

Tuna Fisheries in the Federated States of Micronesia, 1979–90.

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Introduction

The Federated States of Micronesia (FSM) is a sovereign nation consisting of more than 600 islands lying between the equator and lat. 14°N in a band from long. 135°E to 166°E in the tropical western Pacific Ocean (Fig. 1). The Exclusive Economic Zone (EEZ) encloses more than 2,978,000 km² of ocean, including some of the world's richest tuna fishing grounds, and is fished by mostly foreign pole-and-line, longline, and purse seine fleets.

Since 1979, when a management regime was introduced, the catch has risen substantially, and there have been significant changes in fleet size and composition. With a land area of only 271 mi.² and a population of about 100,000 (Anonymous, 1990a), the economy relies heavily on revenues derived from fishing. Initially, the aim of management was to maximize revenue from license fees. The number of vessels was not restricted and license fees grew to comprise a major portion of the national revenue. The introduc-

tion of purse seining and the rapid increase in landings led to concern over possible overexploitation and the effects of fishery interactions. Management objectives now emphasize stock assessment and the evaluation of the effects of fishing as well as securing an equitable return from foreign vessels.

This paper outlines tuna fishery developments and changes in management aims since 1979. The status of stocks is reviewed and the approach to setting harvest levels is discussed.

The Fisheries

Prior to 1979

Commercial tuna fishing in Micronesia was initiated by the Japanese after they took control of the region from Germany at the start of World War I. The Japanese surveyed the resource in the 1920's (Smith, 1947) and began pole-and-line fishing from Palau in 1925. By 1937 the catch of skipjack tuna, *Katsuwonus pelamis*, in Micronesia had reached 33,000 metric tons (t), with 12,433 t landed in Chuuk and 4,064 t in Pohnpei (Wilson, 1971). The fishery was interrupted by World War II and resumed in the late 1950's with vessels carrying bait from Japan. During the 1960's, the pole-and-line fishery produced about 30,000 t per year (Skipjack Programme, 1980), and catch rates remained high during the 1970's (Anonymous, 1978), peaking at about 50,000 t per annum in 1976 when effort was high. Japanese longline vessels targeting yellowfin tuna, *Thunnus albacares*, began to fish Micronesian waters in the early 1950's. They were followed by Korean and Taiwanese longliners in the late 1960's (Skipjack Programme, 1981).

Several purse seine pilot studies undertaken by Japanese and U.S. fisher-

men in the early 1970's led to the introduction of large-scale purse seining in the region in 1980 (Anonymous, 1980). The development of purse seining up to 1981 is detailed by Franklin.¹

The FSM fisheries are seasonal and characterized by temporal changes in vessel numbers, type, and flag. A brief description of each fishery since 1979 is given below.

Pole-and-line

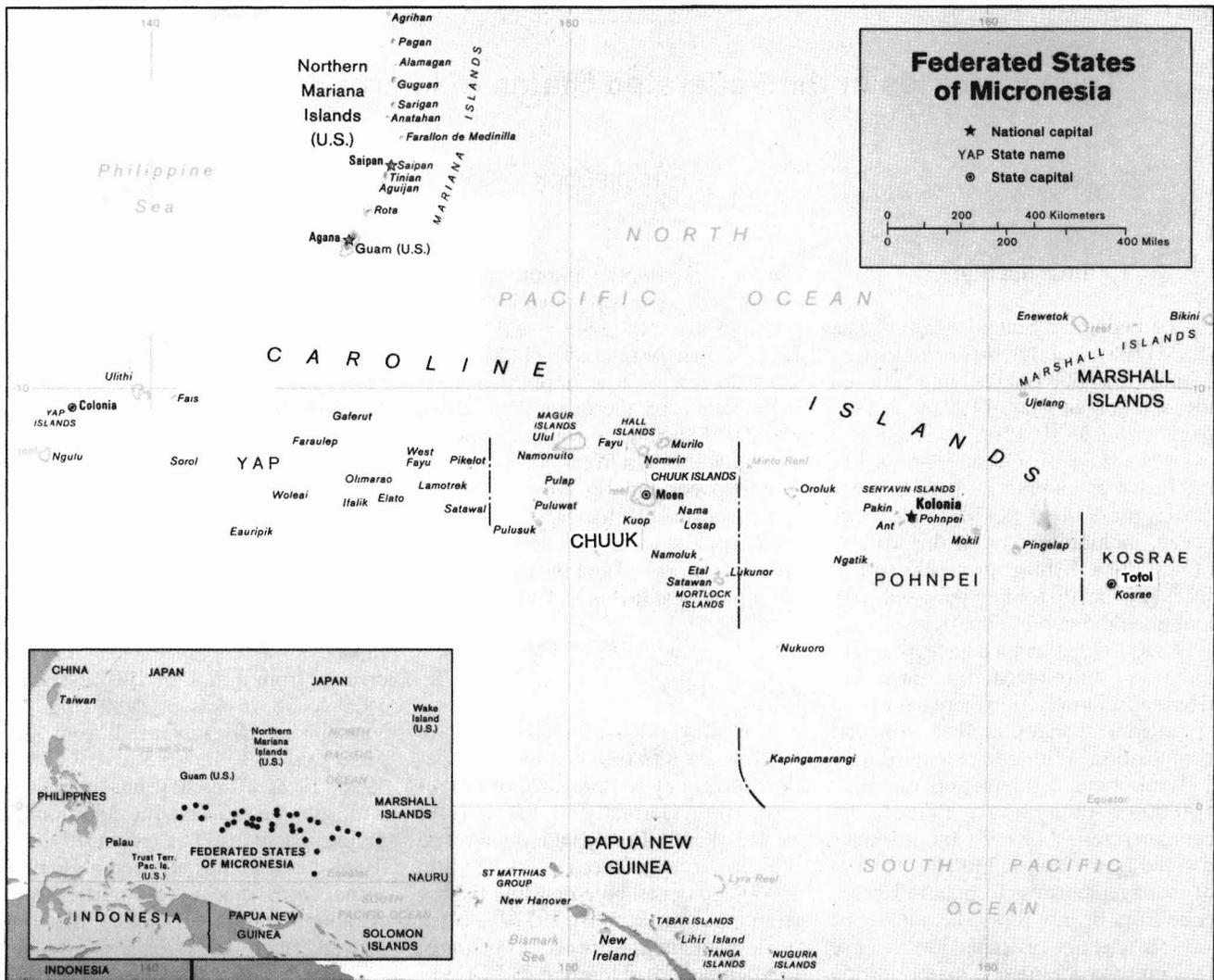
The foreign pole-and-line fleet in the FSM has consisted exclusively of Japanese vessels. Fleet size has decreased from a high of 200 vessels in 1979 to 58 vessels in 1989 (Fig. 2). Vessel size has increased from 402 gross tons (GT) in 1985 to 458 GT in 1990. Fleet efficiency has improved with automation and the addition of poling machines. The enhanced quality of the catch has allowed higher returns from market diversification. Although vessel efficiency has improved, fleet size is expected to decline as vessels are not being replaced.

