



Secretariat of the Pacific Community

FIELD REPORT No. 20

on

FISH AGGREGATING DEVICE (FAD)

FISHING SKILLS, HORIZONTAL

LOGLINE FISHING, AND TUNA

HANDLING AND GRADING

WORKSHOPS IN KOROR, PALAU

28 October to 6 December 2002

by

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Noumea, New Caledonia
2003

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This field report forms part of a series compiled by the Fisheries Development Section of the Secretariat of the Pacific Community's Coastal Fisheries Programme. These reports have been produced as a record of individual project activities and country assignments, from materials held within the Section, with the aim of making this valuable information readily accessible. Each report in this series has been compiled within the Fisheries Development Section to a technical standard acceptable for release into the public arena.

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Prepared at
Secretariat of the Pacific Community headquarters
Noumea, New Caledonia, 2003

ACKNOWLEDGEMENTS

The Secretariat of the Pacific Community would like to acknowledge Ministry of Resources and Development Minister, Mr Fritz Koshiba and the Bureau of Marine Resources including Mr Theo Isamu, Director; Ms Evelyn Oiterong, Fishery Specialist; Mr Pablo Siangeldeb, Fisheries Training Technician (and captain of F/V *Elechil*); and all other staff members who offered assistance. The SPC would also like to acknowledge the Palau Visitors Authority including Ms Lisa Abraham and Ms Anna Hideo for their support and help in organizing the workshops, and the Palau Federation of Fishing Associations for use of their bait freezer.

The Australian Government, through AusAID, the New Zealand Government through NZAID, and the Government of Taiwan/ROC provided funding for the fieldwork carried out during this project, and SPC acknowledges with gratitude this funding support.

SUMMARY

In March 2002, the Fisheries Development Section was requested by the Republic of Palau to provide technical assistance in the form of several workshops. A Memorandum of Agreement was signed in July 2002, which clearly set out the roles and responsibilities of both parties. The MoA also outlined the objectives of the technical assistance, which were to have the SPC conduct workshops and train staff of BMR and interested parties in mid-water fishing methods for tunas and other pelagic species associated with fish aggregation devices (FADs), tuna longlining including the rigging of gear and the fishing technique through practical fishing trials; and the correct on-board handling, processing and icing practices for tuna and other species, especially sashimi or export quality fish.

The project commenced on 28 October 2002 with the arrival of Fisheries Development Officer, Steve Beverly, in Palau. Prior to the FAD fishing skills workshop and the tuna longline skills workshop, two one-day tuna handling and grading workshops were conducted by SPC's Fisheries Training and Education Adviser, Michel Blanc. These workshops focused on the correct killing, bleeding and cleaning of tunas destined for export to high-priced sashimi markets.

The FAD fishing skills workshop was conducted over a three-week period, with a mix of classroom and practical fishing activities. Participants learnt the theory of mid-water fishing methods such as vertical longlines and palu-ahi lines, as well as making up this gear for practical sessions. Six fishing trips were made, five to a FAD on the east side of Palau, and one to the west side in deep water outside the main shipping channel to try out the gear. A total of 25 vertical longline sets were made resulting in a catch of five yellowfin tuna (total 58 kg) and one mahi mahi (6 kg). While the vertical longlines were drifting, other fishing activities were undertaken, including trolling, and mid-water handlining. Catches from these methods were small.

The tuna longline fishing skills workshop was run in a similar fashion to the FAD fishing skills workshop, with many of the same participants. Classroom sessions covered the theory of tuna longlining and gear was made up for the practical component. Four longline trips were made, all on the east side of Palau, with three to six participants on each trip along with the captain and Fisheries Development Officer. A total of 928 hooks were set during the training trips, with a catch of just 15 fish (13 saleable and 2 rejects) weighing a total of 353 kg. Thresher sharks made up the bulk of the catch (5 fish weighing 215 kg). Catch per unit of effort, or CPUE, for saleable fish (excluding the blue shark) was 1.3 fish/100 hooks or 32.7 kg/100 hooks.

The catch from the workshops were consumed by participants or friends, sold by PVA to local restaurants, or consumed at the closing ceremony to the workshops.

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1. INTRODUCTION AND BACKGROUND

1.1 Palau

The Republic of Palau is an island country comprised of over 200 islands which form an archipelago in the western central Pacific Ocean bounded by 2° and 8°N latitude, and 131° and 135°E longitude (Figure 1). Palau is a part of what was formerly called the Western Caroline Islands, a part of Micronesia. Only nine of the islands are inhabited (Anon. 2002). The total land area is 478 km² and the total area of the EEZ is 629,000 km². The Palau fishing zone shares common borders with the Federated States of Micronesia, the Philippines, and Indonesia. More than 35 per cent of Palau's EEZ borders international waters (Ward 1995). Most of Palau is surrounded by a 459 km long barrier reef that encloses a large lagoon of 1456 km². Palau has a variety of geological formations. The largest island, Babeldaob, is of volcanic origin while the Rock Islands, including Koror (where most of the population lives), are composed of limestone. Peleliu and Angaur in the south are low platform islands. Kayangel to the north is a coral atoll, while the southwest Islands, which lie approximately 300 miles to the south-west of Koror, are mostly atolls and uplifted reef flats (Anon. 2002).

