SOUTH PACIFIC COMMISSION

SIXTH SOUTH PACIFIC ALBACORE RESEARCH WORKSHOP

(Rarotonga, Cook Islands, 5–7 March 1996)

REPORT

Noumea, New Caledonia
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CONTENTS

ACRONYMS

CPUE	Catch Per Unit of Effort
DNA	Desoxyribonucleic acid
DWFN	Distant Water Fishing Nation
ECOTAP	Etude du comportement des thonidés par l'acoustique et la pêche à la palangre en Polynésie française
EEZ	Exclusive Economic Zone
ENSO	El Niño Southern Oscillation
EVAAM	Etablissement pour la valourisation des activités aquacoles and maritimes
FAD	Fish Aggregation Device
FFA	Forum Fishing Agency
FAO	Food and Agriculture Organization of the United Nations
GRT	Gross registered tonnage
IFREMER	Institut francais de recherche pour l'exploitation de la mer
JAMARC	Japanese Marine Fisheries Resources Research Centre
LCF	Length to caudal fork
MAF	Ministry of Agriculture and Fisheries (New Zealand)
MSY	Maximum sustainable yield
NFRDA	National Fisheries Research and Development Agency (Republic of Korea)
NIWA	National Institute of Water and Atmospheric Research (New Zealand)
NMFS	National Marine Fisheries Service (United States of America)
NRIFSF	National Research Institute of Far Seas Fisheries (Japan)
NTU	National Taiwan University
OFP	Oceanic Fisheries Programme (SPC)
ORSTOM	Institut français de recherche scientifique pour le développement en coopération
PAFCO	Pacific Fishing Company Limited
PIMAR	Pacific Island Marine Resource Project—USAID
SAGA	Scientific Advisory Group on Albacore
SPAR	South Pacific Albacore Research Group
SPARCLE	South Pacific Albacore Catch at Length Estimator
SPC	South Pacific Commission
SPRTRAMP	South Pacific Regional Tuna Resource Assessment and Monitoring Programme (SPC)
STCZ	Sub-Tropical Convergence Zone
UN	United Nations
USAID	United States Agency for International Development
USMLT	United States Multilateral Treaty

I. INTRODUCTION

The first South Pacific Albacore Research (SPAR) Workshop was held in Auckland, New Zealand in June 1986. It provided a forum to review existing albacore fisheries in the South Pacific, identify types and availability of albacore fishery statistics, review research and research findings on albacore, identify and assign priorities for future albacore research, and finally provide for coordination of research on albacore in the South Pacific. The first SPAR Workshop took place in an atmosphere of 'development', emphasising exploratory trolling to identify distribution of the resource in time and space, and to assess resource potential. In addition to survey work, studies on age and growth, reproductive biology, mortality rates and stock identity were highlighted as requiring regular attention.

In the years following the first SPAR Workshop, the fishery underwent substantial changes. The troll fishery developed steadily, and, in 1988/89, a large fleet of driftnet vessels, primarily from Japan and Taiwan, entered the South Pacific fishery. These developments resulted in the surface catch of albacore reaching an estimated 30,449 mt (Table 2) in 1988/89, doubling the total catch that had been taken by all fisheries at the time of the first SPAR Workshop. Because of these events the second SPAR Workshop, held in Suva, Fiji, in June 1989, focussed more on the status of the stock and the possible effects of the increase in surface-fishery catches, although research review and coordination remained important functions.

Partly because of the uncertainty expressed by the second SPAR Workshop regarding the sustainability of the increased surface catches and their possible effects on the longline fishery, Pacific Island countries and the distant-water fishing nations concerned began a series of consultations on arrangements for management of the South Pacific albacore fishery. At the second of these consultations in Honiara, Solomon Islands, in March 1990, it was agreed that the SPAR group would function as an interim Scientific Advisory Group on Albacore (SAGA), advising future management consultations on the status of the stock and other scientific matters.

Since then, SPAR workshops have been held regularly, the third in Noumea, New Caledonia (9–12 October 1990), the fourth in Taipei, Republic of China (8–12 November 1991), the fifth in Papeete, French Polynesia (29 March–1 April 1993), and the sixth, the subject of this report, in Rarotonga, Cook Islands (5–7 March 1996).

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1. PRELIMINARIES

1.1 Opening address

The Honourable Tepure Tapaitau, Minister for Marine Resources, was unable to attend the opening and Mr Colin Brown, outgoing Secretary of the Ministry of Marine Resources, presented the Minister's address. He said that in the period since the first SPAR Workshop in Auckland nearly ten years ago, SPAR had reviewed the South Pacific albacore fishery, identified the suitability and availability of the albacore fishery statistics, reviewed the research and research findings on albacore, and had identified and assigned priorities for future research. The continuation of this consultative process was vital for the management of the fishery. Pacific Island countries were now concerned about the state of the fisheries resources in the region, including albacore, and wished to ensure that these resources were exploited in a sustainable manner so future generations would enjoy the benefits associated with this. The Minister expressed his gratitude to the Government of Taiwan for funding the workshop and hoped that other major beneficiaries of the fishery would also provide funding support to ensure SPAR continued to meet when necessary. The Workshop was then declared open.

2. REVIEW OF FISHERIES

2.1 Review of the fishery since 1993

American Samoa

Estimated annual domestic landings of albacore in American Samoa increased dramatically in 1995 to around 25 mt. Prior to 1995, domestic landings had been less than 1 mt. This increasing trend has continued in to the first few months of 1996 and the domestic catch is expected to continue rising. There are presently 6 full-time domestic fishermen.

The increased catches can be attributed to several factors, including a change in fishing operations from vertical longlining to horizontal longlining, improved fishing gear, particularly line haulers, and improved cannery prices. These factors have in turn led to an increased commitment by the fishermen.

Annual landings of albacore by foreign vessels to the two canneries has been increasing in recent years. In 1994, around 33,600 mt were landed, this figure increasing to nearly 36,000 mt in 1995. While total landings are increasing, the direct unloadings from longline vessels are falling, with an increasing amount of albacore arriving on carrier vessels and in containers. Highest landings for all types of deliveries occurred in April and September and the lowest during the December-January and June-July periods.

Cook Islands

Since June 1994, a locally-based tuna longline operation has become established in the Cook Islands. Currently three vessels of around 28 meters are licensed although only two vessels have actually conducted fishing operations (the first beginning in June 1994 and the second in January 1995). There has been some interest shown by Cook Islands investors in entering the fishery using smaller vessels.

The two active vessels have been targeting fish for the fresh sashimi market in Japan and the United States. Some fish was also sold locally and in New Zealand. In general trips are undertaken on a weekly basis and on average five sets of 1100 hooks each were made per trip. The total catch for 1995 was 139 tonnes with approximately 29 tonnes being albacore. Other significant components were striped marlin at 30 tonnes and swordfish at 28 tonnes. Bigeye accounted for 13 tonnes and yellowfin 19 tonnes.

In the past the Cook Islands has licensed both Taiwan and Korean longliners but in 1992 the Korean fleet did not seek to renew licenses and in 1995 the Cook Islands Government decided that it would only licence Taiwan longliners as part of a regional fishing access arrangement. Negotiations with Taiwan on the regional arrangement are continuing.

French Polynesia

Since 1992, the only DWFN fleet operating in French Polynesia's EEZ has been Korean longliners. The number of fishing units has remained stable at around 50 to 60 with bigeye and yellowfin tuna the target species and albacore the miscellaneous catch. Catch data for the Korean vessels licensed under an access agreement are compiled from vessels radio reports. Completed logbook data are available for only 30-40 per cent of the fleet. Around 20 vessels are equipped with Argos satellite transponders enabling monitoring of their movement within the French Polynesian EEZ. Additional vessels are expected to be monitored under this system in the future.

During the past three years the domestic fleet increased from 25 vessels at the end of 1992 to 73 vessels in 1995 (66 of them being active). Vessel length ranges from 12 to 25 meters. Between 1994 and 1995, albacore catches decreased slightly from 913 mt to 740 mt. Albacore catches represent more than 30 per cent of the commercial catch.

A small-scale handline fishery began a few years ago. Catch statistics for this fleet are more accurate but the activity coverage remains low and must be improved in future. A substantial increase in handline albacore catch was noted in 1994. This was due to handline activity around FADs where the albacore catch can reach more than 70 per cent.

Since 1993, the ECOTAP programme designed by EVAAM, IFREMER and ORSTOM has assisted the development of the domestic longline fishery. Fishing experiments are conducted using instrumented longlines and the results obtained have focused on the gear used and its effect on catch variability.

Fiji

The progress attained in the development of the albacore fishery in Fiji has been shown through the record landings of the local tuna sashimi longliners, together with the Taiwanese longliners, for the PAFCO cannery in Levuka. There has been an average increase of 27 per cent in the total catch for the Taiwanese fleet and 20 per cent increase for the sashimi longliners during this period. Although albacore is treated as by-catch by sashimi longliners, it has comprised more than 70 per cent of the total tuna landed in Fiji from 1993-1995.

The increase in landings for the period may have been reflected to some extent by the increase in the numbers of local longliners possibly increasingly targeting albacore. This had been validated by the

decrease in number of the fleet for the Taiwanese but an increase in landings. Market price for albacore has been increasing steadily for the last 3 years, and it may have been the trigger for this increase.

The Fisheries Division recently has set up an offshore section to look after all tuna and deepwater fishery issues. The section will be the focus for albacore stock assessment and research for Fiji, and particularly to strengthen the ongoing data collection and a future local observer programme. Intensive tuna stock assessment in Fiji is the main agenda item for the next triennium.

Japan

Japanese longline and pole-and-line fisheries operate in the SPAR area with the longline fishery taking albacore as a bycatch, in operations targeting bigeye and southern bluefin tunas, for the past two decades. The longline albacore catch has fluctuated around 5000 mt since 1981 until 1992. More than 60 per cent of the catch has come from the western area (the Coral Sea, Tasman Sea and around New Zealand), although the percentage of overall effort in this area was minor. In 1993 and 1994, the catch was estimated to be about 8000 mt, which was more than twice the catch in 1992. The increase of catch mainly occurred in the western area, especially in the Coral Sea–Solomon Islands area.

Japan noted that the lower catch rates of albacore by Japanese longliners operating in the Eastern Pacific are difficult to interpret due to the changed targeting practices of the fleet. However, attempts to standardise the effort to account for this still indicate a lowering in CPUE such that in addition to the change in fishing behaviour, the data might also be indicating a change in albacore abundance in this area.

The Japanese pole-and-line fishery in the SPAR area has been minor, with only sporadic operations. The driftnet fishery has ceased to operate since 1990.

Niue

Albacore is not targeted nor commonly seen in the small-scale domestic inshore pelagic fishery although small incidental catches have been observed, particularly from small-scale vertical longlining around FADs. These fish average roughly between 7–15 kg.

Niue has licensed foreign Taiwanese longline vessels under a bilateral fishing agreement for the periods 1993–94, 1994–95, and 1995–96 with a total of 30, 48, and 16 vessels licensed for these years respectively. From the required reports, submitted by the vessels, calculated totals of 345 mt, 663 mt, and 318 mt of albacore tuna have been caught within Niue's zone for the respective years of licensing. Niue noted that despite the bilateral agreement with the Taiwanese industry clearly stipulating agreed catch and reporting requirements, compliance with these conditions remained poor. Some improvement has been noted and there is now better communication between Niue and the Taiwanese, but despite this, the situation remains poor. In alignment with agreement provisions, most of the catches have been off-loaded in Pago Pago (designated port).

