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

Koror
Republic of Palau
August 9-11, 1994

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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 the fisheries exploiting this species in the central and western Pacific Ocean. The Group was organized in 1990 as the result of 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. 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)

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
FFA	Forum Fisheries Agency

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
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
UH	University of Hawaii, United States
WPFCC	Western Pacific Fisheries Consultative Committee
WPRFMC	Western Pacific Regional Fisheries Management Council, United States

Gary T. Sakagawa, Chairman, WPYRG
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1.0 INTRODUCTION

The fourth meeting of the Western Pacific Yellowfin Tuna Research Group (WPYRG) was held in Koror, Palau, under the chairmanship of Gary Sakagawa. This was the final meeting in a series designed to assemble scientific information for answering three resource-related questions frequently asked by fisheries administrators: What is the safe level of yield and exploitation for the stock? What is the interaction among the different fisheries? and What factors contribute to local depletion?

To address these questions, the Group defined a study area bounded on the north by 40° N, on the west by Australia and 120° E, on the east by 150° W, and on the south by 40° S (Figure 1). Within this area, it is hypothesized from tag-recapture and other data that a single, fisheries management stock of yellowfin tuna, *Thunnus albacares*, is available

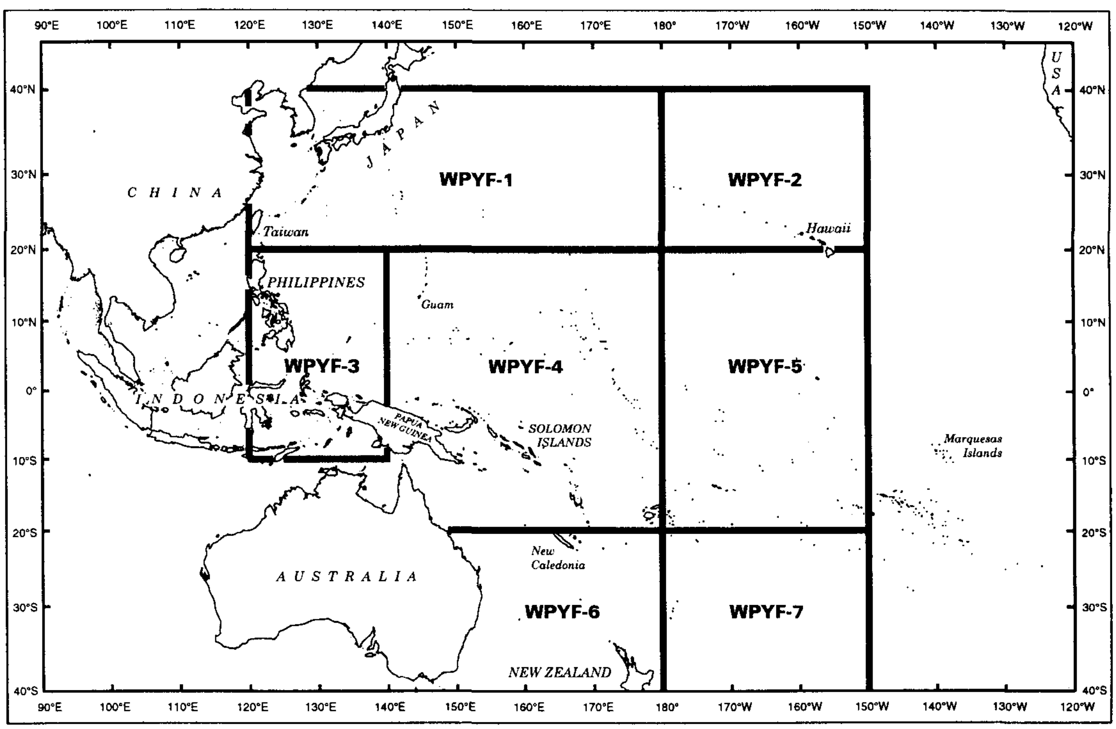

Figure 1. Western Pacific Yellowfin Tuna Research Group study area and statistical areas (WPYF = Western Pacific Yellowfin Tuna).

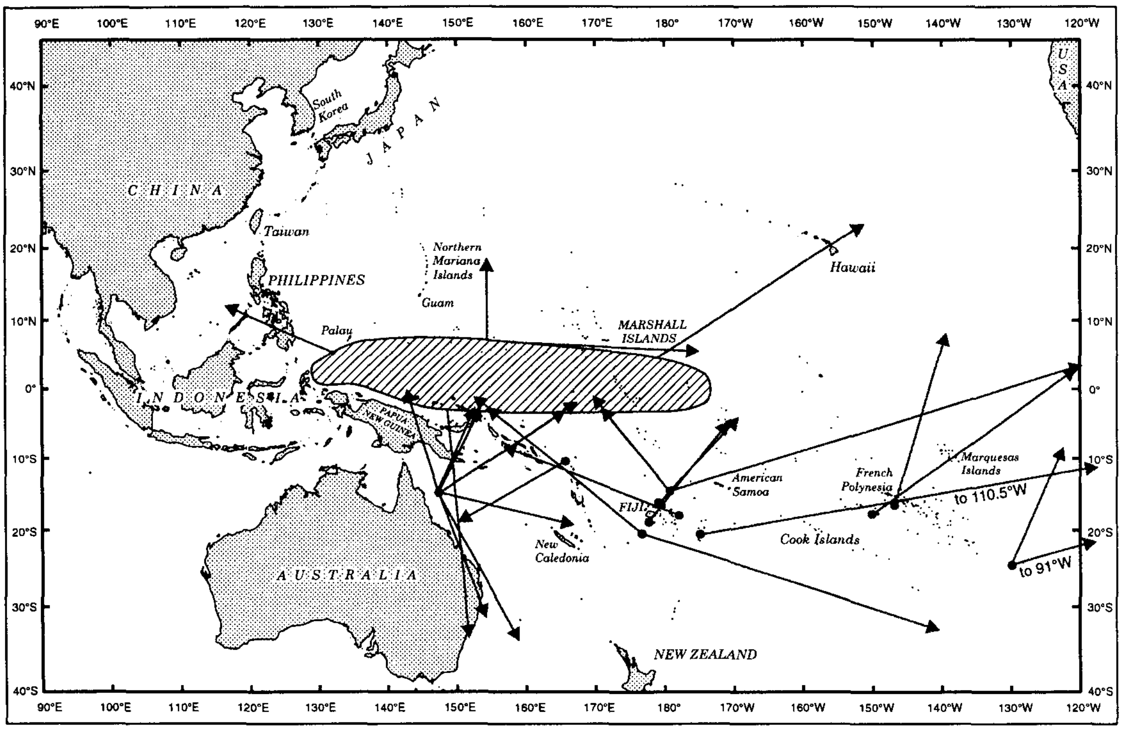

Figure 2. General movement of yellowfin tuna from South Pacific Commission tagging studies in the western Pacific Ocean. The area of greatest number of tag releases and recaptures is hatched. Recaptures greater than 1,000 nm and outside the hatched area are shown with arrows from the release point.

(Figure 2). However, this does not preclude the possibility that the management unit or "stock" might consist of overlapping clusters, or subgroups of yellowfin tuna with adjacent subgroups mixing freely and distant units mixing less freely or not at all.

The chairman welcomed the participants (Appendix A) and noted the expanding number of participating organizations (see Preface for list). These organizations have devoted both resources and staff to execute crucial tasks recommended by the Group. Their contribution is much appreciated and is a vote of support for the Group's objectives and its unique organizational structure. Without such support, the Group would not have achieved the high level of progress and accomplishment it has enjoyed to date.

The Group was reminded that this fourth meeting was specifically organized to address the three resource-related questions. Data, information and, latest research findings pertinent to the questions should be reviewed and weighed carefully; and answers to the questions should be comprehensive and presented in clear terms so that they are understandable to the public and to administrators for use in decision making.

The Group was also reminded that, since this meeting was the last in the series, the Group should consider the future of the WPYRG, i.e., whether the Group and process should continue and if so, for what objectives?

2.0 AGENDA AND RAPPORTEURS

A draft agenda was circulated earlier to participants, and comments were received by correspondence and incorporated. The latest draft was circulated and reviewed by the Group. Additional adjustments were made, and the agenda (Appendix B) was adopted. Discussion leaders and rapporteurs for major sections were appointed by the chairman as follows:

Review of Fisheries
Discussion Leader: Subodh Sharma
Rapporteur: Pierre Kleiber

Review of research assignments
Discussion Leader: Gary Sakagawa
Rapporteur: Pierre Kleiber

Review of Fisheries Statistics
Discussion Leader: Gary Sakagawa
Rapporteur: Atilio Coan

Review of stock status
Discussion Leader: Bernard Thoulag
Rapporteur: Antony Lewis

Review of Fishery Interaction
Discussion Leader: Reuben Ganaden
Rapporteur: Kevin McLoughlin

Review of New Developments
Discussion Leader: Chi-Lu Sun
Rapporteur: Pierre Kleiber

Future Research
Discussion Leader: Gary Sakagawa
Rapporteur: David Itano

Responsibility for coordinating the rapporteurs' reports was assigned to Pierre Kleiber. Working papers for the meeting are listed in Appendix C. References to working papers in this report are made by document number preceded by "WPYRG4/." Full names of organization initials used in this report are found in the Preface.

3.0 REVIEW OF FISHERIES

The WPYRG conducts an annual review of fisheries catching yellowfin tuna in the central-western Pacific in order to evaluate trends and to keep abreast of developments. This year, the review was conducted through correspondence and at the WPYRG meeting in Koror. Experts involved in monitoring or familiar with the monitoring of the major distant-water tuna fishing fleets (Japan, Korea, Taiwan, and U.S.) and coastal tuna fishing fleets (e.g., Federated States of Micronesia (FSM), Indonesia, Philippines, and the Solomon Islands) participated in the review. Reports on individual fisheries were presented, and available fisheries statistics were evaluated and summarized (Appendix D). For fisheries lacking current years' statistics, the most recent values were extrapolated forward, i.e., values were assumed constant.

The results of the review indicate that total catch of yellowfin tuna from the central-western Pacific in 1993 increased by about 2% from the previous year. Between 1970 and 1992, total catch grew at an average rate of 14% per year to 391,000 metric tons (t) in 1992. In 1993, it grew slightly to 397,000 t (Figure 3). This drop in growth rate was largely due to reduced fishing effort by purse seiners. Factors such as the implementation of the FFA policy of limiting the total number of vessels to 205 purse seiners and prohibiting at-sea transshipments, protracted negotiations for renewal of access agreements for some fleets, loss of several vessels through sinking, and low prices for raw tuna destined for canning are believed to have contributed to the reduced fishing effort.

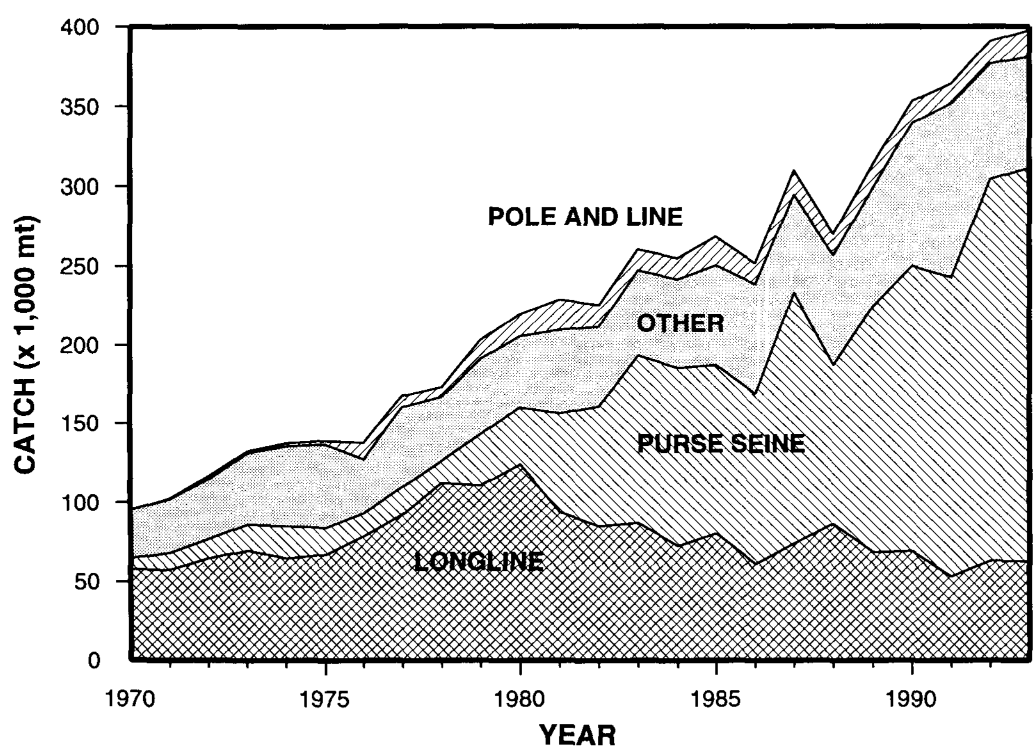

Figure 3. Total catch by gear of yellowfin tuna from the central-western Pacific Ocean (WPYRG study area), 1970–93.

Purse seiners from distant-water nations (Japan, Korea, Taiwan, and U.S.) are principally responsible for the large production of yellowfin tuna from the central-western Pacific. In 1993, these fleets produced 54% of the total catch and 87% of the purse seine catch. Each landed between 44,000 t and 56,000 t of yellowfin tuna in 1993. Their overall tuna catch, however, was much larger because skipjack tuna, *Katsuwonus pelamis*, is the dominant species taken (Figure 4). For example, for the U.S. fleet in 1993, about 26% of the catch was yellowfin tuna and 74% skipjack tuna (Figure 5). This dominance of skipjack tuna is largely because yellowfin tuna, bigeye tuna (*T. obesus*), and skipjack tuna are often mixed in log-associated catches. Log-associated schools have long been the

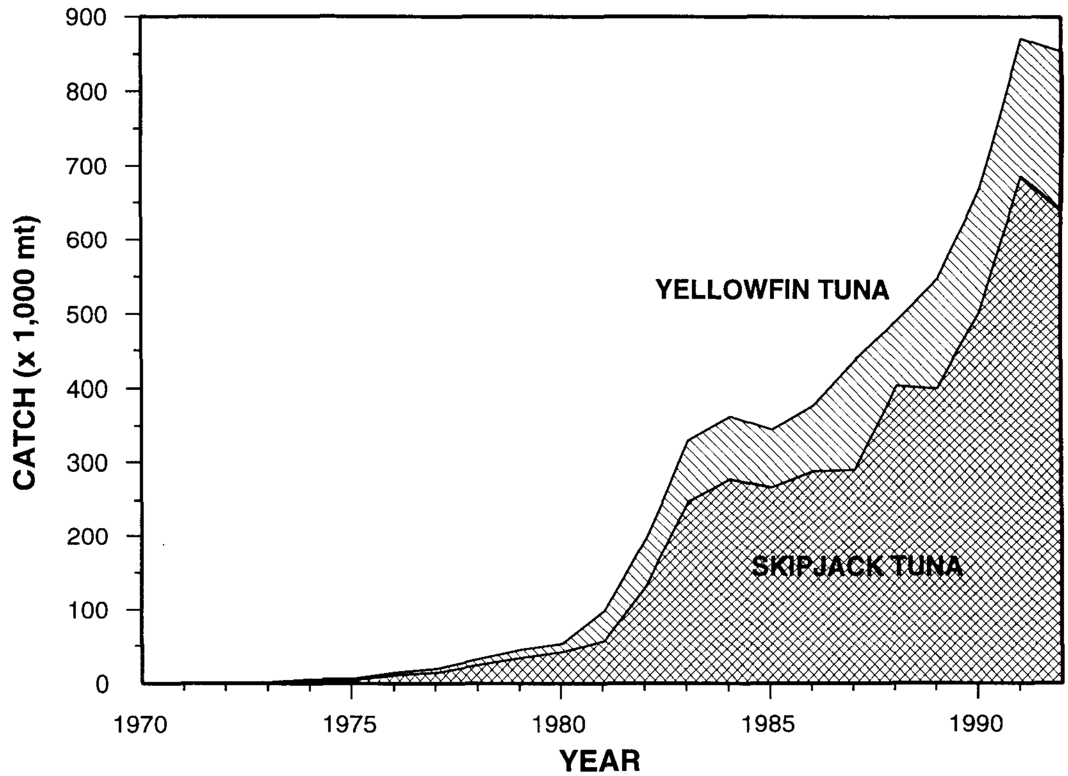

Figure 4. Total catch of yellowfin tuna and skipjack tuna by purse seiners fishing in the central-western Pacific Ocean, 1970–92.

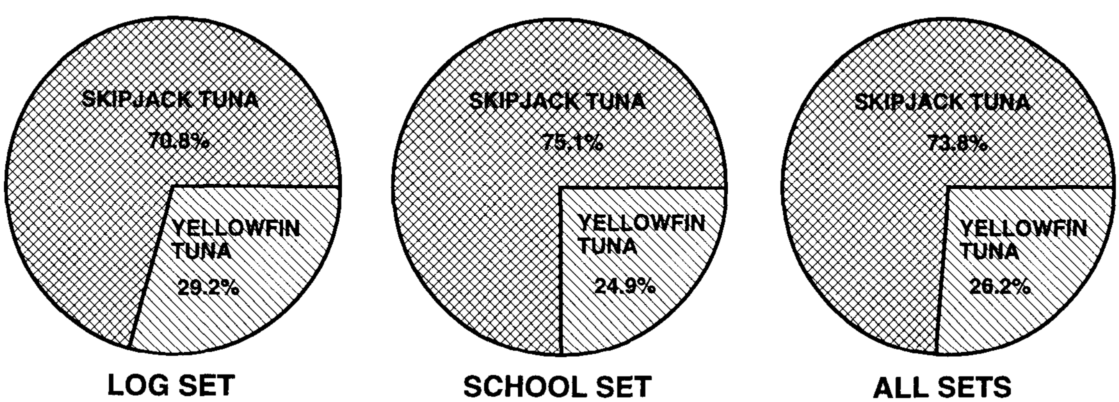

Figure 5. Species composition of the tuna catch by set type for the U.S. purse seiner fleet. Catches of yellowfin tuna include small amounts of bigeye tuna.

mainstay of the purse seine fishery and are largely taken in WPYF Area 4. Recently, there has been greater interest in targeting free-swimming schools consisting of virtually pure yellowfin tuna of large sizes. These schools are largely found in WPYF Area 5.

