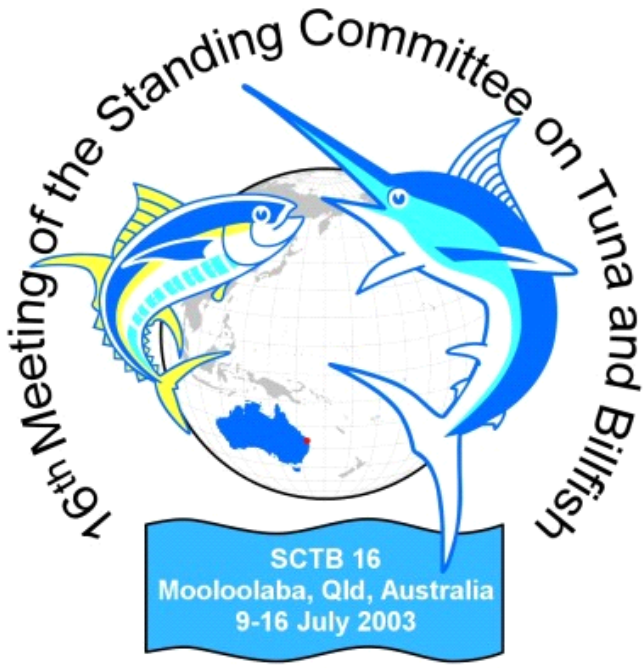

REPORT OF THE SIXTEENTH MEETING OF THE STANDING COMMITTEE ON TUNA AND BILLFISH

9–16 July 2003

Mooloolaba

Queensland, Australia

December 2003

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Sixteenth Meeting of the
STANDING COMMITTEE ON TUNA AND BILLFISH
Mooloolaba, Queensland, Australia
9–16 July 2003

EXECUTIVE SUMMARY

The sixteenth meeting of the Standing Committee on Tuna and Billfish (SCTB 16) was held on 9-16 July 2003 in Mooloolaba, Australia at the invitation of the Chairman, and hosted by the Commonwealth Scientific and Industrial Research Organisation and Agriculture, Forestry, Fisheries - Australia. SCTB 16 was attended by participants from Australia, Canada, Cook Islands, European Union, Federated States of Micronesia, Fiji, France, Indonesia, Japan, Korea, Marshall Islands, New Caledonia, New Zealand, Niue, Palau, Papua New Guinea, the Peoples Republic of China, Philippines, Taiwan, Tonga, United States of America, Vanuatu and Vietnam. Representatives from various regional and international organizations also attended the meeting. These included the Forum Fisheries Agency (FFA), the Inter-American Tropical Tuna Commission (IATTC) and the Secretariat of the Pacific Community (SPC).

The SCTB provides a forum for scientists and others with an interest in the tuna and billfish stocks of the western and central Pacific Ocean (WCPO) to meet to discuss scientific issues related to data, research, and stock assessment. Its aims are to:

1. coordinate fisheries data collection, compilation and dissemination according to agreed principles and procedures;
2. review research on the biology, ecology, environment and fisheries for tunas and associated species in the WCPO;
3. identify research needs and provide a means of coordination, including the fostering of collaborative research, to most efficiently and effectively meet those needs;
4. review information pertaining to the status of the stocks of tunas and associated species in the WCPO, and to provide statements on stock status where appropriate, and;
5. provide opinions on various scientific issues related to data, research and stock assessment of WCPO tuna fisheries.

The SCTB Chairman and Working Group and Research Group Coordinators for SCTB 16 were as follows.

SCTB Chairman:	Dr SungKwon Soh
Fishing Technology WG:	Mr David Itano
Methods WG:	Dr John Sibert
Statistics WG:	Mr Tim Lawson
Albacore RG:	Mr Régis Etaix-Bonnin
Bigeye RG:	Dr Naozumi Miyabe
Skipjack RG:	Dr Gary Sakagawa
Yellowfin RG:	Dr Robert Campbell
Billfish and Bycatch RG:	Mr Paul Dalzell

The meeting agenda, working papers presented at the meeting and list of participants are provided in Appendices 1, 2 and 3, respectively. The meeting convened as eight working groups: the Statistics Working Group (SWG), the Fishing Technology Working Group (FTWG), the Methods Working Group (MWG), the Skipjack Research Group (SRG), the Albacore Research Group (ARG), the Yellowfin Research Group (YRG), the Bigeye Research Group (BRG), and the Billfish and Bycatch Research Group (BBRG).

The initial overview of Western and Central Pacific Ocean (WCPO) tuna fisheries noted that the estimated total catch for 2002 for the four main tuna species was 1,982,000 mt, the second highest annual catch on record after 1998 (2,037,600 mt). The 2002 WCPO catch of skipjack (1,321,900 mt) was the highest ever, eclipsing the previous record catch attained in 1998 (1,314,200mt), and as usual dominated the total catch. The WCPO yellowfin catch (438,000 mt; 22%) was the lowest for six years and about 65,000 mt lower than the record catch in 1998 (503,000 mt). The WCPO bigeye catch for 2002 (107,600 mt; 5%) was slightly higher than in 2001, while the WCPO albacore catch (114,500 mt; 6%) was slightly down on that taken in 2001. The record catches for these species are 111,000 mt and 148,000 mt, respectively and were taken during 1999. In contrast to the WCPO, the EPO yellowfin catch for 2002 was the highest ever (427,700 mt), but the EPO bigeye catch was the lowest since 1984.

Reports on relevant activities of other organizations were received from IATTC and PFRP.

The three Working Groups (Statistics, Methods and Fishing Technology) held a series of meeting in the two days prior to SCTB16 and considered a range of issues relevant to their respective terms of reference. Summaries of these meetings were presented to SCTB16 and summary statements for each Working Group are provided.

The five Research Groups considered regional fishery developments, advances in research, stock assessment and research coordination and planning for those species or groups of species. Summary statements on these matters are provided for each research group.

Cross-cutting issues arising from discussion in the three Working Groups and five Research Groups were considered in a separate session of SCTB for the first time. The discussion, which considered issues relating to estimation of catch, catch rates and size/species composition, biological and ecological, stock assessment and emerging management issues, identified certain research issue as priorities with time frames for implementation. Those issues which were identified as being of a high priority included:

- Better estimates of current catch from Indonesia, Philippines and Vietnam, noting that some progress had been achieved in this area;
- Reconstruction of early catch history (catch, effort, size composition) for all fisheries;
- Further development of methods to standardise effort, including the better use of vessel operational details, environmental data and archival tagging data;
- General efforts to reduce uncertainty in assessments, through improved data inputs, sensitivity analysis and simulations;

- Evaluation of possible regime shifts/changes in productivity and development of improved/alternative estimates of recruitment where possible;
- Development of appropriate formats to frame advice for managers.

The session also reaffirmed the recommendation from previous SCTB meetings that large scale tagging experiments for the main target tuna species in the WCPO be carried out, and in coordination with tagging experiments in the eastern Pacific Ocean (EPO). Such experiments were seen as being crucial to helping the estimation of movement and fishing mortality rates in the assessment models and providing an independent means of validating model results, and as such should be regarded as the appropriate regular monitoring approach for highly migratory species in the WCPO. Finally, the session reaffirmed the value of directed fisheries research, and its central role in the quality of management advice provided and in reducing uncertainty in the advice provided. The session also noted the likely negative consequences to both the management of the fishery and the status of stocks (mainly bigeye and yellowfin tuna) if such research is delayed.

The meeting held initial discussions on defining and measuring fishing capacity in WCPO tuna fisheries and what role SCTB might have, given other regional and international initiatives. The meeting noted that the primary focus of SCTB was stock assessment and in this regard was interested in measures of effective fishing effort. SCTB was unable to agree on a definition of fishing capacity. While it remained unclear what SCTB could do in relation to measuring fishing capacity it was noted that there were contributions it could make in areas of improving data availability, in fishing effort standardization and possibly others. Having noted that other agencies were still grappling with how to address the issue after several years of consideration, it was recognised that fishing capacity issues were broader than what could be resolved in this initial discussion. SCTB members were encouraged to consider this issue over the coming year, and to consider discussing fishing capacity again at SCTB 17.

The meeting also considered proposals for improving the organisation of future SCTB meetings. A number of options were discussed and adopted. In acknowledgement of the time required to undertake the assessments, a recommendation to hold the SCTB meeting at a later date (possibly in August) was also adopted.

Finally, the meeting considered the arrangements for 17th SCTB meeting. Dr Sung Kwon Soh was thanked for his outstanding performance in chairing SCTB 16 and reaffirmed as the chair for SCTB 17. Dr Max Stocker was elected as the new chair for the Albacore Research Group while all other chairs of the Working and Research Groups remained unchanged. The meeting also considered the venue for the next meeting and accepted an offer from the Marshall Islands to host SCTB 17 in Majuro in 2004 (exact dates to be advised). The meeting closed on Wednesday 16 July at 17:00 hrs.

STATISTICS WORKING GROUP – SUMMARY STATEMENT

The objective of the Statistics Working Group is to coordinate the collection, compilation and dissemination of tuna fishery data. Highlights of the current status of data collection, compilation and dissemination include the following:

- In recent years, estimates of the annual catches of the target tuna species (albacore, bigeye, skipjack and yellowfin) have been provided within six months following the end of the calendar year for all fleets, except those covering the longline and pole-and-line fleets of Japan; however, most of these estimates do not include discards. Estimates of annual catches of billfish are less complete. The availability of data (primarily observer data) to estimate the annual catches of other highly migratory species covered by the WCPF Convention, and species of special interest (marine turtles, sea birds and marine mammals), will be reviewed by the SPC Oceanic Fisheries Programme (OFP).

- For 2001, the most recent year for which all or most data have been compiled, the OFP holds catch and effort logsheet data covering 44.3% of the catch of target species in the WCPO. These data cover catches taken by the domestic fleets of SPC member countries and territories, catches by distant-water fleets fishing with the EEZs of SPC members, and catches of certain distant-water fleets on the high seas (such as the purse-seine fleets of Korea and Taiwan, but not Korean and Taiwanese distant-water longline fleets or any Japanese fleets). Excluding the domestic fisheries of Indonesia and the Philippines, for which no catch and effort data have been provided, and the coastal fisheries of Japan, the logsheet coverage is 64.3%.

- Coverage by catch and effort data aggregated by time and area (5° latitude by 5° longitude by month for longline and 1° by 1° by month for pole-and-line and purse seine), which are derived from data held by the OFP or provided by distant-water fishing nations, is complete for 1950–2001, except for those covering certain fleets in the early part of the times series. The National Research Institute of Far Seas Fisheries of Japan recently provided historical longline catch and effort data, aggregated by 5° by 5° and month, for 1952–1961. Aggregated catch data covering the domestic fleets of Indonesia and the Philippines are based on estimates of annual catches that are highly uncertain and effort data for these fleets have not been collected.

- The coverage by length or weight data is currently sufficient for all gear types, except for the domestic fleets of Indonesia, the domestic fleets of the Philippines and the coastal fleets of Japan. Size sampling should be established for these fleets.

- Information regarding the coverage by catch and effort logsheet data and size data that are not held by the OFP – primarily data held by Japan, Korea and Taiwan – has not been provided in most cases.

- Estimates of annual catches for the domestic fleets of Indonesia and the Philippines have been provided on a timely basis; however, annual catch estimates in recent years (1992–2002 for Indonesia and 1997–2002 for the Philippines) have not been

broken down by gear type and estimates of annual bigeye and yellowfin catches for all years have been reported as a combined catch. Catch data at a higher resolution and effort data have not been provided. Species composition and size data have been collected in the Philippines since 1997, but this programme was interrupted in 2002 due to funding constraints. No sampling is being conducted in the Pacific Ocean waters of Indonesia. The SWG, in collaboration with the relevant national authorities, will continue to develop project proposals and seek sources of funding to establish sampling programmes in the Pacific Ocean waters of Indonesia and to provide support for ongoing sampling programmes in the Philippines.

- Uncertainties remain regarding the past and present species composition of small tropical tunas caught by purse seiners in association with floating objects, particularly in regard to bigeye.

A one-day meeting of the SWG on standards for the design of national and regional observer programmes was held immediately prior to SCTB16. Guidelines were established for coverage rates relating to research objectives for observer programmes covering the offshore longline fleets targeting South Pacific albacore (American Samoa, Cook Islands, Fiji, French Polynesia, New Caledonia, Samoa, Tonga). Further analyses will be conducted to establish guidelines for the offshore longline fleet targeting bigeye and yellowfin and the purse-seine fleets fishing in tropical waters on the basis of observer data held by the SPC Oceanic Fisheries Programme; however, observer data are not available to conduct similar analyses for the distant-water longline fleets.

Recent developments in port sampling and observer programmes were discussed. Port sampling programmes are currently being conducted in Australia, Cook Islands, Federated States of Micronesia, Fiji, Japan, Kiribati, Korea, Marshall Islands, New Caledonia, New Zealand, Palau, Papua New Guinea, Solomon Islands and Taiwan. Observer programmes have been developing slowly in regional and national organisations throughout the WCPO, but in recent years have expanded more rapidly in response to the need for detailed information on fishing effort, discards and catch statistics for non-target species. Observer programmes are being conducted in Australia, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Kiribati, New Caledonia, New Zealand, Papua New Guinea, Solomon Islands and the United States (Hawaii), and the Forum Fisheries Agency manages the observer programmes covering the United States and FSM Arrangement purse seiners. Observer programmes are being developed in American Samoa, Japan, Korea and Taiwan.

The problem of the mis-identification of bigeye as yellowfin on purse-seine logsheets was addressed. In particular, an analysis of the proportion of bigeye in the combined catch of yellowfin and bigeye, based on purse-seine observer data held by the OFP for 1998–2001, was presented. Several data sets that can be used as input data for the MULTIFAN-CL assessment of bigeye were produced, based on varying assumptions regarding the statistical relatedness of the proportion of bigeye in the combined catch of yellowfin and bigeye with variables such as school association, year, quarter, area, flag and size group. A report of a review of the accuracy of species identification by port samplers in American Samoa was also presented; it was verified that the accuracy of the two samplers was 100% over the size range of fish that were examined (41 cm

yellowfin, 45 cm bigeye). It was recommended that similar work be conducted to verify port sampling throughout the region, preferably when yellowfin and bigeye of smaller sizes are available.

SKIPJACK RESEARCH GROUP – SUMMARY STATEMENT

Key attributes

Skipjack tuna is found year-round concentrated in the tropical waters of the WCPO. Its distributional range expands seasonally into subtropical waters to the north and south. It is a species characterized by large stock size, fast growth, early maturing, high fecundity, year-round spawning over a wide area, relatively short life span (maximum age of 4 or 5 years old) and variable recruitment.

A single stock is assumed to reside in the WCPO. Currently, stock assessment for this stock is largely undertaken with the MULTIFAN-CL model. The Methods Working Group has noted concerns about the model's ability to produce accurate estimates for some parameters. Consequently, the Skipjack Research Group (SRG) has taken into account the concerns and has largely relied on trends and ratios instead of point estimates from the model in assessing current stock status.

Recent developments in the fishery

Skipjack tuna catches exceed any other tuna species, and a majority of the catch is taken by purse seine. Catches from purse seine sets consist of a mixture of skipjack, yellowfin, and bigeye tuna, with the proportions varying depending on whether sets are made on free schools or floating objects.

Over the past 4-5 years, the catch has been at record high levels exceeding 1.2 M mt annually (Figure 1) and accounting for more than 60% of the annual catch of principal tuna species landed from the region. Along with the record catches, the price for skipjack tuna has fallen to levels not seen since the 1970s. Since about 1996, increased use of Fish Aggregating Devices (FADs) by purse seiners has contributed to the record catches. Typically, the bulk of the catch consists of two age groups (size range 40–70 cm FL).

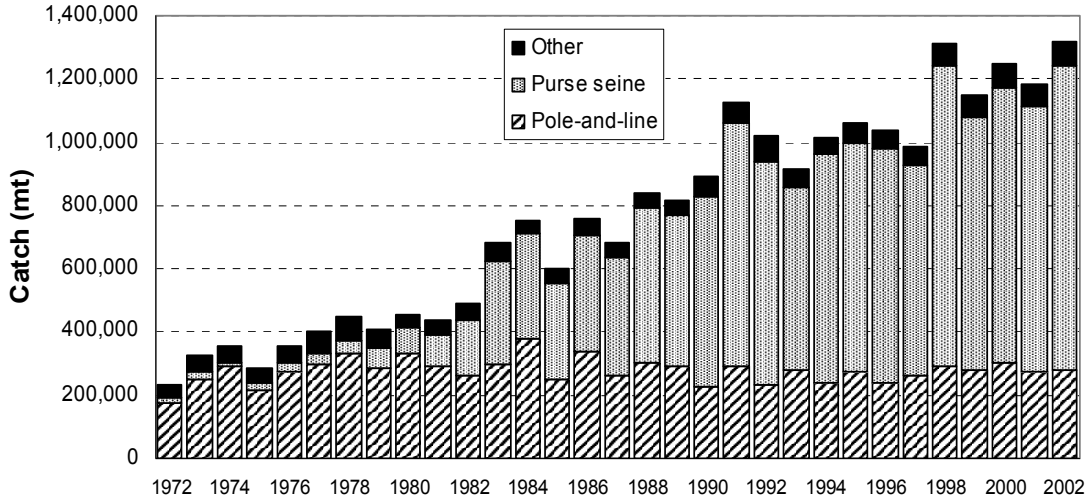


Figure 1. WCPO skipjack catch (mt) by gear.

In 2002, an estimated catch of 1.3M mt tuna was landed, the highest on record. Seventy-three percent (962,700 mt) was taken by purse seine gear, 21% (280,600 mt) by pole-and-line gear and 6% (70,000 mt) by other gears.

Trends

CPUE

Nominal CPUE for all purse seine fleets, except the U.S. fleet, continues to show an upward trend, reaching a record high average rate of approximately 30 mt/day fished in 2002. This increase is due to increase in efficiency associated with setting on floating objects. Standardized CPUE for the Japanese pole-and-line fleet, on the other hand, shows no trend.

Sizes of Fish Caught

Sizes of fish in the catch (based on weight) has largely been constant with a dominant mode at about 50-60 cm FL and a significantly smaller mode at about 30 cm FL (Figure 2). The larger mode consists of fish mainly caught by purse seine and pole-and-line gears and the smaller mode, by various gears of the domestic fisheries of the Philippines and Indonesia.

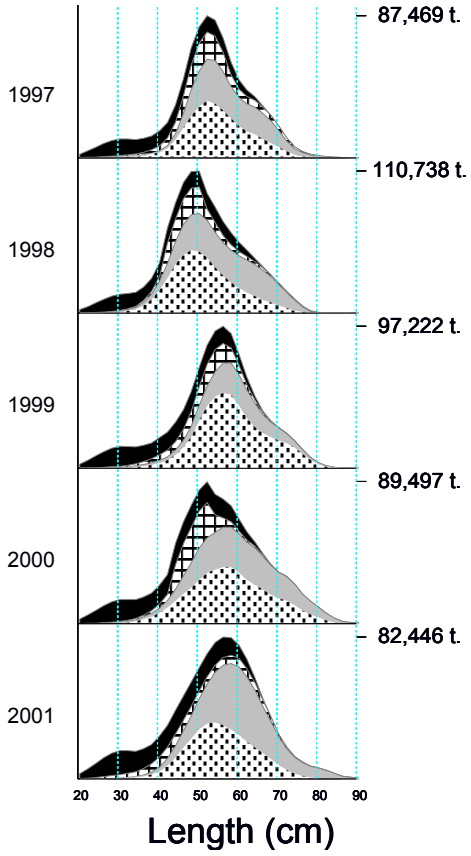


Figure 2. Annual Skipjack tuna catch-at-size in the WCPO, 1997–2001.

The catch is broken down into the Indonesian/Philippines domestic fisheries component (black), the pole-and-line fishery component (hatched), unassociated-set catch from the purse-seine fishery (grey) and associated-set catch from purse-seine fishery (dotted). The y-axis scale is in weight – the figures on the right indicate the catch weight in a 2-cm size class.

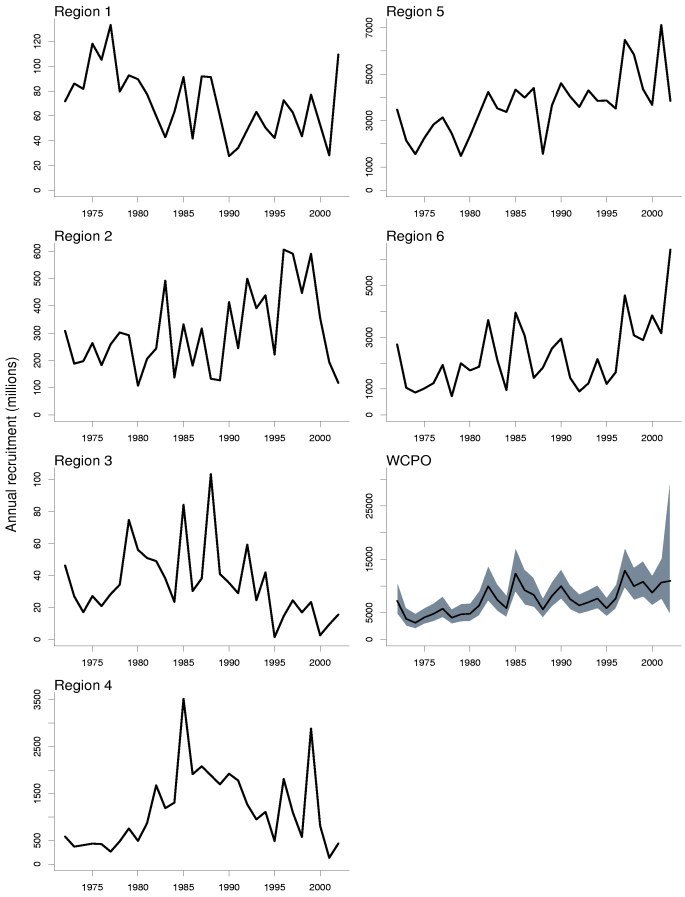


Figure 3. Estimated annual recruitment (millions) by region and for the WCPO for the base-case analysis. The shaded area for the WCPO indicates the approximate 95% confidence intervals.

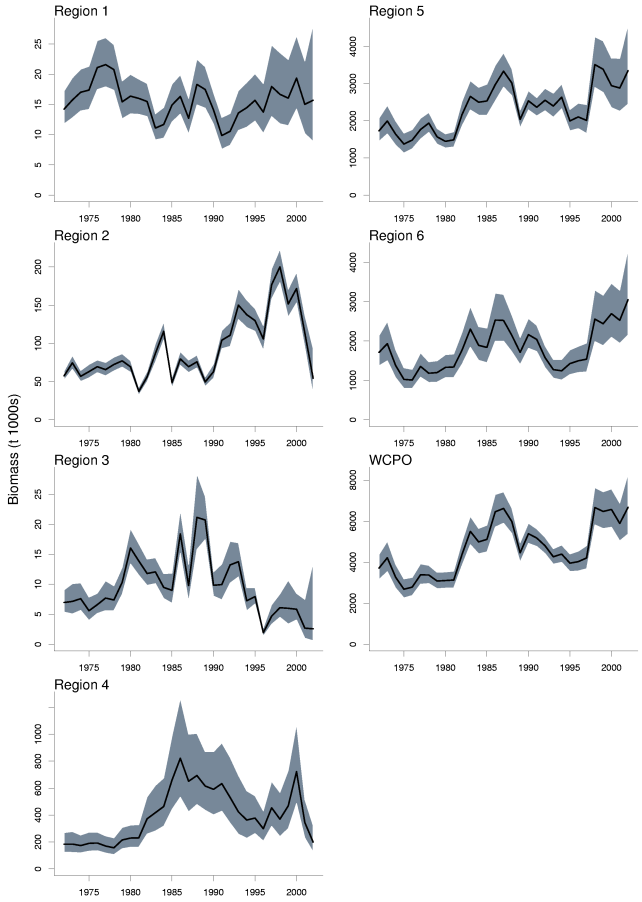


Figure 4. Estimated annual average total biomass (thousand t) by region and for the WCPO for the base-case analysis. The shaded areas indicate the approximate 95% confidence intervals.

Recruitment

Estimated recruitment has varied (about three fold) since 1972 and the trend has been upward. Estimated current recruitment, although less precise than estimates for earlier year classes, is among the highest in the time series (Figure 3). This high recruitment appears to be related to El Nino events.

Biomass

The level of biomass of skipjack tuna is largely dictated by the level of incoming recruitment to the population. Since 1972, the trend in estimated biomass has been upwards, following an apparent step-wise increase in recruitment (Figure 4). Current biomass is well above the biomass that would produce MSY.

Fishing mortality

The trend in estimated fishing mortality rate has been upwards since 1972, with the current overall fishing mortality rate (F) at a modest level of approximately 0.20-0.25 per year (Figure 5).

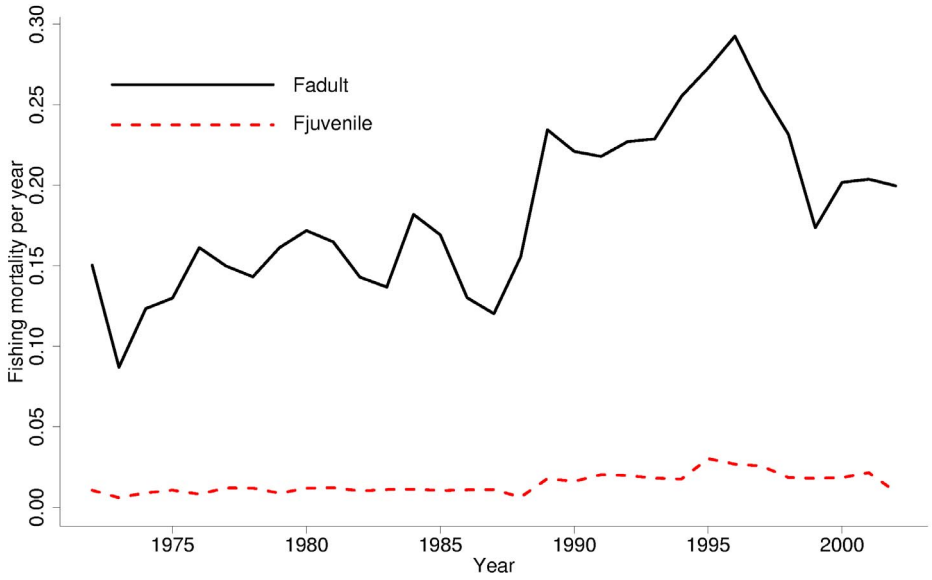


Figure 5. Estimated annual average fishing mortality rates for juvenile (age classes 1 and 2) and adult age-classes from the base-case assessment.

Stock status

Estimated biological reference points, particularly B-current/B-msy and F-current/F-msy, indicate that the skipjack tuna stock of the WCPO is not overfished owing to recent high levels of recruitment and a modest level of exploitation relative to the stock's biological potential (Figure 6). Continued catches at the 1.2 M mt level is sustainable with continued high levels of recruitment (Figure 7), which are believed to be determined by principally environmental factors and not owing to a strong spawner-recruit relationship.

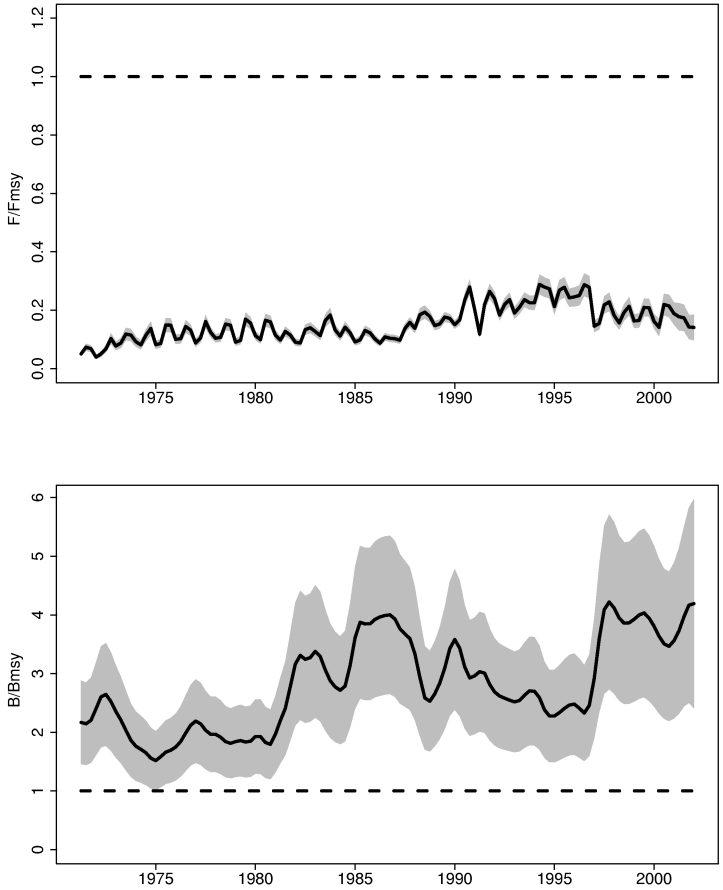


Figure 6. Ratios of F_t / F_{MSY} (top) and $B_t^{adult} / B_{MSY}^{adult}$ (bottom) with 95% confidence intervals. The horizontal lines at 1.0 in each case indicate the overfishing (a) and overfished state (b) reference points.

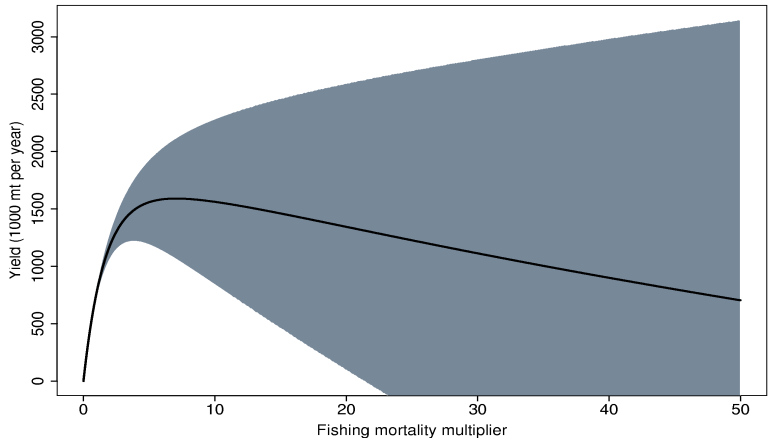


Figure 7. Predicted equilibrium yield and 95% confidence intervals as a function of fishing mortality (relative to the average fishing mortality-at-age during 1997-2001).

YELLOWFIN RESEARCH GROUP – SUMMARY STATEMENT

Key attributes

Yellowfin tuna are fast growing, mature at about two years of age and are highly fecund. Yellowfin can grow to 180 cm in length and weigh over 100 kg when they are about six years of age or older. The majority of the catch is taken from the equatorial region where they are harvested with a range of gear types, predominantly purse seine and longline. Catches of yellowfin tuna represent the second largest component (21–27% since 1990) of the total annual catch of the four main target tuna species in the WCPO. For stock assessment purposes, yellowfin tuna are believed to constitute a single stock in the WCPO.

Recent developments in the fishery

Since 1990, there have been large increases in the catches of juvenile yellowfin tuna by the purse seine FAD fishery, though in recent years catches in the purse seine fishery overall have declined from the record catch taken in 1998. The catches of juvenile yellowfin in the Philippine and Indonesian domestic fisheries have also increased significantly since 1990, with these increases continuing to 2002.

Trends

Catch and effort

Longline fisheries developed in the early 1950s with yellowfin tuna being the principal target species, though a major change took place after the mid-1970s with the increased targeting of bigeye tuna. Large-scale industrial purse seine fisheries developed in the early 1980s, principally targeting skipjack tuna but also taking large catches of yellowfin tuna. This development, together with increased catches by Indonesian and the Philippines, resulted in the yellowfin catches in the WCPO doubling from 200,000 to 400,000 mt between 1980 and 1990. Over the past decade, 40-60% of the total yellowfin catch each year has come from the purse seine fishery.

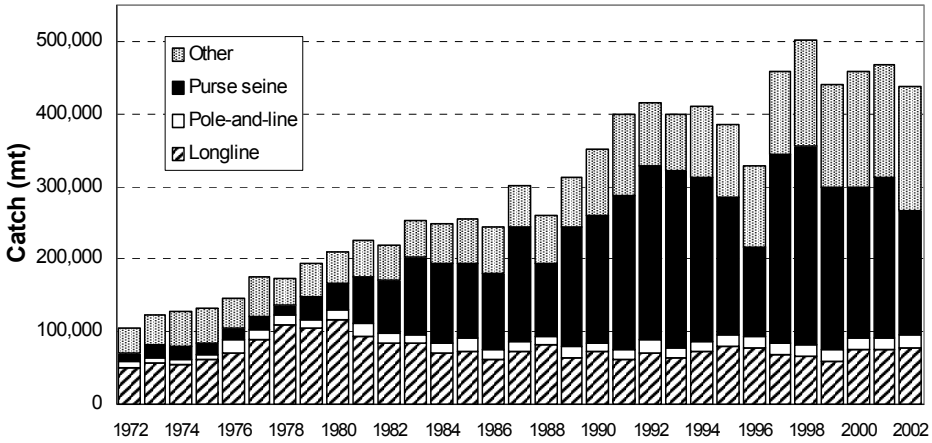


Figure 8. Annual WCPO yellowfin catch (mt) by gear.

In 2002, the total catch of yellowfin tuna in the WCPO is estimated to have been 437,984 mt, the lowest since 1996 and down from the peak catch of 502,960 mt taken in 1998 (Figure 8). The relatively low total catch during 2002 was largely due to a

decrease in the purse seine catch, which for 2002 was 171,767 mt (39% of the total). This catch was the lowest since 1996. In contrast, the EPO purse seine catch of yellowfin (417,472 mt) for 2002 was an all-time record. Nominal CPUE for purse seine fleets generally show no overall trend but high interannual variability that is believed to be due to environmental variation that affects recruitment and catchability. Low catch rates observed during 2002 are considered unusual for an El Nino event.

The longline catches since 1990 (60,000–80,000 mt) have been well below catches taken in the late 1970s to early 1980s (87,000-117,000 mt). The 2002 catch is estimated to be 77,177 mt, or 18% of the catch by all gears. Time-series of nominal catch rates for the Japanese longline fleet display high inter-annual variability and regional differences, with an overall decline since the early 1950s in the equatorial WCPO but little or no overall trend in more temperate regions. Time-series of standardised catch rates for this fleet also display regional differences, with large differences also seen between the different indices within several regions. The GLM based index displays similar (if sometimes smaller) trends to the nominal catch rates, while the indices based on the statistical habitat based method (SHBS) generally indicate smaller changes in biomass over time.

During 2002, the pole-and-line fisheries took 17,770 mt (4% of the total) while 'other' fisheries (largely taken by fisheries in the Philippines and Indonesia) accounted for 171,270 mt (38% of the total).

Size of Fish Caught

The annual catch-at-size by principal fisheries are shown in Figure 9 while recent trends in quarterly catch-at-size are shown in Figure 10. The domestic surface fisheries of the Philippines and Indonesia take large quantities of small yellowfin in the range 20–50 cm. Purse seine sets on floating objects (i.e. associated schools) generally take smaller fish than sets on unassociated or free-swimming schools, which are often 'pure' schools of large yellowfin. However, the size ranges of the yellowfin taken in associated and unassociated purse seine sets vary from year to year. Yellowfin taken in unassociated purse-seine sets are of a similar size range to fish taken in the longline fishery and the handline fishery in the Philippines (both gears target adults in the range 80–160 cm). The purse-seine catch of adult yellowfin tuna is in fact higher than the longline catch in most years. There was a relative absence of medium-sized (60–100cm) yellowfin in the catches from both the longline and purse seine fisheries during most quarters of 2000 and 2001, although a "pulse" in this size range appears by the 4th quarter 2001.

Recruitment

Trends in estimated recruitment are sensitive to the standardised effort indices used in the assessment model (Figure 11). For the GLM index, recruitment displays no overall trend since the early 1950s, while under the SHBS index recruitment is estimated to have increased between the mid-1970s and the mid-1980s, with overall recruitment levels since that time being around twice the levels before this transition. The SHBS index also indicates that recruitment variability may have increased in recent years. Whether this change in the productivity of the stock is real, and if so, whether it reflects a change (or a 'regime' shift) in oceanographic conditions or is an artifact of the increased catch of juvenile fish taken in the surface fisheries over this period remains unclear.

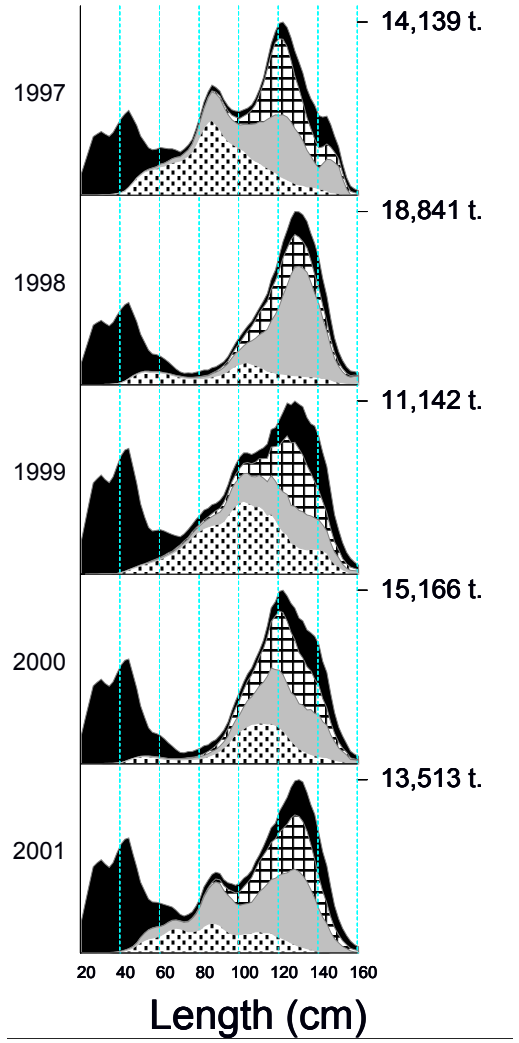


Figure 9. Annual Yellowfin tuna catch-at-size in the WCPO, 1997–2001.
The catch is broken down into the Indonesian / Philippines domestic fisheries component (black), the longline fishery component (hatched), unassociated-set catch from the purse-seine fishery (grey) and associated-set catch from purse-seine fishery (dotted). The y-axis scale is in weight – the figures on the right indicate the catch weight in a 2-cm size class.

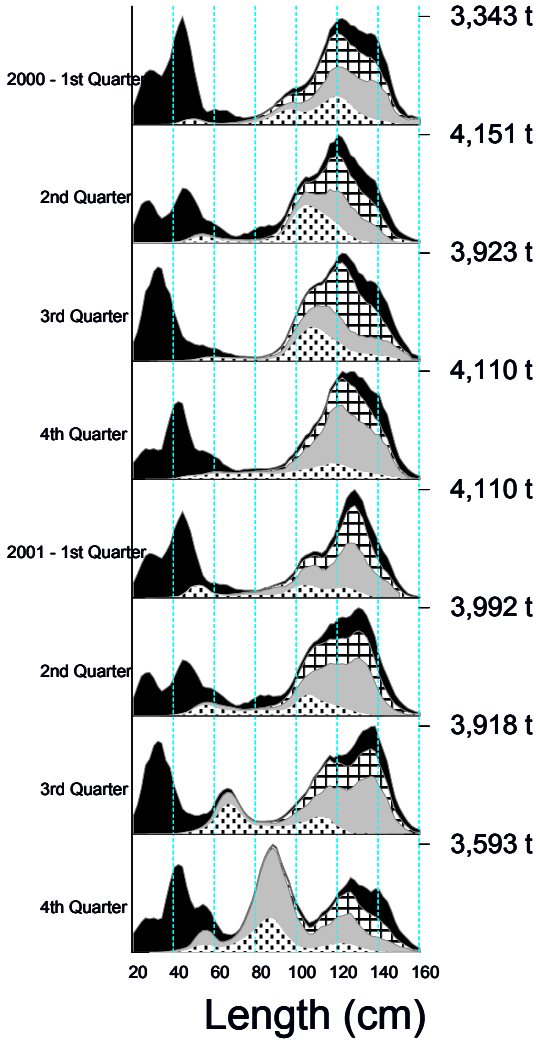


Figure 10. Quarterly Yellowfin tuna catch-at-size in the WCPO, 2000–2001.
The catch is broken down into the Indonesian / Philippines domestic fisheries component (black), the longline fishery component (hatched), unassociated-set catch from the purse-seine fishery (grey) and associated-set catch from purse-seine fishery (dotted). The y-axis scale is in weight – the figures on the right indicate the catch weight in a 2-cm size class.

Biomass

Trends in estimated total biomass are sensitive to the standardised effort indices used in the assessment model (Figure 12). For the GLM index there is an overall declining trend in total biomass over time, while the pattern for the SHBS index is somewhat different - declining until the mid-1970s, increasing until 1990, after which time it decreased before increasing back to 1990 levels in recent years. Estimates of the current level of depletion of yellowfin in the WCPO indicate that the current biomass is 20-35% less than the level that would have occurred in the absence of fishing. However, depletion is greater for some regions, notably the equatorial regions where recent depletion levels are near 50%.

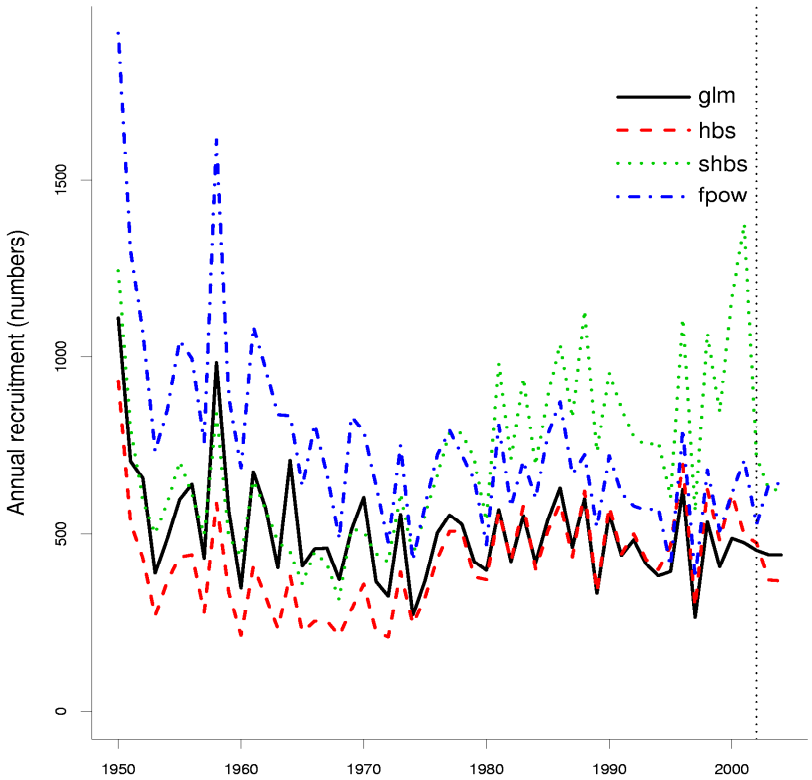


Figure 11. Time-series of estimated annual recruitment of yellowfin for the WCPO.

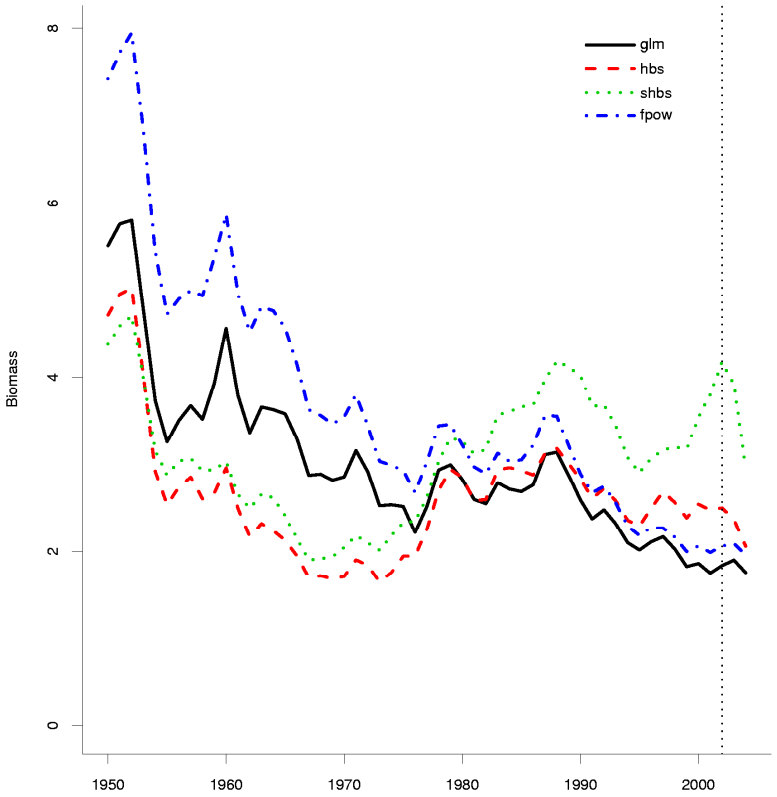


Figure 12. Time-series of estimated annual total yellowfin biomass (million t) for the WCPO.

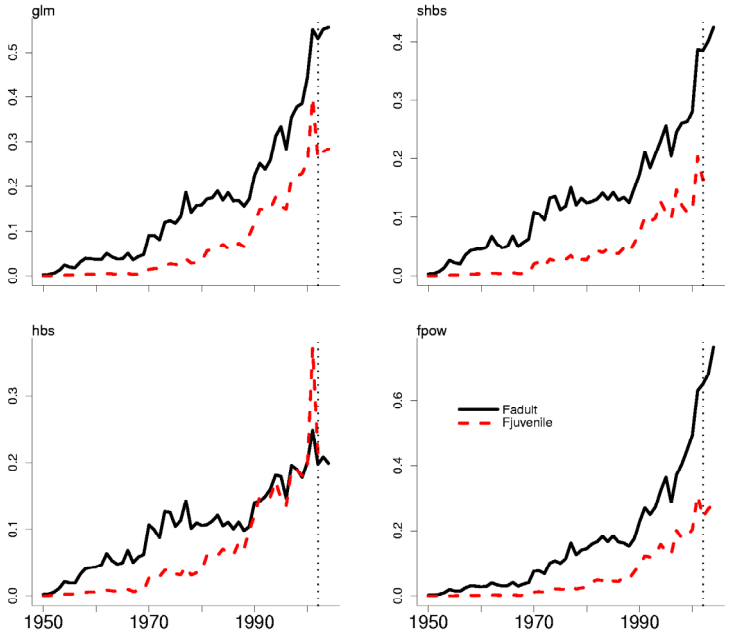


Figure 13. Time-series of estimated annual juvenile and adult fishing mortality for the WCPO.

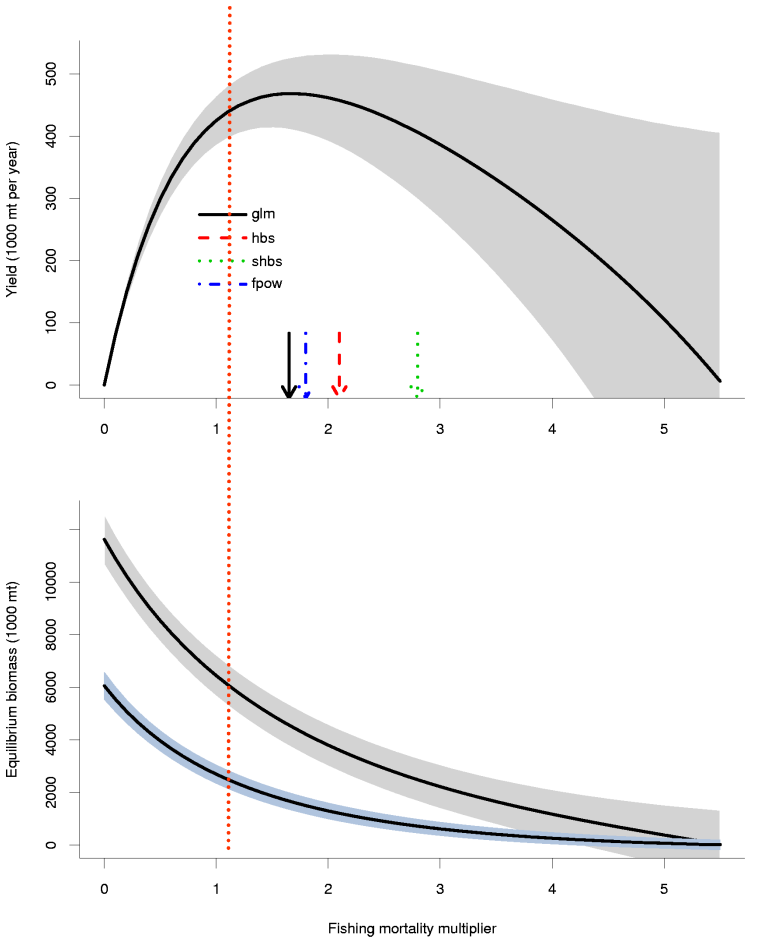


Figure 14. Yield, equilibrium biomass and equilibrium spawning biomass as a function of fishing mortality multiplier.

Fishing mortality

Trends in estimated fishing mortality rates are shown in Figure 13. Fishing mortality for both juveniles and adults is estimated to have increased continuously since the beginning of industrial tuna fishing, with significantly more rapid increases since the early 1990s. These increases are attributable to increased catches of juvenile yellowfin in purse seine fisheries and catches in the domestic Indonesian and Philippine fisheries, together with the declines in overall biomass over the past decade.

Stock status

The assessment reviewed by SCTB16 reaffirms the result of the previous assessment that the yellowfin stock in the WCPO is presently not being overfished (ie. $F_t/F_{MSY} < 1$) and that it is not in an overfished state ($B_t/B_{MSY} > 1$). However, the stock is likely to be nearing full exploitation and any future increases in fishing mortality would not result in any long-term increase in yield and may move the yellowfin stock to an overfished state. While biomass-based reference points (Table 1) indicate that the long-term average biomass should remain above that capable of producing *MSY* if present catches are maintained, yield estimates (Figure 14) indicate that there may be limited potential to expand long-term catches from the fishery at the current pattern of age-specific selectivity. The assessment also indicates that the equatorial regions are likely to be fully exploited, while the temperate regions are likely to be under-exploited. While these spatial patterns of exploitation remain uncertain, if true, this may indicate the potential need for different management in different regions. Furthermore, the attribution of depletion to various fisheries or groups of fisheries indicates that the Indonesian fishery has the greatest impact, particularly in its home region. The purse seine fishery also has high impact, particularly in the equatorial regions.

While recognizing continuing uncertainties associated with the present stock assessment, the SCTB reiterates the previous recommendation that there be no further increases in fishing mortality (particularly on juvenile yellowfin) in the WCPO. If future evidence supports a shift to a lower productivity regime, a decrease in total catch would be anticipated in order to maintain the stock at sustainable levels.

Table 1. Estimates of performance measures based on the 2002 and 2003 stock assessments.

Management Quantity	2003 Assessment				2002 Assessment
	GLM	HBS	SHBS	FPOW	HBS
Estimated MSY	381,000 to 554,000 (Assuming Average Recruitment)				290,000 (Low Recruitment) 372,000 (Average Recruitment) 500,000 (High Recruitment)
Y_{Fcurr}/MSY	0.91	0.82	0.71	0.89	na
$B_{curr}/B_{curr,F=0}$	0.65	0.71	0.80	0.69	~0.63
F_{curr}/F_{MSY}	0.61	0.45	0.36	0.56	~0.50
B_{curr}/B_{MSY}	1.59	2.62	2.86	1.47	na

BIGEYE RESEARCH GROUP – SUMMARY STATEMENT

Key attributes

Bigeye tuna are a relatively slow growing species that matures at approximately three to four years of age. Bigeye are known to grow to about 200 cm and over 180 kg when eight years or older. They have a wide distribution between 40°N and 40°S (Figure 15) and vertically between surface and 500 m deep (occasionally to 1000 m) due to their tolerance of low oxygen levels and low temperatures. These and other characteristics make them less resilient to exploitation than skipjack and yellowfin tunas. There is no clear evidence of plural stocks in the Pacific and geographical distribution is known to be continuous throughout the Ocean. On this basis, and considering the existence of two major surface fishing areas in the western and central Pacific and eastern Pacific, stock assessment has been carried out on two different stock hypotheses, i. e., two-stock hypothesis (western and central Pacific and eastern Pacific) and a Pacific-wide stock hypothesis allowing the extent of basin-scale mixing to be estimated. Large fish are caught mainly by longline, and these longline-caught bigeye are the most valuable among the tropical tunas. Juvenile fish tend to form mixed schools with skipjack and yellowfin, which results in catches by the surface fishery, particularly in association with floating objects. Natural mortality is estimated to be relatively low compared with other tropical species.

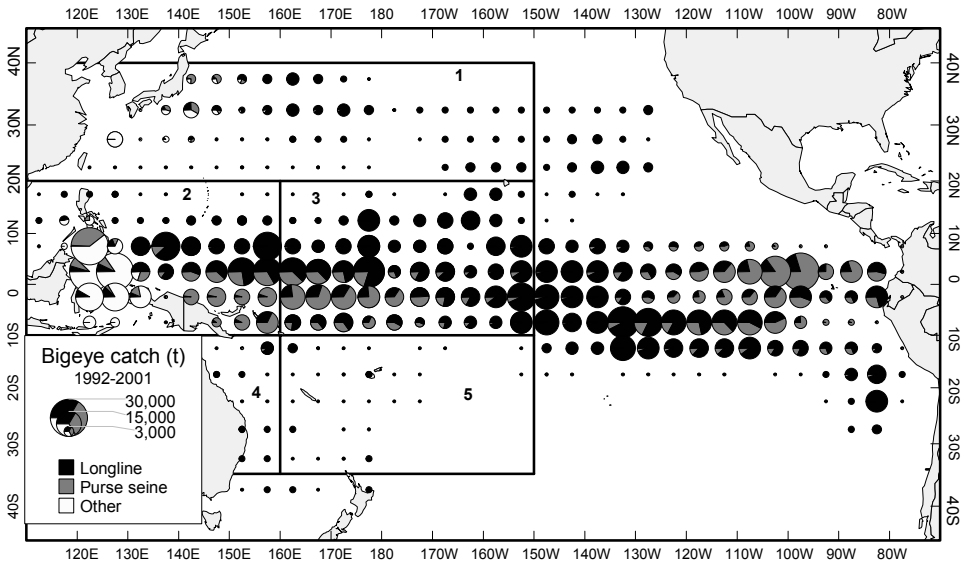


Figure 15. Distribution of bigeye tuna catch, 1992–2001. The spatial stratification used in the WCPO MULTIFAN-CL model is shown.

Recent developments in the fishery

The number of purse seine vessels has exceeded 200 since the early 1990s. In more recent years, there has been an increase in the number of vessels flagged by the Pacific Island countries while the number of purse seiners in other nationalities has reduced slightly. There had been an increase in purse seine catches of juvenile bigeye

tuna associated with the increased use of the drifting FADs during the late 1990s. However, recent catches have fallen to some extent mostly due to a reduced use of drifting FADs since 1999.

Overall longline fleet size has been stable. The number of foreign vessels based in Pacific Island countries fell during the past 6 years, while the number of Pacific Island domestic vessels has increased since the early 1990s. The distant-water longline fleet has decreased to some extent, since some countries reduced their distant-water longline vessels. The catch composition in the longline fishery has changed from BET-25%, YFT-55%, ALB-20% in 1980 to BET-30%, YFT-35%, ALB-35% in 2002, suggesting increased targeting of bigeye as well as albacore.

Catch and effort Trends

The total bigeye tuna catch in the WCPO was 108,000 MT in 2002, similar to 2001 and representing 62% of the total Pacific catch in the same year. Available statistics (Figure 16) indicate that 60% of the WCPO catch was taken by longline, and most of the remainder by purse seine (21%) and by the domestic fisheries of Indonesia and Philippines and others (18%). The total catch of small bigeye tuna by the purse seine fishery is uncertain, as they are not systematically separated from yellowfin at the unloading sites nor recorded separately on fishing logs. Purse seine catch in 2002, estimated through the statistical analysis of sampling data, continued to reduce since the 1999 record high of 34,568 mt due to a decreased use of drifting FADs. There is also considerable uncertainty in the estimation of the Indonesian and Philippines catches due to the lack of (or limitations in) systematic sampling programs. Nominal (unadjusted) CPUE for WCPO bigeye tuna derived from longline data indicated a sharp decline during the early stages of the fishery but has been fairly stable over recent years.

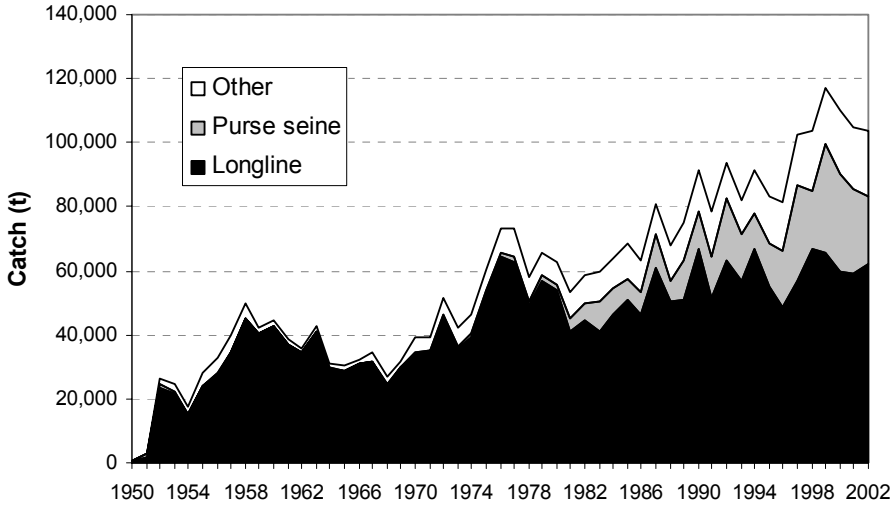


Figure 16. WCPO bigeye tuna catch, by gear.

Stock assessment

The stock assessment was conducted using the statistical model 'MULTIFAN–CL' applied to data for the WCPO as has been done in recent years. However, there are a number of differences in methods and data used in the 2003 analysis from the previous ones. Most important of these are the extension of the data to 1950 including

the additional longline catch and effort data, disaggregation of size data into length and weight, definition of separate longline fisheries for the fleet of Taiwan and fleet of Mainland of China in the tropical regions, application of different methods in standardizing longline effort, the incorporation of equilibrium yield projections and the computation of a wide range of reference points useful for management purposes.

This year's assessment results were quantitatively different from last year's, although the trend of biomass was similar for the comparative period analyzed last year. The largest difference, that was common in all runs made this year, was a sharp increase in recruitment from 1990. This appears to be directly related to increasing catches of small fish over the same period. It is not clear that the model, as formulated for bigeye, can distinguish changes in catchability from changes in recruitment. Consequently, this model behavior raises questions regarding low recruitment estimates in the early years when catches were also low. The summary results of this year's analysis were given in Table 2, however, the Group considers these results should be viewed with caution because of this problem. The Group decided not to select a single model to estimate standardized effort for the longline fisheries. This is because the present application of habitat models relies on the assumption of a spatially and temporally invariant habitat preference. There is some evidence that this assumption may not hold, and further work on habitat-based standardizations is required. Therefore, the Group decided to continue to consider a range of standardization methods until this issue is resolved. Also, the Group considered that it is not appropriate to quote the absolute numbers of population estimates, and that qualitative statements on stock status and relative bench marks should be provided.

Table 2. Estimates of performance measures based on the 2002 and 2003 stock assessments.

Management Quantity	2003 Assessment	2002 Assessment
MSY	40,000~80,000 MT	90,000 MT
Y_{Fcurr} / MSY	1.98~2.85	1.2
B_{curr} / $B_{curr,F=0}$	0.27 ~ 0.34	0.6
F_{curr} / F_{msy}	1.11~2.00	0.3
B_{curr} / B_{msy}	1.35~1.76	3.0

Abundance indices

The abundance indices are generally similar to each other except for areas 4 and 5 (see Figure 15 for area stratification used in the Multifan-CL application). The trends for the first 10 years are somewhat different in areas 2 and 3. All of these indicated decreasing trends but areas 2 and 5 indicated an increase and later decline between 1970 and 2000.