Niue strongly supports replacing the bilateral agreement with Taiwan with the proposed multilateral sub-regional agreement.

Republic of China (Taiwan)

Taiwanese tuna longline vessels have fished in the South Pacific since the middle of the 1960s. Most of the longline vessels are larger than 200 GRT, and they mainly target albacore.

In 1989, some small Taiwanese tuna longline vessels began to shift their fishing operations away from the waters adjacent to Taiwan. Up to now, their fishing grounds have extended to past 170° W. Catch reports reveal that these vessels have been fishing north of the equator. Almost all of the small-type tuna longline vessels target yellowfin and bigeye tunas. Albacore is one of the by-catch species only.

The coverage rate for the Taiwanese-administered logbook programme for the distant water longline vessels operating in the Pacific is estimated to be around 35 per cent in 1994. A separate data source, the landings data, is based on information supplied from the various fishing agents in the Pacific. These data are believed to cover around 95 per cent of total Taiwanese landings in the Pacific.

Taiwan also noted that its government is actively encouraging fishermen to improve their reporting behaviour. Data reporting has improved, and further improvements are expected in the future.

Solomon Islands

Foreign longline fishing has a long history and has been the only fishery that harvests albacore in Solomon Islands waters. Since the declaration of a 200 mile EEZ in 1978, the fishery has depended on bilateral access agreements under Head Agreements with Japan, Taiwan and, on one occasion, Korea.

The highest foreign longline albacore catch for the last three years - 838 mt - was taken by Japanese longliners and recorded in 1994. Taiwan has not been providing catch statistics. The average number of foreign longline vessels licensed to fish in Solomon Islands water each year for the last three years (1993–1995) was 60 (Japan) and 20 (Taiwan).

By 1995 a total of five locally-based fishing companies had been established, and 35 longline vessels are licensed under charter arrangements to longline in Solomon Islands waters. These longliners were mainly from Korea with a few from Japan, Vanuatu and Panama. The total albacore catch recorded during 1995 was 500 mt, but only 12 vessels were covered.

No research has yet been done on albacore. The chances of national fisheries observers collecting length frequency data on albacore tuna, however, are good as albacore has dominated foreign chartered longline catches.

Tonga

The tuna fishery in Tonga started in the mid 1970s. However, no records of catches are available until 1982. From 1982 to 1992, the *M.V. Lofa*, the only longliner operating in Tonga, landed about 3210 mt of tuna. About 61 per cent of the total catch consists of albacore, which was exported to the canneries in American Samoa and Fiji.

The success of the Tonga/USAID's PIMAR project on small-scale tuna fishing boats from November 1991 to December 1994 attracted some local investors to invest in the tuna fishery. As a result

the number of longliners increased from one in 1992 to 8 in 1995. Five of these are small-scale fishing vessels, ranging in size from 40 to 50 ft, and equipped with monofilament mainline, targeting bigeye and yellowfin for the sashimi market. However, data collected from these vessels in the last five months indicate that their main catch is albacore, ranging from 30 to 50 per cent. The other two vessels in addition to the *M.V. Lofa* are targeting albacore for the cannery in Pago Pago. Therefore one can expect to see an increase in landed albacore from 1993-1995. However, the actual figures are yet to be finalised.

Considering the importance of the tuna resource for the country's economy and to protect the domestic commercial industry, the Government, through a Cabinet decision in 1993, established the current policy of not licensing locally-based foreign vessels. Licences to harvest the tuna resource inside Tongan waters are only issued to locally-owned fishing vessels.

United States of America

American troll vessels have participated in the South Pacific albacore fishery since 1986. The fishing season for the fleet is generally from December to April of the following year. Fishing occurs on the high seas in the Sub-Tropical Convergence Zone (STCZ), principally between 35° S to 45° S latitude and 140° W to 175° W longitude. Of the US troll boats that do not head south for the southern season, some fish for crabs and salmon, others may remain in port for maintenance and repair.

American participation reached a peak in 1990–91 with 58 vessels and declined steadily to 12 vessels in 1994–95. This decrease is attributed to poor availability of fish owing to the persistent El Nino-like condition in the South Pacific.

The catch during 1990–91 to 1994–95 ranged from 603 mt to 5,540 mt. For the 1994–95 season, the catch was 2,916 mt and the catch rate, 150 fish/day fished. Fish in the catch ranged from about 47 cm fork length (FL) to 104 cm FL. Fish were generally larger than albacore caught during the 1992–93 and 1993–94 seasons.

The meeting commended the US for the quality and detail of its report.

Western Samoa

The albacore fishery in Western Samoa is based on foreign fishing vessels, mostly Taiwanese and recently domestically-based 9m alias, the number of which has gradually been rebuilding following a series of cyclones in the early 1990s that caused serious damage to the fleet. There are now 15 vessels, 9m alias, dedicated to vertical longlining, and this constitutes 20 per cent of the total Western Samoan fleet. Albacore is either air-freighted to sashimi markets in Australia, Hawaii and New Zealand, or frozen on-shore and sent via container to Pago Pago.

Foreign fishing vessels are licensed to fish and harvest the tuna resource within Western Samoa's 200 mile EEZ. Although a requirement is included in the bilateral access agreement for longliners licensed in Western Samoa to supply data, few catch data have been submitted. Data on tuna catches from 1962–1977 from Japanese, Korean and Taiwanese longliners have been compiled and summarised by the Oceanic Fisheries Programme of SPC. No albacore data from licensed foreign fishing vessels have since been supplied due to poor reporting by longliners, especially the Taiwanese fleet.

In the 1994 and 1995 period, thirty seven (37) Taiwanese longliners were licensed to fish with an access fee of about 1000 tala (US$400) per vessel. Albacore landings for this period have yet to be submitted.

Sixty-two percent of the local fleet involved in the tuna fishery harvested mostly skipjack and yellowfin species prior to 1991. Since then, 20 per cent of the local boats have been targeting large size tunas including albacore and bigeye using both vertical and horizontal longlining methods.

About 17 mt and 24 mt of albacore were landed in 1993 and 1994 respectively. The total albacore landings for 1995 are yet to be fully compiled. However, the total albacore export for the sashimi market was estimated at 40 mt.

Western Samoa is in favour of a subregional multilateral access arrangement with Taiwan rather than a bilateral arrangement. The 1995 access agreement period is completed and Western Samoa is not licensing Taiwanese longliners for the 1996 period.

A domestic sampling programme will soon be in place to collect catch and effort data from locally-based foreign vessels and the domestic alia fleet harvesting albacore and other tuna species using longline methods. Monitoring exports of albacore will also be part of the sampling programme.

3. REVIEW OF AVAILABLE FISHERY DATA

3.1 Updated best estimates of total catch and effort

Mr Tim Lawson presented Agenda Item 3. The tables of annual catches by longliners (Table 1) and surface fisheries (Table 2) were updated during the course of the meeting. Changes to the tables presented at past SPAR meetings include the following:

- Columns were added covering the recently-developed longline fisheries of American Samoa, Cook Islands and Western Samoa.

- American longliners fished in the waters of Fiji during 1994; however, estimates for the American vessels were included in a separate column, rather than in the column for Fijian longliners.

- The column for the Australian longline fishery was separated into two columns, one covering domestic vessels and one for Australia-Japan joint-venture vessels. The question was raised as to whether the joint-venture vessels were also covered in the column for Japanese longliners; however, it was the understanding of the meeting that, in the past, these vessels had not been covered in the Japanese statistics.

- Artisanal catches are not covered in the table; therefore, the small artisanal catches (30 mt per annum) on Easter Island, which had been included in the past under 'Other Troll', were excluded.

- All estimates for driftnet and troll represent the fishing season (usually December to April), rather than the calendar year; the seasonal catches listed in Table 2 are allocated to the year in which the season ended.

There was discussion regarding the source of the annual catch estimates for Taiwanese distant-water longliners. Dr Wang explained that National Taiwan University received estimates of the amounts unloaded to canneries, or transshipped, from the agents of the fishing vessels in each of the ports where unloading occurred, both within the Pacific Ocean and elsewhere. The amounts unloaded that are reported by the agents can be broken down by ocean area in which the fishing occurred; therefore, Dr Wang considered that the estimates of annual catches for the Taiwanese distant-water longline fleet in the whole Pacific Ocean were accurate. The estimates for the south Pacific Ocean for 1967–1991 were estimated by multiplying the catch for the whole Pacific by the proportion of the total catch which took place in the south Pacific; the proportion of the catch in the south Pacific was determined from logbook data. The provisional estimates for 1992–1994 are based on annual reports published by the Taiwan Fishery Bureau and the Tuna Research Center of National Taiwan University. The estimate for 1995 represents landings for the whole Pacific Ocean.

In this regard, it was suggested that the unloadings of albacore by Taiwanese longliners in Levuka (Fiji) and Pago Pago (American Samoa) be compared to the estimates of annual catches in WP.13 Although a limited time series of unloadings data was available to the meeting, these statistics are presented in Table 3. The statistics on unloadings in Levuka and Pago Pago listed in Table 3 include only those by Taiwanese longliners, rather than those by transshipment vessels, which may also include catches of albacore by Taiwanese longliners; the total unloadings listed in Table 3 for 1993 and 1994 are therefore minimum estimates of the catch. While the total unloadings for 1994 are less than the annual catch estimate reported in WP.13, the total unloadings for 1993 are considerably greater than the annual estimate in WP.13. Mr Lawson and Dr Wang agreed to liaise in order to resolve these discrepancies.

It was also noted that the estimates of annual catch for the Taiwanese longline presented in WP.13 were reported to be for the SPC statistical area, rather than the whole of the south Pacific. However, the estimates for 1967–1990 are identical to previous estimates reported to SPAR, which cover the whole south Pacific.

The meeting also noted that there are still considerable discrepancies between the estimates presented in WP.13 and those determined from data aggregated by 5° longitude by 5° latitude and month, which have been provided to the OFP and other organisations by National Taiwan University. Table 4 presents a comparison of the two time series. The differences between the two time series range from -4,532 mt (1978) to +10,336 mt (1992). The total catch determined from the 5x5 data ranges from 61 per cent (1984) to 159 per cent (1993) of the estimates reported in WP.13.

Dr Wang explained that the estimates reported in WP.13, which are based on landings data, are more reliable than the estimates determined from the 5° x 5° data. The 5° x 5° data represent logsheet data which have been raised to represent the total catch. The procedure used to raise the logsheet data has varied within the time series, and has been based either on landings, number of trips, or number of hooks, etc, depending on the year. It was noted that discrepancies between the total landings and estimates of the total catch determined from the 5° x 5° data would almost certainly arise for years for which the raising procedure was not based on landings. Since the 5° x 5° data have been, and continue to be, widely used for research purposes by the OFP and other organisations, Taiwan was strongly encouraged to revise the 5° x 5° data in order to minimise the discrepancies with the landings data.

The Japanese longline catch was stable in 1994, compared to 1993, while the Taiwanese longline catch increased. The annual catch from longline fisheries in 1994 was estimated to be 30,105 mt, which represents a 12 per cent increase over the estimated 1993 catch of 26,875 mt.