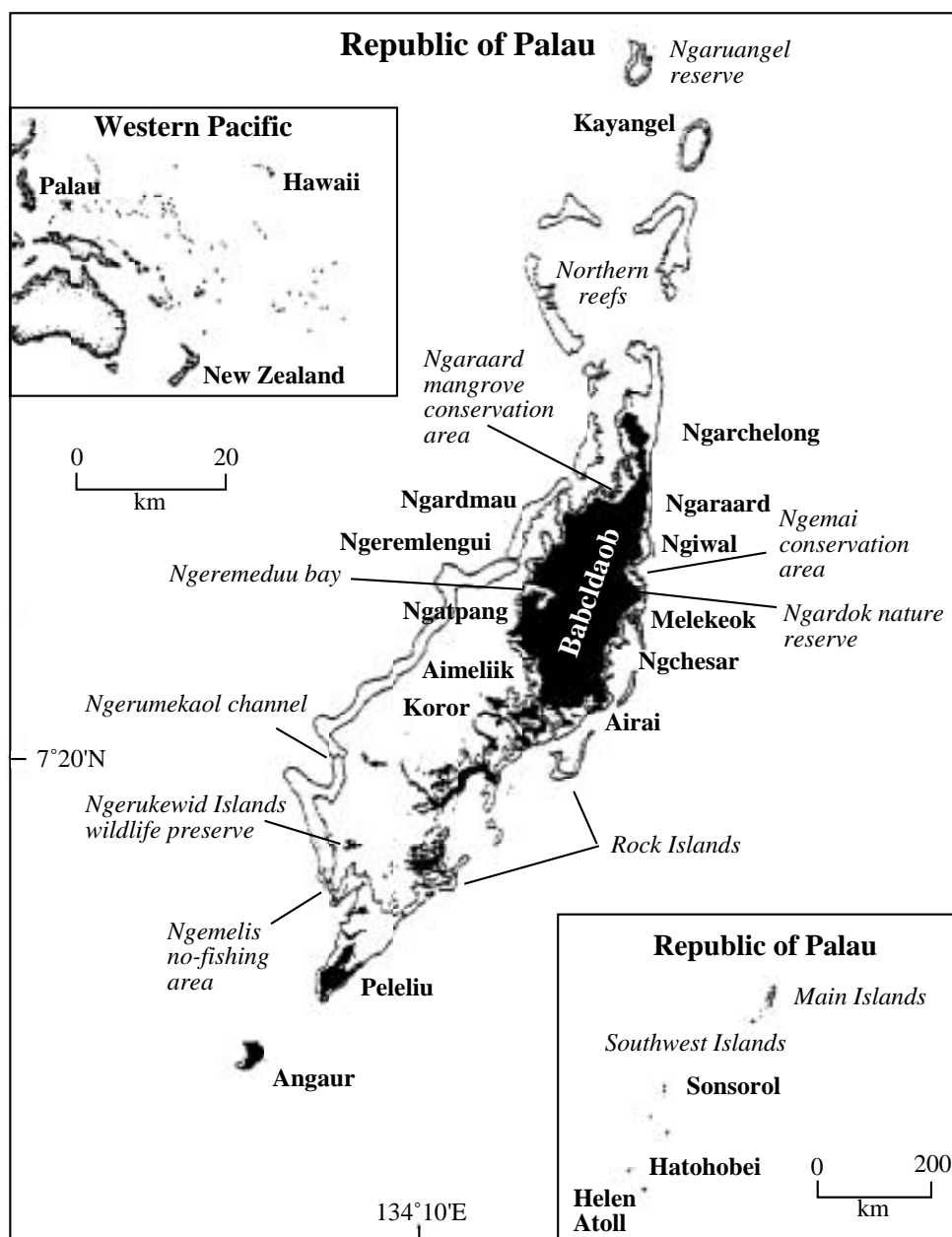


Figure 1: The Republic of Palau

Palau has a tropical maritime wet climate. Rain falls throughout the year and average annual rainfall is 370 cm with maximum rainfall in July and minimum between February and April. Average temperature is 27°C and relative humidity averages 75 to 80 per cent. Northeast trade winds prevail between November and May. Winds are light to variable the remainder of the year, mostly blowing from the west or southwest. Stormy season is roughly from June to October and, although Palau is only infrequently struck by cyclones, it often receives heavy precipitation associated with storms moving through the Marianas to the north. Most of Palau lies within the influence of the North Equatorial Current (flowing east to west between November and May) and the Equatorial Counter Current (flowing west to east the rest of the year). Sea surface temperature ranges from 27° to 30°C (Anon. 2002). The thermocline (15°C isotherm) — the place in the water column where temperature changes rapidly — is at a depth ranging from 100 to 175 m in Palau waters, going deeper from west to east across the zone (Ward 1995).

Palau was first settled by voyagers from Indonesia, probably as early as 2500 BC. When the first Europeans arrived in 1783 the population was estimated to be around 40,000 to 50,000. The population declined rapidly due to the introduction of epidemic diseases. In 1901 the German administration estimated that there were only about 3700 Palauans. The population has grown steadily since then. The 2001 census counted 19,625 inhabitants, of which about 70 percent were Palauans (Anon. 2002).

Spain controlled Palau from 1865 to 1899 when it was sold to Germany. Japan assumed control during World War I. After the war the League of Nations gave Japan a mandate over all of Micronesia, including Palau. After World War II all of the Japanese mandated islands became the Trust Territory of the Pacific, which was administered by the United States. Palau ratified their first constitution in 1981 and began negotiations with the US for a political status called a Compact of Free Association (COFA). Palau became an independent republic in 1994, but remains in the COFA relationship with the USA. The economy of Palau is based mostly on consumption. The gross domestic product (GDP) in 2001 in Palau was over 120 million USD and was supported mostly by trade, administration, hotels and restaurants, and construction. Fisheries contributed 3.372 million dollars to the economy during 2001. Per capita income in 2001 was \$6157 (Anon. 2002).

1.2 Fisheries in Palau

There are approximately 400 to 500 subsistence fishermen in Palau who fish in the lagoons and along the outer reefs, often using 18 to 30 foot (5.5 to 9 m) outboard powered boats. Fishing methods range from simple collection of reef species to diving using spearguns, handline fishing, trolling, and deep-bottom fishing. There are also a sizeable number of fishermen who sell part or all of their catch. In 2001 there were 835 commercial fishermen in Palau, including 430 operating out of Koror. During 2001 these fishermen landed a total of 270 mt of fish with a value of USD \$786,987. This was down from 2000 when 419 mt of fish with a value of USD \$1,060,121 was landed; but up from 1999 when 217 mt of fish with a value of USD \$596,222 was landed (Anon. 2002).

There is also a domestically based foreign fleet of longline boats operating out of Palau. Recorded fish landings for this fleet during 2001 included the following: 681 mt of yellowfin tuna, 882 mt of bigeye tuna, 80 mt of blue marlin, 75 mt of broadbill swordfish, and about 90 mt of various other species (including rejects of the above species) totalling 1808 mt. The catch in 2001 was down from the catches of 2000 (2611 mt) and 1999 (2473 mt), but slightly more than the catches for 1998 (1774 mt) and 1997 (1520 mt — Anon. 2002).

Palau has had a history of having an important offshore tuna fishery. In 1964 Van Camp established a tuna transshipping operation for fish from pole-and-line boats and purse seine boats fishing around Palau and the rest of Micronesia. At its peak in 1979/80, the 2000 mt capacity plant had 100 employees and handled about 15,000 mt of fish annually. In 1981 there were three locally based 300 GRT purse seiners and 12 to 16 locally based pole-and-line boats providing fish to the Van Camp operation and to a katsuobushi plant. Both the transshipment plant and the katsuobushi plant were closed in 1982. In 1983 there were up to 290 Japanese vessels, mostly longliners, licensed to fish in Palau waters, however, the focus of effort of these vessels had shifted to the south and to the east and they were only rarely fishing in Palau waters (Anon. 2002).

In 1995 SPC's Oceanic Fisheries Programme produced a confidential National Fisheries Assessment for Palau to inform them of the status of their tuna fisheries and the stocks that support them (Ward 1995).

During 1999 FFA and SPC assisted Palau in preparing a Palau tuna management plan. One of the consultant's reports from that study (Gillett 1999) was on the relationship between the tuna fishery and other marine sectors such as tourism and sportfishing. One of the major issues identified in the report was the perceived impact of locally based longliners on shark populations. Viewing sharks while scuba or skin diving is considered to be one of the main attractions that bring tourists to Palau. It was concluded in the report that the sharks that divers view are only rarely the same species of sharks that longline boats catch, so the impact of longliners on this activity is minimal. Another perception is that longliners compete with sportfishermen for the same resource. Most sportfishermen wanted an exclusionary zone of 25 to 75 nm around Palau. The report concluded that, based on experiences elsewhere, such exclusion zones have little effect on sportfishing; and that interactions between sportfishing and longlining are difficult to demonstrate, in any case.

