15th Meeting of the Standing Committee on Tuna and Billfish

SCTB 15
Honolulu, Hawaii
22–27 July 2002

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

22–27 July 2002

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TABLE OF CONTENTS

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EXECUTIVE SUMMARY

The fifteenth meeting of the Standing Committee on Tuna and Billfish (SCTB 15) was held on 22–27 July 2002 in Honolulu, Hawai'i, at the invitation of the Chairman, and hosted by the Pelagic Fisheries Research Program of the University of Hawai‘i, NOAA Fisheries Honolulu Laboratory and the Western Pacific Regional Fisheries Management Council. SCTB 15 was attended by participants from Australia, Canada, Cook Islands, Federated States of Micronesia, Fiji, France, French Polynesia, Indonesia, Korea, Marshall Islands, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, the Peoples Republic of China, Philippines, Samoa, Solomon Islands, Taiwan, United States of America, Vanuatu, Vietnam and Wallis and Futuna. Representatives from various regional and international organizations also attended the meeting. These included the Food and Agriculture Organization of the United Nations (FAO), the Forum Fisheries Agency (FFA), the Indian Ocean Tuna Commission (IOTC), the Inter-American Tropical Tuna Commission (IATTC) and the Secretariat of the Pacific Community (SPC).

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 2001 for the four main tuna species was 1,910,000 mt, the second highest annual catch on record after 1998 (2,038,000 mt). The 2001 WCPO catch of skipjack (1,213,000 mt) was slightly lower than in 2000 and well below the 1998 record catch (1,310,000 mt) and as usual dominated the total catch. The WCPO yellowfin catch (473,000 mt; 25%) was the highest since the record catch in 1998 (500,000 mt), and continues to comprise 35–40% of the global catch. The bigeye (107,000 mt; 6%) and albacore (117,000 mt; 6%) catches were similar to 2000 levels, but not as high as the record catches for these species taken during 1999 (111,000 mt and 148,000 mt, respectively).

Reports on relevant activities of other organizations were received from IATTC, FAO, and IOTC.

The Statistics Working Group reviewed the status of data collection, compilation and dissemination and the directives to the SWG that were made during SCTB 14. These concerned the compilation of data from Indonesia, the Philippines and Vietnam; methods to determine the extent of unreported catches in the WCPO, including trade statistics and catch certification schemes; discrepancies between bigeye species composition sampling by observers and port samplers for purse seiners; a workshop on standards for the design of national and regional observer programs; the targeting of albacore by longliners; the compilation of vessel and gear attributes; and increasing the observer coverage of most fleets. Directives to the SWG that were made during SCTB 15 include several activities related to the development of standards for the design of national and regional observer programs; the evaluation of the reliability of port sampling data and observer data; the examination of discrepancies in the proportion of bigeye in 'yellowfin plus bigeye' determined from purse-seine port sampling data and observer data; the development of a project to sample the species composition and lengths of fish caught in the domestic fisheries of Indonesia; and the documentation of procedures that are used by Indonesia and the Philippines for collecting data and estimating annual catches.

The Methods Working Group conducted research during the inter-sessional period to evaluate the performance of several stock assessment models. The OFP operational model was used to generate "simulated data" for analysis by MULTIFAN-CL, SCALIA, A-SCALA, ADAPT, and age-structured and Fox production models. MULTIFAN-CL and some of the other complex models appear to estimate ratios of certain population parameters with acceptable accuracy. Therefore, MWG participants were cautiously optimistic about the accuracy of MULTIFAN-CL biological reference point estimates (e.g., B/B_{MSY} and F/F_{MSY}). During the inter-sessional period prior to SCTB 16, the MWG will continue the simulation work to evaluate model performance, focusing on the role of spatial structure and population movement in assessment results. Assessment models will also be tested with more realistic levels of variability in the simulated data. The MWG will conduct an in-depth review of the MULTIFAN-CL yellowfin assessment for presentation to SCTB 16.

A preparatory meeting of the Fishing Technology Working Group met prior to SCTB 15 where participants discussed 15 papers related to: fleet reports; technical reference papers; technical data collection; the economic condition of surface fisheries; advances in vessel efficiency; anchored and drifting FAD technology and bycatch; regional purse seine management initiatives, harvest capacity issues, regional bigeye tuna management issues and new entrants to the WCPO fishery. A detailed report of this meeting is appended to the SCTB 15 final report. During the plenary session of the FTWG, the report of the preparatory meeting was presented in addition to presentations on fishing strategies, vessel performance factors, current status and outlook for the US western Pacific purse seine fleet, and technical advances in regional purse seine and longline technology. Directives to the FTWG arising from discussion during SCTB 15 included work to: improve information useful to define and adjust for increasing efficiency in surface fisheries (particularly FAD-related issues); assist with observer training to recognize and document new fishing technologies; investigate the impact of new fishing technology on at-sea and port sampling programs; and assist efforts to improve catch and effort data describing mixed bigeye/yellowfin landings.

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.

Several crosscutting issues emerged from the Research Group discussions that SCTB wishes to highlight.

1. Stock assessments for skipjack, yellowfin and bigeye tunas continue to be hampered by the lack of adequate fisheries statistics (catch, effort, size and species composition) for some areas. In particular, data collection in the fisheries of Indonesia and Philippines needs to be strengthened.

2. There is a need for improved observer coverage in order to sample the proportion of bigeye and yellowfin in purse-seine catches, estimate catch rates for non-target species, and to collect size composition data.

3. The assessments for yellowfin and bigeye tuna indicate that both stocks are likely to be nearing full exploitation, in contrast to the skipjack and South Pacific albacore stocks, which appear capable of sustaining current levels of exploitation. The catches and fishing mortality of juvenile yellowfin and bigeye have increased greatly over the past decade, due primarily to increased catches in Indonesia, Philippines, and the international purse seine fishery. In respect of the purse seine fishery, the increased use of drifting FADs has increased juvenile mortality of both species. SCTB 15 therefore reiterated the recommendation of SCTB 14 that there be no further increase in fishing mortality in surface fisheries for these species in the WCPO.

4. The Research Groups identified various research and fishery monitoring activities that would lead to improved understanding of the stocks. Large-scale conventional tagging to provide better information on natural mortality, fishing mortality, movement and stock structure was seen as critical for all species. Also, archival and pop-up tagging of yellowfin, bigeye and albacore are needed to provide detailed information on vertical habitat utilization used in CPUE standardization studies. SCTB 15 therefore recommended that a small group be established to plan future tagging programs and consider funding alternatives.

The SCTB Chairman and Working Group and Research Group Coordinators for SCTB 15 were as follows.

SCTB Chairman:	Mr. Bernard Thoulag
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. Chi-Lu Sun
Skipjack RG:	Dr. Gary Sakagawa
Yellowfin RG:	Dr. Robert Campbell
Billfish and Bycatch RG:	Mr. Paul Dalzell

The Chair of SCTB was scheduled for rotation after the two-year term of Mr. Bernard Thoulag of Federated States of Micronesia. The meeting endorsed the nomination of Dr. Sung-Kwon SOH (or his designate) of Korea for a new two-year term as SCTB chair.

The meeting considered the timing and venue of the 16th SCTB meeting. The meeting accepted an offer from Australia to host the meeting in Mooloolaba, Queensland in July 2003 (exact dates to be advised). The meeting closed on Saturday 27 July at 14:00 hrs.

SKIPJACK RESEARCH GROUP—SUMMARY STATEMENT

Skipjack tuna are the most important tuna resource in the WCPO, in terms of its contribution by weight to the total catch. In the past decade, skipjack tuna catches have been approximately 1 million mt per year, contributing about 63% to the total tuna catch from the region. The 2001 catch was slightly more than 1.2 million mt, the second highest catch on record. The purse seine fishery accounted for most of this catch (69%) with 24% from the pole-and-line fishery.

The CPUEs for purse seine are variable with nominal CPUE for log and FAD sets showing an increasing trend (mainly due to increased efficiency of purse seiners), particularly in recent years. Nominal CPUEs for free-swimming school sets and for pole-and-line fisheries are essentially flat. A lack of trend was also seen in standardized pole-and-line CPUEs.

Skipjack tuna are concentrated in tropical waters but expand seasonally into subtropical waters to the north and south. Their fast growth, early maturity, high fecundity, year round spawning, relatively short life span, high and variable recruitment, and few ages classes on which the fishery depends makes this species unique among the main tuna species. Ongoing fishery oceanography and environmental studies continue to improve understanding of the factors influencing availability and productivity of skipjack tuna in the WCPO. They suggest a positive impact of El Niño skipjack tuna recruitment, particularly when followed by a La Nina event. The cause for these recruitment differences appears to be changes in the area of the spawning habitat with temperature and in forage availability. Modeling results predict lower skipjack tuna recruitment over the next 2 years resulting from the 1998-2000 La Nina event. The biomass trend appears to be recruitment driven, with large variability and with the largest biomass levels estimated to be for the model period 1998 to 2000. The model results suggest that the skipjack tuna population in the WCPO in recent years is at an all time high relative to the last 30 years.

Tag-based assessments from the early 1990s suggested low to moderate exploitation at catch levels slightly lower than those in recent years. Recent results from MULTIFAN-CL model analysis, which incorporates tagging and other information, were consistent with earlier assessments but indicated that fishing mortality had continued to increase from the 1970s and falling to some extent in recent years, probably due to economic factors. While fishing mortality has increased, the impact of fishing on the stock is estimated to be relatively slight throughout the time period. The ratio of fishing mortality relative to F_{MSY} is small (<0.20) and fishing mortality over the past 30 years has been significantly less than natural mortality. Similarly, estimates of recent spawning stock biomass (SSB) are considerably higher than the estimated level producing MSY ($SSB/SSB_{MSY} > 5.0$). The skipjack tuna stock appears to be healthy and capable of sustaining the current catch without adverse effect on stock condition.

Nevertheless, the Group noted that it does not appear that skipjack tuna move over great distances rapidly and hence do not thoroughly mix over the entire region. Concentrated and sustained fishing effort in local areas, consequently, could result in local depletion. In such areas, further increase in fishing effort may not result in proportionate increase in catches, but instead result in decline in CPUE and even in average size of skipjack tuna taken. The experience in the Atlantic skipjack tuna fisheries where this has occurred was noted.

Future advances in the basic biology, data collection and stock assessment of skipjack tuna are required to substantiate the information required for the management of this economically and ecologically important species. Of particular importance is the need to estimate the magnitude and size composition of skipjack tuna caught in the domestic fisheries of the Philippines and Indonesia.

YELLOWFIN RESEARCH GROUP—SUMMARY STATEMENT

Catches of yellowfin tuna represent the second largest component (21-28% 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.

The catch of yellowfin tuna in the WCPO first exceeded 200,000 mt in 1980. With the expansion of the purse seine fishery during the 1980s catches doubled to reach around 414,000 mt by 1992. Since that time yellowfin catches in the WCPO have varied between 326,000 and 500,000 mt, with the catches during the last five years being at historical high levels, averaging 464,000 mt. The catch during 2001 is currently estimated to be 473,000 mt, the second highest recorded. Purse seine vessels harvested the majority of the yellowfin catch (45% by weight) during 2001, while longline and pole-and-line fisheries caught 17% and 3% respectively and various other gears accounted for 34 % (mostly eastern Indonesia and the Philippines).

Nominal catch rates of yellowfin for purse seine fleets are characterized by strong interannual variability believed to be associated with variation in environmental conditions associated with the El Niño Southern Oscillation cycle. Catch rates for most fleets indicate no clear trend over the available time series of data, despite the increased efficiencies associated with the use of drifting FADs. Nominal catch rates of yellowfin for the Japanese distant water longline fleet display a steady decline during the 1980s, increased during the mid-1990s, dropped sharply to a historical low during 1999 before recovering somewhat during 2000. However, after accounting for the increased targeting on bigeye tunas since the mid-1970s, standardized catch rates for this fleet in most regions of the WCPO display large interannual variability, no overall long term trend, but somewhat higher values between the mid-1970s through to the late 1990s.

New research on the displacement patterns of tagged yellowfin, together with the results of research on juvenile recruitment patterns; indicate the possibility that short to medium (less than 1000 km) distance movements may be more characteristic of overall yellowfin movement patterns than long-distance migrations and large scale mixing. While further work with archival tags is required to increase our understanding of movement patterns, the higher degree of regionalization of yellowfin populations implied by these results increase the risk of localized depletions where catch levels are too high relative to local immigration rates of yellowfin.

New research on the trophic ecology of yellowfin associated with natural and man-made aggregation sites is also improving our understanding of the ecological consequences of the increased used of FADs. However, further work is required to understand habitat preferences, trophic dynamics and the influences of recent increases in fishing efficiencies (e.g., the increased used of drifting FADs) to help improve the standardization of catch rates.

Tag-based assessments from the early 1990s found exploitation levels of yellowfin tuna to be low to moderate at catch levels at that time, about 20-25 percent below those in recent years. However, more recent assessments of the yellowfin stock in the WCPO using the MULTIFAN-CL model indicate that fishing mortality has increased significantly since this time, largely as a result of catchability increases in the purse seine fisheries. The results from the latest assessment reaffirm these earlier findings as well as the result from last year's assessment that indicated recent recruitment may have declined significantly. The reasons for this decline remains uncertain though do not appear to be related to a decline in spawning biomass due to fishing. It is possible that a shift to a lower productivity regime characterized by lower average recruitment has occurred.

The recent declines in recruitment have produced a significant decline of around one-third in overall stock biomass since 1997. Biomass levels in 2000 and 2001 are estimated to be the lowest since the mid-1970s. The decline in biomass is most evident in the main catch regions of the western equatorial Pacific where current biomass is estimated to have declined by over 50 percent since the mid-1990s. For the WCPO in total, the current biomass is estimated to be around 35% less than that which would have occurred in the absence of fishing.

Attempts to estimate an MSY for yellowfin continue to be hampered by uncertainty in the stock-recruitment relationship and the age-specific exploitation patterns as well as other uncertainties in the stock assessment models. The possibility of two different productivity regimes also complicates the situation, as estimation of the MSY level and associated spawning biomass ratio (the ratio of spawning biomass to that for the unfished stock) are dependent on overall stock productivity. Nevertheless, the assessment reviewed by SCTB 15 reaffirms the result of the previous assessment that the yellowfin stock in the WCPO is presently not being overfished (i.e., $F/F_{MSY} < 1$) nor is it in an overfished state ($SSB/SSB_{MSY} > 1$). However, the current trends in both ratios are towards their respective reference points, and if a shift to a lower productivity regime has occurred, it is believed that present catches may not be sustainable.

There is increasing evidence that the north Pacific Ocean is undergoing an environmental regime change and this is likely to have an effect on the productivity and distribution of tunas in the Pacific Ocean. The results of recent assessments of yellowfin tuna in the WCPO suggest that the stock may be responding to this regime change with lower recruitment now than before. The results, however, have elements of uncertainty because of assumptions used in the assessment models and incomplete fisheries information available for the analyses. Furthermore, due to the short time-series on which they are based, estimates of recruitment and cohort strength in the most recent years are the most poorly determined. As a result, further years data will be needed to confirm the present results, especially in terms of future stock productivity. Nonetheless, if the stock is entering a regime of low recruitment, the current catch of 475,000 t is significantly higher than the estimated MSY for a low recruitment regime (~290,000 t) and is not sustainable. In such an event fishing mortality would need to be reduced, especially on juvenile yellowfin in the equatorial regions where the stock is believed to be close to if not already fully exploited. If, however, recent estimates of low recruitment are normal variability of a high-recruitment regime, the current catch is estimated to be close to the estimated MSY for a high recruitment regime and appears to be sustainable.

While recognizing continuing uncertainties associated with the present stock assessment, the Group 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 fishing mortality is recommended.

Furthermore, the Group believes that this uncertainty and its impact on stock status advice highlights the need for the following immediate actions.

1. The condition of the yellowfin stock should be closely monitored over the next few years.

2. Fishery data collections should be significantly improved, particularly for the fisheries that catch a significant amount of yellowfin tuna.

3. Options for fishery management actions required for maintaining a healthy stock in a low recruitment regime should be evaluated in order to be prepared should further analyses validate that the future is a low-recruitment regime.

4. A greater understanding of changes in catchabilities is required in order to develop improved indices of stock abundance based on CPUE.

5. Further development of stock assessment models, particularly MULTIFAN-CL should be undertaken.

6. The development of alternative recruitment indices, other than those provided by MULTIFAN-CL, should be developed.

7. Studies on the multi-species influences of the assessment should be carried out.

8. The Group also saw the need for additional large-scale and archival tagging to help validate the recent level of fishing mortality estimated from the assessment models and provide additional information on yellowfin movement, natural mortality and exploitation rates to support future stock assessment analyses.

ALBACORE RESEARCH GROUP—SUMMARY STATEMENT

The South Pacific albacore comprises a single stock. Catch in 2001 reached about 52,000 mt with a noticeable increase of fish caught by longliners from some Pacific Island countries (PICs). These vessels accounted for almost 50% of the total longline catch, which was estimated at 46,000 mt in 2001. Less than 15% of fish are taken east of 150° west, and most fishing occurs from 10ºS to 50°S.

The total catch last year was the highest since the peak recorded in 1989 when driftnet vessels fished in the region of the subtropical convergence zone (STCZ). The albacore surface fishery is now composed only of trollers with a fishing season spanning from November to April around the STCZ and in New Zealand coastal waters.

Albacore CPUE of Taiwanese longliners operating in the South Pacific showed a slight increase during the 1990s except at the lowest latitudes where a drop was recorded in the most recent years. This appears to be related to changes in the fishing practices of this fleet towards targeting of bigeye and yellowfin, particularly in the waters north of French Polynesia. Changes in fishing practices of PIC longliners may also explain some recent trends in the albacore CPUE recorded in the EEZs of these countries. Some of these vessels are now fitted to target different species with flexibility.

CPUE for the New Zealand troll fleet has been relatively stable during the 1990s, showing some convergence in recent years with that of the US troll fleet, which was previously higher and more variable.

The length frequency data collected from longline and troll fleets indicate a single multiple-age class mode throughout the year with some overlap in the size composition of fish taken by both fisheries from January to March.

From the most recent stock assessment carried out with the MULTIFAN-CL model, biomass levels appear to reflect the variation of recruitment: the current biomass is about 85% of the estimated equilibrium unexploited biomass.

The impact of the fisheries on total biomass is estimated to be low (reduction of less than 20% from the unexploited conditions). However, there is a need to improve the assessment with additional tagging data and more information on tag-reporting rates. Better knowledge of the South Pacific albacore stock with respect to recruitment and biomass is expected from the use of a high resolution environmental and population dynamics simulation model originally developed for skipjack (SEPODYM model). With regard to albacore this model gives encouraging preliminary results but further refinement is required.

The MULTIFAN-CL model results indicate that current catches are less than the MSY, aggregate fishing mortality is less than F_{MSY}, and the adult biomass is greater than B_{MSY}. The assessment could be improved by the following priority research and monitoring activities.

1. Strengthen the monitoring of catch, effort and size composition of albacore caught by PIC longline fleets.

2. Obtain information on the fishing depth of longline gear targeting albacore.

3. Conduct conventional tagging to improve estimates of natural mortality, fishing mortality and movements, and archival tagging to obtain information on albacore vertical habitat utilization.

BIGEYE RESEARCH GROUP—SUMMARY STATEMENT

Bigeye tuna account for a relatively small proportion of the total tuna catch in the Pacific Ocean, but their economic value probably exceeds US$1 billion annually. The preliminary estimate of Pacific-wide catch of bigeye in 2001 is 183,372 mt, slightly down on the record catch of the previous year (204,149 mt). In the WCPO, the 2001 catch was an estimated 107,262 mt, unchanged from 2000. The longline catch in the WCPO in 2001 increased to a record level (61,019 mt) while the purse seine catch (26,707 mt) decreased by about 15% from the level observed in 2000. During the meeting, preliminary catch estimates were presented on a rapidly developing longline fishery based in Vietnam, for which the catch in 2001 may consist of up to 70% bigeye tuna. Catches by other gears (pole-and-line and various gears in Indonesia and Philippines) remained largely unchanged from the levels reported in recent years. In the Eastern Pacific Ocean (EPO), bigeye catch in 2001 was an estimated 76,110 mt, down considerably from the 2000 catch of 97,402 mt. This decrease was due to a drop in the purse seine catch from the 2000 record level of 70,098 mt to 43,009 mt in 2001. The EPO longline catch of bigeye in 2001 was 33,101 mt, about a 20% increase over the previous year.

Considerable progress has been made in understanding bigeye tuna vertical habitat utilization and movements as the results of archival tagging experiments in various parts of the Pacific come to hand. Work being conducted in the Coral Sea, around Hawai‘i, and in the eastern tropical Pacific suggests that bigeye vertical distribution varies across the Pacific and is likely to be related to variation in several oceanographic variables. This information will be of considerable value in the estimation of effective longline effort for bigeye using habitat models. Movement data thus far collected from archival tags suggest a degree of regional fidelity, although longer-term recaptures are required before strong inferences can be drawn regarding stock structure and mixing rates.

The group examined several nominal and standardized CPUE time series. The purse seine CPUE trends for the main fleets generally reflect the extent to which associated sets, especially on drifting FADs, which have produced higher juvenile bigeye catches in recent years, have occurred in the fishery. Nominal CPUE for Japanese longliners fishing in the tropical WCPO has been fairly stable over a long period of time. However, habitat-model standardized CPUE, which removes variability due to changes in targeting and some environmental variables, shows a declining trend.

Two stock assessment models were presented for WCPO bigeye, one using the MULTIFAN-CL method and the other using the A-SCALA method. While some of the details of the respective model results differed substantially because of different assumptions and data analyzed (e.g., absolute biomass levels and biomass trends differ appreciably in the two analyses), both indicate that recent fishing mortality rates, particularly in the tropical region where most catch occurs, are near or above commonly used overfishing reference points. The MULTIFAN-CL analysis indicated somewhat lower impacts of fishing in the sub-tropical regions of the WCPO. On a WCPO-wide basis, the MULTIFAN-CL model estimated that fishing mortality rates and spawning biomass had not yet reached their respective MSY levels. The A-SCALA model suggested that current levels of fishing mortality are likely to be beyond the F_{MSY} reference point, although it was noted that some of the assumptions used in this analysis (particularly the assumption of constant catchability by the purse seine fishery) are probably unrealistic. However, both analyses agree that further increases in fishing mortality rates are unlikely to result in significant increases in long-term average yield with the current pattern of age-specific exploitation. Moreover, it is clear that the high juvenile fishing mortality generated by the fisheries in the Philippines and Indonesia, and by purse seine FAD and log sets in the WCPO, are limiting potential yields from the fishery and are likely impacting longline fishery performance in the tropical region.

The Group recognized that: (1) the fishing mortality rates on adults are low and without a trend; (2) there are continuing uncertainties inherent in the assessments and, in particular, uncertainties associated with estimates of the juvenile bigeye catch; and (3) there is concern regarding increasing catches, indications that current yields appear to be sustained only by recent periods of above average recruitment, and that fishing mortality rates on juveniles are high (relative to natural mortality) and increasing. For these reasons, the Group reiterated its recommendation that there be no further increase in the fishing mortality rate on juvenile bigeye tuna in the WCPO.

The Group noted that the following research and fishery monitoring activities should lead to improved stock assessment for bigeye tuna in the WCPO:

1. Improved catch, effort and size composition data from the Indonesian and Philippines fisheries, and from the rapidly developing Vietnamese fishery;

2. Improved estimates of bigeye catch from the WCPO purse seine fishery;

3. Continued acquisition of data on bigeye tuna habitat (through archival and pop-up satellite archival tagging), and the incorporation of these data into habitat models to provide estimates of effective longline effort;

4. Additional conventional tagging of bigeye to provide additional information on fishing and natural mortality, movements and other parameters.

BILLFISH AND BYCATCH RESEARCH GROUP—SUMMARY STATEMENT

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 Program (OFP) generates an annual estimate of commercial billfish catches, but currently not on recreational billfish catches. A system for reporting of 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.

During the 15th SCTB, the BBRG dealt with turtle bycatch in WCPO pelagic fisheries, and other species bycatch in WCPO pelagic fisheries.

The BBRG heard about the progress of a project to assess the global ecological impacts of longline fisheries on sea turtles, seabirds, and sharks. The principal items in the first year of this study were the declining population trends of Atlantic sharks, mapping ocean features and bycatch, and estimates of total black footed albatross longline-related mortality in North Pacific. Work was currently underway on determining longline-related sea turtle mortality in the Pacific. The goal of the study was to generate bounded estimates and determine relative threat of fisheries versus other sources of mortality. The discussions on this study noted difficulty on obtaining the data needed to accomplish the study objectives, changes in the operational characteristics of longline fisheries over time, and the documentation of other sources of turtle mortality so as to place longline related impacts in the correct context.

The results of a review by OFP of turtle bycatch in longline fisheries in the tropical WCPO from observer data were presented. There was little information on the nature of fishery interactions with longliners, e.g., tangling or hooking. Depth was a major factor in interactions, with shallow set longlines set at night catching an order of magnitude more turtles than deep sets made in the day. Olive Ridley and green turtles were the most frequently encountered turtles. An annual total of about 2000 turtle interactions with longlines within the tropical WCPO were estimated from observer data. The review listed recommendations on a variety of improvements including fishery observer coverage, species identification, collection of turtle biometrics, interaction descriptions, crew education and awareness.

The BBRG heard about progress of research to reduce longline-turtle interactions in the Hawai‘i-based swordfish fishery. Data from the first phase of experimental fishing for swordfish, which may catch fewer turtles, have been completed and the results were currently being analyzed. The start of the second phase of this project to test direct mitigation measures such as blue dyed bait and distance of hooks from the float was uncertain due to a legal challenge to the fishing experiment by several conservation advocacy organizations. Research on the behavior and physiology of turtles using captive animals was ongoing. Results to date indicate that captive turtles are attracted to red-dyed bait, and not to blue bait. Also, turtle vision may be less acute under low light conditions than the fish targeted by longlining, and this may assist in the design of light sticks, that would attract fish but not turtles.

BBRG heard how at-sea observer programs can help turtle research by collecting information on the pelagic life phase of sea turtles. This includes tag deployment, collection of biological data and specimens for genetic research. Recent research on the use of pop-up satellite archival tagging (PSAT) of sea turtles was discussed to determine post-hooking survivorship of sea turtles. PSATs record hourly depth, temperature, and a daily geolocation. The state-of-the-art tag provides somewhat questionable geolocation data, and is also difficult to attach to sea turtles, but the one redeeming quality of the PSAT is its ability to provide data even in the event of mortality. PSATs have been deployed on hard shell turtles and tests were currently underway with a new method for attachment of PSATs to leatherback turtles. Results of tagging of turtles with ARGOS tags was reviewed and showed the how turtles use oceanic features such as fronts and eddies. Data collected on diving behavior showed the percentage of time turtles spend at various depth ranges.

The preliminary results of recent tagging of oceanic sharks were reviewed by the BBRG. This project was attaching PSATs to blue and other oceanic sharks and collecting blood samples to determine key biochemical indicators for hooked and released sharks. The PSATs also record the time spent at different depths by oceanic sharks. This work was being augmented with data from longline fishing using time-depth recorders to look at the depth and time of day sharks were taken on longlines.

An update was given on ongoing research on the biology of opah (moonfish) and monchong (pomfrets). This project was collecting basic biological information and life history data for the opah and two monchong species. Updates were also given on the MULTIFAN-CL stock assessments of North Pacific swordfish and Pacific blue marlin. Problems associated with data inputs for both assessments were noted and discussed.

A report was given on a recently initiated food web study on the tuna ecosystem of the WCPO. The objective of this study is to understand pelagic predator-prey relationships and to provide a model to assess the environmental and fishing impact on the ecosystem and tuna stocks. Diet and trophic level of the different components of the ecosystem were established by examining stomach contents and by analyzing the isotopic composition of muscle samples. Data from this study will be used in biodynamic ecosystem models.

Sequential changes in swordfish catch rates off eastern Australia were reviewed by the BBRG. As fishing effort had increased, fishing spread further offshore to maintain high catch rates. Similar scenarios were noted for many longline fisheries, where catch rates were initially high then dropped off markedly. The East Coast Australia fishery has been studied from its inception and provides an opportunity to investigate this phenomenon. Several hypotheses were being explored; including the concept of resident sub-populations around seamounts, environmental changes and changes in the longline fleet composition over time. The BBRG was presented with the initial results of an age and growth study for juvenile swordfish in Taiwan using otolith microstructure. If the micro-increments observed in the sagittal otoliths were laid down on a daily basis, then juvenile swordfish reached a size of about 94 cm in their first year. Estimates of spawning dates, based on the otolith analysis, ranged from February to October.

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. Efforts 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. There are many protected-species issues emerging in the U.S. that can have a great impact on tuna fisheries, e.g., the recent Pacific longline and gillnet moratorium petition designed to protect leatherback turtles. The BBRG also notes that changes to existing fishery management statutes may be used to influence seafood exporters to the US to conform with various bycatch mitigation measures.

4. The BBRG recommends that a watching brief be maintained on other bycatch issues as they arise, e.g., future developments under the FAO IPOA on seabird-fishery interactions. Two meetings of note are the Second International Fishers Forum (Nov 2002) and International Marine Turtle Technical Workshop (February 2003), which are both focused on turtle-longline mitigation.

SUMMARY OF DISCUSSIONS

1. PRELIMINARIES

The Fifteenth Meeting of the Standing Committee on Tuna and Billfish (SCTB 15) was held from 22–27 July 2002, in Honolulu, Hawai‘i, USA. The Pelagic Fisheries Research Program (PFRP) of the University of Hawai‘i, USA, served as Secretariat for the meeting.

SCTB 15 was attended by participants from Australia, Canada, Cook Islands, Federated States of Micronesia (FSM), Fiji, French Polynesia, Indonesia, Korea, New Caledonia, New Zealand, Niue, Northern Mariana Islands (CNMI), Marshall Islands, Palau, Papua New Guinea (PNG), the Peoples Republic of China, Philippines, Samoa, Solomon Islands, Taiwan, Tonga, United States of America (USA), Vanuatu, Vietnam and Wallis and Futuna. Representatives of several regional and international organizations also attended the meeting. These included the Food and Agriculture Organization of the United Nations (FAO), the Forum Fisheries Agency (FFA), the Indian Ocean Tuna Commission (IOTC), the Inter-American Tropical Tuna Commission (IATTC) and the Secretariat of the Pacific Community (SPC).

The agenda is presented in Appendix 1. The working papers presented at the meeting are listed in Appendix 2. The list of participants is presented in Appendix 3.

1.1 Opening Ceremony

Dr. Barry Raleigh, dean of the School and Ocean and Earth Science and Technology at University of Hawai‘i, provided an opening address. Dr. Raleigh welcomed the participants and noted the substantial mutual trust that occurs amongst SCTB participants and the effective organization of the research group in providing scientific advice on tuna fisheries. He noted that this forum will face the challenging task of addressing alarming 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.

Mr. Bernard Thoulag assumed his role as Chairman of SCTB 15.

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. Rob Campbell
- Albacore Research Group — Mr. Régis Etaix-Bonnin
- Bigeye Research Group — Dr. Chi-Lu SUN

- Billfish and Bycatch Research Group Mr. Paul Dalzell
- Methods Working Group Dr. John Sibert

1.2 Adoption of the Agenda and Appointment of Rapporteurs

The agenda was adopted without modifications.

The SCTB 15 Secretariat (PFRP) and the Honolulu Laboratory of NOAA Fisheries assumed responsibility for coordinating the rapporteuring process and compiling the report of the meeting, with the assistance of participant rapporteurs. Mr. Keith Bigelow and Mr. David Itano were appointed as coordinating rapporteurs.

The SPC OFP provided most of the rapporteurs for agenda item 2 (Ms. Deirdre Brogan, Dr. Marc Labelle, Dr. Patrick Lehodey, Mr. Peter Sharples, and Mr. Peter Williams). In addition, Dr. Shiham Adam (PFRP), Dr. Rob Campbell (CSIRO), Mr. Tim Park (NORMA, FSM) and Mr. Neville Smith (MAF, New Zealand) volunteered to serve as rapporteurs for some of the national tuna fishery report presentations. Rapporteurs for the SCTB working and research groups were appointed as follows.

- Agenda item 4—Statistics WG: Dr. Robert Skillman
- Agenda item 5—Fishing Technology WG: Ms. Deirdre Brogan
- Agenda item 6—Skipjack RG: Dr. Talbot Murray
- Agenda item 7—Yellowfin RG: Dr. John Kalish
- Agenda item 8—Albacore RG: Dr. Valérie Allain and Mr. Peter Sharples
- Agenda item 9—Bigeye RG: Dr. Ray Conser and Mr. Bert Kikkawa
- Agenda item 10—Billfish and Bycatch RG: Dr. Jerry Wetherall
- Agenda item 11—Methods WG: Dr. John Sibert

1.3 Adoption of the Report of the Fourteenth Meeting of the SCTB

The report of the Fourteenth Meeting of the SCTB, held in Noumea, New Caledonia, from 9–16 August 2001, was adopted.

2. OVERVIEW OF WESTERN AND CENTRAL PACIFIC OCEAN TUNA FISHERIES

2.1 Regional Overview

Mr. Peter Williams provided an overview of the WCPO tuna fisheries, referring the meeting to Working Papers (WP) GEN–1 and SWG–2. The presentation describes broadly each of the fisheries by gear and fleet (Figure 1), with emphasis on 2001 catches (Figure 2) relative to those of recent years and is an introduction to the National Fisheries Reports (NFRs) which provide more detail on the catch and activities of each fleet.

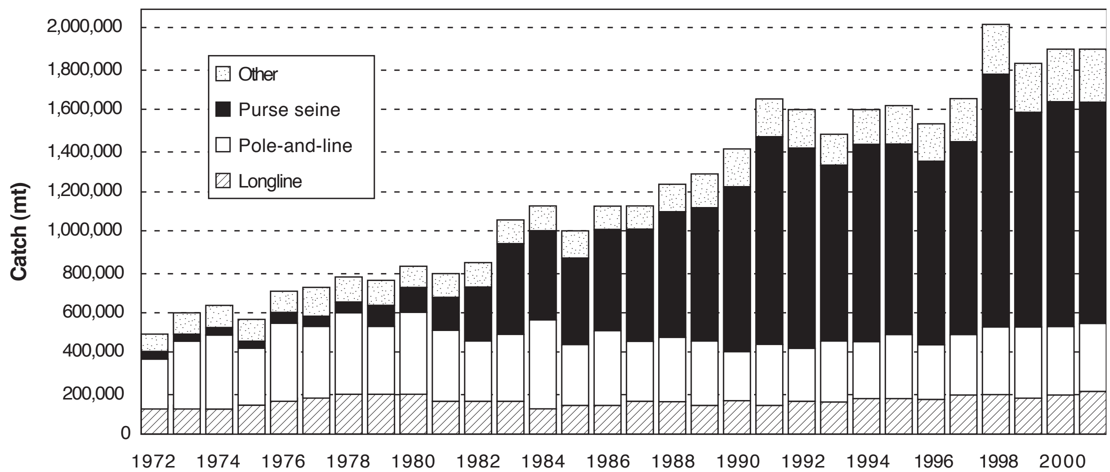

Figure 1. Annual total catch of skipjack, yellowfin, bigeye and albacore tuna, by fishing method, in the WCPO.

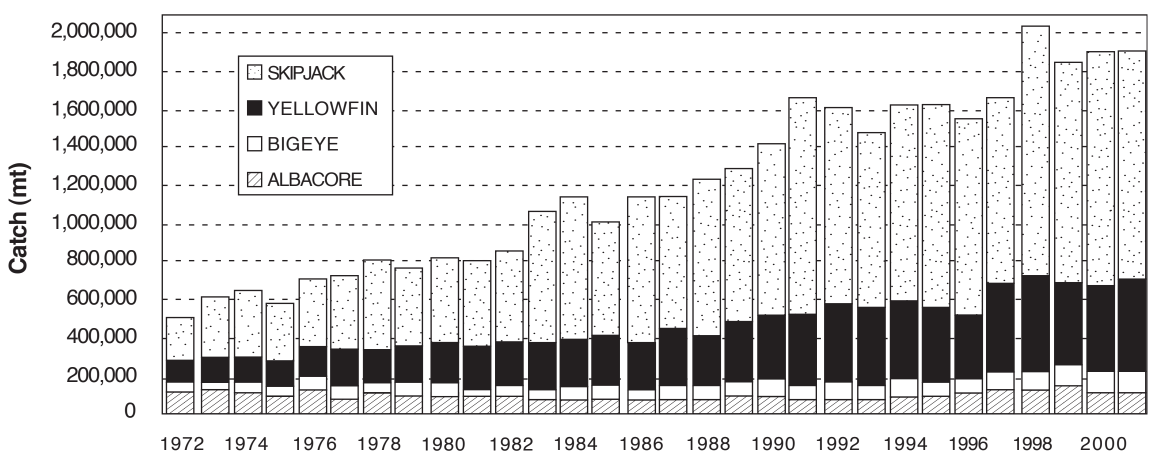

Figure 2. Annual total catch, by species, in the WCPO.

The provisional total WCPO catch of tunas during 2001 was estimated at 1,909,721 mt, slightly higher than the 2000 catch of 1,898,692 mt and the second highest annual catch recorded after 1998 (2,037,602 mt). During 2001, the purse seine fishery accounted for an estimated 1,089,270 mt (56% of the total catch). Pole-and-line took an estimated 330,381 mt (17%), the longline fishery an estimated 221,874 mt (13% and a record for this fishery), and the remainder (14%) taken by troll gear and a variety of artisanal gears, mostly in eastern Indonesia and the Philippines.

The WCPO tuna catch represented 75% of the total estimated Pacific Ocean catch of 2,559,775 mt in 2001, and 49% of the provisional estimate of world tuna catch (3,863,435 mt) of the four species. The Eastern Pacific Ocean (EPO) catch in 2001 (650,054 mt) was the second highest on record. The provisional global catch of the four main species for 2001 was the second highest ever (after 1999), and has increased by over half a million tonnes since 1996.

The 2001 WCPO catch of skipjack (1,212,596 mt) was slightly lower than in 2000 and well below the 1998 record catch (1,310,463 mt). As usual, skipjack dominated the total species catch (63%). The WCPO yellowfin catch (473,236 mt; 25%) was the highest since the record catch in 1998 (499,575 mt), and continues to comprise 35–40% of the global catch. The bigeye (107,262 mt; 6%) and albacore (116,627 mt; 6%) catches were similar to 2000 levels, but not as high as the record catches for these species taken during 1999 (110,619 mt and 147,770 mt, respectively).

The provisional 2001 purse-seine catch of 1,089,270 mt was the fourth consecutive annual catch in excess of 1,000,000 mt and was attained despite voluntary reductions in effort as a result of economic conditions (i.e., lower cannery-bound tuna prices) as existed in the fishery during 2000. The purse seine skipjack catch for 2001 (843,412 mt; 77%) was nearly 105,000 mt less than the 1998 catch (947,113 mt), but still much higher than pre-1998 levels, and the annual WCPO skipjack seems likely to stay at this new elevated level. The purse seine yellowfin catch for 2001 (219,151 mt; 21%) increased from the 2000 catch, which was considered low, but typical of what is expected in a La Nina period. The estimated purse seine bigeye catch for 2001 (26,707 mt; 2%) was down on the record 1999 catch (34,541 mt), primarily due to continued reduction in fishing effort on drifting FADs during 2001. The percentage of sets on drifting FADs for all fleets dropped during 2001 and continued the trend seen in 2000. Sets on unassociated schools were the predominant fishing method for the four main purse seine fleets for the first time since 1998.

Vessel numbers for the four main distant-water purse seine fleets was generally stable during 2001 except the US fleet, which continues to decline in numbers. The Papua New Guinea (PNG) purse seine fleet continues to grow with 22 vessels fishing in the region throughout 2001 and catching nearly 90,000 mt.

The preliminary pole-and-line catch estimate for 2001 (330,381 mt) is a slight increase on the 2000 level (327,632 mt), but is essentially the same as 2000 because the estimates for the two fleets (Japan and Indonesia) taking most of this catch have not yet been provided for 2001, and the 2000 estimates have been used for 2001 at this stage.

The 2001 longline catch (221,874 mt) was a record for the WCPO, eclipsing the previous high (208,224 mt) in 2000. The overall species composition of the 2001 WCPO longline catch was 35% yellowfin, 35% albacore and 30% bigeye. The bigeye (61,019 mt) and albacore (WCPO–82,573 mt; south Pacific–45,708 mt) catches for 2001 were records for this fishery. The 2001 yellowfin catch (77,262 mt) was the highest catch in nearly 20 years and continued the significant recovery from the lowest catch (56,767 mt) recorded for nearly 30 years in 1999, only two years earlier.

2.2 Economic Condition of the Fishery

Forum Fisheries Agency

Mr. Joel Opnai presented WP GEN–4. Estimates of purse seine catch indicated a slight decrease from 2000 levels, with decreases noted in skipjack and bigeye landings and slight increases in yellowfin take. US, Japanese and Taiwanese purse seine landings were down slightly from 2000 levels while the Korean fleet registered a slight increase. Estimated catch from the Filipino and Spanish fleets were down significantly from 2000 levels. Regional vessels (44) flagged by FFA member countries in 2001 registered a 4% increase in estimated catch over 2000 levels.

In 2001, Bangkok prices recovered from depressed levels seen during much of 1999 and 2000, stabilizing in the range of US$700-800/mt. Skipjack prices in other world markets (Yaizu, South-east Asia, Europe, Latin America, Africa) during 2001 also recovered somewhat from the depressed levels of 1999 and 2000. However, Bangkok skipjack prices remain at the bottom of the range observed over the 10-year pre-1999 period.

Bangkok yellowfin prices also increased during 2001 although the increase was of a lesser magnitude compared to the skipjack recovery. Prices for yellowfin (20lbs and up, c&f) fluctuated somewhat but stabilized for the remainder of 2001 trading in the range US$950-1020/mt. Yaizu purse seine yellowfin prices fell but were generally higher in Europe during 2001 compared with 2000 levels. During 2002 prices have been generally increasing for the Bangkok and European markets.

