Report of the Fifth Meeting of the Western Pacific Yellowfin Tuna Research Group

Noumea
New Caledonia
August 21-23, 1995

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PREFACE

The Western Pacific Yellowfin Tuna Research Group (WPYRG) is an informal organization of scientists and fisheries officers studying the population biology of yellowfin tuna, *Thunnus albacares*, and monitoring fisheries exploiting this species in the central and western Pacific Ocean. The Group was organized in 1990 in response to concerns about expanding fisheries and significantly increasing catches of yellowfin tuna from the western Pacific. The Group's purpose is to exchange information and data, plan and cooperate in collaborative research projects, foster a common understanding of the condition of the yellowfin tuna stock, and offer scientific advice on fishery management issues. In 1995 the changes of the Group were expanded to include bigeye tuna, *T. obesus*, and skipjack tuna, *Katsumonus pelamis*, issues as they affect the yellowfin tuna fisheries monitored by the WPYRG. Meetings held to date:

First meeting—	June 20-21, 1991, Port Vila, Vanuatu (Host: Vanuatu Fisheries Department)
Second meeting—	June 17-24, 1992, Honolulu, Hawaii, U.S.A. (Host: U.S. National Marine Fisheries Service)
Third meeting—	June 21-23, 1993, Pohnpei, Federated States of Micronesia (Host: Micronesian Maritime Authority)
Fourth meeting—	August 9-11, 1994, Koror, Republic of Palau (Host: Palau Maritime Authority)
Fifth meeting—	August 21-23, 1995, Noumea, New Caledonia (Host: South Pacific Commission)

Organizations sponsoring participating scientists and fisheries officers are:

AIMS . . . . . . Australian Institute of Marine Science, Australia
BFAR . . . . . . Bureau of Fisheries and Aquatic Resources, Philippines
BRR . . . . Bureau of Rural Research, Australia
CSIRO . . . . . Commonwealth Scientific and Industrial Organization, Australia
DF . . . . Department of Fisheries, Vanuatu

DFMR...... Department of Fisheries and Marine Resources, Papua New Guinea

DMWR..... Department of Marine and Wildlife Resources, American Samoa

EVAAM.... Etablissement pour la Valorisation des Activités Aquacoles et Maritimes, French Polynesia

FAO....... Food and Agriculture Organization of the United Nations, Italy

FFA........ Forum Fisheries Agency, Solomon Islands

FFD........ Fiji Fisheries Division, Fiji

MAF....... Ministry of Agriculture and Fisheries, Solomon Islands

MENRD.... Ministry of Environmental and Natural Resources Development, Kiribati

MF........ Ministry of Fisheries, Tonga

MMA...... Micronesian Maritime Authority, Federated States of Micronesia

MRD....... Ministry of Resources and Development, Marshall Islands

NFRDA..... National Fisheries Research and Development Agency, Korea

NIWAR.... National Institute of Water and Atmospheric Research, New Zealand

NMFS...... National Marine Fisheries Service, United States

NRIFSF.... National Research Institute of Far Seas Fisheries, Japan

NTU....... National Taiwan University, Republic of China (Taiwan)

PMA....... Palau Maritime Authority, Palau

RIMF...... Research Institute for Marine Fisheries, Indonesia

SPC........ South Pacific Commission, New Caledonia

STMMPM.. Service Territorial de la Marine Marchande et des Peches Maritimes, New Caledonia

UH......... University of Hawaii, United States

WPFCC.... Western Pacific Fisheries Consultative Committee, Philippines

WPRFMC.. Western Pacific Regional Fisheries Management Council, United States

Sachiko Tsuji, Chairperson, WPYRG
Shimizu, Japan

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1.0. INTRODUCTION

The Western Pacific Yellowfin Tuna Research Group (WPYRG) was organized in 1990 to promote cooperation and to facilitate collaborative research on the yellowfin tuna, *Thunnus albacares*, population and fisheries of the central-western Pacific Ocean (Figure 1). The research would focus on scientific questions of importance in resolving contemporary fishery management issues. The Group's efforts produced answers to key fishery management questions concerning the safe level of exploitation and yield for the yellowfin tuna stock, the level of large-scale fisheries interaction, and factors contributing to local depletion (WPYRG4 1994). Follow up efforts include extending

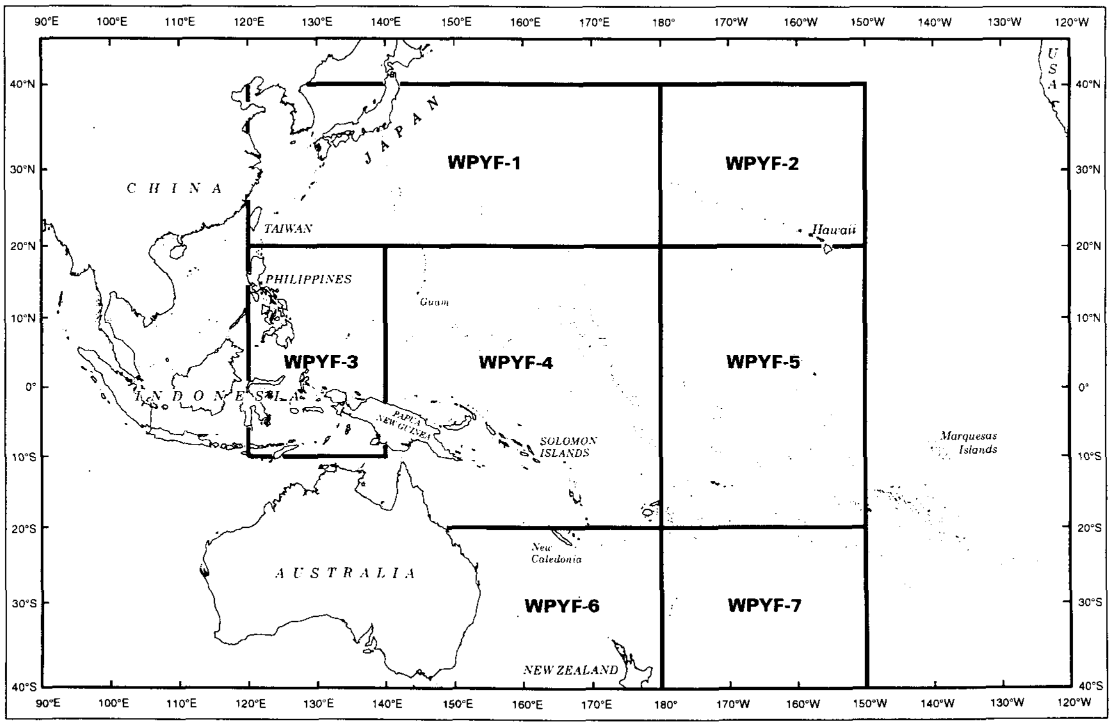

Figure 1. Western Pacific Yellowfin Tuna Research Group study area and statistical areas. (WPYF = Western Pacific Yellowfin Tuna are numbered)

investigations to associated species, such as bigeye tuna, *T. obesus*, and improving the precision of estimates of population parameters.

The Fifth meeting of the WPYRG was held in the new facilities of the South Pacific Commission (SPC) in Noumea, New Caledonia, following the Eighth meeting of the Standing Committee for Tuna and Billfish (SCTB8) of the SPC. The meeting was chaired by Sachiko Tsuji, who welcomed the participants (Appendix A). A draft meeting agenda was distributed for approval (Appendix B). The Chairperson appointed discussion leaders and rapporteurs for key agenda topics; Al Coan was designated overall coordinator for rapporteur reports:

Report item 2.0. Review of Fisheries

Leader: Regis Etaix-Bonnin
Rapporteur: Karl Staisch

Report item 3.0. Review of Data Bases

Leader: Atilio Coan
Rapporteur: Peter Ward

Report item 4.0. Review of Advances in Biological Research

Leader: Sylvester Diake
Rapporteur: Pierre Kleiber

Report item 5.0. Review of Advances in Stock Assessment Research

Leader: John Sibert
Rapporteur: Robert Campbell

Report item 6.0. Review of Current Knowledge on Bigeye Tuna in the Pacific

Leader: Naozumi Miyabe
Rapporteur: John Hampton

Report item 7.0. Future Direction of the WPYRG

Leader: Gary Sakagawa
Rapporteur: David Ardill

References to working papers in this report are made by document number preceded by "WPYRG5/" (Appendix C). Full names of organizations whose initials are used in this report are found in the Preface.

2.0. REVIEW OF FISHERIES

Reports on the performance of the major tropical tuna fisheries of the central-western Pacific were prepared by participants involved in monitoring the individual fisheries. The reports were reviewed at the earlier SCTB8 meeting. Tony Lewis was designated to summarize the conclusions of that review, particularly the results for yellowfin and bigeye tuna fisheries. Participants were encouraged to contribute to the report.

The 1994 yellowfin tuna catch in the central-western Pacific (or WPYRG area—Figure 1) is estimated at 370,300 t, down from a historical high of 397,600 t in 1993. Apart from catches by various gears in eastern Indonesia and the Philippines (about 128,000 t), yellowfin tuna catches in the central-western Pacific are mainly produced by purse seine gear (59% in 1994). However, purse seine catches accounted for only 12% of the decrease in the 1994 catch. The longline catch, in contrast, increased from 61,000 t in 1993 to 67,700 t in 1994.

The 1994 bigeye tuna catch in the WPYRG area is an estimated 65,900 t, a significant increase over 60,100 t for 1993. This increase was primarily due to increased catches by the short-range longliners from China and Taiwan that operate out of Pacific island ports, mainly in Micronesia. The bigeye tuna catch is likely underestimated because of underreporting or misreporting of juvenile bigeye tuna as yellowfin tuna. This matter is under investigation by the WPYRG.

2.1. Fisheries of American Samoa (WPYRG5/16)

Tanielu Su'a, who is involved in monitoring landings in American Samoa, contributed a fishery report (WPYRG5/16) that was not reviewed earlier by SCTB8. He reported that total (all species) landings at the two canneries in American Samoa ranged from 160,000 t to 223,000 t annually for the period 1988-1994. The majority of the landings are from purse seiners. The artisanal fishery accounted for only 7 t to 20 t annually. Yellowfin tuna accounted for 18% of all fish landed at the canneries and has averaged 37,000 t annually since 1986. The majority (93%) were from purse seiners.

Between 1990 and 1994, artisanal and sport fisheries of American Samoa were significantly affected by the high number of cyclones (typhoons) that visited the area, destroying boats and keeping fishermen from going to sea. Catches fell for all artisanal fisheries during that period. In 1994, catches rebounded as there were no cyclones, and fishermen were able to repair their boats and spend time at sea fishing.

2.2. Sport Fisheries

Following Su'a's presentation, the chairperson noted that sport fishing for tunas was growing and felt that WPYRG should pay more attention to monitoring this growth.

The chairperson asked the participants to describe their monitoring efforts for statistics on sport fisheries for yellowfin tuna and bigeye tuna. The responses by country are as follows:

Australia. . . . . Difficult to monitor, but undertaking some monitoring and developing a data base for sport fishing tournament (catch-effort) data and for tagging data.

Fiji. . . . . No monitoring at this stage.

French Polynesia . . . . . Data collected and included in 1994 statistics for the first time. For earlier years, no data were collected.

Indonesia . . . . Game fishing tournaments are held, but no statistics are kept.

Japan . . . . No significant sport fishery for yellowfin and bigeye tunas.

Kiribati. . . . . No significant sport fishery for yellowfin and bigeye tunas.

Korea . . . . No sport fishery.

New Caledonia. . . . . . . Sport fishery is significant; however, the target species are normally billfishes. Statistics on yellowfin and bigeye tuna catches are incomplete.

Solomon Islands . . . . . Sport fishery is developing; however, no monitoring scheme for collecting statistics has been organized.

Tonga . . . . Annual sport fishing tournament held, but the target is billfishes and no significant amount of tunas caught.

United States . . . . Sport fishery is complex and difficult to monitor. Some catches enter commercial channels and are reported in U.S. statistics; some are reported in sport fishing survey statistics. A significant amount of catch is used for home consumption and not reported in statistics.

IPTP . . . . Sport fishing is a significant tourist industry in many IPTP countries. An example is the Mauritius sport fishing catch of approximately 1,000 t per annum. South Africa collects sport catch statistics by issuing catch-record cards at bait and tackle shops for anglers to complete. A good advertising campaign has resulted in many of these cards being returned to fishery authorities.

2.3. Monofilament Longline Gear

Regis Etaix-Bonnin reported that the catches of small bigeye tuna (less than 15 kg) by short-range longline vessels based in New Caledonia and using monofilament gear were greater than catches by long-range (Japanese) vessels using traditional gear. He speculated that because monofilament gear is fished inshore and traditional gear offshore, this difference may be due to the fishing location or behavior of the bigeye tuna taken, which Etaix-Bonnin designated as a substock phenomenon.

The Group agreed that there is some evidence that suggests that there are behavior-related differences among bigeye tuna; for example, tagging studies in the Coral Sea suggest that bigeye tuna remain in the area for several years, as fish tagged were recaptured in the same area four years later.

It was noted that juvenile bigeye tuna tend to aggregate near seamounts and submarine features as well as with drifting objects. If the outer reef slope of New Caledonia was aggregating juvenile bigeye in a similar manner, then longline vessels fishing inshore waters would likely have higher catch rates of small fish compared to fleets fishing offshore and the deeper oceanic environment.

It was pointed out that gear type as well as how the gear is deployed by the fishermen can determine its fishing characteristics. Consequently, differences observed in the catches and catch rates may not be solely explained by fishing area or gear type.

The Group concluded that data on gear type and gear deployment are required to better understand differences observed in catch rate, fish sizes and fishing performance by different types of longline gear. Such data should be collected from the fisheries. It was pointed out that collection of such data on large longliners is difficult because the longliners are currently in a transitional phase. The Japanese fleet, for example, is experimenting with different types of "monofilament" longline gear while continuing to use the traditional gear. In some sets, both traditional and "monofilament" gears are used, but logbook information alone does not reveal this practice. Also, some fishermen may be reluctant to record such information in logbooks, even if required.

3.0. REVIEW OF DATABASES

Following the recommendation of the WPYRG4, data correspondents met to tabulate and verify fisheries statistics for yellowfin, bigeye and skipjack tunas. These three species are consistent targets of the surface fishery of the central-western Pacific Ocean and are often taken together. Yellowfin and bigeye tunas are target species for the longline fishery. The numbers of fishing vessels operating in the WPYRG study area are provided in Appendix D. Catch statistics are provided in Appendix E (yellowfin tuna), Appendix F (bigeye tuna), and Appendix G (skipjack tuna).

Significant issues discussed by the data correspondents are reported in this section.

3.1. Procedure Changes

A suggestion was made to move the eastern boundary of the WPYRG area from 150°W longitude to 130°W longitude so that all of the fisheries of French Polynesia could be considered in WPYRG deliberations. The Group felt that the WPYRG boundaries need not be changed because they are arbitrary boundaries, but take in most of the fishing area for the yellowfin tuna stock. Furthermore, French Polynesian fisheries are not precluded from WPYRG considerations. In fact, information from the fisheries is welcome and would appear in statistical tables. A footnote would designate the source of the information and note that the fisheries extend beyond the WPYRG eastern boundary.

The Group agreed to restate its policy for reporting of joint-venture catches. That is, joint-venture and charter vessel catches should be reported by the vessel flag country; however, in cases where this is not done, the host country should report the catches.

The Group agreed that computerized copies of work sheets used for creating appendices D, E, F and G would be made available to WPYRG participants upon request to Al Coan.

3.2. Yellowfin Tuna Statistics

Significant revisions were made to yellowfin tuna fisheries statistics (Appendix E). The revisions are as follows:

- Statistics from newly identified fisheries

  Statistics from two fisheries were not included in previous statistical tables and were added: (1) catch and effort for the Cook Islands longline fishery, 1994 and (2) catch and effort for the Western Samoa longline fishery, 1993 and 1994.

- Joint-venture catches

  Differences in reported catches were identified in individual national reports and as reported in SCTB8 Paper 2 for Australia, Federated States of Micronesia (FSM), Fiji, Solomon Islands and Indonesia. The differences were mainly due to treatment of joint-venture catches in national reporting procedures. The differences were corrected, or accounted for.

- Missing catch and effort data

  Philippines fisheries data for 1994 were not available. Values for 1993 were substituted as preliminary estimates.

■ Japanese coastal and offshore/distant-water effort

Number of vessels for Japan were updated to include only active vessels. Also, vessels were separated into two categories, coastal and distant-water.

■ Longline and purse seine catches by WPYF areas (Figure 1)

1991 to 1994 longline and purse seine catches by WPYF areas were updated.

3.3. Bigeye Tuna Statistics

Bigeye tuna catch statistics for the WPYRG area were tabulated from information provided by the data correspondents (Appendix F). Because this was a new task for the Group and the first year for tabulation, standards for future reporting of bigeye tuna statistics were developed. They are as follows:

■ Processed versus whole weights

Some national reports regularly report bigeye tuna catches in gill-and-gutted weights or processed weights. The Group agreed that whole weights should be reported instead. If whole weights are not available, gill-and-gutted weights should be converted using standard conversion factors.

■ Korean longline catches

Preliminary 1970 to 1979 longline catches for Korea were estimated from SPC Yearbook and FAO statistics (FAO Yearbook, Fishery Statistics). They are foot-noted as to source and will be replaced when better statistics become available. NFRDA scientists were tasked to review the estimates and to provide final statistics.

■ Joint-venture catches

As with yellowfin tuna catches, differences in reported bigeye tuna catches were identified in national reports and in SCTB8 Paper 2 for Australia, FSM, Fiji, Solomon Islands and Indonesia. The differences were due to the treatments of joint-venture catches. Procedures identical to those used for yellowfin tuna catches should be followed.

■ Missing catch data

For many fisheries, catches of bigeye tuna are combined and reported with yellowfin tuna catches. Such statistics are identified with an asterisk in Appendix D. A priority of the Group is to correct these aggregated species catches and separate the bigeye tuna catch from the yellowfin tuna catch.

3.4. Skipjack Tuna Statistics

Tabulation of skipjack tuna statistics is also a new task for the Group. Catches were tabulated (Appendix G), and standards were discussed for future reporting of skipjack tuna statistics.

- Joint-venture catches

  Differences in reported catches of national reports and SCTB8 Paper 2 for Australia and FSM were noted. The differences were mainly due to treatment of joint-venture catches and the statistics were corrected to be consistent. Procedures used for yellowfin tuna should be used in the future.

- Missing catch data

  Fiji troll catches were added.

3.5. Improvements in Data Collection

Statistical Area. The Group reviewed the boundaries of the WPYRG area (Figure 1), which were established for yellowfin tuna, and noted that they do not fit the distributional range of fisheries or stock structure hypotheses for bigeye tuna. For example, longliners from French Polynesia target bigeye tuna and albacore. Their fishing area extends eastward to 135°W longitude, well beyond the WPYRG eastern boundary at 155°W. The distribution of bigeye tuna appears continuous across the entire Pacific Ocean within a band of about 40°N latitude and 40°S latitude. This has been cited as evidence of a single Pacific-wide stock. The stock, hence, appears to extend beyond the WPYRG eastern boundary.

The Group also noted that the area does not correspond to statistical areas used by other organizations, such as FAO, and hence, comparison of statistics by area among organizations is difficult. Faced with such difficulty, organizations often arrange their statistical boundaries to be compatible with each other. For example, the SPC recently moved its southwestern statistical boundary to 141°E to be compatible with Australia's statistical boundary. The Group; however, agreed not to change the WPYRG boundaries at this time. Instead, it agreed that:

- Data correspondents should indicate in footnotes when catch statistics also contain catches from immediately outside the WPYRG area. The type of fishing activity outside the WPYRG area should also be specified.

