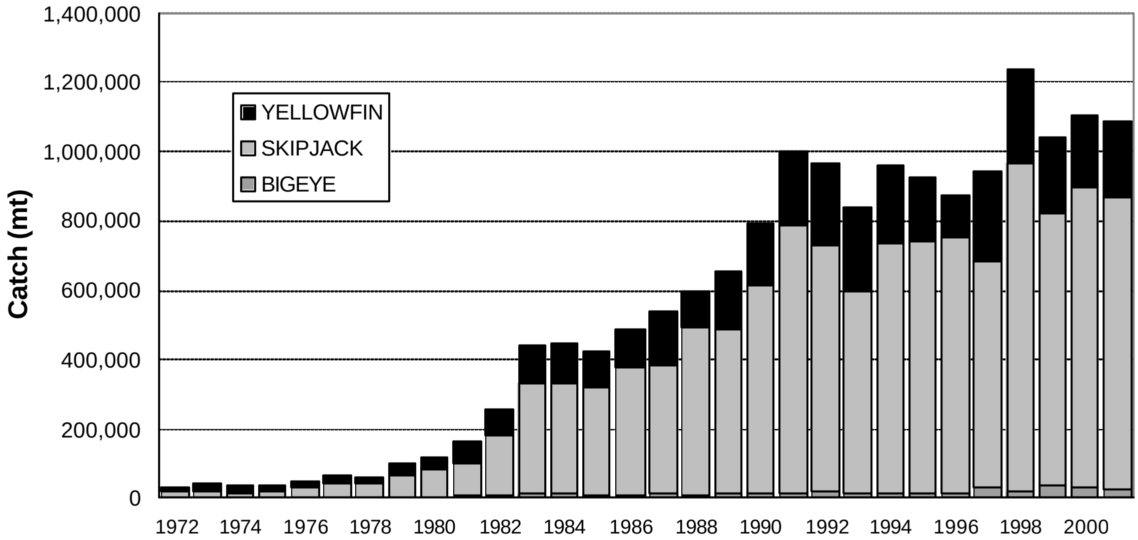

Figure 5. Purse-seine catch of skipjack, yellowfin and bigeye tuna in the WCPO.

2.1.2 The Year 2001 Fishery

Catch estimates and fleet sizes

The 2001 purse-seine catch of 1,089,270 mt was the fourth consecutive annual catch to exceed 1,000,000 mt. This catch level was attained despite voluntary reductions in effort in response to declining prices that existed in the fishery since 2000. The formation of World Tuna Purse Seine Organisation (WTPO) in recent years has led to a catch reduction programme in an effort to address the problems of over-supply and low prices. During the early months of 2001, the situation in the WCPO resulted in the unprecedented move by the entire US purse seine fleet to voluntarily forego fishing during the entire month of January and part of February. A reduction in effort was also apparent with the Korean and Taiwanese fleets during this period but not to the extent seen with the US fleet. A positive trend in skipjack prices eventuated in the first quarter of 2001 and remained at this level leading into 2002. Overall fleet size remained similar, except for the continuing reduction of the USA fleet and some redistribution of domestically-based vessels in the Pacific Islands.

The purse-seine skipjack tuna catch for 2001 (843,412 mt; 77%) was less than the record 1998 catch (947,113 mt). The purse-seine yellowfin tuna catch for 2001 (219,151 mt; 20%) increased from the 2000 catch, which was considered low, but typical of what is expected in a *La Niña* period. The estimated purse seine bigeye catch for 2001 (26,707 mt – 3%) was down on the record 1999 catch (34,541 mt), primarily due to continued reduction in fishing effort on drifting FADs in the past two years.

During 2001, catches were similar to 2000 for most DWFN fleets, except the US fleet (182,485 mt–1999, 125,351 mt–2000 and 115,524 mt–2001), which continues to reduce in vessel numbers. Taiwan, catching more than 200,000 mt per year, has been the highest producer in the tropical purse seine fishery over the past four years. The steady increase in catch by the PNG fleet (38,302 mt–1999, 67,456mt–2000 and 93,085 mt–2001) is also noteworthy.

The percentage of sets on drifting FADs decreased for the four major purse seine fleets during 2001, continuing the trend seen in 2000 (Figure 6). Sets on unassociated schools were the predominant fishing method for the four main fleets for the first time since 1998.

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, with considerable variation over years and areas. In general, 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. This may, however, be accompanied by somewhat reduced catch rates, as was the case for the US fleet during 2000 and again in 2001. Fishing in eastern areas during El Niño periods (1997–98), on the other hand, involves mostly unassociated and log sets.

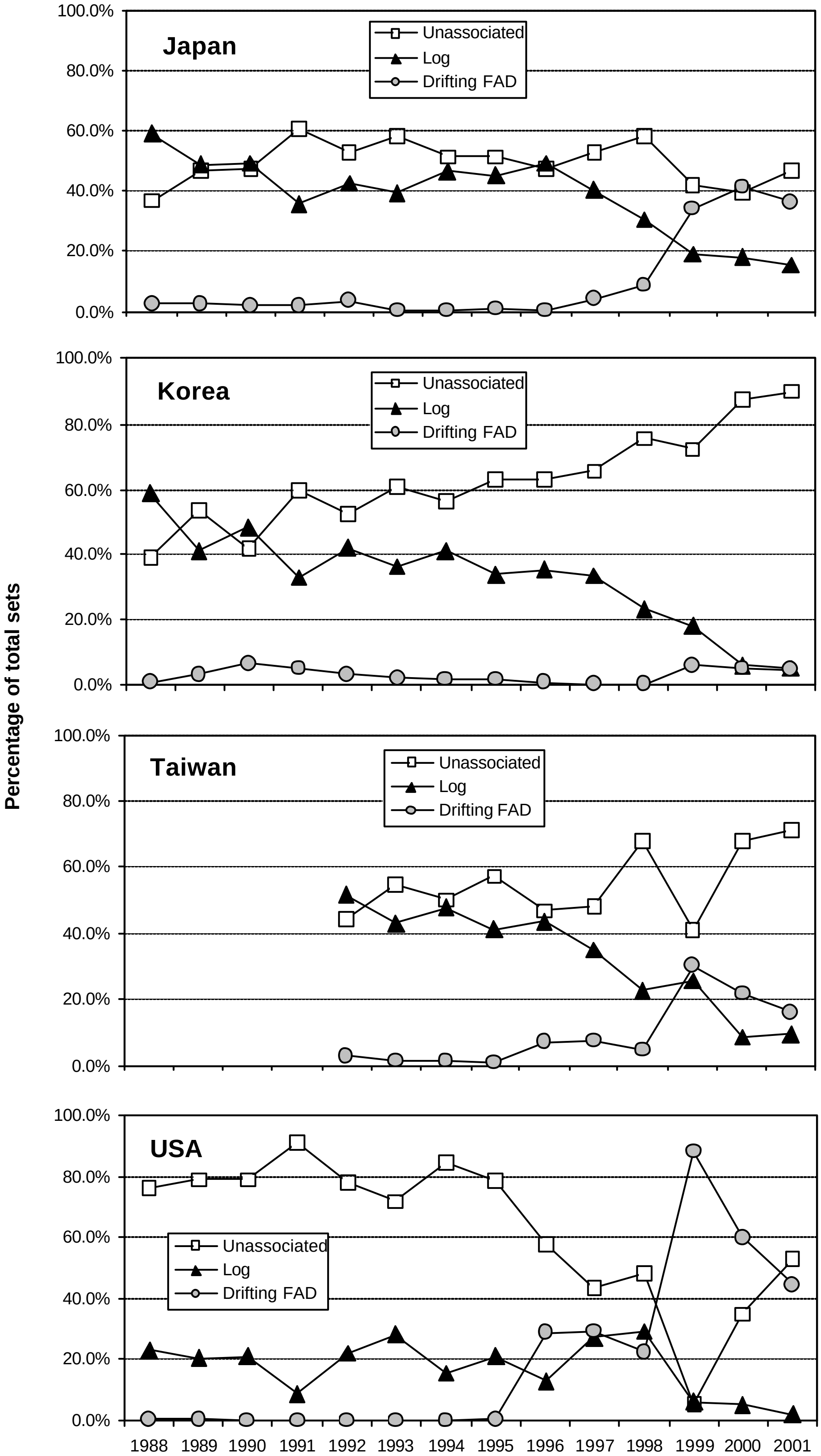

Figure 6. The percentage of total sets by set type for the major purse-seine fleets operating in the WCPO.

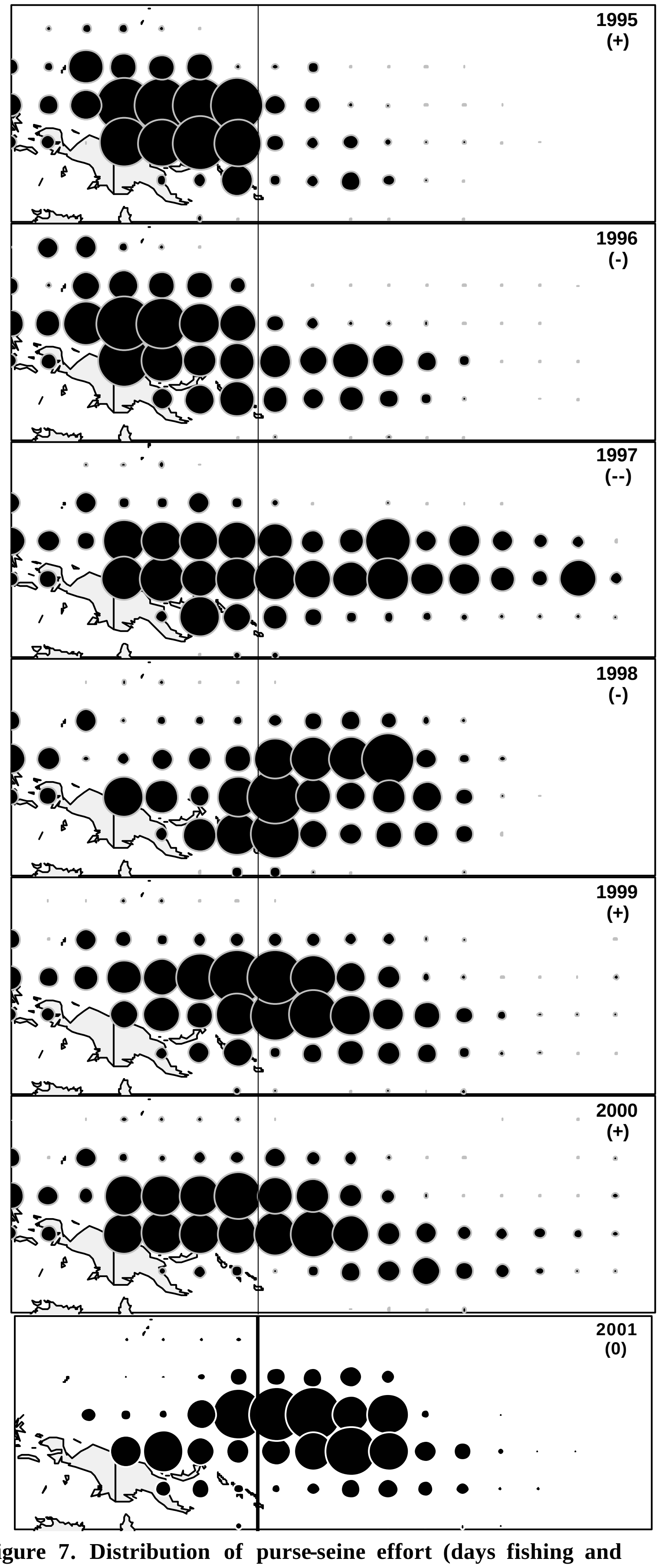

Figure 7. Distribution of purse-seine effort (days fishing and searching), 1995–2000. ENSO periods are denoted by: '+' = La Niña; '-' = El Niño; '--' = strong El Niño; '0' = transition period.

2.2 *Pole and Line*

2.2.1 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 numbers of vessels has occurred in all pole-and-line fleets over the past decade. Pacific Island domestic fleets have declined in recent years – fisheries formerly operating in Palau, Papua New Guinea and Kiribati are no longer active, only one or two vessels are now operating in Fiji, and there have been problems in the Solomons fishery over the past 2 years. Several vessels continue to fish in Hawai'i, and the French Polynesian *bonitier* fleet remains active, but more vessels are turning to longlining activity. Against this trend, there has been a reported increase in Indonesian catches since 1999, apparently as a result of increased demand for catch and possibly technological advances.

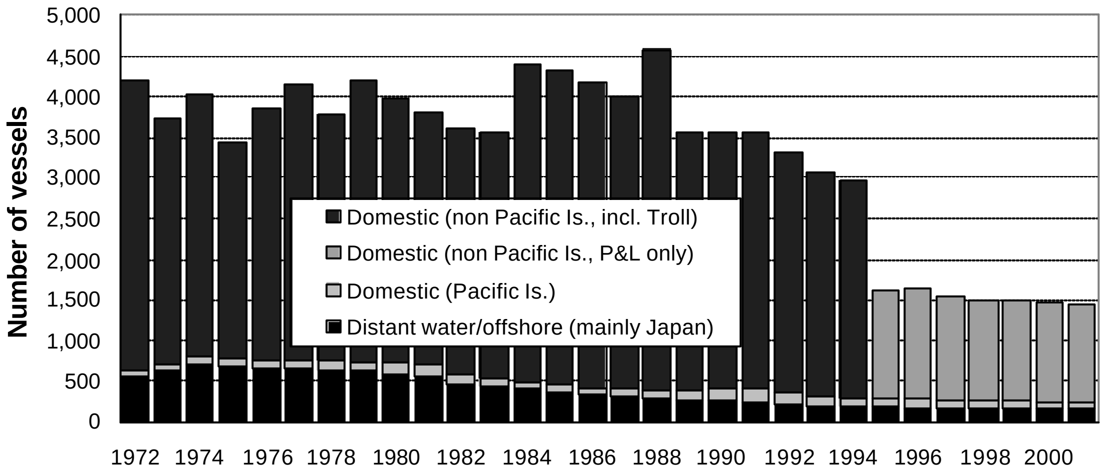

Figure 8. Pole-and-line vessels operating in the WCPO.

2.2.2 The Year 2001 Fishery (*provisional*)

Catch estimates and fleet sizes

The preliminary pole-and-line catch estimate for 2001 (329,932 mt) is a slight increase on the 2000 level (327,311 mt), but is essentially the same as 2000 since the estimates for the two fleets (Japan and Indonesia) taking most of this catch have not yet been provided for 2001 (Figure 9). As in 2000, this catch represents about 17% of the total WCPO tuna catch. As in previous years, skipjack accounts for the vast majority of the catch (88%); albacore taken by the Japanese coastal and offshore fleets in the temperate waters of the north Pacific (6%), yellowfin (5%) and a small component of bigeye (1%) make up the remainder of the catch. While the 2001 catch estimate is yet to be finalised, it is clear the Japanese distant-water and offshore (135,872 mt in 2000) and the Indonesian fleets (169,218 mt in 2000) are expected to once again account for most of the catch. The trend of low catches by the Solomon Islands fleet continued during 2001 with a total catch of only 4,710 mt (up from 2,692 mt in 2000), with fishing only conducted during the second half of the year.

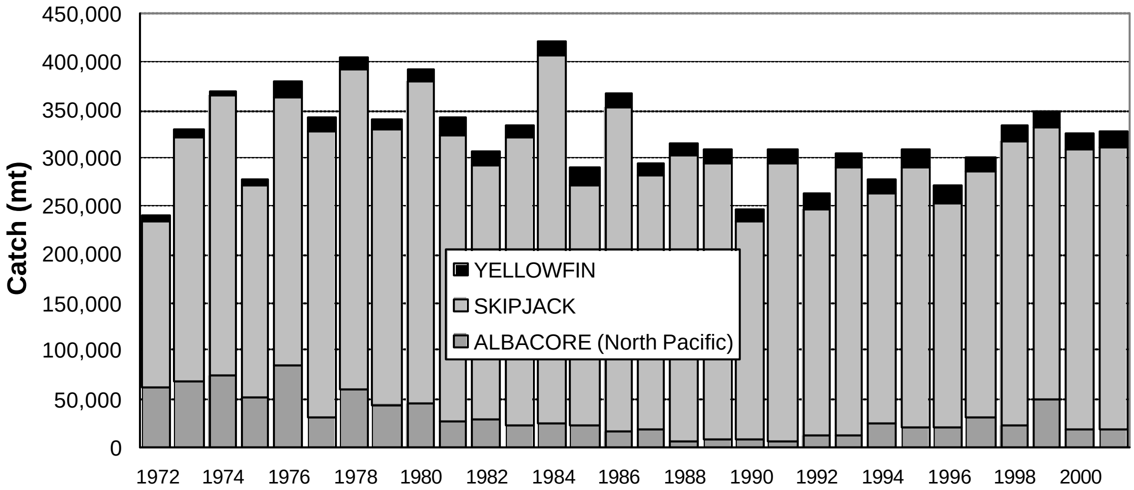

Figure 9. Pole-and-line catch in the WCPO.

