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The Western and Central Pacific Tuna Fishery 1999

Overview and Status of Stocks

John Hampton, Antony Lewis and Peter Williams

Oceanic Fisheries Programme

Tuna Fisheries Assessment Report N° 2

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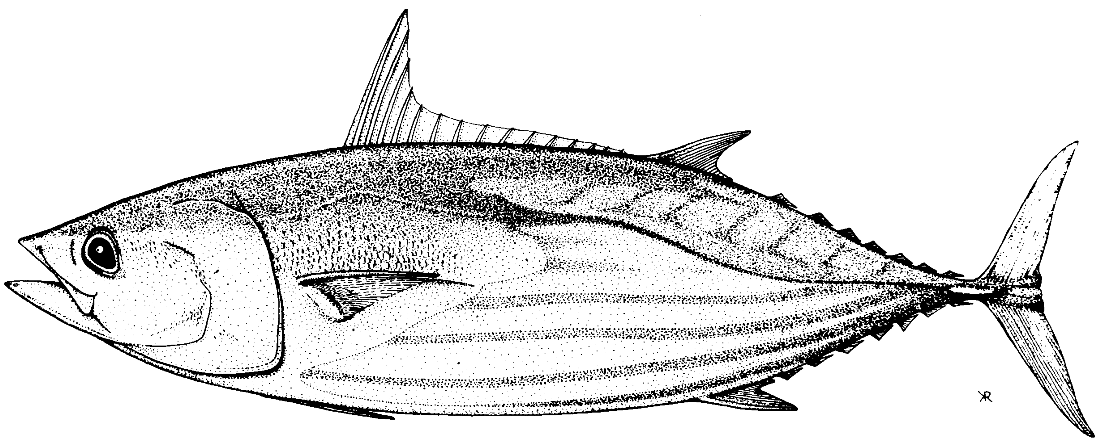
John Hampton, Antony Lewis and Peter Williams



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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, that are impacted by them. This report focuses on the main tuna stocks targeted by the fishery — skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*) and South Pacific albacore tuna (*T. alalunga*).

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

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Further information, including a complete French version of this report, is available on 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 :

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

Abstract

Overview of the Western and Central Pacific Tuna Fishery

The tuna fishery in the western and central Pacific Ocean (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 catches have been relatively stable since 1991, after steady increases during the 1980s. The 1999 catch is estimated at 1,718,776 metric tonnes (mt), a decrease of almost 200,000 mt on the 1998 catch. The purse-seine fishery accounted for an estimated 60% of the total catch, pole-and-line 17%, and longline 11%, with the remainder (12%) taken by troll gear and a variety of artisanal gears, mostly in eastern Indonesia and the Philippines. The 1999 tuna catch represented 72% of the total estimated Pacific Ocean catch of 2,380,271 mt, and 48% of the provisional estimate of world tuna catch (3,571,114 mt).

The 1999 catch featured a continuation of high skipjack tuna catches (1,101,617 mt; 64% of the total). The yellowfin tuna catch (396,747 mt; 23%) was down slightly on the 1998 level, while the bigeye tuna catch (105,365 mt; 6%) was an all-time record. The albacore tuna (North and South Pacific) catch in 1999 (115,047 mt; 7%) was slightly below the recent highs in 1997 and 1998.

The 1999 **purse-seine** catch of 1,033,967 mt was about 170,000 mt lower than the 1998 record catch, but was still the second-highest ever despite the prevailing unfavourable economic conditions in the fishery — historically low prices for part of the year resulted in some voluntary effort reduction. Skipjack tuna (780,853 mt; 76%) continued to be the basis of the fishery, but was down approximately 150,000 mt from the record 1998 catch. The yellowfin tuna catch (218,177 mt; 21%) showed a 40,000 mt decrease on the 1998 catch, but the bigeye tuna catch (34,937 mt; 3%) was a record for the western and central Pacific. The Japanese, Korean and Taiwanese fleets all had substantial reductions in catch in 1999, while the United States fleet recorded a slight increase. Pacific Island domestic purse-seine fleets contributed 126,000 mt, 12% of the 1999 purse-seine catch, with the Vanuatu and Solomon Islands fleets recording significant increases over their 1998 catches.

The 1999 **pole-and-line** catch of 285,747 mt showed a slight increase from the 1998 level and accounted for 17% of the total WCPO catch. As in previous years, skipjack tuna comprised the vast majority of the catch (84%); albacore tuna taken by the Japanese coastal and offshore fleets in the temperate waters of the North Pacific (10%), yellowfin tuna (5%) and a small component of bigeye tuna (1%) made up the remainder of the catch. By fleet, the Japanese distant-water and offshore fleet (135,800 mt provisional) and the Indonesian fleet (90,125 mt provisional) accounted for most of the catch; the Solomon Island fleet accounted for 30,520 mt.

The 1999 **longline** catch of 185,077 mt accounted for only 11% of the total western and central Pacific catch, but rivals the much larger purse-seine catch in terms of catch value. The 1999 catch represented a marginal decrease on the 1998 catch of 193,172 mt. The species composition of the 1999 longline catch was 28% yellowfin tuna, 41% albacore tuna and 30% bigeye tuna, but these values vary markedly by area and fleet. As in previous years, most of the 1999 catch was taken by the large-vessel, distant-water fleets of Japan, Korea and Taiwan. 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. In contrast, the offshore fleets from Japan, mainland China and Taiwan and the domestic fleets of Pacific Island countries are restricted to tropical waters and target bigeye and yellowfin tuna for the fresh-sashimi market.

The 1999 **troll** catch of South Pacific albacore tuna (3,641 mt) was the lowest in over ten years. As in previous years, catch and effort were concentrated in two main areas — in coastal waters around New Zealand, and in the central Pacific in the vicinity of the sub-tropical convergence.

Status of Tuna Stocks

Skipjack Tuna

The available fishery indicators (catch per unit of effort and size data) suggest that, while skipjack tuna stock biomass in the western and central Pacific shows considerable inter-annual variation, the fisheries have had little impact. The analyses of tag-recapture data, which indicate exploitation rates in the early 1990s in the vicinity of 0.20, are consistent with this interpretation of the fishery data. The preliminary application of the MULTIFAN-CL assessment model gave results generally consistent with the fishery indicators and tag-based assessment, but in addition indicated that fishing mortality may have increased significantly since the early 1990s, particularly in the tropical region west of 165°W. Nevertheless, the overall estimates of recent fishing mortality-at-age are 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. This preliminary analysis will be refined in the future by expanding the geographic scope of the analysis to cover the entire stock range and including additional tagging and fisheries data from the North Pacific.

Yellowfin Tuna

Catch per unit of effort and size-based fishery indicators are mostly stable, indicating that fishery performance has been sustained over a long period of time. The possible exception to this is the decline in standardised longline CPUE in 1997 and 1998. 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. In addition, fishing mortality rates are estimated to have increased recently, particularly for juvenile yellowfin tuna. This increase is at least partly due to increased catchability, probably resulting from the now widespread use of deployed FADs by purse seiners. The impact of fishing on the stock is therefore estimated to have increased strongly in recent years, from a 20–25% impact on biomass in the early 1990s to a 50% impact in 1999. If the MULTIFAN-CL estimates are accurate, the WCPO yellowfin tuna stock is probably close to fully exploited at present. At the same time, we should note that these most recent estimates are subject to high uncertainty, particularly in view of the lack of longline fishery data for 1999. Data for the years 1999 and 2000 are urgently required from all fisheries to update this assessment.

Bigeye Tuna

Bigeye tuna are demonstrably slower growing, longer lived, and, as a consequence, less resilient to fishing than skipjack and yellowfin tuna. The results of limited tagging in the early 1990s indicated that bigeye tuna exploitation rates at that time were at least as great as those for skipjack and yellowfin tuna. Preliminary estimates of relative stock abundance from standardised longline CPUE indicate a decline in abundance during the late 1970s in the EPO and a decline since 1990 in the WCPO, with current levels of longline exploitable abundance at around half the levels that existed in the early years of the fishery. A preliminary Pacific-wide analysis using the MULTIFAN-CL model has provided additional information on population trends and the impacts of fishing. For the WCPO, recruitment is estimated to have fallen in the 1990s and is currently at a low level. At the same time, catches and fishing mortality of juvenile bigeye in particular have increased. If these conditions persist in the coming years, further declines in the stock would be predicted. Management intervention will likely be required if this occurs. Further MULTIFAN-CL analyses planned in 2001 using updated longline data should provide more information on recent trends in the stock.

South Pacific Albacore Tuna

Fishery indicators and the MULTIFAN-CL analysis both suggest that the South Pacific albacore tuna stock declined significantly from the mid-1970s to early 1990s. This decline in stock biomass is attributed to a sharp downward shift in recruitment in the mid-1970s, which may have been related to a large-scale climatic regime shift. The partial recovery of longline CPUE indicators and stock biomass during the 1990s may indicate a return to higher recruitment levels. One hypothesis concerning the relationship between recruitment and oceanographic conditions predicts that recruitment may increase further over the next few years. The impact of the fishery on the stock is estimated to be very small, although this is to some extent a reflection of the low tag-recovery rate for albacore. The 2001 assessment will investigate the impact of the tagging data and assumptions regarding tag-reporting rates on the analysis results.

Résumé

Bilan de la pêche thonière dans le Pacifique occidental et central

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

Les prises annuelles sont demeurées relativement stables depuis 1991, après avoir augmenté régulièrement au cours des années 80. La prise de 1999 est estimée à 1 718 776 tonnes, soit une diminution de près de 200 000 tonnes par rapport à la prise de 1998. La pêche à la senne a représenté environ 60 pour cent du total des prises, celle à la canne 17 pour cent et celle à la palangre 11 pour cent; les 12 pour cent qui restent ont été réalisés à la traîne et par divers engins artisanaux, principalement en Indonésie orientale et aux Philippines. La prise de thon de 1999 a constitué 72 pour cent du total estimé des prises dans l'océan Pacifique, qui atteignaient 2 380 271 tonnes, et 48 pour cent de la prise mondiale de thon, estimée provisoirement à 3 571 114 tonnes.

La prise de bonite en 1999 est demeurée à un niveau élevé et a atteint 1101 617 tonnes, soit 64 pour cent du total des prises. La prise de thon jaune (396 747 tonnes, 23% du total) accuse un léger recul par rapport à celle de 1998, tandis que la prise de thon obèse atteint le chiffre record de 105 365 tonnes (6% du total). La prise de germon (Pacifique Nord et Sud), qui a atteint 115 047 tonnes (7% du total), accuse une légère baisse par rapport aux chiffres records de 1997 et 1998.

En 1999, les prises des **senneurs** de 1 033 967 tonnes, ont été de 170 000 tonnes inférieures à la prise record de 1998, tout en restant en deuxième position malgré les conditions économiques défavorables qu'ont subies les pêcheries. Les prix n'ayant jamais été aussi bas, pendant une partie de l'année, ont contraint les senneurs à réduire délibérément leur effort de pêche. Cette activité reste fondée sur la pêche de bonite (780 853 tonnes, 76% du total), malgré une diminution de 150 000 tonnes environ par rapport au chiffre record de 1998. La prise de thon jaune (218 177 tonnes, 21%) a accusé une baisse de 40 000 tonnes par rapport à la prise de 1998. Par contre, celle de thon obèse (34 937 tonnes, 3%) a battu un record pour le Pacifique occidental et central. Les flottilles japonaise, coréenne et taiwanaise ont subi de fortes diminutions des prises en 1999, tandis que celle des États-Unis d'Amérique a enregistré une légère augmentation. Les prises des flottilles nationales océaniennes de senneurs se sont élevées à 126 000 tonnes, soit 12 pour cent des prises des senneurs de 1999, celles des flottilles de Vanuatu et des Îles Salomon étant nettement supérieures à leurs prises de 1998.

En 1999, les prises **à la canne**, avec 285 747 tonnes, ont affiché une légère augmentation par rapport à celles de 1998 et représenté 17 pour cent du total dans l'océan Pacifique occidental et central. Comme les années précédentes, la bonite a représenté la vaste majorité des prises (84%); le germon pris par les flottilles côtières et hauturières du Japon dans les eaux tempérées du Pacifique Nord (10%), le thon jaune (5%) et une faible proportion de thon obèse (1%) ont représenté le reste. Si l'on effectue la ventilation par flottille, la flottille japonaise pratiquant la pêche hauturière et au large et la flottille indonésienne ont réalisé la majorité des prises, estimées provisoirement à 135 800 et 90 125 tonnes respectivement; la flottille des Îles Salomon a réalisé des prises de 30 520 tonnes.

Les prises de 1999 réalisées par les flottilles de **palangriers**, soit 185 077 tonnes, n'ont représenté que 11 pour cent du total dans le Pacifique occidental et central, mais, sur le plan de la valeur marchande, elles rivalisent avec celles des senneurs, pourtant bien plus importantes. Les prises de 1999 ont représenté une diminution minime par rapport à celles de 1998 qui atteignaient 193 172 tonnes. La composition par espèce des prises réalisées à la palangre en 1999 a été de 28 pour cent de thon jaune, 41 pour cent de germon et 30 pour cent de thon obèse, mais ces pourcentages varient fortement selon la région et la flottille. Comme les années passées, la majeure partie des prises de 1999 a été réalisée par les

flottilles du Japon, de la Corée et de Taiwan pratiquant la pêche hauturière et composées de navires de grande taille. 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 de haute mer du Japon, de la Chine continentale et de Taiwan, et les flottilles nationales des États et territoires océaniens, par contre, se limitent aux eaux tropicales et ciblent le thon obèse et le thon jaune pour le marché du *sashimi* frais.

En 1999, la prise à la **traîne** de germon du sud (3 641 tonnes) a été la plus faible réalisée ces dix dernières années. Comme les années précédentes, les prises et l'effort se sont concentrés dans deux principales zones : les eaux côtières entourant la Nouvelle-Zélande et le Pacifique central aux abords de la convergence subtropicale.

État des stocks de thonidés

Bonite

Les indicateurs de pêche dont nous disposons (prises par unité d'effort et données morphométriques) 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'y exerce qu'une faible influence. Les analyses des données obtenues grâce à la récupération des marques, qui indiquent que les taux d'exploitation au début des années 90 se situaient aux environs de 0,20, corroborent cette interprétation des données halieutiques. L'évaluation préliminaire réalisée à l'aide du modèle MULTIFAN-CL a donné des résultats qui confirment généralement les indicateurs et l'évaluation faite au moyen des marques, mais qui indiquent en outre que la mortalité due à la pêche a probablement beaucoup augmenté depuis le début des années 90, en particulier dans la région tropicale, à l'ouest de 165° de longitude est. Néanmoins, 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. Pour affiner cette première analyse, il faudra en étendre la couverture géographique de manière à prendre en compte la totalité du stock et à inclure les données halieutiques et celles issues du marquage relatives au Pacifique Nord.

Thon jaune

D'après les indicateurs de l'état de la pêcherie fondés sur les prises par unité d'effort et la taille, stables dans l'ensemble, le rendement de la pêche est resté constant pendant une longue période. La seule exception éventuelle à cette constatation est la diminution des PUE normalisées de la pêche à la palangre en 1997 et en 1998. Les estimations des prises et d'effort effectifs des palangriers influent considérablement sur les résultats de l'analyse au moyen de MULTIFAN-CL. Celle-ci fait en effet apparaître une diminution de la biomasse et du recrutement, au cours de ces dernières années, ce qui corrobore la récente baisse des PUE des palangriers. En outre, les taux de mortalité due à la pêche auraient récemment augmenté, d'après les estimations, en particulier celui du thon jaune juvénile. Cette augmentation s'explique, en partie du moins, par les moyens accrus de capture, associés probablement à l'emploi désormais étendu des DCP mouillés par les senneurs. On estime donc que l'impact de la pêche sur les stocks a fortement augmenté ces dernières années, passant de 20–25 pour cent sur la biomasse au début des années 90 à 50 pour cent en 1999. Si les estimations effectuées grâce au modèle MULTIFAN-CL sont exactes, le stock de thon jaune dans le Pacifique occidental et central est probablement près d'être totalement exploité à présent. Cependant, il convient de noter que les estimations les plus récentes sont sujettes à caution, notamment en l'absence de données sur la pêche à la palangre en 1999. Il faudrait obtenir d'urgence les données de 1999 et 2000 relatives à l'ensemble des pêcheries pour actualiser cette évaluation.

Thon obèse

Le thon obèse a sans conteste une croissance plus lente et une plus grande longévité et, par conséquent, il est plus vulnérable à la pêche que la bonite et le thon jaune. Les quelques marquages, qui ont été faits au début des années 90, indiquaient que les taux d'exploitation du thon obèse étaient à l'époque au moins aussi élevés que ceux de la bonite et du thon jaune. Des estimations préliminaires de l'abondance relative du stock à partir de données normalisées sur les prises par unité d'effort à la palangre indiquent qu'il y a eu diminution de l'abondance à la fin des années 70 dans le Pacifique oriental et un déclin depuis les années 90 dans le Pacifique occidental et central, le niveau actuel d'abondance du stock exploitable à la palangre équivalant à la moitié environ de celui qui existait au commencement de cette pêche. Une analyse préliminaire faite sur l'ensemble du Pacifique à l'aide du modèle MULTIFAN-CL a fourni des informations complémentaires sur l'évolution du stock et les effets de la pêche. Pour ce qui est du Pacifique occidental et central, on estime que le recrutement a chuté au cours des années 90 et qu'il est faible à présent. En même temps, les prises et la mortalité du fait de la pêche, celle du thon obèse juvénile en particulier, ont augmenté. Si ces conditions perdurent au cours des prochaines années, on peut prévoir que le stock continuera de s'amenuiser. Si tel est le cas, il s'avérera probablement nécessaire d'intervenir dans la gestion des stocks. D'autres analyses prévues en 2001 à l'aide du modèle MULTIFAN-CL, et prenant en compte des données actualisées sur la pêche à la palangre, devraient fournir des précisions sur l'évolution récente du stock.

Germon du Sud

Les indicateurs de l'état de la pêcherie et les résultats de l'analyse MULTIFAN-CL laissent craindre que le stock de germon du sud n'ait fortement décliné à partir du milieu des années 70 jusqu'au début des années 90. Cette diminution de la biomasse du stock est attribuée à une chute brutale du recrutement au milieu des années 70, qui a peut-être été liée à une modification à grande échelle du régime climatique. Le redressement partiel des indices de prises par unité d'effort à la palangre et de la biomasse du stock au cours des années 90 signale peut-être un retour à des niveaux de recrutement plus élevés. Selon une hypothèse concernant les relations existant entre le recrutement et les conditions océanographiques, le recrutement pourrait encore augmenter au cours des prochaines années. L'impact de la pêche sur le stock est estimé très faible bien que, cette estimation ne soit peut-être fondée, dans une certaine mesure, que sur le faible taux de récupération des marques pour le germon. L'évaluation de 2001 consistera, entre autres, à étudier l'impact des données issues du marquage et des hypothèses concernant les taux de récupération sur les résultats de l'analyse.

Table of Contents

1 Introduction....1
2 Total Catch in the Western and Central Pacific Ocean....1
3 Tuna Fishery by Gear Type....3
3.1 Purse Seine....3
3.1.1 Overview....3
3.1.2 Recent Developments....4
3.2 Pole and Line....8
3.2.1 Overview....8
3.2.2 Recent Developments....8
3.3 Longline....9
3.3.1 Overview....9
3.3.2 Recent Developments....11
3.4 Troll....12
3.4.1 Overview....12
3.4.2 Recent Developments....13
4 Status of Tuna Stocks....13
4.1 Skipjack Tuna....14
4.1.1 Catch....14
4.1.2 Catch Per Unit of Effort....15
4.1.3 Size of Fish Caught....17
4.1.4 Stock Assessment....18
4.2 Yellowfin Tuna....22
4.2.1 Catch....22
4.2.2 Catch Per Unit of Effort....23
4.2.3 Size of Fish Caught....27
4.2.4 Stock Assessment....29
4.3 Bigeye Tuna....32
4.3.1 Catch....32
4.3.2 Catch Per Unit of Effort....33
4.3.3 Size of Fish Caught....35
4.3.4 Stock Assessment....35
4.4 South Pacific Albacore Tuna....39
4.4.1 Catch....39
4.4.2 Catch Per Unit of Effort....41
4.4.3 Size of Fish Caught....42
4.4.4 Stock Assessment....42
5 References....45

List of Figures

Figure 1. The western and central Pacific Ocean and the eastern Pacific Ocean 1
Figure 2. Annual total catch of skipjack, yellowfin, bigeye and albacore tuna, by fishing method, in the WCPO 2
Figure 3. Annual total catch, by species, in the WCPO 2
Figure 4. Number of purse-seine vessels operating in the WCPO 3
Figure 5. Purse-seine catch of skipjack, yellowfin and bigeye tuna in the WCPO 4
Figure 6. Time series showing the percentage of total sets by school type for the major purse-seine fleets operating in the WCPO 5
Figure 7. Distribution of 1998 and 1999 regional purse-seine effort by quarter 6
Figure 8. Distribution of purse-seine effort, 1995–1999 7
Figure 9. Pole-and-line vessels operating in the WCPO 8
Figure 10. Pole-and-line catch in the WCPO 9
Figure 11. Average distribution of WCPO pole-and-line effort, 1991–1997 9
Figure 12. Longline catch in the WCPO 10
Figure 13. Longline vessels operating in the WCPO 10
Figure 14. Distribution of distant-water longline effort and offshore and domestic longline effort during 1998 11
Figure 15. Distribution of longline catch, by species, during 1998 12
Figure 16. Troll catch of albacore tuna in the South Pacific Ocean 13
Figure 17. Distribution of South Pacific albacore tuna troll fishery effort during 1997 13
Figure 18. WCPO skipjack tuna catch, by gear 14
Figure 19. Distribution of skipjack tuna catch, 1990–1998 15
Figure 20. Nominal skipjack tuna CPUE by major set type categories for Japanese and USA purse seiners fishing in the WCPO 16
Figure 21. Nominal skipjack tuna CPUE for Solomon Islands pole-and-line vessels 17
Figure 22. Nominal and standardised skipjack tuna CPUE for Japanese distant-water pole-and-line vessels 17
Figure 23. Mean and upper 95th percentile lengths of skipjack tuna sampled from purse-seine catches 18
Figure 24. Estimated annual skipjack tuna fishing mortality rates for the WCPO, by age groups 20
Figure 25. Estimated relative quarterly skipjack tuna recruitment with a four-quarter moving average 21
Figure 26. Estimated relative total and adult skipjack tuna biomass, by area 21
Figure 27. The estimated impact of fishing on skipjack tuna biomass 22
Figure 28. WCPO yellowfin tuna catch, by gear 23
Figure 29. Distribution of yellowfin tuna catch, 1990–1999 24
Figure 30. Nominal yellowfin tuna CPUE by major set type categories for Japanese and USA purse seiners fishing in the WCPO 25
Figure 31. Nominal and standardised yellowfin tuna CPUE for distant-water longline vessels in the WCPO 26
Figure 32. The seven areas used to compile yellowfin tuna size data 27

Figure 33. Mean and upper 95th percentile lengths of yellowfin tuna sampled from longline catches in the seven regions shown in Figure 32 28
Figure 34. Estimated annual yellowfin tuna fishing mortality rates for the WCPO, by age groups 30
Figure 35. Estimated relative quarterly yellowfin tuna recruitment with a four-quarter moving average 30
Figure 36. Estimated relative total and adult yellowfin tuna biomass, by area 31
Figure 37. The estimated impact of fishing on yellowfin tuna biomass 31
Figure 38. Bigeye tuna catch in the Pacific Ocean 33
Figure 39. Distribution of bigeye tuna catch, 1990–1999 33
Figure 40. Standardised and nominal bigeye tuna CPUE by distant-water longliners 34
Figure 41. Mean and upper 95th percentile lengths of bigeye tuna sampled from longline catches in the WCPO 35
Figure 42. Estimated annual bigeye tuna fishing mortality rates for the WCPO and EPO, by age groups 36
Figure 43. Estimated relative quarterly bigeye tuna recruitment with a four-quarter moving average for the WCPO and the EPO 37
Figure 44. Estimated relative total and adult bigeye tuna biomass, for the WCPO and EPO 38
Figure 45. The estimated impact of fishing on bigeye tuna biomass in the WCPO and the EPO 39
Figure 46. South Pacific albacore tuna catch, by gear 40
Figure 47. Distribution of South Pacific albacore tuna catch, 1988–1996 40
Figure 48. Nominal South Pacific albacore tuna CPUE for Taiwanese longliners 41
Figure 49. Nominal South Pacific albacore tuna CPUE for the New Zealand troll fleet and the USA troll fleet 41
Figure 50. Mean and upper 95th percentile lengths of South Pacific albacore tuna sampled from longline catches 42
Figure 51. Estimated average annual fishing mortality rates for juvenile and adult South Pacific albacore tuna 43
Figure 52. Estimated relative annual South Pacific albacore tuna recruitment 44
Figure 53. Estimated South Pacific albacore tuna relative biomass by region 44

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
IATTC	Inter-American Tropical Tuna Commission
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
SOI	Southern Oscillation Index
SPC	Secretariat of the Pacific Community
SSAP	Skipjack Survey and Assessment Programme
STCZ	sub-tropical convergence zone
WCPO	western and central Pacific Ocean

1 Introduction

The tuna fishery in the western and central Pacific Ocean (WCPO) is diverse, ranging from small-scale, artisanal operations in the coastal waters of Pacific states, to large-scale, industrial purse-seine, pole-and-line and longline operations both in the exclusive economic zones of Pacific states and on the high seas. The main species targeted by these fisheries are skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*) and albacore tuna (*T. alalunga*).

