SOUTH PACIFIC COMMISSION

TUNA TAGGING AND OBSERVATIONS ON A JAPANESE GROUP PURSE SEINE VESSEL (9–28 April 1990)

by

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ABSTRACT

An experimental tagging cruise was conducted on Japanese vessels of the Kotobuki purse seine group. Observations and tagging operations took place from 9 to 28 April 1990 in the waters of the Federated States of Micronesia and in international waters. Tuna were tagged from seven of the eight successful sets made during the cruise and a total of 118 skipjack (*Katsuwonus pelamis*), 144 yellowfin (*Thunnus albacares*) and 30 bigeye tuna (*Thunnus obesus*) released. The majority of releases were immature fish between 45 and 55 cm in fork length and a practical means of tagging the larger yellowfin was not successfully developed. The nature of the group purse seine operation allows fish to be released in very good condition for longer periods than is possible on conventional single purse seine or ring net vessels. Return rates for all releases total 21.6 per cent of which most were recaptured soon after release. A summary of data is presented here with detailed information and observations on Japanese group seine operations. Recommendations for improvements to the tagging procedures used during the cruise and suggestions for further improvement are given.

RESUME

Des observations et des opérations de marquage ont été effectuées à bord des bateaux japonais du groupe de senneurs Kotobuki à l'occasion d'une campagne expérimentale qui s'est déroulée du 9 au 28 avril 1990 dans les eaux internationales et dans celles des Etats fédérés de Micronésie. Sept des huit coups de pêche positifs de cette campagne ont permis le marquage et le lâcher de 118 bonites (*Katsuwonus pelamis*), 144 thons jaunes (*Thunnus albacares*) et 30 thons obèses (*Thunnus obesus*). Les poissons relâchés étaient pour la plupart immatures et mesuraient de 45 à 55 centimètres de longueur à la fourche. Aucune solution pratique pour le marquage des grands thons jaunes n'a pu être trouvée. Par sa nature même, la pêche à la senne en groupe permet de relâcher le poisson en excellente condition et après des périodes plus longues que dans le cas des senneurs autonomes ou des bateaux équipés de filets tournants. Le taux de récupération par rapport à l'ensemble des poissons relâchés a atteint 21,6 pour cent, la majorité ayant été repris peu après leur lâcher. On trouvera dans ce document un résumé des données ainsi que des informations et observations détaillées sur les opérations japonaises de pêche à la senne en groupe. On y trouvera enfin des recommandations visant l'amélioration des techniques de marquage utilisées durant cette campagne ainsi que des suggestions pour l'avenir.

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1. INTRODUCTION

A trial tagging cruise was conducted by a fishery scientist of the South Pacific Commission (SPC) on board vessels of the Kotobuki purse seine group during the 1990 season. Observations and tagging took place from 9 to 28 April 1990 in the waters of the Federated States of Micronesia (FSM) and adjacent high seas areas. The cruise was carried out in support of the SPC Regional Tuna Tagging Project (RTTP) which was established in 1989 to investigate yellowfin, skipjack and bigeye tuna population parameters, biology and fishery interaction in the western Pacific region. This cruise offered a unique opportunity to release tagged fish in the centre of regional purse seine activity and examine this option as a means for tagging large yellowfin tuna difficult to tag using conventional methods. Knowledge of fishing gear and methods used in the Japanese southern-water group seine fleet was also expanded and updated.

This valuable opportunity was provided by the Government of the Federated States of Micronesia through fishing access negotiations between the Micronesian Maritime Authority (MMA) and the Federation of North Pacific District of Purse Seine Fisheries Co-operative Associations of Japan. A list of the agreed arrangements is included as Appendix I. Travel costs of the scientist to and from the vessel boarding and disembarkation points were covered by RTTP funding provided by the Sixth Development Fund of the European Community. Food and lodging were generously provided during the cruise to the scientist on the vessels *Kotobuki Maru 23, Kotobuki Maru 7* and *Shoichi Maru 32*. Particular credit is due to all members of the Kotobuki purse seine group for rendering complete co-operation and assistance to the project.

2. BACKGROUND INFORMATION

Seven Japanese purse seine groups were licensed to operate in the southern-water tuna fishery during 1990. They included vessels of the Kotobuki, Matsuo, Suwa, Hakko, Hakuryu, Shoichi and Myojin groups. These groups engage in three separate fisheries throughout the year, harvesting northern bluefin (*Thunnus thynnus*), yellowfin and skipjack tuna from May to September, mackerel and small coastal pelagic species from October to December and then entering tropical waters from January to April or May to seine yellowfin, skipjack and small quantities of bigeye tuna.

2.1 Japanese group purse seine operations

The May to September Japanese tuna season supplies the domestic sashimi market, with the catch held on ice for a maximum of three days before unloading. Four or more carrier vessels are used to shuttle the fresh catch between the offshore fishing grounds east of Honshu and Hokkaido and the unloading ports. This high-value fishery produces the greatest earnings to the fishermen who concentrate on supplying the lucrative bluefin sashimi market. The winter mackerel and sardine fishery operates in the coastal waters off eastern Honshu, landing large volumes of catch at a lower ex-vessel price.

The 1990 tropical fishery operated only in the waters of the Federated States of Micronesia and the high seas pocket between the FSM and Papua New Guinea. All the tuna taken in the southern-water fishery are frozen on board the carriers for transport to Tinian. The catch is then transferred to bulk carriers for delivery to canneries in Southeast Asia.

2.2 Group seine vessel types

2.2.1 General

A typical southern-water group seine operation consists of one net boat, two carrier vessels and one search boat. A total of 28 vessels in seven groups operated during the 1990 season and are listed in Appendix II. The characteristics of each vessel type are briefly described below.

2.2.2 *Net boat or catcher vessel*

Japanese net boats are either 116 GRT vessels of approximately 31 m or the newer 135 GRT ships measuring 35 – 36 m in length. The net boat carries the fishing master, purse seine net and 19 to 22 crewmen. The fishing master directs the movements of all the group vessels during fishing operations from the bridge or upper bridge house of the net boat. The net boat is supplied with the deck machinery necessary for net-setting and retrieval and is well equipped with electronics used for communications, school detection and assessment. Figure 1 shows the *Kotobuki Maru 23* net boat.

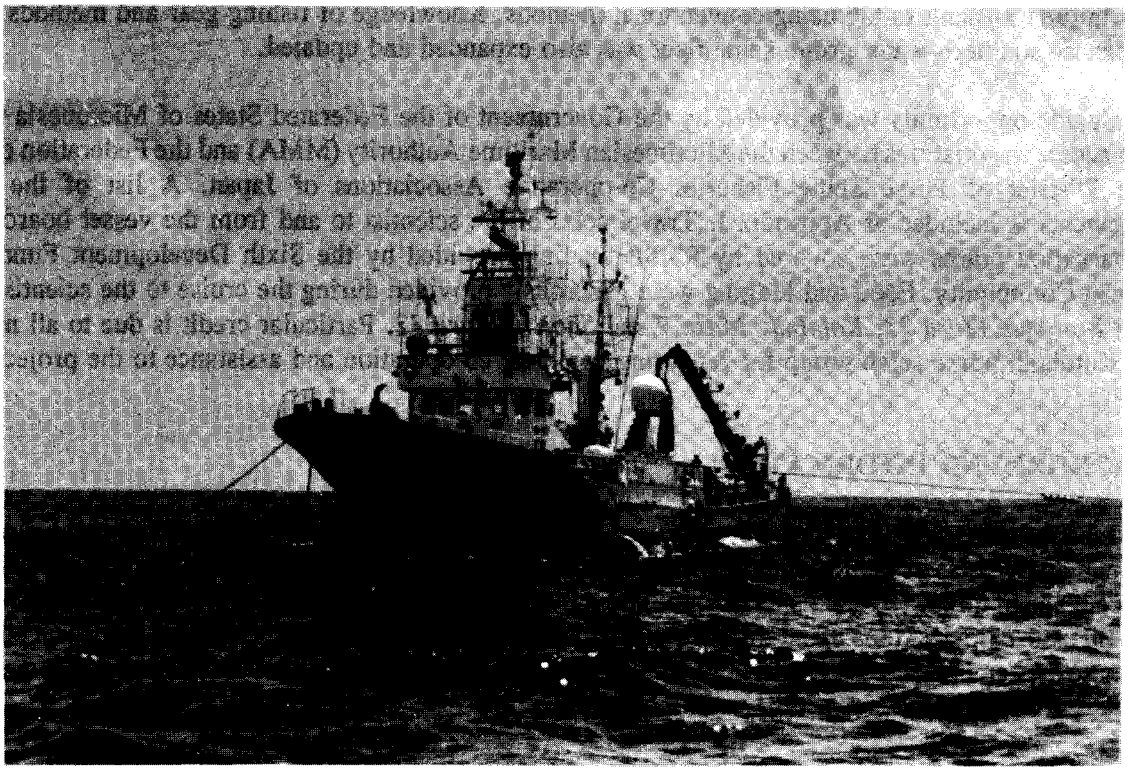

Figure 1. ***Kotobuki Maru 23*****, group purse seine net boat**

2.2.3 *Search boat*

The search boats are smaller support vessels of 82 to 99 GRT, 31 – 33 m long. They typically carry a crew of eight or nine men and are equipped with one auxiliary skiff stored on a stern ramp for easy launching and retrieval. The search boat is used to tow the net boat away from the net during net pursing and hauling and to keep the net boat and carrier separated as the catch is brailed from the net. There is little room for the crew to search for fish visually from the upper bridge deck, but the ships are well equipped with searching electronics, including sonar, bird-detecting radar and depth sounders. Search boats are also equipped with a saltwater rail-mounted spray system similar to those installed on pole-and-line tuna vessels. The spray is used when the vessel is over skipjack schools to help attract the school to the boat or lessen the avoidance by the school of the ship. The search boats are often used to investigate bird schools, tuna schools and schools associated with drifting logs or debris.