Geographical distribution

Figure 10 shows the average distribution of pole-and-line effort for the period 1995–2000. Effort in tropical areas is usually year-round and includes the domestic fisheries in Indonesia and the Solomon Islands and the Japanese distant-water fishery. The pole-and-line effort in the vicinity of Japan by both offshore and distant-water fleets is seasonal (highest effort and catch in the 2nd and 3rd quarters). The effort in French Polynesian waters is essentially the bonitier fleet.

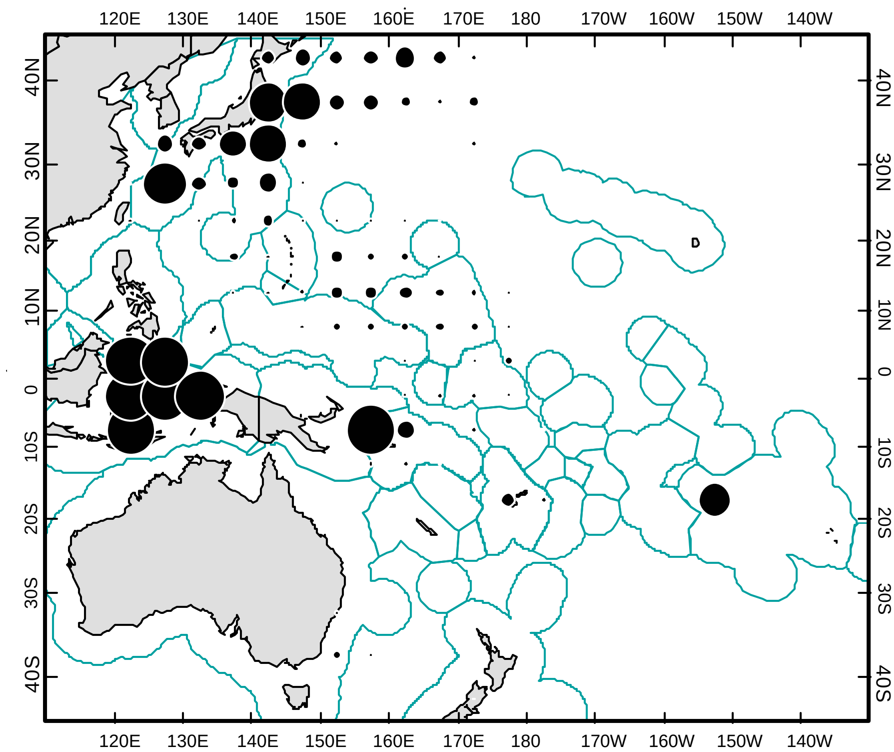

Figure 10. Average distribution of WCPO pole-and-line effort, 1995–2000.

2.3 *Longline*

2.3.1 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 11).

The fishery involves two main types of operation:

- Large (typically >250 GRT) **distant-water** freezer vessels, which undertake long voyages (months) and operate over large areas of the region (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 distant-water) has occurred in recent years.
- Smaller (typically <100 GRT) **offshore** 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 vessels in Indonesia and the Philippines (not included in Figure 11) target yellowfin and bigeye by handlining and small vertical longlines, usually around numerous arrays of anchored FADs in these waters. These fisheries have similar species composition as longliners operating in the same area.

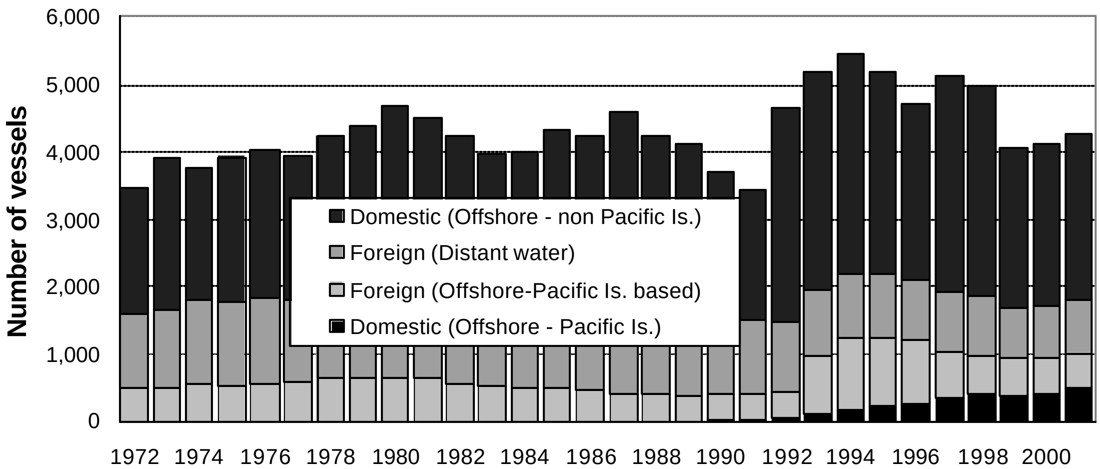

Figure 11. Longline vessels operating in the WCPO.

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 11) 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, but for which catch estimates are not yet available).

The annual total longline tuna catch has been relatively stable during the past 25 years (Figure 12), with total catches generally between 130,000 and 200,000 mt. and comprised almost entirely of yellowfin, bigeye and albacore (Lawson, 2002).

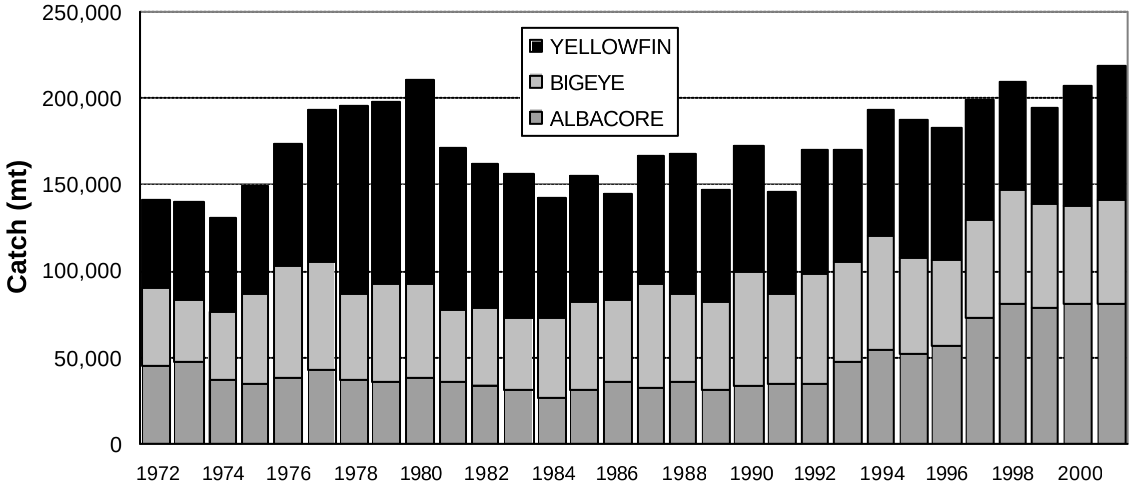

Figure 12. Longline catch in the WCPO.

2.3.2 The Year 2001 Fishery

Catch estimates and fleet sizes

The 2001 longline catch (221,874 mt) was a record for the WCPO, eclipsing the previous high (211,187 mt) in 1998. The overall species composition of the 2001 WCPO longline catch was 35% yellowfin, 37% albacore and 28% bigeye, in contrast to 1981, when yellowfin dominated the catch (117,361 mt; 55%). The 2001 yellowfin catch (77,262 mt) was the highest catch in seven years and continued the significant recovery from the lowest catch (56,767 mt) recorded for nearly 30 years in 1999, only two years earlier. The 2001 albacore catch in the WCPO (82,033 mt) was a record for this fishery, just above the previous record attained in 2000 (81,006 mt). The albacore catch was clearly the highest ever in the south Pacific fishery (45,708 mt) as the result of increased growth in Pacific Island domestic fisheries (American Samoa, Fiji, French Polynesia, Samoa and Tonga).

Domestic fleet sizes continue to increase at the expense of foreign-offshore and distant-water fleets (Figure 11), although the Taiwanese distant-water longline fleet increased by 30% (to 101 vessels) during 2001. This increase was primarily due to several vessels shifting activities to the Pacific Ocean from the Indian and Atlantic Oceans (Dr. Shyh-bin Wang, pers. comm.). Most of these vessels are "super-cold" longline vessels targeting bigeye and yellowfin tunas, and now contribute to a more diverse fleet that previously only concentrated on targetting albacore.

Geographical distribution

Figure 13 shows the distribution of effort by category of fleet for 2000 activities (representing the most recently available data for all fleets, but reflecting the likely distributions for 2001). As in previous years, most of the 2001 WCPO catch was taken by the large-vessel, distant-water fleets of Japan, Korea and Taiwan although the overall proportion of the catch is declining. Effort by these fleets is widespread as sectors of these fleets target bigeye and yellowfin for the frozen sashimi market, and albacore in the more temperate waters for canning. Activity by the offshore fleets from Japan, mainland China and Taiwan are restricted to the tropical waters, targetting bigeye and yellowfin for the fresh sashimi market; these fleets have limited overlap with the distant-water fleets. The substantial "offshore" effort in the west of the region is primarily by Indonesian and Taiwanese domestic fleets targetting yellowfin and bigeye. The growth in domestic fleets in the South Pacific over recent years has been noted; the most significant examples are the increase in the Fijian fleet, and the establishment of the domestic Samoan and French Polynesian fleets.

Figure 14 shows species composition by area for 2000 (2001 data incomplete). The majority of the yellowfin catch is taken in tropical areas, especially in the western parts of the region, with smaller amounts in often seasonal subtropical fisheries. The majority of the bigeye catch is also taken primarily from tropical areas, but in contrast to yellowfin, mainly in the eastern parts of the WCPO, adjacent to the traditional EPO bigeye fishing grounds. The albacore catch, in contrast, is taken in subtropical and temperate waters in both hemispheres.

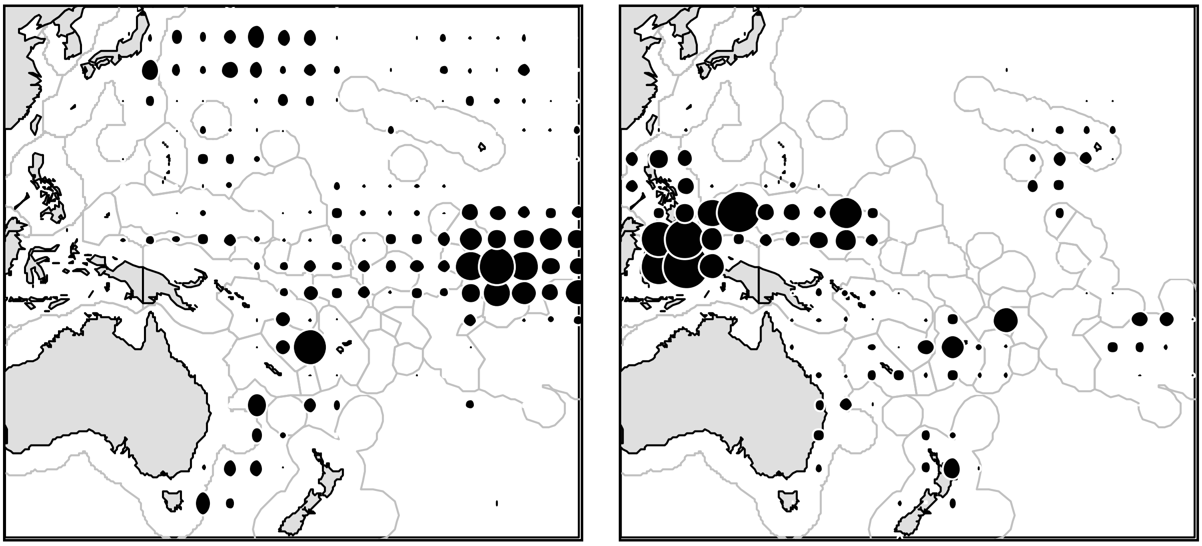

Figure 13. Distribution of distant-water (left) and offshore and domestic longline effort (right–excludes Japanese domestic fishery) during 2000.

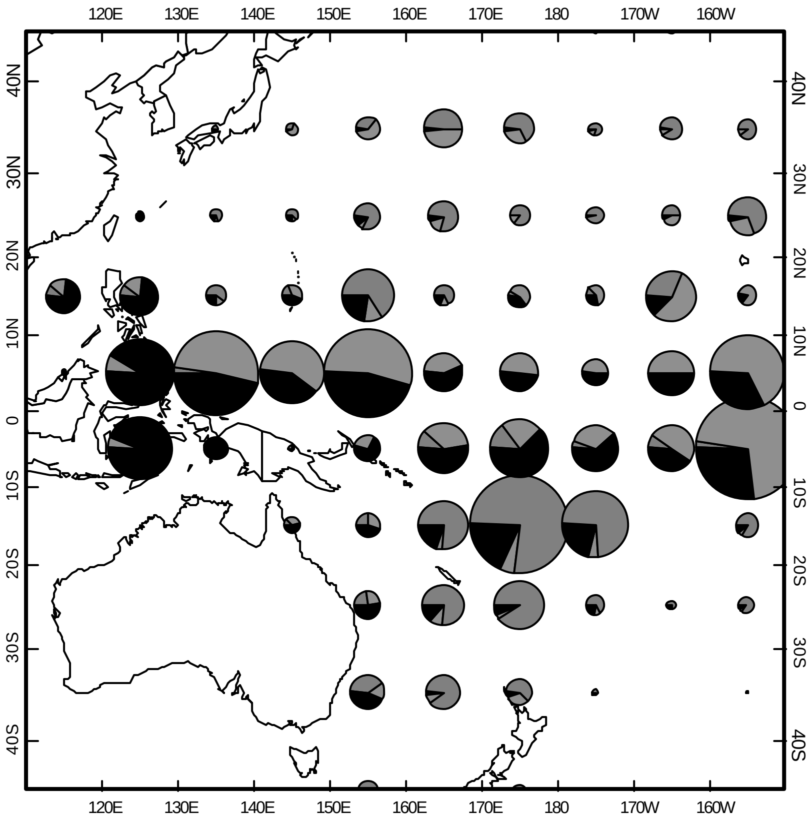

Figure 14. Distribution of longline catch, by species, during 2000 (black = yellowfin tuna; hatching = bigeye tuna; grey = albacore tuna).

2.4 Troll

2.4.1 Historical Overview

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

The fishery expanded following the development of the STCZ fishery after 1986, with the largest annual catch (around 8,200 mt) taken in 1989 (Figure 15; Lawson 2002). Since then, annual catches have varied between 3,000 and 8,000 mt. The level of effort expended by the troll fleets each year tends to reflect the price commanded for the product (albacore for canning) to some extent, and by expectations concerning likely fishing success.

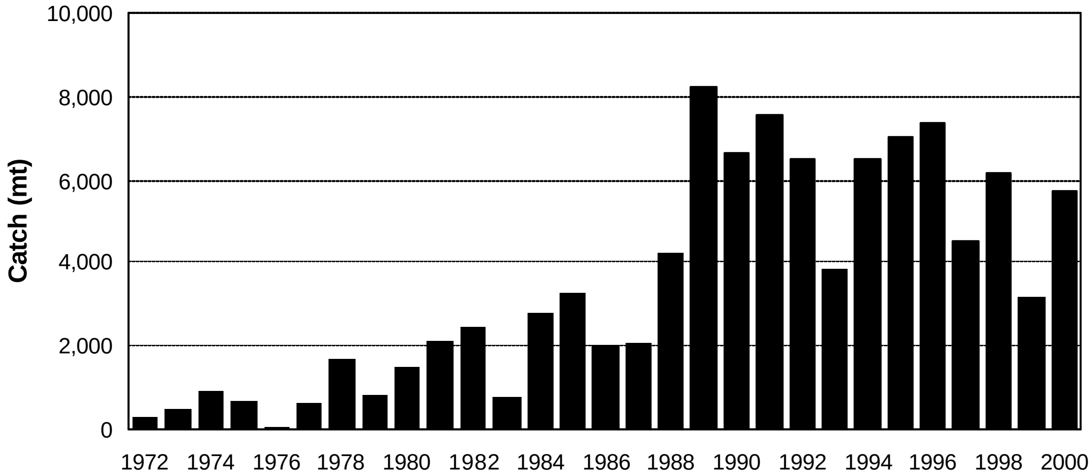

Figure 15. Troll catch of albacore tuna in the South Pacific Ocean.

2.4.2 The Year 2000 Fishery

The 2001 troll albacore catch (5,547 mt) was a slight drop on the 2000 level, and essentially made up of the NZ (3,254 mt) and US (2,085 mt) fleet catches. Figure 16 shows the distribution of effort for troll fleets for 2000, which is expected to be a likely distribution of fishing effort for 2001 (i.e. off the coast of New Zealand and in the STCZ).

