U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southwest Fisheries Center
Honolulu and La Jolla Laboratories
P. O. Box 3830
Honolulu, Hawaii 96812

Date: March 11, 1976

Reply to Attn. of:

To: Richard S. Shomura, Director, Honolulu Laboratory F142

From: Tamio Otsu, Chief, Tuna Assessment and Development Investigations

Subject: Trip report, trip to Japan, January 30-February 20, 1976

My itinerary on this trip to Japan was as follows:

January	30	- 1430, departed Honolulu via NW 009.
	31	- 1830, arrived Tokyo.
February	1-9	- In Shimizu, Shizuoka Prefecture. Attended Japanese Tuna Research Conference, visited staff members of Far Seas Fisheries Research Laboratory, and Tokai University Faculty of Marine Science and Technology.
	10	- In Tokyo. Visited the Japan Marine Fishery Resource Research Center (JAMARC), and the American Embassy.
	11-12	- In Sendai. Visited the Tohoku Regional Fisheries Research Laboratory in Shiogama City.
	13-19	- In Tokyo. Visited staff members of various government and industry offices including Overseas Fishery Cooperation Foundation, Bumble Bee Seafoods Co Universal Marine Consultant Co., Japan Fisheries Agency, Iwatani & Co., Ltd., Japan Marine Products Photo Materials Association, Sanyo Hydrographic Survey Co., and Asuka Manufacturing Co., Ltd.
	20	- 2130, departed Tokyo via NW 010. - 0930, arrived Honolulu.

This trip report is arranged by subject matter. The following subjects are covered:

A. The Japanese tuna fishery in continuing depression

B. The tuna longline fishery of Taiwan and Korea

C. Japanese southern water skipjack tuna fishery, February-December 1975

D. Tuna purse seining

E. Skipjack tuna fishery survey in Micronesia

F. Bluefin tuna rearing

G. The bluefin tuna fishery in Hokkaido

H. Antarctic krill

I. List of persons contacted during trip.

A. THE JAPANESE TUNA FISHERY IN CONTINUING DEPRESSION

In last year's trip report, dated March 28, 1975, I reported that the Japanese tuna industry was facing a major depression as a result of 1) tripling of oil prices, 2) increased cost of fishing gear and provisions needed for extended fishing operations, 3) generally declining catch rates throughout the areas of operation, 4) depressed fish prices in Japan, and 5) virtual closing of the United States markets to Japanese exports of albacore, yellowfin, and skipjack tunas.

The situation has not changed. In spite of the fact that there have been increases in fish prices, both domestically and abroad (particularly in export prices for albacore), and a gradual re-opening of the U.S. market, other factors tend to keep the industry in a continuing dilemma. Although albacore prices in the U.S. have increased considerably to $1,150-$1,200 per short ton, CIF, and skipjack tuna prices to $750 per short ton, CIF, the Japanese industry officials consider these prices marginal. It is for this reason that the Japanese industry has undertaken a major promotional campaign to increase sales of canned tuna in the domestic market. The Japanese feel that the export market is too unstable, that in order to stabilize the industry, they must promote greater utilization of albacore and skipjack tuna at home. This effort has been paying off, since the domestic consumption of canned albacore has been increasing each year and has reached approximately 2 million cases (about 20,000 metric tons (MT)) at present, primarily of HAGOROMO's "Sea Chicken" brand.

One crisis after another

The Japanese tuna fishery has faced one crisis after another the past several years. These included the Bikini radioactivity crisis, the canned tuna "decomposition" problem, the dollar devaluation, the

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Conversion rate used in this report: 300 yen to US$1.

mercury-in-tuna problem, and most recently, the "oil shock." Today the industry is attempting to counteract the prevailing depression in the tuna industry by taking certain positive steps to stabilize fish prices. It is purchasing fish (particularly albacore) directly from the vessels and holding it in freezers during periods of low prices; promoting increased domestic consumption of tunas that were formerly exported; restricting imports of tunas, particularly those fish delivered directly to Japanese ports by foreign vessels; securing government assistance in providing a fuel subsidy to tuna vessels; and reducing the number of vessels in the tuna fleet.

The Japanese tuna industry is primarily a conglomeration of small businesses. Most of the ship owners manage only one or two vessels. In 1975 there were 1,688 vessel owners operating a total of 2,670 longline and pole-and-line vessels. The average number of ships operated per owner was 1.6. This can be broken down further: 68.4% of the owners operated only one vessel; 18.1%, 2 vessels; 7.2%, 3 vessels; 3.7%, 4 vessels; and the remaining 2.6%, between 5 and 17 vessels. Vessel owners with one or two vessels have made up most of the bankruptcies that have come in the wake of the depression, since losses could not be balanced out as in the case of owners operating several vessels.

The contribution of the tuna fishery relative to total marine fishery production in Japan

The tuna fishery (longline and pole-and-line) production increased from a total 691,709 MT in 1963 to a peak of 740,969 MT in 1966, then hit a low of 546,802 MT in 1971. Accompanying the recent shift in fishing effort from longline fishing to skipjack pole-and-line fishing (Figure 1) the landings increased to 654,943 MT in 1973. In 1963, the tuna fishery accounted for 11.2% of the total marine fishery production in Japan (all species), but the contribution declined to 6.7% in 1973. Taking the two tuna fisheries separately, the contribution by the longline fishery decreased from 8.6% in 1963 to 3.1% in 1973. On the other hand, the skipjack tuna pole-and-line fishery increased its contribution from 2.6% in 1963 to 3.7% in 1973.

Although the tuna landings are relatively small in terms of total marine fishery production in Japan, they figure high in value. Tuna landings accounted for about 20% (average) of the total value of marine fishery production throughout the 10-year period. The landings by the tuna longline fishery, however, decreased from 17.6% of total value in 1963 to 13.7% in 1973, while the landings of the skipjack tuna fishery increased from 3.8% of total value in 1963 to 6.5% in 1973.

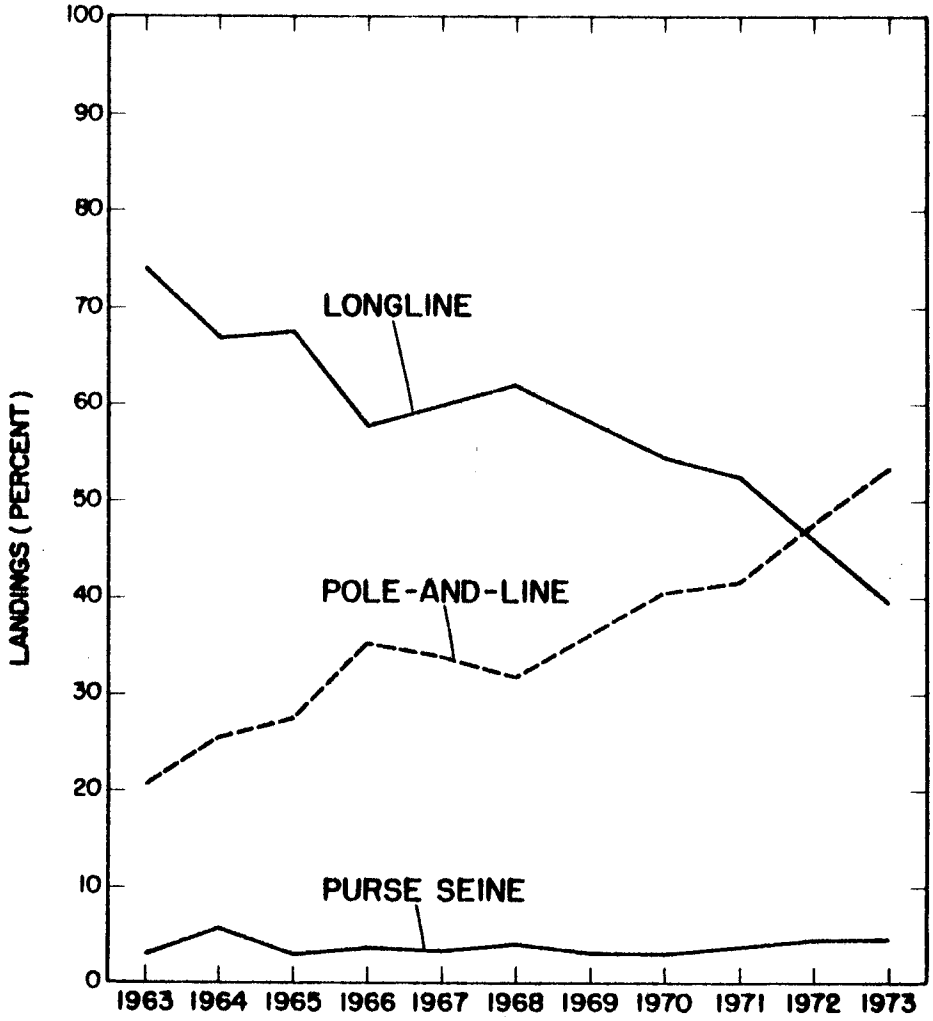

Figure 1.--The annual landings (percent) of tunas and billfishes in Japan by different fishing methods, 1963-73.

Declining catches in the tuna longline fishery

The main elements in the tuna longline fishery of Japan are the vessels in the 200-500 ton class. These vessels averaged around 1.8 MT of tuna per day of fishing in 1963. The catch has presently declined to approximately 0.8 MT per day, for a decrease of more than 50% in 10 years. Concomitant with this decrease in catch rate has been the lengthening of the fishing trips. In 1963 the vessels averaged 106 days of fishing per trip; in 1973, it was 259 days, or a 144% increase in 10 years.