2.2.4 *Carrier vessels*

The catch is brailed directly from the net to freezer carriers for transport to Tinian. Usually only one carrier works with the net boat while the other carrier is discharging catch or in transit to or from the fishing grounds. Eleven to 13 men typically man the 300 to 400 GRT vessels. The catch is held in circulating brine or dry holds at −15° to −40° Centigrade with storage capacities of around 150 to over 300 tonnes. Most group seine carriers are converted pole-and-line vessels but an increasing number of reconstructed or newly built refrigerated carriers are joining the fleet. The *Myojin Maru 18* is a good example of a reconstructed carrier built with the stern pilot-house/engine-room section of a pole-and-line boat joined to a new forward

section with enlarged freezer holds and equipment designed specifically for brailing and sorting the catch. The *Hakuryu Maru 82* is one of the new-generation carriers built specifically to load and unload quickly and to freeze and transport a larger catch. Both of these vessel hulls use a bulbous bow design for increased fuel economy. The carriers also supply the net boat and search boat with fuel, food, mail and crew replacements (if necessary) on the fishing grounds, allowing the group to concentrate on searching and fishing during the entire season. Figure 2 shows the search boat *Kotobuki Maru 25* and the carrier *Kotobuki Maru 7.*

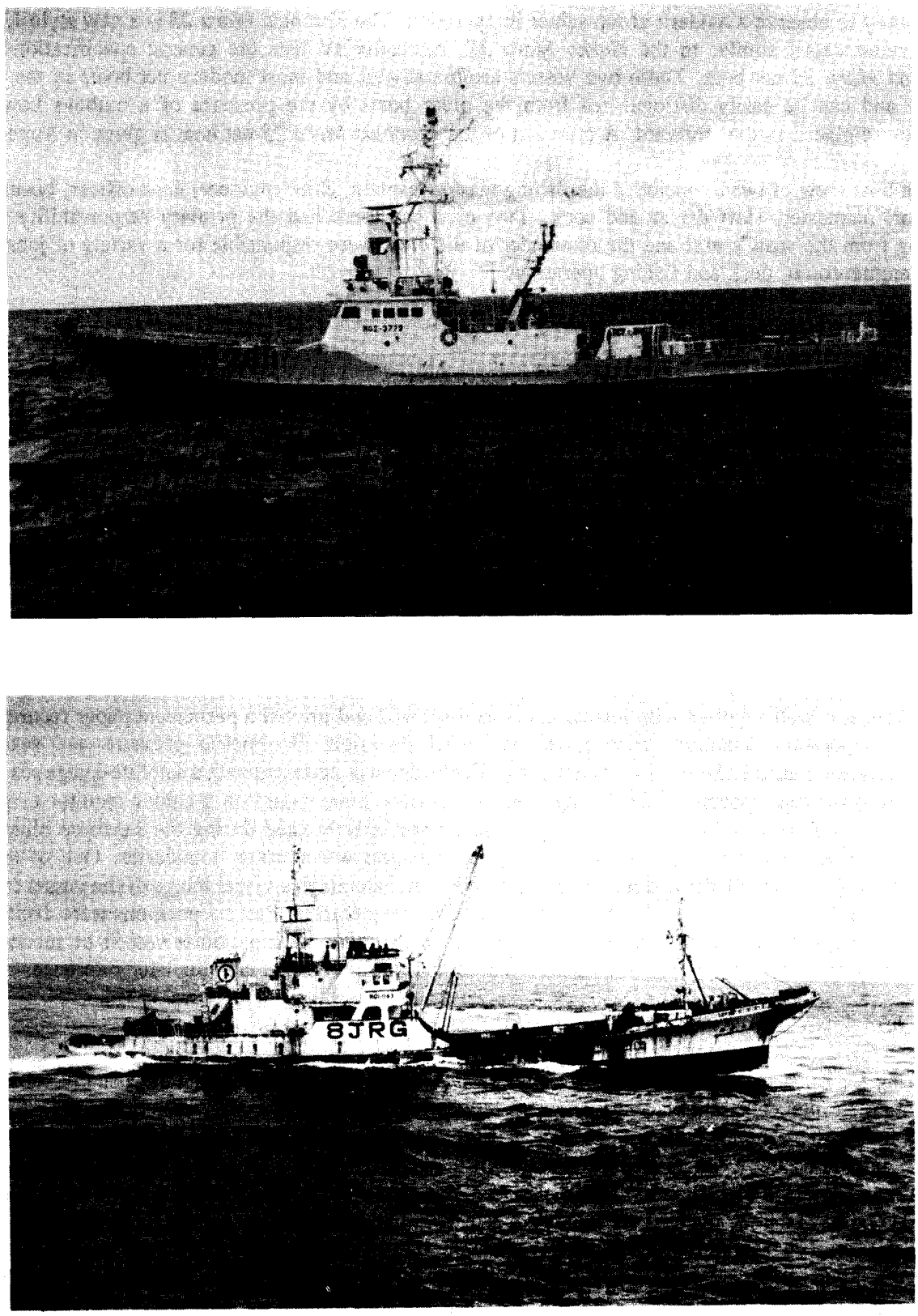

Figure 2. The search boat *Kotobuki Maru 25* and carrier *Kotobuki Maru 7*

3. KOTOBUKI GROUP – VESSELS AND GEAR

3.1 Vessels and personnel

Tagging and observer activities took place on the *Kotobuki Maru 23* net boat under the command of fishing master Takahashi Seiko. Group support vessels at this time included the carrier *Kotobuki Maru 7* and the search boat *Kotobuki Maru 25*. Appendix III lists the characteristics of the vessels in the Kotobuki seine group, which were manned by 51 men of Japanese race and nationality. The cruise offered a valuable opportunity to observe a modern group seiner in operation. The *Kotobuki Maru 23* is a new style 135 GRT group seine vessel similar to the *Hakko Maru 35*. Appendix IV lists the general specifications of the *Kotobuki Maru 23* net boat. These two vessels are the newest and most modern net boats in the tropical fishery and can be easily distinguished from the older boats by the presence of a bulbous bow and a wheelhouse placed farther forward. A crew list of the *Kotobuki Maru 23* net boat is given in Appendix V.

The net boat crew of twenty included the fishing master, captain, chief engineer, deck officer, bosun, radio operator, netmaster, skiff driver and cook. Two crew members had the primary responsibility for fish spotting from the crow's nest and the remainder of the crew were responsible for a variety of jobs related to the engine-room, deck and fishing operations.

3.2 Marine electronics

3.2.1 Communication

A wide range of radio and communication gear is housed in a large, separate room beneath the bridge and linked to microphones on the bridge and upper wheelhouse. This room also houses the facsimile receivers, radio direction finder, Loran C receiver and the INMARSAT Earth Station equipment. Satellite weather maps and world news briefs are received daily. Telephone and fax communications are possible through the INMARSAT system and the crew were permitted to use the telephone system to keep in touch with their families in Japan. The fishing master also used the telephone to discuss fishing information privately over long distances with other vessels on the fishing grounds.

3.2.2 Navigation and weather

The bridge was well supplied with instruments that displayed and printed a permanent paper record of sea-surface temperature, position, wind speed and wind direction. Barometric pressure and sea-surface temperature were entered hourly in the ship's log. The bridge was equipped with a satellite-image sea-surface temperature receiver capable of displaying ocean sea-surface temperature on a colour monitor or printing the full colour image for later reference. This system was mainly used during the Japanese bluefin tuna season to locate favourable current patterns, upwellings and warm water boundaries. One of the most frequently-used electronic devices was a course plotter that maintained a visual image of the vessel track and displayed vessel position, speed, heading, and sea-surface temperature. Past set positions were displayed on screen and waypoints were often entered at the positions of productive logs, other vessels or successful set positions by other seiners. A data recorder stored all this information on tape for later reference.

3.2.3 Fish detection and monitoring

Searching for surface tuna schools was greatly assisted by an S-band bird radar unit, usually set at the 12 nautical mile range. The unit was very effective in locating and displaying bird schools and the other group vessels within this range even through rain squalls or choppy seas. The unit was mounted near the helm to assist rapid and accurate course changes towards bird and tuna schools. A doppler current meter was set to display current speed and direction at 30-, 50- and 100-metre depths and the information was graphically displayed on a screen for the past six-hour period in 30-minute intervals. A colour chromoscope and paper recording sounders monitored school size and depth information beneath the vessel. One of the units recorded on paper the depth achieved by the net during each set, via transducers attached to purse rings at three locations along the chainline. This information was also displayed by gauges mounted on the bridge.

A paper recording depth telesounder could receive and print soundings sent by a device mounted on the search boat. This allowed the fishing master on the net boat to judge the size of schools directly beneath the search boat, which was often used to assess logs or schools.

The most important electronic fishing gear on the bridge consisted of three colour scanning sonar units mounted behind the helmsman which allowed for unobstructed viewing by the fishing master. The highly sophisticated units displayed vessel position, speed and course, sea-surface temperature, current speed/direction, sonar range settings and transducer tilt angle in a compact display in the corner of the viewing screen corner. The horizontal distance, true distance, depth and bearing of any sonar target (school) were also readily available. The units were set and calibrated to operate efficiently for different ranges and target types. The most sensitive unit could discern very small targets to an optimal range of less than 400 m. The other units were set to work efficiently at ranges to 700 m and 1000 m respectively. By varying the transducer angle between the units it was possible to display an accurate size and depth profile of one school simultaneously. Display monitors for the bird radar, course plotter and sonars were also mounted in the upper bridge room where the fishing master directed daytime sets. The electronic equipment mounted in the bridge of the *Kotobuki Maru 23* is listed in Appendix VI.

3.3 Engine room

The *Kotobuki Maru 23* was powered by a 640 PS Niigata diesel main engine driving a single fixed-blade screw. Two auxiliary engines (Niigata 220 PS, Yanmar 150 PS) powered Taiyo Electronics generators to supply 100 and 220 volt AC power. Hydraulic power for most of the deck machinery was supplied by two electrically-driven pumps. Hydraulics for the powerful purse winch came from four separate pumps driven by a power take-off link to the Niigata main engine. A reverse osmosis-type water maker with a rated output of 5 mt per day supplied ample drinking and bathing water.

The lack of fish holds on the net boat eliminated the need for large freezer compressors, accumulators and circulating brine pumps. The engine-room had a small workshop area with a drill press, vice and grinder. Oxygen/acetylene and arc welding gear were available.

3.4 Deck machinery

3.4.1 Purse winch

The main purse winch was equipped with bow and stern cable drums and independently controlled fairlead rollers to lay the cable evenly during pursing. The entire purse cable consisted of approximately 2800 m of six-strand steel cable varying from 20 to 30 mm in diameter. The different cable sizes were joined using smooth long splices forming one continuous length of cable. The towline cable attached to the stern end of the purse seine was kept on a separate hydraulic drum mounted aft of the purse winch. The purse cable ran through two heavy purse blocks mounted on a heavy steel davit that was stored below the level of the work deck when not in use.

3.4.2 Power block

The net retrieval system consisted of a deck-mounted power block or *net leader* and a standard sheave-type power block mounted on an extendable, pivoting crane. The seine was hauled over the net leader block, under a stainless steel idler drum and up to the crane-mounted block where it fell to the net bin to be stacked by the crew. The net leader performed most of the hauling work at deck level, passing the net bundle to the power block in a compact bunch, and the power block was kept relatively close to the deck. This resulted in a very stable hauling system reported to be effective in winds up to 30 knots. The net leader was stored below deck during net setting and when not in use. The net crane eliminated the need for the stern mast and conventional boom controlled by topping and vang winches that are used on older vessels. The *Kotobuki Maru 23* was the only net boat in the 1990 tropical fishery equipped with a stowable net leader and power block crane.

3.4.3 Auxiliary winches

The final stage of net hauling or *drying up* prior to brailing is accomplished with specialised rail rollers and pinch rollers mounted along the starboard side. Nine rubberised side rollers line the entire starboard rail from the wheelhouse to the stern. Netting is hauled from the water using the side rollers, with assistance from the crew. Larger portions of netting are hauled using three pinch roller winches or two high-speed net rollers mounted inboard of the side rollers. The general specifications of the machinery described above are listed in Appendix VII. Figure 3 shows the net hauling gear of the *Kotobuki Maru 23* in operation.