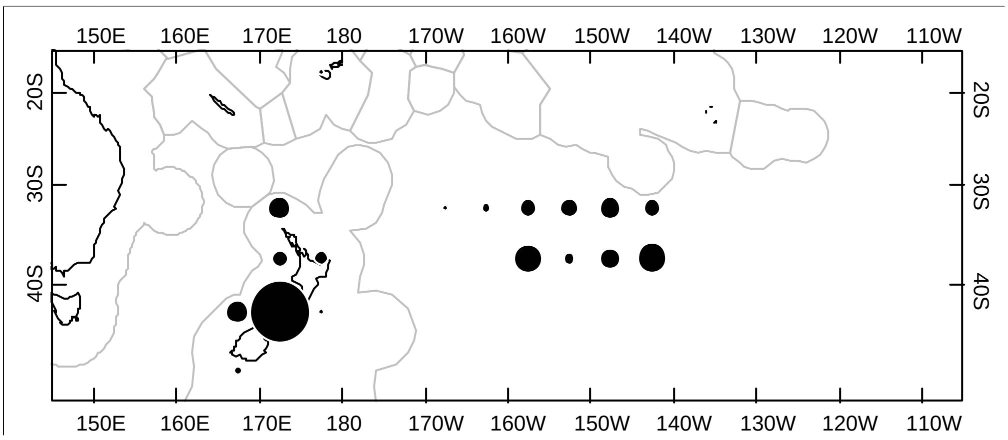

Figure 16. Distribution of South Pacific albacore tuna troll fishery effort during 2000.

3 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, yellowfin and bigeye tuna is the WCPO as earlier defined. 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, focusing on the most recent MULTIFAN-CL analyses, are reviewed.

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.

3.1 Skipjack Tuna

3.1.1 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 800,000–1,200,000 mt), with catches of more than one million metric tonnes occurring in 1991, 1992, 1995, 1996, 1998–2001 (Figure 17). 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 2001 catch of 1,212,037 mt, the third highest on record, comprised:

- Purse seine — 843,412 mt (70% of the total), of which most was taken by the four main distant-water fleets (589,713 mt) and the Philippine purse-seine and ringnet fleet (estimated 103,000 mt);
- Pole-and-line — 291,184 mt (24%), of which around 120,000 mt was taken by Japanese fleets, an estimated 150,000 mt by Indonesia, but a continuing reduced contribution (4,508 mt) by the Solomon Islands fleet compared with catches in the 1990s;
- Other gears — ~75,000 mt (6%) representing 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 18). The distribution (and catch) of skipjack tuna in equatorial areas east of Papua New Guinea is strongly influenced by ENSO events.

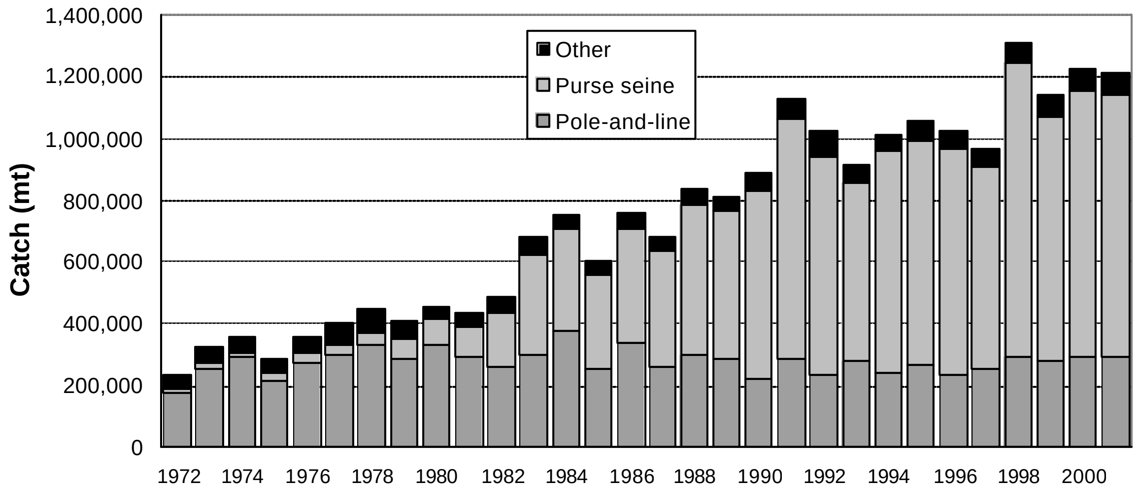

Figure 17. WCPO skipjack tuna catch, by gear.

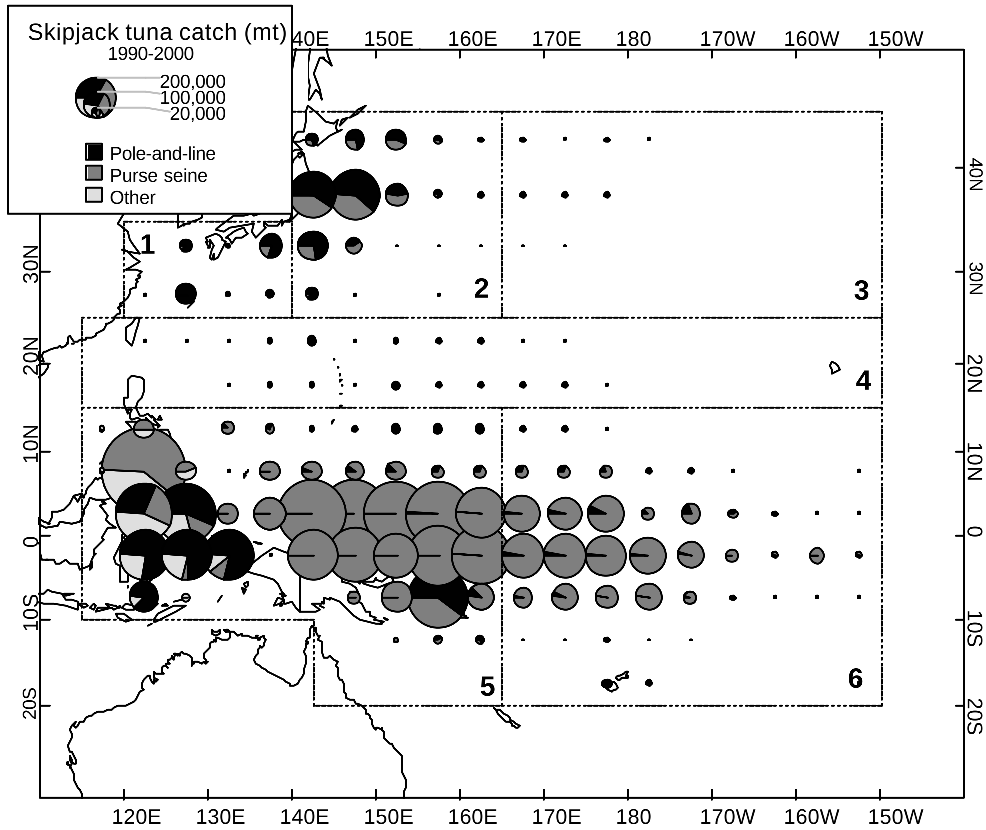

Figure 18. Distribution of skipjack tuna catch, 1990-2000. The six-region spatial stratification used in stock assessment is shown.

3.1.2 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 19. These fleets are the major purse-seine fleets fishing in the WCPO.

Skipjack tuna CPUE was generally stable during the period 1988–1997 for all fleets and set types. The slight increase in skipjack CPUE for free-school sets over the past 5 years is possibly related to technological advances enabling better detection of free-swimming schools. For log and FAD sets, CPUE was substantially higher over the period 1998–2001 than previous periods. These increases may be due to higher skipjack stock levels, an increase in the effectiveness of purse seine effort, or both.

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

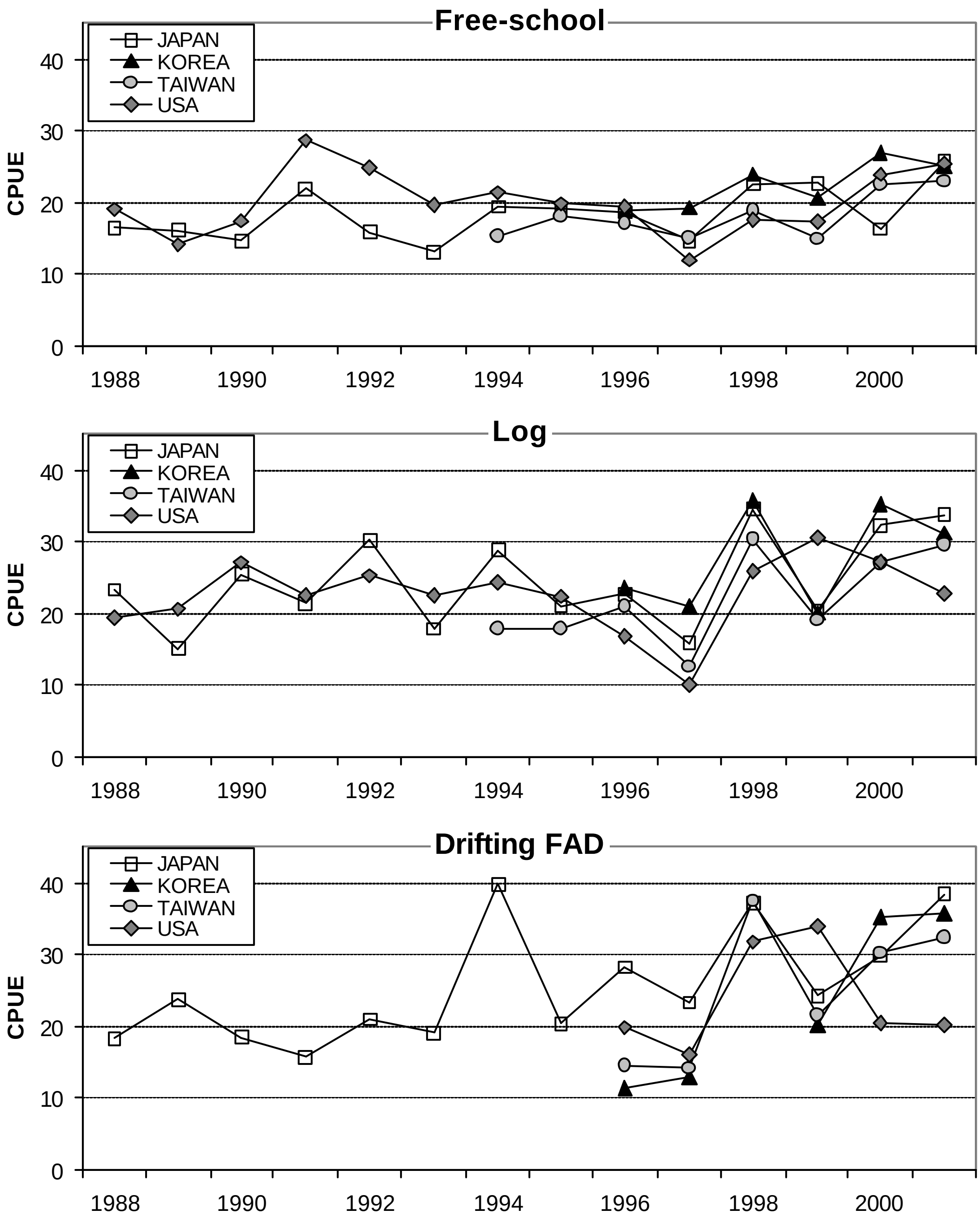

Figure 19. Skipjack tuna CPUE (mt per day) by major set type categories (free-school, log and drifting FAD sets) for Japanese, Korean, Taiwanese and USA purse seiners fishing in the WCPO. Effort and CPUE were partitioned by set type according to the proportions of total sets attributed to each set type.

Nominal skipjack CPUE for the offshore and distant-water Japanese pole-and-line fleets show no clear trend since 1994 (Figure 20). The skipjack CPUE for the offshore fleet, active in and around the Japanese home fishery, shows an oscillating pattern (between 4–6 mt/day) for most of the 1990s. In contrast, the distant-water fleet, primarily active in tropical waters, consistently accounted for a higher CPUE (between 6–8 mt/day) over this period. 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. Skipjack CPUE in the Solomon Islands domestic pole-and-line fishery tends to be stable but lower than the Japanese fleets. Nominal skipjack CPUE for the Japanese and Solomon Island fleets tend to follow similar patterns from year to year, suggesting that stock-wide effects are involved.

Some increases in CPUE by the Japanese fleet have coincided with substantial effort reduction and the departure of less competitive boats from the fishery, as well as the acquisition of improved technology, e.g. bird radar. Ogura and Shono (1999) considered several of these factors in estimating the standardised CPUE for the Japanese pole-and-line fleets (Figure 21). The importance in considering these factors is demonstrated when comparing nominal (Figure 20) and standardised (Figure 21) CPUE for the Japanese distant-water fleet where, for example, standardised CPUE shows a more accentuated decline than nominal CPUE in the late 1980s–early 1990s. However, on the basis of these time series in general, we would conclude that the skipjack tuna stock in the WCPO remains healthy.

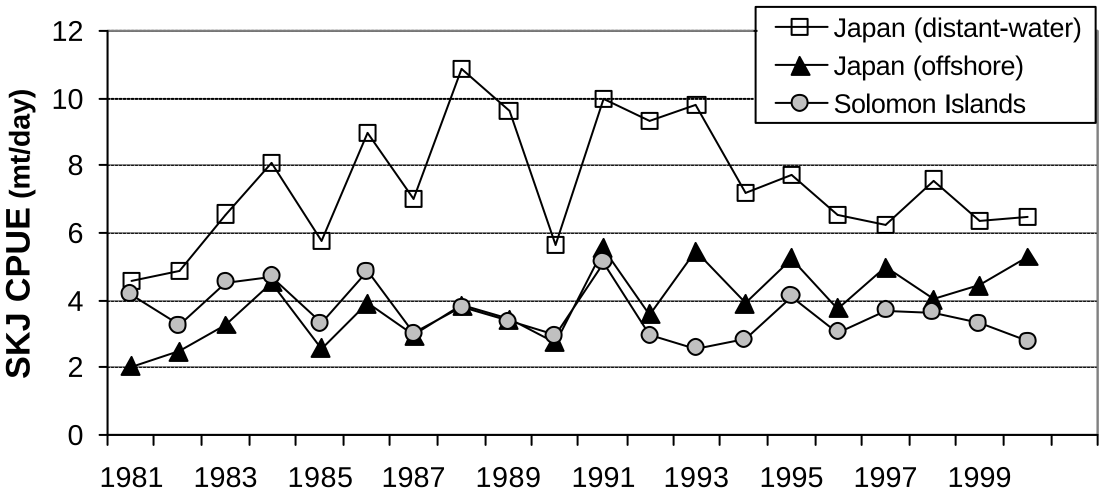

Figure 20. Nominal skipjack tuna CPUE (mt/day) for selected pole-and-line fleets.

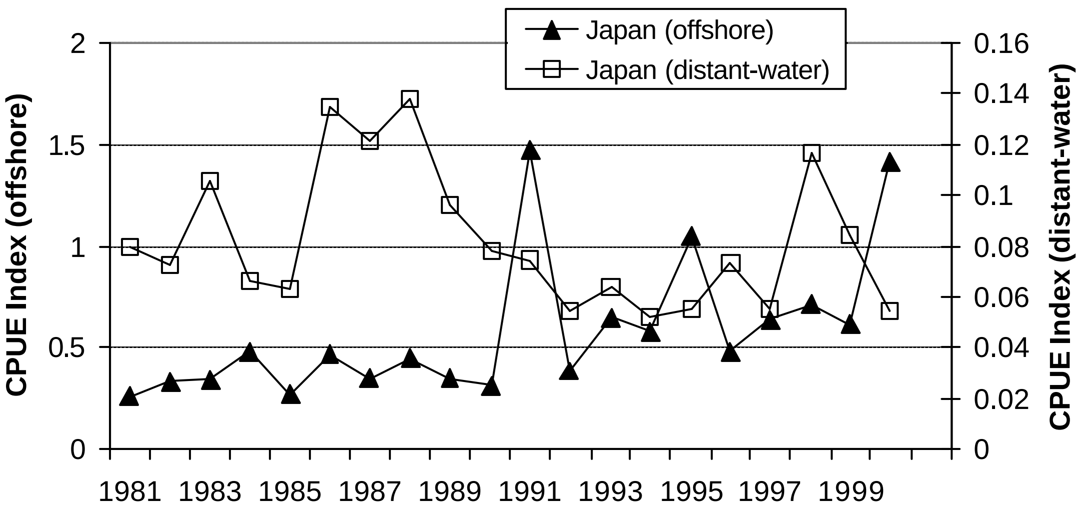

Figure 21. Standardised skipjack tuna CPUE (mt/day) for Japanese pole-and-line fleets.

3.1.3 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.

Annual estimates of catch-at-size for the Indonesian/Philippines domestic fisheries, the pole-and-line and purse-seine fleets during recent years are shown in Figure 22. The Indonesian/Philippines domestic fisheries tend to catch smaller skipjack than the other fisheries described here. The purse-seine unassociated-set catch usually accounts for slightly larger fish than the pole-and-line and purse-seine associated-set (i.e. log and FAD) catch. The clear mode of larger fish in the range 70–85 cm during 2000 is probably the age class corresponding to the strong recruitment in 1998.

3.1.4 Stock Assessment

An integrated, length-based, age- and spatially-structured model known as MULTIFAN-CL (Fournier et al. 1998; Hampton and Fournier 2001) is now routinely applied to tuna stock assessment in the WCPO. For skipjack tuna, a six-region stratification of the WCPO (see Figure 19) similar to that employed by Ogura and Shono (1999) is used.

