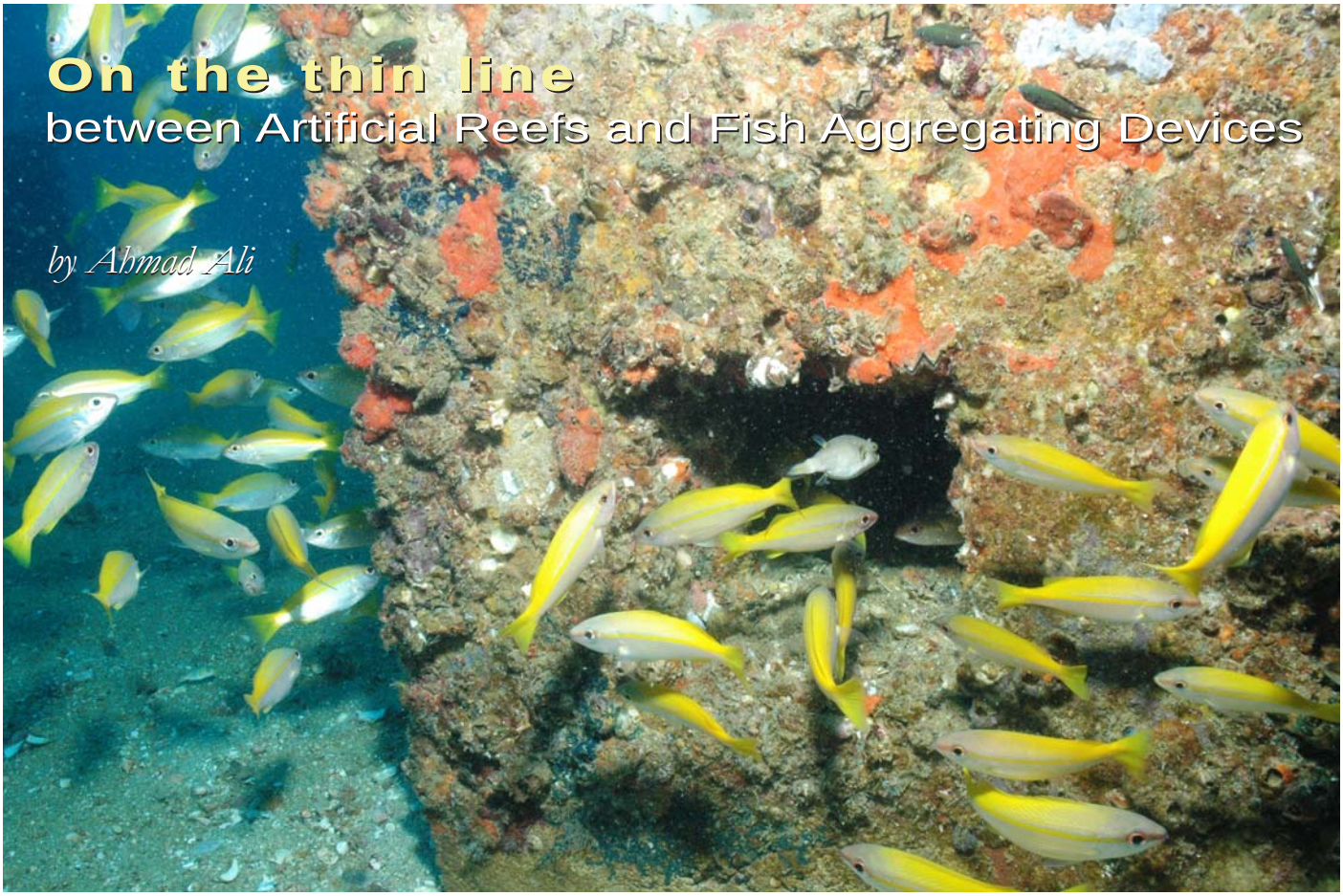

On the thin line
between Artificial Reefs and Fish Aggregating Devices

by Ahmad Ali

Because of the destruction of natural reefs and seagrass beds through coastal development and damaging trawling activities, many feeding, spawning and nursery grounds in the already fragile marine ecosystems have been destroyed. Much effort has been expended in attempts to rebuild these destroyed ecosystems, often following a strategy promoting the development of artificial reefs (ARs). Artisanal fishers and local government have developed various designs of ARs and also fish aggregating devices (FADs) to create fishing grounds close to the fishing villages. These efforts have become widespread for a substantial period in the region; in some areas fishermen have done this for nearly a century. With the actual combination of ARs and FADs, these structures can aggregate many varieties of fish species and attract both pelagic and demersal fish.