The Japanese attribute this decrease in catch rate to greatly increased fishing effort for the larger tunas. There has been greatly increased longline fishing effort on the part of Korea, Taiwan, and Cuba, for example. There also has been increased surface fishing effort for tunas by United States, Spain, France, and Mexico. As an example, Korea had only 11 vessels fishing longline out of American Samoa in 1963. That year these vessels made 50 trips and took about 3,102 MT of tunas. Taiwan had 54 vessels catching 9,607 MT of tunas. At present, however, Korea has increased its longline fleet to 568 vessels; Taiwan may have close to 700 vessels. Thus the combined longline fleets of these two countries far exceed the Japanese longline fleet in numbers.

The Japanese tuna longline vessels no longer fish for albacore and yellowfin tuna intended for export as raw materials for canning. Most of the tuna vessels have been pulled out of foreign bases (e.g., American Samoa) and have been converted to the "sashimi fleet." Thus, the foreign-based operations for albacore and yellowfin tuna now depend upon Korean and Taiwanese longline vessels, mostly the latter.

As catch rates declined over the years, the Japanese vessel owners invested in larger vessels that could operate in more distant waters, and in expensive freezing equipment capable of reaching as low as -60°C. The result was that the vessels could now bring back to Japan fish of very high quality that would be suitable for use as sashimi or sushi. These fish commanded higher prices that tended to offset the losses from decreasing catch rates. Furthermore, to make operations less costly, labor saving devices such as the line-winder machines were adopted by many vessels, thus effecting a reduction of manpower.

However, sales of high-quality sashimi fish in Japan have been slow in the last year due to overall recession in the Japanese economy. This has been particularly noticeable in the slow-down in sales to high-class restaurants and sushi shops.

Major problems in the skipjack tuna pole-and-line fishery

The Japanese southern water skipjack tuna fishery experienced two very poor seasons in succession, mainly attributable to very high bait mortality. Thus, this fishery continues to be plagued with baitfish problems. Furthermore, the coastal water fishery was also very poor in 1975. One report indicated that there was a decrease in average landings of skipjack tuna per vessel of from 358 MT in 1974 to 270 MT in 1975, or a decrease of 75%. Operating costs during the period increased by 106.7%. Obviously, the skipjack tuna pole-and-line fishery is also having its problems.

Returning to the baitfish problem, the skipjack vessels depended on natural circulation of water in their baitwells prior to 1965. The baitfish survived only for a short period, and so the fishing trips tended to be short. Fishing grounds were necessarily limited to coastal waters, and catches fluctuated greatly, depending on how well the baitfish survived. It was around 1965 when the forced-circulation system was introduced. This development resulted in a great increase in the length of time that baitfish could be held alive in the baitwells, and enabled vessels to make longer trips to more distant waters. The skipjack tuna fishery expanded to southern waters soon thereafter, and it then became possible to fish for skipjack tuna on a year-round basis.

Around 1972, when it became evident that the larger tunas were being fished at or near the maximum level, the Japanese implemented a national program to shift the fishing effort from longline fishing to skipjack tuna pole-and-line fishing. There was a shifting of tonnages from longline to skipjack tuna vessels, and there also was a building boom for larger skipjack tuna vessels. Landings of the pole-and-line fishery started to increase greatly around this time.

About 70% of the landings of the skipjack tuna pole-and-line fishery is made up of skipjack tuna, about 20% of albacore, and the remainder os various other species (bluefin tuna, yellowfin tuna, bigeye tuna, and frigate mackerel (Table 1). Up to now, most of the catches of this fishery have either been exported or processed in various ways, and very little has been utilized as fresh fish. Thus fish prices have continued relatively low for fish caught by this fishery. For example, between 1963 and 1973, longline-caught tunas increased in average price by 400% to 529 yen/kg ($0.91 per pound). In comparison, pole-and-line fish increased by only 212% to 206 yen/kg ($0.36 per pound). In order to improve the situation in the pole-and-line fishery, various measures have been taken. An intensive effort has been made to improve bait-holding capabilities. Most of the larger ships have been equipped with freezing equipment that enables them to freeze their catches to around -30° or -40°C. This makes it

Table 1.--The landings by the Japanese skipjack tuna pole-and-line fishery, 1971-73.

Year	Total landings	Bluefin tuna	Albacore	Bigeye tuna	Yellowfin tuna	Small yellowfin tuna	Skipjack tuna	Frigate mackerel	Others
	Metric tons								
1971	230,098 (100.0%)	740 (0.3%)	52,957 (23.0%)	931 (0.4%)	2,570 (1.1%)	5,729 (2.5%)	157,380 (68.4%)	8,086 (3.5%)	1,705 (0.7%)
1972	291,054 (100.0%)	472 (0.2%)	60,591 (20.8%)	2,364 (0.8%)	4,287 (1.5%)	8,711 (3.0%)	199,836 (68.7%)	12,288 (4.2%)	2,505 (0.9%)
1973	358,857 (100.0%)	179 (0.1%)	68,808 (19.2%)	852 (0.2%)	8,600 (2.4%)	9,839 (2.7%)	254,259 (70.9%)	12,379 (3.4%)	3,940 (1.1%)

Data provided by Mr. M. Honma, Far Seas Fisheries Research Laboratory.

possible to bring back to Japan frozen fish of much better quality. In fact, some small use is now being made of frozen southern water skipjack tuna as sashimi, a new development in Japan. Many of the skipjack tuna vessels have reduced manpower in order to lower operating costs; some have installed automatic fishing machines that enable them to reduce manpower still further (Table 2). Another big step, already mentioned was the intensive promotion of canned albacore for domestic consumption.

Table 2.--Number of fishermen (average per vessel) on Japanese skipjack tuna vessels, by size class, 1964-73.

Year	30-50 tons	50-100 tons	100-200 tons	200-500 tons
1964	26.0	36.0	47.5	44.5
1965	24.5	35.0	44.5	43.0
1966	25.0	31.0	42.5	40.5
1967	23.5	31.5	42.5	39.5
1968	--	30.0	39.5	37.5
1969	22.5	25.0	35.0	34.5
1970	22.0	23.0	35.0	34.5
1971	21.0	23.0	35.3	35.1
1972	22.3	23.7	34.8	35.7
1973	21.8	22.8	28.7	32.4

Unpublished data provided by Dr. R. Ishida, Tohoku Regional Fisheries Research Laboratory

Foreign imports

In early 1974, just as the industry was beginning to recover from the mercury shock, fish prices suddenly started to decline. It was around this time that foreign imports of tunas and billfishes first began to appear in Japanese ports, mostly in the form of direct deliveries by foreign vessels. This has served to depress prices further in the Japanese market. The bulk of the foreign vessels are Korean, and ironically, most are former Japanese vessels that had been traded in by Japanese owners when they built larger vessels. These vessels had been bought by Japanese trading companies who in turn sold the vessels to Koreans.

In 1974, the imports amounted to 3.5 times the volume imported in 1970. In 1975, Japan imported 110,065 MT of tunas and billfishes, of which Korea delivered 59,139 MT, Taiwan 25,460 MT, and Panama (mostly crewed by Korean fishermen) 6,341 MT. The United States contributed 1,692 MT (619 MT of bluefin tuna, 608 MT of other tunas, and 451 MT of billfishes).

In December 1974 there happened to be 38 foreign vessels in the port of Shimizu. When Japanese vessels returned to port they could not even find docking space, let alone make arrangements to unload their catches. The freezer spaces had been taken up by foreign imports and fish prices dropped drastically. These were the conditions that brought Japanese fishermen "up in arms," culminating in a series of loud demonstrations demanding that the government restrict foreign imports. Some agreement has apparently been reached between Korea and Japan; the latest information is that the Koreans have agreed to a 45,000 MT quota for direct delivery of tuna to Japan.

Increase in foreign imports related to United States market

With the virtual closing of the United States market in 1974-75, those foreign vessels (particularly Taiwan and Korea) that had been catching tuna mainly for export as raw materials for canning, found themselves without their principal market. They rapidly turned their effort towards fishing tuna for the sahimi market in Japan, perhaps at the prodding of the Japanese trading companies holding interest in these vessels. They began fishing for bigeye tuna in particular, since these fish are in demand in the Japanese sashimi market, and their fishing grounds are relatively accessible. During the last half of 1975, a total of 60,519 MT of tunas and billfishes were imported (Korea, 35,067 MT; Panama, 5,188 MT; Taiwan, 12,000 MT). Imports had increased by 94% over the same period of the previous year.

It is now said that regardless of the outlook in the United States market, many of the Korean vessels will continue to fish for the Japanese market. This is because the Koreans have built many new vessels equipped with expensive freezing equipment specifically for the Japanese sashimi market. Furthermore, there is a considerable price differential between export fish and Japanese sashimi fish, the latter bringing the better price. Thus, it appears that the Japanese fishermen will be faced with stiff competition for their own market for years to come.

Status of the Japanese tuna industry

It is reported that about two-thirds of the Japanese longline vessels are presently operating either marginally or "in the red." One of

the biggest factors responsible for this is the great increase in labor costs. On Japanese vessels it has been reported that 50% of total operating costs involve labor costs, as compared to 10% on Korean vessels. It is no wonder that the Japanese tuna industry's competitive position in the world tuna market has so weakened over the last few years. (As an aside, it might be mentioned here that two-thirds of all businesses in Japan are reported to be operating in the red at this time.) A recent survey of tuna vessel owners indicated that many are now operating at a level that, if continued, is certain to lead to bankruptcy.