The data analysed in the most recent assessment cover the period 1972–2000 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 (219,809 releases, 17,251 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 (2002a) (see http://www.spc.int/OceanFish/Html/SCTB/SCTB15/skj-1.pdf); only the subset of results of direct importance to stock assessment is given here.

Annual fishing mortality rates are highest for adult skipjack tuna (< 45 cm) and have increased continually over time for both age groups since the beginning of the analysis until about 1997 (Figure 23). Since 1997, there has been a reduction in fishing mortality that is coincident with the increase in stock biomass. Juvenile skipjack tuna are relatively lightly exploited. 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 24). 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 25). Large peaks are observed in 1988, 1991 and 1998–2000, 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 26, 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.

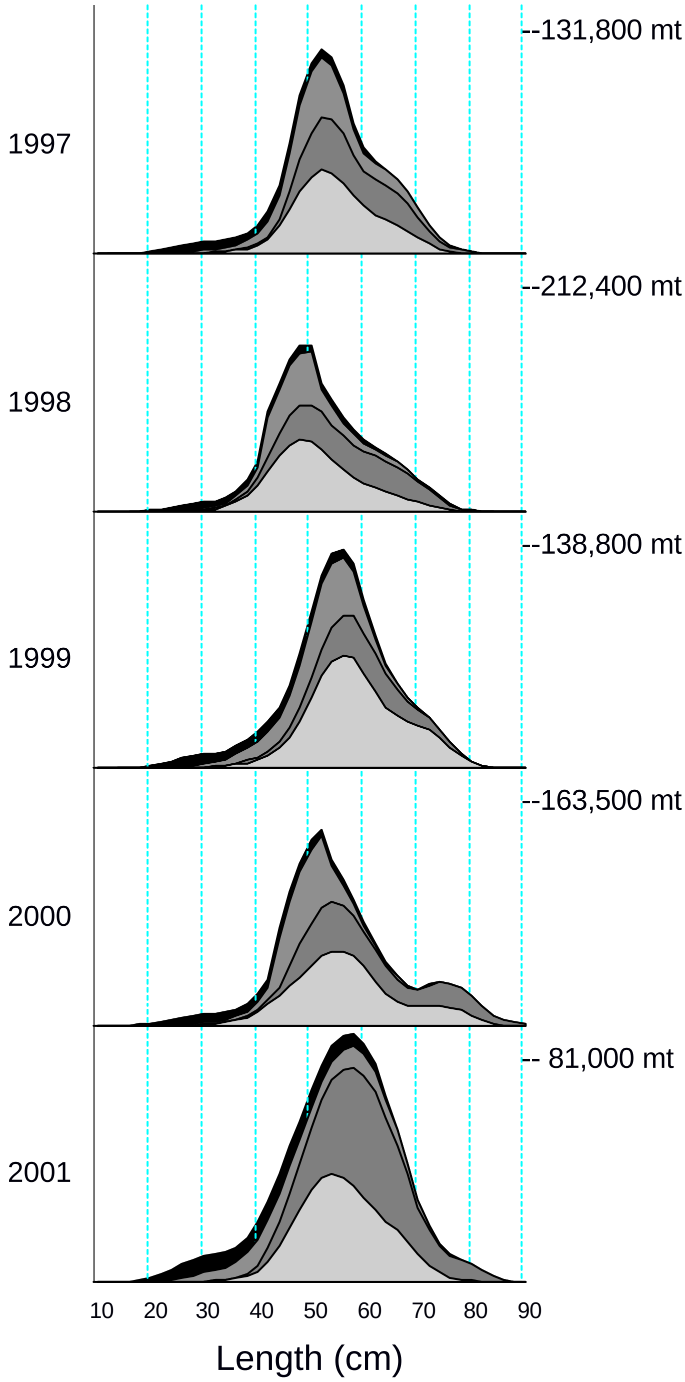

Figure 22. Annual Skipjack tuna catch-at-size in the WCPO, 1997–2001. The catch is broken down into the Indonesian/Philippines domestic fisheries component (black), the pole-and-line fishery component (hatched), unassociated-set catch from the purse-seine fishery (grey) and associated-set catch from purse-seine fishery (dotted). The y-axis scale is in weight - the figures on the right indicate the catch weight in a 2-cm size class. (2001 data are provisional)

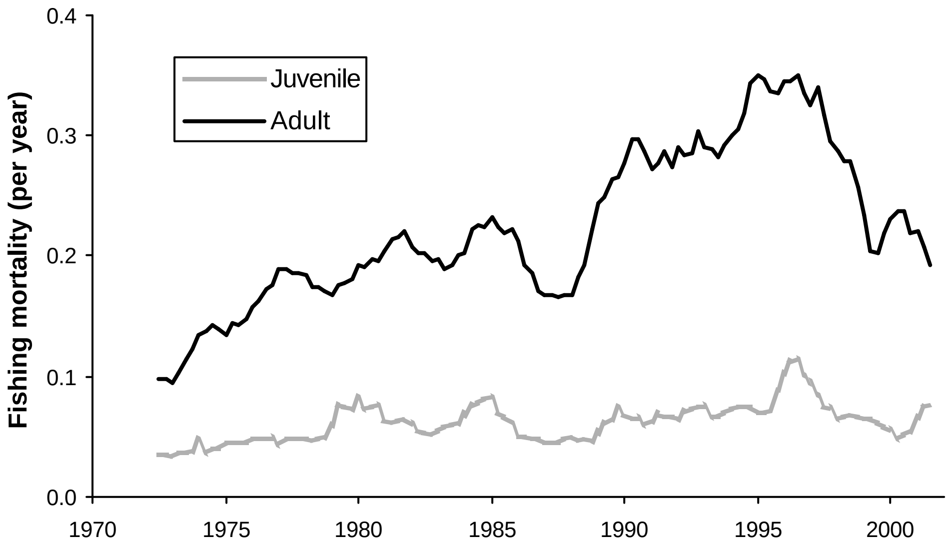

Figure 23. Estimated annual fishing mortality rates for juvenile (< 45 cm) and adult skipjack tuna.

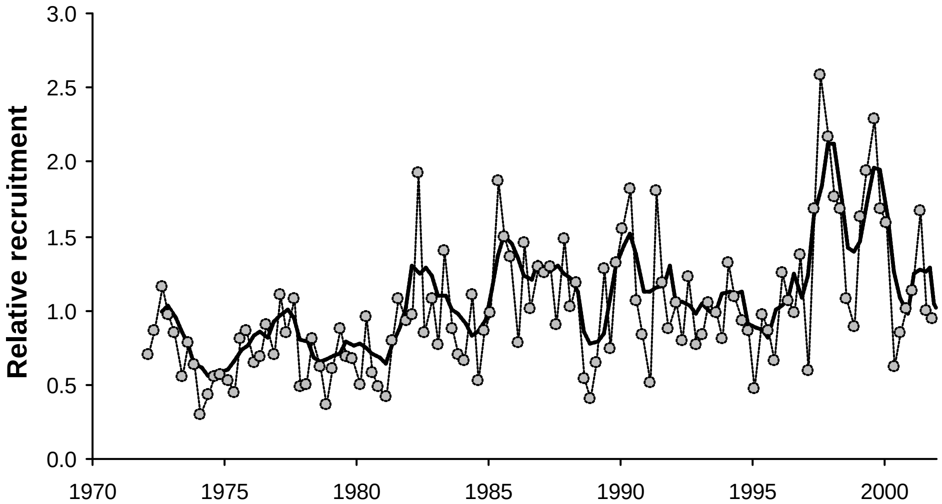

Figure 24. Estimated relative (scaled to the average) quarterly skipjack tuna recruitment with a four-quarter moving average (solid line).

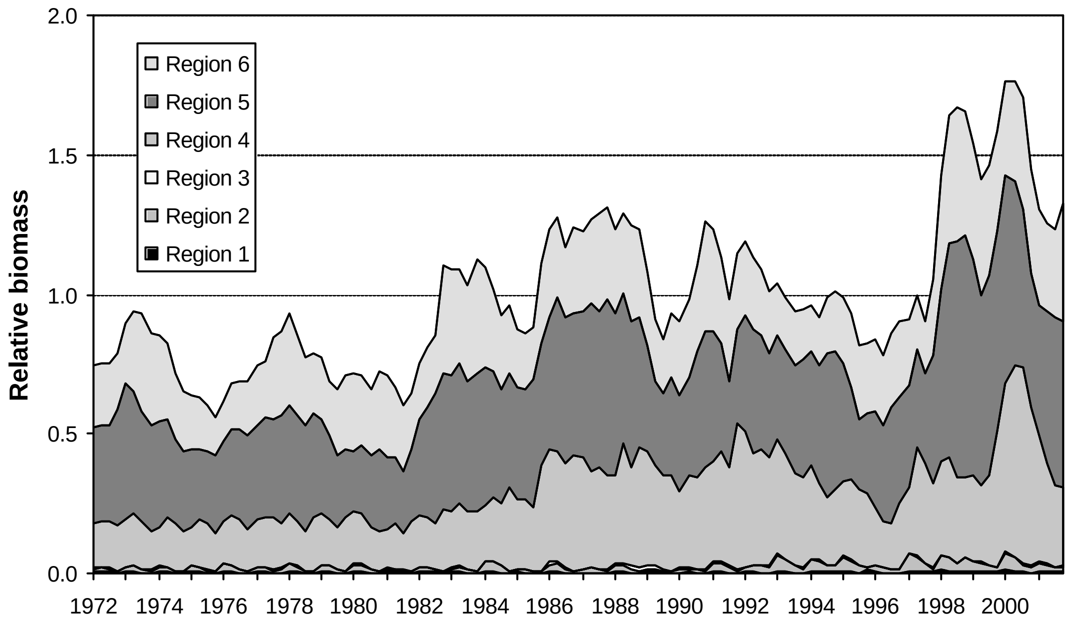

Figure 25. Estimated relative total skipjack tuna biomass, by region. Estimates are scaled to the average spatially aggregated biomass.

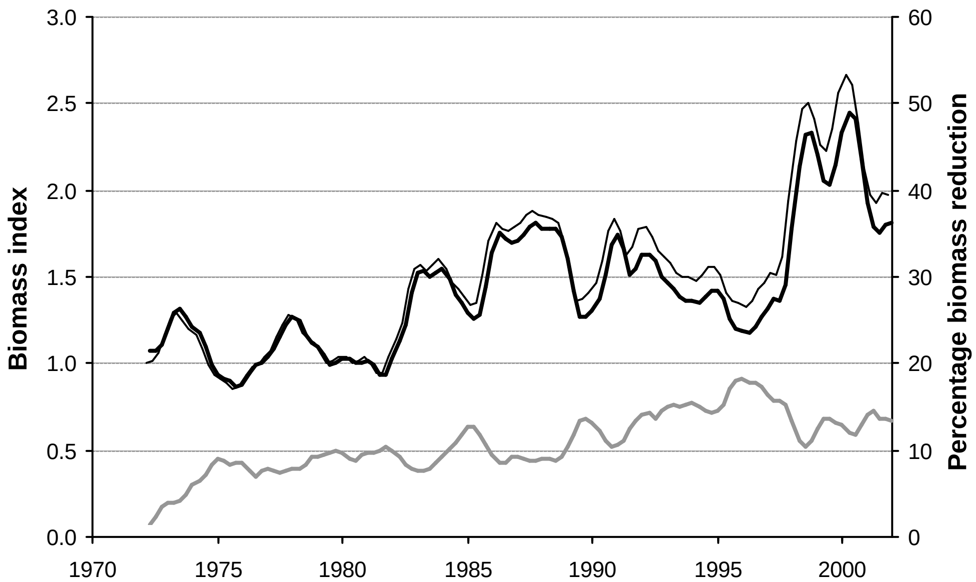

Figure 26. The estimated impact of fishing on skipjack tuna biomass. The lower biomass trajectory (darkest line) represents the model estimates of total biomass. The upper trajectory is the estimated biomass that would have occurred in the absence of fishing assuming that recruitment was unaffected by 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.

3.2 Yellowfin Tuna

3.2.1 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 320,000–500,000 mt (Figure 27). Purse seiners harvested the majority of the yellowfin tuna catch during 2001 (219,151 mt – 46% by weight), while longline and pole-and-line fisheries comprised 16% (77,262 mt) and 3% (16,406 mt), 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 34% of the catch in 2001. 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.

The eastern Pacific (EPO) purse seine catch of yellowfin (409,511 mt) for 2001 was an all-time record and more than 100,000 mt higher than the previous record in 1999. The 2001 Pacific-wide yellowfin catch (all gears) of 881,928 mt was also a record, exceeding the previous record in 1998 by over 100,000 mt.

Longline catches in recent years (56,000–80,000 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 27 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.

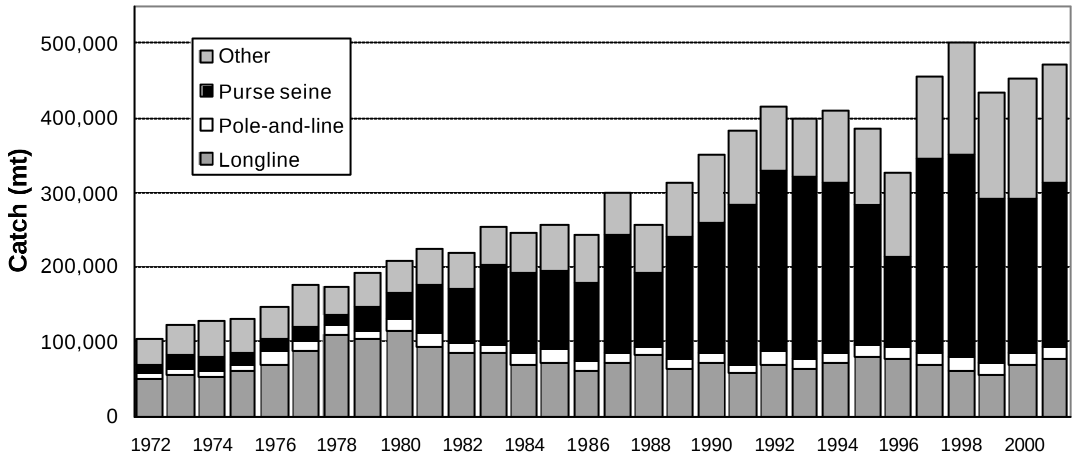

Figure 27. WCPO yellowfin tuna catch, by gear.

Figure 28 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.

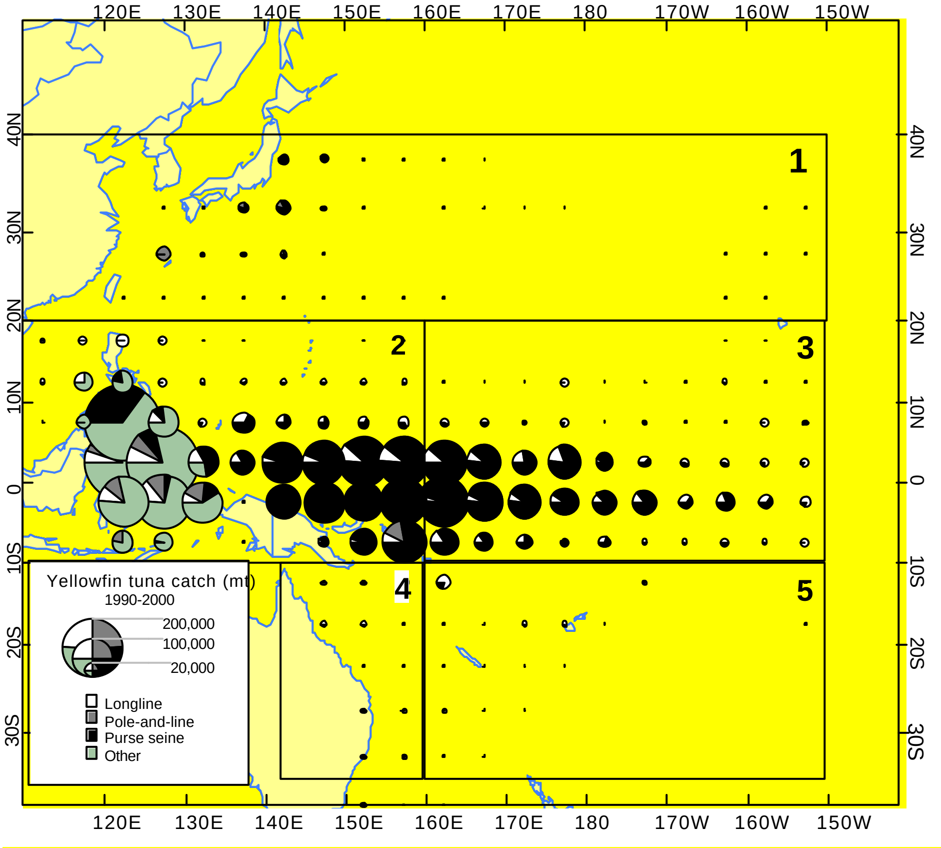

Figure 28. Distribution of yellowfin tuna catch, 1990-2000. The five-region spatial stratification used in stock assessment is shown.