Palau Conservation Society (Anon. 1999) did a study on the benefits and costs to Palau of the locally based foreign tuna fishery. The report stated that from 1993 to 1997 the fishery had average annual earnings of USD \$28 million — \$25 million from fresh bigeye and yellowfin tuna and the rest from byproduct species. Total direct net benefits to Palau were about USD \$2 million annually. However, the fishery has been declining in terms of effort, catch, revenues, and benefits to Palau since 1993. From 1993 to 1997, for example, revenues declined 35 to 45 per cent. The report stated that there were additional, unquantifiable costs including impacts on the physical and social environments, and that most of these were being borne by Palau. The report reiterated the concerns raised in the FFA report (Gillett 1999) that there was perceived conflict between tourism and sportfishing activities, on the one hand, and commercial longline fishing on the other. It was concluded that restricting the longline fleet would have the effect of reducing perceived competition but may also reduce longline vessel profits to the point where the fleet stops fishing in Palau.

At the time of the current project there were three commercial longline fishing companies operating in Palau: Palau International Traders Inc (PITI), Palau Maritime Industries Corp (PMIC), and Kuniyoshi Fishing Company (KFC). All of the vessels operating out of Palau were foreign vessels operating domestically under charter arrangements, with the exception of one locally owned longline vessel fishing for PMIC and one locally owned pole-and-line boat fishing for KFC. All of the vessels had Indonesian, Filipino, or Chinese (PRC) crews. In November 2002 there were a total of 67 longline boats and one pole-and-line boat fishing out of Palau. There were no Palauans working on any of the longline fishing vessels and only a handful of Palauans working on shore in the processing plants. All three of the companies with chartered boats were doing their own packing and exporting using mostly foreign labour. None of the companies were engaged in any type of value added products. According to information given by company managers, during 2001 a total of 138 mt of frozen byproduct was exported to Taiwan and a total of 1754 mt of fresh tuna was exported to Japan. At least one of these companies reportedly was operating at a loss and was considering liquidation if catch rates and operating conditions did not improve in the near future (personal communication from company manager).

1.3 Previous SPC visits to Palau

The South Pacific Commission's Deep Sea Fisheries Development Project (DSFDP) conducted four coastal fisheries projects in Palau between 1980 and 1992, focusing on deep-bottom fishing, FAD deployments, and FAD fishing techniques. SPC Masterfisherman, Pale Taumaia, spent three months in Palau conducting deep bottom fishing trials around Babeldaob (Taumaia and Crossland 1980). Two vessels were used for fishing trials, 10.5 m F/V *Oleyau*, and 12.9 m F/V *Kizzy*, both of which were equipped with FAO Samoan handreels (Anon. 1985). A total of 1975 kg of various species of marketable bottom fish was caught during eleven trips, including some large specimens of the short-tailed snapper, *Etelis carbunculus*. It was speculated that fishing was generally poor around Palau because of strong currents that prevented fishing about half of the time. Marketing results indicated that deep bottom fishing in Palau would not likely be very profitable.

Masterfisherman Taumaia visited Palau again in 1983 to conduct further deep-bottom fishing trials (Taumaia and Cusack 1997). The vessel used for the project was a 10.6 m fibreglass diesel powered fishing boat, F/V *Mesekiu*, that had been donated to Palau by the Government of Japan. The boat was equipped with six FAO handreels rigged with standard deep-bottom fishing gear. Most of the fishing activities were for deep-bottom snappers, but trolling and mid-water handlining methods were also included in the effort. During 42 trips a total of 10,183 kg of fish were caught of which 63 per cent was considered saleable. Results from this project indicated that a deep-bottom fishery could be viable in Palau — based on catch rates, high value species landed, and the level of enthusiasm demonstrated by local fishermen. The report cautioned, however, that the project was fishing on unexploited stocks and the catch rates probably were not sustainable.

During a six-month period in 1987 and 1988 SPC Masterfisherman, Lindsay Chapman, conducted further deep-bottom fishing trials using F/V *Mesekiu* (Chapman 1997). Trolling and mid-water fishing techniques were also included in the fishing effort. The main objective of the project, however, was to search for new fishing grounds in the form of offshore seamounts. One new 170 m (95 fa) seamount was located during the project on the west side near Koror. A total of 23 fishing trips were made, with average trip duration of 26 hours. In all 977 fish weighing 2583 kg were caught, of which 2218 kg were saleable. No fish were caught on the vertical longlines. Project results indicated that the deep-bottom fishery was possibly already being heavily exploited. Among other things the project report recommended that in the future FADs be deployed around Palau and that offshore fishing techniques, such as vertical longline fishing for tuna, be introduced.

The fourth DSFDP visit was conducted by SPC Masterfisherman, Peter Watt, during an eleven-and-a-half month period during 1991 and 1992 (Watt and Chapman 1998). The main objectives of this project were to conduct FAD site surveys, rig and deploy FADs, and to introduce vertical longline fishing techniques. Trolling and bait fishing techniques were included in the effort. F/V *Mesekiu* was once again used, both for FAD work and for fishing trials. Ten bottom contours were drawn and a total of six suitable FAD sites were chosen during the FAD portion of the project, and three FADs were rigged and deployed. Twelve vertical longline trips yielded 17 fish weighing 703 kg. Thirty-three sets were made in all. Significantly, the majority of the catch during these trials was sharks – no tuna were caught on any of the vertical longlines.

In 1994 the SPC conducted a sub-regional FAD workshop in Palau with participants from several SPC member countries and territories. Masterfisherman, Steve Beverly, who was a tutor during this workshop, was requested by Palau's Marine Resources Division to stay over for an additional two weeks after its conclusion (Beverly 1994). The purpose of the extended visit was to assess the suitability of MRD's new grant aid Japanese vessel, F/V *Elechil*, for use as a mini-longliner and for training and fishery research work in tuna longlining. It was concluded that with some alterations, the vessel would be suitable but only as a survey or training vessel. Some changes needed to be made to the existing gear to make it workable. The limited volume of the fish hold, however, rendered the boat unsuitable as a model for a commercial vessel and unsuitable as a platform for teaching proper fish chilling techniques. Recommendations included the following: change swivel snaps on all pre-fabricated branchlines, make new floatlines using tarred polyester rope, and make branchline bins and avoid using supplied leader carts for storing branchlines. Scenarios for setting and hauling the longline were provided in the report.

SPC Fisheries Development Advisor, Lindsay Chapman, visited Palau in 1999 to provide input into the development of a National Tuna Development and Management Plan, and to look at domestic development options, training and infrastructure needs for the tuna fishing industry and support services (Chapman 2000). Among other things, Chapman's report suggested that the fisheries department (BMR) establish a training programme to demonstrate and to train Palauans in the use of a hydraulic mainline reel and monofilament tuna longlining gear, its construction and the technique used, and the correct on board handling of the catch to export standards. The report also suggested that the government consider implementing a FAD programme as a mechanism for development in the inshore artisanal fishery and sportfishery. As regards BMR's vessel, F/V *Elechil*, the report suggested that repairs and upgrades be carried out, and that BMR officially request the assistance of SPC's Fisheries Development Section in implementing a longline fishing training programme using F/V *Elechil*.