The pole-and-line fishery is seasonal with little activity in FSM waters during the boreal summer (June to August). The most intense fishing occurs from February to March. Effort is generally concentrated east of long. 150°E between lat. 2°N and lat. 10°N but is variable between years. The catch is predominantly skipjack tuna (99%) with a small bycatch of yellowfin tuna (1%). Catch rate has averaged 6.4 t per boat per day. Since 1979 the catch has fluctuated from a low of 2,190 t in 1982, when the Japanese were excluded from the EEZ, to a high of 31,700 t in 1986 (Fig. 3).

¹ Franklin, P. 1981. Southwestern Pacific skipjack and purse seine fishery-development-current status-future. Forum Fish. Agency, Honiara, Solomon Isl., Unpubl. rep. FFA/IN 11, 24 p.

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ABSTRACT—*The management of tuna fisheries in the Federated States of Micronesia since independence in 1979 is reviewed, noting the development, seasonality, and geographic range of the fisheries. The status of stocks, including trends in catch per unit effort and the approach to setting harvest levels for the major species, are also reviewed. Future developments and management aims are discussed.*



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Figure 1.—The Federated States of Micronesia.

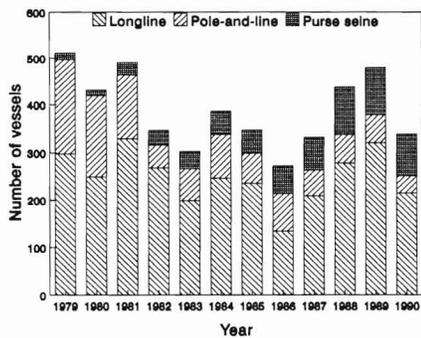


Figure 2.—Number of tuna vessels by gear type from 1979 to 1990.

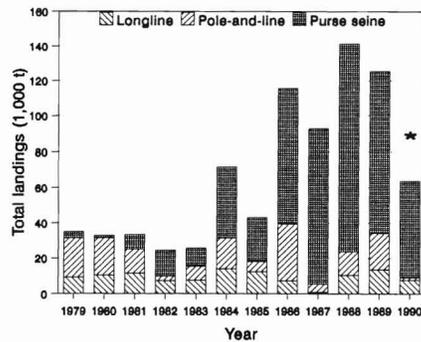


Figure 3.—Total landings (t) by gear type for the years 1979–1990. The asterisk(*) indicates data for the period January 1989 to August 1990 only.

Longline

Longlining in the FSM is also dominated by the Japanese. In 1979, almost 900 permits were issued to Japanese longliners, but less than half that number actually fished in the zone. Since 1979, fleet size has varied from more than 320 vessels in 1981 to less than 130 in 1986 (Fig. 2). From 1979 to 1987, most vessels ranged from 59 to 69 GT, with about 5% of the fleet composed of vessels less than 20 GT. Since then the number of small longliners has increased. In 1989, 28% of the fleet were vessels <20 GT. In 1989 about 250 Japanese and 60 Taiwanese longliners entered the zone.

Japanese vessels <20 GT generally fish between lat. 4°N and 10°N and west of long. 156°E. Japanese vessels >20 GT fish in two separate areas. The area of most intense fishing lies south of lat. 6°N to the edge of the EEZ and extends the full width of the zone from long. 135°E to 166°E. A band of less intense fishing lies north of lat. 8°N and extends from long. 140°E to 158°E. Between these areas, fishing effort is much less intense. The Taiwanese fleet operates mostly in the western part of the zone between lat. 3°N and 9°N and as far east as long. 150°E.