B. THE TUNA LONGLINE FISHERY OF TAIWAN AND KOREA

According to a reliable source in Japan, there are presently 680 tuna longline vessels (larger than 50 tons) in Taiwan. Of these, about 270-280 vessels have been tied up since the oil shocks of a few years ago. With the recent increases in export prices, many of the owners of these inactive vessels are now attempting to get them back to sea. The problem they face, however, is that of recruiting crew members. Former fishermen have found jobs ashore and are reluctant to return to sea.

While prices are generally up, the catch rates are low. The catch rate in the South Pacific, according to Taiwan statistics, is around 0.7 MT per day. It is around 1.5 MT per day in the Atlantic, and considerably lower in the Indian Ocean. They say that the break-even point for their vessels is around 1.0 MT per day (the figure would be higher for Japanese vessels because of the higher labor and fuel costs in Japan). Fuel costs around $90 per ton in Taiwan as compared to $100-$110 per ton in Japan.

In Korea there reportedly are 568 tuna longline vessels operated by 73 vessel owners (average 7.8 vessels per owner). The total vessel tonnage is 157,974 tons. Although there are more tuna vessels in Taiwan than in Korea, the Korean vessels are larger and exceed the Taiwan fleet in total tonnage.

As for reactivating tuna vessels that have been tied up to the docks, it is said that Taiwan boat owners are better able to do this than Koreans because they have ready access to short-term credit from banks and Japanese trading companies. It appears that it is much more difficult financially for Korean tuna vessel owners to reactivate their ships.

Most of the Korean tuna longline vessels are now being used to catch tunas for the Japanese sashimi market. Only a few vessels are left in foreign ports (e.g., Samoa and Abidjan). One report indicates that there are 230 vessels in the Korean fleet mortgaged to Japanese trading companies (these are 250-ton vessels). Most of the Taiwan

vessels are smaller (150-ton class), and fish mainly for export (albacore). Yellowfin tuna is no longer a profitable fish to them ever since Italy began to purchase Atlantic yellowfin tuna from French and Spanish purse seiners, thereby causing the Italian import price for yellowfin tuna to decline drastically.

Instead of tying up their vessels and releasing the crews, however, some Taiwan owners continued to operate by shifting over to fishing for sharks in the Bay of Bengal, or gillnetting for wahoo around Guam and Indonesia. Some of these fish are being consumed in Taiwan, others are being exported to Japan. These vessel owners are in the best position to switch back to tuna fishing because they were able to retain their crews.

Fishing for sashimi fish is far more profitable than fishing for albacore, but the Taiwanese have not entered the sashimi market in great numbers. The reason given for this was that Taiwan fishermen are "warm climate people" and are most reluctant to fish in cold waters where sashimi fish abound. It was stressed that Taiwan fishermen are even reluctant to work in the ships' reefers, which is necessary if they fish for sashimi fish.

C. JAPANESE SOUTHERN WATER SKIPJACK TUNA FISHERY, February-December 1975

The following is a preliminary summary of the recent fishing situation in the Japanese southern water (south of lat. 24°N) skipjack tuna fishery as prepared by Mr. Tamotsu Tanaka, Yaizu Branch Office of the Tohoku Regional Fisheries Research Laboratory. A final report, together with charts, will be forthcoming from the Tohoku Laboratory, at which time a separate translation will be issued. Data on the landings of southern water skipjack tuna in Yaizu between July 1974 and May 1975 are given separately in Table 3.

February 1975

The very good fishing experienced in waters east of the Solomons a year ago did not materialize this year; the catches rarely reached the maximum of 20 tons per day, and average catches were on the order of 2-4 tons per day. The surface water temperature ranged from 28.9°-30.0°C. Similarly, poor fishing was experienced in waters extending from around Manus Island to the vicinity of New Hanover Island.

Skipjack tuna taken in waters north of the Solomon Islands showed the following size composition: larger than 4.5 kg, 2.6%; 2.5-4.4 kg, 85.1%; and 1.5-2.4 kg, 12.3%. In the Solomon Sea area, the fish sizes were: larger than 6.8 kg, 0.8%; 4.5-5.9 kg, 7.6%; 2.5-4.4 kg, 63.2%; 1.5-2.4 kg, 28.0%; and smaller than 1.4 kg, 0.4%. There were 60-70 vessels fishing in the Solomon Sea area.

Table 3.--The landings of southern water skipjack tuna at Yaizu port during the 1974 fishing season (July 1974-May 1975).

Year	Month		No. of vessels	Amount landed	Landings per vessel
				MT	MT
1974	July		12	751.4	62.6
		W	4	721.8	180.4
	August		61	5,675.5	93.0
		W	6	655.0	109.1
		P	1	[1]192.2	
	September		50	4,310.6	86.2
		W	1	106.5	106.5
	October		96	7,914.7	82.4
	November		78	6,526.9	83.6
	December		95	7,948.7	83.6
		P	1	[2]63.3	
1975	January		23	2,494.9	108.4
	February		41	4,354.4	106.2
	March		113	11,040.0	97.6
	April		100	11,093.1	110.9
	May		39	4,298.7	110.2
		P	1	[3]247.8	

W = Fishing ground east of 180°.

P = Purse seiner landings.

[1]Includes 83.5 MT of small yellowfin tuna.

[2]Includes 30.6 MT of yellowfin tuna.

[3]Includes 60.2 MT of small yellowfin tuna, 2.2 MT of large yellowfin tuna, and 5.3 MT of small bigeye tuna.

In waters east of long. 180°, a good fishing ground developed around lat. 6°-8°N, long. 180°-173°W, where the water temperature ranged from 27.4° to 27.8°C. The maximum day's catch per vessel reached 30-40 tons; the average was around 6-7 tons per day. Towards the end of February, fishing also improved in adjacent waters west of long. 180°, where catches exceeded 10 tons per day, showing a western extension of the fishing ground. Fish sizes were: larger than 6 kg, 27.2%; 4.5-5.9 kg, 58.3%; and 2.5-4.4 kg, 14.4%. Most of the catch consisted of fish larger than 5 kg. There were about 20 vessels fishing in this area.

Some fishing also took place in waters south of lat. 10°S by vessels larger than 400 gross tons:

1) In mid-February, one vessel fished near Tahiti at lat. 14°S, long. 145°W, where the water temperature was 28.7°-29.0°C.

2) In late February, five or six vessels fished near Fiji at lat. 15°-16°S, long. 178°-179°E, where the water temperature was 29.0°-29.4°C.

3) In late February two or three vessels fished near New Caledonia at lat. 19°S, long. 160°-163°E, where the water temperature was 28.6°-29.2°C. The results of these operations are given in greater detail in the report for March.

March 1975

In early and mid-March, 30 to 40 vessels fished in the Solomon Sea (lat. 7°-12°S, long. 153°-160°E), where the water temperature ranged from 29.5° to 30.0°C. The best catches were around 15-20 tons per day; the average was around 4-5 tons per day per vessel. Toward late March, the average catch increased slightly to around 6-8 tons per day, but only about seven or eight vessels were fishing this area by then. Fish sizes were: larger than 4.5 kg, 10.6%; 2.5-4.4 kg, 63.6%; 1.5-2.4 kg, 25.2%; and smaller than 1.4 kg, 0.5%.

In waters east of long. 180°, fishing during early March centered around lat. 7°-8°N, long. 175°-178°W. However, after mid-March, the effort shifted toward the Marshalls to lat. 9°-13°N, long. 165°-173°E, where the water temperature was 26.5°-27.9°C. Here, the maximum catch reached 72 tons per day, with numerous catches of 15-20 tons per day. As a result of this good fishing, many vessels moved into the area. The catches averaged 7-8 tons per day for the 40-50 vessels that fished this area. The sizes of skipjack tuna taken were: larger than 6 kg, 48.8%; 4.5-5.9 kg, 34.0%; 2.5-4.4 kg, 13.8%; and 1.5-2.4 kg, 3.2%. Most of the fish were large fish. There were very many skipjack tuna schools associated with whale sharks in this area.

Furthermore, many vessels returning to Japan from this area paused in the vicinity of Wake Island (lat. 15°-16°N, long. 165°-166°E; water temperature, 26.9°C) to fish skipjack tuna using what bait was left in the bait tanks. Here some vessels reported taking 15-20 tons per day of 8-13 kg skipjack tuna. Many vessels fished near Wake Island on their way home and reported taking around 10 tons of skipjack tuna per day. For this time of the year, our records indicate that these were unusually good catches for the Wake Island area.

From mid-February, fishing continued around Tahiti, Fiji, and New Caledonia, and the results were as follows:

1) Tahiti (lat. 14°S, long. 145°W).

Fishing in mid-February resulted in catches of up to 35 tons per day. The skipjack tuna were generally small, ranging from 1.5 to 3.0 kg, and most of the schools appeared to be "shoal associated." Also, at lat. 10°S, long. 148°-149°W, catches of 10-15 tons per day (maximum of 20 tons per day) of 10-15 kg skipjack tuna were reported. It is anticipated that this area may become a good fishing ground in the future. Only one vessel fished these waters.

2) Fiji (lat. 15°-16°S, long. 178°-179°E; water temperature, 29.0°-29.4°C).