SPC Fisheries Training Advisor, Michel Blanc, visited Palau in January and February 2002 to discuss current training needs of Palau's fisheries sector with BMR and the Palau Visitors Authority (PVA). One outcome of the discussions was that BMR and PVA both wanted some sort of FAD fishing skills workshop to take place and BMR wanted a tuna handling workshop followed by a horizontal longline workshop. Blanc also met with PFFA, Happy Fish Market, Palau Modekgnei, Inc, Department of Transportation, Palau Community College, and the Taiwan/ROC Embassy to further discuss Palau's fisheries training needs.

Finally, Lindsay Chapman again visited Palau in May 2002 to set up a work plan for the FAD fishing and longline fishing workshops and to participate in a preliminary workshop for local charter boat and sportfishing operators.

1.4 Project initiation and objectives

The horizontal longline portion of the project was first envisioned in 1994 during an SPC visit (Beverly 1994) to survey the newly acquired vessel, F/V *Elechil*, to determine its suitability as a training vessel. Palau's Marine Resources Division (now called Bureau of Marine Resources) had discussed the idea of using F/V *Elechil* as a training vessel for Palauans wanting to enter the commercial longline fishery in Palau, either as fishermen, or as owner/operators. Unfortunately, nothing came to fruition until 2002. This may have been because interest level among Palauans to enter this fishery was low. Notwithstanding the limited interest, correspondence began anew between SPC, BMR, and PVA, to organize and run a fishing workshop using F/V *Elechil*. This led to a project proposal that went beyond the original scope of a horizontal longline fishing workshop. It was decided by all parties (BMR, PVA, and SPC's Fisheries Development Section and Fisheries Training Section) to include a FAD fishing skills workshop, and to preface the two fishing workshops with a tuna handling and grading workshop. The rationale behind this approach was that workshop participants could apply fish handling skills on board the training vessel soon after they were learned. The FAD skills workshop would fill a gap as most Palauan artisanal fishermen are probably not likely to enter the horizontal longline fishery but would likely continue with FAD fishing techniques, which are more suited to small-scale operations and small boats.

PVA had a big hand in organizing the workshops and was also very instrumental in selecting the participants. The trainees were not all artisanal or commercial fishermen. The group included fishermen, tour boat operators, dive boat operators, sportfishermen, and educators. Management at PVA wanted to include members of the tourist industry in the fishing workshops so that they would have a better understanding of the fishery, especially horizontal longline fishing. The tourism sector and the commercial fishing sector in Palau are often at odds with each other and better understanding might help to clear up any misconceptions and alleviate any future problems.

In July 2002 a Memorandum of Agreement (MoA) was signed between the Government of The Republic of Palau and the Secretariat of the Pacific Community to clearly set out the roles and responsibilities of both parties. The main objectives of the project, as set out in the MoA, will be to have the SPC conduct workshops and train staff of BMR and interested parties in the following:

- Mid-water fishing methods for tunas and other pelagic species associated with fish aggregation devices (FADs);
- Tuna longlining including the rigging of gear and the fishing technique through practical fishing trials; and
- The correct on-board handling, processing and icing practices for tuna and other species, especially sashimi or export quality fish.

1.5 BMR's vessel, F/V *Elechil*

F/V *Elechil* (means baby whale in Palauan — Figure 2) was part of a grant aid scheme from the government of Japan in 1994. It is an all-purpose fisheries training boat made of FRP and powered by a single diesel engine. Along with the vessel, Japan donated fishing equipment and gear including longline reel and gear, vertical longline hauler and gear, trolling outriggers and gear, electric deep-bottom fishing reels and gear, and materials to make several FADs. Much of the fishing gear was still on hand during the current workshop, including sufficient materials to conduct both workshops (with the exception of swivel snaps specific to monofilament gear).



Figure 2: BMR's training vessel, F/V *Elechil*

F/V *Elechil* was made by Yanmar of Japan. Particulars are as follows:

- LOA: 14.83 m
- Breadth : 3.4 m
- Depth: 1.92 m
- GRT: 17.0
- Main engine: six cylinder in-line water cooled Yanmar 6HAE diesel
- HP: 165
- Service speed: 10.0 kt
- Crew complement: 5
- Ice hold volume: 1.2 m³
- Insulated fish hold: 2.5 m³
- Fuel oil: 2500 litres
- Fresh water: 500 litres
- Electronics: all Furuno including SSB radio, VHF radio, RDF, radar, echo sounder, GPS, and SST monitor
- Fishing equipment: L-P 27 inch x 30 inch (75 x 83 cm) hydraulic longline reel (Figure 3), hydraulic vertical longline hauler with detachable reels (Figure 4), electric deep-bottom fishing reels, and fibreglass trolling outriggers



Figure 3: Longline reel on F/V *Elechil*



Figure 4: Vertical longline hauler on F/V *Elechil*

2. TUNA HANDLING AND GRADING WORKSHOP

Two one-day fish handling workshops were held at BMR headquarters during the week of 28 October to 1 November. The first workshop covered on-board fish handling only, while the second workshop repeated the on-board handling and also covered sashimi tuna grading. The participants in the fish handling workshop were fishermen for the most part while the participants in the second workshop were involved in fish processing and marketing. All fish for the workshops were provided by BMR staff. They were small (less than 10 kg) yellowfin tuna that had been caught at a FAD using handlines. Michel Blanc conducted the workshops following guidelines in SPC's manual (Blanc and Desurmont 1996) and SPC's instructional video on on-board handling of sashimi grade tuna. After the classroom sessions were completed, participants had an opportunity to stun, spike, *taniguchi*, bleed, and gill and gut a fresh tuna, as if they were preparing it for chilling on a longline boat.

Participants in the second fish handling workshop went through the same on-board handling instruction and additionally were taught all of the factors that are used in sashimi fish grading. Tuna are graded on size, body shape, appearance, firmness, colour of flesh, oil content of flesh, and freshness, among other things. After the fish is examined externally, a cut is made in the tail so that the flesh can be examined. Bright red, translucent flesh with a slight oily shine (but no rainbow sheen) is preferred. If the flesh is observed to change colour and become a brighter red after being exposed to air, this is a good sign indicating the presence of flavour enhancing myoglobin. Often visible fat layers (white striations) give an indication of the presence of fat in the flesh. Mushy flesh, brown flesh, or signs of blood in the flesh are all signs of reject fish. Fish are graded in four basic categories: A, or #1; B or # 2; C, or #3; and reject (Japan uses the A, B, C system while US markets use the 1, 2, 3 system). Export markets usually accept the first two grades for sashimi, but grade C is usually used only for cooking and is sold domestically. Reject fish may also be used for cooking. Further refinements to grading tell of fat content by adding + or – signs after the grade — for example, a fish might be graded as #2+, meaning it is second grade but has a high oil content. The importance of size has mostly to do with the yield. For yellowfin tuna the minimum size for exporting is around 30 kg while for bigeye tuna it is around 40 kg. Smaller fish cannot be graded as A or #1 fish (Blanc 2002).