In contrast, the total longline catch of yellowfin tuna peaked at 123,000 t in 1980 before declining and then stabilizing at the 60,000 to 85,000 t range since about 1983. In 1993, the catch was 63,000 t, about the same as in 1992. The market for this catch is mainly in Japan and for use as sashimi, which is of higher per unit value than canned products. The Japanese fleet is by far the largest producer of this catch—50% of the total.

Although the total longline catch of yellowfin tuna has been relatively stable in recent years, the fishery has undergone significant changes. Most notable is the recent expansion in the Micronesian Triangle (Guam, Palau, and FSM). In the 1980s, Japanese and Taiwanese longline vessels moved into EEZ waters of Guam and expanded operations in EEZ waters of Palau to exploit concentrations of yellowfin and bigeye tunas. A system for landing and delivering the catch to market was gradually developed and perfected. The system involves the use of short-range longliners that average 7- to 15-day fishing trips, work out of local ports serviced by air transportation, use crushed ice or iced seawater to preserve the catch, and airfreight the catch to sashimi markets, mainly in Japan, to be sold as a fresh product. Beginning in 1991, this system was being fully implemented and introduced to the FSM. The number of participating vessels greatly increased in the triangle. By 1993, about 500 short-range longline vessels were involved in this fishery. The largest fleet is from the People's Republic of China (China), followed by Taiwan and Japan in that order. The Chinese vessels are mainly converted coastal gill net and trawl vessels with bare necessities and in very poor condition (dilapidated and rusted). The Taiwanese and Japanese vessels are conventional longline vessels, many formerly operated in the coastal tuna fishery of those countries. The total yellowfin tuna catch for the combined fleets is estimated to be about 15,000 t for 1993.

Like purse seiners, longline vessels do not catch solely yellowfin tuna, but a mixture of tuna species and, incidentally, other species. The species composition of the tuna catch varies from fleet to fleet and largely depends on fishing practices involving targeting. In general, longliners fishing in the central-western Pacific target bigeye tuna, a premium-valued species. The average catch (based on data for Japanese, FSM, Chinese, and Korean longliners), therefore, consists of about 52% bigeye tuna, followed by yellowfin tuna at 43% and albacore, *T. alalunga,* at 5% (Figure 6).

For the short-range vessels of the Triangle, the species composition of the catch is variable and probably differs considerably from their landings. For example, in Palau—where the longline landings are for export only—a U.S. $0.125/kg export tax is levied on longline landings regardless of species. This indirectly creates an incentive for fishermen to sort their catch and discard at sea in order to retain and land only the species with a high export value. The species composition of the landings in Palau is, therefore, not an accurate source of catch-composition data.

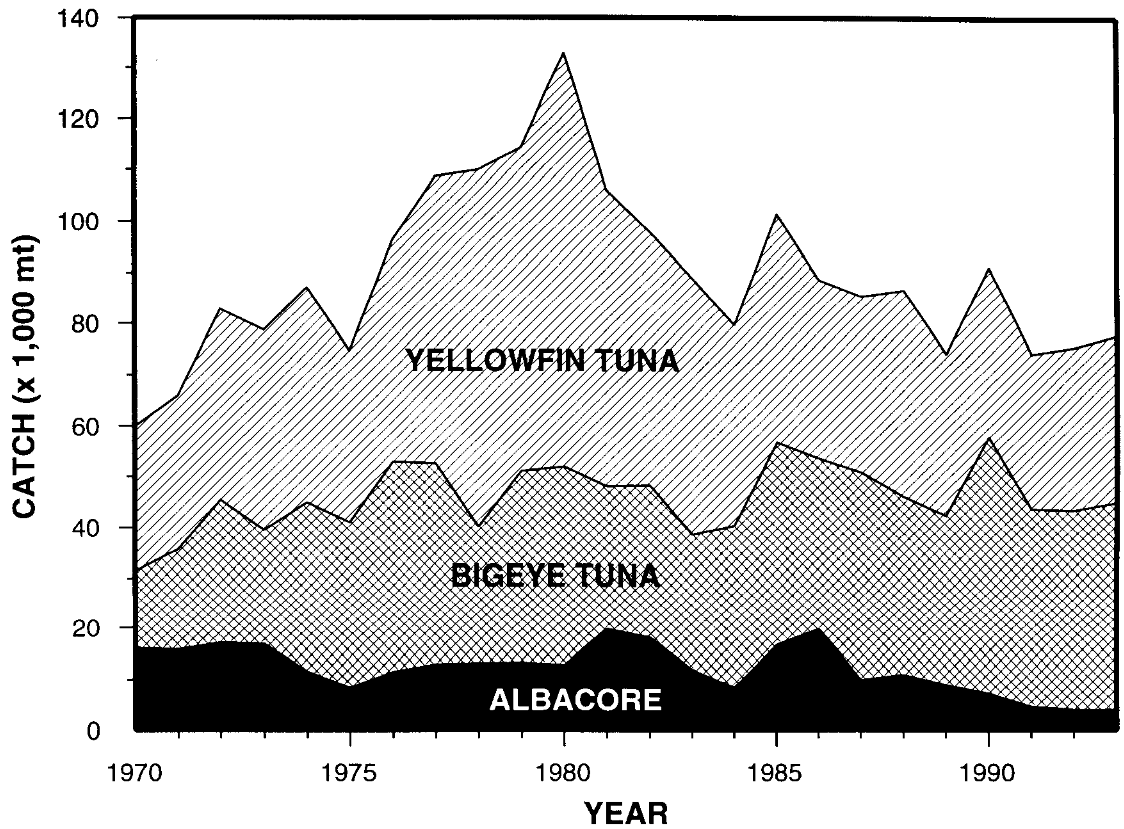

Figure 6. Total catch of yellowfin tuna, bigeye tuna, and albacore by Chinese, FSM, Japanese, and Korean longliners fishing in the central-western Pacific Ocean, 1970–92.

The review also revealed new developments in the fisheries. Four were of particular interest to the Group. One is the rapid expansion of the Micronesian Triangle fishery eastward into the Marshall Islands' EEZ. Currently, 5 short-range longliners are operated by a Marshall Islands enterprise out of Majuro, and the catch is airfreighted primarily to the fresh tuna market in Hawaii. The expansion will greatly increase the number of vessels involved in this fishery and open another distribution route to the Japanese market. The percentage of longline yellowfin tuna catch from WPYF Areas 3 and 4 is thus expected to increase.

The second development is the incorporation of blast freezing and storage capability aboard large purse seiners in the Japanese and Taiwanese fleets. A growing number of purse seiners are involved in this development, which originated in the Japanese fleet for preserving skipjack tuna for the prepared foods market, e.g. "kasuobushi," "tataki," etc. The new development is focused on adding value to the large yellowfin tuna that are increasingly being caught in free-swimming schools, and that are increasingly in demand for premium-end canning and prepared foods. The procedures used on the purse seiners involve sorting and special handling (ice bath, grading, etc.) of catches containing large yellowfin tuna, blast or brine freezing the fish, and storage in dry freezers. The dry freezers add a few hundred tons of hold space above normal brine well capacity on these vessels, thus increasing the overall load capacity. The higher quality fish can be quickly transshipped to carriers. However, this process entails discarding of smashed or small tuna at sea and high-grading of fish in the dry freezers.

Another variation of this development is being tested by the Korean purse seine fleet in the FSM EEZ. It involves use of a longline vessel with sashimi-quality freezing capability to work with purse seiners and to serve as a processing platform. The system requires the purse seiners to catch, sort, and deliver soon after capture the large yellowfin tuna to the longline vessel, and for the longliner to process the fish for the sashimi market.

The third development is the eastward shift of the purse seine fishery. This movement was started by the U.S. fleet and has begun to involve all the major fleets because of the second development discussed above. The target of this shift is large yellowfin tuna in free-swimming schools that are seasonally found in WPYF Area 5. Fishing effort is increasingly being directed from the traditional WPYF Areas 3 and 4, where log-associated schools are prevalent, to WPYF Area 5. In 1990, WPYF Area 5 produced 12% of the yellowfin tuna catch from purse seiners (Figure 7). More recent data, which are not yet available, will probably show a larger percentage.

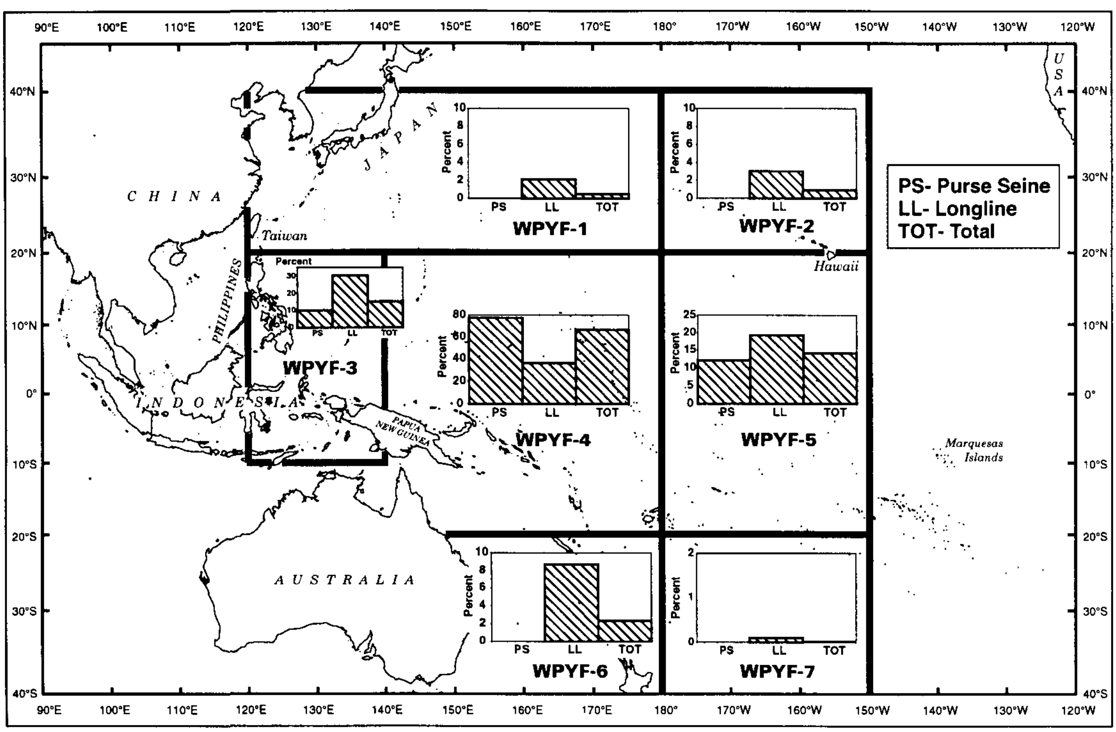

Figure 7. Location of catches of yellowfin tuna in 1990 by fishing gears. Percentages are relative to the total for each gear.

The fourth development is the steady proliferation in short-range longline fisheries in the southern hemisphere between 15°S and 25°E. In Australia, Fiji, New Caledonia, the Solomon Islands, French Polynesia, and Tonga, longline fisheries are expanding or being developed to supply sashimi and fresh fish (e.g., swordfish, *Xiphias gladius*) markets in the U.S., Japan, and other locations. The system used in the Micronesian Triangle is apparently being followed as a model.

3.1 Federated States of Micronesia (Reported by Craig Heberer)

The growth and expansion of the FSM domestic fishing fleet continued during 1993 with a total of 14 vessels harvesting an estimated 16,882 t of the principal market species of tunas. Of this total, 99% was taken by the domestic purse seine fleet, which currently numbers 8 vessels with a combined fishhold capacity of over 5,000 t.

The domestic purse seine catch has increased steadily since the first year of operation in 1991, and the outlook for 1994 is for a catch in excess of 18,000 t. Yellowfin tuna catches for 1993 totalled 4,663 t and came almost entirely from WPYF Area 4. It should be noted that this figure is from vessel catch reports stored on the Regional Tuna Fisheries Database, for which corresponding catch position information is available. Industry sources have indicated that the overall 1993 catch may be more than 5,500 t. Effort for the fleet during 1993 totalled 1,266 days.

Size-composition data for the domestic purse seine fleet has been gathered for the first time: a total of 751 length frequencies were recorded by Micronesian Maritime Authority fisheries observers. An additional 738 measurements have been collected during the first 6 months of 1994.

For FSM flag longliners, the 1993 fleet of 7 vessels harvested 103 t, down 21% from the 1992 figure of 131 t. Yellowfin tuna constituted roughly half of the 1993 total—55 t, of which 24 t was taken in WPYF Area 3 and the remainder (31 t) in WPYF Area 4. The MMA's Port Sampling Program was very active in all 4 states of the FSM during 1993, and coverage of the foreign and domestic longline unloadings has been generally good. In Yap state, approximately 11,403 yellowfin tuna length/weight samples were collected during 1993. In Chuuk state, the port sampler began monitoring soon after the first longliners began unloading in the latter half of 1993, and 13,818 yellowfin tuna were sampled for length/weight measurements. In Pohnpei state, a total of 6,022 yellowfin tuna samples were collected. In Kosrae state, longline transshipments began only in late December, 1993, and as a result only 63 fish were sampled for the year. For 1994, 476 yellowfin tuna have so far been sampled for length/weight measurements.

Other significant developments in the FSM during 1993 include the commencement of in-port transshipment operations in Chuuk and Kosrae states. From June to December 1993, over 100,000 t of tuna were exported from Chuuk state destined for the major tuna canneries of the world, particularly in Thailand and Korea. From January to July, 1994, approximately 120,000 t were exported from Chuuk state, mainly by the Taiwanese, Korean, and FSM purse seine fleets. Monitoring of the purse seine transshipment operation has been in place since the arrival of the first seiner in early March 1993.

Beginning in late 1993, an influx of Chinese longline vessels entered the FSM longline fishery, and now over 200 vessels are based in the 4 states of the FSM. In Pohnpei state, the opening of the Pohnpei Fish Processing Facility coincided with the arrival of the Chinese longliners, who supply product to the facility as part of their terms for access to the FSM EEZ. In Chuuk, the National Fisheries Corporation–Chuuk State joint-venture longline transshipment base (Chuuk Fresh Tuna Inc.) has begun operation with the ability to service 100–120 longline vessels. It is anticipated that the base will service foreign longline vessels as well as the developing FSM domestic fleet. The foreign component will include Taiwanese, Chinese, and Japanese longliners. A similar transshipment base in Yap (Yap Fresh Tuna Inc.) began operations in early August 1994 and will service mainly Taiwanese and Chinese longliners. A possible joint-venture arrangement between the FSM National Fisheries Corporation and the Japan Okinawan Tuna Longliners is currently being discussed; it could increase the numbers of longline vessels using the Chuuk and Yap bases.

Licensing fees collected from access arrangements with the major distant-water-fishing nations totaled over $20M for the first time since the establishment of the 200-mile FSM EEZ. For 1993, approximately 173,011 t of the principal market species of tuna were harvested from the FSM EEZ. This represents an increase of 24% over the 1992 total of 139,915 t. The 1993 total shows a 25% increase over the 1988–92 5-year average of 138,008 t (see Table 1). This increase is attributed mainly to the higher purse seine catch, because longline catches have increased only moderately while pole-and-line catches have decreased markedly.

Table 1. Catches (t) of tuna by gear type in the FSM EEZ for 1988–93.

YEAR	PURSE SEINE	LONGLINE	POLE AND LINE	TOTAL
1988	131,637	10,037	13,160	154,834
1989	92,167	13,031	20,472	125,670
1990	102,789	14,886	10,547	128,222
1991	107,713	10,278	23,410	141,401
1992	123,302	13,470	3,143	139,915
1993	149,881	16,557	6,573	173,011
1988-92 Avg.	111,522	12,340	14,146	138,008

Skipjack tuna accounted for 59% (~102,000 t) of the 1993 total, and yellowfin tuna accounted for 37% (~56,000 t). Bigeye tuna, harvested primarily by the longline fishery, contributed an additional 4% (~7,000 t).

3.2 Indonesia (Reported by Nurzali Naamin, WPYRG4/6)

The preliminary estimate of the Indonesian longline catch of yellowfin tuna in WPYF Area 3 for 1993 is 6,554 t, compared to 6,242 t in 1992. The number of vessels increased from 141 in 1992 to 309 in 1993. Since the end of 1992, many longliners have moved from Bali-based operations in the Indian Ocean to Bitung-based operations in the Banda and Sulawesi Seas, targeting yellowfin tuna for the sashimi market.

The Indonesian purse seine catch of yellowfin tuna was 2,200 t in 1992, and increased to 4,829 t in 1993 because of the return of three purse seiners to Biak-based operations. The number of ring net vessels operating in the Sulawesi Sea was 153 in 1993.

Yellowfin tuna landings by Indonesian pole-and-line vessels increased slightly from 5,319 t in 1992 to 5,585 t in 1993. The activities of 26 15-GT pole-and-line vessels based in Maumere ceased in December 1992 owing to damage by a tsunami. There were 823 pole-and-line vessels based in eastern Indonesia in 1993.

Yellowfin tuna landings by artisanal fisheries (handline and unclassified fishing gear such as gill net, danish seine, and troll line) increased from 4,794 t in 1992 to 5,034 t in 1993 for handline and from 36,770 to 38,608 t for unclassified gears. The number of handline vessels increased from 286 to 307.