Five or six large vessels fishing these waters caught as much as 25-30 tons per day beginning in late February. The skipjack tuna taken were generally small fish of 1-3 kg. In this area, as in waters near Tahiti, most of the skipjack tuna schools appeared to be shoal-associated schools, and thus consisted mainly of small fish. Toward the end of March, one vessel ventured off to fish around lat. 10°S, long. 180°, and caught around 10 tons per day.

3) New Caledonia (lat. 19°-20°S, long. 160°-165°E; water temperature, 28.6°-29.2°C).

Three large vessels fished this area and made good catches of 10-29 tons per day beginning in early February. However, bad weather tended to hamper fishing most of the time. There appeared to be large numbers of yellowfin tuna schools in these waters. Fish sizes were: larger than 12 kg, 27.0%; 6.0-11.9 kg, 31.0%; 4.5-5.9 kg, 8.7%; 2.5-4.4 kg, 24.3%; and 1.5-2.4 kg, 8.7%.

April 1975

The Marshall Islands area developed into a good fishing ground during this month. At lat. 7°-13°N, long. 157°-168°E (water temperature,

26.6°-27.8°C), the maximum catches in early and mid-April were around 25-30 tons per day; the average was around 6-7 tons per day. Toward the latter part of the month, however, many vessels departed the area after learning that the albacore fishing season in Japanese coastal waters was beginning. Many of the vessels switched over to albacore fishing at this time. A few, however, remained to fish skipjack tuna in waters west of Wake Island and near Uracus Island in the Marianas.

In the waters west of Wake Island the maximum catches were around 14-15 tons per day, with an average catch of around 5-6 tons per day. Fish sizes ranged from 3 to 10 kg (4 to 8 kg fish were dominant). In the Marianas, the maximum catches were around 15-16 tons per day, and the average was around 5-6 tons per day. The fish were 3 to 9 kg in size. In this area, there were 10-15 smaller vessels of the 59-ton class fishing alongside the larger vessels. There were an estimated 70 to 80 vessels operating in the Marshall Islands area.

In the northern Marshalls, the fish sizes were: larger than 6 kg, 55.6%; 4.5-5.9 kg, 26.4%; 2.5-4.4 kg, 15.0%; and 1.5-2.4 kg, 3.0%. In the southern Marshalls, fish sizes were: larger than 6 kg, 19.0%; 4.5-5.9 kg, 43.8%; 2.5-4.4 kg, 29.2%; and 1.5-2.4 kg, 7.8%.

After mid-April, large fish (larger than 6 kg) decreased in numbers, and at the same time there was a noticeable increase in the 2.5, 4.5, and 5.0 kg groups. It was reported that the larger fish were more abundant in the northern parts of this fishing ground.

May 1975

Three or four vessels fished in the Solomon Sea (lat. 7°-11°S, long. 150°-157°E) and reported catches of up to 12-13 tons per day. The average catch was around 3-4 tons per day. The sizes of skipjack tuna taken were unchanged from the previous month and ranged from 1.5 to 3.5 kg. Also, at lat. 9°-11°S, long. 165°W-179°E (between Tokelau Islands and Ellice Islands), two vessels caught an average of 4-5 tons per day. The skipjack tuna taken were: larger than 6 kg, 40.4%; 4.5-5.9 kg, 13.0%; 2.5-4.4 kg, 39.7%; and 1.5-2.4 kg, 6.8%.

The purse seiner, Fukuichi Maru (499 tons), chartered by the Japan Marine Fishery Resource Research Center (JAMARC), fished around log-associated schools at lat. 0°, long. 138°-141°E between late April to early May, and in 12 days of fishing caught 248 tons of fish (180.1 tons of skipjack tuna, 5.3 tons of small bigeye tuna, 60.2 tons of small yellowfin tuna, and 2.2 tons of large yellowfin tuna).

Towards late April, vessels from Kagoshima Prefecture reported catching 10-20 tons per day of large skipjack tuna (6-9 kg) at lat. 13°-14°N, long. 142°-144°E. These vessels reportedly continued fishing this area until early May.

June 1975

In June skipjack tuna fishing was widespread in subtropical waters extending from the Marianas to Minami-Torishima (Marcus) and to Wake Island (lat. 16°-21°N, long. 142°-170°E). There were more vessels that arrived there after quitting albacore fishing earlier than in previous years.

Usually, vessels do not leave the albacore fishery so early in the season. This year, there were about 50-60 vessels fishing these waters by the end of the month. In the Marianas (lat. 19°-21°N, east of long. 160°E) the water temperature was higher than normal at 29.5-30.4°C. Perhaps because of this, baitfish (anchovy and sardine) mortality was very high at 40%-50%. The mortality was highest in baitfish that had been brought south directly from the albacore grounds. Perhaps this indicated that very large baitfish (10-15 g per fish) such as are used in the albacore fishery are unsuitable for southern water skipjack tuna fishing. This may be because large baitfish cannot tolerate the high temperatures in southern waters, or because these fish are in a weakened condition following spawning.

In the Marianas west of long. 160°E, there were also some reports of high baitfish mortality, but here the vessels were making catches of 20-25 tons per day (average 6-7 tons per day). Fish sizes were: 1-2 kg, 10%; 3-4 kg, 60%; and 6-8 kg, 30%. Toward the eastern part of this area (lat. 19°N, long. 169°E) the water temperature was around 27°-28°C. Here vessels continued for a while to catch 10-15 tons per day of large skipjack tuna. Fish sizes were: larger than 9 kg, 28%; 6 kg, 20%; 4.5 kg, 2%; and 2.5 kg or smaller, about 50%.

There were three or four vessels fishing to the east of long. 180° at lat. 24°-29°N, long. 166°-179°W (water temperature, 21.0°-26.5°C) in the area extending from Midway toward the Hawaiian Islands. Most of the skipjack tuna taken were small fish (1.5-3.0 kg), and the 9-15 kg skipjack tuna taken in these waters in previous years were not encountered. The maximum catch per day was 36 tons; the average was around 10-15 tons per day, including yellowfin and bigeye tunas.

The chartered purse seiner Fukuichi Maru (499 tons) fished experimentally in southern waters beginning in late May. The trials centered around lat. 3°-7°N, long. 135°138°E and also around lat.

0°, long. 138°-139°E. In 17 sets of the seine, the vessel took 182.9 tons of skipjack tuna, 41.1 tons of large yellowfin tuna, 54.3 tons of small yellowfin tuna, and 4.9 tons of small bigeye tuna. As usual, the vessel aimed her sets around schools associated with drifting logs. However, this may have been the first time in which sets were made on six consecutive days around the same log-associated school.

In June, 15 vessels unloaded 1,185.2 tons of southern water skipjack tuna (including 11 tons of small yellowfin tuna) at Yaizu. The landings per vessel averaged 79.7 tons. Another vessel that fished in southern waters to the east of long. 180° returned with 202.9 tons (including 25.6 tons of small yellowfin tuna, and 3.6 tons of small bigeye tuna). One purse seiner unloaded 182.9 tons (including 41.1 tons of large yellowfin tuna, 54.3 tons of small yellowfin tuna, and 4.9 tons of small bigeye tuna).

July 1975

Fishing grounds developed extensively throughout the subtropical area east of the Marianas at lat. 19°-21°N, long. 145°E-170°W. In waters west of long. 160°E, the water temperature was just as high as in June (29.4°-30.0°C). To the east of long. 160°E, it was around 28°C. In waters east of long. 180°, the temperature was around 27°C. Whether related to temperature or not, there were reports of higher bait mortality among vessels operating in high-temperature waters west of long. 160°E.

In the area long. 179°E to 170°W, the catches reached a maximum of 40-50 tons per day of large (8-15 kg) fish. Along with these large fish, some 1.5 kg fish were also taken. In the area long. 160°-165°E, the maximum catches were 20-25 tons per day of 3.0-3.5 kg and 8-13 kg skipjack tuna. In the vicinity of long. 153°E, the maximum catch was 30 tons per day of mostly 3.0-3.5 kg skipjack tuna. There were also some 1-2 kg and 8-13 kg fish taken in the area. Finally, near long. 145°E, the catches reached 30-35 tons per day of largely 2-4 kg skipjack tuna, along with some 7-8 kg fish. In general, the average catch throughout the extensive subtropical area was around 6-7 tons per day and was considerably better than the same time a year ago. Since this area appeared to yield a steady, reliable harvest, about 150 vessels fished there, while only four or five vessels ventured farther south at this time. Although there were some vessels that fished the shoal-associated fish in the vicinity of the Marianas, catches there only averaged around 3-5 tons (maximum 10 tons) of 1.5-2.5 kg fish per day.

Those few vessels which ventured south fished at lat. 1°-2°N, long. 149°-150°E (water temperature, 29.0-29.4°C) and experienced catches of 10-20 tons per day but only for a few days. The catches soon

turned poor. At lat. 0°, long. 138°-139°E, catches were again from log-associated schools and amounted to 10-15 tons per day. However, here again, good fishing was of short duration. A few vessels shifted to areas east of long. 180° to fish shoal-associated schools, but the results were disappointing.

Towards the end of July, the vessels fished log-associated schools at lat. 5°-6°N, long. 170°-175°E and made good catches of around 40 tons per day.

In July, 47 vessels returned from southern waters to unload 3,799.1 tons of skipjack tuna at Yaizu. This included 44.2 tons of small yellowfin tuna and bigeye tuna. The landings per vessel averaged 80.4 tons. There were 192.7 tons of fish taken from waters east of long. 180°.