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Based upon knowledge and experiences accumulated through the years by fishermen and several studies in the coastal waters of Peninsular Malaysia, the researchers of SEAFDEC Marine Fisheries Resources Development and Management Department (MFRDMD) introduced a new design of durable Artificial Reef Fish Aggregating Device (ARFADs) that will provide a more stable and dependably enriched ecosystem for fishers to exploit fisheries resources. This is a new approach that aims both to aggregate multiple fish species and to enhance fisheries resources in coastal areas.

ARFAD: What is it in short?

The Artificial Reef Fish Aggregating Device is a structure made up of a 3.2 tonnes concrete anchor, plastic appendages and floats that will be deployed in appropriate shallow coastal areas. After a few years of deployment, this structure becomes a new habitat that resembles a natural habitat for several demersal fish species and acts as a sanctuary for pelagic fish and other marine creatures. The concrete anchor may also act as a hindrance to illegal trawlers encroaching in the areas

ARFADs, ARs and FADs : what are the differences ?

	Function	Material	Installation Area	Type
ARs	- Enhance resource (flora and fauna) - Aggregate demersal fish - Create fishing ground - Habitat protection	- Concrete/Ferroconcrete - PVC - Tyre - Fiberglass - Metal - Others	Shallow water	Bottom
FADs	- Aggregate pelagic fish - Create fishing ground	- Sticks - Platic stripes - Bundle of brush or fronds - Bamboo - Canvas - Others	Shallow to deep water	Floating Anchored
ARFADs	- Enhance resource (flora and fauna) - Aggregate pelagic and demersal fish - Habitat protection	Concrete for the anchor Plastic stripes for the attractor	Shallow water	Floating and anchored

while the whole structure creates a new fishing spot close to traditional fishing communities for their subsistence or for recreational purposes. The aggregation, enhancement and diversification of pelagic and demersal fish resources resulting from this ARFADs structure could, in many cases, lead to economic gain for the coastal communities, directly from fishing or from ecotourism.

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Unrestricted fishing around an AR or FAD may lead to exploitation of the resources, as the device usually just attracts marine life from surrounding areas, but doesn't produce as much. This is especially true for pelagic species, which are just attracted to these structures. Without proper management, it can enhance some sessile, demersal resources at low trophic levels while catching too many valuable pelagic fish of higher trophic levels. Thus, to guarantee the sustainability of the ARFADs and to ensure that their resource enhancement effects outweigh their contribution to resource harvesting, fishing effort in their vicinity must be strictly regulated. In this context, traditional fishers using selective gear, especially hook and line that are known to be very selective, catching only marketable sized fish should only use ARFADs. This may eventually increase the catch performance of traditional fishers while not causing an unsustainable fishing pressure on the coastal resources.

The ARFADs are also popular sites for recreational anglers and divers because they provide convenient sites with high concentrations of fish and a multitude of other marine organisms, both flora and fauna, similar to natural coral reefs.

Both a FAD and AR

An ARFAD has three components: floats, an attractor, and an anchored mooring. The upper part of the structure, consisting of the floats, appendages and mooring line, is commonly referred to as a fish-aggregating device. Thus, it is used to attract pelagic fish, mostly thanks to the presence of fish attractors, made of plastic strips and attached to the anchor line. The main function of this anchor line, also known as the mooring line and made of polyethylene rope, is to attach the float section to a heavy moulded concrete anchor resting on the bottom of the sea. This anchor acts to hold the FAD in position as well as being an AR important to demersal fishes.

Deploying the ARFADs

To benefit small-scale fishers, the selected sites for the deployment of ARFADs should not be too far away from the fishing village. The criteria considered for the deployment of these ARFADs are based upon the availability of fish for aggregation and the oceanographic and meteorological conditions. In evaluating a particular site, consideration should be given to the bottom topography, wind, wave and current actions and other infrastructures, like a jetty or pontoon, for transferring ARFADs material to the selected site. The ideal location should be in shallow and calm areas (15-30 m) out of important shipping lanes. It is very important to take sediment samples before any deployment of ARFADs because the structure will sink into the seabed if the bottom sediments are not hard or stable enough to support the concrete anchor. As the ARFAD hinders trawling activities, the selected deployment spots should not be into a legal trawling or drift netting area, however, they might be deployed to protect areas where such fishing activities are forbidden.

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As the installation of an ARFAD involves a heavy weight anchor of about 3.2 tonnes, adequate safety procedures must be observed and the deployment should follow an anchor-last method, carried-out during daylight with clear and calm weather conditions. Thus, the upper part of the ARFAD, which contains the polypropylene rope with appendages and floats, is jettisoned first while the anchor that is tied at the other end of rope remains on board. The barge then slowly drifts away to prevent the entanglement of the upper part of the ARFAD, once everything is clear, the anchor is finally released into the sea.