- Data correspondents would provide a map of the geographical extent of their bigeye tuna and skipjack tuna fisheries for reference purposes, and provide information on the types of fishing activity and amount of catch generally taken outside the WPYRG study area for each fisheries.

Statistics from sport and artisanal fisheries. The Group reviewed the need for catch and effort statistics from sport and artisanal fisheries. Because many of these fisheries are small, i.e., catches are small and scattered, collecting statistics from them would be expensive relative to the amount of information gained. Hence, in general, the Group assigns lower priority to collecting catch-and-effort statistics from such fisheries. Nonetheless, the Group agreed that for certain types of studies, such as those that focus on fisheries interactions and local effects of large-scale fisheries on artisanal or sport fisheries, detailed data from such fisheries would be necessary. Furthermore, some artisanal fisheries are in fact concentrated and produce a significant amount of catch, such as in the Philippines, Indonesia, Kiribati, the Solomon Islands and Fiji (WPYRG5/18). For these fisheries, a significant attempt needs to be made to collect catch and effort statistics even if the effort data may be crude measurements of fishing power.

Improvements in Japanese purse seine data. The Group reviewed plans of NRIFSF scientists for port sampling of purse seine catches in Japan (WPYRG5/3). The main objective of the plans is to quantify catches and to determine the size distribution of small tunas (yellowfin, bigeye and skipjack) caught by the Japanese purse seine fishery in the tropical waters of the Pacific and Indian oceans. This project was started in 1994 and is to continue for three years. The project itself was consigned to the Japan Marine Resources Research Center (JAMARC) by the Fishery Agency of Japan, but the NRIFSF is significantly involved in most activities, especially in determining the sampling scheme, data processing and analysis. The most important activity is taking measurements of fish at unloading sites. Unfortunately, routine port sampling was not previously established because it was unwelcome by the industry. Supposedly because it created unnecessary work for employees engaged in unloading the catch, and it delayed the processing of the catch, contributing to reduced quality of the fish. Recently, the attitude of the tuna fishing industry (fishing companies and markets) changed, and this made it possible to execute this port sampling project.

Two major unloading ports, Yaizu and Makurazaki, were selected for port sampling. Samples are collected from two vessel trips in Yaizu and one vessel trip in Makurazaki each month. This level of sampling covers slightly less than 10% of the total trips for the purse seine fleet. Samples are taken for every market category as well as from certain wells (three wells in most cases) with catches that can be identified to a reasonably small resolution of time and area of capture and school type. Market category is structured by species and size of fish. "PS-grade fish" for use as sashimi (higher grade but with the same size category as the normal brine-frozen fish) are not accessible and are not sampled. About 100 fish are measured for each market category, and about 1,000 kg are measured for fish in wells irrespective of tuna species.

Logbooks and sales slips of unloading from all purse seiners fishing in the tropical area are gathered and computerized in order to estimate the total catch at size by species.

This information will also be used to compare information gathered from the port sampling.

Observer program versus port sampling program. The Group discussed the merits of port sampling and observer programs for obtaining detailed information on catches. At the outset, the Group acknowledged that observer programs have more diverse functions than port sampling programs and that collection of detailed catch information could be a lower priority. Hence, the programs are not equal. However, the Group assumed for the discussion that both types of programs rank collection of detailed catch information high to moderate priority.

The observer program managed by the FFA for U.S. purse seiners was reviewed. The program targets 20% of the trips and costs about US$300,000 a year. Size-frequency data collected by the program and by NMFS port samplers for the same years were compared in an analysis performed by the SPC. The comparison indicated close correlation and consistency between the data sets. This is attributed largely to the catch handling procedure used by U.S. purse seiners. That is, entire catches from single sets are often placed in specific wells and not touched again until unloading at port. Port samplers are thus able to accurately select wells for sampling of single set catches or catches from a fine resolution of time and fishing area. Because the cost of port sampling is less than for at-sea observer sampling, port sampling for size-frequency data appears to be more cost effective for this fleet.

For other purse seine fleets or fisheries, the analysis could be different. For example, the Japanese purse seine fleet normally employs a complex scheme of selection and sorting of catches at sea, moving fish and repacking wells aboard the vessels. When landing their catch, complex landing and marketing procedures are also used. This limits full access to landings for port samplers as well as obscures catches from single sets. Hence, an observer program may be the better procedure for collecting detailed data on this fleet's catches.

The discussion highlighted the need for fleet-specific analysis of trade-offs and implementing procedures required for a successful, cost-effective sampling program. The Group recommended the following:

- That the SPC review current port sampling and observer programs with a view to optimizing sampling protocols for length-frequency data

  The programs to be considered for this review should include those for which the SPC currently provides technical support; that is, programs involving longline and purse seine fleets that unload their catches in the ports of SPC member countries and territories. In assessing the effectiveness of sampling approaches, the study should specify the target level of coverage and focus on data precision required by *specific stock assessment models. A length-based stock assessment model, for example, could test the effects of various sampling protocols (sample sizes and sampling regimes) and use existing port sampling data (size and species composition) such as those collected from nearly 100% of the short-range longline vessels based in the Micronesian area.*

Salvage of Japanese length-frequency data. There was no progress made in salvaging historical length-frequency data from the Japanese purse seine fishery. The task appears to be more difficult than initially thought. Furthermore, the Group felt that the needs in other areas of data collection for Japanese purse seiners have higher priority at this stage.

Sulawesi fisheries. The Group reviewed progress in monitoring artisanal and joint-venture activities off Sulawesi in the Celebes and Molucca seas (WPYRG5/14). In the past, either no data were collected from these fisheries or data collected were for species and gear groupings, e.g., reported as either "skipjack" or "tuna," and not made available in a timely manner, i.e., delays of one to two years. Recently, the Japan International Cooperation Agency (JICA) provided Indonesia with funding to improve fisheries data collection. The funding is being used to acquire computers to speed compilation, implement collection of fisheries data (although principally catch and not fishing effort) from artisanal fisheries, and develop a species identification manual for use by artisanal fishermen for accurate reporting of species composition in their catches. Some improvements are being realized already as in statistics on average weight (kg) of yellowfin tuna landed by gear.

Year	AVERAGE WEIGHT (kg)			
	Pole-and-line	Purse seine	Handline	Longline
1991	2.5	2.5	20.0	40.0
1992	2.0	2.0	25.0	35.0
1993	2.0	1.5	23.0	40.0
1994	2.2	1.7	25.5	40.5

Under an Indonesian-Philippine joint-venture agreement, a Filipino fishing company is allowed to operate in Indonesian waters (WPYRG5/14). The firm agreed to operate ring net vessels, employ "payaos" (about 15% of the total catch) and land the catches at canneries in Bitung, North Sulawesi. It also agreed to report total catches to Indonesian authorities. So far, the fishing company has not fulfilled the terms of the agreement. The vessels instead land all their catches in General Santos, Philippines, and have not reported to Indonesian authorities. The landings reported to Philippine authorities are included in the Philippine statistics.

The number of purse seine vessels reported for Indonesia increased from 3 in 1992 to 156 in 1993 and 162 in 1994 (WPYRG5/14). This increase is due to inclusion in the statistics of ring net vessels based in Bali and that fish in the Banda Sea. These vessels have not been included in Indonesian statistics reported to WPYRG in the past. They should continue to be excluded from WPYRG statistics; the number of large Indonesian purse seiners fishing in the study area remains at three.

Catch-by-size estimates. Past attempts at creating catch-by-size for each fleet and gear type have produced unreliable results because of limitations of available data. Nevertheless, the Group felt catch-by-size should be assembled for the entire catch because the process will highlight where data are incomplete or missing. The Group can then focus its attention on where improved collection of statistics is required. Eventually, when all data gaps are bridged, a reliable catch-by-size data set will be available and will serve as a valuable database for applying length-based assessment models and for other studies (e.g., fisheries interaction, impact of concentrated exploitation of mature fish).

4.0. REVIEW OF ADVANCES IN BIOLOGICAL INFORMATION

4.1. Reproductive Biology (WPYRG5/7)

David Itano presented a progress report on his study of the reproductive biology of yellowfin tuna in Hawaiian waters and the western Pacific region (WPYRG5/7). His study objectives are to (1) define seasonal, areal and size-related patterns in the reproductive parameters of yellowfin tuna; (2) investigate vulnerability and interaction of fish taken by surface and sub-surface gears by comparison of the reproductive biology parameters; and (3) compare and contrast yellowfin tuna reproductive biology in the western Pacific along the equator where spawning occurs all year to reproductive biology around the Hawaiian Islands where spawning is seasonal.

The study area lies between 10°N-10°S latitudes from Hawaii in the east to the Philippines and eastern Indonesia in the west. Purse seine, longline, handline and troll fisheries are sources for samples. Sample collection will span two years, from 1994 to May 1996, and include both years of El Niño and non-El Niño conditions in the western Pacific.

All samples are processed for histological analysis, and tissues slides are examined with light microscopy to determine reproductive condition and for classification of maturity state. Classification information is coupled to sample information, such as gear, capture location, date, capture depth, and school type, for analyses. Preliminary results of purse seine and longline samples from the equatorial region indicate presence of post-ovulatory follicles in ovaries. This is evidence that spawning occurred within 24 hours of capture. The samples indicate spawning at night, with a nearly daily rhythm.

Fish taken with purse seines from actively feeding schools were mostly recent or about to spawn, whereas fish from longline catches were all mature but mostly not in spawning condition. However, those few that appear to be in spawning condition had characteristics identical to purse seine-caught fish. This suggests that the longliners may have been fishing at shallow depths and depths identical to those fished by purse seine gear. If so, there is direct surface-longline gear interaction for yellowfin tuna.

Mean spawning frequencies for different samples were 1.13 days/spawning for actively feeding surface fish (boilers or foamers) caught by purse seine, 1.18 days/spawning for log-associated fish caught by purse seine, and 1.24 days/spawning for fish caught by longline gear. The different spawning frequencies by school types might be more a reflection of different forage abundance in the sampling areas than of school type. For instance, the equatorial region is rich with large concentrations of surface forage fish, e.g., the pelagic anchovy (*Encrasicholina punctifer*) and seasonally abundant juvenile reef fishes. The high energetic costs of daily spawning by adult yellowfin tuna are easily supported in this region, but not in other parts of the Pacific. Further work is planned to investigate this aspect of the samples as well as the relation to El Niño conditions.

Large yellowfin tuna (>40 kg) are available to the Hawaiian troll and handline fisheries during the late spring and summer. The fish are in spawning condition during this period. Batch fecundity estimates of these fish range from 1.8 to 10.5 million eggs per batch. Batch spawning is nearly daily and occurs throughout the summer months.

4.2. Species Composition of Purse Seine Catches (WPYRG5/5, /6, /13, /15)

Jang Uk Lee reported on a study that examined logbook data for information on school type and species composition of schools fished by Korean purse seiners. The study also used observations from an observer trip aboard a purse seiner in June 1995 (WPYRG5/5). Log-associated schools contributed 19% to 42% (average 31%) of the purse seine catches during 1992-95. Skipjack tuna accounted for 83%, yellowfin tuna 16% and other species (including bigeye tuna) 1% of the total catch from log-associated schools.

On one cruise with a scientific observer, the vessel made six sets, all on log-associated schools. The logs were of natural origin ranging from 3 m to 15 m long. Each set was successful, catching both skipjack and yellowfin tunas. Repeat sets were made on two logs (3 m and 15 m long), and catches decreased with additional sets. Species composition of the schools average 60% skipjack tuna, 38% yellowfin tuna and 2% bigeye tuna. A total of 11 by-catch species were caught; sharks were present in all sets. Rainbow runner (*Elagatis bipinulatus*) was the dominant by-catch species followed by trigger fishes (*Balistidae*).

Size of log(m)	**Total catch(t)**	**SPECIES COMPOSITION(%)**			**No. of by-catch species**	**Remark**
		Skipjack	**Yellowfin**	**Bigeye**		
15	40	87.5	12.5	-	3	
15	9.5	5.3	94.7	-	5	re-set
3	60.5	47.9	50.4	1.2	9	
3	10.5	47.6	47.6	4.8	4	re-set
5	30.5	59.0	39.3	1.7	6	
8	36.0	69.4	27.8	2.8	6	

The length distribution of yellowfin tuna sampled by the observer indicates two modes: one at 58-62 cm fork length (FL) with a range between 30 cm and 70 cm FL, and the other at 100-104 cm FL with a range from 80 cm to 120 cm FL.

Gary Sakagawa reported on estimation procedures used for bigeye tuna catches in U.S. purse seine catches for 1989-94 (WPYRG5/6). Data used in the analysis were from port sampling for species composition in Pago Pago, American Samoa. Samples of 100 fish were drawn from landings labeled as "yellowfin tuna" and species determined. All fish were measured for fork length, and catch information, such as area, date and set type, was retrieved from logbooks. The samples were stratified by set type (log-associated and free-swimming) and size of fish (small [<10 kg] and large [>9 kg]). His results showed that stratified samples produced a significantly different percentages of bigeye tuna in the "yellowfin tuna" landing than unstratified samples. Furthermore, the type of set appears to have a major effect on the proportion of bigeye tuna in the catch—with log-associated sets having a higher proportion of bigeye tuna. The results were used to estimate the bigeye tuna catch and to adjust yellowfin tuna catches downward for the U.S. purse seine fishery. The U.S. bigeye tuna catch ranges from 1,763 t in 1990 to 3,823 t in 1993. The average for 1989-94 is 2,507 t.

YEAR	YELLOWFIN TUNA (t)	BIGEYE TUNA (t)
1989	42,703	2,456
1990	51,657	1,763
1991	37.194	1,641
1992	43,528	3,516
1993	45,801	3,823
1994	55,329	1,840
Average	46,035	2,507

Naozumi Miyabe reported on a similar effort to estimate the bigeye tuna catches by Japanese purse seiners. However, Miyabe relied only on information from logbooks (WPYRG5/15). He examined data for 1994 and for WPYF-4 (Figure 1), where most of the fleet's fishing takes place. He considered only sets in which catches of skipjack, yellowfin and bigeye tunas were recorded. Data were stratified by quarter and school type: "associated" (log-, FADS-, boat-, shark-, whale-associated); and "free-swimming" (free-swimming, with birds, jumping, boiler).

His results showed that associated schools accounted for 52-65% of the total sets and was the dominant type in all four quarters. Skipjack tuna dominated the catch by weight in all school types, but was higher in associated school. Bigeye tuna accounted for 0.4-0.8% in associated schools and 0-0.2% in free-swimming schools. In contrast, yellowfin tuna accounted for a much smaller portion in associated schools (16-20%) than in free-swimming schools (23-47%).

Chi-Lu Sun and Su-Zan Yeh submitted a paper (WPYRG5/13) that contained information on species composition of associated school sets by Taiwan purse seiners. Their data were from logbook records for 1983-94. Skipjack tuna dominated the catch in all years, ranging from 78% to 87% by weight. Yellowfin tuna largely made up the rest. Bigeye tuna was reported in significant amount (0.2%) only in 1983.

The Group discussed procedures used for estimating bigeye tuna catches when catches of yellowfin tuna and bigeye tuna are combined in reporting forms and landings. The Group concluded that procedures using logbook data alone would not yield reliable results. Logbook data need to be supplemented with port sampling and/or observer program data. The Group recommended that as soon as current Japanese efforts at port sampling of purse seine catches yield sufficient data, Miyabe's study should be repeated using both logbook and port sampling data. The Group also noted that developing accurate estimation procedures is necessary for adjusting mixed species catch statistics, but this alone is not adequate. The principal need is accurate reporting of separate bigeye tuna and yellowfin tuna catches. Without such accurate reporting, analyses of bigeye tuna stock condition and catch statistics in their own right will be questionable.

4.3. Feasibility of Tagging Longline-Caught Yellowfin Tuna (WPYRG5/17)

Results of an SPC project to investigate the feasibility of tagging yellowfin tuna caught on longline gear were discussed at SCTB8; hence, the results were not reviewed again except for a brief presentation by John Hampton. Hampton noted that SPC has successfully tagged yellowfin tuna caught on longline gear, and others have done so as well. However, the numbers caught and available for tagging are insufficient to support a large-scale experiment which requires large numbers of fish released in a short period.

Robert Campbell related CSIRO's experience with tagging southern bluefin tuna (SBT) from Japanese longliners operating off eastern Tasmania (WPYRG5/17). Tagging aboard longliners has been on-going since 1992 and seems to be working quite well with tags being deployed over a wide area. The number of tags released each year together with the recaptures to date is as follows:

YEAR	RELEASES	RECAPTURES	
		NUMBER	PERCENT
1992	88	12	13.6
1993	366	51	13.9
1994	158	9	5.7
1995	84	-	-

These recovery rates compare well (often exceeding) to those obtained from tagging of surface-caught SBT off southern Australia.

The SBT longline tagging program has resulted in tag releases over a wider area than before and, of course, the tagging of longline-caught fish, whereas previously surface-caught fish were predominantly tagged. The results have provided a greater understanding of both the movement of SBT and their likely involvement in interactions between surface and longline fisheries. For example, the movement of SBT from eastern Tasmania back to the surface fisheries off South Australia has been confirmed for the first time. There is a high degree of interaction between the longline and surface fisheries around Tasmania, and movement between fisheries is rapid (<30 days). Finally, examination of the growth increments from longline-tagged fish suggests that these fish grow at comparable rates to fish in the surface fisheries off western and southern Australia.

It was noted that SBT may be considerably more robust than yellowfin tuna and thus have a greater ability to survive hooking on a longline. It was also clear from the SBT experience that tag return results can be different for fish caught and tagged with longline gear versus surface gears.

4.4. Archival Tag Attachment Study

Pierre Kleiber briefly reported on a study of external attachment of archival tags in captive yellowfin tuna. (Archival tags are currently designed for implantation in the body cavity.) Thirteen fish were held at the NMFS Kewalo Research Facility (Honolulu, Hawaii) for approximately nine months after insertion of dummy archival tags in the dorsal musculature. Of the ten survivors, three shed their tags, all of which had been placed with the sensor stalks facing posteriorly. Fish that retained their tags all had sensors facing anteriorly or perpendicular to the body surface. Histological examination revealed no signs of edema, inflammation or infection at any tag site. Kleiber concluded that intramuscular implantation appears to be a viable method of archival tag attachment.

4.5. ENSO Application Center at the University of Hawaii (WPYRG5/8)

John Sibert reported that the University of Hawaii has recently established the Pacific El Niño-Southern Oscillation (ENSO) Applications Center to provide services and to conduct research on ENSO and its impacts in the Pacific islands (WPYRG5/8). The Center provides a variety of information including a quarterly newsletter, "Pacific ENSO Update," which can be obtained by request to the Center (telephone: (808) 956-2324).

The Group noted that there are other sources for oceanographic information besides the ENSO Application Center. One convenient source for a variety of oceanographic data summaries is the Pacific Marine Environmental Laboratory in Seattle, Washington (telephone: (206) 526-6811).

4.6. 1995 *Shoyo-Maru* Cruise (WPYRG5/9)

It is well known that deep longlining technique, which was introduced during the late 1970s in the Japanese fleet, increased the efficiency of capturing bigeye tuna. Recently, another change was introduced in the Japanese longline fleet, particularly in distant-water longliners. This change is in the material of the longline main line, which up to recently has been Kuralon rope. Recently, fishermen have been experimenting with monofilament nylon, braided nylon and small-diameter synthetic line for the main line.