August 1975

As fishing became unproductive throughout the subtropical waters (along lat. 20°N), vessels began to scout areas south of lat. 10°N. Toward the end of July excellent fishing had been experienced on log-associated schools at lat. 4°-5°N, long. 170°-173°E (water temperature, 28.4°C) with catches of 40-60 tons per day. After initial reports of good catches, vessels had flocked to the area and catches had fallen to 20-30 tons per day from both log-associated and other types of schools. Fish taken from log-associated schools showed the following size composition: larger than 6 kg, 7.4%; 4.5 kg, 21.3%; 2.5 kg, 35.9%; and 1.5 kg, 35.4%. Sizes of fish taken from other types of schools were: larger than 6 kg, 13.1%; 4.5 kg, 39.8%; 2.5 kg, 42.9%; and 1.5 kg, 4.2%.

Toward the end of this month, the fishing grounds shifted slightly to the west to lat. 4°-5°N, long. 165°-168°E (water temperature, 28.5°C), where average catches of 7-8 tons per day were experienced. There were 40-50 vessels fishing this area.

In the Carolines, where fishing remained poor until mid-August, there was a definite improvement towards the end of the month. At lat. 3°-5°N, long. 148°-150°E (water temperature, 28.5°C), 10-22 tons of 3-5 kg skipjack tuna were caught per day. Vessels moving toward the east paused here to fish, and there were 20-30 vessels in the area by late August.

Baitfish mortality increased sharply as the vessels moved southward beyond lat. 10°N. The mortality was particularly marked on vessels that had departed Japan after mid-August, and many of these vessels reported mortalities of 70%-90%. They had obtained their bait mainly from the baiting areas along the west coast of Kyushu (Yokoura, Miyanoura, Kohama, etc.) and also from Sajima in Kanagawa

Prefecture, but bait mortality did not seem to differ between baiting areas. The baitfish appeared healthy at first glance but there were instances when the bait died little by little each day after departure from Japan, and also cases where the baitfish survived all the way to the fishing grounds and suddenly succumbed to mass mortality. There are at present no certain countermeasures against such heavy mortalities.

In August, 69 vessels arrived in Yaizu from southern waters to unload 7,906.6 tons of skipjack tuna (including 152.6 tons of small yellowfin and bigeye tunas) for an average of 114.5 tons per vessel.

September 1975

Throughout September fishing took place in the Marshalls and near Kusaie Island (lat. 5°-10°N, long. 165°-175°E), where the water temperature was 27.5°-28.7°C). There was also some fishing farther to the east but catches were not very good. In the main fishing grounds near the Marshalls, the best catches were around 25 tons per day with a daily average of 4-5 tons. Although the catches were not spectacular, fishing was steady. The fish taken were: 6-10 kg, 21%; 4-5 kg, 47%; and 1-2 kg, 32%. There were 60-70 vessels fishing in this area.

The Carolines continued to show poor fishing throughout the month. Even where large numbers of schools had been seen a month ago at lat. 3°-5°N, long. 148°-150°E, the fishing was very poor this month. The Kagoshima Prefecture vessels, which usually fish the Carolines area, shifted their operations to waters east of long. 160°E.

The baitfish mortality continued high. According to reports of vessels that had departed Japan in mid-August and returned to Yaizu this month, there were cases of mortalities as high as 90%.

In September, 83 vessels unloaded 7,817.6 tons of skipjack tuna (including 256.0 tons of small yellowfin and bigeye tunas) at Yaizu for an average of 94.2 tons per vessel. One purse seiner returned with 199.3 tons of skipjack tuna, 80.2 tons of large yellowfin tuna, 20.6 tons of small yellowfin tuna, and 5.7 tons of other species.

October 1975

Baitfish mortality continued to be high. Although some fishing took place in the Carolines and Marshalls, no satisfactory operations were possible because of the heavy bait mortalities. In the Carolines at lat. 4°-6°N, long. 144°-157°E (water temperature, 29.5°-

30.0°C), considerable numbers of skipjack tuna schools were sighted but because of the shortage of bait (from mortality) and also because skipjack tuna responded poorly to the chummed bait (probably because it included too many dead baitfish), only about 2-8 tons per day of fish were taken. The skipjack tuna taken were between 2-5 kg in size. There were 30-35 vessels in the area.

In the Marshall Islands area at lat. 6°-13°N, long. 162°-175°E (water temperature, 28°C) catches were around 3-10 tons per day and these low catches were again attributable to bait mortality. The skipjack tuna taken ranged from 4 to 12 kg (6-12 kg fish dominant) but there were also large numbers of 1.5 kg fish taken (about 30%). It is interesting to note the sighting of large schools of juvenile skipjack tuna of around 25 cm (250-300 g) in this area.

Also, large numbers of schools of small skipjack tuna of 0.5-1.5 kg were reported to the west of long. 140°E near Palau.

In October, 87 vessels returned to Yaizu from southern waters to unload 5,523.6 tons of skipjack tuna (including 198.8 tons of small yellowfin and bigeye tunas); the average delivery per vessel was 63.5 tons. This low average reflected the effect of heavy bait mortality experienced by many of the vessels.

November 1975

At lat. 5°-12°S, long. 175°-180°, (water temperature around 27°C), five or six vessels operated with maximum catches of 20-25 tons per day. The fish taken were large (5-13 kg) skipjack tuna. The average catch was around 5-8 tons per day. When compared with other areas with very poor fishing, this area was relatively productive, resulting in as much as 180-220 tons per trip for several of the larger (more than 400 tons) vessels.

The skipjack tuna vessels that fished the Coral Sea this year did not do well at all, averaging only around 40 tons per vessel (per trip). Two purse seiners fishing in the Coral Sea took only about 250 tons of fish each.

The main fishing grounds in November developed around lat. 4°-6°N, long. 146°-160°E (water temperature 29.0°-29.5°C). In mid-November, the vessels were taking a maximum of 20-25 tons per day with an average of 7-8 tons per day. Toward the end of the month, however, fishing conditions deteriorated rapidly and only about 3 tons per day could be caught on the average. Most of the fish taken were around 3-5 kg. The chartered purse seiner Fukuichi Maru fished this same area and found fishing very poor at this time.

In the vicinity of the Marshalls, at lat. 9°-13°N, long. 165°-175°E (water temperature 28.0°C), rather good catches were reported in early and mid-November. The maximum catches amounted to 20-25 tons per day; the average was 5-6 tons per day. Again, fishing turned poor toward the end of the month. The vessels started to shift westward. Some of the larger vessels headed for waters south of the equator.

It was reported that the vessels based in the Solomons and in New Britain were also experiencing extremely poor fishing at this time.

In November, 78 vessels unloaded 6,592.4 tons (including 438 tons of small yellowfin and bigeye tunas) of southern water skipjack tuna at Yaizu. The average landings per vessel amounted to 84.5 tons. In addition, two purse seiners landed 406.3 tons of skipjack tuna, 114.8 tons of large yellowfin tuna, and 64.9 tons of small yellowfin and bigeye tunas for a total of 586.0 tons.

December 1975

Fishing conditions in waters east of long. 160°E deteriorated very rapidly and most of the vessels shifted their operations to waters west of long. 150°E. In early December, some catches of up to 20 tons per day were made in the area northwest of Truk (lat. 8°-9°N, long. 149°-151°E, water temperature 28.2°C). The skipjack tuna were mainly large fish of 6-8 kg. However, starting in mid-December, although fish schools were encountered, the fish responded very poorly to chum. Most vessels then shifted westward. In mid-December, at lat. 2°-4°N, long. 142°-147°E (water temperature, 29.4-29.5°C), some vessels fished log-associated schools and caught up to 14-15 tons per day (average 3-5 tons) of 2-4 kg skipjack tuna. About 20%-25% of the catches comprised of 1-2 kg skipjack tuna, indicating an increase in smaller fish in the area.

Towards late December, many vessels moved westward and fished around lat. 2°-5°N, long. 132°-136°E (water temperature 29.3°-29.5°C), aiming mainly at log-associated schools. The maximum catches were around 20 tons per day (average 5-6 tons) of small skipjack tuna (about 30%-50% were 1-2 kg fish). Also, at lat. 0°, long. 139°-143°E (water temperature 29.5°-29.8°C), five or six vessels fished log-associated schools and made good catches of 10-25 tons per day. These vessels took 95-185 tons (per trip) from this area. The fish were small, however, and ranged from 1 to 4 kg. Seventy percent of the catch consisted of 1-2 kg fish. Since virtually all fishing was done on log-associated schools, as expected there was a rather large proportion (4%-10%) of small yellowfin and bigeye tunas mixed in the catches.

There still were a few reports of heavy bait mortalities.

In December, 100 vessels delivered 8,315.0 tons (including 339.7 tons of small yellowfin and bigeye tunas) of southern water skipjack tuna at Yaizu. The average landings per vessel amounted to 83.1 tons. Four purse seiners landed 891.3 tons (including 297.9 tons of yellowfin and bigeye tunas).

D. TUNA PURSE SEINING

There are essentially three categories of purse seining in Japan. These are: 1) tuna purse seining (coastal and distant water); 2) seining for tunas and other species (coastal waters); and 3) seining for bigeye scad and mackerel (coastal waters). Here we are concerned with tuna purse seining only.