Fishing mortality

There has been a consistent increase in fishing mortality (F) on juvenile and on adult age classes since the beginning of the fishery (Figure 17). The adult F increased very quickly from the beginning of the fishery and has been higher than juvenile F by 25-50% up until 1990. F for adult bigeye peaked in the mid 1990s. Juvenile F continued to increase and is at a similar level to the adult F in the most recent years. The impact

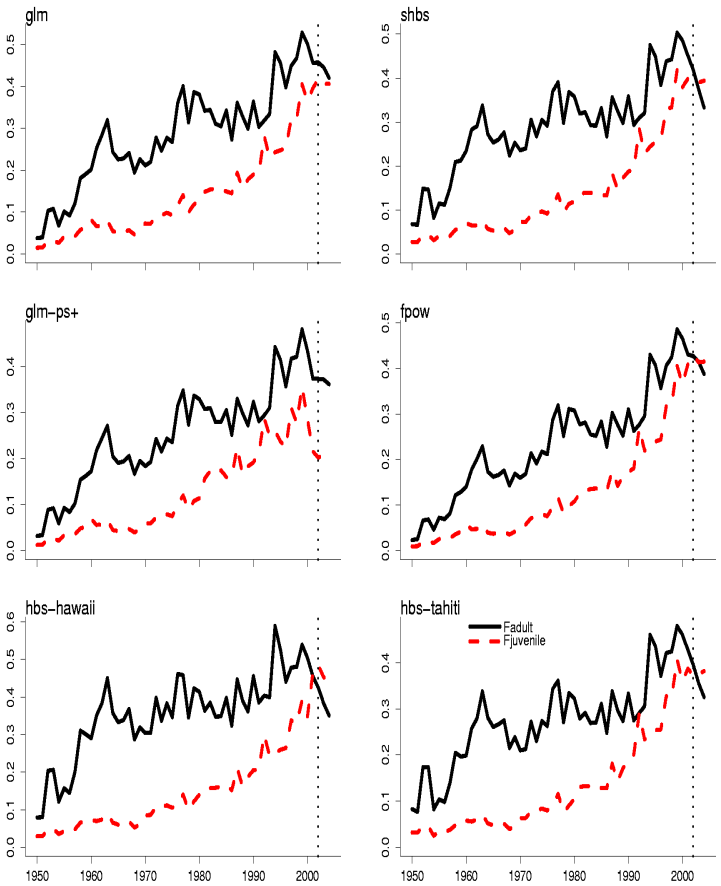


Figure 17. Estimated annual average juvenile and adult fishing mortality for the WCPO obtained from the separate analyses using different standardised effort for the LL1–LL5 longline fisheries.

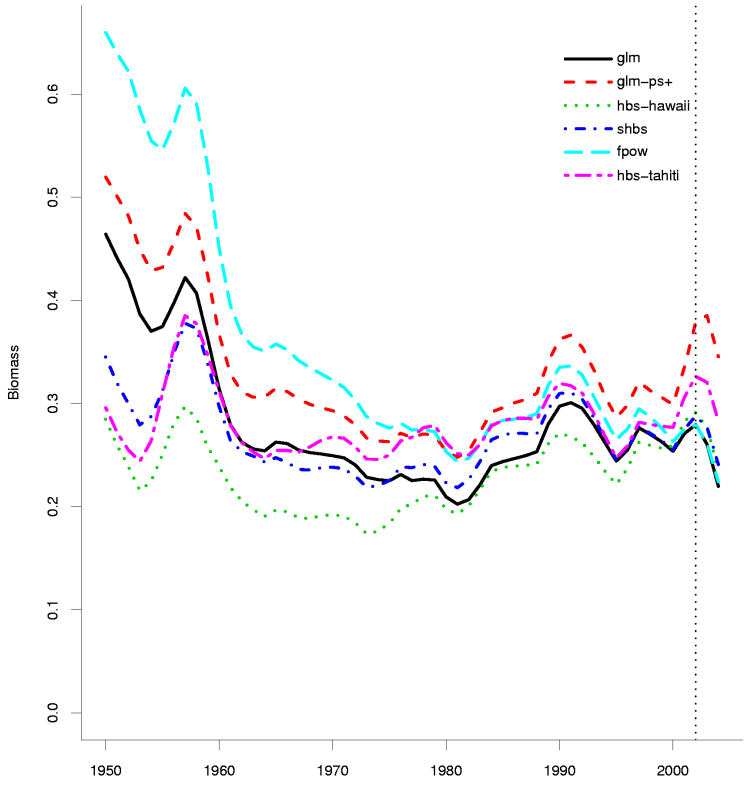


Figure 18. Estimated annual average total biomass (million t) for the WCPO obtained from the separate analyses using different standardised effort for the LL1–LL5 longline fisheries. The vertical dotted line indicates the point at which population projections are made with assumed levels of effort.

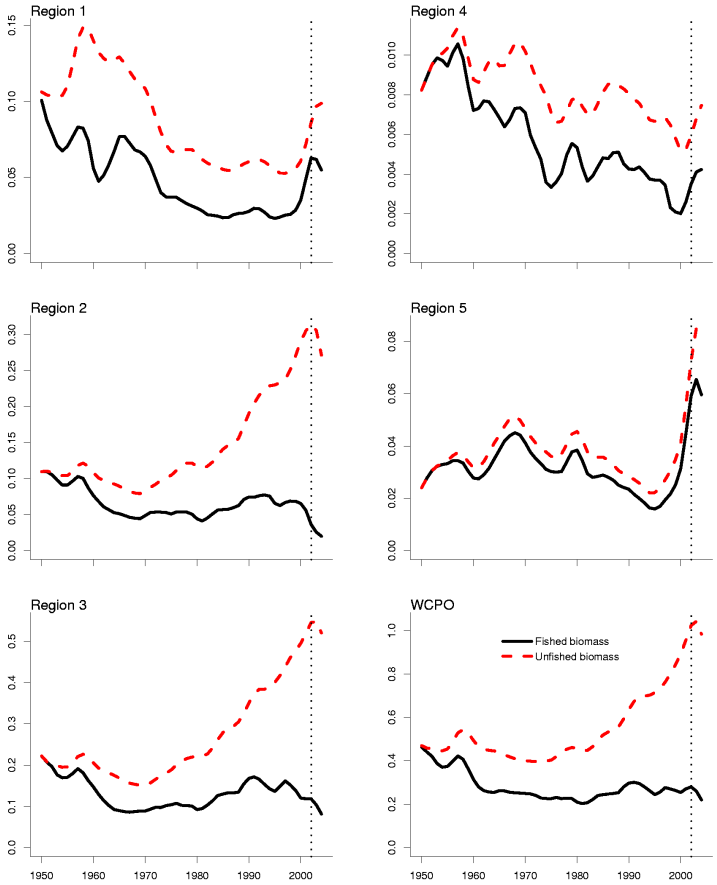


Figure 19. Comparison of the estimated biomass trajectories (lower heavy lines) with biomass trajectories that would have occurred in the absence of fishing (upper thin lines) for the GLM-based model for each region and for the WCPO. Y-axis units are million t.

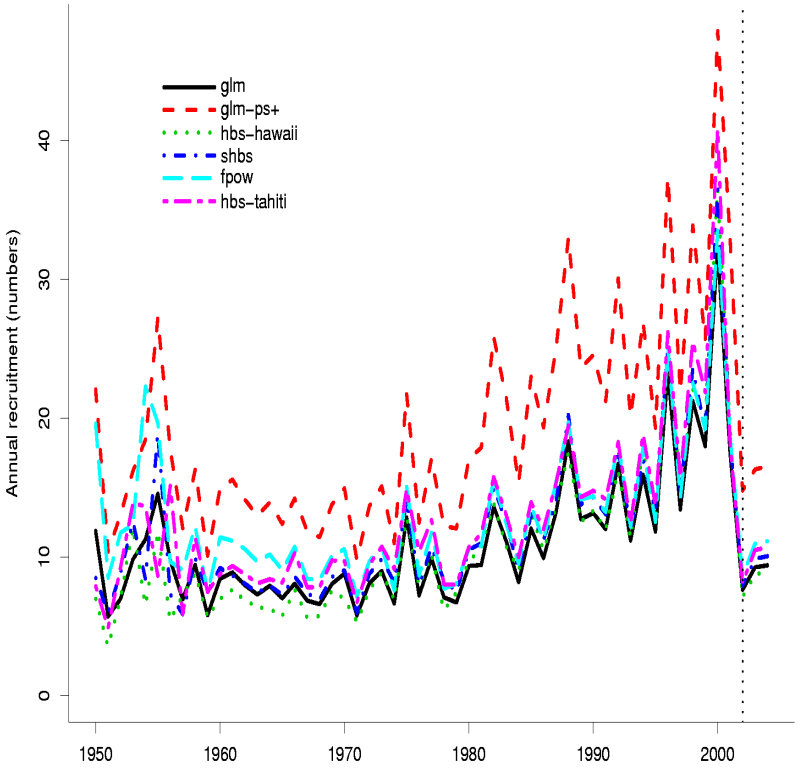


Figure 20. Estimated annual recruitment for the WCPO obtained from the separate analyses using different standardised effort for the LL1 –LL5 longline fisheries. The vertical dotted line indicates the point at which population projections are made with assumed levels of effort.

of the fisheries on the stock is much higher in the tropical regions than in the sub-tropical regions, consistent with the distribution of the catch.

Biomass

Total estimated biomass of bigeye tuna in the WCPO indicated a decline during the 1950s and 1960s of about 30 % (Figure 18). Thereafter it has been fairly stable. This trend can be seen in all areas except area 5. In areas 2 and 3, where the stock was heavily exploited during the beginning of the fishery, biomass recovered during the 1970s and 1980s before entering a sharp decline in the 1990s (Figure 19).

Recruitment

Generally, estimated recruitment (Figure 20) indicated some fluctuation but with an increasing trend since the early 1980s and reached the highest level in 1999, which is about 2.5–3 times higher than in 1980. However, as noted above, this pattern may be an artifact related to surface fishery development and/or the lack of early size data. This issue requires further investigation.

Stock status

The bigeye assessment results of this year are both uncertain and for key management benchmarks, inconsistent with the bigeye assessment presented at SCTB 15 (Table 2). In particular, the SCTB 15 assessment concluded that overfishing was not occurring ($F_{current}<F_{msy}$), while this year's assessment concluded that overfishing is occurring ($F_{current}>F_{msy}$). Given that it is unlikely that the true status of the bigeye stock has changed so dramatically, as indicated by changes in the parameters in Table 2 since last year, the Group cannot discount last year's assessment. Consequently, caution should be exercised in using the bigeye assessment results for management purposes until such time that these issues can be resolved.

The current stock status was assessed by the yield curve (Figure 21) and a range of reference points. The analyses indicated that the current F is larger than FMSY. However, the current biomass remains higher than BMSY. In other words, overfishing is occurring, but the stock is not yet overfished because of the recent above-average recruitment.

Overall, the longline fishery has had the largest impact on the stock, and later development of the purse seine fishery and increases in the Philippines and Indonesian catch have also had high impact on the stock. In this regard, the assessment results are consistent with those from a Pacific-wide assessment as well as the current status of the stock in the eastern Pacific. The current level of exploitation appears not to be sustainable in the long term, unless the high recent recruitment is continued in the future.

Therefore, the Group believes that there should be no further increase in the fishing mortality rate for bigeye tuna, until the results is further confirmed. The Group noted, however, while recognizing the current uncertainty in the stock assessments, all the stock assessment results conducted this year were more pessimistic than the last year's. If further assessments confirm the concern derived from this year's results, the managers should consider practical management action to prevent further decline of stock.

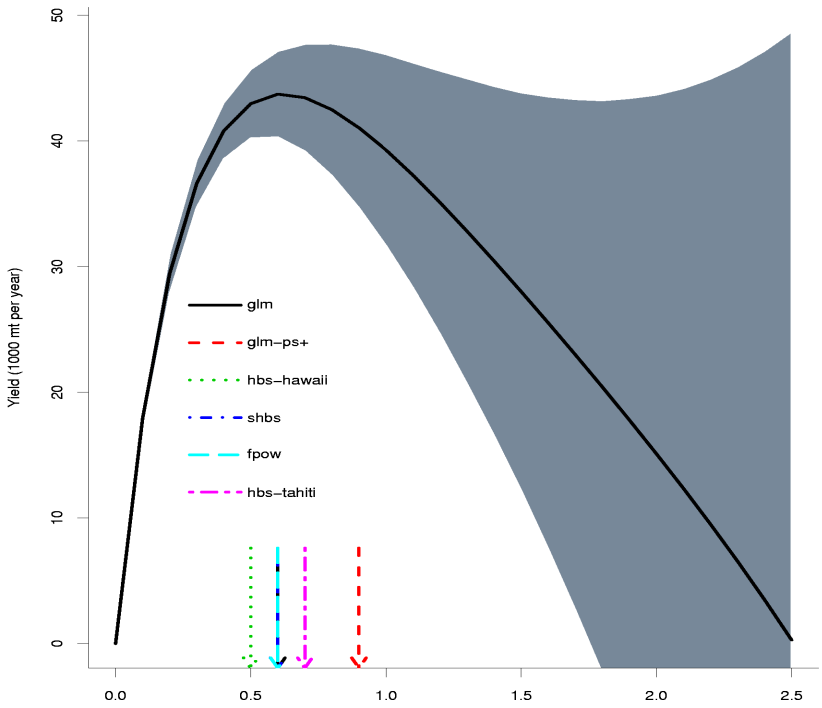


Figure 21. Yield curves estimated for four different levels of recruitment for the WCPO. Recruitments are averages for 1950-2002(SRR), 1952-1980, 1981-2001, 1990-2001.

ALBACORE RESEARCH GROUP – SUMMARY STATEMENT

Key attributes

Albacore tuna comprise a discrete stock in the South Pacific Ocean. Mature albacore (age at first maturity, 4 – 5 yr; ~ 90 cm FL) spawn in tropical and sub-tropical waters between about 10°S and 25°S during the austral summer, with juveniles recruiting to surface fisheries in New Zealand coastal waters and in the vicinity of the sub-tropical convergence zone (STCZ – about 40°S) in the central Pacific about two years later, at a size of 45–50 cm in fork length. From this region, albacore appear to gradually disperse to the north, but may make seasonal migrations between tropical and sub-tropical waters.

Albacore are relatively slow growing, and have a maximum fork length of about 120 cm. Natural mortality is low compared to tropical tunas, with significant numbers of fish reaching an age of 10 years or more.

Recent developments in the fishery

Catch in 2002 reached 51,000 mt, which is the second highest in the post-drift net period (Figure 22). Since drift netting ceased in 1992, catches have predominantly come from troll fleets of New Zealand and the US south of 30°S, and by longliners which fish mainly between 10°S and 50°S (Figure 23).

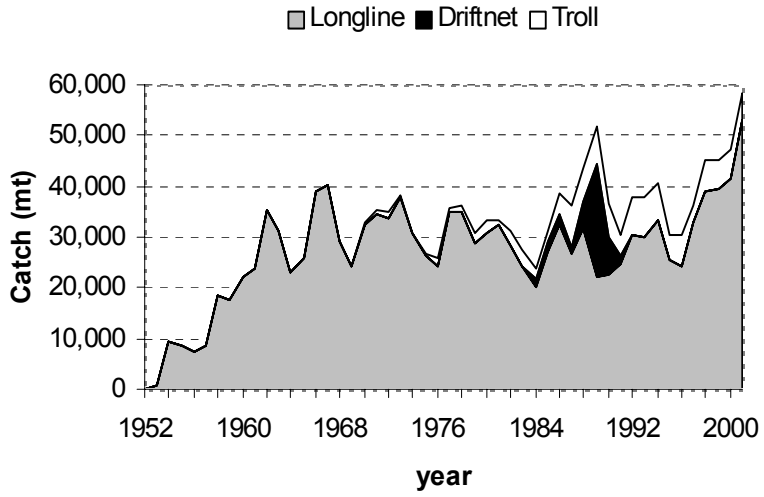


Figure 22. South Pacific albacore catch by gear type.

Catches from the Pacific Island Country (PIC) longline fleets have increased in recent years. In 2002 these fleets accounted for 50% of the total longline catch. The Taiwanese fleet, which has traditionally targeted albacore and has accounted for the majority of the historical longline catch, recently moved some of its activities to target seasonally northern albacore or bigeye in the equatorial waters of the WCPO. The catch of albacore by this fleet has therefore fallen in recent years.

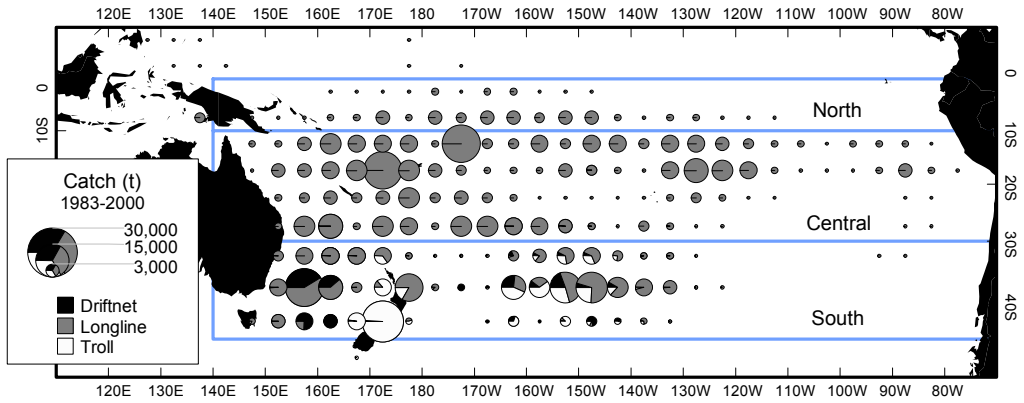


Figure 23. Albacore catch distribution (1983-2000) by fleet. The spatial distribution used in the MULTIFAN-CL model is shown

Trends

Catch and effort

CPUE has been fairly stable in the central zone (10°–30°S), where catch rates from the PIC fleets have tended to converge in recent years. The current CPUE in several PIC longline fleets is significantly less than the levels attained in the early years of these fisheries. In some cases, high CPUE has been maintained by expanding the area of fishing to the extremes of the EEZs and beyond. There has been a gradual decline in the catch rates in a number of fisheries. This decline has been gradual in some fisheries and stronger in other areas, particularly Samoa and American Samoa. However, the CPUE for the Samoan and American Samoan fleets remains higher than other fleets despite these declines. Some degree of convergence in CPUE is also noted for the New Zealand and the US troll fleets, although CPUE for the US vessels has generally been higher and more variable.

Size of fish

Longliners catch larger albacore, with the size distribution typically comprising a single multi-age-class mode with a modal length of 90–100 cm (Figure 24). Troll catches are of smaller albacore, typically 50–85 cm in length. Size composition varies from year to year, but no trends are evident over the past five years.

Recruitment

Recent application of a high resolution environmental and population dynamics simulation model (SEPODYM) to South Pacific albacore has provided some preliminary results on the possible mechanisms for recruitment variability. Recruitment as estimated by MULTIFAN-CL (see stock status below) appears to be negatively correlated with El Nino events, which may explain low recruitment rates in the 1980s and 90s (Figure 25).

Biomass

Biomass levels have largely reflected the variation in estimated recruitment, peaking in the late 1950s and late 1970's (Figure 26). Current biomass is estimated to be about half of the maximum estimated levels and about 60 % of the estimated biomass in the early 1950s. Biomass is concentrated in the area south of 10°S.

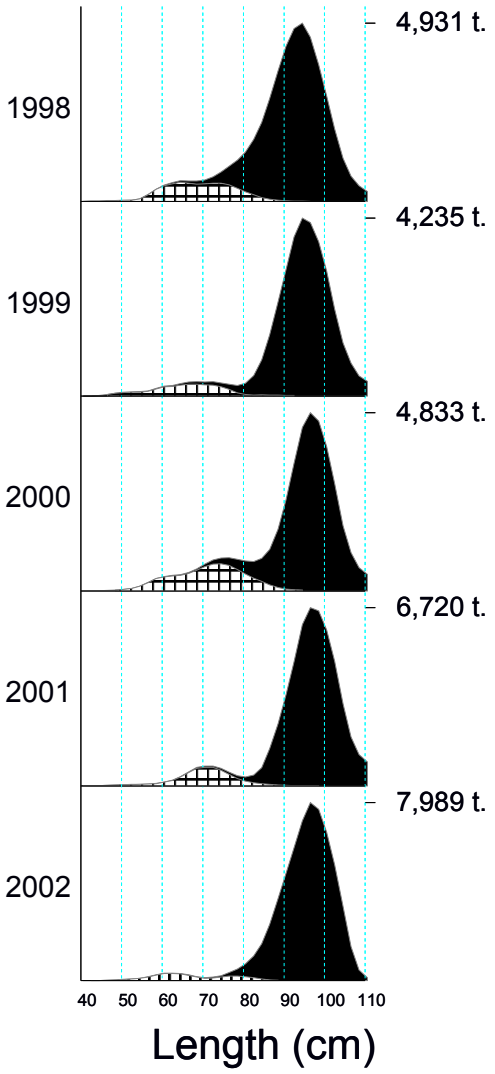


Figure 24. Annual albacore tuna catch-at-size in the south Pacific, 1998–2002. Longline = black; troll = hatched. The y-axis scale is in weight - the figures on the right indicate the catch weight in a 2-cm size class.

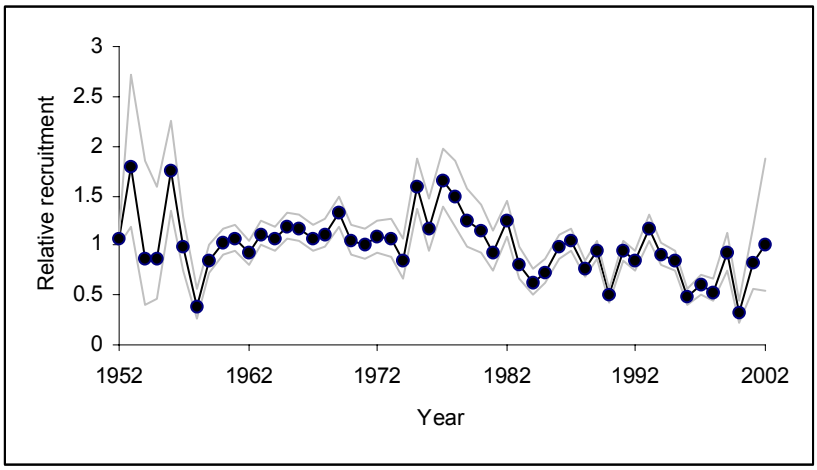
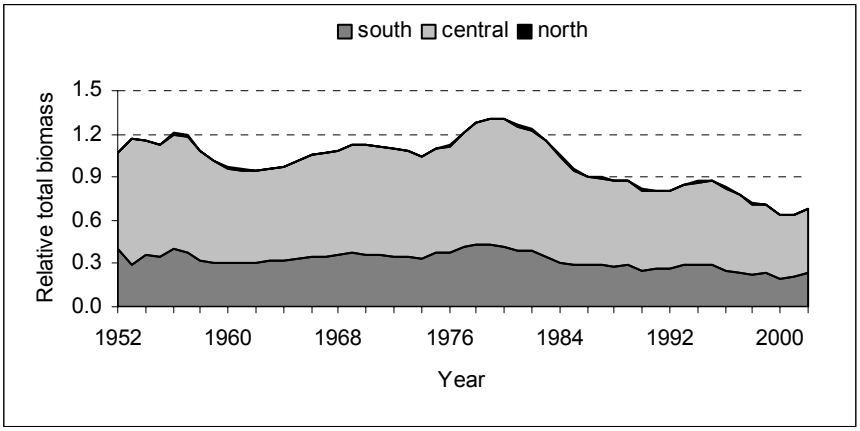


Figure 25. Estimated annual recruitment, with 95% confidence intervals, scaled to the average of the points estimates.



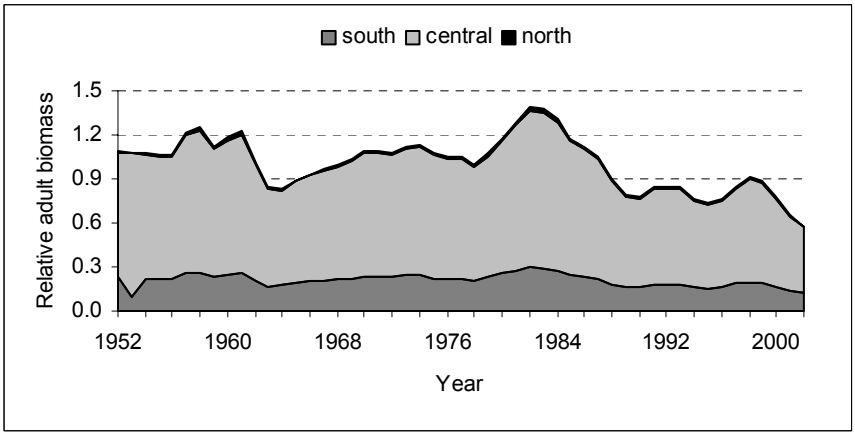


Figure 26. Estimates of relative total and adult biomass, by region.

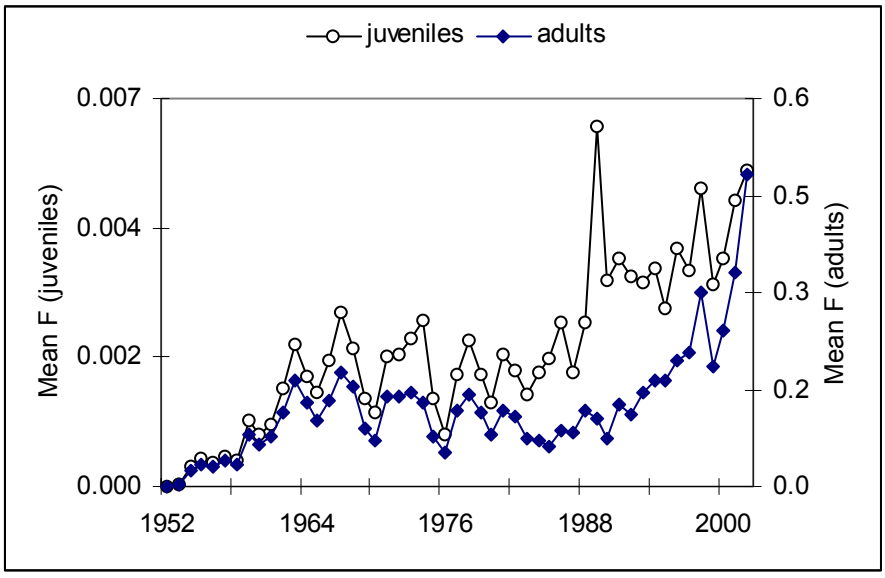


Figure 27. Estimated average annual fishing mortality rates for juveniles (ages 1-5) and adult (ages 6-12) albacore in the South Pacific.

Fishing mortality

Fishing mortality is higher for adult albacore than for juveniles, reflecting the predominantly longline exploitation (Figure 27). Total fishing mortality appears to be considerably lower than natural mortality. The impact of the fisheries on total biomass is estimated to have increased over time, but is likely to be low to moderate across a plausible range of model assumptions.

Stock status

The current stock assessment was conducted with MULTIFAN–CL. The fishery for albacore is unique in that it has exhibited no significant trend in catches over the period of 1960 – 1995. Due to the problems faced by all assessments conducted with limited data on stocks, which have been apparently exploited at only low exploitation rates over the period of the fishery, the results obtained provide little information on the biomass of the stock. Improved results from this model would be expected if there were better return rates of tags placed on albacore. An analysis based on a Schaefer production model provided an estimate of MSY, but the Group considered that this methodology requires further review before it can be used to provide advice on stock status.

The assessment gave similar results to last year's assessment, with a low impact of fishing on biomass, and indicated that the current biomass is at about 60% of unfished levels. It is therefore unlikely that the stock is being overfished or is in an overfished state.

BILLFISH AND BYCATCH RESEARCH GROUP – SUMMARY STATEMENT

During SCTB 16, the BBRG dealt with billfish catches and catches of other species, with focus on mahimahi and wahoo.

Billfish

The Billfish and Bycatch Research Group has a more varied perspective than the single species research groups. Issues include non-targeted catches in pelagic fisheries, protected species interactions and the catch of billfish by commercial and recreational fisheries. SPC's Oceanic Fisheries Programme (OFP) generates annual estimates of commercial billfish catches, but currently not on recreational billfish catches. A system for reporting catches by recreational fishing clubs in the WCPO was established by the OFP. Ensuring that such data are collected and provided to the OFP, however, requires considerable work, and it has not been possible to adequately cover this activity (for most countries) over the past year.

There were several papers and presentations on the biology and management of swordfish fisheries. Research by CSIRO has been focused on developing an operational model for swordfish management in the Australian East Coast longline fishery. It is thought that the swordfish stock is currently not overfished but a better understanding of the sustainable harvest is required. In the absence of a swordfish stock assessment the operational model provides a framework for the evaluation of alternative harvest strategies.

Other studies by CSIRO have included investigation of declines in the catch per unit of effort (CPUE) of swordfish in the Australian East Coast longline fishery, and age and growth studies for swordfish caught by this fishery. The CPUE study, using generalized linear models, investigated a number of different hypotheses for the decline in CPUE, including competition between vessels, fishing down of seamounts, and changes in fishing practices and/or fleet structure. The analyses supported the notion that there has been a sequential spatial depletion of the swordfish resource off the central east coast of Australia. However, the changes in observed CPUEs do not appear to be supported by the hypothesis that these changes have been due to changes in fishing strategies adopted by fishers or oceanographic conditions on the fishing grounds.

The ageing study validated annulus formation indirectly in the second anal fin spines of swordfish from eastern Australia. Growth curves fitted to age-at-length data fell within the range of studies conducted elsewhere. A validation study of age-at-length for swordfish is still required. A study of factors affecting swordfish catch in New Zealand's longline fishery was also presented. Targeting of swordfish in this fishery is prohibited but swordfish are caught and retained by vessels targeting bigeye tuna. Various factors such as fleet type, area, season, operational characteristics and environmental effects were found to have an influence on swordfish CPUE. However, the number of light sticks was found to have the greatest effect, and could increase swordfish CPUE four-fold. A collaborative project to develop an age and sex

structured population assessment model for North Pacific swordfish was presented to the BBRG. The model will address uncertainties in the current North Pacific swordfish stock assessment resulting from swordfish sexual size dimorphism, where females grow faster and larger than males.

Three presentations were made on marlin catches. The first, from the Australian Bureau of Rural Sciences, concerned interactions between longline and charter sportsfishing vessels taking striped marlin off the southeast coast of Australia. The study concluded that both that the catch rates in both fisheries are likely to be predominantly reliant on the underlying abundance or availability of striped marlin. Some evidence for commercial targeting of this species was presented and a possible link to reduced charter fishery catch was discussed. The second was a study by the Japanese National Research Institute of Far Seas Fisheries (NRIFSF) of the vertical distribution of blue marlin CPUE in the Atlantic. The study showed that the vertical CPUE trends with respect to depth and temperature relative to the surface are not always consistent with the vertical distribution of blue marlin. The final presentation referred to an information paper on the ongoing tagging of recreationally caught billfish and gamefish.

Sharks and Other Species

There were two presentations on sharks. The first concerned a directed shark longline fishery in Papua New Guinea given by the PNG National Fisheries Authority. This fishery has grown in importance in PNG and comprises 9 freezer equipped longliners which annually land about 1,500 mt of dressed shark, most of which is exported along with the fins. Half of the catch comprises silky shark, and the fishery is managed under a shark longline management plan approved in 2002. NRIFSF presented information on Japanese purse seine and pole and line tuna fisheries that make use of seasonal migrating whale sharks associated with schools of skipjack tuna. Fishing around whale sharks peaks between July and August and is concentrated in an area to the east of Japan.

A regional overview of mahimahi catches in various pelagic fisheries in the western and central Pacific was presented jointly by the Oceanic Fisheries Programme (OFP) and the Western Pacific Fisheries Council. The overview also included depth descriptions of CPUEs and mean lengths of mahimahi and wahoo in pelagic longline and troll fisheries in the US Flag Pacific Islands. A summary was made of the results of a dietary study of mahimahi, wahoo and lancetfish by the OFP. The results showed that mahimahi consumed primarily epipelagic fishes, while wahoo consumes a mix of epipelagic and mesopelagic fish and mollusks. The main dietary items for lancetfish included a pelagic gastropod, epipelagic and mesopelagic fish and mollusks. Lancet fish were also noted to demonstrate a high degree of cannibalism.

OFP also presented a preliminary ECOPATH model of the western Pacific warm pool ecosystem. A simulation run was shown where the current level of fishing effort was doubled for 25 years and resulted in declines of the biomass of sharks, billfish, yellowfin and piscivorous fish, but an increase in the biomass of small scombrids. Little confidence could be placed in these results at present, but they demonstrated the type of simulations that can be conducted with the model. The limitations and

weaknesses of the current model were discussed, as was its potential application for generating reference points for ecosystem-based fishery management.

Two studies of longline fishery bycatch were presented by the Australian Fisheries Management Authority (AFMA) and Japan's NRIFSF. The AFMA study evaluated the Bycatch reporting rates from logbooks versus those from observers. Non-commercial species and regulatory discards such as blue and black marlin appear not to be fully recorded in logbooks. Similarly, bycatch of seabirds and turtles appear to be under-reported, although for turtles, this conclusion may be confounded by the rarity of interactions. Observer coverage has been set at about 5%, a level sufficient to provide an accurate estimate of catch of most target and bycatch species.

NRIFSF presented a synopsis of its activities concerning shark, seabird and turtle bycatch. The main objectives for sharks include improving data collection, stock assessment and effective utilization. NRIFSF is continuing an ongoing program of mitigation research to reduce interactions between seabirds and pelagic longline vessels. Apart from tori poles, other methods being tested include blue dyed bait and weighted hooks. Results to date have been used to require longline vessels fishing within 20 miles of Torishima Island, the main breeding site of the endangered short-tail albatross, to use two seabird mitigation measures. NRIFSF also has an ongoing research program for longline-turtle mitigation, including the use of circle hooks, and modification of bait and depth of set. Turtle conservation measures also include nesting beach protection and management in Japan for loggerheads, and in Irian Jaya for leatherbacks.

The OFP made a brief presentation concerning the development of an individual-based model for North Pacific loggerhead turtles. The model will be adapted from an existing model developed for skipjack. The model will be used to simulate oceanic foraging and consequent interactions with fisheries.

The BBRG made the following recommendations (edited from SCTB 15 report)

1. A strong focus should continue to be maintained on monitoring regional billfish catches, both in commercial pelagic fisheries and from recreational fisheries

2. The BBRG notes the importance of observer programs in obtaining accurate estimates of bycatch. As such efforts should be made to improve observer coverage in WCPO pelagic fisheries in order to obtain more reliable statistics on bycatch, and to permit risk analysis on bycatch species. Prior to implementation, the objectives for an observer program and the process by which these objectives can be met should be clearly identified. The risk assessment currently being conducted to set objectives for an observer program for the Australian East Coast swordfish fishery may be a useful paradigm for this process;

3. Participants should strengthen data collection on turtle interactions in pelagic fisheries in order to refine estimates of the interaction problem, due to concerns regarding the population status of Pacific turtles. The BBRG also recommends closer collaboration and liaison by participants with the appropriate government and regional agencies to ensure that turtle nesting sites are inventoried, and non-fishery related impacts on turtle populations are clearly identified and addressed, to place fishery

impacts to turtle populations in context. Some of this broader analysis may be done by other organizations, but SCTB should remain informed of the issues and be able to evaluate information and analyses as they are used to set management policy.

4. The BBRG recommends that a watching brief be maintained on other bycatch issues as they arise, e.g., future developments under the FAO IPOAs on seabird-fishery interactions, and on shark fisheries.

5. The BBRG recommends that additional research be conducted on stock structure and stock boundaries of species of interest to the BBRG.

6. The BBRG, noting the review of logsheet programs and biological data programs by the Statistics Working Group, recommends that data collection programs be modified to better report bycatch species.

FISHING TECHNOLOGY WORKING GROUP – SUMMARY STATEMENT

The work of the Fishing Technology Working Group was presented and discussed during a preparatory meeting and during the SCTB 16 plenary session. Brief summaries emphasizing new developments by national and distant water representatives were provided, emphasizing new developments in regional fisheries, expansion / contraction of fishing effort, port sampling and observer programs and developments in shore-side processing facilities. A common theme throughout the major purse seine fleets was a continued and self-enforced reduction in FAD associated sets due to the tendency of these sets to produce smaller, lower value catch compared to unassociated schools. Industry efforts to reduce overall effort and catch by self-enforced, extended port calls and efforts to control IUU fishing were also noted.

A review of the Palau Arrangement was provided to the Group, detailing numbers of agreed and reported purse seine vessels that may operate within the region in categories of multilateral, bilateral foreign, domestic locally based, new bilateral and special arrangements. The "New Bilateral" category allows access to vessels from China and the EU while "Special Arrangements" were established to accommodate additional purse seine vessels from the EU, China and the Philippines. As of April 2003, 194 vessels had been licensed and were operating in the region.

The Palau Arrangement effort cap of 205 vessels was established in 1992 as a per vessel limitation on total purse seine effort in the WCPO. While efforts to precisely quantify increases in vessel efficiency have not yet been realized, it is widely recognized that effective fishing effort in purse seine fisheries has been increasing steadily.

In this regard, the work of the FTWG was recognized as essential, and that work toward quantifying increases in effective fishing effort in both longline and purse seine fisheries should be a priority task. The group presented work toward identifying key components of increasing efficiency in fleets and the development of historical timelines of the introduction of key gear and targeting practices by regional purse seine fleets. Work along these lines will continue with cooperation from regional and DWFN agencies.

Additional presentations and inter-sessional work concentrated on training materials for regional and national port sampling and observer programs to better define advances in fishing power and the accurate reporting of species specific catch and effort. The Group presented work to document and characterize the historical development and current status of the latest technology available to regional purse seine vessels, and this work will be expanded to include longline gear and fleets. Improved reporting of bigeye landings, especially from mixed catches by purse seine fleets was recognized as a broad, cross-cutting measure of high priority to the region. The Group supported these efforts with the development of an identification key for purse seine caught bigeye and yellowfin for training purposes.

Due to the ecological and resource implications of FAD utilization, the Group monitors recent developments in both large-scale anchored FAD arrays and the use of drifting FADs by regional purse seine fleets. The large numbers of anchored FADs supporting purse seine operations in PNG as well as means to monitor and regulate these FADs were presented and discussed.

The application of innovative technology and fishing methods to reduce bycatch is a specific FTWG task. The Group presented information on proposed and ongoing efforts to reduce purse seine bycatch of undersize tuna and associated finfish bycatch as well as gear related to bycatch reduction and improved targeting in longline fisheries.

Several critical issues that may be directly addressed by the Terms of Reference of the FTWG arose during SCTB 16, such as estimating effective effort for catch rate standardization, potential gear related methods to reduce juvenile bigeye mortality and technology issues related to estimating harvesting capacity in regional fisheries. The FTWG will actively pursue these priority activities and related studies inter-sessionally, with results presented to SCTB 17.

METHODS WORKING GROUP – SUMMARY STATEMENT

The Methods Working Group (MWG) had two major tasks for SCTB 16. The first task was to carefully scrutinize the MULTIFAN-CL assessments of yellowfin and bigeye tunas. Lack of reliable fisheries data, in particular size-frequency and fishing effort from Indonesia and the Philippines is a continuing concern in both assessments. The influence of different methods of effort standardization emerged as an additional source of uncertainty in all stock assessments, especially for yellowfin and bigeye. The influence of recent high catches of juvenile bigeye in the purse seine fishery on high estimates of recruitment is a major uncertainty in the bigeye assessment. The second major task before the MWG was a comparison of the performance of different stock assessment methods against "data" from an operational model with known properties. Seven stock assessment methods were tested against forty different realizations of five different fishery scenarios of increasing complexity. Time did not allow completion of this task, effectively an analysis of 1,400 different stock assessments, but preliminary results indicated that the performance of the stock assessment methods varied widely. The MWG also compiled a list of general criteria or principles to assist fishery managers in selecting a stock assessment method. Finally, the MWG prepared a table illustrating the general effects of alternative fishery management actions both on stocks and on the industry under different stock conditions.

SUMMARY OF DISCUSSIONS

1. PRELIMINARIES

1. The Sixteenth Meeting of the Standing Committee on Tuna and Billfish (SCTB 16) was held on 9-16 July 2003 in Mooloolaba, Queensland, Australia at the invitation of the Chairman, Dr SungKwon Soh. The meeting was hosted by the Commonwealth Scientific and Industrial Research Organisation Division of Marine Research (CSIRO Marine Research) and Agriculture, Forestry, Fisheries – Australia (AFFA). CSIRO Marine Research and the Oceanic Fisheries Programme (OFP) of the Secretariat of the Pacific Community (SPC) served as Secretariat for the meeting.

2. SCTB 16 was attended by participants from Australia, Canada, Cook Islands, European Union, Federated States of Micronesia, Fiji, France, Indonesia, Japan, Korea, Marshall Islands, New Caledonia, New Zealand, Niue, Palau, Papua New Guinea, the Peoples Republic of China, Philippines, Taiwan, Tonga, United States of America, Vanuatu and Vietnam. Representatives from various regional and international organizations also attended the meeting. These included the Forum Fisheries Agency (FFA), the Inter-American Tropical Tuna Commission (IATTC) and the Secretariat of the Pacific Community (SPC). The list of participants is provided in Appendix 3.

3. The SCTB provides a forum for scientists and others with an interest in the tuna and billfish stocks of the western and central Pacific Ocean (WCPO) to meet to discuss scientific issues related to data, research, and stock assessment. Its aims are to:

- coordinate fisheries data collection, compilation and dissemination according to agreed principles and procedures;
- review research on the biology, ecology, environment and fisheries for tunas and associated species in the WCPO;
- identify research needs and provide a means of coordination, including the fostering of collaborative research, to most efficiently and effectively meet those needs;
- review information pertaining to the status of the stocks of tunas and associated species in the WCPO, and to provide statements on stock status where appropriate, and;
- provide opinions on various scientific issues related to data, research and stock assessment of WCPO tuna fisheries.

1.1 Opening Ceremony

4. Senator Ian MacDonald, Federal Minister for Fisheries, Forestry and Conservation, provided an opening address. Senator MacDonald welcomed the participants and outlined the importance of this group in providing scientific advice of the tuna resources of the WCPO. He noted that this forum will face the challenging task of addressing declines in some fish stocks and the need to formulate scientific advice for the newly established Preparatory Conference. He concluded by encouraging the participants to have a successful deliberation. The full version of the Senator's address is provided in Appendix 4.

1.2 Adoption of the Agenda and Appointment of Rapporteurs

5. The Agenda for the meeting together with a list of the Working Papers presented at the meeting are provided in Appendices 1 and 2 respectively.

6. The meeting convened as eight working groups; the Statistics Working Group (SWG), the Fishing Technology Working Group (FTWG), the Methods Working Group (MWG), the Skipjack Research Group (SRG), the Albacore Research Group (ARG), the Yellowfin Research Group (YRG), the Bigeye Research Group (BRG), and the Billfish and Bycatch Research Group (BBRG). For the first time the meeting also held separate sessions to address i) cross-cutting issues arising from each the individual working groups, ii) fishing capacity in the WCPO, and iii) organisational arrangements for future SCTB meetings.

7. The SCTB 16 Secretariat (CSIRO Marine Research and OFP) assumed responsibility for coordinating the rapporteuring process and compiling the report of the meeting, with the assistance of participant rapporteurs. Dr Robert Campbell was appointed as coordinating rapporteur.

8. The appointment of coordinators for each SCTB research group was confirmed as follows.

Statistics Working Group	Mr Tim Lawson
Fishing Technology Working Group	Mr David Itano
Skipjack Research Group	Dr Gary Sakagawa
Yellowfin Research Group	Dr Robert Campbell
Albacore Research Group	Mr Régis Etaix-Bonnin
Bigeye Research Group	Dr Naozumi Miyabe
Billfish and Bycatch Research Group	Mr Paul Dalzell
Methods Working Group	Dr John Sibert

9. Rapporteurs for each of the main agenda items were appointed by each of the coordinators as follows.

Statistics WG:	Dr Robert Skillman
Fishing Technology WG:	Ms Deirdre Brogan
Skipjack RG:	Dr Robert Skillman
Yellowfin RG:	Drs. Natalie Dowling and Dale Kolody
Albacore RG:	Dr Max Stocker
Bigeye RG:	Dr Ray Conser and Mr Bert Kikkawa
Billfish and Bycatch RG:	Dr Jerry Wetherall
Methods WG:	Mr Neville Smith and Dr Naozumi Miyabe

1.3 Adoption of the Report of the Fifteenth Meeting of the SCTB

10. The report of the Fifteenth Meeting of the SCTB, held in Honolulu, Hawaii, from 22-27 July 2002, was adopted.

2. OVERVIEW OF WESTERN AND CENTRAL PACIFIC OCEAN TUNA FISHERIES

2.1 Regional Overview

11. Mr Peter Williams provided an overview of the WCPO tuna fisheries, referring the meeting to Working Papers GEN-1 and SWG-2. The presentation describes broadly each of the fisheries by gear and fleet, with emphasis on 2002 catches relative to those in recent years and was an introduction to the National Fisheries Reports (NFRs) which provide more detail on the catch and activities of each fleet.

12. The provisional total WCPO catch of tunas during 2002 was estimated at 1,982,001 mt, the second highest annual catch recorded after 1998 (2,037,644 mt). As in recent years, the catch was dominated by the purse seine fishery (Figure 2.1). During 2002, the purse seine fishery accounted for an estimated 1,157,045 mt (58% of the total catch), with pole-and-line taking an estimated 330,993 mt (17%), the longline fishery an estimated 221,818 mt (11%), and the remainder (14%) taken by troll gear and a variety of artisanal gears, mostly in eastern Indonesia and the Philippines. The 2002 catch estimate for the longline fishery was the highest on record.

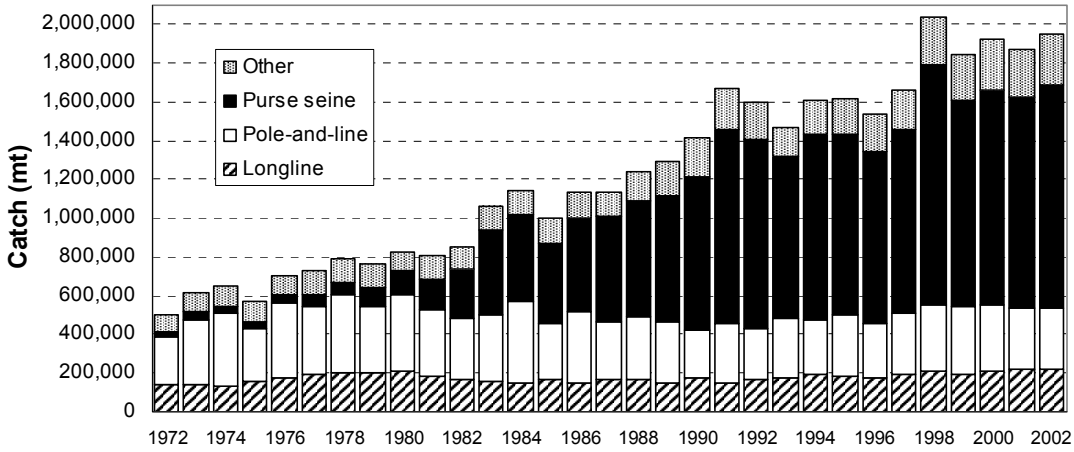


Figure 2.1. Catch (mt) of albacore, bigeye, skipjack and yellowfin in the WCPO, by longline, pole-and-line, purse seine and other gear types.

13. The WCPO tuna catch represented 75% of the total estimated Pacific Ocean catch of 2,656,773 mt in 2002, and 50% of the provisional estimate of world tuna catch (3,965,346 mt) of the four species. As for the WCPO, the Eastern Pacific Ocean (EPO) catch in 2002 (674,771 mt) was the second highest on record (after 2001), and the provisional global catch of the four main species for 2002 was the highest ever.

14. The WCPO catch by species, shown in Figure 2.2, has always been dominated by skipjack (67% in 2002). The 2002 WCPO catch of skipjack (1,321,939 mt) was the highest ever, eclipsing the previous record catch attained in 1998 (1,314,239 mt). The WCPO yellowfin catch (437,984 mt; 22%) was the lowest for six years and nearly 70,000 mt lower than the record catch in 1998 (502,960 mt). The WCPO bigeye catch for 2002 (107,568 mt; 5%) was slightly higher than in 2001, and the WCPO albacore (114,511 mt; 6%) catch was down on the 2001 level. In contrast to the WCPO, the

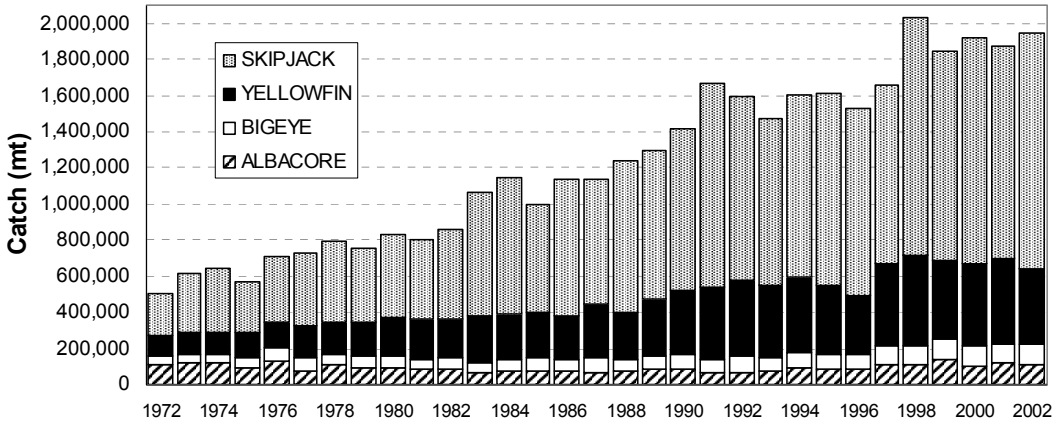


Figure 2.2. Catch (mt) of albacore, bigeye, skipjack and yellowfin in the WCPO.

EPO yellowfin catch for 2002 was the highest ever (427,664 mt), but the EPO bigeye catch was the lowest since 1984.

15. The provisional 2002 purse-seine catch of 1,157,045 mt was the second highest on record and maintained the catch in excess of 1,000,000 mt since the record year attained in 1998. A general absence of the restrictions placed on effort in the purse seine fishery in previous two years (as a result of falling prices) no doubt contributed to this higher catch level.

16. The purse seine skipjack catch for 2002 (962,740 mt – 83%) was a record for this fishery (slightly higher than the previous record in 1998 – 947,149 mt). In contrast, the purse seine yellowfin catch for 2002 (171,767 mt – 15%) was the lowest for six years, and considered unusual for an *El Nino* period. The estimated purse seine bigeye catch for 2002 (22,538 mt – 2%) continues the declining trend in catches since the record 1999 catch (34,932 mt), primarily due to the gradual reduction in fishing effort on drifting FADs over recent years. Catches for three of the four main purse seine fleets (i.e. Korea, Taiwan and US) except Japan increased during 2002. Taiwan has been the highest producer in the tropical purse seine fishery for the past 6 years. The steady increase in catch by the PNG fleet in recent years is noteworthy (this fleet took slightly more than the US fleet during 2002).

17. The percentage of sets on drifting FADs for all fleets dropped during 2002 and continued the trend seen since 2000. Sets on unassociated schools were the predominant fishing method during 2002 except for the PNG purse seine fleet, the domestic component of which predominantly sets on anchored FADs. For the first time since 1998 (the most recent El Nino year prior to 2002), the proportion of log sets for all fleets except the US was more than for drifting FAD-associated sets.

18. The preliminary pole-and-line catch estimate for 2002 (330,993 mt–17% of total WCPO catch) is a slight increase on the 2001 level (324,800 mt), although the Japanese fleet catch estimate for 2002 has yet to be provided. As in previous years, skipjack accounts for the vast majority of the catch (84%); albacore taken by the Japanese coastal and offshore fleets in the temperate waters of the north Pacific (9%), yellowfin (5%) and a small component of bigeye (1%) make up the remainder of the catch. The Japanese distant-water and offshore (130,497 mt in 2001) and the

Indonesian fleets (182,545 mt in 2002) typically account for most of the WCPO pole-and-line catch. The Solomon Islands fleet (9,652 mt) continues to recover from low catch levels experienced in recent years (only 2,692 mt in 2000), but was still far from the level (of over 20,000 mt annually) experienced in most years of the 1990s.

19. The 2002 longline catch (221,818 mt) was the highest on record, but only 500 mt more than the previous record catch in 2001 (221,248 mt). The bigeye catch (64,185 mt) was the largest for four years, and the albacore catch (WCPO–76,828 mt; south Pacific–46,819 mt) was the second highest on record (after the 2001 catch). The 2002 yellowfin catch (77,177 mt) was the highest catch in seven years and continued the significant recovery from the lowest catch (60,414 mt) recorded for nearly 30 years in 1999.

20. The 2002 troll albacore catch (4,477 mt) for the south Pacific was more than 1,000 mt less than the 2001 level. The fleets of New Zealand (3,311 mt) and USA (1,020 mt) accounted for over 95% of this catch, with minor contributions coming from vessels from Canada and Australia.

2.2 Economic Condition of the Fishery

21. Dr Chris Reid presented GEN–2. Estimates of purse seine catch indicated an increase of around 3 per cent from 2002 levels, with significant decreases noted in yellowfin and bigeye landings and an 11 per cent increase in skipjack landings. Landings for the Taiwanese purse seine fleet increased by around of 12 per cent on 2001 level, while the landings of the US and Korean purse seine fleets increased marginally from 2002 levels. The Japanese fleet registered an 11 per cent decline in total landings. Estimated catch from the Filipino and Spanish fleets was down significantly from 2001 levels. Regional vessels (45) flagged by FFA member countries in 2002 registered a 15 per cent increase in estimated landings over 2001 levels driven primarily by an increase in landings by the Papua New Guinea fleet.

22. In 2002, Bangkok skipjack prices were much steadier than seen over the previous 3 years with prices for 4-7.5lb size fish, trading in the range of US$670-790/Mt cost&freight (c&f). In 2003 skipjack prices (4-7.5lb, c&f) declined over the period to April reaching a low of around US$480/Mt toward the end of April before recovering to around US$720/Mt in late June.

23. Yellowfin prices ended 2002 at significantly higher levels then seen at the start of the year. Bangkok prices for yellowfin (20lbs and up, c&f) started the year at US$850-900/Mt and ended the year at US$1200-1250/Mt having reached a 4 year high of US$1350-1400 during August and September. Prices in 2003 were fairly steady through to May trading in a range of US$1100-1250/Mt before rising in June and at the end of June were trading in a range of US$1300-1350/Mt.

24. The estimated ‘delivered’ value of the purse-seine catch for 2002 was around US$925 million. This represents a small increase of around US$2 million on the estimated ‘delivered’ value of the catch in 2001. Thus, the 3 per cent increase in overall catch in 2002 was accompanied by a negligible increase in value despite a rise in yellowfin prices of around 11 per cent. This occurred as a result of the higher

proportion of lower valued skipjack taken in the 2002 catch and the Thai skipjack import price and Yaizu price falling respectively by 5 and 3 per cent in US$ terms.

25. The preliminary estimate of the total catch in the longline fishery in 2002 is 221,665Mt. This represents a reduction of 1,372Mt or less than 1 per cent on the 2001 catch. Preliminary catch estimates indicate that catches of bigeye and yellowfin both increased by 5 and 2 per cent to 62,308Mt and 78,150Mt respectively. Albacore catches declined by 5 per cent 77,590Mt. Significant increases in longline catches by regional fleets were noted.

26. Yellowfin prices on a number of Japanese markets rose in 2002 with average prices at 10 major Japanese wholesale markets rising by 1 per cent for fresh yellowfin and 3 per cent for frozen yellowfin. Longline caught yellowfin prices landed at Yaizu increased by 2 per cent, average fresh yellowfin prices at selected Japanese ports increased by 6 per cent and fresh yellowfin import prices increased by 3 per cent. For bigeye significant declines in the average price of fresh bigeye landed at 49 selected Japanese ports in 2002 and imports from the Oceania region were recorded in 2002 while the average price at 10 major Japanese wholesale markets also declined but to a lesser extent and the average price of fresh bigeye imports in total was steady. Import prices for albacore frozen albacore into the US, Thailand and Japan all declined sharply in 2002.

27. The preliminary estimate of the total catch in the pole and line fishery in 2002 is 346,020Mt. This represents an increase of 4,990Mt on the 2001 catch, an increase of around 1 per cent. Japanese pole and line caught skipjack prices were mixed in 2002, rising in the southern water WCPO fishery while fallingl for the Japanese distant-water fishery.

2.3 National Fishery Reports

28. The Chairman called for presentations of national tuna fishery reports, which provide the meeting with an overview of recent fishery developments at a national level, involving domestic and foreign fleet activity.

Australia

29. Dr Don Bromhead presented NFR-2, *Tuna and Billfish Fisheries of the Eastern Australian Fishing Zone and Adjacent High Seas*. The majority of catch of tuna and billfish taken off Australia's east coast is by longline, with smaller catches taken by purse seine, pole and line and minor line methods. In 2002, domestic longline effort increased to 11.8 million hooks, the highest on record. Longline catches of yellowfin tuna (2193 mt) were the highest on record while catches of bigeye (810 mt) and striped marlin (427 mt) were lower than those achieved in the previous year (1,053t and 528 mt respectively). Broadbill swordfish catches (1,444 mt) were marginally higher than in 2001 (1,402 mt) but were still not reaching the levels achieved between 1998 and 2000. Catch rates were slightly higher for yellowfin, but lower for bigeye tuna and striped marlin when compared to the previous year.

30. Catches of skipjack by purse seine and pole-and-line in the eastern AFZ declined to only 84 mt in 2002. This fishery had in the past taken significant catches of skipjack, peaking at over 6,000 mt in 1992, before declining to 1,000 mt in 1998

and increasing again to about 4000 mt in 2000. The recent declines are due to closing of the Eden cannery in 1999, the cessation of supply contracts held by east coast skipjack fishers and their diversification into other fishing ventures. Other gears have continued to take minor catches of skipjack, yellowfin and albacore tunas.

31. Striped marlin continued to feature in recreational and charter gamefish reports in 2002 but in lesser numbers than in the late 1990s (1998-2000). Yellowfin tuna catches by recreational and charter vessels were higher relative to the late 1990s. 2002 was also a record year in the Cairns heavy tackle black marlin fishery and increased numbers of blue marlin were a feature of east coast gamefishing tournaments.

Canada

32. Dr Max Stocker presented the summary of Canadian fisheries referring the meeting to NFR-3. Canadians began fishing albacore tuna (*Thunnus alalunga)* in the north Pacific with troll vessels using tuna jigs in the mid-1930s. Canadian trollers began fishing albacore in the south Pacific in the mid 1980s. In the last two decades, larger vessels in the Canadian troll fleet have increasingly expanded their albacore fishing from the North American coast westward past the dateline and southward to the subtropical convergence zone.

33. The Canadian jig fishery is comprised of two fleets. The coastal fleet operates within and near the Canadian and United States fishing zones in accordance with zone and port access privileges under the Canada/U.S. Albacore Tuna Treaty. Vessels in this fleet, mostly 35 to 60 feet in length, concentrate their fishing effort primarily from the southern California coast to the northern tip of Vancouver Island and, in some years, as far north as off the west coast of the Queen Charlotte Islands. The catch is primarily bled and blast frozen with some vessels holding fresh caught fish in ice or frozen brine. The catch from the coastal fleet is sold either into US or Canadian plants where the fish are sold in the canned tuna market or the fresh-frozen sashimi market. The Canadian high seas fleet is comprised of larger jig vessels (most greater than 60 feet) with crews typically of two to four fishermen that remain at sea for trips of several months. These vessels, most of which are equipped with large freezers, operate primarily from west of the dateline to the Canadian zone in the north Pacific. Offshore fishing in the north Pacific on the Midway and Wake Islands grounds usually starts in late May or June and, weather and tuna abundance permitting, lasts through late fall as the vessels follow albacore towards the North American coast. Offshore vessel catches are also sold into the canned market, although the majority is bled and blast frozen then sold into the fresh-frozen sashimi market. There are a number of small processors that have established special niche markets for albacore. The product is either smoked (hot or cold) or loined and sold directly to consumers.

34. The 2002 catch estimates are still preliminary. Logbooks have been received from 85% of an estimated 248 vessels that were fishing albacore in 2001, and 90% of an estimated fleet of 232 vessels that were fishing in 2002. The total estimated Canadian catch for 2002 was 5,140 mt, compared to 5,191 mt in 2001. Most of this catch (94%) was taken in FAO Area 67. Catches in the other FAO areas in 2002 were similar to 2001.

35. In recent years, between two and five Canadian flag vessels have fished southern albacore stocks below the equator during the November to March seasons.

These vessels fished primarily in an area that extends from 130°W to 165°W and 30°S to 45°S. They have landed their catch at ports in American Samoa, Fiji, French Polynesia (Papeete) and Canada. Based on analyses of transshipment records and discussions with skippers, Canadian landings in this fishery from 1995/1996 to 2001/2002 are estimated to have ranged from 136 to 351 mt per season. Based on log book, sales slips, transshipment data, and fisherman interviews, the preliminary 2001/2002 catch of southern albacore by Canadian registered vessels was 144 mt compared to 206 mt in 2000/2001.