Catches by the New Zealand troll fishery increased during the 1993/94 season, while catches by American trollers declined. Preliminary estimates indicate that catches by both the American and New Zealand troll fisheries increased substantially during the 1994/95 season. The catch by the surface fishery increased slightly from 4,989 mt in 1993 to 5,073 mt in 1994, while the surface fishery catch in 1995, based on preliminary estimates, increased to 9,125 mt. Histograms of annual longline and surface catches are given in Figures 1 and 2 respectively.

3.2 Review of trends in fishery indices

Dr Lewis gave a brief summary of trends in fishery indices, then the meeting considered four background papers concerning standardised catch rates. Referring to the nominal catch rates presented in WP.2 and elsewhere, Dr Lewis noted that:

- Catch rates for the American troll fleet have been variable, with no apparent trend.

- While there are no hard data for the New Zealand troll fleet for the 1995/96 season, Dr Talbot Murray of the National Institute of Water and Atmospheric Research (NIWA) of New Zealand reported by telephone that the catch was approximately 6,000 mt, with catch rates of up to 3 mt per day, which is relatively high compared to historical catch rates.

- The Taiwanese longline fishery accounted for 51 per cent of the longline catch, and 43 per cent of the total catch, in 1994. Over the period from 1986 to 1990, nominal catch rates declined by about 50 per cent, although it has not been clear whether this decline was related to the driftnet fishery. Since 1990, catch rates have been increasing.

- Since the late 1970s, nominal catch rates for the Japanese longline fleet have been stable; however, since 1992, catch rates have increased. There would appear to be higher catch rates in the western part of the area fished by the Japanese, off the east coast of Australia, even after correcting for targeting.

- The time series of data for the offshore longline fleets of Australia, Fiji, French Polynesia, New Caledonia and Tonga are relatively short; however, downward trends in nominal catch rates are not apparent, in spite of increased catches.

Japanese longline

Dr Yuji Uozumi then presented a paper on standardised catch rates for the Japanese longline fishery (WP.18). The effects of year, area (ten sub-areas), season (quarter), and gear configuration (3–7, 8–11, 12–15 and 16–20 hooks between floats), and interactions, on albacore CPUE were determined using a general linear model with lognormal errors. The same effects on catch were determined by including them as linear terms in a Poisson model of the expected catch in numbers of fish. The analyses were conducted for the total area (all ten sub-areas), for a tropical area (five sub-areas), and for a temperate area (four sub-areas).

For the CPUE model in the temperate area, year, sub-area and quarter, but not hooks between floats, were significant; R^2, a measure of the amount of variation in CPUE explained by the model, was high, 0.67, and the fit was good. For the CPUE models in the total area and the tropical areas, year, sub-

area, quarter, and hooks between floats, were significant; R^2 was 0.49 and 0.39 respectively. The standardised CPUE for the total area, the tropical area, and the temperate area, are shown in Figure 3. Standardised CPUE for the total area has increased since 1989, reaching the highest level in the time series in 1994. The results for the model of the expected catch in numbers of fish were similar to those for the model of CPUE.

It was noted that standardised yellowfin CPUE for purse-seine fisheries has also shown an upward trend, but that it has generally been accepted that the trend, which extends back to the early 1980s, is probably due to technological changes and an increase in experience, which together have increased catchability. The question was posed as to whether technological changes have taken place in the Japanese longline fishery. Dr Uozumi noted that there has been an increase in the use of monofilament longline gear since 1993, and particularly in 1995, but that the increasing trend in standardised CPUE goes back to 1990.

It was also noted that the sub-areas used to define the tropical area include both the eastern and western Pacific, whereas the temperate area includes only sub-areas in the western Pacific. It was suggested that it may be more meaningful to exclude the eastern sub-areas from the tropical area, for comparison with the temperate area.

Taiwanese longline

Dr Wang presented a paper describing the estimation of effective fishing effort using both Honma's method and a general linear model (WP.14). Estimates of effective fishing effort for 1967–1991 were based on catch and effort data, aggregated by 5° latitude by 5° longitude, covering Japanese longliners from 1967 to 1990, Korean longliners from 1975 to 1987, and Taiwanese longliners from 1967 to 1991. Five-year moving averages of Taiwanese longline effort were taken as estimates of effective fishing effort for 1991–1994. Neither the factors tested in the linear model, nor R^2 or goodness of fit, were reported in WP.14. The resulting trends in CPUE are presented in Figure 4. Nominal CPUE, and CPUE determined using effective effort estimated with Honma's method and with the linear model, all indicate an increase in CPUE from the level in 1989–1991 to that of 1992–1994.

It was noted that while estimates of CPUE in Figure 3, which are for the Japanese fleet alone, peak in 1988, CPUE estimates in Figure 4, which are based on multiple fleets for 1967–1991 and the Taiwanese fleet for 1992–1994, peak in 1986 and then decline considerably by 1989. Various possibilities were suggested to account for the discrepancy, including differences in the area fished, size composition, species targeted, and time-area stratification, covered by the two sets of data. Dr Uozumi and Dr Wang agreed to liaise in order to further study this issue.

Japanese driftnet

Dr Uozumi presented a paper on standardised Japanese driftnet CPUE and catch (WP.17). The methodology was similar to that described above for the standardisation of Japanese longline CPUE, except the effects tested included fishing year (1983/84 to 1989/90), month (December to March), area (three sub-areas), absolute latitude (six classes from 0–2° to 10–12°), and interactions. The final model for both CPUE and catch included fishing year, month, and area. For the CPUE model, R^2 was 0.34 and the fit was good. Standardised driftnet CPUE is shown in Figure 5.

American troll

Dr Gary Sakagawa presented a paper on the American troll fishery in which standardised monthly and seasonal CPUE were determined by averaging estimates of CPUE calculated for 10 day, 1° x 1° time-area strata (WP.19). Standardised CPUE for the American troll fishery is presented in Figure 6. CPUE declined considerably between the 1989/90 season and the 1992/93 season. The decline was attributed to abnormally warm surface waters, which were associated with a strong El Niño period and which made it difficult for the troll vessels to find significant concentrations of albacore.

It was noted that for the period covered by the two time series, 1986/87 to 1989/90, the qualitative behaviour of standardised Japanese driftnet CPUE (Figure 5) and standardised American troll CPUE (Figure 6) are similar.

3.3 SPAR database

A call for data for the SPAR database was made in Issue 2 of SPAR News, dated October 1995, and several sets of data aggregated by time-area strata were received by the OFP. These included:

- Korean longline catch-and-effort data for 1993;
- American troll catch-and-effort data, and length-frequency data, for the 1993/94 and 1994/95 seasons;
- Japanese, Korean and Taiwanese longline length-frequency data, sampled in Pago Pago (American Samoa) by the National Marine Fisheries Service;
- French Polynesian longline catch-and-effort data for 1993 (although these data are aggregated by 5x5 by year, rather than by month).

The availability of data for the SPAR catch-and-effort database is presented in Table 5. The status of sets of aggregated catch-and-effort data which have not yet been provided are as follows:

- Several data sets are unavailable; these include American Samoan longline data for 1995, Japanese longline data for 1952–1961, Korean longline data for 1958–1974, New Zealand troll data for 1968/69–1981/82, Taiwanese longline data for 1954–1966, Taiwanese driftnet data for 1987/88 and 1989/90–1990/91.
- The provision of Japanese driftnet data for 1983/84–1987/88 will be discussed within the National Research Institute of Far Seas Fisheries (NRIFSF) following SPAR 6.
- New Zealand longline data for 1992–1994 and troll data for 1991/92–1994/95 should be made available following a request to be made of the New Zealand Ministry of Fisheries by the OFP.
- Tongan longline data will possibly be made available through the Tongan Ministry of Fisheries, and through the efforts of a port sampler in Tonga who is funded by the OFP.

The availability of data for the SPAR length-frequency database is presented in Table 6. The status of sets of aggregated length-frequency data which have not yet been provided are as follows:

- Japanese longline data for 1992–1994 collected by observers of the Australian Fisheries Management Authority will be made available following SPAR 6.

- Albacore length-frequency data for Japanese longliners, collected by vessel crew and compiled by NRIFSF, have been provided for the SPAR database for certain time periods; however, the possibility of providing the complete time series of length-frequency data will be discussed within NRIFSF following SPAR 6.

- The existence and availability of New Zealand troll length-frequency data for 1992/93–1994/95 will be asked of the New Zealand Ministry of Fisheries.

Table 1. Longline catches (metric tonnes) of south Pacific albacore

YEAR	AMER SAMOA	AUSTRALIA DOMESTIC	USTRALIA JAPAN JV	COOK ISLANDS	FIJI	FRENCH POLYNESIA	JAPAN	KOREA	NEW CALEDONIA	NEW ZEALAND	TAIWAN	TONGA	UNITED STATES	WESTERN SAMOA	TOTAL
1952							154								154
1953							803								803
1954							9,578								9,578
1955							8,625								8,625
1956							7,281								7,281
1957							8,757								8,757
1958							18,490	146							18,636
1959							17,385	456							17,841
1960							21,638	610							22,248
1961							23,412	330							23,742
1962							34,620	599							35,219
1963							29,120	1,367							30,487
1964							19,390	2,911							22,301
1965							17,793	6,405							24,198
1966							21,627	10,817							32,444
1967							15,104	13,717			11,723				40,544
1968							6,659	10,138			12,375				29,172
1969							4,894	9,963			9,557				24,414
1970						+	5,297	11,599			14,682				31,578
1971						+	3,472	14,482			15,880				33,834
1972						+	3,027	14,439			16,780				34,246
1973						+	2,550	17,452			17,742				37,744
1974						+	1,868	12,194			17,246				31,308
1975						+	1,333	9,015			16,939				27,287
1976						+	2,054	12,212			13,653				27,919
1977						+	2,328	13,176			21,452				36,956
1978						+	2,845	10,989			20,935				34,769
1979						+	2,274	8,682			14,952				25,908
1980						+	2,216	10,852			25,579				38,647
1981						+	4,203	14,793			14,367				33,363
1982						+	4,899	12,586			12,644	106			30,235
1983						+	5,723	6,669	12		12,106	143			24,653
1984						+	3,804	5,730	112		11,155	135			20,936
1985						+	3,868	14,267	131		9,601	174			28,041
1986						+	4,426	18,799	179		11,913	206			35,523
1987		131				+	4,490	8,646	563		15,009	252			29,091
1988		107				+	7,469	5,600	584		17,120	242			31,122
1989		93	474		5	100	5,365	3,997	566	19	10,867	195			21,681
1990	+	125	146		263	156	6,428	2,586	1,053	249	9,689	152			20,847
1991	+	170	67		416	146	4,401	1,225	909	325	11,235	174			19,068
1992	+	207	106		310	174	3,708	1,556	520	706	18,989	199			26,475
1993	+	185	129		463	714	8,255	2,600	755	539	12,986	232		17	26,875
1994	+	355	46	25	562	913	8,101	1,283	840	245	17,034	599	78	24	30,105
1995	25	439	19	30	...	739	...	...	...	...	15,201	...	...	40	...

