MARINE BIODIVERSITY CONSERVATION AND MANAGEMENT

Edited by

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CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

TATAPURAM P.O, COCHIN-682 014

1996

XV. FISH AGGREGATING DEVICES - A MEANS TO AUGMENT FISH CATCH

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"Fish aggregating devices help to transform coastal fisheries from a hunting and collecting activity to a breeding and cultivating activity. If this is so, the system is not only a means to enhance fish catch but also is a means to augment natural production."

INTRODUCTION

Fish aggregating devices (FADs) of various kinds are considered effective man-made habitats in the aquatic environment to improve fish catch (Turner, 1969). But according to Ahmed (1993), their abilities to increase natural production of fishes is still a debated question among the scientific communities. Fishes have a natural tendency to gather around and concentrate on floatsams of tree-branches, planks, artificial substrates as well as underwater structures like shipwrecks. This aspect of fish behaviour, called thigmotrophism, was being exploited to attract them to artificial substrates by traditional fishermen all over the world. They may get attracted to FADs for shelter, food or even for breeding purposes. FADs are made out of many types of material and are installed at different depths. Some are constructed out of hard materials like granite blocks, or concrete and laid at the sea bottom and are generally termed Artificial Reefs (ARs). Other FADs are made of, light materials and are allowed to float, at desired depths with the help of anchors and ropes.

FISH AGGREGATING DEVICES

Willmann (1990) and, Wong, (1990) have summarised the general objectives and aims of construction and installation of FADs and ARs of different types. FADs enhance biological productivity and fishery resources in coastal waters by serving as sanctuaries and nurseries or breeding grounds. They serve to rehabilitate and conserve marine habitats that have been adversely affected by overexpoitation of aquatic resources. FADs may help in the regeneration, recovery and conservation of marine resources of inshore waters and thereby to improve catches by artisanal gears. Willmann (1990) is of the opinion that FADs reduce the searching time for fish shoals by fishermen and thus help in saving fuel consumption. Fish aggregating devices can also enhance recreational facilities by providing sites for sports fishing, diving and underwater photography.

Material used

Different types of material are used in various countries for the installation of FADs and ARs. Used tyres, when available is a favoured material. A combination of tyre and bamboo poles is used in Philippines (Anon, 1982). The advantage in this combination is that it is relatively of lightweight and easily transported and installed. They also have moderately long life span and cause very little aquatic pollution by disintegration. But a major disadvantage with tyre is that it needs additional binding material at added cost and are easily damaged by mechanised fishing boats (Delmendo, 1990). Concrete blocks or rings and pipes with opening of various shapes and sizes as fish apartments are also widely used (Anon, 1982).

Though, concrete structures are suitable fish aggregating devices, often they are very heavy and are hence difficult to transport to desired places. Further, the cost of production is also on the higher side. Moreover on soft or muddy bottom these heavy structures sink fast, and thus the habitat gets lost. However, on rocky or hard bottom they function very effectively. Fibre glass-reinforced plastic, (FRP) can also be used in a variety of size and shapes.

Sandbags sunk with anchors can attract yellow tail tunas, sharks, dolphin fishes etc. (Anon, 1982). In Sri Lanka and Malaysia fishermen use mangrove wood and coconut woods in estuaries and lagoons to create artificial habitats for fishes. These are fixed at the bottom to prevent damage or shifting by wind and waves. Along the southerncoast of Kerala granite blocks are piled up to create ARs (Rajan, 1994).

Granite blocks, like concrete structures are heavy to handle and have the problem of subsidence in sandy bottom. At sites with heavy turbulance or underwater current the structure get submerged in a short period. In some parts of southeast coast of India bundles of screwpine and a local leguminous plant called *Kavali* are bundled together and cast over with the help of ropes. This attracts flying fish in large numbers as a nesting site (Atapattu, 1990). Dip nets are used to catch the aggregated fishes. The most common form of floating or subsurface device is called *Payaos* (Payaws), *Rumpon* in Indonesia and *Unjang* in Malaysia (Prado, 1990, Hardjono, 1990). It is made of coconut leaves and twigs of other trees and are anchored with the help of thick ropes, one to five kilometers away from the shore at a depth of twenty to thirty meters. The dominant material used for building artificial reef in Japan and some other countries is still concrete. Use of steel has become more common in recent years as the reefs have tended to increase in size. Steel is also preferred where large and complex reef structures are to be fabricated (Grove, *et al*, 1994)

Design of the unit

Prism shaped concrete units with vertical open slots on all three sides as well as concrete prisms with vinyl cover on the lateral sides may be used to create a tent shaped artificial reef as is tried in some parts of the Gulf of mexico. Rectangular blocks with fish holes were found effective in some parts of Indo-Pacific areas (Russel, *et al*, 1974). In the case of granite blocks specification of form is not strictly adhered to. Often a combination of cones and pyramids may attract relatively more fishes, than ARs made of uniform shaped components (Anon, 1982).