The estimated ‘delivered’ and ‘ex-vessel’ value of the purse-seine catch for 2001 was around US$886 million and US$752 million respectively. This represented an increase of around US$218 million (33%) and US$222 million (42%) for the ‘delivered’ and ‘ex-vessel’ values of the catch in 2000 respectively. The increase in value was primarily driven by the recovery in prices seen in 2001 and to a lesser extent due to an increase in the proportion of higher value yellowfin and bigeye in the catch.

The longline catch of all three main species, albacore, bigeye and yellowfin increased during 2001 representing a 9% increase over 2000 levels. Significant increases in longline catches by regional fleets were noted. Market conditions in Japan remained subdued in 2001 with 2001 yellowfin prices at the lowest level since 1995. However, Japanese imports of fresh yellowfin were 36,282 mt in 2001 up by 3,615 mt compared with 1997 and were at their highest level since 1995. The market conditions in Japan for bigeye also remained subdued in 2001 with fresh bigeye import prices down by 3% and average fresh bigeye prices at selected Japanese ports declined by 12%. Imports of fresh bigeye declined marginally in 2001 to 21,605 mt, the lowest level seen over the period 1995 to 2001. Market conditions for frozen albacore were good for much of 2001 but deteriorated late in the year. Average import prices for frozen albacore into the US, Thailand and Japan all rose in 2001. However, prices tended to fall toward the end of the year and continued to decline into 2002.

Total pole and line catches during 2001 were within one per cent of 2000 levels for all species. skipjack, albacore, yellowfin and bigeye. Japanese pole and line caught skipjack prices were mixed in 2001, dropping in the southern water WCPO fishery while rising for the Japanese water fishery. The Solomon Islands fishery recovered slightly but remains well below catch and effort levels seen during the 1990s.

The major economic issues for the purse seine fishery in the future would include the ability of the WTPO to influence supplies and prices for skipjack raw material for canning, demand for finished product in major markets particularly the US, and fuel prices. The major economic issues for the longline fishery going forward are likely to remain the state of the Japanese economy, and the Japanese Yen/US Dollar exchange rate for operators whose major costs are incurred in US dollars.

Hawai‘i and American Samoa longline fisheries

Mr. Joseph O’Malley presented an economic analysis and recent developments in the Hawai‘i and American Samoa longline fisheries (WPs GEN–2 & GEN–3). Interest in the economic health of these vessels has arisen from fisheries managers because of the rapidly expanding American Samoa domestic fleet and changes in the Hawai‘i fleet. Fishers in American Samoa and Hawai‘i were interviewed to determine their annual operating costs. It is estimated that, in 2001, the annual cost to operate a large longline vessel (>50 feet) in American Samoa was approximately US$479,856 per vessel. At the average 2001 albacore cannery price of US$2496/mt the fleet was profitable, at the first quarter 2002 cannery price of US$1,884/mt, however, the fleet was likely barely meeting expenses.

In 2000, the tuna component of the Hawai‘i longline fleet earned an estimated net revenue of US$58,550 per vessel, while the swordfish component earned approximately US$40,868 per vessel. When compared to a 1993 cost/earning study of the Hawai‘i longline fleet, the tuna fleet was more profitable in 2000 primarily due to increases in gross revenue, and the swordfish fleet was also more profitable in 2000, however this was due to lower costs. The recent ban on shark finning resulted in an estimated annual loss of US$10,652 per tuna vessel and US$20,435 per swordfish vessel.

2.3 National Tuna Fishery Reports

Mr. Thoulag called for presentations of the latest developments in national tuna fisheries. These presentations provide the meeting with, *inter alia*, a more detailed overview of recent domestic and foreign fleet activity in the region (Figure 3).

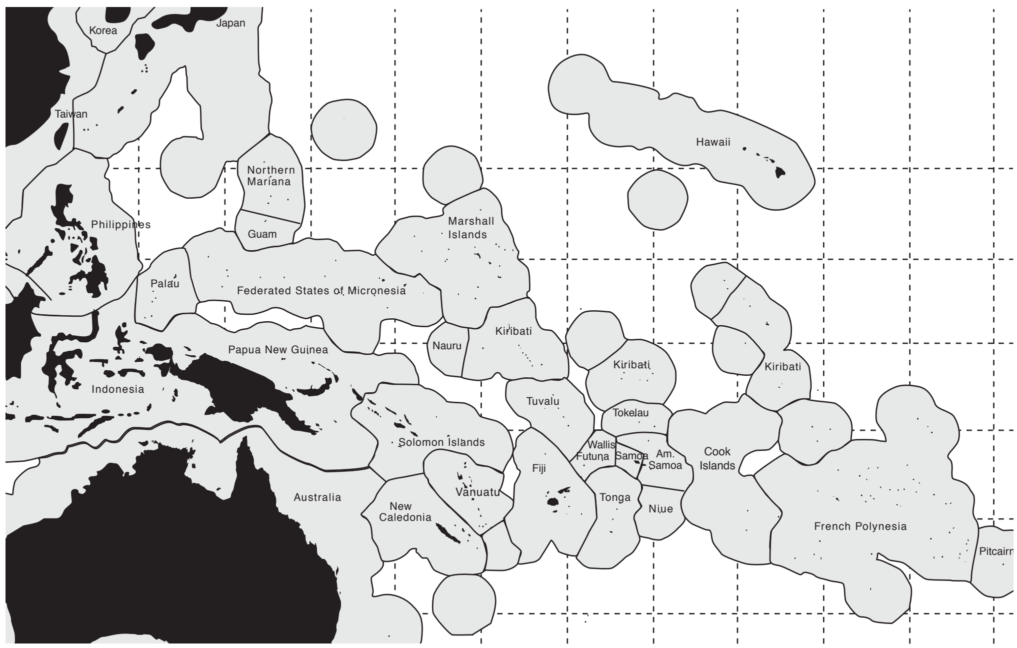

Figure 3. Countries and territories of the western and central Pacific Ocean.

American Samoa

Mr. Dalzell presented an overview of the pelagic fisheries in American Samoa. The ready market for albacore at the two canneries in Pago Pago drove the expansion of the local longline fishery. The longline fishery in American Samoa began with the introduction of alia-catamaran based artisanal longlining from neighboring Samoa in 1994. Pioneer alias in the fishery were about 30ft in length and restricted to one-day trips. Newer super-alias, 40-50 ft in length, have recently entered the fishery and are capable of trips lasting up to 3 days in length.

Pelagic fishery landings, primarily tunas, increased from around 10 mt/year in the early 1980s to about 830 mt/year in 2000. Landings in 2001 increased markedly to 3,700 mt due a rapid large-scale expansion of the longline fishery in the second and third quarters of the year. This expansion was due to the entry of about 27 large (>50ft) monohull longline vessels, although there was also a significant expansion of the alia fleet. The new vessels entering the fishery were owned by local and mainland US companies, and were not 'refugees' from the Hawai'i fishery displaced by the closure of swordfish longlining north of the equator.

Albacore tuna form about 77% of the catch, unlike the Hawai'i based fishery, where catches are dominated by bigeye tuna, swordfish and sharks. Catch data are collected by logbooks compiled by all vessels and by creel survey interviews conducted with alia vessel crews. Albacore CPUE declined from 1996 to 1999, but then recovered to former levels. However, alia catamarans restricted to fishing around Tutuila Island have continued to experience relatively lower catch rates. Albacore CPUE is seasonal, with peaks in the 3rd and 4th quarters of the year.

Current longline fishery management measures include federal permits, catch logbooks and observer requirements, as well as turtle conservation measures designed to minimize injuries to accidentally hooked turtles. More recently 50 nm closed areas were implemented around the American Samoa islands in which only small (<50ft) vessels were allowed to fish. A limited entry program is currently being developed for the fishery, with agreement reached recently on caps to the alia and monohull vessel fleet sizes.

Australia

Dr. James Findlay summarized WP NFR–2. Improved weather conditions in 2001 contributed to a new record level of domestic longline effort in the eastern AFZ and adjacent high seas (10.7 million hooks). In parallel, domestic catches of yellowfin, bigeye and striped marlin were record highs at 2,193 mt, 1,050 mt and 527 mt respectively. There was a decline in swordfish catch to 1,396 mt in 2001, down from 1,699 mt the year before. This may be explained by a shift in targeting from swordfish to tuna; however, vessels targeting swordfish continue to fish further offshore presumably due to declining catch rates inshore. Replacement of smaller 50-60' longliners with larger 70'+ vessels continues possibly as a reflection of a need to fish further offshore in pursuit of swordfish.

Despite record catches, nominal CPUE trends are a growing management concern for most target species especially in inshore areas. Bycatch issues such as sharks, seabirds and turtles are now a major focus for management and this focus is expected to expand in the next few years.

Purse seine and pole catches of skipjack were very small in 2001 (500 mt). Reportedly this decline in catches is due to a lack of demand following the Eden cannery closure in 1999 and cessation of supply contracts in 2000.

Catches by troll and other minor line gears were very small in 2001. Fishers reported a lack of yellowfin on the inshore grounds. Similarly, recreational and charter fishers also reported very few large yellowfin in catches. The main focus of gamefishers continued to be striped marlin. Conflict between the gamefishing and commercial sectors continues to increase.

In 2003, Australia will implement a new management plan for tuna and billfish fisheries in the eastern AFZ and adjacent high seas. Included in the plan will be the ability to regulate the number of longline hooks set in the fishery each year.

China

Dr. Liu-Xiong XU summarized WP NFR–4. Mainland China's distant water longline fishery began to develop in the late 1980's when seven longliners, reconstructed from inshore trawlers arrived in the WCPO. This fleet rapidly increased to a peak of 457 vessels in 1994 that caught a nominal catch of 12,885 mt. Thereafter, there was a steadily reduction in fleet size, due to inefficient fishing and poor returns. In 1999 only 66 vessels were active and caught 1,024 tonnes, Since 1999 the fleet has increased and in 2001 there were 117 vessels which caught 7,682 tonnes.

Fishing vessels from 24 to 30 m in length (50 to 149 GRT) dominate the fleet and these fish mainly within the EEZ waters. These vessels typically set between 800 and 1000 hooks per set with five to seven hooks per baskets. Larger (>40 m) vessels typically set 2500 to 3000 hooks and target albacore with seven to 15 hooks per baskets. A single purse seiner (345 tonne capacity) joined China's tuna fishing fleet in 2001 to fish for skipjack in the WCPO.

Bigeye and yellowfin tuna have been the main target species of the small vessel 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.

Small longliners tranship bigeye and yellowfin mainly to Japan, whilst other species tend to be sold on the local markets in the countries in which the vessels fish. Large longliners send albacore to canneries.

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 the China Fisheries Society. The tuna technical group is charged with submitting data to regional organizations in line with China's international obligations. Members of the group have worked in the Atlantic and Indian Oceans to gain in depth knowledge of China's tuna fisheries and this year the tuna technical group will send one scientific observer on the Chinese Pacific tuna fleet.

During discussion it was noted that catches tabulated in WP NFR–4 seemed low, averaging 166 mt per vessel. This is possibly due to under-reporting by company's and agents as these are the sources for catch estimates; however, target species landings data support China's estimates of bigeye and yellowfin catches, but estimates of albacore are higher than landings data indicate. There may still be problems with estimates of non-target species.

Cook Islands

Mr. Josh Mitchell discussed the tuna fisheries in the Cook Islands. He noted that the period 1998 to 2000 was characterized 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 in Pago Pago. Since 2000, the licensing of foreign fishing vessels has been discontinued, with the exception of three American Samoan longline vessels that have been licensed on a short-term test-fishing basis. Since the beginning of 2002 the domestic longline industry has grown markedly and now consists of eight vessels, six of which are fully locally owned and based in Rarotonga. The vessels range from 12 m to 33 m in length.

There are two fishing strategies employed by the vessels operating in the EEZ. The first involves targeting high value sashimi grade tunas including bigeye and yellowfin for export to markets abroad, primarily to Japan. These vessels operate in the southern part of the Cook Islands EEZ, and over a four-month period, approximately 25 mt of fish has been air freighted to overseas markets. Bycatch from these vessels is currently sold on the local market. The second strategy involves fishing in the northern Cook Islands EEZ, targeting albacore for the canneries in American Samoa. One participant found that these fishing strategies were in direct contrast to the normal fishing patterns—albacore in the colder southern waters and bigeye targeting closer to the equator. Mr. Mitchell noted that this was a direct result of marketing needs, with the cannery closer to the northern fishing grounds and air freight available to the southern zones.

Onshore developments include the development of fish processing and packing facilities, and additional blast freezing and ice making capacity. The port of Avatiu is also being further developed to cope with the increasing number of fishing vessels. Government has also revised its fisheries policy and legislation to assist in the continued growth of the industry, and has also established an observer program and a Maritime training school as part of its ongoing commitment to the commercial fisheries sector.

Federated States of Micronesia (FSM)

Mr. Park summarized WP NFR–6. The three main tuna fisheries in FSM are purse seine; longline; and, pole and line. The best estimate of the 2001 total catch from these fisheries is 78,529 mt, of which 75,880 mt were target tuna. Though this estimate is preliminary due to outstanding log sheets, there has been a general decline in catch in recent years.

The 2001 purse seine fleet was composed of 102 vessels from five countries, which took 70,258 mt or 90% of the total FSM tuna catch. Taiwanese vessels took most of the catch (30,904 mt). There has been an increase in nominal CPUE for this fishery through time. In 2001, the fleet operated further to the southeast of the FSM EEZ than normal.

Changes in unloading ports have been apparent in recent years, with purse seine transshipment in Pohnpei increasing significantly since 1999 with a corresponding decrease in Chuuk. Pohnpei recorded 105 transshipments during the initial six months of 2002 while Chuuk recorded none.

The estimated total longline catch for 2001 was 5,582 mt of which 4,906 mt were target tuna. The fishery was composed of 239 active vessels from five nationalities and deployed over 22 million hooks. Japanese vessels dominated the fleet, in particular the small Guam-based vessels had the highest effort and catch within the FSM EEZ, followed by the Guam-based offshore Taiwanese fleet. The decline in catch for 2001 from previous years is due to lower effort for these two fleets. There appears to have been a decrease in nominal CPUE for the target species through time. The effort of fleets was somewhat separated geographically. The Japanese fleet was mostly concentrated to the central west and south of the EEZ, while the Taiwanese fleet was in the central south. Chinese and domestic fleets fished close to their homeports of Pohnpei and Yap. Catches in the longline fishery are sent to the fresh sashimi market in Japan.

The pole and line fleet consisted of only 14 Japanese active vessels in the EEZ and caught 688 mt in 2001 which was the second smallest annual catch recorded for the fishery. The fleet operates mostly in the northern FSM EEZ.

The FSM Fisheries Observer Program in 2001 made 26 purse seine trips, 19 longline and one pole and line trip. Observer coverage increased in 2001 to 2.6% of the total of trips and 4.0% of total effort (days).

Fiji

Mr. Apolosi Turaganivalu presented WP NFR–7. Total reported catch for the Fiji-based fleets was 12,219 mt, of which 11,200 mt were tuna and billfish. Approximately 90% (11,092 mt) of the catch was caught in the EEZ. The 2001 catch was a 7% increase over the 2000 catch, despite the number of licensed vessels being nearly double in 2001. All 101 longliners and 3 pole and line vessels were domestic, but some vessels did not fish throughout the year. Logsheet coverage of the Fijian longline fleet was 77% during 2001. Tuna constituted 88% of the total pelagic landings, of which 75% was albacore and bycatch billfish and sharks contributed 5.8%. In addition, 42 foreign vessels landed 7,530 mt of albacore in Levuka cannery.

CPUE for albacore increased from below 1.0 per 100 hooks in 1996 to around 1.5 per 100 hooks. The yellowfin CPUE was also higher but bigeye CPUE declined over time. Billfish

CPUE also declined for four species (black marlin, blue marlin, striped marlin & swordfish).

A new Tuna Development and Management Plan was commissioned in 2001. This plan suggests a limit of 110 vessels in the domestic longline fleet with a total EEZ TAC set at 15,000 mt (albacore, bigeye & yellowfin). A Fiji National Fisheries Observer Program was restarted with the training of seven full time fisheries observers/port samplers.

Japan received 61% of exported sashimi tuna; the US 37% and the remaining 2% was exported to Canada, China, Australia and Korea. The value of exported tuna, billfish & bycatch for 2001 is estimated at FJD250, 000,000. The future development of Fiji's tuna long-line fishery is toward Fiji being a fish-landing base more than a potential fishing zone location.

In response to a question about the doubling of the number of vessels, Mr. Turaganivalu indicated that prior to the 2001 management plan, a TAC was in place but there was no limit on vessels numbers.

French Polynesia

Mr. Christophe Misselis summarized WP NFR–8. In the 1990s, the French Polynesia government began development of oceanic tuna fisheries by introducing the pelagic longline technique. By 2001, 57 French Polynesian fishing boats were using pelagic longline gear. The overall catch in 2001 is estimated at 10,317 mt, of which 7,800 mt were caught by longliners, representing an increase over 2000 catches. The number of artisanal fishing boats declined in 2001 due to increasing difficulties selling their products on the local market. Some freezer longliners did not freeze their catch and delivered fish to the fresh market.

The total catch was composed of 42% albacore, 13% yellowfin, 12% skipjack, 7% bigeye and 26% other species. In 2001, 3,400 mt of fisheries products were exported, of which 23% were fresh fish and 77% frozen loins. Fresh and frozen tuna exports in 2001 were the highest on record. Onshore infrastructural development is directed at developing fish exports, increasing ice production, refurbishing the fish processing plant for the local market and developing the fishing harbor for the projected 61 additional vessels. Developing the fishing industry is one of the government's priorities and intends to increase production to 23,000 mt by 2006 of which 15,000 mt will be exported.

An inquiry was made as to where the projected 60 boats would be constructed. Mr. Misselis indicated that 60 boats would be an initial first step and vessels would be constructed in China, Korea and French Polynesia.

Indonesia

Ms. Dyah Retnowati prepared and Mr. Bachtiar Gaja presented WP NFR−9. The catch of all Indonesian marine fisheries in 2000 was 3.81 million tons, 76.04% of the TAC of 5.01 million mt. The capture of skipjack, eastern little tuna (*Euthynnus affinis*), other tunas and billfish was 650,040 mt in 2000 (90% of TAC).

Vessels include the purse seine fleet (609,243 mt), tuna longline fleet (74,763 mt), 'drift' longliners (43,774 mt), 'set longliners' (78,807 mt), 'skipjack pole and liners' (150,722 mt), 'other pole and line' vessels (277,045 mt), 'troll' vessels (127,704 mt) and 'other' vessels (2,445,133 mt). The production of these fleets increased 8.5% per year, i.e., from 515,930 mt in 1997 to 650,040 mt in 2000.

The landings of skipjack, eastern little tuna, and other tunas in eastern Kalimantan, northern Sulawesi and Mollucas—Papua increased from 39.2% of total landings (202,310 mt) in 1997 to 44.2% (227,465 mt) in 2000, a growth of 13.4% per year. In this same period there was a 11.8% increase per year Thunnus sp. landings and an annual increase in landings of 15.9% for skipjack and 9.6% for eastern little tuna.

The production of these species in the WCPO (FAO area 71) in 1997 was 422,918 mt and increased to 564,763 mt in 2000 which corresponds to an annual increase of 10.6%. From 1997 to 2000, there was a 13.0% annual increase for skipjack, 6.2% for eastern little tuna and 15.2% for Thunnus sp.

It was clarified that the 'tuna' species category represents yellowfin and bigeye, the vessel category of 'other pole and line' was a 'punai,' which is a small pole and line vessel of four to five crew that conduct half- day trips and target skipjack, and the TAC of 5.01 million mt included all marine species.

Korea

Dr. Jeong-Rack KOH summarized WP NFR–10. The report covers Korea's tuna fishing activities in the Pacific Ocean, with primarily focus on the WCPO. During 2001, about 87% of total Korean tuna catch in the Pacific was caught in the WCPO.

A total of 203 vessels were active in the WCPO during 2001, of which 177 were longline vessels and 26 were purse seiners. The longline vessels ranged from 200 to 600 GRT while purse seiners ranged between 700-2000 GRT. The combined catch in the WCPO during 2001 from purse seine and longline fleets was 206,571 mt (86% from purse seine fishery and 14% from longline fishery).

The WCPO purse seine catch during 2001 was estimated to be 178,072 mt. This is an increase of 4.7% compared with previous year. Most of the purse seine catch is skipjack tuna (80.7%), followed by yellowfin (19.2%). The longline catch in the WCPO during

2001 was estimated to be 28,499 mt with 48.7% bigeye, 33.2% yellowfin, 6.7% albacore and 11.4% others (mainly billfishes).

The estimated reporting coverage of the fleets was poor compared with 2000 (~20% for purse seine and ~40% for longline). Part of the poor reporting is believed to be due to long voyages of the fleet, which can be more than a year. Most of the longline catch is exported for the Japanese sashimi market. Local markets include canneries and local consumption. The Fisheries Institute is currently re-structuring its fishery database to facilitate data transmission and greater cooperation with research activities in the region.

Marshall Islands

Mr. Glen Joseph reported on tuna fisheries in the Republic of Marshall Islands (RMI). The RMI pelagic fisheries include tuna purse seine, pole and line, tuna longline and shark longline fisheries. In the last 12 months the RMI has been focussed on development of regional agreements, access arrangements and onshore facilities for processing catches.

The RMI became a party to the FSM arrangement in early 2000, which provides for the development of a domestic purse seine fleet, and the RMI currently has five sponsored and flagged vessels operating under the arrangement. The domestic fleet operated a full calendar year for the first time in 2001 resulting in a significant increase in landings. In 2001, EEZ landings for these vessels were just over 4,700 mt (skipjack–4,358 mt and yellowfin 370 mt), an increase from 385 mt in 2000. WCPO landings for this fleet outside the RMI EEZ were over 35,000 mt (skipjack–31,983 mt and yellowfin–3,011 mt), an increase from 7,560 mt in 2000.

The purse seine fleet consists of 150 licensed vessels. More licenses were issued in 2001 compared to 2000, but still below the high in 1999. An additional 68 vessels were licensed for pole and line fishing in the EEZ. The tuna longline and shark longline fisheries are fairly new operations in the RMI, as both operations began in late 2001. Currently 46 fresh chilled longline vessels are licensed, targeting tuna species for the fresh sashimi market in Japan, with a further two licensed longliners targeting shark for the Asian market.

A tuna loining plant went into full production in November 1999 and has employed over 300 people and processed approximately 10,000 tons of fish annually. The plant processes tuna loins with a recovery rate of 42% from the raw material with the remainder being processed into fishmeal. The primary market for loins is Pago Pago, American Samoa where it is further processed and canned.

An estimated 119,700 mt of pelagic species were transshipped in Majuro during 2001. Also of note is a recent trend for albacore boats to call into Majuro for transshipment. Transshipments from 374 vessels (mostly purse seine vessels) occurred in the 2000/01 year, a significant increase compared to 1998/99 levels (~180).

New Caledonia

Mr. Etaix-Bonnin summarized WP NFR–12. New Caledonia's tuna fleet is only composed of longliners, which target tuna mainly for the Japanese sashimi market. As of June 2002, almost 25 vessels were licensed to fish in the EEZ. These longliners are registered through a system passed in August 2001 under a new fisheries policy. The fisheries department has initiated an observer program funded by the EDF under PROCFISH, which will assist in fishery monitoring and better resource management.

It is expected that the fisheries department can improve catch statistics by only using logsheet data. In the past, catch statistics have had to rely on customs and landing data as well. Available catch statistics indicate that the total catch in 2001 was about 2,000 mt composed of 50% albacore and 30% yellowfin. The bigeye catch dropped to 6% in 2001 but this estimate needs to be re-evaluated. Mahi-mahi comprise more than 30% of the bycatch (numbers of fish) with a peak catch in spring.

With regard to marketing strategies, New Caledonia is currently facing difficulties as the tuna fishery develops. Difficulties include a reduction in cargo capacity planned for next year which will affect export of sashimi tuna to Japan. For albacore tuna in particular, the local market for raw product cannot expand further and cannery prices remain low. In the future some vessels may process albacore loins for export to the European Union (EU) and the USA.

In the ensuing discussion, Mr. Etaix-Bonnin clarified that a new system of licenses was implemented in the 2001 management plan. A measure may be considered to limit the number of boats in the fishery, perhaps 35–40 boats may be adequate though the actual number is preliminary and not based on scientific data.

New Zealand

Dr. Murray summarized WP NFR–13 on the tuna fisheries in New Zealand, consisting of seasonal troll and purse seine fisheries and year-round longline fisheries currently worth NZ$45 million per year. Although the seasonal nature of tuna fisheries limits the scope for development in the EEZ, these fisheries are especially important for the large number of small inshore vessels.

The main markets are for cannery raw material outside New Zealand (Indonesia and Thailand) and albacore (Spain and the USA). Fresh and frozen bigeye, southern bluefin, Pacific bluefin, yellowfin and swordfish are primarily exported to Japan, Australia and the USA. Domestic consumption is low.

Of note is the increase in the number of domestic owned and operated longliners targeting southern bluefin and bigeye tunas (1 vessel in 1989 to 132 vessels in 2001). Several longliners also operate on the high seas and in other EEZ's. The purse seine fleet targeting skipjack (10 vessels in 2001) has also expanded since 1999. The additional four super-seiners fish within the EEZ in summer when not fishing in the equatorial Pacific. This means that purse seiners now catch most of New Zealand's total tuna catch (over 5,300 tonnes of tuna from outside the NZ EEZ in 2001). In addition, 328 troll vessels (generally less than 50 GRT) were active in 2001 (fleet has varied from 200 vessels in 1991 to a maximum of 492 in 1994). Pole-and-line is only occasionally used (2 to 5 vessels report using this method since 1997) and like 'other' gear types contribute little to total tuna landings.

Since the mid-1990s, skipjack catches have ranged from about 4,000 to nearly 10,000 mt, with 3,690 mt within the EEZ in 2001. Albacore catches have also been variable since the late 1980s ranging from 2,000 to nearly 7,000 mt, with 5351 mt within the EEZ in 2001 (3,254 mt troll, 2,093 mt longline, and pole-and-line 4 mt). Bigeye catch, nearly all by longline, reached a maximum of 480 mt in 2001. Yellowfin catches, since 1994 have ranged from 100 to about 200 mt, with 137 mt caught within the EEZ in. Southern bluefin tuna is restricted by a national catch limit of 420 mt. When catch has exceeded quota (4 of the last 15 years), the catch limit has been reduced in the following year. Pacific bluefin tuna, first recorded in the longline fishery in 1991 are a minor but increasing component of longline catches (maximum of 50 mt in 2001). Incidental longline catches of swordfish (averaging 372 mt per year since 1990) have rapidly increased since 1996 with the maximum catch 1029 mt in 2001. When caught, billfish species other than swordfish must be released whether alive or dead.

New Zealand's observer program on tuna longliners targeting bigeye and southern bluefin tunas began in 1987. Typically, coverage has been low (generally < 10% of sets) and has focused primarily on Japanese vessels fishing for southern bluefin tuna during winter months (up to 100% of sets covered). Considerable information has been collected on catch composition, sex ratios, size composition and discard practices on these vessels. The target for observer coverage across all months and targets is 10% of sets. Port sampling has also been done since 1997 to monitor size composition in New Zealand's albacore troll fishery. There has been no observer coverage on troll or purse seine vessels since the 1980s.

The reason why swordfish catch had appeared to stabilize since 1999 when longline vessel numbers continued to increase was asked. Dr. Murray responded that the reason was unknown but may be due to recent fishery entrants being less experienced in longline fishing combined with the prohibition on targeting swordfish. The status of purse seine observer data collected in the 1970s and 1980s was also asked. While the information from this observer program was available as published summaries Dr. Murray said he would check on the availability of the original data in electronic form and advise the OFP fisheries statistician. It was asked how New Zealand had arrived at an estimate of 10% observer coverage as an appropriate level for their longline fishery. Dr. Murray noted that determining an appropriate level of observer coverage should be based on the desired level of precision in the statistic being derived from the data. Mr. Neville Smith (Ministry of Fisheries) clarified that the 10% coverage had been estimated from analysis of chartered longliners (100% coverage) using statistics on non-target fish catch and incidental non-fish catch of particular interest. Since statistics on minor catch components could be estimated with acceptable precision it was felt this level would also meet the requirements for the more commonly caught species in the longline catch.

Niue

Mr. Brendon Pasisi presented a summary of pelagic fisheries in Niue. Niue does not have a domestic offshore tuna fishery, although it has licensed foreign distant water fishing vessels to fish in its EEZ over the last 15 years and currently licenses 18 distant water longline vessels under a commercial arrangement to fish within its EEZ. Niue has licensed a varied number of vessels (up to 48) over the years but these have rarely fished in the zone as there is a total reported catch of 417 metric tonnes over six years since 1993. Niue's rugged coastline with restricted water access limits it to a small artisanal fishery. It consists of aluminum skiffs from 3.7m to 8m in length (50-60 are active) and traditional outrigger canoes (113) that operate within sight of land. A total tuna catch of roughly 100 mt were caught using troll and deepwater fishing methods for the period June 2001–May 2002. Approximately 52% of the catch was yellowfin and bigeye, 42% skipjack with a small percentage of albacore. In the artisanal fishery wahoo comprise a large percentage of the total pelagic catch, particularly in the troll fishery. Most of the catch is consumed locally on a subsistence basis or sold through the local market.

For the last five years, Niue expended considerable effort in trying to become more directly involved in and to develop an offshore tuna fishery. These efforts are continuing and it is expected that considerable developments will take place in 2002 and could see Niue's entry into the fishery as early as 2003.

Northern Mariana Islands

Mr. Ray Roberto summarized fisheries activities in the CNMI during the past five years. The fishing industry in the CNMI is largely artisanal and includes small scale commercial, subsistence, and part-time commercial fisheries. The pelagic fishing fleet consists of vessels <8 meters in length that fish within a 20–30 nm radius from Saipan. There are larger vessels in operation, but these only comprise a small percentage of the fishing fleet, as most conduct bottom fishing in waters north of Saipan. Trolling is the primary fishing method and targets mainly skipjack tuna, which is the most locally marketable species. Yellowfin and mahimahi are also marketable but have high seasonality. Billfish are rarely targeted except during fishing tournaments or by charter boats. The fisheries mainly supply the island's hotels and restaurants. There has not been a successful establishment of pelagic fish export in the CNMI, and only a small volume of deep-water bottom fish is exported to Guam and Japan.

Landings data are based on data collected and compiled through a Commercial Landing monitoring system that operates a "trip ticket" invoicing system for all commercial landings with 75 vendors participating in the program. Total landings since 1997 ranged from 71 to 108 mt/year. Recorded landings in 2001 were 54 mt of skipjack, 7 mt of yellowfin, 1 mt of marlins, 6 mt of mahimahi, 2 mt of wahoo and 10 mt of other pelagic species.

With the enactment of the Magnuson-Stevens Fishery Conservation and Management Act, the CNMI along with the territories of Guam and American Samoa have signed unto a PIAFA, authorizing foreign fishing within the exclusive economic zone and creating funds available for fisheries research and management.

Papua New Guinea

Mr. Ludwig Kumoru summarized WP NFR–17. The PNG purse seine catch over the past five years has fluctuated between 100,000 and 200,000 mt, averaging 140,000 mt per year. In 1995 the government introduced a domestication policy banning foreign vessels from longlining and limiting archipelagic waters to PNG based purse seine operators. Incentives for foreign investment in onshore development were also put in place.

The current PNG fleet consists of 38 domestic licensed tuna longliners but nine of these are targeting sharks. Vessels not targeting sharks typically have 10–12 day trips targeting sashimi grade tuna. However, in recent years, several of these 15–35 m (35–120 GRT) vessels have moved towards transshipping to sister vessels or carriers to increase the time spent at sea to four to six weeks. Ten more longliners are expected to join the fleet over the next three years. There are 25 domestic or locally based foreign purse seiners with carrying capacities between 400 and 650 tonnes. An additional 121 foreign licensed purse seiners account for the majority of tuna vessels fishing in PNG waters.

A preliminary estimate of total catch for all species and gears combined in 2001 is 109,151 tonnes, with the domestic catch increasing to 50,000 mt in 2001. Problems exist in estimating longline catch due to poor logsheet reporting and past difficulties in processing logsheet reports. In 2001 there was a reported catch of 1,000 mt from logsheets yet export receipts provide an estimate of over 2,000 mt. Considering discards and local marketing of product that does not qualify for export the longline catch in 2001 is probably closer to 3,000 mt. Tuna exports from PNG in 2001 were as canned (9,400 mt), dry meal (1,300 mt), fresh chilled (1,745 mt) and frozen (29,850 mt) product.

There is one cannery in PNG with a present capacity of 100 mt per day and currently employs 2,500 people. The canning company also has cold storage and wharf facilities and plans to increase production to 130 mt per day. Two loining plants are under construction and a third is planned. The NFA is building two fisheries wharves and will be building several fisheries jetties for artisanal fishers at selected locations in the country. NFA and the National Fisheries College (NFC) have been dramatically restructured in recent years to be more client-focused in serving the fishing industry and PNG people more efficiently. Redundancies and recruitment funded through an ADB loan have resulted in NFA being one third its previous size, now out-sourcing many of its previous functions. Observer and port sampler activities have increased significantly.

Philippines

Mr. Noel Barut summarized WP NFR–18. The main fishing methods in the Philippines are purse seine, ringnet and handline. The Philippine tuna fisheries are unique in that operations are almost always performed in conjunction with FADs locally known as a payaos.

Total tuna production for 1997–2001 increased from 312,506 mt to 352,483 mt. During this period, catches of yellowfin and bigeye tuna increased from 67,342 to 96,450 mt, skipjack from 110,097 to 112,238 mt; frigate/bullet tuna from 108,494 to 115,905 mt, and eastern little tuna from 26,573 to 27,890 mt. Catch estimates were not stratified by species and gear.

There were 109 purse seine licenses in 1998, 162 in 1999, and 135 in 2000. Purse seine vessels fall into two categories, with a division at 3 GRT. There were nine longline licenses in 1998, 12 in 1999, and 14 in 2000. There were 18 ringnet licenses in 1998, and 29 during 1999–2000. There were 34 commercial handline licenses in 1998, 23 in 1999, and 18 in 2000, but there are over 10,000 unlicensed handline operations.

Currently, there are 10 canneries in operation that process about 120,000 mt of tuna. About 70% of purse seine and ringnet catches goes to these canneries. Total exports of fresh, chilled or frozen tuna were 22,073 mt in 2001. Canned tuna exports were 34,000 in 2001.

Japan, USA and Thailand are the top importers of the fresh, chilled and frozen tunas. Canned tuna is mostly exported to Japan, Germany, USA, Canada and Singapore while smoked tunas are primarily exported to Japan and USA. Transshipment of tunas is only allowed in one fishing port located in Davao City in Mindanao, though other fishing ports are being considered for transshipment.

There are fishing regulations in place to reduce catches of juvenile tuna through net size limitations and area closures and to minimize gear conflicts in some regions (e.g., no purse seining where handlines operate).

Samoa

Mr. Dan Su'a summarized WP NFR–20. Although a wide variety of subsistence and commercial fisheries exist, the offshore commercial longline fishery continues to be the most important export earner in Samoa. During 2001, a total of 6,200 mt of longline caught tuna were exported with an export value of SAT$ 46 million. The fleet consists of 116 Class-A boats (<10 m OAL), 14 Class-B (10–12.5 m), 8 Class-C (12.5–15m OAL) and 11 Class-D (> 15m OAL). Vessels in class B-D may be classified as 'normal' to 'modern' tuna longline fishing vessels. The catch and effort data was collected through logsheets, ports sampling, visual census surveys and interviews with vessel operators.

During 2001, the total catch was reported to be 6,180 mt (5% increase compared to 2000), including 4,208 mt of albacore (69%), 353 mt of yellowfin (6%), 168 mt of bigeye (3% of total) and 1,402 mt of other bycatch species. The average CPUE across all vessel categories ranged between 63–83 kg/ 100 hooks. Approximately 85% of the longline catch was exported as frozen to the two canneries in American Samoa and 15% as fresh chilled to the mainland US, New Zealand and Australia.

Solomon Islands

Mr. Edwin Oreihaka presented the Solomon Islands national report, WP NFR–21. Following the social unrest in 2000 the Solomon Islands fishery has struggled to recover. During 2001, a total of seven locally based companies were licensed to fish for tuna. Of the companies, three were licensed to operate purse seiners, one for pole-and-liners and three for longliners. In addition to this, Japanese (PL, LL and PS), Taiwanese (LL & PS) and Korean (LL & PS) foreign flag vessels also fish in Solomon Islands waters under bilateral agreements, whilst US purse-seiners have restricted access under the US Multi-lateral Treaty arrangements.

The total tuna catch during 2001 was 35,915 mt, nearly a three-fold increase compared with the 2000 catch. The domestic fleet's contribution was 77%, an increase compared to the last year. The domestic single purse-seiners increased markedly from 2,365 mt in 2000 to 20,727 mt in 2001 a reason for marked increase in catch during the year. Longline catches fell from 1,197 mt in 2000 to 407 mt in 2001.

In total, 192 fishing vessels were licensed to fish in Solomon Islands waters during 2001. This included 45 tuna longliners (27 domestic and 18 foreign), 33 pole and liners (2 domestic and 31 foreign), 105 purse seiners (5 domestic and 100 foreign) and 9 shark longliners.

Canning and export of fresh fish continued on a reduced scale compared with levels prior to 2000. The major buyers of fresh fish during 2001 were Japan and Thailand; canned products were exported to the UK, Vanuatu and Papua New Guinea and fishmeal to Singapore and Hong Kong. The observer-program was re-activated during 2001. Twelve observers employed on a contract basis have made 16 trips during 2001 and as at end of June 2002, a total of 95 trips have already been made. Port sampling remained suspended due to the social unrest currently being experienced.

Taiwan

Dr. Shu-Hui Wang summarized WP NFR–22. Taiwan participates in three types of tuna fisheries throughout the Pacific Ocean. They are the frozen tuna longline fishery, the distant-water purse seine fishery and the fresh/chilled longline fishery. During 2001, the frozen tuna longline fleet constituted 101 vessels, which was an increase of about 30% from 2000. This fleet targets south Pacific albacore tuna, but in recent years has included albacore fishing in the North Pacific. There has also been some effort in targeting bigeye in the eastern tropical areas of the WCPO. The provisional estimate for 2001 catch from this fleet was 32,536 mt, made up of approximately 50% albacore, but increasing proportions of bigeye and yellowfin due to increased effort in tropical waters.

The fresh/chilled tuna longline fishery, represented by vessels based in Taiwanese ports and operating in and around Taiwanese waters, are typically smaller than 100 GRT. Taiwanese fresh/chilled vessels are also based out of ports in PICs. For 2001, the provisional fresh/chilled longline catch estimate, based on unloadings in Taiwan (including vessels operating in distant waters) was 50,069 mt, including 14,080 mt of yellowfin, 3,292 mt of bigeye and 15,892 mt of billfish. The provisional 2001 estimate for yellowfin and bigeye for the foreign-based fleet was 7,106 mt and 6,001 mt, respectively.

The distant-water purse seine fishery operates over a wide area of the tropical WCPO generally between 135°E−180° and 8°N−8°S. This fleet, currently comprising 41 vessels, has become one of the major components of the Taiwanese tuna fishery. The 2001 catch estimates for this fleet was 234,978 mt, including 194,499 mt (77%) of skipjack and 38,579 mt of yellowfin. Nominal catch rates for this fleet have fluctuated between 20-40 mt/set over the past five years dependent on both area and set type.

During 2002, the observer program was expanded from two to six observers covering the three major oceans.

Tonga

Ms. Melesia Aho summarized WP NFR–23. The Tonga tuna fishery essentially comprises the local longline fleet, which has only developed recently despite some vessels operating over the past ten years. The provisional total estimated catch for this fleet during 2001 was 1,988 mt, comprising mainly albacore (1,268 mt), with smaller quantities of bigeye (191 mt) and yellowfin (259 mt). Estimates by species are not available for the five years previous to this, but the Ministry of Fisheries estimates the 2000 catch for example to be of the order of 1,200-1,500 mt. The catch of this fleet is exported to markets through New Zealand to Japan and the USA.

The development of the domestic tuna industry has been hampered by a number of factors, including lack of fishing knowledge, lack of suitable vessels, infrastructure (e.g., wharf facilities) and high operating costs. Currently (2002) there are 28 vessels licensed in the longline fleet with 21 vessels fishing during 2001. A Tuna Management Committee recently increased the cap on the fleet from 25-30 vessels to 30–50 vessels. There are currently three processing centers for export in Nuku'alofa with each facility equipped with cold storage, ice-making machines, bench saws and other necessary equipment for processing tuna for export.

United States of America

Mr. Russell Ito summarized WP NFR–24. The five U.S. fisheries for HMS are as follows.

- the purse seine fishery for skipjack, yellowfin, and bigeye tunas
- the longline fishery for large tunas and swordfish
- the distant water troll fishery for albacore
- the troll and handline fishery for tuna, marlins, and other pelagic species
- the pole and line fishery for skipjack tuna

Total catch of HMS from these fisheries in 2001 (132,252 mt) declined 8% from 2000. The catch in 2001 consisted predominantly of skipjack tuna (65%) and yellowfin tuna (19%), with the remainder comprising bigeye, albacore, billfish, and other miscellaneous pelagic species.

The distant-water purse seine fishery, which is the largest U.S. fishery for HMS in the WCPO, experienced relatively low catches in 2001. The total combined catch of skipjack, yellowfin, and bigeye tuna was down 8% to 115,524 mt in 2001, the lowest level observed during the five-year period. Low catches in 2001 resulted from the purse seine fleet remaining in port during January and February to protest low fish prices and a decline in number of vessels fishing from 33 in 2000 to 31. No significant changes in areas fished, fleet sizes or catches for most of the U.S. fisheries in the CWP are expected in 2002.