Average weights (kg) of yellowfin tuna caught by the Indonesian fisheries were as follows:

FISHERY	1991	1992	1993
Longline	40	35	40
Handline	20	25	23
Purse seine	2.5	2.0	1.5
Pole-and-line	2.5	2.0	2.0

3.3 Japan (Reported by Naozumi Miyabe, WPYRG4/13)

Longline, pole-and-line, and purse seine are the main gears used by Japanese fishermen to catch yellowfin tuna in the central and western Pacific. In 1992, these gears caught 22,983 t, 6,829 t, and 52,889 t, respectively. The catch by longline and pole-and-line gears has been decreasing in recent years with the decline in number of licensed vessels. The number of licenses for purse seiners, however, has been constant.

The Japanese longline fishery expanded its operation to further offshore areas of the Pacific after the limitation on the operational area was lifted in 1952 by the Occupational Forces. At the same time, the size of the fleet increased. There are three license categories for longline vessels, according to size: coastal vessels (<20 GRT), offshore vessels (20–120 GRT), and distant-water vessels (>120 GRT). Coastal and offshore longliners operate in WPYF Areas 1, 3, and 4, where most of the Pacific yellowfin tuna catch is made, and in the western part of WPYF Areas 2 and 5. Distant-water longliners operate in the eastern part of WPYF Areas 2 and 3 as well as in Area 6. There has been very little fishing in Area 7 by longliners.

During the early stages of the longline fishery, target species were albacore and yellowfin tuna for canning, but in the early 1970s, the target began to shift to bigeye tuna, yellowfin tuna, and southern bluefin tuna for the sashimi market. This fishery also developed the so-called deep longlining and introduced it in tropical waters in the mid 1970s. The objective of deep longlining was to increase the catch of bigeye tuna, which occur in deeper water than other tuna species.

The Japanese pole-and-line fishery also has a long history. The primary target of this fishery is skipjack tuna, followed by albacore. Yellowfin tuna is caught as a by-catch, especially when log-associated schools are fished. Yellowfin tuna accounts for 5% or less of the total pole-and-line catch. There are two major fishing areas for this fishery: one around Japan and the other in the tropical western Pacific. The catch in the Japanese area accounts for approximately 70% of this fishery's total yellowfin tuna catch.

The Japanese purse seine fishery in the western tropical Pacific started in the mid-1960s on an experimental basis. Year-round operations were established in the 1970s, and major expansion of the fishery occurred in the 1980s. The main fishing area is the tropical area between 10°N–10°S and 130°–170°E. Normally, yellowfin tuna accounts for about 25% of the total catch. Logs and fish aggregation devices (FADs) are the dominant types of sets made by this fishery, but free-swimming-school sets have increased considerably in recent years.

3.4 Korea (Reported by Jang-Uk Lee; WPYRG4/12)

Annual total catch of yellowfin tuna from Korean longline and purse seine fisheries in the WPYRG study area has generally increased from year to year, with a peak of 76,900 t in 1992. In this area, annual CPUE from longline fishing has been higher than in the rest of the Pacific Ocean, but has showed large yearly fluctuations. The CPUE for Korean purse seiners during the 1990s has remained constant at about 8 t per set.

The Korean longline fishery for yellowfin tuna in the Pacific Ocean is concentrated in the equatorial region of the western Pacific during the summer months. Longline catches of yellowfin tuna suggest that the fish occur mainly at a depth of 150–250 m. Korean purse seine fishing is conducted only in WPYF Area 4, concentrated mainly in northern Papua New Guinea waters.

Length compositions of yellowfin tuna sampled from the Korean catch ranged from 72 to 168 cm fork length (FL) for longline-caught fish, and from 40 to 144 cm FL, with three separated modes, for purse seine-caught fish. Yellowfin tuna in the purse seine catch ranged in weight from 2 to 54 kg.

Sex ratio of yellowfin tuna from samples of the purse seine catch was 51.2% males. The length-weight relationship was found to be $w(kg) = 2.551x10^{-5} L(cm)^{2.921}$.

3.5 Palau (Reported by Masubed Tkel)

Fishermen from foreign nations operating in Palauan waters mainly use longline gear. Yellowfin and bigeye tunas are the target species. Since 1991, the foreign fleet has comprised Japanese, Chinese, and Taiwanese vessels. Catch reports and transshipment summaries indicate that Japanese vessels have taken most of the total catch as well as most of the smaller fish, but the growing Chinese interest in Palauan fishing grounds has shifted the major part of the catch to Chinese vessels.

Chinese and Taiwanese vessels obtain licenses to fish in Palauan waters by charter to locally based transshipping companies. Palau International Traders Inc. (PITI) was the first such company to operate in Palau, and it has the most extensive facilities. Palau Marine Industries Corp (PMIC) was established later, and has fewer and smaller shore-side facilities. Kuniyoshi Fishing Co. (KFC), established in 1993, handles the fewest vessels and has the smallest facilities.

Japanese vessels obtain their licenses directly from the office of the Palau Maritime Authority (PMA). Although some Japanese vessels off-loaded their catch in Palau in 1991 and 1992, their licensing agreement with PMA allows them to take their fish to Japan for off-loading.

Table 2 shows tonnage of fish landed in Palau ports from 1991 through 1993. (The figures do not include catch by Japanese vessels that was off-loaded in Japan.)

Table 2. Landings (t) in Palau by longliners chartered to trading companies.

YEAR/TRADING COMPANY	BIGEYE TUNA	YELLOWFIN TUNA	BLACK MARLIN	OTHER
1991				
PITI	804.47	975.37	15.88	3.86
PMIC	248.95	297.77	11.10	1.17
1992				
PITI	757.81	723.66	2.50	.39
PMIC	1,009.76	919.39	5.05	.22
1993				
PITI	747.53	587.64	9.70	31.44
PMIC	204.69	203.97	24.23	21.45
KFC	4.19	4.37	.51	.14

For the 1991 and 1992 fishing seasons, PITI had both Taiwanese and Chinese vessels, but in 1993, PITI stopped chartering Taiwanese vessels because of insufficient reporting of operations and inconsistent port calls. In 1992 PMIC had 55 Taiwanese and 25 Chinese vessels, and KFC had 26 Taiwanese and no Chinese vessels under charter.

3.6 Philippines (Reported by Reuben Ganaden)

The landings of yellowfin tuna in the Philippines have declined markedly in the past several years. In 1991, the catch of yellowfin tuna by the various gears was a high of 95,594 t from both the commercial (boats >3 GT) and municipal (boats ≤3 GT) sectors. The landings decreased in 1992 to 45,026 t and continued to decline to 38,198 t in 1993. Because there is no official breakdown of the catch by gear, it cannot be determined whether the decrease occurred in the purse seine/ring net fishery, the handline fishery, or both. These gears account for approximately 90% of the catch of yellowfin tuna.

The decline in landings may be attributed to overexploitation as well as noninclusion in the statistics of the landings of Philippine vessels operating outside the Philippine EEZ. In 1991, for example, about 15 large purse seiners were fishing in Papua New Guinea and Solomon Islands waters, and these vessels caught about 8,174 t of yellowfin tuna not included in the official Philippine statistics. In addition, a large number of Philippine fishing vessels have recently operated in Indonesian waters, and their catches are also not accounted for in available statistics.

The average weight of yellowfin tuna landed by the various gears in the Philippines in 1992 is as follows (data from BFAR Tuna Sampling Project):

GEAR	NUMBER SAMPLED	AVG. WEIGHT (KG)
Drift gill net	5,096	4.3
Ring net/Purse seine	5,852	0.8
Handline	9,739	33.2

The Philippine government plans to stop allowing new fishing vessels into the fisheries because of the perception that the resource is overexploited by excessive fishing capacity. The moratorium will be implemented in 1994 or early 1995, depending on the outcome of public hearings.

Another development that might affect the fisheries is the devolution of fisheries functions for municipal waters (15 km from shoreline) to local government units. This devolution might adversely affect the collection of municipal fisheries statistics. Traditionally, the municipal sector accounted for about 45–50% of the landing of yellowfin tuna, and most of the landing of large fish for the sashimi market.

3.7 Taiwan (Reported by Chi-Lu Sun; WPYRG4/9)

The numbers of Taiwanese distant-water tuna longliners operating in the Pacific Ocean in 1992, 1993, and 1994 were 92, 119, and 122, respectively. The total yellowfin tuna catch from the central and western Pacific was 841 t for 1992 and 1,088 t for 1993. In 1991, most of the catch (80%) was from WPYF Areas 4 and 5. By contrast, most of the catch in 1992 (78%) was from the WPYF Area 3 (Table 3). The nominal catch rate decreased from 0.72 fish/1,000 hooks in 1991 to 0.65 fish/1,000 hooks in 1992 (the fleet targets albacore).

During 1992, 1993, and 1994, 43 Taiwanese distant-water purse seiners operated in the western Pacific Ocean. Landings of yellowfin tuna by this fleet rose from 44,459 t in 1992 to 62,241 t in 1993, an increase of 17,782 t. The yearly nominal catch rate increased from 5.64 t/day in 1992 to 10.64 t/day in 1993.

The purse seine fleet currently operates in the EEZ of the FSM and Papua New Guinea as well as in the high seas adjacent to both EEZs (i.e., WPYF Areas 3 and 4). Six purse seiners have been licensed to fish the Kiribati EEZ this year to explore new fishing grounds.

Table 3. Taiwan distant-water longline catches (t) of yellowfin tuna in the central and western Pacific by month and WPYF area, 1992.

MONTH	WPYF AREA							TOTAL
	1	2	3	4	5	6	7	
1	-	-	-	-	121.7	-	0	121.7
2	-	-	-	-	-	-	0	0
3	-	-	0	-	-	-	0	0
4	-	-	0	-	-	-	0	0
5	-	-	0	-	-	-	0	0
6	-	-	81.2	-	-	-	1.7	82.9
7	-	-	96.8	-	-	-	7.2	104.0
8	-	-	55.7	-	38.4	-	4.0	98.1
9	-	-	91.9	-	11.4	-	0.6	103.9
10	-	-	182.3	-	0	-	0	182.3
11	-	-	84.4	-	0	-	0	84.4
12	-	-	63.5	-	-	-	0	63.5
Total	-	-	655.8	-	171.5	-	13.5	840.8

- = No data
0 = No yellowfin tuna catch

The number of Taiwanese offshore longline vessels fishing in the central-western Pacific decreased from 1,898 in 1992 to 1,791 in 1993. The landings of yellowfin tuna, however, increased from 10,151 to 11,000 t over the same period. Most of the offshore longliners operate in WPYF Area 3.

The total Taiwanese catch of yellowfin tuna rose from 55,995 t in 1992 to 74,648 t in 1993. The increase was due mainly to increased production by the purse seiners.

3.8 United States (Reported by A. Coan; WPYRG4/1)

Three main types of U.S. fisheries catch yellowfin tuna in the central and western Pacific: a distant-water purse seine fishery, Hawaii-based commercial fisheries, and artisanal fisheries.

The distant-water purse seine fishery operates over a large area of the western Pacific and accounts for approximately 95% of the U.S. central and western Pacific yellowfin tuna landings. The fleet targets yellowfin tuna and skipjack tuna. The catch averages about 26% yellowfin tuna (Figure 5). The number of vessels participating in this fishery peaked at 62 in 1983, declined to 32 in 1988, increased to 46 in 1992, and declined to 42 in 1993. Most vessels in the fleet are of 1,000–1,800 t carrying capacity.

Yellowfin tuna landings for this fishery peaked at 66,400 t in 1987, declined significantly the next year to 25,200 t, increased to 57,100 t in 1990, and declined to 44,200 t in 1993. Both catch rate and average size of yellowfin tuna landed in 1994 are expected to increase owing to good fishing in the Jarvis Island area, where significant catches of large yellowfin tuna (>120 cm) were made in June. If this improved fishing continues, the total yellowfin tuna landing in 1994 is projected to increase by 5 to 10% over that of 1993. The number of vessels likely to fish in 1994 is 45.

Artisanal and Hawaii-based commercial fisheries operate within the EEZs of Hawaii, Guam, American Samoa, and the Northern Marianas and account for approximately 5% of the U.S. central and western Pacific yellowfin tuna landings. Primarily handline, troll, and longline gears are used to target a variety of tunas, billfishes, and other large pelagic species. Most of the yellowfin tuna landings come from waters off Hawaii. Hawaii-based landings of yellowfin tuna peaked at 2,200 t in 1986. Since then, landings have decreased, with 1,800 t reported in 1993. Off Guam, American Samoa, and the Northern Marianas, artisanal fisheries report catches of yellowfin tuna and other large pelagic species. Annual landings of yellowfin tuna typically are below 90 t.

For 1994, yellowfin tuna landings are forecasted to be approximately 1,800 t for the Hawaii-based fisheries and about 50 t for the artisanal fisheries of Guam, American Samoa, and the Northern Marianas.

3.9 Others (Reported by Tim Lawson; WPYRG4/8 and 15)

Longline fisheries other than those reviewed above and that catch yellowfin tuna in the western Pacific include the fleets of Australia, China, Fiji, French Polynesia, the Marshall Islands, New Caledonia, New Zealand, and Tonga. According to data held at SPC, the Chinese fleet grew from about 72 vessels in 1992 to 319 in 1994; the yellowfin tuna catch during 1993 for this fleet is estimated at 2,259 t. The Australian fleet caught 547 t of yellowfin tuna in 1993, while the Fijian fleet caught 324 t and the New Caledonian fleet caught 387 t. The remaining fleets caught collectively less than 100 t of yellowfin tuna during 1993.

Pole-and-line fleets of Australia, Fiji, French Polynesia, Kiribati, New Zealand, and Palau target skipjack tuna and caught small amounts of yellowfin tuna in 1992. The Solomon Islands pole-and-line fleet decreased from 32 vessels in 1992 to 27 in 1993, and caught 3,692 t of yellowfin tuna in 1993; the proportion of yellowfin tuna in the total catch increased from 6% in 1992 to 13% in 1993.

The purse seine fleet of the Solomon Islands, which included three vessels in 1993, caught 5,706 t of yellowfin tuna in 1993, which represented 50% of the total catch for this fleet. Six Russian vessels were active in the Solomon Islands under joint ventures; these vessels caught 5,215 t in 1993. Several Filipino purse seiners fished the waters of Papua New Guinea and the Solomon Islands; 14 vessels caught 11,141 t of yellowfin tuna in 1993. The purse seine fleets of Australia and New Zealand each caught small amounts of yellowfin tuna.

4.0 REVIEW OF RESEARCH ASSIGNMENTS

4.1 Assessment Model Development (WPYRG4/3 and 14)

A progress report was presented by the working group charged with developing an integrated stock assessment model for yellowfin tuna in the central and western Pacific.

The working group met in Honolulu in November 1993 to examine the prospects for developing an integrated model of yellowfin tuna dynamics, incorporating both size and spatial structure. Such a model would help address the three key issues that WPYRG has focused on: maximum yield, local depletion, and interaction, as well as other important issues. A draft proposal for funding the model's development and its application to the yellowfin tuna data was developed and presented to the Group. The proposal, which seeks funds of $120,600 over a two-year period, will be submitted for consideration to the University of Hawaii's Pelagic Fisheries Research Program.

The proposal describes a modeling strategy that builds on a length-based albacore assessment model (SPARCLE) available from the SPC. The group plans to extend SPARCLE by incorporating spatial structure, initially in the form of the seven WPYF Areas (Figure 1), into the model by means of transfer coefficients that could be subject to seasonal or environmental effects. Inputs to the proposed model will include total catch and effort data, length-frequency data, and tagging data, with various stratifications by gear, fleet, area, and time period. The data would be assembled from the data base held by the SPC. Where necessary, supplemental data would be provided by the project collaborators (Pierre Kleiber, Sachiko Tsuji, and Tom Polacheck). As a first step and feasibility assessment, the existing SPARCLE model will be applied to available summarized yellowfin tuna data, with fisheries defined according to the WPYRG areas. Depending on the results, spatial structure will be added, and the model will be implemented on various hardware platforms. A consultant will be hired to help modify the SPARCLE model.

4.2 Growth

Analysis of length-increment data from 1,603 yellowfin tuna tag returns has recently been undertaken. The growth model used to analyze the data included the von Bertalanffy growth parameters L_∞ (or asymptotic length) and K (or growth rate), as well as variance terms for length measurement error, individual variation in L_∞, and a residual observation error. The estimates of L_∞ and K were 181 cm FL and 0.219 yr^{-1}, respectively, suggesting somewhat slower average growth than for eastern Pacific yellowfin tuna. Variation in length increments was high, and mostly attributed to L_∞. This resulted from the increasing variation in length increments with increasing time at liberty. The consistency of these growth estimates with those obtained from analysis of length-frequency data using MULTIFAN is currently under investigation.

4.3 Reproductive Biology (WPYRG4/2)

In its third meeting, the Group supported the consolidation of regional research activities to address reproductive studies on yellowfin tuna in relation to geographic, vertical (surface versus subsurface), and temporal variations in reproductive parameters. The consolidated study involves collaboration by scientists at the SPC, MMA, NRIFSF, and UH, as well as significant cooperation from the BFAR, RIMF, NMFS, and FFA (see Preface for full names). The main objectives of this large-scale project are to define the time, space, and size-related patterns in reproductive parameters for yellowfin tuna in the WPYRG study area, and to compare the reproductive parameters of fish taken by surface and subsurface gears. Ovary samples are being collected from catches by surface and subsurface fisheries throughout the region by at-sea observers, port samplers, and cooperating fishermen.

Major effort has, so far, been devoted to training workers to sample representatively across the size distribution in the catch. Samples are sent to UH for histological analysis, i.e., interpretation for spawning stage and frequency. Also, data useful for determining reproductive parameters and spatiotemporal patterns in spawning distributions are being collected and entered into a database for analysis.