In this report, we provide an overview of the fisheries, with emphasis on recent developments, 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 1999 Tuna Fishery Yearbook (Lawson 2000), and on material presented at the July 2000 13th meeting of the Standing Committee on Tuna and Billfish (SCTB), held in Noumea, New Caledonia (see the SCTB homepage at http://www.spc.int/oceanfish/).

2 Total Catch in the Western and Central Pacific Ocean

While each of the tuna stocks is distributed throughout the tropical and temperate waters of the Pacific Ocean, the 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 the 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).

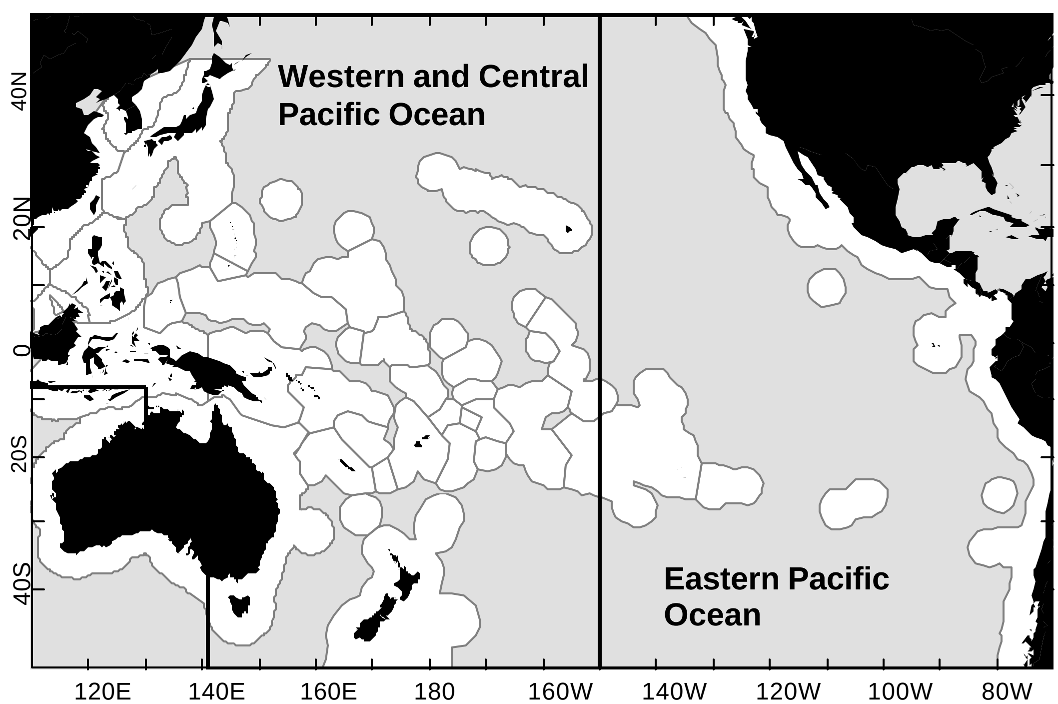

Figure 1. The western and central Pacific Ocean and the eastern Pacific Ocean.

Total annual catches of the four main tuna species (skipjack, yellowfin, bigeye and albacore tuna) in the WCPO have been relatively stable since 1991 (Figures 2 and 3). The total WCPO catch of tunas during 1999 was estimated at 1,718,776 mt, the second highest annual catch recorded after 1998 (1,900,290 mt). The purse-seine fishery accounted for an estimated 1,033,967 mt (60% of the total catch), the pole-and-line fishery an estimated 285,747 mt (17%), and the longline fishery an estimated 185,077 mt (11%), with the remainder (12%) taken by troll gear and a variety of artisanal gears, mostly in eastern Indonesia and the Philippines (Figure 2). The 1999 WCPO tuna catch represented 72% of the total estimated Pacific Ocean catch of 2,380,271 mt in 1999, and 48% of the provisional estimate of world tuna catch (3,571,114 mt) of the four species.

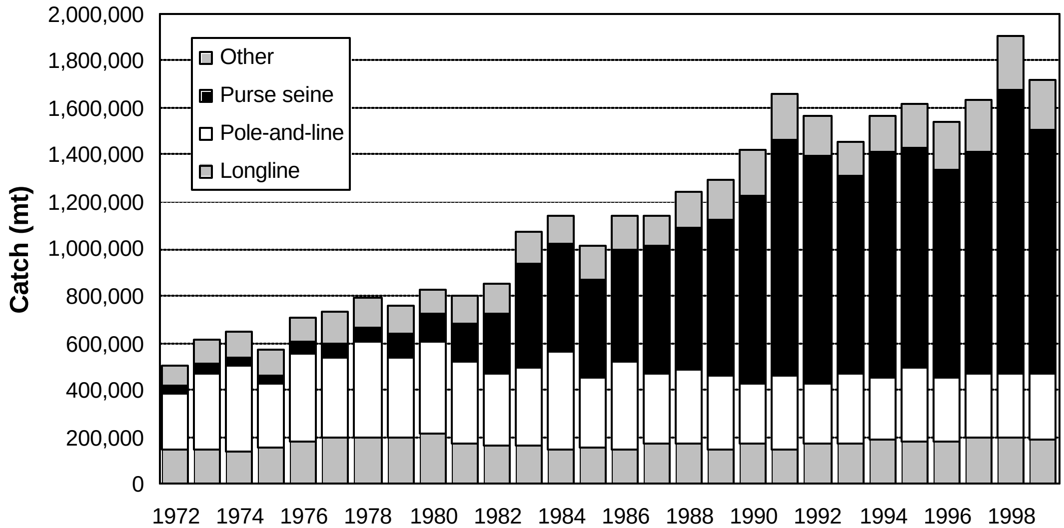

Figure 2. Annual total catch of skipjack, yellowfin, bigeye and albacore tuna, by fishing method, in the WCPO.

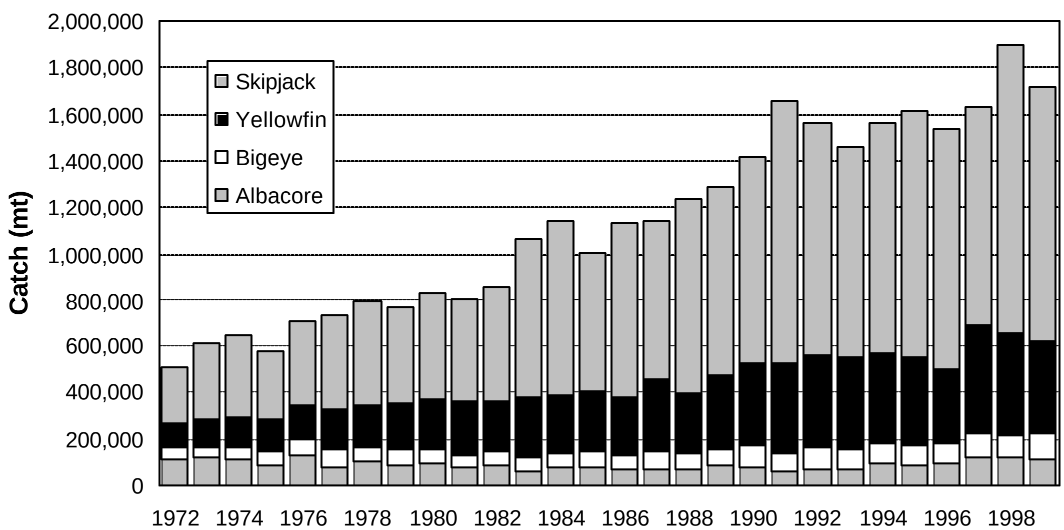

Figure 3. Annual total catch, by species, in the WCPO.

The 1999 catch by species (Figure 3) was dominated, as usual, by skipjack tuna (1,101,617 mt; 64% of the total tuna catch), but was slightly down on the record level of the previous year (1,244,349 mt). Yellowfin tuna (396,747 mt; 23%) and albacore tuna[1] (115,047 mt; 7%) catches were also slightly down on the 1998 levels, but the bigeye tuna catch (105,365 mt; 6%) was a record high, eclipsing the previous record catch taken in 1997 (103,886 mt).

[1] Includes catches of North and South Pacific albacore tuna west of 150°W, which comprised 89% of the total Pacific Ocean albacore tuna catch of 130,000 mt in 1999.

3 Tuna Fishery by Gear Type

3.1 Purse Seine

3.1.1 Overview

The purse-seine fishery has accounted for around 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 is taken by the four main distant-water fishing fleets (Japan, Korea, Taiwan and USA) but with an increasing contribution from the growing number of Pacific Islands domestic vessels (Figure 4) in recent years. Skipjack tuna regularly account for 70–75% of the purse-seine catch: the WCPO purse-seine fishery is essentially a skipjack fishery, unlike those of other ocean areas. The purse-seine catches in recent years have been the highest ever — the WCPO record was established in 1998 (1,206,267 mt), with the second highest taken in 1999 (1,033,967 mt), despite the prevailing unfavourable economic conditions in the fishery, with historically low prices for part of the year, and some voluntary effort reduction.

Features of the purse-seine fishery during the past decade have been:

- Annual skipjack tuna catches fluctuating between 600,000 and 700,000 mt until the sharp increases with the 1998 and 1999 catches;
- Increases in the proportion of yellowfin tuna in the catch during El Niño years (Figure 5), and sharp reductions during La Niña years (1995/96 and to a lesser extent 1998/1999);
- A sharp increase in the use of drifting FADs since 1996, resulting in record bigeye tuna purse-seine catches, first in 1997 (31,337 mt) and then again in 1999 (34,937 mt).

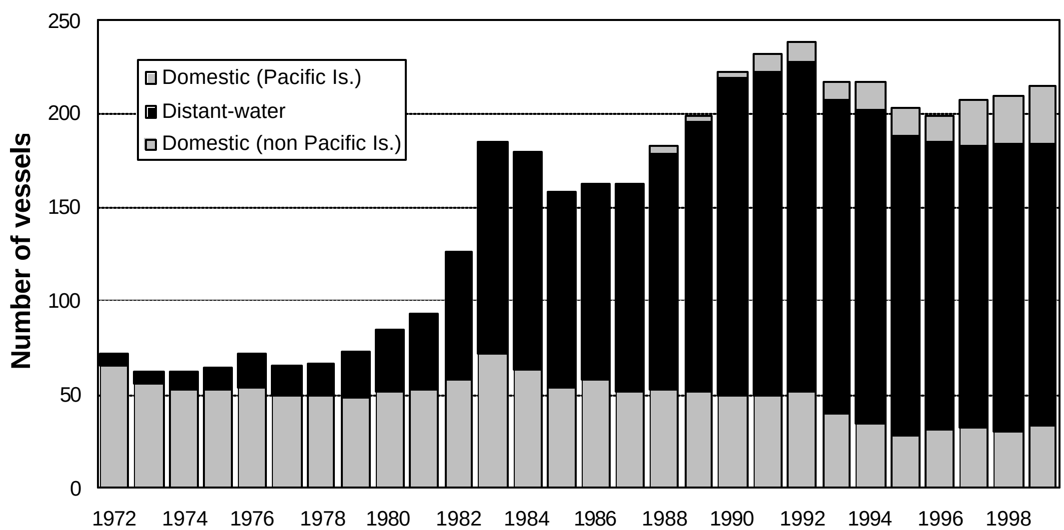

Figure 4. Number of purse-seine vessels operating in the WCPO. Domestic (non Pacific Is.) includes vessels based in Australia, Indonesia, Japan and New Zealand.

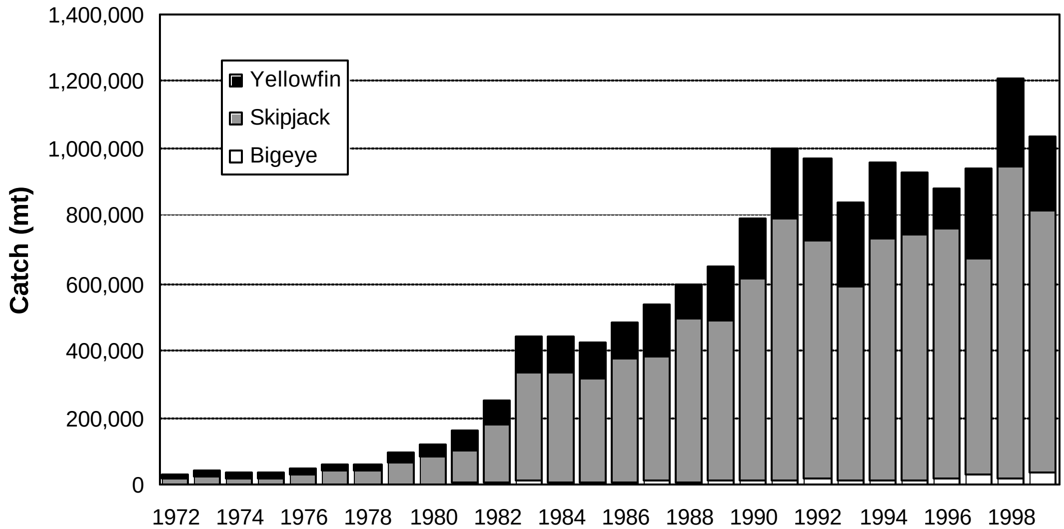

Figure 5. Purse-seine catch of skipjack, yellowfin and bigeye tuna in the WCPO.

3.1.2 Recent Developments

The 1999 purse-seine catch of 1,033,967 mt was only the second annual catch to exceed 1,000,000 mt. The purse-seine skipjack tuna catch for 1999 (780,853 mt; 76%) was nearly 150,000 mt less than the record 1998 catch (929,492 mt). The purse-seine yellowfin tuna catch for 1999 (218,177 mt; 21%) continued to decline from the record 1997 catch; the decrease in the catch in 1999 is understood to be typical of a La Niña situation. In contrast to skipjack and yellowfin tuna, the purse-seine bigeye tuna catch for 1999 (34,937 mt; 3%) was the highest on record.

The purse-seine catches for three of the four main purse-seine fleets operating in the WCPO (Japan, Korea and Taiwan) declined significantly in 1999. The USA fleet maintained their 1998 catch levels during 1999, despite a reduction in total days fished, through greatly increased use of drifting FADs, which increased their overall CPUE.

The Pacific Islands domestic purse-seine fleets continue to take a significant proportion of the WCPO purse-seine catch, around 12% of the total purse-seine catch in 1999. The major Pacific Islands domestic fleets are from Federated States of Micronesia, Papua New Guinea, Solomon Islands and Vanuatu. The 1999 Solomon Islands catch (39,055 mt) was the highest ever, nearly double that of 1998.

The percentage of sets on drifting FADs increased for most fleets during 1999 (Figure 6). Drifting FAD sets accounted for close to 90% of all sets made by the USA purse-seine fleet during 1999 (up from about 20% of sets in 1998) and represented a significant change in fishing strategy for this fleet. This strategy resulted in a sharp increase in skipjack CPUE and is the likely cause of increased bigeye tuna catches in 1999 by the USA fleet, to a record 16,673 mt, easily exceeding the previous high of around 10,000 mt in 1997. The proportion of drifting FAD sets also increased significantly for the Japanese and Taiwanese fleets. However, unassociated sets remained the predominant fishing strategy for the Korean fleet during 1999.

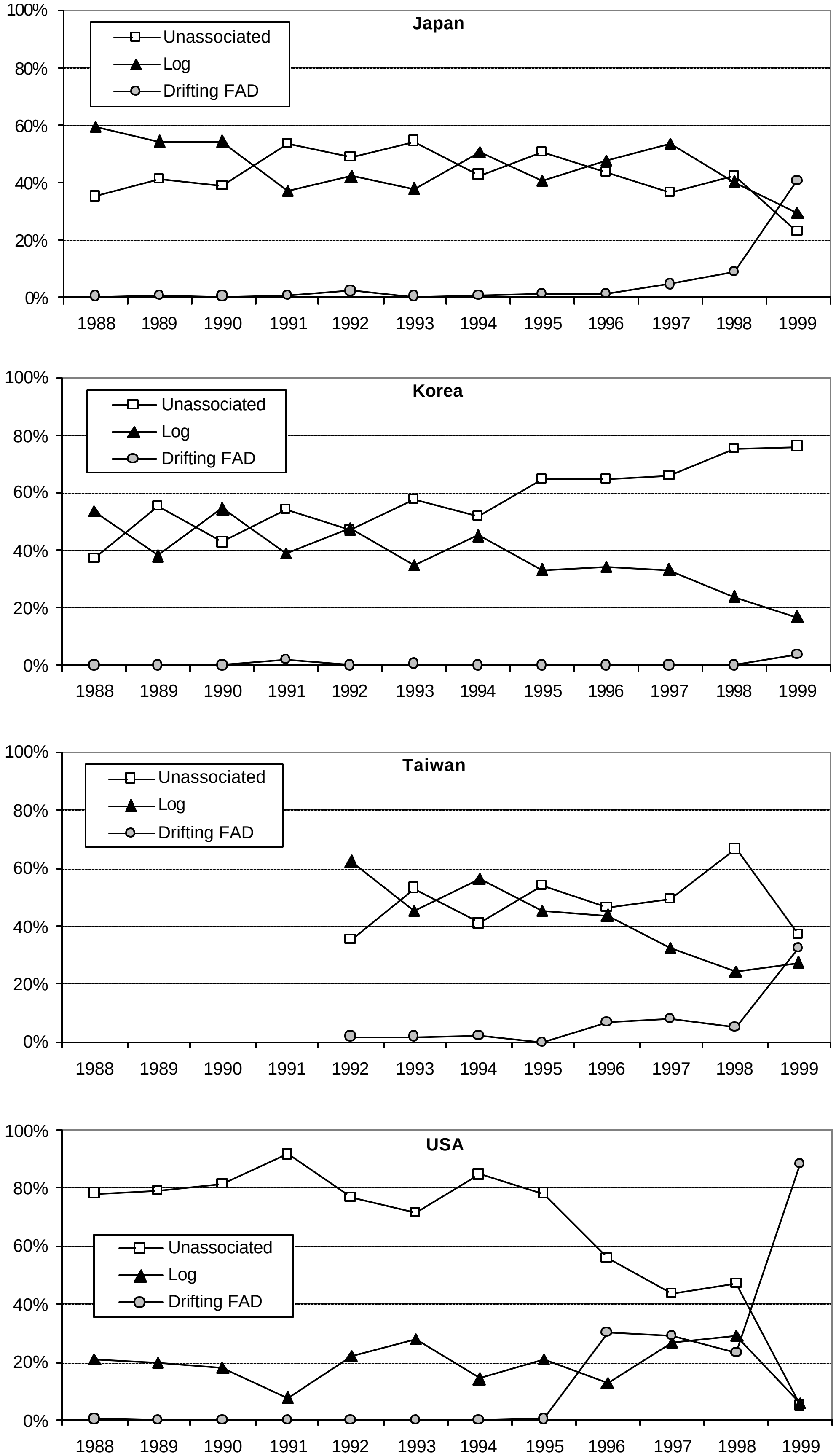

Figure 6. Time series showing the percentage of total sets by school type for the major purse-seine fleets operating in the WCPO.

Figure 7 highlights the shift in areas fished by quarter during 1998 and 1999, relative to the warm pool (water warmer than 28°C) and illustrates the relationship with the Southern Oscillation Index (SOI — El Niño/La Niña phenomena). The SOI remained in the positive range (normally related to a La Niña episode) throughout 1999. This was reflected in the fishing effort for most fleets contracting further westwards during this period. The USA purse-seine fleet was a notable exception, with considerable effort in the eastern areas setting almost exclusively on drifting FADs.

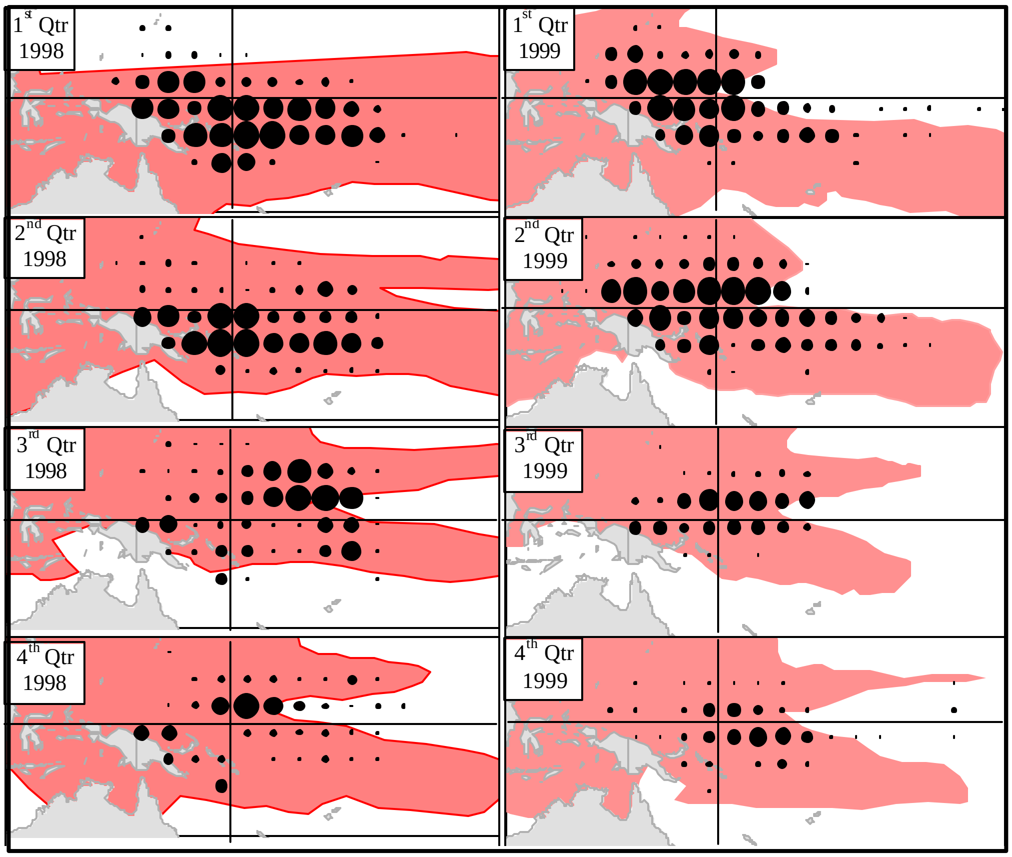

Figure 7. Distribution of 1998 and 1999 regional purse-seine effort by quarter. The shaded area is the warm pool (>28°C), with lines for the equator (0° latitude) and 160°E longitude included.

Figure 8 shows the annual effort distribution for the years 1995–1999 inclusive, and demonstrates on a wider scale the effect of ENSO events on the spatial distribution of the purse-seine catch.

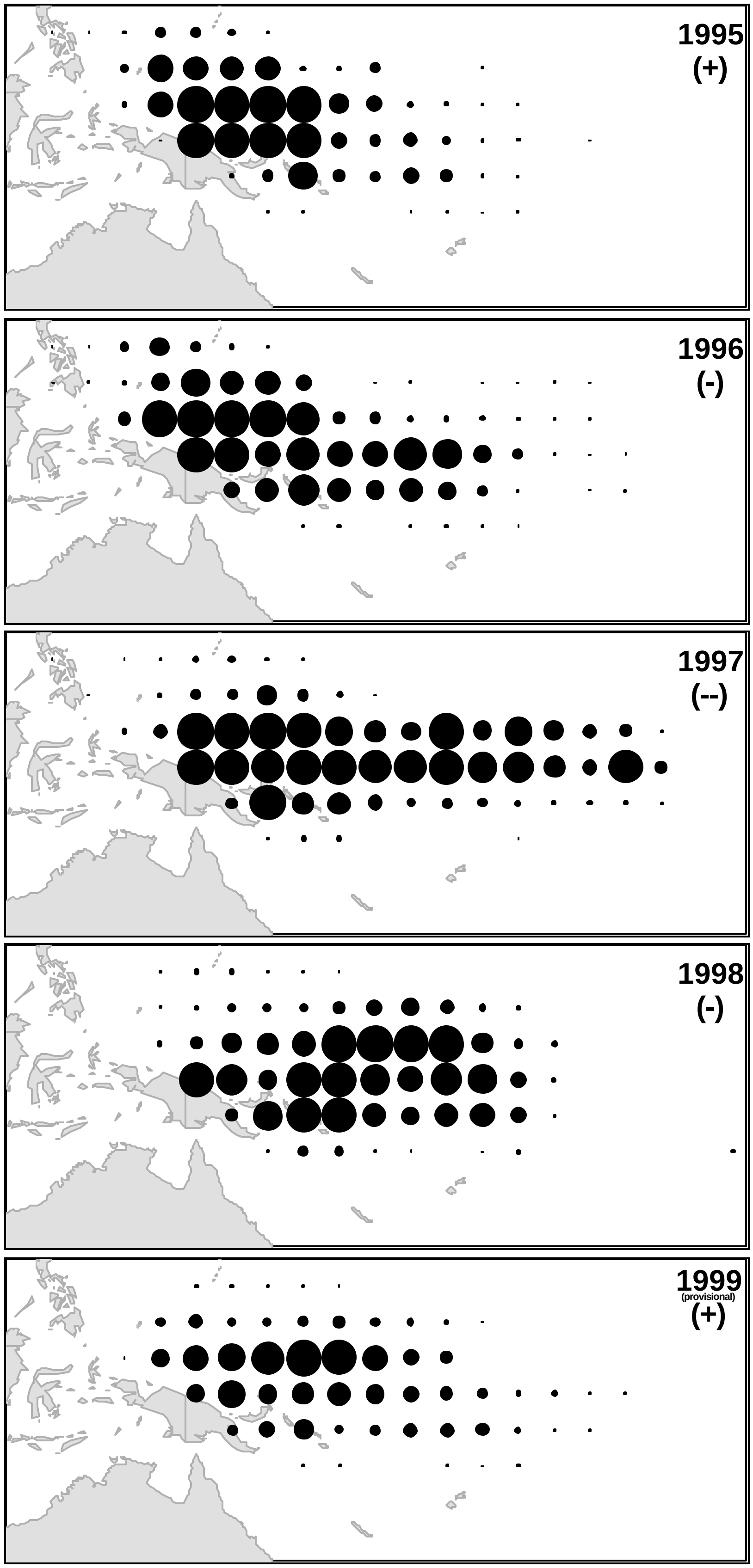

Figure 8. Distribution of purse-seine effort, 1995–1999. ENSO periods are denoted by: '+' = La Niña; '-' = El Niño; '--' = strong El Niño.