The U.S. longline fishery was the second largest fishery for HMS with landings decreasing 8% to 12,682 mt in 2001. The largest of three U.S. longline fisheries is the Hawai'i/California-based longline fishery, with 125 active vessels in 2001. The effort of the Hawai'i-based longline fishery is almost exclusively directed towards large tunas (bigeye, yellowfin, and albacore) while the California-based longline fishery operates on the high seas and primarily targets swordfish. Landings from this longline fishery produced 8,891 mt; down 30% from 12,748 mt in 2000. This decrease is attributed to regulations implemented to prohibit the targeting of swordfish and regulations prohibiting the practice of finning sharks. The number of vessels in the American Samoa longline fishery grew from 37 vessels in 2000 to 67 vessels in 2001. This longline fishery that targets albacore produced 3,689 mt in 2001; up from 819 mt in 2000. Five U.S. longline vessels operating in the EEZ of the Federated States of Micronesia and Republic of the Marshall Islands produced 102 mt in 2001.

The U.S. distant-water troll fishery for albacore is made up of vessels that fished east of New Zealand. The number of vessels fishing decreased from 36 in the 1999-2000 season to 33 in the 2000-2001 season. Catches also decreased from 2,562 mt in the 1999-2000 fishing season (December-March) to 2,128 mt in the 2000-2001 season. The 2001-2002 fishing season for the U.S. distant-water troll fleet for albacore has ended and the preliminary albacore catch estimate of 1,540 mt represents a 28% decrease from the 2000-2001 catch. Most of the vessels unloaded in American Samoa or transshipped to a developing sashimi market in British Columbia.

The troll and handline fishery in American Samoa, Guam, Hawai‘i, and the Commonwealth of the Northern Mariana Islands was composed of 1,851 relatively small vessels in 2001. Troll and handline catches decreased from 2,001 mt in 2000 to 1,961 mt in 2001. The catch was predominantly yellowfin (44%) and skipjack (27%).

The pole-and-line fishery is based in Hawai‘i and operates exclusively within the Hawai‘i EEZ. Six pole-and-line vessels caught 449 mt in 2001, up 41% from the previous years catch. Catches were predominately skipjack tuna with small quantities of yellowfin.

Bycatch was reported for the purse seine, the Hawai‘i/California-based longline and American Samoa longline fisheries. Logbook data for the purse seine fishery listed 1,769 mt of tunas and 66 mt of other species discarded in 2001 while FFA observers, deployed on about 20% of the U.S. purse seine trips, recorded 2,714 mt of tuna discards and 172 mt of other species discarded in 2001. Bycatch (discarded catch or protected species interactions) in the Hawai‘i/California-based and American Samoa longline fisheries are recorded in logbooks as number of individuals. Because many of the nontarget species (e.g., mahimahi, opah, and wahoo) are highly marketable, these fishes are referred to as incidental catches. Blue shark was the major species discarded by the Hawai‘i/California-based longline fishery because no market has developed for this catch and made up 66% of the bycatch. Swordfish was the second largest component of the bycatch at 7%, followed by mahimahi (6%) and albacore (5%). Skipjack tuna was the largest bycatch species in the American Samoa longline fishery at 27%, followed by blue shark (14%), and yellowfin tuna (10%).

Vanuatu

Mr. William Naviti summarized WP NFR–25. A number of foreign fleets operate in the EEZ but all catches are currently landed in offshore countries (currently Fiji and American Samoa). The number of vessels registered to fish in Vanuatu waters was 64 during 2001 but had increased to 90 as of July 2002. Forty of these are Taiwanese longline vessels targeting albacore, but Korea and China had 14 vessels and Fiji had 10 vessels. Two US vessels, previously based in New Zealand, are now based in Vanuatu. The number of vessels allowed to fish in the EEZ is currently limited to 100.

Total catch during 2000, which was caught entirely by longline vessels, was 2,688 mt. This was an almost three-fold increase on the total catch of 945 mt for 1999 and a ten-fold increase on the catch of 253 mt for 1998. Albacore tuna comprised 75 percent of the 2001 catch with yellowfin tuna contributing another 15 percent. Billfish and sharks comprised 3.7 percent and 1 percent of the catch respectively. Catch statistics for 2001 are currently incomplete, but indicate that around one-quarter of the catch had been taken by US purse seiners.

China has recently expressed interest in establishing operations in Vanuatu, but nothing has yet been finalized. A review of the national Fisheries Act should be finalized by the end of 2002 and will assist in the collection of catch and effort data from vessels fishing in Vanuatu waters. During 2003 it is also intended to employ a fisheries statistician and begin the implementation of a vessel monitoring program which aims to cover 50 percent of all Vanuatu flagged tuna longliners.

Vietnam

Mr. Long Tri DUONG presented an overview of the Vietnamese tuna fisheries (WP NFR–26). As this was the first time Vietnam had attended SCTB, an overview of Vietnam's marine sector was given. With an EEZ of around 1 million square km, the government has defined fisheries as a key economic sector since 1991. Total fisheries production in 2001 is estimated to be around 2.27 million mt, of which 1.35 million mt comes from the marine sector and 919,000 mt comes from aquaculture and inland fisheries. Seafood products currently account for around 10 percent of total exports.

Due to the over-exploitation of inshore coastal resources, since 1997 the Vietnamese Government has initiated the Offshore Fishing Development Program. This program is attempting to reduce the number of small boats which mainly fish inshore (~ 40 percent of boats have an engine capacity of less than 20 hp) and encourage offshore exploitation.

During 2001 there were around 6,000 offshore fishing vessels, with gill netting being the most commonly used gear, accounting for over 34 percent of all gears. Other gears include trawl net (26%), longline (13.4%), purse seine (4.3%) with a variety of other gears (squid catching, light using, etc) mainly being deployed in the inshore areas. During 2000 offshore fishing accounted for around 35 percent of total marine fishing production.

Fishing for tuna species in Vietnam has developed rapidly in recent years. In the past mainly small tunas where caught and due to the poor condition of storage on boats these fish were mainly used for domestic consumption. However, in more recent years an export market has developed for frozen tuna and tunas for canning. While accurate catch statistics are not available, the catch by all methods during 2000 was estimated to be around 20,000 mt of which around 14,000 mt were exported. Longline is the main fishing method used with the main fishing season being from November to March. Bigeye and yellowfin tuna are the main target species with the former estimated to account for 70 percent of the catch. The purse seine fishery is not well developed and mainly targets small tuna species such as frigate and bullet tunas.

3. REPORTS BY REGIONAL FISHERY ORGANISATIONS

Inter-American Tropical Tuna Commission (IATTC)

Dr. Mark Maunder presented the report of the IATTC, with preliminary estimates of tuna catches in the eastern tropical Pacific (ETP) in year 2001.

- yellowfin 408,000 mt (395,000 mt by purse seine)
- bigeye 76,000 mt (44,000 mt by purse seine)
- skipjack 144,000 mt (almost all by purse seine)

IATTC status reports for the main tuna species and striped marlin in the EPO were presented to the meeting.

Status of yellowfin tuna. The current spawning biomass ratio (SBR) is greater than the SBR required to produce average maximum sustainable yield (AMSY). The current fishing mortality rates are lower than those required to produce AMSY. The average weight of a yellowfin in the catch is much less than the critical weight and increasing the average weight could substantially increase AMSY. There have been two different productivity regimes and the levels of AMSY and the biomass required to produce AMSY may differ between the regimes.

Status of bigeye tuna. The most recent recruitments have been low and will cause biomass to decrease. Current spawning biomass is below the level required to produce AMSY. In the most recent years the fishing mortality is close to or less than that required to produce AMSY. Current average weight is less than the critical weight. Stock recovery depends on what catchability will occur in the future.

Status of skipjack tuna. Fishing mortality estimates are similar to or lower than natural mortality. The biomass is highly variable and is driven by fluctuations in recruitment. High recruitments during 1998 increased biomass and catches, but biomass has declined in 2000 and 2001. The assessment is highly uncertain.

Status of striped marlin. The stock structure is uncertain. Biomass is about the level that is required to produce maximum sustainable yield.

Recent IATTC resolutions include the following.

1. Conservation
2. Purse seining for tuna prohibited in the entire eastern Pacific during December 2002.
3. Commission's Yellowfin Regulatory Area (CYRA) is no longer a management feature.
4. Vessels with observers may transit fishing grounds during closure.

5. Purse-seine fleet capacity
   - The Regional Vessel Register to be the definitive list of purse-seine vessels authorized to fish for tunas in the EPO.
   - Any purse-seine vessel fishing for tunas in the EPO that is not on the Register would be considered to be undermining IATTC management measures.
   - Entry of new vessels to the Register only to replace vessels removed from the Register without increasing the total capacity.
   - The capacity of any existing vessel may only be increased if an equivalent capacity is removed from the Register.
   - Certain exemptions provided for Costa Rica, El Salvador, Guatemala, Nicaragua, Peru, and United States.

Food and Agriculture Organization of the United Nations (FAO)

Dr. Jacek Majkowski updated SCTB on activities of the FAO of interest to the meeting and thanked participants and their institutions, particularly SPC OFP, for their collaboration with FAO. A recent FAO initiative, the Fisheries Global Information System (FIGIS) was described. Dr. Majkowski outlined the following data and other information that has been collated by FAO for their inclusion to FIGIS.

1. Two sets of global nominal catches by
   - FAO statistical areas, countries and years, which are a part of more general data routinely collated for all fish species; and
   - stock, fishing gears, country and year, which are collated for principal market tuna species only.
2. The 5x5 degree catch data by fishing gear, years and their quarters (now presented through FAO's home page in a form of the Atlas of Tuna and Billfish Catches).
3. Species Identification Sheets on most fish species including tunas and tuna-like species.
4. Overviews of
   - resources and fisheries of tuna and tuna-like species (a periodically updated section of the Review of the State of World Fishery Resources);
   - biological characteristics of tuna and tuna and tuna-like species;
   - tuna fishing technique; and
   - fisheries targeting tuna and tuna-like species.
5. Some specific publications on tuna and tuna-like species.

Dr. Majkowski noted that in response to a request made at the last meeting of FAO's Committee on Fisheries, FAO has formulated a technical project on the management of tuna fishing capacity. Its objective would be to provide necessary technical information and to identify, consider and resolve technical problems with the management of tuna fishing capacity on the global scale taking into account conservation and socio-economic issues. For the effectiveness of the project, it would be critical to implement it in close collaboration with all tuna fishery bodies and other international institutions involved in tuna fisheries research and management. Therefore, it is envisaged to create the Project's Technical Advisory Committee composed of experts from these organizations, the donor country and FAO.

The project is envisaged to consist of substantive technical work preparatory to the Expert Consultation on Management of Tuna Fishing Capacity and the actual consultation.

The preparatory work would consist of the collation of relevant data and other information, their analysis and related studies. The subjects of the studies would include the following.

1. a review of tuna resources and fisheries
2. the quantification of the tuna fishing capacity
3. the determination of the demand for tuna products
4. a review of the socio-economic importance and profitability of the tuna industry
5. the determination of options for fisheries management, particularly that of tuna fishing capacity

Completing his presentation, Dr. Majkowski noted that FAO is assisting SPC OFP with the release of MULTIFAN-CL and its manual through the FAO home page.

Indian Ocean Tuna Commission (IOTC)

The IOTC was created four years ago under the FAO framework in order to manage the Indian Ocean tuna and billfishes stocks. Indian Ocean tuna and billfish catches have reached 1.2 million mt during recent years. Major fisheries are a combination of artisanal fisheries some of them very old, longliners since 1952 and purse seiners since 1982 (about 1/3 of total catches for each gear).

The IOTC has a small staff (three scientists and statisticians, no field staff); it is based in Victoria, Seychelles Islands. Because of its small staff, the IOTC relies almost entirely on statistics and on research conducted by member nations. The scientific work done by IOTC is handled by an ad hoc body of member nation scientists that meet as the Tropical Tuna Working Group and the IOTC Scientific Committee.

Scientific priorities for the IOTC are (1) the improvement of statistics (catch, effort and size data) and the creation of WINTUNA, a standard data base and software and (2) the immediate development of a large scale tagging program on YFT, SKJ and BET during a 3 year period. This program will be funded by voluntary donors. Until now, only BET and YFT stocks have been evaluated by the IOTC. The present conclusion is that these 2 stocks appear to be already overfished with excessive numbers of juveniles taken in association with drifting FADs.

Various management schemes to regulate regional fisheries have been discussed by the IOTC, (such as moratorium on FAD use by purse seine, limitation of fleets, quotas) but practical management measures have not yet been agreed upon, or implemented by the IOTC.

4. STATISTICS WORKING GROUP (SWG)

4.1 Coordinator's Report on Data Collection, Compilation and Dissemination

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

Data Collection

Regarding the Statistics Working Group objective of coordinating data collection, the procedures that were established at SCTB11 included (a) establishing minimum standards for data collection forms and reviewing forms used in the region, (b) developing coverage tables, and (c) developing a regional sampling design for port sampling and observer programs. Concerning data collection forms, it was reported that Mr. Atilio Coan (NMFS), Dr. Michael Hinton (IATTC), and Mr. Lawson (OFP) reviewed the Taiwanese logsheets (Appendix 4). The Taiwanese logsheets were considered well designed although there was a lack of information on most major non-target species. Korean logsheets may be reviewed following SCTB15. It was also reported that the SPC/FFA Data Collection Committee is developing prototype logbooks (rather than logsheets) for longline and purse seine. The logbooks will allow more information on gear and vessel attributes and on catches of major non-target species and species of special interest (sharks, marine reptiles, marine mammals and seabirds).

Tables of the coverage by data held by the OFP, for all fleets, were presented in SWG–1. For 1999, the most recent year for which all or most data have been compiled, the OFP holds catch and effort logsheet data covering 47% of the catch of target species in the WCPO. Excluding the domestic fisheries of Indonesia and the Philippines, the logsheet coverage is 77%. Coverage by port sampling data for 1999 is less than one percent and coverage by observer data is only 2.9%.

A preparatory meeting of the SWG was held on 18 July 2002 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. The agenda included the types of data to be collected, sampling protocols, data collection forms and coverage rates for observer programs. The activities that will be addressed during the next SCTB intersessional period include a review of sampling protocols, case studies of the relationship between coverage and the bias and variance of measures estimated from observer data for certain fleets, and an investigation into the feasibility of pilot observer programs. The participants agreed to report on the progress with these activities at a preparatory meeting of the SWG to be held in 2003, prior to SCTB 16.

Data Compilation

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, and in the OFP Data Catalogue, which is available on the OFP website at www.spc.int/oceanfish.

In regard to the compilation of annual catch estimates, estimates of catches during 2001 were requested from most fishing nations prior to SCTB 15. All those fishing nations provided estimates of annual catches, except for Japan. Estimates of annual catches for the Japanese fleets for recent years were therefore determined from aggregated catch and effort data. Indonesia provided estimates for 1992–2000 and the Philippines provided estimates for 1996–2000; however, these estimates are not broken down by gear type.

The meeting was reminded that in 1998, the tables of annual catch estimates compiled for SCTB (see SWG–2) were extended from 1970 back to 1950. In 1999, prior to SCTB 12, many historical estimates were provided. However, the time series for total bigeye and yellowfin catches in the WCPO, and estimates of the total catch of the four target species in the WCPO, and estimates of global catches will not be complete until estimates for Japanese longliners for 1950–61 have been determined.

In regard to the compilation of statistics on the number of vessels by size category, information was provided prior to SCTB 14 by several fishing nations and information was also presented in several SCTB 14 national fishery reports. Information is also available for several fleets from data held by the OFP. However, in general, the coverage of the statistics on the number of vessels by size category remains poor.

In regard to the compilation of catch and effort data, logsheet data covering the fleets of SPC member countries and territories are provided on a regular basis, although coverage varies. Coverage has improved for the domestic fleets of Fiji, Papua New Guinea and Tonga. The Cook Islands and Samoa have begun compiling logsheet data for their recently developed domestic longline fleets and will provide these data to the OFP in due course. New Caledonia intends to compile logsheet data for the domestic longliners that began fishing in the Northern Province in 2001.

SPC members also provided logsheet data covering the fleets of Japan, Korea, and Taiwan. 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 from Japan, Korea and Taiwan. In May 2002, Japan provided data covering offshore and distant-water longliners during 1998–2000, pole-and-line vessels during 1998–2000, and purse seiners during 1999–2000. In July 2002, Korea provided data covering longliners during 1987–2001 and purse-seine data during 1980–2001. In June

2002, Taiwan provided data covering distant-water longliners during 1999–2000. The provision of catch and effort data by these fleets is therefore up-to-date.

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.' This 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

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 public-domain catch and effort data were downloaded from the OFP website 42 times during 2001 and 52 times during January–June 2002. Non-public-domain data were released by the OFP in response to 13 requests during 2001 and seven requests during January–June 2002. Information other than data was provided by the OFP in response to 42 requests in 2001 and 15 requests during January–June 2002.

4.2 Review of SCTB 14 Directives to the Statistics Working Group

The directives to the SWG that were made at SCTB 14 were reviewed.

General

1. Compile annual catch estimates, catch and effort data and length data from Indonesia and the Philippines and examine the availability of data for Vietnam. (OFP)

Mr. Williams presented SWG–8 describing the current status of data available from the Indonesian and Philippines domestic tuna fisheries. The contribution made by the domestic tuna fisheries of Indonesia and the Philippines to the total catch in the WCPO (20% and 13% respectively in 2000) is considerable; therefore, improving information on this fishery should be a priority item. He noted that the recently established tuna fishery in Vietnam is a relatively small fishery and that the Vietnamese government has not yet collected data.

With respect to Indonesia, the Directorate General of Capture Fisheries (DGCF) is responsible for the collection and compilation of fishery information used to estimate annual catches. The paper lists five high priority areas requiring more information with respect to annual catch estimates from this fishery. Catch and effort data stratified by time and area and size composition data have been collected by the Research Institute for Marine Fisheries (RIMF) over the past twenty years, in conjunction with the Indo-Pacific Tuna Programme (IPTP) up to 1992. Catch and effort data are only available through the monitoring of landings. Coverage of these data has been relatively lower since IPTPs involvement ceased in 1992 and sampling stopped altogether in 1999 due to funding constraints. It was noted that the size, diversity and broad areas covered by Indonesian domestic fisheries suggest that any undertaking to improve the data will require considerable resources and that such work appears to be beyond the resources of the Indonesian government. During the discussion, it was suggested that funding should be sought for sampling in the Pacific Ocean waters of Indonesia, which would complement the sampling of catches in the Indian Ocean waters of Indonesia that is currently being conducted in a joint project with RIMF, IOTC and CSIRO.

With respect to the Philippines domestic tuna fisheries, the Bureau of Agricultural Statistics (BAS) is responsible for the collection and compilation of fishery information used to estimate annual catches. The paper listed four high priority areas requiring more information with respect to annual catch estimates from this fishery. The Bureau of Fisheries and Aquatic Resources (BFAR) has collected catch and effort data stratified by time and area and size composition data over the past twenty years. As with Indonesia, catch and effort data are only available through the monitoring of landings. Coverage of these data has been variable, with high coverage during the Landed Catch and Effort Monitoring Project (LCEM) during 1993–1994, but no sampling in 1995. In 1997, the National Stock Assessment Project (NSAP) was established and now provides relatively high coverage compared to previous years. As with the Indonesian fishery, the size, diversity and broad areas covered by the domestic fisheries of the Philippines suggest that any undertaking to improve the data will require considerable resources. However, it is encouraging to see that a commitment to do this work has recently been made through the NSAP. During the discussion, Mr. Barut noted that while the NSAP project is currently in full swing, the project is currently undermanned, with respect to scientific staff, in the central office in Manila.

The fundamental importance of the data collected from the domestic tuna fisheries of Indonesia and the Philippines to regional stock assessments was noted several times during SCTB 15. The meeting strongly recommended that improvements to the data currently available be made, primarily through increased port sampling of the species composition and lengths, by gear type. It was also recommended that the procedures that are used by DGCF and BAS for collecting data and estimating annual catches be documented and that the possibility that these catches are under-reported be examined.

2. Evaluate methods to determine the extent of unreported catches in the WCPO, including trade statistics and catch certification schemes. (OFP)

Mr. Lawson reported that FAO compiles trade data from over 200 countries, but that the country of origin for imports and the country of destination for exports are not recorded.

FAO also holds the COMTRADE data that are compiled by the UN Statistics Division from 70–90 countries and which include the countries of origin and destination. However, it is not possible to determine total catches in the WCPO, and hence the extent of unreported catches, from either of these data sets.

Mr. Lawson also presented the report of the FAO Expert Consultation on the Harmonization of Catch Certification Schemes (SWG–6), which was hosted by IATTC in La Jolla California, from 9 to 11 January 2002. Trade documentation and catch certification schemes can be useful in determining the extent of unreported catches, and have been implemented by CCAMLR (toothfish), CCSBT (southern bluefin), ICCAT (bluefin) and IOTC (bigeye), and IATTC has a catch certification scheme to monitor dolphin-safe tuna. It was noted that ICCAT intends to introduce a trade documentation scheme for bigeye and swordfish that will cover landings in the WCPO that are exported to ICCAT member countries (e.g., Japan, USA). The FAO Committee on Fisheries (COFI) Sub-Committee on Trade will consider the report of the Expert Consultation. One of its recommendations is to give priority for the development of new schemes to fisheries that are or may be subject to significant levels of IUU fishing. During the discussion of the report at SCTB 15, it was suggested that while the extent of unreported catches in the WCPO is unknown, there is no reason to believe that it is a major problem at present. Therefore, the development of catch certification or trade documentation schemes for the WCPO should not be considered a priority. However, such schemes should be reconsidered if and when evidence of unreported catches, anecdotal or otherwise, is reported.

3. Examine the discrepancies between bigeye and yellowfin sampling by observers and port samplers by considering (a) sampling protocols, (b) the accuracy of species identification and (c) the effects of Spanish-style brailing on sampling by observers. (OFP, FFA, NMFS, FTWG)

Mr. Lawson presented SWG–5, sampling the proportion of bigeye in the catch by purse seiners in the WCPO. Bigeye catches by purse seiners are usually reported as yellowfin in logsheet and landings data because juveniles are difficult to distinguish and the same price is usually paid for both species. Therefore, port samplers and observers have sampled the proportion of bigeye in the purse-seine catch. The paper summarizes the port sampling data and observer data held by the OFP and examines data quality. An objective evaluation of data quality was conducted by examining the proportion of log and FAD sets for which yellowfin, but not bigeye, were sampled. Bigeye are often present in log and FAD sets that contain yellowfin, so the data for port samplers or observers for which the proportion of sets that contain yellowfin, but not bigeye, is high indicates that the port sampler or observer may have difficulty identifying bigeye. A subjective evaluation was conducted by having their supervisors categorize the port samplers and observers in regard to their reliability. The subjective evaluation of the port samplers (excluding the NMFS samplers, which were considered to be reliable, and the Japanese samplers, for which information on individual samplers was not available) indicated that only 19 out of 129 port samplers (15%) were reliable. The subjective evaluation of the port samplers was consistent with the objective evaluation. The subjective evaluation of the observers indicated that 83 out of 151 observers (55%) were reliable. In contrast to the evaluation of the port samplers, the subjective evaluation of the observers was not consistent with the objective evaluation, which suggests that the subjective evaluation of observers may not be as accurate as the subjective evaluation of port samplers. The data held by the OFP must be more rigorously evaluated, using both subjective and objective criteria. The port sampling and observer data can then be used to estimate the proportion of bigeye in the purse-seine catch. The data could also be used to examine differences that may arise in the proportions determined from port sampling and observer data.

Dr. Paul Crone presented SWG–9, 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). Landing estimates of individual species are critical sources of data for conducting stock assessments and generally considered one of the most important time series for evaluating the status of a fish population. The purpose of the study was to evaluate the current species-composition sampling program for U.S. purse-seine landed tunas and in particular, to determine the quality (i.e., sampling error or precision) of the sample estimates of species composition. The current data collection approach is considered a stratified, multistage sampling design combined with post stratification. Beginning in the mid-1990s, the purse-seine fleet began fishing more regularly with FADs (an ‘associated’ set), which dramatically influenced the biological attributes of the purse seine catches. This dramatic shift from ‘unassociated’ sets on free-swimming schools to ‘associated’ (FAD) sets was the motivation for the analysis presented here, i.e., it became evident that sample estimates of species composition could vary substantially across different strata. In general, the mean estimates of species composition (in proportion) for each stratum were relatively precise, particularly, for species encountered more frequently. For example, estimates for species that composed larger proportions (>25%) of the mean estimated compositions had associated coefficients of variation of the mean (CVs) that were generally less than 10%. Whereas, species that composed smaller proportions of the overall compositions had moderately to highly variable landing estimates (i.e., CVs generally >20%). More importantly, the annual-based time series of estimated species compositions (in tonnes), summed across strata, were very precise, with CVs <6% for skipjack and yellowfin tuna landing estimates and CVs <13% for bigeye tuna landing estimates. To summarize, the results indicate that the catch time series for these species are reliable sources of data and thus, are not likely to introduce substantial amounts of variability in assessment models used for these fisheries. The potentially influential non-sampling error associated with the monitoring program was generally discussed.

Mr. Park described the difficulties in obtaining samples when Spanish-style brailing is used. In regular brailing, the brail is handled manually and each brail holds 1–2 tonnes. Observers have ample time to randomly select fish to sample. In Spanish-style brailing, the brail is handled mechanically, each brail holds up to 5 tonnes and the fish are immediately dumped into the hopper. Sampling when Spanish-style brailing is used is still possible, though considerably more difficult.

4. Convene a workshop to determine minimum standards for research data collected by observers. (OFP)

A preparatory meeting of the SWG was held on 18 July 2002 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.

Albacore Research Group

5. Examine the targeting of albacore by longliners, by year and MULTIFAN-CL area. (OFP, NFRDI, OFDC, NRIFSF)

The targeting of albacore by longliners was examined by the OFP (ALB–4).

6. Compile summary tables of catch and effort by gear types for South Pacific albacore. (OFP)

Summary tables were compiled by the OFP for albacore, bigeye, skipjack and yellowfin (ALB–3, BET–4, SKJ–3 and YFT–5).

7. Examine means to increase coverage of Taiwanese distant-water longliners by observer data and landings data. (OFP, OFDC)

SPC OFP has liased with the Vanuatu Ministry of Fisheries in an effort to increase observer coverage on Taiwanese vessels. The vessels and the observer have been identified, but no deployment has yet taken place.

OFDC reported that six observers are now working aboard Taiwanese longliners and purse seiners in the Pacific, Atlantic and Indian Oceans. It is expected that observers will spend six months aboard longliners in the Pacific Ocean during 2002.

8. Confirm the attributes of catch and effort data (e.g., units of catch) for US longliners based in American Samoa and Guam. (OFP, NMFS)

This was confirmed by the OFP.

9. List the availability of length data for South Pacific albacore. (OFP)

Summary tables were compiled by the OFP for albacore, bigeye, skipjack and yellowfin. See Working Papers ALB–3, BET–4, SKJ–3 and YFT–5.

Fishing Technology Working Group

10. Compile vessel and gear attributes, as identified by the FTWG. (OFP)

The usefulness of vessel and gear attributes for scientific purposes were ranked in three categories by the FTWG. The FTWG considered that the attributes in the highest category would be an appropriate set of attributes to be included in the FFA Regional Register for Foreign Fishing Vessels and compiled by the OFP for the domestic fleets of SPC member countries and territories that are not included in the Regional Register. The Forum Fisheries Committee will further consider this issue.

Billfish and Bycatch Working Group

11. Increase observer coverage of catches of non-target species, particularly species of special interest (sharks, marine reptiles, marine mammals and sea birds). (All agencies)

The USMLT program achieved 30% coverage in 2001, while the FSM Arrangement observer program, also managed by FFA, was just below their target of 20%. The longline observer program for the Hawai‘i-based fleet achieved 20% coverage, while New Zealand achieved 10% coverage. Papua New Guinea was targeting 5% coverage of all foreign fleets, with varying levels of coverage on domestic fleets. The well-established program of the Federated States of Micronesia achieved 2.7% coverage during 2000.

The Solomon Island observer program recommenced in March of 2001 and had high levels of coverage between 20% to 100% on their domestic fleets. The Australian program for domestic longliners also commenced in 2001 and has so far achieved 9% coverage to the south of 30^{o}S. This program was set up primarily to monitor bird bycatch. Coverage of vessels north of 30^{o}S will start in 2002. The Cook Islands, Kiribati, Marshall Islands and New Caledonia all started observer programs in 2002 and have completed several trips. There is currently no active observer program in Palau, Samoa, Tonga and Vanuatu.

4.3 Other Contributions

Mr. William Walsh presented SWG–7, development and application of generalized additive models to correct incidental catch rates in the Hawai‘i-based longline fishery. The Hawai‘i-based longline fishery primarily targets bigeye, yellowfin and albacore, but several other pelagic species e.g., blue shark (*Prionace glauca*), blue marlin (*Makaira mazara*), dolphinfish or ‘mahimahi’ (*Coryphaena hippurus*), opah (*Lampris guttatus*) and wahoo (*Acanthocybium solandri*) are taken incidentally and together comprise a large fraction of the total catch. Therefore, a series of statistical studies has been conducted at the Honolulu Laboratory of the U.S. National Marine Fisheries Service to assess the quality of the relevant data. The objectives were increased accuracy of logbook reports, which are the principal monitoring tools used in this fishery, and improved understanding of logbook reporting behavior on individual and fishery-wide scales.

The approach employed by the Honolulu Laboratory for the analysis of incidental catch rates involves fitting one or more generalized additive models (GAMs) to fishery observer data, evaluating and interpreting the effects of the predictors, and then applying the model coefficients fishery-wide to estimate catch rates on unobserved trips. The response variable in the GAM is the catch per set and the underlying probability distribution is assumed to be the Poisson. The forward entry fitting procedure entails minimizing the Akaike Information Criterion (AIC) and residual deviance, maximizing the pseudocoefficient of determination, and computing sequential F-tests. Fishery-wide application of the GAM is intended to reveal instances of under- and non-reporting and other logbook inaccuracies, to identify and permit characterization of trends in specific sectors of the fishery, and to improve understanding of logbook reporting behavior. It is also used to estimate total catches and underreporting and to recreate the catch history.

It was recommended that GAM analyses of incidental fish catch rates be preceded by preliminary data quality assessments. For example, both captains and observers sometimes misidentify fish. Clear indications that data are inaccurate or false were required before deleting them from development or application sets. Parsimony was sought in modeling, requiring all predictors to be statistically significant and limiting the degrees of freedom so as to ensure parameter comprehensibility. While this approach has undoubtedly sacrificed some accuracy and overlooked some instances of under- or non-reporting, it was nonetheless suggested that these methods and approach could be adopted or adapted for use elsewhere.

4.4 SCTB 15 Directives to the Statistics Working Group

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 (OFP)
    - study on coverage rates for the United States purse-seine fleet in the WCPO (NMFS)
    - study on coverage rates for the Hawai‘i-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 (OFP, NORMA)
    - investigation into the feasibility of pilot observer programs (OFP)
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)
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)
4. Develop a project to sample the species composition and lengths of fish caught in the domestic fisheries of Indonesia. (OFP, RIMF, DGCF)

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)
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.
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.

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

5. FISHING TECHNOLOGY WORKING GROUP (FTWG)

5.1 Introduction

The coordinator, Mr. Itano opened the session and outlined the primary emphasis and scope of work of the group as listed in the FTWG Terms of Reference adopted during SCTB 14.

5.2 Report of the Preparatory Meeting of the FTWG—19 July 2002

At the outset of the meeting, Mr. Itano summarized the Report of the Preparatory Meeting of the FTWG (Appendix 6), which was held on 19 August 2002. The following working papers and topics were presented and discussed, with details provided in Appendix 6.

5.3 Fleet and Country Reports

5.3.1 Pacific Island and DWFN

Mr. Oreihaka reported that domestic purse seine and pole and line activity in the Solomon Islands was increasing gradually despite continued civil unrest. Mr. Park reported on an improved observer database system for the FSM, while cautioning SCTB on difficulties imposed on their observers due to faster fish loading techniques being adopted by some DWFN fleets. Mr. WU made a detailed presentation in the Preparatory Meeting on the Taiwanese WCPO purse seine fishery for 2001 (FTWG–8) with details and discussion available in Appendix 6. Mr. Whitelaw reported on AFMA Observer program initiatives to test bird bycatch mitigation measures.

Mr. Coan presented a summary of the 2001 U.S. WCPO purse seine fishery (FTWG–1). Catches in 2001 decreased for the second consecutive year, in response to low cannery prices, to the lowest levels since 1989. For the first time since 1998, the occurrence of free-swimming school sets in 2001 were higher than FAD sets as the fleet moved away from setting on drifting FADs in an attempt to target larger, higher value tuna. An increase in the average capacity of the fleet from 1,250 mt in 2000 to 1,400 mt in 2001 was noted.

In response to a query on purse seine CPUE calculations in FTWG–1, Mr. Coan responded that a single day of effort was divided among multiple sets per day, i.e., if three sets are conducted during the same day, each set was allotted 1/3 day of effort.

Mr. Coan presented FTWG–2, which provided an update of information on the U.S. WCPO purse seine fleet, tracking changes in the fishing strategies and performance factors of 15 U.S. vessels that fished continuously from 1988 through 2001. The vessels switched from fishing mainly on free-swimming school sets in 1989–1995 to FAD sets in 1996–1999. The maximum use of FADs occurred in 1999, after which FAD use in 2000 and 2001 decreased to 1997 levels. The switch to FAD sets caused efficiency to increase as catch rates increased, trips became shorter and more frequent, days fishing decreased, with fewer sets catching more fish. However, catches of small target tuna and juvenile bigeye increased. During 2000–2001, this switch back to free-swimming school sets caused catch per day fished to decrease from 34 mt per day in 1999 to 24 mt per day in 2001. Other vessel performance parameters returned to levels similar to 1997 such as an increase in days and sets per trip and a slight decrease in bigeye catches, all of which resulted from the switch back to free-swimming school sets.

Although not specifically examined in this study, bycatch levels likely increase with increased effort on FAD associated schools. Mr. Park noted that bycatch levels and species composition in the catch vary between fleets reflecting their different setting and targeting practices. It was suggested that Mr. Coan and the FTWG specifically examine and compare bycatch levels between drifting FAD, free-swimming school and anchored FAD sets.

5.3.2 WCPO Purse Seine Fleet Dynamics

Mr. Michael McCoy presented FTWG–15, summarizing a PFRP project on the status of the U.S. WCPO purse seine fleet with factors affecting its future involvement in the region. He explained that this project was intended to be the first stage of a larger investigation on the fleet dynamics of all the major DWFN fleets to provide information useful for regional management and planning. The project gleaned information from published documents and interviews with government officials, fishery managers and key stakeholders involved in the U.S. and WCPO tuna industry to document fleet history, operational characteristics, primary business entities and major issues affecting the current and future outlook of the fleet. A great deal of uncertainty was noted regarding the future of the U.S. fleet in the region, with continued viability threatened by low or stagnant prices, relatively high operating costs, reduced or potentially declining advantages for basing in American Samoa, and a lack of generational continuity in the industry. However, it was noted that the fleet has overcome or adapted to many difficult situations in the past, and with low debt issues, some stakeholders may remain in the fishery despite the difficulties. However, Mr. McCoy stated that it is likely that the dynamics of vessel ownership may shift to greater corporate ownership of multiple vessels, as fishing families exit the fishery. Various scenarios of future U.S. involvement in the fishery are explored in the report with potential management implications. Possible implications of a significant decrease in U.S. fleet activity include the entry of new fleets or expansion of fleets to areas currently dominated by the U.S. fleet, a degradation in the quality of available fisheries data and observer coverage, and an increase in FAD based fishing. The final paper will be published as a PFRP project document and available during the fourth quarter 2002.

Participants questioned the importance of the lack of generational continuity to the future of the U.S. fleet over other fleets, and a suggestion was given that the vessels mitigate operating costs by hiring lower cost crew. Mr. McCoy explained that many US vessel owners are aging and economically comfortable, thus may prefer to sell out to other entities if no one in their immediate family wishes to take over the business. He also noted that crew costs had been cut about as far as possible by the hiring of non-U.S. crewmen in the lower paid ranks, while U.S. law requires them to employ U.S. citizens in key officer and engineer level (high paid) positions. High annual cost for insurance was also noted as an economic hardship on the fleet.

5.3.3 New Entrants to the WCPO Fishery

New entrants to the WCPO purse seine fishery during 2001 include two ex-US vessels now operated by New Zealand and China. Also, an agreement signed July 6, 2002 will allow up to 11 EU seiners to operate within the EEZ of Kiribati.

5.4 Technical Data Sources and Compatible Programs

The second FTWG research task for SCTB 15 was to translate key documents of the European Union project ESTHER. Mr. Itano informed the meeting of three ESTHER documents, including the final project document that had been partially translated to English thanks to the project coordinator Mr. Daniel Gaertner and the translation and interpretation section of the SPC. These reference documents were submitted to the meeting as FTWG–3, FTWG–4 and FTWG–5 as described in Appendix 6.

Research Task 3 supported further contact and information sharing with commercial fishing and industry related organizations. FTWG–6 describes the establishment and current activities of the World Tuna Purse Seine Organization (WTPO). The primary activities of this consortium of purse seine vessel owners and tuna processors concern the stabilization of world tuna prices at economically viable levels through voluntary effort reductions. FTWG–7 consists of recent WTPO initiatives concerning voluntary effort reductions and the establishment of fish quality standards for tuna purse seine fleets.

Mr. Itano described FTWG–9 in relation to Research Tasks 4 and 5, which was a report of a survey on the type and detail of vessel and gear data that should be collected in conjunction with the FFA Regional Register system. Though responses to the survey were low in number, the meeting felt the compiled results provide a useful baseline for FFA and the Forum Fisheries Committee (FFC) to deal further with these issues while incorporating input from SCTB. Details of the report and discussion are provided in Appendix 6.

5.5 Issues Related to FADs

Research Task 7 deals with documentation of the status of large-scale anchored FAD arrays in the region. Mr. Kumoru presented FTWG–12, which provides information on the status of anchored FADs and a FAD Management Policy for PNG. Exact numbers and locations of anchored FADs are not currently known, noting that 800 FADs have been reported in use by 26 purse seine vessels, while that the actual number is likely to be higher. Problems have occurred due to gear conflict issues with an expanding domestic longline fishery and enforcement issues related to the allocation of FADs to particular vessels.

Research Task 8 was related to the size and species composition of target and bycatch on anchored and drifting FADs. Ms. Brogan presented summarized target and bycatch information from FAD sets from SPC observer data holdings. Some minor species differences were noted for bycatch between anchored and drifting FADs but no significant differences were noted in the length frequencies of target catch. However, it was suggested that further analyses of the data be carried out to better examine seasonal and area effects.

5.6 Recent Advances in Purse Seine and Longline Technology

5.6.1 State of the Art Purse Seine Vessel

Research Task 4 charged the FTWG with documenting the most advanced purse seine and longline technology as an example of where fishing fleets and technology might be headed in the future. Mr. Itano presented FTWG-10, describing a modern, fully equipped tuna purse seine vessel. The working paper compared the vessel characteristics and fishing gear attributes between a typical US style tuna purse seine vessel operating in 1982 with a hypothetical purse seiner built in 2002. Important sources of information included published observer trip reports and fleet descriptions from the early 1980s, industry trade periodicals, SCTB reports and ESTHER documents.

Tuna purse seiners have increased in size to exceed 100 m in overall length with carrying capacities of 2500–3000 mt, with corresponding increases in the size and power of fishing gear. The most significant changes to fishing efficiency were noted as the adoption of "Spanish style" sacking and brailing of the catch, increased refrigeration capacities, faster unloading systems, the increased use of drifting FADs and improvements in marine electronics. Advances in radio buoy technology were described that include buoys that track the location of drifting FADs, transmitting GPS position and SST via high frequency radio signal with a range in excess of 1000 nm. Satellite transmitting radio buoys provide remote sounding/sonar data for estimates of biomass in the vicinity of a drifting FAD with essentially unlimited transmitting range. The paper noted that increases in fishing power have been clearly demonstrated by some modern vessels that now land twice as much tuna per year as vessels operating in the past or smaller vessels currently in operation.

5.6.2 State of the Art Longline Vessel

Mr. Stephen Beverly reported on FTWG–11, describing a modern, fully equipped tuna longline vessel ideally suited for operations in the SCTB region in 2002. This vessel was designed in response to the dramatic increase in longline catches of albacore tuna in the WCPO during the last decade. Longline catches of albacore have doubled during this time period, from 20,000 to 40,000 mt annually, while catches of all tuna have increased only 1.1 times. In French Polynesia, for example, longline catches of albacore have gone from 27% of the total catch to 55% of the total catch since 1991. In Fiji the albacore catch rate has gone from 36% to 66%, while the bigeye catch rate has dropped from 21% to 5%. Boats targeting bigeye are catching considerable amounts of albacore resulting in marketing problems such as gluts on the local market and low overseas prices for fresh fish while saturating infrastructure for exporting frozen cannery-bound fish. The example vessel described in FTWG–11 is a 20 m steel longliner built in Tasmania for a New Caledonia company, and has the capability to blast freeze and store albacore and to chill sashimi grade yellowfin and bigeye. Fish holds consist of three 10 mt RSW holds, one 15 mt freezer hold, and a 2 mt blast freezer. These features allow the vessel to target both the fresh sashimi market and the frozen cannery market and can work independently of shore based ice suppliers and freezer works, increasing vessel profitability. The cost of these vessels complete with full electronics and fishing gear was stated as USD$850,000.