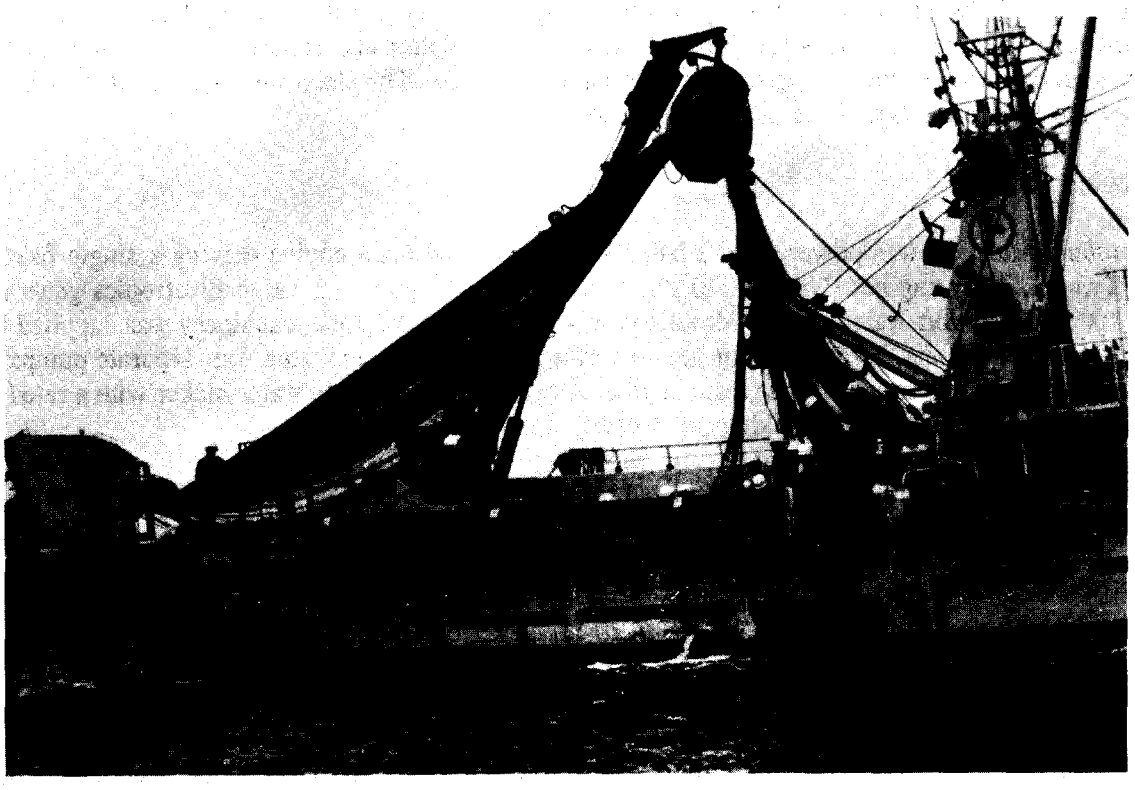

Figure 3. Net hauling gear on the *Kotobuki Maru 23*

3.5 Purse seine net

The *Kotobuki Maru 23* uses three separate purse seine nets during different times of the year for mackerel, small baitfish and tuna fishing. The tuna seine used in FSM waters has a corkline length of 2121 m, chainline length of 1959 m and maximum depth of 396 m. Average corkline hanging ratio is 26.6 per cent, and 16.6 per cent at the chainline. The net regularly purses or fishes to a depth of 180 – 200 m in low to moderate current conditions. This net is lengthened to 2348 m every year for use in the Japanese bluefin tuna fishery.

The corkline consists of approximately 5000 to 5400 yellow polystyrene corks strung on a nylon line lashed to the main corkline. Each cork alternates with a lashing, providing an easy handhold for stacking and a holding edge for the ridges on the power block during net retrieval. The chainline consists of a continuous galvanised chain weighing about 2145 kg. Nylon rope bridles connect the 162 steel rings to the chainline. The first two and last two rings are specialised roller-type rings used to reduce the friction from the purse cable during pursing.

The low density of the corkline and relatively light weight of the chainline are the result of the lightweight construction and the use of knotless, two-strand nylon webbing. The net is basically composed of 31 vertical panels of webbing laced together with nylon twine. The mesh size ranges from 240 mm (stretched mesh length) in the centre of the seine to 75 mm at the heavy *sack* or brailing pocket where the catch is concentrated prior to brailing. Mesh twine diameters in the seine varied from a Japanese net size of 40 to size 200, with most of the net composed of size 50 – 70, which corresponds approximately to American twine sizes of 24 – 36. A summary of net specifications is included in Appendix VIII[1].

4. FISHING METHOD

4.1 Information

School-sighting and catch information is shared quite freely among the Japanese group and single seine fleets and there do not seem to be any separate code groups or formalised alliances. However, the group seiners seemed to remain close to each other during the period of the tagging cruise, and several groups were often fishing within sight of each other. The 499-tonne single seiners seem to work more independently and were spread out over a much larger area.

4.2 Fishing strategy

The captain stated that a prevailing low price for canning-grade skipjack and small yellowfin discouraged them from fishing on log-associated and pure skipjack schools. Whenever possible, the group concentrated on making daytime sets on unassociated yellowfin tuna schools or fishing on whale- or whale shark-associated yellowfin schools that contained large fish. Log schools and skipjack schools were fished when encountered, but visually locating drifting logs was apparently not stressed and rafts or payaos were not deployed during the cruise. This strategy did not produce a large yellowfin catch, due to the low success rate while fishing on unassociated yellowfin schools.

4.3 Searching

The net boat normally searched for fish at a speed of 10 to 11 knots, with the other vessels of the group ranging 4 to 8 nautical miles on either side. Visual searching was conducted from all group vessels, aided by bird radar units on the *Kotobuki Maru 23* net boat and *Kotobuki Maru 25* search boat. Searching from the net boat started shortly after dawn and usually continued until one or two hours before sunset. Two men were always in the crow's nest, with two to four crewmen spotting from the flying bridge. Most of the spotters used 10 x 70 binoculars, but 7 x 50 power units were also used. The ship was also fitted with a swivel mount on the flying bridge for 20 x 120 power binoculars, but this unit was out of repair during the cruise. The scanning sonars, depth chromoscope and bird radar were always operating and monitored by the captain or fishing master when searching for fish. The preference for setting on feeding yellowfin schools favoured the use of the bird radar during the cruise, but a visual watch for logs and schools was always maintained.

4.4 School and set types

Japanese purse seine fishermen differentiate between several categories of tuna school and set type. Most of these terms have commonly used equivalents in the American and Australian purse seine fleets, although Americans seldom if ever make sonar or ship-associated school sets. The school types commonly differentiated by Japanese fishermen are listed and described in Table 1.

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1. Some confusion has been noted by other authors concerning Japanese net dimensions. Net sizes and lengths are often expressed by Japanese fishermen in measurements of **sun**, **shaku** and **ken** instead of metric equivalents. (One **ken** = five **shaku** = fifty **sun** = 1.51515 metres)

Table 1: School and set types

U.S. term	Japanese term	Description
Shiners	*Haragaeshi*	Sub-surface school, fish turning and reflecting in sunlight
Finners	*Boko hane*	Individual fish breaking surface
Jumpers	*Hane*	Individual fish jumping clear of surface
Breezer, rippler	*Mizumochi*	Surface school causing rippled surface
Splasher	*Hanewaki*	Fish feeding, splashing surface
Boiler, foamer	*Shirawaki*	Fish very actively feeding, appears white
Log school	*Kizuki*	Associated with natural log
Payao school	*Jinkoryuboku*	Associated with man-made raft
Whale school	*Kujirazuki*	Whale-associated
Whale shark school	*Samezuki*	Whale shark-associated
Sonar school	*Sonaa active*	Sub-surface, unassociated school set by sonar
Ship school	*Funazuki*	Skipjack school under or around search boat

4.5 Unassociated school set

The fishing master directed all daytime unassociated school sets from a small upper bridge room, located above the navigation bridge, that offered an unobstructed view of the back deck and setting area. The target school was often followed and assessed for hours before a set was attempted. Japanese group seiner vessels set in a clockwise direction, finishing at the net skiff where cables attached to the bow end of the seine and purse cable are passed to the net boat. Pursing and towline retrieval started immediately while the search boat, carrier and net skiff drove in circles near the towline and on either side of the net boat in an attempt to keep the school in the centre of the net. Deck crewmen also pounded the sides of the vessel with hammers or spare purse rings to assist this effort. As soon as pursing began, the transducers for the net depth recorders were lowered into the water, allowing the net depth to be monitored on the bridge. Pursing may be slowed or temporarily stopped to allow the net to sink to the desired pursing depth. The search boat then attached to a towing bridle on the port side and began to tow the net boat away from the encircling net and inward pull of the purse cable. The net leader and power block were positioned for use and pursing continued until all 162 rings were lifted clear of the water under the davit. The same procedure would be used for sonar, whale- or whale shark-associated schools.

Net stacking began immediately, with assistance from crewmen transferred to the net boat from the carrier(s) and search boat. The purse rings (which remain on the purse cable) were untied from the net bridles and re-tied to another set of rings lined up on the starboard side of the net deck. This procedure allowed net rolling to begin as soon as pursing was completed. The purse cable was then rewound before the finish of net stacking. All gilled fish were removed from the net during net stacking. The large work force available for net stacking allowed most holes and net repairs to be made during the stacking procedure.

If the set was successful, the carrier tied up to the corkline opposite the sack and net stacking continued until a large, square pocket of net remained between the net boat and carrier. The net was then dried up using the side rollers and pinch rollers as described in section 3.4.3. The fish were scooped from the net with a triangular panel of netting or brailer connected to booms and hydraulic winches. The catch was usually brailed directly to refrigerated brine holds on the carrier but was dumped on the carrier deck to allow the sorting of by-catch or undersize tuna when necessary. Each brailer load could scoop about 3 mt of catch from the net per operation. Figure 4 shows the brailer in operation.

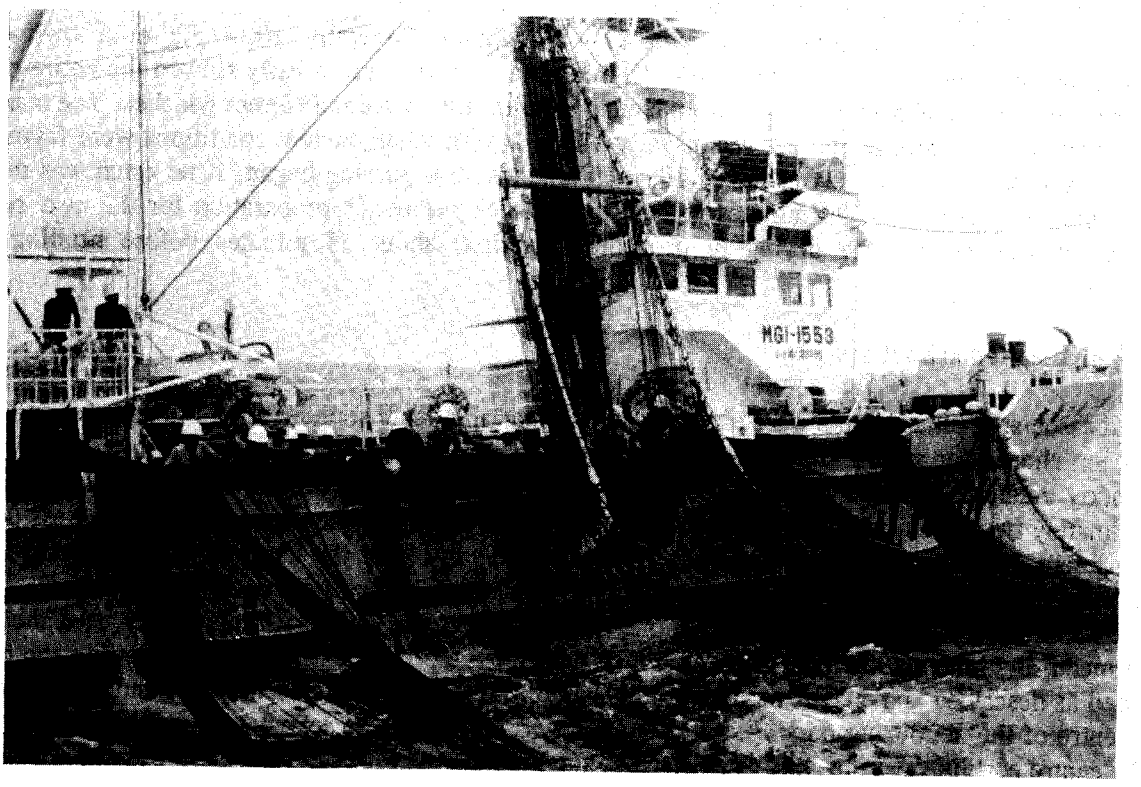

Figure 4a. Brailer in position between the net boat and carrier immediately before use