The Japanese longline fishery is seasonal with highest catches during the spring and summer months. The total annual catch for vessels <20 GT is usually less than 1,000 t, while vessels >20 GT land between 8,000 and 9,000 t per annum. The Taiwanese fleet operates mostly from July to December, and although catch reporting is poor, the annual catch is estimated to be more than 1,000 t. The average number of hooks set by Taiwanese longline vessels is about half the number set by Japanese vessels. The total longline catch has fluctuated between 13,188 t in 1984 and 7,128 t in 1986 (Fig. 3).

Purse Seine

The purse seine fishery has grown rapidly in terms of fleet size and catch (Fig. 2, 3). The number of vessels licensed has increased from 14 in 1979 to 112 in 1989, including 39 Japanese (32 single and 7 group) seiners, 15

Taiwanese (13 single and 2 group) seiners and 32 U.S., 18 Korean, 3 Indonesian, 3 Vanuatu, and 1 Australian (all single seiners).

Purse seine effort is concentrated in the southern part of the EEZ south of lat. 6°N. The Japanese and Taiwanese fleets tend to operate in the western part of the zone, west of long. 154°E, but the area is variable between years. The Korean fleet operates south of lat. 5°N between long. 150°E and 160°E. U.S. purse seiners fish mostly in the south of the EEZ close to the Papua New Guinea (PNG) zone and international waters.

The purse seine fishery is seasonal. Maximum activity is between March and July, when the Equatorial Counter Current moves north bringing more flotsam to the zone.

Management

Organization

After WWII, what is now the Federated States of Micronesia, together with Palau, the Northern Mariana Islands, and the Marshall Islands, belonged to the Trust Territory of the Pacific Islands (TTPI) administered by the United States under mandate from the United Nations. Fisheries management was not actively pursued until the Fishery Zones Jurisdiction (Title 52 of the Trust Territory Code pursuant to Public Law 7-71) covering the TTPI (except for the Northern Marianas) came into force on 1 January 1979 establishing an Extended Fishery Zone (EFZ) of 200 n.mi. breadth from the low tide mark or outer reef line (Buchholz, 1987).

When internal self-government was granted to the FSM on 10 May 1979, the FSM sought to maintain jurisdiction over the EFZ and garner income from the rapidly developing fisheries in its waters. The Micronesian Maritime Authority (MMA), hitherto a TTPI entity, was reorganized as an FSM instrument to undertake fisheries regulation and accrue revenue from license fee collection. The primary objective of the MMA then was to maximize the net return of fisheries to the national income by way of fishing access fees.

This mandate was pursued effectively throughout the 1980's. At the same time, detailed catch and effort information was collected as part of the fee determination process and to provide comparative data for stock assessment.

In 1989, a 200 nautical mile EEZ was proclaimed, and a revised Title 24 of the Code of the Federated States of Micronesia empowered the MMA to have the following authorities, duties, and functions:

- 1) To adopt and promulgate regulations for the conservation, management, and exploitation of all living resources in the EEZ of the FSM;
- 2) To negotiate or conclude foreign fishing agreements;
- 3) To issue foreign fishing permits;
- 4) To rebate according to regulation approved by the Authority, all or portion of a fee from joint fishing ventures in the FSM;
- 5) To participate in the planning and execution of programs relating to fisheries, or fishing in the EEZ in which any agency of the FSM government has proprietary interest, direct or indirect, by way of stock ownership, partnership, and joint venture;
- 6) To provide technical assistance in the delimitation of the FSM EEZ; and,
- 7) To perform other duties and functions as may be required or necessary to carry out the purpose of Title 24.

The new Act required the MMA, for the first time, to assess the current level of fishing on the stocks.

Access Agreements

Initially, the MMA focused on obtaining recognition from foreign countries of FSM jurisdiction over its fisheries resources. Having established the principle of payment for access, the MMA required foreign vessels to pay license fees to fish within the EFZ and later the EEZ. To achieve this access, negotiations were undertaken with fishing companies and associations of distant-water fishing nations (DWFN's) on a bilateral basis.

The MMA sought to ensure a fair return from the resources, and access

fees collected from foreign fishing vessels rapidly increased after 1984 (Fig. 4). Since 1987, purse seiners have contributed most license fee revenue as catches have increased. Although the longline catch remains relatively small, longliners generate significant revenues due to the high fees based on the value of their landed catch (Fig. 3, 4). In 1989, fees for fishing access contributed more than 61% of the FSM domestic revenue and 25% of total national revenue. Most of the remainder comes from the U.S. aid provided under the Compact of Free Association.

The first access agreement between FSM and a DWFN was signed with the Japanese Fisheries Association in 1979. The agreement was based on a lump-sum payment system whereby vessels paid a single fee to operate in the EEZ during the agreed period. A per-vessel-per-trip (PVPT) system was introduced in 1984. Under the PVPT system, vessels pay an annual registration fee and a permit fee each time they enter the EEZ. The permit fee is derived from the quantity and price of the major species at the Japanese ports where fish taken in FSM waters are landed, combined with estimates of the average catch per trip and a royalty factor. The Japanese have had continuous access to the zone except for two periods from January to May 1982, and from August 1983 to January 1984 when agreement could not be reached on fee levels.

Japan has been the major contributor of fishing access fees. This is due both to the duration of access agreements and the high value of the landed

catch, particularly that of longliners. The value of access fees from DWFN's since 1979 is detailed in Table 1.