Selection of most suitable structural design for optimization of fish habitat depends on both the target species and environmental factors. The reef shapes of each unit structure gives different shadow area, void space and surface area attracting different fish species.

Quality of material used

Several material including rubber and metal products, concrete, granite and plastics along with plants like mangels and coconut leaves are utilised in the construction of FADs and ARs, all over the world. However, the material used may be critically examined for the following aspects. They should not leach out any toxic material in the long run into the environment and cause any aquatic pollution. As far as possible the raw material should be cheap and should be easily available. Thin metal based materials get easily corroded especially in the marine environment while wooden components may be attacked by wood-boring organisms thus weakening the structure. Rubber material, among all, cause little pollution and lasts relatively long (Wong, 1990)

SITE SELECTION

The physiographic and biological characteristic of the site of FADs is very important for the laid structure to mature and help fishing. The seabed should be firm in the sense that the bottom might be composed of hard rock. This will prevent sinking of the entire structure in the long run. Areas of sand shifting, sea erosion and influx of rain water may be avoided, for shifting sand might submerge the reef. The depth of the area should be ideal for underwater observation and fishing. Water quality should be ideal and the areas with industrial and organic pollutants and heavy surges must be avoided. The selected site should not obstruct navigation or traditional uses, and FADs may not be made over underwater cables or pipelines (Montemayor, 1990). FADs made near to a rich natural habitat like a coral reef and seagrass bed may ensure recruitment of fishes and other organisms at an early date.

MODE OF INSTALLATION

A tyre reef module may have a basal area of $3m^3$ with a height of two meters. Individual modules are send down to the desired site along a long shot rope. Concrete modules can also be send down along shot rope and divers can arrange them as per specification. In Kerala large pieces of irregularly shaped granite pieces are simply cast from country crafts into the sea at a depth of twenty to thirty meters and no attempt is made to rearrange them into any specific form. Still, very good catch was reported after a few weeks. In Lakshadweep dead coral rubbles and reef corals are piled up with ample interspaces in shallow lagoon bottom. Payaos may be installed with firm floats and anchors at desired sites with the help of strong nylon ropes.

ECOLOGICAL SUCCESSION

Bacteria, and other microalgae are perhaps the first living organisms to settle on the newly laid artificial structures. Epizoic and epiphytic organisms soon colonise and is to be followed by other marine organisms from the adjacent habitats. The structure and composition of the fauna that may colonise on the ARs and FADs may have great affinity towards the local fauna (Woodhead, *et al.* 1982). Fishes may soon start inhabiting and as the system matures the biodiversity may gradually increase. As pointed by several authors a natural coral reef may harbour several hundred species of fishes depending on the extent of the reef. Representative of several families of demersal and pelagic fin fishes may aggregate on an artificial reef also. The ichthyo fauna of an artificial reef as in the case of a natural reef, may display different types of response to reefs. Some fishes like *Lethrinus* sp. and *Plectorhynchus* sp. may feed from the surrounding sandy area of the reef and may stay there for a while. About 8% of the fish fauna belong to this category, and are called transient species. Many species of fishes are diurnal or nocturnal visitors to reefs for various purposes. These form about 20% of the total species that may be inhabiting on a reef. But a good majority of the reef fishes are resident forms and are permanent occupants of the reef. They guard their territory of feeding and breeding ground and the resident forms may constitute about 64% (Russel, *et al*, 1974). Some of the fishes which swim around the reefs to collect their food but rarely reside on the reef, are called peribions. But large number of species live within the crevices of reef rocks or artificial installation hiding partly or fully and area called *Cryptic*. Seasonal fluctuation is often reflected in fish assemblage of FADs. Parker (1979) observed that in winter there was less species diversity on artificial reefs laid in South Carolina, compared to summer, though the individual size was relatively large. In spring juveniles were more common. As summer approached species diversity increased though there was a relative reduction in the average size compared to winter months. In tropical conditions such variation may not be conspicuous though juvenile recruitment during breeding season may effect size range of specimens.