5.6.3 Discussion Related to Increases in Fishing Power

The ability of current stock assessment models to adjust to changes in fishing technology and vessel efficiency was posed by Dr. Sibert. Dr. John Hampton stated that the impact of increased efficiency is expressed as improved catchability by species and gear within the MULTIFAN–CL model, so that these smaller technical details are incorporated and analyzed in a general sense. A discussion followed as to how purse seine effective fishing effort can be better estimated before it enters the model. Participants suggested that the FTWG should identify a list of items that change or influence catchability. Dr. Alain Fonteneau indicated that the ESTHER program had already done this for EU seiners in the Atlantic and Indian Oceans. Mr. Itano suggested that it might be cost effective and useful to translate the final ESTHER project document for examination by the FTWG. Mr. Lawson noted that revised purse seine and longline logbooks were being drafted which could request greater detail in gear attributes while others suggested that changes in gear and vessel attributes be captured in annual registries or surveys. Mr. Itano questioned the importance of collecting highly detailed technical data that is seldom analyzed, suggesting that overall vessel performance in landings data (mt/year production) may be a relatively simple way to document changes in fishing power over time. However, many participants agreed that it was still important to collect some level of detail in vessel and gear attributes.

Dr. Sakagawa suggested that an initial approach might be to conduct a case study of one well-documented fleet to determine the dates of introduction of new gear and techniques and attempt to correlate the historical impact of these changes. He suggested that the information could then be used to target the type of information needed from other fleets. It was noted by Mr. Park that a great deal of this information has already been collected by regional observer programs and should be looked at and properly considered before looking further. In relation to observer programs, Mr. Itano noted that observers need to be properly trained to recognize new gear and technology and supplied with well designed forms that facilitate the recording of this information.

Dr. Campbell asked whether the ESTHER program had been able to quantify the increase in fishing power by the EU fleets. Dr. Fonteneau who was a scientific contributor to the program stated that they did not arrive at any single figure but they estimated that fishing power in their fleets has been doubling about every ten years. He also stated that in addition to the technical and operational items described in FTWG–10, he felt that net depth and the use of sonar and bird detecting radar were also significant factors to increasing fishing power of purse seine vessels. The use of remote sensing technologies was also mentioned.

5.7 Regional Management Issues

During the FTWG Preparatory meeting, Mr. Opnai presented an update on the FFA review of the Palau Arrangement (FTWG–13) and FFC efforts toward regional management of bigeye (FTWG–14). Parties to the Palau Arrangement agreed to keep the number of purse seine vessels allowed to operate in the region at 205 to be managed on the basis of allowable vessel days. It was acknowledged that a great deal of work remains in developing and implementing this management strategy. During 2002, the FFC agreed that regional bigeye management initiatives should focus on limiting purse seine effort on floating objects, compulsory retention of juvenile tuna and adopting a holistic bigeye management regime within the broader context of the Preparatory Conference. The FFC also stressed the strengthening of observer and port sampling programs for purse seine fleets to improve data availability, ensure compliance and to assess the efficacy of management initiatives.

5.8 Research Coordination and Planning

A draft Task List for SCTB 16 was distributed during SCTB 15 for comments and briefly presented in plenary. Due to time constraints during plenary, the FTWG coordinator suggested that the draft list be finalized post-SCTB via email. After consideration, the following FTWG Task List was developed for SCTB 16.

Research Tasks Arising from SCTB 15

1. Compile descriptions of the development of WCPO purse seine and longline fisheries by fleet. (FFA, SPC, OFDC, NFRDI, NORMA, NMFS)
   a) Identify items which contribute to increased catchability in regional fisheries, utilizing ESTHER translations where appropriate.

   b) Compile a timeline for gear introductions and shifts in fishing strategies by fleet and study impact of changes on efficiency, concentrating initially on a case study of a well-documented fleet.
   c) Rate vessel production, or average purse seine landings per vessel/year and fleet over past 20-year period.
2. Develop a draft monitoring form to document changes in gear and vessel attributes and fishing strategies relevant to effective fishing effort. (FFA, SPC, FTWG)
3. Assist in the development of materials useful for training observers to recognize new fishing gears and technology. (FFA, SPC, FTWG)
4. Quantify effect of increased efficiency in regional tuna fisheries. (All)
5. Assist efforts to improve bigeye discrimination in mixed bigeye/yellowfin landings. (All)

Ongoing Tasks

6. Report on significant advances in fishing gear and methods in regional fisheries. (FFA, SPC, OFDC, NFRDI, NORMA)
   a) Specific examinations: drifting FADs and associated gear, remote-sensing technology, use of sonar, bird radar, and net design.
7. Compile information on the status of anchored FAD arrays for use by industrial fisheries within the WCPO. (SPC, BFAR, RIMF, Solomon Islands, PNG)
8. Investigate size and species composition of target catch and bycatch taken by purse seine sets on free-swimming, anchored and drifting FADs. (SPC, FFA, NFA, OFDC, NMFS)
9. Investigate the impact of new fishing technologies, i.e., Spanish style brailing, on length frequency and species composition sampling at sea. (SPC, NORMA, NMFS)
10. Maintain contact with and report on commercial tuna fishing associations and industry related organizations to advance cooperative studies and information sharing.
11. Coordinate with FFA and SPC as the FFA improves its management of data on vessel and gear attributes in the Regional Register, including attempts to rehabilitate the historical data. (FFA, SPC, FTWG)

Background Reference Tasks

12. Compile a reference list and electronic library of documents of interest to the FTWG to address the FTWG Terms of Reference and Task List. (FTWG, PFRP)
13. Compile and translate ICCAT, ESTHER and other documents useful to the FTWG to English language versions for inclusion in the electronic reference library. Summarize particularly useful documents for FTWG members. (FTWG, EU scientists, SPC)

6. SKIPJACK RESEARCH GROUP (SRG)

The coordinator, Dr. Gary Sakagawa, led the session of the Skipjack Research Group.

6.1 Regional Fishery Developments

Mr. Williams provided an overview of the WCPO skipjack tuna fisheries (GEN–1). Primarily purse seine and pole-and-line gears take skipjack tuna in the WCPO, with smaller catches by artisanal gears in eastern Indonesia and the Philippines. The estimated catch of 1,212,596 mt in 2001, the second highest on record, comprised 843,412 mt (69%) from the purse seine fishery, a provisional estimate of 292,291 mt (24%) from the pole-and-line fishery and ~75,000 mt (7%) mostly by unclassified gears in Indonesia, Philippines and Japan.

The spatial distribution of skipjack catch in the WCPO for the period 1990–2000 shows most of the catch taken in equatorial areas, particularly in the Indonesian, Philippines and equatorial purse seine fisheries, with relatively smaller amounts in the seasonal home-water fishery of Japan.

The 2001 purse seine CPUE for skipjack tuna in free-swimming school (unassociated) sets was consistent for all fleets and equal to or slightly higher than corresponding levels experienced during 2000. The gradual increase in skipjack tuna CPUE for free-swimming school sets over the past 5 years is possibly related to technological advances that enable better detection of free-swimming schools.

The decline of skipjack tuna CPUE for drifting FAD (associated) sets continued for the U.S. purse seine fleet during 2001, although the drifting FAD CPUE for other fleets increased. This difference was possibly due to differences in areas fished by each fleet as well as differences in fishing strategy. For the U.S. fleet, the low ex-vessel prices for skipjack tuna early in the year resulted in increased emphasis on setting on free-swimming schools with their higher content of yellowfin tuna, which general command a higher price than skipjack tuna.

The skipjack tuna CPUE for the offshore Japanese pole-and-line fleet, active in and around the Japanese home waters, shows an oscillating pattern (between 4 and 6 t/day) for most of the 1990s. In contrast, the distant-water Japanese pole-and-line fleet, primarily active in tropical waters, consistently accounted for a higher CPUE (between 6 and 8 t/day) over this period. Skipjack tuna CPUE in the Solomon Islands domestic pole-and-line fishery tend to be stable but lower than that for the Japanese fleets. Nominal skipjack tuna CPUE for the Japanese and Solomon Island fleets tend to follow a similar pattern each year, suggesting that stock-wide effects are involved.

Skipjack tuna sampled from the purse seine fishery are typically between 30 and 70 cm FL. During 1999-2001 there were only small differences in the length composition between associated and unassociated sets. However, there are instances when unassociated sets capture skipjack tuna of a greater size range than in associated sets. This was apparently the case for several months during 2000 and 2001.

In the discussion that followed Mr. Williams' presentation, it was noted that length-frequency distributions suggested that the purse seine fishery in 2001 caught smaller fish in all months relative to 1999 and 2000. While the reasons for this are unknown, it was noted that because the data appears to be from primarily the U.S. fleet, the results may be specific to the U.S. fleet and not to the entire fishery. It was also suggested that in the future, plots of average fish size (as is done for Atlantic fisheries) could be provided for the Group to review.

The SRG coordinator noted that total catches were now in excess of 1 million tonnes, representing an increase of >140% over the last decade, while logbook coverage remained at 34–44%. Observer coverage remained low at 3% in 2001, limited largely to the US fleet, and port sampling coverage remained unchanged at a low 0.3% over the last decade. Of particular concern is the fact that over 25% of the total skipjack tuna catch from the WCPO is taken in the Philippine and Indonesian archipelagic areas and is not being fully monitored. It was generally agreed that work was needed to address these issues and that the approach should include modeling perspective to determine what coverage rate (of logsheets and observers) was required for stock assessment analyses. Particular attention should also be directed at determining how to reduce the likely bias in the spatial and temporal coverage of logbooks and observers placement. It was suggested that stratifying data in ways other than by flag might be a more appropriate way of evaluating coverage. It was noted that the issue of observer training and verification of vessel activity (e.g., use of FADs) through VMS and observer placements was an area needing attention.

6.2 Biological and Ecological Research

Age and Growth

No papers were presented for review, but the SRG coordinator reported that Japanese scientists have undertaken recent studies on validating daily ring formation in otoliths of juvenile skipjack tuna (reported at the Lake Arrowhead Conference in May). Their results indicate daily formation of rings.

In the discussion that followed, SPC staff reported that the results might not apply to larger or older fish. In an SPC OFP study using juvenile skipjack tuna otoliths, ring formation appeared to be variable, not formed daily and appeared to be dependent on the feeding regime of individual fish. The coordinator also noted that the age-length relationship for skipjack require validation although an age-length relationship is currently being used in stock assessments (Figure 10 in SKJ–1). It was pointed out that estimated age from SPC's tagging data fit this curve well for fish younger than 2 years old but for older fish, the mean length estimated from the curve is substantially higher than growth estimates from tagging data.

Natural Mortality

Dr. Hampton reviewed the estimated relationship between natural mortality rate (M) and skipjack age (SKJ–1, Figure 14) derived from tagging data. Natural mortality rate is high in the first year following recruitment (about 20 cm FL); M subsequently declines to a minimum in quarters 7-8 (quarters after recruitment) before increasing again. Natural mortality is typically high also in older skipjack (quarters 10 onwards). It was postulated that the change in M with age might be related to a change in sex ratio with size with males surviving longer than females, as occurs in some other tunas.

Schooling/Aggregation Behavior

No papers were presented for review, but it was noted that recent archival tagging by IATTC in the eastern Pacific Ocean would be relevant. Dr. Maunder reported that a handful of archival tags were released this year. No tags were recovered yet.

Effects of ENSO Events

Dr. Patrick Lehodey presented SKJ–5, applying the SEPODYM model to skipjack tuna. Changes concerning tuna movement and forage abundance were made to the model. A simple linear relationship has been introduced to link movement (diffusion and advection coefficients) to the size of the fish. With the extension of the model to the entire Pacific basin, the parameterization of the forage population has been revised to take into account differences between tropical and temperate regions. The two parameters T_r and λ that characterize the forage have been linked to SST and parameterized to have a "mean age" ($T_r + 1/\lambda$) or turn-over time for the forage population in agreement with biological characteristics of key prey species in these different regions. Changes due to this new parameterization mainly affect the sub-tropical and temperate regions. In particular, the seasonal peak of forage biomass predicted in the Kuroshio extension region (45N-35N) occurs later in summer between July and October and creates an interesting synchronization between seasonal peaks of forage abundance and skipjack tuna catches.

Several simulations were conducted with different parameterizations of the spawning habitat. The simulation predicting similar levels of recruitment and biomass than those estimated with the MULTIFAN-CL model are obtained with a habitat constrained by temperature and primary production. These results suggest that extension of the temperature spawning habitat combined with an increase of primary production in the western central Pacific during El Niño conditions are favorable to high recruitment of skipjack. Results confirm the impact of the ENSO variability with a positive (negative) effect of El Niño (La Niña) events on the recruitment that is propagated into the stock in the following two years. After the peak of biomass and catch associated to the strong

1997-98 El Niño, the last La Niña episode of 1998-2001 should lead to a decrease of the skipjack tuna stock biomass in the next two years.

Several technical details on the model were sought and the practical implications of the model discussed. Of particular interest was the sensitivity of results to model assumptions and parameter estimates. While it was noted that there were plans to align specific aspects of the SEPODYM model with the MULTIFAN-CL model, it was noted that the strength of the former model was its ability to model movement that may improve MULTIFAN-CL modeling efforts.

6.3 Data Issues

Mr. Williams presented a summary of aggregate skipjack tuna catch/effort and size composition data available to the SCTB (SKJ–3). The summarized information provided was in response to SCTB 14 directives to provide a list of available data for one particular species and general informal comments on the need to have this type of document available for all species groups. Tables in the paper are ordered by gear and vessel flag and are for data relevant to skipjack tuna only; therefore catering for the requirements of the SRG.

It was noted that a more detailed, quantitative measurement of the data holdings, including the sources of data provided, is available in the OFP Data Catalogue, which can be found on the SPC OFP website (www.spc.int/oceanfish). Detailed text on the sources, coverage and quality of data exist for catch and effort data, but have not been incorporated at this stage, although it was hoped that this could be included for next year's SCTB meeting. It was also suggested that provisional annual catch estimates for each fleet be provided for review during next year's SCTB meeting, rather than waiting until estimates are finalized (usually only after each SCTB meeting).

Dr. Chi-Lu SUN reported on a new project he is undertaking to develop a standard routine for port sampling and at-sea sampling to collect biological data from Taiwanese distant-water purse seiners in support of skipjack tuna studies (SKJ–4). This project is initially funded for five years by the Taiwan Fisheries Administration. During the first year (2001), 932 skipjack tuna fork lengths and 486 weights were recorded by port samplers at Kaohsiung, Taiwan. At-sea observers measured 1,240 skipjack tuna for fork length (311 from school sets, 929 from FAD sets) with 85 fish measured for weights (25 from school sets, 60 from FAD sets). Also, 109 whole skipjack tuna from port sampling and 45 fish heads and gonads from 10 fish from observer sampling were obtained for biological purposes. Otoliths were successfully extracted for an age and growth study. Gonads, muscle, spine and vertebrae were removed and stored respectively for further research. This is a first attempt at collecting biological data from observer and port sampling programs for tunas organized by Taiwan scientists and demonstrates commitment to contributing data for stock assessment and conservation of this species. In

2002, the project plans to collect additional biological data, facilitate data analysis and improve the database for stock assessment.

Dr. SUN was asked to comment on the representativeness/randomness of his sampling protocol and whether samples could be linked to logbook data so as to assign samples to time/area strata. He noted that random sampling of port landings was difficult and that he identified factors that need to be resolved. He also noted that he is hopeful that the project would continue beyond the initial five-year trial period.

6.4 Stock Assessments

Index of Abundance

The SRG coordinator noted that indices of skipjack abundance were presented in earlier papers (FTWG–2 and GEN–1). Nominal CPUE trends were noted in Figure 21 (of GEN–1) by school type for the purse seine fishery and in Figure 22 (of GEN–1) for the pole-and-line fishery (Japan and Solomon Islands). This latter figure is the same as available to SCTB 14 and has not been updated because more recent data were not available in time for incorporating in GEN–1. However, standardized CPUE for the Japanese pole-and-line fleet was available in time for incorporating in the latest stock assessment (SKJ–1).

Trends in the pole-and-line and in free-swimming school sets by purse seine gear are relatively flat while both log and FAD sets show an increase in CPUE. This increase may be due to the use of new technology but it is not yet possible to estimate the impact of technological advances on effective effort. The FTWG coordinator was asked to review aspects of changing technology that might affect purse seine CPUE as an index of abundance. While a number of potential factors were mentioned it was clear that without a systematic identification of potential factors and information on when they were introduced to the fleet, consideration of such information would remain largely anecdotal and not useful for analyses. It was suggested that the FTWG list the major technological changes and provide information on when (and how long) they were used to target skipjack.

It was noted that in the Atlantic, increased use of FADs might have changed the behavior of skipjack tuna, which may in turn have resulted in changes in natural mortality and other biological factors relevant to stock productivity. For this reason incorporating changes in fishing practices in modeling CPUE was considered an important area for research and the work of the FTWG should focus more on this area. As an example it was noted that the use of anchored FAD had coincided with an increase in the catch of small-sized skipjack tuna. This coupled with the absence of data from Philippine fisheries could be having a major impact on the skipjack tuna stock assessment. It was agreed that there was a need to obtain data from poorly monitored fisheries and learn more about the impacts of FADs, aggregation and the basic behavior of skipjack tuna.

Dr. Hampton presented SKJ–1, an assessment of skipjack tuna in the WCPO using the MULTIFAN-CL model. The analysis was an update of that presented at SCTB 14 and included data up to 2001. The main stock assessment conclusions of the analysis were as follows.

- Recruitment showed an upward shift in the mid-1980s and has been at a high level since that time. Particularly 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 possible mechanisms involved in this relationship are 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 1998–2000. 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 relatively slight throughout the model domain.
- An equilibrium yield analysis confirms that skipjack is currently exploited at a modest level relative to its biological potential. Furthermore, the estimates of F_t / F_{MSY} and $B_t^{adult} / B_{MSY}^{adult}$ suggest that the stock is neither being over-fished nor in an over-fished state. Recruitment variability, influenced by environmental conditions, will continue to be the primary influence on stock size and fishery performance.

Recommended research and monitoring required to improve the skipjack tuna assessment include the following.

- Continued monitoring and improvement in fisheries statistics is required. In particular, better data generally are required for the Philippines and Indonesian fisheries.
- New conventional tagging experiments, undertaken regularly, would provide additional information on recent levels of fishing mortality, refine estimates of natural mortality and possibly allow some time-series behavior in movement to be incorporated into the model.
- Further research on environmental influences on skipjack tuna recruitment and movement are required. Environmental time series identified by such research could be incorporated into the MULTIFAN-CL model.

Concern was raised over the flat catchability curve for a major purse seine fishing area given the range of technological developments that have been adopted by the purse seine fleet over time. It was noted that the flat curve maybe an artifact owing to paucity of data for some major fishing fleets operating in the area. Improved data from the Philippine and Indonesian fisheries should clarify this point.

Dr. Maunder presented the most current stock assessment of skipjack in the EPO, estimated with the A-SCALA model, an age-structured, statistical catch-at-length analysis. This method was used for the 2001 skipjack assessment in the EPO. The differences compared to the previous assessment include extending the modeling time frame to start in 1975 (as opposed to 1981) and investigation of the sensitivity to dome-shaped selectivity curves versus asymptotic (monotonic) selectivity curves. New catch, effort, and length-frequency data have been included for 2001 and updated for previous years. The stock assessment requires a substantial amount of information. Data on landings, discards, fishing effort, and the size compositions of the catches of several different fisheries have been analyzed. Several assumptions regarding processes such as growth, recruitment, movement, natural mortality, fishing mortality, and stock structure have also been made. Environmental influences on recruitment have been investigated. The assessment is still considered preliminary because 1) it is unknown if catch-per-day-fished is proportional to abundance for purse-seine fisheries, 2) it is possible that there is a population of large skipjack that is invulnerable to the fisheries, 3) stock structure in relation to the EPO and western and central Pacific stocks is uncertain, and 4) estimates of absolute biomass have changed by more than an order of magnitude from the previous assessment.

The recruitment of skipjack tuna to the fisheries in the EPO is variable. The rate of fishing mortality is estimated to be about the same or less than the rate of natural mortality; this is supported by estimates from tagging data. Biomass fluctuates mainly in response to the variations in recruitment, except for the low biomass levels in the early 1980s that were estimated to be a consequence of high fishing mortality rates.

The analysis indicates that a group of very strong cohorts entered the fishery in 1998–99, and that these cohorts increased the biomass and catches during 1999 and 2000. There is also an indication that the most recent recruitments have been low, which may lead to lower biomasses and catches. However, these estimates of low recruitment are based on limited information, and are therefore very uncertain.

There is considerable variation in SBR for skipjack tuna in the EPO. In 2002 the SBR is at a low level (about 0.23). AMSY and yield-per-recruit calculations estimate that maximum yields are achieved with infinite fishing mortality because the critical weight is less than the average weight at recruitment to the main fisheries. However, this is uncertain because of uncertainties in the estimates of natural mortality and growth.

The SRG coordinator noted that both WCPO and ETP analyses indicate low fishing mortality rates (low Fs), which implies healthy stocks with considerable scope for further fishery yields from the stock. He furthered noted that with such low Fs, there might not be much stock status information within the fisheries data. He suggested that given the little change in stock status from year to year that the Group might be more effective focusing on the role of skipjack in the ecosystem. The lack of understanding of the multi-species nature of the fishery led others to speculate as to whether the continued increase in skipjack tuna catch with little perceived impact might be due to changes in ecological dynamics. For example, if skipjack tuna were to expand into habitats and become exploited where other tunas (e.g., bigeye and yellowfin tunas) were being fished down. The Group concluded that, while there is a continuing need to assess stock status of skipjack tuna, there is also a need to better understand its relationship to other species with which it is regularly caught.

6.5 Research Coordination and Planning

During the discussions of working documents and research results, the Group identified data gaps and research needs for skipjack tuna stock assessment. The Group noted that many of the data gaps and research needs are common to all of the tropical species simply because the fisheries, from which a large part of the stock assessment data is derived, are multi-species in targeting as well as in operations. Furthermore, the research effort has traditionally been largely multi-species directed and opportunistic because of the high costs and limited resources available for conducting single-species, directed research on wide-ranging species that are exploited by an international fishery. The Group lists the following needs.

Data Needs

1. Continued improvement of fisheries statistics is required. However, the pace needs to be accelerated. Priority areas for improvement are in catch, size composition of catches, areas of catch, and fishing effort for all fleets, but particularly those of the fleets of the Philippines and Indonesia and evolving New Zealand distant-water purse-seine fleet and the Vietnam longline fishery. A “brainstorming” workshop on new ways to accelerate progress in closing gaps in data needs may be required to assist in advancing this task.
2. Besides improvement of reported fisheries statistics, effort needs to be focus on accounting for removals that are not generally reported. Removals such as discards of undersized or damaged skipjack tuna at sea, catches from artisanal sources, skipjack tuna catches mixed in catches of non-tuna fisheries, etc.
3. Need for better information on changes in catchability of purse seine gear owing to changes in gear technology and advances in fishing operations (e.g., FAD technology).

Research Needs

1. Need for further understanding of the population dynamics and ecology of skipjack tuna.
    - age and growth (hard parts analysis, conventional tagging)
    - natural mortality (conventional tagging)
    - influence of environmental factors on behavior (archival tagging)
    - aggregation dynamics owing to FADs (archival tagging, food studies)

2. Need for analyses and development of stock assessment metrics.
   - standardization of purse seine fishing effort, including use of information gathered through the FTWG efforts
   - continued efforts in refining and applying assessment models of different types
   - exploring use of new tools/methods for indexing abundance
   - increased studies on the role of skipjack tuna in the ecosystem

6.6 Summary Statement

A summary statement for skipjack was drafted, circulated to participants and discussed. The accepted wording appears below.

SKIPJACK RESEARCH GROUP (SRG)—SUMMARY STATEMENT

Skipjack tuna are the most important tuna resource in the WCPO, in terms of its contribution by weight to the total catch. In the past decade, skipjack tuna catches have been approximately 1 million mt per year, contributing about 63% to the total tuna catch from the region. The 2001 catch was slightly more than 1.2 million mt, the second highest catch on record. The purse seine fishery accounted for most of this catch (69%) with 24% from the pole-and-line fishery.

The CPUEs for purse seine are variable with nominal CPUE for log and FAD sets showing an increasing trend (mainly due to increased efficiency of purse seiners), particularly in recent years. Nominal CPUEs for free-swimming school sets and for pole-and-line fisheries are essentially flat. A lack of trend was also seen in standardized pole-and-line CPUEs.

Skipjack tuna are concentrated in tropical waters but expand seasonally into subtropical waters to the north and south. Their fast growth, early maturity, high fecundity, year round spawning, relatively short life span, high and variable recruitment, and few ages classes on which the fishery depends makes this species unique among the main tuna species. Ongoing fishery oceanography and environmental studies continue to improve understanding of the factors influencing availability and productivity of skipjack tuna in the WCPO. They suggest a positive impact of El Niño on skipjack tuna recruitment, particularly when followed by a La Nina event. The cause for these recruitment differences appears to be changes in the area of the spawning habitat with temperature and in forage availability. Modeling results predict lower skipjack tuna recruitment over the next 2 years resulting from the 1998-2000 La Nina event. The biomass trend appears to be recruitment driven, with large variability and with the largest biomass levels estimated to be for the model period 1998 to 2000. The model results suggest that the skipjack tuna population in the WCPO in recent years is at an all time high relative to the last 30 years.

Tag-based assessments from the early 1990s suggested low to moderate exploitation at catch levels slightly lower than those in recent years. Recent results from MULTIFAN-CL model analysis, which incorporates tagging and other information, were consistent with earlier assessments. These data indicated that fishing mortality had continued to increase during the 1970s and fell to some extent in recent years, probably due to economic factors. While fishing mortality has increased, the impact of fishing on the stock is estimated to be relatively slight throughout the time period. The ratio of fishing mortality relative to FMSY is small (<0.20) and fishing mortality over the past 30 years has been significantly less than natural mortality. Similarly, estimates of recent spawning stock biomass (SSB) are considerably higher than the estimated level producing MSY (SSB/ SSBMSY > 5.0). The skipjack tuna stock appears to be healthy and capable of sustaining the current catch without adverse effect on stock condition.

Nevertheless, the Group noted that it does not appear that skipjack tuna move over great distances rapidly and hence do not thoroughly mix over the entire region. Concentrated and sustained fishing effort in local areas, consequently, could result in local depletion. In such areas, further increase in fishing effort may not result in proportionate increase in catches, but instead result in decline in CPUE and even in average size of skipjack tuna taken. The experience in the Atlantic skipjack tuna fisheries where this has occurred was noted.

Future advances in the basic biology, data collection and stock assessment of skipjack tuna are required to substantiate the information required for the management of this economically and ecologically important species. Of particular importance is the need to estimate the magnitude and size composition of skipjack tuna caught in the domestic fisheries of the Philippines and Indonesia.

7. YELLOWFIN RESEARCH GROUP (YRG)

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

7.1 Regional Fishery Developments

Mr. Williams provided an overview of the WCPO Yellowfin tuna fisheries, referring the meeting to the relevant section in GEN–1. Yellowfin are an important component of WCPO tuna fisheries harvested with a diverse range of gear types, from large 'distant-water' longliners and purse seiners that operate widely in equatorial/tropical waters to small-scale artisanal fisheries in Pacific Island and southeast Asian waters. Purse seiners take a wide size range of yellowfin, whereas the longline fishery takes mostly adult fish. Yellowfin usually represent ~20–25% of the overall purse seine catch and may be directly targeted by purse seiners, especially as unassociated schools.

The 2001 yellowfin catch in the WCPO was 473,236 mt, including 219,151 mt (45%) from the purse seine fishery. The longline and pole-and-line fisheries caught 17% (77,262 mt) and 3% (16,406 mt), respectively, with various assorted gears (primarily handline in eastern Indonesia and the Philippines), accounting for 160,417 mt (34%).

Significantly, the EPO purse seine catch of yellowfin (391,379 mt) for 2001 was an all-time record and nearly 100,000 mt higher than the previous record in 1999. The 2001 Pacific-wide yellowfin catch of 882,747 mt was also a record, exceeding the previous record in 1998 by nearly 100,000 mt.

Strong interannual variability and differences amongst the fleets characterize yellowfin purse seine CPUE. Free-swimming school CPUE is strongly related to ENSO variation in the WCPO, with CPUE generally higher during El Niño episodes as was experienced during 1997–1998. In contrast, CPUE is typically low in La Nina periods (for example, 1995–96 and 1997–98). During 2001, the CPUE increased in line with the weakening of La Niña. The consistency in yellowfin CPUE trends for all purse seine fleets since 1996 (except perhaps the Japanese fleet in recent years) was noted.

The trends in nominal longline CPUE shows a sharp decline over the period 1978–1991, with at least part of this decline attributable to the change in targeting behavior of longline fleets. In contrast, the standardized CPUE does not exhibit as strong a decline over this period. Over the entire time series, standardized CPUE had low points in the late 1960s to early 1970s, 1989–1991 and a decline from 1996 through 1999. While standardized CPUE for 1999 is the lowest observed for about 25 years, they are not much lower than those observed in the early-1970s.

Available yellowfin size composition data for the period 1999–2001 show two clear size modes in fish sampled from associated purse seine sets during 1999, the second clearly overlapping with the mode in the samples from the longline fishery by September of that year. The relative absence of medium-sized (60–100 cm) yellowfin in the catches from both the longline and purse seine fisheries during 2000 and 2001 compared to 1999 was noted.

The Chair of the YRG observed that purse seine CPUE for yellowfin tuna was far more variable than that for skipjack. It was also noted that poor recruitment in the mid-1990s could be observed in the purse seine catch around 1996 and again a few years later in the longline catch and CPUE. The catch-at-length series also supported poor recruitment of yellowfin in the mid-1990s.

7.2 Biological and Ecological Research

Dr. John Gunn gave a presentation on the origin of yellowfin tuna recruits to the fishery off eastern Australia. The Australian longline fishery targets yellowfin and bigeye tuna and swordfish within and adjacent to the Australian EEZ. Japanese, Taiwanese, New Caledonian, and New Zealand longline fisheries target the same species in neighboring EEZ's and on the adjacent high seas. Bound by national legislation, Australian fishery managers are required to develop management plans designed to ensure the sustainability of catches within "their" fishery. The manager's question, "Is there any point in restricting domestic catch and effort when the catch of yellowfin and bigeye in equatorial waters are orders of magnitude higher than in the Coral and Tasman Seas?" is similar to that posed by island and coastal states throughout the range of many tuna and billfish stocks. For the science community the question requires an understanding of the movements, residence times/regional fidelity and mixing rates of fish between these areas. In an attempt to answer the question for yellowfin in the Coral and Tasman Seas, the present study used tagging, genetic, otolith chemistry, catch and effort and physical oceanographic data.

The main results of the study were as follows.

1. Although there is evidence for significant variation among yellowfin collected throughout the Pacific, microsatellite genetic data do not allow us to reject the null hypothesis of a single panmictic yellowfin tuna population in the western Pacific Ocean. However, this does not mean that the null hypothesis is true, just that there is insufficient evidence to reject it.
2. Tagging programs within and outside the Coral and Tasman Seas suggest a high degree of localized movement of yellowfin—most fish do not move more than a couple of hundred miles from their point of release, regardless of time at liberty. Tagging conducted by SPC in the early 1990s demonstrated the potential for large-scale movement by yellowfin out of the Coral Sea—individuals were recaptured as far afield as south of Japan and eastern FSM—but only one of over 40,000 yellowfin tagged outside the Coral Sea was recaptured within it, or further south in the Tasman Sea.

3. Otolith chemistry suggests a close link between yellowfin spawned in the Coral Sea and those caught in the Tasman Sea, and patterns of recruitment into the Tasman Sea fishery suggest that pulses of fish spawned in the summer months are the major sources of recruits to the domestic longline fisheries. The patterns of recruitment align closely with regional circulation in which there is a high degree of recirculation of water between the Coral and Tasman Seas.

On the basis of these varied data sources, the study concluded that in many years there is limited immigration of yellowfin into the Coral and Tasman Seas from the equatorial regions to the north, and that in these years spawning in the Coral Sea is likely to be the major source of recruits to the Australian fishery.

Mr. Bert Kikkawa presented YFT–4. Monthly weight frequency distributions of yellowfin tuna (*Thunnus albacares*) landed by Taiwanese and Japanese coastal longliners in the Guam fresh tuna transshipment fishery were used in a modal progression analysis. The objective of this study was to investigate inter-annual variations in the parameters K, L_∞, and recruitment age in the von Bertalanffy model. Nine year classes (1989–2000) were tracked from 4–5 years. Recruitment occurred around the first quarter. The growth parameter, K, exhibited a low of 0.334 in for the 1993 year class, but for the other classes ranged from 0.511 to 0.775, with an overall mean of 0.612 per year. L_∞ ranged from 152 to 173.1 cm FL. Age at 100 cm FL ranged from 1.30 to 2.61 years.

Dr. Sibert presented YFT–5. An advection-diffusion-reaction model is applied to the data from three different tuna tagging experiments in the WCPO to reexamine the question of to what extent the population dynamics and spatial characteristics of tropical tunas require international cooperation for effective management. The analysis estimated median lifetime displacements of skipjack ranging from 420 to 470 nautical miles. The estimated lifetime displacement of yellowfin is about 20% less. The median half-life, a measure of residence time, of skipjack and yellowfin in WCPO exclusive economic zones (EEZs) is three to six months. Fishing decreases the lifetime displacement and increases the half-life. The authors concluded that international arrangements between neighboring EEZs are essential for effective conservation, but that Pacific Island countries can achieve benefits from domestic conservation and fishery development policies. It may also be possible to implement effective sub-regional policies in jurisdictions that are separated by distances exceeding the median displacement.

Dr. Shu-Hui WANG presented RG–1, examining biological information on seasonal/quarterly and/or sex-specific condition factors (CF), gonadosomatic index (GSI), fork length-body weight relationship and sex ratios for bigeye and yellowfin tunas sampled from waters surrounding Taiwan. Results showed that fork length-body weight relationship for yellowfin tuna can be described as $BW= 3.799 \times 10^{-5} FL^{2.8537}$ (and $BW=5.856 \times 10^{-5} FL^{2.7884}$ for bigeye tuna). The GSI value, in general, was higher in spring and summer (i.e., January to July) for yellowfin tuna, indicating that spawning activity of this species may mostly occur in the second and third quarters of the year. The condition factor of yellowfin tuna fluctuated seasonally for both sexes. There was essentially no relationship between GSI and CF, and between CF and sizes of fish for both species. This indicates that change in CF seems to be unrelated to their maturity, and that the feeding conditions for different sizes of fish were similar for both species. In addition, sexual dimorphism with male fish predominant in almost all seasons and size classes for both species were discussed.

Dr. Dean Grubbs presented YRG–6, summarizing work on the tropic ecology of yellowfin and bigeye tuna from natural and man-made aggregations in Hawaiian waters. The primary sampled aggregation sites include offshore-anchored weather buoys that act as FADs, a productive offshore seamount and inshore-anchored FADs surrounding the main Hawaiian islands. The objectives are to compare the trophic ecology of yellowfin and bigeye tuna across these sites, to evaluate the potential trophic benefit of aggregating, and to evaluate the effect of artificial aggregative structures on tuna trophic biology. To date, 810 samples have been collected, 436 in port and 374 at sea (29% yellowfin and 71% bigeye).

Preliminary results support an extremely diverse forage base of both species, while percent abundance data indicate that relatively few taxa are numerically important in the sampled diets. Both species were found to employ generalized feeding strategies when associated with the seamount but were much more specialized when associated with the offshore buoys. No significant dietary overlap was found between yellowfin and bigeye tuna regardless of association. These results are notable considering results from telemetry data suggesting that vertical segregation of the species breaks down near FADs and that both species are caught in near-surface mixed aggregations at the offshore weather buoys and the Cross Seamount. Also, the diet of seamount-associated tuna of both species was different from those associated with offshore buoys. These data also suggest that associating with the Cross Seamount may impart a significant trophic advantage to bigeye tuna but may offer little or no advantage to yellowfin tuna. In addition, results indicate that association with the offshore weather buoys offers no trophic advantage to either tuna species and may actually be metabolically costly to bigeye tuna.

7.3 Data Issues

Dr. Campbell presented YFT–5, a summary of aggregate catch/effort and size composition data available for yellowfin tuna in the WCPO. It was pointed out that the document gave a good overview of the available data and enabled one to identify gaps in the time-series. Length data for the longline fisheries has been dominated by data collected from Japanese vessels, with the number of samples generally varying between 100,000–150,000 fish per year. However, the level of sampling from other fleets increased rapidly in the early 1990s with around 80,000 fish being sampled recent years. Similarly, length data for purse seine fisheries is dominated by samples from the US fleet (around 50,000 per year) but in recent years a similar number of samples have been collected from other fleets.

In response to a question about what data is used in the MULTIFAN-CL assessments, Dr. Hampton advised that all available data is incorporated in the MULTIFAN-CL model. While the Japanese longline CPUE series and length data dominate in most regions for yellowfin, other longline CPUE series and length data are included when available. Dr. Hampton also advised that set type and area separated purse seine inputs. Dr. Hampton concluded that this separation should capture any large differences in catch-at-length between fleets and/or areas.

The Research Group Chair raised the use of performance indicators in reporting the results of stock assessment. It was suggested that a series of data-based fishery indicators should be compiled and examined for the YFT fishery, in addition to the model-based indicators that have been the main focus in recent years. This list would include time series of total catch, nominal catch rates, standardized catch rates and size distributions, all broken down by spatial units or fisheries if appropriate. Dr. Fonteneau suggested that a comparison of indicators currently presented for tuna assessments across the three ocean basins would greatly assist this group when trying to decide on a suite of performance indicators for use in reporting on stock assessment outcomes for the WCPO.

7.4 Stock Assessments

Dr. Hampton presented an assessment of yellowfin tuna in the WCPO using the MULTIFAN-CL model (YFT–1). This year's analysis differs from previous analyses in that a five region spatial structure was adopted in place of the previous seven-region structure, and that weight frequency data for several longline fisheries were incorporated into the model for the first time. Figure 4 illustrates nominal and standardized longline catch rates for the five region model. The major stock assessment conclusions of the analysis are as follows.

- Recruitment shows considerable variation at several different time scales, but the main feature of the estimates is an increase in total recruitment during the late 1970s to early 1990s, followed by some decline.

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

- Fishing mortality for juvenile yellowfin tuna has increased strongly since about 1992, partly as a result of catchability increases in the purse seine fisheries. But a significant component of the increase is attributable to the Philippines and Indonesian fisheries, which have the weakest catch, effort and size data. This is of continuing concern. There has been recent progress made in the acquisition of a large amount of historical length frequency data from the Philippines and regular sampling operations are now in place there. However, uncertainty with the total catch and size composition data for the Indonesian fishery continues to be a problem.

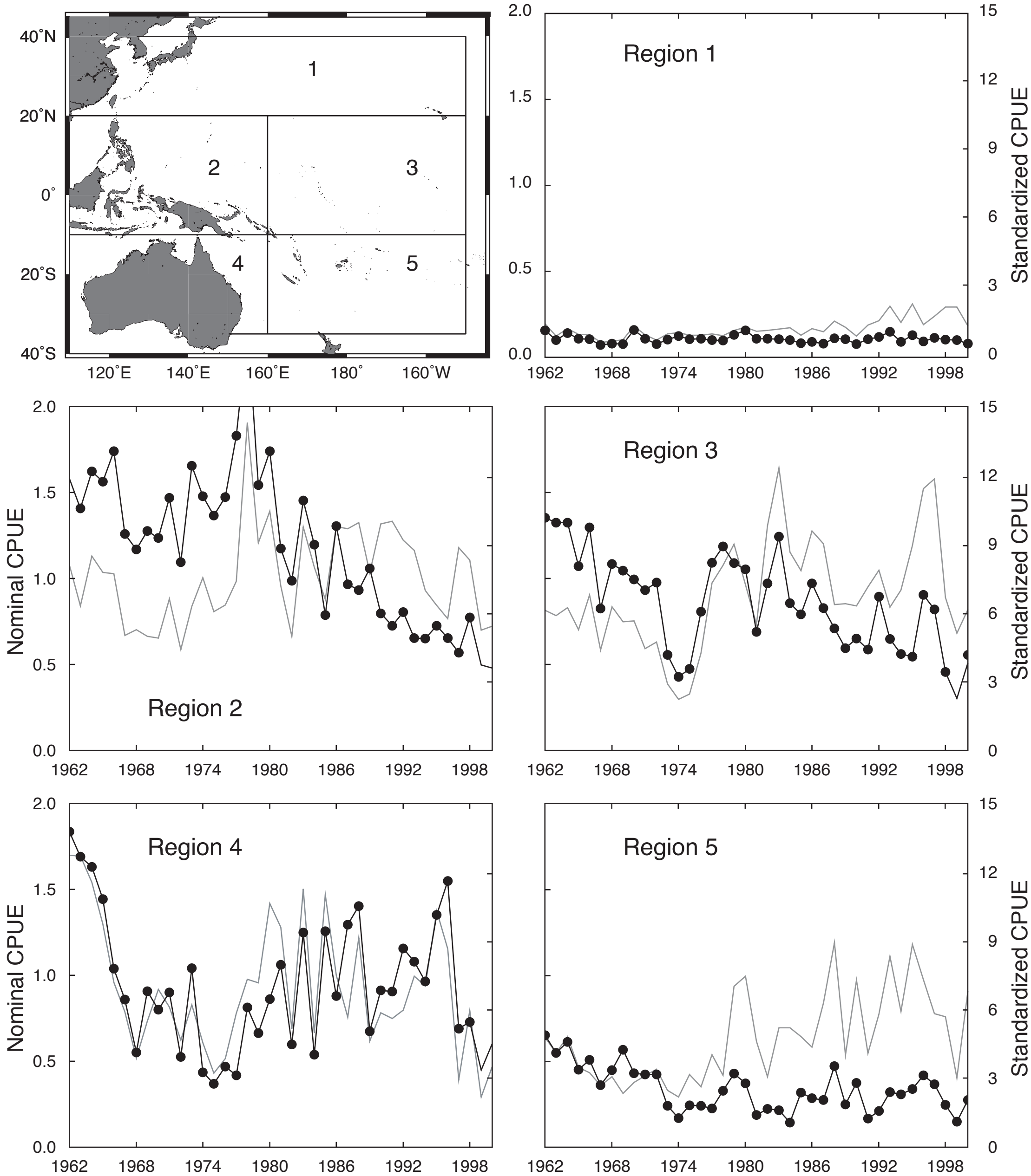

Figure 4. Nominal (solid line with dots) and standardized (solid line) catch rates for yellowfin tuna within the five regions used in the MUTLIFAN-CL assessment in the WCPO.