3.2 *Pole and Line*

3.2.1 Overview

The WCPO pole-and-line fishery has several components:

- The tropical skipjack tuna fishery, mainly involving the domestic fleets of Indonesia, Solomon Islands and French Polynesia, and the distant-water fleet of Japan;
- Seasonal sub-tropical skipjack tuna fisheries in the home waters of Japan and Australia;
- A seasonal albacore/skipjack tuna fishery east of Japan (largely a subset 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, and only one or two vessels are now operating in Fiji Islands. Several vessels continue to fish in Hawai'i, and the French Polynesian *bonitier* fleet remains active.

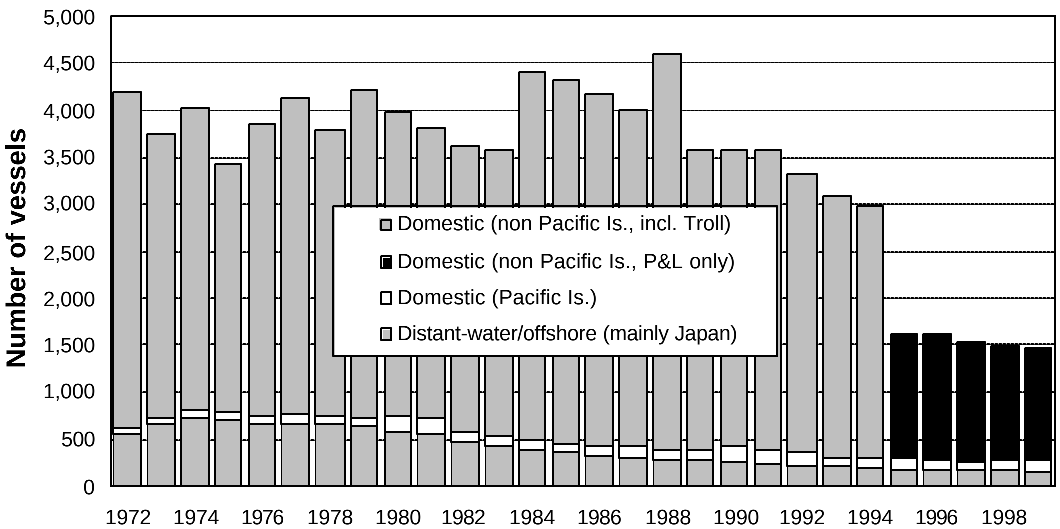

Figure 9. Pole-and-line vessels operating in the WCPO.

3.2.2 Recent Developments

The pole-and-line catch estimate for 1999 (285,747 mt) is a slight increase on the 1998 catch (279,717 mt) and represents about 17% of the total WCPO catch (Figure 10). As in previous years, skipjack tuna accounts for the vast majority of the catch (84%); albacore tuna taken by the Japanese coastal and offshore fleets in the temperate waters of the North Pacific (10%), yellowfin tuna (5%) and a small component of bigeye tuna (1%) make up the remainder of the catch. The Japanese distant-water and offshore fleet (125,673 mt of skipjack and yellowfin tuna in 1999) and the Indonesian domestic fleet account for most of the catch. The Solomon Island fleet recorded a catch of 30,580 mt during 1999, its highest in five years.

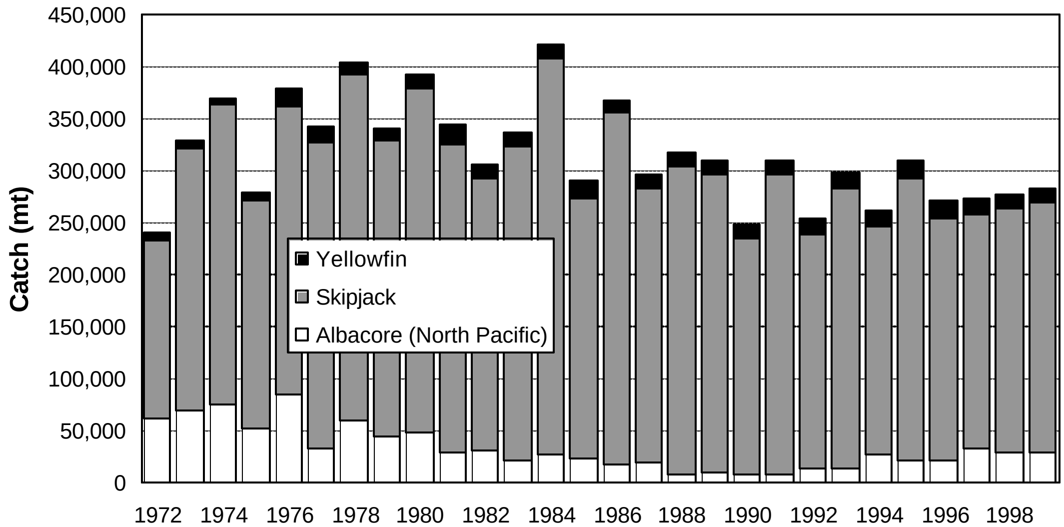

Figure 10. Pole-and-line catch in the WCPO.

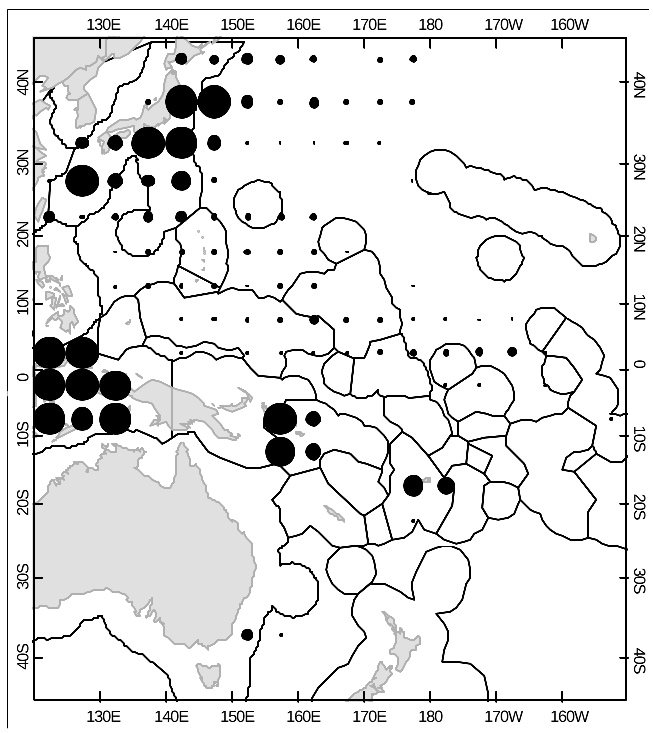

Figure 11. Average distribution of WCPO pole-and-line effort, 1990–1997.

3.3 Longline

3.3.1 Overview

The longline fishery provides the longest time series of catch estimates for the WCPO, with estimates available since the early 1950s. The annual total longline catch has been relatively stable during the past 25 years (Figure 12), with total catches generally between 130,000 and 200,000 mt. The fishery involves two main types of operation:

- Large (typically >250 GRT) freezer vessels, which undertake long voyages (months) and operate over large areas of the region; they may target either tropical (yellowfin and bigeye tuna) or subtropical (albacore tuna) species; these vessels continue to produce a large proportion of the WCPO longline catch.

- Smaller (typically <100 GRT) vessels, usually domestically based, with ice or chilling capacity, and serving fresh or air-freight sashimi markets; they operate mostly in tropical areas.

Additionally, small vessels in Indonesia and Philippines take quantities of large yellowfin and bigeye tuna by handlining and small vertical longlines.

There have been significant changes in fleet operations during the past two decades. For example, a feature of the 1980s was a change in targeting practices in order to capitalise on the higher price of bigeye tuna compared to that of yellowfin tuna. The gradual increase in the number of Pacific Island domestic vessels, and entrance into the fishery and subsequent decline of the smaller 'offshore' sashimi longliners of Taiwan and mainland China during the past decade (Figure 13) 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.

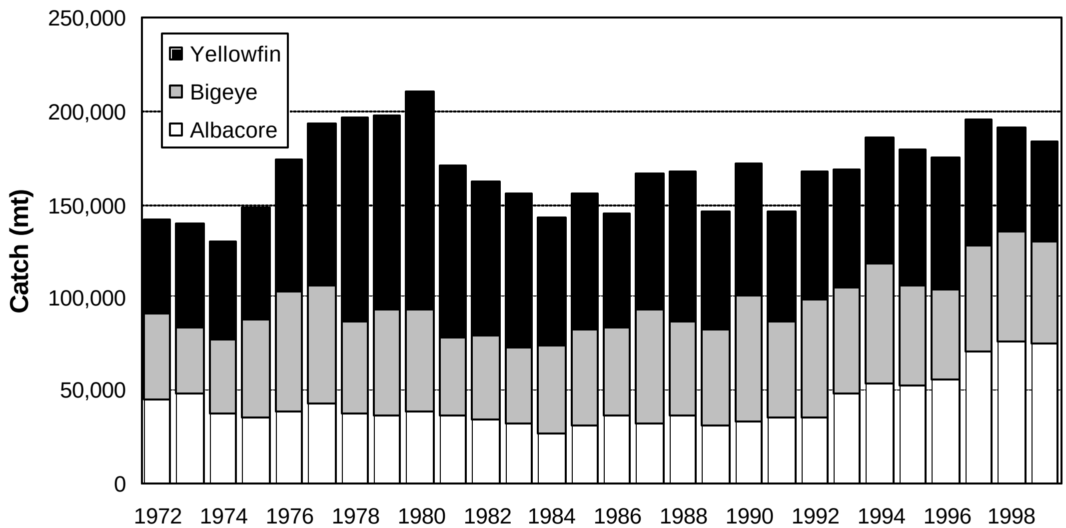

Figure 12. Longline catch in the WCPO.

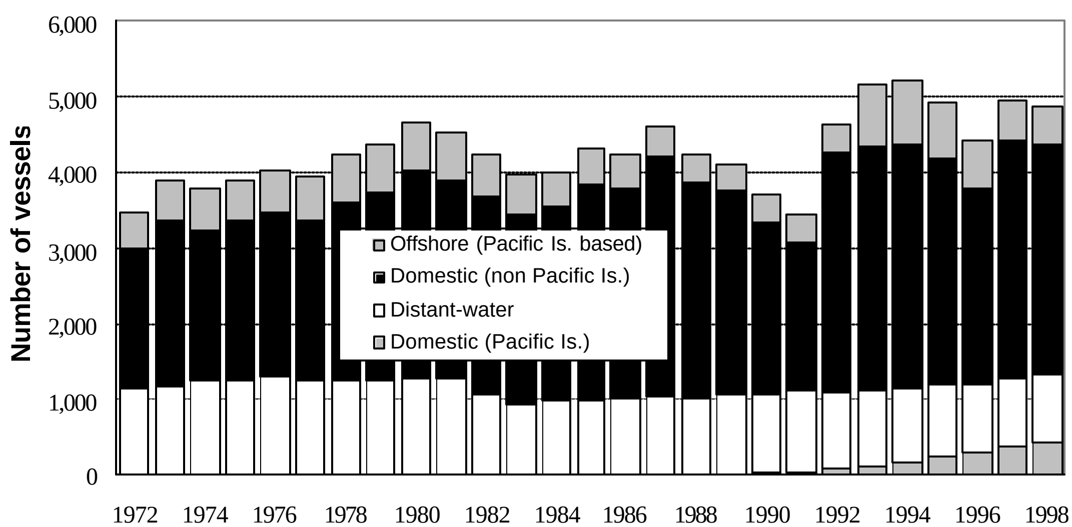

Figure 13. Longline vessels operating in the WCPO.

3.3.2 Recent Developments

The longline catch in the WCPO in 1999 of 185,077 mt accounted for 11% of the total WCPO catch, but rivals the much larger purse-seine catch in value. This catch represents a slight decrease on the 1998 catch of 193,172 mt. The species composition of the 1999 catch was 29% yellowfin, 41% albacore and 30% bigeye. The yellowfin catch of 52,580 mt was the lowest for nearly 30 years which appears to be attributable to a reduction in the number of distant-water vessels and to low overall CPUE. Figure 14 shows the geographical distribution of effort by category of fleet, and Figure 15 shows the species composition by area for 1998. As in previous years, most of the 1999 WCPO catch was taken by the large-vessel, distant-water fleets of Japan, Korea and Taiwan. 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.

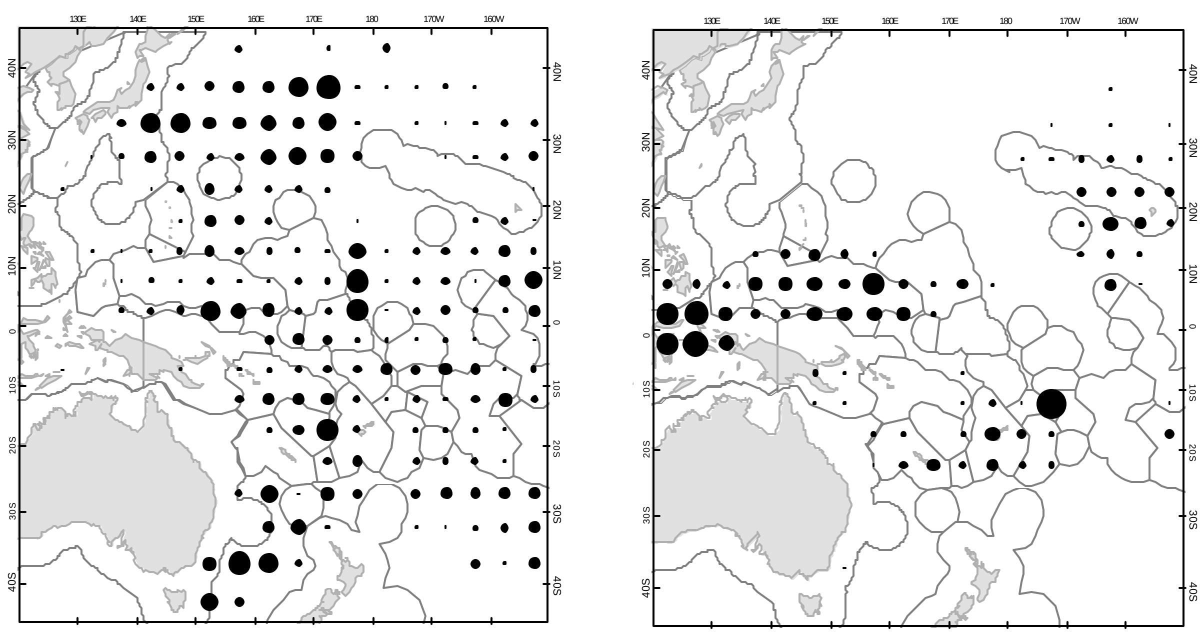

Figure 14. Distribution of distant-water longline effort (left) and offshore and domestic longline effort (right) during 1998.

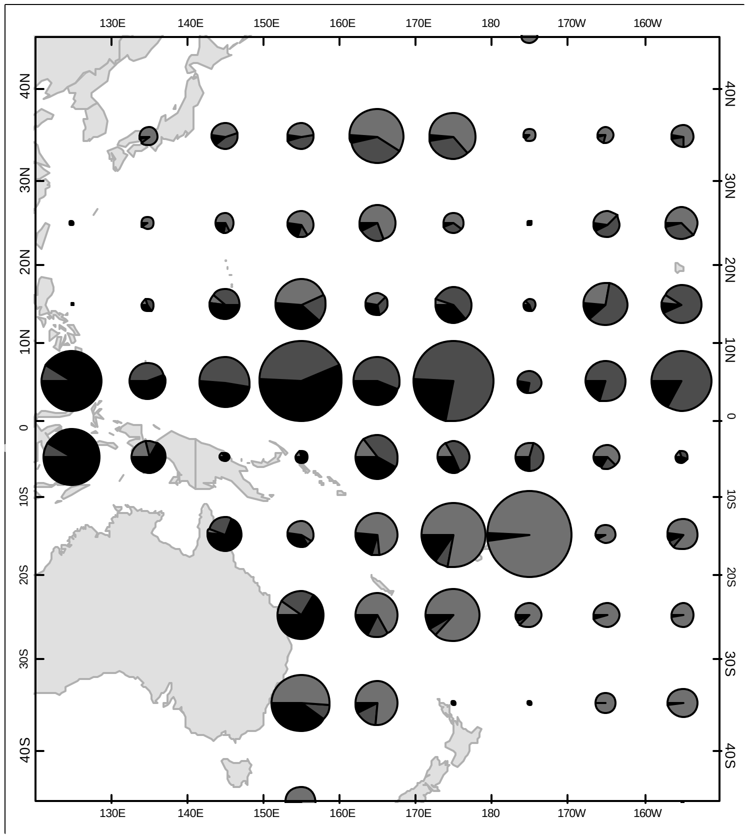

Figure 15. Distribution of longline catch, by species, during 1998 (black = yellowfin tuna; hatching = bigeye tuna; grey = albacore tuna).

3.4 Troll

3.4.1 Overview

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

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

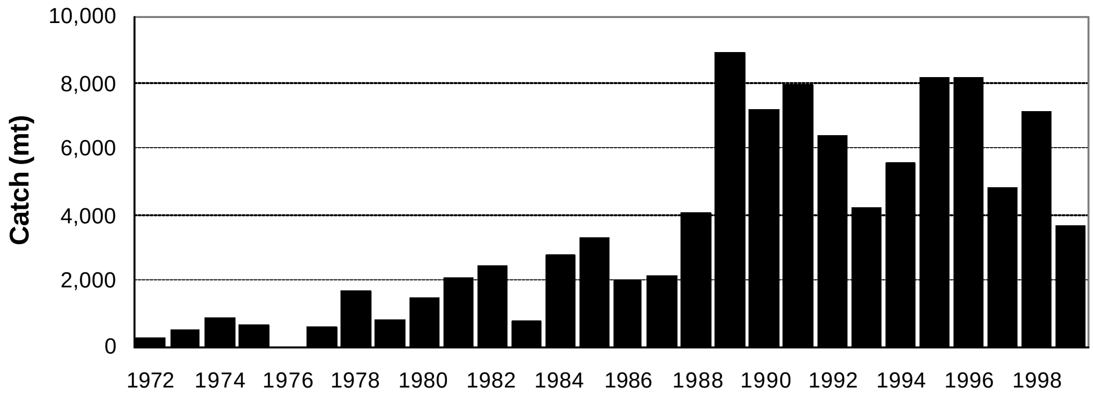

Figure 16. Troll catch of albacore tuna in the South Pacific Ocean.

3.4.2 Recent Developments

The 1999 troll albacore tuna catch was at the low end of its recent range, slightly less than 4,000 mt (Figure 16). Figure 17 shows the distribution of effort for the South Pacific troll fleets for 1997, which is expected to also approximate the distribution of fishing effort for 1998 and 1999 (i.e. off the coast of Australia and New Zealand, and along the STCZ).

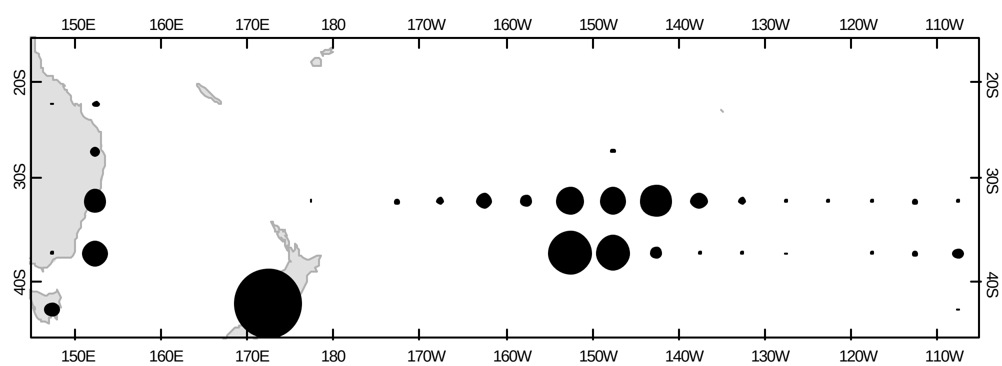

Figure 17. Distribution of South Pacific albacore tuna troll fishery effort during 1997.

4 Status of Tuna Stocks

In this section, we review the status of skipjack, yellowfin, bigeye and South Pacific albacore tuna stocks. The reference area used for skipjack and yellowfin tuna is the WCPO as earlier defined. For bigeye tuna, there is uncertainty regarding the appropriate area that should be considered for stock assessment, so information for the WCPO, the EPO and the Pacific as a whole is considered. For albacore tuna, the entire Pacific Ocean south of the Equator is considered.

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, population modelling approaches to stock assessment, where they have been applied to these species, are considered.

4.1 *Skipjack Tuna*

4.1.1 Catch

Skipjack tuna are taken primarily by purse-seine and pole-and-line gear, with smaller catches by artisanal gears in eastern Indonesia and the Philippines. Catches in the WCPO have increased steadily since 1970, more than doubling during the 1980s. The catch has been relatively stable during the 1990s (range 800,000–1,100,000 mt), with catches of more than a million metric tonnes occurring in 1991, 1992, 1995, 1998 and 1999 (Figure 18). Pole-and-line fleets, primarily Japanese, initially dominated the fishery, with the catch peaking at 380,000 mt in 1984, but the relative importance of this fishery 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 1999 catch of 1,101,617 mt comprised:

- Purse seine — 781,000 mt (71% of the total), of which most was taken by the four main distant-water fleets (544,000 mt) and the Philippine purse-seine and ringnet fleet (124,000 mt);
- Pole-and-line — 241,000 mt (22%), of which 130,000 mt was taken by Japanese fleets, an estimated 80,000 mt in Indonesia and 29,000 mt in Solomon Islands;
- Other gears — 79,000 mt (7%), mostly unclassified gears in Indonesia, the Philippines and Japan.

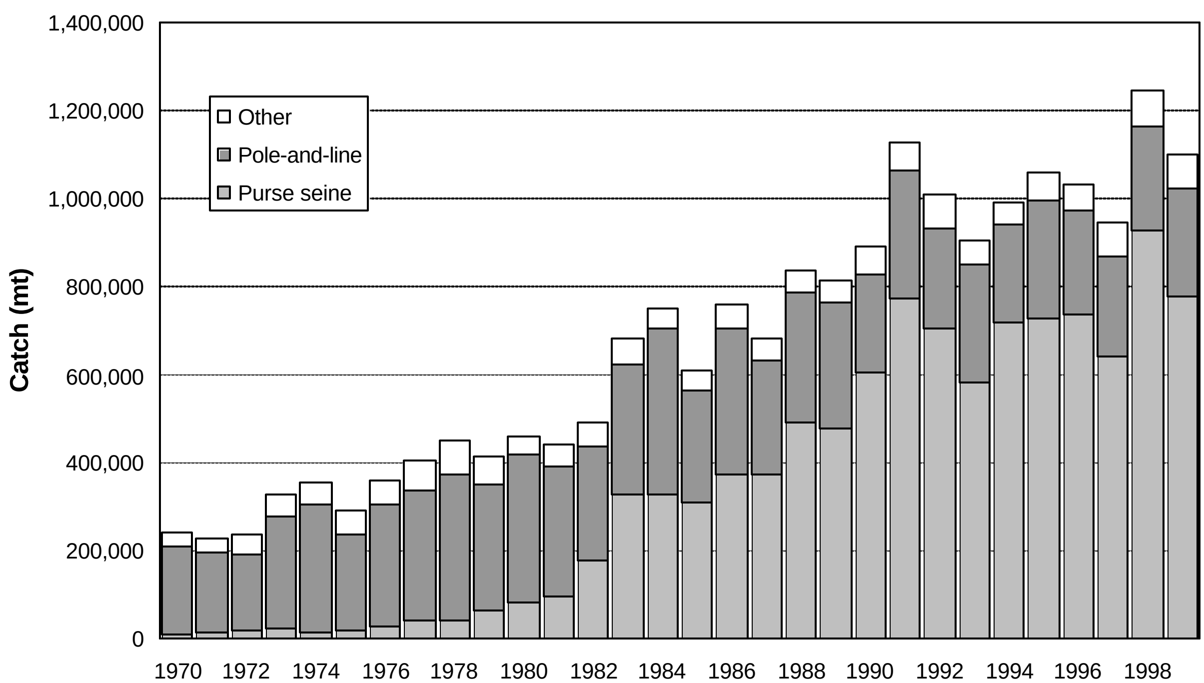

Figure 18. WCPO skipjack tuna catch, by gear.

