Small-scale FAD associated fishing techniques used in the Pacific region

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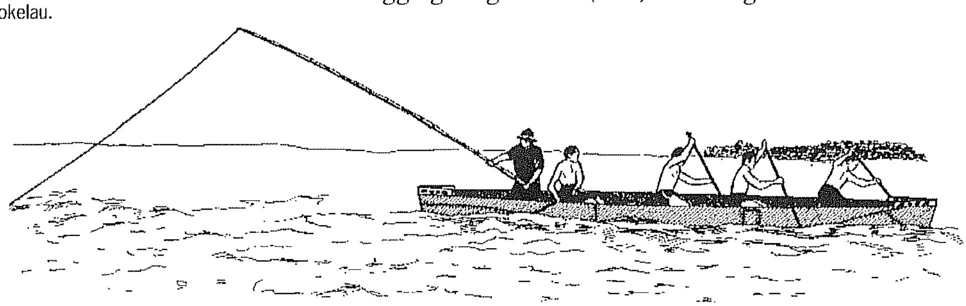
Abstract

Over the last 16 years, the Secretariat of the Pacific Community (SPC-formerly the South Pacific Commission) has been developing and providing information on midwater fishing techniques targeting the larger, deeper-swimming tunas that aggregate around FADs. SPC master-fishermen have conducted in-country fishing trials to test methods, such as vertical longlines, and train local fishermen in their construction and use. Vertical longline catch rates have varied considerably due to a range of reasons with no catches reported in some locations, or just sharks, to highs of over 6.5 kg/10 hooks per hour being recorded in other locations. Other methods like drop-stone, "palu-ahi", and single-hook drifting lines have been developed within the region, with SPC adopting and transferring this technology to other locations. To further disseminate this information, SPC has recently published a technical manual outlining a range of midwater fishing gears and techniques that can be used in association with FADs. An outline of the main gears and techniques with catch data where available is presented, with factors influencing catches discussed based of the findings of SPC masterfishermen over the years.

Introduction

In many Pacific Island countries and territories, offshore pole-fishing and pole-trolling for tunas has been traditional (fig. 1), especially in Polynesia. During these offshore fishing expeditions a variety of canoe designs was used. Fishermen looked for surface schools of tunas, and in some cases, located them in association with flotsam and jetsam in the water. Generally, when schools were located in this way, good catches resulted. Flotsam and jetsam such as this were therefore the first form of Fish Aggregating Device (FAD) in the region.

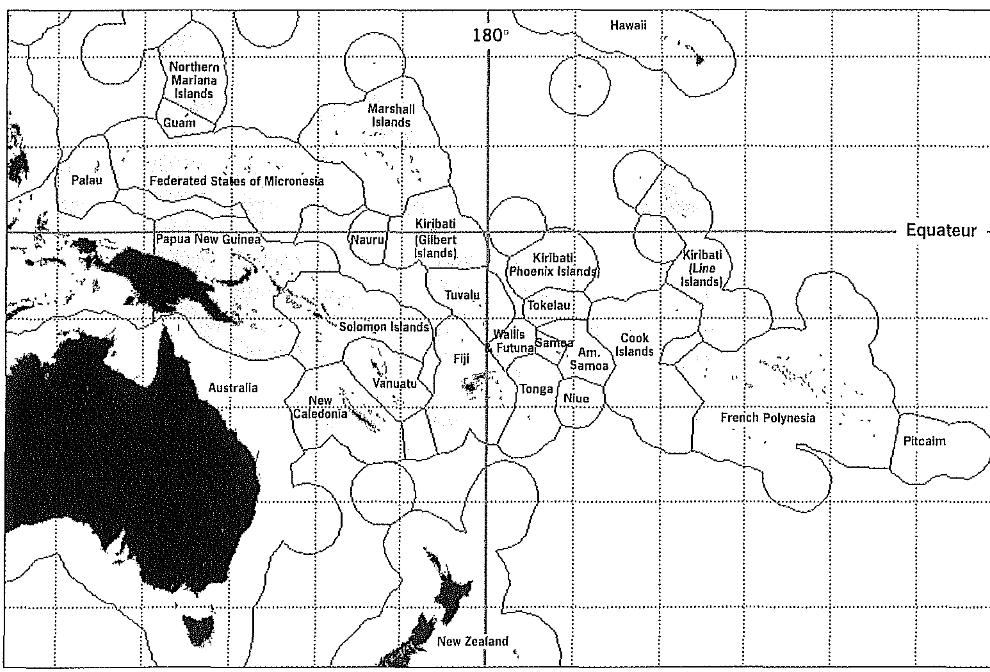
Figure 1
Traditional pole-trolling in Tokelau.