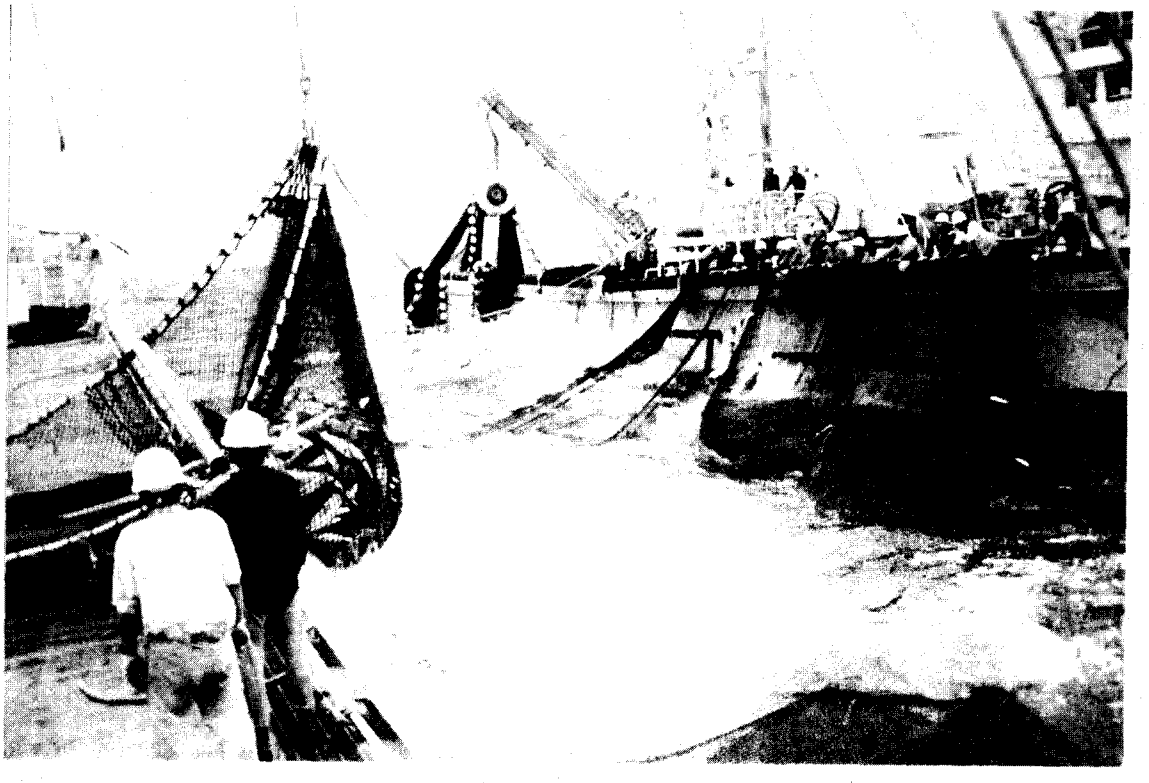

Figure 4b. Brailer loaded with skipjack being lifted to the deck of the carrier *Hakuryu Maru 82*

The following information was obtained from the 15 sets observed during the cruise. The net was set at a speed of 10.5 knots and net deployment usually took 6 – 7 minutes. Pursing began almost as soon as the cable was retrieved from the net skiff, requiring 23 – 36 minutes. Generally, 400 – 500 m of towline were used on school fish sets, which required 10 – 13 minutes to retrieve and greatly slowed the entire pursing procedure. The purse and towline cables were hauled simultaneously from different winches. The maximum pursing depth at the centre of the net was usually 180 – 200 m when current conditions were favourable. This maximum depth was usually achieved 10 – 15 minutes after pursing began. If no catch was made, it required approximately 75 – 90 minutes to haul and restack the net in preparation for the next set. If a sizable catch was netted, the drying-up procedure required about 45 minutes before brailing could commence.

4.6 Log-associated school set

Logs and associated tuna schools were evaluated with sonar and depth sounder from the net boat and search boat. A log chosen for setting the next morning was marked with a radio buoy and flashing beacon taped to the buoy antennae and the group vessels moved away to drift at least two kilometres from the log. Approximately two hours before dawn, the search boat came alongside the log and began to assess the tuna school present. A powerful underwater light was lowered 10 m below the log and bright deck lights were turned on in an effort to attract and concentrate the baitfish and tuna schools close to the surface. The net boat then approached the log approximately one hour before dawn, as the fishing master used the sonar, current meter and information from the search boat to judge the proper setting strategy. Setting and pursing proceeded as described above. The auxiliary skiff from the search boat was used to tow and position the log in the centre of the net during pursing. After pursing was complete, the search boat steamed out of the net over the centre corkline and the skiff usually towed the log out over the corkline near the net boat bow. This procedure unfortunately resulted in trapping most of the larger log-associated by-catch in the net; this then had to be sorted and discarded from the catch during brailing. The observer was informed that logs with large amounts of by-catch were usually towed slowly out of the net before net hauling begins, to allow the by-catch to escape. The log was then tied to the towing line between the net boat and search boat until the end of the set. The remainder of the set was similar to that described above for unassociated schools.

4.7 Ship school set

Nine ship school or *funazuki* sets were made by the *Kotobuki Maru 23* during the 1990 season, although none were conducted during the period of the tagging cruise. This appears to be a highly effective method, as nine ship school sets resulted in 454 mt of skipjack with only one of the sets resulting in no catch. The following description of this method is taken from information supplied by the Captain and crew.

Only sets on skipjack schools during daylight are attempted with this technique. The search boat steams toward a promising school while pumping seawater out of the rail-mounted spray system. The search boat will drift within the school, which, with luck, will remain breezing or feeding around the ship or sink just below the surface. School soundings are transmitted to the fishing master on the net boat via the depth telesounder. A set will be attempted if the school remains closely associated with the drifting search boat. The set proceeds as for a log-associated set, except that it is conducted during the day without lights. The search boat steams out over the corks after pursing is finished.

5. FISHING RESULTS

5.1 Catch summary

A total of 92 sets was made by the *Kotobuki Maru 23* during the 1990 southern-water season, of which the last 15 were during the period of the tagging cruise. The fishing master and vessel captain estimated a total of 1566 mt of tuna was taken during the entire season, of which 61.0 per cent was recorded as skipjack, 8.5

per cent yellowfin and 30.5 per cent mixed schools of skipjack, yellowfin and bigeye tuna. The amount of each species caught in the mixed schools was not recorded in the records examined, but half of the catch came from log-associated sets and half from unassociated school sets. If half of this mixed catch is assumed to be skipjack, the total catch would be roughly 75 – 80 per cent skipjack, 20 – 25 per cent yellowfin, with a small tonnage of bigeye from the log-associated sets. Appendix IX lists the date, position, school type and catch from all 92 sets from information taken from the ship's log.

5.2 Set type and catch per unit of effort (CPUE)

Slightly over half the 92 sets (51 per cent) resulted in no catch, with the majority of these 'skunk' sets made on unassociated school fish. Unassociated surface or sub-surface (sonar set) sets accounted for almost half of the catch but required two-thirds of the fishing effort or 62 of the 92 sets.

The success ratio (number of successful sets/total number of sets) of unassociated sets was 40 per cent, while the more reliable associated school sets had a success ratio of 73 per cent. The most reliable setting methods were log- or ship-associated sets, which resulted in almost half of the tonnage landed. Not surprisingly, sub-surface daytime sonar sets were one of the least productive fishing methods used. This information is summarised in Table 2.

The average CPUE for the entire season was 17 mt per set or 33 mt per successful set. Unassociated school sets took 12 mt/set or 30 mt/successful set. Associated school sets had a significantly higher CPUE of 27 mt/set or 37 mt/successful set.

Table 2: *Kotobuki Maru 23* – set types and catches for the 1990 season

Set type	No. of sets	No catch	Success ratio (%)	Skipjack (mt)	Yellowfin (mt)	SJ/YF/ BE (mt)	TOTAL CATCH
Jumpers	12	6	50	0	76	0	76
Breezer	3	1	67	60	0	0	60
Splasher	41	25	39	351	16	242	609
Boiler	1	1	0	0	0	0	0
Sonar	5	4	20	0	13	0	13
Unassociated	**62**	**37**	**40**	**411**	**105**	**242**	**758**
Ship	9	1	89	454	0	0	454
Log (dawn)	14	2	86	92	9	176	277
Log (day)	2	1	50	0	0	60	60
Whale	4	3	25	0	17	0	17
Whale shark	1	1	0	0	0	0	0
Associated	**30**	**8**	**73**	**546**	**26**	**236**	**808**
TOTAL	**92**	**45**	**51**	**957**	**131**	**478**	**1566**

6. TAGGING CRUISE SUMMARY

6.1 Daily activities

The entire tagging/observer trip lasted 20 days, with seven days spent in transit to and from the fishing grounds on the carriers *Shoichi Maru 32* and *Kotobuki Maru 7*. The remaining 13 days were spent on the net boat *Kotobuki Maru 23*, during which time 15 sets were made, taking 164 mt of tuna consisting of an estimated 104 mt of skipjack, 52 mt of yellowfin and 8 – 9 mt of bigeye tuna.

A full day of searching usually lasted 10 to 11 hours, interrupted only by sets or major net repairs. School sightings were generally low during the cruise, with low overall fishing success. All seven of the seine groups had finished their southern-water season and headed back to Japan by the end of April 1990. Table 3 lists school sighting and fishing information noted during the period of the tagging cruise.