36. The recent albacore sashimi initiative that originated in Canada during recent years has now collapsed due to too many other operators becoming involved (i.e. flooding the market).

China

37. Mr Xu Liuxiong summarised NFR-4. Mainland China's distant water longline fishery began to develop in the late 1980s. In 1988, seven longliners, reconstructed from inshore trawlers, arrived in WCPO waters. This fleet rapidly increased to a peak of 457 vessels in 1994 that caught a nominal 12,885 mt. The fleet then steadily reduced, due to inefficient fishing and poor returns, until in 1999 it bottomed out at 66 vessels that caught 1,024 mt. Since 1999 the fleet has been more stable at around 110-120 vessels and in the year 2002 there were 123 vessels, which caught 7,941 mt, 260 mt more than in the previous year. Fishing vessels from 24 to 30 metres in length (50 to 149 GRT) dominate the fleet and these fish mainly within the EEZ waters of the countries that they are licensed to fish in. These vessels typically set between 800 and 1,000 hooks in five to seven hook baskets. The larger (greater than 40 metre) vessels typically set 2,500 to 3,000 hooks in seven to fifteen hook baskets targeting albacore.

38. A single purse seiner (345 mt capacity) joined China's tuna fishing fleet in 2001, and two purse seiners were active fishing for skipjack in WCPO waters in 2002, catching 7,360 mt of skipjack and yellowfin tuna. At present, there are four tuna purse seiners operating in WCPO waters.

39. Bigeye and yellowfin tuna have been the main target species of the small vessel longline fleet. Since 1998 the catch of albacore by the larger vessels has been increasing in part due to increased seasonal movement between the southern and northern Pacific high-sea albacore fishing grounds.

40. Total catch of the Chinese fleet was 15,300 mt in 2002, 52% of which was caught by longline fishery and 48% by purse seine fishery. Bigeye and yellowfin caught by small longliners mainly go to Japan, whilst the other species tend to be sold on the local markets in the countries in which the vessels fish. Large longliners send albacore to canneries. The catch of purse seiners goes to Thailand. One 3,000 mt deep frozen cold store was constructed in 2002 by Japanese technology, and Japanese equipment was also introduced to produce tuna products for Japanese sashimi market.

41. China has carried out little pure scientific research on tuna in Pacific waters but a small tuna technical group was established at the Shanghai Fisheries University with support of the Bureau of Fisheries in China's Ministry of Agriculture and of the China Fisheries Society and the Distant Water Branch of China Fisheries Association. The

tuna technical group is charged with sending observers and submitting data to regional organisations in line with China's international obligations. One observer trained for work on the tuna fleet in WCPO could not go in 2002 because of technical problems, however, two observers were sent to the fishing fleet in the Pacific Ocean in June 2003. There is a lack of size frequency data submitted by fishing companies and some increased efforts are needed in this respect.

42. In response to a question as to where the purse-seine vessels fish, it was noted that most fishing occurs between 07N-10S and 147E-175E in the WCPO. Catch data are collected from the two companies fishing and supplied to the Tuna Working Group

Cook Islands

43. Mr Josh Mitchell presented the summary of Cook Islands tuna fisheries, referring the meeting to NFR-5. The period 1998–2000 was characterised by licensing foreign fishing vessels based out of American Samoa. Approximately 1,000 mt of fish predominantly albacore was taken during this period and unloaded at Pago Pago. Since 2000, the licensing of foreign fishing vessels has been discontinued, except through charter arrangements with local companies. This was due to government policy aimed at promoting the development of a domestic longline fisheries industry. From the beginning of 2002 to the present, the domestic fishing fleet has continued to grow rapidly, as a result of several factors including stable economic environment, increased support from lending institutions and strategic government policies (e.g. removing import tariffs/levies on bait, gear and fuel).

44. As in past years, there are two main strategies employed in the Cook Islands longline industry. These are a) fishing activities concentrated in the northern Cooks EEZ, targeting albacore for unloading to canneries in American Samoa; and b) fishing activities in the southern Cook EEZ based out of Rarotonga, targeting fresh chilled fish for sashimi markets, mainly Japan, the US and NZ. The total catch for 2002 was 1,118 mt, with an average CPUE of 65.6 kg/100 hooks set. The preliminary catch for 2003 is 454 mt for the first half year, with a much lower CPUE of 41.5 kg/100 hooks. The longline fleet currently comprises 14 local vessels, and 7 foreign fishing vessels licensed under charter; totalling 21 vessels. In 2002, the bulk of the catch was albacore (78.6%) followed by bigeye (5.9%), yellowfin (4.4%), swordfish (1.4%) and others (9.7%). Approximately 10 mt of Pacific bluefin tuna was also taken in 2002, and catches of this species have continued into 2003. Samples from several individuals have been sent to CSIRO to confirm species identification.

45. Onshore developments include port expansion/development on Rarotonga, construction of two new fish processing facilities, and a new legislative framework and management plan for the fishery. An integrated database package incorporating data from sources such as logsheets, the observer programme, and port sampling has also been developed with assistance from SPC/OFP.

Federated States of Micronesia

46. Mr Tim Park presented the summary of FSM fisheries, referring the meeting to NFR-6. The current estimate of the total catch by purse seine, pole-and-line and longline fisheries from logsheets submitted to NORMA (National Oceanic Resource Management Authority) for 2002 is 44,124 mt. This is composed of 40,884 mt

reported caught by purse seine, and 4,240 mt by longline. There is currently no catch estimate for the Japanese pole-and-line fleet for 2002. It was noted that the total catch estimate for 2002 from SPC for all sources is about 61,000 mt. This is significantly lower than that of 2001 and well below that of 1999 (~164,000 mt); however the 1999 estimate is only composed of catches reported in the FSM EEZ whereas the current 2002 estimate includes catches reported but outside the FSM.

47. There has been a drastic decline in the catch of the fisheries since the record year of 1995, largely as a response to changing ENSO events. In 2002, the fishing effort by purse seine fleets was to the far southeast of the FSM zone into international waters toward Nauru. The domestic purse seine fleet reported very little effort or catch in the FSM EEZ. In meeting flag state responsibilities, domestic companies were asked for effort and catch information beyond the EEZ. Only two of the purse seine companies representing 3 of the 5 FSM purse seiners and none of the longline companies responded. A current best estimate of the catch from four of the five FSM purse seiners from industry and logsheets is 12,614 mt.

48. Both transshipment numbers and volumes at FSM ports were lower than in previous years. There were only 135 transshipments for a total of 70,829 mt transshipped; the lowest figures for some years. Whereas Chuuk was once the main purse seine transshipment port, there have only been two transshipments in almost two years. Similarly, Kosrae has not received any transshipments in about 18 months. Pohnpei has become the most used transshipment port in the FSM with 130 transshipments. Yap has not had any transshipments for some years though a concentration of fishing effort along a temperature front resulted in Yap receiving 51 purse seine transshipments over April and May 2003. Similarly transshipments appear to be higher in 2003 for Pohnpei for the first half of 2003.

49. There were 774 longline unloadings in FSM ports for a total of 1,830 mt with most undertaken in Pohnpei.

50. The FSM observer program made 42 placements in 2002 trips of 1,148 sea-days on the three main fishing gear types equating to a coverage of 3.7% overall for 2002. The trend in coverage for the program has been positive with a general increase in coverage over the past few years.

51. It was noted that there has been a great deal of purse seine activity in the western areas of FSM in the first few months of 2003.

French Polynesia

52. A report on the tuna fisheries of French Polynesia (NFR-8), prepared by Christophe Misselis, could not be presented in person, but is summarized as follows. Both domestic coastal and offshore tuna fleets operate in French Polynesia. There has been no fishing by DWFN vessels under access agreements since 2000. The coastal fleet comprises multi-purpose *poti marara* (237 boats) and larger pole-and-line skipjack boats *(bonitiers* - 55 boats*)*, with the combined fleet landing 2,301 mt in 2002, just a slight increase over the past 12 years. The coastal fleet is facing increased competition, and is supported by the maintenance of an FAD network, market development and fish auctions, and licence limitation.

53. The offshore fleet comprises *bonitiers* converted for longlining (6), fresh fish longliners (30), freezer longliners (16) and mixed longliners (2), and is strongly encouraged under government development initiatives, with a goal of achieving annual production of 30,000 mt. Port infrastructure in particular is being significantly upgraded. The total catch by the offshore fleet was 7,401 mt in 2002, of which 62% was albacore, 9% bigeye and 7% yellowfin. Albacore CPUE increased during 2002, whilst bigeye and yellowfin CPUE showed a slight decrease.

54. The total catch within the large EEZ was 9,702 mt during 2002, compared to 10,317 mt in 2001. Exports amounted to 2,825 mt, with fresh fish and frozen exports increasing and decreasing respectively.

Fiji

55. Mr Jone Amoe presented the summary of Fiji fisheries, referring the meeting to NFR-7. Domestic longlining is the main component of the Fiji tuna fishery, although foreign longliners and a large domestic pole-and-line fishery have operated in the Fiji waters in the past. The 2002 total catch is estimated at 16,472 mt, based on 90% logsheet coverage, of which 10,906 mt was tuna (albacore, followed by yellowfin and bigeye). 74% of the catch was taken within Fiji waters, with the remainder in Vanuatu and adjacent high seas. Albacore comprised 50% of the total landed catch and over 70% of the tuna catch, with catch rates relatively stable since 1996. Yellowfin catch rates have been more variable, and bigeye catches have declined steadily over time. The second and third quarters generally provide the best albacore and yellowfin catches. Billfish and shark made up nearly 20% of the landed catch in 2002, with significant quantities of other by-catch species.

56. The domestic fleet comprised 101 longline vessels and 2 pole-and-line vessels in 2002. A number of foreign fleets unload their catch in Fiji ports, including DWFN longliners, mainly Taiwanese. Unloadings totalled 11,344 mt in 2002. Exports were valued at F$ 250 million in 2002, with Japan and the USA the main destinations for airfreight exports.

57. The previous year, 2002, was the first year of implementation of the National Tuna Development and Management Plan. A TAC of 15,000 mt of target tuna species has been established for the Fiji longline fishery, with a vessel limit of 110, and observer, port sampling and transshipment monitoring programmes established. Establishment of a National Fisheries Authority is anticipated in 2004.

58. In discussion, the apparent disparity between the large increase in the swordfish catch (717 mt in 2002) in contrast to the declining CPUE was noted; the large amount of "other species" in the longline catch for 2002, even when billfish, shark and wahoo/mahi mahi were excluded, was noted, with being made up mostly of skipjack, opah and barracuda. Explanation was sought on the origin of the present TAC (15,000t of the three main tuna species), with Fiji replying that this was imposed under sovereign rights consistent with the LOSC.

Indonesia

59. Dr Gede Merta presented the summary of Indonesian fisheries, referring the meeting to NFR-10. During the period 1990-1997, the average total production of tunas and small tunas in the eastern part of the Indonesian waters (EIW) was 261,481 mt, with

an average annual increase of 5.1%. The tuna fisheries were mainly carried out by pole-and-liners of 10-30 GRT in North Sulawesi (Bitung), Maluku (Ambon) and Irian Jaya (Sorong). Small scale pole and line has also developed using outrigger canoes or very small outboard motor powered vessels in Bitung and Ambon. Another important gear is handline which has developed in North Sulawesi (Gorontalo) and Maluku (Labuha), to catch tunas around FADs (rumpons). Another important gear is purse seine, mainly in North Sulawesi. Joint venture companies of Indonesia and the Philippines had developed from the end of 1990 through 1999, in North Sulawesi waters. In their operation, they were using FADs. After some years of their operations, some negative impacts have been observed. The number of pole-and-line vessels and their CPUE was decreasing. The size of exportable fish was also decreasing with the proportion of smaller fish increasing.

60. Research on tunas was carried out under IPTP during the period 1970-1992, to monitor catch and effort, as well as the size of fish caught. Monitoring was carried out in some minor landing sites such as Bitung, Gorontalo, Ambon, Labuha, and Irian Jaya. Tagging was carried out in 1984 as part of this project. About 10,000 fish (mainly skipjack) were tagged in North Sulawesi, Maluku and Irian Jaya. The recovery rate was very low (<5%). In 1991/1992, tagging was conducted in the Sulawesi Sea by SPC, in collaboration with Indonesia and Philippines. With funding from the World Bank, tagging was carried out in the same waters, in 1996/97 and 1998/99, and in 1999/2000 using national funds. The number of fish tagged was 13,277 with average recoveries of 7.9% per year. The wide area of EIW and adjacent areas such as Philippines, PNG and Australia needs research collaboration regionally or internationally in the near future.

61. In response to a question concerning the inclusion of the catch by non-classified gears in the statistics, Dr Merta replied that there are still few data on such catches.

Japan

62. Dr Naozumi Miyabe presented the summary of Japanese fisheries referring the meeting to NFR-11. Longline, pole-and-line and purse seine fisheries are used to catch tunas and billfishes in the WCPO. In addition to these three fisheries, trolling, which has long been conducted by small boats in the coastal waters of Japan, is the next important fishing gear in terms of tuna catches. The magnitude of tuna catch by this gear is nearly 20,000 mt annually. Catches by other gears are very minor.

63. Over the past 20 to 35 years, the fleet size of three main tuna fisheries has been reduced considerably except for the purse seine fleet which has been stable since the early 1980s (at around 35 distant water purse seiners). In both longline and pole-and-line fisheries, 20-49 GRT boats had declined very quickly during the 1960s and 50-199 GRT boats have followed this trend since the early 1980s. These declines were very drastic, with less than 15% of each vessel type remaining compared to the number at peak levels. In the case of pole-and-line boats the largest boat size (over 200 GRT) has also declined since the mid 1970s, but the same size of longline boat were maintained at the same level until 1999. These declines were caused by economic factors.

64. Reflecting these changes in fleet size, fishing effort has also shown a similar decreasing trend. Longline indicated a 55% decline from a peak in 1981. Similarly,

pole-and-line effort showed a 70% decline from a high in 1977. Catch declined for all species except for albacore and swordfish. The pole-and-line catch has declined by 55% since 1977. Only albacore showed some recovery of catch in recent years. On the other hand, purse seine fishing effort has been high and stable since the mid 1980s, and the catch has been at the highest level since the late 1980s. In accordance with these changes, some changes have occurred in the areas fished. Longline effort was reduced in the waters around Japan as well as in the western part of WCPO. Pole-and-line fishing area has generally contracted and much less fishing is exerted in the equatorial region. When the albacore season commences (June to September), almost all fleets go to the Kuroshio extension zone (30-38N) for albacore fishing. Changes in the fishing grounds have also occurred in the purse seine fishery, with the fleet moving further eastward from Nauru to Marshall Islands and Kiribati since 1999.

65. Total catch of tuna and billfish in 2001 by the longline fishery (over 20 GRT) was 54,000 mt, 10% lower than 2000; this represents only 42% of the historical high in 1980. This is mainly due to the decline of yellowfin catch and to a lesser extent, bigeye tuna as well as billfishes.

66. Pole-and-line and purse seine fisheries are essentially skipjack fisheries, this species representing 75% and 80% of total catch, respectively. The 2001 total catch for these two fisheries was 130,000 mt and 220,000 mt, respectively. The catch of both fisheries was slightly reduced in 2001.

67. The 2001 total catch of bigeye, yellowfin and skipjack tunas combined for all fisheries and all sizes of boat was 33,000 mt, 56,957 mt and 282,000 mt, respectively. The combined total catch for these three species was 372,000 mt which is 65,000 mt down on 2000 catches and is equivalent to 65 % of the highest amount recorded in 1984.

68. In response to a question regarding the variation in catches of longline-caught species, Dr Miyabe said that there was possibly some concern with bigeye, but that shifts in targeting and areas fished, and the economics of the fishery (meaning that the fleet numbers have declined to some extent) are probably the main reasons for some decline in catches.

Kiribati

69. Mr Johnny Kirata submitted an overview of the tuna fisheries of Kiribati as NFR-12. The year 2002 was another very good fishing season with the prevailing *El Nino* conditions. Kiribati has a small domestic commercial tuna fleet, consisting of one purse seine vessel operated by a joint venture company and one locally constructed 33ft "wauowa", an FAO canoe-catamaran prototype) used by the Fisheries Division for longline fishing trials, and an ex-USA longline vessel operated by the Fisheries Training Center. Except for the purse seine vessel licensed under the FSM, the two longline vessels did very little fishing in 2002. A bigger and improved version of the canoe-catamaran, or "super wauowa", built for the national fishing company (Central Pacific Producer) was completed at the end of 2002, and is currently operating from Kiritimati Island. The domestic fleet which does harvest significant quantities of tuna and other pelagic fish is the artisanal and subsistence fishery. According to creel surveys conducted on each island at two to three year intervals, this capture fleet consists of about 990 skiffs, 320 FAO canoes and 4,160

traditional canoes. The revised annual aggregated catch estimate for this fishery is around 6,300 mt of tuna, mostly skipjack, and 2,400 mt of shark.

70. As usual, the tuna fishery was predominantly operated by foreign fishing vessels. Besides the US Treaty and FSM Arrangement, Kiribati had a total of 22 bilateral access arrangements with fishing companies and associations from seven distant water fishing nations (DWFNs). Over A$41.7 million was generated in access fees and a total of 393 fishing vessels (purse seine 167, longline 225 and pole-and-line one) and 40 support vessels (31 reefer carriers and 9 tankers) were licensed in 2002. An estimated catch of around 200,000mt of skipjack, 60,000 mt of yellowfin and 10,000 mt of bigeye was caught by the DWFN fleets. Tuna transshipment was conducted at Tarawa on the western side, and for the only the second time in history, transshipment was also conducted at Kirimati on the eastern side of the country. A total of 60,000 mt of catch was transshipped from 78 vessels in Tarawa and 82,000 mt from 27 vessels in Kirimati.

71. There are plans by Government to set up a fishing base in Kirimati and the national fishing company (CPP) is planning to construct two more super wauowa to follow the first one now in operation. Plans are also underway for a small scale onshore tuna processing facility in Tarawa that may see an increase in activity in the surface tuna fishery, especially for the artisanal fishery, which already deals with a saturated market for fresh tuna.

Korea

72. Dr Jeong-rack Koh presented a summary of the Korean National Tuna Fishery Report (NFR–13). During 2002, total catches of Korean tuna fisheries in the Pacific were about 266,466 mt, an increase of about 13% on the previous year's catch. Purse seiners caught 195,390 mt (81%), whereas longliners caught 46,802 mt (19%) in the WCPO. Almost 97% of the total catch in the WCPO was composed of three tuna species, skipjack (66.3%), yellowfin (21.5%) and bigeye (9.0%). Total catches of billfishes were 4,551 mt, 9.7% of the total longline catch, which increased by 45.7% compared with that in 2001. Blue marlin was dominant, comprising 63% of the total billfish catch.

73. In 2002, 26 purse seiners and 162 longliners were active in the WCPO. Dominant vessel capacity size ranged from 300 to 500 GRT for longliners and 700 to 1,400 GRT for purse seiners. Most tuna catches from the Korean longline fishery were exported to Japan for sashimi; about half of the tuna catches from purse seine fishery were sold to the Japanese cannery market, and about half of the skipjack and yellowfin catches were processed in local canneries.

74. The Korean government has initiated training of international observers in 2002. The government is planning to expand this training program in 2003.

75. In response to a query that the observer coverage in 2002 appeared to be lower compared to that in 1998, Dr Koh advised that this was due to the increasing remoteness of vessel operating areas and the difficulty of deploying observers under these circumstances. Noting that Table 4 in NFR-13 showed a considerable increase in swordfish catch since 1997, clarification was sought as to whether this was due to targeting of swordfish or spatial reallocation of effort. Advice provided was that the

fleet is not targeting swordfish and that whilst reasons for this increase are not presently known, industry contacts would be consulted for possible explanations.

Marshall Islands

76. Mr Glen Joseph presented NFR-14 reporting on tuna fisheries in the Republic of Marshall Islands (RMI) for the years 2001 and 2002. The RMI pelagic fisheries include purse seine, pole-and-line, and longline fisheries, with access agreements for 2001/2002 granted to Taiwan, mainland China, Korea, Japan and the USA, and to some Vanuatu flag vessels as well as the Marshall Islands Fishing venture, which contracts chilled longline vessels from some of the DWFNs. There were also 5 RMI-based purse seine vessels operating under the FSM Arrangement.

77. The purse seine catch in the RMI EEZ by all vessels totalled 34,639 and 28,915 mt in 2001 and 2002 respectively, whereas the catch by five RMI vessels fishing over wide area of the WCPO was 38,242 mt in 2002. The longline catch in the EEZ was 4,174 and 1,992 mt in 2001 and 2002 respectively, with most of the catch by Japanese vessels. Most purse seine and longline effort occurs south of 10^{o}N. The pole-and-line catch in the EEZ by Japanese distant water vessels was 16,242 and 7,316 mt in 2001 and 2002 respectively.

New Caledonia

78. Mr Regis Etaix-Bonin presented the summary of fisheries in New Caledonia referring the meeting to NFR-16. Since 2000, the New Caledonia tuna fleet has increased considerably - 25 longliners were active in 2002 whereas there were only 14 such boats in the fishery two years before. This is mainly due to the establishment of new fishing companies of which the largest is operating 10 longliners in the Northern Province.

79. Consequently, catches have also increased, however this has been slower than expected because of a reduction of the average size of the vessels. The catch attained 2,200 mt last year in comparison to 2,050 mt in 2001 and 2,000 mt in year 2000.

80. The fishing strategies are also evolving. Whereas yellowfin and bigeye were preferentially targeted until recently, fishing companies are currently considering catching more albacore (already representing more than 50 per cent of the total catch in 2002) since the construction of a processing plant in Nouméa, inaugurated in March 2002. This plant, as well as the one operated in the Northern Province, is EC-approved and gives the New Caledonia tuna industry the opportunity to explore markets other than its traditional ones which are the Japanese sashimi market, the canneries in the region and its own local market.

81. With regard to legal matters, the fisheries policy for the EEZ passed in August 2001 is now fully implemented. Under this framework the local government is allowed to set technical provisions for the management of living resources. Fishing licences have been imposed to all the vessels operating in the EEZ and it is planned to set up a new vessel-tracking system in 2004.

82. The tuna sector is tending to be more and more complex in terms of vessels and markets. To better monitor this evolution New Caledonia initiated a national observer

programme under the ProcFish programme early last year and is about to establish a socio-economics project within its fisheries department.

83. In discussion, an explanation for the low swordfish catch in the New Caledonian longline was sought. It was noted that trials targeting swordfish were undertaken during the late 1980s, but marketing difficulties led to their discontinuation, and a change in targeting occurred, initially to bigeye and yellowfin and recently, to albacore. It was noted that although one former Noumea-based vessel had moved to French Polynesia, there had been no movement in the other direction.

New Zealand

84. Dr Talbot Murray presented the summary of fisheries in New Zealand referring the meeting to NFR-17. New Zealand tuna fisheries began in the early 1960s with troll landings of skipjack and albacore, and developed during the 1970s into the summer albacore troll and skipjack purse seine fisheries. During the 1980s domestic handline and troll fisheries for southern bluefin tuna in winter developed. Since 1991 domestic longlining progressively expanded and today purse seine, troll and longline fisheries target all commercially valuable tuna species present in the EEZ year-round. In addition to fishing in the EEZ, New Zealand fishers helped to establish the high seas troll fishery for albacore that is now primarily the domain of troll vessels from the USA and Canada. Most recently four New Zealand super seiners (formerly USA flagged) have fished the western Pacific for skipjack, yellowfin and bigeye tunas under bilateral access agreements and the Palau Arrangement.

85. The number of New Zealand flagged vessels fishing for tuna in 2001 was 472 and in 2002 the number fishing increased to 495. Most of these vessels are albacore trollers (69% in 2001 and 65% in 2002) with the longline fleet accounting for 28% of all tuna vessels in 2001 and 32% in 2002. The number of vessels using purse seine has also increased to 9 in 2001 and 11 in 2002. Most tuna vessels in the EEZ using troll, longline and pole-&-line methods are small (< 50 GRT) vessels. While purse seine vessels are larger, they also tend to be small (< 400 GRT).

86. Catches in 2001 and 2002 were composed of albacore (5,353 and 5,638 mt); bigeye (480 and 200 mt); Pacific bluefin (50 and 55 mt); skipjack (3,691 and 3,344 mt); southern bluefin (358 and 450 mt); yellowfin (137 and 25 mt) and swordfish (1,029 and 929 mt) respectively. In addition the distant water purse seine vessels in 2001 and 2002 caught skipjack (4,769 and 8,912 mt), yellowfin (667 and 2,045 mt) and bigeye (0 and 5 mt) respectively. The main gear types catching these species are troll (60% of albacore); purse seine (nearly all skipjack) and longline (40% of albacore, minor quantities of skipjack and nearly all of the remaining species above).

87. No canning is done in New Zealand but Spain and the United States of America are important markets for canned albacore while Indonesia and Thailand are important for canned skipjack tuna caught in the EEZ. Some skipjack is also re-imported to New Zealand under various labels. Fresh and frozen bigeye, southern bluefin, Pacific bluefin and yellowfin tunas and swordfish are exported, primarily to Japan, Australia and the USA. There is little domestic consumption of tuna.

88. In discussion, details were sought on the catch of mako shark in the longline fishery eg numbers retained, extent of finning; it was noted that such details should be

available from observer data, but were not readily to hand. The size of the catch of Pacific bluefin tuna (50-55mt) in the longline fishery drew some comment but the quality of the data was affirmed and implications in relation to the southern bluefin quotas explained. More fish are caught in more northern parts of the EEZ, but also along both coasts.

Niue

89. Mr Paul Pasisi presented the summary of fisheries in Niue referring the meeting to NFR-18. As reported in previous sessions, restricted access due to the rugged coastline as well as minimal harbour facilities have limited Niue to a small scale artisanal fishery. This fishery remains relatively unchanged, with approximately 50 – 60 small aluminium skiffs and 100 – 120 outrigger canoes in operation that account for an estimated catch of 100 mt of the 4 main tuna species (combined) for the period of June 2002 - May 2003. The composition of this estimated catch was 55% yellowfin and bigeye (combined), 40% skipjack and 5% albacore. The remaining portion of the 200 mt total estimated pelagic catch for the same period (100 mt) is predominantly made up of wahoo as well as others. There were no exports for this period except for small quantities taken off island by travellers. The majority of fish is sold to traders, hotels and restaurants, with a large portion also being consumed locally on a subsistence basis.

90. Not yet having its own domestic offshore fishery, Niue has continued to license distant water longline vessels to fish in its EEZ. For the period 2002/03 Niue licensed 20 Taiwanese distant water longline vessels under a commercial agreement. However, significant headway has been made by Niue in its efforts to establish its own domestic offshore tuna fishery. Niue has recently completed a Tuna Longline Feasibility Study with the assistance of an outside consultant, FFA, SPC and Niue Fisheries, and is presently exploring the options for vessels and infrastructure development with a view to creating a sustainable commercial tuna fishing industry. Niue is also in the process of negotiating Joint Venture proposals with offshore interests, with one of the main criteria being the establishment of an onshore processing facility and development of export markets. From the progress to date it is envisaged that Niue may well be positioned to enter the fishery by late 2003 or early 2004.

91. In line with regional initiatives to ensure sustainable conservation and management of the regions tuna resources, Niue has set an initial preliminary sustainable catch estimate of 3,000 mt with the aim of developing its fishery in an incremental, closely monitored and orderly fashion up to this initial sustainable catch estimate. It is anticipated that this approach will provide for orderly development which will ensure the long term economic and biological sustainability of the fishing industry of Niue.

Palau

92. Mr Celestine Yangilmau presented NFR-20. Fisheries resources comprise the second largest revenue source for Palau after tourism. The Bureau of Oceanic Fishery Management assumed duties and functions prescribed under the 2002 amendments to pelagic fisheries legislation. Fisheries negotiations, licensing and revenue collection are the primary functions of the Bureau, but it is also responsible for research, fisheries statistics, and development of tuna fishing industries in Palau. Foreign

fishing entities are required to conclude a fisheries access agreement negotiated with the Bureau before being approved by the national legislature.

93. In 2002 the fleet structure comprised of 95 longline vessels (29 Chinese, 19 Japanese, 47 Taiwanese) and 18 Japanese purse seiners. There was a noticeable reduction in Taiwanese vessels between 2000 and 2001 due to reluctance of those vessels to implement a vessel monitoring system.

94. Longline effort is seasonal and spatially distributed, with the different fleets adopting different patterns. The Chinese fleet concentrates its effort in the south-east of the zone, as does the Taiwanese fleet though the latter distributes its effort more widely. The Japanese fleet concentrates its effort to the south-west. Chinese and Taiwanese vessels are more active in the second half of the year, with October being the busiest month for the Chinese and August for the Taiwanese. In contrast, the Japanese tend to be most active in the first quarter of the year.

95. The Taiwanese fleet caught 769 mt in 2001 (66% yellowfin, 31% bigeye, 1.6% blue marlin, 1.4% swordfish). The Chinese fleet caught 869 mt in 2001 (53% bigeye, 30% yellowfin, 7.5% blue marlin, 0.5% black marlin, 0.5% striped marlin, 8.5% other). Since the ban on shark catches, no shark catch has been reported; however, this is likely to be due to discarding or transshipment rather than zero catch. Within 48 hours of unloading, all sashimi-grade tuna are air-freighted to markets in Asia. Bycatch, constituting rejects and billfish, are stored in port facilities until being shipped to canneries.

Papua New Guinea

96. Ludwig Kumoru presented NFR-21. The Papua New Guinea (PNG) fishery is significant in both the regional and global sense. It typically produces 20% of the regional purse-seine catch and in some years, 10% of the global tuna catch is taken in the PNG EEZ. PNG is conscious of the need to have good catch data and so has made considerable effort to improve statistical coverage and monitoring over the last few years, with the assistance of SPC/OFP. The data coverage is now good.

97. The average annual catch in PNG has been 180,000 mt by all vessels in years 1998-2002 with the purse-seine catch accounting for 98% of the total. The catch has been variable between years due to large-scale environmental events and changes in access agreements. The estimated purse seine catch in 2002 was 166,000 mt, with 40% of this taken by domestic and locally-based foreign vessels. The locally-based foreign vessels, whose numbers continue to increase, fish widely throughout the WCPO and take only about 30% of their catch in PNG waters. All in all, over 120 bilateral and multilateral vessels fish under access agreements in PNG waters. The smaller longline catch (~ 4,000 mt per year) is taken entirely by domestic vessels, under a domestication policy in place since 1995

98. The PNG longline fishing fleet is made up of 40 longline vessels (growth has levelled off) and nine shark longline vessels, the latter recently established as a separate fishery. The domestic purse-seine fleet now comprises 17 vessels, including some non-PNG flag vessels based in PNG and which unload all their catch for canning in PNG. Locally based foreign vessels continue to increase. Almost all are associated with planned onshore developments and fish under the FSM Arrangement

The number of these vessels was 8 in 2002 but has increased to 13 this year (2003). There are more than 120 vessels under foreign access, but only part of the catch by these vessels is taken in PNG waters.

99. Catch estimates for the longline fishery from logsheet coverage is 3,800 mt for all vessels for 2002. Logsheet coverage for this category was poor prior to 2001 and catch by vessels targeting sharks was not separated. A raised estimate for the tuna longline catch was 2,650 mt for all species, of which 1,832 mt was yellowfin (70%), 368 mt bigeye (14%) and a small percentage of albacore. The shark longline (now with logsheet coverage) total catch was 1,965 mt dressed weight for year 2002, of which shark was 80% and the rest mostly tuna and billfish. All retained catch was frozen on board. Catch by domestic and locally based foreign purse-seine vessels was about 72,000 mt in year 2002. Most of the catch was on associated sets (>60%). Overall, about 70% was skipjack and the percentage of yellowfin and bigeye declared was relatively high.

100. There is significant commitment to the observer and port sampling programs in PNG, but coverage is still less tha 5% overall but increasing.

101. Japan and Australia are main market destinations for fresh chilled longline tuna exported from PNG, whilst frozen shark (fins and meat) is exported to Taiwan. Catch from domestic and locally-based foreign purse-seine is increasingly being processed onshore. Exports are increasing and the value of tuna products currently exported is greater than US$60 million; this is expected to reach USD 250 million in the next five (5) years. Canned product is currently valued at USD 22 million and will increase with improved market access and growth in the number of onshore plants.

102. PNG is at a stage where a lot of emphasis is now given to fisheries development and onshore investment. Two wharves have already been built under the ADB fisheries project of which one is associated with a fish processing facility. There is one cannery currently operating with an output of 120 mt per day. Two loining plants are also under construction and will have an output of 200 mt and 100 mt per day respectively and another three more in the planing stage. A second cannery is in the process of approval and will have an output of 200 mt per day. There are also plans by one company to go into frozen smoked tuna. If all plans go well, about 175,000 mt of fish will likely be processed in PNG per year.

103. Information was sought on the extent of logsheet coverage for the shark longline vessels; with the introduction of a new logsheet during 2002, backed up with a requirement for the monthly submission of landings data, coverage is now 100%.

Philippines

104. Noel Barut (BFAR) presented NFR- 22, the national report of the Philippines. The tuna fishery of the country is composed of the commercially exploited species such as yellowfin, bigeye, skipjack, frigate, bullet and eastern little tuna. The total commercial tuna production for 2002 was 273,445 mt., an increase of 62,958 mt from that of 2001, while the contribution of the municipal sector for 2002 was 133,379 mt, or a decline of 8,617 mt compared to the 2001 production. Despite the decline in the municipal tuna production, the total tuna production for 2002 was higher than that of the 2001 production reaching a total landed catch of 406,824 mt as against the 2001

production of 352,483 mt. Yellowfin/bigeye tuna contributed 99,794 mt to the total tuna production while skipjack contributed 109,977 mt. Frigate/bullet and eastern little tuna contributed 163,132 and 33,921 mt respectively.

105. The increased production of the commercial sector and the decline of the municipal sector may be attributed to the reclassification of the pumpboats or handline boats from municipal to commercial boats since tuna pumpboats are more than 3 gross tonnage. The prior classification of pump boats was as municipal fishing boats regardless of gross tonnage.

106. The tunas are exported in three types such as fresh/chilled/frozen, canned or smoked/dried. The total fresh/chilled/frozen export in 2002 was 23,621 mt while the canned tuna was 47,970 mt and smoked/dried tuna 705 mt with a FOB value of $50,648, $93,173 and $1,335 respectively. The three major importing countries for the fresh/chilled/frozen tuna were Japan, USA and Hong Kong. On the other hand canned tunas were exported mainly to Canada, Germany and Singapore. The major destinations of the smoked/dried tuna were Japan, Taiwan and USA.

107. Responding to questions, Mr Barut advised that the available port sampling data were not yet used to disaggregate bigeye and yellowfin in the catch, but may be so used in the future. With proposed changes to minium mesh sizes for purse seine and ring net vessels, it was noted that this change may have some impact on data used in stock assessments. The predominance of sailfish in the billfish landings was noted, as was the high level of swordfish catches, one of the highest in the WCPO. The possibility of misidentification or use of colloquial names was raised, and this needs clarification in the future. Marlin species identification (blue vs. black) is now applied more rigorously in port sampling programmes. The possibility that figure for fresh/chilled tuna exports may include off-loadings in Davao by Taiwanese vessels was raised, and needs confirmation.

Taiwan

108. Dr Shih-Chin Chou summarized NFP-25 on the Taiwan tuna fisheries in the Pacific Ocean, which are composed of the frozen tuna longline fishery (FTLL), the distant-water purse seine fishery (DWPS) and the fresh and/or chilled tuna longline fishery (CTLL).

109. During 2002, the FTLL constituted 133 vessels, which was an increase of about 30% from 2001. This fleet traditionally targeted north and south Pacific albacore tuna, and in recent years, also tropical tunas. The provisional estimate of the 2002 catch from this fleet was 55,260 mt, of which the composition of bigeye and yellowfin tunas significantly increased from 2001 and accounted for 34% and 17% respectively, due to an increase in effort in tropical waters. Albacore catch is at similar level to previous years but accounted only for 38% of the total catch.

110. The CTLL vessels are typically smaller than 100 GRT, but operate both in coastal and offshore regions of Taiwan and in distant waters. They land their catch in Taiwan or in foreign ports. The total catch of tuna and tuna-like species landed in Taiwan by this fleet was 39,641 mt in 2002, made up of about 23% yellowfin, 5% bigeye, 2% albacore, 6% swordfish, and 27% other billfishes, with a high proportion of by-catch. These catches come from both the Pacific and Indian Oceans, especially

for the billfishes for which the market price in Taiwan is much higher than other markets. The provisional 2002 estimate for bigeye and yellowfin catch for the foreign-based fleet in the Pacific Ocean was 5,754 mt and 7,895 mt, respectively.

111. The DWPS operated over a wide area of the tropical WCPO generally between 135-180E and 8N-8S. However, in 2002, the fishing grounds extended to as far as 151W due possibly to the impact of El Niño. This fleet, current comprising 36 vessels, has made 258,126 mt of catches in 2002, including 229,415 mt of skipjack, 26,068 mt of yellowfin and 2,643 of bigeye.

112. Taiwan has encouraged distant-water fishing vessels to install a vessel monitoring system (VMS) through an incentive program from July 1996 through June 2000. All purse seine vessels and some longline vessels have installed such a system. An experimental observer program has also been conducted since 2001 and two observers have been placed on vessels in the Pacific Ocean in 2002 and 2003.

113. In discussion, information was sought on the extent of VMS coverage of the Taiwanese fleets; advice was given to the effect that all purse seine vessels (together with around 70 longline vessels) now carried VMS. With respect to the increase in the swordfish catch by the freezer longline vessels in 2002, and where this increase in catch was taken (ie in which hemisphere), no breakdown could be provided at this time. With respect to the billfish species composition in the fresh/chilled domestic longline fishery, where there had been some uncertainty previously, it was felt that billfish identifications in the landings data are now satisfactory. In considering the high level of other species in the landings by fresh/chilled tuna longline vessels (over 30% of landings), it was noted that much of this is mahi mahi.

Tonga

114. Mr Siliveinusi Ha'unga presented the summary of fisheries in Tonga referring the meeting to NFR-27. The Tongan tuna fishery is in a developmental phase, with 35 domestic longline vessels landing close to 2,000 mt in recent years. Logsheet coverage has been poor until recently. The 2002 catch of 1,794 mt, slightly below the 2001 catch due to prevailing unfavourable weather conditions, was dominated by albacore (60%), with smaller quantities of yellowfin, bigeye and billfish, and significant by-catch landings. The fleet is comprised of local (17), locally-based foreign (14) and Government vessels (2).

115. Development is guided by a Tuna Management Plan and Committee, with a current cap on vessel numbers of 50. Vessels currently fishing are in the size range 15-39 m (average 25 m). The main export markets are Japan (fresh fish, via NZ) and the USA (including the Pago canneries). The value of exports declined by 20% during 2002. Efforts are being made to expand the existing fleet, increase exports, develop better infrastructure (wharf, processing facilities) and develop an effective conservation and management regime.

United States of America

116. Dr Robert Skillman presented the summary of US tuna fisheries, referring the meeting to NFR-29. The U.S.A. fishery is made up of five fisheries, namely purse seine, longline, troll and handline, distant-water troll, and pole-and-line. The purse seine fishery accounted for 86% of the total catch in 2002 and the longline fishery

12%. The 2002 catch of the purse seine fishery increased slightly from its 2001 level to 119,000 mt, with skipjack tuna making up 73% and yellowfin tuna 24% of the total. The catch of the longline fishery was 16,200 mt in 2002, up from 12,700 mt in 2201, with tuna catches predominating and a lesser proportion of billfishes. The increase in catches was attributed to the continued expansion of the longline fishery based in American Samoa, with catches nearly doubling from 2001 to 7,100 mt in 2002. Albacore dominated the catches. In the North Pacific, the proportion of tuna in the longline catch increased due to restrictions and then closure of the swordfish fishery in Hawaii.

117. The U.S. distant-water troll fishery in the South Pacific experienced a 58% decline in vessel participation and a 51% decline in catches. The catch of the small-scale troll and handline fisheries in American Samoa, Guam, Hawaii, and Northern Marianas declined from 3,000 mt in 2001 to 2,100 mt in 2002. Tunas predominate in the total statistics. The pole-and-line fishery in Hawaii continued at a low level.

118. In the discussion that followed, it was noted that the 2002 catch in American Samoa longline fishery surpassed the Hawaii fishery. Catches in the American Samoan longline fishery during the first quarter 2003 were depressed, but have shown some increase in recent months. It was noted that an observer program will be established in America Samoa shortly and will ultimately provide valuable information to compliment the logbook system for this fishery

Vanuatu

119. Mr William Naviti presented NFR-30. Vanuatu does not have a domestic tuna fleet but the Vanuatu flag fleet comprises 51 large-scale longliners and about 14 purse seiners. The Vanuatu tuna fishery is also accessed by foreign purse seine and longline vessels. As there are no onshore storage or processing facilities for tuna in Vanuatu, most of the catch is offloaded in American Samoa and Fiji, either to onshore processing facilities or for transshipment.

120. To facilitate better provision of data and fishery management, all domestic commercial tuna operations with the exception of recreational tuna fishing will be licensed as of 2004, provided the pending Fisheries Bill is enacted in 2003. Also, a new satellite vessel monitoring system is currently being upgraded to enable vessels to provide near-real time data for fishing operations and catch offloading.

121. Total catch by longline vessels during 2001 was 925 mt, comprising 68% albacore, 20% yellowfin, 4% bigeye, 2.5% shark and 2.5% other, with minor catch of marlin and swordfish. Provisional catches for 2002 are 145 mt caught by longline and 64 mt by purse seine. Catch to date for 2003, as supplied by 17 longliners, is 281 mt.

3. REPORTS BY REGIONAL FISHERY ORGANIZATIONS

Inter-American Tropical Tuna Commission (IATTC)

122. Dr Michael Hinton presented INFO-4 reporting on the activities of the Inter-American Tropical Tuna Commission (IATTC) and on the fisheries for tunas and tuna-like species occurring in the eastern Pacific Ocean (EPO). In 2002 the surface-gear fisheries of the EPO took a record 666,000 mt of principal market tunas, including catches of bigeye, 35,000 mt; skipjack, 158,000 mt; and yellowfin 419,000 mt. Details of the catches by species, area, and set type were presented. The historical trend in capacity of the surface-gear fishing fleet in the EPO was reviewed. This metric has provided a good measure (158,000 cubic meters purse well volume) of the fishing capacity that is appropriate to facilitate management and conservation of stocks and to maximize the combined catch of bigeye, skipjack and yellowfin tuna resources in the EPO.

123. Highlights for assessments of bigeye and yellowfin tuna were presented. Misidentification of small bigeye as yellowfin and/or skipjack in the catches, particularly those made in association with floating objects, was addressed through an intensive sample design study with a subsequent revision of the estimates of catch by species. Recruitment levels for yellowfin in the early period (1975-mid 1980s) were low, while since it has been relatively high, and since about 1985, the spawning biomass ratio has been above that required to maintain the yield at or above maximum sustained yield (MSY). Starting in 1995 significant catches of bigeye (previously principally a longline catch) began to be made by purse seine vessels fishing on floating objects. Since about 1998 recruitment has been estimated to be below average, and it is expected that the spawning biomass ratio will fall below that which will support MSY by 2004.

124. Resolutions passed by the IATTC at its meeting held in June, 2003, were reviewed, including those for conservation of bigeye and yellowfin tuna, adoption of a new convention, reduction of bycatch, positive listing of longline vessels authorized to fish in the EPO, and adoption of a bigeye statistical documentation program to track imports.

125. In response to a question on how recruitment estimates were derived, it was explained that they are modelled from longline data, as outlined in the stock assessment reports distributed via the IATTC website –http://www.iattc.org

Pelagic Fisheries Research Program (PFRP)

126. The Pelagic Fisheries Research Program (PFRP) is a unit of the University of Hawaii's Joint Institute for Marine and Atmospheric Research (JIMAR). It sponsors research to provide scientific information in support of management of tunas and billfish. The PFRP augments the scientific information used by the Western Pacific Regional Fishery Management Council to formulate and administer fishery management plans.

127. PFRP Program Manager Dr John Sibert presented INFO-1 which includes a list of current projects and a request for proposals for research funding. There are 28 current projects under the headings: Biology, Sociology & Economics, Oceanography & Ecosystem, Protected Species, and Statistics and Modelling. The PFRP is presently soliciting letters of intent to conduct research, with particular emphasis on the the following areas: ecosystem-based fishery management, integrated statistical models of protected species population dynamics, and the dynamics of tuna aggregation.

4. STATISTICS WORKING GROUP (SWG)

128. Mr Tim Lawson, the coordinator, led the session of the Statisitics Working Group.

4.1 Co-ordinator's Report on Data Collection, Compilation and Dissemination

129. The objectives of the Statistics Working Group are to co-ordinate the collection, compilation and dissemination of tuna fisheries data. Mr Lawson presented SWG–1.

Data collection

130. The procedures that were established at SCTB11 to co-ordinate data collection include (a) establishing minimum standards for data collection forms (which was done for catch and effort logsheets at SCTB12) and reviewing forms used in the region; (b) developing coverage tables for catch and effort logsheet data, unloadings data, port sampling data and observer data; and (c) developing a regional sampling design for port sampling and observer programs.

131. Regarding the review of data collection forms, it was reported that Korean catch and effort logsheets had been reviewed by Mr Al Coan (United States) and Mr Lawson (SPC) (see SWG–5 and Appendix 8). There is a lack of fields for most major non-target species and data are recorded only for sets and not for other activities, but otherwise the Korean logsheets were considered to be well designed.

132. Regarding coverage tables, tables of the coverage by data held by the OFP, for all fleets, were presented in SWG–1. For 2001, the most recent year for which all or most data have been compiled, the OFP holds catch and effort logsheet data covering 44.3% of the catch of target species in the WCPO. Excluding the domestic fisheries of Indonesia and the Philippines, and the coastal fisheries of Japan, the logsheet coverage is 64.3%. Coverage by observer data is only 3.2%. Coverage tables for data not held by the OFP – primarily data held by Japan, Korea and Taiwan – were requested in the years following SCTB11, but have not been provided.

133. Regarding the design of sampling programmes, a preparatory meeting of the SWG was held on 7 July 2003, immediately prior to SCTB16, to discuss the establishment of guidelines for coverage rates for observer programmes. The report of the meeting is presented under agenda item 4.2.

Data compilation

134. The procedures for coordinating data compilation include reviewing the compilation of annual catch estimates, the number of vessels by size category, catch and effort data, and length data. Details on the compilation of data are given for each fishing nation in SWG–1, by species in SKJ–3, YFT–3, BET–3 and ALB–3, and in the OFP Data Catalogue, which is available on the SPC/OFP website at www.spc.int/oceanfish.

135. Regarding the compilation of annual catch estimates for the domestic fleets of Indonesia and the Philippines, estimates of the total annual catch have been provided on a timely basis; however, annual catch estimates in recent years (1992–2002 for Indonesia and 1997–2002 for the Philippines) have not been broken down by gear type and estimates of annual bigeye and yellowfin catches for all years have been reported as a combined catch. More information regarding data collection in Indonesia and the Philippines is presented under agenda item 4.4.

136. It was also reported that, in recent years, all annual catch estimates have been provided within six months following the end of the calendar year, except those covering the longline and pole-and-line fleets of Japan.

137. Regarding the compilation of catch and effort data, it was reported that the National Research Institute of Far Seas Fisheries of Japan provided longline catch and effort data, aggregated by 5° by 5° and month, for 1952–1961. These data have been used in MULTIFAN-CL analyses and to estimate annual catches. As a result, the time series of annual catches of bigeye and yellowfin catches in the WCPO, for all fleets, are now complete back to 1952, while the time series of skipjack catches is complete back to 1951. These time series will be complete back to 1950 with the provision of estimates of Japanese longline catches of bigeye and yellowfin in 1950–1951 and the Japanese pole-and-line catch of skipjack in 1950.

138. Logsheet data covering the fleets of SPC member countries and territories are provided on a regular basis, although coverage varies. Coverage has continued to improve for the domestic fleets of the Cook Islands, Fiji, Papua New Guinea, Samoa and Tonga.

139. Logsheet data covering the fleets of Japan, Korea and Taiwan are also provided by SPC members. However, these data are compiled under access agreements and data for the Japanese fleets do not cover the high seas, while coverage of the longline fleets of Korea and Taiwan is incomplete. Therefore catch and effort data grouped by time-area strata are requested on an annual basis from Japan, Korea and Taiwan. In April 2003, Japan provided data covering offshore and distant-water longliners during 1998–2001, pole-and-line vessels during 1972–2001, and purse seiners during 2000–2002. In July 2002, Korea provided data covering longliners during 1987–2001 and purse-seine data during 1980–2001. In May 2003, Taiwan provided data covering distant-water longliners during 2000–2001. The provision of catch and effort data for these fleets is therefore up-to-date.

140. Nevertheless, there continue to be significant problems with catch and effort data provided by Japan and Korea. For Japanese longline data, catches are reported in units of numbers of fish, but not in kilograms. The unit of time for Korean longline data for 1988–1993 is year, instead of month. The units of catch for Korean longline data for 1994–1997 are kilograms only and not numbers of fish. The Korean purse-seine data have been provided with effort in units of ‘days on which a set was made’, rather than ‘days fished or searched’, which renders these data less useful for stock assessment, although it should be noted that the OFP holds logsheet data for this fleet with coverage of greater than 90%.

Data dissemination

141. The procedures for coordinating the dissemination of data by the Statistics Working Group include reviewing instances of dissemination on an annual basis. It was reported that during the twelve-month period prior to SCTB16, from July 2002 to June 2003, there were 135 releases of public domain data via the OFP website (up from 97 during the previous period), 26 releases of data by the OFP other than via the website (up from 13), and 44 releases of statistics and other information (up from 39), as shown in Figure 4.1.

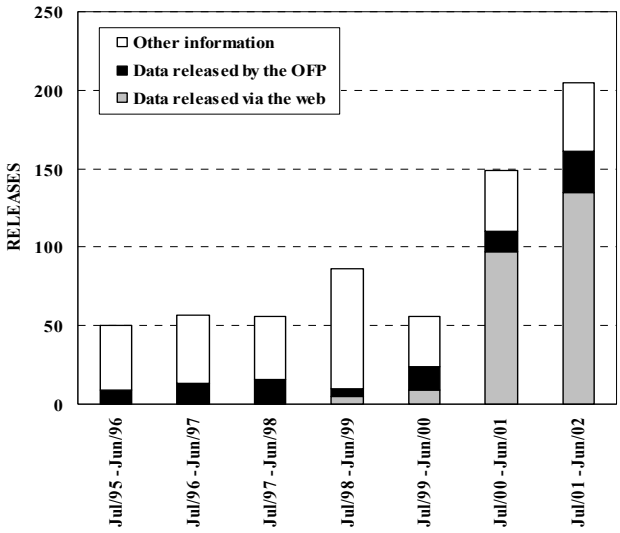


Figure 4.1. Annual data releases by OFP.

Review of SCTB15 directives to the Statistics Working Group

142. The directives to the SWG that were made at SCTB15 were reviewed.

1. Conduct the following activities related to the establishment of standards for the design of national and regional observer programs:

- *review of sampling protocols for observer programs (SPC);*
- *study on coverage rates for the United States purse-seine fleet in the WCPO (NMFS);*
- *study on coverage rates for the Hawaii-based longline fleet (NMFS);*
- *study on coverage rates for domestic Australian longliners (AFMA/CSIRO);*
- *study on the variability of catch rates for offshore longliners fishing in tropical and sub-tropical waters, and implications for coverage rates (SPC, NORMA); and,*
- *investigation into the feasibility of pilot observer programs (SPC).*

These studies were presented at the preparatory meeting of the SWG that was held on 7 July 2003. The report of the meeting is presented under agenda item 4.2.

2. Evaluate the reliability of port sampling data and observer data held by the OFP, particularly in regard to the sampling of the proportion of bigeye in the catch by purse seiners. (OFP, NMFS and port sampler and observer supervisors)

The OFP evaluated species composition samples for target species (skipjack, yellowfin and bigeye) taken by observers onboard purse seiners during 1998–2001.

Species composition samples for other years will be evaluated in due course. Observer estimates of catches of non-target species taken by longliners and purse seiners will also be evaluated in due course.

3. Examine the discrepancies in the proportion of bigeye in 'yellowfin plus bigeye' determined from purse-seine port sampling data and observer data. (OFP, NMFS)

The analysis of the proportion of bigeye in 'yellowfin plus bigeye' (SWG–6) revealed that the proportions estimated from port sampling data and observer data were roughly consistent. However, there was a considerable difference in the proportion for associated sets determined from port sampling data for 1988–1995 and observer data and port sampling data for 1996–2001 (see agenda item 4.5).

4. Develop a project to sample the species composition and lengths of fish caught in the domestic fisheries of Indonesia. (OFP, RIMF, DGCF)

A project proposal developed by SPC and CSIRO was submitted to ACIAR for consideration of funding; however, ACIAR has advised that it is reluctant to provide funding unless funding from other sources is also provided. Nevertheless, it may be possible to conduct pilot sampling in Indonesia through a GEF project that may be implemented in 2004.

5. Document the procedures that are used by DGCF and BAS for collecting data and estimating annual catches and examine the possibility that these catches are being under-reported. (OFP, DGCF, BAS)

This directive will be addressed during the next SCTB inter-sessional period.

6. Compile catch estimates by fleet, together with the availability and quality of data, in working papers for meetings of the SCTB Species Research Groups.

Working Papers SKJ–3, YFT–3, BET–3 and ALB–3 were prepared. Improvements to the content and format of these working papers will be addressed prior to SCTB17.

7. *At future meetings of the SCTB, distribute reports of meetings of the SPC/FFA Data Collection Committee, which is responsible for maintaining the catch and effort logsheets, port sampling forms and observer forms used by the SPC/FFA member countries*.

The report of the Fifth Meeting of the SPC/FFA Tuna Fishery Data Collection Committee, 2–6 December 2002, Brisbane, was distributed at SCTB16 (see INFO-5).

4.2 Report of the SWG Meeting on Standards for the Design of National and Regional Observer Programs

143. A preparatory meeting of the SWG was held on 7 July 2003 to consider research activities carried out following a meeting of the SWG that was held prior to SCTB15 to discuss the establishment of standards for the design of national and regional observer programs for tuna fisheries of the WCPO. The report of the meeting is presented in Appendix 5.

4.3 Recent developments in port sampling programmes and observer programmes

144. Mr Peter Sharples presented a summary of the status of and recent developments in port sampling and observer programmes in the region. The OFP

continues to support collection of length and species composition data for stock assessment on a regular basis through port sampling programmes in 25 harbours in the WCPO. Australia and New Zealand also collect length frequency data in support of these activities.

145. Observer programmes have been developing slowly in regional and national organisations through the region, but in recent years have expanded more rapidly in response to the greater importance given to need for detailed information on fishing effort, on discards, and on catch statistics for non-target species at species level. Highlights of this expansion include:

- In American Samoa, the National Marine Fisheries Service plans to employ twenty observers to cover the 40 plus longliners operating there; this work is to commence in January 2004.

- In Australia, legislation has mandated 5% observer coverage of the tuna longline fleet, starting July 2003.

- In the Cook Islands, a new port sampling and observer programme has already achieved 70% coverage of landings and 6% of vessel trips respectively, since commencing in mid 2002.

- In the Federated States of Micronesia, there are twelve fully operational observers available. There are no immediate plans to expand the observer programme, but it has been recognised that further expansion is required in order to meet coverage goals. There is one full-time port sampler in each of its four island states – Chuuk, Kosrae, Pohnpei and Yap.

- In Fiji, an Observer and Port Sampling Supervisor was appointed in mid 2002, with SPC support. Port sampling activities in Fiji have expanded to now monitor 100% of landings for both compliance and sampling purposes. The observer programme in Fiji now targets four trips per month, but there are plans to expand coverage.

- In French Polynesia, an Observer and Port Sampling Supervisor and two observers were appointed with SPC-EU support. There has also been a modest revival of port sampling activities and a small, but intense observer programme has commenced.

- In Guam, packing lists, which contain weights of individual fish in lieu of length frequency data, have been provided to the OFP. These data cover the large gap in sampling of landings that existed in Guam for many years.

- In Kiribati, port samplers were trained to sample the catches of the purse-seine fleet that unloaded on Christmas Island during late 2002. An Observer and Port Sampler Supervisor was appointed, with SPC support, in late 2002 and the observer programme has commenced.

- In the Marshall Islands, a memorandum of understanding was established between the Marshall Islands Marine Resource Authority and SPC to facilitate the

appointment of a Port Sampling and Observer Supervisor, who will commence duties in August 2003.

- In New Caledonia, port sampling activities in a second port (Koumac, in addition to Noumea) commenced in mid 2002 with the appointment of a Port Sampling and Observer Supervisor and one (very busy) observer.

- In New Zealand, a doubling of observer activity has been proposed, but it has yet to be approved, dependent upon further review.

- In Palau, there are early plans for an observer programme to complement their well-developed port sampling activities.

- In Papua New Guinea, a comprehensive observer programme has developed over the past three years, which included a shift of a large portion of observer activity from compliance coverage of transshipments on carriers to catch and effort sampling of 100% of fishing vessels transshipping to these carriers. SPC supported the appointment of a Deputy Observer Manager in early 2002. Since that time, the number of observers has expanded from 30 to 55. Port sampling activities have expanded to the port of Alotau.

- In the Solomon Islands, observer activities have recommenced and there are plans to recommence port sampling activities if fishing activity stabilises as civil unrest eases.

- Observer coverage of purse seiners, other than those in the United States fleet, has increased as a result of the rapid increase in the number of vessels operating under the FSM Arrangement and the observer requirements that are imposed as a condition of joining that fleet.

146. In 2002, the OFP enhanced its technical support for national port sampling and observer programmes with the appointment of a Port Sampler and Observer Trainer and a Port Sampler and Observer Coordinator, in addition to the Fisheries Monitoring Supervisor. This team will provide training, management support and assistance with data quality control. The emphasis for 2003 is to produce tools for improving feedback to observers and to improve data quality control. Training new observers will remain an important activity, in order to meet the increasing demand for observer data, but refresher training of experienced observers and training of staff to debrief observers will take a higher priority.

4.4 Tuna Fisheries Data for the Domestic Fisheries of Indonesia and the Philippines

147. Mr Peter Williams gave a brief overview of activities related to data collection and the estimation of catches in Indonesia and the Philippines over the past year, and provided suggestions for activities in the coming year. He referred the meeting to a detailed paper produced for SCTB15 on the status of data collection in both countries. A visit to the Philippines during January 2003 covered the following activities:

- Technical assistance for NSAP database system was provided.

- Further information on handline and ringnet fisheries was obtained.

- Further information on procedures used to produce annual catch estimates was obtained from the Bureau of Agricultural Statistics.

148. Port sampling activities in the Philippines have been conducted under the National Stock Assessment Project (NSAP) since 1997 and covered more than 200 sites in 2002. However, this project was halted in August 2002 due to funding constraints, which presents a major concern to potential users of these data. The NSAP port sampling data processed to date cover most months for the period 1997–1999, and National Fisheries Research and Development Institute (NFRDI) hope to complete the balance of data entry (2000–2002) by the end of 2003. It was noted that the Philippines Fisheries Statistics Working Group, which is comprised of representatives from NFRDI, the Bureau of Agricultural Statistics, the Philippines Fisheries Development Authority and industry, deal with fisheries statistics for all fisheries, but that an attempt will be made to focus on tuna fisheries in the future.

149. For the coming year, the following activities were proposed:

- The SWG should review port sampling data collection forms and data collection protocols.
- The SWG should review data collection forms and protocols used in the process to estimates catches of tuna.
- Port sampling of domestic tuna fleets should recommence as a matter of urgency, at the very least by concentrating effort on the main fishing port (i.e. General Santos City).
- An attempt should be made to identify key ports of tuna unloadings in the Philippines, other than General Santos City.
- The balance of port sampling data collected to 2002 should be processed by the end of 2003.

150. Activities in regards to Indonesia during the past year include an informal meeting between OFP and CSIRO scientists to discuss port sampling in Indonesia, with the expectation of future collaboration. An informal invitation had been extended to the OFP to visit the offices of the Directorate General of Capture Fisheries (DGCF) to get a better understanding of the information used to estimate catches; it is expected that the visit will take place in early 2004.

151. For the coming year, the following activities were proposed:

- The SWG should review port sampling data collection forms and data collection protocols. The forms that have been used in Indonesia in the past are similar to the original forms developed by the FAO/UNDP Indo-pacific Tuna Programme, which are also used in the Philippines, so this task could probably be done in conjunction with the Philippines port sampling forms. Note that this review does not include the data collection forms used in the CSIRO joint venture project.
- The SWG should review data collection forms and protocols used in the process to estimates catches of tuna.