Fishermen were quick to pick up on this phenomenon: fish aggregating around floating objects. As a result, man-made Fish Aggregating Devices (FADs), both drifting and anchored, were developed, and have been used in the Pacific region for several decades. Initially, the man-made FADs were used by industrial fishing fleets using pole-and-line and purse seine fishing techniques, targeting surface schools of skipjack tuna (*Katsuwonus pelamis*) and juvenile yellowfin tuna (*Thunnus albacares*) that were aggregated by them.

As the use of FADs became more known in the region (fig. 2) in the early 1980s, National Fisheries Departments requested SPC to assist them in developing appropriate mooring systems and buoy designs for anchored FADs. The FADs were to be used by local troll fishermen, with the aim of increasing the availability of surface tunas, extending the fishing season for these tunas, providing a specific location for fishing activities, and increasing sea safety by having fishing effort concentrated in known locations. This worked well in many locations, with subsistence and artisanal fishermen venturing out to anchored FADs to troll for tunas.

Figure 2
Region covered by the Secretariat of the Pacific Community (SPC).



SPC's FAD work in the region soon extended beyond the initial focus on FAD design, to include gear development for small-scale fishermen to enable them to target the larger, deeper-swimming tunas that also aggregate around FADs. For many years, SPC masterfishermen have conducted in-country fishing trials using both new gear developed by them and other fishing methods used around the region and adapted for use around FADs.

A variety of small-scale fishing techniques have been tested in association with FADs over the years. Trolling is the most common FAD-associated fishing method, and SPC has produced a manual for fishermen on this subject (Preston *et al.*, 1987). Given the widespread use of trolling, and the vast variety of gears and personal preferences, it is only mentioned here for completeness.

Trials with surface-set gillnets to catch surface-schooling tunas around FADs have proved unsuccessful, as gear damage resulted and catches mainly consisted of sharks. Fish traps have also been suspended under FADs, as a means of catching bait for other midwater fishing activities. Availability of suitable bait is also a very important requisite for midwater fishing activities, although it is not covered in this paper as suitable frozen bait is now readily available in the region.

The main focus of this paper is on SPC's gear development work and use of alternative midwater fishing gears. These gears are vertical longlines, drop-stone and "palu-ahi" handlines, and single-hook drifting lines. Many country reports have outlined the work of individual masterfishermen projects and the results of fishing activities using a variety of midwater fishing gears. This paper will summarise much of SPC's work in this area, and will also draw on information provided in a recently published SPC manual covering fishing gears and techniques used around FADs (Preston *et al.*, 1998).

Vertical longlines

Vertical longlining is a simple and relatively cheap way to fish for tunas and related species in the water column around FADs by presenting baited hooks at a range of depths where these fish may be congregating. A basic vertical longline comprises a single, long, weighted main line of rope or Nylon monofilament, suspended from the surface to a depth of 300 m or more (fig. 3). Connected to the main line are a series of 3-6 m monofilament Nylon branch lines (also called snoods), each of which carries a baited hook. The branch lines are attached using swivelled longline clips, snapped to swivels, which are built into the main line at intervals of 10-20 metres.

There are numerous varieties of gear components and ways to make up vertical longlines. Table 1 outlines the specifications for the general materials used to make a rope or monofilament vertical longline. The lines may be fished from a basket or bin (generally with a rope main line) and be worked by hand, or can be wound onto a fishing reel (generally Nylon monofilament main line). The swivels that are built into the main line act as markers or attachment points for the branch lines, as well as greatly reducing tangles normally caused by line-twist, especially when more than one fish is on the line at one time.