4.4 CPUE Analysis (WPYRG4/11 & 13)

Two papers were presented on catch per unit of effort (CPUE) of yellowfin tuna in longline and purse seine fisheries: one dealt with the Japanese fishery and the other with the Taiwanese fishery. In both cases generalized linear models (GLMs) were used to "standardize" the yellowfin tuna CPUE. Ideally, such standardization removes from the CPUE time series the effects of various explanatory variables that modify (or are related to other things that modify) the relationship between catch and effort so that only an abundance signal is left in the time series of year effects.

The Japanese purse seine CPUE was treated substantially the same as in the previous year's analysis (see WPYRG3 Report) with standardizing variables of year, season (quarter), skipjack tuna catch as a proportion of total tuna catch, and log-associated sets as a proportion of total number of sets. This year's analysis included data for an additional year, 1992. The additional data did not substantially change the picture of relative stability in the standardized CPUE of small yellowfin tuna, but showed an increase in the standardized CPUE for 1992 of large yellowfin tuna (Figure 8). Treating the total of large and small yellowfin tuna CPUE produced an intermediate rising trend (Figure 8).

Although somewhat different in detail, the time trend in standardized Taiwanese purse seine CPUE had much the same pattern as reported previously (see WPYRG3 Report), with a decline prior to the mid-1980s and increase since the late 1980s (Figure 9). The analysis differed in that a new standardizing variable (set type) was added and two variables (area and whether in a peak spawning stratum) were dropped when their effects were found statistically not significant. The resulting model included year, season (month), and set type. Significant interaction effects were found between year and set type and between year and season.

For this WPYRG4 meeting, the standardizing variables for analyzing Japanese longline CPUE comprised year, season (month), area, depth of set, albacore catch, and bigeye tuna catch. This was a different set of variables than in the previous year's analysis (see

WPYRG3 Report), which comprised year, season (quarter), area (5° square), and season by area (quarter, 5° square) interaction. Comparison with the previous year's results shows that the approximately 30% decline in CPUE in the late-1980s is no longer evident (Figure 10). The Group noted that one or more of the standardizing variables may be "overstan-

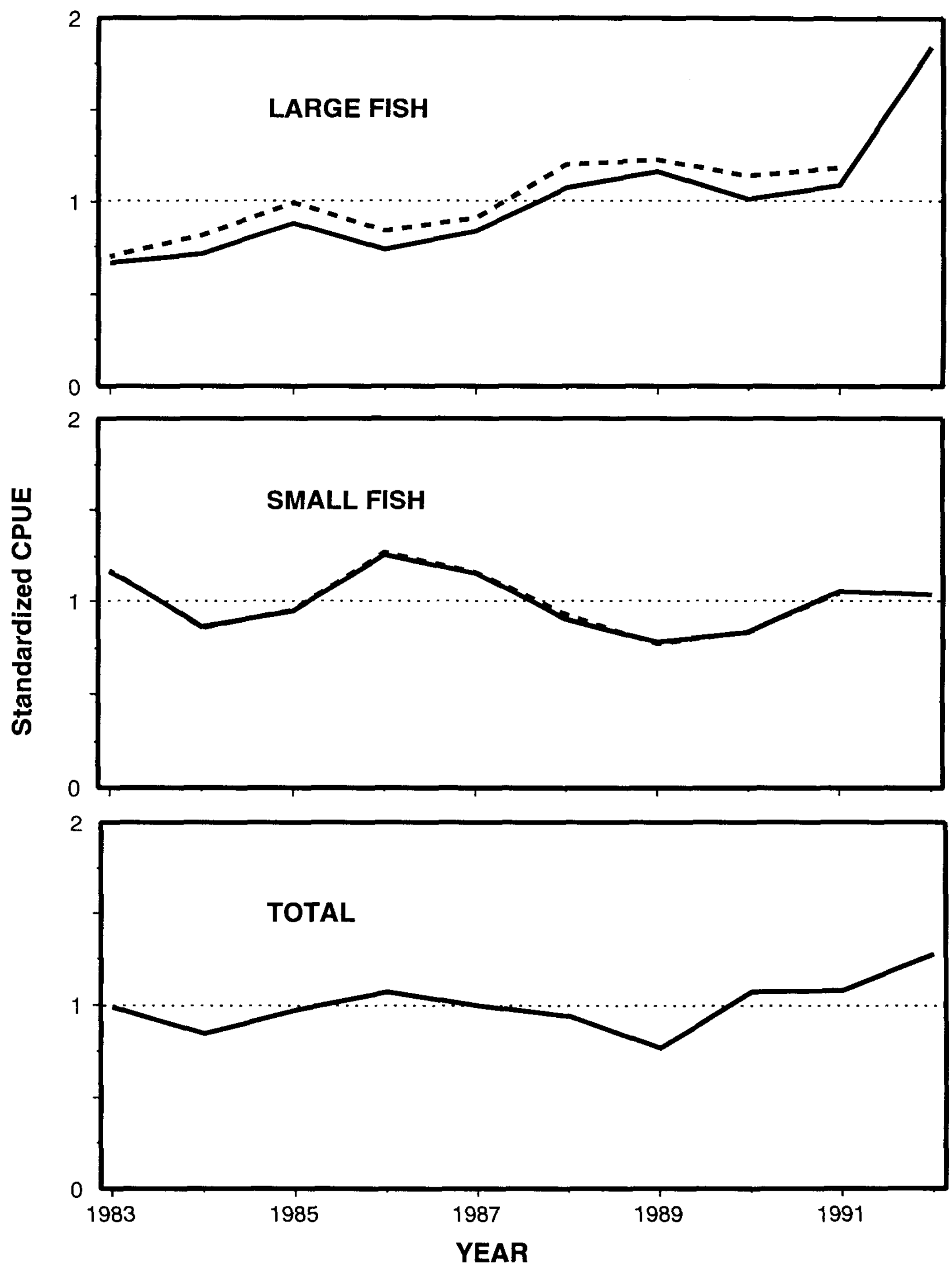

Figure 8. Comparison of standardized Japanese purse seine catch-per-unit of effort (CPUE) estimated by WPYRG3 (dotted line) and WPYRG4 (solid line). Values have been scaled to allow the two time series to be juxtaposed.

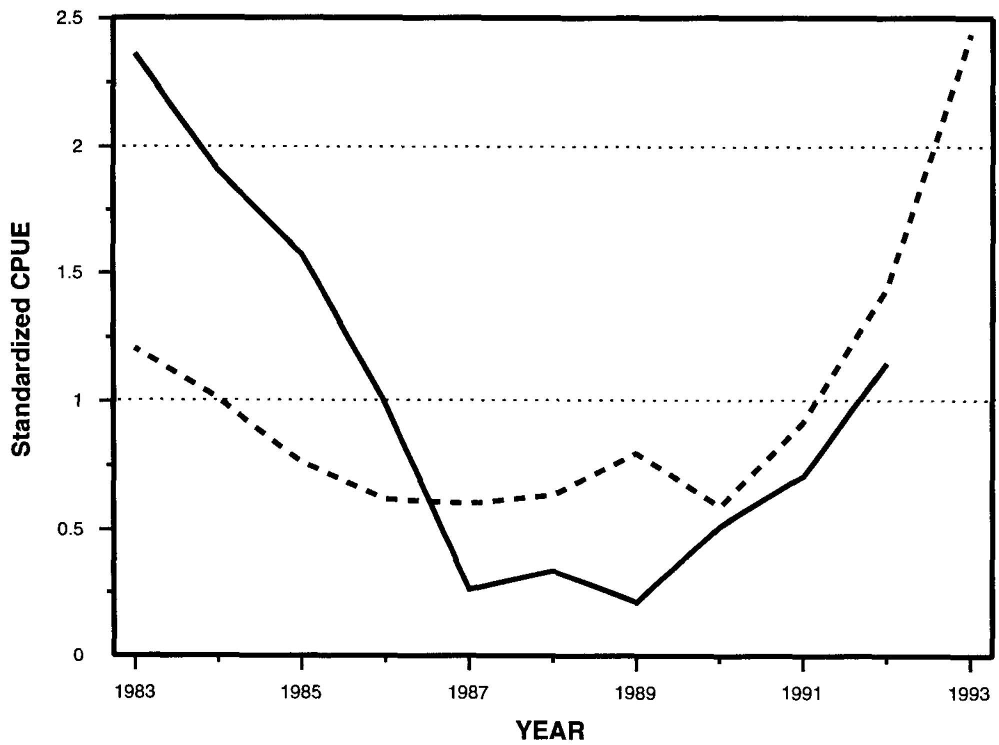

Figure 9. Comparison of standardized Taiwanese purse seine catch-per-unit of effort (CPUE) estimated by WPYRG3 (dotted line) and WPYRG4 (solid line). Values have been scaled to allow the two time series to be juxtaposed.

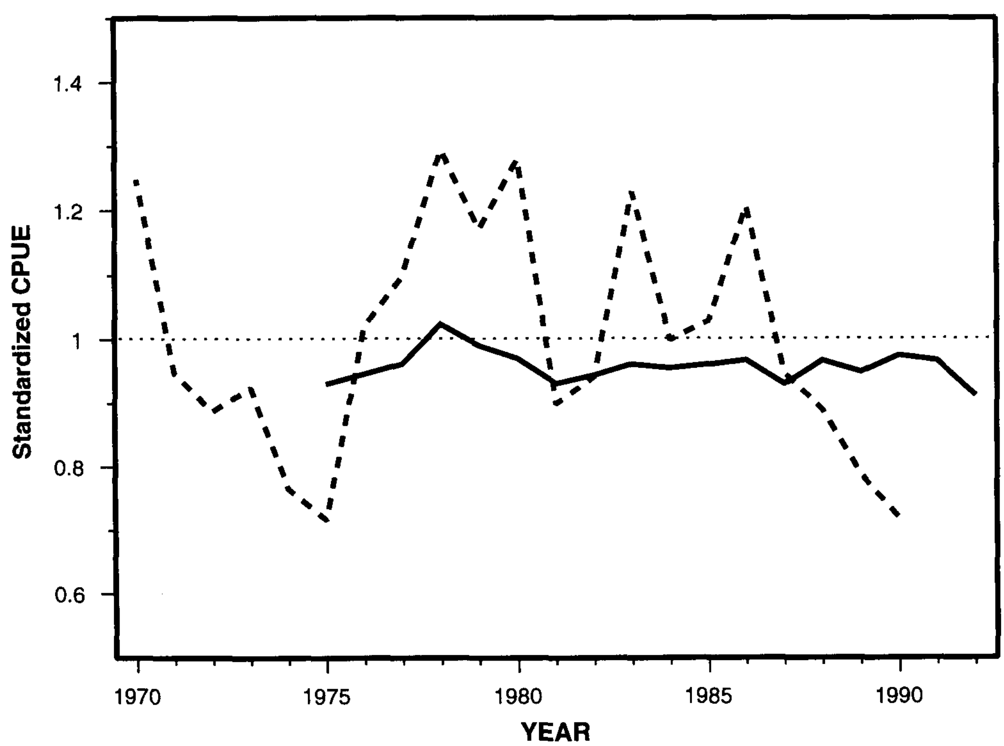

Figure 10. Comparison of standardized Japanese longline catch-per-unit of effort (CPUE) estimated by WPYRG3 (dotted line) and WPYRG4 (solid line). Values have been scaled to allow the two time series to be juxtaposed.

dardizing" the CPUE, that is, removing some of the signal that is related to yellowfin tuna abundance. The bigeye tuna variable, which was expressed as absolute catch rather than proportion of the total catch, is particularly suspect and may be a reason that the statistical model fits the data unusually well.

Taiwanese longline CPUE was standardized with the same suite of variables as reported in the WPYRG3 Report, that is, year, season (month), WPYF area, and whether within or out of the time-area strata defined as optimal for spawning. Adding another year to the time series did not change the overall picture of a declining trend since the early 1970s (Figure 11).

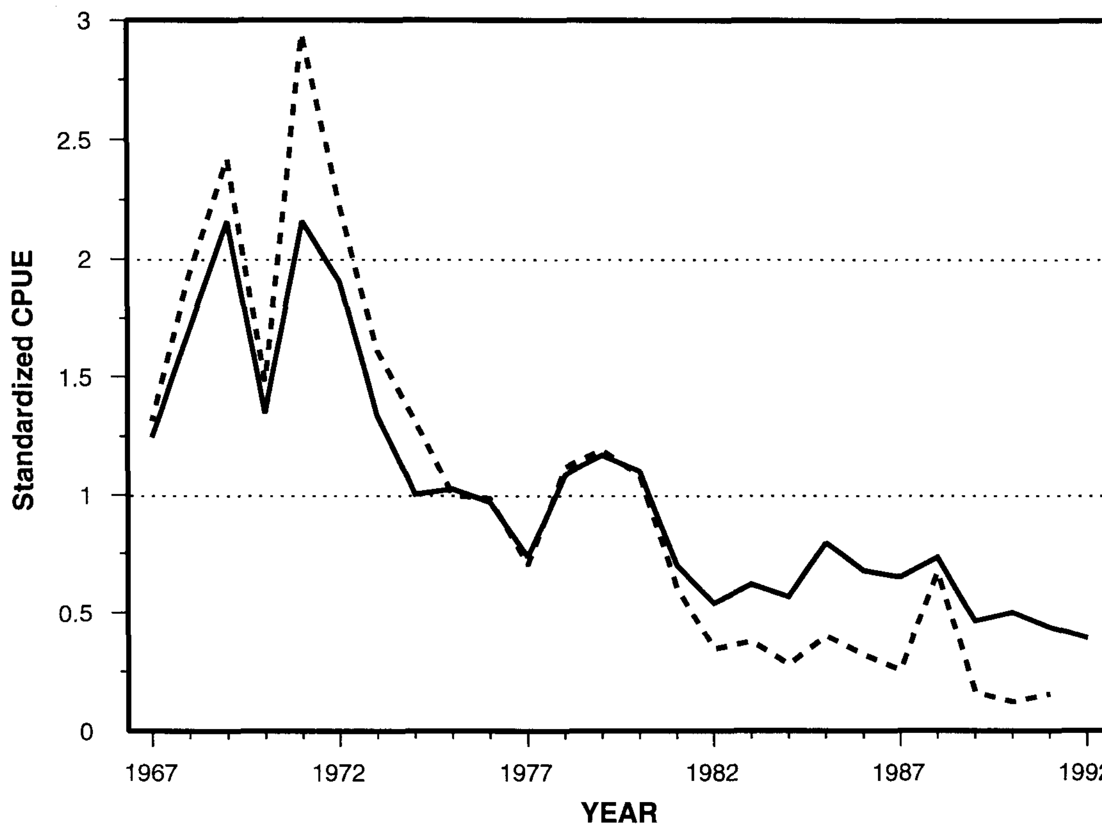

Figure 11. Comparison of standardized Taiwanese longline catch-per-unit of effort (CPUE) estimated by WPYRG3 (dotted line) and WPYRG4 (solid line). Values have been scaled to allow the two time series to be juxtaposed.

The Group discussed the value of standardized CPUE for obtaining an index of yellowfin tuna abundance, considering that yellowfin tuna is not always the main target of the fleets whose data are used in the analyses. Also, extraneous effects could still lurk in the "standardized" time series for lack of appropriate standardizing variables, and overstandardization can obscure true trends in abundance. Furthermore, interaction effects between year and other variables make the results difficult to interpret in terms of a time series of yellowfin tuna abundance.

From the fishermen's point of view, the nominal (unstandardized) CPUE is probably more interesting than the standardized CPUE, because the nominal CPUE measures actual return for an investment of effort. Even though the standardized longline CPUE may be relatively unchanging, the decline in nominal CPUE (Figure 12) is certainly of concern to the longline fleets. Likewise, the upward trend in nominal purse seine CPUE (Figure 13) is of interest to the purse seine fleets.

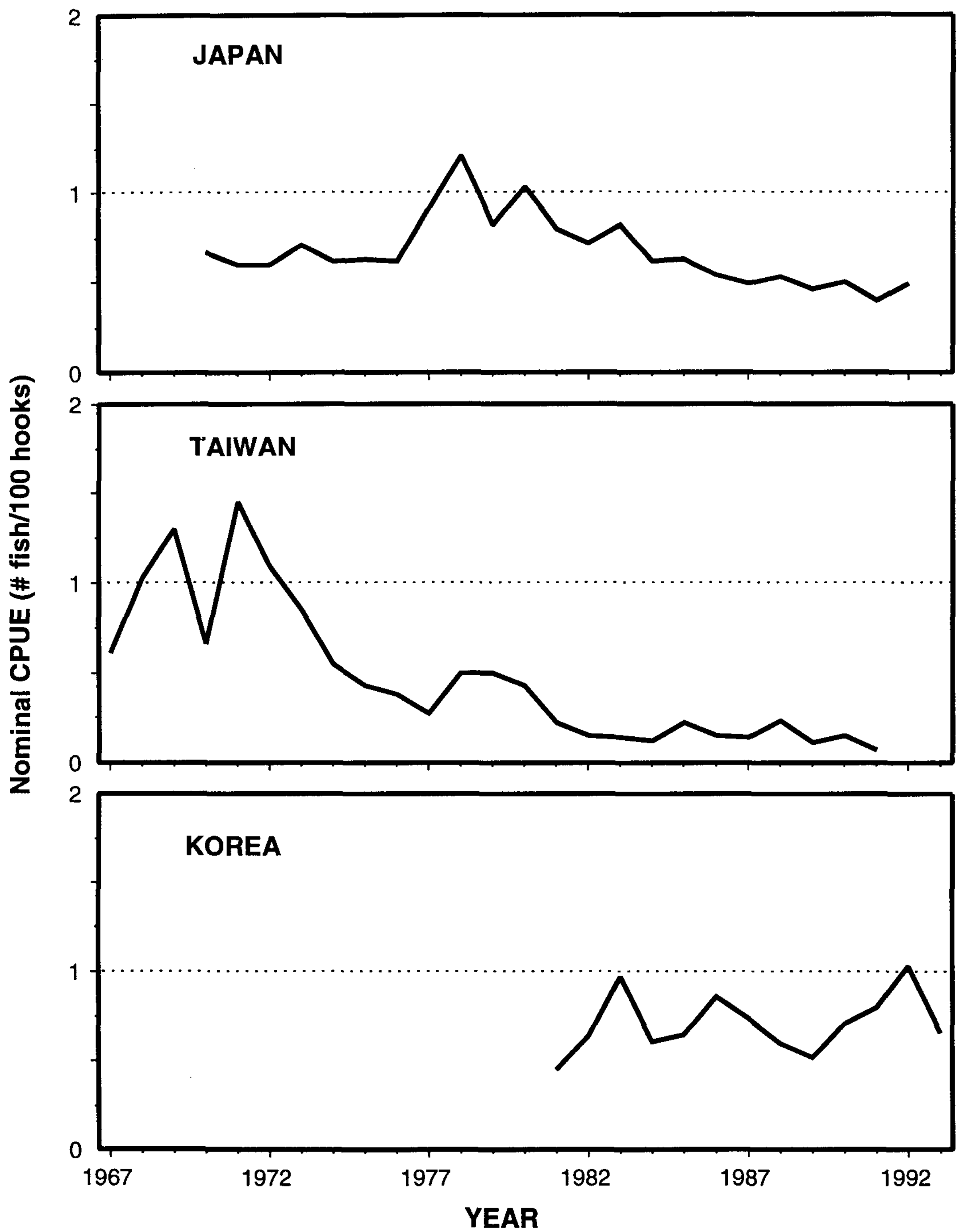

Figure 12. Nominal catch-per-unit of effort (CPUE) for Japanese, Korean, and Taiwanese longline fleets fishing in the central-western Pacific Ocean.