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

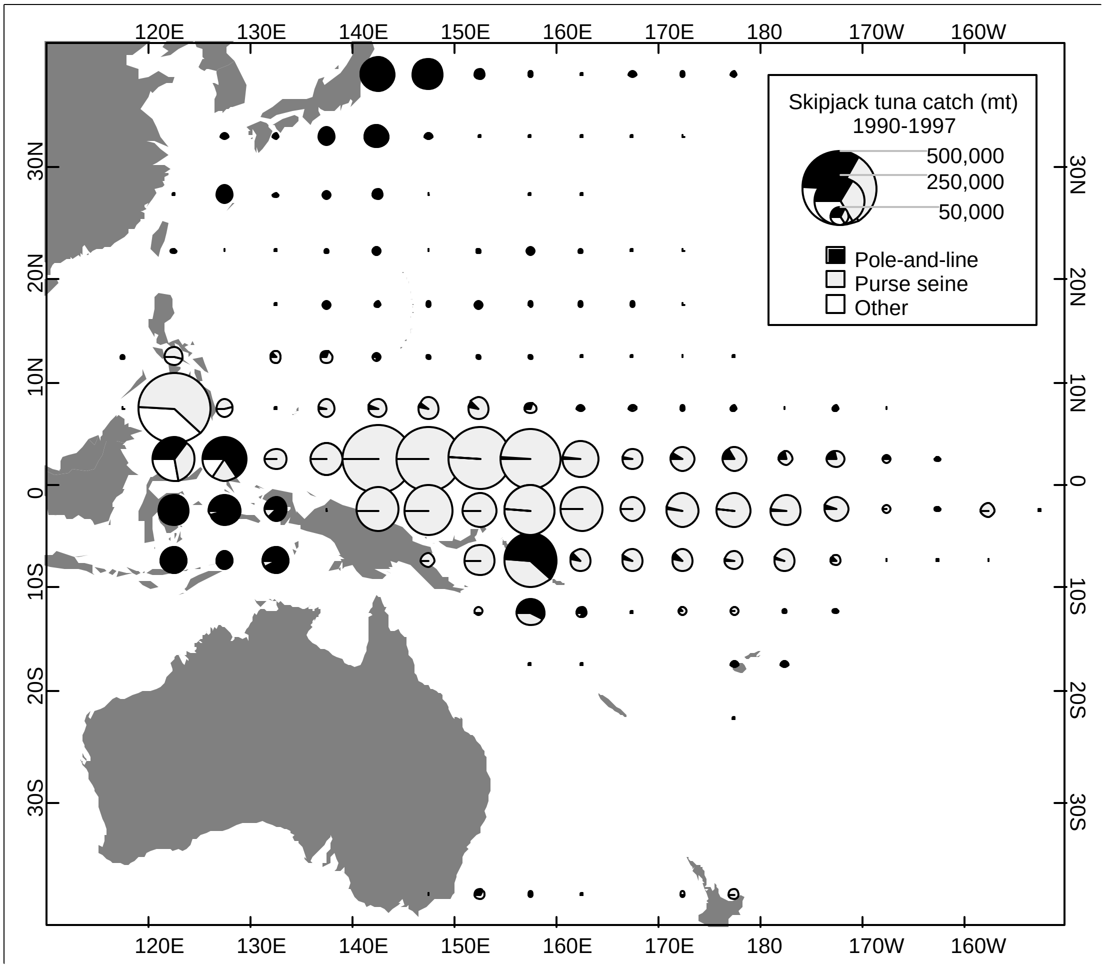

Figure 19. Distribution of skipjack tuna catch, 1990 - 1997.

4.1.2 Catch Per Unit of Effort

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

Skipjack tuna CPUE by the Japanese and USA fleets generally increased throughout the 1980s for all set types, probably due to acquired expertise and experience, new technology and co-operative searching among vessels. Since about 1991, CPUE has tended to flatten out, although high levels were recorded in both 1998 and 1999, particularly for log and FAD sets.

For both the Japanese and USA fleets, the highest overall CPUEs are obtained from sets on drifting FADs. In 1999, 49% of sets by Japanese vessels and 92% of sets by USA vessels were made on drifting FADs. It is clear that purse-seine effort has become more effective in recent years with the use of this new technology, and is likely to be resulting in higher levels of fishing mortality even though the overall number of boat days fished has declined since the early 1990s.

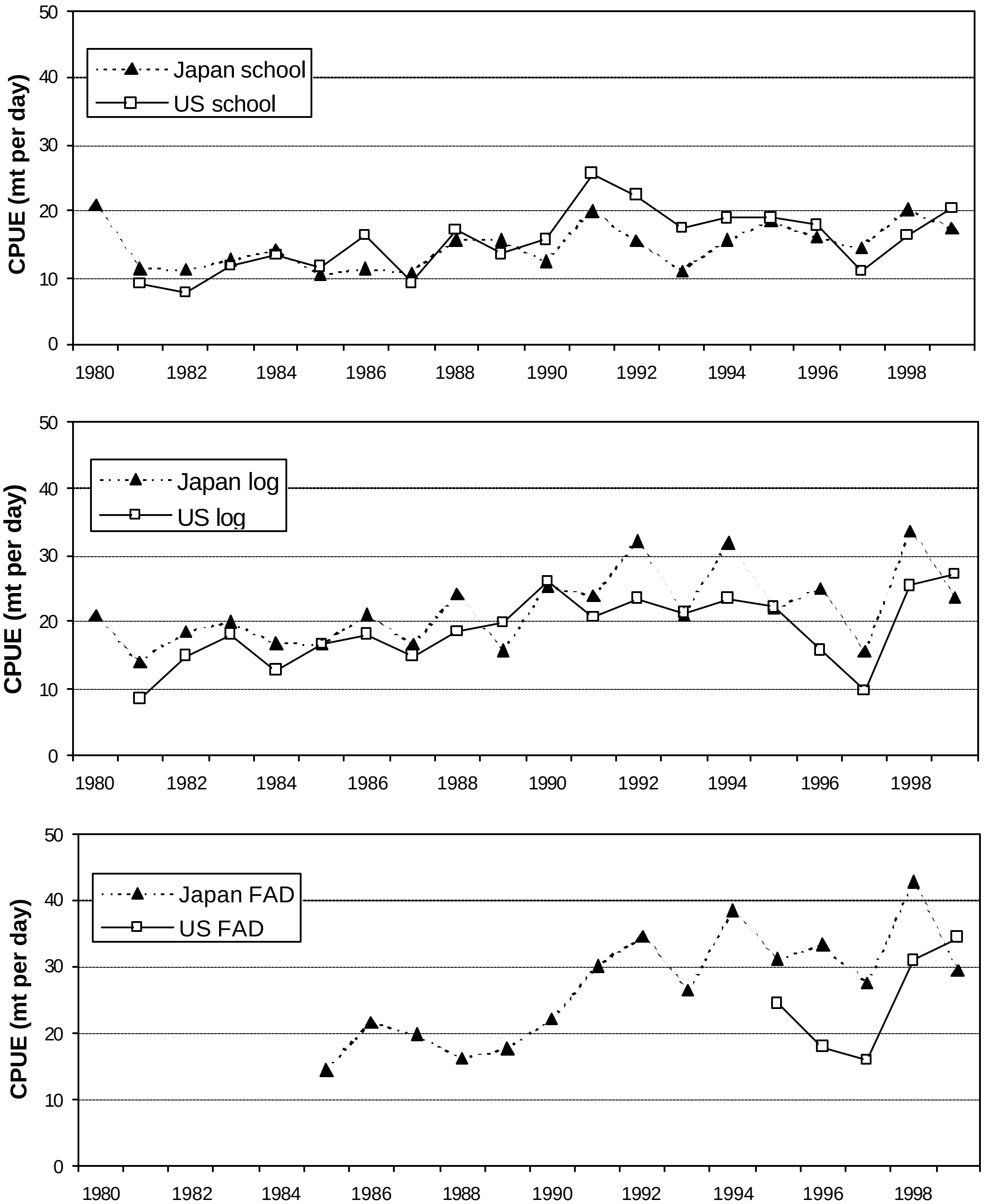

Figure 20. Nominal skipjack tuna CPUE by major set type categories (free-school, log and drifting FAD sets) for Japanese and USA purse seiners fishing in the WCPO.

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. Therefore, the nominal CPUE of this fleet (Figure 21) may provide a better index of skipjack tuna abundance than the purse-seine fleets (at least in the area around Solomon Islands, where these vessels fish). Nominal CPUE was marginally higher in the 1980s (average of 3.9 mt per day) than in the 1990s (average of 3.5 mt per day). Such a modest decline would not suggest a serious depletion of the skipjack tuna resource, either locally or in the WCPO.

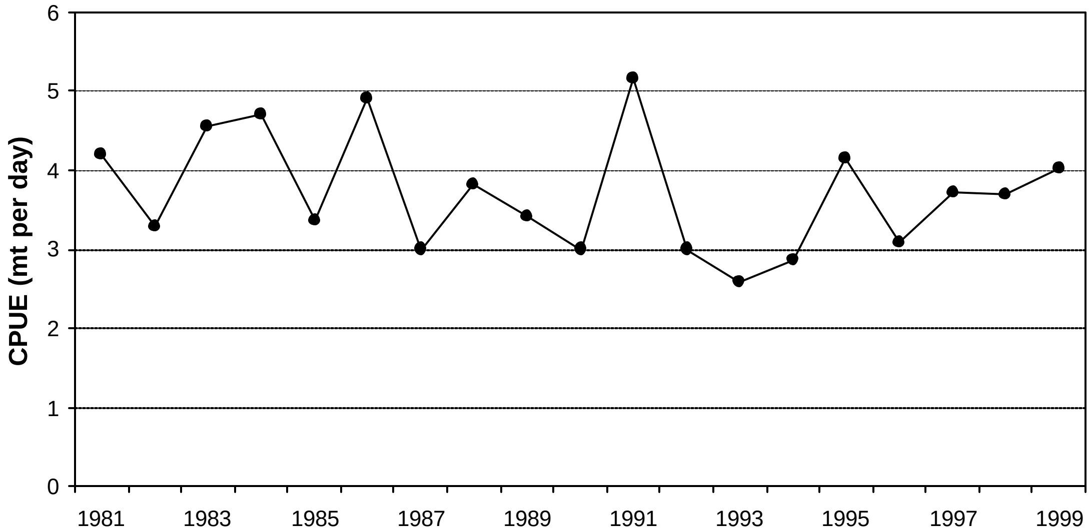

Figure 21. Nominal skipjack tuna CPUE for Solomon Islands pole-and-line vessels.

The Japanese distant-water pole-and-line fleet has operated over a wide area of the WCPO for many years, and its CPUE may also be useful for interpreting trends in skipjack tuna abundance. However, in contrast to the Solomon Islands fleet, the Japanese fleet has changed considerably over the years, with smaller, less-efficient vessels dropping out of the fleet as it reduced in size, and the remaining vessels adopting new technology as it became available. Ogura and Shono (1999) have estimated the effects of a range of vessel characteristics on skipjack tuna CPUE, resulting in estimates of CPUE that have been adjusted for the factors found to be significant. Both the nominal and standardised CPUE from this study are shown in Figure 22. The nominal CPUE shows an increasing trend until the early 1990s, followed by a decline. The standardised CPUE shows a similar pattern, but the variability is much reduced. On the basis of the standardised time series (which excludes the 1998 and 1999 high-catch years), we would conclude that the skipjack tuna stock in the WCPO remains in a healthy condition.

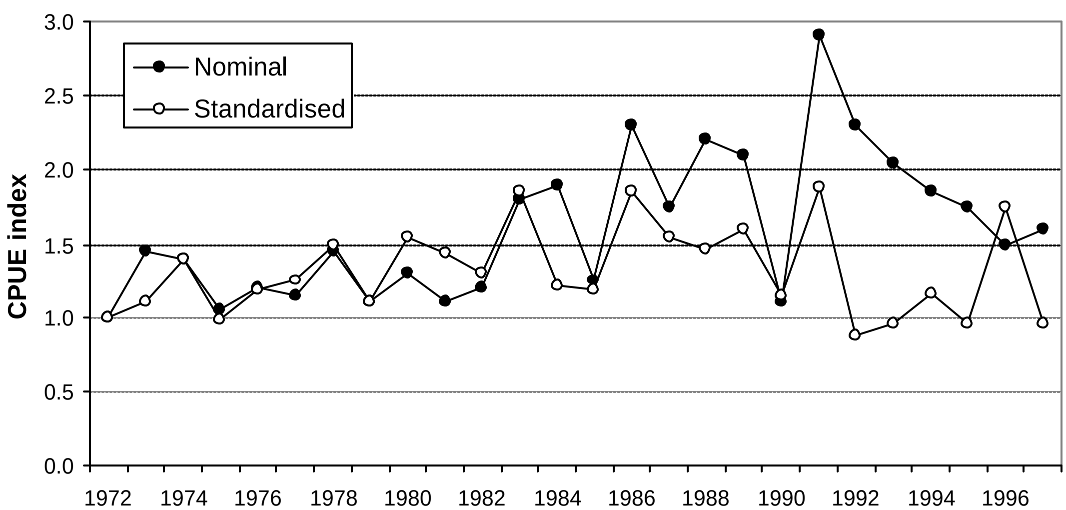

Figure 22. Nominal and standardised skipjack tuna CPUE for Japanese distant-water pole-and-line vessels.

4.1.3 Size of Fish Caught

As fisheries become heavily exploited, the average size of fish caught often declines. It is therefore useful to monitor the size of fish in the catch as another potential indicator of the impact of fishing. Bear in mind, however, that other factors, such as variable recruitment, will introduce a certain amount of noise into the system. This would be expected in the case of a short-lived fish such as skipjack tuna, where only a few age classes are present in the population to any significant extent.

Average size data for skipjack tuna sampled from purse-seine vessels (mainly the USA fleet) are summarised in Figure 23. For floating object sets, there has been little change in average size or the size of the upper 95th percentile (an indicator of the occurrence of large fish in the catch) of the sampled catch. For sets on free-swimming schools, there is some suggestion of a slight decline in mean size since the early 1990s, although the upper percentile measure has been stable. Overall, the size measures appear to be fairly stable, and are not indicative of any significant change in the size or age structure of the population that could be attributed to fishing.

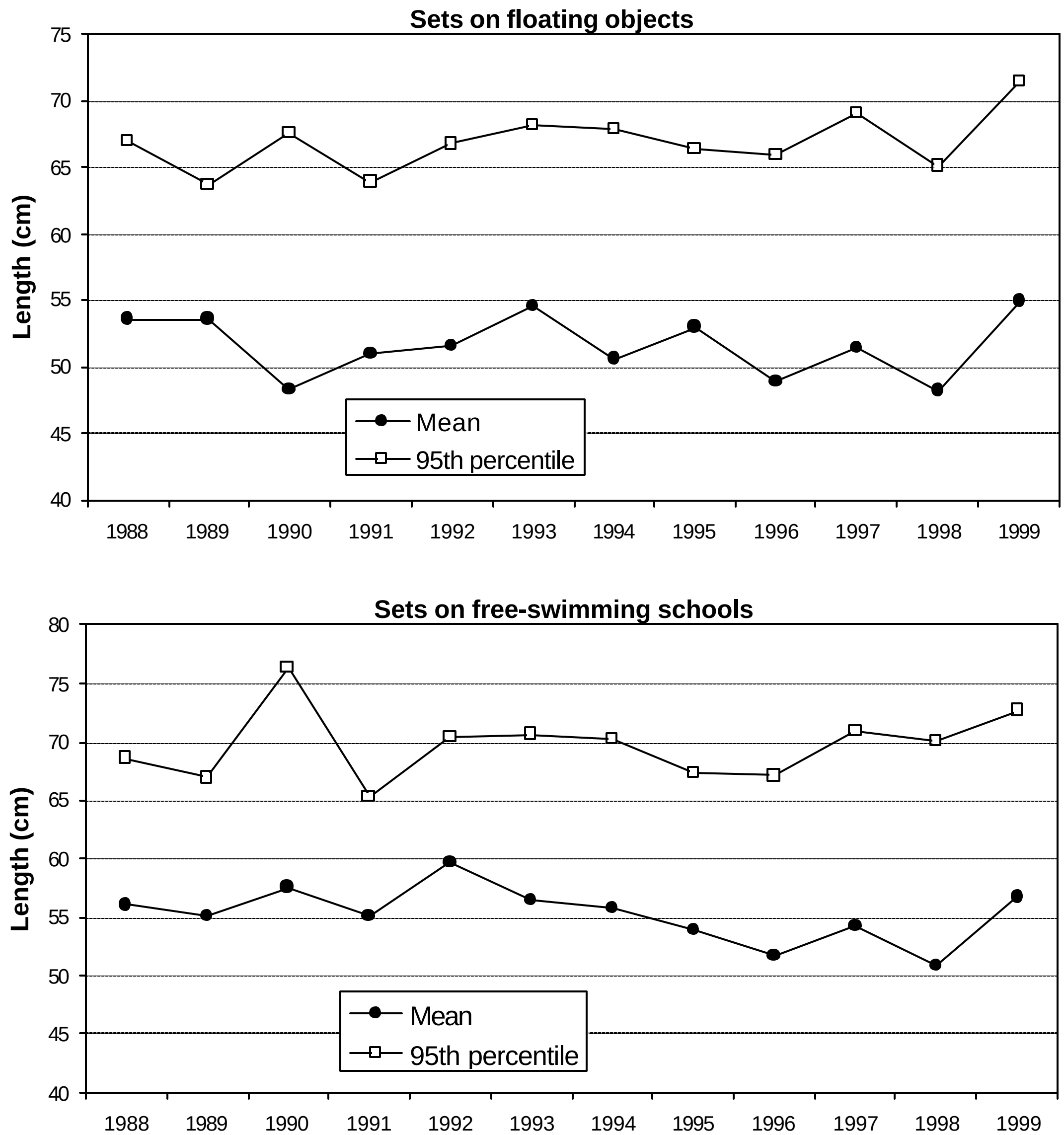

Figure 23. Mean and upper 95th percentile lengths of skipjack tuna sampled from purse-seine catches.

4.1.4 Stock Assessment

Tagging

The SPC has undertaken two major tag-recapture studies, the Skipjack Survey and Assessment Programme (SSAP) during 1977–1982 and the Regional Tuna Tagging Project (RTTP) during

1989–1992. During the SSAP, approximately 140,000 skipjack tuna were tagged and released, from which approximately 6,000 (4%) were recaptured and the tags returned. During the RTTP, 98,401 skipjack tuna were tagged for 12,447 returns (12.6%). These experiments, undertaken at very different times during the development of the fishery, have thus provided a valuable database with which to assess the current impact of fishing on the skipjack tuna stock.

Tag-attrition models have been fitted to both data sets (Kleiber et al. 1987; SPC 1994). For the SSAP data set, the total attrition rate (analogous to total mortality rate) was estimated to be 0.17 per month, with an exploitation rate (proportion of total attrition due to fishing) of 0.04. While the accuracy of the exploitation rate estimate was limited by a lack of reliable information on the reporting rate of tags, the results nevertheless imply that the effect of fishing on the skipjack tuna stock during the late 1970s and early 1980s was very small; the total annual catch of skipjack tuna at this time was of the order of 400,000 mt.

For the RTTP data set, more information was collected on tag-reporting rates and other sources of tag loss, and these were incorporated into the analysis (Hampton 1997). A similar estimate of total attrition was obtained (0.16 per month), but the estimated exploitation rate had increased to 0.20, reflecting an increase in the average annual skipjack tuna catch during the RTTP to around 950,000 mt. This analysis also incorporated an explicit estimate of the tag-reporting rate (0.59 overall) derived from tag-seeding experiments. Another feature of the RTTP analysis was the incorporation of various sources of uncertainty into the analysis, resulting in estimates of 95% confidence intervals on all parameters. The estimated 95% confidence intervals for the exploitation rate were 0.16–0.25. These results indicate that the impact of the fisheries on the WCPO skipjack tuna stock had increased as would be expected with the increases in catch that had occurred up to the early 1990s, but that the exploitation rate at the time of the RTTP was certainly not excessive.

MULTIFAN-CL

Since 1991, the OFP has been collaborating with Otter Research Ltd (based in Victoria, British Columbia) on the development of an integrated, length-based, age- and spatially-structured model for routine tuna stock assessment. The model, known as MULTIFAN-CL, was initially developed for South Pacific albacore tuna assessment (Fournier et al. 1998). The first version of the model analysed fishery catch, effort and size composition data to estimate time series of recruitment, stock biomass, fishing mortality rates and other parameters. Subsequently, the modelling of tagging data was incorporated to support more realistic parameterisations of movement and natural mortality. The model is highly integrated in the sense that parameters that describe how the length composition of the catch is converted to age composition are estimated simultaneously with recruitment, mortality rates and other parameters of the age-structured model. The advantage of this approach (over the usual sequential estimation of age composition followed by stock size, mortality, etc.) is that errors in the length-to-age conversion are automatically incorporated into the estimates of confidence intervals on parameters of interest such as the time series of recruitment.

During 2000, the MULTIFAN-CL model was applied to skipjack tuna for the first time. The analysis was restricted to the tropical region of the WCPO (15°N–20°S), with a simple two-region spatial structure (a longitudinal boundary along 165°E). For future assessments, it is planned to also include the north-western Pacific and the Japanese pole-and-line fisheries that occur in this region.

The data cover the period 1972–1998 using a quarterly time stratification. Catch, effort and size data for 14 fisheries (6 pole-and-line, Philippine and Indonesian domestic, and 6 purse-seine 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 both the SSAP and RTTP (182,315 releases, 12,733 returns) were incorporated into the analysis. The time period covered by the analysis is 1972–1999 at quarterly resolution. The skipjack tuna population is assumed to comprise 12 quarterly age classes (the last being a cumulative age class), which are exploited by the 14 fisheries with estimated age-specific selection patterns and time-varying catchability.

Complete details of the data, model structure and an earlier set of results are given in Bigelow et al. (2000a) (see http://www.spc.int/OceanFish/Html/SCTB/SCTB13/skj2.pdf); only the subset of results of direct importance to stock assessment is given here.

Annual fishing mortality rates have increased steadily over time and are highest for 1–2 year old skipjack tuna where they are approximately 0.4–0.6 per year in recent years (Figure 24). Despite the recent increases, overall fishing mortality rates remain considerably less than the corresponding natural mortality rates (which are around 2.0 per year). However, the region-specific estimates suggest strong recent increases in fishing mortality rates (to about 1.0 per year) in the western region. While such levels of exploitation are still within the bounds of responsible fishing, continued assessment and monitoring will be required, particularly given the changes in purse-seine fishing methods (FAD sets) that have occurred in recent years.

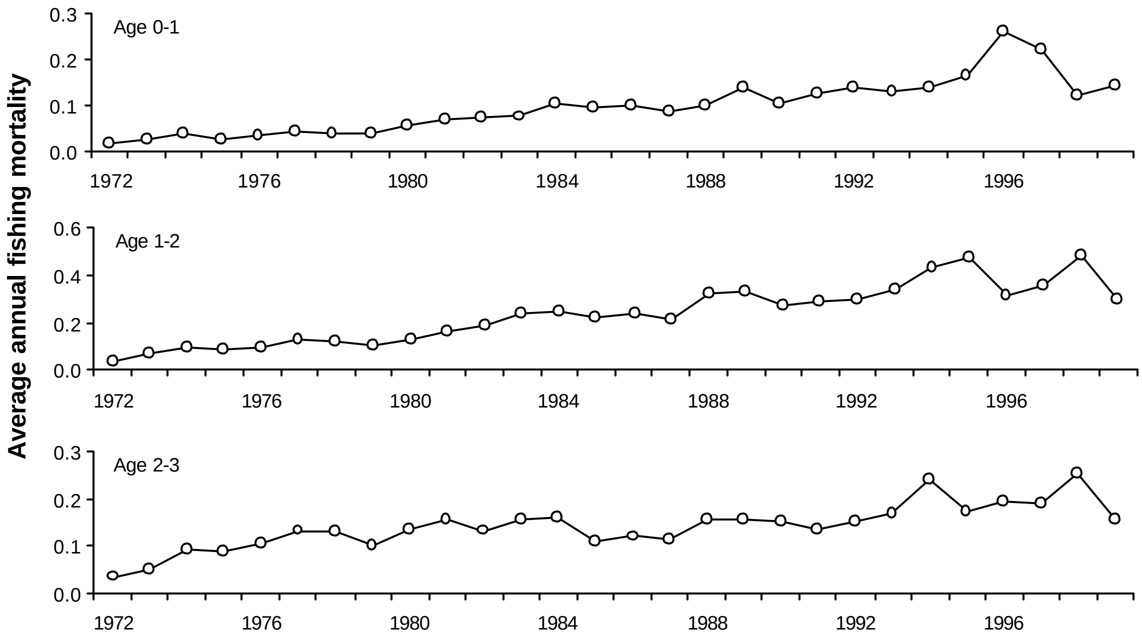

Figure 24. Estimated annual skipjack tuna fishing mortality rates for the WCPO, by age groups.

