FISH AGGREGATING DEVICES: THE OKINAWAN/PACIFIC EXPERIENCE

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Background

In the Pacific region, fishers from most coastal communities predominantly engage in gleaning for sea shells and crustaceans on the dry reef flats and in shallow water pools formed at low tide. Fishers also engage in line fishing, netting and diving activities along the reef dropoffs, bays, coves, inlets, and lagoons, while those with sailing canoes and powered punts frequently undertake offshore trolling for pelagic species. The spread of urbanisation into once rural areas and the increasing reliance on cash to cope with urban demands has turned many subsistence fishing activities into semi-commercial or fully commercial activities that equate earning capacity with quantity harvests. This puts considerable pressure on reef stocks, and the result is that some areas face reef damage or deterioration of fisheries resources, which can take years to recover. Encroachment of urban fishermen into rural fishing areas also increases the rate of fisheries resource extraction in these fishing grounds and leads to larger areas of declining reef stocks.

Regional fisheries organisations, country fisheries departments, fisheries-affiliated NGOs, and environmental groups are actively trying to curtail unsustainable and destructive fisheries practices. Fisheries management systems are continually being reassessed to enforce efficient and effective measures that relieve pressure on reef stocks. These systems focus on sustainable harvesting methods conducive to ecosystem development and attuned to progressive environmental maintenance, while at the same time encouraging sufficient yields to appease fishermen's livelihood requirements within reasonable means. However, to successfully get fishing communities to cooperate with fisheries management policies, alternate or substitute fishing activities needed to be identified to encourage fishers to move away from over-fished reef areas (Fig. 1).

Many options have been recommended to communities. High among these are the closure of demarcated fishing areas, which proved successful in several cases and had impacting results in the recovery of reef stocks. In some islands, however, this was constrained to small fishing ground owners whose options were either to fish their limited reef area or abstain from fishing entirely. The other viable prospect was to shift the focus from quantity harvest to the production of "value-added" quality products using minimum resources.

The introduction of fish aggregating devices (FADs) to the Pacific region gradually became popular among offshore fishermen targeting pelagic species, especially tuna. As fishermen became familiar with FADs, their popularity increased and more fishermen participated in FAD fishing, which turned fishermen's attention away from nearshore reef resources. FADs provide fishermen the alternative to fish for pelagic species while the reef stocks are given time to recover.

FADs in the Pacific region

FADs were first introduced to the Pacific region in the late 1970s from the Philippines. Since then, many designs were experimented with producing

Figure 1: Nauruan fishermen and fisheries officers at a FAD fishing methods workshop discuss methods of relieving pressure on reef resources

mixed results. The Secretariat of the Pacific Community (SPC) plays a major role in the promotion of FADs in the region and backs this with technical support to island countries interested in implementing FAD programmes[1].

The principal criteria for Pacific Island FAD designs are that they be cost effective to construct and deploy, and durable enough to withstand adverse sea conditions, especially strong westerly winds and cyclones that pass through the region.

SPC has experimented with several designs in the region with some degrees of success as well as noticeable failures. These designs include a modified version of the Indian Ocean FAD (Fig. 2) and the spar buoy FAD (Fig. 3).

Although these designs did not remain in place as long as desired, the fish aggregating results were impressive enough to encourage further exploration in this area and also induced canoe fishermen to request simple designs to be moored closer to reefs. An inshore FAD programme was implemented by the Asian Development Bank-funded Community Fisheries Management and Development Project in Kavieng, Papua New Guinea in late 2005 to deploy inexpensive but durable bamboo FADs (Fig. 4) for several rural coastal communities[2].

Two main factors were initially identified as the cause of FAD failures: vandalism and the inadequacy of the designs to withstand the region's rough sea and weather conditions (especially designs that had large surface areas resistant to