"+" denotes small catches of unknown size; "..." denotes unknown catches

Table 1 continued

American Samoa	SPAR 6 Working Paper 9 (Su'a, 1996):
Australia	Estimates of catches by domestic vessels (including ex-Japanese vessels) were taken from the SPC Tuna Fishery Yearbook, 1994, except for the 1995 estimate, which was taken from SPAR 6 Working Paper 8 (Skousen and Caton, 1996) and raised assuming a coverage rate of 95 per cent (417 / 0.95 = 439). Estimates of catches by Australian-Japan joint-venture vessels were taken from Table 3 of Skousen and Caton (1996).
Cook Islands	SPC Tuna Fishery Yearbook, 1994
Fiji	SPC Tuna Fishery Yearbook, 1994. These catches do not include American longliners operating in Fijian waters; American vessels are covered in a separate column.
French Polynesia	Estimates for 1989—1991 were provided by EVAAM. Estimates for 1992—1995 were taken from SPAR 6 Working Paper 15 (Yen and Stein, 1996).
Japan	SPAR 6 Working Paper 16 (Matsunaga and Uozumi, 1996)
Korea	Estimates for 1958–1987 were taken from the report of SPAR 2; these estimates include some catch from the North Pacific. Catch estimates for 1988–1991 for the entire Pacific Ocean were provided by NFRDA; these were adjusted to reflect the proportion of albacore catch taken annually in the South Pacific for 1984–1987. Catch estimates for 1993—1994 were determined from aggregated data provided by NFRDA; thee data were raised using the coverage rate for 1992.
New Caledonia	SPC Tuna Fishery Yearbook, 1994
New Zealand	Catch estimates for 1989–1992 were provided by Ministry of Agriculture and Fisheries at SPAR 5 (Murray, 1993). Catch estimates for 1993–1994 were taken from the SPC Tuna Fishery Yearbook, 1994
Taiwan	All estimates were taken from SPAR 6 Working Paper 14 (Wang, 1996), except for 1994 (Wang, personal communication, March 1996); the estimate for 1995 represents the whole Pacific Ocean.
Tonga	SPC Tuna Fishery Yearbook, 1994
United States	SPC Tuna Fishery Yearbook, 1994
Western Samoa	The 1993 estimates was taken from the SPC Tuna Fishery Yearbook, 1994. Estimates for 1994—1995 were provided by Mulipola (personal communication, March 1996).

Table 2. Surface fishery catches (metric tonnes) of south Pacific albacore. Estimates for driftnet and troll, which are for the fishing season, have been allocated to the year in which the season ended.

YEAR	AUSTRALIA	FRENCH POL TROLL	JAPAN P&L	JAPAN DRIFTNET	KOREA DRIFTNET	TAIWAN DRIFTNET	NZ TROLL	USA TROLL	OTHER TROLL	TOTAL
1960			45							45
1961			-							-
1962			-							-
1963			16							16
1964			-							-
1965			-							-
1966			-							-
1967			-							-
1968			-							-
1969			-							-
1970	100		-							100
1971	100		-							100
1972	100		-							100
1973	100		-							100
1974	100		-				898			998
1975	100		-				646			746
1976	100		-				25			125
1977	100		-				621			721
1978	100		-				1,686			1,786
1979	100		-				814			914
1980	100		19				1,468			1,587
1981	5		8				2,085			2,098
1982	6		1				2,434			2,441
1983	7		2	32			744			785
1984	8		-	1,581			2,773			4,362
1985	9		-	1,928			3,253			5,190
1986	10		-	1,936			1,911			3,857
1987	11		-	919			1,227	751		2,908
1988	12		-	4,271		1,000	330	3,253	140	9,006
1989	13	90	-	13,263	172	8,520	5,161	3,068	162	30,449
1990	15	327	-	5,667	-	1,859	2,525	3,898	-	14,291
1991	20	326	-	-	-	821	2,464	5,540	103	9,274
1992	70	72	49	-	-	-	3,856	3,016	...	7,063
1993	55	45	5	-	-	-	3,856	1,028	...	4,989
1994	70	-	...	-	-	-	4,400	603	...	5,073
1995	25	184	...	-	-	-	6,000	2,916	...	9,125

"+" denotes small catches of unknown size; "..." denotes unknown catches

Table 2 continued

Australia	Caton (personal communication, March 1996). Catch estimates for 1970-1980 represent incidental catches of albacore by pole-and-line vessels targeting southern bluefin. Estimates for 1981-1990 represent increasing catches by the recreational fishery. Estimates for 1991-1995 represent recreational and troll catches.
Chile	The FAO Yearbook, Fishery Statistics, Vol. 76 (1993), does not provide statistics for individual tuna species; however, the following estimates are given for 'tuna-like fishes': 27 mt for 1988, 102 mt for 1989, 308 mt for 1990, 210 mt for 1991, 32 mt for 1992, and 134 mt for 1993. It has also been estimated that the artisanal fishery of Easter Island catches 30 mt of albacore (Labelle, personal communication).
French Polynesia	SPAR 6 Working Paper 15 (Yen and Stein, 1996)
Japan	SPAR 6 Working Paper 16 (Matsunaga and Uozumi, 1996)
Korea	SPC Tuna Fishery Yearbook, 1994
Taiwan	SPC Tuna Fishery Yearbook, 1994
New Zealand	Catch estimates for 1974-1994 were taken from the SPC Tuna Fishery Yearbook, 1994. The estimate for 1995 was provided by Murray (personal communication, March 1996).
United States	SPAR 6 Working Paper 19 (Childers and Coan, 1996)
Other Troll	'Other Troll' includes catches by Canadian and Fijian trollers.

Table 3. Comparison of estimates of annual catches of albacore by Taiwanese longliners and landings of albacore by Taiwanese longliners in Levuka (Fiji) and Pago Pago (American Samoa)

YEAR	CATCH ESTIMATES	UNLOADINGS		
		LEVUKA	PAGO PAGO	TOTAL
1990	9,689	...	5,543	...
1991	11,235	...	7,709	...
1992	18,989	...	15,224	...
1993	12,986	3,502	14,375	17,877
1994	17,034	3,338	8,276	11,614
1995	15,201	4,139	...	...

Table 4. Comparison of estimates of annual catches (metric tonnes) of albacore by Taiwanese longliners in the south Pacific Ocean presented in WP.13 and those determined from data aggregated by 5x5

YEAR	WP.13	5x5	DIFF	%
1967	11,723	15,036	3,313	128
1968	12,375	15,570	3,195	126
1969	9,557	9,948	391	104
1970	14,682	16,651	1,969	113
1971	15,880	19,714	3,834	124
1972	16,780	22,322	5,542	133
1973	17,742	26,563	8,821	150
1974	17,246	19,219	1,973	111
1975	16,939	19,611	2,672	116
1976	13,653	18,363	4,710	134
1977	21,452	24,356	2,904	114
1978	20,935	16,403	-4,532	78
1979	14,952	12,214	-2,738	82
1980	25,579	26,177	598	102
1981	14,367	12,379	-1,988	86
1982	12,644	10,324	-2,320	82
1983	12,106	7,873	-4,233	65
1984	11,155	6,785	-4,370	61
1985	9,601	5,934	-3,667	62
1986	11,913	10,053	-1,860	84
1987	15,009	11,508	-3,501	77
1988	17,120	14,056	-3,064	82
1989	10,867	8,563	-2,304	79
1990	9,689	8,486	-1,203	88
1991	11,235	9,840	-1,395	88
1992	18,989	29,325	10,336	154
1993	12,986	20,628	7,642	159

Table 5. Availability of data for the SPAR catch-and-effort database

SOURCE	VESSEL NATIONALITY	GEAR TYPE	TIME PERIOD	STATUS	COMMENTS
AUSTRALIA	AUSTRALIA	L	1985-1994	√	Transferred from the Regional Tuna Fisheries Database.
AUSTRALIA	AUSTRALIA	T	1991/92	√	Provided by Bureau of Resource Sciences for Albacore Troll survey.
AUSTRALIA	AUSTRALIA	T	1991/92-1994/95	√	Transferred from the Regional Tuna Fisheries Database; includes trolling on multi-gear vessels.
COOK ISLANDS	COOK ISLANDS	L	1994	√	Transferred from the Regional Tuna Fisheries Database.
FIJI	FIJI	L	1989-1994	√	Transferred from the Regional Tuna Fisheries Database.
FRENCH POLYNESIA	FRENCH POLYNESIA	L	1992, 1994	√	Provided by EVAAM.
FRENCH POLYNESIA	FRENCH POLYNESIA	T	1991/92	√	Provided by EVAAM.
JAPAN	JAPAN	G	1983/84-1987/88	x	Requested of NRIFSF.
JAPAN	JAPAN	G	1988/89-1989/90	√	Provided to SPC during SPAR 3, Oct/90.
JAPAN	JAPAN	L	1952-1961	x	Requested of NRIFSF.
JAPAN	JAPAN	L	1962-1993	√	Published by the Fisheries Agency of Japan (1962-1980) Provided to SPC (1981-1993).
KOREA	KOREA	L	1958-1974	x	Requested of NFRDA.
KOREA	KOREA	L	1975-1993	√	Published by the National Fisheries Research and Development Agency.
NEW CALEDONIA	NEW CALEDONIA	L	1983-1994	√	Transferred from the Regional Tuna Fisheries Database.
NEW ZEALAND	NEW ZEALAND	L	1979-80,1989-91	√	Transferred from the Regional Tuna Fisheries Database.
NEW ZEALAND	NEW ZEALAND	L	1992-94	x	Requested of MAF.
NEW ZEALAND	NEW ZEALAND	T	1968/69-1981/82	x	Catch data only for 1968/69-1981/82. Requested of MAF.
NEW ZEALAND	NEW ZEALAND	T	1982/83-1990/91	√	Provided by MAF.
NEW ZEALAND	NEW ZEALAND	T	1991/92-1994/95	x	Requested of MAF.
SPC	NEW ZEALAND	T	1991/92	√	Catch and effort data collected during SPC observer and port sampling activities.
TAIWAN	TAIWAN	G	1987/88	x	Data are unavailable at Tuna Research Center, Taiwan National University (NTU).
TAIWAN	TAIWAN	G	1988/89	√	Provided by the Tuna Research Center, NTU.
TAIWAN	TAIWAN	G	1989/90-1990/91	x	Requested of the Tuna Rsearch Center, NTU.
TAIWAN	TAIWAN	L	1954-1966	x	Data are unavailable at Tuna Research Center, NTU.
TAIWAN	TAIWAN	L	1967-1993	√	Data provided by the Tuna Research Center, NTU.
TONGA	TONGA	L	1982-1993	√	Transferred from the Regional Tuna Fisheries Database.
TONGA	TONGA	L	1994	x	Requested of Tonga Fisheries Division.
UNITED STATES	UNITED STATES	L	1994	√	Transferred from the Regional Tuna Fisheries Database.
UNITED STATES	UNITED STATES	T	1986/87-1994/95	√	Data provided by NMFS.
WESTERN SAMOA	WESTERN SAMOA	L	1993-1994	√	Transferred from the Regional Tuna Fisheries Database.