Recruitment estimates show considerable low and high-frequency variation (Figure 25). Recruitment appears to be higher following El Niño episodes, e.g. during 1990–91 and 1997–98, which is consistent with hypotheses currently being advanced regarding the impact of ENSO events on tropical tuna productivity (Lehodey 2000). There is also an overall increasing trend (although rather weak) in recruitment since about the mid-1970s, through until the early 1990s, which may be related to decadal-scale changes in biological productivity.

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

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

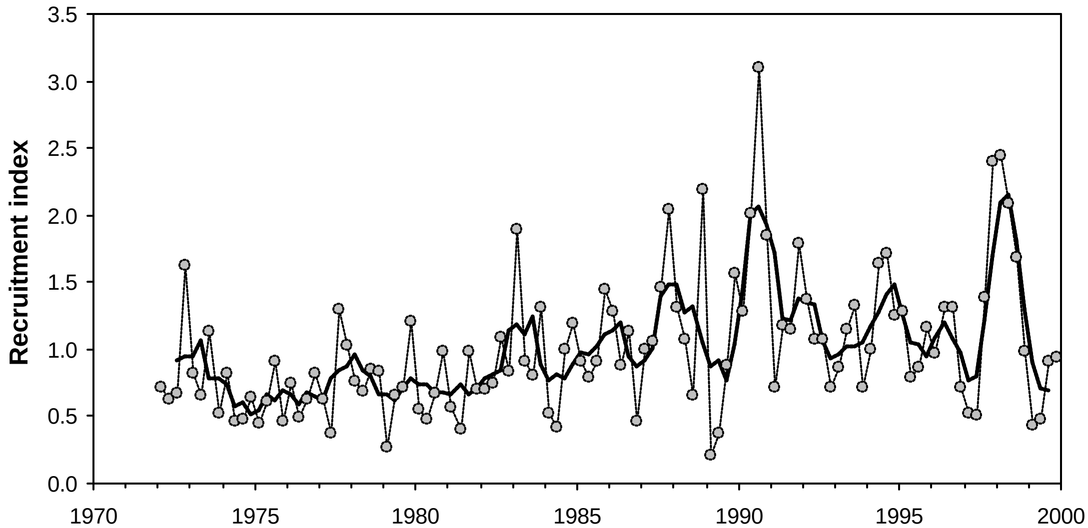

Figure 25. Estimated relative (scaled to the average) quarterly skipjack tuna recruitment with a four-quarter moving average (thicker line).

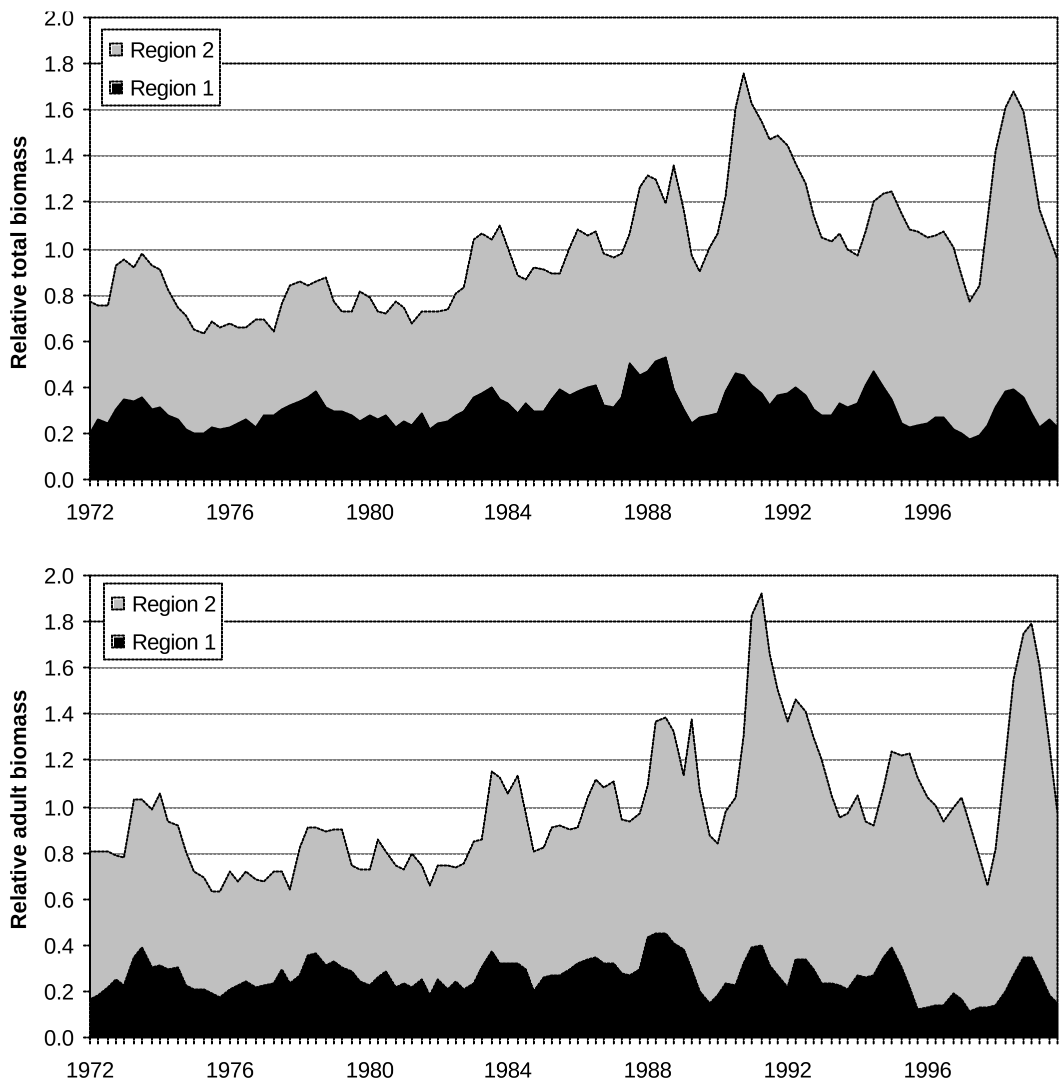

Figure 26. Estimated relative total (upper) and adult (lower) skipjack tuna biomass, by area. Estimates are scaled to the average spatially aggregated biomass.

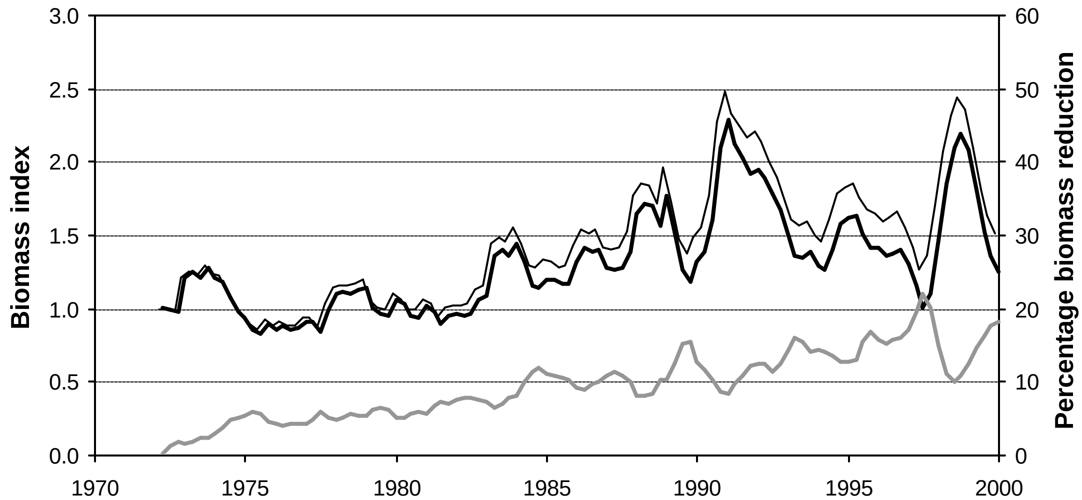

Figure 27. The estimated impact of fishing on skipjack tuna biomass. The lower biomass trajectory (darker line) represents the model estimates of total biomass. The upper trajectory is the estimated biomass that would have occurred in the absence of fishing assuming that recruitment was unaffected by 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 analyses of tag-recapture data, which indicate exploitation rates in the early 1990s in the vicinity of 0.20, are consistent with this interpretation of the fishery data. The preliminary application of the MULTIFAN-CL assessment model gave results generally consistent with the fishery indicators and tag-based assessment, but in addition indicated that fishing mortality may have increased significantly since the early 1990s, particularly in the tropical region west of 165°W. Nevertheless, the overall estimates of recent fishing mortality-at-age are 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. This preliminary analysis will be refined in the future by expanding the geographic scope of the analysis to cover the entire stock range and including additional tagging and fisheries data from the North Pacific.

4.2 Yellowfin Tuna

4.2.1 Catch

Yellowfin tuna, an important component of tuna fisheries throughout the WCPO, are harvested with a diverse variety of gear types, from small-scale artisanal fisheries in Pacific Island and Southeast Asian waters to large, distant-water longliners and purse seiners that operate widely in equatorial and tropical waters. Purse seiners catch a wide size range of yellowfin tuna, whereas the longline fishery takes mostly adult fish.

Since 1990, the yellowfin tuna catch in the WCPO has varied between 322,000 and 458,000 mt (Figure 28). The elevated total catches since 1997 followed the lowest catch for ten years in 1996, a result of greatly reduced purse-seine catches. Purse seiners harvest the majority of the yellowfin tuna catch (57% by weight in 1997–1999), with the longline and pole-and-line fisheries comprising 14% and 3% of the total catch, respectively. Yellowfin tuna usually represent approximately 20–25% of the overall purse-seine catch and may contribute higher percentages of the catch in individual sets. Yellowfin tuna are often directly targeted by purse seiners, especially as unassociated schools.

Longline catches in recent years (52,000–74,000 mt) are well below catches in the late 1970s to early 1980s (which peaked at 117,000 mt), presumably related to changes in targeting practices by some of the larger fleets. Catches in the 'Other' category in Figure 28 are largely composed of yellowfin tuna from the Philippines and eastern Indonesia. These catches come from a variety of gear types (e.g. ringnet, bagnet, gillnet, handline and seine net) and have increased steadily over the past decade.

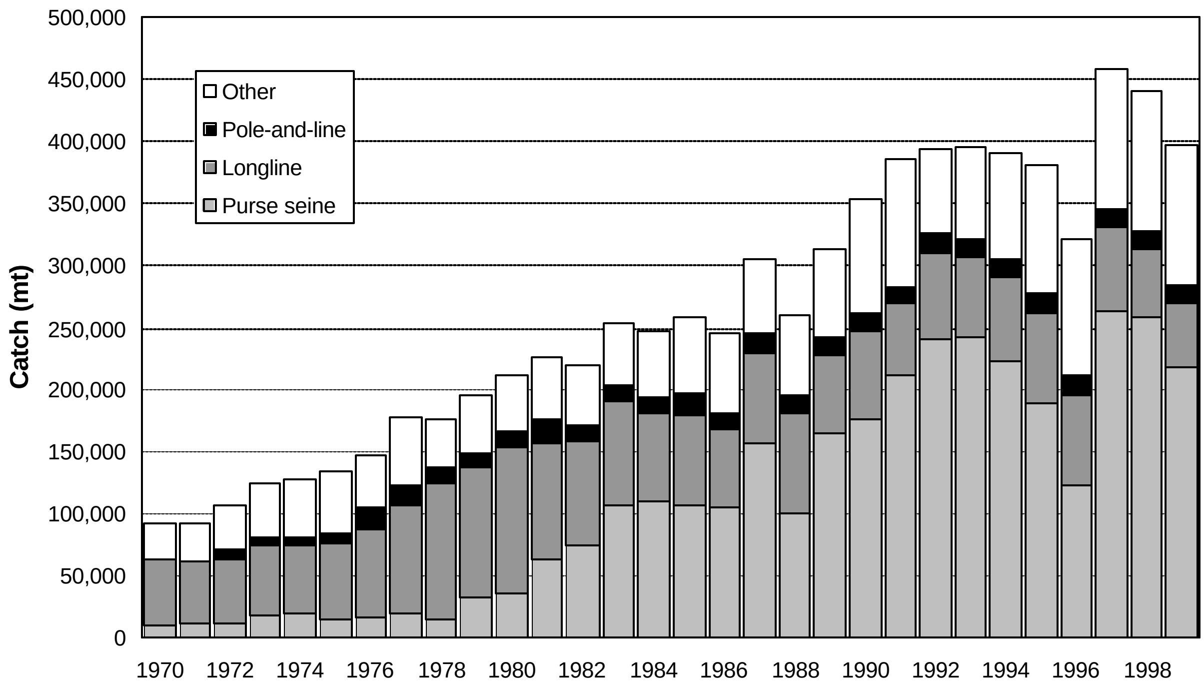

Figure 28. WCPO yellowfin tuna catch, by gear.

Figure 29 shows the spatial distribution of the yellowfin tuna catch in the WCPO for the past ten years. As for skipjack tuna, the majority of the catch is taken in equatorial areas, with declines in both purse-seine and longline catch towards the east. Also, the east–west distribution of catch is strongly influenced by ENSO events, with larger catches taken east of 160°E during El Niño episodes.

4.2.2 Catch Per Unit of Effort

Yellowfin tuna purse-seine CPUE is characterised by strong inter-annual variability, particularly for sets on free-swimming schools (Figure 30). School-set CPUE is strongly related to ENSO variation in the WCPO, with CPUE generally higher during El Niño episodes. This is believed to be related to increased catchability of yellowfin tuna due to a shallower surface mixed layer during these periods. ENSO variability is also believed to impact the size of yellowfin and other tuna stocks through impacts on recruitment.

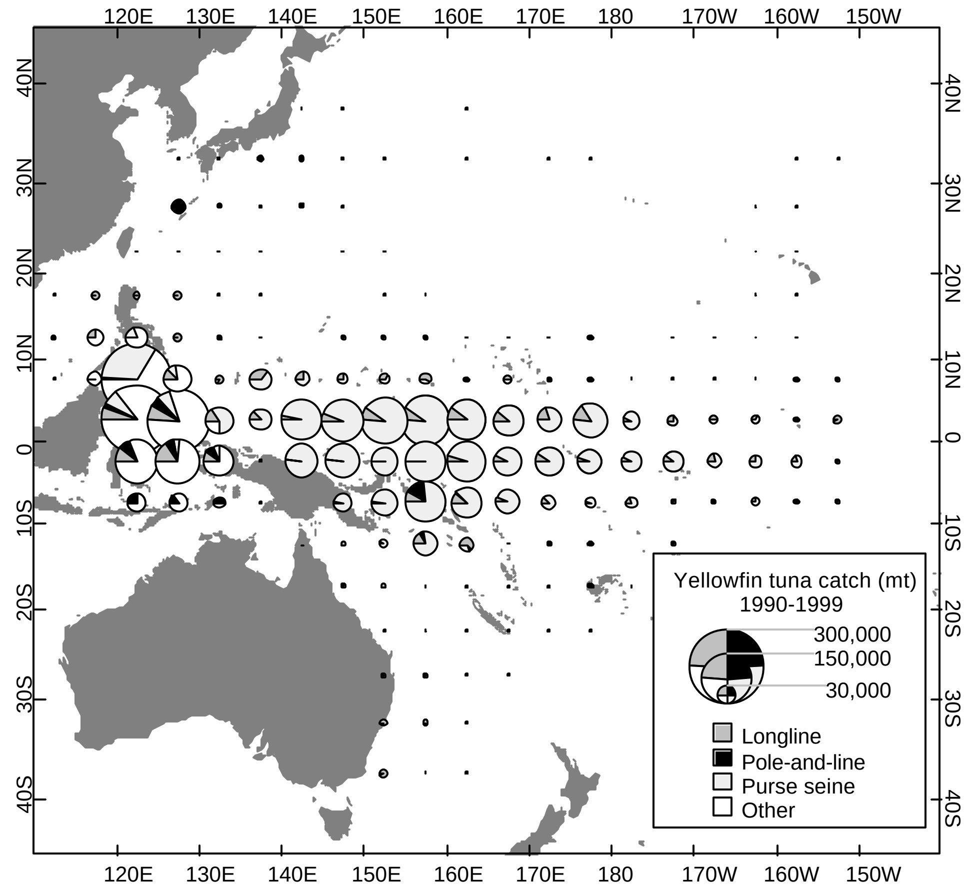

Figure 29. Distribution of yellowfin tuna catch, 1990 - 1999.

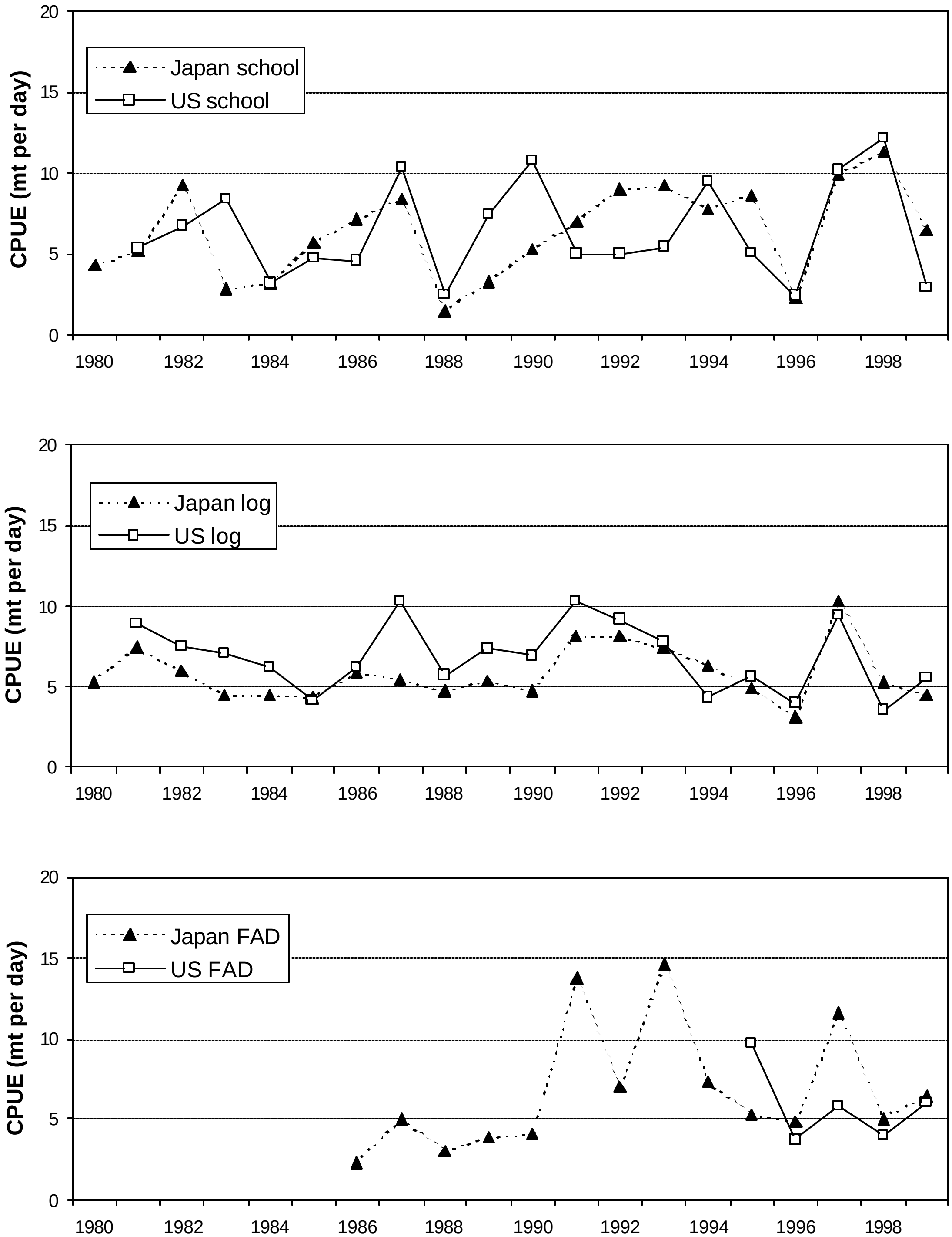

Figure 30. Nominal yellowfin tuna CPUE by major set type categories (free-school, log and drifting FAD sets) for Japanese and USA purse seiners fishing in the WCPO.

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.

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 separately for the Japanese, Korean and Taiwanese distant-water longline fleets. The estimates were then summed across these fleets and raised to represent the total longline catch by 5°-month. Time series of nominal CPUE and standardised CPUE (catch per unit of ‘effective’ effort) are shown in Figure 31. Nominal CPUE declined sharply from 1978 to 1991, and at least part of this decline is attributable to the change in targeting behaviour of the longline fleet; the standardised CPUE therefore does not exhibit as strong a decline over this period. Over the entire time series, standardised CPUE had low points in the mid-1970s, 1991 and 1997–1998. While these most recent points are the lowest observed standardised CPUEs in the history of the longline fishery, they are not much lower than those observed in the mid-1970s. Nevertheless, this indicator suggests that the portion of the yellowfin tuna population available to the longline fishery has been at a relatively low level in recent years. 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 29 may err on the optimistic side to some extent.

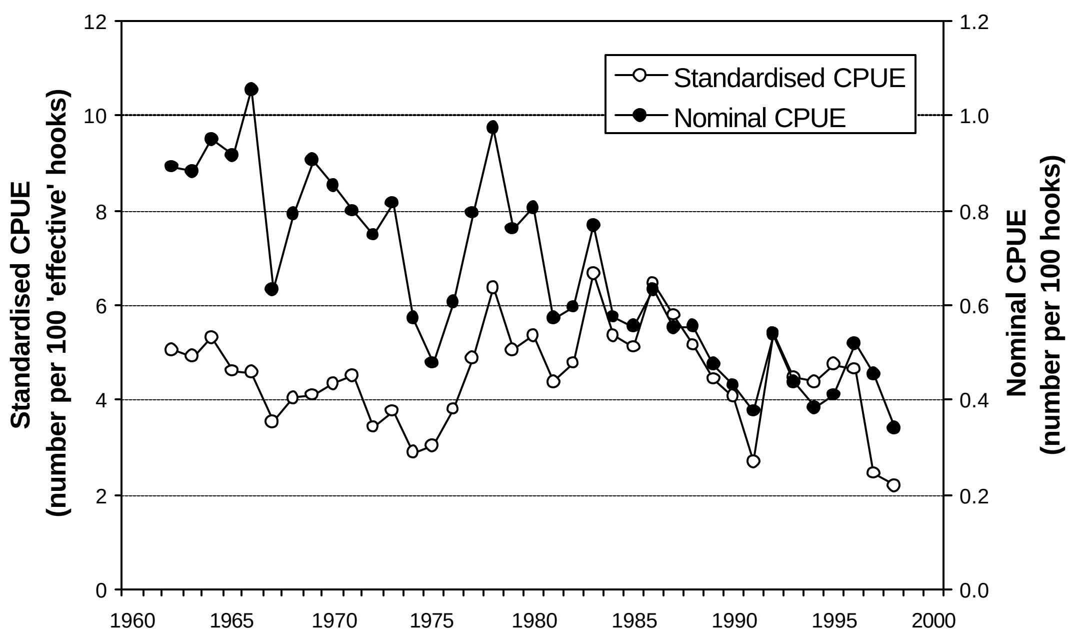

Figure 31. Nominal and standardised yellowfin tuna CPUE for distant-water longline vessels in the WCPO.