- The overall impact of fishing on stock biomass is estimated to be in the vicinity of 35% in recent years. The impact is differentially high in the tropical regions (around 50%) compared to the subtropical regions.

- Further work in this year's assessment has been carried out on the application of reference points. The estimates of F_t / F_{MSY} and $B_t^{adult} / B_{MSY}^{adult}$ suggest that the stock is neither being overfished nor is it in an overfished state. We note, however, that the current trends in both ratios are towards the reference points and that further increases in fishing effort are unlikely to produce significant increases in long-term average catch. Current levels of catch would be sustainable if recruitment remains at the above-average post-1980 levels; however such catch are unlikely to be sustainable if recruitment reverts to the below-average levels of pre-1980.

Recommended research and monitoring required to improve the yellowfin tuna assessment include the following.

- Continued monitoring and improvement in fisheries statistics is required. In particular, better data generally are required for the Philippines and Indonesian fisheries.

- New conventional tagging experiments, undertaken regularly, would provide additional information on recent levels of fishing mortality, refine estimates of natural mortality and possibly allow some time-series behavior in movement to be incorporated into the model.

- In view of the importance placed on longline effort data by this model, additional archival tagging is required to characterize the depth distribution of yellowfin tuna and its environmental correlates across the stock range to enable better estimation of effective longline effort.

The biggest change in the 2002 WCPO YFT assessment compared to 2001 was the exceptionally large biomass estimated in Area 5 in the mid-late 1990s. Since Area 5 is only lightly exploited, this feature is inferred from relatively little data, and it remains unclear to the assessment analyst how reliable the estimate is, and what data is driving it. It was suggested that this could be an artifact related to a catch length frequency distribution dominated by an exceptionally large mode corresponding to a young age class. Conversely, it was noted that the timing of the peak roughly corresponds with a peak in skipjack biomass estimated by SEPODYM, in which case both species might have experienced exceptional production via related oceanographic mechanisms (but it is worth noting that the MULTIFAN-CL skipjack assessment did not corroborate this peak, nor was it substantial in areas 1–4 in the yellowfin assessment).

Dr. Maunder presented YRG–3, an assessment of yellowfin tuna in the EPO using an age-structured, catch-at-length analysis (A-SCALA). The A-SCALA method has been used for the two most recent assessments of yellowfin in the EPO, and readers are referred to the submitted manuscript (Maunder and Watters) for technical details. The stock assessment requires a substantial amount of information. Data on landings, discards, fishing effort, and the size compositions of the catches from several different fisheries have been analyzed. Several assumptions regarding processes such as growth, recruitment, movement, natural mortality, fishing mortality, and stock structure have also been made. The assessment for 2002 differs in several from the previous assessment carried out in 2001.

1. Catch, effort, and length-frequency data for the surface fisheries have been updated to include new data for 2001 and revised data for previous years.

2. Catch and effort data for the Japanese longline fisheries have been updated to include new data for 2000 and updated data for 1998 and 1999. Effort data are extrapolated for 2001 and catch is predicted by the assessment model.

3. Effort data for the Taiwan longline fisheries have been updated to include data for 1998.

4. Longline effort data are based on habitat-standardized effort data supplied by the SPC OFP.

5. The modeling period was changed to start in the first quarter of 1975 and run through to the start of 2002, to enable a better coverage of the regime shift that occurred in 1984.

6. Due to the extension of the modeling period to before the start of the environmental data, the environmental data are correlated with recruitment outside the model.

7. The model is fitted to otolith length-at-age data to provide information for estimating mean length at age and variation in length at age.

It appears that the yellowfin population in the EPO has experienced two different productivity regimes (1975–1983 and 1984–2001), with greater recruitment and resulting biomass during the second than the first. The SBR of yellowfin in the EPO was below the level that will support the AMSYs during the low-recruitment regime, but above that level during the high-recruitment regime. The two different productivity regimes may support two different levels of AMSY and associated SBRs. The current SBR is above the SBR level at AMSY. The effort levels are estimated to be less than the levels that will support the AMSY (based on the current distribution of effort among the different fisheries). However, due to the large recruitment that entered the fishery in 1998, the catch levels are greater than the corresponding values at the AMSY. Because of the flat yield curve, current effort levels are estimated to produce, under average conditions, catch that is only slightly less than AMSY. Future projections under the current effort levels and average recruitment indicate that the population will decline to an SBR level less than the current level, but will remain above that which will support the AMSY. These simulations were carried out using the average recruitment for the 1975–2001 period. If they had been carried out using the average recruitment for the 1984–2001 period it is likely that the estimates of SBR and catches would be higher.

The analysis of yellowfin in the EPO indicates that strong cohorts entered the fishery in 1998 through 2000 and that these cohorts increased the population biomass during 1999 and 2000. However, they have now moved through the population, and the biomass decreased in 2001. The overall average weights of yellowfin tuna that are caught have consistently been much less than the critical weight, indicating that, from the yield-per-recruit standpoint, the yellowfin in the EPO are not harvested at the optimal size. There is substantial variability in the average weights of the yellowfin taken by the different fisheries, however. The AMSY calculations indicate that the yield levels could be greatly increased if the fishing effort were directed toward the fisheries that catch yellowfin closest to the critical weight (longlining and purse-seine sets on yellowfin associated with dolphins, particularly in the southern area). This would also increase the SBR levels.

Moderate changes in the level of surface fishing effort in the EPO are predicted to affect the SBR, the total catch of the longline fleet, and the average weight of fish in the catch from all fisheries combined. Increasing the level of surface fishing effort to 125% of its recent average would decrease the SBR, average weight of fish in the combined catch, and total catch taken by the longline fleet. Reducing the level of surface fishing effort to 75% of its recent average would have the opposite effects. The catch from surface fisheries would increase only slightly with a 25% increase in the level of surface fishing effort. The catch from surface fisheries would decrease moderately with a 25% decrease in the level of surface fishing effort. Avoiding the capture of unmarketable yellowfin tuna around floating objects, particularly fish-aggregating devices (FADs), would not significantly affect the SBRs and catches, but would moderately increase the average weight.

A sensitivity analysis was carried out to determine the effect of a stock-recruitment relationship. The results suggest that the model with a stock-recruitment relationship fits the data slightly better than the base case. The results from the analysis with a stock-recruitment relationship are more pessimistic, and they suggest that the effort level is greater than that which would produce AMSY; however the yield at this effort level is only slightly less than AMSY. The biomass is estimated to have been less than the biomass that would give rise to AMSY for most of the modeling period, except for the last two years.

The EPO assessment results are very similar to the results from the previous assessments. The major differences occur, as expected, in the most recent years. The current assessment estimates that the biomass increased in 2000 whereas the previous assessment estimated a decline. In addition, SBR and the SBR required to produce AMSY have increased compared to the previous assessment because average recruitment has been calculated over a longer period which includes more years from the low-recruitment regime.

It was recognized that the both the WCPO and EPO yellowfin assessments have a strong reliance on catch rates and the associated catchability assumptions. Abundance and catchability are highly confounded, in such a way that increasing abundance and increasing catchability may be indistinguishable in the data, and assessment results could vary dramatically depending on catchability assumptions. In the assessments described above, there is a strong assumption that catch rate standardization for the Japanese longline fishery via the habitat-based model is reliable and can account for important temporal trends in gear technology and targeting. The MFCL yellowfin assessment includes additional assumptions that longline catchability is equal across areas. This is a constraining assumption that prevents MFCL from estimating extremely divergent biomass estimates among different areas. However, efforts are made to use consistent data in the catch rate analyses (e.g., using only day sets to minimize bigeye targeting effects). The effects of constant catchability assumptions on the conclusions of future stock assessments should be investigated through sensitivity analysis.

WCPO and EPO yellowfin assessments both estimated recruitment time series with strong auto-correlation, or "regime shifts," although the regimes were not synchronized across the two regions. The presence of alternative regimes (assuming that they are not an artifact of catchability changes as indicated above) has important implications for the classical fishery descriptors that tend to only relate to a single average state (e.g., B_{MSY}, F_{MSY}). For example, the WCPO biomass was estimated to be above the levels that occurred in the initial years of exploitation for most of the time series. This is related to the recruitment history, that appears to be characterized by a low regime from about 1962–1975, followed by a high regime that persisted through the 1980s into the 1990s. Comparison of stock size with B_{MSY} during the productive period can falsely give the impression that fishing has a negligible effect, if one does not realize that the apparently high biomass is dependent on higher than average recruitment. Thus there is a concern that B_{MSY} is a poor reference point for stocks with high recruitment variability (particularly regime shifts). The related F_{MSY} was suggested as an alternative fishery reference point, but this has a different set of problems related to the assumption of fixed relative selectivities among gear types. It was suggested that alternative descriptive reference points should be considered for these stocks (including descriptors that are based on alternative recruitment time windows). It was also considered that current emphasis on MSY was a bit unfortunate, given that it has fallen out of favor as a target reference point (although still has merit as a limit reference point). Regardless of the choice of descriptor, it was pointed out that if the stock returns to a low recruitment regime, the WCPO assessment suggests that current catch levels may no longer be sustainable.

Assessment implications were discussed in light of the re-examination of movement dynamics inferred from tagging studies. Since average migration rates are now thought to be lower than previously assumed, it was argued that spatial representation that can describe some localized depletion is probably preferable to a fully aggregated model. It also follows that if localized depletion is important, then the descriptive reference points (e.g., B_{MSY}, F_{MSY}) might need to be considered in a spatially disaggregated context.

7.5 Research Coordination and Planning

The YRG identified the following specific tasks to be addressed prior to SCTB 16. Organizations assigned to take a lead in the compilation of each task are shown in parentheses.

1. Continued collection of, and where appropriate improved, fisheries statistics is required. Priority areas are those where there are gaps in the information needed for the assessment models. In particular, better catch, species composition and size composition are required for the Philippines, Indonesia and Vietnam (All, OFP in collaboration with Indonesia, Philippines and Vietnam).

2. Data collection programs for the main fishing fleets should be documented and, where possible, sources of under-reporting identified. Where this is an issue, some means of estimating under-reporting should be developed so nominal catch statistics can be corrected (All, OFP in collaboration with Indonesia, Philippines and Vietnam)

3. A better understanding of the fishing operating and strategies for individual fleets is required to help identify the appropriate fleet structures to be used in the assessment models. (All, OFP)

4. Compilation of pre-1962 Japanese longline data (catch, effort and size composition) is required for inclusion in stock assessment models. (OFP, NRIFSF)

5. Identification of methods or training programs is required to improve the identification of yellowfin and bigeye tuna in sampling programs. (OFP, NMFS, others)

6. Further studies are required to increase our understanding of the following.

    - the population dynamics of yellowfin tuna, including the influence of environmental variability.

    - the movement dynamics of yellowfin tuna, including the levels of mixing between regions and the likelihood of local or regional depletion.

    - the aggregation dynamics of yellowfin tuna and the ecological consequences of the use of FADs (e.g., ECO-TRAP hypothesis).

    - the association between regime shifts in oceanographic conditions in the Pacific and the productivity of yellowfin tuna.

7. Refinement of methods, and the better use of existing and new data, for standardization of purse seine and longline effort is required. Where appropriate, the data being complied by the FTWG should be utilized. In particular, additional archival tagging is required to help characterize the habitat and depth preferences of yellowfin

tuna in order to enable better estimation of effective effect. More effective reporting of the results is also required, together with sensitivity analyses to identify critical input assumptions. (OFP, CSIRO, IATTC, NMFS and UH)

8. Better identification and reporting of appropriate stock and recruitment indicators is required, including the greater use of empirical indicators based on observed catch, effort and size distributions. (OFP, CSIRO and IATTC)

9. Continued development of assessment models to incorporate the latest data and knowledge on fleet structure and the biology and movement of yellowfin tuna is required. Also, sensitivity tests should be conducted to identify critical input parameters and assumptions (e.g., the use of longline indices of abundance). (OFP and IATTC)

10. A new conventional tagging experiment is required in order to validate the recent level of fishing mortality estimated from the assessment models and to help refine estimates of natural mortality and movement. The data from such an experiment would also provide valuable additional information for future assessments based on these models.

7.6 Summary Statement

A summary statement for yellowfin was drafted, circulated to participants and discussed. The accepted wording appears below.

YELLOWFIN RESEARCH GROUP (YRG)—SUMMARY STATEMENT

Catches of yellowfin tuna represent the second largest component (21-28% 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.

The catch of yellowfin tuna in the WCPO first exceeded 200,000 mt in 1980. With the expansion of the purse seine fishery during the 1980s catches doubled to reach around 414,000 mt by 1992. Since that time yellowfin catches in the WCPO have varied between 326,000 and 494,000 mt, with the catches during the last five years being at historical high levels, averaging 464,000 mt. The catch during 2001 is currently estimated to be 473,000 mt, the second highest recorded. Purse seine vessels harvested the majority of the yellowfin catch (45% by weight) during 2001, while longline and pole-and-line fisheries caught 17% and 3% respectively and various other gears accounted for 34 % (mostly eastern Indonesia and the Philippines).

Nominal catch rates of yellowfin for purse seine fleets are characterized by strong interannual variability believed to be associated with variation in environmental conditions associated with the El Niño Southern Oscillation cycle. Catch rates for most fleets indicate no clear trend over the available time series of data, despite the increased efficiencies associated with the use of drifting FADs. Nominal catch rates of yellowfin for the Japanese distant water longline fleet display a steady decline during the 1980s, increased during the mid-1990s, dropped sharply to a historical low during 1999 before recovering somewhat during 2000. However, after accounting for the increased targeting on bigeye tunas since the mid-1970s, standardized catch rates for this fleet in most regions of the WCPO display large interannual variability, no overall long term trend, but somewhat higher values between the mid-1970s through to the late 1990s.

New research on the displacement patterns of tagged yellowfin, together with the results of research on juvenile recruitment patterns, indicate the possibility that short to medium (less than 1000 km) distance movements may be more characteristic of overall yellowfin movements patterns than long-distance migrations and large scale mixing. While further work with archival tags is required to increase our understanding of movement patterns, the higher degree of regionalization of yellowfin populations implied by these results increase the risk of localized depletions where catch levels are too high relative to local immigration rates of yellowfin.

New research on the trophic ecology of yellowfin associated with natural and man-made aggregation sites is also improving our understanding of the ecological consequences of the increased used of FADs. However, further work is required to understand habitat preferences, trophic dynamics and the influences of recent increases in fishing efficiencies (e.g., the increased used of drifting FADs) to help improve the standardization of catch rates.

Tag-based assessments from the early 1990s found exploitation levels of yellowfin tuna to be low to moderate at catch levels at that time, about 20-25 percent below those in recent years. However, more recent assessments of the yellowfin stock in the WCPO using the MULTIFAN-CL model indicate that fishing mortality has increased significantly since this time, largely as a result of catchability increases in the purse seine fisheries. The results from the latest assessment reaffirm these earlier findings as well as the result from last year's assessment that indicated recent recruitment may have declined significantly. The reasons for this decline remains uncertain though does not appear to be related to a decline in spawning biomass due to fishing. It is possible that a shift to a lower productivity regime characterized by lower average recruitment has occurred.

The recent declines in recruitment have produced a significant decline of around one-third in overall stock biomass since 1997. Biomass levels in 2000 and 2001 are estimated to be the lowest since the mid-1970s. The decline in biomass is most evident in the main catch regions of the western equatorial Pacific where current biomass is estimated to have declined by over 50 percent since the mid-1990s. For the WCPO in total, the current biomass is estimated to be around 35% less than that which would have occurred in the absence of fishing.

Attempts to estimate an MSY for yellowfin continue to be hampered by uncertainty in the stock-recruitment relationship and the age-specific exploitation patterns as well as other uncertainties in the stock assessment models. The possibility of two different productivity regimes also complicates the situation, as estimation of the MSY level and associated spawning biomass ratio (the ratio of spawning biomass to that for the unfished stock) are dependent on overall stock productivity. Nevertheless, the assessment reviewed by SCTB 15 reaffirms the result of the previous assessment that the yellowfin stock in the WCPO is presently not being overfished (i.e., $F/F_{MSY} < 1$) nor is it in an overfished state ($SSB/SSB_{MSY} > 1$). However, the current trends in both ratios are towards their respective reference points, and if a shift to a lower productivity regime has occurred, it is believed that present catches may not be sustainable.

There is increasing evidence that the north Pacific Ocean is undergoing an environmental regime change and this is likely to have an effect on the productivity and distribution of tunas in the Pacific Ocean. The results of recent assessments of yellowfin tuna in the WCPO suggest that the stock may be responding to this regime change with lower recruitment now than before. The results, however, have elements of uncertainty because of assumptions used in the assessment models and incomplete fisheries information available for the analyses. Furthermore, due to the short time-series on which they are based, estimates of recruitment and cohort strength in the most recent years are the most poorly determined. As a result, further years data will be needed to confirm the present results, especially in terms of future stock productivity. Nonetheless, if the stock is entering a regime of low recruitment, the current catch of 475,000 t is significantly higher than the estimated MSY for a low recruitment regime (~290,000 t) and is not sustainable. In such an event fishing mortality would need to be reduced, especially on juvenile yellowfin in the equatorial regions where the stock is believed to be close to if not already fully exploited. If, however, recent estimates of low recruitment are normal variability of a high-recruitment regime, the current catch is estimated to be close to the estimated MSY for a high recruitment regime and appears to be sustainable.

While recognizing continuing uncertainties associated with the present stock assessment, the Group 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 fishing mortality is recommended.

Furthermore, the Group believes that this uncertainty and its impact on stock status advice highlights the need for the following immediate actions.

1. the condition of the yellowfin stock should be closely monitored over the next few years
2. fishery data collections should be significantly improved, particularly for the fisheries that catch a significant amount of yellowfin tuna
3. options for fishery management actions required for maintaining a healthy stock in a low recruitment regime should be evaluated in order to be prepared should further analyses validate that the future is a low-recruitment regime
4. a greater understanding of changes in catchabilities is required in order to develop improved indices of stock abundance based on CPUE
5. further development of stock assessment models, particularly MULTIFAN-CL should be undertaken
6. the development of alternative recruitment indices, other than those provided by MULTIFAN-CL, should be developed
7. studies on the multi-species influences of the assessment should be carried out

The Group also saw the need for additional large-scale and archival tagging to help validate the recent level of fishing mortality estimated from the assessment models and provide additional information on yellowfin movement, natural mortality and exploitation rates to support future stock assessment analyses.

8. ALBACORE RESEARCH GROUP (ARG)

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

8.1 Regional Fishery Developments

The coordinator provided a brief overview of the albacore fisheries in the WCPO. South Pacific albacore consists of a single stock. Catch in 2001 reached about 51,000 mt with a noticeable increase of fish caught by longliners from some PICs. The total albacore longline catch in 2001 was 46,000 mt with approximately 50% taken by PIC longliners. Most of the albacore catch occurs from 10–50°S with less than 15% of the catch taken east of 150°W.

The total catch in 2001 was the highest since the peak recorded in 1989 when driftnet vessels fished in the region of the STCZ. The albacore surface fishery is now composed entirely of trollers with a fishing season spanning from November to April around the STCZ and in New Zealand coastal waters.

Albacore CPUE of Taiwanese longliners operating in the south Pacific shows a slight increase during the 1990s except at low latitudes where a decline was evident in recent years. The decline may be related to changes in fishing practices as the Taiwanese fleet targets bigeye and yellowfin particularly in the waters north of French Polynesia. Changes in fishing practices of PIC longliners may also explain some recent trends in the albacore CPUE recorded in the EEZs of these countries. Some of these vessels now have the flexibility to target different species. Catch rates in the New Zealand troll fleet were relatively stable throughout the 1990s and in recent years have converged with the US troll fleet, which typically has higher but more variable catch rates.

Length frequency data collected from longline and troll fleets indicate that each fishery harvests distinct age classes throughout the year with some overlap in the size composition of fish taken by both fisheries from January to March.

Fishing Practices

Mr. Williams presented ALB–4, an extension of a paper presented by Mr. Colin Millar to SCTB 14. Mr. Millar's paper attempted to identify and distinguish trends in targeting by the Taiwanese distant-water longline fleet, which has fished widely over a long time period throughout the south Pacific. The conclusion given was that it was difficult to distinguish where targeting occurs and species composition of the catch was probably more dependent on local availability of tuna species in the different areas being fished.

The emphasis of ALB–4 was to examine the targeting of albacore by Taiwanese longliners, by year and MULTIFAN-CL area. Species composition of albacore in the total tuna catch was analyzed over several combinations of time and area strata—all years by 5° latitude strata; five year periods by 5° latitude bands; quarters by 5° latitude bands; and 5° latitude and 5° longitude areas. The data, provided by the OFDC, demonstrated high proportions of albacore in southern latitudes, and a decline as vessels fished further north.

No significant changes were noted through the five-year periods. However, there were demonstrable differences when analyzed on a quarterly basis with the greatest variation seen in the middle MFCL area. The proportion of albacore caught in the 10–25°S latitude band peaked during the 4th quarter and was lowest during the 2nd quarter, a time period known to have relatively high bigeye and yellowfin catches.

The albacore proportion of the total longline catch was 20–40% at 0–5°S, 50–60% at 5–10°S, and 70–80% at 10–15°S. Albacore proportions vary considerably over longitude within the latitude bands of 0–5°S and 5–10°S. A higher proportion of albacore is evident between 175°E and 150°W. Within this area, the albacore proportion is typically double than the area west of 175°E.

Mr. Williams concluded that the albacore proportion was 100% with little variance to the south of 25°S. The albacore proportion decreased almost exponentially to the north of 25°S; bigeye targeting in the east is clearly apparent in recent years. The highest variation in albacore proportion was due to latitude but overall trends were fairly consistent and changes to the south Pacific albacore MULTIFAN assessments areas may be considered.

Topics requiring further research include a study of the Taiwanese fleet composition (especially freezer vessels) and targeting practices; other fleet characteristics; the influence of depth, time of set and subsurface water temperature on catch rates and variation of fish size with area. The future introduction of logbooks designed to gain a greater breadth of information will assist in these studies. The respective roles and importance of fisheries departments and observer programs in gathering and ensuring data quality also needs to be addressed.

8.2 Biological and Ecological Research

Dr. Jeffrey Polovina presented a new study (ALB–2) characterizing the oceanography of the American Samoan longline fishing grounds which primarily harvest albacore. Support has been awarded by the PFRP. The impetus of the project is in response to the rapid growth of the fishery to over 60 boats with an annual fishing effort of >6 million hooks.

Species such as blue marlin, wahoo, mahimahi and skipjack are also targeted by local troll fishers and form much of the incidental catch in the deep longline fishery. There are concerns that the local supplies of these large pelagics may be threatened as catch rates of these species in both the troll and longline fleets have declined.

The American Samoan fishing grounds are heavily influenced by the meandering flow of the South Equatorial Current and two prominent geological features may further complicate the flow regime and water column properties. The undersea volcano, Vailulu'u rises to within 590 m of the sea surface in the eastern fishing grounds and the Tonga trench is to the immediate southwest of American Samoa.

Satellite oceanographic remote sensing and *in situ* shipboard surveys will be used, coupled with fishery information, to develop a functional understanding of spatial and temporal occupation and movement of south Pacific albacore and the role of the environment on longline fishing performance. Time-depth-temperature recorders (TDRs) will also be used in conjunction with catch information from fisher's logbooks. If possible data from fish instrumented with popup archival tags will also be used.

Discussion focused on the use of popup tags in general and on albacore in particular, which are perceived to be a poor species for archival tagging due to capture induced biotrauma. It was suggested that further tagging of albacore from the alia fleet would make a useful additional component to the study and that the work should be extended to the adjoining waters of independent Samoa.

Length Frequency

Dr. Murray presented a paper on the length structure of commercial landings of troll caught albacore tuna at the two main landing sites in New Zealand during the 2001–2002 fishing season (ALB–5). This sampling program was initiated in 1997 by SPC with funding support from Taiwan. New Zealand has continued sampling in recognition of the critical importance of the data input to the MULTIFAN-CL regional assessment.

Sampling of 1000 albacore per month per port is carried. Sampling strategy was designed to ensure that any size/area/boat stratification is captured (e.g., smaller fish appear to be caught near to shore and larger fish further offshore). Fish were randomly sampled from at least five vessel unloadings, with sampling spread evenly throughout each month. The New Zealand Ministry of Fisheries has required a target coefficient of variation (CV.) for the length composition of 30% (mean weighted CV across all size classes). The appropriateness of this performance standard for both this study and other similar sampling regimes in the region is open for review and comment. Mean fork-length (FL) for both ports was the same (63.6 cm). However, size distribution between the two ports was noticeably different. An inquiry was made whether the combined data had been raised to the port landings and noted that such raised data should be re-parameterized to the original sample size.

Stock assessment scientists confirmed that, with all other data coming from mature longline caught fish, this is the main window of interpretation for the juvenile albacore stock and has become particularly important with the decline of the STCZ surface fleet. The continued sampling of this fishery is keenly encouraged.

8.3 Stock Assessments

MULTIFAN-CL

Dr. Hampton presented ALB–1, an assessment of albacore tuna in the south Pacific Ocean using the MULTIFAN-CL model. This year's analysis used similar data and structural assumptions as in previous analyses. The major stock assessment conclusions of the analysis are as follows.

1. Recruitment was higher on average prior to 1980 and during the early 1990s. Recent recruitment levels have been below average, but these estimates are relatively imprecise.

2. Biomass levels have largely reflected recruitment variation, peaking in the late 1970's. Current biomass is estimated to be approximately two-thirds of the maximum estimated level and about 85% of the estimated equilibrium unexploited biomass.

3. Fishing mortality is higher for adult albacore than juveniles, reflecting the predominant longline exploitation. Fishing mortality rates are lower than natural mortality rates over a plausible range of tag-reporting rates.

4. The impact of the fisheries on total biomass is estimated to have increased over time, but is likely to be low, a reduction of <20% 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, over a plausible range of assumed tag-reporting rates, the model results indicated that current catches are less than the MSY, aggregate fishing mortality is less than F_{MSY} and the adult biomass is greater than B_{MSY}.

Research required to improve the quality of the south Pacific albacore assessment includes the following.

1. Improved estimates of total catch and fishing effort by Pacific Island longline fleets.

2. Information on vertical habitat utilization by albacore and gear configuration and fishing depth information for longline vessels targeting albacore, to enable estimation of effective longline fishing effort.

3. Accurate estimation of fishery impacts and sustainable yield ultimately requires information allowing more accurate estimation of absolute abundance. For widely distributed mobile species such as albacore, large-scale conventional tagging probably remains the only viable option.

A scientist from the OFDC inquired as to a projection on future recruitment. Dr. Hampton indicated that the recent recruitment doesn't look higher than the previous years and he highlighted the poor reliability of these data on recruitment considering the large confidence intervals observed in recent years. Dr. Chien-Hsiung WANG commented that considering several regions in the stock assessment is necessary and that it could be important to revise the spatial boundaries of regions. A previous study inferred the existence of three albacore groups that might have different migration routes; however, more data are necessary to confirm this hypothesis.

Mr. Beverly commented about a discussion he had with a fisherman working in the northern hemisphere and who caught large albacore (~20 kg) with a deep troll line, but according to the data presented albacore caught on a troll line are smaller than those caught on a longline. Dr. Hampton asked if the fishermen specified the depth at which he was fishing. According to Mr. Beverly the fisherman didn't want to give this information because he was fishing at a much deeper depth than the other fishermen.

A scientist from CSIRO discussed the fact that reference points in the MULTIFAN-CL assessments have large 95% confidence intervals and that tagging data may help reduce the intervals. He was concerned about the influence of the Taiwanese longline CPUE as this fleet is of major importance for CPUE and is used as an abundance index. Dr. Hampton agreed and indicated that the Taiwanese fleet probably changed their technology and hence their fishing effort. These changes of technology were confirmed by a scientist from OFDC who also indicated that the Taiwanese fleet move seasonally to target bigeye.

Mr. Su'a asked whether biomass estimates would be available by region. He also talked about the general decrease of biomass from the assessment. Dr. Hampton indicated that the decrease in biomass was really modest according to estimates and quite similar when considering the three regions separately. He also highlighted the fact that recruitment in the model is assumed to occur in the southern area only and movements are inferred from this area. However, the lack of tagging data does not allow a confirmation of this assumption and induces uncertainty in the model. Tagging data is an important task to address for the improvement of the model.

Dr. Fonteneau informed the group that albacore in other oceans are caught with live bait by Spanish pole-and-line vessels, by new French purse seiners and by midwater pelagic trawlers, fish being located by sonar.

Dr. Hampton stated that current assessment is that the albacore stock is healthy and could sustain additional catches, however the precautionary approach should be considered if countries are considering fishery increases as local effects may appear even if the regional stock is in a good condition.

Dr. Sakagawa noted the presence of Chilean and Spanish longline fleets in the south Pacific. Though these fleets probably do not target albacore, it is important to obtain information from these fleets such as fleet size and catches.

Mr. Beverly noted that the proportions of bigeye and yellowfin are decreasing in longline catches within French Polynesia, New Caledonia, Samoa and American Samoa while albacore is increasing. He referred to a question raised by Dr. Sibert on the migration of tuna species and wondered if the decline in bigeye and yellowfin proportions may represent a high exploitation of resident fish, which are not replaced by migratory bigeye/yellowfin but rather by albacore. He also asked if advice could be given to island countries to avoid a potential local depletion of bigeye and yellowfin. Dr. Hampton responded that even if the fisheries are targeting bigeye and yellowfin, albacore in subtropical areas will always be dominant. He indicated that the depletion of bigeye and yellowfin has been observed in developing fisheries. He highlighted that local depletions may occur even if the stock is locally abundant and enhanced the importance of a cautious approach in local fisheries management.

SEPODYM

Dr. Lehodey presented preliminary results of an application of a spatial environmental population dynamics model (SEPODYM) to albacore in the Pacific Ocean (ALB–6). Compared to the skipjack application, the parameterization has been modified to take into account the biological patterns of the species, its lower temperature optimum and its deeper vertical habitat. For the initial simulation, the spawning habitat was only constrained by SST. Results showed realistic spatial distributions of larvae and juveniles and of adults in both the northern and southern hemispheres with a natural separation between the two stocks along the equator. Recruitment did not show important fluctuations as expected with a spawning habitat index only constrained by SST. However the level of recruitment and biomass in the three regions defined for the MULTIFAN-CL analysis for the southern stock were similar to the average levels predicted by the statistical population model. These initial results suggest that the modeling approach developed for skipjack can be adapted to long living species like albacore with appropriate parameterization. Parallel development in modeling and parameterization of both skipjack and albacore will assist in exploring the recruitment mechanisms that show apparent opposite trends. Future tasks will consider the effect of primary productivity in the spawning habitat and the introduction of fisheries in the model.

Dr. Chien-Hsiung WANG noted a large difference between recruitment estimations between the SEPODYM and MULTIFAN-CL models. Dr. Lehodey indicated that spawning was only constrained by temperature in this preliminary study and a very flat recruitment pattern results. This preliminary pattern does not reflect reality well and the addition of primary production as a constraint could improve the parameterization and results may be more comparable between assessments.

Surplus Production Model

Dr. Chien-Hsiung WANG presented the estimation of the populations parameter, r, q and K based on a surplus production model (ALB–7). The population parameters, r=1.90056, q=9.2925E-09, K=161,786 mt were obtained by fitting the standardized effort and CPUE to a Schaefer's surplus production model. The difference between the net production rate and fishing mortality showed the index of the biomass fluctuation. Biomass decreased from the virgin stock continuously before 1994. Thereafter, biomass varied year by year and around a stable level. The albacore stock was considered to be in good condition.

8.4 Research Coordination and Planning

The Chairman discussed the work plan for the forthcoming year and indicated that two main points of interest that needed to be addressed.

1. Improvement of data quality that includes the monitoring of fishing vessels and observer programs especially for the small Pacific Island countries. An important task to improve the observer data quality is to provide them feedback on how the data they collect is used and useful to research and what is the outcome these studies.

2. Improvement of inputs to stock assessments through both conventional and archival tags to acquire information on the habitat of the species.

Dr. Murray stressed the importance of being informed on observer data and that it was necessary to inform the observer programs on what sort of data to collect for stock assessment purposes. Mr. Peter Sharples indicated that data collection forms are standardized in the region and revised every two years and are fully documented in reports compiled by the SPC and FFA. Dr. Murray suggested that this report should be distributed to the working group to know what data are collected and to make improvements. Dr. Sakagawa requested that the countries concerned by albacore fisheries should provide information on their fisheries as accurately as possible. Mr. Thoulag raised the issue that observer coverage and data collection issues are not specific to albacore, and it may be necessary to give specific directives on data collection to all observers. Dr. Hampton suggested that observers using TDRs on longlines could collect information on albacore habitat. Dr. Murray noted the importance of maintaining studies on fishing characteristics for the Taiwainese fleet and other fleets for evaluation of the CPUE.

8.5 Summary Statement

A summary statement for south Pacific albacore was drafted, circulated to participants and discussed. The accepted wording appears below.

ALBACORE RESEARCH GROUP (ARG)—SUMMARY STATEMENT

The South Pacific albacore comprises a single stock. Catch in 2001 reached about 52,000 mt with a noticeable increase of fish caught by longliners from some Pacific Island countries (PICs). These vessels accounted for almost 50% of the total longline catch, which was estimated at 46,000 mt in 2001. Less than 15% of fish are taken east of 150° west and most fishing occurs from 10ºS to 50°S.

The total catch last year was the highest since the peak recorded in 1989 when driftnet vessels fished in the region of the subtropical convergence zone (STCZ). The albacore surface fishery is now composed only of trollers with a fishing season spanning from November to April around the STCZ and in New Zealand coastal waters.

Albacore CPUE of Taiwanese longliners operating in the South Pacific showed a slight increase during the 1990s except at the lowest latitudes where a drop was recorded in the most recent years. This appears to be related to changes in the fishing practices of this fleet towards targeting of bigeye and yellowfin, particularly in the waters north of French Polynesia. Changes in fishing practices of PIC longliners may also explain some recent trends in the albacore CPUE recorded in the EEZs of these countries. Some of these vessels are now fitted to target different species with flexibility.

CPUE for the New Zealand troll fleet has been relatively stable during the 1990s, showing some convergence in recent years with that of the US troll fleet, which was previously higher and more variable.

The length frequency data collected from longline and troll fleets indicate a single multiple-age class mode throughout the year with some overlap in the size composition of fish taken by both fisheries from January to March.

From the most recent stock assessment carried out with the MULTIFAN-CL model, biomass levels appear to reflect the variation of recruitment—the current biomass is about 85% of the estimated equilibrium unexploited biomass.

The impact of the fisheries on total biomass is estimated to be low (reduction of less than 20% from the unexploited conditions). However, there is a need to improve the assessment with additional tagging data and more information on tag-reporting rates. Better knowledge of the South Pacific albacore stock with respect to recruitment and biomass is expected from the use of a high resolution environmental and population dynamics simulation model originally developed for skipjack (SEPODYM model). With regard to albacore this model gives encouraging preliminary results but further refinement is required.

The MULTIFAN-CL model results indicate that current catches are less than the MSY, aggregate fishing mortality is less than F_{MSY}, and the adult biomass is greater than B_{MSY}. The assessment could be improved by the following priority research and monitoring activities.

1. Strengthen the monitoring of catch, effort and size composition of albacore caught by PIC longline fleets.

2. Obtain information on the fishing depth of longline gear targeting albacore.

Conduct conventional tagging to improve estimates of natural mortality, fishing mortality and movements, and archival tagging to obtain information on albacore vertical habitat utilization.

9. BIGEYE RESEARCH GROUP (BRG)

The coordinator, Dr. Chi-Lu SUN, led the session of the Bigeye Research Group.[1]

9.1 Regional Fishery Developments

The preliminary estimate of Pacific-wide catch of bigeye in 2001 is 183,372 mt, slightly down on the record catch of the previous year (204,149 mt). In the WCPO, the 2001 catch was an estimated 107,262 mt, unchanged from 2000. The longline catch in the WCPO in 2001 increased to a record level (61,019 mt) while the purse seine catch (26,707 mt) decreased by about 15% from the level observed in 2000.

Mr. Williams presented a summary of aggregated catch/effort and size data for bigeye available to the SCTB (BET–4). At this stage, the paper consists of separate longline and purse seine tables indicating the number of available bigeye catch/effort records by vessel fleet, and time/area strata. The number of bigeye length frequency records available by spatial and temporal strata are given for longline and purse seine fleets with additional weight frequency data available for some longline categories. Mr. Williams indicated that more detailed data related to these tables is available in the OFP Data Catalogue on the SPC website. Further iterations of this report may include text indicating data sources, coverage rates and data quality.

9.2 Biological and Ecological Research

Tagging

Dr. Shiham Adam described an analysis of conventional tagging data from the Hawai‘i Tuna Tagging Project (BET–5). The tagging work was designed in response to local concerns over possible over-exploitation, interaction and market competition related to Hawai‘i based fisheries for bigeye and yellowfin tuna, while providing a means to estimate movement patterns, exploitation rates and residence times of bigeye and yellowfin in Hawaiian waters. Much of the tagging and interaction concerns focused on the offshore tuna handline fishery operating on the Cross Seamount and offshore FADs.

Tag recapture data was incorporated into a size and site-specific tag-attrition model, developed to examine natural mortality, fishing mortality and transfer rates by spatial areas and aggregation types (i.e., FADs, seamounts and open water areas). Yellowfin were found to be highly vulnerable on the seamount but were estimated to have half the residence time of bigeye and make up a minor proportion of the catch. For both species, emigration was found to be the greatest source of overall losses from the seamount. While

[1] The BRG Section 9 of this report is limited to descriptions of presented papers. Summary discussions and comments on the presentations were not submitted to the meeting secretariat.

exploitation rates by the seamount fishery were considered moderate, the current level of the fishery does not appear to be adversely impacting the local tuna resource or their recruitment to inshore fisheries. However, Dr. Adam suggested that the seamount fishery be closely monitored, considering the increased vulnerability of tuna aggregations on seamounts and FADs to simple gear types.

Mr. Itano followed on with related discussion points listed at the end of WP BET–4. The importance of improved catch and effort monitoring of the offshore handline fishery was noted, considering that this fishery harvests a significant proportion of bigeye taken by all Hawai‘i based pelagic fisheries, and the proportion of bigeye in the reported catch is considered under-reported or misreported as yellowfin tuna. The analysis does not support the need for restrictive management based on biological parameters or stock depletion. However, he noted that problems of gear interaction and market competition between fishing sectors remain, suggesting that further discussion of local management should be based on social and economic considerations.

Increased research efforts on the link between Hawai‘i and equatorial bigeye resources was suggested due to increasing international concern over the condition of the main WCPO bigeye stock which is most likely the source of recruits to Hawai‘i’s handline and longline fisheries for bigeye tuna.

Dr. Jeff Polovina presented a study to investigate the role of oceanography on the aggregation and vulnerability of bigeye tuna in the Hawai‘i-based longline fishery (BET–3). Research objectives are to 1) examine closely the relationships between bigeye tuna CPUE from the Hawai‘i-based longline fishery and oceanographic features observed using moored, shipboard, and satellite time series of the vertical and spatial structure of the upper ocean; and 2) utilize those relationships to develop methods to improve stock assessment estimates based on standardized logbook CPUE using remotely-sensed observations of sea surface height (altimeter), sea surface temperature (AVHRR), ocean color (SeaWiFS), and surface winds (scatterometer). This project is funded by the PFRP with principal investigators Rusty Brainard, Jeffrey Polovina and Michael Seki.

The first major component of this program was the deployment of an oceanographic mooring to provide a high resolution time series of the vertical oceanographic structure. Two mooring deployments and recoveries have been made collecting temperature, current velocity and shear, conductivity and dissolved oxygen data.

The second major component is a series of shipboard surveys to (1) expand the spatial representativeness of the mooring observations, (2) closely examine the vertical water column structure associated with oceanic variability; e.g., fronts, eddies and frontal meanders, and (3) obtain information of longline performance particularly in response to prevailing oceanographic conditions. Five research cruises have been conducted and have focused on obtaining measurements of dynamic oceanographic variability and its influence on the biology.

The final major component of the program involves examining relationships between surface features observed using satellite remote sensing and both the vertical structure of the upper ocean temperatures and currents and fishery-dependent CPUE of bigeye tunas. Early efforts focused on relating satellite observations of pronounced mesoscale features (e.g., eddies), to shipboard observations of the vertical structure. These efforts have since moved on to refining the use of Topex altimetry to index changes in vertical thermal structure. Preliminary examination of concurrent *in situ* vertical temperature collected on research cruises and along track Topex satellite sea level height measurements indicates that there is a generally a good coherence between the two parameters.

9.3 Stock Assessments

Dr. Hampton presented an assessment of bigeye tuna using the MULTIFAN-CL model (BET–1). The assessment is applied to bigeye tuna in the WCPO; however, a separate analysis for the entire Pacific Ocean is also available.

This year's analysis differs from previous analyses in that a five region spatial structure is used for the WCPO and that weight frequency data for several longline fisheries (e.g., Australia and offshore fleets unloading in Guam) were incorporated into the model for the first time. Figure 5 illustrates nominal and standardized longline catch rates for the five region model.

The four data components that contribute to the log-likelihood function in the model fit are 1) total catch data, 2) length-frequency data, 3) weight-frequency data and 4) tagging data. The results of fitting the model to these data are as follows.

- The fit to the total catch data by fishery is very good, which reflects our assumption that observation errors in the total catch estimates are relatively small.
- The fit to the length data has captured the main features of the data. There appears to be some systematic lack of fit to the weight-frequency data for longline fisheries in regions 2 and 3. Length-frequency data are also available for these fisheries and these data are not always consistent with the weight-frequency data, which may result from weight data coming from Taiwanese longliners in region 2 and from Hawai‘i and Pacific Island longliners in the case of region 3. In contrast, the length-frequency data are sourced mainly from Japanese longline fleets.
- The fit of the model to the tagging data is fairly consistent with the aggregate tag-return data, although the predicted returns are generally fewer than observed for the longer times at liberty. This discrepancy is almost entirely due to an inability of the model to predict the large numbers of returns recorded by the Australian longline fishery.