3.2.2 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 29). School-set CPUE is strongly related to ENSO variation in the WCPO, with CPUE generally higher during El Niño episodes. This is believed to be related to increased catchability of yellowfin tuna due to a shallower surface mixed layer during these periods. ENSO variability is also believed to impact the size of yellowfin and other tuna stocks through impacts on recruitment. In line with this hypothesis, and as seen in previous *La Niña* years (1995–96), the yellowfin CPUE for 1999–2000 generally declined from the highs experienced in the *El Niño* years of 1997–98 (Figure 29). During 2001, the CPUE increased in line with the weakening of *La Niña*. Note also the consistency in yellowfin CPUE trends for all purse seine fleets since 1996 (except perhaps the Japanese fleet in recent years).

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

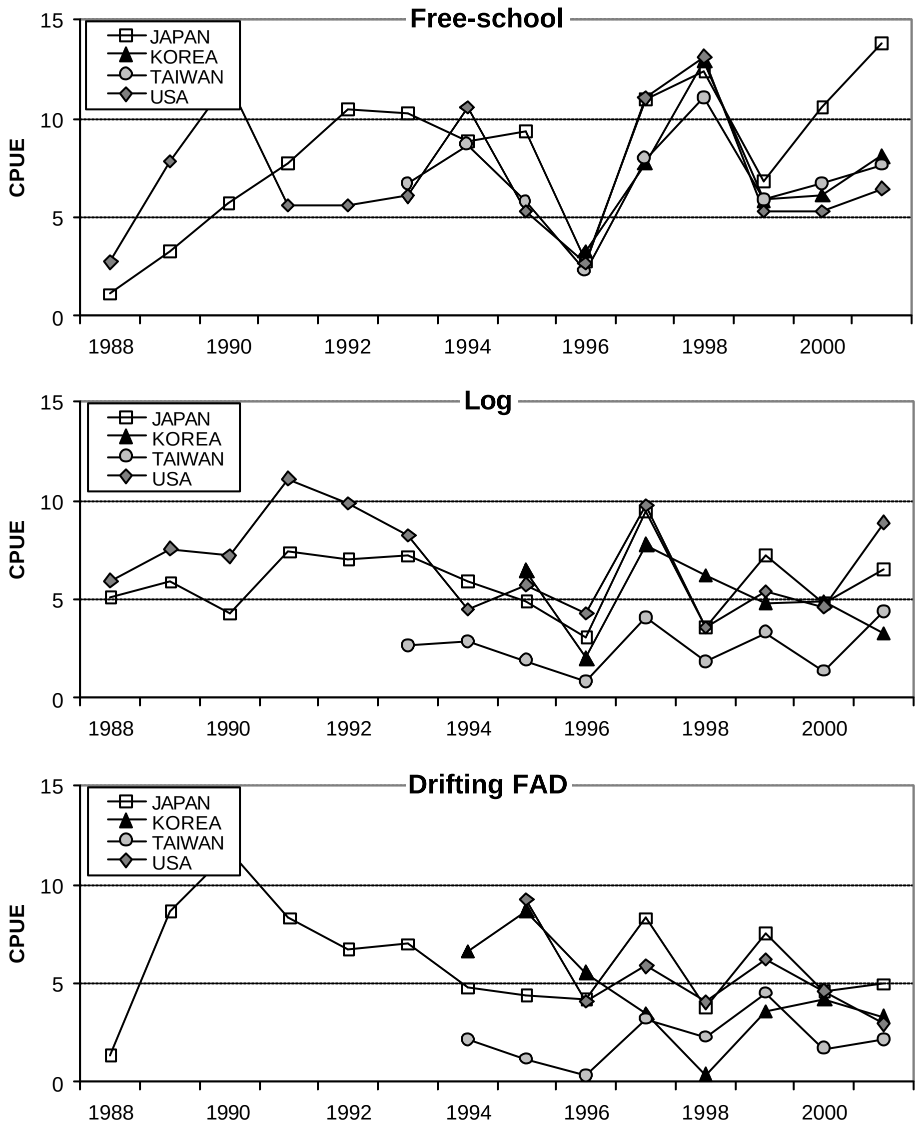

Figure 29. Yellowfin tuna CPUE (mt per day) by major set type categories (free-school, log and drifting FAD sets) for Japanese, Korean, Taiwanese and USA purse seiners fishing in the WCPO. Effort and CPUE were partitioned by set type according to the proportions of total sets attributed to each set type.

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) for the areas where yellowfin tuna are primarily taken by this fleet are shown in Figure 30. Nominal CPUE declined steadily 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 mid 1970s and 1998–1999. While standardised CPUE for 1999 is the lowest observed for about 25 years, they are not as low as those observed in the late 1960s to mid 1970s. Nevertheless, this indicator suggests that the portion of the yellowfin tuna population available to the longline fishery was recently at a relatively low level in 1999 but has seen some recovery in the past year or so. 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 30 may err on the optimistic side to some extent.

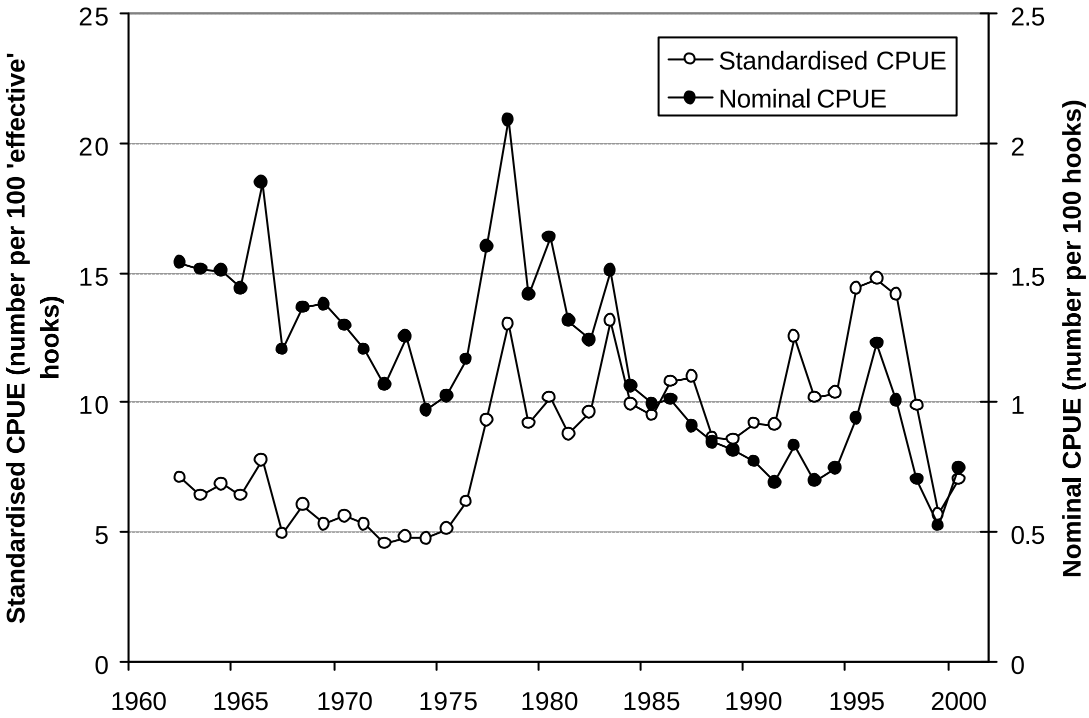

Figure 30. Nominal and standardised yellowfin tuna CPUE for Japanese distant-water longline vessels in the stock assessment areas 2 and 3 (see Figure 28).

3.2.3 Size of Fish Caught

Annual estimates of catch-at-size of yellowfin tuna in the WCPO are shown in Figure 31. The smallest yellowfin are taken in the Indonesian/Philippine domestic fisheries (handline, pole-and-line, purse seine and ringnet). Large yellowfin are targetted in the longline fishery, in purse seine school sets, and the handline fishery in the Philippines and Indonesia. Relatively smaller fish are caught in purse seine log 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. Interannual variability in the size of yellowfin taken exists in each fishery. For example, there were very few fish less than 100 cm in the catch from unassociated purse seine sets during 1998 compared to 1997 and 2001. The relatively high proportions of yellowfin taken from associated purse-seine sets during 1997, and again in 1999, correspond to years of strong recruitment, with the age class of fish taken in these years present as larger fish taken in unassociated purse seine sets in the following years (i.e. 1998 and 2000, respectively).

3.2.4 Stock Assessment

The most recent application of the MULTIFAN-CL model to yellowfin tuna in the WCPO was amended to a five-region analysis as shown in Figure 28. The time period covered by the analysis is 1962–2001. Catch, effort and size data (both length and weight frequency), stratified by quarter, for 15 fisheries (6 longline, 2 Philippine domestic, 1 Indonesian domestic, and 6 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 (2002b) (http://www.spc.int/OceanFish/Html/SCTB/SCTB15/yft-1.pdf).

Annual average fishing mortality rates for juvenile (< 100 cm) and adult yellowfin tuna for the WCPO as a whole are shown in Figure 32. Juvenile fishing mortality appears to have increased strongly since 1992 (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 at different time scales, but the main feature of the estimates is an increase in total recruitment during the late 1970s to early 1990s, followed by some decline (Figure 33).

The main feature of both the total and adult **biomass** estimates is a strong increase in the late 1970s and a decline since the mid-1990s (Figure 34). The decline would appear to be driven by the lower recruitments that have occurred in recent years, although higher fishing mortality has also contributed.

The impact of fishing on the total biomass has increased over time, as catches and fishing mortality have increased, and is estimated to be in the vicinity of 35% in recent years (Figure 35). The impact is differentially high in the tropical regions (around 50%) compared to the subtropical regions.

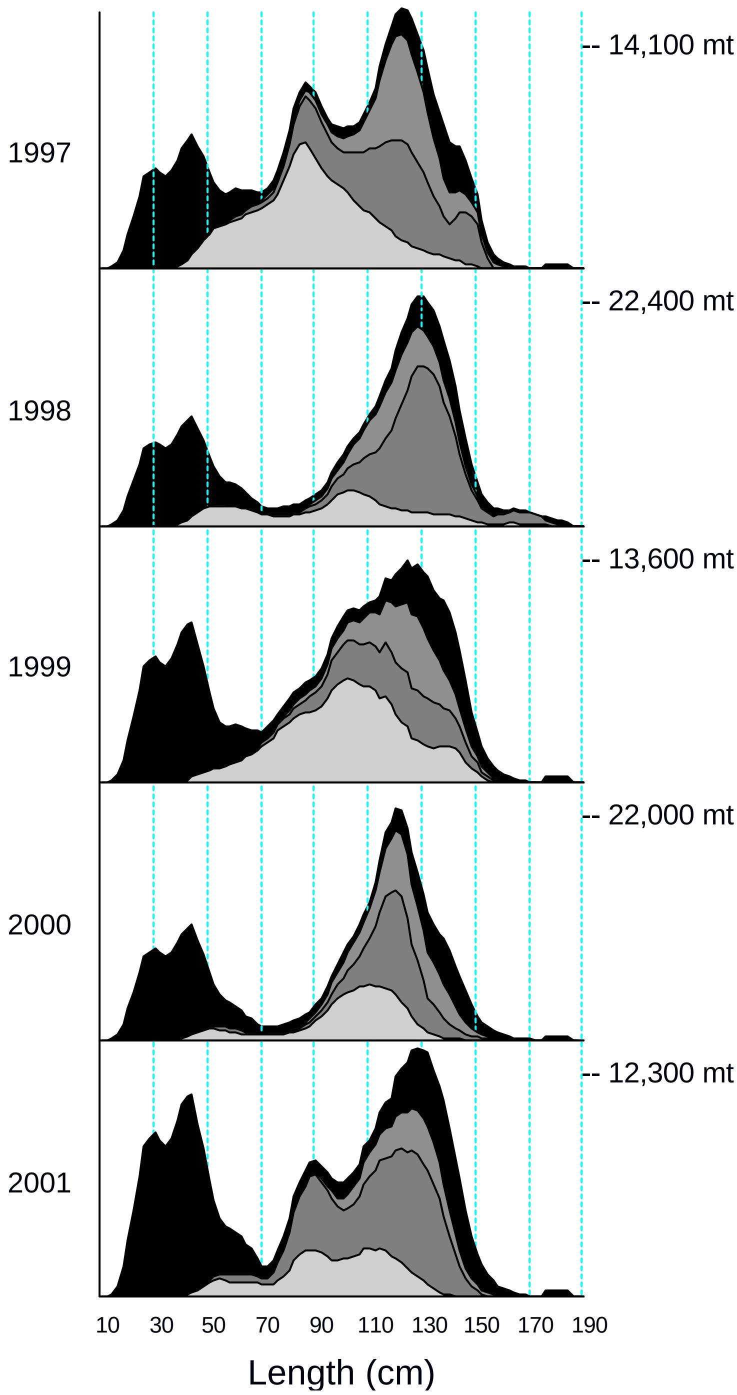

Figure 31. Annual Yellowfin tuna catch-at-size in the WCPO, 1997–2001. The catch is broken down into the Indonesian/Philippines domestic fisheries component (black), the longline fishery component (hatched), unassociated-set catch from the purse-seine fishery (grey) and associated-set catch from purse-seine fishery (dotted). The y-axis scale is in weight - the figures on the right indicate the catch weight in a 2-cm size class. (2001 data are provisional)

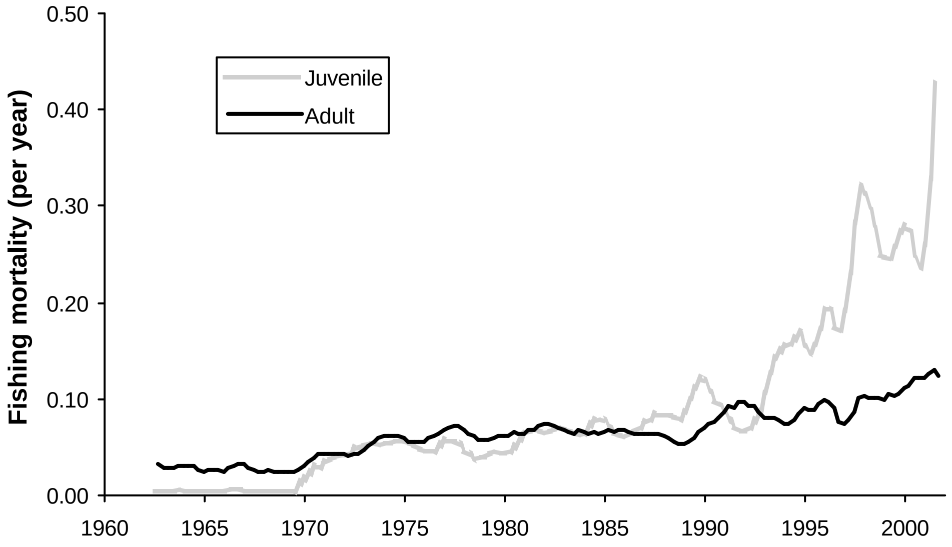

Figure 32. Estimated average annual fishing mortality rates for juvenile (< 100 cm) and adult yellowfin tuna.

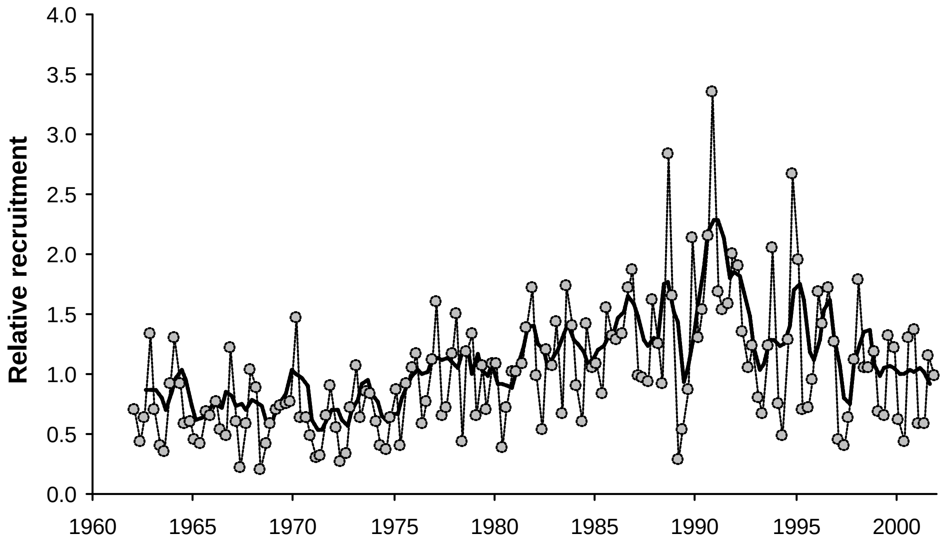

Figure 33. Estimated relative (scaled to the average) quarterly yellowfin tuna recruitment with a four-quarter moving average (solid line).