At the conclusion of the fish handling workshops the subject tuna were prepared and eaten along with soy sauce and wasabi, in the traditional manner. Many of the participants in the fish handling workshops were also enrolled in the fishing workshops to be held the following week.

3. FAD FISHING SKILLS WORKSHOP

3.1 Preliminaries

One FAD fishing skills workshop was held during a three-week period, at BMR headquarters and on board F/V *Elechil*. The workshop consisted of a classroom session, a gear workshop session, and several one-day fishing trips using the techniques and gear from the land session. Prior to the first workshop session the Fisheries Development Officer and the BMR Fisheries Training Technician began assembling gear from the stores at BMR. The government of Japan had previously given Palau fishing gear in the form of ready-made vertical longlines, ready-made branchlines, floats, flagpoles with strobe lights, materials for rigging FADs, materials to make up palu-ahi lines, lead weights, fish baskets, wooden fishing line tubs, and a variety of spare materials including hooks, crimps, lead weights, swivels, etc. F/V *Elechil* came equipped with a hydraulic vertical longline hauler that proved ideal for setting and hauling the vertical longlines. In addition, BMR had several FAO wooden reels on hand that could be used for either vertical longline fishing or palu-ahi fishing.

3.2 The classroom session

The classroom session consisted of a series of short lectures on the following topics: FADs — their history and how they work; how to rig and deploy FADs; the components of a vertical longline; how to rig a vertical longline; how to fish a vertical longline around a FAD, targeting fish at different depths around

a FAD; how to rig a palu-ahi line; how to fish a palu-ahi line around a FAD; how to fish single hook drift lines around a FAD; and how to splice three-strand rope and how to crimp monofilament. The brief lectures were supplemented with demonstrations and with SPC's FAD fishing manual (Preston 1998). Each participant received a copy of the manual. SPC videotapes on sea safety (Better Safe Than Sorry and Rambo Goes Deep Sea) were shown. A brief lecture was given on sea safety which included showing the sea safety grab bag which contains an EPIRB, a hand-held VHF radio, a flash light, a mirror, a first-aid kit, a fishing kit, an inflatable life jacket, a knife and spare food and water— all in a water-proof canvas bag. SPC materials on marine pollution issues, and bycatch issues were given out to all of the participants. In addition, they were given a card showing how to release hooked turtles.

The second part of the classroom session was held outdoors at BMR headquarters, under a covered patio. Here the participants, under the watchful eyes of the Fisheries Development Officer and the Fisheries Training Technician, modified and assembled four complete vertical longlines, including floats, floatlines, and flagpoles; and six palu-ahi lines. Branchlines were all coiled into a fish basket that was rigged specifically for use on the boat (Figure 5). All of the gear was then loaded onto F/V *Elechil* for a morning departure. This included winding the mainline portion of the vertical longlines onto hydraulic drums (Figure 4).



Figure 5: Coiling branchlines into a specifically prepared fish basket

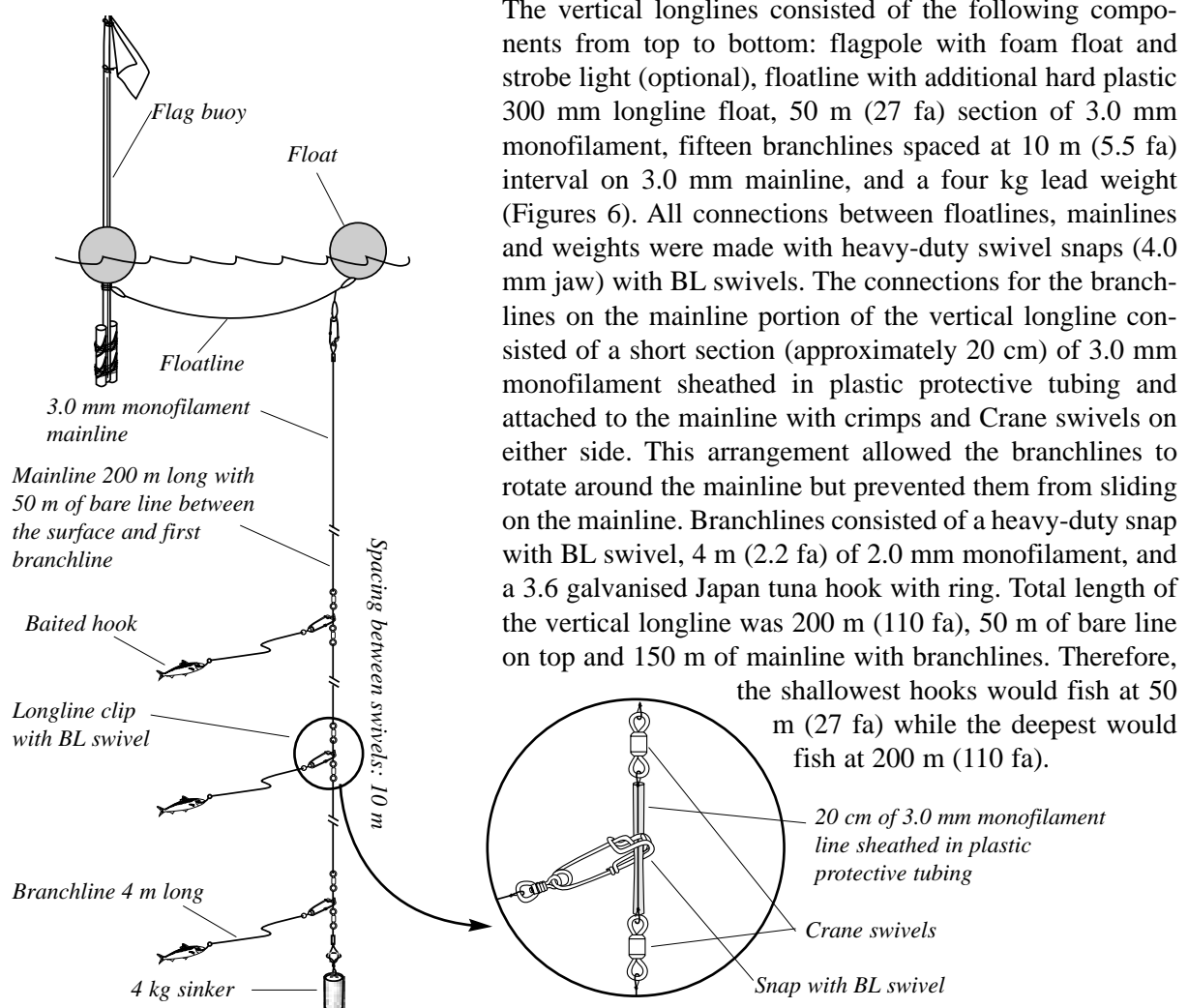


Figure 6: Vertical longline configuration used during the workshops

Six palu-ahi rigs were also made up during the workshop. The design followed that outlined in SPC's FAD fishing manual (Preston et al. 1998). 2.0 mm bloodline (Super Toto) was used for the palu-ahi lines. They were each 200 m long. Four of the lines were stored in wooden fishing tubs (Figure 7) and two were loaded onto FAO wooden handreels (Figure 8). The traces were made from 1.5 mm monofilament and hooks were 14/0 and 16/0 tuna circle hooks. Several of the fishermen in the workshop also brought along their own drop stone fishing rigs, which were similar to the palu-ahi rigs but were made from lighter bloodline (1.0 to 1.5 mm).