Tuna purse seining in tropical waters has improved considerably, and there are presently several commercial seiners operating in the western Pacific. The catch rates have improved significantly from last year's average of around 10 tons per set to around 16-20 tons. I was told that purse seiner captains are now able to evaluate quite accurately whether or not a school is seinable, thus increasing their percentage of success on sets made. They have begun to seine schools not only associated with drifting objects, but those associated with birds as well (Table 4).

Table 4.--Results of visual scouting for fish schools and fishing for skipjack tuna, Fukuichi Maru, 1975.

Type of schools (association)	Total schools sighted	Skipjack tuna (present or absent)					
		Present	B/A	Absent	C/A	No. of sets made	D/B
	A	B		C		D	
			%		%		%
Solitary	0	0	0	0	0	0	0
Birds	197	102	52	95	48	10	10
Drifting objects	177	80	45	97	55	45	56
Whales-sharks	5	1	20	4	80	0	0
Total	386	183	47	206	53	55	30

From: Data provided by JAMARC.

An interesting recent trend has been the conversion in the purse seine fishery from two-boat seining to one-boat seining (Table 5). Perhaps this trend is the consequence of the promising results obtained by the one-boat seiners which operated experimentally in tropical waters under charter to JAMARC. Another reason may be the lower costs involved in one-boat seining.

Table 5.--The landings, by species, of tunas by the Japanese purse seine vessels, 1968-73.

Year	Type	No. of vessels (units)	Species[1]						
			BF	AL	BE	YF	Small YF	SJ	FM
			Metric tons						
1968	One-boat	--	22	--	25	1,012	229	4,350	--
	Two-boat	--	5,989	66	158	3,059	2,305	2,301	--
1969	One-boat	16	14	41	48	489	17	5,714	3
	Two-boat	55	2,288	193	48	1,548	141	3,631	10
1970	One-boat	21	89	38	106	2,400	30	2,791	--
	Two-boat	49	1,660	124	77	2,386	361	2,484	7
1971	One-boat	29	46	151	167	2,197	119	8,626	--
	Two-boat	41	2,521	744	27	1,069	668	2,077	--
1972	One-boat	38	61	273	761	3,744	84	13,614	--
	Two-boat	34	3,352	2	--	746	264	1,239	3
1973	One-boat	43	353	1,326	189	5,880	467	16,301	7
	Two-boat	19	1,169	24	4	1,575	51	1,791	--

Data provided by Mr. M. Honma, Far Seas Fisheries Research Laboratory.

[1]BF = bluefin tuna; AL = albacore; BE = bigeye tuna; YF = yellowfin tuna; SJ = skipjack tuna; and FM = frigate mackerel.

One-vessel seining requires 19-22 men in the crew of a 500-ton seiner. Two-vessel seining requires 44-45 men in the crews of two vessels in each unit.

One of the newest one-boat seiners is the 500-ton Fukuichi Maru, which has 18 men in her crew.

In tropical waters, Table 6 shows an increasing success rate (successful sets/total sets) over the years. Since 1971, the success rate has been at around 60%. The total landings by the purse seine vessels have also increased considerably since 1973.

Table 6.--Tuna landings by Japanese purse seiners in southern waters, 1967-74.

Year	No. of vessels	No. of sets	No. of successful sets (percentage)	Species[1]				
				BE	YF	SJ	Other	Total
				Metric tons				
1967	3	42	12(28.6%)	--	120	130	1	249
1968	4	89	22(24.7%)	--	220	208	--	427
1969	2	22	8(36.4%)	--	3	77	--	80
1970	4	95	39(41.1%)	--	123	338	--	461
1971	5	115	82(71.3%)	35	200	706	3	944
1972	4	60	40(66.7%)	47	188	539	8	782
1973	6	197	111(56.3%)	84	412	1,245	10	1,752
1974[2]	7	353	-- --	36	407	2,159	19	2,621

Data provided by Mr. M. Honma, Far Seas Fisheries Research Laboratory.

[1]BE = bigeye tuna; YF = yellowfin tuna; SJ = skipjack tuna.

[2]Estimated.

The results of the most recent charter cruises were reported by JAMARC as follows:

Vessel: Fukuichi Maru, 499 tons

Survey area: Caroline Islands area, lat. 10°N-1°S, long. 135°-158°E.

Survey periods:

First cruise: Departed Yaizu 10 April 1975; returned Yaizu 17 May 1975.

Second cruise: Departed Yaizu 24 May 1975; returned Yaizu 27 June 1975.

Third cruise: Departed Yaizu 7 July 1975; in Guam 11-15 August 1975; returned Yaizu 17 September 1975.

Bad weather precluded fishing on 7 days during the survey period. There was an unusual number of squalls, which had some effect on visual scouting for fish schools. One-hundred eighty-three fish schools out of a total of 386 schools sighted contained skipjack tuna (Table 4). In 55 sets, 82% were on schools associated with drifting objects; the remainder (18%) were on schools associated with bird flocks. Last year only 4% of the sets had been made around bird-associated schools. The success rate this year in setting around bird-associated schools was 40%, indicating the feasibility of successfully fishing around this type of school in addition to schools associated with drifting objects. The first cruise resulted in an average catch of 19.6 MT of tuna per set; the second in 16.9 MT, and the third in 16.7 MT per set, thus exceeding the performance of a year ago by a considerable margin (Table 7). The total catch amounted to 959.2 MT as compared to the 500 MT taken during last year's charter cruise (June-November 1974). This year's results gave promise of the possibility for year-round purse seining in tropical waters.

Table 7.--Purse seining results of the Fukuichi Maru, 1975.

		Cruise			
		First	Second	Third	Total
Total No. of days per trip		38	35	65	138
No. of days on fishing grounds	A	23	24	50	97
No. of days fished (No. of sets)	B	13 (13)	15 (17)	23 (25)	51 (55)
B/A (%)		57	63	46	65
Total catch (MT)		254.2	287.5	417.5	959.2
Catch per set (MT)		19.6	16.9	16.7	17.4

Catch (MT)				
Skipjack tuna	184.2	185.8	288.2	658.2
Yellowfin tuna	62.4	92.6	123.6	278.6
Small yellowfin tuna	5.4	4.8	5.7	15.9
Others	2.2	4.3	0	6.5

Data provided by JAMARC.

E. SKIPJACK TUNA FISHERY SURVEY IN MICRONESIA

JAMARC again chartered the No. 20 Akitsu Maru (192 tons) to survey Micronesian waters. This was the second of three planned surveys in Micronesia. The first was conducted between 1 July and 15 October 1974, during which only Ponape was surveyed. The planned survey of Truk did not materialize because no agreement could be reached with local chiefs during pre-survey negotiations. The results of the Ponape survey were in general disappointing. The observers cited the following reasons: Bait was scarce and sufficient quantities could not be taken; this often precluded the vessel from fishing during the best hours of early morning and late afternoon. Furthermore, some of the baitfish (anchovies in particular) were very weak, some were stronger but too scarce (clupeids), and some, although rather plentiful and strong, were too big (carangids). The bait survey included the use of the stick-held lift net (bo-uke ami) and the drive-in net (oikomi-ami), the latter for taking reeffish.

The second survey was conducted between 21 May and 20 September 1975. Negotiations with local authorities were fairly successful this time and the survey included Ponape, Palau, and western Truk, with about a month spent at each locality. In general, the results showed that, of the three areas, only Palau abounded in baitfish. The situation in Ponape was unchanged from that of the first survey. Truk also revealed a scarcity of baitfish.

Bait surveys were conducted by bait fishing with the stick-held lift net (bo-uke ami). After the bait were taken, they were transferred into a bait receiver for holding tests. At Ponape, only a small bait receiver, 3 m x 3 m square, was used. The baitfish were swum into the receiver by lowering the edge of the receiver netting. After 26 h in the receiver, the 25 buckets of baitfish suffered an 80% mortality. Similarly, in Truk, 10 buckets of baitfish held in the bait receiver suffered a 60% mortality after 26 h. A longer holding experiment was conducted in Palau where a larger receiver, 9 m in diameter, 32 m deep, was set up in the lagoon. The vessel was anchored and the receiver placed next to it. After catching bait by stick-held lift net, the bait were transferred into the receiver. Small quantities

of bait were transferred each time to the receiver over a 5-day period. The bait survived well for more than 5 days. Ten days later, however, only 20 buckets of a total of 214 buckets remained alive, resulting in a 9.3% survival. Not all of the bait had died; considerable amounts were seen escaping from the receiver by jumping over the netting. The clupeid, Harengula ovalis, were particularly adept at escaping from the receiver. A factor contributing to the mortality was the large numbers of birds which constantly attacked the bait in the receiver.

In Ponape, 718 buckets of baitfish consisting mostly of Stolephorus heterolobus were taken over the survey period. The average catch per set of the lift net was 14.6 buckets. In Truk, 797 buckets were taken, averaging 17.7 buckets per set. Most of the bait consisted of Spratelloides delicatulus. In Palau, where the most bait was seen, 1,300 buckets were collected, mostly S. heterolobus, averaging 24.6 buckets per set.

According to the observer who accompanied the vessel, S. heterolobus was altogether absent from Truk, whereas this baitfish was the chief component both in Ponape and Palau. As for the availability of baitfish in these areas, the tentative conclusion drawn at this point is that neither Ponape nor Truk would be able to support a skipjack tuna fishery of more than a few vessels. Palau has greater potential, since many of the areas with bait are not now being utilized by the existing fleet of 12 vessels serving the Van Camp Company. The observer felt that Palau could support a larger fishery providing other baiting areas are opened up. To do this, however, he thought that it would be necessary to provide navigational aids that would permit safer passage to the outlying bait areas at night. The Palau fishery at present permits only 1-day trips because of weak bait. Improvements are needed in this area to make longer trips possible.