Table 1.—Total access fees from Distant Water Fishing Nations from 1979 to 1990.

Country	Access fee (\$US)
Japan	30,863,063
United States	3,793,740
Guam-based	
Japanese vessels	1,492,000
Taiwan	1,384,500
Republic of Korea	1,232,394
Indonesia	120,000
Mexico	100,000
Philippines	53,000
Australia	52,000
Solomon Islands	3,000
Others	21,600
Total	39,067,597

Taiwan, like Japan, historically fished in the region now covered by the FSM EEZ. The first fishing access agreement with the Taiwan Provincial Fishermen's Association (TPFA) was effected in 1979 with the licensing of more than 30 small longline vessels under a lump-sum payment system. In mid 1982, two Taiwanese group seiners were licensed to operate in the EEZ. The purse seine fleet, with increasing numbers of vessels, had access to the zone up to 28 February 1990. The Taiwanese longline fleet did not seek access to the EEZ from 1981 until the end of 1984. They were readmitted from 1985 to February 1990. All Taiwanese agreements were under the lump-sum system. The access agreement with the TPFA expired at the end of May 1990 and was not renewed. Through a special arrangement between a foreign company and the Pohnpei State Economic Development Authority, 9 Taiwanese longline vessels based in Pohnpei were licensed in 1991.

The licensing of a single purse seiner in November 1980 marked the establishment of a fishing access agreement with the Republic of Korea (ROK). In 1982, further purse seine vessels were admitted, and by early 1989, 19 single seiners were operated by ROK companies in the EEZ. Since then the fleet has expanded rapidly, and 32 vessels were licensed in 1990. Almost all the ROK purse seiners are second-hand vessels bought from the United States, Japan, and Mexico. Current catch esti-

mates for the ROK fleet place them third behind the Japanese and U.S. purse seine fleets. All agreements with ROK were under the lump-sum system. There has been no fisheries access agreement with ROK since July 1990, despite numerous negotiations.

In 1981 the FSM, Republic of the Marshall Islands, and Palau entered into a multilateral arrangement with the American Tunaboat Owners Association (ATA). This was to circumvent the then U.S. government policy of not recognizing individual country's claims to "highly migratory species" such as tuna. The agreement lasted until 1982. From 1983 to 1984, the Republic of Kiribati joined the multilateral arrangement, but the Republic of the Marshall Islands chose not to participate. After 1984, no agreement was reached between FSM, Palau, Kiribati, and the ATA. The major issues preventing continuation of the agreement were fee levels and reporting requirements. From 1985 until the middle of 1988 there was no multilateral agreement with the ATA, and the FSM licensed individual U.S. vessel owners and issued short-term permits.

In 1984, the U.S. government and the Forum Fisheries Agency member countries, including the FSM, began negotiating a multilateral fisheries agreement to allow U.S.-flagged vessels access to their EEZ's. This initiative was prompted by the absence of access agreements and the repeated fisheries violations by U.S.-flagged vessels in the EEZ's of Pacific island nations. A multilateral approach was considered to be the only way to overcome the U.S. government tuna policy. The Regional Treaty on Fisheries between the Governments of Certain Pacific Island States and the Government of the United States was signed in Port Moresby on 2 April 1987 and put into effect on 15 June 1988. It was a 5-year agreement worth about \$60,000,000, of which 15% was to be shared equally between the parties to the agreement. The remaining 85% was allocated in proportion to the volume of catch taken in each party's EEZ. During the first agreement period, 15 June 1988 to 14 June 1989, there were about 35 vessels

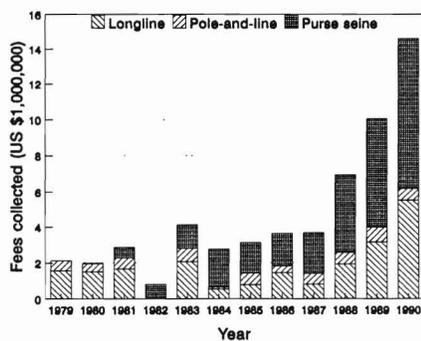


Figure 4.—Fee collection by gear type from 1979 to 1990.

licensed through the treaty. The FSM received \$2,200,195.

In the western Pacific, the U.S. fleet ranges from Kiribati in the east to Palau in the west and from the FSM in the north to New Caledonia in the south. Although their traditional fishing grounds have been in the eastern Pacific, it is likely that they will shift back and forth between the eastern and western Pacific fishing grounds in response to oceanographic conditions, such as El Niño, which affect the catchability of tuna. The U.S. purse seine fleet consists of about 100 vessels, and 49 vessels operated in the western Pacific in 1990.

The FSM has entered into bilateral agreements with several other countries. Two lump-sum agreements covering purse seiners were made with a Philippine company in 1984. Two more agreements were made in 1986. The Philippine purse seiners are small vessels designed to fish close to shore-based facilities and around "payaos" (floating fish aggregating devices), deployed close to the shore. Because of their limited size, the fleet can only operate in the FSM EEZ if they utilize an island transshipment point or employ carrier vessels for transshipment at sea and for provisions. The latest agreement involved fish carriers and was based in PNG.

From 1986 until 1989 there was an agreement with an Indonesian-based company covering three single seiners of 600 GT. The arrangement was not renewed due to problems with compliance on catch data.