Hiroaki Okamoto reported on research conducted aboard the R/V *Shoyo-Maru* (1,362 gross tonnage) with small-diameter, synthetic line for the mainline of the longline gear. The research was conducted during May 5 to July 6, 1995, in the tropical and sub-tropical waters of the eastern Pacific Ocean (WPYRG5/9). Primary objectives were to investigate the fishing depth of hooks over time for different methods of setting the gear and to study the behavior of adult tunas by sonic tracking. During the cruise, 22 longline sets were made using about 700 hooks per set. Biological data (species, length, weight, sex, alive or dead at capture on board, gonad weight, etc.) were collected from the catch, and oceanographic observations (CTD, XBT and EPCS) were made as well. About 40 TDRs (Time and Depth Recorder) were attached to dropper lines about 2 m above the hooks. Results indicate that the depth of hooks tended to vary, changing with soak time and did not correspond to the theoretical catenary-curve model. Analysis of the data is continuing with plans to include the oceanographic data, e.g., current and wind strength, in the analysis.

Sonic tagging and tracking of tunas during the cruise was not accomplished. However, procedures for collection and release of sonic-tagged fish were explored.

4.7. Additional Studies

The Group was informed of several other research projects underway on yellowfin tuna of the central-western Pacific. One study involves small-scale tagging of yellowfin and bigeye tunas on a seamount off Hawaii. This study is designed to investigate fish movement, validate ageing from otoliths, and study fisheries interaction. Another study being conducted by Australian researchers in the Coral Sea is designed to investigate the biology of feeding in yellowfin tuna aggregations. Still another study involves research cruises with the R/V *Omi Maru* to investigate the distribution of tuna larvae and young in the region around FSM and Palau. This study is organized by Japanese researchers, in cooperation with FSM and Palau agencies.

5.0. REVIEW OF ADVANCES IN STOCK ASSESSMENT

The Chairperson introduced this agenda item by explaining the "modus operandi" behind stock assessments for yellowfin tuna. In broad terms, the stock assessment process is to examine catch and effort and other data, interpret the results and make inferences about stock size or trends in stock abundance. Of key importance in this process is developing a reliable relationship between catch and effort and a valid relationship between catch-per-unit of effort and stock size.

Two general types of stock assessment models are used. The first type explicitly models the fishing processes using data in different ways to describe the processes involved. The second type uses statistical relationships, typified by the General Linear Models. These do not attempt to model the fishing processes but instead use catch rates and constrain the relationships between factors involved in the fishing process. Both types of models are being explored by WPYRG participants.

The Group discussed the process and points raised by the chairperson and noted two issues. The first is the ability to infer information accurately about the population biology from basic biological information and catch statistics for use and inclusion in an assessment model. The second is the ability of models to adequately deal with the imperfections inherent in most fisheries data.

5.1. Model Development (RASCLE)

John Hampton presented a progress review of a yellowfin tuna modeling project (RASCLE). As an initiative of the WPYRG, a small group of scientists met in Honolulu, Hawaii, in October 1993 to plan a model development project and to develop a proposal. The small group recommended that an age-structured yellowfin tuna modeling project, based on the SPARCLE (South Pacific albacore model) approach, be pursued. A project proposal for funding that included the involvement of David Fournier to undertake the model development was assembled. The proposal was recently accepted by the Pelagic Fisheries Research Program of the UH for funding.

Work is about to commence on the project. Initially, a SPARCLE-type model will be used. The yellowfin tuna fisheries will be defined according to area (initially the seven WPYRG areas) and gear type. Further stratification of the fisheries by vessel nationality will be considered at a later time. Data required are estimates of total catch in number of fish for each fishery by quarter for the period 1970-94, as well as estimates of fishery effort. Length-frequency data in the same stratification would be used where available. An important feature of the model is that missing data will be recognized, and elaborate substitution schemes will not be used. Supplementary data, particularly tag recapture and age-at-length data, will be included to provide, information on mortality, growth and age composition.

Ultimately, the model will be extended with spatial structure and estimated transfer coefficients to allow for movement of yellowfin tuna among spatial strata. This additional structure will be necessary, in particular, to address questions of interaction between spatially separated fisheries.

A number of technical issues related to the model were reviewed by the Group. The manner in which recruitment is modeled was discussed. The discussion focused on the use of parameters to estimate the size of the recruiting year classes. The ability to identify the most appropriate spatial strata was also discussed. While the present formulation uses the seven WPYRG areas (Figure 1), the project will be considering different stratification schemes based on both the biology of the species and the spatial extent of the fisheries themselves. Identification of the most appropriate stratification scheme would; however, require data to be available in a number of different spatial aggregations.

The manner in which the model handled missing data was discussed at some length. Two issues were seen as important. The first issue is how catch-at-age data are to be obtained when there are no length-frequency data for a particular fishery, for example, the large Indonesian handline fishery. Two approaches were suggested: (1) substitute the catch-at-age from the Philippine handline fishery, which possibly has a similar size structure and for which size data are available; or (2) re-stratify the data so that the Indonesian and Philippine fisheries are aggregated into a single fishery (i.e., the national separation of the two is removed from the model). Related to this point is the associated problem of how to convert catch in weight to catch in numbers. This is particularly a problem for catches of the large purse seine fisheries.

The second issue relates to the manner in which the model predicts or "substitutes" for missing data. It was explained that, except in the situations where entire sets of data are missing, the model will make predictions for those situations where some of the data are missing. For example, if a certain area is fished in some years but not others, then the size of the stock in the area during the years not fished can be inferred or predicted by the model parameters. In this manner additional data are not being added to the existing observed data by some "substitution" method, but are only being inferred by the model parameters. Parameter estimation is therefore based only on the comparison of the model predictions with the observed data.

The Group also discussed the extent to which one can increase the complexity of the model (i.e., the number of parameters in the model) and still be able to obtain good parameter estimates. It was argued that there are a number of statistics associated with the estimation procedure which can be used to determine both the goodness of fit of the model to the data and the accuracy of the estimates. For example, examination of the associated covariance matrix can be used to examine the likely over-parameterization of the model. The ability of the model to obtain good parameter estimates can be examined by fitting the model to simulated data. It was also pointed out that many of the fisheries operating in the western Pacific are small and that the number of parameters could be reduced by initially limiting the model to the major fisheries only.

The Group endorsed the work plan for the model and was informed that results should be available for next year's meeting.

5.2. Standardized CPUE (WPYRG5/15)

Nominal catch-per-unit-effort (CPUE) and standardized CPUE were updated for the Japanese tuna fisheries by Naozumi Miyabe (WPYRG5/15). Models and assumptions used in the standardization of CPUE are the same as those used in last year's analysis (see WPYRG4 Report). An error was found in the longline CPUE input data used last year. After the correction of this error, the diverging results of the two different treatments which incorporate bigeye tuna CPUE effect in last year's results disappeared. The two treatments gave nearly identical results. The model explained 49% of the total variation. The standardized longline CPUE trend mimics the trend in the nominal CPUE, i.e., low in the mid-1970s, a steep peak in 1978 and then decreasing gradually thereafter (Figure 2). However, the decline is less significant in the standardized CPUE, suggesting a greater effect of bigeye tuna targeting in recent years. Miyabe pointed out that the decline of longline CPUE started much earlier than the expansion and increase in yellowfin tuna catch by the purse seine fishery. Also, in 1994 the longline CPUE was at about the same level as in 1975.

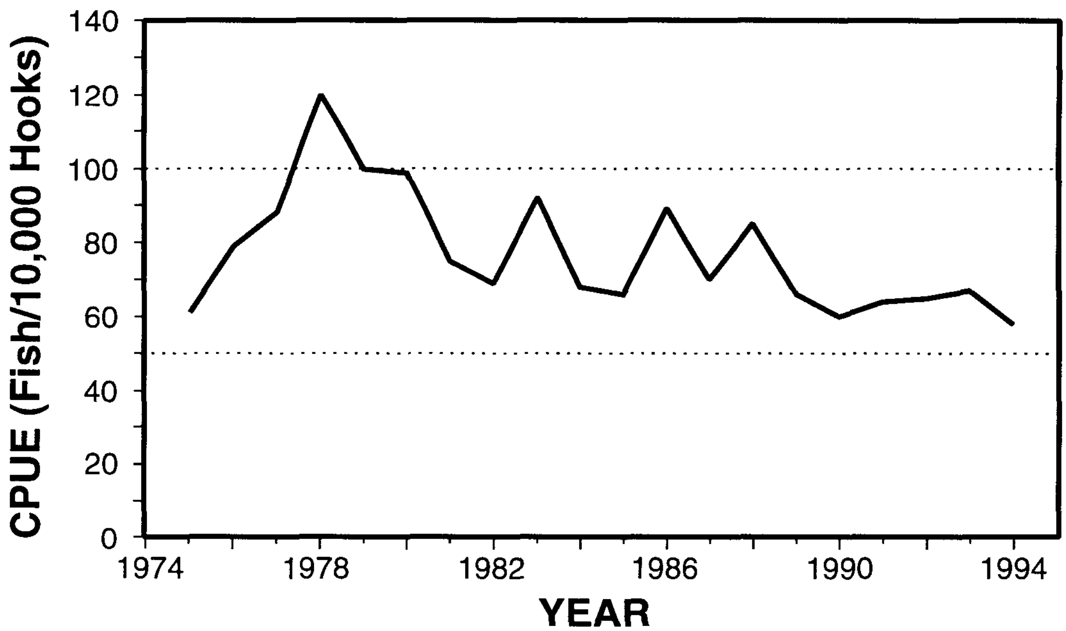

Figure 2. Standardized CPUE for yellowfin tuna caught by the Japanese longline fleet in the central-western Pacific Ocean.

The trend in standardized purse seine CPUE showed no change from results of last year's analysis (see WPYRG4 Report). The results show that while the CPUE for small yellowfin tuna (<10 kg) is more or less stable, for large yellowfin tuna (>9 kg) the trend is upward since the mid-1980s (Figure 3). The combined, all-sizes CPUE follows the trend of the large yellowfin tuna CPUE (Figure 3).

A number of technical features of the standardization model were described for clarification. Data used in the model were from logbooks and stratified by 5x5-degree area, month and number of hooks-per-basket (ED in the model). Zero catches are not accepted by the model, so were dealt with by adding one to such observations. Another possible way to handle zero catches is to use a Poisson distribution to model catches (instead of catch rates), but this was not used. The model is linear, but contains quite a large number of variables (about 170); hence, its behavior is not easily predictable. Inclusion of environmental factors affecting catch rate was suggested by the Group in the past. This suggestion was considered but not attempted because it would have

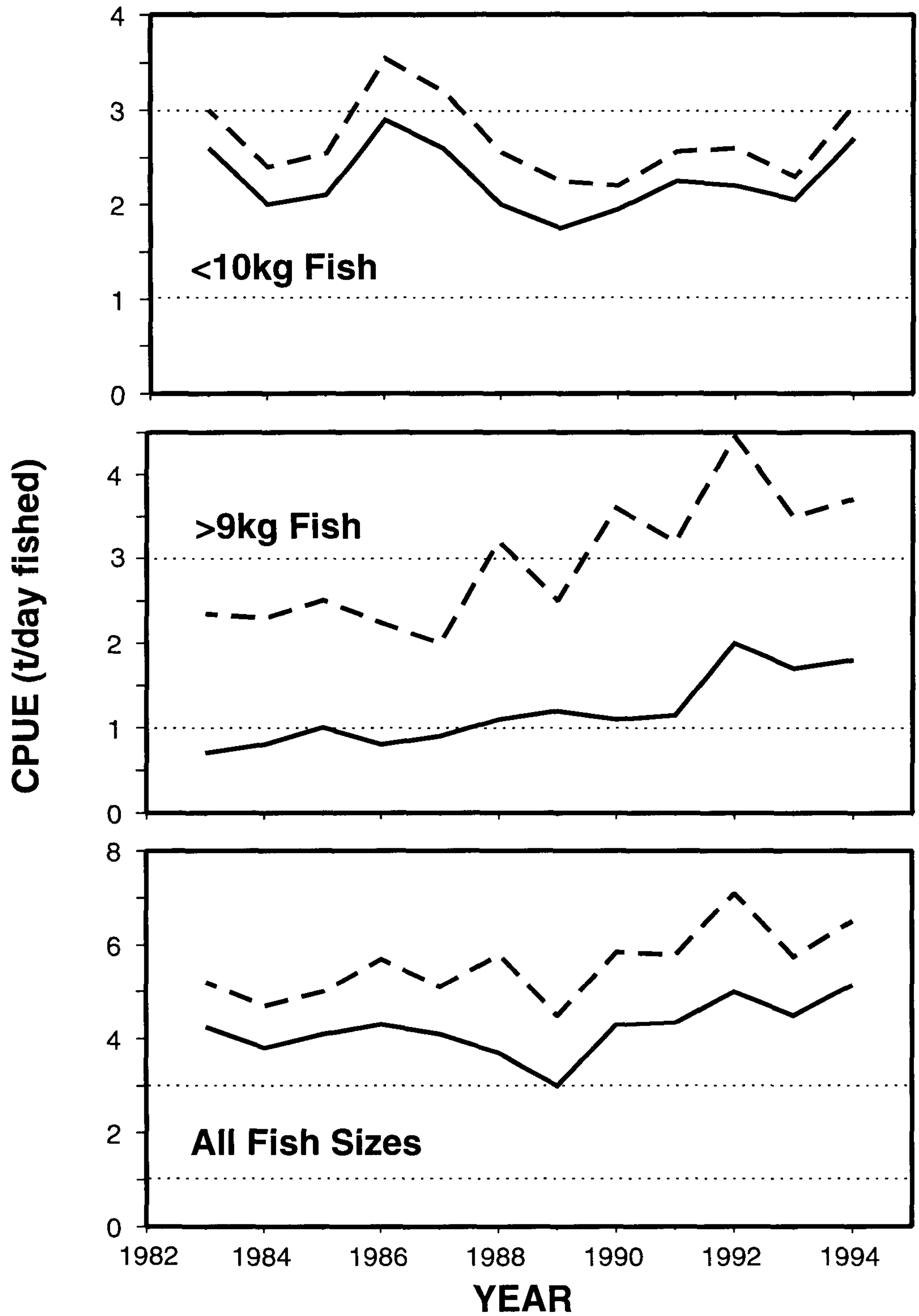

Figure 3. Standardized CPUE for yellowfin tuna caught by the Japanese purse seine fleet in the central-western Pacific Ocean. Size of fish (<10 kg; >9 kg) was one of the key factors used to stratify CPUE data for the standardization. Results of a multiplicative model (solid line) and an addictive model (dash line) used in standardization are shown.

added more variables to the model and because data on environmental factors of interest are not readily available at this time. For example, data from the TOGA program are only available for the equatorial region and not for the entire WPYRG area.

The Group discussed approaches for standardizing catch rates from purse seine fisheries to obtain accurate indices of stock abundance. The Group agreed that the standardization requires accurate and meaningful measurements of fishing effort. So far, this has been difficult to do because of systematic and continuous changes in efficiency of the fleets (e.g., helicopter spotting, sonar, bird radar, fish aggregating devices, GPS navigation, etc.). It was further agreed that fishing effort and associated data collected from the fleets so far probably lack sufficient detailed information to account for change in efficiency and for carrying out the necessary standardization analyses. The Group recommended that this shortcoming in data collection be corrected so that sufficient information would be available for future analyses.

5.3. Modeling Schooling Dynamics (WPYRG5/10)

Results of a modeling experiment designed to evaluate tag-recapture data when tagged fish move in schools were presented by Pierre Kleiber (WPYRG5/10). The experiment was designed to determine how parameter estimates of an analytical model behave when assuming tagged fish "school," i.e., movement is dependent on each other, and another case assuming fish move independently of each other, i.e., not schooling. The results showed that estimates of fishing mortality, natural mortality, advection and diffusion are less precise and the goodness of fit is poorer for the case that assumes schooling than for the case assuming fish move independently of each other. However, the parameter estimates do not appear to be biased.

During the discussion, a suggestion was made that the difference between the minimum likelihood values obtained for the independent and schooling models may contain information about the level of aggregation in the data, i.e, the degree of divergence between the two minima is a measure of the lack of independence in the movement behavior of the fish. Detailed results of the analysis were not in-hand for the Group to evaluate this suggestion. However, Kleiber noted that another algorithm of school behavior in the model produced a much flatter spread of likelihood values, indicating uncertainty in selection of a minimum.

The Group also discussed reasons for tuna tending to aggregate in schools. Suggestions included for protection, feeding and reproduction. The tendency to form schools may be strongest when tuna are young and weaker as tuna mature. Also, the integrity of schools over time and the manner in which they dissolve and reform are largely unknown and require research.

John Sibert informed the Group that a new post-doctorate position at the University of Hawaii has been created for a person to examine questions of tuna schooling behavior.

6.0. REVIEW OF CURRENT KNOWLEDGE ON BIGEYE TUNA IN THE PACIFIC (WPYRG5/11)

Naozumi Miyabe was assigned the task of assembling available information on bigeye tuna of the Pacific for presentation to the Group. He introduced his working document (WPYRG5/11), which reviews the biology and fisheries of Pacific bigeye tuna, and summarized some important biological and fisheries characteristics:

- Larval distribution: widespread throughout the Pacific.
- Age and growth: not accurately known.
- Reproductive biology: multiple spawners, almost daily spawning frequency.
- Sex ratio: dominance of males at large size.
- Stock structure: circumstantial evidence supporting both Pacific-wide stock and separate eastern and western stocks.
- Preferred temperature: range of 10-15°C.

Longline fisheries are the dominant producers of bigeye tuna in the Pacific Ocean. The fisheries occur over a broad area which includes temperate and tropical waters. Adult or large bigeye tuna (>70 cm FL) are predominantly caught.

Smaller quantities of bigeye tuna are caught by surface fisheries (mainly purse seines) and taken in the tropical western and eastern Pacific. In the western Pacific, the surface fishery catches mainly small bigeye tuna (<70 cm FL) associated with logs (Figure 4). In the eastern Pacific, both small- and large-sized bigeye tuna are taken in the surface fisheries (Figure 5), but a higher proportion is large fish as compared to the western Pacific. Furthermore, in the eastern Pacific, catches are mainly from log-associated schools as well as from Fish Aggregating Devices.

Recently, significantly large catches of bigeye tuna have been reported for the purse seine fishery of the eastern Pacific. This increase is alleged to be due to purse seiners shifting to alternative forms of schools to avoid fishing on dolphin-associated schools. Large catches are being reported from log-associated schools and FADs and in an area off Colombia and Ecuador. If this pattern continues, there could be a significant effect on the catch of the longline fishery in the eastern Pacific.