Key: G, driftnet; L, longline; T, troll; √ available; x unavailable

Table 6. Availability of data for the SPAR size-frequency database

SOURCE	VESSEL NATIONALITY	GEAR TYPE	TIME PERIOD	STATUS	COMMENTS
AUSTRALIA	AUSTRALIA	T	1991/92	√	Test fishing sponsored by BRS.
AUSTRALIA	JAPAN	L	1979-1991	√	AFZ observer programme.
AUSTRALIA	JAPAN	L	1992-1994	x	Requested of BRS.
FIJI	FIJI	L	1991-1994	√	Port sampling in Suva.
FIJI	KOREA	L	1991-1993	√	Port sampling in Levuka.
FIJI	TAIWAN	L	1989-1994	√	Port sampling in Levuka.
FIJI	TONGA	L	1990	√	Port sampling in Levuka.
FIJI	NEW ZEALAND	T	1989/90	√	Port sampling in Levuka.
FIJI	UNITED STATES	L	1994	√	Port sampling in Suva.
FIJI	UNITED STATES	T	1989/90	√	Port sampling in Levuka.
FRENCH POLYNESIA	UNITED STATES	T	1986/87-1991/92	√	Port sampling in Papeete.
JAPAN	JAPAN	G	1988/89-1989/90	√	Provided by NRIFSF.
JAPAN	JAPAN	L	1954-1961	x	Requested of the Fisheries Agency of Japan.
JAPAN	JAPAN	L	1962-1980	√	Published by the Fisheries Agency of Japan.
JAPAN	JAPAN	L	1981-1985	x	Requested of NRIFSF.
JAPAN	JAPAN	L	1986-1988	√	Provided by NRIFSF.
JAPAN	JAPAN	L	1989-1994	x	Requested of NRIFSF.
NEW CALEDONIA	NEW CALEDONIA	L	1993-1994	√	Port sampling in Noumea.
NEW ZEALAND	NEW ZEALAND	T	1972/73-1985/86	x	Requested of MAF.
NEW ZEALAND	NEW ZEALAND	T	1986/87-1991/92	√	MAF observer and port sampling data.
NEW ZEALAND	NEW ZEALAND	T	1992/93-1994/95	x	Requested of MAF.
SPC	FIJI	T	1990/91	√	Observers aboard chartered vessels.
SPC	JAPAN	G	1988/89	√	Port sampling in Noumea by SPC staff.
SPC	JAPAN	G	1989/90	√	Sampled by SPC observers on JAMARC vessel.
SPC	NEW CALEDONIA	L	1990-1992	√	Port sampling in Noumea by SPC staff.
SPC	NEW ZEALAND	T	1988/89-1991/92	√	Sampled by SPC observers.
SPC	COOK ISLANDS	T	1991/92	√	Sampled by SPC observers.
SPC	UNITED STATES	T	1988/89-1991/92	√	Sampled by SPC observers.
UNITED STATES	JAPAN	L	1962-1972, 1987	√	Pago-based vessels. Provided by NMFS.
UNITED STATES	JAPAN	L	1962-1972, 1987	√	Pago-based vessels. Provided by NMFS.
UNITED STATES	KOREA	L	1962-1992	√	Pago-based vessels. Provided by NMFS.
UNITED STATES	TAIWAN	L	1964-1994	√	Pago-based vessels. Provided by NMFS.
UNITED STATES	UNITED STATES	T	1986/87-1994/95	√	Provided by NMFS.

Key: G, driftnet; L, longline; T, troll; √ available; x unavailable

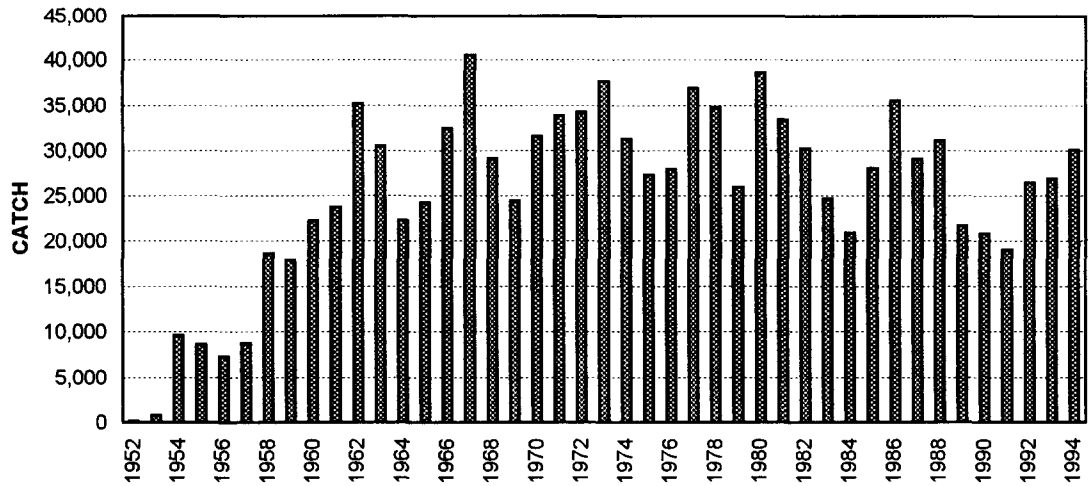

Figure 1. Annual catches (metric tonnes) of south Pacific albacore by longliners

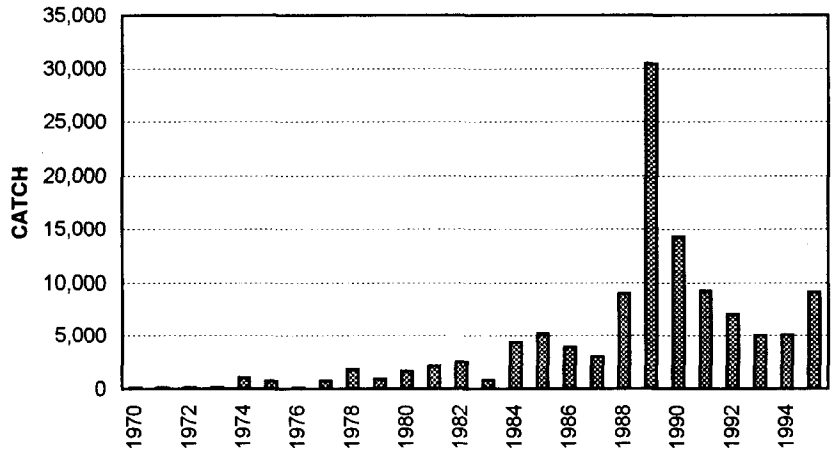

Figure 2. Annual catches (metric tonnes) of south Pacific albacore by surface fisheries

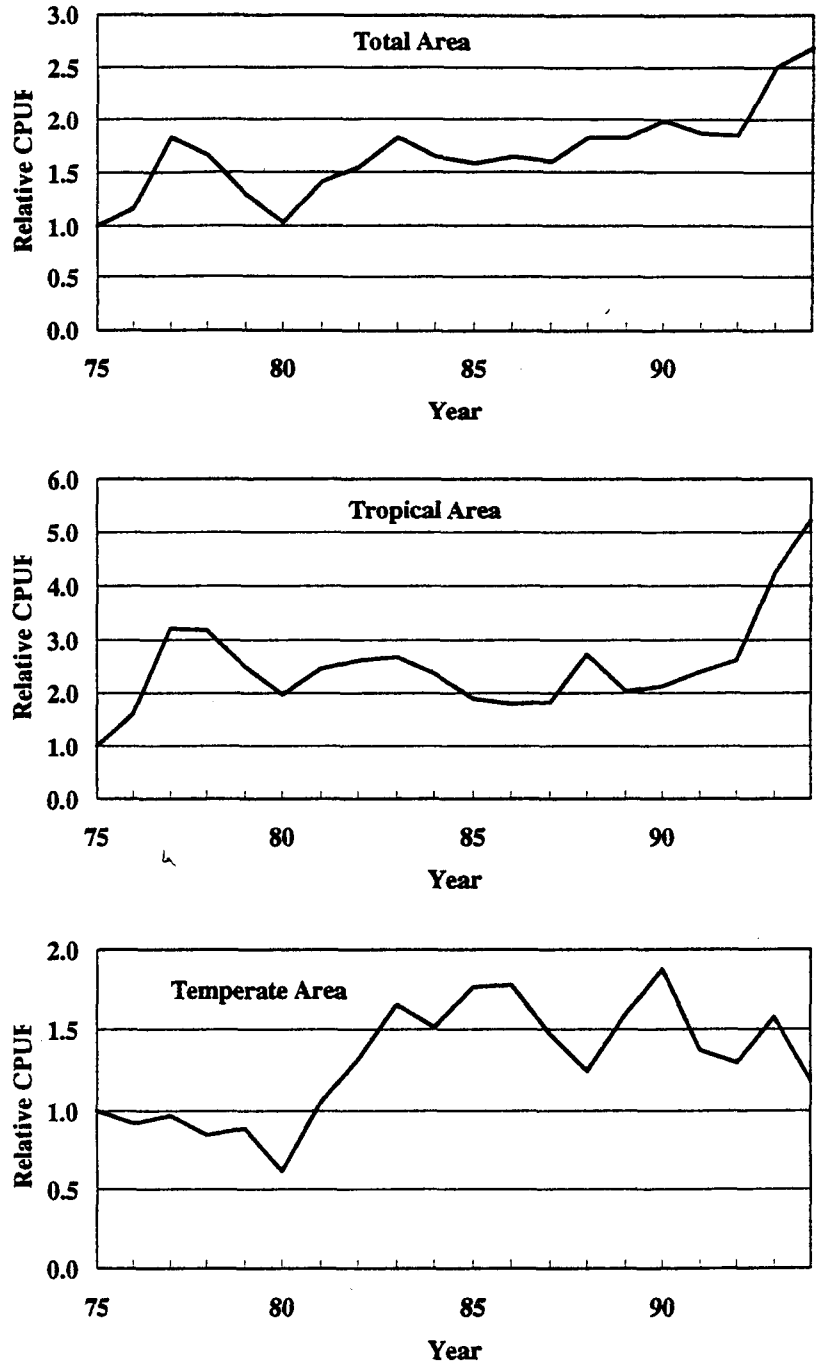

Figure 3. Standardised albacore CPUE for Japanese longliners. Dotted lines indicate the upper and lower 95 per cent confidence limits.