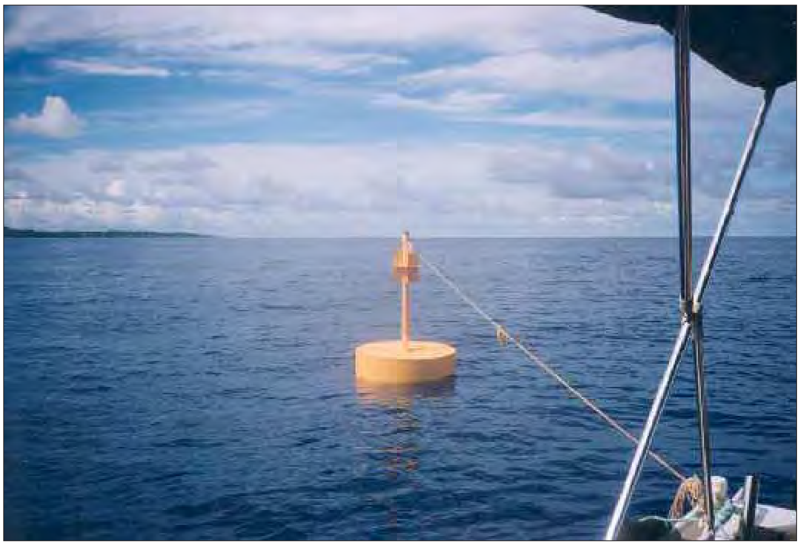


Figure 2 (top): Indian Ocean FAD in Kavieng, PNG

Figure 3 (bottom): Spar buoy FAD in Nauru shortly after deployment

weather action and thereby creating more strain on the mooring section).

Later findings revealed that the Indian Ocean type FADs were susceptible to collapse as a result of the foam purse-seine floats being "squeezed out" when subjected to depths beyond its pressure rating. This occurs when the FADs are forced underwater after reaching their extreme surface stretch point due to strong currents and stormy conditions.

Widespread interest in FAD programmes throughout the region invited considerable

1 Four FAD manuals were produced by SPC to complement work carried out in the Pacific region and to facilitate fisheries departments or interested parties to conduct FAD projects

2 Sokimi W. 2005. Field Report No 29 Technical assistance on small-scale baitfishing trials and course presentation to the national Fisheries College, and FAD experiments to the Community Fisheries Management Development Project assisting in Kavieng, Papua New Guinea. 38 p.

debate and literature on the impact of FADs on ecosystems, fisheries development, and community welfare. The main apprehension is the use of FADs as tools to supplement industrial-scale commercial fishing activities participated in by large tuna purse-seine vessels and pole-and-line vessels. The companies that operate these vessels deploy their own FADs to supplement the vessels' search for tuna (Fig. 5). FADs aggregate juvenile yellowfin and bigeye tuna alongside huge schools of skipjack tuna targeted by these vessels. While pole-and-line vessels are generally selective of skipjack target species, purse-seine vessels do not discriminate the catch entrapped in their nets so many juvenile yellowfin and bigeye tuna end up as bycatch or are dumped overboard as rejects. The concern is the overall impact that large-scale extraction of juvenile yellowfin and bigeye tuna will have on the region's tuna stocks.

Figure 4 (top): Inshore bamboo FAD in Kavieng, PNG

Figure 5 (bottom): Torpedo-shaped steel FAD currently used by PNG-based purse-seine vessels.

However, when comparing industrial FAD catch rates to small craft FAD catch rates, the impacts from small craft fishing around FADs are negligible. The Okinawan FAD fishery in Japan is one of the most active FAD fisheries in the Pacific, and keeps good records of catches. Since 1989, the Okinawa FAD fishery has produced yellowfin catches that fluctuate from 600–1300 mt/year[3] compared with 312,000–460,000 t/year from purse seine and longline catches in the western and central Pacific Ocean[4]. Although these are 1999 figures, the catch ratio has not changed much since then.

The FAD fishing experiences of the Okinawan fisherman's associations is a good example of how FADs can benefit coastal fishing communities and contribute to sustainable fishing practises and recovery of reef stocks.

Fish aggregating devices (FADs) in Okinawa's Itoman District

Although FADs have been trialled and used in Okinawa for 30 years, projects for offshore FADs deployed in depths greater than 1000 m began in 1982 through experimental work carried out by the Okinawa Experimental Station and two fisheries cooperatives in Miyako. By 1984, Okinawa had an established commercial FAD fishery. Initially FADs were designed to be as inexpensive and simple as possible but the quest to have longer-lasting

[3] Kakuma S. 1999. Synthesis on Moored FADs in the North West Pacific Region. 16 p.