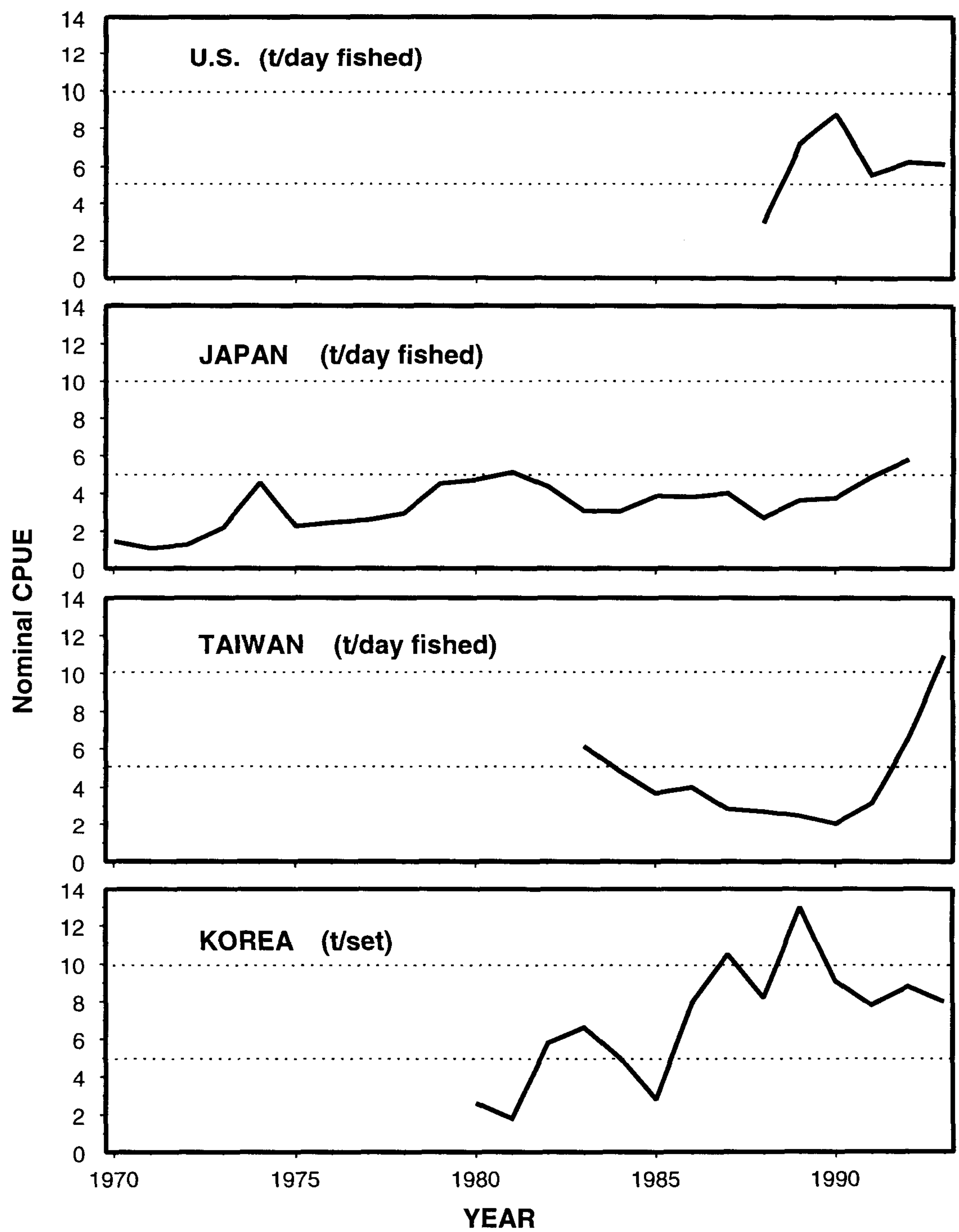

Figure 13. Nominal catch-per-unit of effort (CPUE) for major purse seine fleets fishing in the central-western Pacific Ocean.

4.5 Length-Weight Analysis (WPYRG4/5 & 12)

Two papers were presented dealing with the collection of length-weight (LW) data for yellowfin tuna. WPYRG4/5 presented preliminary results of U.S. port sampling, and WPYRG4/12 reported on Korean port sampling.

Length and corresponding weights were taken by port samplers in Pago Pago, American Samoa, of 1,180 yellowfin tuna landed by U.S. purse seiners in the southwestern Pacific. Fish ranged in size from 32 to 146 cm FL. The estimated LW relationship is W(kg) = 0.00002287 L(cm FL)$^{2.966098}$. Sampling will continue into 1995 because a larger sample size (approximately 250 fish per 1 cm interval) is needed, particularly for fish greater than 120 cm FL.

Length and corresponding weights were taken at a landing port by Korean scientists from 369 yellowfin tuna landed by Korean purse seiners fishing in the western Pacific. Fish ranged in size from 40 to 144 cm FL. The LW relationship is W(kg) = 0.00002551 L(cm FL)$^{2.921}$.

These LW relationships are very similar and also very close to the relationship reported by Nakamura and Uchiyama, which is currently being used by the WPYRG.

5.0 REVIEW OF FISHERIES STATISTICS

The Group discussed progress in collecting data and monitoring fisheries catching yellowfin tuna. WPYRG statistical tables (Appendix D) were revised and updated from data and information provided by the participants. The Group also reviewed progress with ongoing tasks of data preparation and collection.

5.1 Fishery Statistical Tables

Data correspondents met and updated fisheries statistics on yellowfin tuna. Major revisions to the statistical tables (Appendix D) were made for the following.

- Korean longline and purse seine catches.

  Korean tuna fisheries statistics were provided by scientists from the NFRDA of Korea. New information resulted in extensive revisions to catch and effort statistics as well as insights into the collection procedures and accuracy of the data.

  Korean longline data for 1981 to 1993 and purse seine data for 1980 to 1993 were revised. Longline catch data for 1975 to 1980 were identified as preliminary; they are being reviewed by NFRDA, and revised numbers are expected in the near future.

- Japanese coastal and offshore/distant-water longline catches.

  The components of the Japanese longline fishery—coastal and offshore/distant-water—were separated for 1970 to 1992. The WPYRG tables now list statistics for these components separately.

- Philippines catches by gear type.

Reliable catch statistics by gear type are not available for the Philippines for 1992 and 1993. The South Pacific Commission's Tuna Fishery Yearbook, 1993, lists catches by gear type for 1992 Philippine catches of yellowfin tuna from official sources. These data were used in the WPYRG statistical tables. For 1993, catches by gear type were estimated from the 1992 proportions by gear type.

- Joint-venture catches.

  The correspondents discussed procedures for accurately accounting for catches by vessels under joint venture or other arrangements and how to prevent double counting or underreporting of catch and effort. The participants agreed to the following procedures: (1) Catches of Taiwanese longliners unloading in Guam and FSM from 1990 to 1993 are included under Taiwanese offshore longliners; (2) U.S. joint-venture longline catch and effort from the Marshall Islands EEZ for 1992 and 1993 are included in U.S. statistics; (3) Purse seine catch and effort in 1993 for Russian joint ventures are shown as Russian statistics; (4) Fishing effort of Philippine purse seine vessels fishing in Indonesian EEZs in 1993 and reported by Indonesia is included in Philippine statistics.

- Catches from newly identified fisheries.

  Catches from three fisheries were not included in previous WPYRG statistical tables and were added: (1) catch and effort for the Chinese longline fleet, 1991 to 1993; (2) catch and effort for the French Polynesian longline fleet for 1992 and 1993; and (3) catch for the Australian troll fleet for 1992 and 1993.

5.2 Improvements in Data Collection

The Group reviewed 1993-94 assignments and progress toward improving data collection procedures. The results were as follows:

- Explore procedures for improving port sampling for size frequency in Japan and Taiwan.

  Progress. Sampling in Japan is being maintained at the same level as in 1992. Coastal longline catches are being sampled at various ports in Japan, and pole-and-line catches are sampled in Yaizu; however, sample sizes are small. The distant-water longline and purse seine catches continue to be sampled and measured by vessel crews. The problems noted last year (see WPYRG3 Report) are still inherent in the Japanese sampling scheme and will be difficult to correct owing to funding constraints, lack of access to the fish at unloading ports, and the sorting of fish by size groups (because of price differences between sizes of fish) for transshipment to Thailand. The NRIFSF will continue to explore ways to improve sampling.

  Many of the problems noted in the Japanese sampling scheme also apply to Taiwanese fish caught by purse seiners and longliners. Purse seine catches, however, are not landed in Taiwan and are therefore not available for home-port sampling. Distant-water longline catches are being measured by vessel crews. Observer programs for purse seiners, and port sampling programs for all landings are being organized by the SPC and island countries in the south Pacific region, and these programs will target Taiwanese catches. The sampling of Taiwanese catches should therefore improve.

Recent implementation of an import certificate program has improved the monitoring of imports into Japan. The certificates contain the source of the catches and could be used to cross-check catch reports from vessels.

- Facilitate training of at-sea observers.

  Progress. The Group expected the South Pacific Regional Tuna Resource Assessment and Monitoring Project (SPR TRAMP) to have begun by the time of the meeting so that the training of observers could be coordinated with it. Unfortunately, start-up was delayed because of funding. SPR TRAMP is now expected to begin in 1995. Four scientific observers will be recruited and will spend as much as 75% of their time at sea, collecting data and training observers from national observer programs.

  A workshop to review current observer programs and to plan future activities will be organized by the SPC and FFA soon after SPR TRAMP's personnel are aboard. It is expected that supervisors of current observer programs from Australia, FSM, Kiribati, New Zealand, and the FFA as well as other SPC member countries and territories will participate in in the workshop.

- Salvage Japanese purse seine length-frequency data.

  Progress. Some historical Japanese length-frequency measurements of yellowfin tuna from purse seine catches are not accurate at the 1-cm interval and month level. The task of salvaging the data by collapsing the data to 5-cm interval and quarter level was assigned to NRIFSF scientists. The task involves extensive examination of individual samples and is continuing.

- Compare length-frequency samples from observers and port samplers.

  Progress. Differences between length-frequency samples taken aboard fishing vessels and from landings in ports were investigated by MMA (WPYRG4/7). Sources of errors in sampling at ports were identified, as well as biases in estimates of mean lengths by set type for purse seine–caught fish. Biases in samples arise from at-sea sorting of catches, discarding to high-grade catches, poor recordkeeping about where catches are placed in wells, and selective unloading of catches. Specific sources of biases are:

  1. At-sea size sorting of yellowfin tuna into separate storage wells (i.e., dry well versus brine well) by Taiwanese purse seiners, which seriously affects accurate selection of wells for port sampling,

2. Off-loading of the catch to more than one carrier at transshipment sites when the port sampler is not around to accurately document the extent of this practice,

3. Violations of the random sampling guideline due to time constraints on the port samplers for collecting samples and the resulting effect on selection of the primary sampling unit (well) and secondary sampling units (fish within a well),

4. The lack of documentation about the placement of the catch in wells after the fishing operation,

5. Nonrandom off-loading procedures at transshipment sites (e.g., size and species selection according to market considerations).

Results of this study indicate that the use of fisheries observers is the recommended procedure for collection of accurate detailed length-frequency data from purse seine catches and to avoid biases in port samples. Observers would also be able to collect accurate discard information as well which is largely missing from current reporting forms.

- Obtain more precise Korean fishery data.

  Progress. Korean data on length-frequency of yellowfin tuna in purse seine catches for the 1980s were presented in a recent report of the FAO Expert Consultation on Interactions of Pacific Tuna Fisheries. The data were taken by vessel crews and are not of high enough quality for use in scientific analyses. Since 1992, the NFRDA has instituted a data sampling system that uses trained personnel. Length-frequency data and other biological data are now being collected by these personnel and will be made available to the Group in the future.

5.3 Gaps in Data

The Group discussed gaps in the fisheries data that need investigating and correction. The gaps are:

- The involvement of Chinese vessels has expanded, and many make short trips that produce small landings. It is difficult to track the vessels because they are not clearly marked for vessel identification purposes. Thus, there may be some double counting of catches.

- Although longline catches by Okinawa-based vessels are included in data for the Japanese longline catch, catches by other Japanese vessels operating off Vietnam may not be included.

- Cannery rejection rates of purse seine landings can be high (30–40 t per landing) and if cannery receipts are used for data, may lead to underestimation of the catches. High grading, or sorting and discarding at sea also contribute to underestimation of the catch.

- Catches by Philippine purse seine vessels fishing in the northern Indonesian EEZ (Celebes Sea) under joint-venture arrangements are not fully known. Catches for this fleet may be underreported.

6.0 REVIEW OF STOCK STATUS (WPYRG4/4 and 10)

The Group reviewed results of an assessment based on tagging data (updated from WPYRG 3 Report), a nonequilibrium production model analysis, analyses of tentative yield per recruit, and biological and fisheries information relevant to estimating the current status of the central-western Pacific yellowfin tuna stock (Table 4).

Table 4. Summary of estimated stock parameters for yellowfin tuna of the central-western Pacific Ocean.

STOCK PARAMETER	ESTIMATE
Natural attrition rate (per month)	0.116–0.139
MSY (t)	600,000–670,000
Exploitation rate at MSY (annual)	0.40–0.50
Current exploitation rate (annual)	0.16–0.26
Highest catch (1993; t)	397,000
Current catch (t)	397,000

The tagging-based assessment presented at last year's meeting has been refined with new estimates of the tag-reporting rate and its variability. The analysis is based on a tag-attrition model in which estimates of fishing and natural mortalities are obtained. A bootstrap approach was used to estimate confidence intervals for the parameters and to account for uncertainties in the various input parameters and for sampling error in the data. The current exploitation rate (proportion of total mortality due to fishing) is approximately 0.2 (95% confidence intervals of 0.16–0.25), and based on this, it is estimated that at an exploitation rate of 0.4, an annual yield of 600,000 t could be sustained. By rule of thumb, a tuna population undergoing an exploitation rate of 0.5 is producing approximately its maximum sustainable yield (MSY). Therefore, 600,000 t would be a somewhat conservative harvest goal. It was stressed that the parameter estimates obtained from the tagging data pertain primarily to juvenile yellowfin tuna. Estimates of exploitation rates for adult yellowfin tuna have not yet been determined, but this might be accomplished by adding size structure to the model and estimating fishing mortality by size class. It was also pointed out that the parameter estimates are averages over the area of the fishery, and some areas (such as the Philippines) will have substantially higher exploitation rates than others.

Analysis with a nonequilibrium stock production model, fitted to standardized data from all fleets for the period 1970–92, led to similar conclusions about the current level of exploitation, an estimated MSY of 670,000 t, and a current fishing mortality rate of 0.261. Despite some questions about the standardization procedure with incomplete catch and effort data, and the possible effect of population structuring, the Group considered the results useful, and recommended that this approach be developed further.

Information from various fisheries about average size of fish taken showed no clear trend, other than an apparent gradual increase in the average weight of yellowfin tuna caught on longlines by the Japanese fleet (Figure 14). The catch of small yellowfin tuna throughout the WPYRG area was not felt to be significantly increasing, despite developments in Indonesia and large catches on log-associated or FAD schools. Yield-per-recruit analyses indicated a significant increase in yield-per-recruit for yellowfin tuna would only be obtained at effort levels five times the present ones, with length at first capture of 70 cm FL.