- OFP staff should visit DGCF offices to compile information concerning the sources of data and procedures used to estimate catches.
- An attempt should be made to identify key ports of tuna unloadings in East Indonesia.
- Opportunities to commence port sampling in key ports of tuna unloadings in East Indonesia should be investigated.

4.5 Estimation of the Proportion of Bigeye and Yellowfin in Catches by Purse Seiners

Analysis of the proportion of bigeye in 'yellowfin plus bigeye'

152. Mr Tim Lawson presented SWG–6: *Analysis of the proportion of bigeye in 'yellowfin plus bigeye' caught by purse seiners in the WCPO based on observer data*. Catches of bigeye are usually recorded on catch and effort logsheets as yellowfin, since juvenile bigeye and yellowfin are difficult to distinguish. Species composition samples that are collected by port samplers and observers can be used to correct the bias introduced by the mis-identification of bigeye as yellowfin. In this study, observer data held by the OFP were used to examine the relationship between the proportion of bigeye in the combined catch of yellowfin and bigeye ('yellowfin plus bigeye') and several variables, including year (1998–2001), quarter (January-March, April-June, July-September, October-December), area (Bigeye Areas 2 and 3), flag (Japan, Korea, Taiwan, United States and all others combined), school association (drifting log, drifting FAD, and unassociated or feeding on baitfish) and size group (fish smaller and larger than 9 kg).

153. The results from analyses of variance indicate that school association is the variable most strongly related to the proportion of bigeye in yellowfin plus bigeye. The other variables are strongly or weakly related or unrelated, depending on the variables that are included in the model. The fact that statistical significance is unstable in this regard suggests that, if possible, sampling should be stratified on the basis of school association, year, flag and area. Quarter was neither strongly nor weakly related in any of the anovas; hence, stratifying by quarter may not be necessary. Size group is unrelated when school association is the first variable in the model, which suggests that if sampling is stratified by school association, then stratifying by size group may not be necessary.

154. On the basis of the analysis of observer data for 1998–2001, the proportions of bigeye in yellowfin plus bigeye that are caught in associated and unassociated sets are, on average, 23.7% and 0.7% respectively. Crone and Coan (2002)[1] estimated the species composition of the United States purse-seine catch during 1997–2001 using port sampling data collected by the National Marine Fisheries Service. Their results indicate that the proportions of bigeye in yellowfin plus bigeye for associated and

[1] Crone, P.R. and A.L. Coan, Jr. 2002. Sampling design and variability associated with estimates of species composition of tuna landings for the U.S. purse seine fishery in the central-western Pacific Ocean (1997–2001). Working Paper SWG–9. Fifteenth Meeting of the Standing Committee on Tuna and Billfish, 22–27 July 2002, Honolulu, Hawaii, United States of America. National Marine Fisheries Service, La Jolla, California, United States of America. 9 pp.

unassociated sets are, on average, 32.0% and 1.4% respectively. These results are considerably different from those based on port sampling data for the United States fleet for 1988–1995. The average values of the proportion for associated and unassociated sets, based on the port sampling data for 1988–1995, is 13.2% and 0.7% respectively.

155. The reason for the large difference in the average proportion of bigeye in yellowfin plus bigeye for associated sets, between 1988–1995 and 1996–2001, for the United States fleet, remains to be determined. It is possible that the difference is due to a change in environmental or biological factors that favoured an increase in bigeye, relative to yellowfin, in associated schools. However, it is doubtful that an environmental factor was directly involved, since the latter period, i.e. 1996–2001, includes both an El Niño event, during 1997–1998, and a La Niña event, during 1999–2001. On the other hand, the difference may well be related to the recruitment of bigeye, which, according to the MULTIFAN-CL assessment, increased during the mid-1990s from relatively stable levels. Changes in gear technology may also have been responsible, although deeper nets (which catch more bigeye) were adopted in the early 1990s, rather than in 1996 and subsequent years. Another possibility is that light boats, which aggregate baitfish that may attract bigeye to the surface, may have been introduced in 1996, in conjunction with the switch to FADs, although this cannot be confirmed with the information currently available. The difference might also be due to an improvement in the identification of bigeye by port samplers in 1996, when there were more sets on associated schools and bigeye were sampled more frequently, although there is no evidence to support this explanation.

156. It is important to determine the causes of the increase in the proportion of bigeye in yellowfin plus bigeye for associated schools, from 1988–1995 to 1996–2001, since this will affect how bigeye and yellowfin catch estimates are adjusted. In particular, it needs to be determined whether the port sampling data covering the United States fleet during 1988–1995 are representative of other fleets. If so, then port

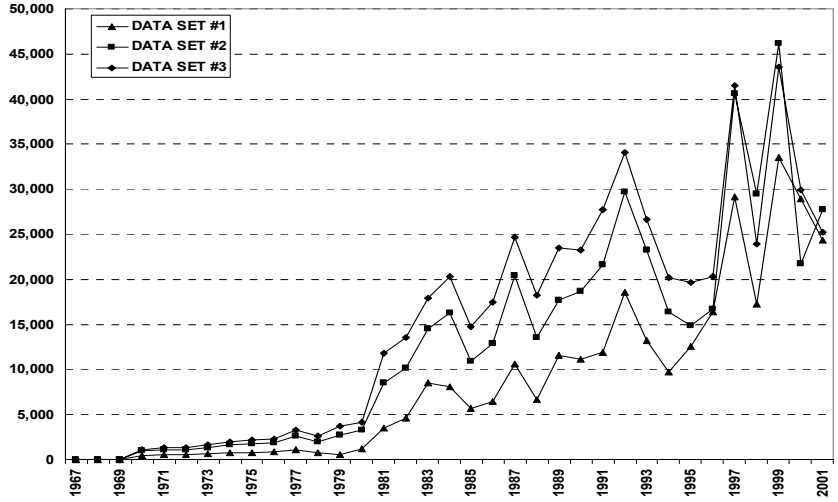


Figure 4.2. Estimates of bigeye catches (tonnes) in Areas 2 and 3. Data set #1 is based primarily on port sampling data for the United States fleet, 1988–1995. Data set #2 is based on an ANOVA of observer data for all fleets, 1998–2001, with all variables**.** Data set #3 is based on an ANOVA of observer data for all fleets, 1998–2001, with school association only.

sampling data for 1988–1995 can be used to adjust catch estimates for other fleets for those years. If not, then the observer data for 1998–2001 should be used. Alternative data sets that can be used as input data for the MULTIFAN-CL analysis were produced (Figure 4.2).

Accuracy of yellowfin and bigeye tuna species identification by American Samoa port samplers

157. Mr David Itano presented FTWG–1: *An assessment of the accuracy of yellowfin and bigeye tuna species identification by American Samoa port samplers*. Estimation of the accuracy of port samplers in discriminating between yellowfin and bigeye was accomplished during a week of sampling in Pago Pago. Given the vessels and fish available, Sampler A was verified on two 100 fish species composition dock sample, one 100 fish wet deck sample and 70 extra fish drawn for length-frequency samples on the dock and wet deck. Sampler B was verified on two 100 fish species composition samples on the dock, one 100 fish sample on the wet deck and 100 extra fish drawn for length frequency samples on the wet deck. The samplers used a variety of identifying characteristics and both were found to be 100% accurate in identifying yellowfin and bigeye of the sizes encountered; the smallest bigeye was 45 cm and the smallest yellowfin was 40 cm.

158. In conjunction with the sampling audit, materials were developed to assist in the training of observers and port samplers in tuna identification. A table of internal and external identifying characteristics of bigeye and yellowfin appended to FTWG–1 was augmented by a visual training aid: *A Handbook for the Identification of Yellowfin and Bigeye Tunas in Frozen Condition.* This guide was developed in MS Powerpoint format to facilitate its direct application to training situations. The handbook is particularly useful for training port samplers, as the digital colour images are of tuna that have been caught, frozen and unloaded from a WCPO purse seiner. The meeting recognized the utility of the handbook to SCTB member countries and strongly supported its timely release. Mr Itano noted that the work was completed under contract to NMFS, which will have to be contacted directly by parties interested in receiving a copy of the handbook.

159. The meeting noted that the Pago Pago samplers and the ID Handbook were based on yellowfin and bigeye of medium size, greater than 40–45 cm. It was recommended that the audit work and the ID Handbook be repeated and expanded to include an examination of smaller fish that are more difficult to identify. Institutionalized calibration of measuring devices and periodic audits were noted as simple ways to validate data quality by the program. Mr Itano also stated that the 100% accuracy of the Pago Pago port samplers should not be transposed to port sampling programmes throughout the region, which require their own audits and evaluation.

4.6 Other matters

Harmonisation of data standards for the WCPO and the EPO

16 0. Dr Michael Hinton discussed a resolution passed by the Inter-American Tropical Tuna Commission (IATTC) concerning the provision of data by IATTC members and its implications for the harmonisation of data standards for the WCPO

and the EPO. At its meeting of June 2003, the IATTC adopted a data provision resolution (IP INFO–3) that calls for the Director of the IATTC to set the technical aspects of information to be provided to the IATTC Secretariat by Parties to the Commission and by cooperating Parties.

161. For many years, the IATTC Secretariat has participated in the SCTB Statistics Working Group. Recognizing that (1) there are currently differences in some of the data collection standards considered minimum by the IATTC and the SCTB (e.g., the recording of the end of set time for a purse seine set, which is used by the IATTC in search time models of purse seine fishing effort, but which is not a minimum standard for SCTB); (2) that many the participants in fisheries in the WCPO and the EPO are the same, and that some will be members of both the IATTC and the anticipated WCPF Commission; and (3) wishing to minimize differences in the data requested while at the same time ensuring data requirements for fisheries are met, it is requested that the SCTB establish a formal contact with the head of the Statistics Department, Tuna/Billfish Section, of the IATTC with the objective of identifying differences in standards that are developed and established by the Director of the IATTC and standards that have been established by the SCTB, so that efforts may be made to develop and adopt, where possible, a single Pacific-wide data standard for collection of minimum statistics and information from fisheries directed at and harvesting tunas and tuna-like species.

162. The meeting agreed that this suggestion was useful and that the coordinator of the SWG should liaise with the head of the Statistics Department, Tuna/Billfish Section, of the IATTC in this regard.

4.7 SCTB16 Directives to the Statistics Working Group

163. The following list of directives to the Statistics Working Group was agreed to:

1. Conduct the following activities related to the establishment of standards for the design of national and regional observer programs:

    examine the relationship between observer coverage rates and the accuracy and reliability of estimators of catches and length frequencies for the offshore longline and purse-seine fleets operating in tropical waters (SPC); and

    review sampling protocols for the collection of species composition data and length data, and develop a proposal for standards for data collection forms (SPC).

2. Review the availability of data to estimate the annual catches of other highly migratory species covered by the WCPF Convention, and species of special interest (marine turtles, sea birds and marine mammals). (SPC)

4. Review the OFP vessel and gear attribute data and report summary information to the Fishing Technology Working Group at SCTB17. (SPC)

5. Review the tuna fishery data collection forms of Indonesia, the Philippines and, if possible, Vietnam. (SPC, DGCF, BFAR, BAS, Vietnam)

6. Review the data sources and the procedures used to estimate catches by the domestic fleets of Indonesia and the Philippines. (SPC, DGCF, BAS)

7. Develop project proposals and seek sources of funding to establish sampling programmes in the Pacific Ocean waters of Indonesia and to provide support for ongoing sampling programmes in the Philippines. (SPC, CSIRO, DGCF, BFAR)

8. Develop a proposal to harmonise data standards for the Western and Central Pacific Ocean and the Eastern Pacific Ocean. (SPC, IATTC)

9. Revise the format of the SCTB data summary working papers, with highlights of data gaps and improved graphical and tabular presentations of data availability.

10. Report estimates of annual catches in the WCPFC Area and consider modifying the WCPO Statistical Area established at SCTB12. (SPC)

164. Other directives to the Statistics Working Group are included in the workplans of the other working groups and research groups.

4.8 Summary statement

165. A summary statement on issues relating to the Statistics Working Group was drafted, circulated to participants and discussed. The agreed statement was incorporated in the Executive Summary (see page 4).

5. FISHING TECHNOLOGY WORKING GROUP (FTWG)

5.1 Introduction

166. The FTWG Coordinator Mr David Itano, serving as session chairman opened the meeting and presented the tentative agenda of the hour-long session. Due to the limited time, it was proposed that a brief summary of the Report of the FTWG – Preparatory Meeting would be followed by three selected presentations (FTWG-3, 4, 5) and a brief discussion on research coordination and planning. It was suggested to hold discussion to brief questions that may flag subjects for more extensive discussion later in the week. The proposed agenda was adopted.

5.2 Report of the Preparatory Meeting of the FTWG

167. Mr David Itano presented the summary of the Preparatory Meeting of the FTWG, held on 8 July 2003 as detailed in the Report of the Fishing Technology Working Group Preparatory Meeting (Appendix 6). Twenty-one research and industry related participants from a mix of PICTs and DWFNs were in attendance. Nine working papers were reviewed with seven presented and discussed during the meeting. Presentations and discussion centered on work that addressed the Task List to the FTWG for SCTB 16. The meeting remained informal and discussion oriented. The preparatory meeting covered the following issues as they related to specific tasks to the FTWG.

5.3 Summaries of National Fishery Reports relevant to FTWG

DWFN fleets

168. Mr Al Coan presented FTWG-2: *Updates (2003) of factors that may have affected U.S. purse seine catch rates in the central-western Pacific Ocean: an examination of fishing strategy and effective fishing effort*. This paper is an update of FTWG working papers presented to SCTB 14 and 15 with inclusion of data for 2002. Associated sets by the U.S. vessels peaked in 1999 when 94% of all sets were on floating objects, lead by drifting FAD sets. Since then, a general trend back to unassociated sets continued in 2002 when slightly more than half of all sets were unassociated. This trend away from FAD fishing was described as a market response to the low price of small skipjack and yellowfin that predominate in FAD and log sets.

169. This trend was mirrored by the Japanese and Taiwanese purse seine fleets while Korean purse seiners maintained their preference for setting on unassociated schools. The Korean fleet was unique in never relying heavily on log or drifting FAD sets, specializing in targeting unassociated schools of larger yellowfin and skipjack.

Palau Arrangement update

170. A brief summary of the status of the Palau Arrangement was provided by FTWG members and later enhanced and edited by Mr Joel Opnai of the FFA who could not attend the Preparatory meeting. This arrangement was established in 1992 and provided for the licensing and operation of up to 205 tuna purse seine vessels under multilateral, bilateral and domestic arrangements. Additional categories have been recently added of "New Bilateral Access" which provides for licensing of

vessels from China and the EU, and "Special Arrangements" which allows potential participation of 15 vessels from the EU, China, Philippines and additional domestic/locally based vessels. This category is a special allocation that will remain in force as long as the number of active U.S. vessels is below its maximum allocation of 40. As of April 2003, 25 U.S. vessels had reported allowing for 15 vessels under Special Arrangements. However, it is unclear what will happen to this category if the region proceeds to manage the fishery on allocations of vessel days. Parties to the Arrangement agreed in April 2003 to increase the number of allowed vessels to 206 to include an additional vessel under the bilateral domestic category. The implications to the region are that vessel numbers are not decreasing and may in fact be effectively increasing if adequate adjustment are not made for increasing efficiency and harvesting capacity within fleets.

PICT reports

171. Short reports on the current situation related to purse seine developments, longline operations and shoreside facilities were provided for the FSM, Solomon Islands, Fiji, New Caledonia, Australia and PNG. These reports are detailed in Appendix 6. Unfortunately, there was no representation from Kirbati and the Marshall Islands at the Preparatory Meeting. It was proposed to develop a more standardized format for these brief reports that would emphasize new developments in regional fisheries, expansion and contraction of localized effort, issues related to FADs and shoreside processing/support industries. For parties that can not attend the FTWG Preparatory Meeting, these parameters can be extracted from their National Fishery Reports to provide a more complete picture of fishery developments in the major tuna harvesting regions.

5.4 Historical development of WCPO tuna fisheries

Classification of gear and technology

172. Mr David Itano presented FTWG-3: *Documentation and classification of fishing gear and technology on board tuna purse seine vessels*. The paper documents technical gear and methods that have been or are in use by WCPO purse seine vessels throughout the history of the fishery. The paper details developments in purse seine nets, hauling gear, brailing systems, unloading systems, marine electronics and computerization of integrated searching/fishing systems. A variety of vessel types, deck equipment, FADs and electronic gear is described to assist in the training of regional observers. A list of gear items that the author felt were of particular importance to increasing effective effort in tuna purse seine vessels was described. These items have increased efficiency by significantly reducing the time involved in fishing operations, maximizing time at sea actually engaged in harvesting fish, reducing or eliminating search time and/or expanded the effective searching power of a single vessel. Of interest to the SCTB; items were chosen for which dates of introduction may be relatively easy to obtain to assist efforts to develop timelines of increasing fishing power by fleet. These items include but are certainly not limited to:

- Snap roller rings
- S Band Bird radar
- Spanish style brailing
- Floating wells for unloading
- GPS transmitting marker buoys for drifting FADs

- Use of FAD supply and tender vessels
- Subscription to satellite image services
- Low frequency long range sonar

173. Mr Itano indicated that illustrations in the paper were left at a high resolution to allow regional observer programs to utilize the graphics to produce training materials. Interested parties should contact the author directly for copies of the file as it is too large for electronic transmission other than via ftp protocols. The meeting strongly noted that similar documentation should be carried out for regional longline fleets and fisheries.

Timelines of gear utilization by fleet and data acquisition

174. Mr Peter Sharples described efforts to produce timelines of gear introductions to WCPO purse seine fleets, which was a specific directive from SCTB 15. Difficulties were encountered in sorting and extracting vessel attribute data from existing SPC and FFA sources. Observer data was noted as a possible means to better obtain necessary information, but most of this data is still not in an electronic, easily sorted format. He also noted that gear and vessel attribute data from observer programs is limited to a few fleets, notably the USMLT purse seine vessels.

175. Discussion centred on how and which gear and vessel attributes should be collected and for which fleets. The outcome of these discussions resulted in some specific tasks for presentation to SCTB 17 and a number of options for possible means to collect such data.

- Task 1 - Clean up and query and summarize FFA Regional Register data.
- Task 2 - Use existing observer data. Clean up and query SPC vessel and gear attribute database for PS-1 and LL-1 observer forms.
- Option a: obtain data via yearly vessel inspections in port by experienced observers or technical expert hired as consultant.
- Option b: require in port vessel inspection be a mandatory requirement of access arrangements.
- Option c: obtain gear and vessel attributes on a voluntary basis by vessels in port during unloading or provisioning visit.
- Option d: encourage countries to survey their own fleets.

176. It was agreed that the Group would not be able to solve these issues during the Preparatory Meeting and that a sub-group of the FTWG would address these issues inter-sessionally to be reported to SCTB 17.

5.5 Recent advances in gear technology and fishing methods for bycatch reduction177. Mr Steve Beverly presented FTWG-9: *Proposal for a deep setting technique for longline fishing to enhance target CPUE and to avoid certain bycatch species.* The paper describes a theoretical means to deploy longline gear to better target deep-swimming target species while reducing interaction rates with important

bycatch species such as seabirds, marine turtles, marlins and some shark species. It was hoped that trial applications of the gear may be reported to SCTB 17.

178. Mr David Itano presented FTWG-7*: Reducing the take of undersize tuna and bycatch in drifting FAD sets: project description*, on behalf of Dr Peter Nelson. The paper briefly describes an ongoing project to develop and evaluate efficacy of sorting grids to reduce bycatch of undersize target catch and finfish bycatch in associated purse seine sets.

5.6 Issues related to FADs

179. Mr Ludwig Kumoru presented FTWG-4*: Notes on the use of FADs in the PNG purse seine fishery*. He noted that the map symbols used in Figure 2 marking anchored FAD locations were used to differentiate different purse seine companies. Papua New Guinea (PNG) is one of the larger fisheries in the region with total purse-seine catch of around 180,000mt annually in recent years. There has been a general increase in FAD use since 1997 by the PNG based fleets. Over the last five years, 2/3 of all sets were on floating objects (30% anchored FADs, 9% drifting FADs and 25% logs). Anchored FADs are deployed mostly by Philippine and domestic fleets. Most are deployed within the Bismarck Sea (archipelagic waters) and areas to the north, assisted by carriers, tenders and support vessels. The total estimated number currently deployed (active FADs) is over 700, though the accuracy of this estimate is not known.

180. Catches from FADs are monitored by observers and port sampling. Observer data suggest a very high percentage of yellowfin + bigeye in FAD (and log) and sets by Philippines and domestic vessels (>60%) and this proportion may be higher in 2002 (most recent data).

181. A FAD Management Policy was introduced this year to govern the use of FADs in PNG waters. The policy provides for:

- Application to anchored FADs only
- Approval needed to deploy
- Limits on anchored FAD numbers in the EEZ (total 1,000) and per catcher vessel (30-40).
- Standardized design, marking and location requirements
- Closed areas and outside 12 miles of land or island except for artisanal and game fishing FADs
- Monitoring and reporting requirements (quarterly)
- Restriction on number of support vessels (3)
- Attempts to minimize gear conflict, especially with longline gear

The policy has been implemented though its effectiveness has yet to be assessed.

182. The Chair noted that there was several research initiatives currently taking place related to the dynamics of tuna aggregation specific to FADs that may be of interest to the PNG situation, such as studies taking place in the Indian Ocean and Hawaii as detailed in the Preparatory Meeting report.

183. Mr Al Coan presented FTWG-5*: Fishery-related attributes associated with FAD and log fishing practices conducted by the U.S. purse seine fleet in the central-*

western Pacific Ocean, 1997-2002. The paper describes a preliminary comparison of purse seine catch characteristics between natural log and man-made drifting FAD sets. Parameters such as nominal catch per set, proportion of bigeye in sets and proportion of small fish (<7.5 lbs) between log and FAD sets were compared. There was some tendency for log sets independent of FAD sets to predominate west of 160°E and FAD sets to be more common independent of log sets to the east of 160°E. For the most part, statistical differences in catch parameters between log and FAD sets were not observed in this study. However, this result may have been confounded by very low reported numbers of log sets in 1999-2001. It was also suggested that the study results could be compromised by mis-reporting of school association types. For example, the difference between a log and FAD becomes quite confused when natural logs are tied together or are enhanced with corks, bamboo flotation and netting. It is unclear if fishermen are reporting logs as FADs or vice versa. It was suggested that observer data and reports and interaction with vessel owners/operators may assist in clarifying these issues. Further study along these lines was suggested.

184. In response to a query from the meeting, Mr Coan noted that comparisons between log and FAD occurrence by 1° square (Figures 3-5 in *FTWG-5*) would designate that "log fishing" or "FAD fishing" had occurred in that square if a single incidence of that association type had been recorded during the year. It was suggested that the data be re-examined using some scaling of the degree of log and FAD use in each area. Mr Coan stated that he would re-examine the data and expand the temporal and spatial scope of the study if possible for presentation to SCTB 17.

185. Dr Don Bromhead made a presentation on the recently completed report *A review of the impact of fish aggregating devices (FADs) on tuna fisheries* (Bromhead, Fister, Attard, Findlay, and Kalish), and provided copies on CD to members of the group. The review contains a great deal of FAD related information including: the biology and ecology of tunas on FADs, fisheries management issues, impacts of FADs on fisheries, and potential impacts to the Australian longline fishery for bigeye tuna. It was noted the work contains a very useful list of FAD related references.

5.7 Training materials and issues specific to the discrimination of bigeye in mixed landings

186. Mr Steve Beverly presented the first printing of the SPC Horizontal Longline Manual – Methods and Techniques, providing copies for final review. The Group noted the high quality and detail of the work and thanked SPC for their excellent technical contributions to the region.

187. Mr David Itano presented an overview of the document *A Handbook for the Identification of Yellowfin and Bigeye Tunas in Frozen Condition*, which was a byproduct of an audit performed on the port sampling program in Pago Pago for purse seine landings as reported in FTWG-1. The handbook details internal and external characteristics of yellowfin and bigeye of different size classes with colour images of frozen fish as they would appear to port samplers throughout the region. The Group recognized the utility of this manual toward species specific reporting of purse seine landings and supported further work along these lines. It was suggested that the handbook could be improved by the addition of colour photographs of very small

yellowfin and bigeye tuna (<35 cm) that could be obtained from PNG port sampling programs.

5.8 Regional Management and Industry Initiatives

188. Mr David Itano presented FTWG-8: *Review of the activities of the World Tuna Purse-Seine Organization (June 2002- June 2003)* on behalf of the author, Mr Julio Morón. The paper provided an update of similar working papers submitted to SCTB 14 and 15 on FTWG activities and goals to rationalize world stocks and prices for purse seine grade raw materials and to control capacity and IUU fishing in all major tuna fisheries worldwide.

189. Mr David Itano presented FTWG-6*: Managing fishing capacity of the world tuna fleet [Executive Summary of FAO Fisheries Circular. No. 982]*. This paper was actually the Abstract and Executive Summary of a paper developed for the FAO and reproduced in summary form for the SCTB with the permission of the author, Dr James Joseph. The study examined issues related to the implementation of limits on harvesting capacity in worldwide tuna fisheries and introduced one means to measure overcapacity in individual fleets. The FTWG tabled the document primarily to serve as a background document to harvesting capacity issues scheduled for discussion during a special plenary session of SCTB 16.

5.9 Research Coordination and Planning

190. The format of the FTWG plenary session was proposed and adopted. The subject of how to collect vessel and gear attributes and which attributes to collect was revisited. It was agreed that these problems could not be adequately addressed during the Preparatory Meeting. Mr Itano agreed to coordinate an intercessional working group to address these issues for reporting to SCTB 17.

191. A draft Task List to the FTWG was developed during SCTB 16 and circulated for comments. Due to time constraints during the plenary session, the FTWG Coordinator suggested that the Task List for SCTB 17 be finalized inter-sessionally via email. After consideration, the following FTWG Task List was developed for SCTB 17.

1. Synthesis of regional information relevant to the FTWG

a. Standardize format of PICT and DWFN reports for reporting to SCTB 17 (FTWG Coordinator, SPC, FFA)
b. All SCTB representatives of PICT with industrial scale tuna fishing activity produce brief reports in line with standardized FTWG format, including information on large-scale anchored FAD arrays (FTWG members).
c Standardize and produce brief annual update of regional purse seine activity noting expansion and contraction of effort by area and fleet (FFA, SPC, NMFS, FTWG Coordinator)

2. Tasks related to the collection of vessel and gear attributes

a. Propose and develop list of gear and vessel attributes to collect useful to SCTB mandate and propose means to collect this information (Coordinator to organize inter-sessional sub-group of FTWG)

b. Review and summarise vessel and gear attribute data held by SPC and FFA (SPC, FFA)
c. Propose and develop forms for national research organizations to collect gear and vessel attributes from their fleets (SPC, FFA, FTWG Coordinator)
d. Promote and conduct studies to quantify increasing efficiency in regional tuna fisheries (All SCTB)

3. Documentation and classification of fishing gears and practices of major DWFN and PICT fleets

a. FTWG members to develop timelines of industrial tuna fishing activity to document fisheries development and introduction of new gear, technology and shifts in fishing modes up to current situation (All FTWG)
b. Rate vessel production, or average purse seine landings per vessel/year and fleet over the past 20-year period. (SPC, FFA)
c. Report on new developments and current status of purse seine technology and fishing practices for major WCPO fleets (SPC, FFA, regional and national observer programs, DWFN agencies)
d. Update performance factors in U.S. WCPO purse seine vessels (NMFS, FTWG Coordinator)
e. Document the development, gear and current status of longline technology and fishing practices for major WCPO longline fleets in a well illustrated format (SPC, FFA, regional and national observer programs, PICT and DWFN agencies)

4. Application of gear technology to bycatch reduction

a. Summarize technology related projects and proposals to mitigate bycatch levels in longline and purse seine fisheries (SPC, WESPAC, AFMA , IATTC, NMFS/PIRO)
b. Report on current initiatives to mitigate purse seine and longline bycatch and improve targeting through the application of new technology (All FTWG)

5. Issues related to FADs

a. Document the development, designs, related gear and utilization of anchored and drifting FADs used by WCPO purse seine fleets (SPC, FFA, regional and national observer programs)
b. Investigate and compare catch parameters between log and drifting FAD purse seine sets and catches (NMFS[2], SPC, NFA, NORMA)

6. Efforts to improve accurate species reporting in mixed yellowfin/bigeye landings

a. Expand existing training materials for bigeye and yellowfin identification to include small fish less than 40 cm FL (SPC, FFA, regional and national observer programs, DWFN agencies)
b. Conduct regular training and audits of port sampling and observer programs to promote accurate species identification and recording procedures (SPC, FFA, NFA, NORMA, MIMRA, NMFS, NFRDI, NRIFSF, OFDC)

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[2] Expansion of timeline and geographical extent of the study presented at SCTB 16, *FTWG-5 Fishery-related attributes associated with FAD and log fishing practices conducted by the U.S. purse seine fleet in the central-western Pacific Ocean, 1997-2002*.

7. Links to industry, management and harvest capacity issues

a. Maintain contact with and report on commercial tuna fishing associations and industry related organizations (FFA, WTPO, ECTBOA)
b. Update of FFA initiatives on the Palau Arrangement and Bigeye management as relevant to fishing technology issues (FFA, SPC)
c. Report on status of harvest capacity issues in world tuna fisheries and issues specific to WCPO (FFA, FAO, IATTC, SPC)
d. Conduct studies to estimate methods to quantify, categorize and define "harvesting capacity" of WCPO vessels and fleets appropriate to SCTB and FTWG Terms of Reference (All SCTB)

5.10 Summary statement

192. A summary statement on issues relating to fishing technology in the WCPO was drafted, circulated to participants and discussed. The agreed statement was incorporated in the Executive Summary (see page 34).

6. METHODS WORKING GROUP (MWG)

193. The MWG was convened during the SCTB plenary on both the 10th and 14th July. Each session was chaired by Dr John Sibert.

6.1 Report of the Preparatory Meeting of the MWG

194. Dr Sibert presented a summary of the preparatory meeting of the MWG held on 7th and 8th July (see Appendix 7).

195. It was queried whether the simulation study had identified a parsimonious scenario where further model complexity no longer improved a particular assessment approach. It was acknowledged that the analysis had not yet proceeded far enough to comment at this stage; however such results are expected at SCTB17.

6.2 Contributed Papers

196. Dr Michael Hinton presented MWG-7: *Methods for standardizing CPUE and how to select among them*. The objectives of the research were to review different methods used to standardise CPUE, describe methods to test for differences among them, and to provide an initial guide to future research into standardising CPUE and to developing indices for specific applications. Standardisation methods used included general linear models, non-linear models (general additive, neural networks, regression trees, integrated standardisation + dynamics), and habitat-based models (deterministic, statistical (statHBS)). Model selection testing used likelihood-based approaches (AIC, BIC, Bayes factors), cross validation, and system-based approaches (with ancillary data incorporated). Model selection for immediate needs is driven by needs of management and conservation, supported by current data available. In meeting future application requirements it is not sufficient to say that what has functioned in the past will continue to suffice for the future.

197. Future application requirements include:

- determine best performing current models;
- develop tests appropriate to select best index of relative abundance from candidate methods;
- determine data holdings and deficiencies;
- define data for collection in future to ensure value of long term series; and
- explore new methods for standardization to anticipate the needs of managers and fishers' response.

198. The MWG noted that CPUE standardisation is a critical issue as we rely on CPUE indices as an index of tuna abundance in the WCPO. Tools for choosing between standardisation methods are useful, but do not improve the quality of the indices. In a general sense, the reliance on the CPUE index still means we are 'standing on soft ground'. It was suggested that tagging estimates of exploitation rates could be used to verify the CPUE indices. MFCL already includes tag data so such an analysis does not seem necessary.

199. It was noted that the diagnostics produced by MFCL might usefully inform future CPUE standardisation work. It was queried whether the authors had considered the balance between data incorporated into the model and the data reserved for consistency checks in the cross-validation process, or whether it would be better to fully integrate the data. Dr Hinton noted that with recent developments in cross-validation, the balance between data incorporated into the model and the data reserved had been addressed. It was also queried whether it was possible to incorporate the effort standardisation into the overall population dynamics models in complex assessments (MFCL, A-SCALA), or was only possible in simpler population dynamics models.

200. It was noted that to do so may be possible, but both models are computationally demanding and it is unknown if the computational demands would be larger than the sum of the demands from the components. The system-based approach to model testing was described: the effort series are put into MFCL or A-SCALA and the total likelihoods (including the data from the CPUE standardization and those of the stock assessment model e.g. length-frequency) compared. This test determines how consistent the effort series is with the population dynamics assumptions and the other data used in the stock assessment. The system-based test is similar to integrating the CPUE standardization into the stock assessment model.

6.3 Future Research Plan

201. The MWG met in plenary session on July 14 to revisit stock assessment issues, refine its tasks for SCTB 17, and formulate some general recommendations for stock assessment. Based on the discussion, the following list of tasks and recommendations for SCTB 17 were agreed:

Tasks

1. Complete simulation analysis
2. Review 2004 OFP bigeye assessment:
    a. convene hands-on intercessional meeting of a subset of MWG participants in Noumea prior to SCTB 17 to promote a greater degree of iterative improvements,
    b. examine both WCPO and Pacific-wide assessments for inter-regional consistency.
3. Conduct additional simulations of bigeye fisheries to investigate:
    a. recruitment artifacts,
    b. effort standardization errors,
    c. sensitivity of estimates of recruitment and natural mortality at age to tagging data.
4. Evaluate utility of current suite of reference points noting planned IATTC meeting on this topic.
5. Further investigation of effort standardization, especially for BET & YFT by:
    a. inclusion of additional variables,
    b. and exploring sub-regional stratification.

Recommendations

6. Recommended future enhancements to MULTIFAN-CL:
   a. sex structure in model and data,
   b. fitting to age data, and
   c. simultaneous assessment of multiple species.
7. Recommended improvements to current MULTIFAN-CL analyses:
   a. include Japanese longline bigeye size composition data prior to 1965,
   b. include Philippines species and size composition data, and
   c. include improved estimates of Indonesian catch data and explore model sensitivity to these data.
8. Document statistical habitat-based effort standardisation methods.
9. General recommendations related to stock assessments:
   a. WCPO participation in ICCAT methods comparison of BET assessments,
   b. encouraged by preliminary work on development of multi-species models that include potential ecosystem effects of species interactions recommends further work in this area, and
   c. develop standards for and implement an archival tag data repository.
10. Reducing uncertainty in regional assessments:
    a. large-scale tagging studies, and
    b. improved data collection from Indonesia and the Philippines.

6.4 Summary statement

202. A summary statement on issues relating to the Methods Working Group was drafted, circulated to participants and discussed. The agreed statement was incorporated in the Executive Summary (see page 35).

7. YELLOWFIN RESEARCH GROUP (YRG)

203. The coordinator, Dr Robert Campbell, led the session of the Yellowfin Research Group.

7.1 Regional Overview and Developments

204. Dr Campbell provided an overview of the WCPO yellowfin tuna fisheries (YFT-2). Yellowfin tuna are harvested with a diverse range of gear types, from small-scale artisanal fisheries in Pacific Island and southeast Asian waters to large 'distant-water' longliners and purse seiners that operate widely in equatorial/tropical waters. Purse seiners take a wide size range of yellowfin, whereas the longline fishery takes mostly adult fish.

205. The 2002 catch for all gears in the WCPO (437,984 mt) was the lowest since 1996, and almost on par with the EPO catch (427,664 mt) for 2002. The relatively low catch of yellowfin in the WCPO during 2002 is considered unusual for an El Nino event. The 2002 Pacific-wide yellowfin catch (all gears) of 865,648 mt was slightly down on the record catch of 2001 (884,514 mt).

206. In the WCPO, purse seine typically harvests the majority of the yellowfin catch, which for 2002 was 171,767 mt (or 39% of the total yellowfin catch). This catch level was the lowest since 1996 and the second lowest annual catch over the past decade. In contrast, the eastern Pacific (EPO) purse seine catch of yellowfin (417,472 mt) for 2002 was an all-time record and continued on from the good catches experienced during 2001.

207. During 2001, the WCPO yellowfin purse seine CPUE increased in line with the weakening of La Niña. However, yellowfin purse seine CPUE for all set types declined in 2002 compared to 2001, for all but the US fleet. The US purse seine fleet effort for 2002 was concentrated more eastwards than the other purse seine fleets into an area where oceanographic conditions may have improved the availability of yellowfin to the gear. The 2002 effort by the other purse seine fleets does not appear to have extended as far east as in the previous El Nino event (1997–1998) and could therefore explain the poor yellowfin catch rates for these fleets during 2002.

208. The WCPO longline catch in recent years (53,000–80,000 mt) is well below catches in the late 1970s to early 1980s (90,000–120,000 mt), presumably related to changes in targeting practices by some of the large fleets and the gradual reduction in the number of distant-water vessels. The 1999 yellowfin catch of 60,414 mt was the lowest for nearly 25 years, but catches have been progressively higher in more recent years. The 2002 catch was 77,177 mt, or 18% of the catch for all gears.

7.2 Biological research

209. Dr Chi-Lu Sun presented YFT-5: *Estimation of growth parameters and age composition for yellowfin tuna*. Length-frequency data of the yellowfin tuna caught by the Taiwanese offshore longline vessels was collected monthly at Tungkang fish market between September 2001 and October 2002. These samples were used to

estimate the von Bertalanffy growth parameters and the mean length at age for yellowfin tuna by the length-based MULTIFAN method. Twenty-four cases were considered and the best match was found in the case when April was set as month 1, the sample number was merged to 12 by month and 3 cm was selected for length interval. In this case, the von Bertalanffy growth parameters were estimated as growth coefficient K = 0.392 yr^{-1}, asymptotic fork length FL_∞ = 175.0 cm, and theoretical age at zero length t_0 = 0.00306 yr. Six age classes were identified and mean length at age was L_1 = 56.16 cm, L_2 = 95.00 cm, L_3 = 120.95 cm, L_4 = 138.48 cm, L_5 = 150.32 cm, and L_6 = 158.32 cm. The estimated longevity (t_{max}) was 7.65 years.

210. Dr Naozumi Miyabe presented RG-4: *Report of the ongoing tagging project on tropical tunas around Japan*. This project has been conducted by the Fisheries Agency of Japan since 1999. The objectives of this project are to provide information on movement (both on large and local scales), local exploitation, utilization by gears, other biological parameters such as growth, and to provide movement information for the Multifan-CL stock assessment model. Up to the end of 2002, 981 bigeye and 3581 yellowfin tuna, mainly small fish, had been tagged and released in the south-western part of Japan (24-30°N, 123-130°E), and 141 bigeye (14.4%) and 295 yellowfin (8.2%) had been recaptured. Fish were usually recovered within a short time and distance, especially for bigeye. The movement was limited and most movements were north-eastward. Movement appeared to be influenced by the strong Kuroshio Current. Yellowfin showed a slightly higher level of movement than bigeye. However, no large-scale movements were observed except for 3 yellowfin that were recovered in the coastal waters of the Philippines. Archival tagging was also conducted. Of 51 bigeye and 47 yellowfin tuna tagged, 9 bigeye and 4 yellowfin were recaptured. Data could be successfully downloaded from 8 bigeye and 2 yellowfin. Some archival tag data indicated a typical diurnal pattern; with fish staying deeper during the day and shallower at night. However, fish recovered around the FAD mostly did not show this pattern and tended to stay in shallower waters all day long. This project will be continued and more detailed analyses are scheduled in the near future.

211. In response to a query about the variation in recovery reporting rates over time Dr Miyabe explained that the high catch rates in the first year were associated with incentives to report (i.e. posters with rewards). Additionally, the influence of the Kuroshio Current implies variation in residence time depending on the time of year. Dr Miyabe also noted that that different movement rates between yellowfin and bigeye tunas could not be fully explained, but it was hypothesised that there could be differences in the nature of each species' association with FADs. Bigeye tuna tend to stay longer than yellowfin tuna on FADs, and if they move, it is only to a nearer FAD.

212. The Chair of the YRG commented on the value of tagging information, particularly that obtained from archival tags from a range of areas as it provides input into habitat-based models.

213. Ms Danielle Williams presented YFT-6: *Data derived from the gamefish fishery and its utility in assessing the size composition and movement of yellowfin tuna in eastern Australian waters.* This study used recreational-based yellowfin tuna tag and release data from the NSW Fisheries Gamefish Tagging Program and actual capture data from Australian gamefishing club annual reports (1959-2001) to explore spatial and temporal variations in the occurrences, size composition and movement patterns of

yellowfin tuna off eastern Australia. Using recapture data and tracing modal weights through time, there was strong evidence that yellowfin tuna stayed within a near-coastal band along eastern Australia. Yellowfin tuna recapture data indicated a far greater percentage of coastal associated movements compared with offshore associated movements. Long distance movements were rare with only 14 out of 504 recorded distances moved by tagged fish being greater than 1000 nautical miles. Numbers of yellowfin tuna captured or tagged by the gamefish fishery were variable on an inter-annual basis, almost certainly reflecting true changes in actual abundance. However, in the absence of fishing effort data, this study was unable to provide evidence of a decline in the abundance of yellowfin tuna. However, it did provide a strong direct indication of a long-term decline in the size composition of the recreational catch in southeastern Australian waters. This was mainly attributed to a marked reduction in the presence of large, adult fish. Data derived from the recreational gamefish sector was shown to be a valuable additional source of information to assess the variability in a fishery. More recently, with the introduction of the NSW Fisheries Gamefish Tournament Monitoring Program, dependable effort indices derived from the Australian gamefishing sector provide the required resolution to test trends concerning shifts in the size related seasonal and spatial shifts indicated by catch data.

214. The recreational weight-frequency data has not been compared with commercial data; however, Ms Williams felt that this is an important task that would provide more conclusive information. In response to a query as to whether there may be a resident and / or a migratory component to the yellowfin resource off eastern Australia Ms Williams stated that while this may be the case, she would consider most of the stock to be resident, and suggested that La Nina events may result in differential recruitment from outside the ETBF. However, interpretation is complicated by differences in tag reporting rates onshore versus offshore.

215. The Chair commented that it was good to see the use of recreational data in research, and that the results complemented those of Drs Sibert and Hampton presented to SCTB-15 and previous paper by Dr Miyabe that lifetime movement patterns may not be extensive. Dr Campbell emphasised that it must be borne in mind that a large proportion of the stock may not exhibit much movement, despite the relatively few large scale movements that have possibly skewed the general perception.

216. The Chair gave the floor the opportunity to inform the WG of other work being done on issues related to biological research. Dr John Hamption informed the meeting of the tagging program recently commenced by the SPC, featuring archival and pop-up tagging of bigeye tuna. He mentioned that pop-up tags had been placed on yellowfin tuna in Papua New Guinea. One of these tags popped up after 10 days, but the second recently popped up after 3 months at sea. This tag will hopefully provide good information on habitat usage in the equatorial region, but it is yet to be analysed.

7.3 Stock assessment

217. Dr John Hampton presented the yellowfin component of RG-2, a GLM-based analysis of Japanese longline catch and effort for yellowfin and bigeye tuna. Data were aggregated by year, month, five-degree square and hooks-between-floats (HBF)

category. Independent analyses using a common model structure were carried out for each of the five MULTIFAN-CL model areas. The final model structure predicted catch as a function of effort, year and a series of interaction terms involving month, latitude, longitude, and HBF. The fitted models accounted for a high proportion of the variance in catch, most of which was attributable to variation in effort. The parameterisation of the various factors was broadly consistent with our understanding of the fishery, with the exception of the relationship between catch and HBF, which showed opposite to expected trends (i.e. increasing catch rate with increasing HBF) in some strata. Standardised CPUE was generally similar to nominal CPUE, and showed variable trends among the five areas. The highest declines in CPUE were observed in the 1950s in regions 4 and 5, although these indices were associated with wide confidence intervals due to the small number of observations. The explanatory power and precision of the estimates may be improved with higher spatial resolution data and by incorporating the catch of other species.

218. The difference in the results from the Habitat-Based Model (HBS) and the GLM were queried. It was suggested that effects may differ from area to area because the GLM does not include environmental factors whereas the HBM does. Dr Hampton agreed and suggested that the GLM and statHBS techniques should be integrated, as the latter can incorporate categorical variables.

219. The Chair noted that the R^2 value was high at 70-80%. He also questioned whether 1-degree spatial data should be used to improve the results as fine-scale oceanographic features often associated with targeting practices are no readily captured at the 5-degree scale used in the current analyses. Dr Campbell also commented that the lack of a pattern of declining YFT catch rate with a higher HBF was surprising. It was explained that the high R^2 value was largely explained by the number of hooks (i.e. effort), which (unlike most GLM CPUE standardisations) was set as a predictor with catch as the dependent variable.

220. Mr Keith Bigelow presented the yellowfin component of RG-3: *Comparison of deterministic and statistical habitat-based models to estimate effective longline effort and standardized CPUE for WCPO yellowfin and bigeye tuna*. He explained that habitat-based standardization (HBS) models have been applied to estimate effective longline effort and standardized CPUE for various pelagic species in the Pacific. A statistical HBS (statHBS) was developed that allows parameter (e.g. habitat preferences, factors modifying the behavior of the gear or species) estimation based on fitting the model to observed catch and effort data.

221. A comparison was conducted of three effort series 1) nominal, 2) HBS and 3) statHBS to ascertain which series better explains variation in Japanese longline catch for yellowfin tuna in the WCPO. The order of best to poorest fit of the variation in catch was: 1) statHBS based on ambient temperature, 2) statHBS based on isotherms, 3) nominal effort and 4) HBS. Fitted ambient temperature preferences from the statHBS were typically from 23–27°C in the WCPO with slightly cooler preference values in the EPO due to catches in the equatorial cold tongue. These temperatures were indicative of yellowfin preferences within 10° of the equator where most of the catch occurred. Comparison of year effects between models showed moderate differences in standardized CPUE trends. The year effects were relatively flat for nominal effort, but year effects for HBS and statHBS (ambient) increased from 1975

to the early 1990's, reached a peak in 1995 and declined thereafter. Year effects were relatively similar for the HBS and statHBS from 1975 to 1990, but statHBS had lower standardized CPUE in the 1990s. Estimates of effective longline effort were also produced for the MULTIFAN-CL assessment.

222. In response to the question of how the targeting of different species was accounted for in the study, it was explained that gear configuration could be determined from effort data recored in logbooks. The accuracy of the gear depth estimation of the hooks was also questioned. It was explained that the Japanese have some simultaneous observations of longline gear configuration and oceanography, and the HBS shoaling estimates were derived from these observations plus catenary geometry assumptions and oceanographic data. However, it was pointed out that the amount of data available for investigating the effects of currents on the fishing gear is limited.

223. Dr John Hampton presented the MULTIFAN-CL assessment of yellowfin tuna in the WCPO referring to YFT-1. He explained that the structure of the model and data was similar to that used in previous years. The main changes in the model from the 2002 assessment included extension of the number of age classes (quarterly) to 28 and definition of separate fisheries for the Chinese/Taiwanese longline fleets operating in regions 2 and 3. Additionally, the assessment considered four different standardized longline effort series for each of the main longline fisheries operating in each region. The main findings of the assessment were as follows:

- Apart from several high recruitment years in the 1950s, recruitment was fairly stable over time. For the HBS analysis, recruitment was lower prior to the mid-1970s, and remained relatively high during the 1980s and 1990s. This is similar to the pattern obtained in the 2002 assessment, which also used HBS effort estimates. However, the slight decline in recruitment from the early 1990s noted in the 2002 assessment is not apparent in the HBS recruitment estimates in this year's assessment.
- There is an overall declining trend in total biomass over time in most of the analyses. This decline occurs in all regions except region 1, in which biomass declined up to the late 1970s, and then increased. The HBS analysis showed a different biomass pattern, declining until the mid-1970s, increasing until the late 1980s, and declining slightly thereafter. The differences among the four analyses occur mainly prior to 1980; thereafter both the trends and absolute estimates are very similar.
- Fishing mortality for adult and juvenile yellowfin tuna is estimated to have increased continuously since the beginning of industrial tuna fishing.
- Biomass depletion by the fisheries has increased steadily over time, reaching a recent level of 0.65–0.80 of the initial unexploited biomass. This represents a moderate level of stock-wide depletion that would be well within the equivalent equilibrium-based limit reference point (the ratio of biomass at MSY to equilibrium unexploited biomass was estimated at 0.37–0.40). However, depletion is somewhat greater for some individual model regions, notably the equatorial regions 2 and 3 where recent depletion levels are approximately 0.50. Other regions are much less depleted, with indices of 0.90 or greater for regions 1 and 4, and around 0.75 for region 5.

- The attribution of depletion to various fisheries or groups of fisheries indicates that the Indonesian fishery has the greatest impact, particularly in its home region (2). The purse seine fishery also has high impact in the tropical regions. It is notable that the composite longline fishery is responsible for biomass depletion of <5% in each region.
- The current level of fishing mortality is considerably less than that required to produce MSY. However, some of the analyses indicated that the potential to increase long-term yields may be as little as 9% at the current pattern of age-specific selectivity. Biomass-based reference points indicate that the long-term average biomass should remain above that capable of producing MSY. This apparently healthy situation arises mainly from low levels of exploitation in sub-equatorial regions of the WCPO.

224. In the discussion an enquiry was made as to the difference in recruitment and biomass trends between this and last year's models. Dr Hampton explained that while last year's MSY values fell within this year's range of values, different oceanographic data was used this year to generate the HBS effort series, and the model now extends back to 1952. In response to a query as to which of the CPUE indices gave the best fit, it was noted that the statHBS was best followed by the two GLMs.

225. In response to a query about the sensitivity to assumed steepness it was pointed out that this does not currently affect the model because the stock is still in the area where the stock-recruitment curve is flat. Steepness only becomes important when the stock is driven down to lower levels. Howver, sensitivity analysis undertaken two years ago showed that the yield component of the model was sensitive to the assumed steepness.

226. In addressing how data uncertainties are taken into account, it was explained that the model downweights small sample sizes and uncertain data (e.g. Indonesian and Philippines fishery data). However, the model is conditioned on total catch and thus assumes that the total catch is correct. Sensitivity analysis should be undertaken here, particularly on the Indonesian and Philippines catch data. It is possible that alternative catches would change the impact in region 2 (Figure 19). The desired result would be a smaller impact if catches are smaller. However, recruitment maybe a confounding factor, since the model may adjust recruitment to account for catch.

227. Regarding the varying levels of catch and impact, it was highlighted that regions 1, 4 and 5 are almost isolated from the main fishery. The model was conditioned on movement assumptions, but since the tag data does not provide an even coverage, these assumptions could be inaccurate, and hence this results in considerable uncertainty. It was pointed out that the impact of fishing in different areas needs to be considered in the context of the spatial distribution of depletions. That is, the spatial distributions of depletions could be incorrect because of movement parameterisation constraints. The same declines could occur in the lower biomass areas 1, 4 and 5 but are not seen because there is little movement to these areas. It was agreed that there are strong regional differences, and that management will ultimately need to consider spatial heterogeneity. However, the CPUE trends in individual regions support the different regional depletion estimates. Even when other movement inputs were trialled, the regional differences were still observed, so the issue was thought to more related to regional effects than to assumptions about movement.

228. It was explained that Taiwan and China were considered as a separate fishery because of the difference in day versus night sets, and because these fleets showed different catch-at-size patterns to the other fleets and the model did not assume a constant catchability among fleets.

229. Figure 18 from YFT-1 showed a pattern of increasing fishing mortality. Additionally, Figure 20a showed a rapid decline in biomass in recent years, indicating a rapid approach to the MSY. It was stated that we should be precautionary if fishing mortality keeps increasing over the next few years. The MSY should be seen as a limit reference point that may soon be exceeded. It was agreed that although the fishery is approaching B(MSY) the current total level of fishing mortality seemed sustainable, but that this may not be the situation in particular regions of the fishery such as in region 2 which includes the Philippines and Indonesia.

230. Noting that there has been a change in FAD use over the past 10 years, it was questioned as to whether the fishing mortalities in Figure 21 of YFT-1 could be decomposed by the different fisheries to see where potential problems (ie. high fishing mortalities) may lay. It was explained that while this could be done, it renders the fishing mortalities harder to interpret because they are age-specific, and an average across ages would have to be taken, which presents its own difficulties. It was stated that Figure 21 is a good way to integrate and concisely present the results.

231. The Chair turned the discussion to possible improvements in the MULTIFAN assessment. Dr Campbell commended the use of the 4 different standardisation indices in this year's assessment but stated that given the different outcomes a key question which needed to be addressed was which index is more credible. While the StatHBS index gave a slightly better fit to the data (and is preferable to HBS), there is little other evidence to determine which index is more accurate. The assumption of constant catchability for the longline fleet was also questionable. It was acknowledged that technological advances for the purse seine fleet have been investigated (eg. FTWG-3) but it was suggested that the technology working group could focus on improvements in the longline fleet. The coordinator of the FTWG, David Itano, agreed that investigating longline technology would be a priority for the next year, but stressed that cooperation between agencies is required in order to compile the required data and knowledge. The Chair stated that it would also be good to standardise the Chinese/Taiwanese effort data, and also to obtain a better conversion of processed to whole weight.

232. In addressing areas in which the assessment could be improved, Dr John Sibert outlined some suggested improvements based on discussions from the MWG. These included the need for area-specific habitat parameters to be incorporated in the statHBS effort standardisation and that variation in the MULTIFAN _CL longline catchability should be allowed, without sacrificing between-area biomass. It was noted that incorporating these modifications in the assessment could produce quite different results. However, it was pointed out that the MULTIFAN_CL assessment model is still in an evaluation stage, and as such, emphasis should not be placed on any one particular result.

233. In reponse to a query about whether retrospective analyses could be performed, Dr Hampton explained that this was undertaken as part of the yellowfin assessment last year, and that the results indicated that the estimation of biomass and recruitment trends for recent years remained uncertain in that previous assessments were not confirmed by the addition of subsequent years of data. It was agreed that retrospective analyses should be undertaken periodically.

234. In Figure 19 of YFT-1, the fished and unfished biomasses match well to 1980. It was queried as to whether this implied that there was no impact of fishing on the biomass until 1980. It was explained that the biomass decline of nearly 40% in the early years was attributable to change in recruitment, not to any fishing impact. The recruitment time series showed recruitment to be higher in this earlier period. The model had difficulty fitting the longline catch data in the early 1950s, due to the steeply declining CPUE – when recruitment was unconstrained, the model wanted to make recruitment huge to compensate for the decline in CPUE. The CPUE was presumably high early for other, unknown, reasons than a high recruitment (e.g fishing may have been more efficient). Recruitment was subsequently constrained in the model but still had a residual effect.

235. The Chair introduced the concept of a possible regime shift in productivity which had been a major focus of the the discussion last year. There had not so much emphasis on this possibility this year, although the statHBS indices suggested low recruitment below 1970 and substantial increases thereafter. It was considered important to determine which model is correct if there is the possibility of a regime shift based on the results of the statHBS. The possibility of a regime shift in the WCPO depends on how much faith is placed in the recruitment estimates, and is also confounded by the boom in the purse seine fishery. An ecological regime shift had occurred in the Northern Pacific in the 1970s but there is no real certainty that such a shift has occurred in the WCPO. Indeed, the evidence that a regime shift has occurred is not convincing.

236. It was noted that it is critical to seek information on tuna biology prior to 1950 to try to explain the very high catch rates in the early 1950s. This could be achieved as a "data rescue" involving a global call for pre-1950 biological information. As we are no more certain of a regime shift this year than we were last year, it is more constructive to do attempt to discover the driving forces for the population dynamics in the early years for all species

7.4 Ecological research

237. Dr Dean Grubbs presented YFT-7: *Biology of FAD-associated tuna: temporal dynamics of association and feeding ecology*. This study is investigating the trophic ecology of Hawaiian yellowfin and bigeye tuna in an effort to better understand the biological significance of aggregation and association behaviors. More than 1500 stomach samples have been collected (49% yellowfin, 51% bigeye). The forage base of both species was extremely diverse and the prey taxa differed significantly as a function of association. That is, tuna fed on different prey types when they were associated with a seamount, a nearshore FAD, an offshore FAD, or when they were unassociated. Interestingly, bigeye tuna and yellowfin tuna fed on distinctly different prey taxa, even when they co-occurred at the same aggregation site. Bigeye tuna

generally occupy deeper waters than yellowfin tuna, though both species are commonly caught near the surface when associated with FADs. The data from this study suggested that the separation in vertical distribution was maintained during feeding. Yellowfin tuna fed primarily on epipelagic prey associated with the shallow mixed layer while bigeye tuna fed on mesopelagic prey associated with the deep scattering layer. This pattern was exhibited for unassociated fish as well as those associated with nearshore FADs, offshore FADs, or the Cross Seamount.

238. The data also suggested that there were distinct and consistent differences in the feeding success of yellowfin and bigeye tuna when they were associated with man-made FADs or the Cross Seamount. Feeding success for yellowfin tuna was comparable between unassociated samples and those from the seamount and offshore anchored FADs (>3000 m depth), but elevated on the nearshore anchored FADs (<900 m depth). It is noteworthy that the feeding success of yellowfin tuna associated with offshore FADs was elevated for the largest fish (>100 cm FL), but quite depressed for smaller classes. For bigeye tuna, feeding success was highly elevated on the seamount, but extremely depressed on the nearshore and offshore anchored FADs. This may have been because certain seamounts provided an enriched source of mesopelagic prey. These prey were largely absent from the anchored surface FADs and bigeye tuna did not appear to switch to the available epipelagic forage. This may suggest that associating with FADs is metabolically costly and quite maladaptive to bigeye tuna. If this pattern is consistent for areas of the tropical Pacific with more extensive deployment of FADs, these structures could act as evolutionary traps for this species. This would warrant detailed evaluations of the ecological impact of FAD deployment in tropical waters.

239. A comment was made that in considering the evolutionary consequences of FADs, we need to consider the balance of phenotypic plasticity with genetic effects. Dr Grubbs responded that similar studies on birds have suggested that phenotypic plasticity is rather limited, and that there is no reason to believe that the case is different for fish. In response to a comment that there is evidence of a size-selective genetic influence on fish populations due to fisheries (specifically, abalone), it was stated that the spatial pattern of FADs may influence the strength of any genetic effect.

240. It was clarified that only adult shrimp were consumed by yellowfin tuna. A thermal restriction may prevent smaller yellowfin tuna from accessing the depths at which the shrimp occur. The Chair questioned whether the index of stomach fullness was dependent on the time of day at which the fish were sampled. While this is possible, it is difficult to determine, since the original samples were taken at sea on commercial vessels, and the handline fishery, from which the remaining samples were taken, catches fish half an hour after sunrise and sunset (i.e. only 2 times per day).

241. Dr Patrick Lehodey presented YFT-4: *First application of SEPODYM to yellowfin tuna population and fisheries in the Pacific Ocean*. The yellowfin tuna population was described with 21 age classes of 1 quarter and an age of first maturity of 1.5 years. Growth, weight and natural mortality coefficients at age were based on those estimated from MULTIFAN-CL analyses. Compared to the skipjack application, the adult habitat index had a lower temperature preference but the spawning habitat index was identical. Two pole and line, four purse seine, and four

longline fisheries were described. Overall, predicted catches by fisheries were in fairly good agreement with observed catches. Biomasses estimated from SEPODYM were similar by region to the MULTIFAN-CL estimates, and in the Eastern Pacific Ocean were at similar levels to those estimated using A-SCALA. The estimates were also in partial agreement with the fluctuations that are linked to ENSO with spatial effects on the distribution of juvenile fish similar to what was predicted for skipjack (i.e. expansion (El Niño) or contraction (La Niña) of the spawning temperature habitat associated with changes in primary productivity). Young yellowfin exploited by surface fisheries had a distribution roughly similar to skipjack with the same impacts of ENSO on their spatial distribution. However, the larger size of adult yellowfin and their longer life span relative to skipjack implies that they can extend their range of movement towards zones of favourable habitat that are not accessible to skipjack. The spatial distribution of adults tended to be more diffuse and extended towards higher latitudes, in general agreement with the spatial distribution of the longline catch. Zonal (east-west) ENSO-related extension and contraction of the adult distribution in the western and central equatorial band were also clearly visible.

242. Although the results were compared with those from A-SCALA, it was questioned whether SEPODYM may be combined with MFCL. It was pointed out that the biomass trend from SEPODYM was predicted to be fairly flat (with interannual variability), as opposed to that from MFCL, which showed a downward trend. It was explained that the SEPODYM recruitment is scaled to MFCL estimates, so that the long term averages from the two models are comparable. Also, SEPODYM is sensitive to natural mortality assumptions

243. Mr Peter Williams gave a brief presentation of data issues referring to YFT-3: *A summary of aggregate yellowfin tuna catch/effort and size composition data available to the SCTB*. The information provided in this paper is in response to directives from SCTB14 and SCTB15. The tables have been ordered by gear and vessel nation to better cater for the requirements of each SCTB Species Research Group (SRG) (similar tables are available for the other target tuna species). Additions to the paper this year include (i) a column for annual catch estimates, (ii) reference to notes on the sources, coverage and quality of data and (iii) graphs showing the number of size composition samples by fleet.