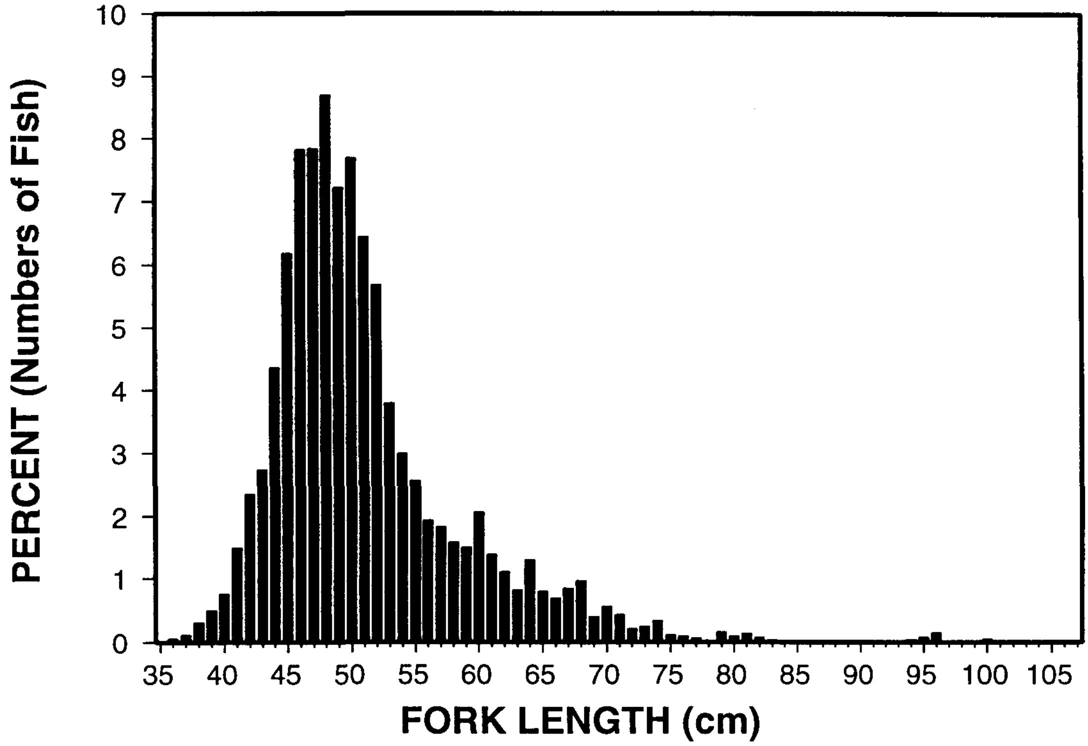

Figure 4. Size frequency of bigeye tuna taken by U.S. purse seines in the central-western Pacific Ocean in 1994.

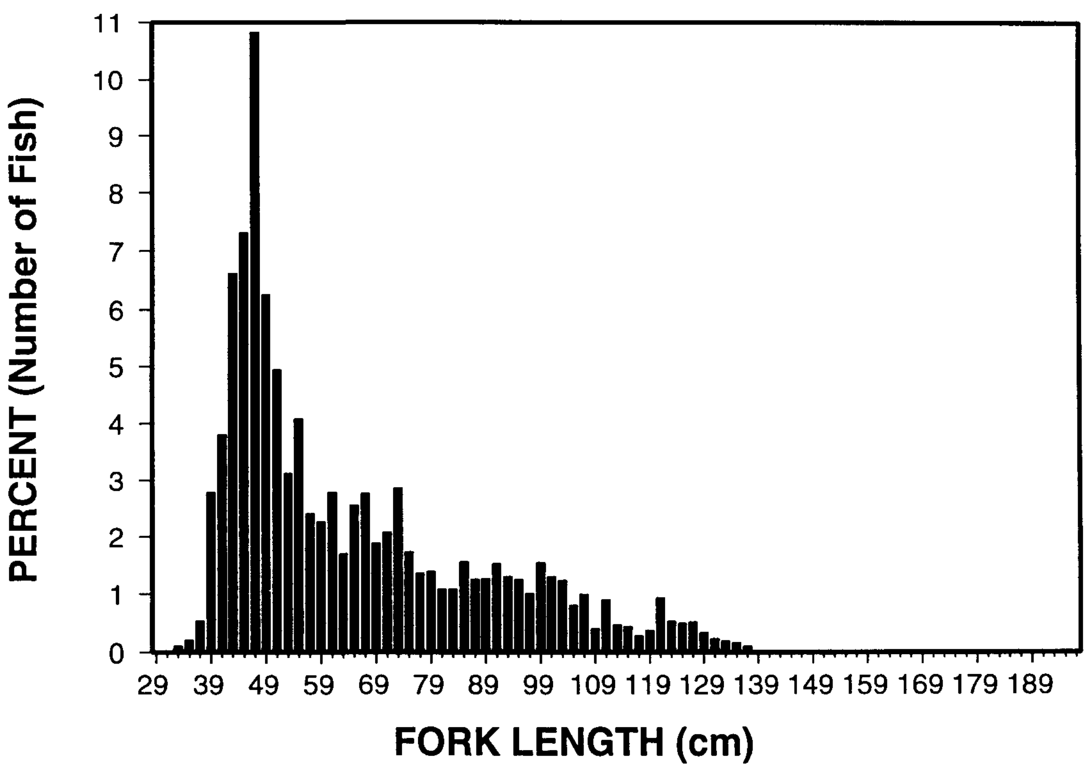

Figure 5. Size frequency of bigeye tuna taken by the purse seine (all fleets combined) fishery in the eastern tropical Pacific Ocean in 1994.

The stock status of bigeye tuna has so far been determined mainly from longline fishery statistics. The procedure involves computing standardized CPUE and analyzing trends to infer changes in abundance. The data are then used in production models to estimate Maximum Sustainable Yield (MSY). Pacific-wide, the trend in standardized CPUE shows a marked decline in the 1950s and 1960s, before stabilizing in the 1980s. MSY estimated from the data has been in the 130,000 t to 167,000 t range or approximately the range of catches in recent years.

The Group discussed the information provided by Miyabe, and several points were raised:

- The distribution of Korean longline effort for 1981 (WPYRG 5/11, Figure 7) is not typical of the area of operation of this fleet in recent years. Recently, effort has targeted on bigeye and shifted to the temperate region.

- The decline in Japanese longline CPUE in the early years may be overstating the decline in abundance because of changes in catchability or in other features of the population dynamics of the animal.

- Different longline setting techniques (e.g., deep vs regular) affect CPUE and also the sizes of bigeye tuna caught; these effects likely vary across the Pacific and are influenced by differences in environmental features, particularly thermal profile, in the area fished.

6.1. Research on Stock Structure

John Hampton provided a progress report on a joint project SPC-CSIRO that is investigating the genetic structure (DNA analysis) of bigeye tuna in the Pacific. Samples of bigeye tuna are being collected from seven locations across the Pacific. In addition, attempts are being made to obtain samples from the Indian and Atlantic oceans for comparative purposes. In several Pacific locations, both small- and large-sized fish will be collected. The investigation is designed to examine size effects on genetic characteristics—differences between sizes of fish may be indicative of the extent of mixing over time—and to relate the genetic data to tag-recapture data where possible. Sampling will be completed by the end of September 1995, and final results should be available at the next meeting.

6.2. CPUE and Production Model Analysis (WPYRG5/12)

Naozumi Miyabe reviewed results of production model analyses using Japanese longline data (WPYRG5/12). His analyses involved standardizing CPUE with General Linear Model analysis, using two stock structure hypotheses (a single Pacific-wide stock and two separate eastern and western stocks) and using production models. His presentation updated results presented last year to the Group and included an alternative two stocks hypothesis for stock structure.

His alternative hypothesis on stock structure, two stocks—one in the west and the other in the east—separates the stocks at around 150°W and, is similar to the division used for yellowfin tuna stock structure. Circumstantial evidence, such as the distribution of fishing grounds, CPUE trend among areas, spawning area, etc., supports a single stock hypothesis. However, other evidence, such as an east-west cline in the sizes of fish caught and in the CPUE and the appearance of limited movement of tagged fish, tends to support the existence of subpopulations and a separate eastern and western stock.

Detailed catch by area statistics for Pacific bigeye tuna are not available to partition the total Pacific-wide catch into eastern and western catches at 150°W. As an alternative, Miyabe used an approximation by substituting FAO catch statistics, which are reported by areas with boundaries close to 150°W. Catches in FAO areas 61, 71 and 81 were assigned to the western stock, and catches in FAO areas 67, 77 and 87 were assigned to the eastern stock. Similarly, Japanese longline CPUE data in Miyabe's areas 1, 3, 4 and 7 (WPYRG5/12) were assigned to the western stock, and the rest of the data (areas 2, 5, 6, 8 and 9) were assigned to the eastern stock.

Estimation procedures used for standardizing CPUE and for production model analysis were similar to those used last year. Also, catch and effort data for standardization of CPUE were separated into two periods, before and after 1975, because gear configuration data (i.e., number of hooks per basket) to determine deep and regular longlining are available only for the recent period.

For each stock structure hypothesis, two different CPUE series per stock were developed. One series takes into account concentration of effort in waters where bigeye CPUE is high, and the other series does not. However, if concentration effect is important, the series does not appear to fully address this effect because the spatial dimension in the model is wider than the basic observations (i.e., 5x5-degree square). To account for this shortcoming, each observation was weighted by the inverse of the number of observations in each 5x5-degree square. The rationale being that the density of data is related to the intensity of concentration.

The results showed the most precipitous decline occurring in the standardized CPUE for the eastern stock. For all stocks, the standardized CPUE generally declined early in the time series and sharply before leveling off. Weighted standardized CPUEs declined significantly after the mid-1970s especially for the single Pacific-wide stock and the eastern stock.

A non-equilibrium surplus production model was fitted to catch and standardized CPUE data. The estimated MSYs are 120,000 t, 40,000 t and 65,000-87,000 t for the single, western and eastern stocks, respectively. Relative benchmarks (B-ratio and F-ratio) for judging the impact of exploitation indicate that the biomass is able to support the MSY and the current fishing mortality (F) under a single stock hypothesis. However under a two stock hypothesis, the current biomass for the eastern stock is not able to support the MSY and current exploitation, and the western stock is underexploited.

Miyabe summarized his principal findings as follows:

- With the two stock hypothesis, standardized CPUE declined in the eastern Pacific but has been relatively stable in the western Pacific. Estimated MSY is higher for the eastern Pacific stock than for the western Pacific stock—reflecting the higher catches in the eastern Pacific. The estimated biomass in the eastern Pacific for current years is less than required to support the MSY.

- With the one stock hypothesis, current catches are close to estimated MSY, and the estimated biomass is sufficient to support the MSY.

The Group noted that this year's results provide alternative views on the condition of the bigeye tuna stock of the Pacific Ocean. However, aside from the results of the production model analysis, the state of the data and concerns are the same as presented last year. That is, the Japanese longline fishery for bigeye tuna accounts for about 80% of the bigeye tuna currently caught in the Pacific Ocean. The catch for this fishery continues to decrease despite intensive fishing. In recent years, catches from other fisheries, Taiwan, China, U.S., etc., both longline and surface, have increased significantly. The increase in purse seine catches is of special concern because it involves large numbers of small-sized bigeye tuna. Considering all of these points, the bigeye tuna stock appears to be fished intensively, and there are some signs of overfishing that may require fishery management on a Pacific-wide basis. On the other hand, the Group recognizes that the evidence is circumstantial and requires further corroboration. Specifically, the Group noted:

- It should be possible to statistically test the production model analyses to determine which stock structure model(s) fits the data best. However, this would not constitute a definitive test of bigeye tuna stock structure or choice of best model.

- Production models are able to provide accurate estimates of MSY and associated parameters only after severe over-fishing has occurred. For intermediate situations, the models tend to provide MSY estimates that approximate the recent catch level. This may be the case for results with the Pacific-wide stock hypothesis.

- The larger proportion of large bigeye tuna in the purse seine catch of the eastern Pacific as compared to the purse seine catch of the western Pacific may be related to the shallower thermocline in the eastern Pacific. The shallower thermocline results in larger bigeye tuna being available closer to the surface and within reach of the nets.

7.0. FUTURE DIRECTION FOR THE WPYRG

A discussion on the future direction for the Group was initiated by the Chairperson to serve as a benchmark in evaluating the relevance of current research activities and to guide future research of the WPYRG. The Group was reminded that the direction must relate to provision of management advice to administrators on major fishery issues and could consider the role of other species besides yellowfin tuna in the Group's focus.

Participants from Pacific island nations confirmed that the focus on provision of management advice was important and appropriate, although they recognized that (1) the Group has no official mandate (or budget) which would authorize it to provide advice to any government or organization, and (2) because the Group has no direct management advice responsibilities, it can deviate and pursue research that may not have immediate relevance to issues or concerns of the time. They acknowledged; however, that this is a strength and not a weakness of the WPYRG. That is, because the WPYRG is able to pursue a wide range of activities, not all of which may necessarily address immediate issues and concerns of administrators, it can investigate emerging issues and discuss results that may be at odds with conclusions from conventional approaches. This is extremely valuable in alerting participants to emerging challenges and different interpretation of results. Also, the Group serves as a "peer review" of research results.

The issue of reliability of current stock assessment models in handling the large amount of data and complex relationships among parameters was raised as a concern. The general sense was that current models do not handle the large data and complex relationships well, and a new functional model is needed. The yellowfin tuna model development project (RASCLE) is creating such a model. An important role of the Group would be to support the development of the new model. Many aspects of the model are currently unclear, and research on the aspects can assist in refining the model. Research needs are in:

- Studying the relation between tunas and the environment;

- Studying the effects of schooling and aggregation;

- Developing specialty models to handle multiple species;

- Developing specialty models that incorporate fleet (fisherman behavior) as well as fish dynamics; and

- Studying age-dependant (sex-dependent) natural mortality.

It was noted that RASCLE requires a vast number of input parameters and data for estimating the parameters. Data that are currently being collected need significant improvement to be of maximum use in the model. Special note was made, in this regard, of lack of complete statistics on small-scale fisheries and on accurate statistics on discards of juvenile tuna in purse seine fisheries and rejects of fish aboard all vessels.

As for the Group taking on research of additional species, it was noted that the Group has in fact expanded its role and included bigeye tuna with this meeting. In the future, other tropical tuna species, and even albacore, may be considered for research depending on the issues being addressed.

The Group's special interest in bigeye tuna is related to bigeye tuna's involvement as a by-catch species in purse seine fisheries. This involvement is not evident from fisheries statistics because of the practice of grouping bigeye tuna in yellowfin tuna catches in purse seine logbook and landing records. Increased port sampling has been recommended as one of the ways to correct this statistical anomaly.

In longline fisheries, conversely, bigeye tuna is a target species for many fleets and yellowfin tuna a "by-catch" species. Hence, the Group has an interest in understanding shifts in targeting and its effect on both yellowfin tuna and bigeye tuna exploitation.

It was noted that the major portion of the bigeye tuna catch from the Pacific Ocean comes from outside the study area. Also, it was noted that the IATTC has a substantial research program on this species.

The Group considered the above points and agreed that the focus would continue to be on yellowfin tuna with emphasis on bigeye tuna to the extent that it impacts on the yellowfin tuna fisheries. Furthermore, it was suggested that if bigeye tuna stock status becomes a significant topic for consideration with regard to yellowfin tuna issues, IATTC researchers might be invited to the Group's meetings to share information on their bigeye tuna research.

As for the future direction of yellowfin tuna research, the Group agreed that it should address the following questions:

- How do reproductive and feeding behavior and the environment affect catchability of yellowfin tuna?

- What are the local interactions between large- and small-scale fisheries in the WPYRG study area?

- What is the effect of bigeye tuna by-catch and of fishing effort directed on this species on the yellowfin tuna stock?

7.1. Action Items for Data Bases

Action items dealing with fisheries data that were discussed earlier in Section 3.0 are summarized as follows:

- Collect information on gear changes/modifications (with particular reference to longline fisheries where significant changes are occurring).

- Examine the effects of gear modifications on species composition and efficiency.

- Include French Polynesian catches in the WPYRG database, and footnote to indicate catches are partially from outside the study area.

- Identify and footnote catches in the database that include catches made in "fringe areas" beyond the study area.

- Include estimates of percentage of coverage of catch data as well as estimates of discards and cannery rejects in the catch database.

- Determine availability of length-frequency data sets from agencies and create a catalogue of the information.

- Through observer programs, obtain reports on changes and developments in tuna fisheries monitored by the programs. (These reports should also be submitted to SCTB as well.)

- Compare length-frequency for U.S. purse seine catches collected by port sampling and by observers.

- Compile data from historical records, research cruises, etc., to estimate bigeye tuna catches by surface fisheries.

- Collect data on length-frequency of bigeye tuna caught in all fisheries.

- Collect data on bigeye tuna catches of vessels fishing around anchored FADs in the Solomon Islands.

7.2. Action Items for Biological Studies

Action items for biological studies were mentioned in the discussion of the Group and are summarized as follows:

- Complete studies on yellowfin tuna reproductive biology.

- Report on the results of a survey to be executed in 1995 by the Tohoku National Fisheries Research Institute on the distribution and abundance of larval and young skipjack tuna in the western Pacific.

7.3. Action Items for Stock Assessment Studies.

The following are recommended action items for stock assessment studies:

- Undertake a study on the effects of environmental factors on the catches of purse seine fisheries.

- Continue with the next phase in the development of the yellowfin tuna assessment model (RASCLE), taking into account suggestions of the Group (see Section 5.1).

7.4. Action Item for Bigeye Tuna Stock Assessment Studies.

- Pursue suggestions of the Group (see Section 6.2) with respect to fitting of production models using revised catch statistics and using the two stock structure hypotheses.

8.0. ADMINISTRATIVE MATTERS

The Group agreed that the Chairperson would supervise the completion of the WPYRG5 report and make draft copies available to participants for review. Final decision on disposition of comments shall be left to the Chairperson.

The place and time for the next meeting will be decided by the Chairperson in cooperation with the SPC. The traditional practice of holding the WPYRG meeting at the same location and adjoining dates of an SPC meeting will be followed in order to reduce costs to participants.

The 5th meeting of the WPYRG adjourned on August 23 after the participants thanked Tony Lewis and the staff of the Oceanic Fisheries Programme, SPC, for hosting the event and for providing the ambience that led to a successful meeting. The Group also thanked Sachiko Tsuji for leading the Group in achieving all of the meeting's objectives.