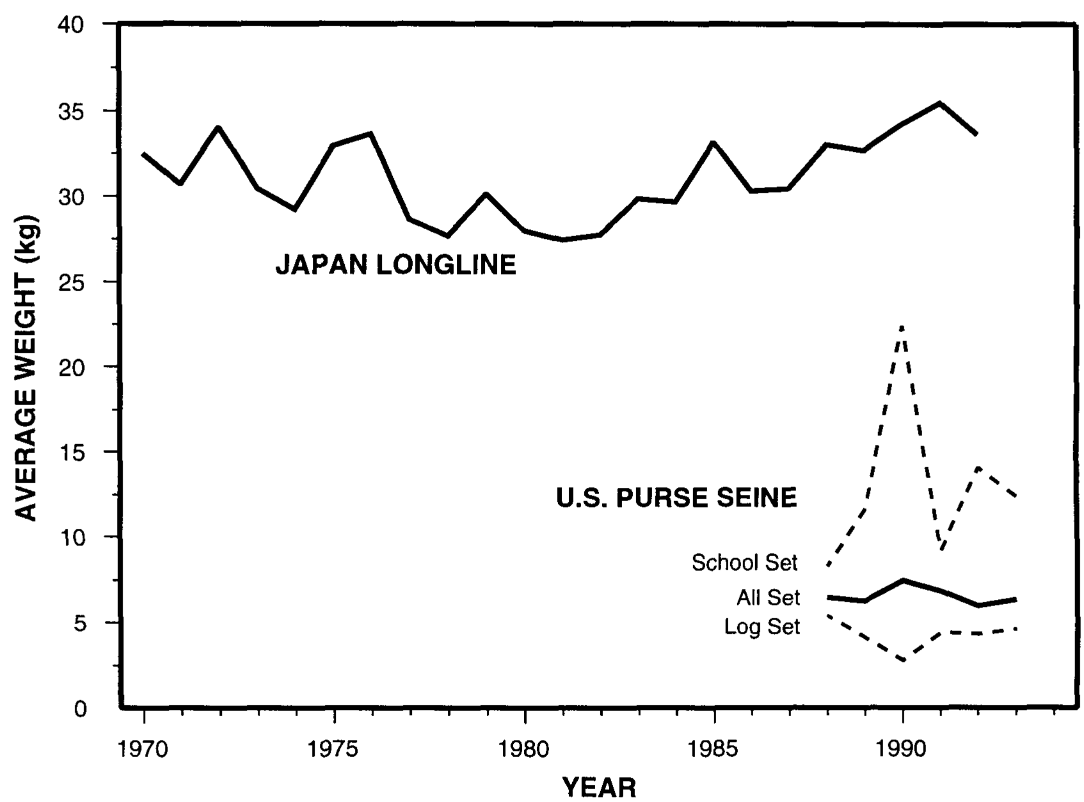

Figure 14. Average weights of yellowfin tuna caught in the Japanese longline fishery and the U.S. purse seine fishery.

Available information generally indicates that current exploitation level of the central-western Pacific yellowfin tuna stock is moderate, with the exploitation rate at the current catch level (380,000 t approx) on the order of 0.20, and that a higher level of around 600,000 t, at an exploitation rate of 0.40 is probably sustainable. The Group noted that this was the "average" situation relative to the total stock, and the effects of high exploitation on local scales may need to be considered.

Despite this optimistic picture, it was recognized that stock condition and developments in the fishery still need to be monitored, particularly in view of continuing declines in the longline catch rate, and the shift to higher catches of adult yellowfin tuna by the purse seiners. Recruitment variability could be a serious concern and that this might be monitored by measuring the proportion of yellowfin tuna in log-associated sets, particularly in WPYF Area 4.

7.0 REVIEW OF FISHERY INTERACTION (WPYRG4/16)

Interaction between the various fisheries that harvest yellowfin tuna is one of the key issues being addressed by WPYRG. The evidence of relatively mild exploitation rate (0.20) means that competitive interaction between fleets is, in general, low. However, because some localities are experiencing substantially higher exploitation rates than the average of the whole region, local depletion could cause significant interaction between fisheries in some areas. Also, the sizes of yellowfin tuna caught by the different gears overlap, particularly for longline and purse seiners (Figure 15). Local depletion and fisheries interaction, however, have not yet been priority topics for investigation by WPYRG.

Of continuing concern is the possibility that large catches of yellowfin tuna by purse seiners may adversely affect catch rates by longliners. One factor that has a substantial bearing on the potential for interaction between surface and longline gears is the availability of the yellowfin tuna population to these gears. It has long been suspected that longline fisheries may exploit only a fraction of the total yellowfin tuna stock of a size vulnerable to longlining (typically fish >100 cm FL). The tagging data generated by the SPC programs provide a means of testing this hypothesis.

Japanese longline and purse seine length-frequency data for 1991 and 1991–93, respectively, which were made available for the study; other such data held at SPC; and the SPC returns for 1991–93 were used to test the null hypothesis that the relative probabilities of capture of large (>100 cm FL), tagged yellowfin tuna by purse seine and longline gear are determined only by the relative catches by these gears. The null hypothesis would be true if yellowfin tuna were equally available to both gears; if the null hypothesis were rejected, unequal availability is one alternative hypothesis that might be posed.

From the study area, 181 returns of tagged yellowfin tuna >100 cm FL were received between 1991 and 1993. Only 4 of these were from longliners. The expected numbers of returns for each stratum by purse seine and longline gears under the null hypothesis were calculated by apportioning the total number of returns in each stratum according to the estimated catch in number by each gear. Overall, approximately 160 purse seine returns and 21 longline returns would be expected under the null hypothesis. Various statistical tests showed that the observed number of longline returns is significantly less than that expected under the null hypothesis. Low reporting rates of longline-caught tagged fish, lack of thorough mixing of tagged fish, and reduced availability of tagged yellowfin tuna to longline gear were identified as potential reasons for the shortfall of longline

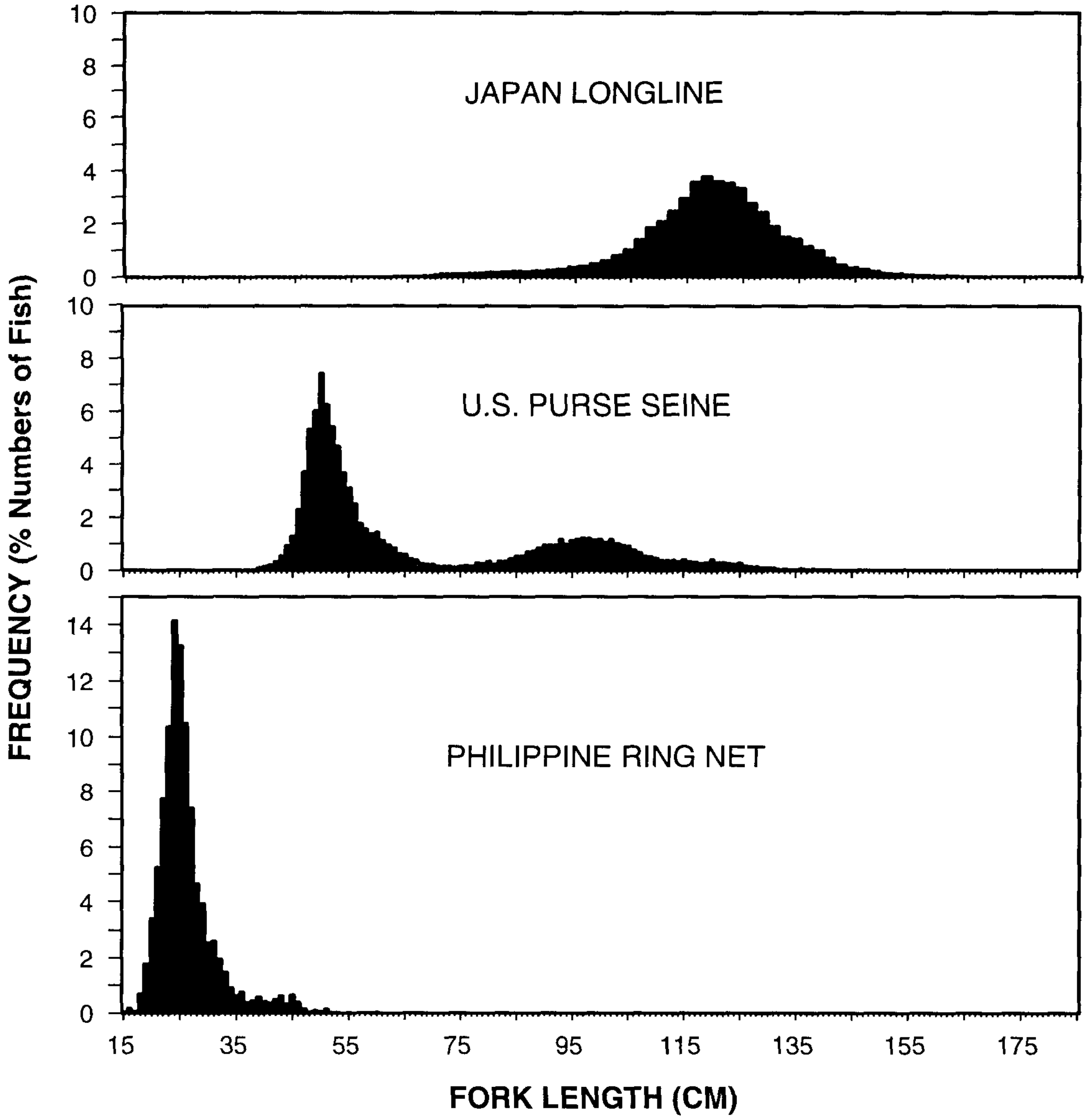

Figure 15. Length-frequency (fork length) distribution of yellowfin tuna caught by different gears in the central-western Pacific Ocean.

recoveries. It is difficult to distinguish among the three hypotheses at present, and additional research will be necessary to resolve the issue.

Further analysis of the tagging data is being planned, as well as investigations on the biological basis for formation of two groups (surface and deep) of yellowfin tuna. One possibility to be investigated is that surface-swimming individuals may have poorly developed swim bladders, whereas their deep-swimming siblings may have more highly developed swim bladders.

8.0 REVIEW OF NEW DEVELOPMENTS

Several new developments in research relevant to yellowfin tuna were reported to the group.

8.1 Archival Tags

A minisymposium on archival tags was held during the 45th Tuna Conference, Lake Arrowhead, California, 23–26 May 1994. Archival tags are designed around a microprocessor and data acquisition system that allows the tag to record data from which daily geographic positions of the fish can be determined. A report on the symposium is being prepared for publication.

Several archival tag developments are worthy of note: The CSIRO of Australia released 100 southern bluefin tuna with archival tags. One tag has been recovered, and the data clearly show migration of the fish along the south coast of Australia. Northwest Marine Technology Inc., Shaw Island, Washington has tested the positional accuracy of a prototype archival tag that does on-board data processing and data compression. Peter Klimley (University of California, Davis) is developing a magnetic sensor for archival tags to improve positional accuracy. The NMFS is conducting an experiment on attaching archival tags to yellowfin tuna at the Kewalo facility in Honolulu, Hawaii.

8.2 Other Developments

No new information was available on stock structure to challenge the assumption that yellowfin tuna within the WPYRG area constitute a functional unit stock for management purposes. The large number of tag returns now available show no substantial movement beyond the area (Figure 2); no new genetic information was available, but CSIRO studies of otolith microchemistry—which produced promising results during a pilot study—are continuing, along with further genetic work.

The Pelagic Fisheries Research Program at the University of Hawaii is sponsoring a project by Peter Klimley (University of California, Davis) to mount acoustic sensors on FADs around Hawaii to monitor acoustic signals from tags on yellowfin tuna. This will provide information on movement and schooling behavior which will be correlated with oceanographic conditions. Also sponsored by the UH program is a project to tag small yellowfin tuna associated with seamounts, and a physiological and behavioral investigation of captive and free-swimming yellowfin tuna by Richard Brill (NMFS, Honolulu).

9.0 FUTURE RESEARCH

9.1. General Suggestions

Discussion centered on the future structure and work load of the WPYRG. Several suggestions were made, including the desirability to:

- Analyze fisheries data within a multispecies framework instead of for only yellowfin tuna in isolation

- Include bigeye tuna research within the WPYRG mandate

- Identify and fill data gaps (see Section 5.3) necessary to meet WPYRG objectives

- Continue to improve and work towards expanding the scope and quality of basic fishery data collection systems

- Get on with the analysis of data already collected, especially through the use of appropriate assessment models

- Combine or streamline the data collection and compilation procedures for the SCTB and WPYRG meetings

- Require fishery reports that include all tropical tuna species taken by the fishery

- Encourage and maximize participation by all scientists monitoring the major fishing fleets at future meetings

- Integrate expertise from the field of economics, social science, and broad-scale oceanography in addressing WPYRG objectives

- Improve catch and effort data collection from small-scale and artisanal tuna fisheries to allow more accurate assessments of fisheries interaction and causes of catch- rate fluctuations

In light of these suggestions, it was noted that future participants in WPYRG meetings should attend the SCTB meetings as well. In this way, database development can be more effectively coordinated and accessibility by researchers clearly defined. The following new studies or direction for WPYRG research were suggested:

- Initiate a study on tuna school dynamics and integrity, including the role of oceanographic factors

- Monitor the ratio of small yellowfin tuna and bigeye tuna to skipjack tuna in log-associated sets, especially in WPYF Area 4 as a way to monitor changes in small-sized yellowfin tuna abundance

- Develop a tagging study that would target the release of significant numbers of large yellowfin tuna vulnerable to longline gear for assessing their subsequent vulnerability to surface and subsurface gears and for contrast to SPC tag results from mainly pole-and-line releases

- Conduct field studies on the size and development of yellowfin tuna swim bladders as a possible indicator of developmental changes that could influence vulnerability to surface and subsurface gears

- Fill data gaps in the Indonesian tuna fishery statistics on a priority basis especially for studying the interaction between Philippine joint-venture purse seine operations and Indonesian domestic pole-and-line fisheries in northern Indonesian waters

- Include catch statistics for all tropical tuna species caught by fisheries for yellowfin tuna in fisheries reports for WPYRG, and provide the statistics for the SCTB and WPYRG meetings

9.2 Work Plan for 1994–95

The following work plan was developed for 1994-95:

- Continue to investigate interaction between longline and purse seine fisheries - NRIFSF

- Identify sources of real-time oceanographic data and maps, and make them available to WPYRG members - John Sibert

- Conduct a literature search and develop a list of possible means to study tuna schooling dynamics and integrity - John Sibert, Pierre Kleiber

- Continue research on the reproductive biology of yellowfin tuna in relation to the possibility of surface and subsurface stocks - Sachiko Tsuji, David Itano

- Investigate the feasibility of and develop the experimental design for a longline-based tagging project - John Hampton, Craig Heberer, David Itano

- Improve data collection and monitoring arrangements between the Philippines and Indonesia fleets for joint-venture fisheries and for interactions with artisanal fishermen - Nurzali Naamin, Reuben Ganaden

- Ensure that small-scale fishery statistics and socio-economic data necessary for addressing local fisheries interaction issues be included, if practical, in the working papers submitted to the FFA-sponsored Multilateral High-Level Conference on South Pacific Tuna Fisheries - Antony Lewis, John Hampton

- Compile species-composition data from western Pacific log-associated purse seine sets and include in fisheries reports for the next meeting - Atilio Coan, NRIFSF, Chi-Lu Sun, Jang-Uk Lee

10.0 ADMINISTRATIVE MATTERS

10.1. FFA-Sponsored Multilateral High-Level Conference

The FFA-sponsored Multilateral High-Level Conference on South Pacific Tuna Fisheries to be held in Honiara (5–9 December 1994) was discussed, and SCTB arrangements for developing two contributing documents for that meeting were felt to be appropriate. The Group agreed to review the documents.

10.2. Future of WPYRG

The chairman solicited the opinion of each participant about continuing the WPYRG and about future research priorities. The Group unanimously endorsed continuing the WPYRG and agreed to meet annually in conjunction with annual SCTB meetings. However, several participants suggested consolidating some of the agenda items that are common to both meetings in order to minimize duplication.

It was generally agreed that the primary WPYRG objectives were still largely unfinished and that the group should continue to work on more focused objectives and strive toward more complete fishery data collection. The need for additional research emphasis on interactions between large- and small-scale fisheries was also highlighted. Finally, the broad representation at the meeting by the major distant-water fishing nations was seen as a highly positive aspect of the WPYRG, and participation by researchers from China in the next meeting was strongly encouraged.

It has been three years since a new chairperson was elected and the chairman felt that it would be good policy to have regular rotation. The Group discussed the merits of a regular rotation (e.g., it would allow opportunity for more members to gain experience and for new research agendas to be championed) as well as the duties of the chairperson, availability of secretarial support, transition requirements, etc. The Group felt that the principal duties of the chairperson are as an impartial judge, consensus builder, and team leader rather than as a competing player with specific research interests. The Group also felt that the chairperson should be from outside the SPC in order to maintain the Group's identity as a separate, informal, and independent group.

Gary Sakagawa pledged to continue to make the current secretarial support available to the new chairperson. The support includes providing mailing labels, typing, data management (e.g., maintaining Appendix D tables), and providing summaries of fishery statistics for meetings, etc.

The Group unanimously elected a scientist from the NRIFSF (Japan) to chair the Group and asked Naozumi Miyabe to pursue this matter with appropriate officials in the NRIFSF. Sachiko Tsuji was later nominated by the NRIFSF.

10.3. Others

The venue and time for the 1995 meeting were briefly reviewed; a final decision was left to the chairperson. This is customary practice in which the chairperson would work with the SPC and consult with key WPYRG members. The WPYRG meeting is customarily held in conjunction with the annual meeting of the SPC SCTB in order to minimize cost. Preliminary information indicated that Australia (Brisbane) and Indonesia (Bali) were candidates for the venue, and the likely time would be in the June–August period.

The Group agreed to follow the customary practice for review and approval of the meeting report. That is, the process is to be handled through correspondence by the chairman. The process includes assembling a draft report as soon as possible after the meeting and mailing it to participants for review. Comments by participants are to be sent to the chairman by a specified time, preferably by FAX or e-mail, for consideration and use in revision of the text. Contentious points are to be resolved by the chairman through consultation with key participants. A second draft will then be produced and mailed for final comments and approval of participants. "No response" from participants will signify approval of the report.

The chairman thanked the host, the staff of the Palau Maritime Authority under the leadership of Noah Idechong, for arranging first-rate accommodations for the meeting and for treating the participants to a taste of Palauan hospitality. Considerable time, resources, and care went into hosting the meeting and were appreciated by the participants. The chairman also thanked Ramon Rechebei and Victorio Uherbelau for inviting the Group to meet in Palau and for supporting the meeting. He noted that Palau and the WPYRG4 meeting will be especially remembered because the participants were in Palau on the eve of the country's independence.