Figure 3
Basic vertical longline arrangement used around FADs.

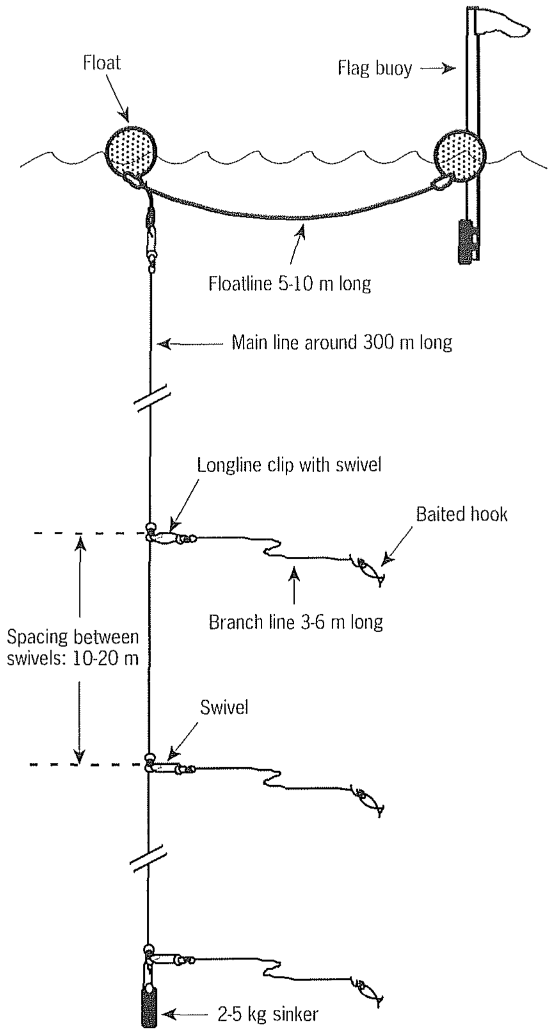


Table 1 - Specifications for materials used to make a rope or monofilament vertical longline.

Component	Typical materials	No./Amount
Surface float	Plastic longline float 300 mm Ø	2
Marker buoy	Bamboo or fibreglass pole	1 x 3 m length
Floatline	Polypropylene rope 6 to 8 mm Ø or 6.4 mm Ø Kuralon longline rope	1 x 5 to 10 m length
Main line	Monofilament Nylon, 200 to 500 kg test or 6.4 mm Ø Kuralon longline rope	1 x 300 m length
Swivels	McMahon heavy duty, size 10/0 to 12/0 or leaded swivels	15
Branch lines	Nylon monofilament, 125 to 250 kg test (breaking strain should be at least 50 kg less than that of the main line)	15 x 3 to 6 m length
Longline clips	Size 1, 12 cm longline clip with swivel	15
Hooks	Mustad tuna circle size 14/0, 15/0 or 16/0 or BKN size 48 or Japan tuna hook size 3.6 mm	15
Sinker	Lengths of rebar 2.5 cm Ø x 22 to 40 cm long, tied or welded together to make weights of 2 to 5 kg	6 pieces

Many different styles of vertical longlines have been used by SPC masterfishermen around FADs over the years in many countries and territories in the region. Catches have fluctuated greatly as well, from no catch in some locations (New Caledonia, Yap and Kosrae) to catches of sharks only (Vanuatu and Papua New Guinea) and good catches as summarised in table 2. The great variation in catch rates is mainly attributed to the seasonality of tunas in different areas and the effectiveness of individual FADs in attracting the deeper-swimming tunas. Even when surface schools of tunas are associated with FADs, this does not automatically mean that larger tunas are deep in the water column.

Table 2 - Catch rates recorded in locations where vertical longline trials were successful.