Mexican-flagged purse seine vessels came to the region in 1983 when U.S. purse seiners shifted their operations to the western Pacific. They were not included in the U.S. multilateral arrangement, and the company representing the vessels signed a 1-year bilateral agreement in 1984. The agreement was extended for another year in 1985. In 1986 the vessels returned to the eastern Pacific.

Three Australian companies entered into short-term arrangements covering small purse seiners during the early part of 1989. In 1990, six vessels were licensed under an agreement with

the Tuna Boat Owners Association of Australia.

In 1985 the MMA entered into an agreement with a Solomon Islands company to license several 59-GT longline vessels that had been given to the Solomon Islands as foreign aid by Japan. The vessels performed poorly and were subsequently sold. In 1989 a single seiner under charter by Solomon Taiyo Ltd.² was licensed under the PVPT system but did not fish in the EEZ. Since 1979, the MMA has also issued 27 research and training permits at a nominal fee to vessels from academic and research institutions.

Joint Ventures

Since 1979 the MMA has licensed three joint-venture arrangements with domestic companies in the FSM. The first, from 1983 to 1985, involved a Japanese group purse seine operation. The vessels had mechanical and crew problems and came under pressure from the Japanese Government to cease operations. The joint-venture was operating outside the Japanese regulatory system on group purse seiners which at that time allowed only seven units to operate in this area.

The second joint-venture was between the Yap Marine Development Venture and Monju Suisan Company Ltd. of Japan. The operation was given a 1-month research permit in February 1989 to drift gillnet for sharks and tuna. The venture suffered low catches and pressure from the Japanese Government to cease the operation. The MMA did not renew the permit in recognition of the global concern about drift netting.

The Caroline Fishing Company was founded in 1990 as a three-way joint-venture between the State of Pohnpei, the FSM National Fisheries Corporation, and an Australian fishing company to purchase and manage three small refurbished purse seiners. As a joint-venture arrangement, they are subject to a rebate on license fees.

The MMA remains supportive of joint-venture operations based in the

² Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

FSM because of the opportunities they provide for employment and training. Before a joint-venture permit is granted each request is reviewed carefully to ensure that adequate benefits will accrue to the FSM economy.

Transshipment Development

Transshipment of sashimi grade tuna began in Micronesia in 1986 when small Japanese longliners landed their fish in Guam for airfreight shipment to Japan. This arrangement proved to be extremely lucrative, and the number of vessels involved grew quickly. At that time the Japanese Government did not regulate the activities of small tuna longliners, but there was an ordinance prohibiting landing and transshipment of tuna in foreign ports.

On 2 October 1989, the Japanese Government took action to control transshipment of tuna at foreign ports. Exploratory fishing licenses valid for 1 year were issued to small Japanese longliners allowing them to land tuna in Guam and Saipan only. By the end of October, 83 exploratory licenses had been issued, 63 to small longliners and 20 to larger longliners. The licenses were issued with strict reporting requirements (Anonymous, 1990b). Many of these vessels wished to fish in FSM waters and yet were not covered by the existing agreement between the MMA and the Japanese Fisheries Association (JFA) which only covered vessels based in Japan. Against great resistance from the JFA, the MMA established an agreement with the transshipment agents in Guam to allow the vessels to fish in the FSM EEZ. These vessels were subsequently incorporated into a single arrangement with the JFA on 1 March 1990 which also authorized some of the vessels to offload in FSM ports. The number of Japanese vessels transshipping in Micronesian ports is expected to increase with the further easing of Japanese Government restrictions. This should result in more vessels seeking access to FSM waters.

In 1990 about 70 Taiwanese longline vessels transshipped in Guam and about 60 in Palau. The number of Taiwanese vessels operating from these ports is also expected to increase.

Transshipment of purse seine catches has been carried out in Pohnpei, Chuuk, and Yap and will increase with the development of dedicated packing facilities and canneries planned for each state. The international pressure to end transshipment at sea may also result in increased purse seine offloading in FSM ports.

State of the Stocks

The first assessment of tuna stocks in FSM waters was carried out by the South Pacific Commission's Skipjack Survey and Assessment Programme (SSAP) between 1979 and 1981. The study showed that the stocks of skipjack tuna exploited by the surface fishery in the western Pacific were very large and only lightly exploited at that time. The SSAP also revealed that skipjack tuna were extremely mobile and could readily migrate between the EEZ's within the region (Kearney, 1983).

Interactions

Interactions may occur through the movement of fish between areas and their interception by other fleets, by conflict between gear types on a fishing ground or by the taking of fish before they become available to another fleet or gear.

The SSAP tagged and released 8,542 tuna during three visits to FSM waters between 1978 and 1980, and about 65% of the 297 fish recaptured were taken in FSM waters. As the remainder were taken in international waters or in the EEZ's of other countries, the SSAP demonstrated skipjack tuna fishery interactions at a subregional level. For the FSM, there appeared to be interactions with fisheries in the waters of the Commonwealth of the Northern Mariana Islands and the Republic of the Marshall Islands. Fish from the Marianas contributed moderately to the throughput of 17.4% in the FSM, while fish from the FSM contributed significantly to the throughput of 37.5% in the Marshalls.