Table 3: Summary of daily activities during the tagging cruise

Date	Area	Activity	Hours searched	Schools sighted	No. of sets	Catch (mt)			
						SJ	YF	BE	Total
09/04/90	Tinian	Board *Shoichi 32*	0	0	0	-	-	-	-
10/04/90	FSM	Transit	0	0	0	-	-	-	-
11/04/90	FSM	Transit	0	0	0	-	-	-	-
12/04/90	FSM	Transit	4	1	0	-	-	-	-
13/04/90	FSM	Board *Kotobuki 23*	9	0	0	-	-	-	-
14/04/90	FSM	Fishing	12	6	0	-	-	-	-
15/04/90	FSM	Fishing	10.5	9	2	0	8	0	8
16/04/90	FSM	Fishing	11	9	5	0	8	0	8
17/04/90	FSM	Fishing	10.5	1	0	-	-	-	-
18/04/90	FSM	Fishing	11	6	2	0	0	0	0
19/04/90	High seas	Fishing	11.5	3	1	0	0	0	0
20/04/90	High seas	Fishing	11.5	3	0	-	-	-	-
21/04/90	FSM	Fishing	3	2	1	0	0	0	0
22/04/90	FSM	Fishing	8	2	1	12	5	1	18
23/04/90	FSM	Fishing	7.5	2	2	8	1	<1	9
24/04/90	FSM	Fishing	5	2	1	4	2	<1	6
25/04/90	FSM	Fishing	1	1	2	80	28	7	115
26/04/90	FSM	Board *Kotobuki 7*	0	0	0	-	-	-	-
27/04/90	FSM	Transit	0	0	0	-	-	-	-
28/04/90	Guam	Depart vessel	-	-	-	-	-	-	-
TOTAL			**115.5**	**47**	**17**	**104**	**52**	**9**	**164**

6.2 Set summary

Catches by set and school type are listed at the end of Appendix IX. Seven of the 15 sets resulted in no catch. Most of these skunk sets were made on unassociated yellowfin schools, although one skipjack school was lost due to a 300-metre tear in the net. Four pre-dawn and one daytime log-associated sets were made on three separate logs, with all resulting in catch. The first two logs yielded only 28 mt in three sets, while the last log produced 105 mt of tuna in two sets.

6.3 By-catch and discards

By-catch of undesirable species was restricted to the five log-associated sets, except for a small quantity of dolphinfish (*Coryphaena hippurus*) taken during an unassociated yellowfin school set. Approximately two tonnes of by-catch were taken during these five sets, consisting of silky sharks (*Carcharhinus falciformis*), round scad (*Decapterus macarellus*), rainbow runner (*Elagatis bipinnulatus*), dolphinfish, triggerfish (*Canthidermis maculata*), rudderfish (*Kyphosus* sp.) and wahoo (*Acanthocybium solandri*). In addition, two blue marlin (*Makaira mazara*) were taken during log set No. 11. Most of the by-catch was discarded, although a small quantity was retained for consumption.

Approximately 3 mt of tuna were discarded during the 15 sets. Most of these fish had gilled in the net and were crushed by the power block during hauling. A small quantity of undersize skipjack were sorted from the catch on the carrier vessel and discarded. Approximately three tonnes of large skipjack were discarded by the carrier crew one day after filling the holds, as they would not fit into the freezer holds. The fish had expanded during freezing to overfill the holds. To assure complete loading of the carrier, this is probably the normal operating procedure and it can be assumed that a few tonnes of catch per well are discarded by all carrier vessels.

6.4 Vessel sightings

One Taiwanese single seiner was sighted in FSM waters on 13/04/90 at 02°57'N, 152°50'E, but the vessel's identity was not learned. The remainder of fishing vessels sighted during the cruise were Japanese group or 499 GRT single seiners. At one time or another the Kotobuki group sighted or was working in proximity to all of the other six group seine groups listed in Appendix II. Some American seiners were reported to be working in the area of the group seiners on 17/04/90, but none were sighted by the author. Generally, it seems that the group seiners often work in the same areas and freely exchange fishing information.

7. FISH TAGGING

7.1 Materials and procedures

The tags used during the cruise were plastic, single-barbed dart tags with yellow plastic streamers 13 cm long by 2.0 mm diameter manufactured in Australia by Hallprint Pty Ltd. The tags were marked twice with a five digit number preceded by the letter X and the legend 'SPC NOUMEA REWARD'. The fish were tagged below the base of the second dorsal fin using 15.5 cm stainless steel applicators which were stored upright in wooden blocks for easy access. Each tagging block held 100 loaded applicators in serially numbered slots. Large fish were tagged and measured on a 70 x 130 x 8 cm vinyl-covered foam mattress marked in one cm gradations. Most tuna were measured and tagged in a plastic lined wooden box measuring 30 x 34 x 80 cm.

One yellowfin was double tagged using one metal-headed harpoon type tag supplied by the Fisheries Research Institute, Cronulla, Australia, and one standard SPC dart tag. The harpoon tag had a sharpened spearpoint head bonded to a yellow plastic streamer bearing the words 'NSW FISH, BOX 21, CRONULLA 2230, AUSTRALIA'. The tag was inserted in the dorsal musculature using a long-handled applicator.

Fish species, fork length to the nearest cm, tagging quality and fish condition were noted using a portable cassette recorder wrapped in plastic and slung around the taggers neck. This information was transcribed to paper forms after each tagging operation and entered on a database using a portable microcomputer.

Tagging took place on the *Kotobuki Maru 7* carrier vessel or from the 5.8 metre auxiliary skiff of the search boat. Fish tagged from the skiff were scooped from the purse seine using long-handled dip nets fitted with 35 mm knotless mesh. Loaded tag blocks, spare tags, cameras, tape recorders and miscellaneous equipment were kept in a waterproof airline type bag for easy transfer to the skiff or carrier. The specifications of the tagging equipment are listed in Appendix X.

7.2 Tagging methodology

Two tagging methods were used during the cruise. Fish over 100 cm in fork length were tagged from the *Kotobuki Maru 7* (carrier) during the brailing process. One fish was selected from each brail load raised to the deck of the *Kotobuki Maru 7* and placed on the vinyl-covered foam tagging mattress. The fish were quickly measured and tagged and the fish condition was noted. Assistants released the tagged fish by moving the entire mattress to the side rail and allowing the fish to slide head first into the water. Figure 5 shows the brailing procedure during a tagging operation.

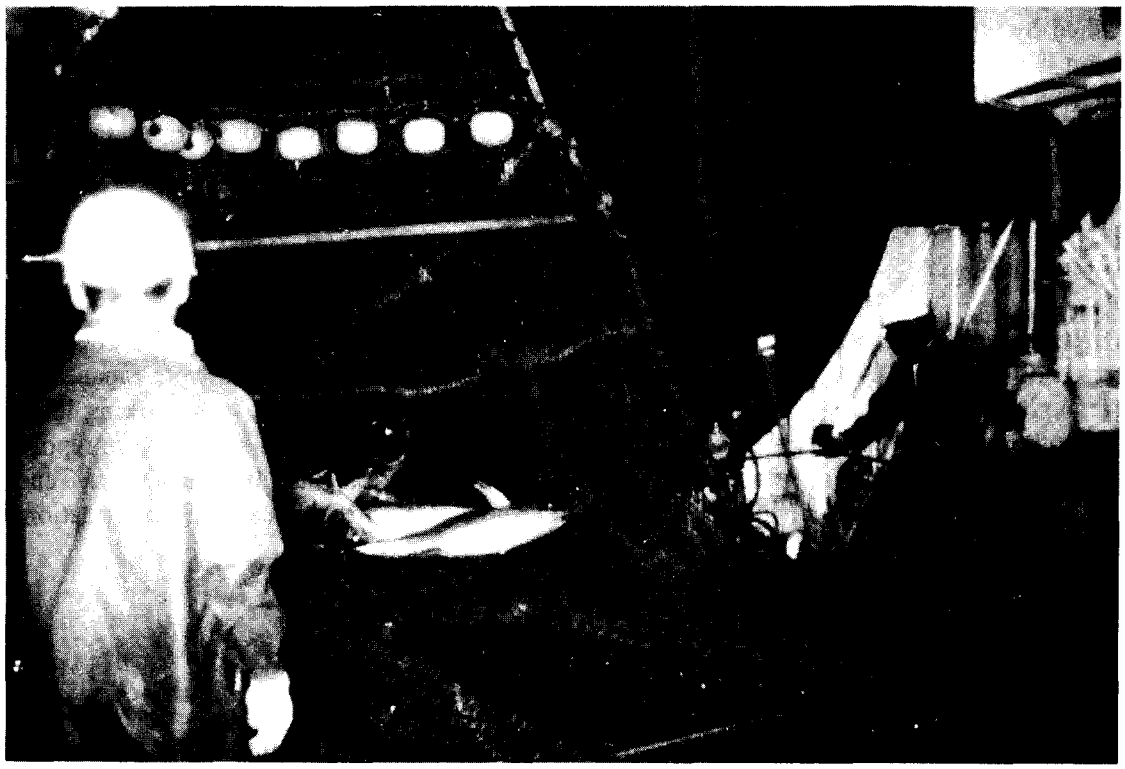

Figure 5. Large yellowfin being brailed during tagging operations

The majority of fish were tagged from the search boats auxiliary skiff, which was positioned between the net boat and carrier before brailing commenced. The skiff was tied on the outside of the net to the corkline stretched between the bow of the net boat and stern of the carrier. Tagging began as soon as fish were driven to the surface by the sacking-up operation on the net boat. This generally occurred five minutes before brailing started. Tagging continued throughout the brailing process. Fish were scooped from the net by two assistants using dip nets. The net material was varied until the best combination of mesh size and material was found that minimised fin damage and body abrasion. A tagging assistant or the tagger quickly removed the fish from the net and placed the fish in the tagging/measuring box. Suitable fish were identified to species, measured, tagged and released as quickly as possible. Fish with damaged fins, net marks or in poor general condition were rejected for tagging and returned to the net. Tagging continued as long as most of

the fish remaining in the net were in good condition or as long as the fishing operation allowed. Figure 6 shows the tagging skiff positioned between the net boat and carrier during tagging operations.

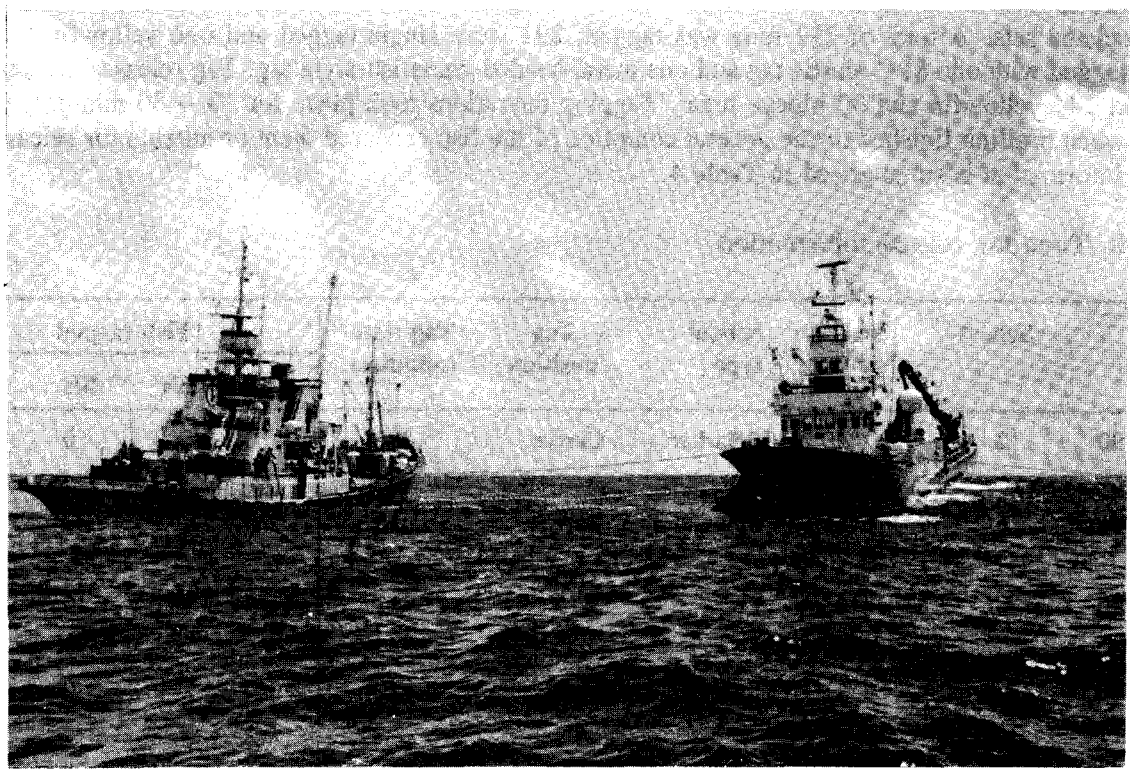

Figure 6a. The carrier *Kotobuki Maru 7* and net boat *Kotobuki Maru 23* in position prior to brailing or tagging operations