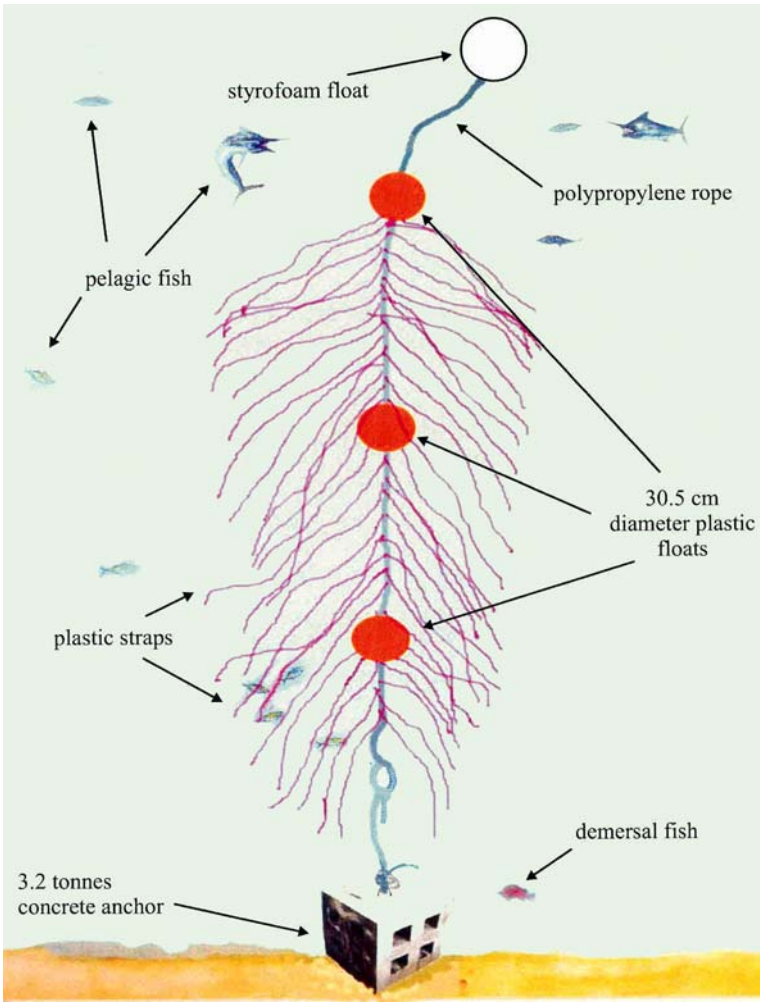
It was found that the function of the ARFADs is more successfully realised when many structures are set up at one site, 25 units are normally deployed in each location. The ARFADs are usually arranged in a square of 5 by 5 units with the distance between each unit of about 10 meters, thus designating an area of 50 by 50 meters or 2,500 m2.

Maintaining and using ARFADs

Users around the ARFADs should always pay attention to the surface floats (made of Styrofoam) because once the floats break loose from the ARFADS, the appendages will fall to the sea floor and become useless. The propellers of passing boats may cut floats on the upper surface of the sea. Any rope not properly attached to a surface float must be fixed to prevent the surface float from drifting. Nonetheless, after 3 to 6 months of deployment, barnacles and other flora and fauna will have covered the appendages and the surface floats will sink under the increasing weight. This needs to be compensated for by placing additional floats, usually made from plastic drums at the upper section of the rope of the ARFAD.

Fishing around ARFADs

Hand lines, squid jigging and trolling are recommended as the only fishing gear allowed to be used around ARFADs. Hand lines are selective gear and the catch can be controlled by using different sized hooks. Fishers can tie the boat to the floats or drift around and use live or dead bait for fishing. Jigging for small pelagic fish using feathers or plastic lures may also be used around ARFADs shortly after their deployment. Live baits are usually used for catching target species like Spanish mackerel (*Scomberomorus* spp.). In trolling, towing live or dead bait at low speed was found more efficient than artificial lures. The fishers of Terengganu use squid jigging around ARFADs, both during the night and daytime to catch squid species like *Loligo* spp., *Sepia* spp. (cuttlefish) and *Sepioteuthis lessoniana* (bogfin reef squid). Other methods including traps and gillnets are strenuously not recommended because they catch more fish than that which would be sustainable and can easily get entangled with the mooring line. Uncollected traps around ARFADs would also cause ghost fishing.



A schematic representation of an Artificial Reef Fish Aggregating Device or ARFAD

"ARFAD structures, especially the concrete anchor, will in the long-term help to enhance the resource base of coastal areas."

In general, the fish caught around the ARFADs are mainly composed of groupers, red snappers, sweetlip, Indian and Spanish mackerel, barracuda, scad, yellow snapper, nemipterids, trevally, starry trigger fish, dolphin fish and shark. The species composition of the catch differs according to the technique employed; for example, with fishers using trolling for Spanish mackerel and dolphin fish, while fishers using hand lines principally get grouper and snapper.