APPENDIX A

LIST OF PARTICIPANTS

APPENDIX A. LIST OF PARTICIPANTS

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APPENDIX B

AGENDA

APPENDIX B. AGENDA

SESSION 1: Review of Fisheries

SESSION 2: Review of Data Bases

- Improvement of data collection for joint-venture and artisanal fisheries in the Philippines and Indonesia (N. Naamin)

SESSION 3: Review of Advances in Biological Information

- Reproductive biology (D. Itano)
- Species composition of log-associated schools (J. U. Lee, G. Sakagawa, N. Miyabe)
- Market measurement of purse seiners in Japan (N. Miyabe)
- Feasibility of a longline-based tagging project (J. Hampton, R. Campbell)
- Archival tag attachments (P. Kleiber)
- Search for real-time oceanographic data and maps (J. Sibert)
- Shoyo-Maru survey in 1995 (N. Miyabe)

SESSION 4: Review of Advances in Stock Assessment

- Review of tuna schooling dynamics (P. Kleiber)
- RASCLE model (J. Hampton)

SESSION 5: Review of Current Knowledge on Bigeye Tuna (BET) in the Pacific

- Review of biology of and fisheries for BET (N. Miyabe)
- Update of stock assessment of BET (N. Miyabe)

SESSION 6: Future Direction of the WPYRG

APPENDIX C

LIST OF DOCUMENTS

APPENDIX C. LIST OF DOCUMENTS

DOCUMENT NUMBER	TITLE/AUTHOR
WPYRG5/1	Report of the fourth meeting of the Western Pacific Yellowfin Tuna Research Group.
WPYRG5/2	Taiwanese catches of skipjack tuna and bigeye tuna for the Pacific Ocean. *(C.L. Sun)*
WPYRG5/3	Japanese tuna fisheries in the Western Pacific Ocean. *(N. Miyabe, S. Chow, I. Warashina, T. Tanaka and Y. Nishikawa)*
WPYRG5/4	U.S. fisheries catching tropical tunas in the Central-Western Pacific Ocean, 1993-1994. *(A.L. Coan, Jr., and D. Prescott)*
WPYRG5/5	On log-school fishery of the Korean tuna purse seine in the Western Pacific Ocean. *(J.U. Lee, D.Y. Moon, and J.B. Kim)*
WPYRG5/6	Bigeye tuna catch in the U.S. tuna purse seine fishery of the Central-Western Pacific. *(A.L. Coan Jr., G.T. Sakagawa and D. Prescott)*
WPYRG5/7	Reproductive biology of yellowfin tuna, Thunnus albacares, in Hawaiian waters and the western tropical Pacific Ocean. *(D.G. Itano)*
WPYRG5/8	The Pacific El Niño - Southern Oscillation (ENSO) Applications Centre. *(SPC)*
WPYRG5/9	Preliminary report of 1995 research cruise by R/V Shoyo-Maru experimental tuna longline operation with nylon monofilament line. *(H. Okamoto and Y. Uozumi)*
WPYRG5/10	Does schooling behaviour affect estimates of movement parameters from tagging data? *(P. Kleiber)*
WPYRG5/11	A review of the biology and fisheries for bigeye tuna, Thunnus obesus, in the Pacific Ocean. *(N. Miyabe)*
WPYRG5/12	Follow-up study on the stock status of bigeye tuna in the Pacific Ocean. *(N. Miyabe)*
WPYRG5/13	Taiwan fisheries for yellowfin tuna in the Central and Western Pacific, 1993-1995, and species composition of log associated sets by Taiwan tuna purse seiners, 1993-94. *(C.L. Sun and S.Z. Yeh)*

WPYRG5/14	Indonesian fisheries for yellowfin tuna in the Western Pacific - Eastern Indonesia. *(N. Naamin and S. Bahar)*
WPYRG5/15	Updated information on yellowfin and bigeye tunas from the Japanese tuna fisheries. *(N. Miyabe)*
WPYRG5/16	Yellowfin tuna landings in American Samoa 1976-1994. *(D. Su'a)*
WPYRG5/17	Experience of longline tagging of SBT. *(CSIRO)*
WPYRG5/18	Yellowfin tuna landing in Fiji (1976-1994). *(S. Sharma)*

APPENDIX D

NUMBER OF VESSELS FISHING FOR TROPICAL TUNAS IN THE CENTRAL-WESTERN PACIFIC OCEAN

APPENDIX D. NUMBER OF VESSELS FISHING FOR TROPICAL TUNAS IN THE CENTRAL-WESTERN PACIFIC OCEAN

Table D1. Number of longline vessels by countries fishing for tropical tunas in the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table D2. Number of purse seine vessels fishing for tropical tunas in the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table D3. Number of pole-and-line vessels fishing for tropical tunas in the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table D1. Number of longline vessels by countries fishing for tropical tunas in the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1]	CHINA[1]	COOK ISLANDS[1]	FSM[2]	FIJI[3]	FRENCH POLYNESIA[1]	INDONESIA[4]	JAPAN[5]		KOREA[6]
								COASTAL	OFF/DW	
1970	-	-	-	-	-	-	-	890	1,553	105
1971	-	-	-	-	-	-	-	908	1,562	122
1972	-	-	-	-	-	-	-	940	1,431	178
1973	-	-	-	-	-	-	-	959	1,428	222
1974	-	-	-	-	-	-	-	518	1,516	270
1975	-	-	-	-	-	-	-	720	1,418	253
1976	-	-	-	-	-	-	-	827	1,396	257
1977	-	-	-	-	-	-	-	726	1,428	217
1978	-	-	-	-	-	-	-	669	1,480	223
1979	-	-	-	-	-	-	-	648	1,495	216
1980	-	-	-	-	-	-	-	821	1,520	211
1981	-	-	-	-	-	-	-	774	1,522	209
1982	-	-	-	-	-	-	-	722	1,356	121
1983	-	-	-	-	-	-	-	561	1,270	102
1984	-	-	-	-	-	-	-	523	1,288	96
1985	-	-	-	-	-	-	28	620	1,299	94
1986	-	-	-	-	-	-	63	536	1,260	134
1987	64	-	-	-	-	-	79	661	1,217	138
1988	62	-	-	-	-	-	70	586	1,192	124
1989	93	-	-	-	4	-	138	650	1,159	152
1990	98	-	-	-	6	-	151	685	1,153	182
1991	82	34	-	2	9	-	145	768	1,122	220
1992	98	72	-	6	18	19	141	793	1,070	166
1993	79	319	-	7	21	49	309	790	1,039	148
1994	80	461	2	10	37	66	293	(790)	(1,039)	160

Table D1. (continued)

YEAR	MARSHALL ISLANDS[1]	NEW CALEDONIA[7]	PHILIPPINES[8]	SOLOMON ISLANDS[1]	TAIWAN[9]		TONGA[1]	USA[10]	WESTERN SAMOA[1]	TOTAL
					DW	OFF				
1970	-	-	-	-	-	829	-	45	-	3,422
1971	-	-	-	-	-	863	-	46	-	3,501
1972	-	-	-	-	-	899	-	42	-	3,490
1973	-	-	-	2	-	1,255	-	32	-	3,898
1974	-	-	-	-	-	1,451	-	33	-	3,788
1975	-	-	-	-	92	1,411	-	31	-	3,925
1976	-	-	-	2	194	1,331	-	33	-	4,040
1977	-	-	-	2	176	1,382	-	35	-	3,966
1978	-	-	-	2	168	1,670	-	29	-	4,241
1979	-	-	-	2	157	1,840	-	21	-	4,379
1980	-	-	-	2	182	1,900	-	11	-	4,647
1981	-	-	-	2	140	1,846	-	13	-	4,506
1982	-	-	61	2	115	1,831	1	10	-	4,219
1983	-	1	62	2	65	1,872	1	18	-	3,954
1984	-	2	62	2	61	1,944	1	23	-	4,002
1985	-	3	55	2	44	2,129	1	23	-	4,298
1986	-	2	41	0	51	2,084	1	21	-	4,193
1987	-	3	62	0	60	2,207	1	37	-	4,529
1988	-	4	27	0	70	1,977	1	50	-	4,163
1989	-	4	3	0	85	1,671	1	80	-	4,040
1990	-	7	26	0	96	1,139	1	138	-	3,682
1991	-	6	(12)	0	82	800	1	143	-	(3,426)
1992	4	4	10	0	92	1,898	1	129	-	4,521
1993	5	4	10	0	119	1,791	7	124	2	4,823
1994	4	6	(10)	0	(70)	(1,753)	9	(127)	2	(4,919)

Table D2. Number of purse seine vessels fishing for tropical tunas in the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1]	FSM[2]	INDONESIA[4]	JAPAN[5]		KOREA[6]	MEXICO[1]	NEW ZEALAND[1]
				COASTAL	OFF/DW			
1970	-	-	-	-	-	-	-	-
1971	-	-	-	23	6	-	-	-
1972	-	-	-	31	7	-	-	-
1973	-	-	-	37	6	-	-	-
1974	-	-	-	42	10	-	-	-
1975	-	-	-	42	12	-	-	-
1976	-	-	-	43	15	-	-	-
1977	-	-	-	50	14	-	-	-
1978	-	-	-	47	14	-	-	-
1979	-	-	-	46	17	-	-	-
1980	-	-	-	50	16	2	-	-
1981	-	-	-	50	23	3	-	-
1982	-	-	-	52	33	10	-	-
1983	-	-	-	59	36	11	-	7
1984	-	-	3	54	33	12	2	5
1985	-	-	3	47	35	11	-	5
1986	-	-	3	53	38	13	-	-
1987	-	-	3	47	34	20	-	-
1988	3	-	3	48	39	23	-	-
1989	1	-	3	43	37	30	-	-
1990	9	-	3	43	35	39	-	-
1991	4	6	3	38	35	36	-	-
1992	3	7	3	31	38	36	-	-
1993	3	7	3	27	36	34	-	-
1994	4	6	3	(27)	(36)	32	-	-

Table D2. (continued)

YEAR	PHILIPPINES[8]		RUSSIA[1]	SOLOMON ISLANDS[1]	TAIWAN[9]	USA[10]	TOTAL
	DW	COASTAL					
1970	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	29
1972	-	-	-	-	-	-	38
1973	-	-	-	-	-	-	43
1974	-	-	-	-	-	-	52
1975	-	-	-	-	-	-	54
1976	-	-	-	-	-	3	61
1977	-	-	-	-	-	1	65
1978	-	-	-	-	-	2	63
1979	-	-	-	-	-	8	71
1980	-	570	-	1	-	14	653
1981	-	697	-	1	-	14	788
1982	(1)	785	-	1	-	24	(906)
1983	0	686	-	1	-	62	862
1984	(3)	712	-	1	5	61	(891)
1985	(5)	724	5	1	5	40	(881)
1986	(5)	685	8	1	11	36	(853)
1987	(5)	813	5	2	15	35	(979)
1988	(9)	779	5	4	24	32	(969)
1989	(14)	198	5	4	22	35	(392)
1990	(13)	549	5	4	31	43	(774)
1991	(15)	546	4	3	40	43	(773)
1992	(14)	407	3	3	43	44	(632)
1993	(14)	(399)	8	3	43	42	(619)
1994	(14)	(399)	4	3	43	49	(620)

Table D3. Number of pole-and-line vessels fishing for tropical tunas in the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1]	FIJI[3]	FRENCH POLYNESIA[1]	INDONESIA[4]	JAPAN[5]		KIRIBATI[1]	NEW CALEDONIA[7]
					COASTAL	OFF/DW		
1970	-	-	-	-	3,148	512	-	-
1971	-	-	-	-	3,168	510	-	-
1972	-	-	-	-	3,596	554	-	-
1973	-	-	-	-	3,020	650	-	-
1974	-	-	-	-	3,225	716	-	-
1975	-	-	-	-	2,648	696	-	-
1976	9	2	-	-	3,101	653	-	-
1977	-	6	-	-	3,348	662	-	-
1978	14	6	-	-	3,035	645	-	-
1979	-	8	-	-	3,480	625	1	-
1980	-	11	46	-	3,232	572	-	-
1981	-	12	51	-	3,064	548	2	1
1982	20	14	46	-	3,011	475	2	3
1983	-	13	46	-	3,021	434	4	3
1984	8	11	51	-	3,904	396	4	0
1985	-	7	49	1,115	2,754	356	4	0
1986	5	6	51	1,287	2,455	330	4	0
1987	5	8	64	1,170	2,404	314	4	0
1988	18	8	53	1,577	2,613	277	5	0
1989	15	8	56	921	2,254	269	6	0
1990	17	10	55	900	2,228	255	5	0
1991	16	10	31	872	2,277	242	3	0
1992	10	11	36	849	2,093	216	3	0
1993	10	9	24	823	1,927	203	3	0
1994	11	8	70	820	(1,927)	(203)	4	0

Table D3. (continued)

YEAR	NEW ZEALAND[1]	PALAU[1]	PAPUA NEW GUINEA[1]	SOLOMON ISLANDS[1]	TUVALU[1]	USA[10]	TOTAL
1970	-	10	5	-	-	-	3,675
1971	-	20	29	-	-	-	3,727
1972	-	11	45	-	-	-	4,206
1973	-	12	43	11	-	-	3,736
1974	-	24	47	11	-	-	4,023
1975	-	21	48	12	-	-	3,425
1976	-	33	40	14	-	-	3,852
1977	-	23	51	20	-	-	4,110
1978	-	26	48	20	-	-	3,794
1979	-	21	45	21	-	-	4,201
1980	-	31	50	22	-	-	3,964
1981	-	36	44	23	-	-	3,781
1982	-	20	-	25	1	-	3,617
1983	-	0	-	27	1	-	3,549
1984	-	0	-	30	1	-	4,405
1985	-	1	-	33	1	-	4,320
1986	-	1	0	35	1	-	4,175
1987	-	1	0	34	1	-	4,005
1988	-	1	0	34	1	-	4,587
1989	-	1	0	33	1	-	3,564
1990	-	1	0	33	1	-	3,505
1991	4	-	0	32	1	-	3,488
1992	-	1	0	32	1	-	3,252
1993	-	1	0	27	-	-	3,027
1994	-	1	0	27	-	-	(3,071)

LIST OF FOOTNOTES FOR APPENDIX D TABLES

[1]From SPC Tuna Fishery Yearbook, 1993, and SCTB8 Paper 2. French Polynesian catches may include catches outside the WPYRG area.

[2]From SPC Regional Tuna Bulletin (3rd quarter 1992) for 1991 and Micronesian Maritime Authority actual unloadings for 1992-94.

[3]From S. P. Sharma (FFD).

[4]From Fisheries Statistics of Indonesia and RIMF sampling program, N. Naamin (RIMF).

[5]From N. Miyabe (NRIFSF). Coastal = coastal fleet. DW = distant-water fleet. OFF = offshore fleet.

[6]From J. U. Lee (NFRDA). Longline data represent number of vessels in the entire Pacific.

[7]From R. Etaix-Bonnin (STMMPM).

[8]From BFAR Fisheries Statistics, R. Ganaden (BFAR). Purse seine vessels include ring net fleet. Coastal = coastal fleet. DW = distant-water fleet.

[9]From Fisheries Yearbook, C. L. Sun (NTU). Distant-water fleet (DW) operates Pacific-wide. Offshore fleet (OFF) operates in coastal and offshore waters. 1993 data include Taiwanese longline vessels fishing in FSM and may be double counted.

[10]From landings, A. Coan (NMFS). Landings and number of vessels for 1992-94, include joint ventures with Marshall Islands from SPC Tuna Fishery Yearbook, 1993, and SCTB8 Paper 2.

APPENDIX E

YELLOWFIN TUNA CATCHES FOR THE CENTRAL-WESTERN PACIFIC OCEAN

APPENDIX E. YELLOWFIN TUNA CATCHES FOR THE CENTRAL-WESTERN PACIFIC OCEAN

Table E1. Total catch (t; all gears) of yellowfin tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table E2. Longline catch (t) of yellowfin tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table E3. Purse seine catch (t) of yellowfin tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table E4. Pole-and-line catches (t) of yellowfin tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table E5. Unclassified (UNCL) or handline, gillnet, troll and other gear catches (t) of yellowfin tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table E1. Total catch (t; all gears) of yellowfin tuna by country for the central-western Pacific Ocean, 1970-1994. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1,2]	CHINA[2]	COOK ISLANDS[2]	FSM[3]	FIJI[4]	FRENCH POLYNESIA[2]	INDONESIA[5]	JAPAN[6]	KIRIBATI[2]
1970	-	-	-	-	-	-	5,500	47,691	-
1971	-	-	-	-	-	-	5,700	42,984	-
1972	-	-	-	-	-	-	9,000	47,765	-
1973	-	-	-	-	-	-	10,200	48,670	-
1974	-	-	-	-	12	-	10,165	50,080	-
1975	-	-	-	-	11	-	11,062	48,560	-
1976	1	-	-	-	84	-	8,037	57,228	-
1977	-	-	-	-	151	-	10,859	64,596	-
1978	16	-	-	-	409	-	10,601	85,027	-
1979	-	-	-	-	403	161	14,663	91,664	-
1980	-	-	-	-	233	253	17,550	102,623	-
1981	-	-	-	-	583	472	21,889	98,779	210
1982	5	-	-	-	753	368	24,313	94,755	170
1983	-	-	-	-	493	238	20,200	98,854	239
1984	5	-	-	-	580	426	26,450	94,231	528
1985	-	-	-	-	727	243	29,587	115,178	503
1986	8	-	-	-	829	232	34,328	92,262	721
1987	712	-	-	-	438	149	40,785	90,763	156
1988	1,076	-	-	-	473	274	43,199	84,615	383
1989	1,138	-	-	-	497	187	45,268	88,118	848
1990	1,493	-	-	-	521	55	48,087	84,597	143
1991	1,869	341	-	2,873	487	105	52,825	83,713	67
1992	1,366	1,124	-	3,753	612	270	55,325	95,302	303
1993	933	2,259	-	5,606	756	449	(60,067)	(97,371)	161
1994	784	4,169	7	5,175	1,306	401	(59,130)	(73,448)	17

Table E1. (continued)

YEAR	KOREA[7]	MARSHALL ISLANDS[2]	MEXICO[2]	NEW CALEDONIA[2,8]	NEW ZEALAND[2,12]	PALAU[2]	PAPUA NEW GUINEA[2]	PHILIPPINES[9]
1970	1,500	-	-	-	-	1	74	(32,000)
1971	3,975	-	-	-	-	10	112	(35,800)
1972	8,850	-	-	-	-	56	1,345	(37,200)
1973	9,000	-	-	-	-	41	916	(44,500)
1974	11,328	-	-	-	1	161	1,416	(51,732)
1975	7,783	-	-	-	1	298	1,744	(52,793)
1976	13,957	-	-	-	-	412	8,563	(32,323)
1977	15,571	-	-	-	-	420	4,009	(50,801)
1978	13,185	-	-	-	15	303	3,099	35,921
1979	17,781	-	-	-	16	1	2,881	47,496
1980	21,645	-	-	-	51	996	3,018	45,608
1981	9,038	-	-	3	26	2,480	4,205	55,663
1982	10,452	-	-	41	2	615	-	51,840
1983	7,852	-	-	32	240	0	-	60,920
1984	6,462	-	1,174	25	233	0	274	58,088
1985	9,511	-	-	119	171	15	930	62,280
1986	8,075	-	-	151	7	19	0	59,151
1987	24,941	-	-	449	7	22	0	51,295
1988	24,329	-	-	436	5	38	0	(57,060)
1989	41,823	-	-	248	9	5	0	(62,146)
1990	43,439	-	-	551	4	8	0	(81,103)
1991	60,052	-	-	506	6	-	0	(95,594)
1992	76,863	9	-	230	8	14	0	(45,026)
1993	59,387	38	-	387	8	14	0	(38,198)
1994	56,991	38	-	390	0	14	0	(38,198)

Table E1. (continued on next page →)

Table E1. (continued from previous page)

YEAR	RUSSIA[2]	SOLOMON ISLANDS[2]	TAIWAN[10]	TONGA[2]	TUVALU[2]	USA[11]	WESTERN SAMOA[2]	TOTAL[13]
1970	-	-	10,387	-	-	320	-	(97,473)
1971	-	141	14,143	-	-	388	-	(103,252)
1972	-	237	12,696	-	-	357	-	(117,506)
1973	-	286	18,842	-	-	340	-	(132,795)
1974	-	310	12,425	-	-	519	-	(138,149)
1975	-	215	16,520	-	-	761	-	(139,747)
1976	-	620	17,070	-	-	1,039	-	(139,334)
1977	-	561	20,022	-	-	1,132	-	(168,122)
1978	-	731	23,960	-	-	1,132	-	174,399
1979	-	1,207	27,338	-	-	1,704	-	205,316
1980	-	1,671	24,691	-	-	2,708	-	221,048
1981	-	1,753	19,990	-	-	18,186	-	233,277
1982	-	1,987	17,818	81	53	24,248	-	227,501
1983	-	3,633	17,069	48	51	56,122	-	265,991
1984	-	3,007	17,957	55	27	47,329	-	256,851
1985	570	3,216	15,981	44	-	25,806	-	264,881
1986	432	2,616	14,890	33	12	35,381	-	249,146
1987	3,381	6,350	22,077	32	90	65,676	-	307,323
1988	850	6,319	25,414	26	21	22,561	-	(267,078)
1989	1,535	5,885	23,672	27	7	44,614	-	(316,027)
1990	621	6,134	27,746	28	26	53,649	-	(348,205)
1991	1,114	5,055	26,536	19	6	38,918	-	(370,086)
1992	437	8,036	55,995	19	2	45,067	-	(389,760)
1993	3,215	9,355	71,690	35	0	47,685	7	(397,621)
1994	3,412	9,279	60,028	110	0	57,389	7	(370,293)