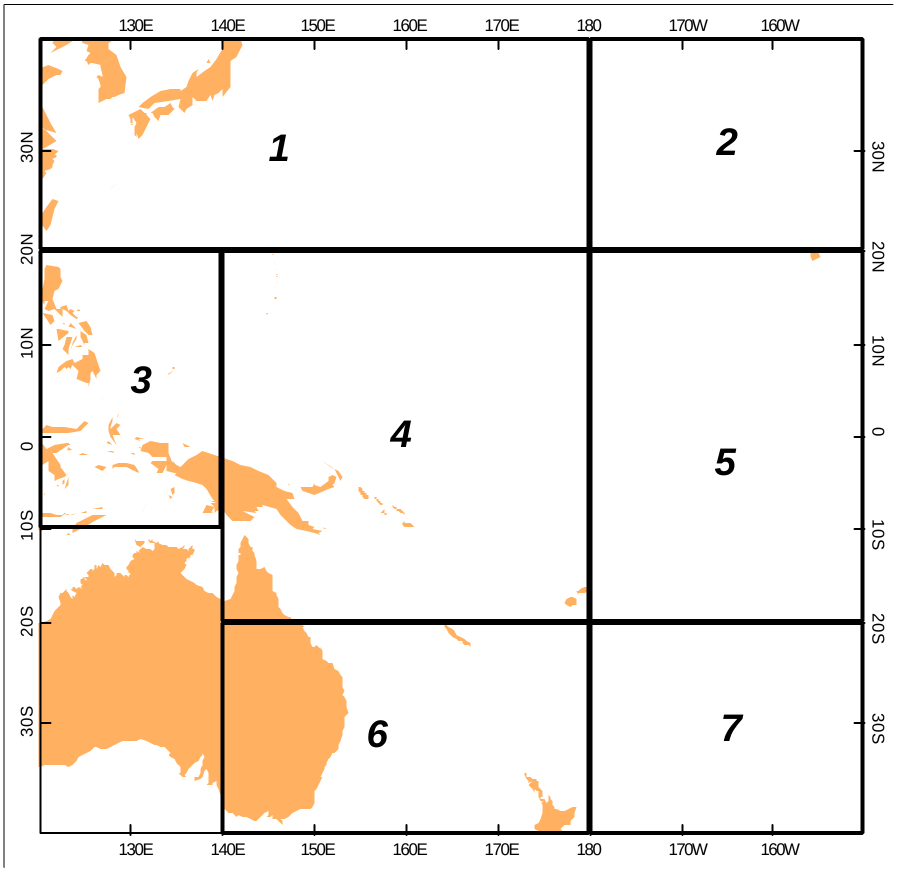

Figure 32. The seven areas used to compile yellowfin tuna size data.

4.2.3 Size of Fish Caught

For examining changes in average size, we restricted the analysis to changes in the longline fishery. This is because the longline fishery targets the largest yellowfin tuna and any fishery-induced changes in the size composition of the population should first become apparent here. Average size and the size of the upper 95^{th} percentile of the sampled catch were compiled for seven statistical areas, as shown in Figure 32. There has been no discernible change in either of the size variables over the 37-year period for which the data are available (Figure 33). This would suggest that there have not been significant changes in the size structure of the yellowfin tuna stock over a long period of time despite the large increase in catch that has occurred.

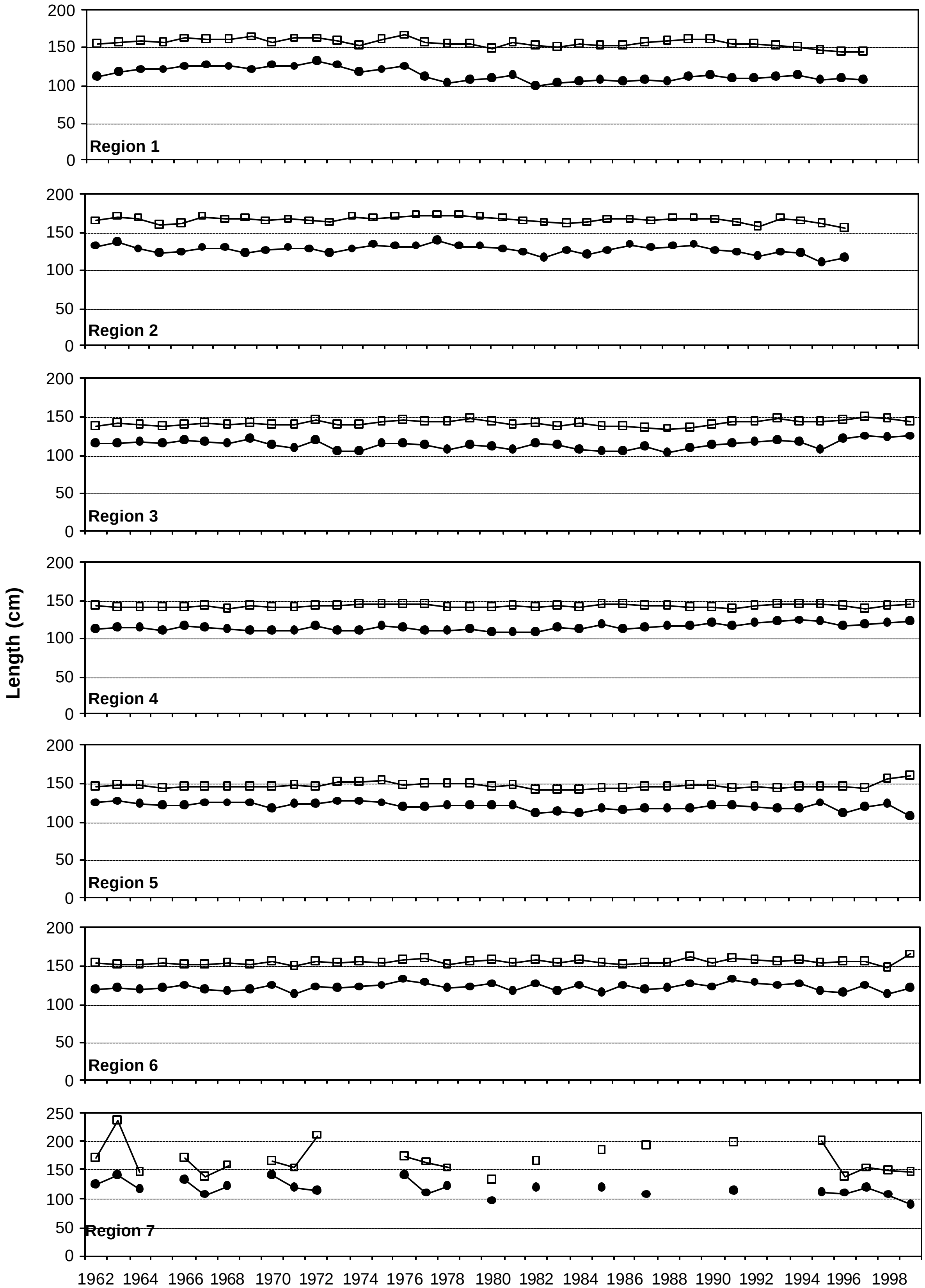

Figure 33. Mean (open circles) and upper 95th percentile lengths of yellowfin tuna sampled from longline catches in the seven regions shown in Figure 32.

4.2.4 Stock Assessment

Tagging

As with skipjack tuna, tagging experiments have provided valuable information on the status of the yellowfin tuna stock in the WCPO. During the RTTP, special efforts were made to tag and release substantial quantities of yellowfin tuna; 40,075 were tagged, from which 4,950 (12.4%) have been recaptured and the tags returned to SPC. A tag-attrition model has been fitted to these data and similar estimates to those obtained for skipjack tuna were derived: total attrition of 0.16 per month and exploitation rate of 0.20 (95% confidence intervals 0.16–0.25). This suggests that the rate of exploitation of yellowfin tuna in the tropical WCPO at the time of the RTTP (early 1990s) was low to moderate.

MULTIFAN-CL

The MULTIFAN-CL model has been applied to yellowfin tuna in the WCPO for several years. The spatial structure used in the analysis consists of the seven areas of the WCPO shown in Figure 32. The time period covered by the analysis is 1962–1999. Catch, effort and size data, stratified by quarter, for 16 fisheries (7 longline, 2 Philippines domestic, 1 Indonesia domestic, and 6 purse seine fisheries classified by set type) were used in the analysis. Tagging data from the RTTP were also incorporated into the analysis. The model structure adopted included: quarterly recruitment, 20 quarterly age classes, independent mean lengths for the first 8 age classes with von Bertalanffy growth constraining the mean lengths for the remaining age classes, structural time-series variation in catchability for all non-longline fisheries, age-specific natural mortality and age-specific movement among the model regions. A more detailed description of the data, the model structure employed for the analysis and the complete set of results is given in Hampton and Fournier (2000a) (http://www.spc.int/OceanFish/Html/SCTB/SCTB13/yft1.pdf).

Annual fishing mortality rates for various age groups for the WCPO as a whole are shown in Figure 34. Fishing mortality has increased for all age groups except yellowfin tuna >4 years of age. Increases have been particularly strong since 1996. Fishing mortality is estimated to be particularly high for the youngest age group, which are caught mainly in region 3 by the Philippine and Indonesian domestic fisheries.

Recruitment estimates display considerable low- and high-frequency variation (Figure 35). The high-frequency variation appears to be seasonal, although the phase is not always consistent. This could be due to growth variability, resulting in errors in the ageing of some length-frequency modes. The low-frequency variation might be correlated with decadal-scale environmental variation. Lehodey (2000) hypothesised that El Niño conditions in the WCPO should generally be favourable for yellowfin tuna (and skipjack tuna) recruitment because high primary and secondary productivity north of Papua New Guinea and the Solomon Islands would enhance spawning and larval survival. The higher recruitment estimates for 1976–1997 (a period of high-frequency El Niño events) are consistent with this hypothesis. Similarly, the decline in recruitment during the last 2–3 years may be related to persistent La Niña conditions since 1998. However, whether these estimates are indicative of a real decline in stock productivity is uncertain at this stage, because the most recent recruitment estimates are subject to the greatest statistical uncertainty.

The time series of estimated relative total and adult **biomass**, by area, is shown in Figure 36. Most of the biomass is estimated to occur in regions 3, 4 and 5. Both total and adult biomass peaked in the mid-1980s and have been trending downwards since that time. The decline during the most recent years is particularly strong and is related to the decline in recruitment. The biomass estimates for the most recent year are approximately 40% of those at the beginning of the time series.

The impact of fishing on the total biomass has increased over time, and catches and fishing mortality have increased (Figure 37). In the early 1990s, the biomass is estimated to have been reduced by 20–25% compared to the level it would have been in the absence of fishing (which is consistent with the earlier tag-based assessment). In recent years, the estimated impact of fishing has increased to 50%.

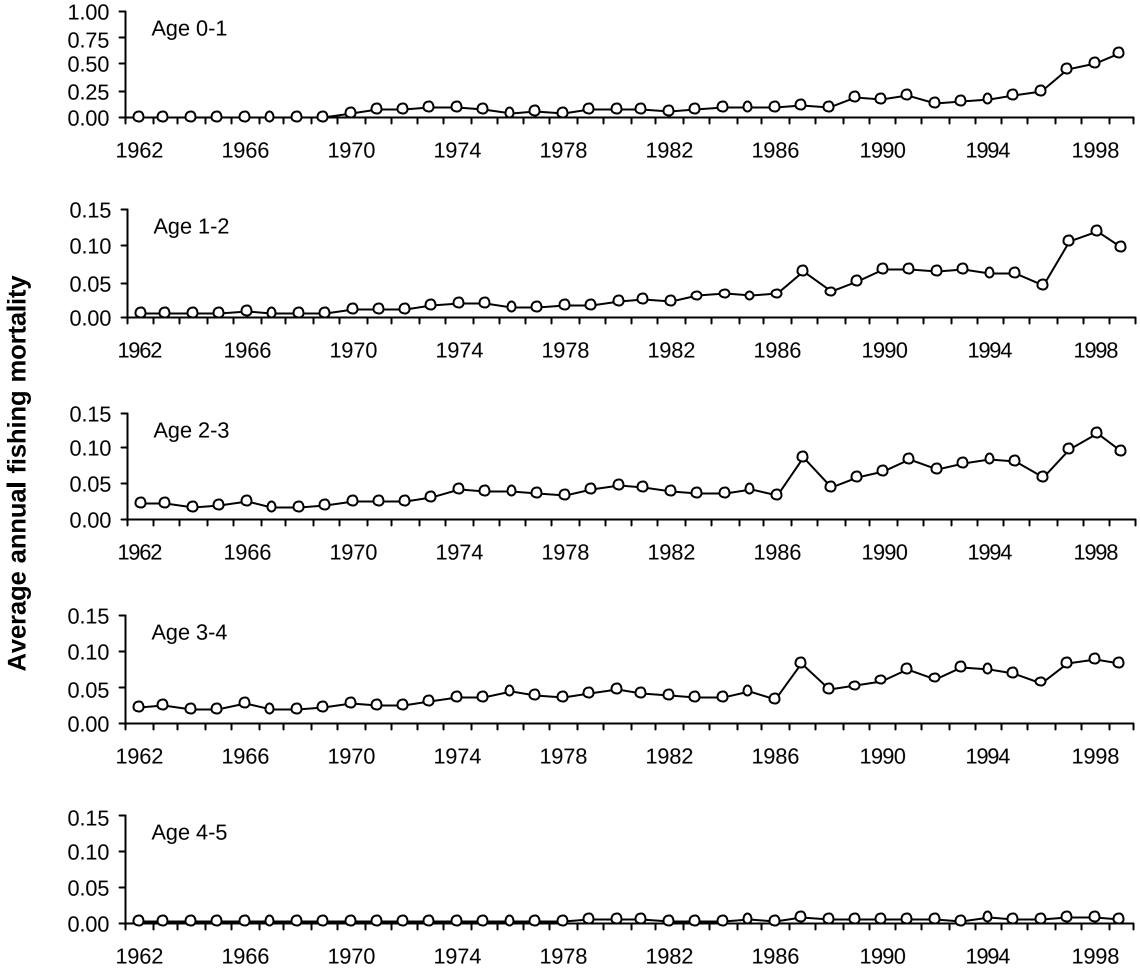

Figure 34. Estimated annual yellowfin tuna fishing mortality rates for the WCPO, by age groups.

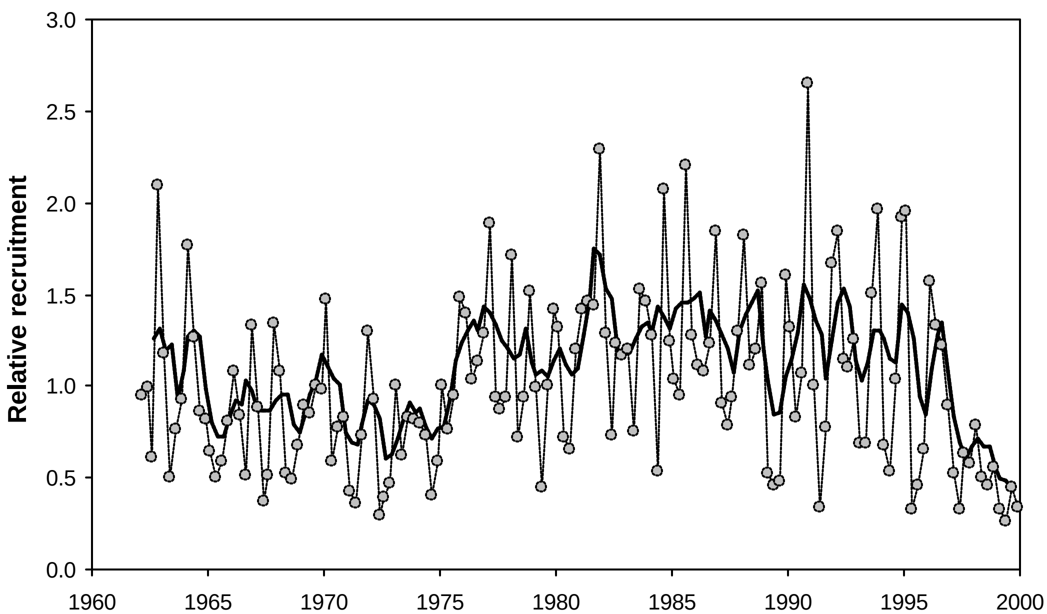

Figure 35. Estimated relative (scaled to the average) quarterly yellowfin tuna recruitment with a four-quarter moving average (thicker line).

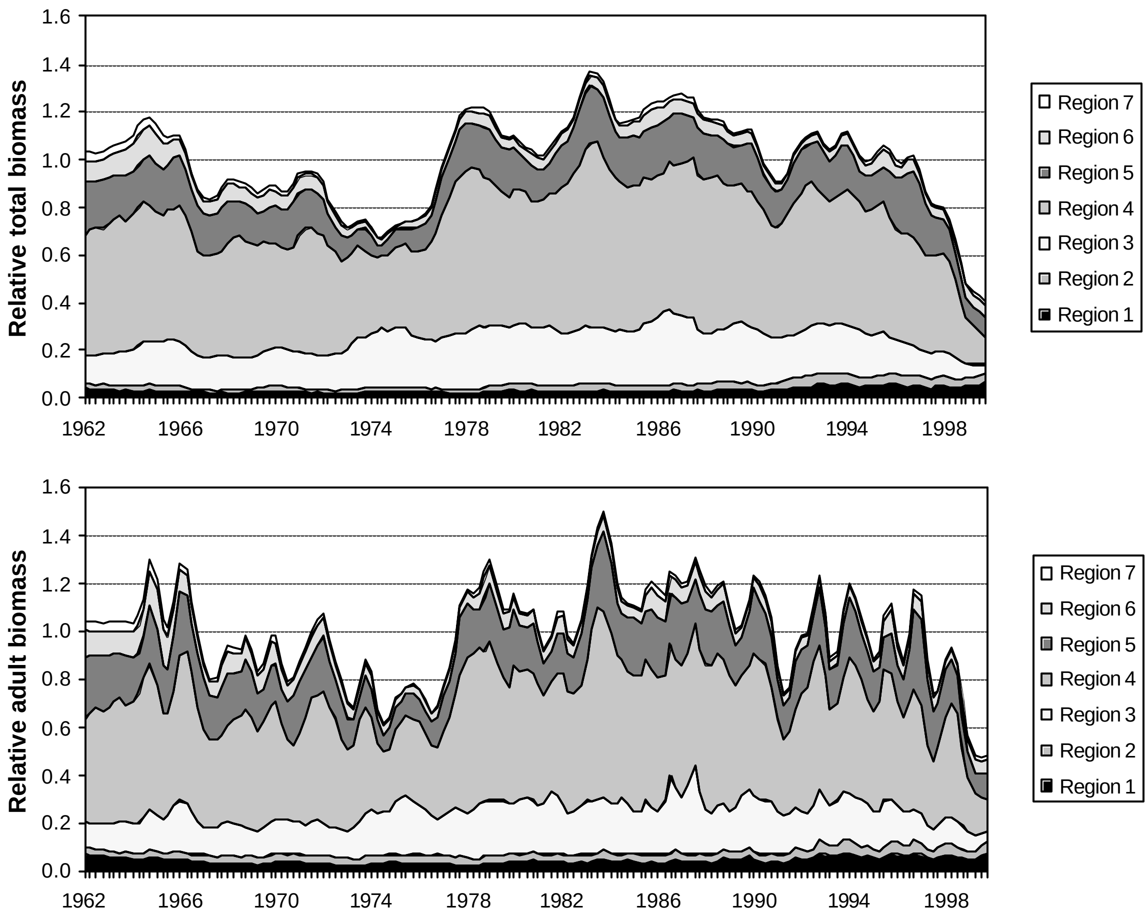

Figure 36. Estimated relative total (upper) and adult (lower) yellowfin tuna biomass, by area. Estimates are scaled to the average spatially aggregated biomass.

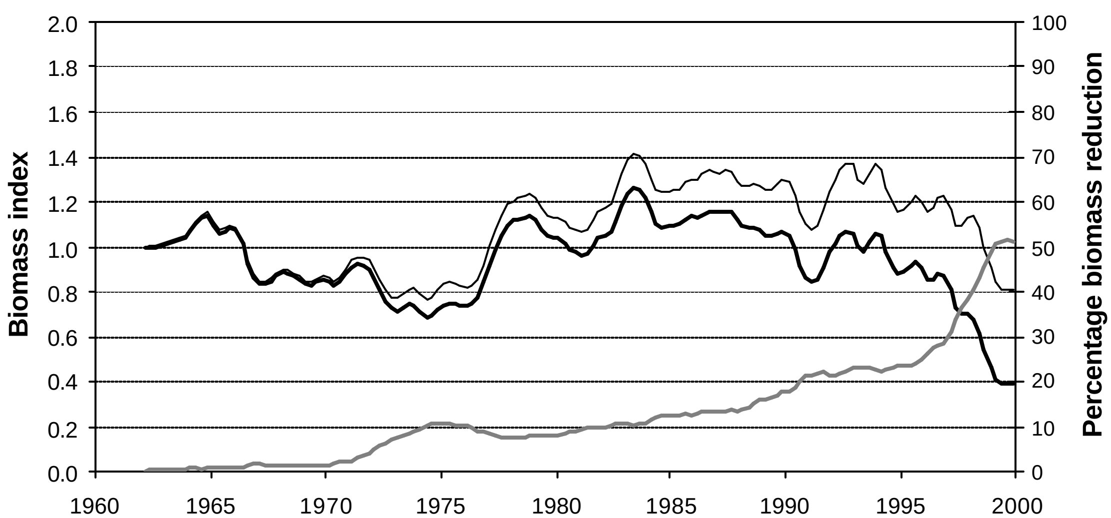

Figure 37. The estimated impact of fishing on yellowfin tuna biomass. The lower biomass trajectory (darker line) represents the model estimates of total biomass. The upper trajectory is the estimated biomass that would have occurred in the absence of fishing assuming that recruitment was unaffected by 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 possible exception to this is the decline in standardised longline CPUE in 1997 and 1998. 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. In addition, fishing mortality rates are estimated to have increased recently, particularly for juvenile yellowfin tuna. This increase is at least partly due to increased catchability, probably resulting from the now widespread use of deployed FADs by purse seiners. The impact of fishing on the stock is therefore estimated to have increased strongly in recent years, from a 20–25% impact on biomass in the early 1990s to a 50% impact in 1999.

If the MULTIFAN-CL estimates are accurate, the WCPO yellowfin tuna stock is probably close to fully exploited at present. At the same time, we should note that these most recent estimates are subject to high uncertainty, particularly in view of the lack of longline fishery data for 1999. Data for the years 1999 and 2000 are urgently required from all fisheries to update this assessment.

4.3 Bigeye Tuna

4.3.1 Catch

Bigeye tuna are an important component of tuna fisheries throughout the Pacific Ocean. Given the possibility that Pacific bigeye tuna may comprise a single basin-wide stock for assessment and management purposes, fishery data from the EPO are included in this report. Bigeye tuna are taken by both surface gears, mostly as juveniles, and longline gear, as valuable adult fish. They are a principal target species of both the large, distant-water longliners from Japan and Korea and the smaller, fresh sashimi longliners based in several Pacific Island countries. Prices paid for both frozen and fresh product on the Japanese sashimi market are the highest of all the tropical tunas. Bigeye tuna are the cornerstone of the tropical longline fishery in the western and central Pacific Ocean; the catch in the SPC area had a landed value in 1996 of approximately US$800 million.

Since 1980, the Pacific-wide longline catch of bigeye tuna has varied between 86,000 and 163,000 mt (Figure 38), 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 50,000–110,000 mt since 1980, surpassing 100,000 mt during 1986 and 1987, but has fallen to below 40,000 mt in recent years. In contrast, the longline catch has been typically 40,000–60,000 mt in the WCPO, the area west of 150°W (Figure 38).

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

The total WCPO bigeye tuna catch in 1999 was a record 105,365 mt,. The total Pacific catch was an estimated 184,546 mt, about 10,000 mt short of the record 1997 catch.

The spatial distribution of Pacific-wide bigeye tuna catch during the 1990s is shown in Figure 39. The majority of the catch is taken in equatorial areas, by both purse seine and longline, but with significant longline catch in some sub-tropical areas (east of Japan, north-east of Hawaii and the east coast of Australia). An important longline fishing area occurs in the equatorial zone at about 110–160°W, an area which overlaps the location of increased purse-seine catches in recent years.