[4] Lawson T.A. (ed). 1999. Secretariat of the Pacific Community Tuna Fishery Yearbook 1998. Oceanic Fisheries programme, SPC, Noumea, New Caledonia. 155 p

FADs saw meant that FAD designs became more complicated and expensive to produce. Fourteen experimental FADs were trialled, producing exceptional results that contributed to the escalation of FAD development throughout Japan. Since then, expensive commercially manufactured FADs have been popular in Okinawa (Fig. 6). In recent years though, with the shifting of FAD responsibilities to fishermen's associations, inexpensive but durable designs are again being considered in order to cut back on costs.

The Itoman fisheries association is now looking at adopting a similar outlook to SPC in order to implement cost effective FADs, although not necessarily as inexpensive as the ones SPC deploys. Currently, SPC's FADs are far less expensive than those deployed in Okinawa, although they are not as durable. However, the latest SPC-modified Indian Ocean design, using pressure floats, has the potential to outlast the previous designs and several of the latest deployments of this modified design have already been in the water for over a year now, showing good signs of remaining in place for even longer.

During earlier FAD programmes Okinawa fisheries associations faced the same predicaments that other Pacific Island countries faced when deploying FADs: the FADs did not remain in place long enough to justify the cost and effort of installing them. FAD losses, due to typhoons and stormy weather, were a serious problem and remains the main cause of FAD losses today (although not as much as in earlier years). In the early stages of FAD deployments, most Okinawa FADs lasted only between 1 and 1.5 years and some less than a year; the same dilemma that currently occurs in the Pacific. Nevertheless, the returns from FAD fishing were enough to warrant persistent new deployments while FAD experts tried to produce more durable designs.

FAD designs from Okinawa and the rest of Japan are now much improved, although very expensive for Pacific Islands to adopt for sustainable FAD programmes. The mooring sections of new designs were improved by replacing the single anchor system with two anchors, the upper mooring rope was replaced with stronger rope, and shackles are now seldom used because they were found to be a common breaking point. Shackles are now replaced by splices or joining knots. Where applicable, especially for smaller FADs, regular maintenance works are carried out to continuously change defective materials whenever they are spotted. For the larger and more costly surface FADs, expensive systems are used for construction, deployment and maintenance. For example, the Nirai FAD (Fig. 7) that was funded by national and prefectural government subsidies is made of durable steel and designed to last at least 10 years. It was moored with huge chains and reinforced wires, and was deployed using a large vessel with proper winches to carry out precise mooring work. The FAD raft is 7 m deep and 13 m at the base, and constructed according to a precision shipwright design.

The Itoman fishermen's association currently has 12 assorted types of FADs moored in depths of 1000–2000 m up to 20 nm offshore along the coastline under its jurisdiction.

Much more can be written about the Itoman and Okinawa FAD experiences, including costs, restrictions, advantages, disadvantages, and successes and failures, but one of the latest FAD innovations that must be mentioned is the "submersible" or "subsurface" FAD concept, which was implemented 15 years ago although a more serious approach was carried out 10 years ago. This FAD design is now proving to be a success story in terms of aggregation and durability.

Okinawa Subsurface FADs

Fifty-six subsurface FADs were deployed throughout the coastal waters of the Okinawa and Amami districts since 1996 by the Japan Marine Fishery Resource Research Centre (JAMARC), and to date, records