Table E2. Longline catch (t) of yellowfin tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1]	CHINA[2]	COOK ISLANDS[2]	FSM[3]	FIJI[4]	FRENCH POLYNESIA[2]	INDONESIA[5]	JAPAN[6]		KOREA[7]
								COASTAL	OFF/DW	
1970	-	-	-	-	-	-	-	4,220	40,970	1,500
1971	-	-	-	-	-	-	-	3,057	35,664	3,975
1972	-	-	-	-	-	-	-	3,794	38,301	8,850
1973	-	-	-	-	-	-	-	2,576	38,094	9,000
1974	-	-	-	-	-	-	-	2,477	37,214	11,328
1975	-	-	-	-	-	-	-	5,237	36,685	7,783
1976	-	-	-	-	-	-	-	7,132	40,420	13,957
1977	-	-	-	-	-	-	-	7,605	47,794	15,571
1978	-	-	-	-	-	-	1,216	7,873	66,576	13,185
1979	-	-	-	-	-	-	1,274	6,867	57,623	17,781
1980	-	-	-	-	-	-	1,478	5,840	69,063	21,577
1981	-	-	-	-	-	-	1,806	5,123	56,520	8,456
1982	-	-	-	-	-	-	3,605	5,117	47,864	8,410
1983	-	-	-	-	-	-	1,048	6,207	51,808	7,053
1984	-	-	-	-	-	-	1,670	5,968	39,654	6,046
1985	-	-	-	-	-	-	2,466	6,229	46,830	7,887
1986	8	-	-	-	-	-	2,437	6,199	32,161	5,648
1987	712	-	-	-	-	-	9,254	7,148	29,237	7,558
1988	1,046	-	-	-	-	-	9,717	7,528	37,827	9,769
1989	1,060	-	-	-	10	-	5,124	7,685	29,878	7,291
1990	518	-	-	-	23	-	5,508	7,800	32,408	8,674
1991	506	341	-	6	106	-	6,059	8,034	22,544	4,636
1992	726	1,124	-	78	202	137	6,242	8,452	25,363	9,881
1993	503	2,259	-	54	324	366	6,241	7,959	25,195	6,728
1994	751	4,169	7	110	625	275	4,600	(7,950)	(25,195)	7,528

Table E2. (continued)

YEAR	MARSHALL ISLANDS[2]	NEW CALEDONIA[8]	PHILIPPINES[9]	SOLOMON ISLANDS[2]	TAIWAN[10]		TONGA[2]	USA[11]	WESTERN SAMOA[2]	TOTAL
					DW	OFF				
1970	-	-	612	-	3,849	6,132	-	251	-	57,534
1971	-	-	685	-	8,700	5,080	-	191	-	57,352
1972	-	-	712	-	9,042	3,323	-	143	-	64,165
1973	-	-	851	91	8,028	10,373	-	88	-	69,101
1974	-	-	990	-	4,313	7,778	-	126	-	64,226
1975	-	-	1,010	-	2,555	13,539	-	84	-	66,893
1976	-	-	618	146	3,286	12,425	-	111	-	78,094
1977	-	-	972	198	3,123	16,471	-	176	-	91,910
1978	-	-	689	207	3,278	19,165	-	172	-	112,361
1979	-	-	907	493	2,966	22,629	-	233	-	110,774
1980	-	-	1,177	564	5,525	18,265	-	495	-	123,984
1981	-	-	1,619	146	1,578	17,778	-	614	-	93,641
1982	-	-	1,897	306	745	16,508	81	397	-	84,930
1983	-	7	2,824	443	492	16,260	48	556	-	86,746
1984	-	25	1,284	213	561	16,107	55	607	-	72,190
1985	-	119	1,819	151	595	13,554	44	466	-	80,160
1986	-	151	2,411	0	289	10,884	33	479	-	60,700
1987	-	449	3,775	0	371	14,061	32	272	-	72,869
1988	-	436	3,196	0	1,256	14,337	26	590	-	85,728
1989	-	248	3,481	0	651	11,933	27	998	-	68,386
1990	-	551	214	0	1,098	10,801	28	998	-	68,621
1991	-	506	255	0	665	8,689	19	726	-	53,092
1992	9	230	1,219	0	841	10,151	19	442	-	65,116
1993	38	387	(1,031)	0	681	8,450	35	757	7	(61,015)
1994	38	390	(1,031)	0	(6,000)	(8,136)	110	(748)	7	(67,670)

Table E3. Purse seine catch (t) of yellowfin tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1]	FSM[3]	INDONESIA[5]	JAPAN[6]		KOREA[7]	MEXICO[2]	NEW ZEALAND[2]
				COASTAL	OFF/DW			
1970	-	-	-	934	164	-	-	-
1971	-	-	-	447	2,867	-	-	-
1972	-	-	-	95	4,184	-	-	-
1973	-	-	-	0	7,281	-	-	-
1974	-	-	-	22	9,419	-	-	-
1975	-	-	-	65	5,595	-	-	-
1976	-	-	-	433	7,649	-	-	-
1977	-	-	-	47	6,807	-	-	-
1978	-	-	-	522	8,523	-	-	-
1979	-	-	-	684	19,013	-	-	-
1980	-	-	2,177	878	19,701	68	-	-
1981	-	-	2,275	45	27,161	582	-	-
1982	-	-	1,428	420	31,035	2,042	-	-
1983	-	-	2,013	5	30,819	799	-	239
1984	-	-	2,108	0	38,647	416	1,174	231
1985	-	-	2,107	119	47,925	1,624	-	170
1986	-	-	1,650	28	44,463	2,427	-	-
1987	-	-	1,683	130	44,504	17,383	-	-
1988	30	-	1,767	2	30,106	14,560	-	-
1989	15	-	2,520	5	40,872	34,532	-	-
1990	953	-	2,665	0	37,617	34,765	-	-
1991	1,353	2,867	2,500	0	46,255	55,416	-	-
1992	633	3,675	2,200	12	52,889	66,982	-	-
1993	405	5,552	4,599	3	57,866	52,659	-	-
1994	-	5,065	4,900	(3)	38,437	49,463	-	-

Table E3. (continued)

YEAR	PHILIPPINES[9]		RUSSIA[2]	SOLOMON ISLANDS[2]	TAIWAN[10]	USA[11]	TOTAL
	PURSE SEINE	RING NET					
1970	(4,920)	(1,772)	-	-	-	-	(7,790)
1971	(5,504)	(1,982)	-	-	-	-	(10,800)
1972	(5,719)	(2,060)	-	-	-	-	(12,058)
1973	(6,842)	(2,464)	-	-	-	-	(16,587)
1974	(7,954)	(2,865)	-	-	-	-	(20,260)
1975	(8,117)	(2,923)	-	-	-	-	(16,700)
1976	(4,969)	(1,790)	-	-	-	200	(15,041)
1977	(7,810)	(2,813)	-	-	-	200	(17,677)
1978	4,133	1,010	-	-	-	200	14,388
1979	8,760	3,541	-	-	-	559	32,557
1980	8,188	4,275	-	449	-	1,059	36,795
1981	14,343	3,839	-	1,342	-	16,299	65,886
1982	16,288	1,388	-	1,444	-	22,990	77,035
1983	17,418	3,361	-	2,530	-	54,668	111,852
1984	18,728	4,261	-	2,397	252	45,812	114,026
1985	15,381	6,210	570	2,882	1,007	24,191	102,187
1986	12,640	4,951	432	2,258	2,869	33,168	104,886
1987	15,171	2,916	3,381	3,385	4,579	63,628	156,760
1988	(14,368)	(4,064)	850	4,068	6,238	20,757	(96,810)
1989	(15,648)	(4,427)	1,535	4,410	10,604	42,703	(157,271)
1990	21,571	8,192	621	3,825	13,694	51,657	175,559
1991	23,981	2,977	1,114	3,275	16,358	37,194	193,290
1992	12,105	2,716	437	5,093	44,459	43,528	234,729
1993	(10,275)	(2,292)	3,215	5,663	62,241	45,801	(250,571)
1994	(10,275)	(2,292)	3,412	5,120	(45,840)	(55,329)	(220,136)

Table E4. Pole-and-line catch (t) of yellowfin tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[2]	FIJI[4]	FRENCH POLYNESIA[2]	INDONESIA[5]	JAPAN[6]		KIRIBATI[2]	NEW CALEDONIA[2]
					COASTAL	OFF/DW		
1970	-	-	-	-	116	-	-	-
1971	-	-	-	-	188	345	-	-
1972	-	-	-	-	258	294	-	-
1973	-	-	-	-	234	55	-	-
1974	-	12	-	-	253	-	-	-
1975	-	11	-	-	285	55	-	-
1976	1	84	-	507	213	-	-	-
1977	-	151	-	591	104	1,676	-	-
1978	16	409	-	1,160	149	769	-	-
1979	-	403	161	1,907	224	5,833	-	-
1980	-	233	253	2,269	111	6,188	-	-
1981	-	583	472	2,015	147	9,050	210	3
1982	5	753	368	1,887	301	9,490	170	41
1983	-	490	238	1,900	191	9,326	239	25
1984	5	580	426	2,282	347	8,690	528	0
1985	-	724	243	2,344	502	12,920	503	0
1986	-	823	232	2,278	326	8,410	721	0
1987	-	425	149	2,323	317	8,464	156	0
1988	-	464	274	2,439	502	7,304	383	0
1989	63	461	187	3,553	472	7,808	848	0
1990	22	478	55	4,433	211	5,867	143	0
1991	10	368	105	5,472	182	5,405	67	0
1992	1	395	133	5,319	209	6,829	303	0
1993	9	328	83	5,585	157	4,485	161	0
1994	33	640	126	5,830	(157)	-	17	0

Table E4. (continued)

YEAR	NEW ZEALAND[2]	PALAU[2]	PAPUA NEW GUINEA[2]	SOLOMON ISLANDS[2]	TUVALU[2]	USA[11]	TOTAL
1970	-	1	74	-	-	18	209
1971	-	10	112	141	-	22	818
1972	-	56	1,345	237	-	25	2,215
1973	-	41	916	195	-	14	1,455
1974	-	161	1,416	310	-	23	2,175
1975	-	298	1,744	215	-	25	2,633
1976	-	412	8,563	474	-	43	10,297
1977	-	420	4,009	363	-	21	7,335
1978	-	303	3,099	524	-	62	6,491
1979	-	1	2,881	714	-	49	12,173
1980	-	996	3,018	658	-	91	13,817
1981	-	2,480	4,205	265	-	89	19,519
1982	-	615	-	237	53	106	14,026
1983	-	0	-	660	51	55	13,175
1984	-	0	274	397	27	54	13,610
1985	-	15	930	183	-	103	18,467
1986	-	19	0	358	12	114	13,293
1987	-	22	0	2,965	90	78	14,989
1988	-	38	0	2,251	21	76	13,752
1989	-	5	0	1,475	7	10	14,889
1990	-	8	0	2,309	26	17	13,569
1991	2	-	0	1,780	6	20	13,417
1992	-	14	0	2,943	2	16	16,164
1993	-	14	0	3,692	0	4	14,518
1994	-	14	0	4,159	0	(9)	(10,985)

Table E5. Unclassified (UNCL) or handline, gillnet, troll and other gear catches (t) of yellowfin tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1] TROLL	FIJI[4] TROLL	INDONESIA[5] UNCL	INDONESIA[5] HANDLINE	JAPAN[6] UNCL	NEW ZEALAND[12] UNCL
1970	-	-	5,500	-	1,287	-
1971	-	-	5,700	-	415	-
1972	-	-	9,000	-	839	-
1973	-	-	10,200	-	430	-
1974	-	-	10,165	-	695	1
1975	-	-	11,062	-	638	1
1976	-	-	7,530	-	1,382	-
1977	-	-	10,268	-	563	-
1978	-	-	8,225	-	615	15
1979	-	-	11,482	-	1,420	16
1980	-	-	11,626	-	842	51
1981	-	-	15,793	-	733	26
1982	-	-	17,393	-	528	2
1983	-	3	15,239	-	497	1
1984	-	-	18,140	2,250	925	2
1985	-	3	20,130	2,540	653	1
1986	-	6	25,226	2,737	676	7
1987	-	13	24,732	2,793	963	7
1988	-	9	26,377	2,899	1,346	5
1989	-	26	31,345	2,726	1,399	9
1990	-	20	32,285	3,196	694	4
1991	-	13	34,959	3,835	1,293	4
1992	6	15	36,770	4,794	1,548	8
1993	16	104	38,608	5,034	1,706	(8)
1994	-	41	37,650	6,150	(1,706)	-

Table E5. (continued)

YEAR	PHILIPPINES[9] UNCL	PHILIPPINES[9] GILLNET	PHILIPPINES[9] HANDLINE	TAIWAN[10] UNCL	USA[11] UNCL	TOTAL[13]
1970	(197)	(2,664)	(21,835)	406	51	(31,940)
1971	(219)	(2,981)	(24,429)	363	175	(34,282)
1972	(228)	(3,097)	(25,384)	331	189	(39,068)
1973	(273)	(3,705)	(30,365)	441	238	(45,652)
1974	(316)	(4,307)	(35,300)	334	370	(51,488)
1975	(324)	(4,395)	(36,024)	426	652	(53,522)
1976	(199)	(2,691)	(22,056)	1,359	685	(35,902)
1977	(311)	(4,230)	(34,665)	428	735	(51,200)
1978	230	4,918	24,941	1,517	698	41,159
1979	281	2,027	31,980	1,743	863	49,812
1980	432	2,301	29,235	901	1,063	46,451
1981	953	2,655	32,254	634	1,184	54,232
1982	1,055	1,386	29,826	565	755	51,510
1983	3,661	1,260	32,396	317	843	54,217
1984	649	2,161	31,005	1,037	856	57,025
1985	1,325	2,040	35,505	825	1,046	64,068
1986	824	2,137	36,188	847	1,620	70,268
1987	866	2,160	26,407	3,066	1,698	(62,705)
1988	(873)	(2,220)	(32,339)	3,583	1,138	(70,789)
1989	(951)	(2,418)	(35,221)	484	903	(75,482)
1990	47,569	811	2,746	2,153	977	90,455
1991	45,488	21	22,872	824	978	110,287
1992	3,047	1,758	24,181	544	1,081	73,752
1993	(2,598)	(1,490)	(20,512)	318	1,123	(71,517)
1994	(2,598)	(1,490)	(20,512)	(52)	1,303	(71,502)

LIST OF FOOTNOTES FOR APPENDIX E TABLES

[1]P. Ward (BRR). Longline Data: Data raised for coverage of 50% (1987 88), 75% (1989), and 85% (1990) of logbooks. In 1983 86, several hundred tons/year may have been caught. Catches prior to 1983 are probably less than 100 tons/year. Includes Japanese joint-venture catches (100% logbook coverage) not reported by Japan. Original data were reported as dressed weights and raised to whole weights by multiplying by 1.15.

[2]From SPC Tuna Fishery Yearbook, 1993 and SCTB8 Working Paper 2. French Polynesian catches may include catches made outside the WPYRG area.

[3]From SPC Regional Tuna Bulletin (3rd quarter 1992) for 1991 and Micronesian Maritime Authority actual unloadings for 1992-94.

[4]From S. P. Sharma (FFD). Pole-and-line: Data cross-checked with logbooks and includes 15 t from purse seiners. Troll: From artisanal and commercial fisheries.

[5]From Fisheries Statistics of Indonesia and RIMF sampling program, N. Naamin (RIMF).

[6]From logbooks, N. Miyabe (NRIFSF). Coastal = coastal fleet. DW = distant-water fleet. OFF = offshore fleet.

[7]Data from J. U. Lee (NFRDA).

[8]From R. Etaix-Bonnin (STMMPM).

[9]From BFAR Fisheries Statistics, R. Ganaden (BFAR). Ring net, purse seine, gillnet, handline and unclassified catches for 1988 89 and 1970 77 were apportioned between gear using data for 1986 87 and 1978 79, respectively. Catches for 1990 and 1991 were apportioned between gears using data in the SPCTuna Fishery Yearbook, 1993 and SCTB8 Paper 2. Unclassified gear includes seine and bag nets.

[10]From C. L. Sun (NTU). Longline: From logbooks for the distant-water fleet (DW) and landings for the offshore fleet (OFF). Longline catches made in Micronesia were included in the offshore category and from SPC Fishery Yearbook, 1993 and SCTB8 Paper 2. Unclassified: Includes troll and pole-and-line gears.

[11]From landings, A. Coan (NMFS). Landings and number of vessels for 1992 and 1994, include joint ventures with Marshall Islands from SPC Tuna Fishery Yearbook, 1993, and SCTB8 Paper 2. Unclassified includes catches of handline, troll and pole-and-line gears.

[12]From FAO Yearbook, Fishery Statistics for 1970-84 and from logbooks for 1985-90, T. Murray (NIWAR). Includes chartered Japanese vessel catches not reported by Japan. Gears are primarily longline and troll. Recreational troll catches (<2 t to about 45 t per year) are not included.

[13]Catches of subsistence/small-scale fisheries for various Pacific Island nations are not included and, in aggregate, may be as high as 3,000 t per year.

APPENDIX F

BIGEYE TUNA CATCHES FOR THE CENTRAL-WESTERN PACIFIC OCEAN

APPENDIX F. BIGEYE TUNA CATCHES FOR THE CENTRAL-WESTERN PACIFIC OCEAN

Table F1. Total catch (t; all gears) of bigeye tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table F2. Longline catch (t) of bigeye tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates; asterisk indicates catch may be included in yellowfin tuna catch.

Table F3. Purse seine catch (t) of bigeye tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates; asterisk indicates catch may be included in yellowfin tuna catch.

Table F4. Pole-and-line catch (t) of bigeye tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates; asterisk indicates catch may be included in yellowfin tuna catch.

Table F5. Unclassified (UNCL) or handline, gillnet, troll and other gear catches (t) of bigeye tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates; asterisk indicates catch may be included in yellowfin tuna catch.