Figure 7: Palu-ahi line stored in a wooden fishing tub



Figure 8: Palu-ahi line stored on a wooden handreel

3.3 Fishing effort and catch

In all, six fishing trips were made, five to a FAD on the east side of Palau, and one to the west side in deep water outside the main shipping channel. The FAD fishing actually proved to be the most productive, although not spectacular. The fishing trip on the west side was unsuccessful. The decision to go west on that particular day was because of bad weather coming from the southeast. The FAD in question was located at 07°14.28'N and 134°44.22'E in about 3000 m of water (Figure 9). It consisted of a large steel tank attached to the mooring with tire rings. There was also a tire ring attached to the FAD raft for tying up small boats. No other details of the FAD were available. The FAD was rigged and deployed by a private pole-and-line fishing company (KFC) for use by their pole-and-line boat. The FAD was also being used by BMR and had been the source of the small tunas used in the Tuna Handling and Grading Workshop and the source of much of the opelu bait used for the FAD Fishing Workshop.



Figure 9: The FAD fished of the east side of Palau

Upon arriving at the FAD (or the designated fishing area) in the morning, vertical longlines were prepared and setting began. Four vertical longlines were set using opelu (*Decapterus* spp), sardines (*Sardinops* spp), or squid (*Illex* spp). Most of the opelu was caught previous to the workshop by BMR staff. Average size was about 120 g. This bait proved superior to the imported baits (some opelu, sardines, and squid). The lines were set so that they would drift past the FAD over a one to one-and-a-half

hour soak, without coming into contact with the FAD mooring. During the soak, a variety of other fishing methods were employed including palu-ahi, drop stone, single hook drift line, handline fishing, and trolling. Vertical longlines were usually set and hauled only once each fishing day unless the drift was fast, in which case they were re-set again up-current to drift past the FAD. On one occasion the boat was tied to the FAD and a vertical longline was hung off the stern of the boat. This technique is a little risky and, in fact, caused a tangle with the FAD mooring. Upon retrieval of that particular vertical longline, several branchlines were lost.

In all during the six fishing trips, 25 vertical longline sets were made resulting in a catch of five yellowfin tuna (total 58 kg) and one mahi mahi (6 kg). During the soak time for the vertical longlines the following fish were caught employing various methods: two mahi mahi (6 and 7 kg), one black trigger fish (2 kg), and one rainbow runner (4 kg) on handlines; two mahi mahi (4 and 7 kg) on single hook drift lines; two yellowfin (5 kg each) on drop stone lines; and one wahoo (5 kg), one mahi mahi (5 kg), two yellowfin (8 kg each), and two skipjack (2 kg each) were caught trolling around the FAD. One wahoo (15 kg) was caught trolling at the edge of the pass upon returning to Koror on the first trip. Twenty-one fish were caught in all, weighing an estimated 123 kg (all of the weights were estimated by the Fisheries Development Officer). CPUE for the vertical longlines was only 17 kg/100 hooks. All fish were given to PVA to sell. No records of actual weights or revenue were obtained but, in any event, the proceeds were used to purchase refreshments for the closing function. Proper fish handling techniques were used on all fish landed during the workshop. Little further instruction had to be given to participants who had been in the fish handling workshop that was held during the week prior to the FAD fishing workshop.

4. HORIZONTAL LONGLINE FISHING SKILLS WORKSHOP

4.1 Preliminaries

Before the horizontal longline fishing workshop began, the Fisheries Development Officer and the captain of F/V *Elechil* loaded five nm of new 3.5 mm monofilament onto the longline reel. Some of the old line was removed before this was done. It had been sun and salt water damaged and there was a risk that the mainline would part if this line were used. In addition, oil and filters were changed on the main engine, fuel was topped up, and all hydraulic fishing equipment was inspected and lubricated. Lastly, several cartons of muro aji (*Decapterus spp*) bait were purchased from one of the domestic longline fishing companies. The bait was stored in the freezers at Palau Federation of Fishing Associations.

4.2 The classroom session

The horizontal longline fishing skills workshop was very similar to the FAD fishing skills workshop and, in fact, most of the participants were the same. For that reason, the sea safety material was not presented again and some gear fabrication techniques that had been previously covered were left off the agenda. The classroom portion of the workshop dealt with the theory and technique of tuna longline fishing, including gear characteristics, gear fabrication, setting techniques (set going downhill, or with the wind), and hauling techniques (haul going uphill, or into the wind). Parameters for choosing a fishing spot were discussed including bottom topography (500 to 1000 fa curves on chart), seamounts, ridges, sea surface temperature, currents, where other boats are fishing, etc. Importance of target depth was also discussed as well as how to get the line down to the target depth. Fish habitat depth was also discussed. Basically, schooling yellowfin tuna and other target species, such as marlins, wahoo, and mahi mahi, inhabit the upper zones of the surface layer of the water column called the mixed and intermediate layers, while larger yellowfin are found deeper in the intermediate layer. Large bigeye tuna and albacore tuna are associated with the lower limits of the intermediate layer down to the thermocline. The mixed layer goes from the surface to about 40 or 50 m, while the intermediate layer goes down to the top of the thermocline, usually ranging from about 100 to 175 m in Palau. A video from Pacific Ocean Producers in Hawaii on longline fishing was shown during the class and each participant was given a product catalogue (most of the participants had asked where to get materials, so this was a useful, if commercial exercise).

Again the participants moved outdoors for the practical session on gear fabrication. Floatlines were made up using tarred 6.4 mm polyester, floats were rigged, and branchlines were modified. Floatlines were all made from second hand basket gear mainline, which came in 50 m (27 fa) sections. For that reason the floatlines ended up being 25 m (13.5 fa) long (each was made with half of a mainline section). All that was needed was to cut the sections in half and then splice a swivel snap onto the cut end, since there was already an eye splice in the other end. Swivel snaps for the floatlines were 148 x 3/16 inch (4.5 mm) x 9/0 American snaps. Forty floatlines were made this way. Forty 300 mm hard plastic floats were rigged with one meter (1/2 fa) pieces of tarred polyester rigged the same way: an eye splice in

one end and a swivel snap on the other. The swivel snaps were the same as the floatline snaps. Flag buoys were also rigged with short sections of tarred polyester and swivel snaps, for attachment to floatlines. Reflective tape was put on all floats and flag buoys in case fishing occurred at night. Additionally, four of the eight flag buoys had strobe lights attached (Figure 10). These were bound to the fibreglass poles with duct tape.