Gear conflict between the pole-and-line and purse seine fisheries could be expected since both target surface tunas. The extent of direct conflict may,

however, be small as pole-and-line vessels operate mostly in the northern portion of the EEZ, while purse seiners are concentrated in the south. Direct interaction is most likely in the area southeast of the Mortlocks and southwest of Chuuk where the fishing grounds for each gear type overlap.

In contrast, purse seine and longline fisheries are both widely distributed within the zone increasing the possibility of interactions through the interception of fish by surface gear before they become available to longlining. Yellowfin tuna are exploited by both fisheries, and the impact of purse seining on the longline catch of yellowfin tuna is of major concern. Based on logbook records, average yellowfin tuna catch rates in the zone have been relatively constant during the past 7 years in both the FSM and the region as a whole (Anonymous, 1991). The adoption of deep longlining by Japanese longliners targeting bigeye tuna, *Thunnus obesus*, has increased bigeye tuna catch rates throughout the FSM and the region. The relationship between surface schooling yellowfin tuna vulnerable to purse seining, and those yellowfin tuna inhabiting the mixed layer above the thermocline fished by regular and deep longline techniques is unclear. It appears that definitive analysis of interactions requires detailed study of both movement and growth.³ The SPC Regional Tuna Tagging Project (RTTP), which began in 1990, is investigating interactions between domestic and foreign fisheries and may also provide information on stock structure and delineation.

Species Assessments

By 1989, considerable concern had been expressed at the prevailing and projected levels of exploitation of tuna stocks in FSM waters. In 1990, the MMA therefore reviewed available data in consultation with experts from

³ Sibert, J. 1990. Tuna fisheries interaction and status of the stocks in Federated States of Micronesia. Food Agric. Organ., U.N., Rome, unpubl. rep., 27 p.

⁴ Sibert, J. 1990. Interaction between tuna fisheries in Federated States of Micronesia. Food Agric. Organ., U.N., Rome, unpubl. rep., 8 p.

FAO⁴ and SPC (Hampton, 1991) and made a preliminary assessment of the status of the stocks of the major species. The assessment was considered necessary as the fisheries had changed markedly since the SSAP regional assessment of 1981.

Since the SSAP study, the pole-and-line fishery has declined, and the development of the purse seine fishery has significantly altered the extent and magnitude of effort in the surface fishery. The SSAP results must therefore be viewed within the context of the pole-and-line fishery then operating, and other data need to be incorporated for an up-to-date stock assessment. The primary data sources are the records of catch and effort provided by DWFN's under access agreements. The relationship between catch and effort is a useful indicator of stock condition, but raw catch per unit effort (CPUE) data should be interpreted cautiously as catch rates are affected by both oceanographic conditions and fishing practices.

Skipjack Tuna

The extent of the skipjack tuna resource vulnerable to the pole-and-line fishery in the FSM EEZ could not be determined from results of the SSAP study owing to insufficient data. Consequently, data for the FSM, Palau, the Marshall Islands, and Guam were aggregated, and the equilibrium standing stock of skipjack tuna vulnerable to the fisheries in the combined areas was estimated to be between 373,000 and 1,305,000 t. The turnover rate (due to natural mortality, fishing mortality, emigration, and growth out of the vulnerable size classes) was estimated to be 23% per month. Under normal conditions, this meant that between 103,000 and 252,000 t of skipjack tuna were moving through the combined area of the fishery each month. The harvest ratio (fraction of throughput harvested each month) was estimated at 2–4.8%. As a result, the pole-and-line fishery within its then geographic limits was considered capable of markedly increased catches without harming the skipjack tuna resources (Tuna Programme, 1984). The assessment of skipjack tuna in Micronesian waters

indicated a large resource with a standing stock of between 2,500,000 and 3,700,000 t (Kleiber et al., 1987). In 1989, the skipjack tuna catch by all fleets in the FSM was less than 15% of that.

Purse seine CPUE (Fig. 5) has been relatively constant since 1979. Pole-and-line CPUE (Fig. 5) is more variable, with an increasing trend since 1985 (the 1990 figures are incomplete). The CPUE figures for the surface fishery are indicative of a healthy stock, although it is possible that some reduction in abundance could have been offset by increases in fleet efficiency. It is therefore prudent to regard the interpretation of short-term trends in raw CPUE in the surface fishery as tentative.

The plot of skipjack tuna catch against effort (Fig. 6) shows a relatively linear relationship with catches

remaining proportional to effort at high levels of effort. The lack of response of the stock to the highest levels of effort is indicative of less than full exploitation and supports the contention that the surface catch may be increased.

Yellowfin and Bigeye Tuna

Because the standing stocks of yellowfin and bigeye tuna were not estimated by the SSAP, stock assessment must rely on the interpretation of catch and effort data. Fortunately, there exists a long history of catch and effort data for the Japanese fishery since 1962. These show several long-term declines in yellowfin tuna CPUE, including one since 1978. This cannot convincingly be ascribed to the effects of purse seining since it was evident several years prior to the expansion of the purse seine fishery. A possible cause is the fishing down of the stock

by longlining, although some later interaction effects with the purse seine fishery cannot be ruled out. Yellowfin tuna CPUE has stabilized since 1984, and bigeye tuna CPUE, which was relatively stable up to 1983, has gradually increased (Fig. 7).

The plots of catch against effort for yellowfin tuna (Fig. 8) and bigeye tuna (Fig. 9) show no indication of the classic dome-shaped production curve when effort reaches high levels. This is considered indicative of less than full exploitation.