Year	Location	Catch		Effort	CPUE
		Number	Weight (kg)	(10 hooks/hour)	(kg/10 hooks/hour)
1983	Rarotonga, Cook Islands	2	20,5	27,0	0,01
1983	Niue	85	887,5	261,0	0,03
1984	Beqa, Fiji	26	448,5	116,1	0,04
1985	Beqa, Fiji	33	801,0	116,3	0,07
1986	Rarotonga, Cook Islands	164	2 683,3	407,0	0,07
1988	American Samoa	27	664,6	84,3	0,08
1990	Western Samoa	130	1 866,1	1 014,0	0,02
1991	Western Samoa	181	2 819,2	864,0	0,03
1997	Rarotonga, Cook Islands	9	160,5	94,1	0,02

The best catch rates were consistently achieved when the fishing gear (with or without the fishing vessel) was attached to the FAD. This kept the gear close to the FAD, even though it was on the down-current side, close to the "feeding zone" where tunas were likely to pass or aggregate (the main feeding zone is considered to be on the up-current side of FADs). Several main lines can be attached to one another by surface floatlines, to increase the number of lines and hooks in the water. Setting gear in this fashion restricts the number of fishermen who can tie their gear to an FAD, although it does reduce the chance of the gear becoming tangled to the FAD mooring, as it is down current. However, when vessels tie to a FAD to fish, especially larger, heavier vessels, added strain is placed on the mooring line, which could shorten its lifespan. Additionally, the weight of vessels tied to the FAD, especially in rough weather, could cause the mooring anchor to drag.

The second approach to setting vertical longlines was to drift them past the FAD. This was required in some countries where regulations prohibited the tying of anything to FADs. Catch rates in general were lower using this technique, especially in strong currents, as the lines drifted past the FAD in a short time, away from the main "feeding zone". Occasionally a line would drift into the FAD mooring and in some cases become stuck on the FAD mooring line. Accidents like this could contribute to FAD loss, especially if baited hooks are tangled to the mooring line, attracting sharks and other fish with teeth.

During one project conducted in Rarotonga, Cook Islands in 1986, an assessment was undertaken to identify the relationship between depth and catch rates using vertical longlines (Chapman & Cusack, 1997). The catch during the eight-month fishing trial was made up of 149 yellow-fin tunas (weighing 2,449 kg), eight albacore tunas (*Thunnus alalunga*, weighing 183 kg), two wahoo (*Acanthocybium solandri*, weighing 22 kg), three "mahi-mahi" (*Coryphaena hippurus*, weighing 23 kg), and two rain-bow runner (*Elagatis bipinnulata*, weighing 6.3 kg).

Fish were taken at all depths along the vertical longlines (fig. 4), although only limited fishing occurred in depths shallower than 80 metres. The hooks set from 80 to 155 m caught 72 of the total 164 fish (43.9%), while the hooks set from 185 to 260 m also caught a similar number (73 fish, 44.5% of the catch by number). Although no definitive relationship between depth and catch rates could be discerned, it is likely that the tunas congregated below a shifting thermocline. It is also possible that chum trails drifting from other fishing operations conducted concurrently may have played a part in promoting strikes at particular depths, which may have skewed the results.

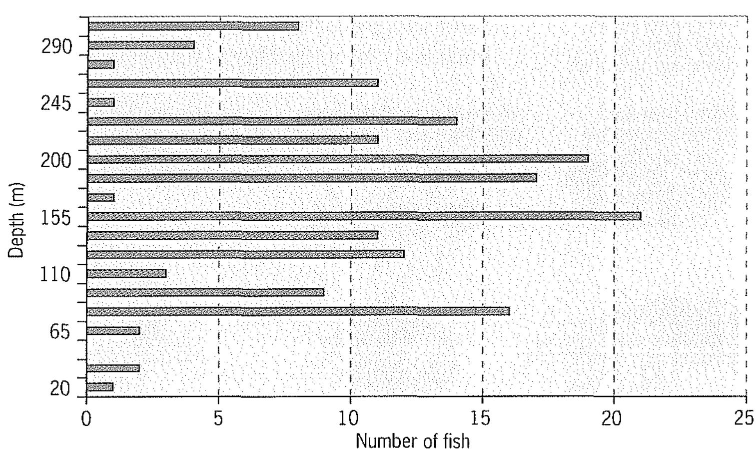


Figure 4
Catch numbers in relation to fishing depth (adapted from Chapman & Cusack, 1997).