The chairman finally thanked the participants for completing WPYRG assignments and for contributing to another successful meeting. The contributions of the discussion leaders and rapporteurs were particularly appreciated. He noted that the WPYRG concept of cooperation in collaborative research and participation by all interested scientists and fisheries officers is working and has advanced our understanding of the fisheries and population biology and ecology of the central-western Pacific yellowfin tuna. More work, particularly on difficult research questions, still needs to be done, as demonstrated by the long list of future research topics (see Section 9.0). It will take persistence, innovative thinking, and new approaches to find breakthroughs to address the tough research questions as well as to make significant progress with routine tasks, such as collection of fishery statistics. This is the challenge and area in which WPYRG can excel through collaborative efforts to significantly improve the information base so that more-informed and better fishery management decisions can be made.

APPENDIX A

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APPENDIX A. LIST OF PARTICIPANTS

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APPENDIX B

AGENDA

APPENDIX B. AGENDA

I. Introduction

II. Review of Fisheries

1. FSM
2. Indonesia
3. Japan
4. Korea
5. Marshall Islands
6. Palau
7. Philippines
8. Taiwan
9. U.S.
10. Others

III. Review of Research Assignments

1. Assessment model development
2. Growth
3. Reproductive biology
4. CPUE analysis (index of fishery performance)
5. Length-weight data
6. Age validation

IV. Review of Fisheries Statistics

1. Each fishery
2. SPRTRAMP

V. Review of Stock Status

1. Assessment information
2. Biological information
3. Fisheries information

VI. Review of Fishery Interaction

1. Assessment information
2. Biological information
3. Fisheries information

VII. Review of New Developments

VIII. Future Direction

IX. Adoption of Report

X. Adjourn

APPENDIX C

LIST OF WORKING DOCUMENTS

APPENDIX C. LIST OF WORKING DOCUMENTS

DOCUMENT NUMBER	TITLE/AUTHOR
WPYRG4/1	U.S. fisheries catching yellowfin tuna in the central and western Pacific, 1992–1994. *(Atilio L. Coan, Jr. and Doug Prescott)*
WPYRG4/2	Progress report on a large-scale investigation on the reproductive biology of yellowfin tuna in the central and western Pacific region. *(David Itano)*
WPYRG4/3	Report of WPYRG yellowfin assessment model development workshop, Honolulu, November 8–12, 1993. *(Pierre Kleiber)*
WPYRG4/4	Yield per recruit: Is there potential benefit from a size limit on skipjack and yellowfin catch? *(Pierre Kleiber)*
WPYRG4/5	Yellowfin tuna length-weight sampling in the southwestern Pacific: A progress report. *(Atilio L. Coan, Jr. and Gordon Yamasaki)*
WPYRG4/6	Indonesian fisheries for yellowfin tuna in the western Pacific–eastern Indonesia *(Nurzali Naamin)*
WPYRG4/7	1993–1994 size composition data for yellowfin tuna collected by the port sampling and fisheries observer programs of the Micronesian Maritime Authority. *(Craig F. Heberer)*
WPYRG4/8	Yellowfin tuna landings in Fiji 1974–1993. *(S. Sharma)*
WPYRG4/9	Taiwan fisheries for yellowfin tuna in the central and western Pacific, 1992–94. *(Chi-Lu Sun and Su-Zan Yeh)*
WPYRG4/10	Nonequilibrium production model of yellowfin tuna in the central and western Pacific. *(Chi-Lu Sun and Su-Zan Yeh)*

DOCUMENT NUMBER	TITLE/AUTHOR
WPYRG4/11	Standardized CPUEs of central and western Pacific yellowfin tuna from Taiwanese distant-water fisheries. *(Chi-Lu Sun and Su-Zan Yeh)*
WPYRG4/12	Korean longline and purse seine fisheries for yellowfin tuna in the central and western Pacific Ocean. *(Jang-Uk Lee and Tae-Ik Kim)*
WPYRG4/13	Japanese yellowfin tuna fisheries in the western and central Pacific and updated CPUE from those fisheries. *(Naozumi Miyabe)*
WPYRG4/14	Project proposal. Stock and fishery dynamics of yellowfin tuna, *Thunnus albacares*, in the western and central Pacific Ocean: Development of an integrated model incorporating size and spacial structure. *(John Hampton)*
WPYRG4/15	Tuna fishery statistics for the tropical western Pacific Ocean. *(Tim Lawson)*
WPYRG4/16	Interaction between surface and longline fisheries for yellowfin. *(John Hampton and Naozumi Miyabe)*

APPENDIX D

FISHERIES STATISTICS FOR YELLOWFIN TUNA CAUGHT IN THE CENTRAL AND WESTERN PACIFIC OCEAN AND MONITORED BY WPYRG

APPENDIX D. Fisheries statistics for yellowfin tuna caught in the central and western Pacific Ocean and monitored by WPYRG

Table D1. Total catches (t) of yellowfin tuna (sum of Tables D2-D5) by country from the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. (Table D1 continues on the next page.)

Table D2. Longline catches (t) of yellowfin tuna by country from the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

Table D3. Purse seine catches (t) of yellowfin tuna by country from the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

Table D4. Pole-and-line catches (t) of yellowfin tuna by country from the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

Table D5. Unclassified (UNCL) or handline, gillnet, troll and other gear catches (t) of yellowfin tuna by country from the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

Table D6. Total longline catch (t) of yellowfin tuna by WPYF area.

Table D7. Total purse seine catch (t) of yellowfin tuna by WPYF area.

Table D8. Number of longline vessels by countries fishing for tunas in the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

Table D9. Number of purse seine vessels fishing for tunas in the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

Table D10. Number of pole-and-line vessels fishing for tunas in the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following this table.

Table D1. Total catches (t) of yellowfin tuna (sum of Tables D2-D5) by country from the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. (Table D1 continues on the next page.)

YEAR	AUSTRALIA	CHINA	FSM	FIJI	FRENCH POLYNESIA	INDONESIA	JAPAN	KIRIBATI	KOREA
1970	-	-	-	-	-	5,500	45,354	-	1,500
1971	-	-	-	-	-	5,700	41,934	-	3,975
1972	-	-	-	-	-	9,000	46,573	-	8,850
1973	-	-	-	-	-	10,200	48,006	-	9,000
1974	-	-	-	12	-	10,165	49,110	-	11,328
1975	-	-	-	11	-	11,062	47,572	-	7,783
1976	1	-	-	83	-	8,037	55,200	-	13,957
1977	-	-	-	151	-	10,859	63,882	-	15,571
1978	16	-	-	409	-	10,601	83,741	-	13,185
1979	-	-	-	403	161	14,663	89,336	-	17,781
1980	-	-	-	233	253	17,550	100,792	-	21,645
1981	-	-	-	599	472	21,889	97,854	210	9,038
1982	5	-	-	813	368	24,313	93,506	170	10,452
1983	-	-	-	565	238	20,200	98,161	239	7,852
1984	-	-	-	580	426	26,450	92,959	528	6,462
1985	-	-	-	727	243	29,587	113,904	503	9,511
1986	-	-	-	825	232	34,328	91,232	721	8,075
1987	1,487	-	-	412	149	40,785	89,353	156	24,941
1988	1,180	-	-	535	274	43,199	82,765	383	24,329
1989	942	-	-	542	187	45,268	86,242	848	41,823
1990	1,832	-	-	559	55	48,087	83,692	143	43,439
1991	2,105	341	1,191	477	105	52,825	82,238	67	60,052
1992	1,528	1,124	3,680	612	270	55,325	91,153	303	76,863
1993	972	2,259	4,718	765	449	(60,610)	(94,005)	161	59,387

YEAR	MARSHALL ISLANDS	MEXICO	NEW CALEDONIA	NEW ZEALAND	PALAU	PAPUA NEW GUINEA	PHILIPPINES	RUSSIA	SOLOMON ISLANDS
1970	-	-	-	-	1	74	(32,000)	-	-
1971	-	-	-	-	10	112	(35,800)	-	141
1972	-	-	-	-	56	1,345	(37,200)	-	237
1973	-	-	-	-	41	916	(44,500)	-	286
1974	-	-	-	1	161	1,416	(51,732)	-	310
1975	-	-	-	1	298	1,744	(52,793)	-	215
1976	-	-	-	-	412	8,563	(32,323)	-	620
1977	-	-	-	-	420	4,009	(50,801)	-	561
1978	-	-	-	15	303	3,099	35,921	-	731
1979	-	-	-	16	1	2,881	47,496	-	1,207
1980	-	-	-	51	996	3,018	45,608	-	1,671
1981	-	-	3	26	2,480	4,205	55,663	-	1,753
1982	-	-	41	2	615	-	51,840	-	1,987
1983	-	-	32	240	0	-	60,920	-	3,633
1984	-	1,174	25	233	0	274	58,088	-	3,007
1985	-	-	119	171	15	930	62,280	570	3,216
1986	-	-	151	7	19	0	59,151	432	2,616
1987	-	-	449	7	22	0	51,295	3,381	6,350
1988	-	-	436	5	38	0	(57,060)	850	6,319
1989	-	-	248	9	5	0	(62,146)	1,535	5,885
1990	-	-	551	4	8	0	(81,103)	621	6,134
1991	-	-	506	6	-	0	(95,594)	1,114	4,228
1992	9	-	230	8	14	0	(45,026)	437	6,339
1993	38	-	387	8	14	0	(38,198)	5,215	9,398

Table D1. (continued)

YEAR	TAIWAN	TONGA	TUVALU	USA	TOTAL
1970	10,387	-	-	320	95,136
1971	14,143	-	-	388	102,202
1972	12,696	-	-	357	116,314
1973	18,842	-	-	340	132,131
1974	12,425	-	-	519	137,179
1975	16,520	-	-	761	138,759
1976	17,070	-	-	1,039	137,305
1977	20,022	-	-	1,132	167,408
1978	23,960	-	-	1,132	173,113
1979	27,338	-	-	1,704	202,988
1980	24,691	-	-	2,708	219,081
1981	19,990	-	-	14,860	229,042
1982	17,818	81	53	23,269	225,333
1983	17,069	48	51	51,053	260,301
1984	17,957	55	27	46,607	254,852
1985	15,981	44	-	30,627	268,428
1986	14,890	33	12	38,821	251,544
1987	22,077	32	90	68,407	309,393
1988	25,414	26	21	27,015	269,848
1989	23,672	27	7	43,551	312,937
1990	27,746	28	26	59,124	353,152
1991	26,536	19	6	36,700	364,110
1992	55,995	19	2	51,582	390,518
1993	74,648	35	0	45,917	397,183

Table D2. Longline catches (t) of yellowfin tuna by country from the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

YEAR	AUSTRALIA[1]	CHINA[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	-	-	-	-	-	2,437	6,199	32,161	5,648
1987	1,487	-	-	-	-	9,254	7,148	29,237	7,558
1988	1,150	-	-	-	-	9,717	7,528	37,827	9,769
1989	864	-	-	10	-	5,124	7,685	29,878	7,291
1990	770	-	-	23	-	5,508	7,800	32,408	8,674
1991	742	341	6	106	-	6,059	8,034	22,544	4,636
1992	886	1,124	79	202	137	6,242	8,452	22,983	9,881
1993	(547)	2,259	55	324	366	6,554	(8,452)	(22,983)	6,728

YEAR	MARSHALL ISLANDS[2]	NEW CALEDONIA[8]	PHILIPPINES[9]	SOLOMON ISLANDS[2]	TAIWAN[10]		TONGA[2]	USA[11]	TOTAL
					DIST.-WATER	OFFSHORE			
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	60,692
1987	-	449	3,775	0	371	14,061	32	272	73,644
1988	-	436	3,196	0	1,256	14,337	26	590	85,832
1989	-	248	3,481	0	651	11,933	27	998	68,190
1990	-	551	214	0	1,098	10,801	28	998	68,873
1991	-	506	255	0	665	8,689	19	726	53,328
1992	9	230	1,219	0	841	10,151	19	429	62,884
1993	38	387	(1,031)	0	1,088	11,001	35	738	62,586

Table D3. Purse seine catches (t) of yellowfin tuna by country from the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

YEAR	AUSTRALIA[12]	FSM[3]	INDONESIA[5]	JAPAN[6]	KOREA[34]	MEXICO[2]	NEW ZEALAND[2]
1970	-	-	-	164	-	-	-
1971	-	-	-	2,867	-	-	-
1972	-	-	-	4,184	-	-	-
1973	-	-	-	7,281	-	-	-
1974	-	-	-	9,419	-	-	-
1975	-	-	-	5,595	-	-	-
1976	-	-	-	7,649	-	-	-
1977	-	-	-	6,807	-	-	-
1978	-	-	-	8,523	-	-	-
1979	-	-	-	19,013	-	-	-
1980	-	-	2,177	19,701	68	-	-
1981	-	-	2,275	27,161	582	-	-
1982	-	-	1,428	31,035	2,042	-	-
1983	-	-	2,013	30,819	799	-	239
1984	-	-	2,108	38,647	416	1,174	231
1985	-	-	2,107	47,925	1,624	-	170
1986	-	-	1,650	44,463	2,427	-	-
1987	-	-	1,683	44,504	17,383	-	-
1988	30	-	1,767	30,106	14,560	-	-
1989	15	-	2,520	40,872	34,532	-	-
1990	1,040	-	2,665	37,617	34,765	-	-
1991	1,353	1,185	2,500	46,255	55,416	-	-
1992	633	3,601	2,200	52,889	66,982	-	-
1993	405	4,663	4,829	(55,741)	52,659	-	-

YEAR	PHILIPPINES[9]		RUSSIA[2]	SOLOMON ISLANDS[2]	TAIWAN[13]	USA[11]	TOTAL
	Purse seine	Ringnet					
1970	(4,920)	(1,772)	-	-	-	-	6,856
1971	(5,504)	(1,982)	-	-	-	-	10,353
1972	(5,719)	(2,060)	-	-	-	-	11,963
1973	(6,842)	(2,464)	-	-	-	-	16,587
1974	(7,954)	(2,865)	-	-	-	-	20,238
1975	(8,117)	(2,923)	-	-	-	-	16,635
1976	(4,969)	(1,790)	-	-	-	200	14,608
1977	(7,810)	(2,813)	-	-	-	200	17,630
1978	4,133	1,010	-	-	-	200	13,866
1979	8,760	3,541	-	-	-	559	31,873
1980	8,188	4,275	-	449	-	1,059	35,917
1981	14,343	3,839	-	1,342	-	12,973	62,515
1982	16,288	1,388	-	1,444	-	22,011	75,636
1983	17,418	3,361	-	2,530	-	49,599	106,778
1984	18,728	4,261	-	2,397	252	45,090	113,304
1985	15,381	6,210	570	2,882	1,007	29,012	106,889
1986	12,640	4,951	432	2,258	2,869	36,608	108,298
1987	15,171	2,916	3,381	3,385	4,579	66,359	159,361
1988	(14,368)	(4,064)	850	4,068	6,238	25,211	101,262
1989	(15,648)	(4,427)	1,535	4,410	10,604	41,640	156,203
1990	21,571	8,192	621	3,825	13,694	57,132	181,121
1991	23,981	2,977	1,114	3,275	16,358	34,987	189,401
1992	12,105	2,716	437	5,093	44,459	50,258	(241,373)
1993	(10,275)	(2,292)	5,215	5,706	62,241	44,164	(248,190)

Table D4. Pole-and-line catches (t) of yellowfin tuna by country from the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

YEAR	AUSTRALIA[2]	FIJI[14]	FRENCH POLYNESIA[2]	INDONESIA[5]	JAPAN[15]	KIRIBATI[2]	NEW CALEDONIA[2]
1970	-	-	-	-	-	-	-
1971	-	-	-	-	345	-	-
1972	-	-	-	-	294	-	-
1973	-	-	-	-	55	-	-
1974	-	12	-	-	-	-	-
1975	-	11	-	-	55	-	-
1976	1	83	-	507	-	-	-
1977	-	151	-	591	1,676	-	-
1978	16	409	-	1,160	769	-	-
1979	-	403	161	1,907	5,833	-	-
1980	-	233	253	2,269	6,188	-	-
1981	-	599	472	2,015	9,050	210	3
1982	5	813	368	1,887	9,490	170	41
1983	-	562	238	1,900	9,326	239	25
1984	5	580	426	2,282	8,690	528	0
1985	-	724	243	2,344	12,920	503	0
1986	-	823	232	2,278	8,410	721	0
1987	-	410	149	2,323	8,464	156	0
1988	-	526	274	2,439	7,304	383	0
1989	63	506	187	3,553	7,808	848	0
1990	22	516	55	4,433	5,867	143	0
1991	10	358	105	5,472	5,405	67	0
1992	3	395	133	5,319	6,829	303	0
1993	4	337	83	5,585	(6,829)	161	0

YEAR	NEW ZEALAND[2]	PALAU[2]	PAPUA NEW GUINEA[2]	SOLOMON ISLANDS[2]	TUVALU[2]	USA[11]	TOTAL
1970	-	1	74	-	-	18	93
1971	-	10	112	141	-	22	630
1972	-	56	1,345	237	-	25	1,957
1973	-	41	916	195	-	14	1,221
1974	-	161	1,416	310	-	23	1,922
1975	-	298	1,744	215	-	25	2,348
1976	-	412	8,563	474	-	43	10,083
1977	-	420	4,009	363	-	21	7,231
1978	-	303	3,099	524	-	62	6,342
1979	-	1	2,881	714	-	49	11,949
1980	-	996	3,018	658	-	91	13,706
1981	-	2,480	4,205	265	-	89	19,388
1982	-	615	-	237	53	106	13,785
1983	-	0	-	660	51	55	13,056
1984	-	0	274	397	27	54	13,263
1985	-	15	930	183	-	103	17,965
1986	-	19	0	358	12	114	12,967
1987	-	22	0	2,965	90	78	14,657
1988	-	38	0	2,251	21	76	13,312
1989	-	5	0	1,475	7	10	14,462
1990	-	8	0	2,309	26	17	(13,396)
1991	2	-	0	953	6	20	(12,398)
1992	-	14	0	1,246	2	19	(14,263)
1993	-	14	0	3,692	0	4	(16,709)