The major stock assessment conclusions of the analysis are as follows.

- Recruitment varies seasonally and interannually, but no persistent trends are evident in the time-series. Recruitment in the late 1990s was at above-average levels.
- Bigeye tuna biomass in the WCPO declined to around 60% of its early 1960s level but has recently increased as a result of above-average recruitment in the late 1990s.

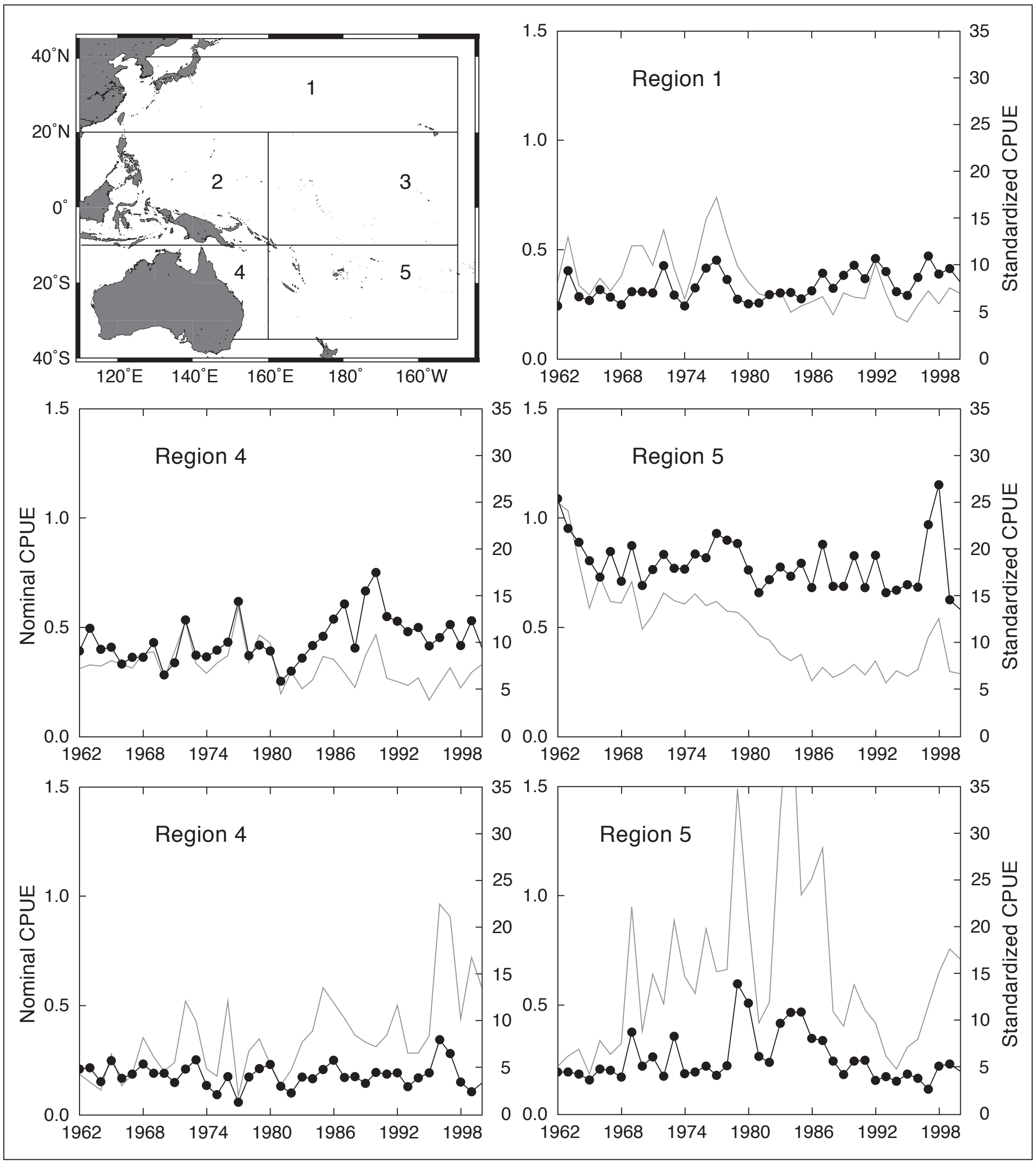

Figure 5. Nominal (solid line with dots) and standardized (solid line) catch rates for bigeye tuna within the five regions used in the MUTLIFAN-CL assessment in the WCPO.

- By the late 1990s, the biomass is estimated to have been approximately 35% below the level it would have been if fishing had never occurred. The impact of the fisheries is differentially high in the tropical regions (>50%) compared to the subtropical regions.
- Fishing mortality for juvenile bigeye tuna has increased strongly since about 1992, partly as a result of catchability increases in the purse seine fisheries. But a significant component of the increase is attributable to the Philippines and Indonesian fisheries, which have the weakest catch, effort and size data. This is of continuing concern. There has been recent progress made in the acquisition of a large amount of historical length frequency data from the Philippines and regular sampling operations are now in place there. However, uncertainty with the total catch and size composition data for the Indonesian fishery continues to be a problem.
- While aggregate fishing mortality increased to at least the mid 1990s, F_t/F_{MSY} has remained below the reference level of 1.0, indicating that overfishing has not yet occurred. Also, $B_t^{adult}/B_{MSY}^{adult}$ has remained significantly above 1.0, indicating that the stock has not yet reached an overfished state.

Recommended research and monitoring required to improve the bigeye tuna assessment include the following.

- Continued monitoring and improvement in fisheries statistics is required. In particular, better data generally are required for the Philippines and Indonesian fisheries, and improved sampling coverage of the purse seine fleet is required to improve the estimates of catch.
- New conventional tagging experiments, undertaken regularly, would provide additional information on recent levels of fishing mortality, refine estimates of natural mortality and possibly allow some time-series behavior in movement to be incorporated into the model.
- In view of the importance placed on longline effort data by this model, additional archival tagging is required to characterize the depth distribution of bigeye tuna and its environmental correlates across the stock range to enable better estimation of effective longline effort.

Dr. SUN presented an update on a WCPO bigeye stock assessment using an A-SCALA approach previously reported on at SCTB 14 (BET–4). The model examines catch, effort and size composition data for four regions and 15 fisheries by quarter. The method uses size composition data when available, but uses a population dynamics model to predict these data during time periods where size data is lacking.

It was noted that the analysis incorporated an increase in fishing mortality on bigeye over time due to expanding FAD based purse seine fisheries and expansion of Philippine and Indonesian fisheries on juvenile fish. Increasing trends in recruitment were noted, possibly due environmental changes or confounded by increasing catchabilities in surface fisheries.

Results of the analysis estimated a MSY for WCPO bigeye of 57,400 mt per annum, which is substantially below current catch levels. Longline catches were predicted to decline to levels seen in the late 1980s and early 1990s while purse seine catches were projected to initially increase before declining.

It was noted that increased catches in the Indonesian fishery resulted in substantial changes to the model estimates of yields in other fisheries. This is due to the small size of bigeye taken by the Indonesian fishery. However, the actual landings and size composition of bigeye in the Indonesian fishery is not well known and size specific estimates of juvenile bigeye from this region are uncertain. Therefore, the impact of the Indonesian fishery on model estimates is potentially high, but also very uncertain. The same could be said for floating object purse seine fisheries or the Philippine fishery. The need for improved data from these fisheries was reinforced.

Dr. Maunder presented BET–2, an assessment of bigeye tuna in the EPO using an age-structured, catch-at-length analysis (A-SCALA).

The A-SCALA method has been used for a previous assessment of bigeye in the EPO, and the current version of A-SCALA is the same as that used for the previous assessment with modifications to some assumptions. The modifications include fixing variation of length at age based on otolith data from the western Pacific bigeye stock, down-weighting the influence of the floating-object catch and effort data on abundance, using habitat-based standardized effort for the longline fisheries, and basing future projections on average observed fishing mortality rather than on effort multiplied by average catchability and selectivity. New and updated catch, effort, and environmental data have been included in the assessment. Purse seine and baitboat catch, effort, and length-frequency data were updated for 1980 to 2000 and new data were included for 2001. New Taiwanese longline catch data were included for 1998. Japanese catch data were updated for 1998 and 1999, and new data included for 2000.

There have been important changes in the amount of fishing mortality caused by the fisheries that catch bigeye tuna in the EPO. On average, fishing mortality on bigeye less than about 20 quarters old has increased since 1993, and that on fish more than about 20 quarters old has decreased since then. The increase in average fishing mortality on the younger fish can be attributed to the expansion of the fisheries that catch bigeye in association with floating objects. The basecase assessment suggests that (1) the use of FADs has substantially increased the catchability of bigeye by fisheries that catch tunas associated with floating objects, and (2) that bigeye are substantially more catchable when they are associated with floating objects in offshore areas.

Recruitment of bigeye tuna to the fisheries in the EPO is variable, and the mechanisms that explain variation in recruitment have not been identified. Nevertheless, the abundance of bigeye tuna being recruited to the fisheries in the EPO appears to be related to zonal-velocity anomalies at 240 m during the time that these fish were assumed to have hatched.

Over the range of spawning biomasses estimated by the basecase assessment, the abundance of bigeye recruits appears to be unrelated to the spawning potential of adult females at the time of hatching.

The biomass of 1+-year-old bigeye increased during 1980–1984 and reached its peak level of about 520,000 mt in 1985. After reaching this peak, the biomass of 1+-year-olds decreased to an historic low of about 232,000 mt at the start of 2002. Spawning biomass has generally followed a trend similar to that for the biomass of 1+-year-olds. There is uncertainty in the estimated biomasses of both 1+-year-old bigeye and of spawners. Nevertheless, it is apparent that fishing has reduced the total biomass of bigeye present in the EPO.

At the beginning of January 2002, the spawning biomass of bigeye tuna in the EPO was at a low level. At that time the SBR was about 0.28 (C.I. 0.15–0.41). This estimate is the lowest seen in the modeling time period and is less than the estimate of SBR_{AMSY} (the spawning biomass ratio required to produce the average maximum sustainable yield), suggesting that, at the start of January 2002, the spawning biomass of bigeye in the EPO was probably less than the level that is required to produce the AMSY.

The average weight of fish in the catch of all fisheries combined has been below the critical weight (~35.5 kg) since 1993, suggesting that the recent age-specific pattern of fishing mortality is not satisfactory from a yield-per-recruit perspective.

Work continued this year on the Pacific-wide bigeye assessment method, which was described at the second meeting of the Scientific Working Group. The method has undergone some important improvements during the year, but new results for the EPO are not yet available. Initial results show that the MULTIFAN-CL method, which is used for the Pacific-wide bigeye assessment, gives essentially identical results to A-SCALA when using the same assumptions and data.

9.4 Research Coordination and Planning

The Group noted that the following research and fishery monitoring activities should lead to improved stock assessment for bigeye tuna in the WCPO.

1. Improved catch, effort and size composition data from the Indonesian and Philippines fisheries, and from the rapidly developing Vietnamese fishery.

2. Improved estimates of bigeye catch from the WCPO purse seine fishery.

3. Continued acquisition of data on bigeye tuna habitat (through archival and pop-up satellite archival tagging), and the incorporation of these data into habitat models to provide estimates of effective longline effort.

4. Additional conventional tagging of bigeye to provide additional information on fishing and natural mortality, movements and other parameters.

9.5. Summary Statement

A summary statement for bigeye was drafted, circulated to participants and discussed. The accepted wording appears below.

BIGEYE RESEARCH GROUP (BRG)—SUMMARY STATEMENT

Bigeye tuna account for a relatively small proportion of the total tuna catch in the Pacific Ocean, but their economic value probably exceeds US$1 billion annually. The preliminary estimate of Pacific-wide catch of bigeye in 2001 is 183,372 mt, slightly down on the record catch of the previous year (204,149 mt). In the WCPO, the 2001 catch was an estimated 107,262 mt, unchanged from 2000. The longline catch in the WCPO in 2001 increased to a record level (61,019 mt) while the purse seine catch (26,707 mt) decreased by about 15% from the level observed in 2000. During the meeting, preliminary catch estimates were presented on a rapidly developing longline fishery based in Vietnam, for which the catch in 2001 may consist of up to 70% bigeye tuna. Catches by other gears (pole-and-line and various gears in Indonesia and Philippines) remained largely unchanged from the levels reported in recent years. In the EPO, bigeye catch in 2001 was an estimated 76,110 mt, down considerably from the 2000 catch of 97,402 mt. This decrease was due to a drop in the purse seine catch from the 2000 record level of 70,098 mt to 43,009 mt in 2001. The EPO longline catch of bigeye in 2001 was 33,101 mt, about a 20% increase over the previous year.

Considerable progress has been made in understanding bigeye tuna vertical habitat utilization and movements as the results of archival tagging experiments in various parts of the Pacific come to hand. Work being conducted in the Coral Sea, around Hawai‘i, and in the eastern tropical Pacific suggests that bigeye vertical distribution varies across the Pacific and is likely to be related to variation in several oceanographic variables. This information will be of considerable value in the estimation of effective longline effort for bigeye using habitat models. Movement data thus far collected from archival tags suggest a degree of regional fidelity, although longer term recaptures are required before strong inferences can be drawn regarding stock structure and mixing rates.

The Group examined several nominal and standardized CPUE time series. The purse seine CPUE trends for the main fleets generally reflect the extent to which associated sets, especially on drifting FADs (which have produced higher juvenile bigeye catches in recent years), have occurred in the fishery. Nominal CPUE for Japanese longliners fishing in the tropical WCPO has been fairly stable over a long period of time. However, habitat-model standardized CPUE, which removes variability due to changes in targeting and some environmental variables, shows a declining trend.

Two stock assessment models were presented for WCPO bigeye, one using the MULTIFAN-CL method and the other using the A-SCALA method. While some of the details of the respective model results differed substantially because of different assumptions and data analyzed (e.g., absolute biomass levels and biomass trends differ appreciably in the two analyses), both indicate that recent fishing mortality rates, particularly in the tropical region where most catch occurs, are near or above commonly used overfishing reference points. The MULTIFAN-CL analysis indicated somewhat lower impacts of fishing in the sub-tropical regions of the WCPO. On a WCPO-wide basis, the MULTIFAN-CL model estimated that fishing mortality rates and spawning biomass had not yet reached their respective MSY levels. The A-SCALA model suggested that current levels of fishing mortality are likely to be beyond the F_{MSY} reference point, although it was noted that some of the assumptions used in this analysis (particularly the assumption of constant catchability by the purse seine fishery) are probably unrealistic. However, both analyses agree that further increases in fishing mortality rates are unlikely to result in significant increases in long-term average yield with the current pattern of age-specific exploitation. Moreover, it is clear that the high juvenile fishing mortality generated by the fisheries in the Philippines and Indonesia, and by purse seine FAD and log sets in the WCPO, are limiting potential yields from the fishery and are likely impacting longline fishery performance in the tropical region.

The Group recognized that (1) the fishing mortality rates on adults are low and without a trend; (2) there are continuing uncertainties inherent in the assessments and, in particular, uncertainties associated with estimates of the juvenile bigeye catch; and (3) there is concern regarding increasing catches, indications that current yields appear to be sustained only by recent periods of above average recruitment, and that fishing mortality rates on juveniles are high (relative to natural mortality) and increasing. For these reasons, the Group reiterated its recommendation that there be no further increase in the fishing mortality rate on juvenile bigeye tuna in the WCPO.

The Group noted that the following research and fishery monitoring activities should lead to improved stock assessment for bigeye tuna in the WCPO.

1. Improved catch, effort and size composition data from the Indonesian and Philippines fisheries, and from the rapidly developing Vietnamese fishery;

2. Improved estimates of bigeye catch from the WCPO purse seine fishery;

3. Continued acquisition of data on bigeye tuna habitat (through archival and pop-up satellite archival tagging), and the incorporation of these data into habitat models to provide estimates of effective longline effort;

4. Additional conventional tagging of bigeye to provide additional information on fishing and natural mortality, movements and other parameters.

10. BILLFISH AND BYCATCH RESEARCH GROUP (BBRG)

The coordinator, Mr. Paul Dalzell led the session of the Billfish and Bycatch Research Group (BBRG). During the15th SCTB the BBRG dealt mainly with turtle bycatch in WCPO pelagic fisheries, and other species bycatch in WCPO pelagic fisheries.

10.1 Turtle Bycatch in WCPO Pelagic Fisheries

Mr. Williams presented the results of an OFP review of turtle bycatch in longline fisheries in the tropical WCPO from observer data. There was little information on the nature of fishery interactions with longliners, e.g., tangling or hooking. In general, interactions were more frequent in tropical areas and adjacent to nesting sites. Depth was another major factor in interactions, with shallow set longlines set at night catching an order of magnitude more turtles than deep sets made in the day. Olive Ridley and green turtles were the most frequently encountered turtles. The review listed recommendations on a variety of improvements including fishery observer coverage, species identification, collection of turtle biometrics, interaction descriptions, crew education and awareness.

Ms. Rebecca Lewison presented a project to assess the global ecological impacts of longline fisheries on sea turtles, seabirds, and sharks. This project was funded by a U.S. foundation—the Pew Charitable Trust. The principal items in the first year of this study were the declining population trends of Atlantic sharks, mapping ocean features and bycatch, and estimates of total black footed albatross longline-related mortality in North Pacific. Work was currently underway on determining longline-related sea turtle mortality in the Pacific. The goal of the study was to generate bounded estimates and determine relative threat of fisheries vs. other sources of mortality. Discussions on this study noted difficulty on obtaining the data needed to accomplish the study objectives, changes in the operational characteristics of longline fisheries over time, and the documentation of other sources of turtle mortality so as to place longline related impacts in their correct context.

Dr. Michael Laurs reviewed progress of research by the NMFS Honolulu Laboratory to rehabilitate swordfish longlining and to generally reduce turtle longline interactions (BBRG–4). Data from the first phase of experimental fishing for swordfish, which may catch fewer turtles compared to conventional swordfish gear, have been completed and the results were currently being analyzed. The start of the second phase of this project to test direct mitigation measures such as blue dyed bait and distance of hooks from the float was uncertain due to a legal challenge to the fishing experiment by several conservation advocacy organizations. Research on the behavior and physiology of turtles using captive animals was ongoing. Results to date indicate that captive turtles are attracted to red-dyed bait, and not to blue bait. Also, turtle vision may be less acute under low light conditions than the fish targeted by longlining, which may assist in the design of light sticks that would attract fish but not turtles.

Dr. Jeffery Polovina discussed how at-sea observer programs assist help turtle research by collecting information on the pelagic life phase of sea turtles (BBRG–5). This includes tag deployment, collection of biological data and specimens for genetic research. Recent research on the use of pop-up satellite archival tagging of sea turtles was discussed to determine post hooking survivorship of sea turtles. PSATs record hourly depth, temperature, and a daily geolocation. The state-of-the-art tag provides somewhat questionable geolocation data, and is also difficult to attach to sea turtles, but the one redeeming quality of the PSAT is its ability to provide data even in the event of a mortality. PSATs have been deployed on hard shell turtles and tests were currently underway with a new method for attachment of PSATs to leatherback turtles. Results of tagging of turtles with ARGOS tags were reviewed and showed how turtles use oceanic features such as fronts and eddies. Data collected on diving behavior showed the percentage of time turtles spend at various depth ranges.

10.2 Other Species Bycatch in WCPO Pelagic Fisheries

Dr. Yonat Swimmer (BBRG–6) reviewed preliminary results of recent tagging of oceanic sharks (BBRG–6). This project was attaching PSATs to blue and other oceanic sharks and collecting blood samples to determine key biochemical indicators for hooked and released sharks useful for estimating tagging induced mortality. The PSATs also record the time spent at different depths by oceanic sharks. This work was being augmented with data from longline fishing using time-depth recorders to look at the depth and time of day sharks were taken on longlines.

Mr. Donald Hawn presented preliminary results on the biology of opah and monchong (BBRG–2). This project was collecting basic biological information and life history data for the opah and two monchong species.

Dr. Pierre Kleiber provided updates on MULTIFAN-CL stock assessments of North Pacific swordfish and Pacific blue marlin (BBRG–3, BBRG–10). Problems associated with data inputs for both assessments were noted and discussed. North Pacific swordfish appeared to be fished at effort levels below that which would generate MSY. Blue marlin catches were currently thought to be at or around the MSY level.

Dr. Valérie Allain reviewed a food web study on the tuna ecosystem of the WCPO (BBRG–7). The objective of the study was to understand the prey-predator relationships and to provide a model to assess the environmental and fishing impact on the ecosystem and tuna stocks. Diet and trophic level of the different components of the ecosystem were established by examining stomach contents and by analyzing isotopic composition of muscle sample. Data from this study was then to be used in bio-dynamic models.

Dr. Campbell reviewed sequential changes in swordfish catch rates off eastern Australia (BBRG–9). As fishing effort had increased, fishing spread further offshore to maintain high catch rates. Similar scenarios were noted for many longline fisheries, where catch rates were initially high then dropped off markedly. The East Coast Australia fishery had been studied from its inception and provided an opportunity to investigate this phenomenon. Several hypotheses were being explored, including the concept of resident stocks, environmental changes and changes in the longline fleet composition over time.

Dr. SUN presented initial results of an age and growth study for juvenile swordfish in Taiwan waters using otolith microstructure (BBRG–8). If the micro-increments observed in the sagittal otoliths were laid down on a daily basis, then juvenile swordfish reached a size of about 94 cm in their first year. Estimates of spawning dates, based on the otolith analysis, ranged from February to October.

10.3 Research Coordination and Planning

The BBRG identified the following recommendations from SCTB 15.

1. A strong focus should continue to be maintained on regional billfish catches, both in commercial pelagic fisheries and from recreational fisheries. OFP generates an annual estimate of commercial billfish catches, but currently no further information on recreational billfish catches. A system for reporting of catches by recreational fishing clubs in the WCPO was established by OFP, but this data is currently not being processed.

2. Efforts should be made to improve the overall level and quality of 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. Examples of how observer programs have been implemented elsewhere, such as for the Australian East Coast swordfish fishery, may be useful paradigms for this process.

3. Member countries should strengthen data collection on sea turtle interactions in pelagic fisheries in order to refine estimates of the interaction problem, due to concerns regarding the population status of marine turtles. There may also be a need to develop assessment methods applicable to data-poor situations, where interaction rates with fishing gear are very low.

4. Closer collaboration and liaison by member countries 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, and so that fishery impacts to turtle populations can be placed in their true context. Some of this broader analysis may be done by other organizations, but SCTB should keep well aware of the issues and be able to evaluate information and analyses as they are used to set management policy. There are many protected-species events emerging that can have a great impact on tuna fisheries, e.g., the recent Pacific longline

and gillnet moratorium petition designed to protect leatherback turtles. The BBRG also notes that changes to existing fishery management statutes may be used to influence seafood exporters to the US to conform with various bycatch mitigation measures.

5. A watching brief be maintained on other bycatch issues as they arise, e.g., FAO IPOA on seabird-fishery interactions, or a future IPOA on turtle-fishery interactions. Two meetings of note are the Second International Fishers Forum (Nov 2002) and International Marine Turtle Technical Workshop (February 2003), which are both focused on turtle mitigation.

A BBRG summary statement was drafted, circulated to participants and discussed. The accepted wording appears in the Executive Summary (p. 10).

11. METHODS WORKING GROUP (MWG)

11.1 Introduction

The coordinator, Dr. John Sibert opened the session and outlined the primary emphasis and scope of work of the group as listed in the MWG Terms of Reference adopted during SCTB 14.

11.2 Report of the Preparatory Meeting of the MWG—18–19 July 2002

The SCTB Methods Working Group (MWG) held its second meeting on July 18–19, 2002. The agenda is provided in Appendix 7. Dr. Shiham Adam, Ms. Melesia Aho, Mr. Keith Bigelow, Dr. Robert Campbell, Dr. Ray Conser, Dr. Paul Crone, Dr. David Fournier, Dr. John Hampton, Dr. Shelton Harley, Dr. Pierre Kleiber, Mr. Dale Kolody, Dr. Marc Labelle, Dr. Jacek Majkowski, Dr. Mark Maunder, Dr. Talbot Murray, Dr. John Sibert, Mr. Neville Smith, Dr. Chi-Lu Sun, and Dr. Chien-Hsiung Wang participated in the sessions. The following is a summary of the working papers and topic that were presented and discussed.

11.3 Simulation Results

MWG activity during the intercessional period between SCTB14 and SCTB15 was directed towards the work plan adopted at SCTB14. The OFP operational model was used to generate "simulated data" for evaluating the performance of several stock assessment models. Dr. Labelle presented a brief overview of the operational model and preliminary results of testing against MULTIFAN-CL with data generated by the model (MWG–1). Four basic scenarios were simulated. Each simulation models process and observation error by generating pseudo-random numbers to mimic these sources of variation. Multiple "realizations" of some scenario sets were generated using different series of random numbers so that the statistical distribution of parameter estimates could be evaluated. Four fishery scenarios, intended to mimic aspects to the WCPO yellowfin fishery, were simulated.

1. One fishery, one region, one realization
2. One fishery, one region, ten realizations
3. Two fisheries, two regions, ten realizations
4. Sixteen fisheries, seven regions, ten realizations

Data sets one through three were circulated by email to MWG participants beginning in February 2002. Analysts sent their results to the MWG coordinator beginning in April, and final results were collated during the MWG meeting.

The following stock assessment methods were applied to the data produced by the OFP operational model.

1. MULTIFAN-CL, Marc Labelle (MWG–1)
2. MULTIFAN-CL, Pierre Kleiber
3. SCALIA, Dale Kolody (MWG–5)
4. Age-structured (ASPM) and Fox production models, Dale Kolody (MWG–8)
5. A-SCALA, Mark Maunder (MWG–7)
6. ADAPT, Keith Bigelow (MWG–6) and Ray Conser

The results of these analyses are summarized in Table 1. All models were not tested with all scenarios because of model limitations and time constraints. The table reports "actual" values of parameters as input to the simulations and the ratio of the values of the parameter estimated by each assessment method. Definitions of the model parameters can be found in MWG–1. Ratios less than 1.0 indicate that the estimate was lower than the actual value; ratios greater than 1.0 indicate overestimates. MWG–1 offers two potential biomass-based reference points. One is the ratio of fished biomass at the end of the time series to the biomass at the beginning of the time series (BF_e/BF_s). The other is the ratio of the fished biomass at the end of the time series to the biomass at the end of the time series in the absence of fishing (BF_e/B_e).

Results vary considerably between both assessment method and scenarios. MWG participants considered the results to be preliminary, but felt that the results were "encouraging." In the simple scenario, the MFCL parameter estimates generally ranged between 0.5 and 2.0 times the actual values. The accuracy of some methods appeared to increase in more complex scenarios with higher exploitation rates. Production models appeared to be less suitable than more complex models. The preliminary results indicate that MFCL may provide more accurate estimates for some parameters than models without spatial structure, however this issue will be a focus of further testing. In general, ratios of parameter estimates (e.g., BF_e/ BFs, BF_e/B_e) appeared to be more accurate than the estimates of the individual parameters regardless of the model used. Chien-Hsiung WANG pointed out that in the context of production models, there are strong linkages between these ratios, biomass trends and levels of fishing mortality.

MWG members agreed to continue the multi-model testing using simulated data sets during the coming intercessional period. The preferred scenarios consist of 1 region by 1 or 2 fisheries and 2 regions by 4 fisheries. The primary focus of the analysis will be on the effects of spatial stratification and use of mark-recapture data under moderate exploitation rates (F~M). Efforts will be made to generate and analyze 50–100 realizations of each scenario.

Introduction of more extensive errors into the simulations, particularly in relation to observational errors in the tagging data, was discussed extensively. Some participants felt that if such errors were found to have minimal impact on the accuracy of MFCL assessments, models that do not include tagging data and spatial structure should be dropped from the list of models to be considered. Other participants felt that overemphasis of a single model could stifle future model development. The current round of simulations was conducted with relatively low levels of error. Future simulations should incorporate more realistic process and observational errors in critical model components (e.g., natural mortality growth, effort, and tag reporting).

Table 1. "Actual" values of parameters as input to the simulations and the ratio of the actual values to the values of selected parameters estimated by each assessment method. Definitions of the model parameters can be found in MWG-1. Ratios less than 1.0 indicate that the estimate was lower than the actual value; ratios greater than 1.0 indicate overestimates. "BFe/BFs" is the ratio of biomass at the end of the time series to the biomass at the beginning of the time series; "BFe/Be" is the ratio of the biomass at the end of the time series to the biomass at the end of the time series in the absence of fishing.

Model Parameter	Actual	MFCL MWG-1	MFCL PK	A-SCALA	SCALIA	ADAPT	ASPM	Fox
Scenario 1Fx1R (1)								
FL-at-age (range)	36–140	1.03	1.02					
M-at-age (range)	0.48–0.24	0.84	0.65			0.08[†]		
Mean biomass (mt, F=ON)	2.07E+06	2.46	1.83			0.27	0.42	
Mean biomass start	2.71E+06	2.16	1.71		0.60	0.27	0.61	2.44
Mean biomass end	1.98E+06	2.46	1.57		0.60	0.31	0.30	1.06
Mean S biomass	8.53E+05	2.47	1.94			0.36	0.45	
Mean S biomass start	1.34E+06	1.80	1.52		0.75	0.39	0.83	
Mean S biomass end	1.12E+06	2.23	1.67		0.63	0.34	0.25	
Mean recruitment	6.96E+07	1.19	1.12		2.51	0.13	0.20	
Overall F by quarter	0.030	0.60	0.67			5.08		
Mean F start	0.035	0.59	0.67			5.14		
Mean F end	0.022	0.55	0.78			4.66		
BFe/BFs	0.732	1.14	0.94		0.97	0.98	0.50	0.42
BFe/Be	0.771	1.14	1.05		0.70		0.40	0.40
Scenario 1Fx1R (10)								
FL-at-age (range)	32–140	1.00	1.02					
M-at-age (range)	0.47–0.24	0.83	0.42					
Mean biomass (mt, F=ON)	2.32E+06	1.82	1.83				0.55	
Mean biomass start	2.98E+06	1.64	1.71		0.69		0.81	6.36
Mean biomass end	2.57E+06	1.68	1.57		0.68		0.46	4.94
Mean S biomass	9.01E+05	2.05	1.94	12.19			0.64	
Mean S biomass start	1.36E+06	1.52	1.52	9.96	0.84		1.18	
Mean S biomass end	9.26E+05	1.94	1.67	11.71	0.80		0.59	
Mean recruitment	8.80E+07	1.61	1.12		0.35		0.22	
Overall F by quarter	0.033	0.72	0.67					
Mean F start	0.036	0.68	0.67					
Mean F end	0.021	0.80	0.78					
BFe/BFs	0.870	1.04	0.94	0.96	0.74		0.51	0.35
BFe/Be	0.796	1.05	1.05		0.76		0.50	0.89
Scenario 2Fx2R (10)								
FL-at-age	31–140	1.01	1.02					
M-at-age (range/Q)	0.53–0.13	0.89	0.55					
Mean biomass (w/ fishery)	4.31E+06	1.32	1.20				117.77	
Mean biomass start	8.16E+06	0.67	0.61		0.90		62.58	3.84

[†] Assumed annual value; not estimated.

Model Parameter	Actual	MFCL MWG-1	MFCL PK	A-SCALA	SCALIA	ADAPT	ASPM	Fox
Mean biomass end	4.88E+06	1.18	1.16		0.83		109.12	4.59
Mean S biomass	2.38E+06	1.33	1.15	1.78			144.43	
Mean S biomass start	5.79E+06	0.49	0.42	1.24	0.93		59.97	
Mean S biomass end	2.94E+06	1.19	1.11	1.65	0.83		124.76	
Mean recruitment	9.70E+07	1.37	0.85		0.53		35.68	
Overall F by quarter	0.070	0.90	0.99					
Mean F start	0.100	0.99	1.04					
Mean F end	0.050	0.98	0.87					
BFe/BFs	0.598	1.80	1.93	1.04	0.76		1.48	1.15
BFe/Be	0.486	0.92	0.93		0.74		1.55	1.35
Scenario 16Fx7R (10)								
FL-at-age	31–144	1.02						
M-at-age (range/Q)	0.53–0.13	1.35						
Mean biomass (w/ fishery)	6.18E+06	1.05						
Mean biomass start	7.74E+06	1.20						
Mean biomass end	5.19E+06	1.60						
Mean S biomass	4.64E+06	0.88						
Mean S biomass start	5.98E+06	0.81						
Mean S biomass end	3.78E+06	0.89						
Mean recruitment	9.45E+07	1.57						
Overall F by quarter	0.027							
Mean F start	0.004							
Mean F end	0.047							
BFe/BFs	0.670	1.10						
BFe/Be	0.660	1.03						

11.4 Other Matters

Dr. Hampton reported on recent enhancements to MFCL (MWG–2). The model now provides ratio estimators of biomass- and fishing mortality-based biological reference points required in some fishery management jurisdictions. MWG participants were cautiously optimistic about these estimates given the preliminary results from the simulation studies on the accuracy of estimates of ratios. Weight frequency data is often the usual information collected at fish auctions and landing ports, and in some instances, is the only available information on size. MFCL is now able to utilize these data in addition to the usual length-frequency data.

Pierre Kleiber summarized the results of a workshop on the use of oceanographic data in longline effort standardization (MWG–4). The workshop focused on the problem of trying to determine the effects of current shear on the depth of hook deployment. MWG participants noted the importance of determining hook depth in longline sets and encouraged the use of time-depth recorders and hook timers in longline sets.

Mr. Dave Foley reported on a project to make oceanographic data more easily available to fisheries scientists. In the near future, estimates of current shear and mixed layer depth will be made available at scales of resolution applicable to fisheries modelers. Problems with estimating depth of the oxycline and the deep scattering layer were discussed.

Dr. Maunder reported on a statistical method to evaluate habitat-based effort standardization. Dr. Maunder pointed out that there is no currently available means to determine if habitat standardization of effort has actually improved measures of fishing effort. He attempted to address this question by computing the likelihood of observing the catch given either the nominal effort or the standardized effort and concluded that standardized effort is a significantly better predictor of catch than nominal effort (MWG–7).

The MWG briefly reviewed its terms of reference in developing a work plan for the next intercessional period. Participants were encouraged by the simulations to date, and felt that the exercise should continue. However, in order to provide better advice to fishery managers, MWG participants felt that the simulations should be more comprehensive. As a longer-term goal, models should be developed that include management interventions based on the results of stock assessments and projections of the subsequent fisheries; therefore, the MWG recommends development of "management strategy evaluation models" over the longer term.

Ongoing review of the application of stock assessment models is identified as an important activity in the MWG terms of reference. MWG Participants agreed that one particular SCTB species assessment should be selected by SCTB15 for in-depth scrutiny prior to SCTB16 with the intention of reviewing a different species assessment each year. Examination of "diagnostic" statistics is a critical important aspect of assessment reviews that may reveal more subtle aspects of model performance. Dr. Conser offered a list of useful diagnostics that might be applied to some of the models under evaluation (Appendix 8).

11.5 Research Coordination and Planning

The primary emphasis for the coming intercessional period will be a more systematic exploration of the effects of spatial structure. If time permits, effects of higher levels of process and observational error will be explored.

1. Future simulations will focus on the following.
    - 1 region x 1 fishery
    - 1 region x 2 fisheries
    - 4 regions x 4 fisheries
    - All at moderate exploitation rates (F~M) with > 50 realizations
    - Increase levels of process and observational error

2. Conduct an in-depth review of the MFCL yellowfin assessment for SCTB 16.

Research Priorities for population modeling include the following.

1. Develop other biological reference points with less restrictive assumptions than B/B_{MSY} and F/F_{MSY}.

2. Begin development of a "management strategy evaluation model," such as currently under development by CSIRO for the Australian swordfish fishery, that will evaluate the performance of the whole fishery management system including fisheries, data collection, stock assessment and regulation.

3. Begin development of multi-species models that will explore potential ecosystem effects species interactions

4. Enhancements to MFCL
    - Seasonal variability movement (currently in progress)
    - Differential growth and mortality of males and females
    - Species misspecification, e.g., reporting of bigeye as yellowfin
    - Population projections ~5 years

12. OTHER BUSINESS

The meeting reviewed draft summary statements prepared by the chairs of each Species Research Group. At this point, the meeting was behind schedule due to a crowded agenda and several lengthy discussions during research and working group sessions. The meeting agreed there was not adequate time to satisfactorily discuss and clear each SRG Summary Statement prior to adjournment of the session. Final drafting and revision of summary statements was conducted by email during the following week and the approved versions of each summary statement appear in the Executive Summary (p. 3–12), and at the end of each Species Research Group section of this report.

Dr. Gunn, representing the Australia delegation graciously offered to host SCTB 16. The venue of the next meeting will be in Mooloolaba, Queensland, Australia possibly during July 2003.

The SCTB chair typically alternates between representatives from coastal states and distant-water fishing nations. Dr. Sung-Kwon SOH of the Korean Ministry of Maritime Affairs and Fisheries was appointed as the new chairman of the SCTB, replacing Mr. Thoulag who chaired the SCTB during the past two productive years.

13. CLOSE

The Chairman thanked all the participants for their assistance, and the Hawai‘i fisheries organizations (e.g., PRFP, NMFS, WPRFMC) for hosting the meeting. He noted that all had done an excellent job. Dr. Sibert thanked the participants and his staff for the productive meeting and the outgoing chair, Mr. Thoulag for his considerable efforts during the past two years.

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 2001 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	68,164
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	72	51,333	69,174
1960	22,248	45	–	–	22,293	17,373	25,156	20,105	773	63,407	85,700
1961	23,742	0	–	–	23,742	17,442	21,476	12,059	1,636	52,613	76,355
1962	35,219	0	–	–	35,219	15,771	9,814	19,753	1,933	47,271	82,490
1963	31,095	16	–	–	31,111	13,471	28,852	25,145	1,445	68,913	100,024
1964	22,930	0	–	–	22,930	15,488	27,269	18,391	1,275	62,423	85,353
1965	25,838	0	–	–	25,838	13,965	41,908	16,557	866	73,296	99,134
1966	39,113	0	–	–	39,113	25,329	24,430	15,337	1,293	66,429	105,542
1967	40,318	0	5	–	40,323	29,516	34,594	17,975	1,328	83,413	123,736
1968	29,051	0	14	–	29,065	24,670	21,503	21,462	2,337	69,672	99,037
1969	24,360	0	0	–	24,360	18,654	34,908	20,192	1,826	75,580	99,940
1970	32,590	100	50	–	32,740	17,808	28,679	21,422	1,604	69,513	102,253
1971	34,708	100	0	–	34,808	13,293	55,028	22,272	2,396	92,989	127,797
1972	33,842	122	268	–	34,232	16,143	64,319	27,521	1,646	109,629	143,861
1973	37,649	141	484	–	38,274	16,937	71,003	17,053	1,985	106,978	145,252
1974	30,985	809	898	–	32,692	13,988	78,341	21,509	1,368	115,206	147,898
1975	26,131	100	646	–	26,877	14,308	55,395	19,043	1,237	89,983	116,860
1976	24,106	100	25	–	24,231	17,957	88,036	16,183	3,227	125,403	149,634
1977	34,849	100	621	–	35,570	17,398	33,431	10,022	2,285	63,136	98,706
1978	34,858	100	1,686	–	36,644	13,589	60,827	16,636	8,102	99,154	135,798
1979	28,739	100	814	–	29,653	14,661	44,965	7,302	4,213	71,141	100,794
1980	31,027	101	1,468	–	32,596	15,604	47,124	7,768	4,723	75,219	107,815
1981	32,632	0	2,085	5	34,722	18,745	28,174	12,837	11,542	71,298	106,020
1982	28,339	1	2,434	6	30,780	17,819	30,039	6,713	13,973	68,544	99,324
1983	24,303	0	744	39	25,086	16,077	21,705	9,584	7,886	55,252	80,338
1984	20,340	2	2,773	1,589	24,704	15,669	27,043	9,354	18,801	70,867	95,571
1985	27,138	0	3,253	1,937	32,328	14,751	22,212	6,471	14,928	58,362	90,690
1986	32,641	0	2,003	1,946	36,590	13,169	16,528	4,738	11,015	45,450	82,040
1987	26,877	9	2,049	930	29,865	15,034	19,240	2,870	11,611	48,755	78,620
1988	31,531	0	4,214	5,283	41,028	15,186	6,814	4,367	19,233	45,600	86,628
1989	22,238	0	8,208	21,968	52,414	13,979	8,683	2,000	20,162	44,824	97,238
1990	22,624	245	6,874	7,538	37,281	16,273	8,647	2,905	26,332	54,157	91,438
1991	24,706	14	7,732	1,489	33,941	17,716	7,103	1,984	11,014	37,907	71,848
1992	30,248	11	6,615	65	36,939	19,728	13,888	4,935	16,909	55,460	92,399
1993	29,987	74	4,313	70	34,444	30,943	12,797	6,748	4,410	54,898	89,342
1994	33,233	67	7,403	89	40,792	30,789	26,389	12,976	3,950	74,104	114,896
1995	25,652	139	7,693	104	33,588	32,510	21,061	9,924	2,555	66,050	99,638
1996	24,129	30	7,634	156	31,949	39,051	20,296	21,011	1,832	82,190	114,139
1997	32,689	21	4,679	133	37,522	47,707	32,311	17,180	4,269	101,467	138,989
1998	39,202	36	6,258	85	45,581	47,600	23,005	18,889	4,368	93,862	139,443
1999	9,512	138	3,391	74	43,115	45,801	50,429	13,311	12,021	121,562	164,677
2000	41,595	102	5,870	139	47,700	45,865	18,857	14,693	5,797	85,212	132,918
2001	45,708	19	5,547	199	51,473	46,312	19,094	16,218	5,719	87,343	138,816

Table 2. 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 2001 are preliminary.