244. Data for most fleets are generally provided in time for inclusion in the annual yellowfin stock assessments. However, the following were identified as significant gaps in the current SCTB datasets:

- Catch/effort data stratified by time and area, and size composition data from the domestic Indonesian and Philippine tuna fisheries;
- Catch/effort data stratified by time and area, and size composition data from the domestic Taiwanese longline fishery (but may be made available to the group in the future);
- Catch/effort data stratified by time and area, and size composition data from the coastal Japanese longline fishery;

7.5 Research coordination and planning

245. The tasks listed last year were reviewed and are briefly summarised as follows. It was noted that the tasks do not appear in order of priority, as it was

generally agreed that all are important and that broad advancements can be made by SCTB scientists across each of the objectives.

i. Continued collection of statistics – Phillippenes, Indonesia, Vietnam. This is an ongoing challenge. The situation has not changed with respect to data availability from the above three nations and obtaining these statistics is still a priority.
ii. Data collection programs for main fishing fleets documented in order to improve our understanding of fleet behaviour. This is a general, ongoing task.
iii. Achieve a better understanding of fishing operations and strategies for individual fleets. This is a general, ongoing task.
iv. Compilation of pre-1962 data. This has been achieved back to 1952, and we are currently attempting to compile data back to 1950.
v. Identify methods or training programs (q.v. David Itano's assessment of American Samoan port samplers FTWG-1). Further funding is required to perform port sampling assessments in other parts of the south-west Pacific.
vi. Further studies to increase our understanding of population dynamics (environmental variability), movement dynamics, aggregation dynamics, and the association between regime shifts in oceanography and the productivity of yellowfin. These issues have been discussed in the above working papers but work is still largely in progress.
vii. Refinement of methods for standardisation of purse seine and longline effort. This is being worked on by the FTWG. The Chair feels that a key issue is how to quantify technological advances for use in standardisation.
viii. Better identification and reporting of appropriate stock and recruitment indicators. The MWG is working on this.
ix. Continued development of assessment models. These were summarised in the MWG.
x. New conventional tagging experiment required. The Chair cannot see any reason to exclude this recommendation as more information on movement and mortality would be good for standardisation and for validating assessment estimates.

246. The Chair proposed that additional priorities should include

- an investigation of pre-1950s biology and oceanography, to help understand the pattern of early high catch rates and their subsequent decline
- an examination of the Chinese/Taiwanese processed to whole weight conversions
- the determination of regional habitat-based indices (i.e. on a finer spatial scale)
- obtaining an understanding and a quantitative description of the increase in longline efficiency.
- the determination of a suite of empirical performance indicators for the fishery

7.6 Summary statement

247. A summary statement on the status of yellowfin tuna in the WCPO was drafted, circulated to participants and discussed. The agreed statement was incorporated in the Executive Summary (see page 12).

8. SKIPJACK RESEARCH GROUP (SRG)

248. The coordinator of the Skipjack Tuna Research Group, Dr Gary Sakagawa, opened the session with introductory remarks. He introduced the agenda for the session and scheduled 10 working papers for review by the Group. He noted that the session's objectives included review of research results on the biology, ecology, environment and fisheries of skipjack tuna that are particularly pertinent to assessing stock status. The Group also promotes cooperation in the collection and exchange of data for research and facilitates coordination of research that advances knowledge on stock status.

8.1 Regional Fishery Development

249. Mr Peter Williams provided an overview of the WCPO skipjack tuna fisheries referring to SKJ-2. Skipjack tuna are taken primarily by purse seine and pole-and-line gear, with smaller catches by other artisanal gears in eastern Indonesia and Philippines. The 2002 estimated catch of 1,321,939 mt was the highest on record and around 7,000 mt more than the record of 1998. A general absence of the restrictions placed on effort in the purse seine fishery in previous years, as a result of falling prices, no doubt contributed to this higher catch level.

250. The 2002 catch comprised a record purse seine catch (962,740 mt - 73%), most of which was taken by the four main distant-water fishing nation (DWFN) fleets (644,704 mt) and Philippines purse seine and ringnet fisheries, but with a significant contribution from the PNG fleet (89,948 mt). The provisional estimate for the pole-and-line gear was 280,578 mt (21%). This catch primarily comprised catches by the Japanese fleet (the most recent estimate was 96,144 mt for 2001–the lowest catch in more than 30 years) and the Indonesian fleet (167,046 mt). There was also a noted recovery in the contribution (9,013 mt) by Solomon Islands fleet compared with the low catches in recent years. The "other" gears, representing mostly unclassified gears in Indonesia, Philippines and Japan, took around 70,000 mt during 2002.

251. The 2002 skipjack purse seine CPUE for all set types was consistent for the three Asian fleets (Japan, Korea and Taiwan) and continues the overall increasing trend since 1997. In contrast, the US fleet, which fished further to the east (and south) during 2002, generally experienced poorer skipjack catch rates. The 2002 skipjack CPUE trends in nearly all instances increased from the levels seen in 2001, and in several instances where at their highest level ever. The gradual increase in skipjack CPUE for free-school sets over the past 5 years is related to a certain extent to technological advances enabling better detection of free-swimming schools. Fishing in the general area either side of the 160°E longitude produced very high rates in the latter months of 2002 and into the first months of 2003.

252. In the discussion it was noted that there seems to be an increase in reporting of bycatch by some fleets licensed to fish in FSM waters and that the factors involved needed investigating. It was also noted that the possibility of changes in fishing strategy by US purse seine vessels should be examined in light of changes in catch rates of this fleet. It was pointed out that the percentage of FAD sets for Asian purse

seine fleets is low in recent years compared to the US fleet and yet, overall catch rates are at historical highs. Misreporting of set types could be occurring possibly because of the issue of large numbers of small fish taken in FAD sets.

253. Following the overview, Mr Williams presented SKJ-3: *A summary of aggregate catch/effort and size composition data available to the SCTB-SKIPJACK*, noting that this paper is in response to directives from SCTB14 and SCTB15. Data for most fleets are generally provided in time for inclusion in the annual skipjack stock assessments. It was noted that complete purse seine catch/effort data for the immediately past calendar year are usually available by the end of the second quarter of each year. Catch/effort data stratified by time and area, and size composition data from the domestic Indonesian and Philippine tuna fisheries were identified as the significant gaps in the current SCTB datasets for skipjack.

254. It was noted in the discussion that the size composition data seemed to be under represented for some national fleets relative to their landings. It was pointed out that this deficiency needs to be corrected as data substitution for these fleets in stock assessment models would weaken the assessment results.

8.2 Biological Research

255. Dr Miki Ogura presented SKJ-8: *Precise age determination of young to adult skipjack tuna with validation of otolith daily increment*. Thisn paper reported on the validation of daily increment formation in sagittal otoliths of skipjack tuna and the estimation of growth trajectories in the western Pacific Ocean. There were three areas of different increment morphology corresponding to larval, young-adult, and adult life stages. The daily deposition rate of increments on the young-adult area was validated by the correspondence between the numbers of the deposited increments and the rearing days of captive fish. (Note, in SKJ-9, validation for juvenile–young skipjack, smaller than 18 cm is presented.) The otolith marking experiments with oxytetracycline injections were carried out for young skipjack, around 30 cm in FL, in 2000 and 2001. On the basis of these results, daily otolith increments were analysed from young to adult skipjack caught in temperate and tropical waters and the relationship between age in days and fork length was estimated: Skipjack in the western Pacific reaches 35 cm at 0.5 year, 40 - 45 cm at 1 year, and around 65 cm at 2 years of age.

256. In the discussion it was suggested that because the pen-held fish were fed on a regular regime, which does not occur in the wild, that trials be conducted with starvation regimes to see if this interrupts increment formation. Since the same increment structure was found over the size range examined, Dr Ogura felt the pattern applies for larger fish (older than age 3) as well. However, he advised that this assumption should be validated. Validation can be done more easily with tagging experiments than with pen rearing, because larger fish can be tagged with greater success than with younger fish. It was also pointed out that since skipjack reach maturity at a size range of 40-45 cm, the results indicate that maturity occurs at about age 1.

257. Dr Miki Ogura presented SKJ-7: *Swimming behaviour of skipjack, Katsuwonus pelamis, observed by the data storage tag at the northwestern Pacific, off*

northern Japan, in summer of 2001 and 2002. Research on skipjack behaviour using small data storage tags (a type of archival tag) was presented. This research was conducted in temperate waters off northern Japan in the summer using free swimming school fish. Swimming depth and body cavity temperature (tag attached internally) or ambient water temperature (tag attached externally) data were retrieved successfully from 7 recaptured skipjack. The tagged skipjack followed a daily vertical movement pattern within the upper mixed layer, spending most of night-time in near surface and in daytime swimming in relatively deeper layer. Skipjack dived to 267 m at the deepest, and the ambient water temperature during these deep dives went down to nearly 10º C. Body cavity temperature decreased according to diving but did not exceed 17ºC. Most of duration of ascent and stay at the surface was short, less than 10 minutes. This result suggests that the surface fisheries have a small chance of encountering free swimming skipjack schools.

258. In the discussion it was noted that in Hawaii sonic tags have been put on 35-50 cm skipjack tuna, and movement determined from receivers on buoys. Data are used to estimate survival. While more limited in capability, these data storage tags appeared to be a cheaper alternative to archival tags. It was also noted that while the temperature probes on internally placed tags measured body cavity temperatures, the data had not yet been examined for evidence of any effect of feeding on body cavity temperature. Possible reasons for differences in daytime depths were discussed with suggestions including meteorological changes and the fish moving into different water masses. It was noted that the results show that skipjack occupy surface waters nearly continuously during night hours but only occasionally and for 10 minutes at a time in daylight hours. It was felt that this information explains the high efficiency of FAD sets, which are made just before daylight.

8.3 Ecological Research

259. Dr David Kirby presented SKJ-4: *An individual-based model for the spatial population dynamics of Pacific skipjack tuna*. An individual-based model has been developed to simulate the spatial population dynamics of skipjack in relation to ocean variability and productivity. The spatial domain is the tropical/sub-tropical Pacific Ocean, and a multi-year time series of observed and simulated data is used. Interactions between skipjack and their environment are mechanistically considered, as are the motivations for the behaviour determining spatial dynamics. Detailed energetics-based modelling is carried out for a relatively small number of model agents (super-individuals) each representing a much larger number of individual fish, thus scaling to realistic natural levels of abundance. Mortality rates that are age-, density- and environment-dependent are then applied to the numbers of fish represented by the model agents. An artificial neural network (ANN) allows agents to evolve movement and spawning behaviour, and a genetic algorithm is used to mimic sexual reproduction, with offspring having characteristics (i.e. weights for the ANN) derived from each parent. After 'training' the ANN with the input data, the model may be used to hind cast and ultimately forecast spatial population dynamics in relation to environmental change.

260. Dr Patrick Lehodey presented SKJ-5: *SEPODYM application to skipjack tuna in the Pacific Ocean: impact of ENSO on recruitment and population*. SEPODYM is a 2D coupled physical-biological interaction model at the ocean basin scale, which

contains environmental and spatial components used to constrain the movement and the recruitment of tuna. Input data includes sea surface temperature, oceanic currents, and primary production, which this year was simulated from a 3D coupled physical-biogeochemical model. The skipjack population is described with 16 quarterly age classes and an age of first maturity of 9 months. Growth, weight and natural mortality coefficients at age are based on those estimated from MULTIFAN-CL analyses. Whether spatial dynamics of temperature, currents (advection), food availability and predation constrain tuna recruitment is evaluated using a spawning habitat index. Fluctuations in the simulated population are similar to those estimated from the statistical model and are related to ENSO events. Overall, predicted catch for two pole-and-line and four purse seine fisheries are in fairly good agreement with observed catch.

261. In the discussion it was noted that the recruitment trend in this analysis seems to be somewhat smoother than with MULTIFAN-CL estimates, but displayed a similar trend. It was also pointed out that the annual environmental signal in the tropics is stronger than the seasonal signals. Since recruitment is related to ENSO and El Niño events, recruitment should be predictable 6 months in advance.

8.4 Stock Assessment Research

262. Dr John Hampton presented SKJ-1: *Stock assessment of skipjack tuna in the western and central Pacific Ocean.* The structure of the model and data was similar to that used in previous years. The main findings of the assessment were as follows:

- Recruitment showed an upward shift in the mid-1980s and has been at a high level since that time. High recruitment occurred in 1997–1998. The strong El Niño at around that time and the high frequency of such events during the 1990s is suspected to have had a positive effect on skipjack recruitment. The investigation of possible mechanisms underlying this relationship is an area of further research.
- The biomass trends are driven largely by recruitment, with the highest biomass estimates for the model period being those in 1998–2001. The model results suggest that the skipjack population in the WCPO in recent years has been at an all-time (over the past 30 years) high.
- Fishing mortality has increased throughout most of the time-series, falling to some extent in recent years. The impact of fishing is predicted to have reduced recent biomass by 20–25%. The impacts of fishing are higher in the northern sub-tropical regions that account for a small proportion of the total biomass.
- An equilibrium yield analysis confirms that skipjack is currently exploited at a modest level relative to its biological potential, with the estimates of various reference points suggesting that the stock is neither being overfished nor is overfishing occurring. Recruitment variability, influenced by environmental conditions, will continue to be the primary influence on stock size and fishery performance.

263. A number of issues were raised in the discussion. It was noted that while the graphs of movement patterns are very informative and easily interpreted, some were

contradictory. Little East-West movement between regions is shown in one plot whereas another graph shows considerable movement. Dr Hampton indicated that some graphs are based on coefficients whereas others are based on numbers of fish and that this may be contributing to different perspectives. He stated that the model treats movement as a constant, i.e. it does not change with time. It was also noted that some of the catchability trends among similar fisheries were quite different, such as between the FAD fisheries. This was probably because the FAD fisheries, for example, are not homogeneous. In response to a query as to why the effort deviations for the Philippines and Indonesian fisheries were unusually flat, Dr Hampton stated that the effort data for both fisheries is sparse, so arbitrary effort statistics are used for both fisheries. The flatness indicates that the arbitrary statistics used were not totally appropriate. In addition, there is some concern about the effort standardization techniques effectively adjusting for changes in catchability. The increasing trend in catchability for many fisheries shown in the results may not be real and is an important issue for further evaluation. It was explained that the ability of the model to estimate real changes in catchability is weak because of the large amount of tagging data.

264. It was noted that the trend in estimated biomass seems to be following the catch trend, which suggests that the model may simply be adding up the increasing catch. It was pointed out, however, that the tagging data indicated a similar increasing biomass. It was also explained that no attempt had been made to estimate the critical age for yield per recruit and it was agreed that this should be done in the future. However, because in the WCPO exploitation generally starts around 40 cm, which is near the size at maturity, fishing is probably near the critical age and the species is quite resilient to fishing. It was also explained that the analysis did not include projections of future biomass because the species is so short lived.

265. It was suggested that it might be informative to run the model without the small fish from the Indonesian and Philippines fisheries as has been done in the bigeye tuna assessment. It was also suggested that the procedure for estimating the unfished biomass should be examined because, given the biology of the species, one would expect skipjack to have compensatory mechanisms. Some approximate procedures might be followed before attempting to parameterize this in the model.

266. The meeting agreed that since a number of changes have occurred in the skipjack fishery since the large-scale tagging experiments were conducted, in the early 1980s and early 1990s, the experiments should be repeated. The experiments should also address some additional issues such as, for example, are new segments of the resource being taken by the fishery now than before and have migration patterns changed? It was also suggested that the estimated recent increased in recruitment for this fishery may indicate that significant ecosystem impacts have occurred, such as reduced predation/competition due to the removal of large predators.

267. Dr Alain Fonteneau presented SKJ-6: *A comparative analysis of skipjack fisheries and stocks world-wide*. This paper compares trends of the various skipjack fisheries by gear and fishing mode, as well as by sizes caught. The geographical distribution of fisheries were compared and analyzed as a function of sea surface temperature. These comparisons contribute to better evaluations of the biological characteristics of skipjack: growth, natural mortality and movement patterns. The

paper also compared the present status of the various skipjack stocks exploited world wide.

8.5 Research Coordination and Planning

268. Skipjack tuna is a commercially important resource in the WCPO region that requires close monitoring and research attention. Because the stock is moderately exploited and with additional scope for expanded exploitation, the urgency for research on this species is not as pressing as for other more heavily exploited tuna species of the region. Participants recommended that priority be given to improving fishery monitoring and sampling of the skipjack tuna catch. In particular, data on catch and sizes of fish caught by the Philippines and Indonesian fisheries need to be improved. Effective monitoring programs for these fisheries need to be implemented immediately. Also needed is better monitoring of discards at sea. Small-sized skipjack tuna of low commercial value is being discarded at sea with increased frequency, but is not fully monitored by conventional procedures. Greater use of observer programs needs to be considered to correct this deficiency in discard data.

269. As for research needs, the participants recommended that studies that are currently underway should continue and new initiatives considered. The research needs identified at SCTB 15 were seen as still being relevant. These are:

1. Understanding of the population dynamics and ecology of skipjack tuna with studies on:
    - Age and growth, including early life stages, with hard parts and conventional tagging methods.
    - Natural mortality, including early life stages, with tagging studies.
    - Studies of reproductive biology.
    - Behaviour and influence of environmental factors with archival tagging.
    - Aggregation dynamics associated with FADs with archival tagging and food habits studies.
2. Development of stock assessment metrics, such as with studies on:
    - Standardization of purse seine fishing effort including with information gathered through the FTWG efforts.
    - Refining and applying assessment models of different types.
    - Development of new tools/methods for indexing abundance.
    - Role of skipjack tuna as a key species in the ecosystem.
    - Interaction of this fishery with fisheries for YFT and BET and the status of these other fisheries, essentially in the context of mixed fisheries – Cross Cutting Issue

8.6 Summary statement

270. A summary statement on the status of skipjack tuna in the WCPO was drafted, circulated to participants and discussed. The agreed statement is incorporated in the Executive Summary (see page 7).

9. BIGEYE RESEARCH GROUP (BRG)

271. Dr Naozumi Miyabe lead the session of the Bigeye Research Group, outlining the agenda and noting that some relevant presentations had already been made under previous working groups, especially the Yellowfin Research Group .

9.1 Regional Fishery Overview and Developments

272. Dr Miyabe provided an overview of the WCPO bigeye tuna fisheries referring to BET-2. Bigeye tuna are taken by purse seine and pole-and-line (surface) gears, mostly as juveniles, and by longline gear, as valuable adult fish. The bigeye catch in the WCPO has an estimated landed value of approximately US$1 billion annually. The total WCPO bigeye catch (107,568 mt) for 2002 was similar to the level attained during 2001, and around 5,000 mt lower than the record level of 1999 (113,168 mt). The Pacific-wide bigeye catch (173,180 mt) for 2002 was the lowest since 1989 and nearly 45,000 mt less than the record catch attained in 2000, primarily due to significant decreases in the WCPO and EPO purse seine catches. The WCPO longline catch for 2002 (64,185 mt) was slightly higher than the catch of 2001, but around 6,000 mt less than the record catch in 1999 (70,459 mt).

273. In the WCPO, purse-seine catches of bigeye are estimated to have been less than 20,000 tonnes per year up to 1996. By 1997, this catch had increased to approximately 30,000 mt through the adoption of similar fishing techniques to those used in the EPO. The estimated 1999 WCPO purse seine catch reached a record level of 34,568 mt, mainly as a result of increased fishing on drifting FADs. Since 1999, bigeye catches have progressively reduced in line with the gradual reduction in fishing on drifting FADs by most fleets. The WCPO purse seine bigeye catch for 2002 was estimated to be 22,538 mt, the lowest catch in five years and directly related to the reduced use of drifting FADs.

274. The WCPO pole-and-line fishery has accounted for between 2,000–4,000 mt of bigeye catch annually over the past decade, and the "other" category, representing a variety of gears in the Philippine and Indonesian domestic fisheries, has taken about 14,000–17,000 mt of bigeye in recent years.

9.2 Data issues

275. Mr Peter Williams gave a brief presentation of data issues referring to BET-3: *A summary of aggregate bigeye tuna catch/effort and size composition data available to the SCTB*. The information in this paper was provided in response to directives from SCTB14 and SCTB15. The tables have been ordered by gear and vessel nation to better cater for the requirements of each SCTB Species Research Group (SRG); similar tables are available for the other target tuna species. Additions to the paper this year include (i) a column for annual catch estimates, (ii) reference to notes on the sources, coverage and quality of data and (iii) graphs showing the number of size composition samples by fleet.

276. Data for most fleets are generally provided in time for inclusion in the annual bigeye stock assessments. Catch/effort data stratified by time and area, and size

composition data from the domestic Indonesian and Philippine tuna fisheries were identified as the significant gaps in the SCTB datasets. It was noted that data have been collected from port sampling of the domestic Taiwanese longline fleet since 1996 and may be available to the group in the future.

277. Information was sought on progress with obtaining data from the growing Vietnam tuna fishery. The fishery is undergoing rapid development and efforts are in progress to obtain better data coverage. Available information on exports suggest that these may be as high as 20,000 mt total (ie. for all species), with growing exports of yellowfin and bigeye to Japan and the USA. It was noted that Japan, as the main bigeye market, is in the process of establishing a database for imports, which may involve sampling of these imports.

278. David Itano referred to an earlier paper (FTWG –1), an audit of the port sampling programme in Pago Pago, confirming the 100% accuracy of bigeye identifications by the samplers. The need to extend this work to other areas and fleets in the region was recognized, as well as the need to examine the species composition of log and FAD catches, even though differences do not appear to be statistically significant.

279. A major issue with bigeye catch data is the apparent shift in the percent of bigeye in associated sets from 1996 onwards, when the bigeye component of the combined bigeye plus yellowfin catch has averaged around 24%. This has given rise to the potential use of two datasets in the MFCL analyses, although recent analyses apply 24% to the whole dataset. These differences may however be real and need further investigation. It was noted that a long time series of purse seine data from the Indian Ocean shows high variability in the percent of bigeye in associated sets.

9.3 Biological and Ecological Research

Tagging Studies

280. The Chair referred to the report on tagging of tropical tunas (yellowfin, bigeye and skipjack) in waters around Japan which had earlier been presented (RG-4). It was noted that a total of 981 small bigeye had been tagged with conventional and small archival tags, mostly around FADs in southern Japan waters, with there being 141 recoveries (14.4%). Archival tag returns confirmed the diurnal variations typically seen in swimming depth. Limited horizontal movement has so far been observed. The project is continuing.

281. Dr Karen Evans presented the results of archival and conventional tagging of bigeye in the Coral Sea involving CSIRO, SPC/OFP and the University of Hawaii. Archival and pop-up archival tags are being used to investigate the depth and temperature preferences of bigeye in the Coral Sea. The archival database comprises >3,000 days of data, from fourteen archival tags, deployed on 70-90cm FL fish and at liberty for periods of 2-36 months. Three pop-up satellite tags have also been deployed, two of which have successfully collected data on larger fish (145-155 cm FL), for periods of 45-60 days. The study examined individual, seasonal, inter-annual and ontogenetic variation in depth and temperature preferences of Coral Sea bigeye and then compared these results with those published for bigeye in the EPO and Hawaii.

282. Although the data can be pooled to derive a view of typical bigeye behaviour in the Coral Sea - the modal depths and temperatures of fish of all sizes were common, and in the range of 400-500m and 10-12C - it is clear that depth and water temperature preferences vary significantly among individuals on all times scales. For example, significantly more daytime surface-orientated behaviour was found during spring and summer, and there was some indication that surfacing may be more common in some years than others.

283. Depth preferences for Coral Sea and EPO fish differed significantly, with the latter having a daytime depth mode centred around 300m compared to 450m in the Coral Sea. However, the temperatures at these depths were similar, indicating the possibility of either common temperature preferences (or limitations) of bigeye in the two areas.

284. The apparent regional variation in habitat/temperature preference was of interest to the group, with Hawaii bigeye appearing to prefer slightly colder water (7^{o}C) relative to EPO and WPO fish (10-12^{o}C). It was also noted that the depth distribution may be influenced by levels of ambient light, that FAD or other associations (eg whale sharks) may affect the time spent near the surface, and the depth of the oxycline may be limiting for bigeye only in some specific areas.

285. It was agreed that there was great value in sharing raw data obtained from archival tagging, since comparisons made so far amongst areas have often been from comparisons of summarized published data. The use of an honest broker eg the PFRP could facilitate such data sharing but that rights to first use of the data and recognition of individual work would need to be respected.

286. It was noted that IATTC had tagged around 9,000 bigeye this year with conventional tags and a further 90 bigeye with archival tags, with many recoveries so far received, including one long term archival tag return after three years

287. Following the presentation on the bigeye archival tagging project in the Coral Sea, Dr John Sibert presented preliminary estimates of the horizontal movements of bigeye tuna tagged in this project. North-south (N-S) movements appeared to be more extensive than eastward movements. The N-S movements were associated with the equinoxes, the time when latitude estimates from archival tags are the least reliable. Analysis of latitude errors from tags deployed on a mooring in the north Pacific indicated a serious autocorrelated bias that could easily be mistaken for N-S movements. Various attempts to statistically correct this bias using a state-space Kalman filter model suggested that the apparent N-S movement of bigeye is an artifact of the autocorrelated errors. Bigeye tuna appear to be full-time residents of the Coral Sea and the east coast Australian EEZ.

288. Mr David Itano briefly described work with double tagging involving both sonic and archival tags in Hawaii, with the sonic tags able to be monitored by a listening device, to provide locational data. Two of the twelve tag sets released have been returned, the archival tags having been supplied by the manufacturer to enable performance to be improved. Data from this work will be reported in future meetings.

289. Dr David Kirby presented a conceptual outline of an individual-based model for bigeye tuna (BET-4) that will be developed through a project funded by the PFRP. The individual-based model will simulate the vertical movements of bigeye tuna and explore the observations derived from archival tag data. Model fish will swim through simulated environmental data from a numerical ocean model, following the horizontal path of tagged fish, but will be free to move in the vertical dimension. Movement rules will emerge through the evolution of weights in an artificial neural network and the model will be used to explore our understanding of what limits vertical movements of bigeye and other pelagic predators.

FAD Ecology

290. Dr Dean Grubbs had earlier presented work on the biology of FAD-associated yellowfin and bigeye tunas (YFT-7). The results of the work relating to the temporal dynamics of association and feeding suggested that whilst bigeye may derive trophic advantage from seamount association, the metabolic cost of FAD association may be high (i.e. possible starvation).

9.3 Stock Assessments

CPUE Standardisation

291. Dr John Hampton presented the bigeye component of RG-2, a GLM-based analysis of Japanese longline catch and effort data for yellowfin and bigeye tuna. Data were aggregated by year, month, five-degree square and hooks-between-floats (HBF) category. Independent analyses using a common model structure were carried out for each of the five MULTIFAN-CL model areas. The final model structure predicted catch as a function of effort, year and a series of interaction terms involving month, latitude, longitude, and HBF. The fitted models accounted for a high proportion of the variance in catch, most of which was attributable to variation in effort. The parameterisation of the various factors was broadly consistent with our understanding of the fishery, including the relationship between catch and HBF, which showed some complex spatial trends. Standardised CPUE was generally similar to nominal CPUE, and declined sharply in most areas in the 1950s, although in some cases the indices had wide confidence intervals. The explanatory power and precision of the estimates may be improved with higher spatial resolution data and by incorporating the catch of other species.

292. Mr Keith Bigelow presented the bigeye component of RG-3: *Comparison of deterministic and statistical habitat-based models to estimate effective longline effort and standardized CPUE for bigeye and yellowifn tuna*. A comparison was conducted of three effort series 1) nominal, 2) habitat-based standardization (HBS) and 3) a statistical HBS (statHBS) to ascertain which series better explains variation in Japanese longline catch for Pacific bigeye tuna. The order of best to poorest fit of the variation in catch was: 1) statHBS based on ambient temperature, 2) HBS based on the Hawaii time-at-temperature hypothesis, 3) nominal effort and 4) HBS based on the Tahiti time-at-temperature hypothesis. Fitted ambient temperature preferences from the statHBS for the entire Pacific Ocean indicate a bimodal distribution which reflects time spent in cooler, deeper waters during the day and warmer, shallower water at night. Fitted preferences were mainly from 9–16°C and 23–27°C. The modes of fitted preferences were typically broader than modes of the individual hypotheses, which probably result from estimating the preferences over a large spatial area. The year

effects were similar for the four effort series from 1975 to 1981, but there were substantial differences thereafter. The standardized CPUE time-series trend based on nominal effort was most optimistic with similar values at the beginning and end of the time-series. There were moderate declines in the HBS (Hawaii) and statHBS time-series and a precipitous decline in the HBS (Tahiti) time-series. Based on these standardizations, effective longline effort data were produced for the MULTIFAN-CL assessment.

293. In discussion, it was noted that both the longline catch data and oceanographic data were currently applied at the level of 5 degree by month, but that this could possibly be applied at a finer scale eg one degree month; alternatively, the models could be applied initially at one degree, then raised later. It was noted that data on gear configuration were available at one degree scale

MULTIFAN-CL

294. Dr John Hampton presented BET-1, the MULTIFAN-CL based assessment of bigeye tuna in the WCPO. The structure of the model and data were similar to that used in the yellowfin assessment. The main changes in the model from the 2002 assessment included extension of the number of age classes (quarterly) to 40 and definition of separate fisheries for the Chinese/Taiwanese longline fleets operating in regions 2 and 3. Additionally, the assessment considered five different standardized longline effort series for each of the main longline fisheries operating in each region, and two different sets of bigeye catch estimates for the various purse seine fisheries. The main findings of the assessment were as follows:

- Recruitment in all analyses is estimated to have increased since about 1980. It is possible that the pre-1965 levels of recruitment and recruitment variability are poorly estimated in this assessment because of the lack of size composition data for the longline fisheries.
- Biomass for the WCPO is estimated to have declined to about half of its initial level by about 1970 and has been fairly stable since then. This pattern is characteristic of all regions except 5, in which biomass is estimated to have remained fairly stable for most of the time-series but to have increased strongly during the last 5 years of the assessment.
- Fishing mortality for adult and juvenile bigeye tuna is estimated to have increased continuously since the beginning of industrial tuna fishing. Current fishing mortality levels are close to or exceed the levels of natural mortality.
- Biomass depletion attributable to the fisheries is estimated to have been rapid, particularly in recent years, with recent biomass levels estimated to be about 30% of the unexploited biomass. This level of biomass depletion is estimated to be near or to slightly exceed that given by the equivalent equilibrium-based limit reference point (ratio of biomass at MSY to equilibrium unexploited biomass). Depletion is unevenly distributed spatially, being greater in the tropical regions.
- The attribution of depletion to various fisheries or groups of fisheries indicates that the longline fishery has the greatest impact throughout the model domain. The purse seine and Indonesian fisheries also have substantial impact in the tropical regions.

295. The fishing mortality and yield-based reference points indicate that overfishing is occurring at the current level and pattern of age-specific fishing mortality. However, the current biomass remains above the equilibrium biomass at

MSY due to estimated above-average recruitment during the past 15 years. If recruitment were to return to average levels, the model predicts that biomass would rapidly fall to below the biomass at MSY reference point.

296. The pessimistic outlook of the assessment is to a large extent related to the estimated increase in recruitment over time. It is possible that this increase is an artifact of either the lack of significant surface fishery catches prior to about 1980 or to the lack of longline size composition data prior to 1965, either of which might have resulted in a negative bias in the early recruitment estimates. This issue will need to be clarified before the management implications of the assessment can be fully evaluated.

297. Considerable discussion focused on the elevated recruitment levels estimated for recent years (three times those of early years) and their impact on the assessment. Recent recruitment levels may indeed be high, as indicated by some observer data and the Pacific-wide model. If current recruitment should be lower then F estimates would be expected to be higher, resulting in a more pessimistic assessment. On the other hand, if estimates of recruitment in the early years of the fishery were negatively biased, then the assessment would be more positive.

298. Other effects on the assessment were possible changes in selectivity over time and estimates of recruitment being biased by low movement levels between areas. The apparently low levels of bigeye recruitment relative to those of yellowfin were noted, as was the lower natual mortality of bigeye. It is assumed that the greater longevity of bigeye and other aspects of its population dynamics would strongly influence these parameters.

299. The value of more representative observer data with respect to bigeye catch and better identification of bigeye in purse seine catches was again noted, especially in the context of the apparent greater percentage of bigeye in the "bigeye plus yellowfin" component of the purse seine catch since 1996. It was suggested these may be compounded by mis-attribution of FAD catches to log set catches.

300. The value of sensitivity analyses relating to the recruitment estimates was affirmed; it was felt that if all present reference points were recomputed taking into account the sensitivity analyses, these might well be more positive. This would especially be the case if early recruitment had been under estimated.

301. The current estimate of MSY was queried as being very low, relative to both historical catches and to bigeye populations in other oceans. However, it was explained that the MSY is a measure of equilibrium catch associated with the equilibrium recruitment – MSY is low compared to recent catches because equilibrium recruitment is low compared to recent recruitment. Low MSY in the WCPO relative to other oceans may also be partly due to the exploitation of very small bigeye by Philippines and Indonesian fisheries, which generally does not occur in other oceans.

302. In looking at how these outcomes might be conveyed to managers, the Coordinator noted that the addition of the earlier years' data from the beginning of the fishery, along with other adjustments, have changed things from last year's

assessmment, including lower average recruitment leading to a lower MSY estimate. The longer time frame was used whilst still requiring size data from the early years. It was suggested that it was appropriate to reiterate the same concerns as last year, but noting that concerns are now broader than just catches of juveniles. The impact of the longline fishery has been consistent since the beginning, whereas the purse seine impact has been recent and large

9.4 Research Coordination and Planning

303. The Coordinator noted that although the current assessment was somewhat more pessimistic than the previous year's, similar general conclusions still pertained. He identified possibilities to further refine or improve the assessment, with the following research issues identified for consideration

- Incorporation of additional datasets in the analyses eg size data from the early years of the fishery, Japanese longline size data.
- The need to continue to improve identification of juvenile bigeye (and species composition data) in surface fishery catches in other areas and fisheries was noted
- Continued application and refinement of habitat models to estimates effective longline effort
- further investigation of the present recruitment indices, and the application of sensitivity analyses to these.
- the possible role of FADs as an evolutionary trap for bigeye tuna, and extension of this work to other areas
- the need for improved indices of abundance from purse seine fisheries especially FAD fisheries (this may also assist with recruitment estimates)
- The use of additional tagging data to provided estimates of exploitation rate, fishing mortality and possibility natural mortality of juveniles
- Refinement of the estimated level of MSY.

9.5 Summary statement

304. A summary statement on the status of bigeye tuna in the WCPO was drafted, circulated to participants and discussed. The agreed statement is incorporated in the Executive Summary (see page 18).

10. ALBACORE RESEARCH GROUP (ARG)

305. Mr Regis Etaix-Bonnin, the coordinator, led the session of the Albacore Research Group.

10.1 Regional Fishery Overview

306. Mr Etaix-Bonnin provided an overview of the south Pacific albacore tuna fisheries referring to ALB-2. South Pacific albacore are exploited by a variety of longline fleets, by an international troll fleet operating seasonally in the region of the subtropical convergence zone (STCZ) and by a domestic troll fleet in New Zealand coastal waters. Longline fisheries targeting this species in several Pacific island countries have grown significantly in the past five years and now provide an important contribution to their nation's economy.

307. Historically, south Pacific albacore catches have generally fallen in the range 25,000–40,000 mt, although a significant peak was attained in 1989 (52,576 mt), when driftnet fishing was in existence. In more recent years, catches have steadily increased annually since the mid-1990s. A record catch (55,701 mt) was attained during 2001, mainly as a result of the significant catch from the longline fishery. The 2002 south Pacific albacore catch of 51,453 mt was the second highest in the post-driftnet period.

309. The south Pacific longline albacore catch for 2002 was the second highest on record (46,819 mt). The catches in several Pacific Island countries continue to increase – Fiji (8,026 mt–2002), Samoa (4,820 mt–2001), French Polynesia (4,557 mt–2002) and American Samoa (3,253 mt–2001) reported individual record catches of albacore during 2001 and 2002. The catch by Pacific-island countries now represents 50% of the total south Pacific albacore longline catch. In contrast, there was a decline in the catch by the Taiwanese longline fleet, which has historically accounted for a significant proportion of the catch. This decline is related to a change of targeting to bigeye (and area fished) for several vessels in this fleet.

310. The south Pacific albacore troll catch for 2002 (4,477 mt) was less than the level for 2001 and mainly due to the reduced catch by the US fleet which was considered to be due to a lower albacore price during this past year.

311. In the discussion the stable catch rates in the New Zealand troll fisheries was noted and it was concluded that catch rates in both the New Zealand and US troll fisheries needed to be more closely investigated.

CPUE Trends

312. Dr John Hampton presented ALB-5, which described temporal and spatial trends in albacore catch rates and size composition in longline fisheries based in New Caledonia, Fiji, Tonga, Samoa, American Samoa, Cook Islands and French Polynesia. The results of the analysis were as follows:

- Albacore catch rates tend to be higher in the eastern part of the WCPO, particularly in the EEZs of Samoa, American Samoa and Cook islands;

- Declines in CPUE have occurred recently in some areas, notably in Samoa and American Samoa, and to a lesser extent in Fiji and Tonga;
- In some EEZs there have been shifts in the spatial distribution of the fisheries from an initial "core" area close to landing ports, to the extremities of the EEZ and beyond (e.g. New Caledonia, Fiji);
- Catch rates tend to decline in "core" areas as cumulative catch increases, and higher catch rates are obtained in the new areas;
- These observations suggest that estimates of standardized effort from these fisheries need to consider spatial expansion of the fisheries.

313. In response to questions regarding further details in relation to figures 13-14 about the trends observed for CPUE per degree square, it was explained that these figures show that when a new fishery develops in a given area, CPUE are quite high at the beginning but decrease with time. Interpretation of this observed trend can be speculated on, but could mean there are local populations of albacore. It was not know whether the same pattern would be seen if the spatial scale of the analysis was increased. The Coordinator reminded the meeting that Pacific Islands are now a major component of the longline fishery, and that these countries should continue to improve the monitoring of their fisheries, especially when level of exploitation is high in their EEZs (Cook Islands, American Samoa and Samoa). It is also important to acquire data on fishing practices and strategies to help interpret variation of the catches. John Hampton explained that when a fishery is developing high catch rates are usually obtained in areas close by but such catch rates cannot be maintained if the fishery has no possibility to extend its fishing grounds.

Fishing Practices

314. Mr Peter Williams presented ALB-6: *Preliminary review of information available on the fishing depth of longline vessels targeting albacore*. He explained that this paper responds to a SCTB15 directive to look at fishing depth in relation to albacore catch, but due to its preliminary status, is merely a presentation of the available information at this stage.

315. This review considered only information available from the "central" stock assessment area (10°–30°S) since (i) most of the south Pacific albacore catch comes from the central area. (ii) albacore are taken by longline fleets in the northern area, but in far fewer quantities than the other areas, and there is no evidence that they are targeted in this area, and (iii) the range of hooks between floats (inferring fishing depth) in the southern area is understood to be small due to much shallower thermocline, therefore a comparison of fishing depth is not considered to be useful.

316. Information on the relationship between catch and fishing depth is available from several different sources. In order of importance (for studies on this subject), these sources are (i) archival tagging, (ii) time-depth recorders, (iii) longline gear setting characteristics collected by observers, (iv) longline catch by hook number collected by observers and (v) the number of "hooks set between floats" and set -start time from logsheet data available at the trip level.

317. Nearly all fleets operating in the central albacore area target albacore, the notable exception being the Australian domestic fleet, which targets bigeye, yellowfin

and swordfish. The information presented suggests that the Pacific Island fleet almost exclusively fish with more than 20 hooks between floats. In contrast, the Australian and Taiwanese distant-water fleets almost always fish with less than 15 hooks per basket.

318. Trends in the species composition of albacore in the tuna catch and albacore CPUE by hook number suggest that fishing depth does not have a marked effect on albacore catch within fleet. The Pacific Islands and Taiwanese distant-water fleets appear to have a high proportion of albacore in their catch and a relatively high CPUE regardless of fishing depth. In contrast, the Australian domestic fleet catch far fewer albacore even though the fishing depth range (inferred to by "hooks between floats") is similar to that of the Taiwanese longline fleet.

319. Figures showing the tuna species composition by hook number and quarter (collected by observers) also provide some insight into the availability of each tuna species to the gear by (relative) depth and season for selected Pacific Islands fleets. Albacore tuna appear to be consistently less available to shallowest (i.e. the first 2–3) hooks for these fleets. Albacore catch beyond the shallowest hooks is higher and reasonably consistent, although there are some instances of variation in the catch by hook depth and season (for example, albacore observed in French Polynesia in the fourth quarter tended to be more available to deeper hooks). In contrast to albacore, there are instances that suggest yellowfin are generally taken on shallower hooks and bigeye taken on deeper hooks. This is generally in line with the results from studies conducted under elsewhere for example, the ECOTAP (*Etude du Comportement des Thonides par l"Acoustique et la Peche*) project using time-depth recorders in the longline fishery in French Polynesia.

320. In concluding the presentation, Mr Williams indicated that it would be prudent to continue efforts to monitor and improve the coverage of this type of information in the future.

321. In response to a query as to whether the bigeye bycatch from the albacore fishery was included in bigeye assessment, Mr Williams confirmed that it was. It was also queried as to whether the number of hooks per basket was a good indicator of fishing depth as the fishing strategies used across the domestic fleets was likely to be quite variable. As a follow-up to this it was suggested that the fishing strategies for each fleet should be documented, and in particular the analysis would need to take into account the presence or not of a line shooter. It was also suggested that the American Samoa data should be included in the analysis as they are available on the web. R. Etaix-Bonnin commented the fact that New Caledonia has just reinitialized ZONECO, a research programme with a project of monitoring longlines with temperature-depth recorders; and that the first results should be available at next SCTB.

Data Coverage

322. Mr Peter Williams gave a brief presentation of data issues referring to ALB-3: *A summary of aggregate albacore tuna catch/effort and size composition data available to the SCTB*. It was explained that the information provided in this paper was in response to directives from SCTB14 and SCTB15. Data for most longline and troll fleets are generally provided on a timely basis. There has been a delay in

receiving, and then processing, some data and this is why the data for some fleets in recent years do not yet appear in the tables described in this paper. Size composition data for the French Polynesian fleet have not been provided in recent years due to a cessation of port sampling, but some size data do exist from observer activities in that country.

323. In the discussion it was noted that some Cook Islands data were missing and Mr Williams indicated that the tables would be corrected once catch estimates are finalized. He also informed the meeting that Cook Islands is starting a port sampling programme that should provide length frequency distributions to SPC.

10.2 Biological and Ecological Research

324. Dr Talbot Murray presented ALB-8: *Measuring the length structure of commercial landings of albacore tuna during the 2002-2003 fishing year*. The port sampling programme provides size-composition data to OFP for stock assessment and this programme is reviewed on an annual basis. In recent years an increasing number of vessels fished off the west coast of the North Island necessitating an additional port (New Plymouth) be sampled during the 2002/03 season. Fish sampled in this port were substantially smaller than those caught elsewhere. The programme has a target CV (mean weighted across size classes) of 30%. In 2002/03 this was slightly exceeded because of increased variability in the size structure of catches. Stratifying the CV estimation by port and increasing sample size is being considered to address this.

325. Clarification was sought as to whether the change in size composition was due to the fleet fishing a different area as opposed to poor sampling in previous years. In response, it was explained that additional analyses had indicated that the sampling in previous years was representative of the distribution of the fleet and that the change in 2002/03 appears to be due to smaller fish being found off the New Plymouth area. The meeting noted that these data were extremely valuable in the albacore stock assessment and provided critical estimates of recruitment to the South Pacific stock and the meeting hoped that this sampling will continue.

326. Dr Patrick Lehodey presented ALB-9: *SEPODYM application to albacore (Thunnus albacares) in the Pacific Ocean*, which describes preliminary results based on the first application of the spatial environmental population dynamics model (SEPODYM) to the albacore species in the Pacific Ocean. Compared to the skipjack application, the parameterization has been modified to take into account the biological characteristics of the species, its lower temperature optimum and its deeper vertical habitat. For this first simulation, the spawning habitat was only constrained by SST. Results showed realistic spatial distributions of the larvae and juveniles and of adults in both North and South hemispheres with a natural separation between the two stocks along the equator. As expected with a spawning habitat index only constrained by SST, the recruitment does not show important fluctuations. However the level of recruitment and biomass for the three regions defined for the MULTIFAN-CL analysis of the southern stock are similar to the average levels predicted by this statistical population model. Therefore these first results suggest that with an appropriate parameterization the modelling approach developed for skipjack can be adapted for long living species like albacore. Parallel development in modelling and

parameterization of both skipjack and albacore will be helpful to explore the recruitment mechanisms that show apparent opposite trends in their fluctuations. Future tasks will consider the effect of primary productivity in the spawning habitat and the introduction of fisheries in the model.

327. In response to a query about whether albacore recruitment should increase with La Niña events, Dr Lehodey confirmed this hypothesis and added that based on this occuring that the fisheries in French Polynesia and American Samoa should be affected (the current La Niña event would be a good test). It was also queried if differences in catchability could reflect change in the depth of the mixing layers. Dr Lehodey confirmed it should be easy to investigate this effect and that he would also like to introduce variability in growth rate into the model. In reply to a question about if there were reasons that could explain the decrease in recent catch rates it was explained that analysis showed that effects vary spatially, an El Niño event producing a stronger impact in the Central Pacific (French Polynesia, Samoas) than in the western region. As a follow-up it was then queried whether it would be necessary to increase the spatial resolution of the MULTIFAN-CL model with an east-west component. Dr Lehodey felt that adding a separate area for the Coral Sea in Western Pacific would be worthwhile. Asked if El Niño might induce a mixing between the North and South stocks during recruitment, Dr Lehodey explained that there is a clear separation between the North and South stocks with an asymmetry between the two and different impacts driven by environment effects.

328. Dr John Hampton presented ALB-4, a GLM-based analysis of Taiwanese longline catch and effort for South Pacific albacore tuna. Data were aggregated by year, month and five-degree square. Independent analyses using a common model structure were carried out for each of the three MULTIFAN-CL model areas. The final model structure predicted catch as a function of effort, year, month and an interaction term for latitude and longitude. The fitted models accounted for a high proportion of the variance in catch, most of which was attributable to variation in effort. The parameterisation of the various factors was broadly consistent with our understanding of the fishery. Standardised CPUE was generally similar to nominal CPUE, and showed similar trends among the three areas – declining in the 1960s followed by a period of stability or slight decline. High variance was associated with some of the indices, particularly in the northern region and in the initial years in the southern region. The explanatory power and precision of the estimates may be improved with higher spatial resolution data.

329. It was noted that the records with zero catch were excluded from the data set and a suggestion was made that they could be included if a Poisson distribution were used in the analysis. Whilst agreeing that this may be possible, Dr Hampton pointed out that the Poisson model may be too restrictive in its variance assumptions. It was also queried whether the declines in CPUE would be more dramatic if zero catches had been included. Dr Hampton felt that the CPUE series in Area 1 could change. It was suggested that it would be useful to further investigate this possibility using the 5-degree square/month resolution.

330. It was reported that the CPUE index of the Taiwanese fleet in the Indian Ocean starts in 1955, and it was queried whether similar data may exist for the Pacific. In reply, Dr Hampton noted that the catch and information goes back as far

as 1964, and the size composition data go back to 1963. However, detailed information by 5-degree squares, needed for the standardisation analysis, starts only in 1967.

331. It was suggested that the increasing trend in bigeye catch of the Taiwanese longline fleet could result in a negative bias in the estimate of albacore CPUE. Dr Hampton agreed that it could have an impact, but noted that the bigeye variable in the model has no significant effect in predicting albacore CPUE.

332. It was further queried as to whether it would be possible to use finer scale data to do the standardisation analysis. Dr Hampton noted that the suggestion of using finer scale data was made in the paper, but indicated that the availability of data would be a limiting factor. A suggestion was made that perhaps a standardized CPUE index could also be derived from data of the Pacific Islands fleet.

10.3 Stock Assessments

333. Dr John Hampton presented the MULTIFAN-CL based assessment of albacore tuna in the South Pacific referring to ALB-1. The structure of the model and data were similar to that used in previous years. The main findings of the assessment were as follows:

- Recruitment was higher on average prior to 1980. Recent recruitment levels have been below average, but these estimates are relatively imprecise.
- Biomass levels have largely reflected the recruitment variation, peaking in the late 1950s and 1970's. Current biomass is estimated to be about half of the maximum estimated levels and about 60 % of the estimated equilibrium unexploited biomass.
- Fishing mortality is much higher for adult albacore than for juveniles, reflecting the predominantly longline exploitation. Fishing mortality rates are lower than natural mortality rates over a plausible range of tag-reporting rates.
- The impact of the fisheries on total biomass is estimated to have increased over time, but is likely to be low, a reduction of about 3% from unexploited conditions.
- The estimation of equilibrium yields as a function of fishing mortality and *F*- and *B*-based reference points is hampered by the very low resolution of absolute abundance estimates by the model. This is likely to result from the combination of low exploitation rates, a small amount of tagging data, and no independent information on tag-reporting rates. Nevertheless, the model results continue to indicate that recent catches are less than the MSY, aggregate fishing mortality is less than F_{MSY} and the adult biomass is greater than B_{MSY}.

334. Discussion ensued around the effort deviation estimates from the Taiwanese longline fisheries in the central and southern regions. Surprise was expressed at the pattern of the effort deviations and it was queried whether all of the effort data was accounted for in the analysis. In reply it was suggested that the autocorrelation behaviour observed in the residuals could be remedied by including variable catchability for these fisheries in the model. The constraints between long-term catchability and environmental variability could perhaps be modelled more effectively in the next assessment.

335. In response to a query as to why the Japanese longline fishery data was added to the Taiwanese longline fishery data in the central region, it was explained that the intention was to have the combined CPUE of these fleets be the main index for the central region. A further query noted that the New Zealand troll residual signals indicated that some seasonal patterns may be causing the large negative and positive deviations during the 1960s and 1980s. It was concluded that the Taiwanese CPUE was an important index for the albacore assessment. If an attempt were made to bring the residuals closer to zero throughout the time series, by changing some of the model assumptions, this would result in the biomass trend more closely following the CPUE trend. Perhaps the inclusion of auxiliary data such as results from archival tagging could be incorporated to improve future assessments.

336. In response to a concern that the tag-reporting information does not include such information as tag-mortality, Dr Hampton agreed that post-release mortality is a problem with tagging experiments but noted that the amount of tagging data not useable was minor.

337. It was noted that for albacore no habitat-based abundance indices have been developed (e.g. HBS, StatHBS), and it was queried whether such analysis may be expected in future assessments. Dr Hampton also noted that for albacore tuna estimation of equilibrium yield and reference points is hampered by the very low resolution of absolute abundance estimates given by the MULTIFAN-CL model. Accurate estimates of fishery impacts and sustainable yield ultimately requires information from tagging experiments.

338. Dr Chien-Hsiung Wang presented an analysis based on Schaefer's surplus production model, referring to ALB-7. Theoretically, a generalized method can be obtained from Schaefer's model. Irrespective of whether the assumptions of catch at equilibrium, constant carrying capacity, and environmental condition are met, it can be applied to assessing fish stocks for estimating the current carrying capacity, virgin carrying capacity, the intrinsic growth rate, and catchability. Based on total longline catch and effort data, the results revealed that the South Pacific albacore stocks are still in good condition.

339. During the discussion of this paper it was pointed out that the index a_t displayed a strictly decreasing trend and seemed to warn of a decrease in biomass. Dr Wang replied that a_t is the relative ratio of the biomass over carrying capacity and as such cannot reflect the variation of biomass directly. It is also dependent on changes in carrying capacity. It was also noted that the catch data in Table 1 of ALB-7 is incomplete as it only included data from the Taiwanese fleet. In response Dr Wang stated that the MSY is based on the total longline catch only. Moreover, it is based on the catch at equilibrium, not on this generalized method.

340. In reply to a query about the relationships between the index a_t and MSY, Dr Wang indicated that the generalized method was used to estimate the varied carrying capacity and as such the concept of MSY should be redefined. From the discussions it was agreed that a further work was required in order that a number of important issues be adequately addressed (in particular, why does the fishery have such an enormous impact on the biomass as indicated by the ratio of biomass to carrying

capacity?) The chairman therefore recommended that Dr Wang investigate these issues intersessionally, in collaboration with other scientists of the group if needed, so that the discrepancies between the results from the models be reduced.

10.4 Research Coordination and Planning

341. It was agreed that the priority activities identified at SCTB15 should be carried over for another year. These include:

- monitoring of catch, effort and size composition of albacore caught by the different fleets, especially the longline fisheries;
- information on vertical habitat utilization by albacore as well as gear configuration and fishing depth.

342. It was also agreed that the possibility of conducting a large-scale conventional tagging project to get more accurate estimation of albacore abundance and fishing mortality should also be investigated.

10.5 Summary statement

343. A summary statement on the status of albacore tuna in the south Pacific Ocean was drafted, circulated to participants and discussed. The agreed statement is incorporated in the Executive Summary (see page 25).

11. BILLFISH AND BYCATCH RESEARCH GROUP (BBRG)

344. Mr Paul Dalzell, the coordinator, led the session of the Billfish and Bycatch Research Group.

11.1 Billfish

345. Dr Don Bromhead presented BBRG-14, *Striped marlin: An analysis of fishery interactions off the southeast coast of Australia*. Tag-recapture data for the southeast coast of Australia demonstrate that the domestic longline and recreational gamefishing sectors are catching striped marlin of the same stock. Both fleets catch the same size classes of striped marlin and recoveries of recreationally tagged striped marlin indicate that around half have been recaptured by commercial longline gear. Spatial mapping of marlin catch and release data show that interactions are low in the northern region, with the exception of waters off Coffs Harbour. In the southeast, spatial interactions are much greater, particularly off Port Stephens and Bermagui. In eastern coastal waters (as opposed to offshore waters), both sectors tend to record their highest seasonal catch in the interaction region off Bermagui..

346. Annual catch rates have increased in both fisheries over the past decade. In 2002, however, catch rates in the southeast charter fishery declined in contrast to longline catch rates. There is little evidence that increasing annual commercial catches have negatively impacted annual charter catch rates but such comparisons might miss negative interactions that may occur on smaller temporal scales. Monthly catch rates in both fisheries tend to mimic one another, which suggests that trends in both fisheries may be predominantly reliant on underling abundance or availability of striped marlin. In March 2002, however, longline catch rates were considerably higher than previously observed, while charter vessel catch rates were comparatively low. The commercial catch of striped marlin was also much higher in this month, and species composition analyses suggested that striped marlin had been deliberately targeted during this period. Interpretation of this one outlying point is confounded, however, by a lack of charter data from Bermagui, which previously had exhibited the highest catch rates for marlin relative to charter operations in other ports. It was recommended that further analyses and monitoring of this interaction region be conducted in future.

347. Without catch rates being standardised, and with limited fine-scale charter data for that month, evidence for a cause and effect relationship in this instance is very limited. Overall it appears that at “normal” historic levels of commercial catch and catch rates, recreational catch rates will be predominantly effected by underlying abundance or availability of marlin. Continued monitoring of the main interaction region is needed into the future, with regular collection of charter catch effort data and need for finer spatio-temporal scale analyses using standardised catch rates.

348. Discussion included whether any inferences could be made on the status of the striped marlin stock. At this stage it was unlikely that any inferences could be made without further investigations into fishing effort standardization. While most tag returns came from Australian waters, one tag had been recovered in Vanuatu. Most recaptures were made seasonally along the coast by longliners within the EEZ, but

few tag returns were received from offshore longliners.

349. Dr Natalie Dowling presented BBRG-4: *A management strategy evaluation (MSE) approach for broadbill swordfish, Xiphias gladius, in the south-west Pacific*. She explained that the aim of a MSE is to evaluate the performance of, and identify the trade-offs among, management objectives under a range of possible harvest strategies. This is done via the use of various operating models (mathematical or statistical representations of the population dynamics) that encompass the range of possible realities in the face of uncertainties. The Eastern Tuna and Billfish Fishery (ETBF) underwent a rapid expansion during the second half of the 1990s, and in 2001 the ETBF agreed to an input control in the form of a total allowable effort (TAE). In establishing an initial TAE, the MSE approach can be applied to investigate the ecological and economic sustainability of alternative effort levels.

350. Using alternative operating models reflecting three alternative assumed historical depletion levels, the effect of eight alternative fixed effort strategies was considered in model projections. The operating models included multiple fleet dynamics across five spatial areas. It was shown that the management decision for an initial TAE involves a trade-off between improved economic but poorer conservation performance. The risk associated with the assumed biological inputs is also an important consideration as the performance indicators show some sensitivity to assumptions regarding movement, natural mortality and the stock-recruitment relationship. An example of a simple empirical decision rule was also presented, as it is unlikely that any management plan would permit a long-term fixed effort level that disregards changes in performance indicators.

351. The MSE framework is a valuable tool for ongoing analyses of alternative harvest strategies, and the results presented are a small subset of the management strategies that may be examined. The MSE can readily incorporate formal stock assessments for broadbill swordfish as they become available. Further, the definitive MULTIFAN-CL stock assessments developed by the SPC could be incorporated into an MSE framework for the WCPO. This would enable a comprehensive evaluation of proposed harvest strategies within the "reality" described by the operating model(s).

352. There was a discussion about including other species in the operational model, especially bigeye and yellowfin tunas. It was pointed out that whilst this remained a longer term objective, some understanding of the decision rules used by fishers to switch targeting from one species to another would be required. Swordfish had been the initial focus of the project as the catch of this species had been a main driver of the fishery in recent years. There were also comments about the need to stratify the study area to account for the spatial separation of spawning grounds, nursery areas and adult habitat.

353. Dr Robert Campbell presented BBRG-3, *Analysis of swordfish-seamount-environment-fishery interactions off eastern Australia*. Until 1995 broadbill swordfish had been only a minor by-catch species in the domestic longline fishery operating off eastern Australia. However, following the successful targeting of swordfish by several vessels in the Mooloolaba region in 1995, a fishery targeting this species developed rapidly with the catch of swordfish increasing to around 3,000 mt in 1999. Fishing effort was initially concentrated inshore. However, as effort in the inshore region

increased there was a significant decline in catch rates and fishing effort moved further offshore where high catch rates were maintained. This pattern has been repeated in subsequent years. Indeed, catch rates in regions fished in previous years tend to show a relatively consistent pattern of decline over time, while relatively high catch rates have been maintained on the periphery of the fishery as it continues to expand further offshore.

354. Several hypotheses were offered to explain this sequential pattern of declining catch rates. First, catch rates may have declined due to competitive interactions between vessels. As more vessels moved into a particular area, and as more hooks were deployed, there was a detrimental effect on catch rates across all vessels. Second, there may be an ongoing sequential depletion of localised sub-populations of swordfish around seamounts. For example, if there is an affinity of sub-populations of swordfish to particular locations (ie. seamounts), and if these sub-populations have a slow replenishment dynamics, then these sub-populations remain vulnerable to fishing. i.e. the rate at which fish are being removed is larger than the replenishment rate, with the consequence that the size of the local resource (and consequently catch rates) in the these fishing area has decreased over time. The build up of excessive effort in these areas would help exacerbate this effect. Third, spatial shifts in the distribution of the swordfish resource may have occurred in response to changes in regional environmental and/or oceanographic conditions. Finally, changes in the composition of the fishing fleet (more vessels with less skill and experience in the fishery) and associated changes in targeting practices may also explain the declines in observed catch rates.

355. Subsequent analyses did not support the hypotheses that the declines in catch rates have been due to preferential targeting or changes around seamounts, changes in the fishing strategies adopted by fishers or oceanographic conditions on the Mooloolaba Grounds. Furthermore, the hypothesis that overall catch rates may have dropped due to the increased presence of less experienced vessels does not appear to be supported. Finally, while the analyses support the notion that competitive interactions between vessels has have been a factor in decreasing overall catch rates, this factor alone does not account for the major declines seen in catch rates across the region. Nevertheless, these conclusions remain contingent on the accurate reporting of fishing practices in logbooks.

356. If the pattern of 'localised decline' in the catch rates of swordfish off eastern Australia continues to be observed in future years there may be negative consequences to the longline fishery and the swordfish populations in this region. This may raise the need for some form of spatial management. Finally, the observations and consequent analyses reported have implications for our understanding of the spatial distribution and the movement dynamics of a 'highly migratory' species such as swordfish.

357. In the discussion it was noted that some seamounts may be more important than others for the longline fishery. It was also noted that these seamounts had been fished previously by Japanese vessels, though it was acknowledged that swordfish had not been targetd by this fleet. There was also pointed out that there is no apparent trend of decreasing size of swordfish with increasing effort based on port sampling data, though a full spatial analysis is yet to be completed.