While there is no direct evidence that purse seine catches of yellowfin tuna have contributed to a reduction in longline yellowfin tuna CPUE, it is possible that other changes such as spatial variations in distribution of longline effort may be masking interaction effects. Substantial changes have taken place in fishing methodology with increased targeting on bigeye tuna, and management of either species will affect the harvest of the other.

There are major deficiencies in knowledge of the biology of yellowfin and bigeye tunas which preclude conclusive stock analysis. The RTTP will provide much needed information on stock structure, migrations, growth, and interactions to allow better stock assessments to be made in the future. However, on the basis of present data, no stocks of tuna within the FSM appear to be overexploited.

Setting Harvest Levels

The preliminary stock assessment carried out in 1990 by FAO and SPC

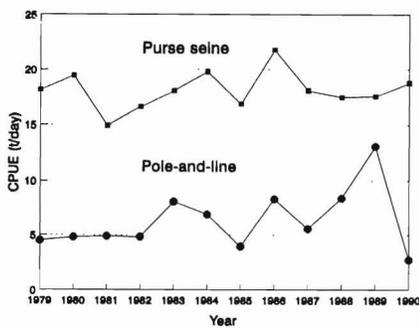


Figure 5.—Purse seine and pole-and-line catch per unit effort from 1979 to 1990.

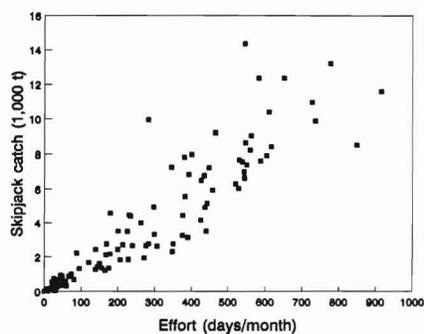


Figure 6.—Monthly skipjack tuna catch against effort for purse seiners from 1979 to 1990.

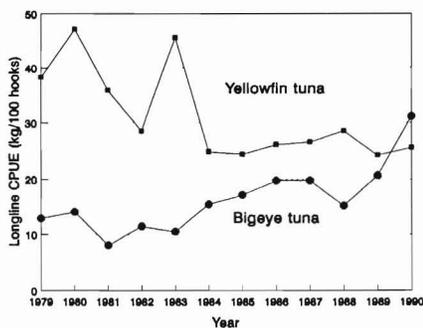


Figure 7.—Longline catch per unit effort for yellowfin and bigeye tuna from 1979 to 1990.

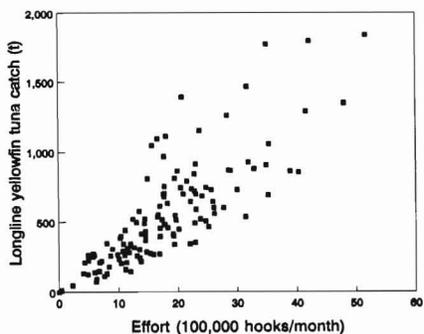


Figure 8.—Monthly yellowfin tuna catch against effort for longliners from 1979 to 1990.

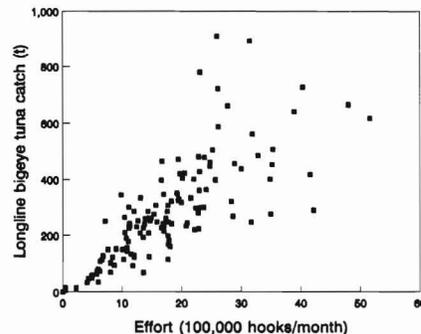


Figure 9.—Monthly bigeye tuna catch against effort for longliners from 1979 to 1990.

indicated that the stocks were in good condition and could support higher levels of exploitation. No stocks appeared overfished by the then prevailing levels of exploitation, and there was no compelling evidence to support reduction in effort in any fleet for the purpose of biological conservation. Despite this, the MMA considered it inadvisable to allow effort to continue to increase, dictated solely by the need for increased revenue. Therefore, a conservative management strategy was implemented, advocating modest increases in present catches. The recommended harvest levels were based on previous catches, taking into account changes that had occurred in the fishery, with the assumption that CPUE was maintainable at the then current levels. This approach requires accurate monitoring of the fishery and frequent assessment of the status of stocks to detect changes indicative of overfishing.

Harvests

The following harvest levels were suggested by FAO and endorsed by Hampton (1991). Historically the purse seine fishery has produced annual yields of 118,000 t of skipjack tuna. This level is considered sustainable at a CPUE of 14.0 t per vessel per day. About 25% of the purse seine catch shown in Figure 3 is yellowfin tuna, and that fishery is considered capable of producing 27,000 t of yellowfin tuna at a CPUE of 4.6 t per day.

The pole-and-line fishery has produced catches of up to 50,000 t per annum, and the present catch of about 15,000 t per annum is only a small fraction of the potential skipjack tuna yield. Thus, it should be possible to substantially increase catches without damaging the skipjack tuna stock. The pole-and-line catch could be increased to at least 32,000 t with an effort of 5,600 boat days at a CPUE of 5.7 t per day (the long-term average from 1972 to 1989).