The observer further reiterated the point that their surveys in Truk and Ponape this year did not include the use of drive-in nets for reef species. Since reef species had been extensively used in prewar years in Micronesia, he emphasized that his conclusions were based only on the lift-net trials, and that a survey of reef resources may show additional potential.

As far as skipjack tuna fishing in these areas was concerned, it was found that skipjack tuna schools were generally scarce. Furthermore, those schools chummed were very unresponsive. In 20 days of fishing around Ponape, only 1.3 tons of skipjack tuna were taken. Around Truk, only 2.1 tons were taken in 19 days of fishing. In Palau, 5.5 tons were taken in 16 days.

The poor fishing results were attributable largely to the poor condition of the baitfish. Weak bait precluded going very far to fish for skipjack tuna. Around Truk and Ponape, those skipjack tuna schools encountered responded very poorly to chumming. Around Palau, where the fishing grounds are relatively far from shore, not enough time could be devoted to fishing skipjack tuna because of the bait experiment underway in the lagoon.

The third in this series of surveys is planned for 1976.

F. BLUEFIN TUNA REARING

The following information is summarized from an article appearing in the Kochi Shimbun dated January 19, 1976, provided by Mr. Hisao Sakamoto of the Nansei Regional Fisheries Research Laboratory in Kochi, Japan.

Although the Kochi Prefectural Fisheries Experimental Station was not a part of the multi-agency cooperative program on tuna culture and rearing sponsored by the Japan Fisheries Agency (1971-73), Kochi researchers independently began work on rearing of bluefin tuna at their branch station facility at Komame, Kochi Prefecture. They worked on this project over a 5-year period, 1970-75, independent of financial support from the national government. The reason given for having undertaken this work was as follows: Yellowtail culture in Japan is considered a leading aquacultural success. Between 1960 and 1970, the production of cultured yellowtail increased thirtyfold. In more recent years, however, the fishery has been plagued with numerous problems including outbreaks of disease (probably related to deteriorating water quality in the culture areas, usually situated in bays and inlets), overproduction, and an alarming decrease in food conversion rate in the cultured fish, all of which have tended to depress the economy of this fishery. Because of these problems with yellowtail, the Kochi Prefectural Fisheries Experimental Station decided to study the feasibility of rearing the highly prized bluefin tuna.

At the outset of the experiments in 1971, the young bluefin tuna, collected by surface trolling and in traps, suffered very high mortality when placed in the rearing enclosures situated in Komame Bay. The mortality was due to injuries incurred when the fish rushed into the sides of the enclosure. After placing the young bluefin tuna in the enclosures, they were fed minced food mixed with antibiotics twice a day. Survival was considerably better among smaller fish; in fish under 300 g, it was extremely good. However, in fish of around 500 g, survival was only around 55%; and in fish larger than 1,000 g, the survival was only 8%. Healthy young fish exhibited a silvery white coloration on their body; weaker fish looked darker and even the body stripes seemed faded.

The Kochi researchers gradually improved rearing techniques and little by little they raised fish to larger sizes. If we look at the results obtained in 1973, it is seen that out of 322 fish placed in the enclosures, 186 had died within the first few days, even before they had begun to feed. Mortality was 58%. Some of the survivors began to feed as early as 3 days after being placed in the enclosures. Between 9 and 12 days, all 136 survivors were feeding and exhibiting growth.

In August 1972, young fish of 0.14 kg were placed in the enclosure. By November 1975 (3 years and 3 months later), the fish had reached a record 50 kg (110 lb). In comparison with this growth rate, a 0.25 kg yellowtail reared from June would reach 1 kg in size by October, 2 kg by March of the following year, and 3.5 kg at the end of 21 months. On the other hand, bluefin tuna started in July at 0. 13 kg reached 1 kg by mid-September; 2.5 kg by November, and in 17 months reached 9 kg in size. During the rearing period, the water temperature in Komame Bay ranged from the maximum 28.8°C in August to a low 15.5°C in February. The bluefin tuna feeds well and exhibits good growth in temperatures ranging between 20.0°-28.5°C.

The bluefin tuna were fed onago(?), mackerel, sardine, and bigeye scad at rates of 16% of body weight in 0.3 kg fish; 10% in 10 kg fish; and 8.5% in 20 kg fish.

In order to test consumer acceptance of reared bluefin, test marketing of the fish showed that the auction prices were similar to those for bluefin tuna taken in the Indian Ocean or in Japanese coastal waters. The quality of the flesh rated high in the markets. During 1973, 1974, and 1975, the average auction price per kilogram was 913 yen and the maximum price was 1,098 yen.

The problem of rearing bluefin tuna in commercial quantities lies in securing sufficient numbers of young fish. Studies are necessary on the resources, their availability, behavior, etc., and methods must be developed for capturing large quantities of young fish. Furthermore, research is necessary to improve survival rate, especially during the early rearing stages. Rather than depend only upon young fish captured in the wild, techniques must be developed to rear larvae hatched from artifically fertilized eggs.

Since bluefin tuna are considerably more sensitive than the yellowtail to water quality, water transparency, and other environmental factors, it is now possible to rear them in only a few selected areas. It appears desirable to set up very large rearing enclosures in deeper, offshore areas where better conditions hold. In fact, this possibility will soon be explored. Because of the favorable results obtained by the Kochi researchers, the Japan Fisheries Agency

has designated the Laboratory to continue this project supported by the Agency's new program, "Development of aquaculture techniques utilizing offshore areas." According to the Director of the Kochi Prefectural Experimental Station, the budget for this project may amount to approximately 100 million yen ($333,330) in 1976 with support from the national government. In 1975, the budget was $33,330. If such support is received, the Kochi researchers hope to work towards commercialization of bluefin rearing. They hope to set up very large enclosures in offshore waters in depths of from 30 to 100 m.

G. THE BLUEFIN TUNA FISHERY IN HOKKAIDO

For many years there has been a small fishery for bluefin tuna along the western coast of Hokkaido. Recently, the fishery has shown signs of expansion. Between 1960 and 1969, the annual total Hokkaido landings ranged between 130 and 500 MT. In 1970, the total incresed slightly to 590 MT, and in 1971 to 677 MT. No data are available for 1972 and 1973, but the 1974 landings amounted to 1,204 MT. There are two areas where bluefin fishing is especially active, one on the northern tip of Hokkaido at Rishiri, where fishing is by longline and pole and line, and the other along the southwestern coast of Hokkaido at Shiribeshi, where bluefin are taken by traps. It is reported that since last year, longline fishing effort has increased at Rishiri and bluefin catches have increased correspondingly. Fish larger than those taken previously have started to enter the catches. Of further interest is the fact that fish with very ripe ovaries have been taken in Hokkaido off Kamuinai in July. One ripe fish was rather small, weighing only 53 kg (147 cm). The gonad weight was measured at 2,710 g, and the gonad index calculated at 8.5. Spawning fish are generally larger than 80 kg. Ripe fish are taken off Taiwan in April-May, and these fish are 175-210 cm in length. Thus, this relatively small fish with ripe ovaries, taken off Hokkaido, is of special interest.

Although the catches at Shiribeshi and Rishiri are relatively small, the bluefin tuna is a high-priced fish and the earnings are good. For example, at Shiribeshi in 1974, a single trap was reported to have grossed 200 million yen ($666,670). The 1971 gross earnings for the Hokkaido landings of 667 MT were reported at 600 million yen (approx. $1.7 million). More recent figures are unavailable.

The fishing season for bluefin tuna along the Japanese coast is from summer to winter. Spawning apparently takes place in the vicinity of Taiwan from April to June. The fish appear off Sanriku (northeastern Honshu) in summer, when purse seiners actively fish this species.

The migratory route of the bluefin tuna into Hokkaido waters is not yet clear. However, the fish begin appearing in July and migrate northward along the Tsushima Current. The northward movement appears to end around October, after which they apparently turn southward. During the period of northward migration the fishing peaks in August. At that time the fish appear relatively close to shore where traps are effective. Fishing peaks again around December during the southward migration. The fish tend to migrate farther off the coast during the southward movement.

The fish taken off Rishiri and Shiribeshi differ considerably in size. The modal sizes of the fish in kg) taken in the two areas are roughly as follows:

Shiribeshi: 1969: 3 kg and 10 kg modes, latter dominant; 90% of fish under 15 kg; no fish larger than 115 kg.

1970: 6 kg, 10 kg, and 20 kg modes; 90% of fish under 25 kg; 1 fish larger than 115 kg.

1971: 5 kg, 12 kg, 23 kg, and 35 kg modes; 90% of fish under 40 kg; 7 fish larger than 115 kg.

1972: 6 kg (dominant), 12 kg, 27 kg, 33 kg modes; 90% of fish under 55 kg; 26 fish larger than 115 kg.

1973: 0.5-1.2 kg (30-37 cm) fish most abundant; smaller modes at 6 kg, and 15 kg; 90% of fish under 20 kg; 26 fish larger than 115 kg.

1974: 4 kg fish most abundant; smaller mode at 12 kg; 90% of fish under 15 kg; 31 fish larger than 115 kg.

The annual sample sizes above ranged from 15,511 fish in 1972 to 73,002 fish in 1974.

Rishiri: 1969: 7 kg, 15 kg, 30 kg modes; 90% of fish smaller than 40 cm; no fish larger than 115 kg.