The AR function of ARFADs

ARFAD structures, especially the concrete anchor, will in the long-term help to enhance the resource base of coastal areas. This anchor will develop into a look-alike natural reef and become an important breeding and nursery ground for several fish species.

Recreational fishing and scuba diving

Marine recreational fishing is a well-known outdoor activity that has the potential to be developed into a profitable economic sector in this region. Over the years, there has been a steady increase in the number of people involved in recreational fisheries and it has become one of the most popular open-air recreational activities in this region. Recreational anglers are fully dependent upon the presence of larger size fish to enjoy their activities. Larger predators like marlin, sailfish, grouper, shark, ray, barracuda, red snapper, trevally, dolphin fish, or tuna are normally only present in deeper water. As not all anglers can afford to pursue large game fish offshore, installing ARFADs in coastal waters can aggregate small fish, which will in turn attract larger predator to the

area. To enhance the coastal fishery resources, these durable ARFADs are useful in attracting and enhancing both pelagic and demersal sport fish. Many ARFADs are already popular sites for recreational anglers and divers, creating a potential alternative source of income for the local communities.

Who owns such structures?

All ARFADs in the coastal waters of the east coast of Peninsular Malaysia are set by MFRDMD and the Department of Fisheries Malaysia (DoFM), and they are considered to be the common property of the local communities. Currently, all traditional fishers and recreational anglers can fish freely around those ARFADs provided that they follow local regulations. DoFM considers the ARFADs deployment program as an indirect support to the coastal fishers, which they believe is seriously needed. The introduction of ARFADs allows fishers to obtain a supply of fresh fishes throughout the year including during the northeast monsoon season.

Management issues

Only big fish are targeted by the local fishers and as long as the total fishing effort on the resources is kept at a low level, the effects of those ARFADs are not harmful to the resources. The only potential problem caused by ARFADs is competition between types of gear and fishers. Fishing effort must be distributed wisely between fishers and gears to avoid conflicts.

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These durable ARFADs are also a very useful mechanisms to prevent trespassing trawling activities. They delimit closed areas from trawling that will protect juveniles in shallow nursery grounds and provide fishing sites for artisanal fishers using selective gear to capture large sized fish.

If these structures are considered to be common property of local communities, i.e. open for everybody to use and fish, fishing effort will be very difficult to control. However, these structures could offer an excellent starting point for introducing rights-based fisheries systems, by allowing only clearly defined community groups to fish in and around individual structures or clusters. It is thus encouraged that the ARFADs should be deployed and used in community-based projects where fishers are encouraged to play a major role during the planning, construction and operational phases.

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The selection of sites of ARFADs should be undertaken through the establishment of Locally Based Coastal Fishery Management, as a tool to help the sustainable exploitation of fisheries resources.

What does it cost?

The table below shows a summary of the overall cost incurred for ARFADs deployed at 25 m depth in 2003. The total cost for the construction of 66 units of ARFADs is around RM 79,000 ($US 20,627): the cost for the construction of concrete anchors and deployment is around RM 68,000 (US$ 17,755) while the remaining structure (appendages, floats and ropes) costs about RM 11,000 ($US 2,872) for the construction of the upper part of ARFADs. The average cost for a single ARFAD is around RM 1,197 ($US 312.50).

No.	Materials	Unit	Cost ($US)
1.	Construction of concrete anchor and deployment	66	17,775
2.	Hard plastic floats (submerged) Styrofoam surface floats Construction of appendages Polypropylene rope (2.2 cm diameter)	66	2,872
	Total Cost		**20,627**

The life span of each ARFAD is expected to be more than 10 years, with the anchors likely to last even longer. Fouling on the appendages will require the setting of additional floats after 6 months.

"The introduction of these ARFADs could even turn some previously unproductive areas into rich ecosystems, while proving local fishermen with a livelihood."

Conclusions

Most of the traditional FADs are made using local materials (bamboo and coconut fronds) which are easily expendable by their nature and they must be continuously renewed every 6 to 8 weeks. The development of durable ARFADs is expensive as the anchor, line and aggregating devices must be able to resist the forces of wind, waves, currents and the corrosive action of seawater. These structures are nonetheless of great interest as they can create convenient artisanal fishing sites while protecting habitats from more destructive forms of fishing. In addition to being effective for artisanal application in which fishing effort is relatively low, well placed ARFADs deployed at suitable sites will in the long term become alike to an artificial reef, enhancing coastal habitats and resources for the benefit of the nearby communities and ecotourism. Potentially, the introduction of these ARFADs could even turn some previously unproductive areas into rich ecosystems, while proving local fishermen with a livelihood.

About the author

Ahmad Ali is the Head of the Resource Exploration and Conservation Unit of SEAFDEC Marine Fisheries Resources Development and Management (MFRDMD). He is working in the field of biology and taxonony of elasmobranch, recreational fishing, and sea turtles.