Figure 6b. Tagging operations from the auxiliary skiff tied between the carrier and net boat

7.3 Tag releases

Tagging took place on seven schools in the south-central FSM zone near the eastern end of the high seas area that separates FSM from Papua New Guinea. Fish were tagged from three unassociated school sets and four log-associated sets. A total of 292 tuna was tagged; 291 were single tagged and one yellowfin tuna was double tagged with one SPC plastic tag and one metal-headed gamefish-style tag. Tag releases included 118 skipjack, 144 yellowfin and 30 bigeye tuna[2]. Tagging operations took place for 10 – 30 minutes, usually ending when brailing finished or the general condition of the fish rendered them unsuitable for release. Tag release information is summarised in Table 4.

Table 4: Tuna tag release information

Date	Sch. #	Position	School type	Tag position	Tag time (minutes)	Fish tagged			
						SJ	YF	BE	Total
15/04/90	2	2°40'N 155°29'E	Splasher	Carrier	30	0	8	0	8
16/04/90	5	2°34'N 155°22'E	Splasher	Carrier	15	0	9	0	9
22/04/90	10	4°38'N 149°19'E	Log	Skiff	31	13	51	19	83
23/04/90	12	4°11'N 148°52'E	Splasher	Skiff	10	40	0	0	40
24/04/90	13	4°23'N 148°47'E	Log	Skiff	19	21	39	0	60
25/04/90	14	3°57'N 148°32'E	Log	Skiff	24	20	31	4	55
25/04/90	15	3°57'N 148°32'E	Log (day)	Skiff	19	24	6	7	37
TOTAL					**148**	**118**	**144**	**30**	**292**

7.4 Length frequencies of releases

Tagged skipjack ranged from 44 to 65 cm (mean 51.7 cm) with most releases grouped around a mode of 53 cm. Tagged bigeye ranged from 43 to 63 cm (mean 52.5 cm) with most of the 30 fish between 48 and 58 cm in fork length. Yellowfin were tagged in two distinct size groups, depending on the tagging method. Unassociated yellowfin tagged from the brailer on the carrier were all large, mature fish 116 – 136 cm in fork length (mean 127.4 cm). The smaller fish (log-associated yellowfin scooped from the net) ranged from 37 to 58 cm with most of the fish 42 – 50 cm in length (mean 46.6 cm). The length frequency distributions of tagged yellowfin, skipjack and bigeye tuna by school association are shown in Figure 7.

2. The totals include six tuna not recorded to species due to a tape recorder malfunction. One was assigned to the skipjack category and five to yellowfin following examination of the species composition of each school.

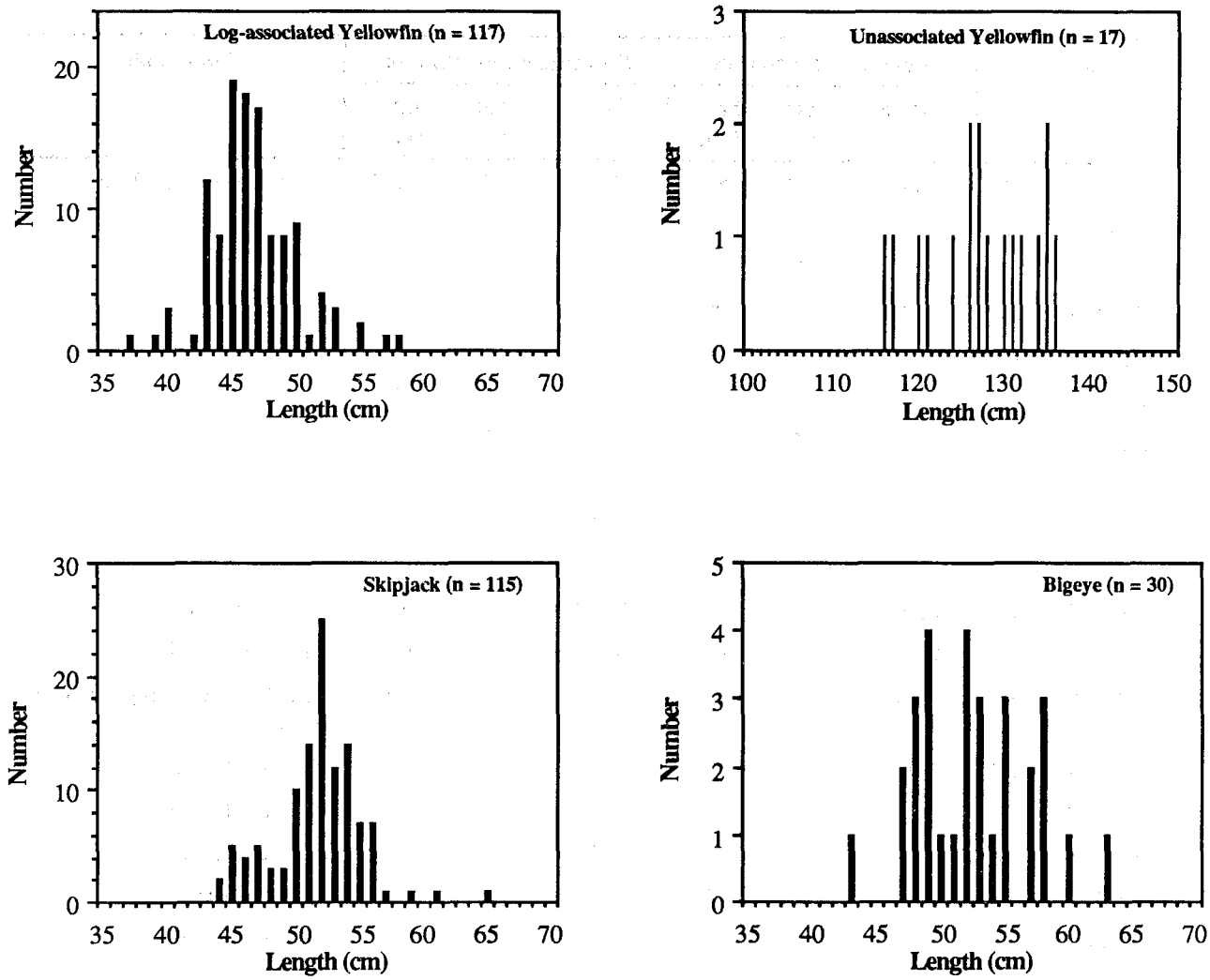

Figure 7. Length frequency distributions of tagged yellowfin, skipjack and bigeye by school association

7.5 Tag recaptures

7.5.1 Recaptures during the tagging cruise

Twenty-two SPC tags were recovered during the cruise by crewmen of the Kotobuki group[3]. All but one of the recoveries were made during three log-associated sets and occurred one day or only hours after the fish had been tagged. One tagged skipjack was found while sorting the catch on the *Kotobuki Maru 7* during the return trip to Guam. Information on the recoveries made during the cruise is summarised in Table 5.

The first group of recoveries during the cruise occurred in log-associated Set No. 11. They consisted of six yellowfin, three skipjack and one bigeye that had been tagged on the same log the previous day. All of the tagged fish were found by fishermen sorting the catch on the carrier during the brailing operation. This was possible as the set contained a considerable amount of by-catch and many of the brailer loads were dumped on deck for sorting. One tag was found on the deck after this set. It remains unclear whether this was removed by a crew member, or shed during passage through the net hauling machinery.

3. This does not include three tagged tuna recovered and then released alive by the crew before the tag numbers were noted.

Table 5: Tag recoveries made during the tagging cruise

Tag no.	Sp.	Release information			Recapture information			Comments
		Date	Set no.	Sch. type	Date	Set no.	Sch. type	
X33122	YF	22/4/90	10	Log 1	23/4/90	11	Log 1	same log one day later
X33126	SJ	"	"	"	"	"	"	"
X33128	YF	"	"	"	"	"	"	"
X33129	SJ	"	"	"	"	"	"	"
X33133	YF	"	"	"	"	"	"	"
X33136	YF	"	"	"	"	"	"	"
X33142	BE	"	"	"	"	"	"	"
X33144	SJ	"	"	"	"	"	"	"
X33166	YF	"	"	"	"	"	"	"
X33188	YF	"	"	"	"	"	"	"
X33183	YF	22/4/90	10	Log 1	23/4/90	11	Log 1	found on carrier
X33215	SJ	23/4/90	12	Spl.	24/4/90	13[1]	Log 2	fish re-released
X33220	SJ	23/4/90	12	Spl.	26/4/90	13	Log 2	found while sorting catch on carrier
X33311	YF	25/4/90	14	Log 3	25/4/90	15[2]	Log 3	fish re-released
X33312	YF	"	"	"	"	"	"	fish re-released
X33316	YF	"	"	"	"	"	"	fish re-released
X33327	YF	"	"	"	"	"	"	fish re-released
X33344	BE	"	"	"	"	"	"	fish re-released
X33345	BE	"	"	"	"	"	"	fish re-released
X33315	SJ	"	"	"	"	"	"	found on deck
X33325	SJ	"	"	"	"	"	"	found on deck
X33334	SJ	"	"	"	"	"	"	found on deck

1. One additional tagged fish re-released by the crew before the tag number was noted.
2. Two additional tagged fish re-released by the crew before the tag number was noted.

One tagged skipjack was recovered during log-associated Set No. 13, during tagging operations from the auxiliary skiff. The fish was in good condition and was re-released after the tag number had been noted[4]. At least two other tagged skipjack were observed in the net during this set and one was re-released alive by a crewman before the tag number could be noted. These fish had been tagged on a skipjack school set the previous day in the vicinity of the Set No. 13 log.

Four yellowfin and two bigeye tuna were recovered during log-associated Set No. 15 after being tagged on the same log earlier on the same day. This set was unusual, in that the net-rolling procedure was halted for 3.5 hours to wait for another carrier to receive the catch, as the *Kotobuki Maru 7* did not have enough hold space available. The net skiff, auxiliary skiff and search boat continued to tow the vessels and net apart to

4. Re-releasing tagged fish is not a regular practice of the RTTP but was done in order to maximise the low number of releases during the cruise.

keep the net open and the fish alive. The fish appeared in surprisingly good condition after this extended confinement and 37 tuna were tagged. Six tagged tuna recovered during the set were re-released after the tag numbers had been noted. At least two other tagged tuna were re-released by crewmen who failed to note the tag numbers. Three tags were found on deck. As noted above (Set No. 11), their origin is unclear.