1970: Largest mode at 27 kg; smaller modes at 15 kg and 45 kg; 90% of fish smaller than 60 kg; 4 fish larger than 115 kg.

1971: A single large mode at around 45 kg; 90% of fish under 75 kg; 25 fish larger than 115 kg.

1972: A single large mode around 60 kg; 90% of fish under 95 kg; 13 fish larger than 115 kg.

1973: A single large mode at around 80 kg; 90% of fish smaller than 100 kg; 20 fish larger than 115 kg.

1974: A single large mode at around 90 kg; 90% of fish smaller than around 115 kg; 144 fish larger than 115 kg.

The sample sizes above ranged from 545 fish in 1969 to 2,484 fish in 1971.

It is seen from the above that there is a progression in modal sizes from 1 year to the next at both areas. The fish sizes are generally larger at Rishiri, where they are taken by longline and pole-and-line fishing.

Hokkaido researchers have estimated the ages of bluefin tuna by the weight-frequency distributions, as follows:

1 year old, 2 kg; 2 years old, 7 kg; 3 years old, 16 kg; 4 years old, 30 kg; 5 years old, 48 kg; 6 years old, 67 kg; 7 years old, 90 kg; and 8 years old, 115 kg.

H. ANTARCTIC KRILL

JAMARC has continued to explore the krill resources in the Antarctic, and has chartered the Taiyo Fishing Company's Capetown-based stern trawler, the No. 82 Taiyo Maru, 3,500 tons, to explore the krill resources off Queen Maud Land. The cruise began in November 1975 and was scheduled to end in March 1976. As of February 15, JAMARC officials reported that the vessel had already taken 1,700 MT and that the ship would catch its capacity in about 10 days. The catch rate was reported at around 40 MT per day.

A previous charter cruise was made in October 1974-March 1975 period by the 1,500-ton No. 11 Daishin Maru. Using a slightly smaller trawl, the vessel took 1,079 MT (gross earnings approx. $606,000); her best catch was around 25.7 MT per day. Thus, this year's results are considerably better.

JAMARC officials are of the opinion that catching krill is no longer a problem. However, the problem of product utilization still remains. Thus far, little progress has been made in this vitally important area. How the krill is to be utilized will determine whether or not present catches are cost-effective in consideration of the long distances to the fishing grounds, high cost of fuel, and other operational requirements.

It is interesting to note that the Nippon Suisan Company has fielded its 3,600-ton stern trawler, Aso Maru, for the second year in a row. This vessel was reported to be making equally good catches and had about 2,600 MT on board as of mid-February.

The great international interest in the krill resources is apparent from the fact that there were, in addition to the two Japanese trawlers, three trawlers from the Soviet Union, one from Poland, one from Chile, and two from West Germany. The West German trawlers were said to be using Montevideo as their base of operation and hosting observers from France and England.

In terms of processing the krill, it was found best to boil it before freezing. On last year's cruise, some krill were experimentally processed on board the No. 11 Daishin Maru as flakes, pressed cake, and dried products. When compared to similar products made ashore, it appeared that these ship-processed products were superior. Further work in this area is being done on the present charter cruise.

I. LIST OF PERSONS CONTACTED DURING TRIP

Far Seas Fisheries Research Laboratory, 1000 Orido, Shimizu

Dr. Y. Fukuda, Director
Dr. Satoshi Mito, Chief, Research Planning and Liaison Office
Dr. Shoji Ueyanagi, Chief, Division of Pelagic Resources
Mr. Koichi Hisada, Division of Pelagic Resources
Mr. Misao Honma, do.
Dr. Shoji Kikawa, do.
Mr. Susumu Kume, do.
Dr. Shou Morita, do.
Mr. Yasuo Morita, do.
Mr. Yasuo Nishikawa, do.
Dr. Chiomi Shingu, do.
Mr. Toshio Shiohama, do.
Mr. Jiro Suzuki, do.
Dr. Tamotsu Yonemori do.
Dr. Ichiro Yamanaka, Chief, Division of Oceanography
Mr. Jiro Morita, Division of Oceanography
Mr. Hajime Yamanaka, do.
Mr. Mori Yukinawa, do.

Tokai University Faculty of Marine Science and Technology, 1000 Orido, Shimizu

Dr. Motoo Inoue, Professor
Dr. Mitsuo Iwashita, do.
Dr. Sigeru Motoda, do.

Tohoku Regional Fisheries Research Laboratory, Shiogama-shi, Miyagi, Japan

Dr. Shigekatsu Sato, Director
Dr. Rikiichi Ishida, Chief, Division of Resources
Dr. Kohei Kasahara, Section Chief, Division of Resources
Mr. Anraku, Division of Resources
Mr. Masahiro Asano, do.
Mr. Naganuma, do.
Mr. Tamotsu Tanaka, do.
Mr. Masakazu Yao, do.
Dr. Tatsuo Yusa, Division of Aquaculture
Dr. and Mrs. Odate (Saury Research)

Federation of Japan Tuna Fisheries Co-operative Associations, 22-3 2-chome Kudankita, Chiyoda-ku, Tokyo

Mr. Shoichi Masuda, President
Mr. Hirosaku Koda, Executive Director, also Vice-Chairman, Japan Tuna Trading Co., Ltd.
Mr. Shiro Yoshizaki, Executive Director
Mr. Shojiro Shimura, Director, Guidance Division
Mr. Mikio Inamori, Chief, Guidance Section, Guidance Division
Mr. Asao Nagamine, Chief, Section of International Affairs
Mr. Suzuki

Japan Marine Fishery Resource Research Center (JAMARC), Godo Kaikan Building, 3-4 Kioicho, Chiyoda-ku, Tokyo

Mr. Kazuo Yasufuku, President
Mr. Kyo Yui, Executive Manager
Mr. Joichi Fujita, Director, Research Division
Mr. Minoru Iida, Chief, Planning Section
Mr. Tadashi Inada, Division of Developmental Research
Mr. Suehiro Machida, do.
Mr. Ryoji Saito, do.

Sanyo Hydrographic Survey Co., 23-7 Shimbashi 5, Minato-ku, Tokyo

Mr. Shigeo Hikosaka, President

Asuka Manufacturing Co., Ltd., 1-chome, Togoshi, Shinagawa-ku, Tokyo

Mr. Y. Kato, President

University of Tokyo, Faculty of Fisheries, Hongo, Tokyo

Dr. Isao Hanyu, Professor
Dr. Robert Izumo, Graduate Student

Universal Marine Consultant Co., Ltd. (UNIMAC), Fuji Building 5-3 1-chome, Yaesu, Chuo-ku, Tokyo

Mr. Masayasu Kato, Executive Managing Director

Institute of Sea Spheres, Takaishi 832-96, Kawasaki-shi, Kanagawa Prefecture

Mr. Hiroyo Koami, Director

Iwatani & Co., Ltd., 7-1 Hatchobori, 2-chome, Chuo-ku, Tokyo

Mr. Teruhiko Yamashita, Deputy Manager, Tokyo Foreign Trade Department
Mr. Shu Furukawa

Bumble Bee Seafoods, Castle & Cooke East Asia, Ltd., Tomihisa Building 5th Floor, 10 Nihonbashi Honcho 3-chome, Chuo-ku, Tokyo

Mr. Y. Munechika, Manager
Mr. Yoichi Horiuchi
Mr. Masahiko Shimada

Japan Fisheries Agency, 1-2-1 Kasumigaseki, Chiyoda-ku, Tokyo

Mr. Teruo Sasaki, Deputy Director General
Mr. Yukio Onda, Chief, Department of Research and Development
Mr. Mutsuya Onda, Chief, Research Division
Dr. Akira Suda, Counsellor, Department of Research
Mr. Koya Mimura, Division of Research

American Embassy, APO San Francisco, California 96503

Mr. Y. Nasaka, Assistant to Regional Fisheries Attache
Ms. Martha A. DeWitt
Ms. Ellen Sasaki

Overseas Fishery Cooperation Foundation, 9-13 Akasaka 1, Minato-ku Tokyo

Mr. Kisaburo Honda, Director, Business Department

Japan Marine Products Photo Materials Association, 601-5-17-1 Hyakunincho, Shinjuku-ku, Tokyo

Mr. Naomi Yoshikawa, Managing Director (Planning and Production)
Mr. Miyoshi

Okinawa Prefectural Fisheries Experimental Station, Itoman, Okinawa

Mr. Akinosuke Tomori, Biologist

Kanagawa Prefectural Fisheries Experimental Station, Jogashima, Miura-shi, Misaki, Kanagawa Prefecture

Mr. Eiji Hanamoto, Biologist

Hokkaido University Faculty of Fisheries 3-chome, Minato-machi, Hakodate 040

Mr. Shoji Saito, Professor

Hokkaido Ritsu Chuo Suisan Shikenjo, 238 Hamanakacho, Yoichi, Hokkaido

Mr. Takashi Yorita, Biologist

NHK, 2-Jinnan, Shibuya-ku, Tokyo

Mr. Yoshio Fukumuro, Director, NHK Eigyo Sokyoku

Nihon Keibi Hosho K.K., 1-7-2 Nishi-shimbashi, Minato-ku (Toranomon Takagi Building), Tokyo

Mr. Norio Chiba, Director, Business Department

Kitasato University, Sanriku-machi, Kesen-gun, Iwate Prefecture 022-01

Dr. Kazuo Fujino, Professor