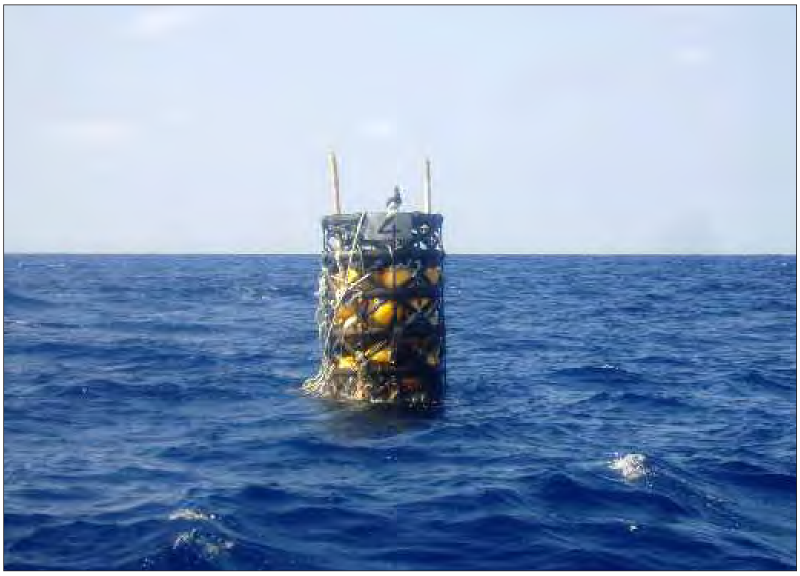
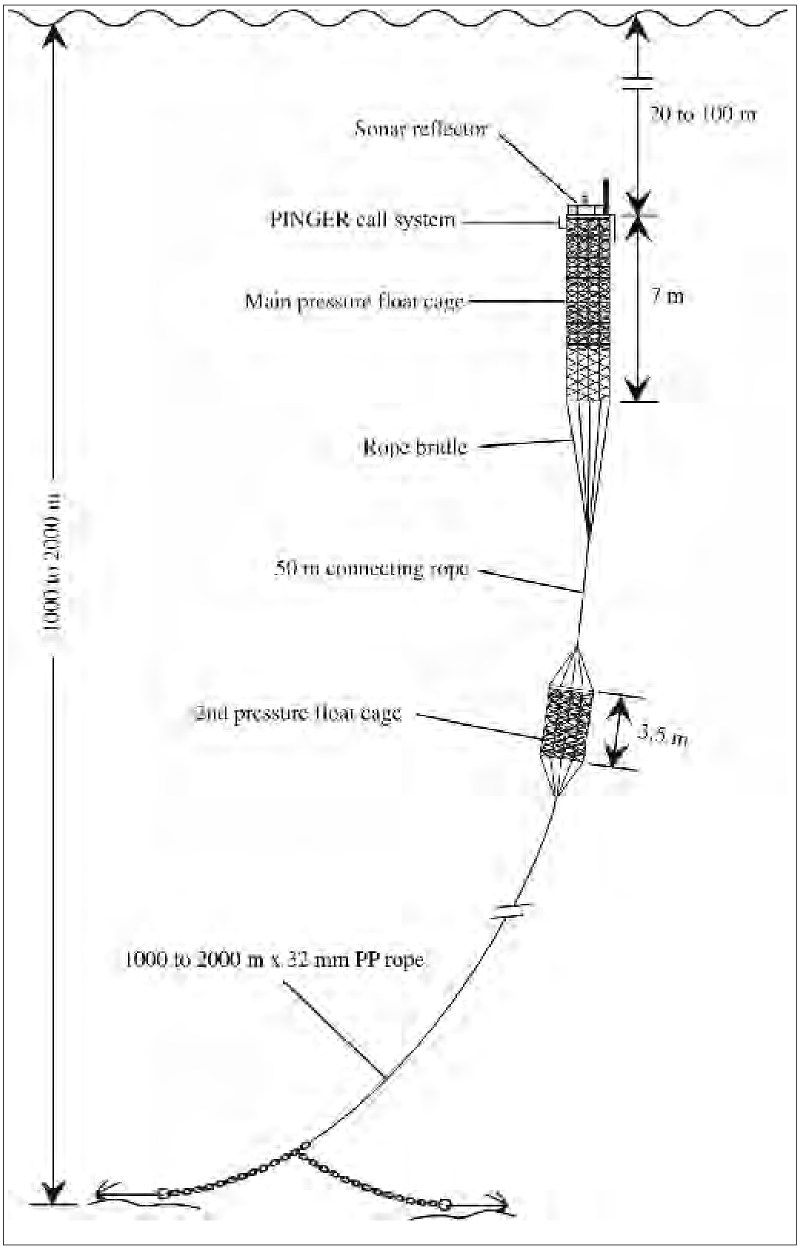


Figure 6: Current Okinawa surface FAD design



indicate that only one has disappeared. The rest are still intact and producing abundant fish stocks for fishermen; some FADs are more successful than others though, probably due to the locality of the FAD. Catch details, which are updated daily or whenever a fishing vessel fishes one of the FADs, can be obtained from JAMARC.

Several observations indicate that subsurface FADs provide good aggregating capabilities and also give fishermen good returns. Some fishermen believe that the subsurface FADs aggregate more fish faster than surface FADs.

The three main advantages of subsurface FADs (Fig. 8) are that they last much longer, aggregate fish faster, and give fishermen good returns because larger fish schools aggregate around these FADs. However, there are several disadvantages, especially for Pacific Islands. These FADs are huge and costly to produce and to deploy. The mooring systems are constructed from bigger and more expensive rope types and deploying the FAD requires a small cargo vessel with several adaptations for deployment.