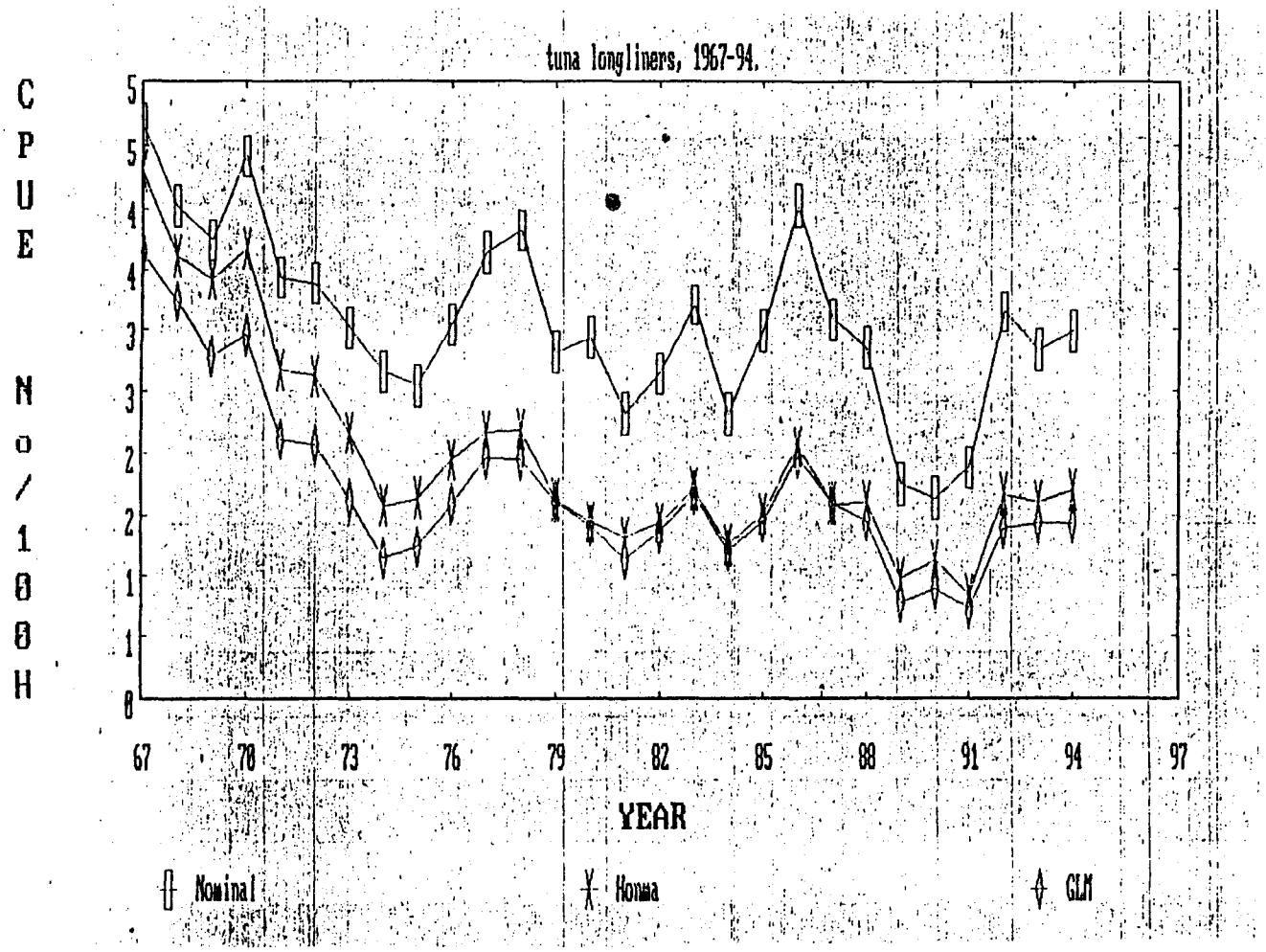

Figure 4. Albacore CPUE determined from data for multiple fleets for 1967–1991 and the Taiwanese fleet for 1992–1994. CPUE determined from nominal effort, and effective effort estimated with Honma's method and a general linear model, are shown.

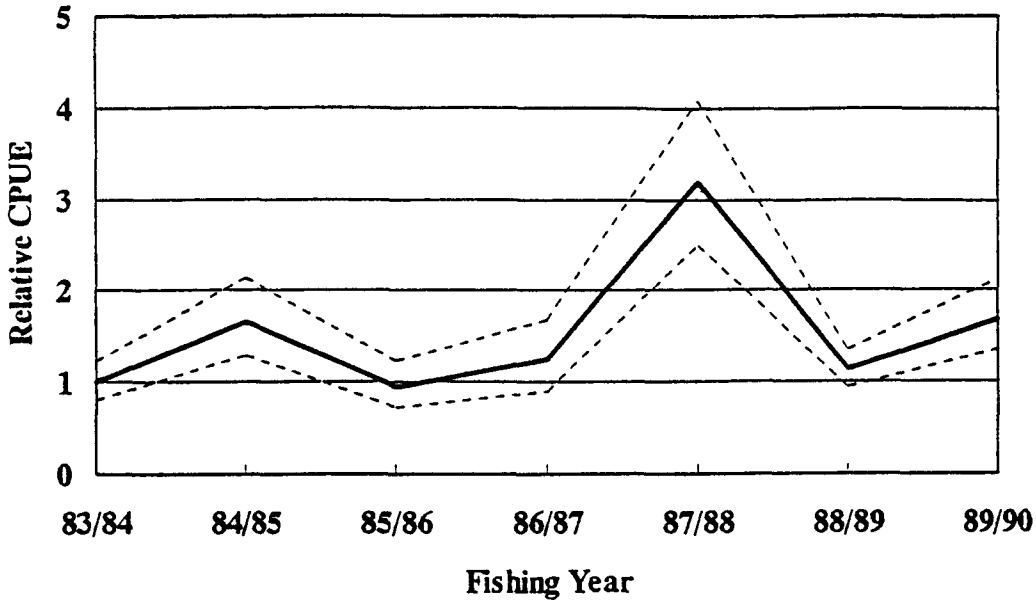

Figure 5. Standardised albacore CPUE for Japanese driftnet vessels. Dotted lines indicate the upper and lower 95 per cent confidence limits.

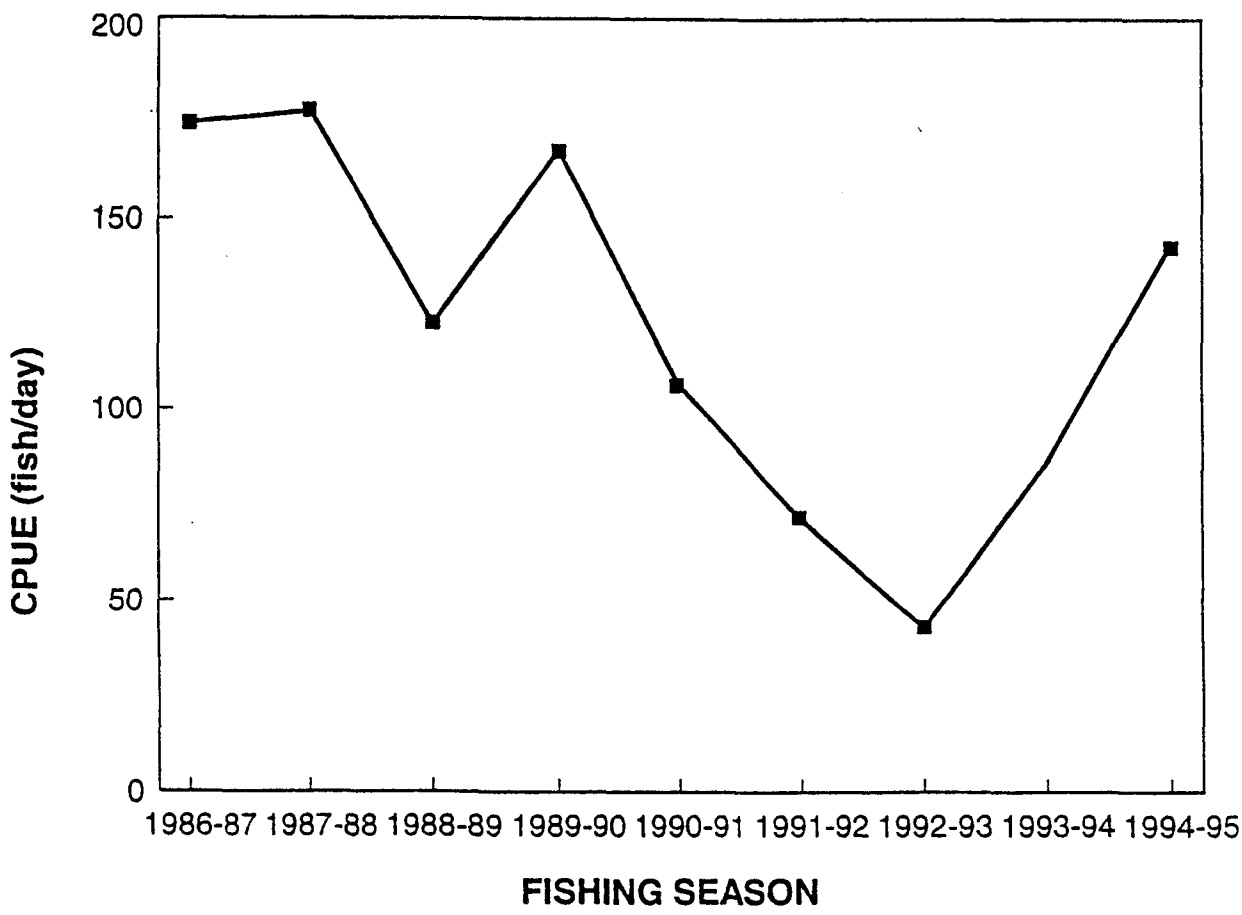

Figure 6. Standardised albacore CPUE for American troll vessels

4. REVIEW OF RECENT RESEARCH

4.1 Tagging experiments

An analysis of available tagging data was presented in WP.3. Since 1986, over 17,000 albacore have been tagged and released by various agencies in the South Pacific, over half of these during a dedicated SPC programme during 1991-92. The overall return rate has been just under 1 per cent, or 168 tags, to date. Many of these recaptures are long term, from mainly Taiwanese longliners, and more are expected to be received.

The tag returns show extensive movement throughout the South Pacific, from 145° E to 70° W, with the average distance between release and recapture points 950 nm. There has also been one recent return from just north of the equator for the first time. The distribution of returns however provides continued support for the existence of two separate albacore stocks in the Pacific, north and south of the equator.

The limited data were also screened and used to generate estimates of growth. Whilst individual variability seems high, the estimates of L_∞ and K are consistent with those obtained from length frequency data, and considerably lower than some earlier estimates obtained from daily otolith growth increment counts.

Discussion focussed on the procedures for the return of albacore tags in Pago Pago, the main source of returns, and on likely levels of non-reporting. This also related to the possible value of continued tagging of albacore on a routine basis by observers, an issue later addressed under item 6 (Future Research Priorities).

4.2 Observer and port sampling programmes

4.2.1 Observer programmes

Observer programmes can provide information on size and species composition of the catch, gear technology and changes therein, by-catch and discards, and provide opportunities for biological sampling and catch validation, all important questions in the context of South Pacific albacore fisheries.

Since the cessation of the four year SPC/MAF observer programme on troll vessels in 1992, little observer activity on vessels taking albacore in the South Pacific has occurred until recently, with the establishment of the SPC SPRTRAMP programme during 1995. This has seen the recruitment of four dedicated scientific observers during 1995, and efforts to standardise data collection procedures. An FFA/SPC Observer Workshop was held in February 1995 (Info Paper 1), and an ad hoc meeting on tuna fisheries data collection forms in December 1995 (Info Paper 2). These observers have made trips on domestic sashimi longliners in Fiji, Cook Islands, New Caledonia and Tonga (plus trips in EEZs north of the Equator), and on Japanese conventional longliners on New Caledonia. There has been no coverage of the Taiwanese albacore longline fleet as yet , due to logistical problems. Observer coverage can be expected to increase as more national observer programmes come on stream, with the support of SPC and FFA observer programmes, and in some cases as a condition of bilateral access arrangements. In the short to medium term, the extent of coverage is still however expected to be low.

In a discussion of observer programmes generally, it was concluded that increased coverage of the Taiwanese longline vessels should be accorded the highest priority, given the need for information on by-catch and discards, currently almost completely lacking.

National observer programmes were then briefly outlined, as per the following notes:

Australia

The present observer programmes, with their main focus on southern bluefin tuna, will probably continue; these are funded from access fees, with a coverage target of 15 per cent; catch validation is therefore an important part of these programmes. The east coast programme, which covers most of the albacore catch, achieves 5–10 per cent coverage.