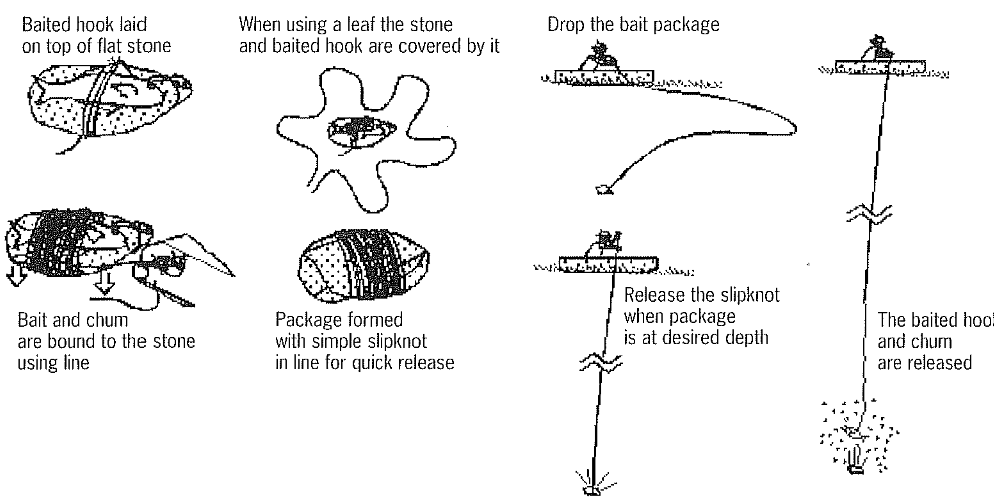
Fresh or frozen locally-caught bait species such as bigeye scad (*Selar* spp.) and mackerel scad (*Decapterus* spp.) generally produced the best catch rates. If these were not available, the next best bait was frozen tuna longline bait, with saury (*Cololabis sairi*), mackerel scad (*Decapterus* spp.) and pilchards (*Sardinops* spp.) being the most productive. Cut bait in the form of strips of larger fish, such as skipjack tuna, were used on occasion, resulting in a higher catch of sharks.

Drop-stone and "palu-ahi" handlines

Drop-stone and "palu-ahi" are two methods of midwater handlining, with the latter evolving from the first. Traditionally, Polynesian fishermen used the drop-stone method to target tunas in midwater, usually in areas where they were known to gather, called "tuna holes". Nowadays, the