7.5.2 Recaptures after six months

Six months after completion of the tagging cruise, a total of 63 tag returns had been received and verified by the SPC; of these 37 were skipjack, 22 yellowfin and 4 bigeye. All of these recaptures were made by Japanese group or single purse seiners, with the total representing an overall return rate of 21.6 per cent. Most of the returns came from vessels of the Kotobuki seine group after one day at liberty. None of the large yellowfin tagged from the brailer have been recaptured to date. Three Japanese single seiners recaptured the rest of the returns after 2 – 15 days at liberty.

The survival of tagged skipjack in the short term was encouraging. The return rate of all tagged skipjack was 31.4 per cent, compared to return rates of 15.3 and 13.3 per cent for yellowfin and bigeye respectively. Forty per cent of the skipjack tagged from School No. 11 were recaptured and 70 per cent from School No. 14.

8. CONCLUSIONS AND RECOMMENDATIONS

The tagging mattress worked well but an improved model should have sturdy handles sewn to the sides to transport tagged fish for release. The mattress should be 150 cm in length to allow the measuring of larger fish.

The scoop nets are the most important piece of equipment for tagging from the skiff. Handles should be lengthened to 1.5 m and the hoop size increased to 65 cm in diameter. This would only be practical if lightweight tubular aluminum was used for construction. Initially, stiff 90 mm mesh was used, but it caused tangling problems, fin damage and skin abrasion. A softer 35 mm mesh was slower to manoeuvre in the water, but was far superior as no tangling problems occurred. Also, the softer, knotless webbing was excellent for minimising damage to the struggling fish.

If this experiment is repeated, a better tagging cradle should be constructed. The tagging box used was too narrow for rapid tagging, and poorly padded; measurements were difficult to read. A wider, well-padded cradle that would allow up to three fish to be held by a tagging assistant would increase the number of releases possible and reduce the stress on fish prior to tagging.

Sets containing less than 10 mt did not allow enough time for tagging, as the brailer quickly emptied the net of catch. Larger quantities of fish in the brailing pocket are needed to force the fish close to the corkline, where they can be easily captured with the dip nets. An ideal set size for tagging would be 30 – 50 mt. The number of releases would increase greatly if the skiff could be tied on the inside of the corkline. This was not allowed during the cruise for safety reasons. Unassociated sets were better than log-associated sets, as by-catch species did not distract or hinder the operations of the men with scoop nets. On the other hand, small- and medium-sized yellowfin and bigeye tuna are common in log-associated sets and can be scooped from the net easily.

The large net area between the net boat and carrier allowed the fish plenty of room to mill in a circle, maintaining water flow over the gills. Fish remained in good condition for at least 30 minutes after brailing started and could be kept in good condition for an indefinite time if more net was left in the water and brailing was temporarily halted. The high return rates of skipjack tagged with this method are encouraging. All the fish tagged in this manner swam away actively and the recaptured fish appeared in good condition. The large size of the net allowed the more delicate skipjack to be tagged in excellent condition. In addition, the tagging methods used interfered very little with normal fishing operations and were relatively easy to

accommodate in the normal routine. One tagger with two netting assistants should be able to tag 60 – 100 tuna in very good condition while brailing proceeded normally, or several hundred fish if brailing was temporarily postponed.

A satisfactory method for tagging quantities of large (> 100 cm) yellowfin tuna was not developed during the cruise. The large size of the brailing pocket is counterproductive for tagging the big fish as they cannot be safely isolated for tagging and release. A large yellowfin that had been suddenly confined for tagging would probably cause itself such damage as to make its tagging inadvisable. The best option may be to tag large fish in the water with gamefish-style harpoon tags using a long-handled applicator. Tagging would take place from small skiffs inside the brailing pocket. The fish could then be released by sinking the corkline and herding the fish out of the net. However, this would require the release of an entire catch and the full, co-ordinated co-operation of the fishing master and crew. A small catch of 10 – 20 mt of large yellowfin would be ideal and could allow the release of hundreds of big fish at once. However, this method would not allow the measuring of fish for growth data or careful placement of tags.

A small number of large fish were tagged after being brailed to the carrier work deck, but the value of doing this is doubtful. It was possible to tag only one fish from each brail and it is probable that the fish suffered considerable trauma, net abrasion and possible internal damage from the brailing process.

The cruise was a useful tagging experiment and a great deal was learned about the gear and fishery. The most significant value of tagging from group seiners would seem to be the opportunity to release medium-sized tuna in good condition among the high seas purse seine fleet. This area has proved very difficult to reach with conventional pole-and-line tagging vessels, due to the long distance from productive baitgrounds. It also allows the tagging of surface schooling tunas that are not vulnerable to pole-and-line gear. This type of study also provides a unique opportunity to study tuna school associations with drifting objects and school integrity.

APPENDIX I

ARRANGEMENTS CONCERNING TAGGING RESEARCH ON BOARD PURSE SEINERS

(as agreed between the Federated States of Micronesia and the Federation of North Pacific District of Purse Seine Fisheries Co-operative Associations of Japan)

1. The research will be carried out on one single purse seine trip and one group purse seine trip, and one FSM scientist shall be on board for each of these trips.

2. In the case of the group purse seine trip, the length of the boarding period of the FSM scientist shall be the same as that of a single purse seine trip, namely a maximum of 45 days.

3. The location(s) of boarding and leaving of the scientists shall be decided between the MMA and the Japan Far Seas Purse Seine Fishing Association of the Federation of North Pacific District Purse Seine Fisheries Co-Operative Associations of Japan.

4. The scientists will be provided with normal accommodation, food and medical care at the cost of the vessels, and working clothes are available on board. The costs of transportation from/to the locations(s) of boarding and leaving the vessels, insurance such as life insurance, medical insurance and injury insurance shall be met by the Government of FSM.

5. The vessels shall not be liable for any accident or injury caused to the scientists as the result of their negligence or *force majeure*.

6. All necessary equipment for tagging and releasing work such as tags, instruments and record papers shall be provided by the scientists, but the fish holding and measuring box(es) for tagging will be provided by the vessels.

7. The scientists shall not intervene in the lawful operations of the vessels.

8. The time for tagging operations shall be about 10 to 15 minutes for each hauling as requested in the consultation held in December 1989.

9. All records and reports shall be shared with the Far Seas Fisheries Research Laboratory, Japan.

10. The fees of one single purse seine trip and one group purse seine trip which can accommodate scientists shall be discounted by 50 per cent of the fee of a single purse seiner.

As the group purse seiners have already made payments of fees for the coming fishing season and reimbursement of the fees once paid seems to be difficult, the discount of fees for the two trips shall be made by means of exempting the total fee of one single purse seine trip.

APPENDIX II

JAPANESE 1990 SOUTHERN-WATER GROUP PURSE SEINE FLEET

Group name	Net boat	Search boat	Carrier 1	Carrier 2
KOTOBUKI	*Kotobuki 23*	*Kotobuki 25*	*Kotobuki 7*	*Kotobuki 8*
MATSUO	*Matsuo 1*	*Matsuo 8*	*Matsuo 72*	*Matsuo 82*
SUWA	*Suwa 58*	*Suwa 6*	*Suwa 33*	*Azuma 8*
HAKKO	*Hakko 35*	*Hakko 37*	*Hakko 28*	*Hakko 38*
HAKURYU	*Hakuryu 75*	*Hakuryu 78*	*Hakuryu 76*	*Hakuryu 82*
SHOICHI	*Shoichi 18*	*Shoichi 21*	*Shoichi 32*	*Nishin 17*
MYOJIN	*Myojin 71*	*Myojin 2*	*Myojin 18*	*Myojin 78*

APPENDIX III

SPECIFICATIONS OF KOTOBUKI GROUP PURSE SEINE VESSELS

Kotobuki Purse Seine Group – Takahashi Seiko, fishing master

Vessel	Type	Call sign	Year built	Length (m)	GRT	Storage cap. (mt)	Crew size	Captain
Kotobuki 23	Net boat	JKDN	1987	36.00	135.00	0	20	Suda Yujiro
Kotobuki 25	Search boat	JE2911	1987	34.66	99.00	0	9	Abe Yoshinaga
Kotobuki 7	Carrier	8JRG	1973	43.20	299.98	150	11	Sato Kiyoichi
Kotobuki 8	Carrier	8JBB	1972	43.20	298.51	150	11	Mitsuo Konno

APPENDIX IV

KOTOBUKI MARU 23 VESSEL CHARACTERISTICS

Vessel name	*Kotobuki Maru 23*
Vessel type	Group purse seine net boat
Owner	K.K Kotobukimaru Tsuda Gyogyobu
Shipyard	Niigata, Japan
Year launched	1987
Fishing Master	Takahashi Seiko
Captain	Suda Yujiro
Call sign	JKDN
GRT	135.00 mt
Length	36.00 m
Beam	7.0 m
Draft	1.8 m (bow), 4.5 m (stern)
Rudder type	Wrap rudder
Main engine	Niigata
Maximum speed	14.5 knots
Cruising speed	13.0 knots
Crew size	20
Net size	2121 m corkline x 1959 m chainline x 396 m depth

APPENDIX V

KOTOBUKI MARU 23 1990 CREW LIST

Takahashi Seiko	Fishing Master
Suda Yujiro	Captain
Sato Yoshiro	Chief Engineer
Fujino Masami	Deck Officer
Aoki Masami	Radio Operator
Kashimura Haruyoshi	Cook
Abe Yasunobu	Bosun
Abe Tadakatsu	Deck Hand
Azumi Isao	Deck Hand
Tsuda Teruo	Deck Hand
Hiratsuka Fukunosuke	Deck Hand
Ishimori Kouchi	Deck Hand
Nagai Gungi	Deck Hand
Sato Toshihiro	Deck Hand
Sanjo Shietsu	Deck Hand
Kameyama Yoshio	Engineer
Akiyama Kazuyoshi	Engineer
Abe Kyoshi	Engineer
Kimura Sakae	Engineer
Kimura Takeshi	Engineer

APPENDIX VI

KOTOBUKI MARU 23 BRIDGE ELECTRONIC EQUIPMENT

Main bridge

Marine vane FV 201 wind speed and direction
Aneroid barometer
Furuno TI-11D sea-surface temperature meter
Murayama electronic sea-surface temperature paper recorder
JRC 24-mile radar
Furuno bird radar – 96 mile range
Furuno current meter
Furuno course plotter and display
Furuno colour chromoscope depth sounder
Furuno FE 651 depth sounder
Furuno TS-32 Mark III telesounder receiver
Furuno RD-120 satellite navigator and printer
Furuno net sonde (3) displays
Furuno CSH-5000 colour scanning sonars (3)
JRC sea-surface temperature receiver, display and printer
Radio microphones linked to radio room
INMARSAT telephone

Upper bridge

Furuno sonar display
Furuno course plotter display
Furuno bird radar display
Furuno Satnav display