Cook Islands

Regional standards are accepted for observers, but currently only two vessels are active. Cook Islands is committed to seeing observer coverage and cost recovery included in any regional arrangement, and see observer coverage of Taiwanese longliners as a priority.

American Samoa

There is no observer coverage of longline vessels in American Samoa.

Fiji

A growing need is seen for a domestic observer programme, given the increase in domestic and foreign longline activity, and a new Offshore Research section has been established within the Fisheries Division.

French Polynesia

No observer programme is currently being undertaken.

Japan

No observer programmes in the SPAR area, but two JAMARC vessels are operating in the Tasman Sea (pole-and-line) and south-eastern Pacific (longline), which collect biological data.

Niue

Provision exists for observer coverage under the current bilateral agreement, but is not yet utilised; Niue would like to use SPC observers if logistical problems can be overcome.

Solomon Islands

There has been an observer programme for six years on domestic vessels, mostly pole-and-line and purse seine. With the growth in numbers of foreign and domestic joint venture vessels, observer coverage is needed; there is currently no coverage of Japanese longline and pole-and-line vessels licensed under access agreements, nor was there coverage of previously licensed Taiwanese longline vessels. There are eight observers on the present roster.

Republic of China (Taiwan)

There is no observer coverage of any fleets, but this may be contemplated in the future.

Tonga

There is no coverage other than by SPC observers. Some coverage of SeaStar vessels may be needed, given the difficulties of sampling the catch in port, both by-catch in Nuku'alofa and albacore in Pago Pago.

United States of America

There is no albacore observer programme in the South Pacific, but there is in the North Pacific. Observers are placed on two vessel code groups; coverage is low, costs are high, and placement is voluntary, with industry support; a relatively large number of fish can be sampled on a ten day trip, and there may need to be trade-offs with port sampling in the future.

Western Samoa

There is no requirement for observer coverage in the bilateral access agreement with Taiwan; Western Samoa would prefer multilateral access with observer requirements.

FFA

Most previous involvement with USMLT, where 20 per cent coverage is the goal; increasing resources will however be devoted to supporting national observer programmes. SPC and FFA cooperate extensively in observer training.

4.2.2 Port sampling programmes

These were considered with relation to WP.2, for both surface (troll) and longline fisheries.

In reviewing the overall coverage, it was noted that the Taiwan longline catch is relatively well covered by port sampling in Levuka (Fiji) and Pago Pago (American Samoa) and the US troll fleet by Pago Pago sampling, but that the coverage of the Japanese longline fleet by onboard sampling was declining, and that the biggest gap now was sampling of the New Zealand domestic fleets (troll and longline).

It was also noted that conversion factors were available for fish landed headed (eg length from snout to first dorsal origin, converted to LCF), and that for the input of length frequency data to existing models, geographical origin of samples (e.g. larger than 5 degree square) may be less important than temporal origin, i.e. month of capture. The transhipment fish landed in Pago Pago, often combined from a variety of sources, were not feasible to sample, even though they were growing in importance.

The meeting noted the importance of continuing sampling at Pago Pago and Levuka, and expressed concern at the currently inadequate coverage of New Zealand troll (and longline) catches, which comprise a significant proportion of the smallest size of fish taken in the albacore fishery.

4.3 Biological studies

4.3.1 Stock structure

The pilot study of albacore stock structure, based on electrophoretic analysis of blood proteins, was completed during 1993. Samples obtained from five South Pacific and three North Pacific sites showed no heterogeneity in the screened loci amongst the South Pacific samples, suggesting that gene flow is sufficient to maintain homogeneity across the South Pacific population. Inclusion of the smaller number of north Pacific samples resulted in heterogeneity in one of the enzyme loci, but it appears that generally there is sufficient genetic exchange across the equator to prevent marked genetic differentiation between north and south Pacific albacore populations.

This conclusion is consistent with the tagging results described earlier, i.e. considerable movement throughout the south Pacific, but minimal movement across the equator, and provides support for the working hypothesis of separate North and South Pacific albacore populations, at least in management terms.

In looking at the global population structure of albacore, NRIFSF (Japan) scientists, using DNA techniques, examined material from the Atlantic and Pacific Oceans (nine sites). Pacific and Atlantic samples showed internal homogeneity, but there was significant heterogeneity between Atlantic and Pacific samples. Analysis of Indian Ocean material is still required to resolve the relationships of albacore amongst all three oceans.

4.3.2 Reproduction

No further work has been carried out since the joint NMFS/SPC study reported at SPAR 5 which demonstrated the annual nature of albacore spawning. This work has since been published (Ramon and Bailey, 1994).

4.4 Other research

The results of experimental fishing using instrumented longlining in French Polynesia were reported (WP.6), with particular reference to albacore. Fishing characteristics of the gear were described, as were details of albacore catches. These comprised over 40 per cent of the total catch by number and weight, were caught down to 400m, at temperatures between 10 and 26° C, with 30 per cent of the fish hooked whilst the line was sinking or rising. Discriminant analysis of catch variables confirmed the spatial separation of catches of the three main tuna species within the EEZ.

It was noted that similar data may be available from Japanese research vessels (Shoyo Maru and JAMARC), and that there were plans to share such data. The relevance of such experimental findings to fishermen was noted.

The SPC Oceanic Fisheries Coordinator reported on the likelihood of funding from Taiwan to the OFP, to support further albacore stock assessment and also collaborative tuna research with NTU scientists. The former proposal has already provided support for participation in SPAR 6, and should support continued development of the SPARCLE model, and port sampling activity, if feasible, in New Zealand unloading ports and Pago Pago. The latter proposal awaits further detail, but could conceivably include some collaborative albacore research.

5. STATUS OF THE SOUTH PACIFIC ALBACORE STOCK

5.1 Tagging Data

Dr Hampton described recent attempts to estimate mortality rates for South Pacific albacore from tagging data. Only longline returns were used in the analysis, and "aggregate" and "quarterly release group" versions of the model fitted. The "aggregate" fit probably over-estimates total mortality because the older time at liberty categories for the more recent releases have yet to be sampled by the fisheries. For the "quarterly release group" version, total mortality is in the range 0.4-0.6. The estimated exploitation rate depends strongly on the assumed type I tag loss rate, presumably mostly non-reporting. The exploitation ranges from 0.02 (70 per cent reporting) to 0.13 (10 per cent reporting).

5.2 Analysis of catch and effort data

No production model analyses were presented to the meeting. However, Dr Wang reported that he had updated MSY estimates for South Pacific albacore using a Pella-Tomlinson time-series model. A paper describing this work is available in Chinese. Dr Wang advised that the paper would be translated into English and made available to the SPAR group.

5.3 Age Structured models

Dr Hampton presented the most recent update of the SPARCLE model, an age structured, likelihood-based catch-at-length model (WP.4). The update includes new data up to and including the 1993 year, and uses newly-available longline length frequency data of much greater spatial and temporal resolution than before. Seven fisheries (4 longline, 2 troll and 1 driftnet fishery) are defined on the basis of gear type and area of operation. The major structural enhancement to the model since

SPAR 5 is the incorporation of spatial structure in the form of three latitudinal bands. Recruitment occurs in the southern-most band (south of 30° S) and fish move to the north as they age. The updated analysis appears more informative than the previous version, with movement rates and the rate of natural mortality all estimated from the data. The recruitment and biomass trends have tighter confidence levels and show considerable cyclical variation. Some preliminary observations on the results are:

- The estimated exploitation rates on both young and older age groups are relatively low, generally less than 10 per cent per year.

- The trends in recruitment and population biomass are therefore unlikely to have been influenced significantly by the fisheries.

- The low exploitation rate of the younger age classes, even at the height of the driftnet fishery, implies that the surface fisheries are unlikely to have had an observable impact on the longline fishery.

- South Pacific albacore recruitment may be linked to El Nino events, with lower than average spawning success or larval survival during such episodes.

It was noted that the model could be easily adapted for use in reference-point-style management and for forecasting. Most discussion centred on possible improvements to the model, which included:

- addition of density-dependent growth and seasonal catchability to the model;

- further stratification of the longline fishery by fleet, and possibly by area for the Japanese longline fishery;

- the possibility of linking recruitment to environmental variation (ENSO) within the model structure;

- the use of relative price data for albacore, yellowfin and bigeye as an indicator of targeting;

- the use of logbook coverage data as an index for the quality of effort data.

5.4 Status of the stock summary

5.4.1 Fishery outlook

The record high catch of South Pacific albacore of 52,000 mt occurred in 1989. Of this catch, about 20,000 mt was taken by the driftnet fleet. Since the moratorium on driftnet fishing, the catch declined to about 30,000 mt per year. For the last three years for which data are available (1992–1994), the total annual catch was steady at 32,000–34,000 mt. Over these three years, the annual longline catch has been constant at about 27,000 mt. The performance of the New Zealand and STCZ troll fisheries has been variable.

Over the next few years, longline catches are likely to be stable. The Taiwanese catch may decrease somewhat if the albacore price drops and more of these vessels switch to yellowfin and bigeye

targeting. On the other hand, continued development of domestic, small-scale longline fleets in Pacific Island countries may see some compensatory increases in catch from this source.

The troll fishery in the STCZ is likely to react to the poor 1995/96 season with fewer US vessels participating in 1996/97. However, more Canadian trollers may join the three vessels that participated in 1995/96. The New Zealand troll fishery has recorded above-average catches for the past two seasons, which may encourage some increase in effort next season.

Overall, no major changes are forecast for the fishery over the next few years, and the outlook is for reasonably stable catches at about the current level, barring a major change in the economic climate or CPUE.

5.4.2 Indicators of stock condition

The meeting considered a range of information potentially useful for evaluating stock condition. The information is in several categories, viz., nominal and standardised CPUE time series, analysis of tagging data and analysis of catch, effort and size composition data using the SPARCLE model.

- The Taiwanese fleet is the longline fleet that has most consistently targeted albacore over the period of the fishery, although there has been some recent shifting to yellowfin/bigeye targeting by some vessels. The CPUE of this fleet therefore remains the most useful indicator of stock condition. Taiwanese longline CPUE (WP.14, WP.2) declined during the late 1960s and early 1970s. Since then, nominal and standardised time series show no clear trend, but considerable inter-annual variability. The lowest CPUEs were recorded during 1989-1991, but recovered to higher levels in 1992–1994.

- The Japanese longline fleet targeted albacore in the 1960s, but have targeted yellowfin/bigeye since the early 1970s. Nevertheless, the albacore CPUE in recent years (mid-1980s on) should be a useful indicator as targeting practices during this period have not changed to any degree. Albacore CPUE by Japanese longliners (WP.18) shows a strong increase from 1991 to 1994, particularly in the tropical area of the fishery.

- The US troll fishery targets albacore seasonally in the STCZ. CPUE has shown considerable variation (WP.19, WP.2). CPUE declined from 1986/87 to 1992/93, before recovering to a high level in 1994/95. While no data are yet available, CPUE for the 1995/96 season is believed to be low. The interpretation of troll fishery CPUE is confounded by the limited distribution of the fishery in relation to the stock and the strong influence of environmental conditions on the availability of fish.