Table F1. Total catch (t; all gears) of bigeye tuna by country for the central-western Pacific Ocean, 1970-1994. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1]	CHINA[1]	COOK ISLANDS[1]	FSM[1]	FIJI[2]	FRENCH POLYNESIA[1]	INDONESIA[1]	JAPAN[3]	KIRIBATI[1]
1970	-	-	-	-	-	-	0	812	-
1971	-	-	-	-	-	-	0	30,631	-
1972	-	-	-	-	-	-	0	42,869	-
1973	-	-	-	-	-	-	0	30,419	-
1974	-	-	-	-	0	-	0	34,248	-
1975	-	-	-	-	0	-	0	33,739	-
1976	0	-	-	-	0	-	0	45,433	-
1977	-	-	-	-	0	-	0	46,785	-
1978	0	-	-	-	0	-	0	40,054	-
1979	-	-	-	-	0	0	0	43,024	-
1980	-	-	-	-	0	0	0	40,544	-
1981	-	-	-	-	0	0	0	35,962	0
1982	0	-	-	-	0	0	0	43,177	0
1983	-	-	-	-	0	0	0	39,156	0
1984	-	-	-	-	0	0	0	41,334	0
1985	-	-	-	-	0	0	0	44,808	0
1986	-	-	-	-	0	0	0	39,472	0
1987	16	-	-	-	0	0	0	47,939	0
1988	51	-	-	-	0	0	0	37,566	0
1989	21	-	-	-	14	0	0	45,046	0
1990	13	-	-	-	27	0	0	50,624	0
1991	15	380	-	1	123	0	0	37,598	0
1992	15	1,226	-	41	187	51	0	44,804	0
1993	16	3,131	-	225	204	163	0	36,655	0
1994	86	6,886	7	73	251	165	0	36,374	0

Table F1. (continued)

YEAR	KOREA[5]	MARSHALL ISLANDS[1]	MEXICO[1]	NEW CALEDONIA[1]	NEW ZEALAND[1]	PALAU[1]	PAPUA NEW GUINEA[1]	PHILIPPINES[1]
1970	(2,203)	-	-	-	-	0	0	0
1971	(8,841)	-	-	-	-	0	0	0
1972	(14,672)	-	-	-	-	0	0	0
1973	(16,741)	-	-	-	-	0	0	0
1974	(27,169)	-	-	-	0	0	0	0
1975	(13,543)	-	-	-	0	0	0	0
1976	(20,176)	-	-	-	-	0	0	0
1977	(15,978)	-	-	-	-	0	0	0
1978	(7,878)	-	-	-	0	0	0	0
1979	(12,448)	-	-	-	0	0	0	0
1980	11,524	-	-	-	0	0	0	0
1981	4,912	-	-	0	0	0	0	0
1982	6,099	-	-	0	0	0	-	0
1983	4,485	-	-	1	0	-	-	0
1984	6,005	-	0	9	0	-	0	0
1985	6,938	-	-	15	0	0	0	0
1986	3,842	-	-	17	0	0	-	0
1987	10,030	-	-	33	0	0	-	0
1988	8,326	-	-	18	0	0	-	0
1989	8,848	-	-	24	0	0	-	0
1990	10,696	-	-	54	0	0	-	0
1991	4,721	-	-	54	0	-	-	0
1992	10,961	5	-	110	0	0	-	0
1993	9,215	31	-	95	0	0	-	0
1994	12,300	32	-	70	0	0	-	0

Table F1. (continues on next page →)

Table F1. (continued from previous page)

YEAR	RUSSIA[1]	SOLOMON ISLANDS[1]	TAIWAN[6]	TONGA[1]	TUVALU[1]	USA[4]	WESTERN SAMOA[1]	TOTAL
1970	-	-	2,774	-	-	0	-	(5,789)
1971	-	0	3,453	-	-	0	-	(42,925)
1972	-	0	4,959	-	-	0	-	(62,500)
1973	-	16	5,754	-	-	0	-	(52,930)
1974	-	0	4,281	-	-	0	-	(65,698)
1975	-	0	5,216	-	-	0	-	(52,498)
1976	-	25	3,022	-	-	0	-	(68,656)
1977	-	34	2,697	-	-	0	-	(65,494)
1978	-	36	2,844	-	-	0	-	(50,812)
1979	-	86	3,295	-	-	32	-	(58,885)
1980	-	98	4,089	-	-	7	-	56,262
1981	-	25	2,390	-	-	10	-	43,299
1982	-	24	1,265	18	0	4	-	50,587
1983	-	34	1,146	17	0	37	-	44,876
1984	0	57	1,368	28	0	13	-	48,814
1985	0	46	2,066	15	-	5	-	53,893
1986	0	0	1,253	12	0	1	-	44,597
1987	0	15	1,284	14	0	819	-	60,150
1988	0	1	2,166	6	0	1,239	-	49,373
1989	0	92	1,234	12	0	3,871	-	59,162
1990	0	2	1,607	11	0	3,168	-	66,202
1991	0	0	2,550	5	0	3,293	-	48,740
1992	0	485	4,583	5	0	5,172	-	67,645
1993	0	86	4,403	61	0	5,802	2	60,089
1994	0	0	5,730	77	0	3,860	2	65,913

Table F2. Longline catch (t) of bigeye tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates; asterisk indicates catch may be included in yellowfin tuna catch.

YEAR	AUSTRALIA[1]	CHINA[1]	COOK ISLANDS[1]	FSM[1]	FIJI[2]	FRENCH POLYNESIA[1]	INDONESIA[1]	JAPAN[3]		KOREA[5]
								COASTAL	OFF/DW	
1970	-	-	-	-	-	-	-	565	-	(2,203)
1971	-	-	-	-	-	-	-	559	29,678	(8,841)
1972	-	-	-	-	-	-	-	732	39,476	(14,672)
1973	-	-	-	-	-	-	-	913	27,823	(16,741)
1974	-	-	-	-	-	-	-	1,091	31,369	(27,169)
1975	-	-	-	-	-	-	-	2,167	29,247	(13,543)
1976	-	-	-	-	-	-	-	2,833	37,949	(20,176)
1977	-	-	-	-	-	-	-	2,512	39,735	(15,978)
1978	-	-	-	-	-	-	-	2,883	31,367	(7,878)
1979	-	-	-	-	-	-	-	3,376	35,497	(12,448)
1980	-	-	-	-	-	-	-	2,658	34,285	11,524
1981	-	-	-	-	-	-	-	2,523	28,388	4,912
1982	-	-	-	-	-	-	*	2,904	32,710	6,099
1983	-	-	-	-	-	-	-	4,201	28,987	4,485
1984	-	-	-	-	-	-	*	5,168	31,506	6,005
1985	-	-	-	-	-	-	*	4,607	33,348	6,938
1986	-	-	-	-	-	-	*	4,475	29,820	3,842
1987	16	-	-	-	-	-	-	4,023	38,416	9,620
1988	51	-	-	-	-	-	-	5,012	29,326	8,326
1989	21	-	-	-	14	-	*	6,101	32,184	8,614
1990	13	-	-	-	27	-	*	7,053	37,116	10,578
1991	15	380	-	1	123	-	*	7,025	25,499	4,717
1992	15	1,226	-	41	187	51	*	7,302	30,852	10,946
1993	16	3,131	-	33	204	163	*	6,889	23,219	9,215
1994	86	6,886	7	73	251	165	*	(6,889)	(23,219)	12,300

Table F2. (continued)

YEAR	MARSHALL ISLANDS[1]	NEW CALEDONIA[1]	PHILIPPINES[1]	SOLOMON ISLANDS[1]	TAIWAN[6]		TONGA[1]	USA[4]	WESTERN SAMOA[1]	TOTAL
					DW	COASTAL				
1970	-	-	-	-	1,623	1,149	-	-	-	(5,540)
1971	-	-	-	-	2,118	1,335	-	-	-	(42,531)
1972	-	-	-	-	3,132	1,812	-	-	-	(59,824)
1973	-	-	-	16	3,789	1,891	-	-	-	(51,173)
1974	-	-	-	-	2,336	1,906	-	-	-	(63,871)
1975	-	-	-	-	1,428	3,787	-	-	-	(50,172)
1976	-	-	*	25	1,330	1,628	-	-	-	(63,941)
1977	-	-	-	34	1,460	1,169	-	-	-	(60,888)
1978	-	-	*	36	1,016	1,780	-	-	-	(44,960)
1979	-	-	-	86	1,183	2,099	-	-	-	(54,689)
1980	-	-	-	98	3,211	871	-	-	-	52,647
1981	-	-	*	25	1,239	1,150	-	-	-	38,237
1982	-	-	*	24	488	777	18	-	-	43,020
1983	-	1	-	34	265	876	17	-	-	38,866
1984	-	9	*	57	334	1,034	28	-	-	44,141
1985	-	15	*	46	234	1,737	15	-	-	46,940
1986	-	17	*	-	155	723	12	-	-	39,044
1987	-	33	*	-	365	803	14	816	-	54,106
1988	-	18	-	-	588	1,274	6	1,225	-	45,826
1989	-	24	-	-	777	374	12	1,406	-	49,527
1990	-	54	*	-	925	410	11	1,361	-	57,548
1991	-	54	*	-	726	1,129	5	1,588	-	41,262
1992	5	110	*	-	3,062	1,085	5	1,582	-	56,469
1993	31	95	*	-	2,235	1,175	61	1,935	2	48,404
1994	32	70	*	-	3,265	1,575	77	(1,864)	2	(56,761)

Table F3. Purse seine catch (t) of bigeye tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) *indicates missing or unavailable data; values in parentheses are estimates; asterisk indicates catch may be* included in yellowfin tuna catch.

YEAR	AUSTRALIA[1]	FSM[1]	INDONESIA[1]	JAPAN[3]		KOREA[5]	MEXICO[1]	NEW ZEALAND[1]
				COASTAL	DW/OFF			
1970	-	-	-	183	-	-	-	-
1971	-	-	-	194	129	-	-	-
1972	-	-	-	761	119	-	-	-
1973	-	-	-	193	182	-	-	-
1974	-	-	-	357	294	-	-	-
1975	-	-	-	543	265	-	-	-
1976	-	-	-	633	390	-	-	-
1977	-	-	-	772	302	-	-	-
1978	-	-	-	1,443	609	-	-	-
1979	-	-	-	892	706	-	-	-
1980	-	-	-	908	564	*	-	-
1981	-	-	-	1,581	925	*	-	-
1982	-	-	*	2,344	1,131	*	-	-
1983	-	-	-	511	1,468	*	-	*
1984	-	-	*	608	697	*	*	*
1985	-	-	*	1,154	1,379	*	-	*
1986	-	-	*	751	1,531	*	-	-
1987	-	-	*	829	1,602	410	-	-
1988	*	-	*	693	605	*	-	-
1989	*	-	*	938	1,527	234	-	-
1990	*	-	*	810	2,121	118	-	-
1991	*	*	*	1,832	1,528	4	-	-
1992	*	*	*	2,388	2,561	15	-	-
1993	*	192	*	2,745	1,885	*	-	-
1994	-	*	*	(2,745)	1,604	*	-	-

Table F3. (continued)

YEAR	PHILIPPINES[1]		RUSSIA[1]	SOLOMON ISLANDS[1]	TAIWAN[6]	USA[4]	TOTAL
	PURSE SEINE	RING NET					
1970	*	*	-	-	-	-	183
1971	*	*	-	-	-	-	323
1972	*	*	-	-	-	-	880
1973	*	*	-	-	-	-	375
1974	*	*	-	-	-	-	651
1975	*	*	-	-	-	-	808
1976	*	*	-	-	-	*	1,023
1977	*	*	-	-	-	*	1,074
1978	*	*	-	-	-	*	2,052
1979	*	*	-	-	-	20	1,618
1980	*	*	-	*	-	*	1,472
1981	*	*	-	*	-	*	2,506
1982	*	*	-	*	-	*	3,475
1983	*	*	-	*	-	*	1,979
1984	*	*	-	*	-	*	1,305
1985	*	*	*	*	25	*	2,558
1986	*	*	*	*	355	*	2,637
1987	*	*	*	15	64	*	2,920
1988	*	*	*	1	123	*	1,422
1989	*	*	*	92	82	2,456	5,329
1990	*	*	*	2	199	1,763	5,013
1991	*	*	*	*	695	1,641	5,700
1992	*	*	*	485	436	3,516	9,401
1993	*	*	*	86	896	3,823	9,627
1994	*	*	*	*	890	(1,840)	(7,079)

Table F4. Pole-and-line catch (t) of bigeye tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates; asterisk indicates catch may be included in yellowfin tuna catch.

YEAR	AUSTRALIA[1]	FIJI[2]	FRENCH POLYNESIA[1]	INDONESIA[1]	JAPAN[3]		KIRIBATI[1]	NEW CALEDONIA[1]
					COASTAL	DW/OFF		
1970	-	-	-	-	-	-	-	-
1971	-	-	-	-	47	-	-	-
1972	-	-	-	-	135	1,626	-	-
1973	-	-	-	-	109	1,141	-	-
1974	-	*	-	-	69	969	-	-
1975	-	*	-	-	53	1,264	-	-
1976	*	*	-	-	59	3,313	-	-
1977	-	*	-	-	35	3,231	-	-
1978	*	*	-	-	38	3,170	-	-
1979	-	*	*	-	88	2,118	-	-
1980	-	*	*	-	22	1,994	-	-
1981	-	*	*	-	56	2,337	*	*
1982	*	*	*	*	109	3,807	*	*
1983	-	*	*	-	93	3,762	*	*
1984	*	*	*	*	26	3,192	*	-
1985	-	*	*	*	111	3,981	*	-
1986	-	*	*	*	118	2,519	*	-
1987	-	*	*	*	86	2,810	*	-
1988	-	*	*	*	221	1,449	*	-
1989	*	*	*	*	373	3,544	*	-
1990	*	*	*	*	144	3,276	*	-
1991	*	*	*	*	130	1,230	*	-
1992	*	*	*	*	75	1,033	*	-
1993	*	*	*	*	31	1,749	*	-
1994	-	*	*	*	(31)	(1,749)	*	-

Table F4. (continued)

YEAR	NEW ZEALAND[1]	PALAU[1]	PAPUA NEW GUINEA[2]	SOLOMON ISLANDS[1]	TUVALU[1]	USA[4]	TOTAL
1970	-	*	*	-	-	*	-
1971	-	*	*	*	-	*	47
1972	-	*	*	*	-	*	1,761
1973	-	*	*	*	-	*	1,250
1974	-	*	*	*	-	*	1,038
1975	-	*	*	*	-	*	1,317
1976	-	*	*	*	-	*	3,372
1977	-	*	*	*	-	*	3,266
1978	-	*	*	*	-	*	3,208
1979	-	*	*	*	-	*	2,206
1980	-	*	*	*	-	*	2,016
1981	-	*	*	*	-	*	2,393
1982	-	*	-	*	*	*	3,916
1983	-	-	-	*	*	*	3,855
1984	-	-	*	*	*	*	3,218
1985	-	*	*	*	-	*	4,092
1986	-	*	-	*	*	*	2,637
1987	-	*	-	*	*	*	2,896
1988	-	*	-	*	*	*	1,670
1989	-	*	-	*	*	*	3,917
1990	-	*	-	*	*	*	3,420
1991	*	-	-	*	*	*	1,360
1992	-	*	-	*	*	*	1,108
1993	-	*	-	*	-	*	1,780
1994	-	*	-	*	-	*	(1,780)

Table F5. Unclassified (UNCL) or handline, gillnet, troll and other gear catches (t) of bigeye tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates; asterisk indicates catch may be included in yellowfin tuna catch.

YEAR	AUSTRALIA[1] TROLL	FIJI[2] TROLL	INDONESIA[1] UNCL	INDONESIA[1] HANDLINE	JAPAN[3] UNCL	NEW ZEALAND1 UNCL
1970	-	-	*	-	64	-
1971	-	-	*	-	24	-
1972	-	-	*	-	20	-
1973	-	-	*	-	58	-
1974	-	-	*	-	99	-
1975	-	-	*	-	200	-
1976	-	-	*	-	256	-
1977	-	-	*	-	198	-
1978	-	-	*	-	544	-
1979	-	-	*	-	347	-
1980	-	-	*	-	113	-
1981	-	-	*	-	152	-
1982	-	-	*	-	172	-
1983	-	*	*	-	134	-
1984	-	-	*	*	137	-
1985	-	*	*	*	228	-
1986	-	*	*	*	258	-
1987	-	*	*	*	173	-
1988	-	*	*	*	260	-
1989	-	*	*	*	379	-
1990	-	*	*	*	104	-
1991	-	*	*	*	354	-
1992	*	*	*	*	593	-
1993	*	*	*	*	137	-
1994	-	*	*	*	(137)	-

Table F5. (continued)

YEAR	PHILIPPINES[1] UNCL	PHILIPPINES[1] GILLNET	PHILIPPINES[1] HANDLINE	TAIWAN[6] UNCL	USA4 UNCL	TOTAL
1970	*	-	-	2	-	66
1971	*	-	-	0	-	24
1972	*	-	-	15	-	35
1973	*	-	-	74	-	132
1974	*	-	-	39	-	138
1975	*	-	-	1	-	201
1976	*	*	*	64	-	320
1977	*	-	*	68	-	266
1978	*	*	*	48	-	592
1979	*	*	*	13	12	372
1980	*	*	*	7	7	127
1981	*	*	*	1	10	163
1982	*	*	*	0	4	176
1983	*	*	*	5	37	176
1984	*	*	*	0	13	150
1985	*	*	*	70	5	303
1986	*	*	*	20	1	279
1987	*	*	*	52	3	228
1988	*	-	-	181	14	455
1989	*	-	-	1	9	389
1990	*	*	*	73	44	221
1991	*	*	*	0	64	418
1992	*	*	*	0	74	667
1993	*	*	*	97	44	278
1994	*	*	*	0	(156)	(293)

LIST OF FOOTNOTES FOR APPENDIX F TABLES

[1]Data from SCTB8 Paper 2. Statistics for French Polynesian fisheries may include catches outside the WPYRG area.

[2]Data from S. Sharma (FFD).

[3]Data from N. Miyabe (NRIFSF). Coastal = coastal fleet. DW = distant-water fleet. OFF = offshore fleet.

[4]Data from A. Coan (NMFS). Longline statistics for 1992-94 from SCTB8 Paper 2.

[5]1970-1979 longline data from SPC Tuna Fishery Yearbook, 1993, and FAO Yearbook, Fishery Statistics for areas 61 and 81. Data for recent years from J. U. Lee (NFRDA).

[6]Data from C. L. Sun (NTU). Coastal = coastal fleet. DW = distant-water fleet.