358. Dr Jock Young presented the results of studies on the reproduction, feeding and ageing of swordfish off eastern Australia (BBRG-8). An annual cycle of marginal increment formation was indirectly validated in the second anal fin spines of swordfish from eastern Australia using both measured and subjective interpretations of spine edge characteristics. The latter was quicker and gave more information as to the status of the spine margin. Presumed daily otolith increments also fell within the size range of 1 year old fish. A standard von Bertalanffy curve was fitted with parameters L_∞ K and t_0 of 323.2, -082 and 4.0 respectively for females and 249.2 - 0.013 and 3.3 for males, falling within the range of previous estimates for swordfish elsewhere. The lack of clarity in some spines and the relatively high differences in readings within and between laboratories may explain some of the variation shown across studies. A validated age and growth of swordfish is needed.

359. In reponse to a question about the estimated age at maturity for swordfish in Australian waters it was stated that this was approximately 10 years for females and 5 years for males. It was also pointed out that approximately 20% of the anal spines had been unreadable.

360. Dr Talbot Murray presented a paper on factors affecting catch rate of swordfish in the New Zealand tuna longline fishery (BBRG-9). The bulk of swordfish catches in the southwestern Pacific Ocean south of 25^{o}S are taken in longline fisheries in the Australian and New Zealand EEZs and adjacent high seas areas. Catches by all fleets had now reached over 2000 mt in the Australian region and 1500 mt in the New Zealand region. While catches in the Australian region were higher than in New Zealand effort in the latter was about twice that in the Australian area reflecting the difference in targets in the two areas. While some of the increase in swordfish catches was clearly due to increasing effort, since 1991 CPUE had risen faster than could be explained by the increase in effort only. However, this increase was only seen in the domestic fleet targeting bigeye. Results from a series of analyses of logbook and observer data showed that fleet, season, area, environment and operational practices all affect swordfish and bigeye CPUE. In particular, in the NZ domestic longline fishery:

- Swordfish CPUE is highest during the March to May while bigeye CPUE is highest in September and October.
- Swordfish CPUE tends to be higher south of 38º S while bigeye CPUE tends to be higher north of 35º S.
- Swordfish CPUE is higher on small sets (< 955 hooks) while bigeye CPUE is higher on longer sets (> 1263 hooks).
- Swordfish CPUE is markedly lower (about half) on sets starting after midnight and before noon, the effect on bigeye CPUE is variable.
- Swordfish CPUE increases with increasing moonlight and is at its highest around full moon, bigeye CPUE is not related to moon phase.
- Swordfish CPUE increases with increasing use of light sticks; moderate to high use is associated with CPUE levels about four times those sets not using light sticks; low to moderate use increases bigeye CPUE about 40%.f

361. In the discussion it was noted that domestic New Zealand longline vessels were not allowed to target swordfish. Prior to the development of the domestic longline fleet, foreign vessels were not allowed to retain catches of striped marlin, and this was extended to other billfish. Domestic boats could retain billfish but were not allowed to target them. There was voluntary agreement on this measure in the early days of the fishery but will be formalized in 2004 with a catch limit.

362. Dr Chi-Lu Sun presented the details of a study for conducting an assessment of the stock of swordfish in the North Pacific based on an age- and sex-structured population dynamics model (BBRG-11). The study will examine the sensitivity of the results of the assessment to changes to assumptions (including the treatment of sex-structure) and data set choices. It will also evaluate the uncertainty of the estimates of management-related quantities using classical (frequentist) and Bayesian methods. The presentation outlined the age- and sex-structured population dynamics model on which the analyses will be based and the objective function that will be minimized to find the "best estimates" of the values for the parameters of the model.

363. There was discussion about the spatial structure and how this would be handled in the model. At this point the authors of the study had not decided on movement parameterization. Dr Pierre Kleiber noted that movement was not well modelled in the Hawaii swordfish simulation model.

364. Dr Kotaro Yokawa presented BBRG-13: *Preliminary resuls of comparison of vertical distribution pattern between Atlantic blue marlin and its CPUE*. Vertical distribution pattern of billfishes have been used for estimating effective fishing effort of Japanese longliners in studies of CPUE standardization using the habitat model. In these studies, the probability that a billfish take bait in a vertical stratum is assumed to be proportional of total time it spends in that stratum. To confirm this hypothesis, a longline research cruise was conducted in the tropical Atlantic in 2002. During this cruise, archival pop-up tags attached on Atlantic blue marlin to obtain data for estimating vertical distribution pattern. A large number of recorders were attached to the longline gear to obtain hooking time, depth and temperature of Atlantic blue marlin. In total for the cruise, the number of time, temperature and depth recorders used was 15% of total hooks deployed. The vertical distribution of blue marlin was estimated using a total of 105 days recorded by archival pop-up tags attached to 6 specimens. The trend of CPUE in the water column was estimated with hooking information on 35 specimens and estimated vertical coverage of gears. The vertical trends estimated by categorizing the data by 25m depth layers or by relative temperature to the surface differed. This result indicated that further study is required to get better input for the habitat model.

11.2 Sharks and Other Species

365. Mr Ludwig Kumoru made a presentation on the shark longline fishery in Papua New Guinea (BBRG-2). Shark fishing has a long history in PNG waters where artisanal and community fishers have contributed to the trade in dried shark fins and various large scale operations have taken place including a drift net fishery and a trial shark fishing for deep water sharks for shark oil.

366. In the mid 1990s, the freezer vessels that were part of the tuna longline fishery became increasingly involved in targeting sharks for fins and meat. The fishery was unregulated and not well documented and the vessels increased to a peak of 21 vessels in 2000. This was considered unsatisfactory as these vessels were licensed as tuna longliners. As a result a separate fishery was recognized, and a Management Plan was developed which recognized that a modest fishery targeting primarily oceanic carcharhinid sharks was sustainable in the PNG EEZ if properly managed.

367. The fishery is presently managed under the Shark Longline Management Plan approved last year and gazetted this year. The fishery is limited to 9 vessels (20-30m LOA), and the vessels are all national. They fish shallow to target sharks, have area preferences, use tuna as bait and all catch is processed and frozen onboard. Logsheet coverage has been poor until recently as the fishery was not distinguished from tuna as noted and logsheets did not capture shark catch well. Estimates of catch are derived from landings and exports and the observer coverage (since 1999) has been important for species composition and documenting fishing and processing practices. Catch for 2002 (all species) was 2000 mt processed weight of which 1530 mt (80%) was shark and the rest was tuna and billfish. Silky shark comprises half the catch of sharks followed by oceanic white-tip and grey reef shark plus a range of other species. There is some variation in the percentage retained in that low value species such as blue sharks are not retained. Fishing is PNG wide species such as silky shark show wide distribution but some show association by area. Fresh chilled tuna longline vessels also catch small amounts of various sharks. Most of the catch is exported frozen to Taiwan, but the meat is of low value so an increasing proportion is now processed locally for food bars. Exports for 2002 were 1329 mt, which were 87% of the estimated catch and was valued over USD 1.5 million.

368. In response to a question about whether there were any conflicts between inshore and artisanal fisheries, and the shark longline fishery it was pointed out that this was not a problem a present. It was also noted that billfish catches were low despite the shallowness of the sets. This was thought to be due to sets being mainly made at night.

369. Dr Valerie Allain presented BBRG-5: *A preliminary ECOPATH model of the warm pool pelagic ecosystem*. It was explained why modelling this ecosystem was important and why ECOPATH was chosen as a modelling tool. ECOPATH requirements were reviewed (biomass, production, consumption, ecotrophic efficiency, diet, fisheries catch) and the study area was presented. The origin of the data and the different groups involved in the model were also detailed. Part of the checking procedure of the model parameters was presented as well as the balanced model outputs. Results of a test ECOSIM run consisting of a doubling of fisheries catch were briefly shown as an example of the approach but the results are not considered plausible as this stage. Details of the work needed to improve the model were provided, though limitations of the ECOPATH modelling approach were also acknowledged. It was concluded that ECOPATH is a useful aggregation tool that allows detection of data gaps and that it will be useful for evaluating management strategies and for gaining a better understanding of the impact of possible regime shifts. By giving information on the impact of management strategies and environmental effects on the bycatch species, it was also seen as a good complement to single-species modelling.

370. In the discussion it was noted that a lot of the ECOPATH processes are unknown and the models are important to generate hypotheses for understanding the ecosystem. The discussion also touched on the possibility that such modelling exercises might be useful for generating ecosystem based reference points and control rules. There might be problems with this, however, in terms of factoring in different values, i.e. existence values versus ecosystem values. For example, it might be shown by the model that harvesting whales would have little impact on the ecosystem, but this would be opposed by environmentalists. It was pointed out that the logical next step would be to incorporate some single species population dynamics into the models; i.e. put in tuna data and build a model which would address management needs and identify data needs. It was noted that Canada's Department of Fisheries and Oceans (DFO) has initiated development of ecosystem-based reference points.

371. Dr Valerie Allain presented BBRG-6: *Diet of mahi-mahi, wahoo and lancetfish in the western and central Pacific*. To determine trophic interactions a large sampling programme has been implemented in collaboration with the observer programmes within the region. Observers are asked to collect stomach samples of target and bycatch species. They are analyzed with a classical protocol at SPC and so far 1000 stomach of 47 different species have been examined. The diet of wahoo, dolphinfish and lancetfish, three major bycatch of the longline fishery were detailed. A fullness coefficient, presence of baits and prey group and species composition were presented. The three species have different feeding strategies eating different preys. The results of this study will be used in the ECOPATH modelling of the pelagic warm pool ecosystem, and completed with isotope analysis they are part of a Pacific-wide project funded by the PFRP: "Trophic structure and tuna movement in the cold tongue-warm pool ecosystem of the equatorial Pacific".

372. In the discussion the hope was expressed that the analysis would be extended to moonfish. It was explained that this was to be done, but that at present only 32 stomach samples had been collected. It was also noted that there were not many fish with full stomachs. It was hypothesized that this may be due to mainly hungry fish being hooked as if a lot of forage is available then catches would be low. In response to a question about regurgitation, and whether this could be an issue, it was explained that the thickness of the stomach wall can indicate whether a stomach has been full and distended, but there was no evidence for this. It was also noted that the number of samples is presently too small to look at seasonal differences. There was additional discussion about complementing the stable isotope work with fatty acid and DNA analysis.

373. Dr Masashi Kiyota presented a preliminary analysis of data from the Japanese pelagic tuna fisheries to estimate seasonal migration of whale sharks (BBRG-12). The geographical and seasonal occurrence of 'shark sets', purse-seine and pole-and-line operations targeting schools of skipjack tuna and albacore associated with whale sharks, was analysed. In the waters near Japan, shark sets occurred in early summer to late autumn, and were most frequently observed between 35-40ºN and 140-150ºE in July-August. The number and rates of shark sets fluctuated year by year, probably due to the changes in the pattern of fishing operations and in the distribution of targeted fish. The authors suggested that the accumulation of fishery-related data on the

occurrence of whale shark would provide valuable information on migration and abundance of this species.

374. The discussion touched on the fate of whale sharks caught in tropical purse seine catches. Observers had recorded small to medium sized fish which were all successfully released. In the Indian Ocean there were similar sets made on whale sharks which were being tagged with electronic tags.

375. Dr Masashi Kiyota presented an outline of Japan's research and management activities directed at solving longline interactions with sharks, seabirds and sea turtles (BBRG-10). In accord with Japan's National Plans of Actions for the Conservation and Management of Sharks and for Reducing Incidental Catch of Seabirds in Longline Fisheries, research activities and educational programs have been promoted in Japan by the Fisheries Research Agency in collaboration with universities and other organizations. Data collection and stock assessments are conducted for the resource management of pelagic sharks. On the other hand, many kinds of mitigation measures have been developed, evaluated and modified to minimize incidental mortality of seabirds in longline operations. Protection of the breeding habitats of Short-tailed albatross (*Diomedea albatrus*) has been promoted by the Ministry of the Environment, and the population is recovering successfully because of the conservation efforts on land and at sea. The conservation of sea turtles is a rather difficult task since sea turtle populations are affected by many factors including direct and indirect disturbance by human activities. The Japanese government sets a policy that holistic management of all the relevant factors is important for the conservation of sea turtles. Preparatory studies for the mitigation of fisheries interactions and for the conservation of nesting sea turtles have also been initiated in Japan.

376. In the discussion the question was asked about the use of circle hooks and other mitigation methods to reduce turtle interactions. It was explained that at present there were no definitive results, other than that depth seemed to be effective in minimizing interactions. It was noted that in the US Atlantic longline fishery, work by NMFS had shown that offset circle hooks and mackerel bait had reduced turtle interactions, but increased swordfish catches.

377. Dr David Kirby gave an outline of a recently commenced project which aims to extend an individual-based model approach initially developed for tunas to the North Pacific loggerhead turtle (BBRG-1**)**. This is a relatively well studied population, in terms of basic biology, nesting activity, pelagic ecology and fisheries interactions, and so the necessary information to allow the initial development of the model should be available. Once it is operational, the model will be made available to researchers interested in developing it further, particularly in comparison with other population dynamics studies of Pacific turtles.

378. In the discussion there was strong support for this type of study as conventional protected species population dynamics models do not show the statistical modelling detail as in fisheries models.

379. Mr Wade Whitelaw reported on observed and logbook longline catch data off Eastern Australia south of 30^{o}S (BBRG-15). This report summarized the catch and bycatch recorded by both logbooks and independent observers. The preliminary

analysis showed that logbook data compared fairly well with observed data for the main target species except for yellowfin tuna. There was, however, a mis-match for bycatch species such as lancet fish, oilfish and pelagic rays and blue and black marlin. The catches of all these species were reported in greater numbers by observers. While the logbook recording of turtles and birds had improved, it still was less than the levels recorded by observers. It was noted that the observed data were mainly collected from daytime sets while the logbook data covered both day and night sets. The longline observer program off eastern Australia is now extending along the entire east coast and it is planned to have a 5.1% coverage for the next 5 years.

380. Mr Paul Dalzell presented a joint study of WCPO mahimahi and wahoo catches in Pacific longline and troll fisheries conducted by the Western Pacific Fishery Management Council and the OFP. Annual mahimahi catches in the Pacific Islands were generally small, of the order of a few hundred tones, but Taiwan, with its large longline fleet landed on average almost 7,000 tonnes per year. Plots of mahimahi and wahoo across the WCPO showed that catch rates of these species were highest in sub-tropical latitudes. Catch rates were also strongly seasonal, with on average a three-fold difference between low and high season. Longline catch rates of mahi and wahoo showed strong stratification by depth (as expressed by distance of the hook from the float line), with mahimahi CPUE highest on the shallowest hook, and wahoo CPUE highest on the third hook from the float line.

381. Information on catches of wahoo and mahimahi in troll and longline fisheries in the US Pacific Islands was also presented. Catches of both species have been variable in both longline and troll fisheries, but have increased markedly in American Samoa due to the rapid expansion of the longline fishery after 2000. Troll and longline catches have increased over the past 20 years in Hawaii. Catch rates have also been variable but both troll and longline catch rates show reasonably similar trends in Hawaii and American Samoa. Similar catch rate trends for mahimahi and wahoo were also noted for troll fisheries in Guam and the Northern Mariana Islands. The average size of wahoo in troll and longline catches in Hawaii had remained relatively stable over the past two decades, as did the troll caught mean size of mahimahi. Hawaii longline caught mahimahi showed a major decline in mean size between the 1980s and the 1990s. The average size of mahimahi and wahoo were larger in longline compared to troll catches. Troll caught wahoo declined in size in American Samoa. The average sizes of mahimahi in Guam and the CNMI were similar, but wahoo were slightly larger in the CNMI troll fishery.

382. It was noted that in the discussion that many mahimahi were caught actually on the haul back, when longline gear was acting like a trolling gear.

11.3 Suggestions for SCTB 17

383. There was support for more emphasis on fish bycatch in future Billfish and Bycatch Research Group meetings, particularly from a trophic perspective.

11.4 Recommendations

384. The BBRG made the following recommendations:

1. A strong focus should continue to be maintained on monitoring regional billfish catches, both in commercial pelagic fisheries and from recreational fisheries

2. The BBRG notes the importance of observer programs in obtaining accurate estimates of bycatch. As such efforts should be made to improve observer coverage in WCPO pelagic fisheries in order to obtain more reliable statistics on bycatch, and to permit risk analysis on bycatch species. Prior to implementation, the objectives for an observer program and the process by which these objectives can be met should be clearly identified. The risk assessment currently being conducted to set objectives for an observer program for the Australian East Coast swordfish fishery may be a useful paradigm for this process;

3. Participants should strengthen data collection on turtle interactions in pelagic fisheries in order to refine estimates of the interaction problem, due to concerns regarding the population status of Pacific turtles. The BBRG also recommends closer collaboration and liaison by participants with the appropriate government and regional agencies to ensure that turtle nesting sites are inventoried, and non-fishery related impacts on turtle populations are clearly identified and addressed, to place fishery impacts to turtle populations in context. Some of this broader analysis may be done by other organizations, but SCTB should remain informed of the issues and be able to evaluate information and analyses as they are used to set management policy.

4. The BBRG recommends that a watching brief be maintained on other bycatch issues as they arise, e.g., future developments under the FAO IPOAs on seabird-fishery interactions, and on shark fisheries.

5. The BBRG recommends that additional research be conducted on stock structure and stock boundaries of species of interest to the BBRG.

6. The BBRG, noting the review of logsheet programs and biological data programs by the Statistics Working Group, recommends that data collection programs be modified to better report bycatch species.

11.5 Summary statement

385. A summary statement on billfish and bycatch isses in the WCPO was drafted, circulated to participants and discussed. The agreed statement was incorporated in the Executive Summary (see page 30).

12. CROSS-CUTTING ISSUES

386. Dr Tony Lewis chaired the session convened to discuss issues which were common to, or cut-across, several of the individual Working and Research Groups. Many of these issues, or themes, emerged from discussions within the previous Working and Research Groups sessions and relate to research needs and, in particular, focused on ongoing needs and gaps in stock assessments. The purpose of the session, therefore, was to prioritise these research tasks and find procedures via which research on these issues could be better progressed and coordinated by SCTB. While such issues have arisen and been discussed briefly at previous SCTB meetings, this was the first time that SCTB had dedicated an entire session to this task.

387. The discussion was guided by a draft list of issues and themes which was circulated by Dr Lewis. The session was rapporteured by Dr Robert Campbell.

12.1 Catch and Operational Details

Catch Estimates

388. Two high priority issues were identified:

a) Philippines Port Sampling - It had been noted during the SWG session that port sampling in the Philippines had ceased last year due to funding constraints. The SCTB placed a high priority on restarting this program, perhaps with an initial emphasis on tuna species. The possibility of obtaining funds from ACIAR or GEF was discussed, but it was agreed that the Commission will need to address the requirement for a long-term solution to this issue, including the sampling needs in Indonesia and elsewhere.

b) Indonesian Catch Statistics. – The accuracy of the Indonesian catch statistics has been an ongoing issue for many years. The large size of the Indonesian catch and the manner in which the trend in these catches may be influencing recruitment trends in the assessment models places a high importance on their accuracy. Whilst the SCTB recognises the difficulty posed by this issue, both short term and long-term solutions to this problem were seen as a high priority. The country report currently being prepared by CSIRO may assist in identifying gaps in the current catch allocation of catch statistics. Similar concerns also exist in relation to the catch statistics for the Philippines and Vietnam.

389. Several other priority issues were also identified:

c) The need to improve the catch statistics of billfish species. At present much of the billfish catch is not classified to the species level.

d) The need to obtain better estimates of total removals, which should include estimates of fishing mortality from predation and discards, both of which are generally not recorded in logbooks. Whilst some data based on observer reports presently exists, it was generally agreed that the scope of these programs need to be greatly broadened.

e) A general need for a greater understanding and documentation of procedures for collating catch and effort statistics by each national fleet was identified, so that estimates of the uncertainty in these statistics could be determined.

Reconstruction of early catch and size data

390. The reconstruction and provision of historical catch, effort and size data for all fleets was seen as a high priority issue for stock assessment purposes. Whilst considerable advances on this issue during the past year were acknowledged (via the addition of the Japanese catch statistics prior to 1962), further work was required to help overcome gaps in the current assessments. In particular, obtaining the size data for the Japanese longline fleets before 1960 was seen as a high priority task. Together with data held by the NRIFSF in Japan, historical data held by NMFS in Honolulu was also identified as a possible source of this data.

391. A need to obtain additional information in relation to historical changes in fishing practices was also identified as a high priority task. This information could be obtained from literature reviews and interviews with fishers. The information may also provide some additional insights into the state of the ecosystems during the early years of these fisheries.

Species composition of catch

392. The ongoing need for well designed observer and port sampling programs to reduce bias and improve catch statistics has been an issue discussed at previous meetings. This issue is particularly relevant to the separation of juvenile yellowfin and bigeye in purse-seine catches where these two species are often categorised together. It was also noted that both these species can often be included in skipjack statistics. Manuals to improve species identification and audits of existing sampling programs were seen as helping to reduce possible errors.

Operational details and fishing strategies

393. The need to construct a database on vessel characteristics, including the timelines of gear used for the main fleets operating in the WCPO was seen as a priority issue. This information is required for understanding changes in the fishing practices and fishing efficiencies of fleets, which is crucial for interpreting changes in catch rates. While developments in purse-seine fleets have been documented by the FTWG in recent years, the session directed the FTWG to concentrate on the main longline fleets as a matter of priority.

Develop and impose data standards

394. The need for developing data standards for the both the recording and handling of data was seen as an ongoing priority issue. Better coordination of data standards for the WCPO and the EPO was also discussed.

12.2 Biological and Ecological Issues

Tagging Experiments

395. The session reaffirmed the recommendation from previous SCTB meetings that large scale tagging experiments for the main target tuna species in the WCPO be carried out, in coordination with tagging experiments in the eastern Pacific Ocean (EPO). Such experiments were seen as having a high priority as they are crucial to helping the estimation of movement and fishing mortality rates in the assessment models and providing an independent means of validating models results. As such,

tagging experiments should be regarded as the appropriate regular monitoring approach for highly migratory species in the WCPO. (This was seen as being equivalent to the routine trawl surveys of ground stocks). However, in order to obtain maximum benefit from such experiments, it was noted that emphasis would need to be placed on obtaining good estimates of reporting rates. The meeting agreed that an inter-sessional working group should be formed to draft a proposal outlining the costs and benefits associated with a range of tagging experiments in the WCPO.

Archival / PSAT tagging

396. The session reaffirmed the value of the data obtained via archival and PSAT tagging programs and the continuation of these programs was seen as a high priority task. However, in order to maximise the value of such programs, it was noted that there was a need for better coordination and experimental design of programs (e.g. selective time and spatial placement in order to optimise return rates) and the need some arrangements for the sharing the data. In particular, there was a need to provide a good coverage across the WCPO in order to help understand the constancy or otherwise of habitat preferences over both space and time.

FAD aggregation dynamics

397. The value of the studies presently being conducted around the Hawaiian Islands was acknowledged and the extension of this work to the equatorial regions, particularly to the region north of PNG where the FAD use was high, was seen as a priority issue. Collaboration with the studies being conducted in the Indian Ocean was also encouraged.

Ecosystem effects

398. A recently published study indicating possible ecosystem effects due to the removal of large predators had received much attention prior to SCTB. While the meeting did not debate the merits of otherwise of this particular study, the meeting saw merit in such studies as they would help identify possible ecological consequences of fishing. It was also acknowledged that this understanding would be optimised by conducting studies across several regions of the WCPO so that an understanding of possible differences in behaviour within different regions of the ecosystem could be developed. The meeting was informed that the GEF funded study on the ecology of the Warm Pool was about to commence.

Understanding likelihood and consequences of regime shifts

399. The need to understand the environmental and oceanographic factors which influence the dynamics of fish populations has long been acknowledged as a high priority for research. In particular, understanding regime shifts in oceanographic conditions is crucial for management purposes if one is to understand and interpret long-term changes in the productivity (i.e. recruitment levels) of fish stocks as predicted by stock assessments. Towards this end, the meeting agreed that, where possible, environmental data should be incorporated into the stock assessment models. Furthermore, our understanding of this issue would be assisted by the documentation of the occurrence and consequences of regime shifts within the other oceans, as this would help to provide a context for assessing the likelihood and impact of such changes in the WCPO. Whilst the SEMODYM models are presently being used to

help understand the associations between the spatial distribution and size of fish stocks and oceanographic conditions, it was acknowledged that until better data and means of predicting changes ENSO conditions are available these models are limited in their capacity to also make predictions.

Recruitment trends

400. As noted in the previous topic, knowing recruitment trends in a timely-manner is crucial for stock assessment and management purposes. While the MULTIFAN_CL model estimates past recruitment levels, the estimates of recent recruitment levels are usually highly uncertain. The meeting discussed the possibility of obtaining better estimates or indicators of recent recruitment levels using data, for example, from the pole-and-line fisheries. Although it was acknowledged that the construction of such indices would not be easy, the meeting agreed that further work on this issue should be undertaken as a matter of high priority.

12.3 Stock Assessment Issues

401. While the meeting acknowledged the coordinating role played by the MWG, the meeting quickly reviewed a number of issues common to the stock assessments presented for each of the four main species.

Effort Standardization

402. Accurate indices of stock abundance were seen as crucial for stock assessment purposes, and towards this end improvements in the data and methods used in the construction of such indices were seen as a high priority, especially for indices based on data from the longline fleets. This work could draw on the database of vessel and gear characteristics, together with more appropriate environmental parameters and habitat data provided from archival tags, both of which will become available via the ongoing research listed in the previous section. The need for conducting sensitivity analyses, so that some measure of uncertainty in the indices could be ascertained, was also identified. A high priory was also placed on developing multi-species models for the standardisation of effort.

Stock Assessment Models

403. A number of suggestions were proposed to help improve the present stock assessment models. These ranged from conducting further sensitivity analyses to better understand and reduce potential biases and uncertainties in the MULTIFAN-CL models (a high priority), to the longer-term priority of developing fully integrated multi-species models (a low short-term priority). The utility of doing stock projections was also discussed. While it was pointed out that their predicive value is limited given that future recruitments cannot be predicted, it was generally agreed that they do nevertheless provide a useful indicator of potential fishery impacts within the context of various hypotheses about stock productivity.

404. Finally, it was agreed that our understanding and interpretation of stock assessment for individual species would be assisted by conducting basin-wide and inter-ocean comparisons.

12.4 Emerging Management Issues

405. A number of emerging management issues were discussed, including i) the options for limiting the surface catch of juveniles, especially bigeye, ii) the choice of appropriate reference points, iii) the development of appropriate formats (eg decision tables) for framing management advice, and iv) the costs of not doing research.

406. The possible need to limit surface catches of juvenile bigeye and yellowfin tuna is based on the large increases in the fishing mortality on juvenile fish estimated to have occurred over the past decade or so. While there has been a long history of fishing on drifting logs, the increases in fishing mortality appear to be related to the increase use of anchored and drifting FADs. While it remains uncertain as to why there may be different dynamics and ecological consequences of fishing on different types of objects, it was agreed that further research was needed to understand the situation. The meeting also agreed that if the SCTB was to be more effective that it should attempt to frame management advice based on identifying a viable range of management options.

407. The meeting supported the expanded list of performance measures and reference values given in each of the assessment papers this year and saw scope for this list to be further developed. However, the group also saw a need to provide some documentation to assist managers understand and interpret this list. A high priority was also placed on further work to help to identify which performance measures and reference values were the most useful of management purposes. For example, it is now recognised in many international agreements (e.g. FAO Code of Conduct, UN agreement on Straddling fish stocks and highly migratory fish stocks) that MSY should be regarded as a limiting condition (or limit reference point) that should not be exceeded, and not as a target reference point.

408. The meeting also saw merit in developing a Management Strategy Evaluation procedure for the fisheries in the WCPO. Such an approach undertakes to evaluate a range of management options and the utility of various decision rules against the achievement of the management objectives (both conservation and economic) for the fisheries. This allows the trade-offs of various management actions to be made explicit. In order to help facilitate this process, the SCTB supported a collaborative and educative approach between the main stakeholder groups (eg. Science/industry/management).

409. Finally, the session reaffirmed the value of directed fisheries research, and its central role in both the quality of the management advice provided and in reducing uncertainty in that advice. The meeting noted that while there is a financial cost of doing research, there may be a greater cost associated with not doing research, such as the costs associated with reduced catches and the placement of restrictions on fishing. The session also noted the likely negative consequences to both the management of the fishery and the status of stocks (mainly bigeye and yellowfin tuna) if such research is delayed. In this regard, the meeting noted that present funding arrangements may not be optimal in regards to ensuring that the present scientific arrangements and outcomes are the most optimal for achieving management objectives.

13. FISHING CAPACITY IN THE WCPO

410. The meeting held initial discussions on defining and measuring fishing capacity in WCPO tuna fisheries and what role SCTB might have given other regional and international initiatives. The meeting noted that the primary focus of SCTB was stock assessment and in this regard was interested in measures of effective fishing effort. SCTB was unable to agree on a definition of fishing capacity. While it remained unclear what SCTB could do in relation to measuring fishing capacity it was noted that there were contributions it could make in areas of improving data availability, in fishing effort standardization and possibly others. Having noted that other agencies were still grappling with how to address the issue after several years of consideration, it was recognised that fishing capacity issues were broader than what could be resolved in this initial discussion. SCTB members were encouraged to consider this issue over the coming year, and to consider discussing fishing capacity again at SCTB17.

14. ORGANISATION ARRANGEMENT FOR FUTURE SCTB MEETINGS

411. Dr Pierre Kleiber chaired a session to consider proposals for improving the organisation of future SCTB meetings.

412. As SCTB has grown, more working groups have been added to its roster and more material has been solicited or offered for presentation. It has come to the point that "microphone time" at the plenary meeting has become a precious commodity. If this trend is to continue, some accommodation needs to be made either by increasing the amount of time for the meeting, or limiting the amount of material to be presented, or increasing the efficiency with which the material is presented. A group of Working Group chairs and interested others formulated a list of proposals, shown below, to address this and related issues. The list was presented to and reviewed by the meeting. Items 1 to 10 of the list were accepted under provisos given below. Item 11, reorganization of species working groups, was not universally accepted by the meeting.

1- Don't present stock assessments for all the species in the SCTB roster every year. Some species might not need annual assessment.

It was accepted that there is not a need to present stock assessments for every species every year. Participants suggested that bigeye and yellowfin assessments should be carried out every year. Albacore and skipjack should be alternated each year, because their status is of less concern due to low estimated exploitation rates. However, working groups should be held for each species every year to allow the presentation of biological and other studies. Reducing the number of assessments would allow for more detailed consideration of the assessments presented, in particular the important assessments of yellowfin and bigeye. Dr John Hampton stated that assessments will probably be produced for all species each year and that most of the time is spent writing detailed reports and doing sensitivity analyses. He suggested that short updates could be produced for the species that are not being considered for assessment. It was suggested that the meeting be moved to August to allow additional

time for the assessments to be completed. It was noted that August is a difficult time for university faculty and there are other meetings in August. It was suggested that participants check their schedules and other meeting dates to determine the latest possible workable date.

2- Be disciplined in accepting papers and presentations simply for their scientific interest.

3- Classify papers into working papers and information papers with working papers having priority for presentation in plenary. This would give working group chairmen a mechanism for assuring that presentations addressing items on the task list are given adequate "microphone time."

It was agreed that chairs of the working groups should classify papers into working papers and information papers.

4- Increase discipline in submission of working papers. As an example, those papers that are submitted later than one week before the meeting will not be considered, or will be deemed to be "information papers" with no microphone time. This might require shifting the time of the meeting to some weeks later to allow time for conducting assessments after fishery data for the previous year become available.

5- Have less repetition in plenary of material presented in the preparatory meetings.

It was noted that some participants may not be able to attend the whole meeting and may miss out on important information if not presented in plenary.

6- Have more working groups conduct preparatory meetings so as to reduce the amount of material to present in plenary.

It was noted that too many simultaneous preparatory meetings may prevent participants from attend all the groups they would like to.

7- Incorporate economics report in fishery overview presentations to avoid repetition of basic catch statistics.

8- Limit use of power point to those presentations that really need it. Minimize technical problems with segways between presentations.

It was noted that this could be improved by chairs and presenters making sure that the presentation were put on the presentation computer well in advance of the presentations and to be diligent about restricting the number of slides used.

9- Rotate chairmanships.

It was noted that the change of chairmanship should be discussed and agreed upon at the meeting.

10- Rotate order of working groups in plenary schedule.

It was noted that the important species should be at the start of the meeting to ensure that enough time is allowed for these species.

11- Reorganize the species working groups along disciplinary or issue-oriented lines, for example: a) Stock Assessment, b) Ecological Modelling, c) Biology. In this way material common to many, or all, species can be presented at one time.

It was generally, but not universally, agreed that the species groups should continue to be used to organize the SCTB presentations. The species groups were said to be important for the production of summary statements. It was also noted that ICCAT started using the proposed method, but changed to the species grouping. One participant, however, suggested that many papers cover multiple species and that the suggested outline would reduce repetition and allow for comparison between species. It was suggested that some of the presentations (e.g. SEPODYM and individual based models) that are used for multiple species only be presented once so that the methodology can be reviewed in more detail and once the methodology is fully developed in later years, the results for all species presented. It was suggested that these presentations could be presented in the cross cutting section.

15. OTHER BUSINESS

413. The meeting reviewed draft summary statements prepared by the chairs of each Species Research Group. The approved versions of each summary statement appear in the Executive Summary (p. 3–12).

414. Mr Glen Joseph, representing the Marshall Islands delegation graciously offered to host SCTB 17. The venue of the next meeting will be in Majuro, Marshall Islands possibly during August 2003.

415. Finally, the meeting considered the arrangements for 17th SCTB meeting. Dr Max Stocker was elected as the new chair for the Albacore Research Group while all other chairs of the Working and Research Groups remained unchanged. The meeting also considered the venue for the next meeting and accepted the offer from the Marshall Islands to host SCTB 17 in Majuro in 2004 (exact dates to be advised).

16. CLOSE

416. The Chairman thanked all the participants for their assistance, and the Australian fisheries organizations (e.g., CSIRO, BRS, AFFA) for hosting the meeting. He noted that all had done an excellent job. Dr Sung Kwon Soh was thanked for his outstanding performance in chairing SCTB 16 and reaffirmed as the chair for SCTB 17. The meeting closed on Wednesday 16 July at 17:00 hrs.

TABLES OF ANNUAL CATCH ESTIMATES

Table 1. Total catches of albacore in the Pacific Ocean. Symbols: '…' = missing data; '–' = no effort, hence no catch; '0' = effort, but no catch. Estimates for 2002 are preliminary.

YEAR	SOUTH PACIFIC					NORTH PACIFIC					TOTAL
	LONGLINE	POLE-AND-LINE	TROLL	OTHER	SUB-TOTAL	LONGLINE	POLE-AND-LINE	TROLL	OTHER	SUB-TOTAL	
1950	-	...	-	-	-	16,740	12,863	32,746	5,835	68,184	68,184
1951	-	...	-	-	-	11,408	14,500	15,629	6,577	48,114	48,114
1952	154	...	-	-	154	26,733	41,787	23,914	1,764	94,198	94,352
1953	803	...	-	-	803	27,800	32,921	15,745	341	76,807	77,610
1954	9,578	...	-	-	9,578	20,971	28,069	12,246	208	61,494	71,072
1955	8,625	...	-	-	8,625	16,286	24,236	13,264	721	54,507	63,132
1956	7,281	...	-	-	7,281	14,347	42,810	18,768	539	76,464	83,745
1957	8,757	...	-	-	8,757	21,057	49,500	21,173	538	92,268	101,025
1958	18,636	...	-	-	18,636	18,439	22,175	14,929	180	55,723	74,359
1959	17,841	...	-	-	17,841	15,807	14,252	21,202	67	51,328	69,169
1960	22,248	45	-	-	22,293	17,373	25,156	20,105	769	63,403	85,696
1961	23,742	0	-	-	23,742	17,442	21,476	12,059	1,631	52,608	76,350
1962	35,219	0	-	-	35,219	15,771	9,814	19,753	1,926	47,264	82,483
1963	31,095	16	-	-	31,111	13,471	28,852	25,145	1,438	68,906	100,017
1964	22,930	0	-	-	22,930	15,488	27,269	18,391	1,271	62,419	85,349
1965	25,838	0	-	-	25,838	13,965	41,908	16,557	863	73,293	99,131
1966	39,113	0	-	-	39,113	25,329	24,430	15,377	1,285	66,421	105,534
1967	40,318	0	5	-	40,323	29,516	34,594	17,975	1,316	83,401	123,724
1968	29,051	0	14	-	29,065	24,670	21,503	21,462	2,327	69,962	99,027
1969	24,360	0	0	-	24,360	18,654	34,908	20,192	1,814	75,568	99,928
1970	32,590	100	50	-	32,740	17,808	28,679	21,422	1,595	69,504	102,244
1971	34,708	100	0	-	34,808	13,293	55,028	22,272	2,385	92,978	127,786
1972	33,842	122	268	-	34,232	16,143	64,319	27,521	1,638	109,621	143,853
1973	37,649	141	484	-	38,274	16,937	71,003	17,053	1,971	106,964	145,238
1974	30,985	809	898	-	32,692	13,988	78,341	21,509	1,359	115,197	147,889
1975	26,131	100	646	-	26,877	14,308	55,395	19,043	1,204	89,950	116,827
1976	24,106	100	25	-	24,231	17,957	88,036	16,183	3,204	125,380	149,611
1977	34,849	100	621	-	35,570	17,398	33,431	10,022	2,249	63,100	98,670
1978	34,858	100	1,686	-	36,644	13,589	60,827	16,636	8,048	99,100	135,744
1979	28,739	100	814	-	29,653	14,661	44,965	7,302	4,182	71,110	100,763
1980	31,027	101	1,468	-	32,596	15,604	47,124	7,768	4,699	75,195	107,791
1981	32,632	0	2,085	5	34,722	18,745	28,174	12,837	11,482	71,238	105,960
1982	28,339	1	2,434	6	30,780	17,819	30,039	6,713	13,910	68,481	99,261
1983	24,303	0	744	39	25,086	16,077	21,705	9,584	7,673	55,039	80,125
1984	20,340	2	2,773	1,589	24,704	15,669	27,043	9,354	18,663	70,729	95,433
1985	27,138	0	3,253	1,937	32,328	14,751	22,212	6,471	14,845	58,279	90,607
1986	32,641	0	2,003	1,946	36,590	13,169	16,528	4,738	10,909	45,344	81,934
1987	26,877	9	2,134	930	29,950	15,034	19,240	2,870	11,475	48,619	78,569
1988	31,531	0	4,296	5,283	41,110	15,186	6,814	4,367	18,925	45,292	86,402
1989	22,238	0	8,370	21,968	52,576	13,979	8,683	2,000	19,913	44,575	97,151
1990	22,624	245	6,975	7,538	37,382	16,273	8,647	2,905	26,155	53,980	91,362
1991	24,706	14	7,805	1,489	34,014	17,716	7,103	1,984	10,791	37,594	71,608
1992	30,248	11	6,578	65	36,902	19,728	13,888	4,935	16,573	55,124	92,026
1993	29,987	74	4,296	70	34,427	30,943	12,797	6,748	4,079	54,567	88,994
1994	33,235	67	7,164	89	40,555	30,789	26,389	13,134	3,451	73,763	114,318
1995	25,653	139	7,708	104	33,604	32,510	21,061	9,903	2,555	66,029	99,633
1996	24,120	30	7,367	156	31,673	39,051	20,296	21,034	1,832	82,213	113,886
1997	32,689	21	4,679	133	37,522	47,698	32,311	17,089	4,269	101,367	138,889
1998	39,266	36	6,258	85	45,645	47,600	23,005	18,884	4,368	93,857	139,502
1999	39,588	138	3,391	74	43,191	45,731	50,429	12,963	12,021	121,144	164,335
2000	41,925	102	5,868	139	48,034	42,690	21,618	14,599	5,243	84,150	132,184
2001	49,898	37	5,567	199	55,701	41,820	29,725	16,307	3,580	91,432	147,133
2002	46,819	7	4,477	150	51,453	41,050	29,987	13,994	4,216	89,247	140,700

Table 1. Total catches of bigeye in the Pacific Ocean. Symbols: '…' = missing data; '–' = no effort; estimates in parentheses have been carried over from previous years. Estimates for 2002 are preliminary.

YEAR	WCPO					EPO					TOTAL
	LONGLINE	POLE-AND-LINE	PURSE SEINE	OTHER	SUB-TOTAL	LONGLINE	POLE-AND-LINE	PURSE SEINE	OTHER	SUB-TOTAL	
1950	...	...	...	...	...	...	...	...	...	...	...
1951	...	...	1,095	...	...	...	...	...	...	...	...
1952	24,355	2,100	1,039	...	27,494	...	...	...	...	...	27,494
1953	23,025	2,400	619	...	26,044	...	...	...	...	...	26,044
1954	16,204	2,100	360	...	18,664	928	...	...	...	928	19,592
1955	24,749	4,000	285	...	29,034	1,043	...	...	...	1,043	30,077
1956	28,342	4,400	908	...	33,650	1,388	...	...	...	1,388	35,038
1957	35,463	5,200	49	...	40,712	5,589	...	...	...	5,589	46,301
1958	44,390	4,200	48	...	48,638	6,104	...	...	...	6,104	54,742
1959	39,789	1,700	36	...	41,525	6,636	...	...	...	6,636	48,161
1960	42,147	1,500	58	...	43,705	10,213	...	...	...	10,213	53,918
1961	36,135	1,800	63	...	37,998	30,215	57	156	-	30,428	68,426
1962	34,616	800	173	...	35,589	44,200	168	160	-	44,528	80,117
1963	41,025	1,800	6	...	42,831	65,300	75	-	-	65,375	108,206
1964	29,451	1,100	231	...	30,782	45,400	68	-	-	45,468	76,250
1965	28,704	1,300	201	...	30,205	28,600	117	-	-	28,717	58,922
1966	31,214	1,100	9	...	32,323	34,100	157	109	-	34,366	66,689
1967	31,813	2,800	60	...	34,673	35,035	748	916	-	36,699	71,372
1968	24,292	2,300	183	...	26,775	34,216	63	2,496	-	36,775	63,550
1969	30,011	1,700	48	...	31,759	50,938	-	576	-	51,514	83,273
1970	33,987	1,600	726	2,820	39,133	33,243	-	1,332	-	34,575	73,708
1971	34,659	900	877	3,060	39,496	29,804	58	2,494	14	32,370	71,866
1972	45,329	1,762	865	3,498	51,454	36,128	66	2,172	-	38,366	89,820
1973	35,478	1,258	1,078	4,218	42,032	50,776	131	1,848	-	52,755	94,787
1974	39,029	1,039	1,389	4,719	46,176	36,961	-	890	-	37,851	84,027
1975	52,779	1,334	1,328	4,943	60,384	41,614	28	3,695	-	45,337	105,721
1976	64,513	3,423	1,312	4,138	73,386	53,846	45	10,193	5	64,089	137,475
1977	62,934	3,325	1,587	5,637	73,483	72,972	2	7,053	-	80,027	153,510
1978	49,394	3,337	1,146	4,243	58,120	69,707	-	11,759	-	81,466	139,586
1979	56,748	2,419	2,033	4,662	65,862	55,306	-	7,531	1	62,838	128,700
1980	54,045	2,243	2,162	4,142	62,592	63,511	-	15,318	103	78,932	141,524
1981	41,239	2,596	4,315	4,919	53,069	52,744	-	10,090	1	62,835	115,904
1982	44,739	4,108	5,150	4,738	58,735	52,643	23	4,079	-	56,745	115,480
1983	41,144	4,055	9,399	4,987	59,585	59,348	21	3,144	95	62,608	122,193
1984	46,156	3,465	8,847	5,176	63,644	46,101	1	5,919	16	52,037	115,681
1985	51,064	4,326	7,009	6,120	68,519	65,449	17	4,497	18	69,981	138,500
1986	46,485	2,865	7,509	6,480	63,339	99,697	-	1,939	-	101,636	164,975
1987	60,646	3,134	11,395	5,563	80,738	95,701	-	771	5	96,477	177,215
1988	50,166	4,125	7,305	6,439	68,035	70,900	2	1,051	-	71,953	139,988
1989	51,182	4,298	12,651	7,137	75,268	70,960	-	1,470	-	72,430	147,698
1990	66,807	3,918	12,143	8,851	91,719	94,985	-	4,701	11	99,697	191,416
1991	51,456	2,097	13,492	11,520	78,565	101,373	25	3,702	13	105,113	183,678
1992	63,431	1,877	19,484	9,105	93,897	82,027	-	5,488	9	87,524	181,421
1993	57,108	2,433	14,397	7,841	81,779	70,311	-	8,043	26	78,380	160,159
1994	65,654	3,044	11,321	10,026	90,045	69,255	-	28,683	692	98,630	188,675
1995	53,655	3,914	14,161	10,290	82,020	55,922	-	36,174	1,154	93,250	175,270
1996	47,615	3,989	17,590	11,533	80,727	43,381	-	50,728	625	94,734	175,461
1997	55,213	3,867	30,557	11,759	101,396	47,852	-	51,625	2	99,479	200,875
1998	70,459	2,904	18,622	15,378	107,363	43,499	-	35,142	12	78,653	186,016
1999	61,432	2,268	34,932	14,536	113,168	29,439	-	40,568	42	70,049	183,217
2000	57,320	3,409	30,872	16,393	107,994	39,502	-	70,153	-	109,655	217,649
2001	60,987	2,956	26,822	16,136	106,901	50,559	-	42,846	-	93,405	200,305
2002	64,185	3,051	22,538	17,794	107,568	30,411	-	35,103	98	65,612	173,180

Table 2. Total catches of skipjack in the Pacific Ocean. Symbols: '…' = missing data; '0' = effort, but no catch. Estimates for 2002 are preliminary.

YEAR	WCPO					EPO				TOTAL
	LONGLINE	POLE-AND-LINE	PURSE SEINE	OTHER	SUB-TOTAL	POLE-AND-LINE	PURSE SEINE	OTHER	SUB-TOTAL	
1950	34	...	...	6,483	...	49,534	5,741	1,299	56,574	...
1951	12	96,214	1,748	8,602	106,576	45,617	5,790	1,109	52,516	159,092
1952	54	78,518	3,716	10,014	92,302	32,724	4,806	905	38,435	130,737
1953	1	65,546	3,371	11,403	80,321	50,812	5,171	0	55,983	136,304
1954	0	88,073	4,534	11,554	104,161	61,221	8,519	1	69,741	173,902
1955	157	92,524	2,906	12,664	108,252	51,558	6,503	1	58,062	166,314
1956	0	91,950	2,145	13,094	107,189	64,971	3,204	0	68,175	175,364
1957	17	92,156	2,813	11,955	106,941	54,414	873	10	55,297	162,238
1958	0	131,441	10,698	15,244	157,383	67,594	5,481	23	73,098	230,481
1959	33	145,447	16,941	14,853	177,274	69,495	9,477	24	78,996	256,270
1960	0	70,428	3,728	15,782	89,938	34,900	11,820	21	46,741	136,679
1961	0	127,011	11,693	18,032	156,736	27,497	40,616	384	68,497	225,233
1962	4	152,387	11,674	17,559	181,624	16,153	52,572	34	68,759	250,383
1963	0	94,757	9,592	18,354	122,703	16,549	76,829	2,318	95,696	218,399
1964	0	137,106	25,064	20,739	182,909	9,783	46,006	3,545	59,334	242,243
1965	0	129,933	4,670	20,601	155,204	19,137	58,246	999	78,382	233,586
1966	0	215,600	10,968	22,890	249,458	13,666	45,119	1,875	60,660	310,118
1967	0	168,846	10,954	24,864	204,664	17,871	97,962	4,906	120,739	325,403
1968	1	162,379	7,485	24,891	194,756	7,008	54,362	9,896	71,266	266,022
1969	53	168,084	4,400	30,031	202,568	6,591	40,879	11,763	59,233	261,801
1970	1,465	197,873	10,586	32,158	242,082	6,998	42,101	6,924	56,023	298,105
1971	1,291	180,945	14,987	29,148	226,371	11,102	87,131	6,494	104,727	331,098
1972	1,417	172,871	19,691	41,777	235,756	6,081	26,434	895	33,410	269,166
1973	1,608	253,065	21,547	50,326	326,546	8,789	34,737	430	43,956	370,502
1974	2,007	289,202	14,742	49,410	355,361	7,150	71,255	399	78,804	434,165
1975	1,827	218,271	18,237	50,176	288,511	13,366	110,083	426	123,875	412,386
1976	1,964	276,581	28,148	51,206	357,899	10,846	114,841	610	126,297	484,196
1977	3,049	294,641	40,122	66,420	404,232	7,218	77,228	1,905	86,351	490,583
1978	3,265	331,401	42,186	73,621	450,473	5,603	163,000	1,303	169,906	620,379
1979	2,286	283,494	65,124	60,400	411,304	5,931	124,673	1,431	132,035	543,339
1980	651	332,465	82,536	42,767	458,419	5,040	123,687	1,949	130,676	589,095
1981	857	294,187	94,931	48,203	438,178	5,780	112,950	887	119,617	557,795
1982	1,120	262,233	174,693	53,048	491,094	3,676	94,682	409	98,767	589,861
1983	2,226	299,762	324,991	56,842	683,821	4,112	53,150	893	58,155	741,976
1984	893	379,474	330,932	44,239	755,538	2,770	56,948	842	60,560	816,098
1985	1,104	250,010	305,207	43,553	599,874	918	48,375	179	49,472	649,346
1986	1,427	336,694	369,609	49,116	756,846	1,939	61,486	150	63,575	820,421
1987	2,317	262,467	373,331	47,825	685,940	2,230	59,941	186	62,357	748,297
1988	1,915	301,031	489,505	49,135	841,586	4,278	80,405	654	85,337	926,923
1989	2,510	289,706	477,572	48,453	818,241	2,892	88,468	1,025	92,385	910,626
1990	1,292	224,591	604,447	60,896	891,226	835	69,883	1,863	72,581	963,807
1991	1,541	289,022	773,739	65,464	1,129,767	1,670	59,708	1,897	63,275	1,193,042
1992	1,063	233,283	707,721	80,562	1,022,629	1,860	81,026	1,083	83,969	1,106,597
1993	940	278,158	581,792	58,480	919,370	3,633	81,500	2,231	87,364	1,006,734
1994	1,793	238,317	721,657	52,187	1,013,954	3,110	70,663	779	74,552	1,088,505
1995	1,390	275,053	724,103	60,826	1,061,372	5,237	131,021	1,995	138,253	1,199,625
1996	1,106	239,894	738,964	57,376	1,037,340	2,583	108,343	1,336	112,262	1,149,603
1997	1,298	261,360	664,629	58,779	986,066	3,292	158,478	236	162,006	1,148,073
1998	4,493	294,286	947,149	68,311	1,314,239	1,642	143,275	324	145,241	1,459,480
1999	4,255	282,500	794,618	70,190	1,151,563	2,108	262,721	1,471	266,300	1,417,863
2000	5,338	304,005	869,606	71,872	1,250,821	232	210,953	198	211,383	1,462,204
2001	5,306	275,584	836,390	74,098	1,191,378	448	145,178	73	145,699	1,337,078
2002	3,629	280,578	962,740	74,992	1,321,939	592	157,384	143	158,119	1,480,058

Table 3. Total catches of yellowfin in the Pacific Ocean. Symbols: '…' = missing data; '–' = no effort; '0' = effort, but no catch; estimates in parentheses have been carried over from previous years. Estimates for 2002 are preliminary.

YEAR	WCPO					EPO					TOTAL
	LONGLINE	POLE-AND-LINE	PURSE SEINE	OTHER	SUB-TOTAL	LONGLINE	POLE-AND-LINE	PURSE SEINE	OTHER	SUB-TOTAL	
1950	...	...	...	8,919	...	-	65,921	15,856	879	82,656	...
1951	...	...	938	10,415	...	-	65,499	6,598	727	72,824	...
1952	17,453	2,595	2,565	10,539	33,152	-	66,108	13,735	1,067	80,910	114,062
1953	23,139	5,228	1,260	10,871	40,498	-	43,920	16,120	-	60,040	100,538
1954	22,662	4,268	4,001	11,763	42,694	-	46,541	7,625	-	54,166	96,860
1955	22,800	3,983	2,944	12,633	42,360	665	50,811	13,086	...	64,562	106,922
1956	25,336	4,399	724	12,818	43,277	1,578	58,828	21,470	...	81,876	125,153
1957	41,911	1,669	1,496	13,481	58,557	9,365	58,402	15,544	...	83,311	141,868
1958	41,804	2,934	3,338	14,682	62,758	7,803	46,776	20,560	...	75,139	137,897
1959	42,802	4,119	4,316	15,673	66,910	4,497	30,053	28,126	...	62,676	129,586
1960	53,617	1,872	1,438	15,919	72,846	7,629	26,199	79,976	...	113,804	186,650
1961	52,717	3,259	2,777	17,044	75,797	16,640	16,762	84,897	984	119,283	195,080
1962	59,172	4,225	6,975	18,150	88,522	14,118	11,855	59,597	0	85,570	174,092
1963	56,791	2,071	2,277	18,676	79,815	22,941	7,678	53,624	726	84,969	164,784
1964	48,521	5,073	3,647	20,183	77,424	20,002	4,327	83,547	776	108,652	186,076
1965	50,699	3,434	3,752	20,958	78,843	18,315	7,417	71,160	321	97,213	176,056
1966	67,302	2,192	5,844	23,409	98,747	10,906	5,852	74,228	531	91,517	190,264
1967	38,975	3,125	3,395	26,303	71,798	11,065	5,214	73,188	1,557	91,024	162,822
1968	44,941	2,706	6,888	26,084	80,619	16,500	4,698	93,942	3,376	118,516	199,135
1969	49,256	2,714	3,857	26,609	82,436	18,000	7,560	119,322	1,976	146,858	229,294
1970	53,080	2,025	9,299	29,422	93,826	12,632	4,688	145,867	5,071	168,258	262,084
1971	49,674	2,667	10,847	31,204	94,392	8,013	5,469	114,416	2,954	130,852	225,244
1972	51,090	7,465	11,765	35,749	106,069	16,859	6,149	169,467	1,512	193,987	300,056
1973	56,828	7,457	16,900	41,726	122,911	11,697	4,355	200,204	694	216,950	339,861
1974	54,102	6,582	19,574	46,997	127,255	7,190	8,659	200,451	1,254	217,554	344,809
1975	60,554	7,751	15,209	48,536	132,050	10,646	6,114	195,442	586	212,788	344,838
1976	70,735	17,186	16,826	40,666	145,413	15,465	3,688	232,286	373	251,812	397,225
1977	87,974	15,257	18,509	55,092	176,832	12,079	2,093	196,427	297	210,896	387,728
1978	109,384	12,767	13,863	38,491	174,505	9,923	4,172	175,807	615	190,517	365,022
1979	104,950	11,463	31,362	46,375	194,150	11,362	5,191	184,236	247	201,036	395,186
1980	117,423	13,132	35,614	43,906	210,075	12,823	1,649	156,878	898	172,248	382,323
1981	92,541	19,268	62,877	50,623	225,309	7,935	1,595	179,371	847	189,748	415,057
1982	83,824	13,835	73,542	48,226	219,427	10,691	1,605	123,272	206	135,774	355,201
1983	83,588	13,266	106,172	50,844	253,870	10,574	4,271	88,779	1,206	104,830	358,700
1984	69,752	13,558	111,648	53,698	248,656	10,115	3,090	141,635	336	155,176	403,832
1985	73,559	18,156	103,331	61,091	256,137	12,680	1,081	215,610	301	229,672	485,809
1986	62,080	13,074	104,719	64,673	244,546	21,163	2,519	265,473	282	289,437	533,983
1987	74,000	13,243	156,647	58,032	301,922	16,971	5,110	266,800	336	289,217	591,139
1988	81,081	13,433	99,244	65,704	259,462	14,052	3,743	283,687	973	302,455	561,917
1989	64,031	15,169	164,335	69,867	313,402	16,845	4,189	284,621	565	306,220	619,622
1990	72,335	13,103	175,239	90,238	350,915	33,129	2,664	268,914	1,751	306,458	657,373
1991	61,323	13,875	211,815	113,432	400,445	29,989	2,909	235,143	1,069	269,110	669,555
1992	71,651	16,303	241,753	85,039	414,746	17,881	3,885	232,811	3,153	257,730	672,476
1993	65,029	13,623	244,182	77,026	399,860	23,747	5,089	223,519	3,463	255,818	655,678
1994	73,010	14,577	224,756	98,688	411,031	29,345	3,755	214,051	1,455	248,606	659,637
1995	80,145	16,303	187,821	102,023	386,292	19,861	1,284	220,445	2,047	243,637	629,929
1996	76,816	16,596	123,476	110,805	327,693	15,526	3,733	245,381	1,056	265,696	593,389
1997	68,744	14,661	260,546	113,801	457,752	20,251	4,386	252,425	1,231	278,293	736,045
1998	65,762	17,256	272,430	147,512	502,960	14,774	5,126	260,325	330	280,555	783,516
1999	60,414	15,140	222,958	142,243	440,755	12,305	1,719	292,744	1,214	307,982	748,736
2000	75,165	17,137	207,775	158,092	458,169	21,199	2,417	270,444	384	294,444	752,612
2001	75,406	16,516	220,226	154,835	466,983	21,408	3,916	392,161	45	417,530	884,514
2002	77,177	17,770	171,767	171,270	437,984	8,697	978	417,472	517	427,664	865,648

Table 4. Total catches of albacore, bigeye, skipjack and yellowfin in the WCPO.
Symbols: '…' = missing data. Estimates for 2002 are preliminary.

YEAR	ALBACORE		BIGEYE		SKIPJACK		YELLOWFIN		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1950	35,438		...		...		...		...
1951	32,485		...		106,576		...		...
1952	69,090	31	27,494	12	92,302	42	33,152	15	222,037
1953	61,676	30	26,044	12	80,321	39	40,498	19	208,539
1954	58,666	26	18,664	8	104,161	46	42,694	19	224,185
1955	49,193	21	29,034	13	108,252	47	42,360	19	228,838
1956	64,209	26	33,650	14	107,189	43	43,277	17	248,324
1957	78,877	28	40,712	14	106,941	38	58,557	21	285,087
1958	57,494	18	48,638	15	157,383	48	62,758	19	326,273
1959	45,623	14	41,525	13	177,274	54	66,910	20	331,332
1960	62,434	23	43,705	16	89,938	33	72,846	27	268,923
1961	57,287	17	37,998	12	156,736	48	75,797	23	327,818
1962	53,586	15	35,589	10	181,624	51	88,522	25	359,321
1963	58,001	19	42,831	14	122,703	40	79,815	26	303,350
1964	56,125	16	30,782	9	182,909	53	77,424	22	347,240
1965	77,286	23	30,205	9	155,204	45	78,843	23	341,538
1966	83,743	18	32,323	7	249,458	54	98,747	21	464,271
1967	93,286	23	34,673	9	204,664	51	71,798	18	404,421
1968	67,677	18	26,775	7	194,756	53	80,619	22	369,827
1969	75,032	19	31,759	8	202,568	52	82,436	21	391,795
1970	69,529	16	39,133	9	242,082	54	93,826	21	444,570
1971	96,504	21	39,496	9	226,371	50	94,392	21	456,763
1972	110,080	22	51,454	10	235,756	47	106,069	21	503,359
1973	122,697	20	42,032	7	326,546	53	122,911	20	614,186
1974	118,375	18	46,176	7	355,361	55	127,255	20	647,167
1975	92,672	16	60,384	11	288,511	50	132,050	23	573,617
1976	128,206	18	73,386	10	357,899	51	145,413	21	704,904
1977	77,350	11	73,483	10	404,232	55	176,832	24	731,897
1978	108,496	14	58,120	7	450,473	57	174,505	22	791,594
1979	90,898	12	65,862	9	411,304	54	194,150	25	762,214
1980	98,323	12	62,592	8	458,419	55	210,075	25	829,409
1981	88,490	11	53,069	7	438,178	54	225,309	28	805,046
1982	90,199	10	58,735	7	491,094	57	219,427	26	859,455
1983	66,709	6	59,585	6	683,821	64	253,870	24	1,063,985
1984	79,623	7	63,644	6	755,538	66	248,656	22	1,147,461
1985	78,793	8	68,519	7	599,874	60	256,137	26	1,003,323
1986	72,877	6	63,339	6	756,846	67	244,546	21	1,137,608
1987	66,753	6	80,738	7	685,940	60	301,922	27	1,135,353
1988	70,664	6	68,035	5	841,586	68	259,462	21	1,239,746
1989	87,623	7	75,268	6	818,241	63	313,402	24	1,294,534
1990	80,838	6	91,719	6	891,226	63	350,915	25	1,414,698
1991	60,892	4	78,565	5	1,129,767	68	400,445	24	1,669,669
1992	69,049	4	93,897	6	1,022,629	64	414,746	26	1,600,321
1993	72,582	5	81,779	6	919,370	62	399,860	27	1,473,591
1994	93,247	6	90,045	6	1,013,954	63	411,031	26	1,608,277
1995	85,305	5	82,020	5	1,061,372	66	386,292	24	1,614,989
1996	96,638	6	80,727	5	1,037,340	67	327,693	21	1,542,398
1997	119,719	7	101,396	6	986,066	59	457,752	27	1,664,934
1998	113,081	6	107,363	5	1,314,239	64	502,960	25	2,037,644
1999	135,535	7	113,168	6	1,151,563	63	440,755	24	1,841,021
2000	105,812	6	107,994	6	1,250,821	65	458,169	24	1,922,796
2001	120,972	6	106,901	6	1,191,378	63	466,983	25	1,886,234
2002	114,511	6	107,568	5	1,321,939	67	437,984	22	1,982,001

Table 5. Total catches of albacore, bigeye, skipjack and yellowfin in the WCPO by gear type. Symbols: '…' = missing data. Estimates for 2002 are preliminary.