- Tagging experiments carried out in the STCZ, New Zealand coastal waters and the Tasman Sea have resulted in low tag recoveries (<1 per cent of releases), with most recoveries made by longliners (WP.3). On face value, the data are suggestive of low surface fishery exploitation in relation to the longline fishery. Attrition model analysis can provide estimates of mortality rates assuming that the tagged fish are representative of the population. Such an analysis of the longline returns suggests a total mortality rate of 0.4-0.6 yr^{-1}. The estimated exploitation rate depends on the assumed level of tag reporting (and survival from other forms of tag loss); exploitation rate ranges from about 0.02 (70 per cent reporting) to 0.13 (10 per cent reporting).

- The length-based age-structured analysis using the SPARCLE model provides considerable new information on the condition of the stock (WP.4). As questions remain regarding some aspects of data quality and further work on the model is planned, the model results should be considered preliminary. The results indicate that recent average exploitation rates are in the range 4–8 per cent. They are thus consistent with the range of likely exploitation rates estimated from tagging data. Total mortality estimates are also reasonably consistent with those obtained from tagging data. The recruitment time series shows considerable variation (possibly linked with environmental conditions) but little indication of a long-term trend. Variations in total biomass appear to have been largely driven by recruitment, with little observable impact of the fisheries. At current levels of fishing, there is unlikely to be an observable impact of the surface fishery on the longline fishery.

5.4.3 Condition of the stock

Total catches of South Pacific albacore have been stable over the past several years, although the success of the troll fishery in the STCZ has been variable. Longline CPUE has been stable or increasing in recent years, and there is no evidence from these data that the current levels of fishing are adversely affecting the stock. Nor is there any indication that the driftnet catches of the late 1980s and early 1990s have had a significant impact on the stock or on the longline fishery. Analyses of tagging data and a length-based age-structured model provide reasonably consistent estimates of growth and mortality rates, which suggest that albacore are slow growing and long lived relative to the tropical tunas. The fisheries potential of albacore is therefore more restricted by comparison with these species. The tagging and age-structured models also provide a preliminary indication that the current exploitation rate is relatively low, probably less than 10 per cent per year. This provides further evidence that the current level of fishing can be sustained.

6. FUTURE RESEARCH PRIORITIES

The Participants reviewed the principal research questions and priorities of SPAR 5 and concluded that they were still relevant objectives. However, the Participants felt that the focus for SPAR 6 should be to flesh-out priorities that have persisted for sometime and that have consistently appeared in SPAR's priority list. The focus would be to identify the specific needs and the likely research teams that could best address each need in the near term. This procedure was followed and specific data and research needs identified by the participants. The results are as follows, with likely research teams to address the needs noted in parentheses:

6.1 Fisheries data

6.1.1 Taiwan longline data

Fishery data for the Taiwan longline fleet have improved over time, but not yet to an acceptable level. Catch statistics and catch-effort (logbook) data [and length-frequency data] are involved and are in need of improvement. Each has specific problems that need addressing.

- Catch statistics. There are significant differences between official annual catch statistics collected by the government and annual catch statistics collected by the SPC from sources at ports where

Taiwan vessels land South Pacific albacore in the region. These differences need to be resolved by detailed comparison of data held by the SPC and Taiwan. (SPC, NTU)

- Logbook data. Coverage of logbook data is too low to be reliable as representative for the fleet. The coverage needs to be improved and this can be facilitated by NTU scientists who process and evaluate the data. (NTU, NMFS)

- Length-frequency data. No significant effort is being made by Taiwan sources to collect length-frequency data on the catch. All efforts so far have been by non-Taiwan organizations. The need is for Taiwan organizations to assume responsibility for this task and implement a comprehensive data collection program. (NTU)

6.1.2. New Zealand troll data

Fishery statistics for the New Zealand troll fleet have deteriorated since 1992. Statistics on catch, catch-effort and length-frequency are involved. They are currently unavailable or from dubious sources. The Ministry of Fisheries needs to re-establish a reliable and credible data collection program for the New Zealand fishery.

6.2 Stock assessment research

6.2.1 SPARCLE model

Preliminary results from the SPARCLE model are encouraging and show promise of the model as a useful stock assessment tool and for identifying data needs. The next phase in the model development is validation and fine-tuning. This phase should be initiated and the SPC (principal investigator) should collaborate closely with NTU and NRIFSF during this phase. (SPC, NTU, NRIFSF)

6.2.2 Age validation and age-length growth curve

Age validation and a reliable growth curve for South Pacific albacore are not available to accurately 'slice' catches into catches by age of fish. Currently, there is no valid method for determining the age of South Pacific albacore, particularly large fish. If a reliable method was available, length-based, age-structured models, such as SPARCLE, can be made more efficient and reliable with respect to assessing current stock condition and forecasting stock abundance. Research on age determination from hardparts needs to be re-initiated for South Pacific albacore. SPC should facilitate the re-initiation of research on this need. (SPC)

6.2.3 Stock structure

Analysis of DNA in tissue samples from South Pacific albacore has been initiated by biologists at NRIFSF to investigate stock structure. This study needs tissue samples from albacore caught throughout the South Pacific and from the Indian Ocean as well. SPAR participants are requested to cooperate and collect albacore tissue samples for this study.

6.2.4 Swimming behavior

Behavior of albacore caught on longline gear are being studied by scientists at ORSTOM/IFREMER in French Polynesia. The study provides information, including vertical and horizontal movements, fish speed, response to environmental conditions including availability of food, etc. that is useful for evaluating catchability of longline gear as well as for understanding the temporal/spatial movements of albacore. The Participants recommended that this study be continued and even expanded to include energetics information. (ORSTOM/IFREMER)

6.2.5 Tagging programme

Opportunistic tagging was conducted for a number of years and the release-return data analysed by SPC. The results indicated a low return rate (1 per cent), but respectable for an opportunistic tagging program. Participants felt that if a dedicated tagging program is executed, greater numbers of fish can be released in a shorter time and return rates could be much higher. More significant, the higher returns would allow better techniques to be used in analyzing the return data and for more information, e.g, fishing gear interactions, exploitation rate, etc. The participants recommended that a small technical group be appointed to scope-out the options for a dedicated tagging program. (SPC, NMFS)

In the course of focusing on persistent needs, the participants identified two general conclusions: First, persistent data needs involve routine fisheries data from specific fishing fleets. The needs can be met if good port sampling programs and/or sound at-sea observer programs are implemented by the flag-countries of the specific fleets. Furthermore, there is growing evidence that observer programs may be more desirable for fleets with a long history of not providing fisheries statistics because observer programs can produce reliable data, including on by-catch and discards, in detailed form and quickly, rather than years later (see section 4.2). Second, persistent research needs mainly involve fundamental biological information to conduct accurate stock assessments. The needs can be met if adequate funding and experienced research talent are applied to key projects. They persist because funding has been inadequate or diverted to addressing other issues.

7. OTHER BUSINESS

7.1 Newsletter

115. Publication of a newsletter was recommended by SPAR 5 as a mechanism for keeping SPAR members informed of events concerning the albacore fishery and of progress with SPAR research initiatives. A newsletter, 'SPAR News', was launched during the biennium and two issues published so far. The participants were pleased with the quality of the publication and thanked the Chairman and members involved in launching the publication.

7.2 Future of SPAR

116. A brief discussion on the future of SPAR ensued. Participants felt that SPAR serves a useful purpose and should be continued with full participation of scientists involved in South Pacific albacore research.

Support and cooperation from French Polynesia, Japan, Korea, New Zealand, Taiwan and the U.S. with major fishing fleets for albacore in the region are essential to SPAR's success. Recently, cooperation and participation in SPAR have fallen off for New Zealand and Korea and have weakened SPAR's ability to accurately monitor stock abundance and fisheries developments. The participants agreed that every effort should be made to restore full participation by these countries and to remind major albacore fishing countries of the need to support regional research bodies, such as SPAR, according to terms of recent international agreements.

7.3 International agreements

Recent international agreements on UN Straddling Fish Stocks and Highly Migratory Fish Stocks and FAO High-seas Vessel Compliance, and current discussions on multi-lateral arrangements for data collection and tuna research in the South Pacific make it clear that regional institutions promoting cooperative and collaborative research will be the backbone for new tuna fisheries management and conservation arrangements. SPAR is such a regional institution. Although it currently operates through an informal basis, it has the potential of becoming a formal organization to meet the needs of a regional fisheries management and conservation agreement; hence, the Participants felt that international developments with respect to albacore fisheries management arrangements should be carefully monitored and shared through SPAR News.

7.4. New chairman

Albert Caton served as chairman of SPAR for the past two meetings. His tenure was during a transition period for SPAR when strong leadership was required. He provided that leadership and set a new benchmark for new SPAR chairmen to meet. The participants thanked Mr Caton for his dedicated service and expert handling of the meetings.

Mr Dan Sua from American Samoa was elected incoming chairman of SPAR.

7.5 Next meeting

SPAR meets on a biennial basis unless there is an emergency. The participants agreed that this schedule should be followed. The chairman would work with the SPC in selecting an appropriate date and place for the next meeting that takes into account the needs of SPAR. If a conflict in choices is encountered, the Chairman shall consult with key members of SPAR to resolve the conflict.

IV. LIST OF WORKING PAPERS

WP.1	Current status of the SPAR database *Oceanic Fisheries Programme, South Pacific Commission*
WP.2	Longline, troll and driftnet catch rates of South Pacific albacore *Oceanic Fisheries Programme, South Pacific Commission*
WP.3	An analysis of the South Pacific albacore tagging data: Estimation of movement patterns, growth and mortality rates *M. Bertignac, P. Lehodey and J. Hampton, South Pacific Commission*
WP.4	South Pacific Stock assessment using the regionalised SPARCLE Model *John Hampton and David Fournier*
WP.5	Albacore landings in American Samoa 1988-1995 *Dan Sua and Gordon Yamasaki*
WP.6	Characteristics of albacore (Thunnus alalunga) catches achieved by experimental fishing using instrumented longline in the French Polynesian Exclusive Economic Zone (EEZ) *P. Bach, R. Abbes, B Wendling and E. Josse*
WP.7	Country statement Solomon Islands *E. Oreihaka*
WP.8	Eastern Australian albacore tuna fisheries - Country Report 26 *T.R. Skousen and A.E. Caton*
WP.9	Fisheries data for longline vessels landing in American Samoa, 1993 and 1994
WP.10	Information on the albacore fishery in Niue's EEZ/territorial seas *Brendon Pasisi*
WP.11	Peculiarity of swimming bladders of large albacore (Thunnus alalunga) caught by longline *Francois Xavier Bard and Erwan Josse*
WP.12	Preliminary Country Report New Zealand
WP.13	Recent developments in the albacore tuna fishery in Fiji from 1993-1995 *I.L. Tuwai*
WP.14	Recent development of Taiwanese tuna longline fisheries in the South Pacific area *Chien-Hsiung Wang*

WP.15 Recent status of the albacore fishery in French Polynesia
S. Yen and A. Stein

WP.16 Recent status of the Japanese albacore fisheries in the SPAR area
Hiroaki Matsunaga and Yuji Uozumi

WP.17 Standardisation of albacore CPUE from the Japanese large-mesh driftnet fishery in the SPAR area
Yuji Uozumi

WP.18 Standardisation of CPUE for albacore caught by Japanese longline fishery in the SPAR area
Yuji Uozumi

WP.19 U.S. South Pacific albacore fishery, 1986-1995
John Childers and Atilio L. Coan, Jr

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