YEAR	WCPO					EPO					TOTAL
	LONGLINE	POLE-AND-LINE	TROLL	OTHER	SUB-TOTAL	LONGLINE	POLE-AND-LINE	TROLL	OTHER	SUB-TOTAL	
1950	…	…	…	…	…	…	…	…	…	…	…
1951	…	…	1,095	…	…	…	…	…	…	…	…
1952	…	2,100	1,039	…	…	…	…	…	…	…	…
1953	…	2,400	619	…	…	…	…	…	…	…	…
1954	…	2,100	360	…	…	…	…	…	…	…	…
1955	…	4,000	285	…	…	…	…	…	…	…	…
1956	…	4,400	908	…	…	…	…	…	…	…	…
1957	…	5,200	49	…	…	…	…	…	…	…	…
1958	…	4,200	48	…	…	…	…	…	…	…	…
1959	…	1,700	36	…	…	…	…	…	…	…	…
1960	…	1,500	58	…	…	…	…	…	…	…	…
1961	…	1,800	63	…	…	…	57	156	–	…	…
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	83,373
1970	33,987	1,600	726	2,820	39,133	31,800	–	1,332	–	33,132	72,265
1971	34,659	900	877	3,060	39,496	29,900	58	2,494	14	32,466	71,962
1972	45,329	1,762	865	3,498	51,454	36,400	66	2,172	–	38,638	90,092
1973	35,478	1,258	1,078	4,218	42,032	53,400	131	1,848	–	55,379	97,411
1974	39,029	1,039	1,389	4,719	46,176	36,500	–	890	–	37,390	83,566
1975	52,779	1,334	1,328	4,943	60,384	41,764	28	3,695	–	45,487	105,871
1976	64,513	3,423	1,312	4,138	73,386	54,239	45	10,136	5	64,425	137,811
1977	62,934	3,325	1,587	5,637	73,483	73,702	2	7,053	–	80,757	154,240
1978	49,394	3,337	1,146	4,243	58,120	70,411	–	11,714	–	82,125	140,245
1979	56,748	2,419	2,033	4,662	65,862	55,342	–	7,531	1	62,874	128,736
1980	54,045	2,243	2,162	4,142	62,592	64,695	–	15,318	103	80,116	142,708
1981	41,239	2,596	4,315	4,919	53,069	53,366	–	10,090	1	63,457	116,526
1982	44,739	4,108	5,150	4,738	58,735	53,270	23	4,079	–	57,372	116,107
1983	41,144	4,055	9,388	4,987	59,574	59,883	21	3,144	95	63,143	122,717
1984	46,156	3,465	8,556	5,176	63,353	46,245	1	5,919	16	52,181	115,534
1985	51,064	4,326	7,311	6,120	68,821	66,176	17	4,497	18	70,708	139,529
1986	46,485	2,865	7,509	6,480	63,339	102,245	–	1,939	–	104,184	167,523
1987	60,646	3,134	11,395	5,563	80,738	97,972	–	771	5	98,748	179,486
1988	50,166	4,112	7,305	6,439	68,022	68,003	2	1,051	–	69,056	137,078
1989	51,182	4,272	12,651	7,137	75,242	69,113	–	1,470	–	70,583	145,825
1990	66,807	3,868	12,143	8,851	91,669	90,699	–	4,701	11	95,411	187,080
1991	51,277	1,909	13,406	10,225	76,817	89,783	25	3,702	13	93,523	170,340
1992	63,429	1,873	19,484	9,105	93,891	77,073	–	5,488	9	82,570	176,461
1993	57,107	2,433	14,397	7,841	81,778	74,147	–	8,043	26	82,216	163,994
1994	66,977	3,014	11,321	10,026	91,338	69,142	–	28,683	692	98,517	189,855
1995	54,832	3,809	14,171	10,290	83,102	55,736	–	36,155	1,154	93,045	176,147
1996	48,808	3,863	17,515	11,533	81,719	42,344	–	50,728	625	93,697	175,416
1997	56,873	3,731	30,494	11,759	102,857	47,780	–	51,617	2	99,399	202,256
1998	66,556	2,886	18,626	15,378	103,446	44,233	–	35,143	12	79,388	182,834
1999	58,837	2,705	34,541	14,536	110,619	23,164	–	41,118	42	64,324	174,943
2000	56,812	2,877	30,665	16,393	106,747	27,304	–	70,098	–	97,402	204,149
2001	61,019	2,877	26,707	16,659	107,262	33,101	–	43,009	…	76,110	183,372

Table 3. Total catches of skipjack in the Pacific Ocean. Symbols: '…' = missing data; '0' = effort, but no catch. Estimates for 2001 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	88,703	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	40,614	384	68,495	225,231
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	7,031	56,130	298,212
1971	1,291	180,945	14,987	29,148	226,371	11,102	87,131	6,590	104,823	331,194
1972	1,417	172,827	19,691	41,777	235,712	6,081	26,434	1,070	33,585	269,297
1973	1,608	253,065	21,547	50,326	326,546	8,789	34,737	569	44,095	370,641
1974	2,007	289,202	14,742	49,410	355,361	7,150	71,255	461	78,866	434,227
1975	1,827	218,271	18,237	50,176	288,511	13,366	110,083	487	123,936	412,447
1976	1,964	276,581	28,148	51,206	357,899	10,846	114,715	684	126,245	484,144
1977	3,049	294,641	40,122	66,420	404,232	7,218	77,228	1,968	86,414	490,646
1978	3,265	331,401	42,186	73,621	450,473	5,603	162,915	1,369	169,887	620,360
1979	2,286	283,494	65,124	60,400	411,304	5,931	124,673	1,446	132,050	543,354
1980	651	332,465	82,536	42,767	458,419	5,040	123,687	1,963	130,690	589,109
1981	857	294,187	94,931	48,203	438,178	5,780	112,948	906	119,634	557,812
1982	1,120	262,233	174,693	53,048	491,094	3,676	94,681	429	98,786	589,880
1983	2,226	299,762	324,603	56,842	683,433	4,112	53,150	903	58,165	741,598
1984	893	379,474	327,058	44,239	751,664	2,770	56,948	857	60,575	812,239
1985	1,104	250,010	309,469	43,553	604,136	918	48,375	200	49,493	653,629
1986	1,427	336,694	369,609	49,116	756,846	1,939	61,486	169	63,594	820,440
1987	2,317	262,467	373,331	47,825	685,940	2,230	59,941	197	62,368	748,308
1988	1,915	295,691	489,505	49,135	836,246	4,278	80,445	663	85,386	921,632
1989	2,510	285,790	477,572	48,453	814,315	2,892	88,468	1,033	92,393	906,708
1990	1,292	224,130	604,447	60,896	890,765	835	69,927	1,883	72,645	963,410
1991	1,541	288,401	773,669	65,326	1,128,938	1,670	59,707	1,900	63,277	1,192,215
1992	1,063	232,784	707,721	80,562	1,022,130	1,860	81,026	1,092	83,978	1,106,108
1993	940	277,504	581,792	58,480	918,716	3,633	81,500	2,256	87,389	1,006,105
1994	1,793	237,251	721,658	52,187	1,012,889	3,110	71,449	898	75,457	1,088,346
1995	1,390	270,474	724,106	60,826	1,056,796	5,237	130,974	2,038	138,249	1,195,045
1996	1,094	233,881	736,732	57,375	1,029,082	2,583	108,444	1,328	112,355	1,141,437
1997	1,333	254,041	653,203	58,779	967,356	3,292	158,398	119	161,809	1,129,165
1998	1,461	293,494	947,113	68,395	1,310,463	1,642	143,160	198	145,000	1,455,463
1999	1,623	282,281	785,865	75,448	1,145,217	2,106	264,643	1,353	268,102	1,413,319
2000	1,356	289,540	864,134	70,795	1,225,825	232	210,984	67	211,283	1,437,108
2001	1,560	292,291	843,412	75,333	1,212,596	448	143,885	0	144,333	1,356,929

Table 4. 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 2001 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	8,919	–	65,921	15,856	879	82,656	91,575
1951	···	···	938	10,415	11,353	–	65,499	6,598	727	72,824	84,177
1952	23,443	2,595	2,565	10,539	39,142	–	66,108	13,735	1,067	80,910	120,052
1953	33,501	5,228	1,260	10,871	50,860	–	43,920	16,120	–	60,040	110,900
1954	36,067	4,268	4,001	11,763	56,099	–	46,541	7,625	–	54,166	110,265
1955	31,362	3,983	2,944	12,633	50,922	665	50,811	13,086	···	64,562	115,484
1956	23,612	4,399	724	12,818	41,553	1,578	58,828	21,470	···	81,876	123,429
1957	54,527	1,669	1,496	13,481	71,173	9,365	58,402	15,544	···	83,311	154,484
1958	55,097	2,934	3,338	14,682	76,051	7,803	46,776	20,560	···	75,139	151,190
1959	53,113	4,119	4,316	15,673	77,221	4,497	30,053	28,126	···	62,676	139,897
1960	62,839	1,872	1,438	15,919	82,068	7,629	26,199	79,976	···	113,804	195,872
1961	71,281	3,259	2,777	17,044	94,361	16,640	16,762	84,897	984	119,283	213,644
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	14,000	4,688	145,867	5,071	169,626	263,452
1971	49,674	2,667	10,847	31,204	94,392	8,000	5,469	114,416	2,954	130,839	225,231
1972	51,090	7,465	11,765	35,749	106,069	16,300	6,149	169,467	1,512	193,428	299,497
1973	56,828	7,457	16,900	41,726	122,911	12,900	4,355	200,204	694	218,153	341,064
1974	54,102	6,582	19,574	46,997	127,255	10,000	8,659	200,451	1,254	220,364	347,619
1975	60,554	7,801	15,209	48,536	132,100	10,761	6,114	195,442	586	212,903	345,003
1976	70,735	17,186	16,826	40,666	145,413	15,607	3,688	232,266	373	251,934	397,347
1977	87,974	15,257	18,509	55,092	176,832	12,161	2,093	196,427	297	210,978	387,810
1978	109,384	12,767	13,863	38,491	174,505	10,138	4,172	175,747	615	190,672	365,177
1979	104,950	11,463	31,362	46,375	194,150	11,439	5,191	184,236	247	201,113	395,263
1980	117,423	13,132	35,614	43,906	210,075	13,588	1,649	156,878	898	173,013	383,088
1981	92,541	19,268	62,877	50,623	225,309	7,952	1,595	179,371	847	189,765	415,074
1982	83,824	13,835	73,542	48,226	219,427	10,943	1,605	123,272	206	136,026	355,453
1983	83,588	13,266	106,103	50,844	253,801	10,900	4,271	88,779	1,206	105,156	358,957
1984	69,752	13,558	109,681	53,698	246,689	10,309	3,090	141,635	336	155,370	402,059
1985	73,559	18,156	105,367	61,091	258,173	13,161	1,081	215,610	301	230,153	488,356
1986	62,080	13,074	104,719	64,673	244,546	22,748	2,519	265,473	282	291,022	535,568
1987	74,000	13,243	156,647	58,032	301,922	18,071	5,110	266,800	336	290,317	592,239
1988	81,081	12,500	99,244	65,704	258,529	13,267	3,743	283,318	973	301,301	559,830
1989	64,031	13,823	164,335	69,867	312,056	15,820	4,189	284,621	565	305,195	617,251
1990	72,335	13,062	175,239	90,238	350,874	30,402	2,664	268,871	1,751	303,688	654,562
1991	59,424	12,186	211,043	101,592	384,245	25,844	2,909	234,974	1,069	264,796	649,041
1992	71,655	16,226	241,753	85,039	414,673	16,250	3,885	232,811	3,153	256,099	670,772
1993	65,016	13,623	244,182	77,026	399,847	24,257	5,089	223,519	3,463	256,328	656,175
1994	73,345	14,478	224,757	98,688	411,268	29,345	3,755	213,177	1,455	247,732	659,000
1995	80,570	15,771	187,798	102,023	386,162	19,808	1,284	220,486	2,047	243,625	629,787
1996	76,895	16,062	122,221	110,804	325,982	15,042	3,733	245,313	1,056	265,144	591,126
1997	69,027	14,573	260,121	113,801	457,522	20,182	4,386	252,214	1,231	278,013	735,535
1998	62,353	17,207	272,503	147,512	499,575	15,009	5,126	260,261	330	280,726	780,301
1999	56,767	15,140	219,711	142,243	433,861	9,035	1,734	293,889	1,214	305,872	739,733
2000	69,050	16,325	207,458	158,092	450,925	16,117	2,417	269,872	371	288,777	739,702
2001	77,262	16,406	219,151	160,417	473,236	14,171	3,916	391,379	45	409,511	882,747

Table 5. Total catches of albacore, bigeye, skipjack and yellowfin in the WCPO.
Symbols: '…' = missing data. Estimates for 2001 are preliminary.

YEAR	ALBACORE		BIGEYE		SKIPJACK		YELLOWFIN		TOTAL
	MT	%	MT	%	MT	%	MT	%	
1950	35,438		…		…		8,919		…
1951	32,485		…		106,576		11,353		…
1952	69,136		…		92,302		39,142		…
1953	61,853		…		80,321		50,860		…
1954	58,679		…		104,161		56,099		…
1955	49,291		…		108,252		50,922		…
1956	64,512		…		107,189		41,553		…
1957	79,556		…		106,941		71,173		…
1958	59,456		…		157,383		76,051		…
1959	48,179		…		177,274		77,221		…
1960	65,039		…		89,938		82,068		…
1961	60,102		…		156,738		94,361		…
1962	52,162	15	35,589	10	181,624	51	88,522	25	357,897
1963	59,373	19	42,831	14	122,703	40	79,815	26	304,722
1964	56,838	16	30,782	9	182,909	53	77,424	22	347,953
1965	77,726	23	30,205	9	155,204	45	78,843	23	341,978
1966	84,312	18	32,323	7	249,458	54	98,747	21	464,840
1967	93,459	23	34,673	9	204,664	51	71,798	18	404,594
1968	68,102	18	26,775	7	194,756	53	80,619	22	370,252
1969	75,716	19	31,759	8	202,568	52	82,436	21	392,479
1970	71,196	16	39,133	9	242,082	54	93,826	21	446,237
1971	98,758	22	39,496	9	226,371	49	94,392	21	459,017
1972	111,428	22	51,454	10	235,712	47	106,069	21	504,663
1973	121,053	20	42,032	7	326,546	53	122,911	20	612,542
1974	115,875	18	46,176	7	355,361	55	127,255	20	644,667
1975	89,472	16	60,384	11	288,511	51	132,100	23	570,467
1976	126,642	18	73,386	10	357,899	51	145,413	21	145,413
1977	76,694	10	73,483	10	404,232	55	176,832	24	176,832
1978	106,428	13	58,120	7	450,473	57	174,505	22	174,505
1979	88,703	12	65,862	9	411,304	54	194,150	26	194,150
1980	94,536	11	62,592	8	458,419	56	210,075	25	825,622
1981	79,364	10	53,069	7	438,178	55	225,309	28	795,920
1982	84,144	10	58,735	7	491,094	58	219,427	26	853,400
1983	64,303	6	59,574	6	683,433	64	253,801	24	1,061,111
1984	74,292	7	63,353	6	751,664	66	246,689	22	1,135,998
1985	74,357	7	68,821	7	604,136	60	258,173	26	1,005,487
1986	68,539	6	63,339	6	756,846	67	244,546	22	1,133,270
1987	66,664	6	80,738	7	685,940	60	301,922	27	1,135,264
1988	71,353	6	68,022	6	836,246	68	258,529	21	1,234,149
1989	89,878	7	75,242	6	814,315	63	312,056	24	1,291,491
1990	82,137	6	91,669	6	890,765	63	350,874	25	1,415,445
1991	62,301	4	76,817	5	1,128,938	68	384,245	23	1,652,301
1992	71,814	4	93,891	6	1,022,130	64	414,673	26	1,602,508
1993	72,083	5	81,778	6	918,716	62	399,847	27	1,472,424
1994	95,006	6	91,338	6	1,012,889	63	411,268	26	1,610,501
1995	88,332	5	83,102	5	1,056,796	65	386,162	24	1,614,392
1996	102,873	7	81,719	5	1,029,082	67	325,982	21	1,539,656
1997	125,460	8	102,857	6	967,356	59	457,522	28	1,653,195
1998	124,118	6	103,446	5	1,310,463	64	499,575	25	2,037,602
1999	147,770	8	110,619	6	1,145,217	62	433,861	24	1,837,467
2000	115,195	6	106,747	6	1,225,825	65	450,925	24	1,898,692
2001	116,627	6	107,262	6	1,212,596	63	473,236	25	1,909,721

Table 6. Total catches of albacore, bigeye, skipjack and yellowfin in the WCPO by gear type.
Symbols: '…' = missing data. Estimates for 2001 are preliminary.

YEAR	LONGLINE		POLE-AND-LINE		PURSE SEINE		OTHER		TOTAL
	MT	%	MT	%	MT	%	MT	%	
1950	…		…		6,483		21,237		…
1951	…		110,714		3,780		25,594		…
1952	…		125,000		7,320		21,014		…
1953	…		106,095		5,250		22,603		…
1954	…		122,510		8,895		23,378		…
1955	…		124,743		6,135		25,441		…
1956	…		143,559		3,776		25,985		…
1957	…		148,525		4,358		25,678		…
1958	…		160,750		14,084		30,132		…
1959	…		165,518		21,293		30,805		…
1960	…		99,001		5,224		31,918		…
1961	…		150,709		14,533		35,355		…
1962	136,980	38	166,141	46	18,822	5	35,954	10	357,897
1963	130,471	43	125,064	41	11,875	4	37,312	12	304,722
1964	110,502	32	167,137	48	28,942	8	41,372	12	347,953
1965	115,491	34	176,158	52	8,623	3	41,706	12	341,978
1966	159,258	34	241,722	52	16,821	4	47,039	10	464,840
1967	132,991	33	205,252	51	14,409	4	51,942	13	404,594
1968	118,321	32	183,982	50	14,556	4	53,393	14	370,252
1969	120,303	31	204,410	52	8,305	2	59,461	15	392,479
1970	134,152	30	225,861	51	20,611	5	65,613	15	446,237
1971	128,369	28	237,569	52	26,711	6	66,368	14	459,017
1972	143,383	28	242,745	48	32,321	6	86,214	17	504,663
1973	142,288	23	330,688	54	39,525	6	100,041	16	612,542
1974	133,146	21	371,196	58	35,705	6	104,620	16	644,667
1975	150,315	26	279,658	49	34,774	6	105,720	19	570,467
1976	175,628	25	382,626	54	46,286	7	98,800	14	703,340
1977	196,231	27	345,257	47	60,218	8	129,535	18	731,241
1978	199,562	25	407,482	52	57,195	7	125,287	16	789,526
1979	200,234	26	342,441	45	98,519	13	118,825	16	760,019
1980	211,050	26	395,065	48	120,312	15	99,195	12	825,622
1981	171,361	22	344,225	43	162,123	20	118,211	15	795,920
1982	163,867	19	310,216	36	253,385	30	125,932	15	853,400
1983	158,643	15	338,788	32	440,094	41	123,586	12	1,061,111
1984	143,780	13	423,542	37	445,295	39	123,381	11	1,135,998
1985	156,598	16	294,704	29	422,147	42	132,038	13	1,005,487
1986	146,580	13	369,161	33	481,837	43	135,692	12	1,133,270
1987	169,385	15	298,093	26	541,373	48	126,413	11	1,135,264
1988	170,082	14	319,117	26	596,054	48	148,897	12	1,234,149
1989	148,966	12	312,558	24	654,558	51	175,409	14	1,291,491
1990	173,766	12	249,952	18	791,829	56	199,898	14	1,415,445
1991	147,737	9	309,613	19	998,118	60	196,832	12	1,652,301
1992	171,250	11	264,782	17	968,958	60	197,518	12	1,602,508
1993	171,236	12	306,431	21	840,371	57	154,386	10	1,472,424
1994	195,856	12	281,199	17	957,736	59	175,710	11	1,610,501
1995	189,316	12	311,254	19	926,075	57	187,747	12	1,614,392
1996	184,057	12	274,132	18	876,468	57	204,999	13	1,539,656
1997	199,795	12	304,677	18	943,818	57	204,905	12	1,653,195
1998	211,187	10	336,623	17	1,238,242	61	251,551	12	2,037,602
1999	196,555	11	350,642	19	1,040,117	57	250,153	14	1,837,467
2000	208,224	11	327,632	17	1,102,257	58	260,579	14	1,898,692
2001	221,874	12	330,381	17	1,089,270	57	268,196	14	1,909,721

Table 7. Total catches of albacore, bigeye, skipjack and yellowfin in the EPO.
Symbols: '…' = missing data. Estimates for 2001 are preliminary.

YEAR	ALBACORE		BIGEYE		SKIPJACK		YELLOWFIN		TOTAL
	MT	%	MT	%	MT	%	MT	%	
1950	32,746		…		56,574		82,656		…
1951	15,629		…		52,516		72,824		…
1952	25,216		…		38,435		80,910		…
1953	15,757		…		55,983		60,040		…
1954	12,393		…		69,741		54,166		…
1955	13,841		…		58,062		64,562		…
1956	19,233		…		68,175		81,876		…
1957	21,469		…		55,297		83,311		…
1958	14,903		…		73,098		75,139		…
1959	20,995		…		78,996		62,676		…
1960	20,661		…		46,741		113,804		…
1961	16,253		…		68,495		119,283		…
1962	30,328	13	44,528	19	68,759	30	85,570	37	229,185
1963	40,651	14	65,375	23	95,696	33	84,969	30	286,691
1964	28,515	12	45,468	19	59,334	25	108,652	45	241,969
1965	21,408	9	28,717	13	78,382	35	97,213	43	225,720
1966	21,230	10	34,366	17	60,660	29	91,517	44	207,773
1967	30,277	11	36,669	13	120,739	43	91,024	33	278,739
1968	30,935	12	36,775	14	71,266	28	118,516	46	257,492
1969	24,224	9	51,514	18	59,233	21	146,858	52	281,829
1970	310,571	11	33,132	11	56,130	19	169,626	59	289,945
1971	29,039	10	32,466	11	104,823	35	130,839	44	297,167
1972	32,433	11	38,638	13	33,585	11	193,428	65	298,084
1973	24,199	7	55,379	16	44,095	13	218,153	64	341,826
1974	32,023	9	37,390	10	78,866	21	220,364	60	368,643
1975	27,388	7	45,487	11	123,936	30	212,903	52	409,714
1976	22,992	5	64,425	14	126,245	27	251,934	54	465,596
1977	22,012	6	80,757	20	86,414	22	210,978	53	400,161
1978	29,370	6	82,125	17	169,887	36	190,672	40	472,054
1979	12,091	3	62,874	15	132,050	32	201,113	49	408,128
1980	13,279	3	80,116	20	130,690	33	173,013	44	397,098
1981	26,656	7	63,457	16	119,634	30	189,765	47	399,512
1982	15,180	5	57,372	19	98,786	32	136,026	44	307,364
1983	16,035	7	63,143	26	58,165	24	105,156	43	242,499
1984	17,369	6	52,181	18	60,575	21	155,370	54	285,495
1985	16,333	4	70,708	19	49,493	13	230,153	63	366,687
1986	13,501	3	104,184	22	63,594	13	291,022	62	472,301
1987	11,956	3	98,748	21	62,368	13	290,317	63	463,389
1988	15,275	3	69,056	15	85,386	18	301,301	64	471,018
1989	7,360	2	70,583	15	92,393	19	305,195	64	475,531
1990	9,301	2	95,411	20	72,645	15	303,688	63	481,045
1991	9,547	2	93,523	22	63,277	15	264,796	61	431,143
1992	20,585	5	82,570	19	83,978	19	256,099	58	443,232
1993	17,259	4	82,216	19	87,389	20	256,328	58	443,192
1994	19,890	5	98,517	22	75,457	17	247,732	56	441,596
1995	11,306	2	93,045	19	138,249	28	243,625	50	486,225
1996	11,266	2	93,697	19	112,355	2	265,144	55	482,462
1997	12,745	2	99,399	18	161,809	2	278,013	50	551,966
1998	14,053	3	79,388	15	145,000	2	280,726	54	519,167
1999	14,771	2	64,324	10	268,102	41	305,872	47	653,069
2000	15,793	3	97,402	16	211,283	34	288,777	47	613,255
2001	20,100	3	76,110	12	144,333	22	409,511	63	650,054

Table 8. Total catches of albacore, bigeye, skipjack and yellowfin in the Pacific Ocean.
Symbols: '…' = missing data. Estimates for 2001 are preliminary.

YEAR	ALBACORE		BIGEYE		SKIPJACK		YELLOWFIN		TOTAL
	MT	%	MT	%	MT	%	MT	%	
1950	68,184		…		…		91,575		…
1951	48,114		…		159,092		84,177		…
1952	94,352		…		130,737		120,052		…
1953	77,610		…		136,304		110,900		…
1954	71,072		…		173,902		110,265		…
1955	63,132		…		166,314		115,484		…
1956	83,745		…		175,364		123,429		…
1957	101,025		…		162,238		154,484		…
1958	74,359		…		230,481		151,190		…
1959	69,174		…		256,270		139,897		…
1960	85,700		…		136,679		195,872		…
1961	76,355		…		225,231		213,644		…
1962	82,490	14	80,117	14	250,383	43	174,092	30	587,082
1963	100,024	17	108,206	18	218,399	37	164,784	28	591,413
1964	85,353	14	76,250	13	242,243	41	186,076	32	589,922
1965	99,134	17	58,922	10	233,586	41	176,056	31	567,698
1966	105,542	16	66,689	10	310,118	46	190,264	28	672,613
1967	123,736	18	71,372	10	325,403	48	162,822	24	683,333
1968	99,037	16	63,550	10	266,022	42	199,135	32	627,744
1969	99,940	15	83,273	12	261,801	39	229,294	34	674,308
1970	102,253	14	72,265	10	298,212	41	263,452	36	736,182
1971	127,797	17	71,962	10	331,194	44	225,231	30	756,184
1972	143,861	18	90,092	11	269,297	34	299,497	37	802,747
1973	145,252	15	97,411	10	370,641	39	341,064	36	954,368
1974	147,898	15	83,566	8	434,227	43	347,619	34	1,013,310
1975	116,860	12	105,871	11	412,447	42	345,003	35	980,181
1976	149,634	13	137,811	12	484,144	41	397,347	34	1,168,936
1977	98,706	9	154,240	14	490,646	43	387,810	34	1,131,402
1978	135,798	11	140,245	11	620,360	49	365,177	29	1,261,580
1979	100,794	9	128,736	11	543,354	47	395,263	34	1,168,147
1980	107,815	9	142,708	12	589,109	48	383,088	31	1,222,720
1981	106,020	9	116,526	10	557,812	47	415,074	35	1,195,432
1982	99,324	9	116,107	10	589,880	51	355,453	31	1,160,764
1983	80,338	6	122,717	9	741,598	57	358,957	28	1,303,610
1984	91,661	6	115,534	8	812,239	57	402,059	28	1,421,493
1985	90,690	7	139,529	10	653,629	48	488,326	36	1,372,174
1986	82,040	5	167,523	10	820,440	51	535,568	33	1,605,571
1987	78,620	5	179,486	11	748,308	47	592,239	37	1,598,653
1988	86,628	5	137,078	8	921,632	54	559,830	33	1,705,167
1989	97,238	6	145,825	8	906,708	51	617,251	35	1,767,022
1990	91,438	5	187,080	10	963,410	51	654,562	35	1,896,490
1991	71,848	3	170,340	8	1,192,215	57	649,041	31	2,083,444
1992	92,399	5	176,461	9	1,106,108	54	670,772	33	2,045,740
1993	89,342	5	163,994	9	1,006,105	53	656,175	34	1,915,616
1994	114,896	6	189,855	9	1,088,346	53	659,000	32	2,052,097
1995	99,638	5	176,147	8	1,195,045	57	629,787	30	2,100,617
1996	114,139	6	175,416	9	1,141,437	56	591,126	29	2,022,118
1997	138,205	6	202,256	9	1,129,165	51	735,535	33	2,205,161
1998	138,171	5	182,834	7	1,455,463	57	780,301	31	2,556,769
1999	162,541	7	174,943	7	1,413,319	57	739,733	30	2,490,536
2000	130,988	5	204,149	8	1,437,108	51	739,702	29	2,511,947
2001	136,727	5	183,372	7	1,356,929	53	882,747	34	2,559,775

Table 9. 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	WCPO		EPO		ATIANTIC		INDIAN		TOTAL
	MT	%	MT	%	MT	%	MT	%	
1950	…		…		42,335		15,230		…
1951	…		…		37,617		9,130		…
1952	…		…		39,012		24,227		…
1953	…		…		38,735		27,516		…
1954	…		…		48,408		39,194		…
1955	…		…		43,120		54,127		…
1956	…		…		52,942		70,381		…
1957	…		…		77,396		59,604		…
1958	…		…		100,474		52,650		…
1959	…		…		122,384		56,985		…
1960	…		…		145,384		69,839		…
1961	…		…		135,231		75,446		…
1962	357,897	42	229,185	27	169,697	20	92,642	11	849,421
1963	304,722	36	286,691	33	188,394	22	76,761	9	856,566
1964	347,953	40	241,969	28	201,987	23	81,632	9	873,541
1965	341,978	39	225,720	26	222,199	25	92,131	10	882,028
1966	464,840	48	207,773	22	181,817	19	110,437	11	964,867
1967	404,594	40	278,739	28	184,929	18	141,346	14	1,009,608
1968	370,252	36	257,492	25	228,018	22	177,884	17	1,033,646
1969	392,479	37	281,829	26	236,695	22	159,481	15	1,070,484
1970	446,237	40	289,945	26	237,191	22	128,532	12	1,101,905
1971	459,017	39	297,167	25	290,960	25	118,343	10	1,165,487
1972	504,663	41	298,084	24	301,937	25	113,440	9	1,218,124
1973	612,542	44	341,826	25	306,180	22	117,881	9	1,378,429
1974	644,667	42	368,643	24	360,996	24	149,213	10	1,523,519
1975	570,467	40	409,714	29	301,679	21	126,968	9	1,408,828
1976	703,340	44	465,596	29	316,953	20	122,503	8	1,608,392
1977	731,241	44	400,161	24	372,569	23	140,170	9	1,644,141
1978	789,526	44	472,054	27	368,658	21	148,351	8	1,778,589
1979	760,019	46	408,128	25	338,014	21	133,820	8	1,639,981
1980	825,622	48	397,098	23	368,051	21	134,812	8	1,725,583
1981	795,920	45	399,512	23	414,702	24	141,098	8	1,751,232
1982	853,400	47	307,364	17	467,019	26	172,226	10	1,800,009
1983	1,061,111	55	242,499	13	427,438	22	194,041	10	1,925,089
1984	1,135,998	55	285,495	14	371,658	18	266,174	13	2,059,325
1985	1,005,487	47	366,687	17	429,526	20	315,958	15	2,117,658
1986	1,133,270	47	472,301	20	422,654	18	365,212	15	2,393,437
1987	1,135,264	47	463,389	19	397,706	17	409,007	17	2,405,366
1988	1,234,149	47	471,018	18	409,025	16	504,385	19	2,618,577
1989	1,291,491	48	475,531	18	418,847	16	504,348	19	2,690,217
1990	1,415,445	49	481,045	17	482,617	17	522,320	18	2,901,427
1991	1,652,301	52	431,143	14	532,223	17	560,698	18	3,176,365
1992	1,602,508	51	443,232	14	492,328	16	621,004	20	3,159,072
1993	1,472,424	46	443,192	14	537,112	17	738,332	23	3,191,060
1994	1,610,501	49	441,596	13	548,747	17	703,408	21	3,304,252
1995	1,614,392	48	486,225	15	507,434	15	730,924	22	3,338,975
1996	1,539,656	47	482,462	15	485,550	15	759,003	23	3,266,671
1997	1,653,195	49	551,966	16	448,587	13	749,278	22	3,403,026
1998	2,037,602	54	519,167	14	464,346	12	763,150	20	3,784,265
1999	1,837,467	47	653,069	17	501,324	13	904,142	23	3,896,002
2000	1,898,692	50	613,255	16	443,777	12	855,445	22	3,811,169
2001	1,909,721	49	650,054	17	(443,777)	11	(855,445)	22	3,858,997

APPENDIX 1. AGENDA

Thursday, July 18

Statistics Working Group—Pago Pago Room, Imin Conference Center, UH campus
Methods Working Group—Tagore Room, Imin Conference Center, UH campus

Friday, July 19

Fishing Technology Working Group—Tagore Room
Methods Working Group (continued)—Pago Pago Room

Monday, July 22

1. PRELIMINARIES—9:00 AM

Announcements
Opening Address:
Dr. C. Barry Raleigh, Dean of the School of Ocean and Earth Science and Technology, University of Hawaii—9:30 AM
Group photo—10:00AM
Break
Adoption of agenda and appointment of rapporteurs—10:30AM
Adoption of the report of the 14th meeting of the SCTB

2. OVERVIEW OF WESTERN AND CENTRAL PACIFIC TUNA FISHERIES
   a) Overview of fisheries (GEN–1)
   b) Economic condition of the fishery (GEN–2)
   c) National tuna fishery reports
3. REPORTS BY REGIONAL FISHERY ORGANIZATIONS

Tuesday, July 23

4. WORKING GROUPS
   a) Statistics Working Group (Coordinator—Tim Lawson, OFP)
   b) Fishing Technology Working Group (Coordinator—David Itano, PFRP)
   c) Skipjack Research Group (Coordinator—Gary Sakagawa, NMFS)

Wednesday, July 24

   d) Yellowfin Research Group (Coordinator—Robert Campbell, CSIRO)
   e) Albacore Research Group (Coordinator—Regis Etaix-Bonnin, New Caledonia)

Thursday, July 25

   f) Bigeye Research Group (Coordinator—Chi-Lu Sun, NTU)
   g) Billfish and By-catch Research Group (Coordinator—Paul Dalzell, WPRFMC)

Friday, July 26

   h) Methods Working Group (Coordinator—John Sibert, PFRP)
5. Consideration of summary statements from RGs on status of stocks
6. Other matters

Saturday, July 27

7. Preparation/clearance of reports/close

APPENDIX 2. LIST OF WORKING PAPERS

Overview of Western and Central Pacific Ocean Tuna Fisheries

GEN-1 Lewis, A. and P. Williams. **Overview of the western and central Pacific Ocean tuna fisheries, 2001**. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

GEN-2 O'Malley, J. and S. Pooley. **Description and Economic Analysis of Large American Samoa Longline Vessels.** National Marine Fisheries Service (NMFS), Honolulu Laboratory, Hawaii.

GEN-3 O'Malley, J. and S. Pooley. **Economic and operational characteristics of the Hawaii longline fleet in 2000**. National Marine Fisheries Service (NMFS), Honolulu Laboratory, Hawaii.

GEN-4 Forum Fisheries Agency. **Economic overview of the tuna fishery**. Forum Fisheries Agency, Honiara, Solomon Islands.

Information Reports

INFO-1 Sibert, J. **Pelagic Fisheries Research Program: Scientific Research in Support of Rational Fishery Management.** Pelagic Fisheries Research Program, Joint Institute for Marine and Atmospheric Research, University of Hawaii.

INFO-2 Schroeder, B. **Prospectus: International longline marine turtle bycatch technical workshop.** Office of Protected Resources, National Marine Fisheries Service, Silver Spring, Maryland.

National Tuna Fishery Reports

NFR-2 Findlay, J. and D. Bromhead. **National tuna fishery report—Tuna and billfish fisheries of the eastern Australian fishing zone.** Fisheries and Marine Science, Bureau of Rural Sciences, Canberra, Australia.

NFR-3 Shaw, W. and M. Stocker. **An Update for Canadian Tuna Fisheries in the North and South Pacific Ocean for 2001**. Fisheries and Oceans Canada, Nanaimo, B.C., Canada.

NFR-4 Xu Liu-Xiong. **National report of China.** Ocean College, Shanghai Fisheries University, Shanghai, P.R. China.

NFR-6 Park, T. **National tuna fishery report for 2001—Federated States of Micronesia.** Micronesian Fisheries Authority, Pohnpei, Federated States of Micronesia.

NFR-7 Amoe, J. **Fiji tuna and billfish fisheries.** Fisheries Division, Ministry of Fisheries and Forests.

NFR-8 Misselis, C. **French Polynesia tuna fisheries.** Service del la pêche, Tahiti, French Polynesia.

NFR-9 Retnowati, D. **Tuna and tuna-like fisheries in Indonesia.** Directorate General of Capture Fishery, Sub Directorate of Data and Statistics, Jakarta, Indonesia.

NFR-10 Koh, J-R, D-Y Moon, and D-H An. **National tuna fishery report in 2002—Korea.** National Fisheries Research and Development Institute, Busan, Republic of Korea.

NFR-11 **Marshall Islands National Tuna Fishery Report 2001-2002.** MIMRA Oceanic and Industrial Affairs, Marshall Islands Marine Resources Authority, Majuro, Republic of Marshall Islands.

NFR-12 Etaix-Bonnin, R. **New Caledonia Tuna Fishery.** Service de la marine marchande et des pêches maritimes. Noumea, New Caledonia.

NFR-13 Murray, T., Griggs, L., and P. Wallis. **New Zealand Domestic Tuna Fisheries, 1990—2001.** National Institute of Water and Atmospheric Research Ltd., Wellington and Ministry of Fisheries, Wellington.

NFR-17 Kumoru, L. **National tuna fishery report—Papua New Guinea.** Papua New Guinea National Fisheries Authority, Port Moresby, Papua New Guinea.

NFR-18 Barut, N. **National tuna fishery report—Philippines.** Marine Fisheries Research Division, National Fisheries Research and Development Institute, Quezon City, Philippines.

NFR-20 Su'a, D., P. Watt, and R. Imo. **Samoa national tuna fishery report.** Fisheries Division, Ministry of Agriculture, Forests, Fisheries and Meteorology, Apia, Samoa.

NFR-21 Oreihaka, E. **Domestic tuna fisheries in the Solomon Islands**. Ministry of Fisheries and Marine Resources. Honiara, Solomon Islands.

NFR-22 Wang, S-H, S-B Wang, and C-L Kuo. **National report: Update on tuna fisheries of Taiwan in the Pacific Region**. Overseas Fisheries Development Council of the Republic of China and Fisheries Administration, Council of Agriculture, R.O.C.

NFR-23 Aho, M. **National Fisheries Report for Tonga**. Ministry of Fisheries, Nuku'alofa, Tonga.

NFR-24 Ito, R., D. Hamm, A. Coan, and J. Childers. **Summary of U.S. fisheries statistics for highly migratory species in the central-western Pacific, 1997-2001**. National Marine Fisheries Service (NMFS), Honolulu Laboratory and National Marine Fisheries Service (NMFS), Southwest Fisheries Science Center, La Jolla.

NFR-25 Naviti, W. **Vanuatu tuna fishery report.** Department of Fisheries, Port Vila, Vanuatu.

NFR-26 Duong Long Tri. **Vietnam fisheries report.** Fisheries Information Centre (FICen), Ministry of Fisheries, Hanoi, Vietnam.

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 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. A. Coan and M. Hinton. **Review of Taiwanese catch and effort logsheets**. Oceanic Fisheries Programme, Secretariat of the Pacific Community, National Marine Fisheries Service, SWFSC, and Inter-American Tropical Tuna Commission (IATTC), La Jolla, CA.

SWG-5 Lawson, T. **Sampling the proportions of bigeye in the catch by purse seiners in the western and central Pacific Ocean**. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SWG-6 Anonymous. **Report of the FAO expert consultation on the harmonization of catch certification schemes, 9-11 January 2002, La Jolla, California, United States of America**.

SWG-7 Walsh, W. and S. Pooley. **Development and application of generalized additive models to correct incidental catch rates in the Hawaii-based longline fishery.** National Marine Fisheries Service (NMFS), Honolulu Laboratory, Hawaii.

SWG-8 Williams, P. **Current status of data available from the Indonesian and Philippines domestic tuna fisheries.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

SWG-9 Crone, P. and A. Coan. **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)**. National Marine Fisheries Service (NMFS), Southwest Fisheries Science Center, La Jolla.

Methods Working Group

MWG-1 Labelle, M. **Testing the accuracy of MULTIFAN-CL assessments of the WCPO yellowfin tuna fishery conditions**. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

MWG-2 Hampton, J. **Recent enhancements to the MULTIFAN-CL software.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

MWG-3 Wang, C.H. **Fundamental limitation of TAC as the goal of fishery management**. Institute of Oceanography, National Taiwan University, Taipei, Taiwan, R.O.C.

MWG-4 Kleiber, P. **Standardizing longline fishing effort in stock assessment models: Effect of oceanic conditions**. National Marine Fisheries Service (NMFS), Honolulu Laboratory, Hawaii.

MWG-5 Kolody, D. **SCALIA: Application of an integrated analysis stock assessment model to the 2002 SCTB Methods Working Group simulated tuna fishery data**. CSIRO Marine Research, Hobart, Australia.

MWG-6 Bigelow, K. **Application of an ADAPT VPA model to the simulated population data**. National Marine Fisheries Service (NMFS), Honolulu Laboratory, Hawaii.

MWG-7 Maunder, M., M. Hinton, K. Bigelow and S. Harley. **Statistical comparisons of habitat standardized effort and nominal effort.** Inter-American Tropical Tuna Commission (IATTC), La Jolla, CA, and National Marine Fisheries Service (NMFS), Honolulu Laboratory, Hawaii.

MWG-8 Ricard, D. and D. Kolody. **Application of production models to the assessment of the SCTB-MWG simulated tuna fishery data.** CSIRO Marine Research, Hobart, Tasmania, Australia.

Fishing Technology Working Group

FTWG-1 Coan, A. and G. Sakagawa. **The 2001 U.S. purse seine fishery for tropical tunas in the central-western Pacific**. National Marine Fisheries Service (NMFS), Southwest Fisheries Science Center, La Jolla, and National Marine Fisheries Service (NMFS), Southwest Regional Office, Pago Pago.