YEAR	LONGLINE		POLE-AND-LINE		PURSE SEINE		OTHER		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1950	...		...		6,483		21,237		...
1951	...		110,714		3,780		25,594		...
1952	68,703	31	125,000	56	7,320	3	21,014	9	222,037
1953	74,745	36	106,095	51	5,250	3	22,449	11	208,539
1954	69,402	31	122,510	55	8,895	4	23,378	10	224,185
1955	72,519	32	124,743	55	6,135	3	25,441	11	228,838
1956	75,003	30	143,559	58	3,776	2	25,985	10	248,324
1957	106,526	37	148,525	52	4,358	2	25,678	9	285,087
1958	121,307	37	160,750	49	14,084	4	30,132	9	326,273
1959	113,716	34	165,518	50	21,293	6	30,805	9	331,332
1960	132,780	49	99,001	37	5,224	2	31,918	12	268,923
1961	127,260	39	150,670	46	14,533	4	35,355	11	327,818
1962	138,404	39	166,141	46	18,822	5	35,954	10	359,321
1963	129,099	43	125,064	41	11,875	4	37,312	12	303,350
1964	109,789	32	167,137	48	28,942	8	41,372	12	347,240
1965	115,051	34	176,158	52	8,623	3	41,706	12	341,538
1966	158,689	34	241,722	52	16,821	4	47,039	10	464,271
1967	132,818	33	205,252	51	14,409	4	51,942	13	404,421
1968	117,896	32	183,982	50	14,556	4	53,393	14	369,827
1969	119,619	31	204,410	52	8,305	2	59,461	15	391,795
1970	132,485	30	225,861	51	20,611	5	65,613	15	444,570
1971	126,120	28	237,564	52	26,711	6	66,368	15	456,763
1972	142,035	28	242,789	48	32,321	6	86,214	17	503,359
1973	143,932	23	330,688	54	39,525	6	100,041	16	614,186
1974	135,646	21	371,196	57	35,705	6	104,620	16	647,167
1975	154,198	27	279,608	49	34,774	6	105,037	18	573,617
1976	177,197	25	382,621	54	46,286	7	98,800	14	704,904
1977	196,886	27	345,257	47	60,218	8	129,536	18	731,897
1978	201,630	25	407,482	51	57,195	7	125,287	16	791,594
1979	202,851	27	342,138	45	98,519	13	118,706	16	762,214
1980	215,253	26	394,683	48	120,312	15	99,161	12	829,409
1981	181,526	23	343,477	43	162,123	20	117,920	15	805,046
1982	170,785	20	309,791	36	253,385	29	125,494	15	859,455
1983	162,367	15	338,181	32	440,562	41	122,875	12	1,063,985
1984	147,803	13	422,509	37	451,427	39	125,722	11	1,147,461
1985	163,821	16	293,171	29	415,547	41	130,784	13	1,003,323
1986	151,732	13	368,729	32	481,837	42	135,310	12	1,137,608
1987	169,755	15	297,963	26	541,373	48	126,262	11	1,135,353
1988	170,312	14	324,805	26	596,054	48	148,576	12	1,239,746
1989	147,098	11	317,802	25	654,558	51	175,076	14	1,294,534
1990	172,755	12	250,389	18	791,829	56	199,725	14	1,414,698
1991	148,698	9	312,111	19	999,046	60	209,813	13	1,669,669
1992	168,938	11	265,362	17	968,958	61	197,063	12	1,600,321
1993	171,986	12	307,085	21	840,371	57	154,149	10	1,473,591
1994	193,715	12	282,394	18	957,734	60	174,434	11	1,608,277
1995	186,529	12	316,390	20	926,085	57	185,985	12	1,614,989
1996	180,056	12	280,805	18	880,030	57	201,507	13	1,542,398
1997	194,214	12	312,220	19	955,732	57	202,768	12	1,664,934
1998	214,374	11	337,488	17	1,238,201	61	247,581	12	2,037,644
1999	197,533	11	350,452	19	1,052,508	57	240,528	13	1,841,021
2000	209,957	11	346,173	18	1,108,253	58	258,413	13	1,922,796
2001	221,248	12	324,800	17	1,083,438	57	256,748	14	1,886,234
2002	221,818	11	330,993	17	1,157,045	58	272,145	14	1,982,001

Table 6. Total catches of albacore, bigeye, skipjack and yellowfin in the EPO.
Symbols: '…' = missing data. Estimates for 2002 are preliminary.

YEAR	ALBACORE		BIGEYE		SKIPJACK		YELLOWFIN		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1950	32,746	19	...		56,574	33	82,656	48	171,976
1951	15,629	11	...		52,516	37	72,824	52	140,969
1952	25,216	17	...		38,435	27	80,910	56	144,561
1953	15,911	12	...		55,983	42	60,040	46	131,934
1954	12,393	9	928	1	69,741	51	54,166	39	137,228
1955	13,841	10	1,043	1	58,062	42	64,562	47	137,508
1956	19,233	11	1,388	1	68,175	40	81,876	48	170,672
1957	21,469	13	5,589	3	55,297	33	83,311	50	165,666
1958	14,903	9	6,104	4	73,098	43	75,139	44	169,244
1959	20,990	12	6,636	4	78,996	47	62,676	37	169,298
1960	20,657	11	10,213	5	46,741	24	113,804	59	191,415
1961	16,287	7	30,428	13	68,497	29	119,283	51	234,495
1962	28,897	13	44,528	20	68,759	30	85,570	38	227,754
1963	42,016	15	65,375	23	95,696	33	84,969	29	288,056
1964	29,224	12	45,468	19	59,334	24	108,652	45	242,678
1965	21,845	10	28,717	13	78,382	35	97,213	43	226,157
1966	21,791	10	34,366	16	60,660	29	91,517	44	208,334
1967	30,438	11	36,699	13	120,739	43	91,024	33	278,900
1968	31,350	12	36,775	14	71,266	28	118,516	46	257,907
1969	24,896	9	51,514	18	59,233	21	146,858	52	282,501
1970	32,715	11	34,575	12	56,023	19	168,258	58	291,570
1971	31,282	10	32,370	11	104,727	35	130,852	44	299,230
1972	33,773	11	38,366	13	33,410	11	193,987	65	299,536
1973	22,541	7	52,755	16	43,956	13	216,950	65	336,203
1974	29,514	8	37,851	10	78,804	22	217,554	60	363,723
1975	24,155	6	45,337	11	123,875	30	212,788	52	406,155
1976	21,405	5	64,089	14	126,297	27	251,812	54	463,602
1977	21,320	5	80,027	20	86,351	22	210,896	53	398,595
1978	27,248	6	81,466	17	169,906	36	190,517	41	469,137
1979	9,488	2	62,838	16	132,035	33	201,036	50	405,397
1980	8,918	2	78,932	20	130,676	33	172,248	44	390,774
1981	16,527	4	62,835	16	119,617	31	189,748	49	388,728
1982	8,359	3	56,745	19	98,767	33	135,774	45	299,645
1983	12,722	5	62,608	26	58,155	24	104,830	44	238,316
1984	13,350	5	52,037	19	60,560	22	155,176	55	281,123
1985	9,103	3	69,981	20	49,472	14	229,672	64	358,229
1986	8,426	2	101,636	22	63,575	14	289,437	63	463,073
1987	11,607	3	96,477	21	62,357	14	289,217	63	459,659
1988	15,051	3	71,953	15	85,337	18	302,455	64	474,796
1989	9,287	2	72,430	15	92,385	19	306,220	64	480,322
1990	10,352	2	99,697	20	72,581	15	306,458	63	489,088
1991	10,622	2	105,113	23	63,275	14	269,110	60	448,120
1992	22,903	5	87,524	19	83,969	19	257,730	57	452,126
1993	16,387	4	78,380	18	87,364	20	255,818	58	437,949
1994	20,714	5	98,630	22	74,552	17	248,606	56	442,502
1995	14,093	3	93,250	19	138,253	28	243,637	50	489,233
1996	17,077	3	94,734	19	112,262	23	265,696	54	489,769
1997	18,091	3	99,479	18	162,006	29	278,293	50	557,869
1998	25,131	5	78,653	15	145,241	27	280,555	53	529,581
1999	25,006	4	70,049	10	266,300	40	307,982	46	669,337
2000	24,418	4	109,655	17	211,383	33	294,444	46	639,900
2001	24,414	4	93,405	14	145,699	21	417,530	61	681,048
2002	23,376	3	65,612	10	158,119	23	427,664	63	674,771

Table 7. Total catches of albacore, bigeye, skipjack and yellowfin in the Pacific Ocean. Symbols: '…' = missing data. Estimates for 2002 are preliminary.

YEAR	ALBACORE		BIGEYE		SKIPJACK		YELLOWFIN		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1950	68,184		...		...		...		...
1951	48,114		...		159,092		...		...
1952	94,306	26	27,494	7	130,737	36	114,062	31	366,598
1953	77,587	23	26,044	8	136,304	40	100,538	30	340,473
1954	71,059	20	19,592	5	173,902	48	96,860	27	361,413
1955	63,034	17	30,077	8	166,314	45	106,922	29	366,346
1956	83,442	20	35,038	8	175,364	42	125,153	30	418,996
1957	100,346	22	46,301	10	162,238	36	141,868	31	450,753
1958	72,397	15	54,742	11	230,481	47	137,897	28	495,517
1959	66,613	13	48,161	10	256,270	51	129,586	26	500,630
1960	83,091	18	53,918	12	136,679	30	186,650	41	460,338
1961	73,574	13	68,426	12	225,233	40	195,080	35	562,313
1962	82,483	14	80,117	14	250,383	43	174,092	30	587,075
1963	100,017	17	108,206	18	218,399	37	164,784	28	591,406
1964	85,349	14	76,250	13	242,243	41	186,076	32	589,918
1965	99,131	17	58,922	10	233,586	41	176,056	31	567,695
1966	105,534	16	66,689	10	310,118	46	190,264	28	672,605
1967	123,724	18	71,372	10	325,403	48	162,822	24	683,321
1968	99,027	16	63,550	10	266,022	42	199,135	32	627,734
1969	99,928	15	83,273	12	261,801	39	229,294	34	674,296
1970	102,244	14	73,708	10	298,105	40	262,084	36	736,140
1971	127,786	17	71,866	10	331,098	44	225,244	30	755,993
1972	143,853	18	89,820	11	269,166	34	300,056	37	802,895
1973	145,238	15	94,787	10	370,502	39	339,861	36	950,389
1974	147,889	15	84,027	8	434,165	43	344,809	34	1,010,890
1975	116,827	12	105,721	11	412,386	42	344,838	35	979,772
1976	149,611	13	137,475	12	484,196	41	397,225	34	1,168,506
1977	98,670	9	153,510	14	490,583	43	387,728	34	1,130,492
1978	135,744	11	139,586	11	620,379	49	365,022	29	1,260,731
1979	100,386	9	128,700	11	543,339	47	395,186	34	1,167,611
1980	107,241	9	141,524	12	589,095	48	382,323	31	1,220,183
1981	105,017	9	115,904	10	557,795	47	415,057	35	1,193,774
1982	98,558	9	115,480	10	589,861	51	355,201	31	1,159,100
1983	79,431	6	122,193	9	741,976	57	358,700	28	1,302,300
1984	92,973	7	115,681	8	816,098	57	403,832	28	1,428,584
1985	87,896	6	138,500	10	649,346	48	485,809	36	1,361,552
1986	81,303	5	164,975	10	820,421	51	533,983	33	1,600,681
1987	78,360	5	177,215	11	748,297	47	591,139	37	1,595,011
1988	85,715	5	139,988	8	926,923	54	561,917	33	1,714,542
1989	96,910	5	147,698	8	910,626	51	619,622	35	1,774,855
1990	91,190	5	191,416	10	963,807	51	657,373	35	1,903,786
1991	71,514	3	183,678	9	1,193,042	56	669,555	32	2,117,789
1992	91,952	4	181,421	9	1,106,597	54	672,476	33	2,052,447
1993	88,969	5	160,159	8	1,006,734	53	655,678	34	1,911,540
1994	113,961	6	188,675	9	1,088,505	53	659,637	32	2,050,779
1995	99,398	5	175,270	8	1,199,625	57	629,929	30	2,104,221
1996	113,715	6	175,461	9	1,149,603	57	593,389	29	2,032,167
1997	137,810	6	200,875	9	1,148,073	52	736,045	33	2,222,803
1998	138,212	5	186,016	7	1,459,480	57	783,516	31	2,567,224
1999	160,541	6	183,217	7	1,417,863	56	748,736	30	2,510,357
2000	130,230	5	217,649	8	1,462,204	57	752,612	29	2,562,696
2001	145,386	6	200,305	8	1,337,078	52	884,514	34	2,567,283
2002	137,887	5	173,180	7	1,480,058	56	865,648	33	2,656,773

Table 8. Catches of albacore, bigeye, skipjack and yellowfin by ocean area.
Symbols: '…' = missing data; estimates in parentheses have been carried over from previous years. Estimates for 2001 are preliminary.

YEAR	ALBACORE		BIGEYE		SKIPJACK		YELLOWFIN		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1950	107,813		…		…		…		…
1951	82,269		…		166,445		…		…
1952	126,770	29	29,792	7	150,441	35	122,862	29	429,864
1953	108,798	27	30,648	8	154,800	38	113,330	28	407,576
1954	113,868	25	29,374	6	194,059	42	124,674	27	461,975
1955	97,799	20	44,624	9	187,492	38	159,122	33	489,036
1956	129,974	23	50,652	9	199,663	35	196,538	34	576,826
1957	148,517	24	67,011	11	187,953	31	205,633	34	609,114
1958	133,173	20	70,685	11	255,038	38	208,112	31	667,008
1959	132,883	19	65,759	9	281,175	40	217,282	31	697,099
1960	158,187	23	79,118	11	162,967	23	299,057	43	699,329
1961	143,476	18	100,386	13	257,345	32	295,794	37	797,001
1962	178,700	21	121,661	14	282,900	32	287,940	33	871,201
1963	191,632	22	147,491	17	266,687	31	266,825	31	872,635
1964	195,057	22	117,548	13	286,004	32	290,486	33	889,095
1965	202,872	23	117,223	13	288,094	32	281,748	32	889,937
1966	196,001	20	115,460	12	369,224	37	306,000	31	986,685
1967	220,564	22	120,924	12	392,614	39	271,644	27	1,005,746
1968	189,211	18	124,352	12	360,436	34	373,882	36	1,047,881
1969	196,678	18	149,019	14	332,896	31	388,382	36	1,066,975
1970	185,932	17	141,327	13	395,819	36	377,730	34	1,100,807
1971	223,160	19	148,458	13	454,499	39	340,475	29	1,166,591
1972	239,200	20	155,255	13	386,559	32	436,982	36	1,217,996
1973	243,706	18	167,651	12	492,730	36	471,142	34	1,375,230
1974	249,869	16	174,726	11	607,241	40	490,099	32	1,521,935
1975	187,338	13	203,106	14	513,917	36	508,890	36	1,413,251
1976	241,884	15	210,536	13	599,996	37	559,945	35	1,612,360
1977	186,615	11	242,823	15	639,317	39	578,590	35	1,647,346
1978	227,112	13	241,543	14	764,880	43	550,148	31	1,783,683
1979	192,798	12	208,045	13	675,071	41	568,152	35	1,644,066
1980	182,806	11	239,474	14	751,354	44	552,430	32	1,726,064
1981	179,537	10	218,013	12	742,028	42	612,524	35	1,752,103
1982	196,453	11	231,837	13	801,454	44	573,191	32	1,802,935
1983	166,332	9	230,914	12	947,257	49	586,582	30	1,931,085
1984	169,754	8	229,969	11	1,056,098	51	618,282	30	2,074,103
1985	174,541	8	268,631	13	908,105	43	764,320	36	2,115,598
1986	199,768	8	287,546	12	1,096,821	46	823,218	34	2,407,352
1987	190,197	8	297,485	12	1,034,408	43	892,001	37	2,414,091
1988	183,107	7	279,374	11	1,273,240	48	908,459	34	2,644,179
1989	184,625	7	294,742	11	1,280,345	47	981,548	36	2,741,259
1990	188,744	6	349,027	12	1,338,019	45	1,081,623	37	2,957,413
1991	156,689	5	356,471	11	1,649,386	51	1,060,551	33	3,223,097
1992	182,315	6	352,665	11	1,535,531	48	1,139,420	35	3,209,932
1993	181,408	6	378,817	12	1,488,300	46	1,201,695	37	3,250,220
1994	210,749	6	433,325	13	1,591,305	47	1,144,445	34	3,379,825
1995	190,565	6	425,134	13	1,677,992	49	1,105,454	33	3,399,144
1996	205,079	6	426,322	13	1,594,867	48	1,081,635	33	3,307,902
1997	225,290	6	456,532	13	1,601,225	46	1,193,002	34	3,476,049
1998	236,351	6	440,360	12	1,927,870	50	1,221,025	32	3,825,606
1999	266,764	7	457,075	12	1,996,063	51	1,222,094	31	3,941,996
2000	241,328	6	446,674	11	2,008,424	52	1,189,806	31	3,886,233
2001	257,072	7	408,451	11	1,886,657	49	1,323,676	34	3,875,856
2002	…	…	…	…	…	…	…	…	…

APPENDIX 1. AGENDA

Date	Time	Agenda
July 7-8	Statistics, Methods, FishingTechnology WGs	
July 9, Wed	8:00-8:30	Registration
	8:30-10:30	Preliminaries (1hr) Announcement Opening statement (Minister Ian Macdonald) Adoption of agenda and format of reports Adoption of the SCTB-15 report Appointment of rapporteur Overview of WCPO tuna fisheries (1hr) GEN 1: Overview of fisheries GEN 2: Economic condition of the fishery
	11:00-12:30	National tuna fishery reports
	14:00-15:30	
	16:00-17:30	Reports by regional fishery organizations
July 10, Thurs	8:30-10:00	Statistics WG (Chair: Tim Lawson)
	10:30-12:30	Fishing Technology WG (Chair: David Itano) Methods WG (Chair: John Sibert)
	14:00-16:00	Yellowfin RG (Chair: Robert Campbell)
	16:30-18:30	
July 11, Fri	8:30-10:30	Skipjack RG (Chair: Gary Sakagawa)
	11:00-12:30	
	14:00-16:00	Bigeye RG (Chair: Naozumi Miyabe)
	16:30-18:30	
July 12, Sat	8:30-10:30	Albacore RG (Chair: Regis Etaix-Bonnin)
	11:00-12:30	
July 13, Sun	Free Day	
July 14, Mon	8:30-10:30	Billfish and Bycatch RG (Chair: Paul Dalzell)
	11:00-12:30	
	14:00-15:30	
	16:00-18:00	Reconvene Methods WG (Chair: John Sibert) Reconvene Statistics WG (Chair: Tim Lawson)
July 15, Tues	8:30-10:30	Cross-Cutting issues (Chair: Tony Lewis)
	11:00-12:30	
	14:00-15:30	Fishing Capacity in the WCPO (Chair: Talbot Murray)
	16:00-17:30	Other matters Administrative matters Preparatory meeting for the BBRG Review of the SCTB-16 procedure and suggestions to SCTB 17 (Reorganization of WG/RGs – Chair: Pierre Kleiber)
July 16, Wed	8:30-17:00	Clear Executive Summary Adoption of the SCTB-16 Report Close
July 17-19	Scientific Coordinating Group	

APPENDIX 2. LIST OF WORKING PAPERS

INFORMATION REPORTS

Anonymous. **Report of the Fifteenth Meeting of the Standing Committee on Tuna and Billfish (SCTB15), 22–27 July 2002, Honolulu, Hawaii.** Pelagic Fisheries Research Programme, Joint Institute for Marine and Atmospheric Research, University of Hawaii. 143 pp.

INFO–1 Sibert, J. **Pelagic Fisheries Research Program – Program Overview and Current Research**. Pelagic Fisheries Research Program. Joint Institute of Marine and Atmospheric Research. University of Hawaii

INFO–2 IATTC. **Status of Stocks of tuna and billfish in the Eastern Pacific Ocean**. Inter-American Tropical Tuna Commission (IATTC). La Jolla. USA.

INFO–3 IATTC. **Draft Resolution on Data Provision (RESOLUTION C-03-05)**. Inter-American Tropical Tuna Commission (IATTC). La Jolla. USA.

INFO–4 **Background Papers for Discussion on Fishing Capacity in the WCPO**

INFO–5 Anonymous. **Report of the Fifth Meeting of the SPC/FFA Tuna Fishery Data Collection Committee**, 2-6 December 2002, Brisbane, Queensland, Australia. Secretariat of the Pacific Community, Noumea, New Caledonia and Forum Fisheries Agency, Honiara, Solomon Islands.

OVERVIEW OF WESTERN AND CENTRAL PACIFIC OCEAN TUNA FISHERIES

GEN–1 Williams, P. **Overview of the western and central Pacific Ocean tuna fisheries – 2002.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

GEN–2 Forum Fisheries Agency. **Economic overview of the tuna fishery.** Forum Fisheries Agency. Honiara. Solomon Islands.

WORKING GROUPS

Statistics Working Group

SWG–1 Lawson, T. **Status of data collection, compilation and dissemination.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SWG–2 Lawson, T. **Estimates of annual catches of albacore, bigeye, skipjack and yellowfin tuna in the Western and Central Pacific Ocean.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SWG–3 Williams, P. **Estimates of annual catches for billfish species taken in commercial fisheries of the western and central Pacific Ocean.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SWG–4 Lawson, T. **Observer coverage rates and the accuracy and reliability of estimates of CPUE for offshore longline fleets targeting South Pacific albacore.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SWG–5 Lawson, T. and A. Coan. **Review of Korean catch and effort logsheets.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SWG–6 Lawson, T. **Analysis of the proportion of bigeye in 'yellowfin plus bigeye' caught by purse seiners in the Western and Central Pacific Ocean, based on observer data.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SWG–7 Bravington, M., C. Burridge and P. Toscas. **Design of observer program to monitor bycatch species in the Eastern Tuna and Billfish Fishery.** CSIRO, Hobart, Australia.

SWG–8 Wetherall, J. **Observer coverage in the Hawaii-based longline fishery: A Case Study.** Pacific Islands Fisheries Science Center. US National Marine Fisheries Service.

Methods Working Group

MWG–1 Labelle, M. **Testing the accuracy of MULTIFAN–CL assessments using an operational model of yellowfin tuna (*Thunnus albacares*) fisheries in the western and central Pacific Ocean.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia

MWG–2 Maunder, M. and S.J. Harley. **Methodological improvements to the EPO tuna stock assessments.** Inter-American Tropical Tuna Commission (IATTC). La Jolla. USA.

MWG–3 Harley, S. and M. Maunder. **Recommended diagnostics for large statistical stock assessment models.** Inter-American Tropical Tuna Commission (IATTC). La Jolla. USA.

MWG–4 Wang, C-H. **Theoretical consideration of estimating the varied carrying capacities.** Institute of Oceanography, National Taiwan University, Taipei, Taiwan, ROC.

MWG–5 Kolody, D. and D. Ricard. **Application of SCALIA and Production Models (Fox, Schaefer, and Age-Structured) to the SCTB MWG 2003 Simulated Tuna Fishery.** CSIRO. Division of Marine Research, Hobart, Australia.

MWG–6 Campbell, R. **An Approach for Estimating Equilibrium Yields within Regions of the Pacific Ocean.** CSIRO. Division of Marine Research, Hobart, Australia.

MWG–7 Hinton, M. and M. Maunder. **Methods of standardising CPUE and how to select among them.** Inter-American Tropical Tuna Commission (IATTC). La Jolla. USA.

Fishing Technology Working Group

FTWG–1 Itano, D.G. and A.L. Coan Jr. **An assessment of the accuracy of yellowfin and bigeye tuna species identification: by American Samoa port samplers.**

FTWG–2 Coan Jr., A.L. and D.G. Itano **Updates (2003) of factors that may have affected U.S. purse seine catch rates in the central-western Pacific Ocean: an examination of fishing strategy and effective fishing effort.**

FTWG–3 Itano, D.G. **Documentation and classification of fishing gear and technology on board tuna purse seine vessels.**

FTWG–4 Kumoru, L. **Notes on the use of FADs in the PNG purse seine fishery.**

FTWG–5 Coan Jr., A. and P. Crone. **Fishery-related attributes associated with FAD and log fishing practices conducted by the U.S. purse seine fleet in the central-western Pacific Ocean, 1997–2002.**

FTWG–6 Joseph, J. **Managing fishing capacity of the world tuna fleet [Executive Summary of FAO Fisheries Cicular. No. 982]**

FTWG–7 Nelson, P. **Reducing the take of undersize tuna and bycatch in drifting FAD sets: project description.**

FTWG–8 Moron Ayala, J. **Review of activities of the World Tuna Purse-seine Organisation (June 2002–June 2003).**

FTWG–9 Beverly, S. **Proposal for a deep setting technique for longline fishing to enhance target CPUE and to avoid certain bycatch species.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia

SPECIES RESEARCH GROUPS

General

RG–1 Anonymous. **Notes on sources, quality and coverage of aggregate catch/effort and size composition data available to the SCTB.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

RG–2 Langley, A. **Standardised analysis of yellowfin and bigeye cpue data from the Japanese longline fleet, 1952 to 2001.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

RG–3 Bigelow, K., M. Maunder and M. Hinton. **Comparison of deterministic and statistical habitat-based models to estimate effective longline effort and standardized cpue for bigeye and yellowfin tuna.** US National Marine Fisheries Service. Honolulu, Hawaii. Inter-American Tropical Tuna Commission (IATTC). La Jolla. USA.

RG–4 Matsumoto, T., M. Okuhara, I. Ohta, M. Mizoguchi and N. Miyabe. **Report of the ongoing tagging project on tropical tunas around Japan.** National Research Institute of Far Seas Fisheries, Shimizu. Kagoshima Prefecture Fisheries Experiment Station, Kagoshima. Okinawa Prefectural Fisheries Experimental Station, Okinawa. Japan NUS Co., Ltd., Tokyo. Japan.

Skipjack

SKJ–1 Langley, A., M.Ogura and J. Hampton. **Stock assessment of skipjack tuna in the western and central Pacific Ocean.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SKJ–2 Williams, P. **Overview of skipjack fisheries in the western and central Pacific Ocean – 2002.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SKJ–3 Anonymous. **A summary of aggregate catch/effort and size composition data available to the SCTB – SKIPJACK.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SKJ–4 Kirby, D., G. Huse, P. Lehodey and P. Hart. **An individual-based model for the spatial population dynamics of Pacific skipjack tuna *Katsuwonus pelamis*: model structure.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SKJ–5 Lehodey, P. **SEPODYM application to skipjack tuna (*Katsuwonus pelamis*) in the Pacific Ocean: impact of ENSO on recruitment and population.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SKJ–6 Fonteneau, A. **A comparative overview of skipjack fisheries and stocks worldwide.** IRD, Seychelles.

SKJ–7 Ogura, M. **Swimming behavior of skipjack, Katsuwonus pelamis, observed by the Data Storage Tag at the NorthWestern Pacific, off northern Japan, in summer of 2001 and 2002.** National Research Institute of Far Seas Fisheries. Japan.

SKJ–8 Tanabe, T., S. Kayama, and M. Ogura. **Precise age determination of young to adult skipjack tuna (*Katsuwonus pelamis*) with validation of otolith daily increment.** National Research Institute of Far Seas Fisheries. Japan.

SKJ–9 Tanabe, T., S. Kayama, M. Ogura and S. Tanaka. **Daily increment formation in otoliths of juvenile skipjack tuna *Katsuwonus pelamis*.** National Research Institute of Far Seas Fisheries. Japan.

SKJ–10 Chi-Lu Sun, Su-Zan Yeh, Shui-Kai Chang, and Ren-Fen Wu. **Biological data collection and study on skipjack tuna caught by Taiwanese tuna purse seine fishery –2002.** Institute of Oceanography, National Taiwan University, Taipei, Taiwan; Fisheries Administration, Council of Agriculture, R.O.C. Overseas Fisheries Development Council of the Republic of China.

Yellowfin

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APPENDIX 4. OPENING ADDRESS BY THE AUSTRALIAN FEDERAL MINISTER FOR FISHERIES, FORESTRY AND CONSERVATION, SENATOR THE HON IAN McDONALD

Good morning, ladies and gentlemen.

I am somewhat overwhelmed to be in the presence of such a distinguished group of very clever people, who are going to ply their trades in the next few days in between, I hope, having a look at the beaches that this particular area is famous for.

I know that the work you do is in biology and ecology, and fisheries generally, reviewing stock assessments and stocks of fish generally, and giving opinions on fisheries and research projects in the central and western Pacific, and it is so very important. I am very, very conscious of the work that you do as the Australian Fisheries Minister, and I am also conscious of how very critical your work is to helping people like me, people like fisheries ministers generally, manage the fisheries. And so, I am delighted, and honoured in fact, to be with you today.

I was just saying to the Australian organising committee I am not sure whether or not I was invited here, or whether I invited myself, but I did particularly want to come along because I wanted to emphasise to the Australian Government, and to the Australian people, just how important the work that you do is.

The climate here on the Sunshine Coast, in what we call the Sunshine State of Australia, is very warm and hospitable, and I want to extend to you all a similar warm welcome, particularly for those of you who have come such a long way to participate in this forum. I especially want to welcome the participants from Japan who returned to this forum after a short absence.

I am a little suspicious of all of you, as I get the feeling that you followed the habits of the fish that you have studied for so long so closely. They always appear to migrate to where conditions are most favourable to their existence but, in this case, it is to one of Queensland's premier tourism locations, and so I really don't blame you for following their migratory patterns, but I understand that you do it all in the name of science of course.

On a more serious note, I think it is fitting that the meeting is hosted here in sunny Mooloolaba, and as it is very much a key port for Australia's commercial fishers, and a very good area for game fishing as well. I am pleased to see representatives from both of those groups here today at your forum. The work that is going to be done at this meeting this morning is, as I have mentioned, very very important to Australia, as it is to each of your countries, because it relates to fish species that travel all over the Pacific.

This, of course, means that we all share the joint responsibility of managing these fish. Your research work requires cooperation and the sharing of data and ideas and this cooperative approach certainly helps the Australian research agencies such as the Bureau of Rural Sciences (BRS) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO), to provide the Australian Government with very

high quality scientific advice so essential both to Australian domestic fishery management decisions, and to our approach to the international fisheries agenda.

We are well aware that the world's fisheries have many difficulties and challenges to overcome if they are going to continue to remain an essential source of protein for human kind. The fact that nearly one billion people rely on fisheries for their food has daunted many by the sheer scale of what the world's fisheries are actually facing. You know better than I that many fisheries are already over exploited, some have collapsed and in most cases there are too many boats and people fishing them to allow any person, community, company or country to profit from the fisheries, or more importantly, for the stocks to be sustainable.

Fisheries management is a very complex business. However, for it to work well, you only need two ingredients, I think: a sound scientific base, and the will to face the hard decisions when they need to be taken so that future generations can benefit from the fish that up until recently have been taken for granted by a very complacent world. This is, of course, where you all come in; your role is very very critical, but your work cannot be viewed in isolation, and whether you recognise it or not, you are in an extremely powerful position in terms of influencing the international fisheries agenda.

The research that you conduct feeds into both national and international decision-making processes that do impact upon fish stocks globally. So you all exercise a position of great responsibility and, as this is the case, I have a request of you today, or maybe it is a challenge, and that is that I ask you to use your influence, your knowledge and your credibility to encourage the governments of your respective countries to throw away the rhetoric and the diplomatic double speak, and to actually take some firm and decisive action in a number of areas that are currently suffering from an overt lack of action.

As you know, as the state of the planet's fisheries has declined, Regional Fisheries Management Organisations (RFMO) have been established to try and reverse this trend and apply management to high seas stocks. But, unfortunately, with only a few exceptions, their usefulness has not lived up to the expectations of their founders.

I want to mention the Indian Ocean Tuna Commission (IOTC). This is probably the least successful of the RFMOs, and to support this I only have to point out that bigeye tuna is being fished at around 60,000 tonnes above the stock's maximum sustainable yield. For this to be allowed to continue knowingly is a disgrace. For all of the countries that are involved in the IOTC it really is time to take strong and united action before it is really too late. Could I ask all of you if you are involved in providing advice to Government to actually start pushing for delegations to get serious about making the IOTC actually deliver what it set out to do, that is, to manage the fish, not to redistribute excess fishing capacity from other fishing nations? If you are asking yourselves 'Why us?' 'Why don't you do something about it yourself, you are the politician?' The answer is that I, and the Australian Government, are devoting a lot of energy and resources behind the scenes to these issues.

I was in Paris recently for an OECD round table of Fisheries Ministers, particularly relating to illegal fishing. I can't tell you exactly what was said because Chatham House Rules were applied to that meeting - but I can tell you that there was some

fairly straight talking between ministers, and some countries at the table, I have to say, became less confident and less comfortable as the full and frank discussions continued.

While I was in Paris I also met my French counterpart and specifically raised the issue of how dysfunctional the IOTC was, and for the need for it to be pulled into gear and to start delivering conservation outcomes. I am delighted to say that the French shared my views and agreed that the Commission risked losing all relevance, and any chance of helping the tuna stocks throughout that region unless it was reformed.

Similarly, while the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) functions much more professionally than the IOTC, there certainly is room for improvement, and Australia will again be urging other members to introduce a better Catch Documentation Scheme (CDS), and a centralised vessel monitoring system (VMS), and some black and white lists of both vessels and registers. I would certainly welcome any support that any of you can give to me by urging your nations to support the proposals that Australia will be putting on the table at the CCAMLR meeting in October.

I recognise that not a lot of the countries represented here are involved in CCAMLR, but through your international scientific connections and networks, you will know other scientists and I would urge you to urge them to urge their countries to really get serious about Regional Fisheries Management Organisations, and I particularly, as I say, mentioned the IOTC and CCAMLR.

But on a brighter note, the area for which you have responsibility is, of course, the Pacific fish stocks, and I do want to talk about the developments for the Western and Central Pacific Fisheries Commission. The Commission, as you understand well, and of course you will be helping this, will be managing the last great stock of fish resources in the world.

Australia is fully committed to supporting the Pacific island countries in our stewardship and management of these fish resources. I cannot tell you how importantly Australia views the sustainability of these fish resources. They are fundamental for the long term prospects and economies of a number of Pacific island countries, and Australia will not weaken or compromise its position in that we need to actually build upon for the current convention text, and we want to ensure that we can deliver to the world the very best Regional Fisheries Management Organisation for these Pacific fish stocks.

I am encouraged by the developments to date through the PrepCon process, but I do remind all countries that are involved that we should not delay unnecessarily bringing the Commission into being - because the longer we delay the more we put at risk the sustainability of these very important stocks of fish.

The work that you are doing in relation to the western and central Pacific is a very good example of what quality input can be achieved in the establishment of the Western and Central Pacific Fisheries Commission - your work, of course, will be central and critical to ensuring that the tuna and billfish stocks of the Pacific Ocean

are able to continue to support the local and international fleets that actually depend upon those resources.

We are 100 per cent committed to working with our South Pacific neighbours to solve issues of importance to them. One of Australia's key goals for the region is to ensure that the Pacific fish stocks are managed in accordance with the principles of ecologically sustainable development.

I am aware that there is a fine line that scientists have to tread and encourage you all to stay the balanced course. There have been instances reported to me where various individuals or groups have used their research for their own gain and glorification rather than the greater good of the global community. I have also been informed that this abuse of science is very much a concern to many of you in this room, with poorly researched but highly publicised fisheries science undermining the credibility that your profession has worked so hard to establish. I am informed that this is particularly true with regard to research on the effects of fishing on predatory fish stocks like tuna and billfish.

I do encourage greater collaboration between the world's tuna research bodies to comprehensively address the question of what the effects of industrial fishing has been on tuna and billfish over the past 50 years, and I am heartened to hear that such collaborations are now in fact taking place.

I am also aware of the considerable and growing concern over the extent of illegal, unreported and unregulated fishing in the world's oceans. This issue makes it more difficult for scientists such as yourselves to have any surety over the assessments that you make. Achieving sustainable fisheries can only come if we all recognise the need to work tirelessly to eliminate IUU fishing.

My Government has taken a lead role in this respect, and I hope that this endeavour is not only recognised, but also supported and pursued by all governments in our region and, in fact, I mention Palau, that country did earlier this year when they destroyed a vessel that had been caught plundering shark find within their Exclusive Economic Zone (EEZ).

I understand that there have been many and considerable advances in fisheries science that many of you have either been responsible for, or have contributed to. Your work has had a very positive effect on the management objectives and practices that will enhance the prospects of long-term sustainability.

If we are to protect, secure and build the world's fisheries resources we must focus on short-term gains that occur at the expense of stocks and fisheries of the future, and we must begin to genuinely focus on the health of our planet and the wellbeing of future generations.

You have been entrusted with this difficult task to come up with advice and solutions for these difficult and complex problems and I have every confidence that if you maintain your focus and dedication you will achieve what you set out to do.

Ladies and gentlemen I wish you all the very best in your combined endeavours throughout the course of this meeting. I see as the Australian Forestry Minister as well that you have contributed a couple of plantations of forests with all of the papers that have been prepared there and so you obviously have a very heavy and intense work program in front of you.

I do wish you all the best and I hope that you are able to take a positive step towards a more sustainable fishing future and the work that you do really is so critically important to the decisions that governments have to make in the very very near future.

Before I conclude can I extend a thank you to those of you who have been instrumental in organising this meeting. First of all, the chair of the SCTB Committee, Dr Sung Kwon Soh, and the rest of his committee, for their tireless efforts and work, and the work that you do, Dr Soh, congratulations and thank you.

To Dr John Hampton and the staff of the Oceanic Fisheries Program of the SPC, whose annual task it is to make sure that this meeting happens. I understand that it started off as a fairly informal gathering of scientists but it has grown in stature, as it has necessarily grown I suspect in formality. It is very good and congratulations to Dr John Hampton and his staff.

The organising committee here in Australia, who I understand are John Kalish and Dr James Findlay, and I can tell you without embarrassing Dr Findlay, that he has to be a very good fellow because his wife actually works with me, so you have a bit of an insider approach to fisheries management in Australia. Although I have to say she is very professional, and she never talks about her husband's work.

Also to John Gunn and Toni Cracknell from the CSIRO, who I know have done a lot of logistical work behind this meeting.

Japan, Papua New Guinea and the SPC for providing the funding for developing nation participants in this meeting, and thank you to those countries for that generosity. And also, my own Government, through my Department, the Department of Agriculture, Fisheries and Forestry - Australia, the Australian Fisheries Management Authority, and the CSIRO for financial support to this meeting.

I understand that my department is actually putting on a dinner for you later on and I hope that you have a wonderful time. I hope you get an opportunity to taste some of Australia's very best wine, because we have not only good fish stocks that we share with you, but we have some of the world's best wines as well and I hope you enjoy that.

The place here, and your presence in Australia, is really a great honour to Australia, and I thank you again for coming, and wish you well in your deliberations over the next week. I certainly do hope that we can all continue to work together very fruitfully and determinedly in this committee now and in the years ahead. And it is with great pleasure that I officially open the 16th annual meeting of the Standing Committee on Tuna and Billfish.

APPENDIX 5. REPORT OF THE STATISTICS WORKING GROUP PREPARATORY MEETING ON OBSERVER PROGRAMS

Introduction

A meeting of the Statistics Working Group (SWG) was held on 7 July 2003, prior to SCTB16. The objective of the meeting was to establish guidelines for coverage rates for observer programs for tuna fisheries of the Western and Central Pacific Ocean (WCPO). The meeting was attended by D. Bromhead (Australia), C. Burridge (Australia), R. Campbell (Australia), S. Chou (Taiwan), R. Clarke (United States), A. Coan (United States), M. Hinton (IATTC), J. Koh (Korea), L. Kumoru (Papua New Guinea), T. Lawson (SPC), A. Lewis (Papua New Guinea), L. Manarangi-Trott (Cook Islands), A. Mobiha (Papua New Guinea), T. Park (Federated States of Micronesia), P. Sharples (SPC), R. Skillman (United States), K. Staisch (FFA), T. Takeshita (Japan), Y. Uozumi (Japan), P. Williams (SPC) and R. Wu (Taiwan). The meeting was chaired by Mr Lawson, coordinator of the SWG.

The meeting was convened to consider research activities carried out following a meeting of the SWG that was held on 18 July 2002, prior to SCTB15 in Honolulu; the objective of the meeting was to discuss the establishment of standards for the design of national and regional observer programs for tuna fisheries of the WCPO.

Observer coverage rates for the United States purse-seine fleet

Mr Coan reported the results of a comparison of estimates of annual catches of the United States purse-seine fleet determined from species composition samples taken by port samplers and observers. Estimates of catches of target species (skipjack, yellowfin and bigeye) based on samples of at least 150 sets had relatively low coefficients of variation (<20%) and were similar to estimates based on extensive port sampling data. These results indicate that this level of coverage (about 2–3% of all sets) is adequate for target species. Coefficients of variation for non-target species are expected to be much greater, but were not investigated.

Review of sampling programs in the Eastern Pacific Ocean

Mr Hinton presented information concerning a review by the Inter-American Tropical Tuna Commission (IATTC) of species composition sampling by port samplers and observers, particularly in regard to bigeye. Particular concern in recent years has been the correct identification of species in the landings from purse-seine fisheries in the Eastern Pacific Ocean, particularly those of bigeye, which may be misidentified as yellowfin, particularly at small sizes, and which are the least common of the target species (yellowfin, skipjack and bigeye) that are taken in sets made on tunas in association with floating objects. The IATTC has undertaken studies to estimate the catch of tunas by species, both in real time using observer hails and vessel logbook hails and unloading weights reported by species, and as indicated by historical 50-fish and standard species sampling, as compared to data obtained from a full well composition sampling design applied to catches from defined fishing areas after the fishery data are available for analysis.

Results obtained indicated that the historical method, the vessel hails, and the landings data all significantly underestimated the catch of bigeye in the landings. Observer hails of the catch of bigeye more closely approximated the estimates obtained from the full well sampling and are now used in real time estimates of catches. Landings data are now adjusted prior to use in analyses of stock status. Copies of study design and results are available.

Observer coverage rates for offshore longline fleets targeting South Pacific albacore

Mr Lawson presented Working Paper SWG–4, Observer coverage rates and the accuracy and reliability of estimates of CPUE for offshore longline fleets targeting South Pacific albacore. Catch and effort data collected by observers covering 499 sets by offshore longliners of seven fleets (American Samoa, Cook Islands, Fiji Islands, French Polynesia, New Caledonia, Samoa and Tonga) from 1992 to 2002 were sub-sampled at coverage rates from 2% to 100% at 2% intervals. Estimates of CPUE for eight species (albacore, blue shark, mahi mahi, wahoo, opah, silky shark, black marlin and hammerhead sharks) representing a range of levels of CPUE, from most common to most rare, were considered. Sub-sampling was conducted with and without stratifying by fleet and year.

Coefficients of variation for estimates of CPUE depended strongly on the level of CPUE. The table below presents CPUE (number of fish per 100 hooks) together with coverage rates (percent of sets) required for a coefficient of variation of 10%. Stratifying the sampling of sets by fleet and year improves the coefficients of variation by an average of 5%.

COMMON NAME	SCIENTIFIC NAME	POOLED CPUE	COVERAGE RATE	
			UNSTRAT	STRAT
Albacore	*Thunnus alalalunga*	1.4053	18	12
Blue shark	*Prionace glauca*	0.1375	24	18
Mahi mahi	*Coryphaena hippurus*	0.1257	32	28
Wahoo	*Acanthocybium solandri*	0.0881	38	28
Opah	*Lampris guttatus*	0.0590	42	36
Silky shark	*Carcharhinus falciformis*	0.0263	64	56
Black marlin	*Makaira indica*	0.0122	84	84
Hammerhead sharks	*Sphyrna spp.*	0.0010	92	92

For all eight species, coefficients of variation declined steeply with an increase in the coverage rate to about 20–30%. Further increases in coverage resulted in smaller incremental improvements.

It was concluded that the coverage rate that should be applied will depend on the species of interest and the coefficient of variation (i.e., the 'reliability' or the 'confidence') of the estimates that is required. If the objective is to monitor all species and if cost or the availability of observers are not limiting factors, then 100% coverage is appropriate. If 100% coverage is not possible, then coverage of 20% may

be an appropriate compromise, given that further increases in coverage result in smaller incremental improvements in the reliability of the estimates.

Observer sampling designs for the Eastern Tuna and Billfish Fishery of Australia

Dr Burridge presented Working Paper SWG–7, Design of observer program to monitor bycatch species in the Eastern Tuna and Billfish Fishery (ETBF). The precision of annual catch estimates for five species or species groups (turtles, black marlin, blue marlin, dolphinfish and blue sharks) under a range of possible designs were considered. The fishery was stratified into five regions and four quarters based on recent logbook data from the ETBF to capture large-scale spatial and seasonal variations in adundance. Observer data covering Japanese longliners during 1991–1995 were used to simulate catch rates in each stratum and the variability among sets within each stratum, except for turtles, for which interview survey data were used. A Poisson distribution was used for turtles, black marlin and blue marlin, while a negative binomial was used for dolphinfish and blue sharks due to overdispersion. Effort data from ETBF logbooks for 2001 were used with the simulated catch rates to produce 5,000 data sets comprised of random samples of observed sets. For each set of data, catches for each of the five species or species groups were estimated. The precision of the estimates was then determined by examining the variation of the estimates among data sets.

Five survey designs were considered, with coverage rates ranging from 5.1% to 18.8%. Two of the designs had an equal number of observed sets among strata, while three had an unequal number, reflecting the distribution of effort among strata. The coefficients of variation for estimates of the total catch for blue sharks, a common species, ranged from 3% to 7% (at 18.8% and 5.1% coverage respectively), while those for turtles, a rare species, ranged from 14% to 35%. Coefficients of variation for dolphinfish, blue marlin and black marlin were intermediate. For turtles, there was a 15% gain in precision for the design in which the allocation of observed sets among strata, at 5.1% coverage, was roughly proportional to fishing effort, compared to the design with an equal number of observed sets.

It was concluded that a reasonable strategy would be to pick an overall level of coverage based on the coefficients of variation suggested by these analyses, and a roughly proportional design. After a few years of data collection, it would then be possible to consider whether gains in efficiency are achievable through modifications to the design.

Observer coverage in the Hawaii-based longline fishery

Mr Skillman presented Working Paper SWG–8, Observer coverage in the Hawaii-based longline fishery: a case study, by Dr Jerry Wetherall. An observer program was established in the Hawaii longline fishery in 1994 to monitor interactions with sea turtles. During the first six years of the program, observers were placed on about 3–5% of fishing trips by the fleet. Data collected by observers indicated that bycatches ("takes") of turtles were particularly likely to occur on fishing operations using shallow-set gear to target swordfish in the subtropical frontal zone north of the main Hawaiian Islands. In mid–2000, in response to a Federal court order, NMFS

implemented new fishing regulations designed to reduce turtle takes, including time and area closures. Likewise, NMFS was mandated to expand observer coverage to 100% on swordfish trips and 20% on tuna trips to increase the precision of turtle take estimates.

In 2001, additional regulations were introduced, including a prohibition on the use of shallow-set gear and the intentional targeting of swordfish. As expected, the various measures imposed have reduced the frequency of interactions with turtles per trip and the total turtle take by the fleet. However, an unintended consequence has been that interactions with turtles are now so infrequent that take estimates are actually less precise than before – despite substantially higher observer coverage.

Given the continuing scrutiny of the fishery and the high cost of fielding observers, it is important that an appropriate level of coverage be determined under the current fishery and management conditions. Thus, in planning and budgeting for observer coverage, managers of the fishery need to decide on a primary monitoring objective (e.g., estimate of annual take of a particular turtle species) and the level of precision required (e.g., a specified coefficient of variation in the take estimate).

Estimation of the variance of mean bycatch rates and of total bycatches in New Zealand fisheries

The meeting was provided with a draft of a New Zealand Fisheries Assessment Report entitled 'Estimation of the variance of mean bycatch rates and of total bycatches of fish, seabirds and marine mammals in New Zealand fisheries', by Elisabeth Bradford. The relationship between observer coverage and the coefficient of variation of estimates of the total catch of several species taken by chartered longliners, based on observer data covering 1997–2000, was examined. The results indicate that the sample size required to reliably estimate the mean catch rate and its variance increases as the mean catch rate decreases. If precise estimates are required for species with low catch rates, then full observer coverage may be required. Longline sets are not randomly sampled by observers; hence, variances of catch estimates may be under-estimated. Several distributions were fitted to measure the probability of high catches and thereby refine variance estimates; however, the distribution parameters were poorly estimated.

Other issues

The following points were also raised:

- Coverage rates can be calculated on the basis of various quantities, such as trips or sets, and hence must be defined.

- Observer coverage under the FSM Arrangement is now defined as 50 days per vessel per year, instead of in terms of the number of trips, after some vessels shortened trips because an observer was aboard. In Hawaii, observers stay onboard for an additional trip if the initial trip was much shorter than average.

- There are various ways of stratifying observer sampling. Estimators of CPUE or the catch – e.g., CPUE averaged over sets, a ratio estimator (or 'pooled' CPUE),

or a Horvitz-Thompson estimator – should take account of the manner in which sampling has been stratified.

- Interannual variability in catch rates is important; hence, observer programmes should be conducted for multiple years.

- Observer coverage rates will also depend on compliance objectives. Costs are another key determinant.

- A pilot observer programme is being considered for Fiji domestic longline fisheries targetting bigeye and yellowfin. Two companies have agreed in principle to allow observers to cover five vessels each, full-time, for one year and perhaps longer. The observers will be recruited both locally and from other Pacific island countries. Expenses for the project will include salaries and insurance for the observers, a daily allowance paid to the companies to cover food for the observers, travel costs for the foreign observers, and travel expenses for SPC/OFP staff, who will supervise the programme.

Conclusions and Future Work

The objective of the meeting was to establish guidelines for coverage rates for observer programs for tuna fisheries of the WCPO. In this regard, each of the studies showed that the establishment of coverage rates depends on the species for which estimates of catches were required and the level of the coefficient of variation of the estimates that is considered acceptable.

Working Paper SWG–4 suggested a more general conclusion for programs for which the objective is to monitor catches of all species, i.e. that coverage of 20% is effective, since further increases in coverage result in smaller incremental improvements in the reliability of the estimates. However, this study was conducted only for observer programs covering offshore longliners targeting South Pacific albacore.

In the future, the relationship between coverage rates and the accuracy and reliability of estimates should be examined for the offshore longline fleets targeting bigeye and yellowfin in tropical waters and the purse-seine fleets. The SPC Oceanic Fisheries Program holds offshore longline and purse-seine observer data that could be used in this regard; however, there are insufficient observer data to examine the relationship for the distant-water longline fleets.

APPENDIX 6. REPORT OF THE PREPARATORY MEETING OF THE FISHING TECHNOLOGY WORKING GROUP

Introduction

A preparatory meeting of the Fishing Technology Working Group was held 8 July 2003 in Mooloolaba, Queensland Australia, one day prior to the commencement of SCTB16. Mr Itano, WG Coordinator served as Chairman of the meeting with 21 participants in attendance (Annex A6-I). The meeting reviewed presentations on DWFN and PICT fleets, items specific to the FTWG Task List developed for presentation to SCTB 16, new developments in fishing technology, issues related to FADs, observer and port sampler training, recent regional management initiatives and then agreed upon the structure and agenda of the FTWG 16 plenary session.

The Chairman noted the structure of the meeting would remain informal and discussion oriented. The provisional agenda to the preparatory meeting was reviewed and edited slightly to the form presented in Annex A6-II.

The emphasis of this group is to monitor developments in any industrial tuna fishery with potential to significantly influence sampling programs, catch and effort analyses, and data sources and data quality useful for management related research. Membership and contributions are open to all SCTB participants and promoted with national, regional and industry affiliated organizations. Information on new fishing methods and technology, bycatch reduction methods, expansions/contractions in regional fishing effort, FAD related issues and the quantification of effective fishing effort are relevant. The formation and Terms of Reference for the FTWG are documented in Working Paper FTWG-4 of SCTB 14 (2001).

Summaries of National Fishery Reports relevant to FTWG

DWFN fleets

Mr Al Coan presented *FTWG-2 Updates (2003) of factors that may have affected U.S. purse seine catch rates in the central-western Pacific Ocean: an examination of fishing strategy and effective fishing effort*. This paper is an update of FTWG working papers presented to SCTB 14 and 15 with inclusion of data for 2002. Thirteen vessels operating continuously between 1988 – 2002 were evaluated in terms of fishing and activity parameters. Since 1996, the fishing strategy of this fleet changed dramatically, shifting toward setting on schools found in association with floating objects. This trend peaked in 1999 when 94% of fishing occurred on floating objects, lead by a heavy reliance on drifting FADs. Since then, the trend in setting strategy has returned gradually to unassociated schools (56% in 2002). Catch per set and catch per day were higher on associated sets. The use of FADs also improved fishing parameters, with vessels making more frequent and shorter trips, spending less time fishing, and making fewer set but at a higher success rate. Their total target catches increased but the presence of juvenile bigeye tunas and small market tuna (<7.5 pounds) in their catch increased significantly. Though not specifically examined, the catch of associated fish bycatch likely increased during years with heavy FAD use.

The reduction in FAD use by the U.S. fleet was noted as a response to world market conditions with depressed prices for small sized skipjack and yellowfin. U.S. vessels

responded by 1) targeting larger, higher value yellowfin and skipjack on unassociated schools, 2) self enforced effort reductions to reduce frozen raw material stocks and 3) a reduction in FAD and log fishing. Mr Coan noted that the average length frequency in 2002 of the sampled catch was not significantly lower than during high FAD use years. A possible explanation was offered related to the lack of samples from Christmas Island where quantities of large, unassociated yellowfin were landed during 2002. However, this possibility was not specifically addressed during the meeting and remains speculative. While U.S. port sampling does not take place at Christmas Island, it was noted that the SPC does supports port sampling activities at Christmas and may be able to add to the U.S. database.

Mr Staisch noted that more than 20 U.S. vessels have signed on to the USMLT with more likely additions. During the latest Treaty period, the FFA observer program achieved a 28% coverage rate. Vessels are considering fishing Eastern Pacific waters as they are allowed one trip per year under the USMLT. Within the FSM Arrangement, Mr Staisch noted a 25% observer coverage with a required minimum of 50 observed days per year.

The Japanese distant water purse seine fleet decreased slightly while average vessel size remained stable. FAD use by the Japanese and Taiwanese purse seine fleets decreased further during 2002, following the trend noted in the U.S. fleet. The number of Taiwanese vessels has declined from 41 in 2002 to 36 in 2003.

The Korean purse seine fleet maintained a high incidence of setting on unassociated schools. This is the only major purse seine fleet in the region that has not relied to any great extend on logs or drifting FADs.

It was noted that the EU has signed an agreement with Kiribati for access of French, Spanish and/or Portuguese purse seine and longline vessels, but it was not believed that any vessels had yet operated in the zone during 2003 which was later confirmed in plenary.

PICT Reports

Mr Park noted a continued decline in purse seine activity in FSM waters, with fleets operating generally east of their zone. Overall levels of licensed longline capacity also declined, while licensed purse seine capacity remained about the same as for 2001. However, the reduction in vessel activity has to some degree resulted in a significant decline in revenues to the government. A notable development has been the reflagging to FSM, and licensing of two 2000+ mt capacity EU seiners to operate under the FSM Arrangement. To date, the vessels have been fishing primarily in the high seas zones to the south of FSM. The purse seiner FV Nien Fieoch of Chuuk State was reported to have sunk at the dock and has been put up for sale. It was noted that SPC has developed a specific database to store vessel and gear attributes that FSM/NORMA has started to use to store data from their extensive observer program.

Mr Staisch reported that conditions of the domestic Solomon Island fisheries were improving slowly despite the effects of ongoing civil unrest. The Tulagi fish base was reported to be closed and not likely to reopen. The Noro cannery is operating on limited domestic pole and line and purse seine landings augmented by transshipped loads from regional purse seine fleets. Basic services and government activities

remain somewhat disrupted though there is cautious optimism that the presence of a multilateral peacekeeping presence may stabilize the situation.

Mr Turaganivalu reported a stable number of longline vessels licensed in 2002 compared to 2001 (101 vessels). The tuna industry is fully domestic and vessels are flagged and based in Fiji. Notably, albacore constitutes the major component of the Fiji longline catch (74%) Longline remains the main offshore tuna fishing method with only two pole and line vessels active in 2002 (same as for 2001). Fiji flagged and based longline vessels also access some high seas areas and EEZs of other PINs, such as Vanuatu and the Solomon Islands.

Shoreside processing capacity has increased from four to five with the addition of another processing plant. This expansion is largely attributed to increased landings by DWFN longline fleets in Fiji. The PAFCO cannery reported increased production of loins for the U.S. market. Fiji's tuna industry has experienced significant growth in employment and trade during 2002. Infrastructure support remains the major deterrent to further development.

Mr Beverly noted that two 25 meter freezer equipped longline vessels are now operating in the New Caledonia zone. These vessels process and freeze albacore loins onboard for U.S. and European markets. Two additional vessels may join the fleet. About 25 ice-storing longline vessels now operate domestically from New Caledonia, with high albacore catches, which are frozen shoreside and shipped to regional canneries or held for domestic sale. These vessels also take swordfish, bigeye and yellowfin. It was suggested that there may be significant potential for expansion into swordfish targeting by the New Caledonia fleet, considering the proximity of an established Australian swordfish ground to the west.

For Australia, Mr Bromhead noted a small domestic purse seine fishery of five to six vessels targeting seasonal skipjack resources of east Australia. This fishery had contracted significantly since the closure of the Eden cannery. However, he noted that a large purse seine vessel is currently under construction. There is some interest in the use of FADs by Australian purse seiners within the Australian EEZ. However, any future use of FADs would be on a trial basis and closely monitored and evaluated by observers.

Dr Lewis noted average annual catches of tropical tunas in the PNG zone of close to 180,000 mt in recent years. Shoreside processing continues to develop with a new loining plant in Wewak, a second cannery in Madang and another in Lae. Catches of domestic and locally-based purse seiners (27 vessels) was reported at 123,100 mt in 2002. 40 domestic tuna longline and 10 shark targeting vessels were licensed in 2002 although not all vessels were active during the year. Longline activity remained stable in 2003. It was noted that PNG has a significant observer and port sampling program in place for all segments of industrial fisheries.

A trial handline fishery using two Philippine *bancas* began in December 2002. These technologically simple vessels have an impressive operational range and are responsible for significant landings of large tunas in the Philippine fishery. The potential for rapid expansion of this gear type and fishing mode within the PNG EEZ was noted and should be monitored in coming years. Hand in hand with the

development of this fishery is expansion of tasteless smoke (carbon monoxide treated) processing, which also bears monitoring in its impact to regional fisheries and global markets.

A summary of the Palau Arrangement that allows for 205 purse seine vessels in the WCPO was presented and briefly discussed. It was noted that 194 vessels were licensed as reported by the Parties to the PA at their annual meeting in April 2003. These vessels are now licensed and operating as of April 2003 under domestic, bilateral and multilateral arrangements. The breakdown of regional purse seine activity is presented in Table A6.1. The Group was reminded that fleets that fail to fully utilise their allocation would be liable to forfeit their unused allocation.

Table A6.1. Number of purse seine vessels agreed to in 2003 and reported as operating by April 2003 within the Palau Arrangement (source FFA).

Type	Flag	Number agreed 2003	Number reported April 2003
Multilateral	USA	40	25
Bilateral foreign access	Japan	35	33
	Taiwan	41	39
	Korea	27	27
	Philippines	11	11
Domestic locally based	All domestic combined[3]	45	51
New bilateral access	China	3	4
	EU	4	0
Total		206	191
Special Arrangements[4]	Spanish vessels part-time in Kiribati waters	5	3
	EU vessels part-time in Kiribati waters only	2	0
	Domestic/locally based	6	0
	China	1	0
	Philippines	1	0
Grand total		221	194

It was noted that four (4) EU purse seine vessels and three (3) Chinese purse seine vessels have negotiated access within the Palau Arrangement in the category of "New bilateral access". The Chinese are reported to be entering the fishery through purchase of older Taiwanese and Korean vessels. Another category for "Special Arrangements" within the Palau Agreement has allowed for the potential operation of five (5) more

[3] PNG 30, FSM 7, Marshall Islands 6, New Zealand 4, Solomon Islands 2, Kiribati 1, 1 uncertain

[4] This category will remain in force as long as the number of U.S. vessels is below its maximum allocation of 40 vessels.