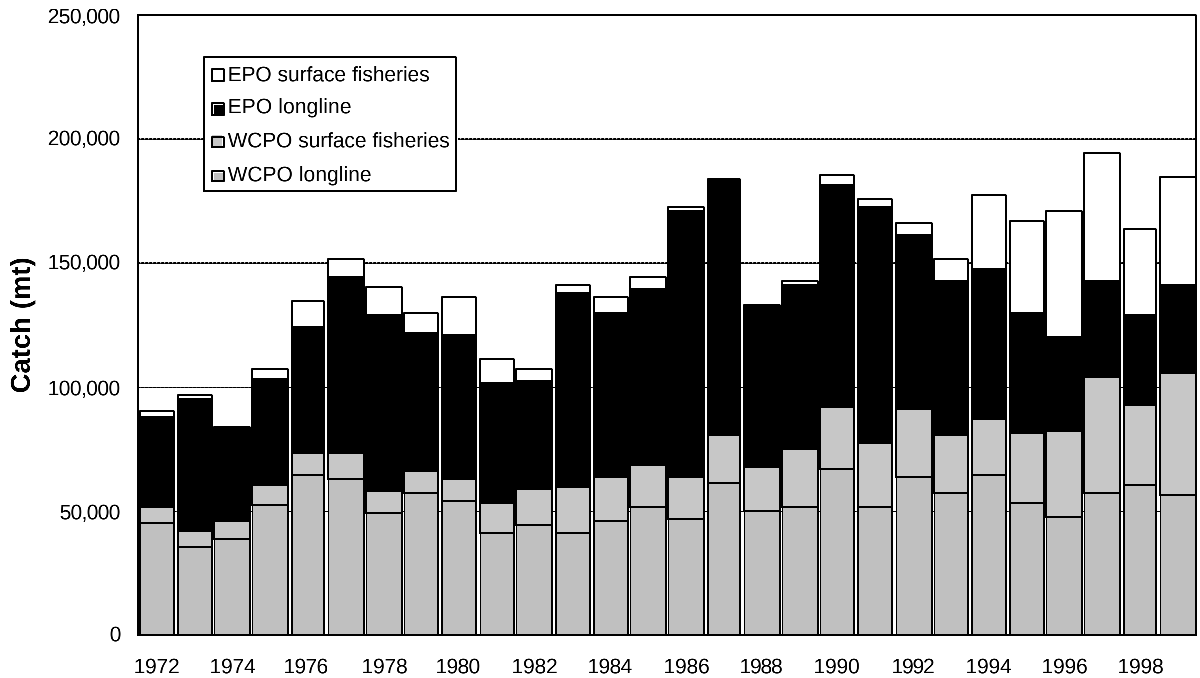

Figure 38. Bigeye tuna catch in the Pacific Ocean.

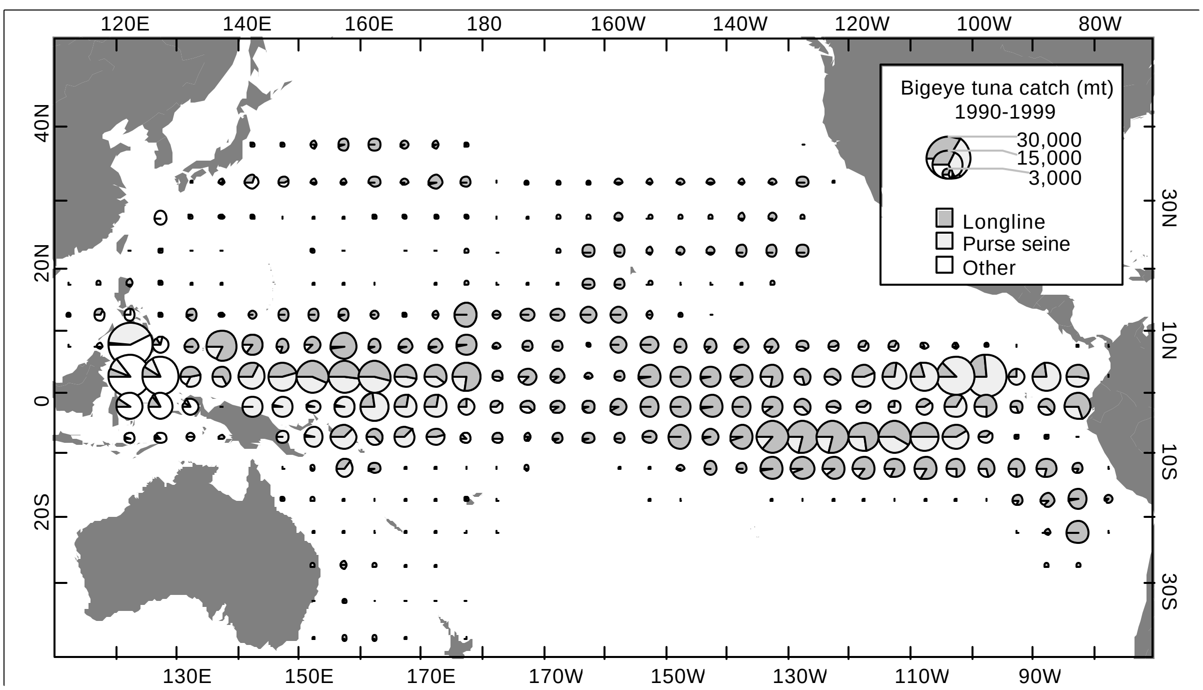

Figure 39. Distribution of bigeye tuna catch, 1990 - 1999.

4.3.2 Catch Per Unit of Effort

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

The changes in targeting behaviour of the Japanese and other longline fleets discussed in section 4.2.2 present similar problems for the interpretation of bigeye tuna CPUE. The changes in setting depth that began in the mid-1970s would be expected to have increased the effectiveness of longline effort for bigeye tuna, particularly in the WCPO where the cooler waters preferred by bigeye tuna are generally >200m. Bigelow et al. (2000b) therefore applied a similar procedure to the estimation of 'effective bigeye tuna' longline effort to that reported in section 2.2.2 for yellowfin tuna. For bigeye tuna, the vertical distribution was defined in relation to their temperature preferences (inferred mainly from acoustical tracking studies) 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 40. The trends are somewhat different to those of the nominal CPUE — in particular, there is a declining trend for the WCPO since about 1990 that is not evident in the nominal CPUE series. For both regions, the most recent standardised CPUE is less than half of the levels recorded in the initial years of the fishery.

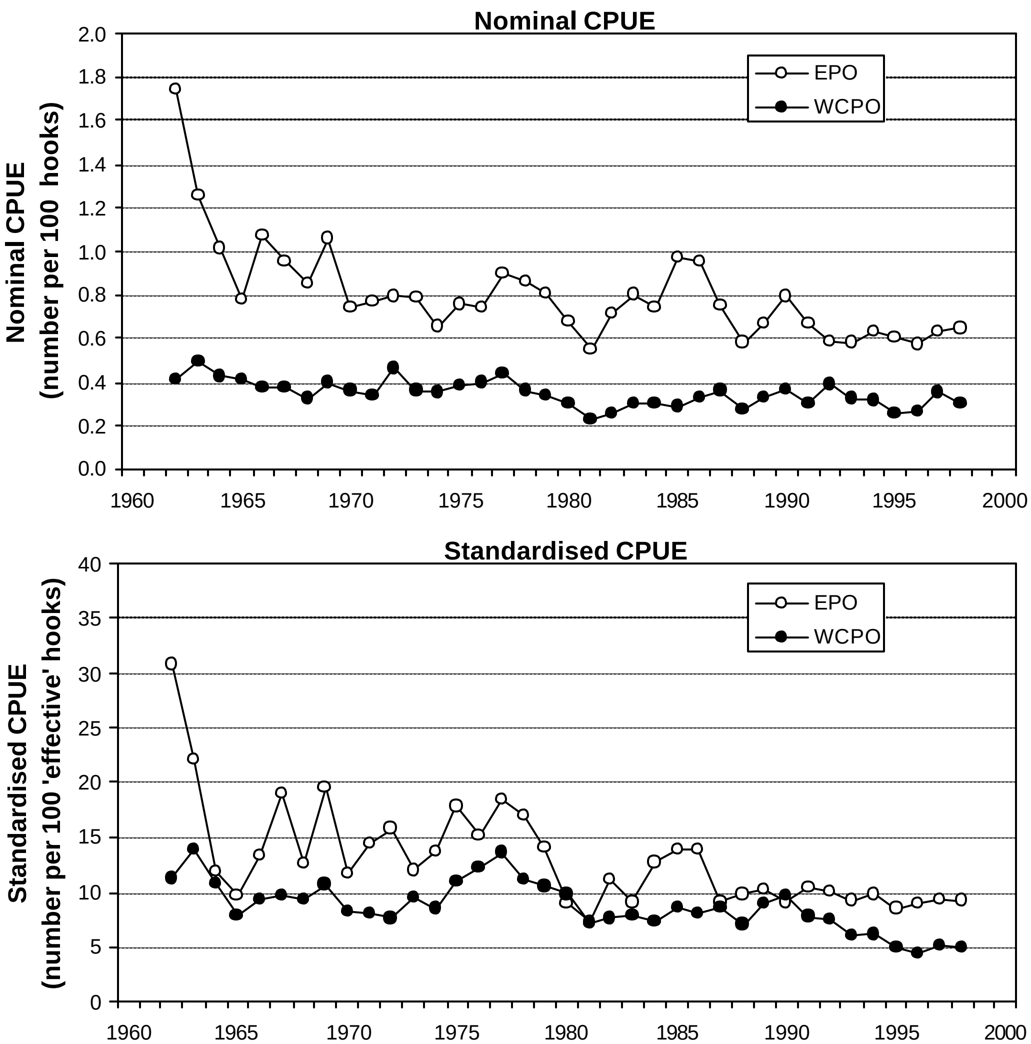

Figure 40. Standardised and nominal bigeye tuna CPUE by distant-water longliners.

4.3.3 Size of Fish Caught

The mean and upper 95th percentile lengths of bigeye tuna sampled from the longline fishery have been fairly stable over a long period of time (Figure 41). This would indicate that the size structure of the population available to the longline fishery has also been stable, under the assumption of a constant selectivity pattern by the longline fishery over this period.

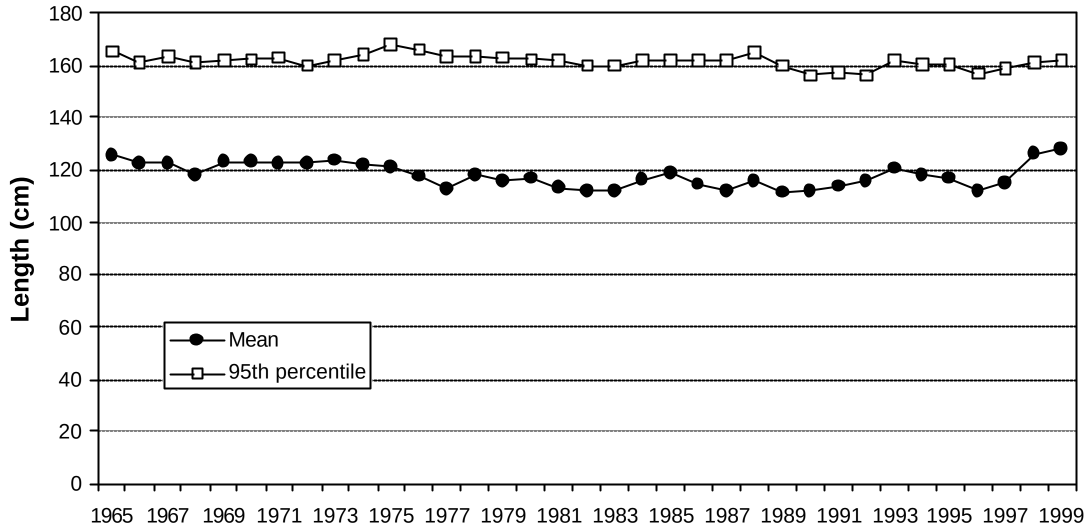

Figure 41. Mean and upper 95th percentile lengths of bigeye tuna sampled from longline catches in the WCPO.

4.3.4 Stock Assessment

Tagging

Some information on the population dynamics and exploitation characteristics of bigeye tuna has been obtained from tagging experiments. During the RTTP, 8,074 bigeye tuna were tagged, from which 1,003 (12.4%) had been returned by the end of 2000. The tagging data demonstrate that bigeye tuna are substantially longer lived than skipjack and yellowfin tuna, with small numbers of returns still being received nine years after release. The estimated exploitation rate derived from these data is slightly larger than that for skipjack and yellowfin tuna, approximately 0.25. Note that this estimate pertains to the early 1990s, prior to the increases in purse-seine catch that have since occurred.

MULTIFAN-CL

OFP, Japanese and IATTC scientists have been collaborating on an initial application of MULTIFAN-CL to bigeye tuna on a Pacific-wide scale. Catch, effort and size composition data covering the period 1962–1999 using a quarterly time stratification have been assembled. The spatial coverage of the model is the entire Pacific Ocean (40°N–40°S, 120°E to the coast of the Americas), within which a four-region spatial stratification (boundaries along 20°N and 160°W) has been adopted. Catch, effort and size data for 15 fisheries (4 longline, 2 Philippines domestic, 1 Indonesian domestic, 5 eastern Pacific purse-seine and 3 western Pacific purse-seine fisheries were used in the analysis. The limited amount of tagging data available from the RTTP 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 all fisheries except three of the longline fisheries, age-specific natural mortality and age-specific movement among the model regions. A detailed description of the data, model structure and preliminary results will soon be available on the OFP web site.

Annual fishing mortality rates for various age groups for the WCPO and the EPO are shown in Figure 42. The trends and values of fishing mortality are generally similar in both regions, particularly for the age groups typically exploited by the longline fishery (older than about age 3). For these age classes, fishing mortality increased gradually from the early years of the fishery but may have declined in recent years in the EPO. For the WCPO, fishing mortality is estimated to have increased strongly in recent years, particularly for the juvenile age groups. Bear in mind, however, that these recent estimates are subject to the greatest uncertainty in the analysis.

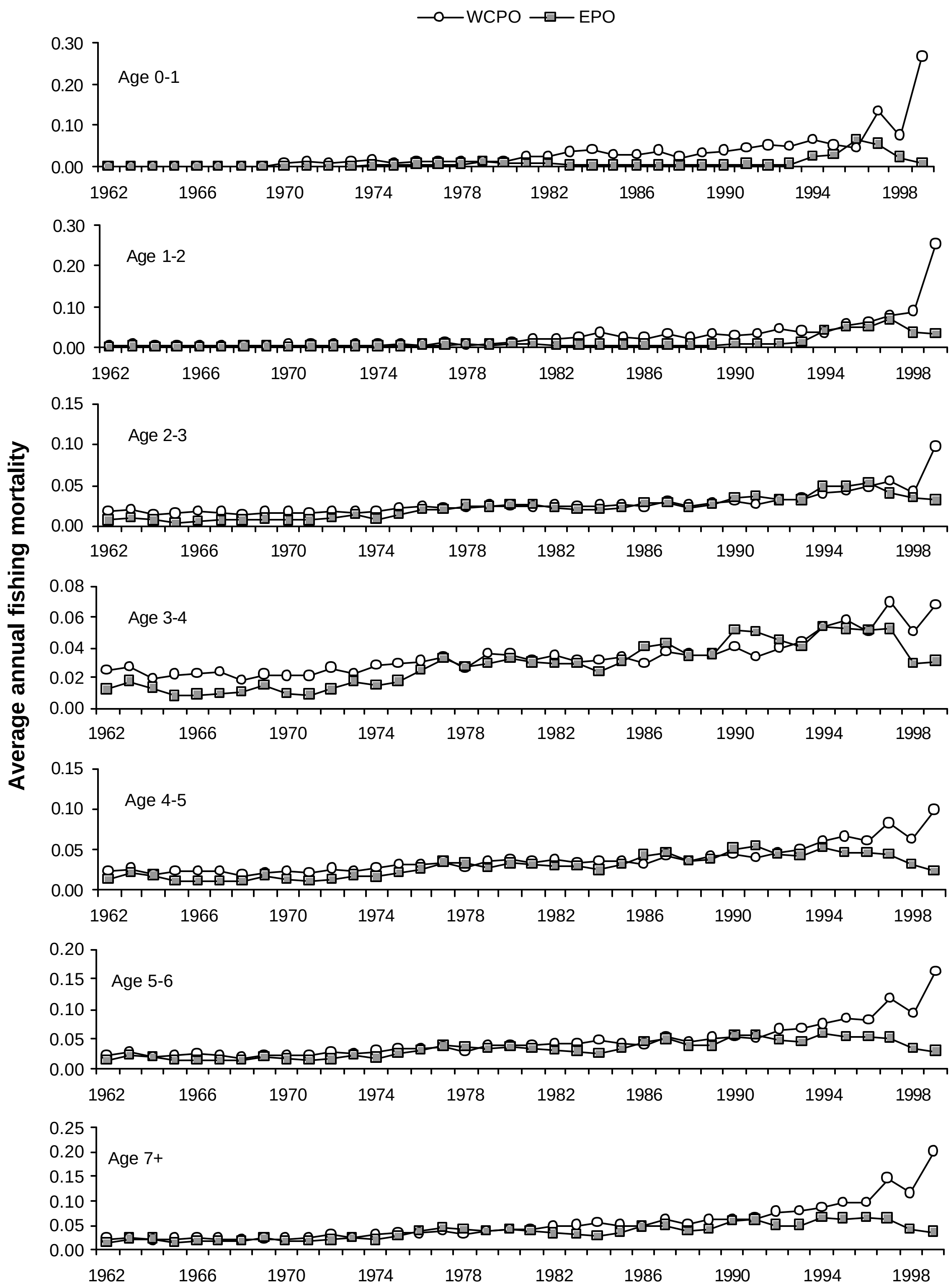

Figure 42. Estimated annual bigeye tuna fishing mortality rates for the WCPO and EPO, by age groups.

Recruitment estimates (Figure 43) show similar low- and high-frequency variation to those for yellowfin tuna. There is a strong seasonal signal in recruitment in the temperate North Pacific model regions and a weaker seasonal pattern in the tropics. As with yellowfin tuna, there is a steady increase in recruitment to the mid-1970s and a decline during the 1990s. The most recent estimates of recruitment for the WCPO are historical lows. By contrast, recruitment for the EPO shows the opposite pattern — a decline up to the mid-1970s and a strong increase during the late 1990s. These patterns of recruitment variability have not yet been related to oceanographic variability, but we note that many of the oceanographic variables that are suspected of affecting recruitment also have antagonistic east–west patterns.

The estimated decline in recruitment in the WCPO, if real, may have fishery management implications. The estimates suggest that the productivity of the bigeye stock in the WCPO is at an all-time low, and this in combination with the recent increase in juvenile catch and fishing mortality may result in overfishing. However, as with yellowfin tuna, it is necessary to point out that the recent recruitment estimates are the most uncertain. We also note that data for the longline fishery were available for this analysis only to 1998, and that more up-to-date data are required to reduce the uncertainty in the recent estimates of recruitment and other parameters.

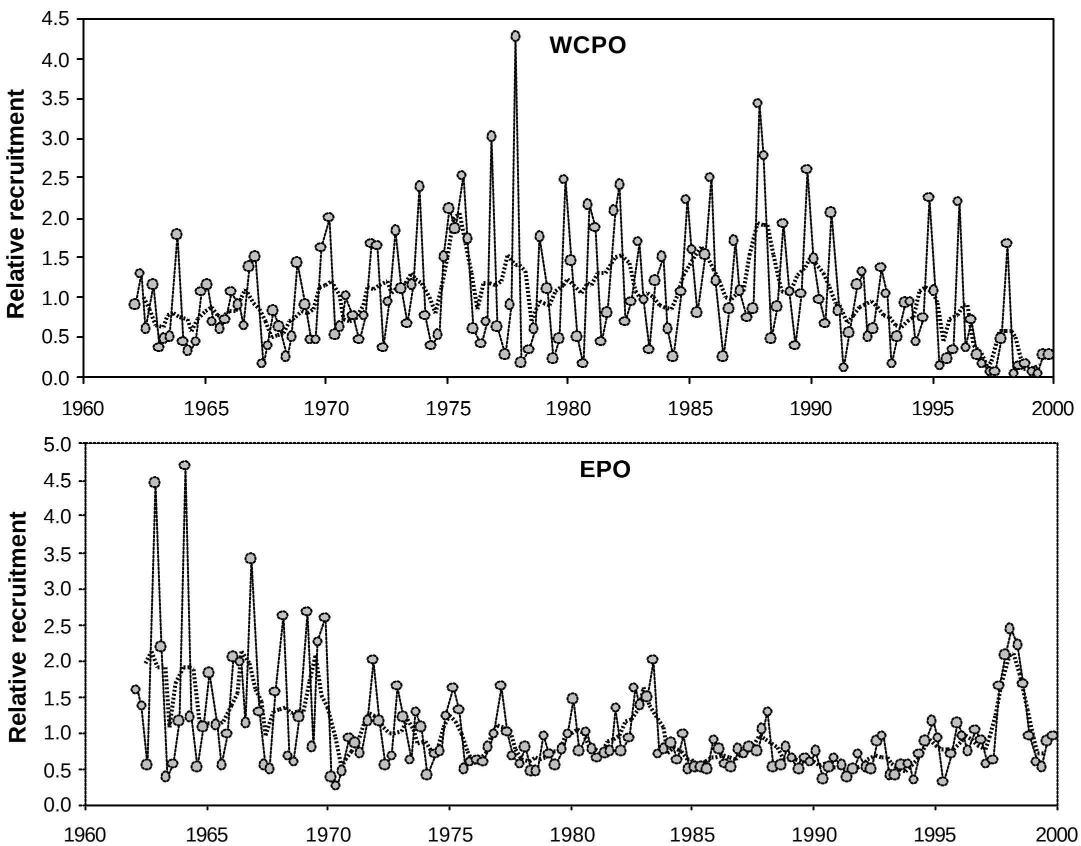

Figure 43. Estimated relative (scaled to the average) quarterly bigeye tuna recruitment with a four-quarter moving average (thicker line) for the WCPO and the EPO.

The time series of estimated relative total and adult **biomass** for the WCPO and EPO are shown in Figure 44. Both total and adult biomass have declined since the beginning of the time series, mostly due to declines in the EPO. For the WCPO, biomass was relatively stable until the early 1990s, after which declines have occurred. In the EPO, total and adult biomass have increased in recent years as a result of the increased recruitment in that region.

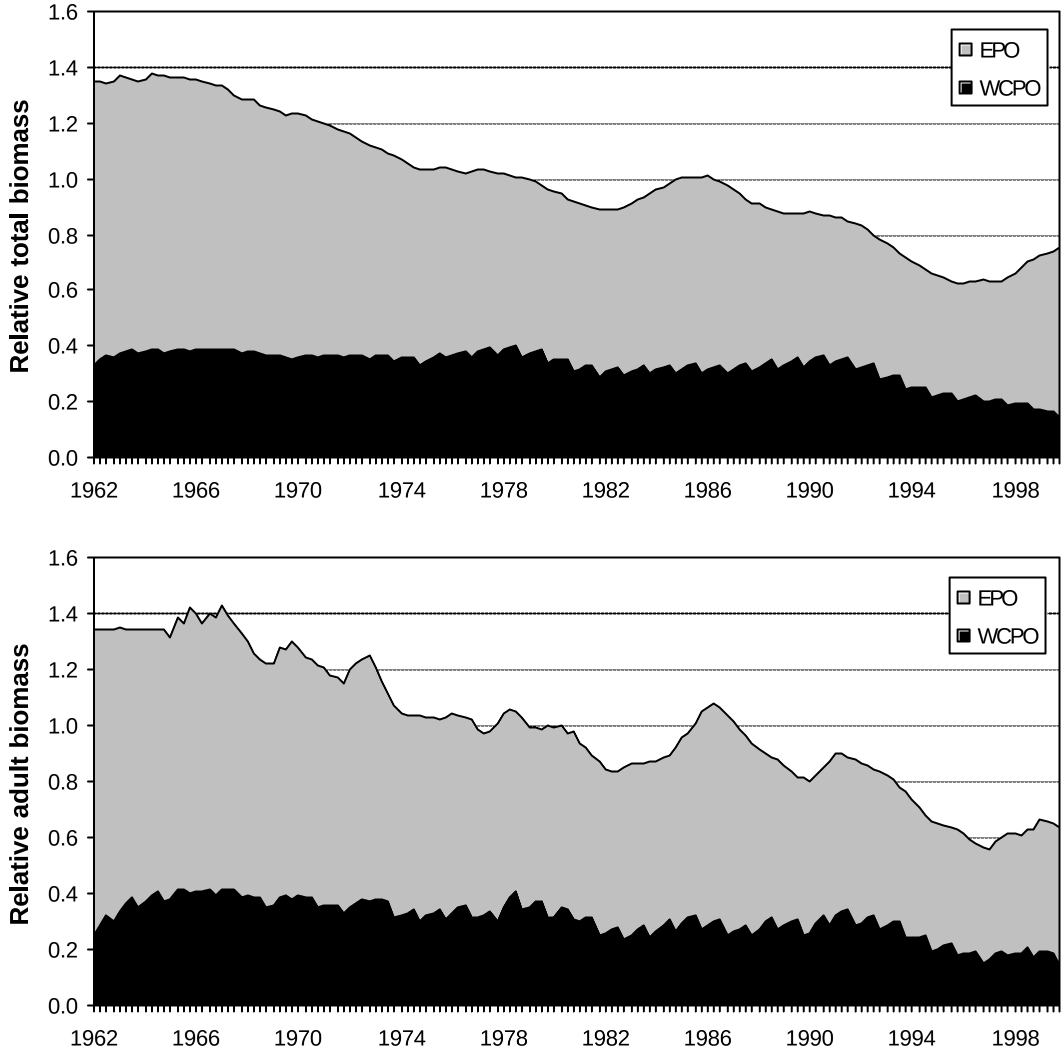

Figure 44. Estimated relative total (upper) and adult (lower) bigeye tuna biomass, for the WCPO and EPO. Estimates are scaled to the average Pacific-wide biomass.

The impact of fishing on the total biomass has increased over time in both regions as catches and fishing mortality have increased (Figure 45). In the WCPO, the most recent biomass level is estimated to have been reduced by 20% compared to the level it would have been in the absence of fishing. This impact would be predicted to rise if recent low recruitment and fishery conditions continue. In the EPO, the corresponding impact on the most recent biomass levels is about 15%.