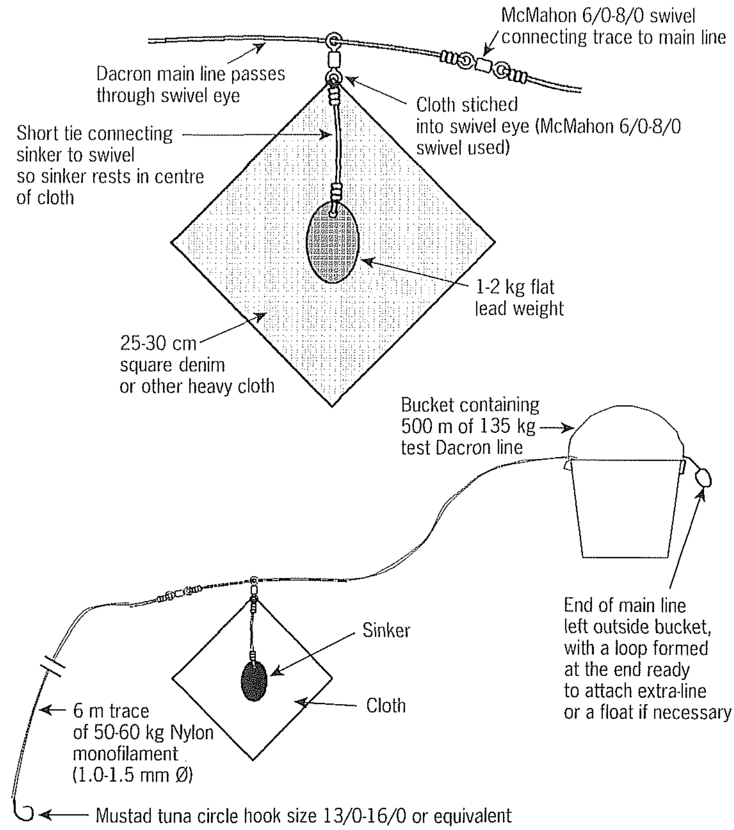
drop-stone technique is the most common method used around FADs by artisanal fishermen in French Polynesia. The gear is simple and consists of a single monofilament Nylon line (around 400 m length and 1.0-1.5 mm diameter) wound onto some sort of spool for storage, a hook (10/0-13/0 Mustad tuna circle), and if desired a sinker (100-300 grammes) to use when the current is strong. In addition to the gear, flat stones of 1-2 kg weight, large flat leaves, bait and chum are needed.
Figure 5 depicts the methods of using this gear. Simply, the baited hook is placed on a flat stone, some chum (chopped fish with coconut flesh or something similar) is placed on top of the baited hook, with the line used to bind the baited hook and chum to the stone. Alternately, the stone, baited hook and chum can be placed on a large flat leaf, the leaf folded around them to form a package, and the line used to bind the package closed. Whether a leaf is used or not, once the package is bound, the line is looped and tucked under the bindings to form a slipknot which secures the package. The package is then dropped into the water, and allowed to sink to the desired depth without any tension placed on the line. Once the desired depth is reached, the line is held and jerked to release the slipknot, allowing the package to unravel with the stone dropping free and the leaf drifting away. This leaves the baited hook and chum together at the desired depth.

Figure 5
Several ways to tie
a drop-stone rig
and the way it is used.



Hawaiian fishermen modified the drop-stone method over time to eliminate the need for stones and leaves and called it "palu-ahi" (chumming tuna). The Nylon monofilament main line was replaced with a braided polyester (Dacron 135 kg test) or Nylon cord connected to a Nylon monofilament trace (3-6 m length and 50-60 kg test) by a swivel (McMahon 6/0-8/0). The stone and leaf were replaced by a square of cloth and a lead weight attached to a corner of the cloth by some cord, so the weight was positioned in the centre of the cloth (fig. 6). The main line cord is passed through the swivel on the cloth to allow the cloth and weight arrangement to slide freely on the main line.

Figure 6
"Palu-ahi" gear arrangement.



To make the package, the two swivels are slid against one another, the trace coiled and placed under the lead weight, and the baited hook placed on top of the weight. Finely chopped chum is then placed over the baited hook. The package is then formed by folding the two sides of the cloth over the chum, followed by the bottom corner and lastly the top corner where the two swivels are. The fisherman then uses the cord to bind the package by first wrapping it five or six turns in one direction. Holding the cord, he turns the package 90 degrees, and makes another five or six wraps. The fisherman then loops the end of the cord and pushes it under the bindings to secure the package with a slipknot. The package is dropped and the slipknot released in the same way as for drop-stone fishing. The difference is that when the package unwraps, the main line is pulled in 3-6 m to pull the cloth and weight away from the baited hook and chum as well as straightening out the trace quickly to avoid tangling.

SPC's fishing trials using these methods have been limited, mainly because of the major effort put into developing the vertical longline technique. Table 3 summarises the catches achieved in the Cook Islands during two separate fishing trials around the FADs. In both cases, the fishing effort was concentrated by tying the vessel to the FAD and allowing it to come and rest around 30-40 m down-current. During these fishing trials, usually one and sometimes two vertical longlines were also used, attached to the vessel by tether lines. This allowed the chum from the drop-stone and "palu-ahi" lines to attract fish to the vertical longlines as well. The bait used was the same as that used on the vertical longline, with old or damaged baits used for chum on the next fishing trip.