APPENDIX VII

KOTOBUKI MARU 23 DECK MACHINERY

Purse winch	
Number of drums	Two
Main drum capacity	2800 metres
Purse cable diameter	Ranging from 20 to 30 mm
Towline winch	
Capacity	800 metres
Cable diameter	20 – 22 mm
Main purse block	approx. 140 X 53 cm
Net leader block	approx. 140 X 53 cm
Net side rollers	8 rollers, 31 cm diameter
High speed net rollers	2 rollers, 24 cm diameter
Pinch roller net winches	3 winches

APPENDIX VIII

KOTOBUKI MARU 23 PURSE SEINE NET SPECIFICATIONS

Corkline length	2121 m (tropical fishery) 2348 m (Japanese bluefin tuna fishery)
Corkline hanging ratio	26.6 per cent
Chainline length	1959 m
Chainline hanging ratio	16.6 per cent
Chainline weight	2145 kg
Rings	156 pieces standard, 4-roller type, 22 cm diameter
Basic construction	31 vertical net panels laced together
Net type	two-strand knotless nylon
Stretched mesh size	75 – 240 mm
Webbing twine size	No: 40, 50, 60, 70, 90, 120, 150, 180, 200
Approximate twine diameter	1.3 – 4.0 mm

APPENDIX IX

KOTOBUKI MARU 23 – SUMMARY OF CATCH (metric tonnes) AND EFFORT IN 1990

Date	Set No.	Lat.	Long.	School type	SJ	YF	SJ/YF	Species	Comments
22/01/90	Vessel departed Ishinomaki, Japan								
01/02/90	1	2°25N	141°53E	Breezer	10	-	-	SJ	
04/02/90	2	2°25N	141°53E	Log	-	-	65	SJ/YF	
05/02/90	3	2°10N	138°30E	Splasher	-	-	20	SJ/YF	
06/02/90	4	2°02N	138°15E	Splasher	75	-	-	SJ	
	5	1°57N	130°04E	Breezer	50	-	-	SJ	
07/02/90	6	2°20N	137°32E	Splasher	10	-	-	SJ	
	7	2°17N	137°37E	Jumpers	-	24	-	YF	
08/02/90	8	2°09N	137°38E	Jumpers	-	25	-	YF	
13/02/90	9	2°49N	143°04E	Splasher	0	0	0	SJ	Skunk
15/02/90	10	4°16N	144°44E	Splasher	30	-	-	SJ	
16/02/90	11	4°24N	144°40E	Log	-	4	-	YF	
17/02/90	12	4°10N	144°43E	Log	-	5	-	YF	Small fish
	13	4°00N	145°06E	Sonar	0	0	0	SJ	Skunk
18/02/90	14	4°00N	145°08E	Sonar	0	0	0	SJ	Skunk
	15	3°57N	145°06E	Ship	28	-	-	SJ	*Kotobuki 25*
	16	3°51N	145°10E	Splasher	60	-	-	SJ	
20/02/90	17	2°35N	146°33E	Ship	90	-	-	SJ	*Kotobuki 25*
	18	2°39N	146°52E	Jumpers	0	0	0	YF	Skunk
	19	2°59N	146°52E	Jumpers	0	0	0	YF	Skunk
21/02/90	20	2°22N	147°17E	Splasher	0	0	0	SJ	Skunk
22/02/90	21	2°56N	148°00E	Splasher	0	0	0	SJ	Skunk
23/02/90	22	2°54N	148°24E	Splasher	71	-	-	SJ	
24/02/90	23	2°05N	152°33E	Splasher	0	0	0	SJ	Skunk
	24	2°05N	152°33E	Splasher	0	0	0	SJ	Skunk
25/02/90	25	2°30N	152°56E	Splasher	0	0	0	SJ	Skunk
27/02/90	26	2°48N	153°30E	Splasher	0	0	0	SJ	Skunk
	27	2°48N	153°28E	Jumpers	0	0	0	YF	Skunk
	28	2°52N	153°23E	Jumpers	0	0	0	YF	Skunk, net rip
01/03/90	29	1°45N	154°31E	Splasher	0	0	0	SJ	Skunk
02/03/90	30	1°36N	154°28E	Splasher	0	0	0	SJ	Skunk
03/03/90	31	5°04N	155°51E	Splasher	0	0	0	SJ	Skunk
04/03/90	32	5°03N	155°49E	Log	-	-	15	SJ/YF	
	33	3°55N	156°07E	Jumpers	-	2	-	YF	
05/03/90	34	3°36N	156°18E	Sonar	-	13	-	YF	Small fish
	35	3°40N	156°19E	Splasher	0	0	0	SJ	Skunk
06/03/90	36	3°56N	156°24E	Jumpers	0	0	0	YF	Skunk
07/03/90	37	3°39N	156°12E	Log	44	-	-	SJ	
	38	3°27N	156°21E	Log	0	0	0	SJ/YF	Skunk, day set
08/03/90	39	3°07N	156°11E	Splasher	24	-	-	SJ	
	40	3°07N	158°11E	Jumpers	-	5	-	YF	
09/03/90	41	2°44N	155°32E	Ship	30	-	-	SJ	*Kotobuki 25*
	42	2°44N	155°32E	Ship	63	-	-	SJ	*Kotobuki 25*
10/03/90	43	2°12N	155°00E	Log	36	-	-	SJ	
	44	2°19N	154°30E	Splasher	16	-	-	SJ	
12/03/90	45	2°54N	150°44E	Log	-	-	23	SJ/YF	
	46	3°15N	150°04E	Jumpers	-	12	-	YF	
18/03/90	47	4°35N	151°02E	Jumpers	0	0	0	YF	Skunk
	48	4°39N	151°06E	Jumpers	-	8	-	YF	

19/03/90	49	4°29N	151°04E	Log	0	0	0	SJ/YF	Skunk
20/03/90	50	3°06N	150°18E	Splasher	0	0	0	SJ	Skunk
	51	3°01N	150°14E	Splasher	-	-	40	SJ/YF	
	52	3°02N	150°12E	Whale	-	-	0	SJ/YF	Skunk, splasher
21/03/90	53	2°48N	150°12E	Splasher	-	-	96	SJ/YF	
22/03/90	54	2°37N	148°58E	Ship	104	-	-	SJ	*Kotobuki 25*
24/03/90	55	3°04N	148°53E	Ship	40	-	-	SJ	Splasher, *Kotobuki 25*
25/03/90	56	2°46N	148°24E	Splasher	0	0	0	SJ	Skunk
26/03/90	57	2°58N	148°11E	Splasher	0	0	0	YF	Skunk
27/03/90	58	2°32N	148°26E	Whale	0	0	0	YF	Skunk, splasher
28/03/90	59	2°53N	147°51E	Splasher	0	0	0	YF	Skunk
30/03/90	60	2°45N	150°40E	Splasher	-	-	74	SJ/YF	
	61	2°45N	150°40E	Splasher	-	-	12	SJ/YF	
31/03/90	62	2°27N	150°57E	Splasher	60	-	-	SJ	
01/04/90	63	2°46N	150°24E	Splasher	0	0	0	YF	Skunk
02/04/90	64	2°26N	150°02E	Whale shark	0	0	0	SJ/YF	Skunk
	65	2°29N	149°57E	Splasher	0	0	0	SJ/YF	Skunk
03/04/90	66	2°35N	149°30E	Splasher	0	0	0	YF	Skunk
05/04/90	67	4°19N	152°13E	Ship	55	-	-	SJ	Splasher, *Kotobuki 25*
	68	4°14N	152°14E	Whale	-	17	-	YF	Splasher
06/04/90	69	4°19N	152°17E	Sonar	0	0	0	SJ	Skunk, net rip
07/04/90	70	5°10N	150°54E	Ship	0	0	0	SJ/YF	Skunk, *Kotobuki 25*
	71	5°13N	150°56E	Splasher	0	0	0	SJ/YF	Skunk
08/04/90	72	5°15N	151°00E	Log	0	0	0	SJ/YF	Skunk
	73	5°25N	151°08E	Splasher	0	0	0	SJ	Skunk
09/04/90	74	4°01N	150°26E	Sonar	0	0	0	SJ	Skunk, *Kotobuki 25*
10/04/90	75	3°25N	149°57E	Ship	44	-	-	SJ	Kotobuki 25
11/04/90	76	3°33N	150°23E	Log	12	-	-	SJ	
12/04/90	77	3°30N	150°31E	Whale	0	0	0	YF	Skunk, breezer
13/04/90	**Start of observer / tagging trip**								
15/04/90	01	2°40N	155°33E	Splasher	0	0	0	YF	Skunk
	02*	2°40N	155°29E	Splasher	-	8	-	YF	Tagged 8YF
16/04/90	03	2°38N	155°27E	Splasher	0	0	0	YF	Skunk
	04	2°42N	155°18E	Boiler	0	0	0	YF	Skunk
	05*	2°32N	155°18E	Splasher	-	8	-	YF	Tagged 9YF
18/04/90	06	2°07N	151°39E	Splasher	0	0	0	YF	Skunk
	07	2°05N	151°38E	Splasher	0	0	0	YF	Skunk
19/04/90	08	2°27N	151°26E	Splasher	0	0	0	YF	Skunk
21/04/90	09	4°31N	149°18E	Breezer	0	0	0	SJ	Skunk, net rip
22/04/90	10*	4°38N	149°19E	Log 1	-	-	18	YF/SJ/BE	51YF, 13SJ, 19BE
23/04/90	11	4°39N	149°12E	Log 1	-	-	4	SJ/YF	No tagging
	12*	4°11N	148°49E	Splasher	5	-	-	SJ	40SJ
24/04/90	13*	4°24N	148°47E	Log 2	-	-	6	SJ/YF	21SJ, 39YF
25/04/90	14*	3°57N	148°32E	Log 3	-	-	45	SJ/YF/BE	20SJ, 31YF, 4BE
	15*	3°57N	148°32E	Log 3 - day	-	-	60	SJ/YF/BE	24SJ, 6YF, 7BE 15 mt *Kotobuki 7* 45 mt *Hakuryu 82*

* Schools in which tags were released.
BE = Bigeye; SJ = Skipjack; YF = Yellowfin

Source: *Kotobuki Maru 23* fishing log.

APPENDIX X

TAGGING EQUIPMENT

Tags

Type 1	Plastic single barb dart, yellow
Manufacturer	Hallprint Pty Ltd, Australia
Size	13 cm streamers, 2.0 mm diameter, 14.8 cm overall
Legend (example)	**X33101 SPC NOUMEA REWARD X33101**
Tag series used	X33101 to X33392
Type 2	Metal-headed, gamefish-style tag, yellow streamer
Manufacturer	Hallprint Pty Ltd, Australia
Size	15 cm streamer
Legend	NSW FISH BOX 21 CRONULLA 2230 AUSTRALIA
Tag series used	S 69451

Applicators

Material	Tubular stainless steel
Size	15.5 cm, # 8 gauge tubing

Tag blocks — Wood, 8 x 12 x 38 cm, 100 applicators per block

Tagging box

Size	30 x 34 x 80 cm
Tagging surface	2 mm thick vinyl sheet in box

Tagging mattress

Size	8 x 70 x 130 cm cushion foam
Tagging surface	Vinyl-covered, marked in cm

Nets

Material	Steel
Hoop size	50 cm diameter
Handle	1.0 m and 1.3 m
Mesh size	35 mm stretched mesh x 2 mm diameter twine

Tagging skiff — 5.8 x 1.9 m