Conclusion

Bigeye tuna are demonstrably slower growing, longer lived, and, as a consequence, less resilient to fishing than skipjack and yellowfin tuna. The results of limited tagging in the early 1990s indicated that bigeye tuna exploitation rates at that time were at least as great as those for skipjack and yellowfin tuna. Preliminary estimates of relative stock abundance from standardised longline CPUE indicate a decline in abundance during the late 1970s in the EPO and a decline since 1990 in the WCPO, with current levels of longline exploitable abundance at around half the levels that existed in the early years of the fishery. A preliminary Pacific-wide analysis using MULTIFAN-CL has provided additional information on population trends and the impacts of fishing. For the WCPO, recruitment is estimated to have fallen in the 1990s and is currently at a low level. At the same time, catches and fishing mortality of juvenile bigeye in particular have increased. If these conditions persist in the coming years, further declines in the stock would be predicted. Management intervention will likely be required if this occurs. Further MULTIFAN-CL analyses planned in 2001 using updated longline data should provide more information on recent trends in the stock.

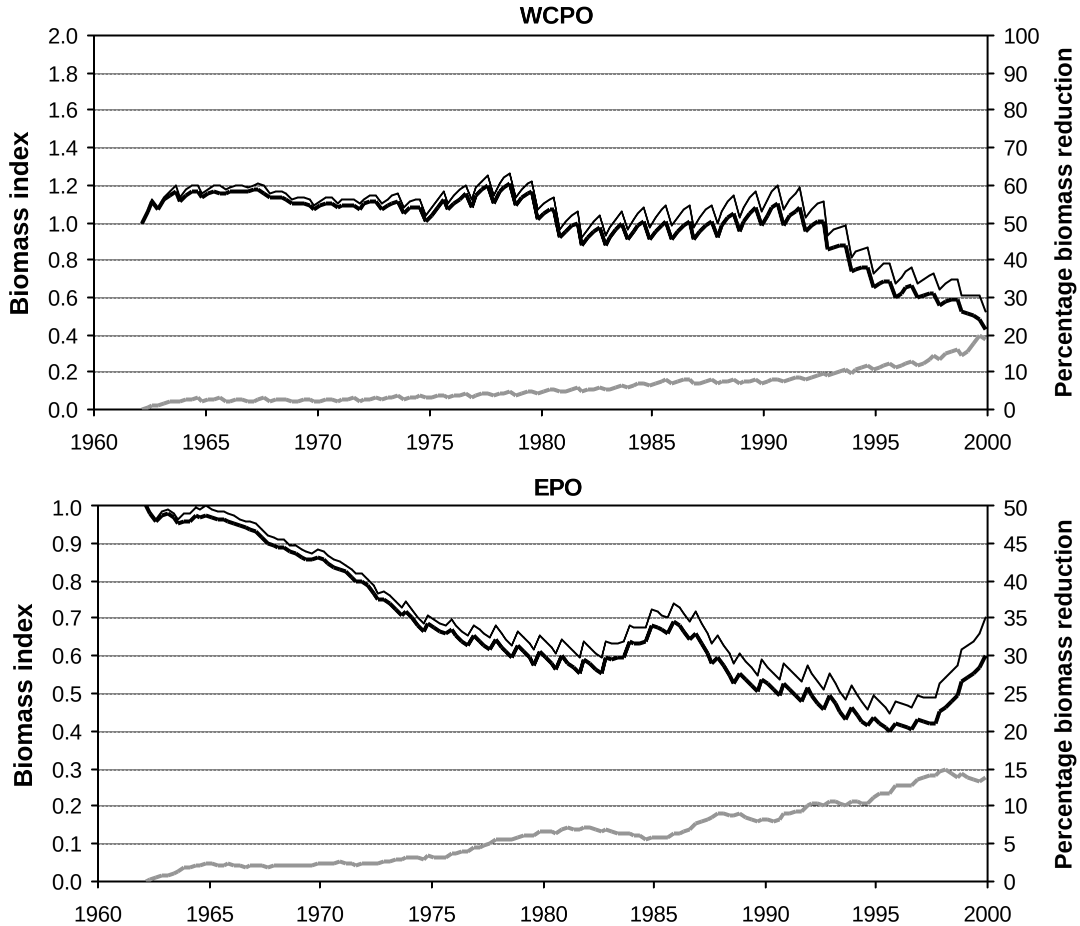

Figure 45. The estimated impact of fishing on bigeye tuna biomass in the WCPO and the EPO. The lower biomass trajectories (darker lines) represent the model estimates of total biomass in each area. The upper trajectories are the estimated biomass that would have occurred in the absence of fishing assuming that recruitment was unaffected by fishing. The lower line plots the percentage biomass reduction due to fishing.

4.4 South Pacific Albacore Tuna

4.4.1 Catch

South Pacific albacore tuna are exploited by a variety of longline fleets, by an international troll fleet operating seasonally in the region of the STCZ and by a domestic troll fleet in New Zealand coastal waters. In the 1990s, the longline catch in the South Pacific has been 23,000–35,000 mt, while the troll fishery, with a season spanning November–April, has caught 4,000–8,000 mt annually (Figure 46). The total catches during most of the 1990s of 32,000–42,000 mt are well below the peak estimated catch of 58,100 mt in 1989, when driftnet fishing was occurring. In 1999, the total catch was approximately 37,000 mt, a reduction of some 5,000 mt from the 1998 catch. This was due to a below-average albacore catch by the New Zealand troll fishery in 1999, as well as some contraction in the longline catch.

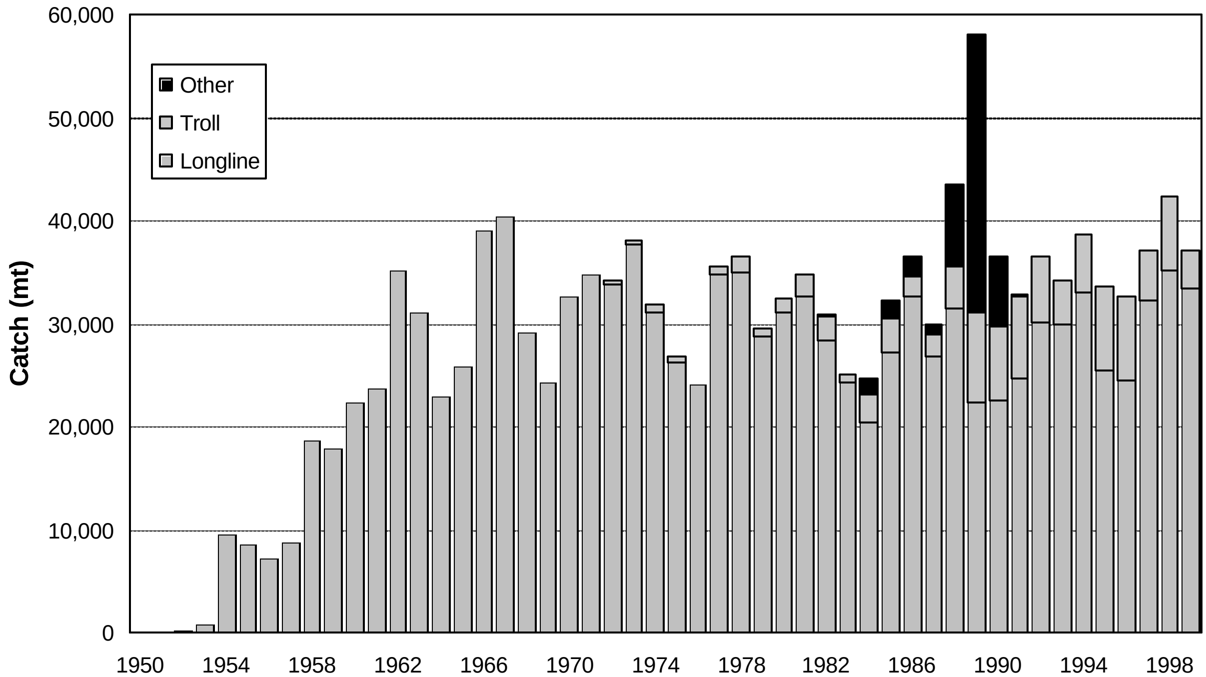

Figure 46. South Pacific albacore tuna catch, by gear. ('Other' is primarily catch by the driftnet fishery.)

The distant-water longline catch, primarily by Taiwanese longliners, is widely distributed in the South Pacific (Figure 47), but with catches concentrated in the western part of the region. Catches by domestic longline fleets in Samoa, French Polynesia, Fiji, Solomon Islands, Tonga and New Caledonia, and the Japanese fleet east of Australia, also contribute significantly to this wide geographical catch distribution.

Troll catches are distributed in New Zealand coastal waters, mainly off the South Island, and along the SCTZ.

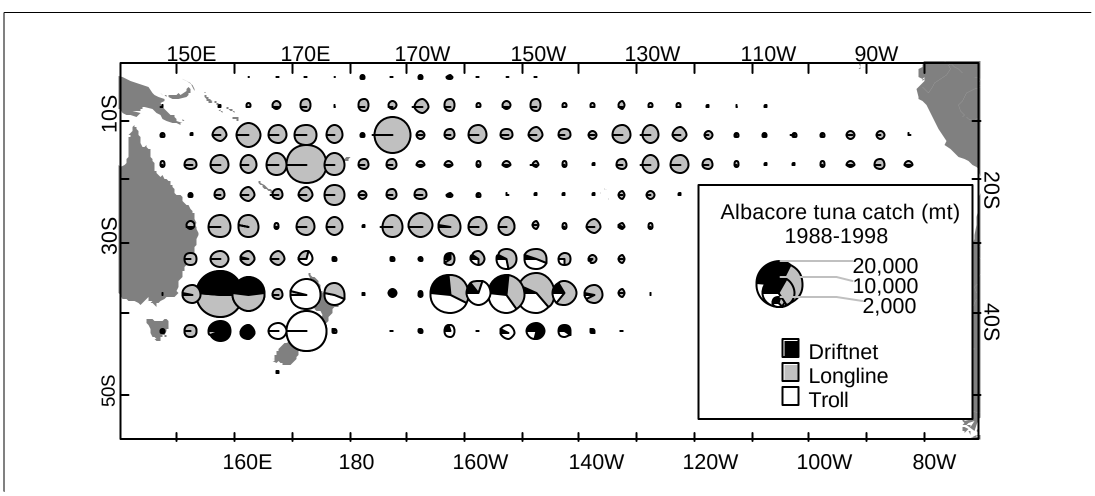

Figure 47. Distribution of South Pacific albacore tuna catch, 1988-1998.

4.4.2 Catch Per Unit of Effort

The key fishery indicators for South Pacific albacore tuna are longline and troll fishery CPUE. For the longline fishery, data from the Taiwanese distant-water fleet are generally used as this fleet has consistently targeted albacore tuna over a long period of time. Longline CPUE (numbers of fish per hundred hooks) is typically highest in the higher latitudes (30–50°S), moderate in the tropics and subtropics (10–30°S) and low near the equator (0–10°S). Time series of CPUE for these latitudinal bands are plotted in Figure 48. 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 49). 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.

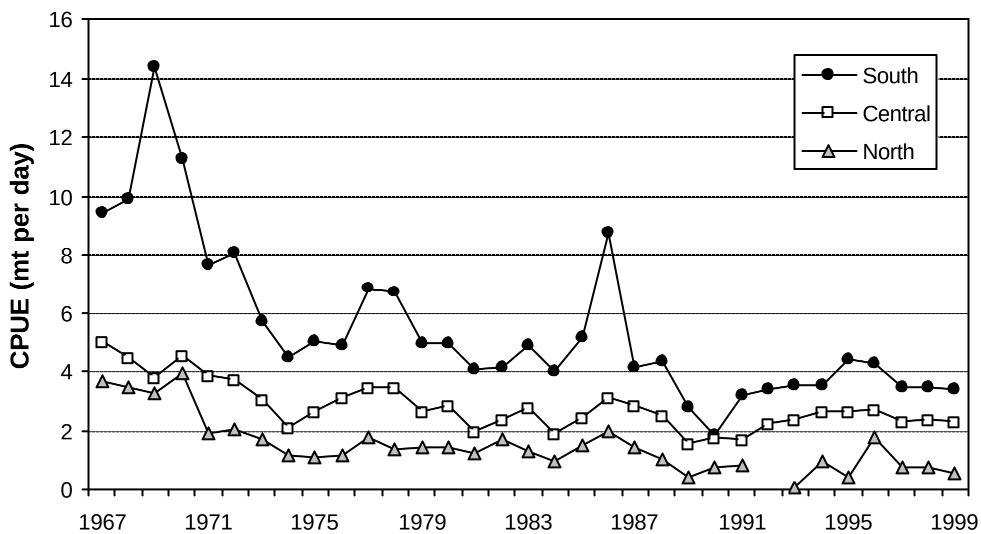

Figure 48. Nominal South Pacific albacore tuna CPUE for Taiwanese longliners. South = 30–50°S, central = 10–30°S, north = 0–10°S.

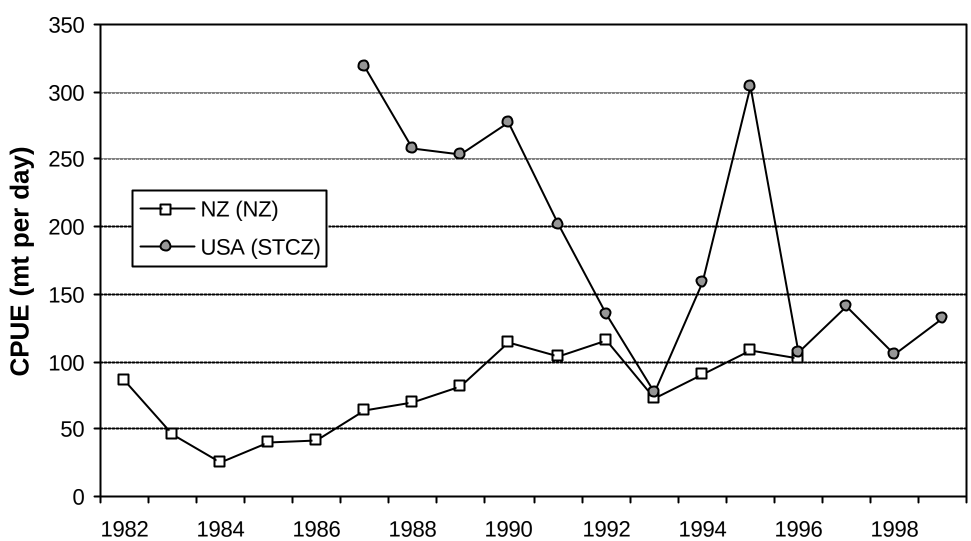

Figure 49. Nominal South Pacific albacore tuna CPUE for the New Zealand troll fleet (operating in New Zealand coastal waters) and the USA troll fleet (operating east of 180° along the STCZ).

4.4.3 Size of Fish Caught

The mean and 95th percentile lengths of South Pacific albacore tuna sampled from longliners is shown in Figure 50. No consistent trends in either length measure are evident.

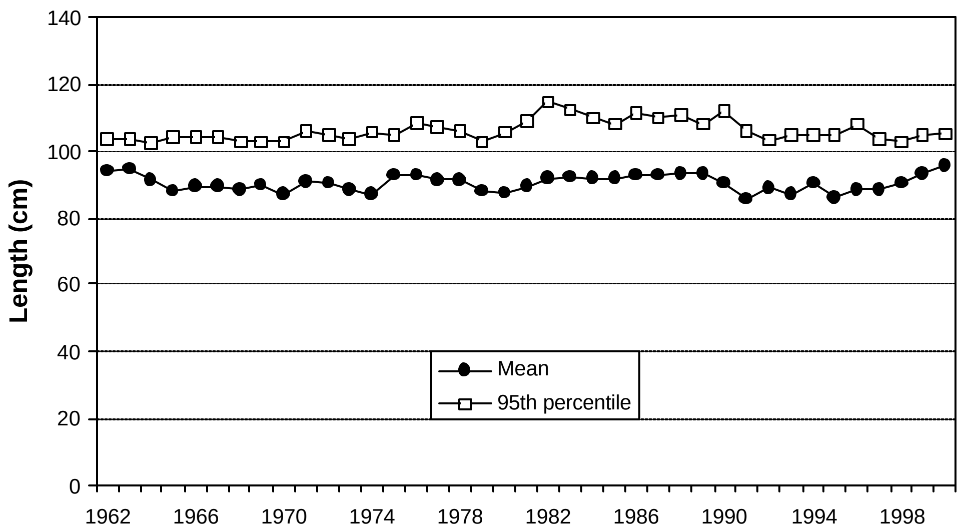

Figure 50. Mean and upper 95th percentile lengths of South Pacific albacore tuna sampled from longline catches.

4.4.4 Stock Assessment

Tagging

Tagging of South Pacific albacore tuna took place from 1986 to 1992 in the troll fishery off New Zealand and in the central Pacific in the region of the STCZ. Of the 17,257 albacore tuna tagged, 295 (1.7%) have been recovered, mostly by the longline fishery. Recaptures have been recorded up to 13 years at liberty.

Bertignac et al. (1996) fitted a tag-attrition model to recaptures received to that time, obtaining estimates of natural mortality rate in the region of 0.4 per year. The average exploitation rate was estimated to be 0.01–0.11 over a wide range of tag-reporting rates, but the lack of independent information on tag-reporting rates restricted further interpretation of the results. However, it could be generally concluded from the tagging results that, if tag reporting was greater than 10% and other possible sources of tag loss were minor, it is unlikely that the exploitation rate would be much greater than 0.10.

MULTIFAN-CL

As noted earlier, South Pacific albacore tuna was the first application of the MULTIFAN-CL model. The analysis considered fishery data from 1962 to 1998, stratified by quarter. 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 a 'domestic' longline fishery 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 given in Hampton and Fournier (2000b) (http://www.spc.int/OceanFish/Html/SCTB/SCTB13/alb1.pdf).

Annual fishing mortality rates for juvenile (ages 1–5) and adult (ages 6+) albacore tuna are shown in Figure 51. Fishing mortality for juvenile fish (primarily taken by surface fisheries) had been 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 has increased since the mid-1980s. The fishing mortality rates for both juvenile and adult albacore are 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 52) shows considerable variability, and is estimated to be at significantly lower levels during the second half of the time series. Lehodey (2000) has hypothesised a positive effect of La Niña conditions on albacore recruitment, which may explain the relatively low recruitment since the early 1980s (a period during which El Niño type conditions prevailed). If Lehodey's hypothesis is correct, an increase in albacore recruitment and population abundance would be predicted over the coming years.

Estimated trends in relative **biomass** are shown in Figure 53. Biomass declined to historic lows in the late 1980s and recovered to some extent during the 1990s. Similar patterns are evident in all regions. Note that biomass is fairly equally distributed between the central and southern regions with a very small proportion occurring in the northern region. The estimated biomass ratio of the last three years to the first three years of the time period is around 0.60.

It is apparent from the low estimated fishing mortality rates that the estimated **impact of the fishery** on the South Pacific albacore population has been very small. While the stock biomass has been considerably lower in recent years compared to the early years of the fishery, these trends are essentially recruitment driven rather than a result of exploitation..

Conclusion

Fishery indicators and the MULTIFAN-CL analysis both suggest that the South Pacific albacore tuna stock declined significantly from the mid-1970s to early 1990s. This decline in stock biomass is attributed to a sharp downward shift in recruitment in the mid-1970s, which may have been related to a large-scale climatic regime shift. The partial recovery of longline CPUE indicators and stock biomass during the 1990s may indicate a return to higher recruitment levels. One hypothesis concerning the relationship between recruitment and oceanographic conditions predicts that recruitment may increase further over the next few years. The impact of the fishery on the stock is estimated to be very small, although this is to some extent a reflection of the low tag-recovery rate for albacore. The 2001 assessment will investigate the impact of the tagging data and assumptions regarding tag-reporting rates on the analysis results.

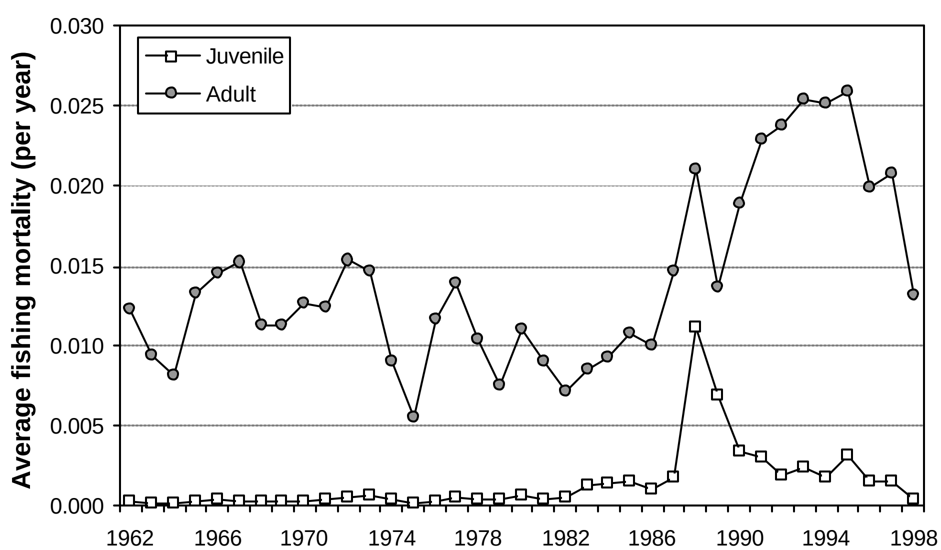

Figure 51. Estimated average annual fishing mortality rates for juvenile (age classes 1–5) and adult (age classes 6+) South Pacific albacore tuna.

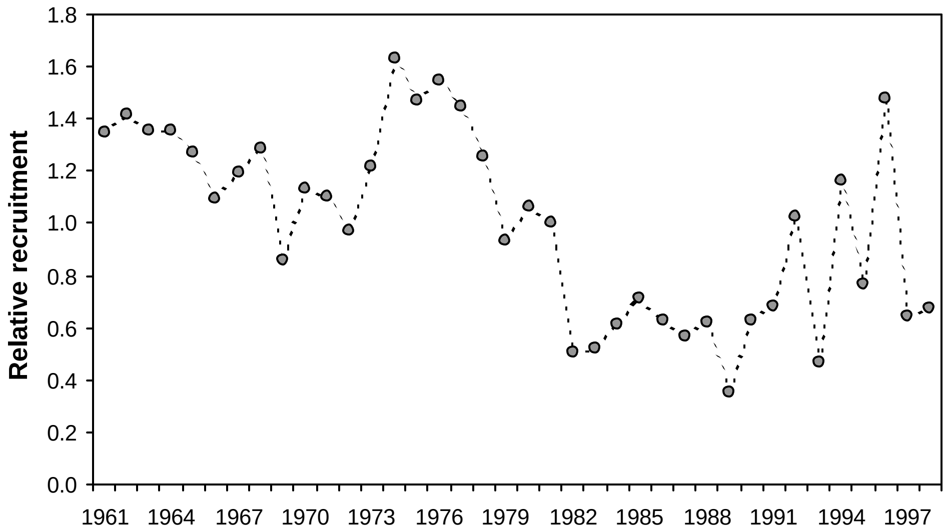

Figure 52. Estimated relative (scaled to the average) annual South Pacific albacore tuna recruitment.

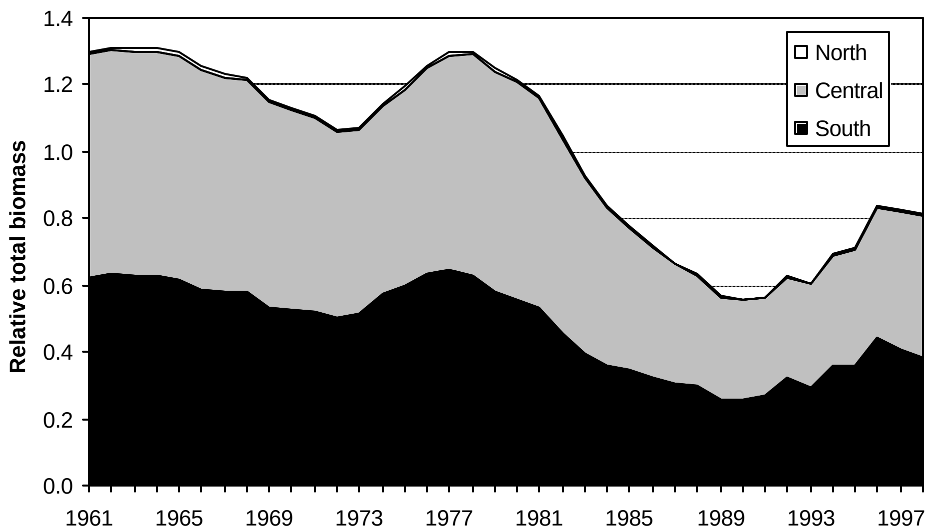

Figure 53. Estimated South Pacific albacore tuna relative biomass by region. Estimates are scaled to the average total biomass.

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