Table 3 - Catch rates for drop-stone and "palu-ahi" fishing trials in Rarotonga, Cook Islands.

Year	Catch		Effort	CPUE
	Number	Weight (kg)	(line-hour)	(kg/line-hour)
1986	110	1 506.3	444.0	3.39
1997	9	168.5	50.3	3.35

These methods were also tested in other locations (New Caledonia, Yap, Papua New Guinea) where the vessel drifted. However, because the vessel constantly moves, there was no continuous chum trail, which resulted in no catch. Additionally, when drifting vertical longlines, this gear needed to be moved as it drifted away from the FAD, which limited the time available to conduct other fishing methods like drop-stone and "palu-ahi".

Single-hook drifting lines

The term single-hook drifting line covers a wide range of gear and is fairly self-explanatory. Figure 7 depicts two simple forms of drifting lines, one designed for smaller surface species such as "mahi-mahi" and the other for larger tunas. For smaller fish, a plastic bottle with 10-30 m of 80-150 kg test Nylon monofilament attached and a single hook (13/0-16/0 Mustad tuna circle) is used. For larger fish, the main line is 50-150 m length and usually made of 6.4 mm Kuralon rope. A Nylon

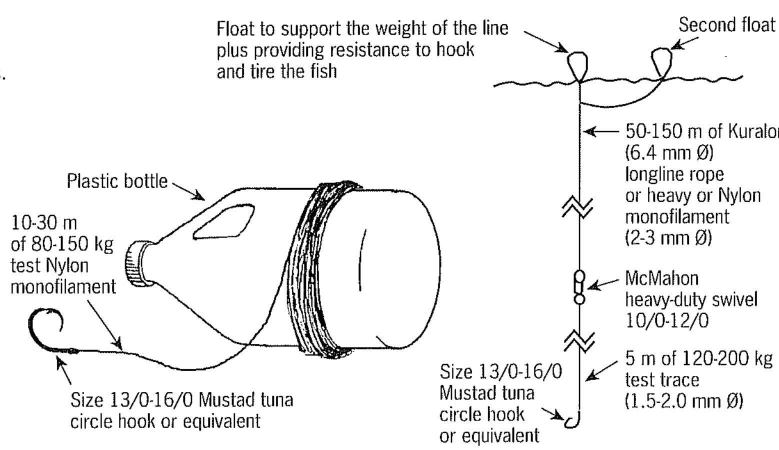


Figure 7
Several arrangements for single-hook drifting lines.

monofilament trace is attached by a swivel to the main line, with a single hook on the other end of the trace. The line is buoyed off by one or two floats.

Fishing with this gear is simple. A vessel motors up-current from an FAD and deploys as many of these lines as they are comfortable using, usually from 5 to 10. The vessel then "patrols" the lines to follow their drift as well as watching for any with obvious signs of a fish being hooked. When fish are seen to be hooked, the line is retrieved and the fish put on board. When the lines have drifted past the FAD, they are retrieved and taken up-current and reset. FAD masterfishermen have observed good catches of tunas and other species taken by local fishermen using this gear around FADs.

Conclusion

The use of midwater fishing techniques has proved very successful in catching larger, deeper-swimming tunas around FADs in some countries and territories in the region. Seasonality of tunas in different locations has been identified as the main limitation to the use of midwater fishing gears, and has greatly affected the results of SPC's fishing trials in the region.

Concentrating fishing effort close to the FAD through securing the gear and/or vessel to it, has produced better catch rates when compared to catches from gear drifted past FADs. This is especially true when using both vertical longlines and drop-stone and "palu-ahi" methods at the same time, where the chum from the handline methods attracts fish to the other lines.

Using this gear is not without its problems. When drifting the gear, there is always the chance that it may tangle with the FAD mooring line, thus adding to the chance of mooring failure. Also, if several vessels, especially larger and heavier vessels, tie up to the FAD at one time, added strain is placed on the mooring line, which may also add to the chance of mooring failure. Vessels tying to an FAD, especially in rough weather, may also cause the mooring anchor to drag.

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