Branchlines supplied by the Government of Japan were well made but not entirely suitable for monofilament longline fishing. For one thing, at 30 m (16 fa) they were too long. If they were used as is there would be problems both in setting and hauling the gear. It was decided to cut the branchlines down to 15 m (8 fa). In addition, the swivel snaps supplied were basket gear snaps, not suitable for monofilament. The eye in the jaw was too big and the snaps would slide on the 3.5 mm mainline. New snaps were ordered from Hawaii to replace the snaps on all of the branchlines. The remainder of the practical session of the workshop was spent modifying the branchlines. After they were cut and new snaps were crimped on, they were loaded into two fish baskets that had been converted to branchline tubs (Figure 11). In all, 240 branchlines were put into the tubs. Each branchline consisted of a 148 x 3/16 inch (4.5 mm) x 8/0 swivel snap, 12 m of 2.0 monofilament, a Futaba swivel, 2.5 m of 2.0 monofilament, 0.5 m of galvanized wire trace, and a 3.6 Japan tuna hook (Figure 12).



Figure 10: Flag buoys made up with strobe lights attached

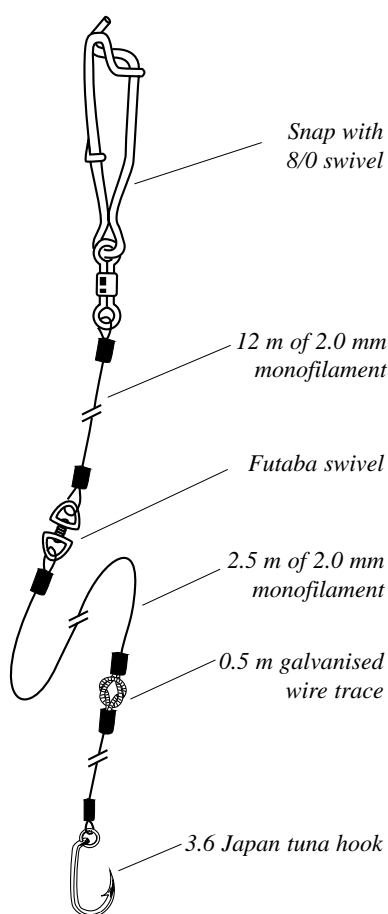


Figure 12: Branchline construction for the horizontal longline



Figure 11: Branchline tub used during the workshop

4.3 Fishing effort and catch

Four longline trips were made, all on the east side of Palau and within the twelve-mile limit (normally not allowed). Three to six participants went on each trip along with the captain and Fisheries Development Officer. The line was set in the morning upon arriving at the chosen zone, generally around 0600. The total length of the line was seven to eight nautical miles. There were approximately 230 branchlines in 15 or 20 hook baskets set each time. Bait was usually muro aji (mackerel scad) but some sardines and squid were also used. Eight flag buoys with floats were set at intervals of about 1 nm so that the line could easily be spotted and recovered if it parted during hauling. The first two flag buoys thrown (the last to be hauled) had strobe lights attached in case hauling ran into the night. F/V *Elechil* has an RDF but

there were no working radio buoys on hand. Several single hard plastic floats were set at intervals between the flag buoys. Setting usually took about one-and-a-half hours.

Since F/V *Elechil* does not have a line setter, the line was set in the manner called 'towing the line'. That is, the line was run directly off the stern of the boat as it steamed away from the gear. Floats and branchlines were attached to the mainline and thrown at intervals. The length of line going out, in this case, was equal to the distance the boat travelled. The sagging ratio, or SR, was, therefore, 1.0 (no sag). In reality there was some sag in the line as the floats moved closer together in the set. The mainline was run through two longline blocks that guided it to the stern of the boat (Figure 13). Setting required



three to four men: a baiter, who baited the hooks and threw the branchlines; a snapper who snapped the branchlines onto the mainline; a floatman who threw the floats and flag buoys at intervals; and a helper who stood by the branchline bin to assist in the operation by handing snaps and hooks, counting hooks in a basket, and dealing with tangles or other problems. A pair of cutters was kept near the branchline bins for safety.

Figure 13: Setting arrangement with mainline passing through 2 blocks

Details of every set were recorded both in F/V *Elechil*'s logbook and in the Fisheries Development Officer's notebook. Included in this were notes on weather and sea condition, moon phase, current set and drift, start and finish times, position of both ends of the line, course during setting, boat speed, number of hooks in a basket, total number of hooks, total length of line set, bait used, and direction to get back to the line during the soak. The boat was steamed back to the end flag buoy at least once during the soak to insure that the line would not get lost. At the conclusion of the soak (after approximately five hours) the end buoy was recovered the hauling commenced. The end of the monofilament mainline was attached to the line on the reel using a blood knot. The boat was steamed in the direction of the line and the line was wound on the reel using the hydraulic control valve. For safety considerations, the Fisheries Development Officer operated the control valve. Besides the boat operator, the main man in the hauling operation was the rollerman, who stood by the open longline block at the rail and detached all of the branchlines and floatlines as they came up (Figure 14). The coiler stood just behind the roller man. His job was to coil all branchlines into one of the branchline bins and to remove bait from the hooks. A third man pulled in all floats, coiled the floatlines, stowed the floats and lines, and stood by to gaff and handle any fish.



Figure 14: Detaching a branchline from the mainline during hauling

The catch from this limited effort was not spectacular. Four sets totalling 928 hooks yielded just fifteen fish (13 saleable and 2 rejects) weighing a total of 353 kg. The catch and estimated fish weights were as follows:

- 5 thresher sharks (25, 50, 40, 60, 40 kg),
- 1 blue shark (50 kg),
- 4 mahi mahi (5 kg each),
- 1 yellowfin tuna (20 kg),
- 1 big-scaled pomfret (8 kg),
- 1 sailfish (40 kg)
- 1 snake mackerel (discarded), and
- 1 pelagic ray (discarded).

Catch per unit of effort, or CPUE, for saleable fish (excluding the blue shark, even though it was consumed in this case) was 1.3 fish/100 hooks or 32.7 kg/100 hooks. That is taking into account target and byproduct species together. All fish, with the exception of the discards, were consumed by participants or friends, sold by PVA to local restaurants, or consumed at the closing ceremony to the workshops, during which certificates were handed out to the participants (Figure 15).



Figure 15: Certificates being handed out at the closing ceremony

5. DISCUSSION AND CONCLUSIONS

The three combined workshops were important to small-scale domestic tuna fishing development in Palau. First of all, local fishermen need to be aware of proper fish handling techniques for sashimi grade tuna even if they are not planning to export to foreign markets. Restaurants and hotels serving the tourism sector are becoming more and more demanding in the quality of tuna sought for sashimi and sushi. Local artisanal fishermen in Palau can fill this niche market easily, if they handle fish properly and produce a product that is competitive to the export fish being produced by the three commercial longline companies in Palau. Furthermore, local fishermen may one day seek out employment on commercial vessels. Knowledge of proper fish handling is important for prospective longline vessel crew. This is also true for any local entrepreneur wishing to enter the industry as a vessel owner.

FAD fishing techniques and small-scale tuna longlining techniques learned during the two fishing workshops can be used in the future by small-scale artisanal fishermen to supply local hotel, restaurant, and supermarket niche markets with tuna and other species. If production becomes regular and quality is maintained, there is an opportunity to export using one of the domestic longline companies. This sort of piggy-back activity has been carried out in other countries with some success, where small-scale fishermen export their catch on a consignment basis along with the catch of larger vessels.