In the past, the longline fishery has produced annual catches of 8,100 t of yellowfin tuna and 3,600 t of bigeye tuna. Harvest levels of 8,000 t of yellowfin tuna and 8,000 t of bigeye tuna with an annual applied effort of be-

tween 36 and 44 million hooks were considered reasonable by Sibert.^{3,4} The wide effort range is due to the different expected hooking rates for yellowfin and bigeye tunas. The relatively large increase in the proportion of bigeye tuna demonstrates the ability of longliners to selectively target that species.

Although stocks appear sound, there are considerable uncertainties and limitations in the data. None of the fisheries have demonstrated significantly decreased catches at the highest recorded levels of effort, and the response of the fisheries to large increases in effort is therefore unknown. Large harvest increases should therefore be proposed only with great caution, although modest increases can be approached more confidently. Suggested harvests shown in Table 2 are based on previous harvests and assume that current CPUE levels are maintained despite increased effort.

Table 2.—Suggested tuna harvest levels (t).

Gear type	Harvest levels (t)			
	Yellowfin	Bigeye	Skipjack	Total
Longline	8,000	8,000		16,000
Purse seine	27,000		118,000	145,000
Pole-and-line			32,000	32,000
Total	35,000	8,000	150,000	193,000

The problem of increased yellowfin tuna catches by the purse seine fishery could become acute should the skipjack tuna catch increase markedly. If large skipjack tuna harvests become a primary management objective, careful consideration must be given to the impact of concomitant yellowfin tuna catches on longline fisheries.

Further Stock Assessments

Detailed and specific assessments of tuna fisheries in the western Pacific have been hampered by data deficiencies. The lack of high-seas data from DWFN's remains a problem and has precluded detailed stock assessment. The provision of high-seas data to complement regional logbooks has been identified as a priority by Pacific island nations and is urgently required, as are provisions for validating logbook data and verifying offloadings. International agreement, regional col-

laboration, and national support are essential to ensure the cooperation of DWFN's.

Powerful new analytical models are required to interpret the complex fishery dynamics presented by the diverse gear types and flags operating in the region. This is the role of regional organizations, and national and international efforts must be intensified to ensure that methodologies are available for accurate and timely stock assessment. Basic biological data are also necessary. Size frequencies, growth estimates, and age-selective mortality estimates are necessary for more detailed models which will improve stock assessments and estimates of the optimum harvest levels.

To this end, the MMA has developed an active fisheries observer program which, with the establishment of a port sampling program, has provided the first detailed description of the catch. Enhancing the quality and coverage of catch and effort data is also a major goal. The MMA recognizes that, although proper stock assessment is a regional task, each country must ensure the collection of basic data.

The Future

Initially, the MMA strived to gain recognition of jurisdiction over resources of the 200-mile zone. Attention was then focused on achieving appropriate returns for access from license fees. While access and fee level negotiations continue, the MMA has increased efforts to assess the status of resources and to ensure a rational approach to setting harvest levels.

With the evidence of interactions provided by the SSAP, it is obvious that management of stocks cannot be undertaken unilaterally. Restrictions on catch and effort will only be effective if implemented on a regional basis. This will require considerable accord between countries of the region and the possible compromise of national fisheries development aspirations.

U.S. funding to the FSM Government under the Compact of Free Association will cease by the year 2002, resulting in increased pressure to maximize revenue from all sources, includ-

ing fisheries. It appears unlikely that domestic fisheries will be sufficiently developed to replace foreign fleets by that time, and thus, fishing access fee revenue will increase in importance. While large increases in the skipjack tuna catch are no doubt possible, some compromise on yellowfin tuna harvests will have to be made. At present there is too little known about the stock structure, fisheries interactions, and population dynamics of yellowfin tuna to be able to propose optimum yields. The RTTP, currently being carried out, will provide better estimates of the size and movements of yellowfin and big-eye tuna stocks and allow more realistic modelling of those populations.

In the future, the MMA will also assume responsibility for monitoring domestic fishing vessels. To effectively manage the fishery resources of the EEZ, the total catch must be monitored. That means all vessels, foreign or domestic, will be required to report their catch and effort within the EEZ.

The MMA has encouraged transshipment in FSM ports by discounting license fees for participating vessels. However, the activities of longline vessels transshipping in FSM ports are severely limited by availability of air freight space, and operations will remain restricted until dedicated freight flights are secured.

In Pohnpei, a fish processing plant is presently being constructed by Pohnpei State's Economic Development Authority, and the National Fisheries Corporation is planning a tuna cannery. In Chuuk State, a longline transshipment base with wharf, coldstore, and processing facilities is being built, and a similar development is planned for Yap State. Major tuna

handling and processing facilities are also planned for Kosrae State. While expanding FSM's involvement in tuna fisheries, these domestic fisheries will also provide unprecedented opportunities for biological sampling and stock monitoring.

In view of the major increase in purse seine catch and the possible effects on resources, the MMA is focusing on active management of the resources. This approach allows controlled increases in effort while closely monitoring catch and CPUE.

Regional and international initiatives on cooperative management will also be boosted. At the same time the MMA will continue to seek higher returns from the resources, including benefits additional to access fee payments. In particular, FSM involvement in the exploitation of the resources in the form of joint-venture arrangements and basing of foreign vessel operations in the FSM will be encouraged.

In the long term, joint-venture and later domestic vessels will replace foreign vessels operating in the EEZ. Until then, the MMA will continue to maximize revenue and encourage development of domestic fisheries while ensuring that stocks are maintained.

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