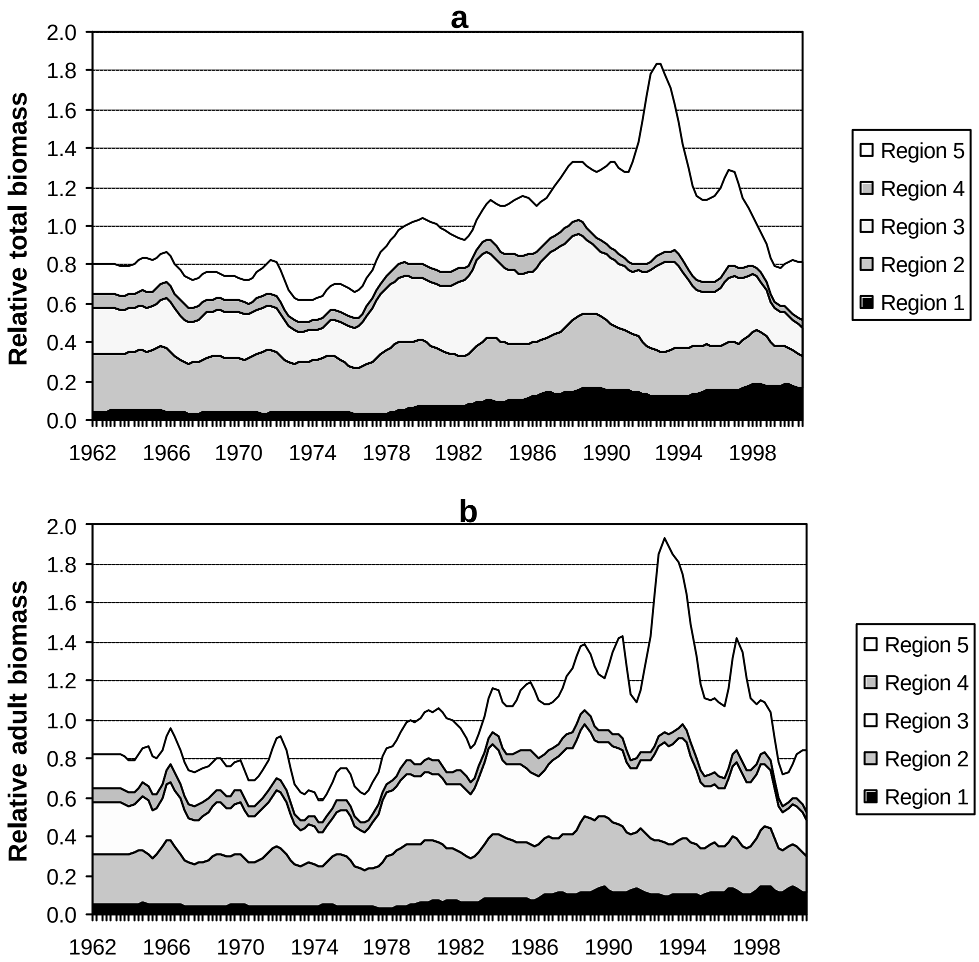

Figure 34. Estimated relative total (a) and adult (b) yellowfin tuna biomass, by region. Estimates are scaled to the average spatially aggregated biomass.

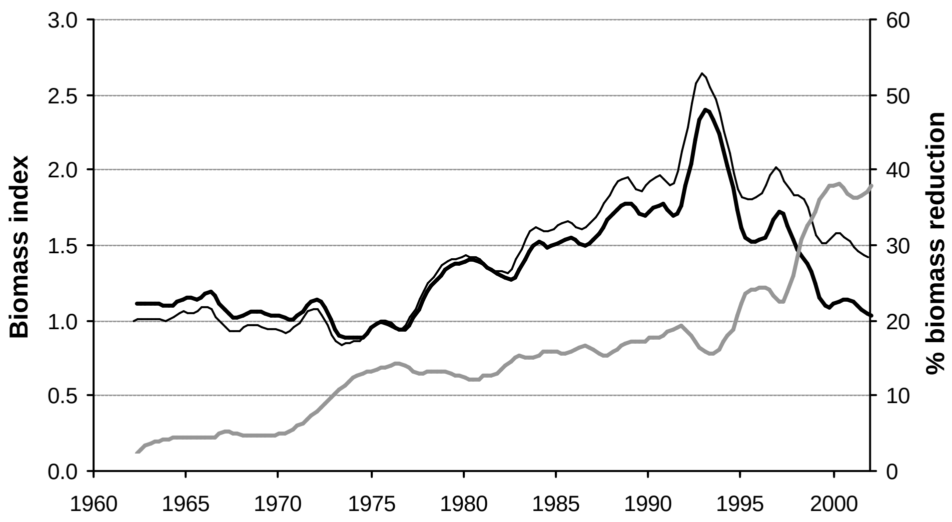

Figure 35. The estimated impact of fishing on yellowfin tuna biomass. The lower biomass trajectory (darkest line) represents the model estimates of total biomass. The upper trajectory is the estimated biomass that would have occurred in the absence of fishing assuming that recruitment was unaffected 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 to about 35% in 2001.

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 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.

3.3 Bigeye Tuna

3.3.1 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 2001 approaching US$1 billion.

Since 1980, the Pacific-wide longline catch of bigeye tuna has varied between 110,000 and 210,000 mt (Figure 36), 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 50,000–102,000 mt since 1980, exceeding 100,000 mt during 1986, but has fallen to below 40,000 mt in recent years (23,164 mt in 1999). In contrast, the longline catch has been typically 40,000–66,000 mt in the WCPO, the area west of 150°W, reaching a record high of 66,556 mt in 1998 (Figure 36).

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 prior to 1994, then to around 50,000 mt in both 1996 and 1997. There was a decline in catches during 1998 (around 35,000 mt), but there have been increases in recent years to a record level in 2000 (70,098 mt). The recent increases in the EPO catch resulted from fishing in largely new or previously lightly fished areas, with different fishing methods, that is the use of drifting 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. By 1997, this catch had increased to approximately 30,000 mt through the adoption of similar fishing techniques to those used in the EPO, before falling to 18,557 mt during 1998. In 1999, the bigeye catch was the highest ever, almost 35,000 mt, mainly as a result of increased fishing on drifting FADs. Since 1999, WCPO purse-seine bigeye catches have reduced primarily due to a progressive reduction in fishing on drifting FADs.

The total WCPO bigeye tuna catch in 1999 was a record 110,522 mt, and was only slightly less in both 2000 (106,540 mt) and 2001 (107,045 mt). The estimated total Pacific catch in 2001 (183,155 mt) was more than 20,000 mt down on the record high in 2000 (203,942 mt) primarily due to significant decreases in the WCPO and EPO purse seine catches. Figure 37 shows the spatial distribution of bigeye catch in the Pacific for the period 1990–2000. The majority of the WCPO catch is taken in equatorial areas, both by purse seine and longline, but with significant longline catch in some sub-tropical areas (east of Japan, east coast of Australia). In these equatorial areas, much of the longline catch is taken in the central Pacific, continuous with the important traditional bigeye longline area in the eastern Pacific, but just south of the Equator.

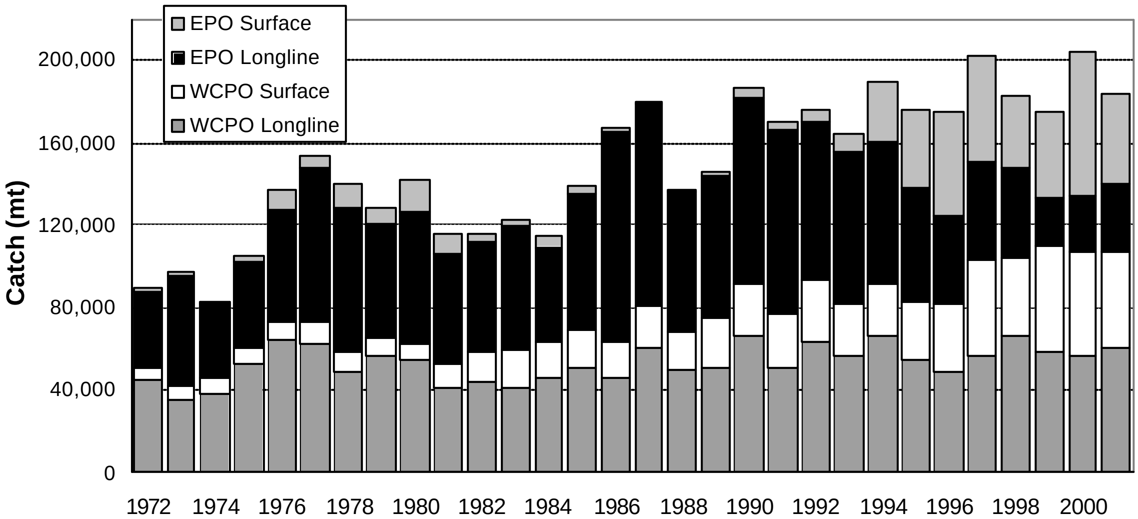

Figure 36. Bigeye tuna catch in the Pacific Ocean.

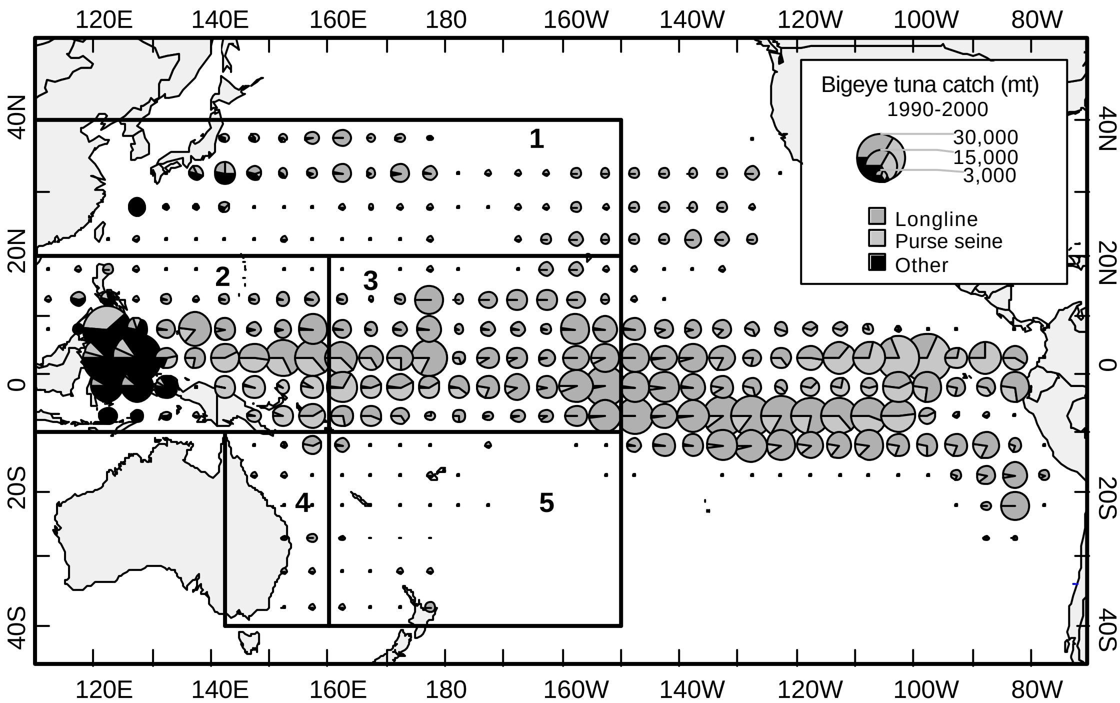

Figure 37. Distribution of bigeye tuna catch, 1990 - 2000. The five -region spatial stratification used in stock assessment for the WCPO is shown.

3.3.2 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 38). 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. (2002) 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 38. The standardised bigeye CPUE for the Japanese distant-water longline vessels for the tropical WCPO shows that despite no obvious trends in nominal CPUE, standardised CPUE can be divided into two distinct periods — the pre-1980 period, where the CPUE index was generally above 9 fish per 100 'effective hooks', and the post-1980 period, where the CPUE index was generally below 9 fish per 100 'effective hooks'. In the years prior to 1980 yellowfin was generally the preferred target species; after 1980 the fleet progressively moved to targetting bigeye in preference to yellowfin.

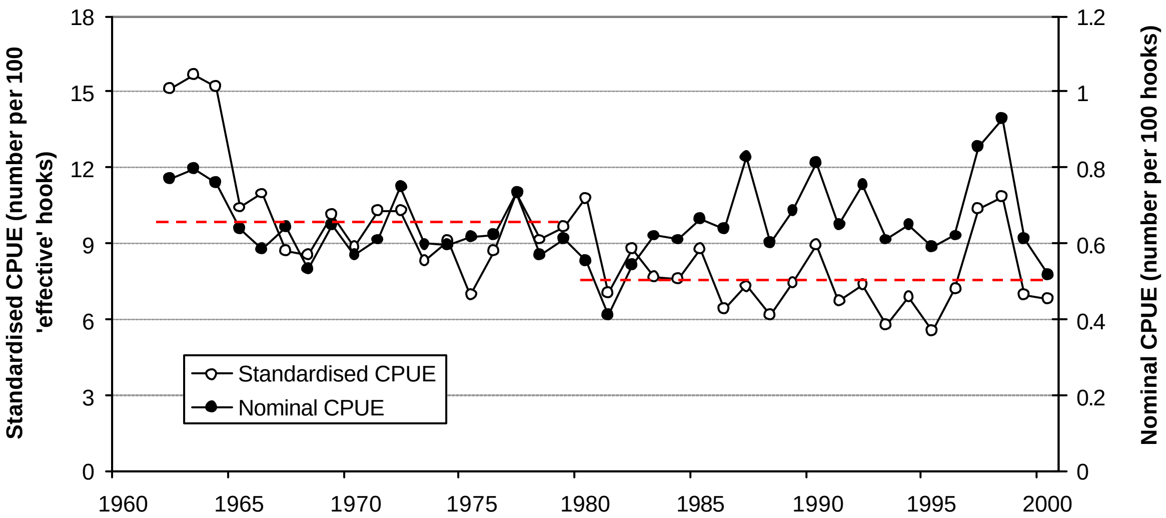

Figure 38. Standardised and nominal bigeye tuna CPUE by distant-water Japanese longliners fishing in stock assessment areas 2 and 3 (refer to Figure 37) in the WCPO. Dashed lines represent the pre-1980 and post-1980 averages of standardised CPUE).

3.3.3 Size of Fish Caught

Annual estimates of catch-at-size of bigeye tuna in the WCPO are shown in Figure 39. As with yellowfin and skipjack, the smallest bigeye are taken in the domestic fisheries of Indonesia and the Philippines. Elsewhere, juvenile bigeye tuna were predominantly caught in FAD and log sets in the purse seine fishery. In contrast to yellowfin tuna, very few bigeye tuna are taken in purse seine school sets (hardly visible in Figure 39), and there is little overlap between the purse seine and longline size compositions.

As with yellowfin tuna, interannual variability is evident in the sizes of bigeye tuna in each fishery. For example, different modes of approximately 57 cm, 75 cm and 93 cm are evident in the associated-set catch of bigeye in years 1998, 1999 and 2000, respectively (with an additional mode of 50 cm in 2000). The relatively higher proportion of bigeye taken by associated purse seine sets in 1997 and 1999 corresponds to stronger recruitment during those years.

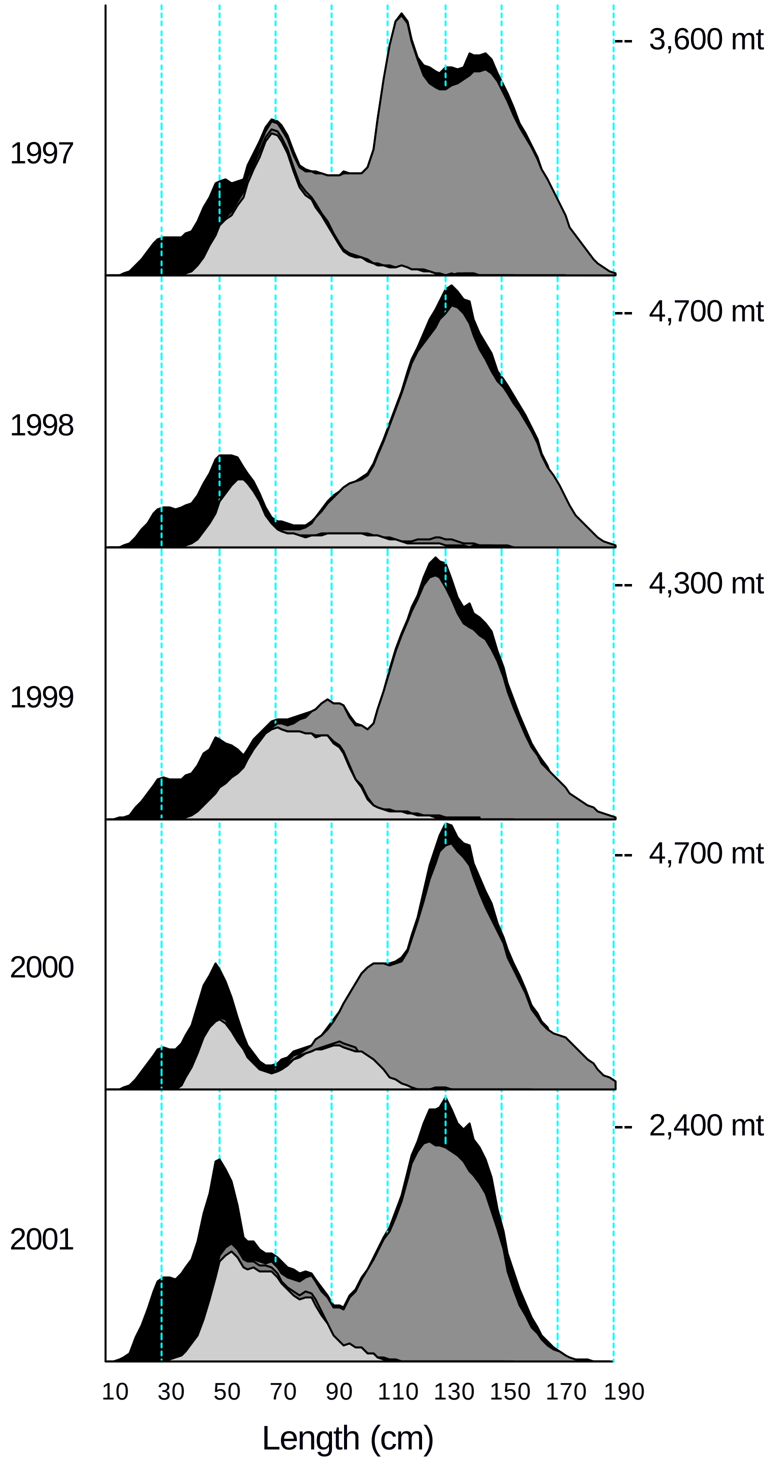

Figure 39. Annual bigeye tuna catch-at-size in the WCPO, 1997–2001. The catch is broken down into the Indonesian/Philippines domestic fisheries component (black), the longline fishery component (hatched), unassociated-set catch from the purse-seine fishery (grey) and associated-set catch from purse-seine fishery (dotted). The y-axis scale is in weight - the figures on the right indicate the catch weight in a 2-cm size class. (2001 data are provisional)

3.3.4 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. The analysis described here 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 1962–2001 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 37) has been adopted. Catch, effort and size data for 15 fisheries (6 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 is available in Hampton (2002c) (http://www.spc.int/OceanFish/Html/SCTB/SCTB15/bet-1.pdf).