For meeting future training needs, BMR should liaise with PVA, PFFA, and PCC to organise training courses for young fishermen in FAD fishing and horizontal longline fishing employing methods and gear used during the workshops. F/V *Elechil*, with its present captain and compliment of fishing gear, is ideal for training purposes. In addition, there is ample gear on hand at BMR to run several training sessions. The government of Japan donated four smaller Yanmar boats to Palau that were being underutilised. These boats could also be used for small-scale tuna fishing workshops and training. They originally came equipped with vertical longline systems similar to that of F/V *Elechil*. BMR should assist the states in revitalizing these vessels and incorporating them into any future training programmes.

The private FAD used during the workshops was ideal for training purposes. However, if an artisanal fishery is to develop successfully, more FADs are needed around Palau. BMR needs to re-initiate their FAD programme as a priority to assist small-scale tuna fishery development. There were some FAD materials on hand at BMR that could be used in the first instance, but more materials will need to be ordered to maintain an on-going programme. F/V *Elechil* is ideal for a FAD survey and deployment vessel. It was used successfully during the SPC Sub-Regional FAD Workshop that was held in Palau in 1994. The GPS and echo sounder on F/V *Elechil* are suitable for FAD work and the deck is adequate for FAD mooring work. Furthermore, the boat's skipper and other staff at BMR have had ample training and experience to carry out a FAD programme.

Fishing gear and FAD materials were found to be stored in several locations around BMR headquarters, some secure and some not. It was not clear what was on hand without conducting a search. This was partly due to the fact that BMR's workshop had been torn down and gear and equipment had to be moved into unused offices and the old condemned fisheries building. Some of the Japanese aid gear was being stored in the original containers, both of which were unsuitable because they could not be closed properly as the doors and hinges were badly rusted. There was a problem with most gear being exposed to the elements and all gear being vulnerable to pilferage. Before any new workshops are conducted and before BMR's FAD programme is re-initiated, it is essential that a survey and inventory be made of all fishing gear and FAD materials. All gear should then be stored in a suitable secure location, out of the elements and easily accessible to BMR staff. It is also necessary that, in addition to proper storage space, BMR staff and F/V *Elechil* crew be given a proper workshop building with storage for tools and spare parts so that functional boat maintenance can be carried out.

F/V *Elechil* was found to be in relatively sound condition at the start of the workshops. Lindsay Chapman had previously recommended repairs to the hydraulic fittings and hoses and these had been carried out. A few items need mentioning, however. The mainline on the longline drum was in poor condition, mostly because of exposure to the sun. Polyamide nylon is very light sensitive and should be covered when not in use. Several miles of line had to be replaced before the horizontal longline workshop. BMR needs to have a suitable cover made for the longline reel. In lieu of this, a small tarp could be purchased and then fitted with bungee cords. Whenever the reel is not in use the line should be covered. This is also true of the vertical longlines and all of the monofilament branchlines. They should be kept out of the sun whenever possible.

Spare parts need to be ordered for the horizontal longline system. Spare parts can be found in the catalogues that were left behind during the workshop. Parts needed include roller bearings for the longline blocks, pawl mechanism for the level winder on the reel, spare belt for the level winder, spare roller assembly for level winder, flange bearings for level winder (2), 3 inch x 1½ inch (75 mm x 38 mm) inside diameter pulley for shaft, 10 inch (25 cm) pulley for level winder shaft, and several metres of spare hydraulic hose and hydraulic hose end fittings. These spare parts should be kept on the boat at all times but especially when the longline system is being used.

During the workshop the captain of F/V *Elechil* changed the main engine oil and oil filters. He recounted that this was the first time this job had been done in several years. Apparently it was a budget problem and not a problem of neglect on his part. This should not be allowed to happen again. It is essential that the boat undergo a regularly scheduled maintenance regime, including oil changes as recommended by the engine's manufacturer (probably every 500 hours). The oil and oil filter in the marine gear should

also be changed (usually every 2000 hours). Zinc anodes in the engine's cooling system need to be inspected and changed periodically, and all hoses, hose clips, belts, fittings, etc need to be inspected. An engine room maintenance checklist is a good way of insuring that nothing gets overlooked. A set of oil and fuel filters should be kept on board at all times and enough engine oil to fill the engine sump in case of leakage. Spare hydraulic oil should also be on hand.

Safety gear and equipment on F/V *Elechil* were found to be adequate and within expiry dates. However, the captain should conduct a brief safety drill before each departure, showing all aboard where the life raft and EPIRB are stored and how to operate them, locating life jackets, life ring, first aid kit, and fire extinguishers, and generally discussing what is expected of passengers and crew in an emergency situation. A pre-departure checklist with all safety items listed is a good way of insuring that nothing is forgotten.

6. RECOMMENDATIONS

Based on the outcomes of the present project in Palau, and the experience of the Fisheries Development officer, it is recommended that:

- (a) BMR liaise with PVA, PFFA, and PCC to organise future training courses for young fishermen in FAD fishing and horizontal longline fishing employing methods and gear used during the workshops;
- (b) BMR use their training vessel, F/V *Elechil*, for future trainings, as this boat is well equipped for this purpose;
- (c) BMR assist the states in revitalizing the four smaller Yamaha boats and incorporating them into any future training programmes;
- (d) BMR re-initiate their FAD programme as a priority;
- (e) BMR order FAD materials in bulk to maintain an on-going FAD programme;
- (f) BMR locate a suitable secure location, out of the elements and easily assessable to staff, to store all of their FAD materials and fishing equipment;
- (g) BMR do a stocktake and inventory of all FAD materials and fishing equipment as they are moved into a suitable secure location so that people know what materials are on hand and what needs to be ordered in future;
- (h) BMR provide a proper workshop building with storage for tools and spare parts so that functional boat maintenance can be carried out;
- (i) BMR have a suitable cover made for the longline reel to stop the mainline being effected by exposure to the sun when not in use;
- (j) BMR order spare parts for the horizontal longline system including;
 - roller bearings for the longline blocks;
 - pawl mechanism for the level winder on the reel;
 - spare belt for the level winder;
 - spare roller assembly for level winder;
 - flange bearings for level winder (2);
 - 3 inch x 1½ inch (75 mm x 38 mm) inside diameter pulley for shaft;
 - 10 inch (25 cm) pulley for level winder shaft; and
 - several metres of spare hydraulic hose and hydraulic hose end fittings;

- (k) BMR ensure that the F/V *Elechil* undergo a regularly scheduled maintenance regime, including oil changes as recommended by the engine's manufacturer, the changing of oil and fuel filters, and the replacement of zinc anodes in the engine's cooling system;
- (l) BMR order and keep in stock a good supply of oil and fuel filters, engine oil, hydraulic oil, and zinc anodes for the cooling system for F/V *Elechil*;
- (m) BMR develop a checklist for F/V *Elechil* for all maintenance work to ensure that nothing gets overlooked;
- (n) BMR ensure that F/V *Elechil* carries all the necessary engine spares and spare parts for the hydraulic reel and system to allow repairs to be undertaken at-sea when necessary; and
- (o) the skipper of F/V *Elechil* conduct brief safety drills before each departure, and ensure that all on board know where all safety equipment is located and how it is operated.

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