The fibre reinforced plastic (FRP) cages are specially manufactured in a factory to calculated specificatins in order to withstand stresses that may be encountered. A second vessel would also be required to simultaneously deploy a second anchor at an angle of 45° to 90° from the main vessel.

Because they are submerged, the FADs are harder to find, so fishing vessels will need a GPS and sonar onboard to locate the

Figure 7 (top): The famous USD 1 million Nirai FAD

Figure 8 (bottom): Submersible FAD design

submerged FAD easily. An echo sounder/fish finder can do the job in place of sonar, but fisherman will need to make several runs directly over the FAD before an image is registered on the echo sounder. This will require excellent judgement to pass over the exact location on the first run since the FAD will shift slightly from the GPS deployment mark according to the daily direction and strength of currents in the area. Pinpointing the exact location of the FAD is important in order to identify the direction in which the fish schools will generally aggregate and to avoid getting lines caught on the mooring.

When a subsurface FAD is deployed, the deployment method needs to be carried out with precision so that the FAD settles in depths of 50–100 m (preferably 50 m). At 50 m it is expected that surface action due to wind and swells will not be experienced. The turbulence caused by swells in the roughest of conditions will rarely be experienced at this depth and recent data show that in the vicinity of subsurface FADs, pelagic species aggregate and spend most of their daylight hours around this depth. These species are mainly seen at the surface at night, very early in the morning, or when they gather to run in schools to pursue baitfish during the day.

The final problem that must be highlighted is the means of carrying out maintenance work on the FADs once they are settled at the submerged depth. A dilemma that the Okinawan fishermen now face is the abundance of growth on the FAD floatation section itself. One of their long lasting subsurface FADs from the experimental days, which has now been in the water for over 10 years, is becoming burdened with heavy underwater growth that eventually may cause its collapse due to excessive weight. On the bright side, this FAD has given more than its share of returns on its cost in the 10 years it has been in the water.

The Itoman fishermen's association are currently constructing half-size subsurface FADs for deployment (Fig. 9). The design is basically the same as the current large sizes; only the cages and number of floats are downsized to be the same as those deployed for surface FADs. The concept of the subsurface FAD is useful for the Pacific region and although the chances are slim that the region will deploy expensive FADs such as those used in Okinawa, there are still very options for deploying inexpensive modified designs of the Okinawa subsurface FADs that are just as effective and durable.

Even the idea of visually pinpointing FADs location can be easily achieved without having to resort to sonar or echo sounder; however, a GPS is very handy for directing fishers to FAD mooring sites.

The Japanese International Cooperation Agency (JICA) has already worked with the Fiji Fisheries Department and the Fiji School of Maritime Studies to deploy two inexpensive subsurface FADs in Fiji in early 2006. One of the FADs was successfully submerged but the second one missed the mark by a large margin and settled in shallower waters resulting in the FAD now being a surface one. Hopefully, the opportunity will arise to experiment with designs to produce a FAD that is more affordable for the Pacific region and just as long lasting and effective as those used in Japan.

Conclusion

Fish aggregating devices may well be the partial solution to relieve pressure on coastal reef resources in the Pacific Islands. Proper implementation of FADs with appropriate management plans can contribute tremendously to the Pacific Islands' coastal fisheries development as experienced in Okinawa, Japan.

Perhaps the next step in FAD programmes for the region should be in trialling subsurface FADs, based on the same criteria for surface FADs ensuring that

Figure 9: The half size FRP cage component of a subsurface FAD

they are inexpensive and durable. This should not be difficult to implement and improvisations such as a location marker can be adopted to make the FAD position known to local fishermen without the use of echo sounders or sonar. However, this will require the full cooperation of the community to ensure that the location marker remains in place. The main objective is to establish an alternative fisheries concept that not only provides fishermen with an additional choice for supplementing their income or subsistence requirements, but also assist in diverting fishing activities from the coastal and inshore reefs. FADs are far ahead as one of the methods for achieving this.

Small craft safety procedures and basic small craft commercial fishing economics are constantly promoted in most SPC FAD fishing method programmes as part of small craft operations management strategies to minimise loss of life at sea and encourage sustainable fishing operations.