Annual average **fishing mortality rates** for juvenile (< 100 cm) and adult bigeye tuna for the WCPO as a whole are shown in Figure 40. Fishing mortality for adults has increased steadily over the time series, flattening out after 1995. In contrast, juvenile fishing mortality has increased rapidly particularly since the early 1990s. A major factor in this increase has been the increase in assumed catches in Indonesia, which are based on yellowfin tuna catches reported by the Indonesian national authorities and an assumption (in the absence of sampling data) that these catches contain a fixed proportion of bigeye tuna. Increased purse seine catches, mainly using FAD sets, have also contributed to increased juvenile fishing mortality. Despite the recent increases, the estimated fishing mortality rates are still less than the corresponding average natural mortality rates for both groups (around 0.4–0.6 per year).

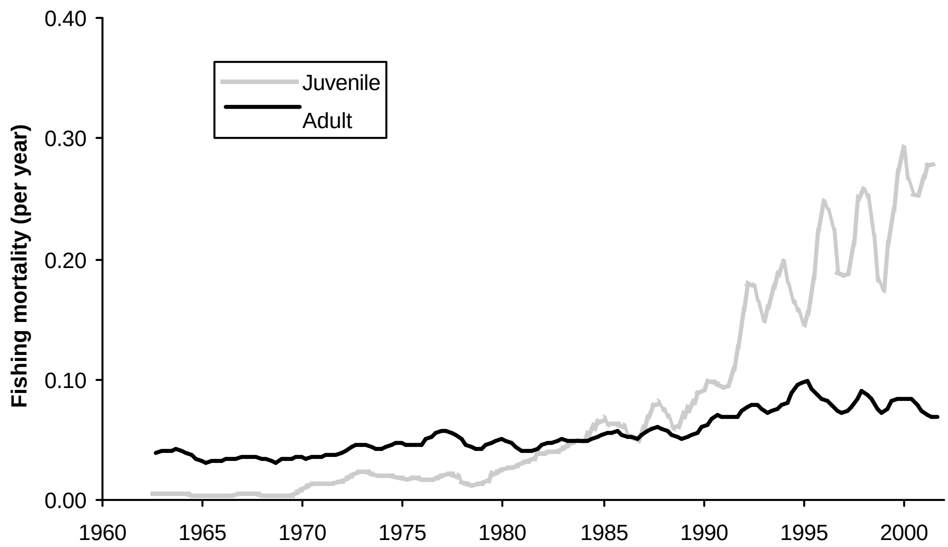

Figure 40. Estimated average annual fishing mortality rates for juvenile (< 100 cm) and adult bigeye tuna.

Recruitment estimates (Figure 41) 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, with some increase post-1995.

The time series of estimated relative total and adult **biomass** are shown in Figure 42. Both total and adult biomass have declined since the beginning of the time series. An increase in biomass is estimated after 1995, although this is attributed only to region 5.

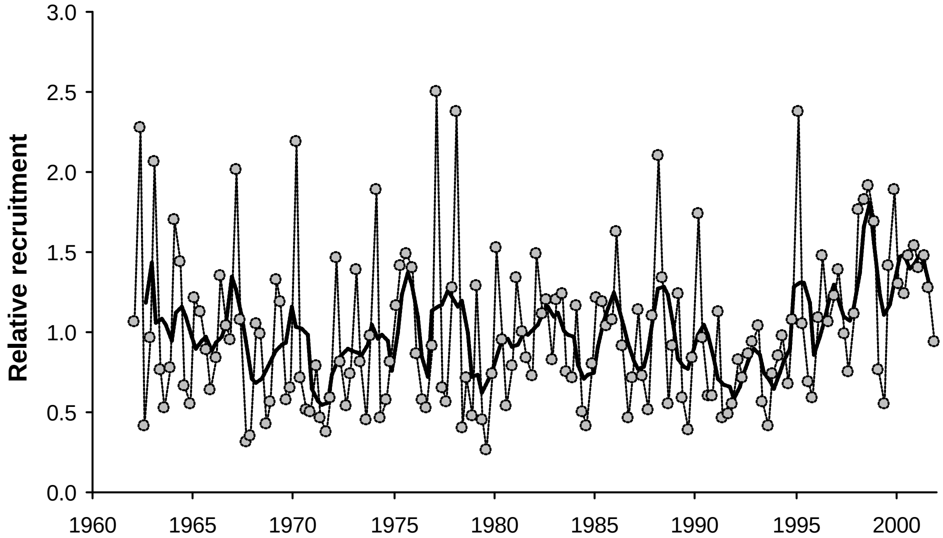

Figure 41. Estimated relative (scaled to the average) quarterly bigeye tuna recruitment with a four-quarter moving average (solid line).

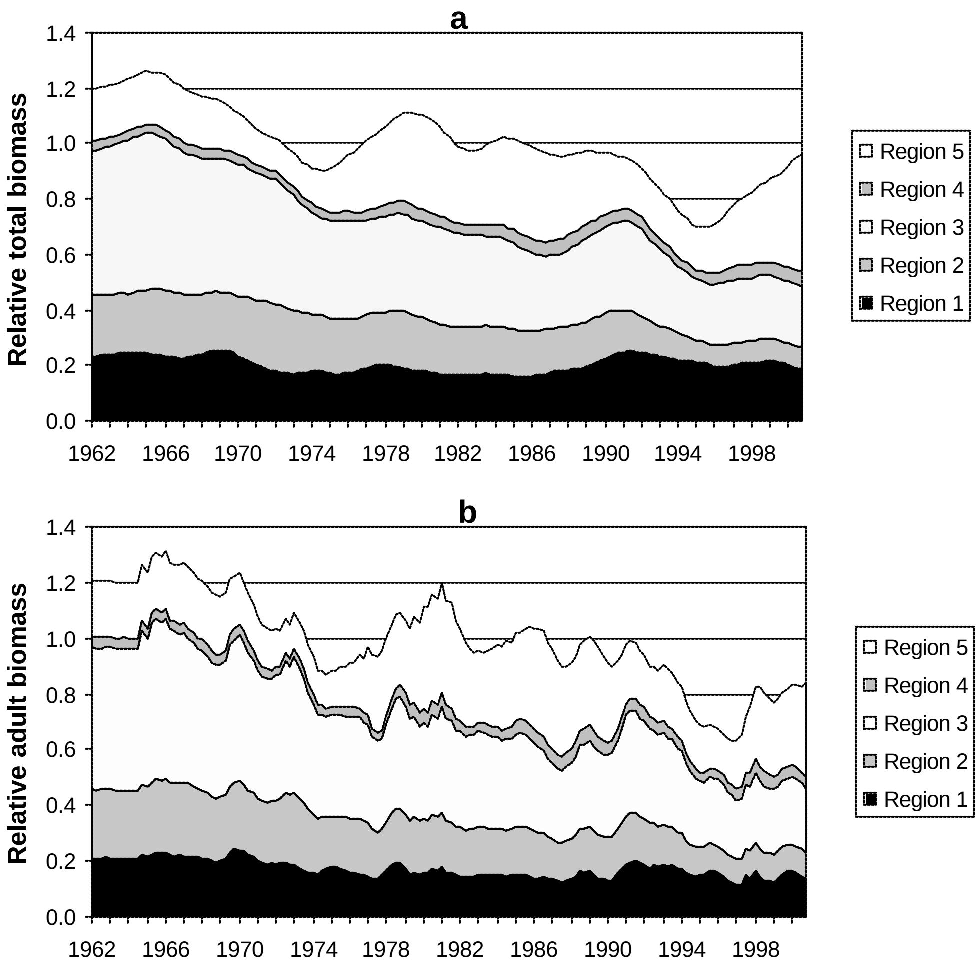

Figure 42. Estimated relative total (a) and adult (b) bigeye tuna biomass, by region. Estimates are scaled to the average spatially aggregated biomass.

The impact of fishing on the total biomass has increased over time as catches and fishing mortality have increased (Figure 43). The most recent biomass level is estimated to have been reduced by about 35% compared to the level it would have been in the absence of fishing. Impact is differentially high in the tropical regions compared to the northern and southern sub-tropical regions.

Conclusion

Bigeye tuna are demonstrably slower growing, longer lived, and, as a consequence, less resilient to fishing than skipjack and yellowfin tuna. Preliminary modelling results and fishery indicators suggest a decline in abundance occurred from the early 1960s until the mid-1990s. Post-1995 biomass is estimated to have risen, but this requires confirmation by future analyses.

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.

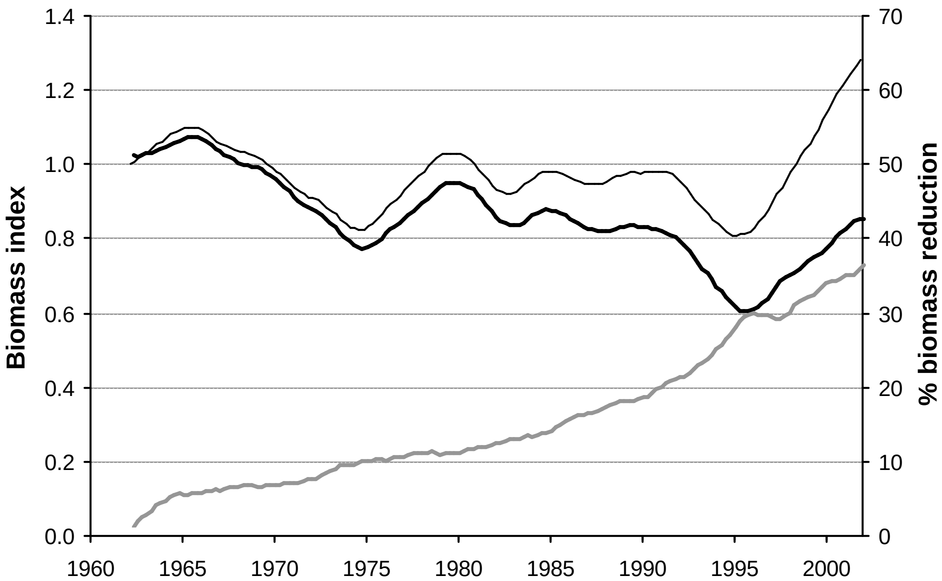

Figure 43. The estimated impact of fishing on bigeye tuna biomass in the WCPO. The lower biomass trajectory (darkest line) represent the model estimates of total biomass in each area. The upper trajectory is the estimated biomass that would have occurred in the absence of fishing assuming that recruitment was unaffected by fishing. The lower line plots the percentage biomass reduction due to fishing.

3.4 South Pacific Albacore Tuna

3.4.1 Catch

South Pacific albacore are exploited by a variety of longline fleets, by an international troll fleet operating seasonally in the region of the subtropical convergence zone (STCZ) and by a domestic troll fleet in New Zealand coastal waters. Throughout the 1990s, the longline catch in the South Pacific has been in the range of 23,000–40,000 mt, while the troll catch, for a season spanning November – April has been in the range 3,000–8,000 mt (Figure 44). The total catch during the 1990s ranged 33,000–46,000 mt, which was well below the peak estimated catch of 52,414 mt in 1989, when driftnet fishing was in existence. In 2001, the estimated total south Pacific albacore catch jumped to 51,473 mt, which is slightly less than the record attained in 1989 and mainly attributable to a record longline catch (45,708 mt). Less than 15% of the south Pacific albacore catch is usually taken east of 150°W (Figure 45). The WCPO albacore catch (116,627 mt in 2001) includes north Pacific catches (from the longline, pole-and-line and troll fisheries) and typically contributes around 80–90% of the Pacific catch of albacore.

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

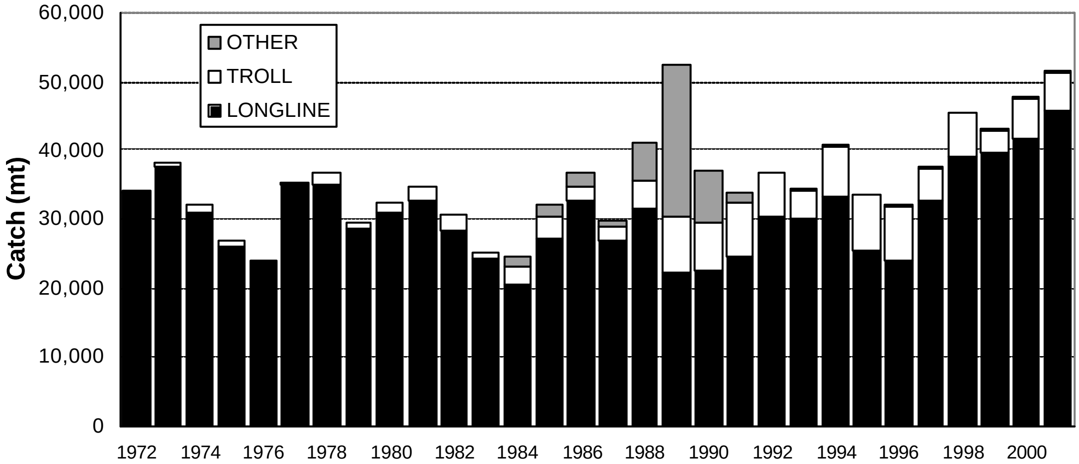

Figure 44. South Pacific albacore tuna catch, by gear. ('Other' is primarily catch by the driftnet fishery.)

The distant-water longline catch, primarily by Taiwanese longliners, is widely distributed in the South Pacific (Figure 45), but with catches concentrated in the western part of the region. Catches by domestic longline fleets in American Samoa, 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.

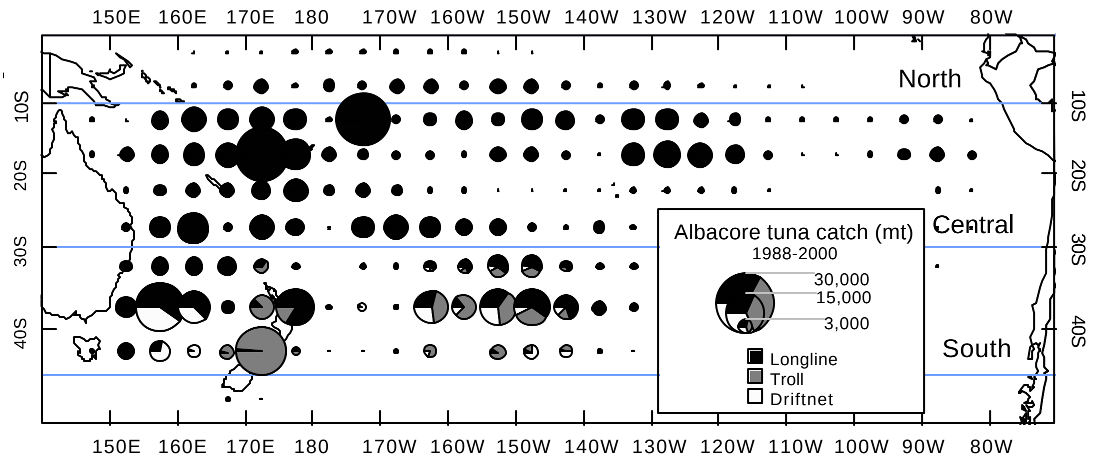

Figure 45. Distribution of South Pacific albacore tuna catch, 1988–2000. The three-region spatial stratification used in stock assessment is shown.

3.4.2 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 (STCZ and 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 46. 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 47). 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.