Table D5. Unclassified (UNCL) or handline, gillnet, troll and other gear catches (t) of yellowfin tuna by country from the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

YEAR	FIJI[16]	INDONESIA[5]		NEW ZEALAND[17]	PHILIPPINES[18]		
	TROLL	UNCL	HANDLINE	UNCL	UNCL	GILLNET	HANDLINE
1970	-	5,500	-	-	(197)	(2,664)	(21,835)
1971	-	5,700	-	-	(219)	(2,981)	(24,429)
1972	-	9,000	-	-	(228)	(3,097)	(25,384)
1973	-	10,200	-	-	(273)	(3,705)	(30,365)
1974	-	10,165	-	1	(316)	(4,307)	(35,300)
1975	-	11,062	-	1	(324)	(4,395)	(36,024)
1976	-	7,530	-	-	(199)	(2,691)	(22,056)
1977	-	10,268	-	-	(311)	(4,230)	(34,665)
1978	-	8,225	-	15	230	4,918	24,941
1979	-	11,482	-	16	281	2,027	31,980
1980	-	11,626	-	51	432	2,301	29,235
1981	-	15,793	-	26	953	2,655	32,254
1982	-	17,393	-	2	1,055	1,386	29,826
1983	3	15,239	-	1	3,661	1,260	32,396
1984	-	18,140	2,250	2	649	2,161	31,005
1985	3	20,130	2,540	1	1,325	2,040	35,505
1986	2	25,226	2,737	7	824	2,137	36,188
1987	2	24,732	2,793	7	866	2,160	26,407
1988	9	26,377	2,899	5	(873)	(2,220)	(32,339)
1989	26	31,345	2,726	9	(951)	(2,418)	(35,221)
1990	20	32,285	3,196	4	47,569	811	2,746
1991	13	34,959	3,835	4	45,488	21	22,872
1992	15	36,770	4,794	8	3,047	1,758	24,181
1993	104	38,608	5,034	(8)	(2,598)	(1,490)	(20,512)

YEAR	TAIWAN[19]	USA[20]	AUSTRALIA[33]	TOTAL[21]
	UNCL	UNCL	TROLL	
1970	406	51	-	30,653
1971	363	175	-	33,867
1972	331	189	-	38,229
1973	441	238	-	45,222
1974	334	370	-	50,793
1975	426	652	-	52,884
1976	1,359	685	-	34,520
1977	428	735	-	50,637
1978	1,517	698	-	40,544
1979	1,743	863	-	48,392
1980	901	1,063	-	45,609
1981	634	1,184	-	53,499
1982	565	755	-	50,982
1983	317	843	-	53,720
1984	1,037	856	-	56,100
1985	825	1,046	-	63,415
1986	847	1,620	-	69,588
1987	3,066	1,698	-	61,731
1988	3,583	1,138	-	69,443
1989	484	903	-	74,083
1990	2,153	977	-	89,761
1991	824	967	-	(108,983)
1992	544	876	6	(71,999)
1993	318	1,011	16	(69,699)

Table D6. Total longline catch (t) of yellowfin tuna by WPYF area.

YEAR	WPYF AREA							TOTAL
	1	2	3	4	5	6	7	
1970	1,715	2,039	12,314	19,847	14,511	2,396	492	53,314
1971	1,061	1,614	9,730	27,717	11,042	3,005	126	54,295
1972	570	924	6,371	28,378	22,110	1,811	208	60,371
1973	1,002	801	20,181	31,237	11,167	2,093	44	66,525
1974	1,232	704	24,531	19,448	13,090	2,675	69	61,749
1975	950	778	31,045	18,274	9,056	1,482	61	61,647
1976	1,361	1,090	26,815	25,850	13,721	1,285	778	70,901
1977	760	1,033	25,786	44,238	11,745	571	185	84,319
1978	553	924	38,358	52,274	10,231	1,754	295	104,390
1979	1,252	1,403	38,340	44,589	16,244	1,966	309	104,103
1980	2,155	841	32,606	58,516	21,316	1,893	710	118,037
1981	1,642	644	27,488	46,921	8,432	3,141	478	88,747
1982	1,144	651	23,942	39,091	12,262	2,207	256	79,553
1983	1,313	451	24,170	40,166	12,743	1,602	98	80,543
1984	1,183	645	21,124	29,887	11,778	1,342	194	66,152
1985	865	539	19,694	36,769	11,794	2,606	261	72,526
1986	1,226	399	16,841	23,913	10,121	2,204	138	54,841
1987	870	682	27,951	22,303	10,380	4,692	138	67,016
1988	1,265	1,646	27,455	29,057	9,179	7,413	98	76,113
1989	1,224	1,617	22,080	21,387	7,882	5,138	95	59,424
1990	1,300	1,867	18,704	22,316	11,871	5,315	75	61,448

Table D7. Total purse seine catch (t) of yellowfin tuna by WPYF area.

YEAR	WPYF AREA							TOTAL
	1	2	3	4	5	6	7	
1970	0	0	6,692	164	0	0	0	6,856
1971	0	0	7,486	2,867	0	0	0	10,353
1972	0	0	7,779	4,184	0	0	0	11,963
1973	0	0	9,306	7,281	0	0	0	16,587
1974	0	0	10,819	9,419	0	0	0	20,238
1975	0	0	11,040	5,595	0	0	0	16,635
1976	0	0	6,759	7,849	0	0	0	14,608
1977	0	0	10,623	7,041	0	0	0	17,664
1978	0	0	5,143	8,723	0	0	0	13,866
1979	0	0	12,301	19,572	0	0	0	31,873
1980	0	0	14,640	21,334	0	0	0	35,974
1981	0	0	20,755	41,095	257	226	0	62,333
1982	0	0	19,209	55,338	1,047	0	0	75,594
1983	0	0	23,050	74,645	8,744	239	0	106,678
1984	0	0	25,402	87,231	84	231	0	112,948
1985	0	0	23,958	81,516	1,193	170	0	106,837
1986	0	0	19,922	88,258	95	0	0	108,275
1987	0	0	19,770	131,448	10,260	0	0	161,478
1988	0	0	21,058	81,796	319	0	0	103,173
1989	0	0	23,871	132,456	0	60	0	156,387
1990	0	0	17,804	134,570	20,952	0	0	173,326

Table D8. Number of longline vessels by countries fishing for tunas in the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

YEAR	AUSTRALIA[22]	CHINA[2]	FSM[3]	FIJI[4]	FRENCH POLYNESIA[2]	INDONESIA[5]	JAPAN[23] (ALL OCEANS)	KOREA[24]	MARSHALL ISLANDS[2]
1970	-	-	-	-	-	-	-	105	-
1971	-	-	-	-	-	-	-	122	-
1972	-	-	-	-	-	-	-	178	-
1973	-	-	-	-	-	-	-	222	-
1974	-	-	-	-	-	-	-	270	-
1975	-	-	-	-	-	-	-	253	-
1976	-	-	-	-	-	-	-	257	-
1977	-	-	-	-	-	-	-	217	-
1978	-	-	-	-	-	-	-	223	-
1979	-	-	-	-	-	-	-	216	-
1980	-	-	-	-	-	-	-	211	-
1981	-	-	-	-	-	-	-	209	-
1982	-	-	-	-	-	-	-	121	-
1983	-	-	-	-	-	-	-	102	-
1984	-	-	-	-	-	-	-	96	-
1985	-	-	-	-	-	28	-	94	-
1986	-	-	-	-	-	63	-	134	-
1987	64	-	-	-	-	79	-	138	-
1988	62	-	-	-	-	70	-	124	-
1989	93	-	-	4	-	138	-	152	-
1990	98	-	-	6	-	151	773	182	-
1991	82	34	2	9	-	145	762	220	-
1992	98	72	6	18	19	141	760	166	4
1993	79	308	7	21	49	309	1,150	148	5

YEAR	NEW CALEDONIA[8]	PHILIPPINES[25]	SOLOMON ISLANDS[2]	TAIWAN[26]		TONGA[2]	USA[11]	TOTAL
				DISTANT-WATER	OFFSHORE			
1970	-	-	-	-	829	-	45	979
1971	-	-	-	-	863	-	46	1,031
1972	-	-	-	-	899	-	42	1,119
1973	-	-	2	-	1,255	-	32	1,511
1974	-	-	-	-	1,451	-	33	1,754
1975	-	-	-	92	1,411	-	31	1,787
1976	-	-	2	194	1,331	-	33	1,817
1977	-	-	2	176	1,382	-	35	1,812
1978	-	-	2	168	1,670	-	29	2,092
1979	-	-	2	157	1,840	-	21	2,236
1980	-	-	2	182	1,900	-	11	2,306
1981	-	-	2	140	1,846	-	13	2,210
1982	-	61	2	115	1,831	1	10	2,141
1983	1	62	2	65	1,872	1	18	2,123
1984	2	62	2	61	1,944	1	23	2,191
1985	3	55	2	44	2,129	1	23	2,379
1986	2	41	0	51	2,084	1	21	2,397
1987	3	62	0	60	2,207	1	37	2,651
1988	4	27	0	70	1,977	1	50	2,385
1989	4	3	0	85	1,671	1	80	2,231
1990	7	26	0	96	1,139	1	138	2,617
1991	6	(12)	0	82	800	1	140	2,295
1992	4	10	0	92	1,898	1	129	3,418
1993	4	10	0	119	1,791	7	(129)	4,136

Table D9. Number of purse seine vessels fishing for tunas in the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following Table D10.

YEAR	AUSTRALIA[27]	FSM[3]	INDONESIA[5]	JAPAN[28]	KOREA[29]	MEXICO[2]	NEW ZEALAND[2]
1970	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-
1977	-	-	-	13	-	-	-
1978	-	-	-	16	-	-	-
1979	-	-	-	16	-	-	-
1980	-	-	-	18	2	-	-
1981	-	-	-	28	3	-	-
1982	-	-	-	39	10	-	-
1983	-	-	-	41	11	-	7
1984	-	-	3	48	12	2	5
1985	-	-	3	40	11	-	5
1986	-	-	3	40	13	-	-
1987	-	-	3	37	20	-	-
1988	3	-	3	40	23	-	-
1989	1	-	3	36	30	-	-
1990	9	-	3	38	39	-	-
1991	4	3	3	45	36	-	-
1992	3	4	3	37	36	-	-
1993	3	8	3	(37)	34,-	-	

YEAR	PHILIPPINES[30]		RUSSIA[2]	SOLOMON ISLANDS[2]	TAIWAN[13]	USA[11]	TOTAL
	DW	LOCAL					
1970	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	3
1977	-	-	-	-	-	-	1
1978	-	-	-	-	-	-	2
1979	-	-	-	-	-	-	8
1980	-	-	570	-	1	-	14
1981	-	-	697	-	1	-	14
1982	-	(1)	785	-	1	-	24
1983	7	0	686	-	1	-	62
1984	5	(3)	712	-	1	5	61
1985	5	(5)	724	5	1	5	40
1986	-	(5)	685	8	1	11	36
1987	-	(5)	813	5	2	15	35
1988	-	(9)	779	5	4	24	32
1989	-	(14)	198	5	4	22	34
1990	-	(13)	549	5	4	31	41
1991	-	(15)	546	4	3	40	42
1992	-	(15)	407	3	3	43	46
1993	-	(15)	(399)	6	3	43	42

Table D10. Number of pole-and-line vessels fishing for tunas in the central and western Pacific Ocean, 1970–93. Dash (-) indicates missing or unavailable data; values in parentheses are estimates. See List of Footnotes following this table.

YEAR	AUSTRALIA[2]	FIJI[31]	FRENCH POLYNESIA[2]	INDONESIA[5]	JAPAN[32]	KIRIBAIT[2]	NEW CALEDONIA[8]
1970	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-
1976	9	2	-	-	-	-	-
1977	-	6	-	-	-	-	-
1978	14	6	-	-	-	-	-
1979	-	8	-	-	625	1	-
1980	-	11	46	-	575	-	-
1981	-	12	51	-	560	2	1
1982	20	14	46	-	450	2	3
1983	-	13	46	-	425	4	3
1984	8	11	51	-	400	4	0
1985	-	7	49	1,115	375	4	0
1986	5	6	51	1,287	360	4	0
1987	5	8	64	1,170	350	4	0
1988	18	11	53	1,577	275	5	0
1989	15	14	56	921	265	6	0
1990	17	14	55	900	255	5	0
1991	16	11	31	872	(255)	3	0
1992	3	11	36	849	(255)	3	0
1993	3	10	24	823	(255)	3	0

YEAR	NEW ZEALAND[2]	PALAU[2]	PAPUA NEW GUINEA[2]	SOLOMON ISLANDS[2]	TUVALU[2]	USA[11]	TOTAL
1970	-	10	5	-	-	-	15
1971	-	20	29	-	-	-	49
1972	-	11	45	-	-	-	56
1973	-	12	43	11	-	-	66
1974	-	24	47	11	-	-	82
1975	-	21	48	12	-	-	81
1976	-	33	40	14	-	-	98
1977	-	23	51	20	-	-	100
1978	-	26	48	20	-	-	114
1979	-	21	45	21	-	-	721
1980	-	31	50	22	-	-	735
1981	-	36	44	23	-	-	729
1982	-	20	-	25	1	-	581
1983	-	0	-	27	1	-	519
1984	-	0	-	30	1	-	505
1985	-	1	-	33	1	-	1,585
1986	-	1	0	35	1	-	1,750
1987	-	1	0	34	1	-	1,637
1988	-	1	0	34	1	-	1,975
1989	-	1	0	33	1	-	1,312
1990	-	1	0	33	1	-	1,281
1991	4	-	0	32	1	-	1,225
1992	-	1	0	32	1	-	1,191
1993	-	1	0	27	(1)	-	1,147

List of Footnotes (Appendix D Tables)

[1]From logbooks, P. Ward (pers. comm.). 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. Data for 1992 and 1993 supplied by K. McLoughlin (pers comm.).

[2]From South Pacific Commission Tuna Fishery Yearbook, 1993.

[3]From SPC Regional Tuna Bulletin (3rd quarter 1992) for 1991 and Micronesian Maritime Authority actual unloadings for 1992 and 1993.

[4]From S. P. Sharma (pers. comm.).

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

[6]From logbooks, N. Miyabe (pers. comm.).

[7]Data from J.-U. Lee (pers. comm.).

[8]From R. E. Bonnin (pers. comm.).

[9]From BFAR Fisheries Statistics, R. Ganaden (pers. comm.). Ring net and purse seine catches for 1988–89 and 1970–77 were prorated using data for 1986–87 and 1978–79, respectively. Catches for 1990 and 1991 were apportioned between gears using data in the South Pacific Commission Tuna Fishery Yearbook, 1993.

[10]From logbooks for the distant-water fleet and landings for the offshore fleet, C.-L. Sun (pers. comm.). Micronesian longline catches were included in the offshore category from South Pacific Commission Fishery Yearbook, 1993.

[11]From landings, A. Coan (pers. comm.). Landings and number of vessels for 1992 and 1993, U.S. joint ventures in the Marshall Islands included from South Pacific Commission Tuna Fishery Yearbook, 1993.

[12]From P. Ward (pers. comm.). Data for 1992 and 1993 from K. McLoughlin (pers. comm.).

[13]From landings, C.-L. Sun (pers. comm.).

[14]From landings, S. P. Sharma (pers. comm.). Data cross-checked with logbooks; 1989 data include 15 t from purse seiners.

[15]From N. Miyabe (pers. comm.).

[16]From S. P. Sharma (pers. comm.). Data from artisanal and commercial fisheries.

[17]From FAO statistics for 1970–84 and from logbooks for 1985–90, T. Murray (pers. comm.). Includes chartered Japanese vessel catches not reported by Japan. Gears are primarily longline and troll. Recreational troll catches (t to about 45 t per year) are not included.

[18]From BFAR Fisheries Statistics, R. Ganaden (pers. comm.). Catches for 1970–77 and 1988-89 were prorated using 1978–79 and 1986–87 data, respectively. Catches for 1990 and 1991 were apportioned between gears using data in the South Pacific Commission Tuna Fishery Yearbook, 1993. UNCL gear includes seine nets and bag nets.

[19]From C.-L. Sun (pers. comm.). Includes troll and pole-and-line gears.

[20]From landings, A. Coan (pers. comm.). Includes catches by handline, troll, and some pole-and-line gears.

[21]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.

[22]From P. Ward (pers. comm.). Data for 1992 and 1993 from K. McLoughlin (pers. comm.).

[23]From N. Miyabe (pers. comm.).

[24]From J. -U. Lee (pers.comm.). Data represent number of vessels in the entire Pacific.

[25]From BFAR Fisheries Statistics, R. Ganaden (pers. comm.).

[26]From Fisheries Yearbook, C.-L. Sun (pers. comm.). Distant-water fleet operates Pacific-wide. 1993 data include Taiwanese longline vessels fishing in FSM and may be double counted.

[27]From P. Ward (pers. comm.). Data for 1992 and 1993 from K. Mcoughlin (pers. comm.).

[28]From N. Miyabe (pers. comm.).

[29]From J.-U. Lee (pers. comm.).

[30]From BFAR Fisheries Statistics, R. Ganaden (pers. comm.). Data include ring net fleet.

[31]From landings, Fiji Fisheries Department, S. P. Sharma (pers. comm.). Data cross-checked with logbooks submitted to Fiji Fisheries Department.

[32]From N. Miyabe (pers. comm.).

[33]From K. McLoughlin (pers. comm.).

[34]From J.-U. Lee (pers. comm.).

[35]Japan coastal longline catches not included.