FTWG-2 Coan, A. and D. Itano. **An update 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**. National Marine Fisheries Service (NMFS), Southwest Fisheries Science Center, La Jolla, and Pelagic Fisheries Research Program, Joint Institute for Marine and Atmospheric Research, University of Hawaii.

FTWG-3 Gaertner, D. and P. Pallares. **The European Union Research Project, Efficiency of Tuna Purse-Seiners and Effective Effort (ESTHER): Scientific report of project**. Institute of Research for Development (IRD-UR 109), Sete Cedex, France, and Spanish Institute of Oceanography (IEO), Madrid, Spain.

FTWG-4 Gaertner, D. and P. Pallares. **The European Union Research Project, Efficiency of Tuna Purse-Seiners and Effective Effort (ESTHER): ESTHER scientific documents and abstracts**. Institute of Research for Development (IRD-UR 109), Sete Cedex, France, and Spanish Institute of Oceanography (IEO), Madrid, Spain.

FTWG-5 Reales, M. **Efficiency of Tuna Purse-Seiners and Effective Effort (ESTHER): Selected annotated bibliography**. Institute of Research for Development (IRD-UR 109), Sete Cedex, France.

FTWG-6 Morón, J. **The WTPO and its significance in the world tuna purse seine fishery**. World Tuna Purse Seine Organization.

FTWG-7 World Tuna Purse Seine Organization (WTPO). **WTPO Resolution, WTPO Declaration (2nd Interim Evaluation Meeting, Kaohsiung, Taiwan, 18 June 2002)**.

FTWG-8 Wu, R. **An overview of Taiwan distant water purse seine fishery—2001.** Overseas Fisheries Development Council of the Republic of China, Taipei, Taiwan.

FTWG-9 Itano, D. **Vessel and gear attributes in the Forum Fisheries Agency Regional Register of Vessels: How much is enough?** Pelagic Fisheries Research Program, Joint Institute for Marine and Atmospheric Research, University of Hawaii.

FTWG-10 Itano, D. **Super superseiner**. Pelagic Fisheries Research Program, Joint Institute for Marine and Atmospheric Research, University of Hawaii

FTWG-11 Beverly, S. **State of the art longliner 2002**. Coastal Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

FTWG-12 Kumoru, L. **Status of fish aggregating devices in Papua New Guinea.** National Fishing Authority (NFA), Port Moresby, Papua New Guinea.

FTWG-13 Opnai, J. **Summary of the progress of the work on the review of the Palau Arrangement**. Forum Fisheries Agency, Honiara, Solomon Islands.

FTWG-14 Opnai, J. **Summary of the FFC species working group meeting on options for bigeye management**. Forum Fisheries Agency, Honiara, Solomon Islands.

FTWG-15 Gillett, R., M. McCoy, and D. Itano. **Status of the United States Western Pacific tuna purse seine fleet and factors affecting its future**. Gillett, Preston and Associates, Lami, Fiji, Pelagic Fisheries Research Program, Joint Institute for Marine and Atmospheric Research, University of Hawaii.

Research Groups

General

RG-1 Wang, S-B, F-C Chang, S-H Wang, and C-L Kuo. **Some biological parameters of bigeye and yellowfin tunas distributed in surrounding waters of Taiwan.** Overseas Fisheries Development Council of the Republic of China, Taipei, and Fisheries Administration, Council of Agriculture, Taipei, Taiwan.

RG-2 Wang, S-B, F-C Chang, S-H Wang, and S-K Chang. **Conversion factors estimated for bigeye and yellowfin tunas distributed in surrounding waters of Taiwan.** Overseas Fisheries Development Council of the Republic of China, Taipei, and Deep Sea Fishery Research and Development Center, Fisheries Administration, Council of Agriculture, Taipei, Taiwan.

Skipjack

SKJ-1 Hampton, J. **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 Maunder, M. **Status of skipjack tuna in the eastern Pacific Ocean in 2001 and outlook for 2002**. Inter-American Tropical Tuna Commission (IATTC), La Jolla, CA.

SKJ-3 Williams, P. **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 Sun, C. and S. Yeh. **Biological data collection and study on skipjack tuna caught by Taiwanese tuna purse seine fishery—2001**. Institute of Oceanography, National Taiwan University, Taipei, Taiwan.

SKJ-5 Lehodey, P. **SEPODYM development and application to skipjack population and fisheries**. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

Yellowfin

YFT-1 Hampton, J. **Stock assessment of yellowfin tuna in the western and central Pacific Ocean.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

YFT-2 Sibert, J. and J. Hampton. **Lifetime displacements of tropical tunas: How much ocean do you need to conserve "your" tuna?** Pelagic Fisheries Research Program, Joint Institute for Marine and Atmospheric Research, University of Hawaii, and Oceanic Fisheries Programme, Secretariat of the Pacific Community.

YFT-3 Maunder, M. **Status of yellowfin tuna in the eastern Pacific Ocean in 2001 and outlook for 2002**. Inter-American Tropical Tuna Commission (IATTC), La Jolla, CA.

YFT-4 Kikkawa, B. and J. Cushing. **Growth of yellowfin tuna (*Thunnus albacares*) in the equatorial western Pacific Ocean**. National Marine Fisheries Service (NMFS), Honolulu Laboratory, and Dept. of Commerce, Govt. of Guam.

YFT-5 Williams, P. **A summary of aggregate catch/effort and size composition data available to the SCTB: Yellowfin.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

YFT-6 Grubbs, R.D., K. Holland, and D. Itano. **Comparative trophic ecology of yellowfin and bigeye tuna associated with natural and man-made aggregation sites in Hawaiian waters.** Hawaii Institute of Marine Biology, University of Hawaii, and Pelagic Fisheries Research Program, Joint Institute for Marine and Atmospheric Research, University of Hawaii.

Bigeye

BET-1 Hampton, J. **Stock assessment of bigeye tuna in the western and central Pacific Ocean.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

BET-2 Maunder, M. and S. Harley. **Status of bigeye tuna in the eastern Pacific Ocean in 2001 and outlook for 2002.** Inter-American Tropical Tuna Commission (IATTC), La Jolla, CA.

BET-3 Polovina, J., M. Seki and R. Brainard. **The role of oceanography in the aggregation and vulnerability of bigeye tuna in the Hawaii longline fishery from satellite, moored, and shipboard time series data: An ongoing study.** National Marine Fisheries Service (NMFS), Honolulu Laboratory, Hawaii.

BET-4 Williams, P. **A summary of aggregate catch/effort and size composition data available to the SCTB: Bigeye.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

BET-5 Adam, S., J. Sibert, D. Itano and K. Holland. **Analysis of Hawaii Tuna Tagging Project (HTTP) data from a site and size-specific tag-attrition model**. Pelagic Fisheries Research Program, Joint Institute for Marine and Atmospheric Research, University of Hawaii, and Hawaii Institute for Marine Biology, University of Hawaii.

BET-6 Sun, C-L, M. Maunder, G. Watters, and S-Z Yeh. **An update of the application of the A-SCALA method to bigeye tuna in the western and central Pacific Ocean.** Institute of Oceanography, National Taiwan University, Taipei, and Inter-American Tropical Tuna Commission, La Jolla, CA.

Albacore

ALB-1 Hampton, J. **Stock assessment of albacore tuna in the south Pacific Ocean.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

ALB-2 Seki, M. and J. Polovina. **A new study to characterize the oceanography of the American Samoa longline fishing grounds for albacore, *Thunnus alalunga*.** National Marine Fisheries Service (NMFS), Honolulu Laboratory, Hawaii.

ALB-3 Williams, P. **A summary of aggregate catch/effort and size composition data available to the SCTB: South Pacific albacore.** Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

ALB-4 Millar, C. and P. Williams. **Further information on targeting in the south Pacific albacore fishery**. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

ALB-5 Griggs, L. **Monitoring the length structure of commercial landings of albacore tuna during the 2001-2002 fishing year**. National Institute of Water and Atmospheric Research Ltd. (NIWA), Wellington, New Zealand.

ALB-6 Lehodey, P. **Preliminary results of SEPODYM application to albacore in the Pacific Ocean**. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

ALB-7 Wang, C-H. **Estimating the population parameter, r, q and K based on surplus production model**. Biological and Fishery Division, Institute of Oceanography, National Taiwan University, Taipei, Taiwan.

Billfish and Bycatch

BBRG-1 Hinton, M. and W. Bayliff. **Status of striped marlin in the eastern Pacific Ocean in 2001 and outlook for 2002**. Inter-American Tropical Tuna Commission (IATTC), La Jolla, CA.

BBRG-2 Hawn, D., M. Seki, and R. Nishimoto. **An investigation of the life history and ecology of opah and Monchong in the North Pacific.** National Marine Fisheries Service (NMFS), Honolulu Laboratory, Hawaii.

BBRG-3 Kleiber, P. and K. Yokawa. **Stock assessment of swordfish in the North Pacific using MULTIFAN-CL**. National Marine Fisheries Service (NMFS), Honolulu Laboratory and National Research Institute of Far Seas Fisheries, Shimizu, Japan.

BBRG-4 Laurs, R.M., C. Boggs, Y. Swimmer, and R. Brill. **NMFS Honolulu Laboratory research to reduce sea turtle Bycatch and mortality in pelagic longline fishing.** National Marine Fisheries Service (NMFS), Honolulu Laboratory, Joint Institute for Marine and Atmospheric Research, University of Hawaii, and Virginia Institute of Marine Science.

BBRG-5 Polovina, J., E. Howell, D. Parker, and G. Balazs. **Dive-depth distribution of loggerhead (*Carretta carretta*) and olive ridley (*Lepidochelys olivacea*) turtles in the central North Pacific: Might deep longline sets catch fewer turtles?** National Marine Fisheries Service (NMFS), Honolulu Laboratory, and Joint Institute for Marine and Atmospheric Research, University of Hawaii.

BBRG-6 Swimmer, Y. and R. Brill. **Determining survival, migration, and diving patterns of sea turtles released from longline fishing gear using pop-up satellite archival transmitters.** Joint Institute for Marine and Atmospheric Research, University of Hawaii and Virginia Institute of Marine Science.

BBRG–7 Allain, V. **Food web study in the tuna ecosystem of the Western and Central Pacific Ocean**. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia.

BBRG-8 Sun, C., H. Lin, and S. Yeh. **Age and growth of the young swordfish *Xiphias gladius* L. in Taiwan waters using otolith**. Institute of Oceanography, National Taiwan University, Taipei, Taiwan.

BBRG-9 Campbell, R. **Sequential changes in swordfish catch rates off eastern Australia and possible implications for the spatial distribution of the local swordfish population.** CSIRO Division of Marine Research, Hobart, Tasmania, Australia.

BBRG-10 Kleiber, P., J. Hampton, M. Hinton, and Y. Uozumi. **Update on blue marlin stock assessment**. National Marine Fisheries Service, Honolulu Laboratory; Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia; Inter-American Tropical Tuna Commission, La Jolla, California; and National Research Institute of Far Seas Fisheries, Shimizu, Japan.

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APPENDIX 4. REVIEW OF TAIWANESE CATCH AND EFFORT LOGSHEETS

INTRODUCTION

The objectives of the Statistics Working Group (SWG) of the Standing Committee on Tuna and Billfish (SCTB) are to coordinate the collection, compilation and dissemination of data on tuna fisheries in the WCPO. With regard to the coordination of data collection, it was agreed at the eleventh meeting of the SCTB (held on 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 during 16-23 June 1999 in Tahiti, French Polynesia (Anon., 1999). The minimum standards are presented in SCTB 14 Working Paper SWG–4, Appendix I.

Catch and effort logsheets developed by MAF (New Zealand) and AFMA (Australia) were reviewed at the first SWG Session on Data Collection Forms, which was held from 14 to 15 June 1999, immediately prior to SCTB 12 (Anon., 1999). Logsheets developed by the SPC/FFA Tuna Fishery Data Collection Forms Committee were reviewed at the second SWG Session on Data Collection Forms, which was held on 3 July 2000, immediately prior to SCTB 13 (Anon., 2000). Logsheets developed by the National Research Institute of Far Seas Fisheries of Japan were reviewed following SCTB 13 and the resulted were reported to SCTB14 (Anon., 2001), which was held from 9 to 16 August 2001. At SCTB 14, it was agreed that a small group would conduct a review of the Taiwanese logsheets and report their findings to SCTB 15. Members of the group included Mr. Atilio Coan, Dr. Michael Hinton and Mr. Tim Lawson.

COMPARISON OF TAIWANESE LOGSHEETS AND MINIMUM STANDARDS

SCTB 14 Working Paper SWG–4, Appendix III, presents a comparison of the Taiwanese logsheets and the minimum standards established by the SWG. The following points are of interest.

"Logbook (Distant-water Tuna Longline Fishery)"

- The format is a logbook, with one page of instructions and one page for vessel attributes and trip information. These are followed by several pages, each of which is used to record catch and effort data for one set, rather than a logsheet (i.e., a single page, with vessel attributes and trip information at the top of the page and one row to record the catch and effort data for each set).

- The page of instructions presents the purpose of the logbook; the units of measurement for the catches and the lengths of fish; the mailing address for the submission of the logbook; and diagrams illustrating the upper jaw to caudal fork length for tuna and the lower jaw to caudal fork length for billfish. A table of species codes is also included at the back of the logbook.

- The forms are used only by vessels registered in Taiwan; 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.

- 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 'sailing' days and the number of 'operation' days for the trip are recorded.

- There are fields to record the catches of six species of tuna, four species of billfish and, as species groups, other tuna, other billfish, sharks, sea turtles, seabirds and whales/dolphins. But all other species are recorded under 'other'. Hence, it is not possible to separately record the catches of other major non-target species, such as wahoo, opah, escolar, lancetfish, etc.

- For each species or species group, there are two columns for the catch including discards, in number of fish and kilograms, and two columns for discards only, in number of fish and kilograms, except for sea turtles, sea birds and whales/dolphins, for which only one column for the number of animals is available.

- Each page has space for recording the species code and length of the first thirty fish caught in each set.

"Logbook (Offshore Tuna Longline Fishery)" for Vessels Based in Taiwan

- The format is a logbook, with one page for vessel identity and trip information and one page of instructions, followed by several pages, each of which is used to record catch and effort data for one set, rather than a logsheet (i.e., a single page, with vessel attributes and trip information at the top of the page and one row to record the catch and effort data for each set).

- The page of instructions presents the purpose of the logbook; the units of measurement for the catches in weight; the submission of logbooks; and diagrams illustrating the upper jaw to caudal fork length for tuna and the lower jaw to caudal fork length for billfish. A table of species codes is also included at the back of the logbook.

- The forms are used only by vessels registered in Taiwan; 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.

- 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.

- There are fields to record the catches of six species of tuna, four species of billfish, dolphinfish and, as species groups, other tuna, billfish, other marlins and sharks. But all other species are recorded under 'other'. Hence, it is not possible to separately record the catches of other major non-target species, such as wahoo, opah, escolar, lancetfish, etc.

- For each species or species group, there are columns for the catch in number of fish, the catch in kilograms and the average length (cm). Discards are not recorded.

"Catch Report for Taiwanese Offshore Longline Vessel Operate in the Water"

- The format is a logsheet (i.e., a single page, with vessel attributes and trip information at the top of the page and one row to record the catch and effort data for each set).

- The call sign and license number are not recorded, however, the vessel name and registration number should be sufficient for identifying the vessel.

- There are fields to record the catches of five species of tuna, four species of billfish, dolphinfish and, as species groups, other marlins and sharks. But all other species are recorded under 'other'. Hence, it is not possible to separately record the catches of other major non-target species, such as wahoo, opah, escolar, lancetfish, etc.

- For each species or species group, there are columns for the catch in number of fish and the catch in kilograms.

- Discards are recorded in three columns for the name of the species, discards in numbers of fish and discards in kilograms. The space for the species name is small and cannot contain more than one name.

- There is a column for the number of damaged fish, presumably by sharks or toothed whales.

"South Pacific Regional Purse-Seine Logsheet"

This form was developed by the SPC/FFA Data Collection Committee. The following comments were made when this form was reviewed prior to SCTB 13 (Anon., 2000).

- The purse-seine logsheet is missing several vessel and gear attributes that are available on the FFA Regional Register. In particular, it was noted that the presence of sonar, bird radar, and the type and number of FADs were not included. The type of FADs could refer to the use of echo sounders and satellite tracking, which is becoming increasingly common.

- It was suggested that consideration be given to including activity codes for planting FADs and for drifting, since the use of FADs has increased considerably and these are now distinct activities for many vessels.

- It was also noted that no environmental data, such as sea surface temperature, are included on the logsheet. Environmental data are known to be correlated to catch rates and so this information may be useful in explaining variation in catch rates.

- The ‘set start time’ is included on the form, but not the time at which the skiff is onboard, i.e., the time of the end of the set. This information is useful for calculating the searching time and thus to determine a more accurate measure of fishing effort.

- It was suggested that a data item concerning the presence of an observer onboard should be included, to allow the logsheet data to be cross-referenced to the observer data.

RESPONSE TO THE “REVIEW OF TAIWANESE CATCH AND EFFORT LOGSHEETS” BY OFDC

The following comments were made by the Overseas Fisheries Development Council of Taiwan in response to the review of Taiwanese logsheets.

First, we appreciate for the constructive comments provided by the reviewers.

We would like to response to the questions in the review paper.

General

Table of species code

- This table of species code is only for translation convenience. It is not included in the original logbook. Anyway, thanks for the correction.

To record the other major not-target species for example the wahoo, shark, and discard etc.

- It is impossible to record the other major non-target fish and discard (NAD) species now. Since the major non-target species will not be separated well by the fishermen for the low economic value and the limit space of the logbook. It may be well done by the port sampling or the observer program.

Port and date of return

- The port and date of return usually mean the port and date of unloading, except for the transshipment, repair and supplying. It can be solved by adding the fishing activity code or to be edited like the format of DWPS.

DWLL

Activity code and target species of the operation

- Till now we do not have the field for the activity code in the tuna longline database. But some of the fishermen also record their situation in the blank space of the logbooks. To add this field, it needs some modification for the logbooks and the database. So the activity code and target species of the operation can be considered to add in the future.

Legal operation area

- The record of the operating site in the logsheet can be used to recognize the operation area and the legal operation. This can also be done by VMS. We think it is not necessary.

OSLL

- The GRT information of the vessel can be referred from the CT-N to the vessel database in Taiwan.

- The unit of Hsin equals to the unit of fathom that is equal to 6 feet in length. Hsin is just a pronunciation of Mandarin for the unit. We don't know the unit of mainline for Chinese longline vessel.

DWPS

- The sea surface temperature, the end of set time will be improved.

REFERENCES

Anonymous. 1998. Report of the Eleventh Meeting of the Standing Committee on Tuna and Billfish, 28 May–6 June 1998, Honolulu, Hawaii, United States of America. Secretariat of the Pacific Community, Noumea, New Caledonia.

Anonymous. 1999. Report of the Twelfth Meeting of the Standing Committee on Tuna and Billfish, 16–23 June 1999, Tahiti, French Polynesia. Secretariat of the Pacific Community, Noumea, New Caledonia.

Anonymous. 2000. Report of the Thirteenth Meeting of the Standing Committee on Tuna and Billfish, 5–12 July 2000, Noumea, New Caledonia. Secretariat of the Pacific Community, Noumea, New Caledonia.

Anonymous. 2001. Report of the Fourteenth Meeting of the Standing Committee on Tuna and Billfish, 9–16 August 2001, Noumea, New Caledonia. Secretariat of the Pacific Community, Noumea, New Caledonia.

APPENDIX 5. REPORT OF THE STATISTICS WORKING GROUP PREPARATORY MEETING ON OBSERVER PROGRAMS

A preparatory meeting was held by the Statistics Working Group (SWG) on 18 July 2002, at the Imin Conference Center at the University of Hawaii, to discuss the establishment of standards for the design of national and regional observer programs for tuna fisheries of the western and central Pacific Ocean (WCPO). The meeting was attended by M. Aho (Tonga), A. Coan (United States), T. Lawson (SPC), L.T. Duong (Vietnam), T. Park (Federated States of Micronesia), G. Sakagawa (United States), P. Sharples (SPC), K. Sissior (Palau), R. Skillman (United States), K. Staisch (FFA), W. Walsh (United States), S-H. Wang (Taiwan), J. Wetherall (United States), W. Whitelaw (Australia), P. Williams (SPC), R.-F. Wu (Taiwan) and G. Yamasaki (United States). Mr. Lawson, coordinator of the SWG, chaired the meeting. The agenda included (1) types of data, (2) sampling protocols, (3) data collection forms, (4) coverage rates and (5) future activities.

1. Types of Data

The kinds of research data that should be collected by observers were the first topic of discussion. It was noted that the design of observer programs should take into consideration other sources of research data, such as logsheet catch and effort data and port sampling data. It was also noted that the priorities for data collection may vary according to management issues that may arise.

Six types of data that should be collected by observers were identified as (i) catch data, (ii) species composition data, (iii) length data, (iv) biological data and samples, (v) information on vessel and gear attributes, and (vi) operational data. The descriptions given below are not exhaustive and they may vary depending on management objectives.

(i) *Catch data*: These data are the observed catch, by species, and can cover target species, major non-target species, minor non-target species and species of special interest (such as sharks, marine reptiles, marine mammals and seabirds), according to the priorities of the observer program. For purse seine, the observed catch of target and major non-target species is usually estimated by counting the number of brails and applying an estimate of the species composition, whereas for longline, each fish caught is identified. The retained catch and discards should also be distinguished. The life status of the fish caught, whether retained or discarded, can also be monitored, as well as the onboard processing of the fish.

(ii) *Species composition data*: Species composition sampling is required for the estimation of the proportion of bigeye in mixed catches of yellowfin and bigeye, in order to adjust logsheet data and landings data for the misidentification of bigeye as yellowfin, for certain purse-seine fleets.

(iii) *Length data*: Samples of the length of fish, which are usually taken for target species and some non-target species, are essential for age-structured stock assessments of tuna in the WCPO.

(iv) *Biological data and samples*: These data and samples are usually collected for specific research projects and can include sex and gonad samples for studies of reproduction, length and weight data required for conversion factors, stomach contents for studies of predator-prey relationships, tissue samples for genetic analyses, and otoliths and other hard parts for studies of growth. Observers may also have opportunities to tag and release animals, or recover tags, for studies of growth, mortality and movement.

(v) *Vessel and gear attributes*: These data are useful for characterizing the type of fishing and for standardizing effort data. It was noted that the SCTB Fishing Technology Working Group will consider essential and desirable vessel and gear attributes in a preparatory meeting to be held on 19 July 2002 (see also Working Paper FTWG–9).

(vi) *Operational data*: Data on fishing operations may include direct measures of fishing effort, such as the time and location of a longline set or a purse-seine set, and ancillary information, such as the use of helicopters or FADs by purse seiners or the type of bait used by longliners. It was suggested that data on meteorological and oceanographic conditions could be considered as operational data or as a separate type of data.

The monitoring of catch quotas was also identified as a type of data that may possibly be required in the WCPO in the future.

It was recognized that certain data that are collected by observers are primarily for compliance purposes, such as pollution and sightings of vessels and aircraft, while catch data and operational data can be used for both compliance (e.g., to monitor the retention of non-take species or fishing within closed areas) and research.

It was noted that problems with data quality invariably arise when observer programs are first implemented, particularly if the training of observers is not fully addressed. This situation is aggravated if fishing nations place observers on their vessels only to achieve a certain level of coverage, without the proper selection of observers or the proper training.

2. Sampling Protocols

The protocols currently in use for sampling the length of fish caught by longliners and purse seiners and the species composition of catches by purse seiners were reviewed. In the observer programs covering purse seiners that are supported by FFA and SPC, five fish per brail are randomly sampled, throughout brailing of the entire set. IATTC observers on purse seiners do not usually sample lengths or the species composition, although catches of non-target species are closely monitored. Two observer trips on Taiwanese purse seiners have been conducted by the Fisheries Administration since 2001.

Taiwanese observers have collected the six types of data listed above, however, the protocols for sampling lengths and the species composition were not reported at the meeting.

For observer programs covering longliners that are supported by SPC, the observer attempts to identify and measure the length of all fish caught. If the longliner is a large distant-water vessel, the observer attempts to monitor hauling of the entire set, which can take up to 12–18 hours, and rest during every third set. In the Australian observer program, the observer monitors the entire set and haul of domestic longliners. When distant-water longliners in the AFZ were covered, Australian observers monitored different portions of the set (beginning, middle, and end) on different days. In the observer program for longliners based in Hawaii, the observer monitors the entire set, except when turtles are encountered, whereupon the observer stops monitoring the catch to deal with the turtle.

In order for the SWG to make an informed decision about standard sampling protocols, SPC agreed to review the protocols used in tuna fisheries in the WCPO and, if possible, other ocean areas. The justification for the protocols will be documented, as well as the reasons why sampling protocols have evolved in certain observer programs.

3. Data Collection Forms

Minimum standards for data collection forms will be considered at a future session of the SWG and will depend, in part, on the establishment of standard sampling protocols. It was noted that Australia, New Zealand, the United States and the SPC/FFA Data Collection Committee have developed observer data collection forms.

4. Coverage Rates

The meeting noted that target coverage rates for observer programs represent a compromise between research objectives, compliance objectives and considerations of cost.

Target coverage rates for research purposes should be determined from the relationship between coverage and the accuracy and reliability (i.e., bias and variance) of measures determined from observer data (e.g., estimates of annual catches, length frequencies by time-area strata, etc.). Ideally, an appropriate observer coverage rate should be determined for each fleet. However, it was recognized that while the observer data currently available for some fleets may be sufficient to determine the relationship between coverage and the accuracy and reliability of measures, the lack of observer data for most fleets implies that generalized target coverage rates should be developed for the major gear types. These generalized target coverage rates could then be used in new or expanding observer programs, until sufficient data are available to determine a coverage rate specific to the particular fleet.

It was noted that the target coverage rates would depend on the priorities of the program (e.g., monitoring major bycatch species, monitoring species of special interest, sampling of lengths, etc.).

Three approaches were identified for investigating the relationship between coverage rates and the accuracy and reliability of measures. First, case studies can be conducted on those fleets for which the levels of observer coverage are relatively high, e.g., Australian (domestic and foreign) longline, New Zealand (domestic and foreign) longline, United States (Hawaii) longline and United States (WCPO) purse seine. The results of the case studies on these fleets may be useful in designing observer programs for fleets with similar characteristics.

Second, for fleets for which the observer coverage is currently insufficient to conduct a case study, studies on the variability of catch rates, and their implications for coverage rates, could be conducted by combining the observer data held by the OFP for general types of fleets (e.g., the offshore longliners of China, Federated States of Micronesia, Japan, Papua New Guinea, Solomon Islands and Taiwan in tropical waters, catching primarily yellowfin and bigeye, and the offshore longliners of American Samoa, Fiji, French Polynesia, New Caledonia, Samoa and Tonga, in sub-tropical waters, catching primarily albacore).

Third, for fleets for which the observer coverage is currently insufficient to conduct a case study, pilot observer programs with relatively high coverage could be considered, which would result in data that can be used to determine the relationship between coverage and the accuracy and reliability of the measures of interest.

5. Future Activities of the Statistics Working Group

The following activities related to standards for the design of national and regional observer programs to be addressed during the next SCTB intersessional period were identified.

- 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)
- investigation into the feasibility of pilot observer programs (SPC)

The participants agreed to report on the progress with the above activities at a meeting of the SWG to be held in 2003, prior to SCTB 16.

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 19 July 2002 on the campus of the University of Hawaii. Mr. Itano, WG Coordinator served as chairman of the meeting with 30 participants in attendance. The meeting reviewed presentations on PIC and DWFN fleets, items specific to the FTWG Task List developed at the close of SCTB 14, recent regional management initiatives, and then agreed upon the structure and agenda of the FTWG plenary session.

For the benefit of those who had not attended SCTB 14, the Chairman explained that the FTWG was formed prior to SCTB 14 where final Terms of Reference for the meeting were adopted which are available on the OFP website. 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, data sources and data quality useful for fisheries management. Membership and contributions are open to all SCTB participants and promoted with national, regional and industry organizations. Information on new fishing methods and technology, bycatch reduction methods, remote sensing technologies, expansions/contractions in regional fishing effort, and FAD issues are relevant.

PIC Fleet Reports

Mr. Park of NORMA, FSM reported briefly on an improved observer database that includes vessel and gear attributes that is being developed with assistance from the OFP. The database is not yet operational but should be usable later in 2002. NORMA fields a significant observer program that board vessels of all gears and many flags, providing them a valuable opportunity to evaluate new trends in fisheries. Their observers have reported significant difficulties in sampling catch from purse seiners that employ the so-called "Spanish style" fish brailing method. Fish are loaded at a high rate from larger brailers making length frequency and biological sampling very difficult. Further examination of this problem was recommended.

Mr. Oreihaka of MFMRRM reported that conditions of the Solomon Islands industrial tuna fishing fleets were improving gradually. NFD is operating two purse seine vessels and the Soltai Fishing and Processing Ltd. cannery in Noro is operational, despite continuing civil unrest in the region.

DWFN Fleet Reports

Mr. Ren-Fen WU of OFDC presented an overview of Taiwan Distant Water purse seine fishery-2001 (FTWG–8). Production from this fleet during 2001 for 41 Taiwanese flagged vessels went over 230,000 mt. Vessels targeted unassociated, log and drifting FAD associated schools at rates of 71%, 10% and 17% respectively.

The meeting noted relatively low reported catches of bigeye from the fishery, despite considerable levels of drifting object sets taking place in previous years. It was suggested that some independent means to verify species composition of purse seine catches is necessary for all fleets. The Fisheries Administration began the first at sea observer program for the Taiwan purse seine fishery in 2001, which was reported on by Mr. Wu. These efforts are commendable as observer programs are extremely useful to verify a number of fishery characteristics, including size and species compositions.

In further discussion, an issue related to the adjustment, or raising of bigeye catch figures from logbook data was raised. It was agreed that greater collaboration and technical exchange of expertise should be fostered between organizations responsible for the collection of national fishery data and scientists highly experienced with these issues.

Mr. Atilio Coan presented the information on the 2001 U.S. purse seine fishery for tropical tunas in the central-western Pacific (FTWG–1). The fleet landed 115,524 t, close to the lowest landings since the beginning of the South Pacific Tuna Treaty in 1988. The low catches were likely due to voluntary tie ups due to low ex-vessel prices (<$US400/t), a reduction in the number of vessels to 31 and a resumption of unassociated school fishing strategy, rising to slightly more than 50% of sets.

Mr. Whitelaw reported on AFMA Observer program initiatives to test bird mitigation measures and devices on Australian tuna longline vessels. Currently, hook setting devices and *Tori* poles are being observed at sea. Unfortunately, all of the observed vessels are equipped with the mitigation devices with none serving as controls without mitigation devices. He noted however that this should change in the future. He was hopeful that a report of findings resulting from these trips would be available for SCTB 16. Further discussion of this topic was deferred to the Billfish and Bycatch Working Group plenary session.

Research Task List Reports

Mr. Itano informed the group of some useful reference materials and information sources in the form of translated ESTHER documents. ESTHER was a two year collaborative effort by the French *Institut de Recherche pour le Développement (IRD)* and Spanish *Instituto Español de Oceanoggrafia (IEO)* to examine factors that may have contributed to increase in fishing power of EU tropical purse seiners operating in the eastern Atlantic and Indian Oceans. This project amassed a great deal of information of direct relevance to the FTWG. However, most of the documents are available only in French or Spanish. Thanks to the efforts of Mr. Gaertner, ESTHER Coordinator, and the services of the SPC translation department, excerpts of some of these documents have been translated to English for the SCTB and are made available in the working documents.

FTWG–5 (ESTHER) Selected Annotated Bibliography, provides several hundred references with detailed abstracts or summaries relevant to fishing technology and studies related to the estimation of effective effort and fishing power. Only a portion of the entire ESTHER Bibliography is reproduced here, and interested parties are encouraged to contact the editor if a full version is desired. FTWG–4 ESTHER scientific documents and abstracts, lists ESTHER documents and translated abstracts from documents presented at scientific meetings. FTWG–3 The European Union Research Project "Efficiency of Tuna Purse-Seiners and Effective Effort" (ESTHER), Scientific Report of Project provides English translations of the table of contents, abstract and conclusions of the final project document. of mostly Asian and European purse seine vessel owners and companies formed with the intent to raise and stabilize tuna purse seine prices on the global market, primarily through voluntary effort reductions. The US fleet is notably not involved in the WTPO, although it has organized some voluntary tie ups of their own to contribute to reducing excessive supply and attempt to raise prices. FTWG–7 WTPO Resolution, WTPO Declaration, (2nd Interim Evaluation Meeting, Kaohsiung, Taiwan, 18 June 2002) provides recently agreed upon WTPO Resolution and Declaration, relevant to effort reduction and fish quality standards for tuna purse seine fleets.

Mr. Itano presented FTWG9, Vessel and gear attributes in the Forum Fisheries Agency Regional Register of Vessels: How much is enough?. This paper reported on the results of a survey circulated via the SCTB listserve to solicit views on the type and detail of data collected in conjunction with application forms of the FFA Regional Register (RR) system. Responses were low in number but accompanied by many constructive comments. Ranked responses were divided into three categories—highest ranked representing data fields that respondents felt should be kept on the RR (ranked Essential); the lowest ranked that may be more efficiently collected by other means (Not Useful); and an intermediate group that may require further evaluation (Desirable). Details are available in tabular form in FTWG-9.

Many of the comments received in the survey were summarized and documented in the report. A notable and repeated comment had to do with the use of GRT to categorize vessels. It was felt that this unit was not useful as a means to identify vessel size in an international vessel register due to the different ways in which GRT is figured between nations. If its use is continued, the vessel registry was required. For fishing vessels, the volume of fish hold capacity was felt to be a better measure of fishing power. The FFA indicated that these problems, and many of the problems noted in the paper have been recently corrected by a revised RR data structure. Vessels are now required to submit vessel registration papers to FFA as well as detailed information on hold space and refrigeration.

Comments by NMFS and FFA noted that the RR is really a compliance tool and was not meant to be a source of data for gear and vessel monitoring. Also, initial and re-application forms are normally filled out by shipping agents or persons not as familiar with detailed vessel and gear specifications compared to vessel captains, making the reliability of this data highly suspect. The meeting also noted that re-application forms are not detailed and agents are likely to sign them without renewing or editing gear and vessel attributes.

The meeting noted that FTWG–9 outlined some useful guidelines and concerns on these matters. It was felt that it may be appropriate to collect the attributes in the highest category of ranking as detailed in the paper. However, the meeting agreed that the structure of the RR should remain an FFC initiative, with the assistance of appropriate technical input to assess the value of lower ranked categories.

Mr. Kumoru presented FTWG–12 Status of Fish Aggregating Devices in Papua New Guinea, reporting on the status of a FAD Management Policy for PNG. He reported that about 4,000 FADs had been set in PNG waters in the last five years, fished on mainly by 26 purse seiners mainly of Philippine origin. About 800 FADs have been reported in use, but the total number is likely much higher. The report provides a chart of FAD sites and notes on design. One innovate design was described for a light equipped drifting FAD. However, most of the FADs are anchored, causing gear conflict with longline gear tangling intact FADs or the anchor lines from FADs that have broken loose. Current allocation policies allow a maximum of 40 FADs per vessel, but the difficulty in enforcing these regulations was noted.

Ms. Brogan presented information on the size and species composition of target and bycatch on anchored and drifting FADs from SPC observer data. There were some differences in species composition of bycatch between anchored and drifting FADs, possibly related to the difference between coastal (anchored FAD) and oceanic (drifting FAD) environments. Size differences in target catch did not appear to be a factor between anchored and drifting FADs. However, spatial and temporal factors were not specifically accounted for in the comparisons, so it is difficult to draw any conclusions from the analysis. Further examination of this data was recommended.

Regional Management Initiatives

Mr. Opnai presented updates on FFA review of the Palau Arrangement (FTWG–13). The Parties to the arrangement reviewed the number of purse seine vessels in 2002, and agreed to keep the number at 205, with 194 purse seiners reported as active in March 2002. During 2001/2002, the PA Parties agreed to change the management strategy from regulating numbers of vessels to managing the number of allowable vessel days. This project will require a great deal of further work as outlined in the paper.

FFC efforts on options for the management of the bigeye fishery of the WCPO were summarized by Mr. Opnai in FTWG–14 Summary of the FFC Species Working Group meeting on Options for Bigeye Management. The meeting considered several options to promote bigeye conservation, and agreed that efforts should focus on limiting purse seine effort on floating objects, compulsory retention, and adoption of an overall (holistic) bigeye management regime. The FFC group stressed the need to strengthen observer and port sampling programs for purse seine fleets and agreed that FFA member countries should promote bigeye tuna management issues within the broader PrepCon context.

Recent initiatives to limit fishing capacity in the Eastern Pacific Ocean were briefly discussed. During the 69th Annual Meeting of the IATTC, a Draft Plan for Regional Management of Fishing Capacity was presented. The main objective of this Plan is to achieve, by 1 January 2006, an efficient, equitable and transparent management of tuna fishing capacity in the EPO, base on the FAO Code of Conduct for Responsible Fisheries. This plan proposes to use fish well volumes in m^3 as the primary unit of capacity in the purse seine fleet. The plan proposes to achieve a target level of well volume by 1 January 2002 through stepped reductions in capacity. This plan, though not far advanced at present was recognized by the FTWG as an important “first step” toward harvest capacity controls in the Pacific. The 69th Meeting of the IATTC adopted a resolution to limit fishing capacity of purse seiners in the EPO tuna fishery.

New entrants to the WCPO fishery were stated to include vessels from New Zealand (ex-US) and one Chinese vessel (ex-US). The recent agreement (signed July 6, 2002) between Kiribati and the EU was briefly discussed. This agreement will allow up to 11 tuna purse seiners to operate in that country’s EEZ.

Dr. Majkowski outlined a proposed FAO project on the management of tuna fishing capacity. If funded, this would be a global-scale project involving all gear types. The fishing capacity would be reviewed in relation to tuna resources, the demand for tuna products, developments in fishing technology; the profitability of industry and other socio-economic factors. It is anticipated that implementation of such a large-scale project would take place in with collaboration with international institutions involved in tuna fisheries research and management.

Mr. Beverly distributed draft copies of SPC’s latest fishing manual, which details horizontal longline fishing techniques to be reviewed and commented upon by the FTWG. The final version should be available by 2003.

Organizational Matters

Presentation of information on Vietnamese fisheries by Mr. DUONG was deferred to the NFR session in plenary. Presentations on recent advances in purse seine and longline technology and a summary of work on the status of the US western Pacific purse seine fleet were provided to the FTWG. Brief versions of these presentations will be presented during the plenary session of the FTWG and summarized in the final report, and are not described here. The structure of the FTWG Plenary session was discussed. It was agreed that the following presentations would be made in brief format due to the limited time available in a busy agenda.

Provisional Agenda—FTGWG Plenary session

- Report of the Fishing Technology Working Group Preparatory Meeting (this report)
- Recent advances in purse seine, drifting FAD and longline technology—documentation of a state of the art tuna purse seine and longline vessel (Itano, Beverly)
- Summary of the 2001 U.S. purse seine fishery with update on fishing strategy and vessel performance factors (Coan)
- Presentation of a study on the status of the US Western Pacific Tuna Purse Seine Fleet and Factors Affecting Its Future (McCoy)
- Research coordination and planning
- Status of SCTB 15 Tasks
- Suggested research and tasks for SCTB 16

APPENDIX 7. AGENDA OF THE METHODS WORKING GROUP

July 18, Imin Conference Center

1. INTRODUCTION—John Sibert
2. RESULTS OF SIMULATION STUDIES
3. Operational model and "true" parameter values; MFCL example fits—Labelle; MWG–1
4. SCALIA fits—Kolody; MWG–5
5. Production model fits—Kolody (tentative)
6. A-SCALA fits—Maunder
7. ADAPT fits—Bigelow; MWG–6
8. Synthesis of results

July 19, Imin Conference Center

1. RECENT DEVELOPMENTS
2. Reference points and incorporation of weight-frequency information in MFCL—Hampton; MWG–2
3. Report of workshop on longline effort standardization—Kleiber
4. A statistical method to integrate habitat based and GLM CPUE standardization—Maunder
5. Availability of oceanographic data—Foley
6. FUTURE PLANS
7. Review MWG terms of reference—Sibert
8. Future plans: whether and how to do the simulation study correctly—group
9. OTHER BUSINESS
10. PREPARATION OF REPORT

July 26, Hawaii Convention Center—SCTB Plenary

1. MWG Report—Sibert
2. Access to Oceanographic Data for Fishery Managers—Foley
3. Fundamental limitation of TAC as the goal of fishery management—C. H. Wang; MWG–3
4. Other Business

APPENDIX 8. DRAFT LIST OF INTERMEDIATE RESULTS AND DIAGNOSTICS COMMONLY USED IN REVIEWING STOCK ASSESSMENT MODELING RESULTS

1. Matrix of predicted catch numbers by age and time period. Similar matrices for stock numbers and instantaneous fishing mortality rates.

2. Table of parameters estimated, values at the global solution, CVs, flags identifying parameters that hit constraints or significant penalties.

3. Details of the phased estimation of parameters. Trace of initial parameter values at the beginning of each phase plus values of parameters (estimated and fixed) and likelihood components at the end of each stage of estimation (including at the global solution).

4. Correlation among selected parameter estimates, namely those directly related to management advice, e.g., recent-period estimates of recruitment, catchability, selectivity, spawning biomass, etc.

5. Examination of the response surface at the global solution—especially with respect to changes in key management parameters. For example, convergence checks using different initial value vectors. Likelihood profiling on key management parameters can also be informative here.

6. Residuals summarized and plotted by various types (including but not limited to size composition residuals).

7. Influence of priors. Plot priors vs. their respective posterior, including implied priors for key management parameters.

8. Predictive capability of environmental factors. Develop predictive relationships and appropriate lags (e.g., for recruitment) using half of the available time series. Examine the utility of environmental factors when applied to the other half of the time series.

9. Compare and contrast results obtained from other assessment methods, e.g., by applying commonly used age-structured models to the predicted catch-at-age data from the A-SCALA model.

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)
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