APPENDIX G

SKIPJACK TUNA CATCHES FOR THE CENTRAL-WESTERN PACIFIC OCEAN

APPENDIX G. SKIPJACK TUNA CATCHES FOR THE CENTRAL-WESTERN PACIFIC OCEAN

Table G1. Total catch (t; all gears) of skipjack tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table G2. Longline catch (t) of skipjack tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table G3. Purse seine catch (t) of skipjack tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table G4. Pole-and-line catch (t) of skipjack tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table G5. Unclassified (UNCL) or handline, gillnet, troll and other gear catch (t) of skipjack tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

Table G1. Total catch (t; all gears) of skipjack tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1]	CHINA[1]	FSM[1]	FIJI[2]	FRENCH POLYNESIA[3]	INDONESIA[4]	JAPAN[5]	KIRIBATI[1]
1970	0	-	-	-	-	12,100	15,232	-
1971	0	-	-	-	-	12,400	15,935	-
1972	0	-	-	-	-	19,600	161,731	-
1973	0	-	-	-	-	22,300	228,393	-
1974	1,900	-	-	0	-	23,613	235,370	-
1975	0	-	-	0	-	23,316	192,814	-
1976	46	-	-	658	-	25,338	248,114	-
1977	31	-	-	1,560	-	26,376	271,285	-
1978	146	-	-	2,115	-	29,422	274,515	-
1979	0	-	-	3,091	535	36,310	245,727	-
1980	0	-	-	2,263	683	44,245	279,379	-
1981	447	-	-	5,252	529	46,919	255,641	354
1982	297	-	-	3,675	666	49,743	282,103	287
1983	219	-	-	3,248	598	64,332	351,560	1,355
1984	78	-	-	3,992	824	70,211	399,761	1,503
1985	0	-	-	3,219	593	72,318	294,946	216
1986	150	-	-	2,296	729	75,964	382,343	693
1987	153	-	-	3,451	729	81,270	304,734	278
1988	1,023	-	-	3,419	441	84,773	327,165	1,089
1989	1,405	-	-	4,675	567	97,508	318,309	1,434
1990	6,363	-	-	3,214	685	94,148	274,122	452
1991	9,066	0	8,448	4,480	614	116,721	313,788	157
1992	7,437	0	11,657	3,748	593	123,607	268,993	248
1993	6,016	0	11,227	2,779	385	123,607	296,386	132
1994	1,705	0	15,914	2,676	892	113,112	314,561	108

Table G1. (continued)

YEAR	KOREA[6]	MARSHALL ISLANDS[1]	MEXICO[1]	NEW CALEDONIA[1]	NEW ZEALAND[1]	PALAU[1]	PAPUA NEW GUINEA[1]	PHILIPPINES[7]
1970	0	-	-	-	-	8,081	2,354	20,000
1971	200	-	-	-	-	2,133	16,862	21,400
1972	500	-	-	-	-	1,463	11,785	23,500
1973	1,700	-	-	-	-	2,309	27,300	26,400
1974	669	-	-	-	0	6,647	40,214	29,456
1975	3,861	-	-	-	0	5,971	15,625	31,657
1976	731	-	-	-	-	4,911	24,358	29,174
1977	66	-	-	-	-	3,592	20,106	55,090
1978	91	-	-	-	0	9,391	45,760	49,718
1979	100	-	-	-	0	5,687	23,976	45,084
1980	476	-	-	-	0	5,580	30,976	31,178
1981	1,462	-	-	226	0	6,931	27,207	38,439
1982	10,167	-	-	827	0	3,438	-	51,561
1983	15,417	-	-	414	5,581	0	-	57,151
1984	13,767	-	2,017	0	3,999	0	2,470	45,446
1985	9,655	-	-	0	2,289	82	8,370	69,684
1986	25,305	-	-	0	4,875	112	0	83,957
1987	40,918	-	-	0	4,178	139	0	85,784
1988	64,032	-	-	0	2,907	119	0	(64,296)
1989	80,903	-	-	0	1,778	72	0	(81,322)
1990	138,460	-	-	0	4,879	80	0	(116,171)
1991	171,951	-	-	0	6,834	-	0	(119,923)
1992	115,290	0	-	0	6,720	61	0	(105,378)
1993	73,989	0	-	0	6,720	61	0	(107,430)
1994	145,541	0	-	0	6,720	61	0	(106,695)

Table G1. (continues on next page →)

Table G1. (continued from previous page)

YEAR	RUSSIA[1]	SOLOMON ISLANDS[1]	TAIWAN[8]	TONGA[1]	TUVALU[1]	USA[9]	TOTAL
1970	-	-	698	-	-	0	58,465
1971	-	4,570	1,272	-	-	0	74,772
1972	-	7,668	1,454	-	-	0	227,701
1973	-	6,318	2,958	-	-	0	317,678
1974	-	10,022	2,302	-	-	0	350,193
1975	-	6,954	2,822	-	-	0	283,020
1976	-	15,326	2,502	-	-	500	351,658
1977	-	11,752	3,671	-	-	700	394,229
1978	-	16,931	6,169	-	-	800	435,058
1979	-	23,087	4,250	-	-	10,939	398,786
1980	-	21,775	4,428	-	-	11,805	432,788
1981	-	23,393	3,740	-	-	23,415	433,955
1982	-	18,163	4,183	0	163	51,203	476,476
1983	-	30,792	13,936	0	286	126,014	670,903
1984	-	33,034	3,631	0	513	115,620	696,866
1985	1,604	27,416	3,597	0	4	84,834	578,827
1986	3,743	41,554	9,488	0	378	89,159	720,746
1987	5,614	22,968	17,103	0	542	79,346	647,207
1988	5,339	33,946	27,247	0	1,069	95,615	(712,480)
1989	3,400	30,235	40,900	0	142	96,317	(758,967)
1990	1,505	23,583	73,814	0	64	109,704	(847,244)
1991	2,601	42,292	59,183	0	23	178,365	(1,034,446)
1992	1,689	24,219	79,024	0	6	156,359	(905,029)
1993	5,499	20,080	113,770	0	0	148,830	(916,911)
1994	3,310	26,661	136,607	0	0	149,898	(1,024,461)

Table G2. Longline catch (t) of skipjack tuna by country for the central-western Pacific Ocean, 1970-1994. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1]	CHINA[1]	FSM[1]	FIJI[2]	FRENCH POLYNESIA[3]	INDONESIA[4]	JAPAN[5]		KOREA[6]
							COASTAL	OFF/DW	
1970	-	-	-	-	-	-	32	124	-
1971	-	-	-	-	-	-	18	114	-
1972	-	-	-	-	-	-	25	92	-
1973	-	-	-	-	-	-	39	140	-
1974	-	-	-	-	-	-	25	38	-
1975	-	-	-	-	-	-	13	84	-
1976	-	-	-	-	-	-	64	35	-
1977	-	-	-	-	-	-	60	42	-
1978	-	-	-	-	-	-	36	28	-
1979	-	-	-	-	-	-	16	39	-
1980	-	-	-	-	-	-	17	29	-
1981	-	-	-	-	-	-	15	28	-
1982	-	-	-	-	-	43	4	36	-
1983	-	-	-	-	-	56	1,134	49	-
1984	-	-	-	-	-	-	13	36	-
1985	-	-	-	-	-	-	54	83	-
1986	-	-	-	-	-	-	36	13	-
1987	-	-	-	-	-	-	30	17	-
1988	-	-	-	-	-	-	46	17	-
1989	-	-	-	-	-	-	42	18	-
1990	-	-	-	-	-	-	57	33	-
1991	-	-	-	-	-	-	82	33	-
1992	-	-	-	-	-	-	79	63	-
1993	-	-	-	-	-	-	157	(63)	-
1994	-	-	-	1	-	-	(157)	-	-

Table G2. (continued)

YEAR	MARSHALL ISLANDS[1]	NEW CALEDONIA[1]	PHILIPPINES[7]	SOLOMON ISLANDS[1]	TAIWAN[8]		TONGA[1]	USA[9]	TOTAL
					DW	OFF			
1970	-	-	-	-	-	0	-	-	156
1971	-	-	-	-	-	1	-	-	133
1972	-	-	-	-	-	18	-	-	135
1973	-	-	-	-	-	61	-	-	240
1974	-	-	-	-	-	261	-	-	324
1975	-	-	-	-	-	66	-	-	163
1976	-	-	-	-	-	115	-	-	214
1977	-	-	-	-	-	118	-	-	220
1978	-	-	2,665	-	145	280	-	-	3,154
1979	-	-	-	-	158	3	-	-	216
1980	-	-	-	-	84	154	-	-	284
1981	-	-	440	-	103	219	-	-	805
1982	-	-	530	-	100	353	-	-	1,066
1983	-	-	-	-	72	383	-	-	1,694
1984	-	-	652	-	18	235	-	-	954
1985	-	-	735	-	4	214	-	-	1,090
1986	-	-	590	-	1	680	-	-	1,320
1987	-	-	2,019	-	2	207	-	-	2,275
1988	-	-	(1,531)	-	20	225	-	-	(1,839)
1989	-	-	(74)	-	5	603	-	-	(742)
1990	-	-	114	-	0	202	-	-	406
1991	-	-	612	-	9	640	-	-	1,376
1992	-	-	717	-	101	68	-	-	1,028
1993	-	-	(735)	-	1,041	41	-	-	(2,037)
1994	-	-	-	-	222	48	-	-	(428)

Table G3. Purse seine catch (t) of skipjack tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1]	FSM[1]	INDONESIA[4]	JAPAN[5]		KOREA[6]	MEXICO[1]	NEW ZEALAND[1]
				COASTAL	DW/OFF			
1970	-	-	-	1,768	365	-	-	-
1971	-	-	-	471	7,948	(200)	-	-
1972	-	-	-	475	12,145	(500)	-	-
1973	-	-	-	479	12,356	(1,700)	-	-
1974	1,900	-	-	298	4,841	(669)	-	-
1975	-	-	-	238	6,749	(3,861)	-	-
1976	-	-	-	516	17,719	(731)	-	-
1977	-	-	-	288	18,255	(66)	-	-
1978	-	-	-	850	25,821	(91)	-	-
1979	-	-	-	195	28,298	(100)	-	-
1980	-	-	-	670	41,138	476	-	-
1981	339	-	-	883	43,912	1,462	-	-
1982	101	-	6,199	359	75,016	10,167	-	-
1983	110	-	(8,017)	205	115,731	15,417	-	5,581
1984	-	-	9,152	129	128,528	13,767	2,017	3,999
1985	-	-	10,187	139	119,155	9,655	-	2,289
1986	73	-	14,434	367	130,805	25,305	-	4,875
1987	94	-	18,509	110	112,924	40,918	-	4,178
1988	533	-	18,873	38	174,346	64,032	-	2,907
1989	1,006	-	17,872	37	120,495	80,903	-	1,778
1990	5,186	-	7,994	43	138,299	138,460	-	4,879
1991	8,024	8,448	(9,911)	175	142,404	171,951	-	6,720
1992	6,637	11,657	(10,495)	110	136,690	115,290	-	6,720
1993	5,578	11,227	(10,495)	84	132,522	73,989	-	6,720
1994	1,281	15,914	(10,495)	(84)	150,760	145,541	-	6,720

Table G3. (continued)

YEAR	PHILIPPINES[7]		RUSSIA[1]	SOLOMON ISLANDS[1]	TAIWAN[8]	USA[9]	TOTAL
	PURSE SEINE	RING NET					
1970	-	-	-	-	376	-	2,509
1971	-	-	-	-	805	-	(9,424)
1972	-	-	-	-	854	-	(13,974)
1973	-	-	-	-	2,361	-	(16,896)
1974	-	-	-	-	1,599	-	(9,307)
1975	-	-	-	-	2,223	-	(13,071)
1976	4,518	4,972	-	-	1,866	500	(30,822)
1977	16,956	5,164	-	-	2,608	700	(44,037)
1978	6,987	7,585	-	-	4,322	800	(46,456)
1979	27,050	-	-	-	3,149	8,000	(66,792)
1980	15,004	-	-	497	3,234	9,900	70,919
1981	14,048	4,683	-	1,486	2,306	21,482	90,601
1982	27,373	4,081	-	1,598	3,293	49,705	177,892
1983	39,971	-	-	2,800	12,550	124,697	(325,079)
1984	30,751	-	-	3,050	2,843	113,755	307,991
1985	37,625	14,303	1,604	2,824	2,603	83,763	284,147
1986	45,971	18,343	3,743	3,267	8,051	87,983	343,217
1987	51,160	11,873	5,614	3,580	15,928	77,575	342,463
1988	(38,033)	(9,006)	5,339	6,467	26,450	93,483	(439,507)
1989	(48,802)	(11,386)	3,400	5,951	39,431	94,639	(425,700)
1990	66,021	17,558	1,505	4,417	72,875	108,956	566,193
1991	75,367	13,614	2,601	7,052	57,574	177,021	(680,862)
1992	65,806	18,721	1,689	5,993	77,680	155,313	(612,801)
1993	(66,882)	(19,183)	5,499	4,655	111,604	147,861	(596,299)
1994	(66,882)	(19,183)	3,310	7,648	135,438	149,042	(712,298)

Table G4. Pole-and-line catch (t) of skipjack tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1]	FIJI[2]	FRENCH POLYNESIA[3]	INDONESIA[4]	JAPAN[5]		KIRIBATI[1]	NEW CALEDONIA[1]
					COASTAL	DW/OFF		
1970	-	-	-	-	6,247	-	-	-
1971	-	-	-	-	5,041	-	-	-
1972	-	-	-	-	10,935	131,678	-	-
1973	-	-	-	-	7,902	197,151	-	-
1974	-	-	-	-	12,864	210,915	-	-
1975	-	-	-	-	8,506	171,564	-	-
1976	46	658	-	-	10,070	212,607	-	-
1977	31	1,560	-	-	12,099	233,302	-	-
1978	146	2,115	-	-	17,673	219,781	-	-
1979	-	3,091	535	-	11,896	197,044	-	-
1980	-	2,263	683	-	13,538	215,464	-	-
1981	108	5,252	529	-	10,556	192,625	354	226
1982	196	3,675	666	22,121	12,841	182,219	287	827
1983	109	3,248	598	(28,609)	12,801	209,300	1,355	414
1984	78	3,992	824	42,910	11,835	245,242	1,503	-
1985	-	3,219	593	43,999	9,520	158,513	216	-
1986	77	2,288	729	48,305	13,090	222,149	693	-
1987	59	3,437	729	49,271	8,425	170,755	278	-
1988	490	3,406	441	51,735	11,505	122,813	1,089	-
1989	399	4,660	567	64,763	8,928	174,467	1,434	-
1990	1,177	3,196	685	70,537	7,357	110,095	452	-
1991	1,042	4,458	614	(87,449)	6,448	144,846	157	-
1992	800	3,705	593	(92,608)	7,554	109,447	248	-
1993	438	2,709	385	(92,608)	9,818	142,812	132	-
1994	424	2,647	892	(92,608)	(9,818)	(142,812)	108	-

Table G4. (continued)

YEAR	NEW ZEALAND[1]	PALAU[1]	PAPUA NEW GUINEA[1]	SOLOMON ISLANDS[1]	TUVALU[1]	USA[9]	TOTAL
1970	-	8,081	2,354	-	-	-	16,682
1971	-	2,133	16,862	4,570	-	-	28,606
1972	-	1,463	11,785	7,668	-	-	163,529
1973	-	2,309	27,300	6,318	-	-	240,980
1974	-	6,647	40,214	10,022	-	-	280,662
1975	-	5,971	15,625	6,954	-	-	208,620
1976	-	4,911	24,358	15,326	-	-	267,976
1977	-	3,592	20,106	11,752	-	-	282,442
1978	-	9,391	45,760	16,931	-	-	311,797
1979	-	5,687	23,976	23,087	-	2,901	268,217
1980	-	5,580	30,976	21,278	-	1,796	291,578
1981	-	6,931	27,207	21,907	-	1,819	267,514
1982	-	3,438	-	16,565	163	1,400	244,398
1983	-	-	-	27,992	286	1,135	(285,847)
1984	-	-	2,470	29,984	513	1,536	340,887
1985	-	82	8,370	24,592	4	851	249,959
1986	-	112	-	38,287	378	942	327,050
1987	-	139	-	19,388	542	1,510	254,533
1988	-	119	-	27,479	1,069	1,723	221,869
1989	-	72	-	24,284	142	1,332	281,048
1990	-	80	-	19,166	64	487	213,296
1991	114	-	-	35,240	23	992	(281,383)
1992	-	61	-	18,226	6	763	(234,011)
1993	-	61	-	15,425	-	713	(265,101)
1994	-	61	-	19,013	-	(514)	(268,897)

Table G5. Unclassified (UNCL) or handline, gillnet, troll and other gear catch (t) of skipjack tuna by country for the central-western Pacific Ocean, 1970-94. Dash (-) indicates missing or unavailable data; values in parentheses are estimates.

YEAR	AUSTRALIA[1] TROLL	FIJI[2] TROLL	INDONESIA[4]		JAPAN[5] UNCL	NEW ZEALAND[1] UNCL
			UNCL	HANDLINE		
1970	-	-	12,100	-	6,696	-
1971	-	-	12,400	-	2,343	-
1972	-	-	19,600	-	6,381	-
1973	-	-	22,300	-	10,326	-
1974	-	-	23,613	-	6,389	-
1975	-	-	23,316	-	5,660	-
1976	-	-	25,338	-	7,103	-
1977	-	-	26,376	-	7,239	-
1978	-	-	29,422	-	10,326	-
1979	-	-	36,310	-	8,239	-
1980	-	-	44,245	-	8,523	-
1981	-	-	46,919	-	7,622	-
1982	-	-	21,380	-	11,628	-
1983	-	-	(27,650)	-	12,340	-
1984	-	-	18,149	-	13,978	-
1985	-	0	18,132	-	7,482	-
1986	-	8	13,225	-	15,883	-
1987	-	14	13,490	-	12,473	-
1988	-	13	14,165	-	18,400	-
1989	-	15	14,873	-	14,322	-
1990	-	18	15,617	-	18,238	-
1991	-	22	(19,361)	-	19,800	-
1992	-	43	(20,504)	-	15,050	-
1993	-	70	(20,504)	-	10,930	-
1994	-	28	(20,504)	-	(10,930)	-

Table G5. (continued)

YEAR	PHILIPPINES[7]			TAIWAN[8] UNCL	USA[9] UNCL	TOTAL
	UNCL	GILLNET	HANDLINE			
1970	20,000	-	-	322	-	39,118
1971	21,400	-	-	466	-	36,609
1972	23,500	-	-	582	-	50,063
1973	26,400	-	-	536	-	59,562
1974	29,456	-	-	442	-	59,900
1975	31,657	-	-	533	-	61,166
1976	19,674	10	-	521	-	52,646
1977	32,684	-	286	945	-	67,530
1978	5,017	14,286	13,178	1,422	-	73,651
1979	1,530	4,435	12,069	940	38	63,561
1980	633	4,908	10,633	956	109	70,007
1981	1,867	2,995	14,406	1,112	114	75,035
1982	9,405	2,437	7,735	437	98	53,120
1983	5,384	1,980	9,816	931	182	(58,283)
1984	1,341	1,221	11,481	535	329	47,034
1985	4,529	2,183	10,309	776	220	43,631
1986	2,519	2,851	13,683	756	234	49,159
1987	3,449	2,656	14,627	966	261	47,936
1988	(2,616)	(2,015)	(11,095)	552	409	(49,265)
1989	(20,169)	(113)	(778)	861	346	(51,477)
1990	31,104	174	1,200	737	261	67,349
1991	30,137	1	192	960	352	(70,825)
1992	6,621	6,249	7,264	1,175	283	(57,189)
1993	(6,784)	(6,403)	(7,443)	1,084	256	(53,474)
1994	(6,784)	(6,403)	(7,443)	899	(342)	(53,333)

LIST OF FOOTNOTES FOR APPENDIX G TABLES

[1]Data from SCTB8 Paper 2.

[2]Data from S. Sharma (FFD).

[3]Data from SCTB8 Paper 2. Catches from outside the WPYRG area may be included.

[4]Data from SCTB8 Paper 2. Domestic catches in 1983 and 1991-94 were not reported by gear and were apportioned as follows. **Purse seine:** 1991-93 purse seine catch by gear estimated using catch ratios by gear for 1990. 1983 catch estimated using ratios in 1982. Catches in 1986-89 are the sum of catches in SPC waters and adjusted catches from domestic fisheries in Indonesian waters. **Pole-and-line**: 1991-93 pole-and-line catch estimated using catch ratios by gear for 1990. 1983 catch estimated using ratios in 1982. **Longline:** 1983 longline catch estimated using catch ratios by gear in 1982. **Unclassified:** 1991-93 unclassified catch estimated using catch ratios by gear for 1990. 1983 catch by gear estimated using ratios in 1982.

[5]Data from N. Miyabe (NRIFSF). Coastal = coastal fleet. DW = distant-water fleet. OFF = offshore fleet.

[6]1971-1979 purse seine data from SPC Tuna Fishery Yearbook, 1993, and FAO Yearbook, Fishery Statistics for areas 61 and 81. Recent years data from J. U. Lee (NFRDA).

[7]Data from SCTB8 Paper 2. Domestic catches in 1994, 1988 and 1989 were not reported by gear and were apportioned as follows. 1994 catch by gear estimated using catch ratios by gear for 1992. 1988 catch by gear estimated using ratios in 1987. 1989 catch by gear estimated using ratios in 1990. Purse seine catches for 1982-94 are the sum of Philippines purse seine catches in SPC waters and catches from domestic fisheries(adjusted catches for 1994, 1899 and 1989) in Philippine waters.

[8]1970-1983 purse seine data from SPC Tuna Fishery Yearbook, 1993, and FAO Yearbook Fishery Statistics for areas 61 and 81. Recent years data from C. L. Sun (NTU). DW = distant-water fleet. OFF = offshore fleet.

[9]Data from A. Coan (NMFS).