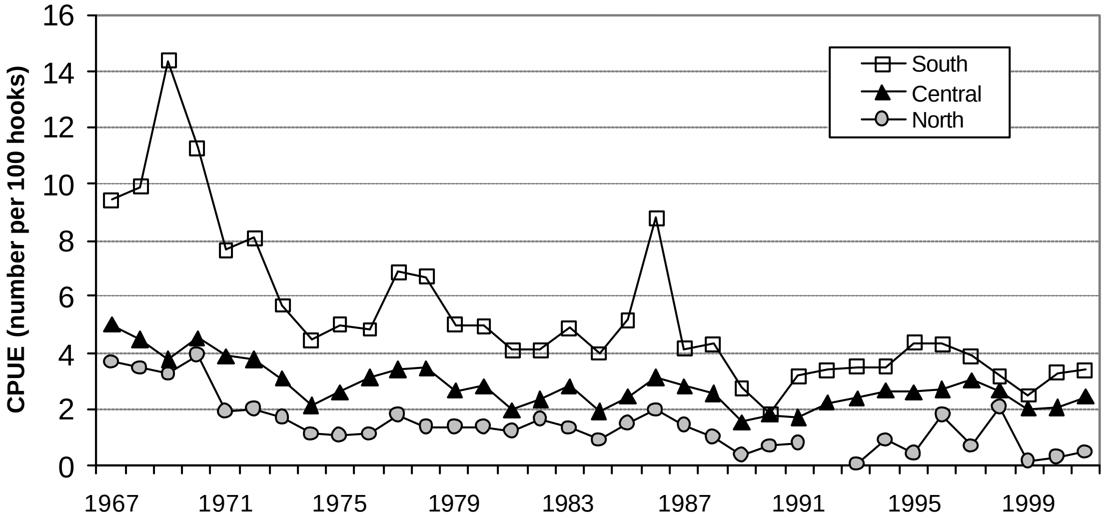

Figure 46. Nominal South Pacific albacore tuna CPUE for Taiwanese longliners. South = 30–50°S, central = 10–30°S, north = 0–10°S.

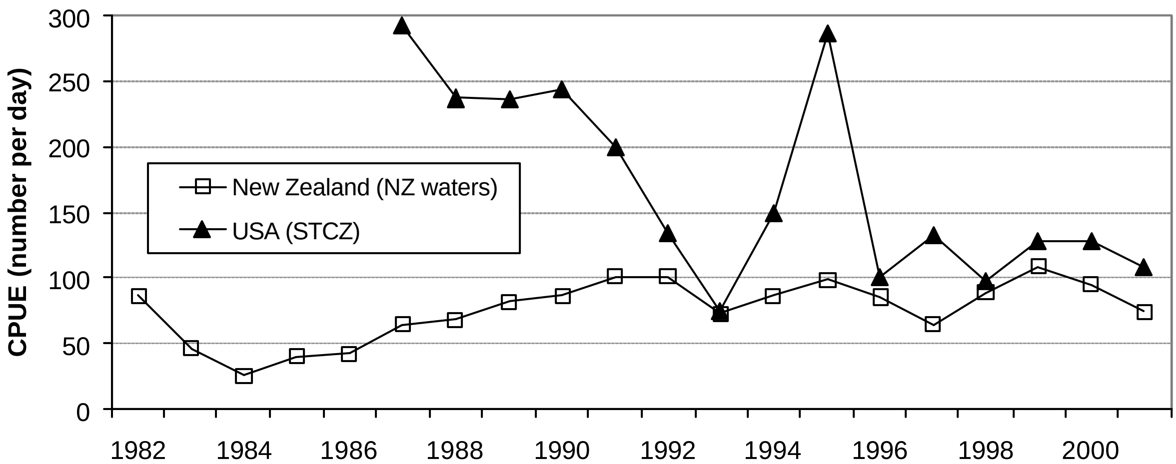

Figure 47. South Pacific albacore tuna CPUE for the New Zealand domestic troll fleet and the USA troll fleet operating east of 180° along the STCZ.

3.4.3 Size of Fish Caught

Estimated annual albacore tuna catch-at-size is shown in Figure 48 for the period 1997–2001. There are no noteworthy changes in the size distributions for the longline or surface components of the fishery.

3.4.4 Stock Assessment

The MULTIFAN-CL analysis considered fishery data from 1962 to 2001, 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 '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 13 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 is available in Hampton (2002d) (http://www.spc.int/OceanFish/Html/SCTB/SCTB15/alb-1.pdf).

Average annual **fishing mortality rates** for juvenile (< 85 cm) and adult albacore tuna are shown in Figure 49. 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. The decline in the final year is a result of incomplete data. In fact, catches of adult albacore are known to have increased significantly in 2001 as a result of developments in Pacific Island longline fleets. 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 50) 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 51. Biomass declined to historic lows in the late 1980s and recovered to some extent during the 1990s. The estimated ratio of recent biomass to the equilibrium unexploited biomass is about 0.85.

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 52). 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.

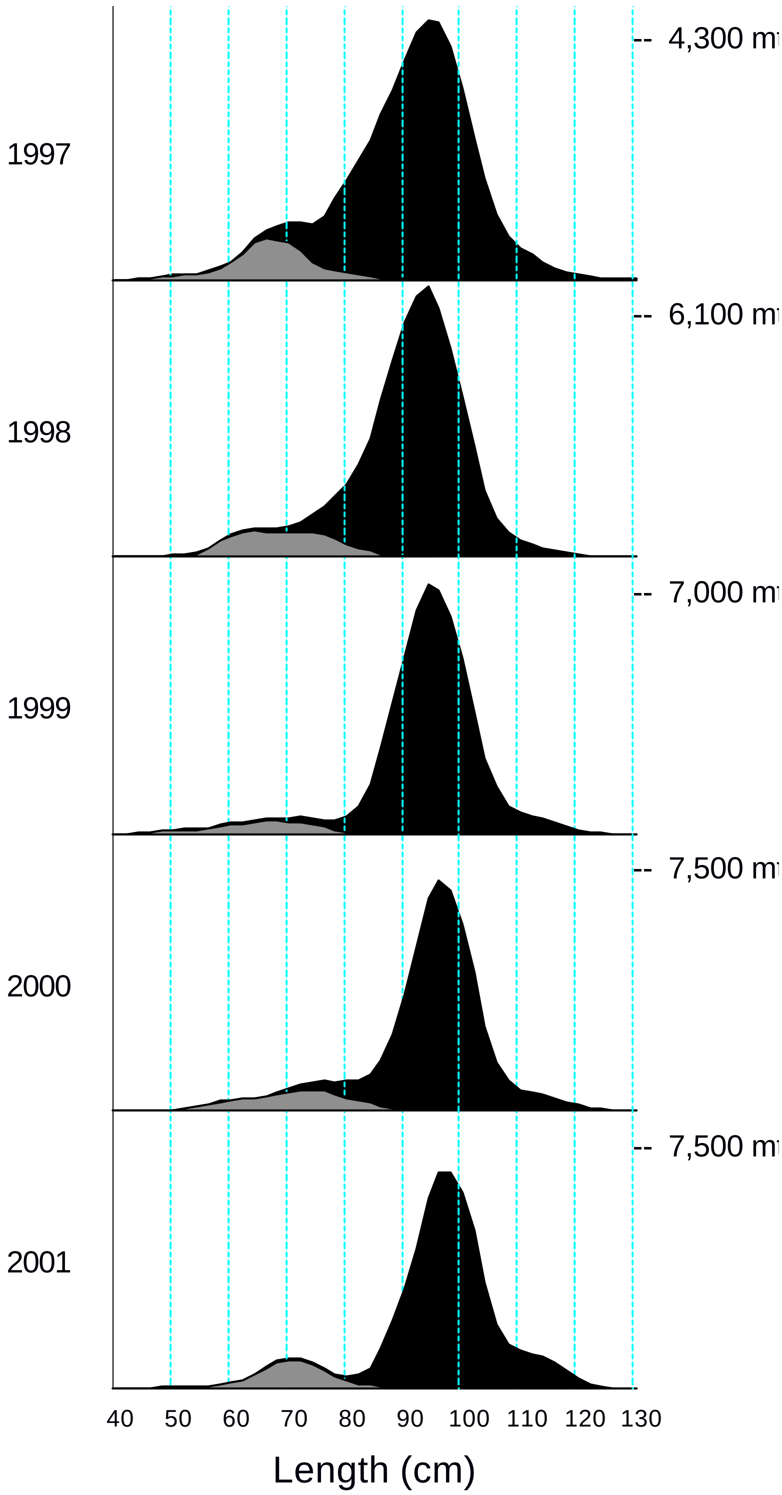

Figure 48. Annual south Pacific albacore tuna catch-at-size in the WCPO, 1997–2001. The catch is broken down the longline fishery component (black) and the troll fishery component (hatched). The y-axis scale is in weight - the figures on the right indicate the catch weight in a 2-cm size class. (2001 data are provisional)

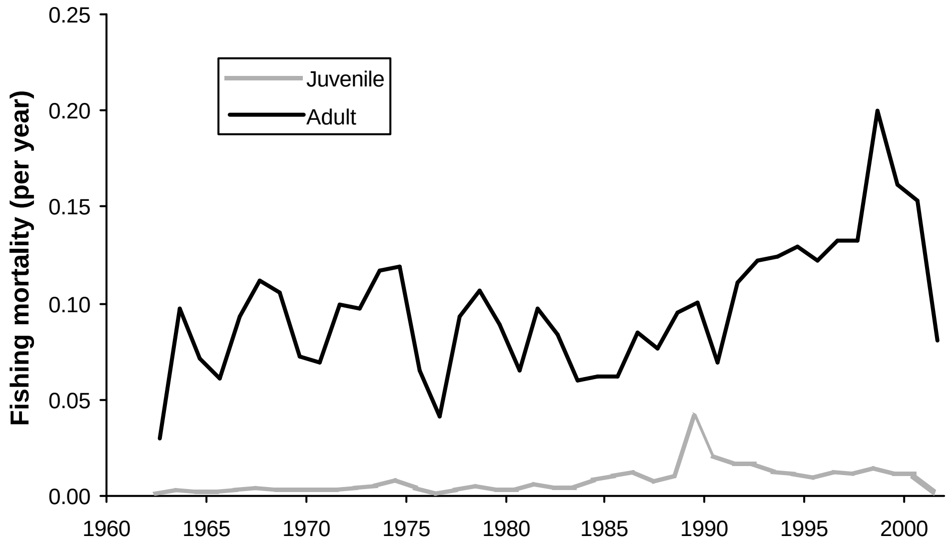

Figure 49. Estimated average annual fishing mortality rates for juvenile (< 85 cm) and adult South Pacific albacore tuna.

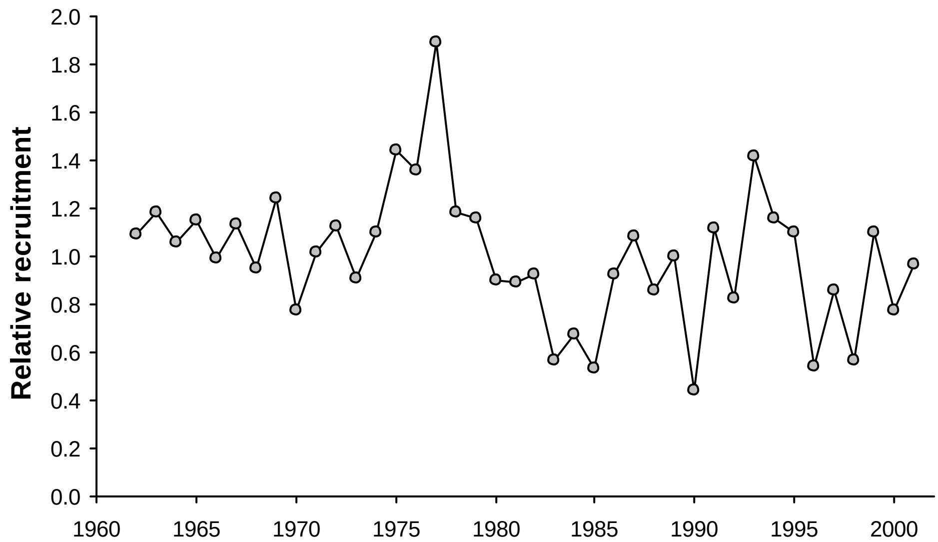

Figure 50. Estimated relative (scaled to the average) annual South Pacific albacore tuna recruitment.

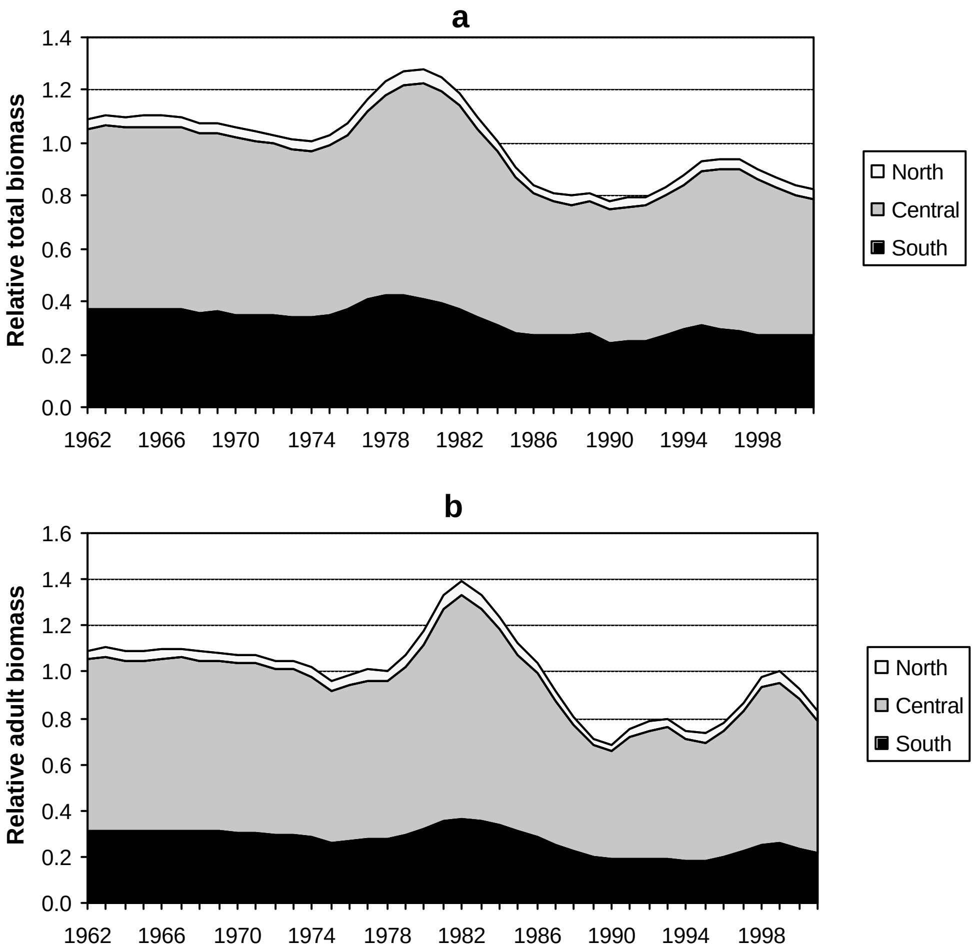

Figure 51. Estimated relative total (a) and adult (b) South Pacific albacore tuna biomass, by region. Estimates are scaled to the average spatially aggregated biomass.

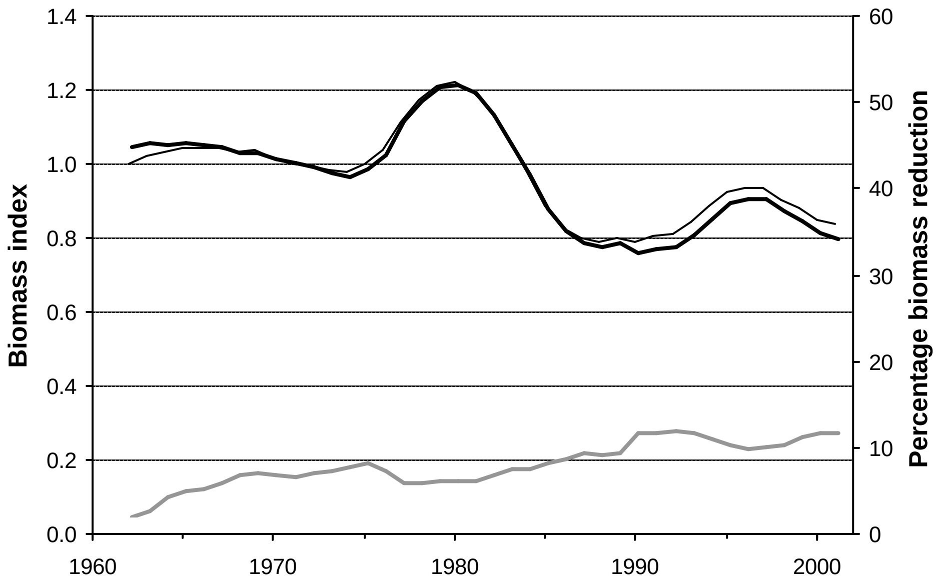

Figure 52. The estimated impact of fishing on South Pacific albacore tuna biomass. The lower biomass trajectory (darkest line) represents the model estimates of total biomass. The upper trajectory is the estimated biomass that would have occurred in the absence of fishing assuming that recruitment was unaffected by fishing. The lower line plots the percentage biomass reduction due to fishing.

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