Spanish vessels in Kiribati, two (2) more EU vessels to operate part-time only in Kiribati, six (6) additional domestic/locally based vessels, one (1) Chinese and one (1) Philippine[5] purse seine vessels. This category will remain in force as long as the number of U.S. vessels is below the maximum allocation of 40 vessels.

The Group noted the most significant potential for expansion of WCPO purse seine capacity may be from large, new vessels built in Taiwan but flagged to other PINs. Twenty-six such vessels were noted (5 Marshall Islands, 16 Vanuatu, 5 currently under construction).

Historical development of WCPO tuna fisheries

Mr Itano presented FTWG-3 *Documentation and classification of fishing gear and technology on board tuna purse seine vessels*. The paper documents technical gear and methods that have been or are in use by WCPO purse seine vessels throughout the history of the fishery. Mr Itano noted that the working paper was an update of previous FTWG working papers in a fully illustrated format to be used for training and information dissemination. He noted that new observers and port samplers are often ill suited for recognizing new technology and developments due to their short-term history in the fishery and rapid turnover rates. A secondary objective was to document the state of the art in purse seine technology to serve as a snapshot of technological advanced for future reference.

The paper details developments in purse seine nets, hauling gear, brailing systems, unloading systems, marine electronics and computerization. A variety of auxiliary vessel types, power block models, FADs, and purse seine vessels were described for training purposes. Mr Itano suggested that the following items or operational changes can produce a significant increase in fishing power of modern purse seine vessels and may be a means to gauge increased effective effort in regional purse seine fleets:

- Snap roller rings
- S Band Bird radar
- Spanish style brailing
- Floating wells for unloading
- GPS transmitting marker buoys for drifting FADs
- Use of FAD supply and tender vessels
- Subscription to satellite image services
- Low frequency long range sonar

Mr Itano indicated that graphics in the paper were left at relatively high resolution to allow regional observer programs to utilize the graphics to produce training materials. However, the inclusion of these graphics produced a document file size too large to be transferred via email or for posting to the SCTB website. Parties interested in obtaining a copy of the presentation or FTWG-3 should contact Mr Itano directly. The Group commended the effort and expressed appreciation and continued support for further work along these lines. It was strongly supported that similar documentation be carried out for regional longline fleets and fisheries.

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[5] The Philippines has one more vessel than their allocation of 10 as agreed to by the parties to the Palau Arrangement in 1992.

Dr Lewis noted the continued importance of satellite imagery to increasing fishing power of fishing vessels. It was agreed that the impact of satellite imagery, computerization and integration of vessel electronics was very important to increased fishing power and should be more thoroughly described to SCTB 17.

Mr Sharples described efforts to produce timelines of gear introductions to WCPO by fleet, which was a directive from SCTB 15 and a task developed for SCTB 16. Unfortunately, difficulties were encountered in sorting and extracting vessel attribute data from SPC and FFA sources. It was found that the Regional Register database has not collected some parameters useful for this exercise and has not been kept up to date with the introduction of new gear and technology. Observer data may be a better means to look at fishery developments, but a great deal of this data is not yet in electronic format, and observer coverage over all fleets is very low. Also, he noted the current structure of the vessel and gear database is difficult to query with many "text only" fields.

A discussion followed on the best means to collect vessel and gear attributes and what those items should be. A list of high priority gear and vessel attributes has already been developed at SCTB 15 (*FTWG-9 Vessel and gear attributes in the Forum Fisheries Agency Regional Register of Vessels: How much is enough?*). It was suggested that this list (Annex A6-III) be consulted and form the base of a complete list of gear and vessel attributes the Group feels should be collected.

It was noted that the FFA Regional Register - Application for Registration as adopted at the Forum Fisheries Committee (FCC) MCS Working Group meeting in March 2003 had been revised. The new version does not contain some items identified at FTWG 15 as high priority items to collect to monitor vessel efficiency (Annex A6-III). However, revised guidelines will require vessel owners to completely fill out a new RR registration form on an annual basis, which will encourage timely updates of vessel and gear attributes. Also a digital photograph will be required with every re-application which can help to identify some modifications to vessels and gear. The new application form will come into effect September 1, 2003.

The group suggested specific tasks and suggested means to collect gear and vessel attributes. The following suggestions were made:

- Task 1 - Clean up and query and summarize FFA Regional Register data.
- Task 2 - Use existing observer data. Clean up and query SPC vessel and gear attribute database for PS-1 and LL-1 observer forms.
- suggestion: obtain data via yearly vessel inspections in port by experienced observers or technical expert hired as consultant.
- suggestion: require in port vessel inspection be a mandatory requirement of access arrangements.
- suggestion: obtain gear and vessel attributes on a voluntary basis by vessels in port during unloading or provisioning visit.
- suggestion: encourage countries to survey their own fleets.

Regardless of the way in which data is collected, the group recognized that the Group needed to focus on defining a priority list of gear and vessel attributes to advise

regional bodies to collect and how these gear lists may be used to quantify effective effort. Such work should be well advanced as soon as possible to facilitate its full consideration by the SCG and the Commission.

Recent advances in gear technology and fishing methods

Mr Beverly presented *FTWG-9 Proposal for a deep setting technique for longline fishing to enhance target CPUE and to avoid certain bycatch species.* The paper describes a proposed technique that would utilize lead weights snapped to the mainline of tuna longline gear to place all hooks at a targeted depth or deeper (due to sag). The system proposes to deploy all hooks at an optimal depth for target species (i.e. bigeye, albacore) and keep all hooks below depths where interaction rates with marine turtles, seabirds, marlin and many shark species are highest. The system may also prove an effective means to target swordfish at great depths during the day. It was noted that the proposed gear could be easily adjusted to different depths during a single set to locate the optimal depth for subsequent sets.

Mr Itano noted that a similar system has already been adopted in a small scale context by a Hawaii based fisherman targeting an isolated seamount in the Hawaii zone. He uses only two baskets of gear set close to each other on the seamount summit and has been able to successfully target medium and large bigeye and pomphret (*Eumegistus illustris*).

Mr Itano presented *FTWG-7 Reducing the take of undersize tuna and bycatch in drifting FAD sets: project description*, on behalf of Dr Peter Nelson. The paper briefly describes a project to evaluate sorting grids on purse seines in the Eastern Pacific Ocean as a means to reduce bycatch of undersize commercial tuna and miscellaneous fish bycatch on associated purse seine sets. The project arises directly from concerns over bycatch levels associated with drifting FAD purse seine sets and is being carried out through collaboration with the I-ATTC and the Center for Marine Biodiversity and Conservation.

Issues related to FADs

Mr Kumoru presented *FTWG-4, Notes on the use of FADs in the PNG purse seine fishery*. PNG has a high proportion of associated purse seine sets (64% for years 98 – 2002) relative to other EEZs due to a combination of high abundance of drifting logs and since 1997 a dramatic increase in the deployment of anchored FADs. The PNG purse seine catch is taken by domestic vessels, locally-based foreign vessels, non-PNG/FSM Arrangement vessels, bilateral foreign vessels and the USMLT fleet. Domestic vessels of PNG and Philippine registry rely heavily or exclusively on fishing anchored FAD arrays, assisted by light boats and supply/FAD tender vessels. FADs are set in the Bismark Sea and for bilateral access vessels, north of the Equator outside archipelagic waters. There are believed to be around 900 anchored FADs set by these vessels. Most of the FADs are of the torpedo shaped, welded steel drum construction and moored with simple concrete anchors.

PNG maintains a large observer program, targeting 100% coverage for mothership operations involved in FAD-associated fishing, vessels engaged in FAD deployments and transshipment operations. Detailed observer data indicating catch by school

association indicate very high proportions of yellowfin and bigeye in anchored FAD catches. Port sampling programs have also collected large length frequency datasets, but were not yet available in disaggregated form.

A *National Fish Aggregating Device Management Policy* was adopted by the NFA Board in late 2002. The Policy regulates a number of FAD related issues, such as limiting the number of FADs in the PNG DFZ to < 1000 with a per vessel limit of 30, (40 if 75% of catch is domestically processed), requirements for minimum standards of FAD marking, mandatory observer coverage of deployments, catch reporting and restrictions on the number of tender vessels per seiner. Provisions are made to minimize gear conflicts with longline gear, but this issue will become increasingly problematic as domestic longline fishing develops. Mr Mobiha also noted that while FADs are deployed by individual companies, PNG regulations specifically state that no company can exercise exclusive access to any FAD.

Group members stated that industry contacts had indicated that they set anchored FADs in specific patterns in the belief that they would divert and retain migrations of tuna through their zone. Mr Itano noted that there are several research initiatives currently taking place related to the dynamics of tuna aggregation specific to FADs that may be of interest to the PNG situation, i.e the EU funded project FADIO examining drifting FADs and tuna behavior, and a suite of projects related to anchored FADs and tuna aggregation in Hawaii.

Mr Coan presented *FTWG-5 Fishery-related attributes associated with FAD and log fishing practices conducted by the U.S. purse seine fleet in the central-western Pacific Ocean, 1997-2002*. The paper describes a preliminary comparison of purse seine catch characteristics between natural log and man-made drifting FAD sets. Parameters such as nominal catch per set, proportion of bigeye and proportion of small fish (<7.5 lbs) between log and FAD sets were compared. There was some tendency for log sets independent of FAD sets to predominate west of 160°E and FAD sets to be more common independent of log sets to the east of 160°E. For the most part, statistical differences in catch parameters between log and FAD sets were not observed in this study. However, this result may have been confounded by very low reported numbers of log sets in 1999-2001. It was also suggested that the study results may be compromised by mis-reporting of school association types. For example, the difference between a log and FAD becomes quite confused when natural logs are tied together or are enhanced with corks, bamboo flotation and netting. It is unclear if fishermen are reporting logs as FADs or vice versa. It was suggested that observer data and reports and interaction with vessel owners/operators may assist in clarifying these issues. Further study along these lines was suggested.

Mr Bromhead presented work he had conducted titled *A review of the impact of fish aggregating devices (FADs) on tuna fisheries* (Bromhead, Fister, Attard, Findlay, and Kalish), and provided copies on CD to members of the group. The review contains a great deal of FAD related information including: the biology and ecology of tunas on FADs, fisheries management issues, impacts of FADs on fisheries, potential impacts to the Australian longline fishery for bigeye tuna. It was noted the work contains a very useful list of FAD related references.

Training materials and issues specific to the discrimination of bigeye in mixed landings

Mr Beverly passed out the initial printing of the *SPC Horizontal Longline Fishing Manual – Methods and Techniques*. The group quickly reviewed the document, noting the high quality of work and detail involved and thanked SPC for their excellent contribution to the region. It was noted that these volumes represent a first printing and a few typographic errors have already been identified. Mr Beverly requested that SCTB members review the handbook and notify Mr Lindsay Chapman (LindsayC@spc.int) of any errors or requests for additional copies.

Mr Itano briefly described work to review port sampling procedures in American Samoa (*FTWG-1 An assessment of the accuracy of yellowfin and bigeye tuna species identification: by American Samoa port samplers*. This paper was scheduled to be presented during the plenary session of the Statistics Working Group, so was not presented in detail here. However, a byproduct of the work was a handbook for the identification of port sampled bigeye and yellowfin from purse seine vessels.

Mr Itano presented *A Handbook for the Identification of Yellowfin and Bigeye Tunas in Frozen Condition* which was produced in conjunction with the port sampling review for the NMFS. The handbook consists of 31 pages of digital photographs of internal and external characteristics of bigeye and yellowfin over a broad size range. The handbook will be particularly useful for training purposes as the pictures were taken on board a commercial purse seine vessel of brine frozen tuna in a typical condition as may be encountered by port samplers. The handbook was produced in MS Powerpoint format for direct utilization for training situations.
It was noted that the handbook did not contain pictures of bigeye and yellowfin of very small sizes (<40 cm) as they were not available during the period of the study mission. The group suggested that the work should be continued with pictures of very small tuna that may be available through port sampling programs throughout the region. The group further recognized the importance and utility of the handbook to regional port sampling and observer programs and urged its speedy review and clearance by the NMFS for availability for research and training purposes.

Regional management and industry initiatives

Mr Itano presented *FTWG-8, Review of the activities of the World Tuna Purse-Seine Organization (June 2002- June 2003)* on behalf of Mr Julio Morón. The report described WTPO attempts to expand their membership, particularly with Chinese and some re-flagged ex-Taiwanese vessels. The WTPO strongly supports the adoption of a World Wide Tuna Boat Registry to stabilize total harvesting capacity in purse seine and longline industries and the elimination of IUU fleets. A resolution to define ongoing effort reduction measures defined at a recent Asian block meeting of the WTPO in Seoul, Korea is included in the working paper for information purposes.

Mr Itano presented *FTWG-6: Managing fishing capacity of the world tuna fleet [Executive Summary of FAO Fisheries Cicular. No. 982]*. The full text of this document runs to over 70 pages and is available online in pdf format or in hard copy from FAO Rome. The author kindly agreed to the submission of the abstract and executive summary of the document to the FTWG to provide a background paper to the plenary discussion on harvesting capacity. The document was commissioned by

the FAO to examine and define means to implement, with respect to tuna, the International Plan of Action for the Management of Fishing Capacity (adopted by the FAO COFI, 1999). The paper describes the situation of high catching capacity by world purse seine and longline fisheries, production trends, the multi-species nature of the fisheries, tuna vessels and fleets, capacity limitation attempts, problems associated with reducing existing capacity and some possible options for limiting fleet capacity in world fisheries. The study specifically examines fleet capacity in the Eastern Pacific Ocean (EPO) purse seine fishery due to the existence of long time series of catch and effort and carrying capacity data available for this fishery. A linear modelling approach was applied (Data Envelopment Analysis) to the EPO situation. The results indicate that excess capacity exists in the fishery and the number of vessels could be reduced substantially without a consequent reduction in total catch. Mr Itano noted that in relevance to the FTWG, the FAO paper suggests that the monitoring of efficiency changes in fishing vessels is essential to effective management of fishing capacity.

Discussion of this paper and topic was not fully developed during the FTWG Preparatory meeting as it was planned to be discussed in the plenary session of SCTB 16. This paper was provided primarily in support of the scheduled plenary session discussions on harvesting capacity

Dr Miyake, as a member of the FAO Project on the Management of Tuna Fishing Capacity, Technical Advisory Committee reported that their group agreed to support efforts towards quantifying fishing capacity in terms of tuna resources available to the fishery in question. Of direct interest to SCTB, Mr Chris Reid of the FFA has been contracted to conduct DEA analysis of WCPO tuna fisheries. He further informed the group of the activities of the Organization for the Promotion of Responsible Tuna Fishing (OPRTF), consisting of industry representation from the major tuna longline countries. The objective of this organization is to reduce IUU longline effort and to establish a worldwide capacity limit on longline fleets.

Dr Uozumi noted that Japan would present a paper on harvesting capacity in WCPO tuna fisheries to SCTB plenary later in the week. The paper would contain projections of increasing effective effort over time in relation to vessel efficiency, size and the economic environment.

Organization of the FTWG Plenary session

The group agreed that the Plenary session of the FTWG should consist of a summary of the Preparatory meeting delivered by Mr Itano followed by brief presentations of FTWG-3, FTWG-4 and FTWG-5. It was agreed these matters would be discussed more thoroughly during the plenary session of SCTB.

Conclusion of meeting, research coordination and planning

The subject of how to collect vessel and gear attributes and which attributes to collect was revisited. It was agreed that these problems could not be adequately addressed at this meeting. The Chairman agreed to coordinate an intercessional working group to address these issues for reporting to SCTB 17.

The Chairman suggested that FTWG group members submit suggestions for specific tasks for presentation to SCTB 17 to him as soon as possible for finalization by email correspondence within a month of the conclusion of SCTB 16.

Annex A6-I. List of Participants

Name	Organization
Steve Beverly	SPC
Don Bromhead	BRS, Australia
Shih-Chin Chou	OFDC, Taiwan
Ray Clarke	NMFS, PIRO, Honolulu
Al Coan Jr.	NMFS, La Jolla
Minoru Honda	FFA
David Itano	PFRP/UH, Hawaii
Jeong Rack Koh	NFRDI, Korea
Ludwig Kumoru	NFA, PNG
Tim Lawson	SPC/OFP
Augustine Mobiha	NFA, PNG
Miki Ogura	NRIFSF, Japan
Tim Park	NORMA, FSM
Peter Sharples	SPC/OFP
Sung Kwon Soh	Ministry of Maritime Affairs and Fisheries, Korea
Karl Staisch	FFA
Taro Takeshita	Japan Tuna
Apolosi Turanganivalu	Fiji Fisheries Department
Yuji Uozumi	NRIFSF
Peter Williams	SPC/OFP
Ren-Fen Wu	OFDC, Taiwan

Annex A6-II. FTWG Plenary Session Agenda - Plenary Session

Thursday, 10 July (1030-1130)

1) Summary Report of Preparatory Meeting of the FTWG (8 July 2003)
2) Questions and comments (may be flagged for later discussion)
3) Selected presentations (10 minutes each)
   a) **Ludwig Kumoru : FTWG-4** Notes on the use of FADs in the PNG purse seine fishery
   b) **Al Coan and P. Crone: FTWG-5** Fishery-related attributes associated with FAD and log fishing practices conducted by the U.S. purse seine fleet in the central-western Pacific Ocean, 1997-2002
   c) **David Itano : FTWG-3** Documentation and classification of fishing gear and technology on board tuna purse seine vessels
3) Research coordination and planning

Annex A6-III. High scoring gear and vessel attribute fields from FTWG-9/SCTB 15.

Data field	Essential %	Desirable	Not Useful	Overall rank %
Longliner	100	0	0	100
Pole and line vessel	100	0	0	100
Purse seiner, single	100	0	0	100
Total storage capacity (cubic metres)	100	0	0	100
Mainline material	100	0	0	100
Line shooter present?	100	0	0	100
Net length (metres)	100	0	0	100
Net depth (metres)	100	0	0	100
Number of lines used	100	0	0	100
Type of gear used	100	0	0	100
Length of net	100	0	0	100
Number of hooks used	100	0	0	100
Length overall (metres)	91	5	0	96
Satellite sea surface images used?	91	5	0	96
Drifting satellite buoys	91	5	0	96
Remote echo sounding buoys	91	5	0	96
Tori poles used? (yes/no)	91	5	0	96
Bait throwers used? (yes/no)	91	5	0	96
Helicopter?	91	5	0	96
If group seiner, number and capacity of carrier vessels	91	5	0	96
Number of hydraulic haulers used	91	5	0	96
Purse seiner, group	82	10	0	92
Troller	82	10	0	92
Ice	82	10	0	92
Chilled sea water,	82	10	0	92
Refrigerated sea water,	82	10	0	92
Air freezer	82	10	0	92
Type(s) of vessel monitoring system(s)	82	10	0	92
Doppler current meter(s)	82	10	0	92
Light boats	82	10	0	92
Mainline length	82	10	0	92
Bait chute used? (yes/no)	82	10	0	92

APPENDIX 7. REPORT OF THE PREPARATORY MEETING OF THE METHODS WORKING GROUP

Introduction

The SCTB Methods Working Group (MWG) held its third meeting on July 7–8, 2003. A list of those who participated in the meeting is given in Annex A7-I. Dr Sibert (Chair) opened the session and outlined the scope of the work of the group as listed in the MWG Agenda (see Annex A7-II). Due to concern with the bigeye tuna stock assessment results, and the similarity between the bigeye and yellowfin tuna stock assessments, the stock assessment review agenda item was expanded to cover the yellowfin and bigeye tuna assessments (previously only a review of yellowfin tuna was to be undertaken). Mr Smith agreed to serve as rapporteur for the MWG.

Simulation Results

MWG activity during the intercessional period between SCTB15 and SCTB16 was directed towards the work plan adopted at SCTB15. The OFP yellowfin tuna operational model was again used to generate "simulated data" for evaluating the performance of several stock assessment models, especially the effects of spatial stratification, tagging information, exploitation levels and data variability on the accuracy of reference point estimates, biomass and depletion trends.

Dr Hampton presented a paper describing the testing of the accuracy of MULTIFAN-CL (MFCL) using an operational model for yellowfin tuna. The operational model has been presented in detail previously and is well specified in the Appendix to MWG-1. In this year's simulations five basic scenarios, each intended to mimic aspects to the WCPO yellowfin fishery, were simulated. Each scenario was repeated 40 times using a different series of random numbers to generate stochastic states and data realisations for each scenario. The scenarios were:

1. One fishery (LL), one region;
2. Two fisheries (LL, PS), one region;
3. Four fisheries (LL, PS), two regions;
4. Seven fisheries (LL), seven regions; and
5. Sixteen fisheries (LL, PS), seven regions.

All scenarios were very similar at the underlying population level. The key differences between the scenarios were the overlaid exploitation patterns in space and time and the level of spatial aggregation of the "data".

One key difference between the analysis of the data from these simulations and a 'real' assessment was the lack of human intervention during assessment runs. This can have the effect of creating anomalous solutions that may normally be detected and rectified during an assessment.

The results of the MFCL runs with the simulated data showed that length-at-age is well estimated, whilst M-at-age estimates were less accurate with M-at-age being consistently underestimated across all simulations. The bias in M-at-age causes other estimates to be biased (recruitment trends & absolute values that are a function of M). As for other stock assessment techniques, estimates of relative values appear to be

more accurate for MFCL than absolute values. MWG members noted that the sources of variability introduced into the yellowfin operational model were not clearly specified and that future reports should clearly describe the variability in the operational model.

In a general sense MFCL appears to provide reasonably precise and unbiased relative outputs for the levels of variability considered in the simulation. MFCL appears to perform better in the more complex scenarios with greatest spatial partitioning, with scenario five comparable to the actual YFT assessment.

Dr Sibert presented a preliminary synthesis of the results from the various models (Table A7.1). The intention was to apply seven different stock assessment methods to the 40 realisations of each of five scenarios produced by the OFP operational model. Unfortunately all models were not tested with all scenarios because of time constraints:

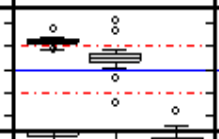
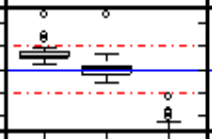
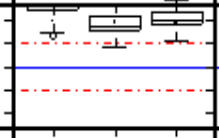
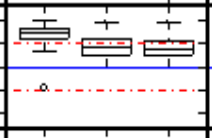
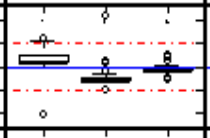
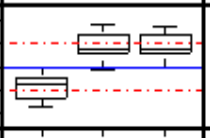
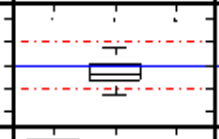
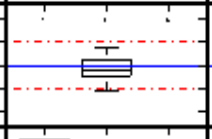
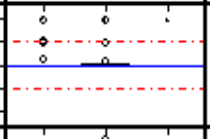
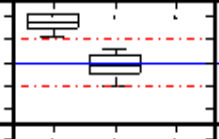
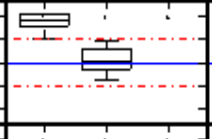
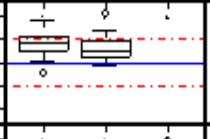
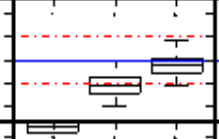
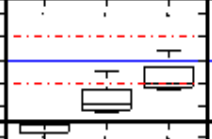
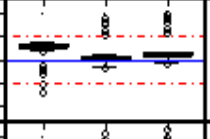
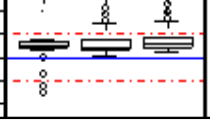
	1Fx1R			2Fx1R			4Fx2R			7Fx7R			16Fx7R		
	MSY	Bmsy	Smsy	MSY	Bmsy	Smsy	MSY	Bmsy	Smsy	MSY	Bmsy	Smsy	MSY	Bmsy	Smsy
MFCL	na			na			na			na			na		
ASCALA										na			na		
SCALIA													na		
Schaefer										na			na		
Fox										na			na		
ASPM-sto										na			na		
ASPM-det										na			na		

Table A7.1. Preliminary example of standardized bias plots for estimates selected reference points. The solid line indicates zero bias. The dashed lines are ± two standard deviations from zero. The box plots indicate the first and third quartile of the distribution of the estimates. "na" indicates that estimates are not yet available for that model/scenario combination.

- MULTIFAN-CL, Marc Labelle (MWG–1);
- SCALIA, Dale Kolody (MWG–5);
- A-SCALA, Mark Maunder and Shelton Harley; and
- Four production models: Deterministic and stochastic age-structured (ASPM), Fox, and Schaefer, Daniel Ricard and Dale Kolody (MWG–5).

Bias was computed as the difference between the simulated ("true") value of a model variable and the estimate of the same variable from an assessment model. The bias was then standardized by dividing by its standard deviation to produce a scale independent measure of bias that also provides an intuitive indicator of statistical significance. Bias in biomass trends and reference points were presented. MWG members noted that this method might reduce the bias of the performance of highly variable model outputs. A variety of diagnostics for comparing the alternate model outputs with the operational model were reviewed. Members of the MWG agreed that these diagnostics were useful subject to the revision of the denominator of the 'intuitive indicator' equation. It was noted that some model outputs had produced curious results, for instance logistic chaos in the biomass trends estimated by Schaefer model for scenario 3.

The biomass trend results vary considerably between the seven assessment methods and five scenarios. MFCL, as indicated above, generally improved in the more complex operating model scenarios. A-SCALA and SCALIA tended to overestimate biomass throughout. The deterministic ASPM, Fox and Schaefer production models did well in the simpler scenarios (outputs were not available for the more complex scenarios from these models). The stochastic ASPM model underestimated biomass. Of note was that all models seemed to have significant bias with respect to scenario 3.

The reference point (MSY, B_{msy} & S_{msy}) bias results were quite different to the biomass trend results. A-SCALA estimated reference points relatively well, SCALIA tended to produce overly optimistic reference points, the Schaefer production model (limited to B_{msy}) did very well, the Fox production model (limited to MSY & B_{msy}) reasonably well especially for B_{msy}, and the stochastic and deterministic ASPMs less well. Reference point estimates were not available from MFCL at the time of this analysis.

MWG members noted that although there appeared to be some significant differences between the various approaches, the differing implementation and assumptions of the various approaches (A-SCALA did not estimate M whereas the other approaches did, similarly SCALIA, ASPM-sto, and ASPM-det estimated the stock recruitment relationship without constraints) meant that caution needed to be applied in interpreting the results. MWG members felt that comparisons should be made with ratios such as B/B_{msy} and F/F_{msy}.

In reviewing the simulation studies to date, the MWG considered whether anything had been learnt from the research to date, and whether additional analyses were required. MWG participants noted that not all results were available to the meeting, but felt that the initial results were useful and indicated that this research should be completed. To date no clear evidence was available to accept or reject any of the methods considered, however, the results were useful for informing interpretations of various approaches to stock assessment in the region.

MWG members discussed whether the current OFP operational model was too complex. The need to manipulate elements of the operational model to better understand the response of the various methods to the simulated data was identified. Access to the operational model code and implementation scripts may also help in this regard. The use of alternate operational models that already contain some of the identified desirable features was noted as an alternate approach. A model that would be useful in this regard has recently been produced by CSIRO.

MWG members reviewed the focus of this simulation study and noted that with the new availability of the MFCL source code (see below), one approach may be to limit the analysis to MFCL based models. Other MWG members suggested that one of the original drivers for this research had been to contrast as many alternate approaches as possible and that this focus should continue at least in the short-term.

MWG members agreed to complete the multi-model testing during the coming intercessional period. The group noted that there were two important components to future work in this area, completion of the current analyses, and revisions to the method for future analyses. Completion of the current work was identified as the priority with the following key tasks:

- clarify documentation of the variation and types of error applied to the operational model;
- review and recalculate the comparison tables with new denominator and all outputs;
- complete the analysis of all scenarios for all models; and
- incorporate all models into the reference point bias summary.

For future simulation studies, it was proposed that:

- a simpler and more easily manipulated operational model that can potentially deal with more than one species be considered;
- the statistical properties of the key reference points be explored; and
- coordination of the research is improved, including specific project funding.

It was also noted that additional scenarios that mimic some of the fleet and catch patterns seen in the BET assessment should be considered in any future simulation-testing project.

The MWG noted with thanks the large amount of detailed modelling work undertaken to complete this simulation study to date.

MULTIFAN-CL Website

Dr Hampton informed the MWG that a website for MULTIFAN-CL has very recently been launched (www.multifan-cl.org). The model source code, Linux and Windows executables, example data, documentation, and graphics support utilities can be downloaded. The MWG welcomed the open access to the MULTIFAN-CL tool and suggested that a simple scenario from the MWG simulation process may be a useful learning module for the website.

Recommended diagnostics for large statistical stock assessment

Dr Maunder presented a summary of recent work on diagnostics for large statistical stock assessment models (MWG-3). This research was prompted by a review of I-ATTC assessments of tuna in the EPO and the MWG discussions at SCTB15.

The research separated diagnostics into two categories: those that should be considered at the interval of the assessment (usually annually); and, periodic diagnostics that should be considered every few assessments. A range of specific research questions critical to assessments using large statistical stock assessment was also identified.

Recommended regular model diagnostics include:

- creation of data objects;
- likelihood profile for important management quantities;
- sensitivity analyses of selectivity and data weighting;
- comparisons with model estimates/predictions (observed versus predicted catches, estimated recruitment in recent years);
- residual plots for the basecase model;
- correlation plots among key parameters and for key management quantities from the basecase model;
- catch-at-age and fishing mortality-at-age matrices (to provide data access to external scientists); and
- model output from each phase of the minimisation.

Recommended periodic model diagnostics include:

- sensitivity analyses of all model and data components;
- retrospective analyses;
- evaluation of phases of estimation; and
- examination of the solution surface using alternative starting values.

Research questions identified that should be evaluated between assessments as well as research improvements, in no particular priority order, were:

- using retrospective analyses to evaluate model predictions and estimates of key parameters;
- evaluation of selectivity functional forms;
- numerically solving the catch equation (in A-SCALA);
- investigation of changes in fishing power;
- simulation studies;
- CPUE time series for purse seine fisheries; and
- weighting length-frequency data.

The MWG noted that the development of this checklist was particularly useful. Many of the diagnostics identified were being addressed for the MFCL assessments and more would be addressed in coming assessments. An additional item identified during the discussion was to include documentation of point estimates in relation to prior bounds

Review of the SPC/OFP Yellowfin & Bigeye Tuna Assessments

Dr Hampton presented the yellowfin tuna (YFT-1) and bigeye tuna (BET-1) stock assessments concurrently. The presentation focused on:

- overview of changes to the model & input data;
- general fishery descriptions;
- data and model structure;
- diagnostics used;
- parameters of interest; and
- stock assessment results.

The key changes from the 2002 assessments were:

- time period has been extended to cover the period 1950 to 2002 with projections to 2004;
- initial population assumed to have equilibrium age-structure based on M-at-age and unfished recruitment;
- extension from 20 to 28 (YFT), and 28 to 40 (BET) quarterly age-classes to accommodate greater number of older age-classes present in the early years of the fishery;
- Chinese/Taiwanese LL effort in Federated States of Micronesia waters separated from other LL fisheries because of distinct fishing practices and because of poor fits to length-at-age in last years assessments;
- main longline size composition disaggregated into length and weight measured data and then incorporated as both length-frequency and weight-frequency data;
- several methods of standardizing longline effort were considered (see RG-3), and alternative BET PS catch estimates were considered; and
- more extensive treatment of reference points.

YFT and BET were primarily taken by longline with relatively stable catches from the 1950s – 1970s. Since that time the development of PS and other fisheries has seen significant increases in YFT catches, whilst increases in LL catches and more recently PS and other methods has seen the BET total catch steadily increasing. Catch-at-size by all methods has been fairly stable since 1997. PS catches are focused in the equatorial WPO, LL in the sub-tropical waters and other gear types in Indonesian and Philippine waters.

A variety of diagnostics were used in the assessment process and discussed by the MWG (as detailed in YFT-1 & BET-1). Fit results suggested models had not all converged to the extent desirable (target gradient at termination <0.01). Some residuals were auto-correlated (Philippines data prior to tag information). Effort deviations showed no clear trends. MWG members noted that it would be more useful to have residuals and effort deviations plotted on the same scales between fisheries. The fits to aggregated length data tend to overestimate larger size classes in some fisheries. The fits to aggregated weight data showed some bias that may be due to the common length-weight conversion used and differences in the sex ratios (sexual dimorphism reflected in weight at age). Lacks of fit to some tag recaptures, particularly in the Australian LL fishery, were discussed, and it was suggested that the problem might be due to inappropriate spatial resolution in the model.

Parameters of special interest in the assessment were reviewed, including:

- growth – both species exhibit linear growth in early years (unlike usual von Bertalanffy pattern);
- natural mortality – initially declines and increases at sizes corresponding to age at maturity and then declines again as males predominate in the populations(thought to be because of higher mortality of females as they spawn at intermediate ages);
- movement – appears to be largely unidirectional, varies greatly from quarter to quarter;
- selectivity – the high selectivity for older age classes in some fisheries does not correlate with data from those fisheries (may be linked to overestimation of larger age-classes in these fisheries), the selectivity is not well set up for projections and selectivity deviations should be set at zero when projecting;
- catchability – the large increases in catchability in the Philippine/Indonesian fisheries in recent years are of concern; and
- tag reporting rates – a key parameter for estimating population size and generally poorly known for some fleets so needs to be the focus of sensitivity analyses.

MWG members expressed concern about the apparent relationship between recent peaks in BET recruitment and the recent increase in PS catches of BET followed by a dramatic drop in BET recruitment linked with the decline in the number of FAD sets. It is not clear whether this is a model artifact, or due to the addition of the most recent years data to the model. It was also postulated that the trend in BET recruitment seen in model results might be associated with the increasing trend in the Philippine and Indonesian catches. Additional model runs were recommended to clarify these sensitivities.

As a result of the MWG review, specific agreed additions to the assessments included:

- review of the Philippine and Indonesian input data to confirm that the most recent best estimates have been used;
- undertake a sensitivity analysis discounting the Philippine and Indonesian catches;
- include yield-per-recruit analyses for both high recruitment and average recruitment regimes in future assessments;
- the addition of tables detailing tag recapture data;
- plot deviations on same scales to allow comparisons;
- superimpose real tag movements on tag movement coefficient plots;
- catchability deviations should be set at zero when projecting model forward;
- plot fishing mortality by gear type where possible in stock assessment outputs;
- further review the estimates of recent recruitment for BET and the influence of those estimates on the assessment;
- examine the effect of the priors used in the model on recent recruitment estimates; and
- generally produce plots in a way that allows comparison between assessments.

Dr Hampton presented some additional results from a comparison of a whole Pacific Ocean assessment for BET, and the EPO assessment for BET. This information

suggested that the WCPO BET analysis is consistent with the EPO and whole PO assessments, that the results were not sensitive to spatial structure, and tagging data allow estimation of natural mortality.

The MWG thanked Dr Hampton for the expansive presentation and the willingness to rerun the model to meet MWG requests.

Habitat Based Standardisation of CPUE

Dr Bigelow presented a comparison of deterministic and statistical habitat-based models to estimate effective longline effort and standardized CPUE for bigeye and yellowfin tuna (RG-3).

Habitat-based Models are used to develop effective effort and standardised CPUE. In this study, effective effort = sum of habitat quality for each hook and relative abundance = Catch per Unit Effective Effort. HBS model to LL data included: compiling data (environmental, gear configuration); deterministic model; calculation of hook depth distribution within water column and species distribution within the environment; calculating effective effort and standardized CPUE; statistical model fitting; structuring habitat preference as parameter(s); incorporation of factors modifying behaviour of gear or species (e.g. shear); and estimating model parameters by fitting to catch yielding a standardised CPUE. Four models were developed for each species (YFT – nominal, HBS, statHBS1, and statHBS2; BET – nominal, HBS1, HBS2, and statHBS as described in RG-3). For both species, statHBS based on ambient temperature (compared to relative SST) distribution provided the best fit to variation on catch data.

The MWG noted significant differences between the indices based on the three models. Whilst acknowledging the differences in the modelling approaches, the reasons for the differences between the model results presently remain unclear. The MWG agreed that there was a need to critically review the data inputs and the assumptions in each model.

The MWG identified a number of new data that should be used in future. These included additional archival tagging of YFT especially in the WPO in key fisheries habitats and better description of tuna habitat including LL gear interaction with that habitat in tuna fisheries. Recommendations for future research include:

- structure additional habitat preferences as parameters (in particular, for bigeye tuna could include dissolved oxygen and/or ambient light);
- additional factors could be added such as categorical variables (e.g. month, area);
- conduct the statHBS on smaller spatial scales such as the 5 MFCL regions;
- incorporate parameters associated with gear configuration; and
- apply the statHBS model to other major fleets.

The MWG discussed the oceanographic data available, in particular the spatial resolution of the data and the accuracy of those data. Oceanographic data are available at 1 x 1.5 degree resolution whilst fisheries data are only available at 5 x 5 degree scale. Some MWG members expressed concern about the order of magnitude in inter-annual variation exhibited by the statHBS. This should be resolved to some extent by

suggested modifications to the method and data additions. MWG members agreed that one measure of effort standardisation success is how well it predicts catch. One conceptual problem identified for the statHBS approach is that it does not allow for expansion/contraction in total habitat through time. Incorporating this into the model would be an improvement, especially in allowing for ENSO type effects.

MWG members agreed that effort standardisation is critical research for the improvement of the stock assessments and research in this area should continue as a priority.

Reference Points

At various stages during the presentations reference points were discussed. One of the key questions was whether non-equilibrium or equilibrium reference points should be utilised. The MWG noted that each served a specific purpose and were useful. However, where ratios of reference points are being calculated the ratio should be either two non-equilibrium reference points or two equilibrium reference points.

In the suite of reference provided in an assessment, information on overfishing status (is current F greater that an agreed F-based reference point) and overfished status (is current B less than an agreed B-based reference point) should both be conveyed.

Dr Maunder informed the MWG that I-ATTC would be hosting a meeting later this year to explore the application of reference points. MWG members noted that participation in that meeting would be particularly useful for the MWG.

Formulating Advice To Management

Dr Sibert presented a draft of some principles that might be helpful in selecting stock assessment methods suitable for WCPO fisheries. The MWG discussed the principles and concluded that stock assessment methods should:

11. include data from all ages exploited by the fishery;
12. include data from all fleets exploiting the stock;
13. include data from all geographic areas where the fishery is prosecuted;
14. provide quantitative descriptions of the statistical uncertainty in estimating critical parameters, reference points and trends; uncertainties in data inputs; uncertainties in model structure;
15. include measures to diagnose model failures;
16. be clearly described in mathematical terms;
17. be subjected to simulation testing using output from operational models;
18. be peer-reviewed;
19. computer code should be “validated”; and
20. produce results consistent with auxiliary qualitative observations.

The MWG noted that publication in peer-reviewed journals was not required, but that exposure of the assessment to a peer review process is particularly important. The MWG agreed that the information was a useful checklist.

Dr Sibert also presented a simple “decision table” that outlines the effects of different management decisions under different conditions of the stock (Table A7.2). The

MWG felt that, although these management impacts should be largely self-evident, it would be useful, nonetheless if they were clearly expressed to potential WCPO fishery managers. The following table briefly describes the consequences of alternative management actions for the stock and the fishing industry for two different stock conditions or "states of nature", with the shaded boxes representing undesirable outcomes relative to the state of nature.

		Impacts	State of Nature	
			Could Increase Effort	Should Decrease Effort
Action Taken	No Action	On Stock	Sustainable Decline	***Unsustainable Decline Overexploitation***
		On Industry	Small decrease in yield; small CPUE decline	***Small increase in yield; large CPUE decline***
	Increase Effort	On Stock	Sustainable Decline	***Unsustainable Decline Overexploitation***
		On Industry	Increase in yield; small CPUE decline	***Small increase in yield; large CPUE decline***
	Decrease Effort	On Stock	Increase	Rebuilding of population
		On Industry	Short-term decline in yield; small CPUE increase	Yield may increase in future

Table A7.2 Decision table outlining the effects of different management decisions under different conditions of the stock.

Future Plans

The MWG reviewed its terms of reference, and felt that considerable progress had been made on most items. Areas for future focus include:

- better coordination with I-ATTC technical working groups;
- addressing descriptions of reference points and their interpretation for fisheries managers by way of informative alternate scenarios including spatial variation in reference points;
- spatial stratification of the WCPO appropriate to the stocks;
- consideration of management strategy evaluation;
- better methods for estimating non-target catches and sustainable harvest levels for non-target catch species;
- review of ecosystem modelling approaches; and
- the development of multi-species models – especially in the context of better understanding the relationship between the various tuna fisheries, and including multi-species approaches to standardising CPUE.

The MWG identified work to be accomplished during the intercessional period:

- complete the synthesis of the simulation project (most of the necessary data are on hand, but some additional assessment runs are required on the more complex scenarios);
- participate in a meeting to be hosted by IATTC on reference points; and

- examine possibility of attempting effort standardization at sub-regional scales.

Contributed Papers

Dr Maunder presented a paper describing methodological improvements to the EPO tuna stock assessments (MWG-2). The paper although not directly related to the WCPO has direct links to the research on recommended diagnostics (MWG-3) and the stock assessment reviews undertaken by the MWG.

The key improvements made to EPO tuna stock assessments included:

- retrospective analysis to determine years to average catchability for forward projections and yield calculations;
- cross validation to determine selectivity smoothness parameters – as long as selectivity curves are smooth results are moderately insensitive, but if selectivity curves are jagged or over-smooth then significantly different results occur;
- using an analytical formula to re-weight length-frequency sample size;
- development of a method to allow missing data in environmental indices – this has allowed the inclusion of additional relevant data sets into the assessment;
- calculation of two new management parameters, MSY_{ref} and SBR_{ref};
- neural network standardisation of CPUE – neural network standardisation performed the same or better than other methods but is still under investigation; and
- likelihood profile approximation to forward projections – projections previously undertaken on point estimates with no parameter uncertainty, this new method includes both parameter and future recruitment uncertainty.

The MWG noted that the likelihood profile approximation to forward projections as described was actually a normal approximation rather than a likelihood profile. The likelihood profile method and future recruitment uncertainty is also used in the current WCPO assessments.

Dr Wang presented a theoretical consideration of how to estimate the varied carrying capacities (MWG-4). The theory shows that a generalised method can be derived from Schaefer's model, and that the derived generalised model can be applied to fishery data to estimate different carrying capacities.

General conclusions of the theory are:

- equilibrium or non-equilibrium cases are special cases of the generalised model;
- the approach does not need to assume whether or not catch is at equilibrium;
- the approach does not need to assume constant carrying capacity;
- the approach does not assume constant environmental conditions;
- use of the approach is simple, with only catch and effort data required; and
- many parameters can be determined.

The theoretical approach noted that Schafer's model has been previously considered too simple, however, this method derives a generalised approach from the Schaefer

model. The approach can be used to evaluate virgin carrying capacity, current carrying capacity and current status of the stocks including the natural net production rate. The key problem with the approach was that it relies on accurate catch effort data that are not always available. A theoretical approach to standardise effort to usefully inform this estimation method is the focus of future research.

MWG members wondered whether the Pela-Tomlinson model might be a better starting point for this theoretical approach. Dr Wang considers that the Pela-Tomlinson model is a derivative of the Schaefer model and as such did not consider that it would add to this research.

Dr Campbell presented an approach for estimating equilibrium yields within regions of the Pacific Ocean (MWG-6). The approach aimed to take an estimate of a sustainable catch level for a 'large area' (e.g. Pacific Ocean) and determine what proportion of that catch could sustainably be taken from a smaller 'local' area. Underpinning the approach is the assumption that the 'sustainable' catch that can be taken from an area is proportional to the size of the resource in that area. Other key assumptions of this approach are equilibrium biological conditions, a stable stock-recruit relationship, stable fishing mortality-at-age, equal productivity in each major region and fast mixing dynamics across all regions. Key implementation elements of the approach include:

- average CPUE over several years to allow for variations in environmental & oceanographic conditions;
- use data from a single fleet so that catchability is more likely to be constant from region to region;
- run model for different periods in fishery to test sensitivity to changes in fishing practice; and
- run model for different levels of MSY as these are poorly know.

From distributions of CPUEs across the large area, and knowing the 'sustainable' catch in the larger stock area (MSY estimate) a proportional estimate of the sustainable catch in the local area can be made. Having determined a 'sustainable yield' from the local area, we can compare this yield with the current catches being taken from that area.

The MWG noted that this type of analyses could be better informed by the spatial outputs of the MFCL assessments to estimate spatial yields (rather than LL CPUE). The MWG noted that this type of method had previously been applied by the OFP in developing Pacific Island state tuna management plans.

Annex A7-I : List of Participants

Tony Lewis, Dinh Van Uu, Ramon Conser, Keith Bigelow, Robert Campbell, John Hampton, Kevin Hill, Pierre Kleiber, Dale Kolody, Mark Maunder, Talbot Murray, John Sibert, Neville Smith, Chi-Lu Sun, Miki Ogura, Peter Miyake, Silivenusi Ha'unga, Yukio Takeuchi, SungKwon Soh, JeongRack Koh, Naozumi Miyabe, Simon Hoyle, Don Bromhead, David Kirby, Peter Williams, Lara Manarangi-Trott, David Itano, Ludwig Kumoru, Augustine Mohiba, Yuji Uozumi, Robert Skillman, Michael Hinton and Chien-Hsiung Wang.

Annex A7-II : SCTB16 Methods Working Group Agenda

July 7

1. INTRODUCTION – John Sibert
2. SELECTION OF RAPPORTEURS
3. ADOPTION OF AGENDA
4. RESULTS OF SIMULATION STUDIES
    1. Operational model and "true" parameter values – Hampton; MWG-1
    2. Model Comparisons – Sibert
    3. Discussion - group
    4. Synthesis of results
5. CONTRIBUTED PAPERS
    1. Comparison of deterministic and statistical habitat-based models to estimate effective longline effort and standardized CPUE for bigeye and yellowfin tuna – Keith Bigelow, *et al.;* RG-3
    2. Recommended diagnostics for large statistical stock assessment models – Shelton Harley and Mark Maunder; MWG-3
6. REVIEW OF SPC/OFP YELLOWFIN & BIGEYE ASSESSMENT
    1. Stock assessment of yellowfin tuna in the western and central Pacific Ocean. Standing Committee on Tuna and Billfish – Hampton; YFT-1; BET-1
    2. Discussion

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6. CONTINUED
    3. Conclusion
7. FORMULATING ADVICE TO MANAGEMENT – Sibert
    1. Principles of stock assessment
    2. Decision table for fishery management
8. FUTURE PLANS
    1. Review MWG terms of reference – Sibert
    2. Future plans
9. OTHER BUSINESS
10. CONTRIBUTED PAPERS (continues)
    1. Methodological improvements to the EPO tuna stock assessments – Mark Maunder and Shelton Harley; MWG-2
    2. Theoretical consideration of how to estimate the varied carrying capacities – Wang Chien-Hsiung; MWG-4
    3. An Approach for Estimating Equilibrium Yields within Regions of the Pacific Ocean – Robert Campbell; MWG-6
11. PREPARATION OF REPORT

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1. MWG REPORT – Sibert
2. CONTRIBUTED PAPERS (continues)
    1. Methods for standardizing CPUE and how to select among them – Michael Hinton and Mark Maunder; MWG-7
3. INTERCESSIONAL WORK PROGRAMME

APPENDIX 8. REVIEW OF KOREAN CATCH AND EFFORT LOGSHEETS

Introduction

The objective of the Statistics Working Group (SWG) of the Standing Committee on Tuna and Billfish (SCTB) is to coordinate the collection, compilation and dissemination of data on tuna fisheries in the western and central Pacific Ocean. In regard to the coordination of data collection, it was agreed at the eleventh meeting of the SCTB, which was held from 28 May to 6 June 1998 in Honolulu, to establish minimum standards for data collection forms and to review data collection forms that are in use in the region (Anon. 1998).

The SWG established minimum standards for catch and effort logsheets at the twelfth meeting of the SCTB, which was held from 16 to 23 June 1999 in Tahiti, French Polynesia (Anon. 1999); the minimum standards are presented in Appendix I of SCTB16 Working Paper SWG–5.

Logsheets developed by the following agencies have so far been reviewed:

- New Zealand Ministry of Fisheries (Anon. 1999);
- Australian Fisheries Management Authority (Anon. 1999);
- SPC/FFA Tuna Fishery Data Collection Forms Committee (Anon. 2000);
- National Research Institute of Far Seas Fisheries of Japan (Anon. 2001);
- Overseas Fisheries Development Council of Taiwan (Anon. 2003).

Logsheets maintained by the National Fisheries Research and Development Institute of Korea were reviewed prior to SCTB16 and the results are reported below and in Working Paper SWG–5. Translations of the Korean logsheets for distant-water longline and purse seine are presented in Appendix II of SCTB16 Working Paper SWG–5.

Comparison of Korean Logsheets and Minimum Standards

SCTB16 Working Paper SWG–5, Appendix III, presents a comparison of the Korean logsheets and the minimum standards established by the SWG. The following points are of interest:

"Korea Logbook for Tuna Fishery – Longliner"

- The format is a logsheet, with fields to record information for 31 days on each page, rather than a logbook, which usually consists of one page for vessel attributes and trip information, followed by several pages, each of which is used to record catch and effort data for one set. The Korean longline logsheet consists of (a) boxes containing fields for vessel name, trip number, vessel attributes, ocean area fished, bait used, name of captain, and departure and arrival dates, and (b) 31 rows to record information for each set in 22 fields.

- No instructions were provided with the translated logsheets.

- The forms are used only by vessels registered in Korea; therefore, there is no field for the country of registration. The only vessel identifier is the vessel name; the registration number, call sign and license number are not recorded. It is questionable whether the vessel name alone is sufficient to identify the vessel.

- Data are recorded only for sets and not for other activities. Hence, there is no activity code to indicate that the vessel is in transit or not fishing due to breakdown or bad weather. However, the number of 'trip days' and the number of 'fishing days' for the trip are recorded.

- Set positions are recorded only to the nearest degree of latitude and logitude and not the nearest minute, as specified in the minimum standards.

- There are fields to record the catches of six species of tuna, five species of billfish and, as a species group, sharks. But all other species are recorded under 'others'. Hence, it is not possible to separately record the catches of other major non-target species, such as wahoo, opah, escolar, lancetfish, etc., nor species of special interest, such as marine turtles.

- If it is intended that the form be printed on A4 size paper, then the space for recording the catches is small.

- For each species or species group, there are two columns for the retained catch in number of fish and kilograms. Discards are not recorded.

"Korea Logbook for Tuna Fishery – Purse seine"

- The format is a logsheet, rather than a logbook. The Korean purse-seine logsheet consists of (a) boxes containing fields for vessel name, call sign, vessel attributes, name of captain, and departure and arrival dates, and (b) 21 rows to record information for each set in 22 fields.

- No instructions were provided with the translated logsheets.

- The forms are used only by vessels registered in Korea; therefore, there is no field for the country of registration. The call sign and license number are not recorded; however, the vessel name and registration number should be sufficient for identifying the vessel.

- The only vessel and gear attributes are 'tons of boat' (i.e. gross registered tonnage), the presence of a helicopter and the number of crew. There is no information on net dimensions, storage capacity, engine power or rated speed.

- Data are recorded only for sets and not for other activities. Hence, there is no activity code to indicate that the vessel is in transit or not fishing due to breakdown or bad weather.

- It is not specified whether the set time should be local time, ship's time or UTC.

- Set positions are recorded only to the nearest degree of latitude and logitude and not the nearest minute, as specified in the minimum standards.

- School association is recorded for 'natural log', 'FAD' and 'free school'; however, there is no code for 'other' together with instructions to explain the 'other' association on the logsheet.

- There are fields to record the catches of three species of tuna, but all other species are recorded under 'others'. Hence, it is not possible to separately record the catches of other major non-target species, such as rainbow runner, shark species, decapturus, etc., nor species of special interest, such as marine mammals or marine turtles. Discards of tuna are recorded as a species group.

Response to the "Review Of Korean Catch And Effort Logsheets" By The National Fisheries Research and Development Institute

"Korean Logbook for Tuna Fishery-Longliner"

- There may be some confusion in the meaning between logbook and logsheet. Fishermen keep their daily fishing operations and trip on the logbook provided by fishing company. For data collecting purpose, Korean government provides data collecting sheet (you called 'logsheet') to fishermen on each trip with instructions. After each trip, fishermen submit to NFRDI the 'logsheet' on which daily fishing activities are recorded during the trip.

- At the left side of the 'logsheet', there are instructions for fishermen to fill the form. However, due to the complexity of the form, NFRDI scientists teach the fishing vessel captains or officers how to fill the form before they begin their journey. This session is given to the captains at each trip.

- The Ministry of Maritime Affairs and Fisheries of Korea issues license to the fishing vessels and the copy of license is kept in NFRDI from which we can easily identify a specific vessel. The license includes vessel specifications, registration number, license number and etc. Only the Korean-flagged vessels are obliged to submit their catch record to NFRDI.

- We instruct fishermen to indicate all activities related to fishing such as transit, returning to port, no fishing due to bad weather etc. on the 'logsheet'. Although the translated sample 'logsheet' which you refer does not include these activities codes, submitted form by fishermen usually includes such activities by their own handwriting.

- Our fishermen record set position to the nearest minute on the 'logsheet'. The form does not discourage fishermen to do so.

- We encourage them to report bycatch species such as sea turtles or seabirds in others section.

- The 'logsheet' is printed on A3 size paper and distributed to fishermen before they begin their journey.

"Korean Logbook for Tuna Fishery-Purse seine"

- At the right side of the 'logsheet', there are instructions so that fishermen can fill the form. Like the longline fishery, we teach the fishing vessel captains or officers how to fill the form before they begin their journey.

- The Ministry of Maritime Affairs and Fisheries of Korea issues license to the fishing vessels and the copy of license is kept in NFRDI from which we can easily identify a specific vessel. The license includes vessel specifications, registration number, license number and etc. Only the Korean-flagged vessels are obliged to submit their catch record to NFRDI.

- At the right side, number 4 indicates other activities into 8 categories.

- I do not believe that our fishermen set time to the one of their hometown when they are fishing in the Pacific Ocean.

- Our fishermen record set position to the nearest minute on the 'logsheet'.

- We encourage them to report bycatch species such as sea turtles or seabirds in others section.

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APPENDIX 9. SCIENTIFIC NAMES OF SPECIES

ENGLISH NAME	SCIENTIFIC NAME
Tuna and Tuna-Like Species	
Albacore	*Thunnus alalunga*
Bigeye	*Thunnus obesus*
Bullet tuna	*Auxis rochei*
Frigate tuna	*Auxis thazard*
Kawakawa, Eastern little tuna	*Euthynnus affinis*
Pacific bluefin	*Thunnus orientalis*
Skipjack	*Katsuwonus pelamis*
Southern bluefin tuna	*Thunnus maccoyii*
Wahoo	*Acanthocybium solandri*
Yellowfin	*Thunnus albacares*
Billfish	
Black marlin	*Makaira indica*
Pacific blue marlin	*Makaira mazara*
Sailfish	*Istiophorus platypterus*
Shortbill spearfish	*Tetrapturus angustirostris*
Striped marlin	*Tetrapturus audax*
Swordfish	*Xiphias gladius*
Sharks	
Blue shark	*Prionace glauca*
Mako shark	*Isurus* spp.
Oceanic whitetip shark	*Carcharhinus longimanus*
Silky shark	*Carcharhinus falciformis*
Thresher shark	*Alopias* spp.
Other Species	
Mahimahi	*Coryphaena hippurus*
Opah	*Lampris guttatus*
Monchong (pomfrets)	*Taractichthys steindachneri, Eumegistus illustris*
Marine Turtles	
Green	*Chelonia mydas*

Leatherback	*Dermochelys coriacea*
Loggerhead	*Caretta caretta*
Olive Ridley	*Lepidochelys olivacea*

Sea Birds

Black-footed albatross	*Phoebastria nigripes*

APPENDIX 10. ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AMSY	Average maximum sustainable yield
ARG	Albacore Research Group
A-SCALA	age-structured statistical catch-at-length analysis
ASPM	age structured production model
AVHRR	Advanced Very High Resolution Radiometer
B	biomass
BAS	Bureau of Agricultural Statistics (Philippines)
B_{MSY}	equilibrium population biomass at maximum sustainable yield
BBRG	Billfish and Bycatch Research Group
BET	bigeye tuna
BFAR	Bureau of Fisheries and Aquatic Resources (Philippines)
BRG	Bigeye Research Group
BW	body weight
c&f	Cost and Freight
CF	condition factors
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
cm	centimeter
CNMI	Commonwealth of the Northern Mariana Islands
COFI	Committee on Fisheries (FAO)
COMTRADE	commercial trade statistics database of the UN Statistics Division
CPUE	catch per unit of effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DGCF	Directorate General of Capture Fisheries (Indonesia)
DWFN	distant water fishing nation
EDF	European Development Fund
EEZ	exclusive economic zone
ENSO	El Niño Southern Oscillation
EPO	eastern Pacific Ocean
ESTHER	*Efficacité des Senneurs Thoniers et Efforts Réels*, or Efficiency of Tuna Purse Seiners and Effective Effort
ETP	eastern tropical Pacific
EU	European Union
F	the instantaneous rate of fishing mortality
F_{MSY}	fishing mortality rate at maximum sustainable yield
FAD	fish aggregating device
FAO	Food and Agriculture Organization of the United Nations
FFA	South Pacific Forum Fisheries Agency

FFC	Forum Fisheries Committee
FIGIS	Fisheries Global Information System
FL	fork length
FTWG	Fishing Technology Working Group
FSM	Federated States of Micronesia
GAM	general additive model
GLM	general linear model
GPS	Global Positioning System
GRT	gross registered tonnage
GSI	gonosomatic index
HMS	highly migratory species
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IEO	Instituto Español de Oceanografía
IPTP	Indo-Pacific Tuna Programme
IOTC	Indian Ocean Tuna Commission
IPOA	International Plan of Action
IRD	Institut de la Recherche pour le Développement (formerly ORSTOM)
IUU	illegal, unreported and unregulated
JIMAR	Joint Institute of Marine and Atmospheric Research (UH)
kg	kilogram
km	kilometer
LCEM	Landed Catch and Effort Monitoring Project (Philippines)
M	the instantaneous rate of natural mortality
m	meters
MAF	Ministry of Agriculture and Fisheries (New Zealand)
MFMR	Ministry of Fisheries and Marine Resources (Solomon Islands)
MIMRA	Marshall Islands Marine Resources Authority
MSY	maximum sustainable yield
mt	metric tonnes
NAD	non-target, associated and dependant (species)
nm	nautical mile
NFA	National Fisheries Authority (PNG)
NFC	National Fisheries College (PNG)
NFR	National Fishery Report
NFRDI	National Fisheries Research and Development Institute (Korea)
NMFS	National Marine Fisheries Service (USA)
NORMA	National Oceanic Resource Management Authority (FSM)
NRIFSF	National Research Institute of Far Seas Fisheries (Japan)
NSAP	National Stock Assessment Project (Philippines)
NTU	National Taiwan University
OAL	overall length
OFDC	Overseas Fisheries Development Council (Taiwan)
OFP	Oceanic Fisheries Programme (SPC)

OPAGAC	Organization de Productores Asociados de Grandes Atuneros Congeladores
PIAFA	Pacific Insular Area Fishery Agreement
PIAO	Pacific Islands Area Office (NMFS)
PIC	Pacific island country
PFRP	Pelagic Fisheries Research Program (UH)
PNG	Papua New Guinea
PROCFISH	Pacific Regional Oceanic and Coastal Fisheries Programme (SPC)
PSAT	pop-up satellite archival tag
RIMF	Research Institute for Marine Fisheries (Indonesia)
RSW	refrigerated sea water
SAT	Samoan Tala
SBR	spawning biomass ratio – the ratio of the spawning biomass to the spawning biomass of the unexploited stock
SCALIA	statistical catch-at-age/length integrated analysis
SCTB	Standing Committee on Tuna and Billfish
SeaWiFS	Sea-viewing Wide Field-of-view Sensor Project
SEPODYM	spatial environmental population dynamic model
SKJ	skipjack tuna
SPC	Secretariat of the Pacific Community (formerly the South Pacific Commission)
SRG	Skipjack Research Group
SSB	spawning stock biomass
SST	sea surface temperature
STCZ	Sub-tropical Convergent Zone
SWG	Statistics Working Group
TAC	total allowable catch
UH	University of Hawaii at Manoa
UN	United Nations
U.S.	United States of America
USA	United States of America
USD	USA dollar
USMLT	US Multi-lateral Tuna Treaty
WCPO	Western and Central Pacific Ocean
WPRFMC	Western Pacific Regional Fisheries Management Council (USA)
WTPO	World Tuna Purse Seine Organization
VMS	vessel monitoring system
VPA	virtual population analysis
YFT	yellowfin tuna
YRG	Yellowfin Research Group