The most important FADs associated pelagic species that are exploited at present in the Pacific islands are skipjack tunas *(Katsuwonus pelamis)* and yellow fin tunas. *Acanthocybium* spp. and rainbow runner *(Elegatis bipinnulata)* are also fished from FADs (Preston, 1990). In Philippines payao attract juvenile tunas and small pelagic species and it is reported that 90% of the tuna catch from philippines is payao associated (Aprieto, 1990). Artificial reefs of various forms such an cylindrical, cubical, jumbo and turtle shapes are widely used in Korean waters. It is noticed that the cylinder shape attracted armoured Rock-fish, White corvenia, and Flounder (Kim, *et al*, 1994). The turtle shaped blocks attracted saw-edged perch and the Cube shapes attracted the common sea bass. Whereas porgy , Flat fish, Black porgy, Seabass and Yellow tail displayed no distinctive preference for structural designs. (Kim, *et al.* 1994).

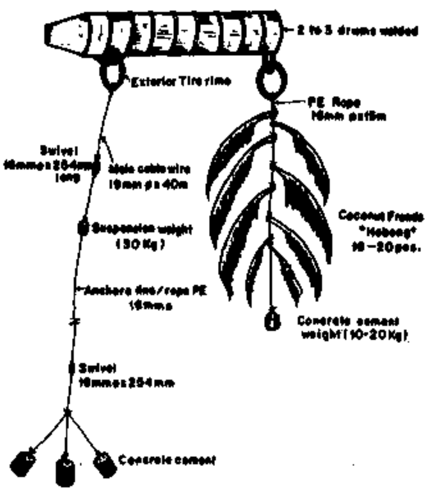
Many types of gears such as hooks and lines, or trolling are used for fishing for FADs. Hand lining is done with live or dead baits in Madagascar. In trolling live baits is found to be effective. Gillnets were tried in an experimental basis in Mauritius but was not effective. In Lakshadweep the fishermen cover the small fish aggregating devices with a castnet and dismantle the rubbles to get the fish entangled in the net.

FADS AND FISH PRODUCTION

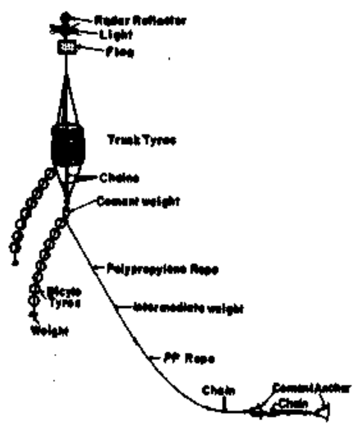
The ability of the FADs of any kind to attract and agreegate fishes from the adjacent zones is undisputably established. The exploited fishery from the FADs are found to be many fold compared to the adjacent areas. An increase in catch from 54 to 150% has been reported at some places (Anon, 1982). However, it is yet to be properly evaluated whether FADs actually increase fish production in nature or only they help drawing fishes from nearby areas providing opportunities for easy catch and perhaps overexploitation. However, several countries have large scale FADs that have enhanced catch. It is possible that these devices simply congregate the resources without increasing the standing stock of an area that could have been produced even without the FADs or ARs. FADs in a way help to draw a resource to a specified site where it was absent due to lack of suitable habitat (Polovina, 1990). In that sense they help increase the biodiversity of the FADs site. In other words FADs help to minimise fishing effort so also to increase catch. Further, they aid the exploitation of a target species. The system is manageable both by traditional fishermen in small scale and also can be operated in a large scale with big funding. As pointed out by Simrad (1990) fish aggregating devices help to transform coastal fisheries from a hunting and collecting" activity to a "breeding and cultivating" activity. If this is so, the system is not only a means to enhance fishcatch but also is a means to augment natural production.

ACKNOWLEDGEMENT

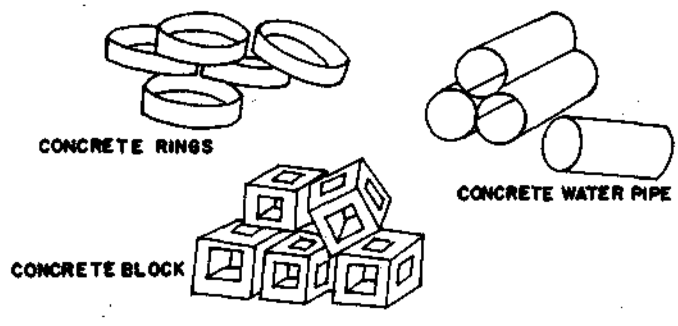
I am thankful to the Director, Central Marine Fisheries Research Institute, Cochin for giving me permission to publish this paper. This paper is the outcome of the encouragement and guidance I received from my course teacher Dr. C.S. Gopinadha Pillai to whom I am immensely grateful.



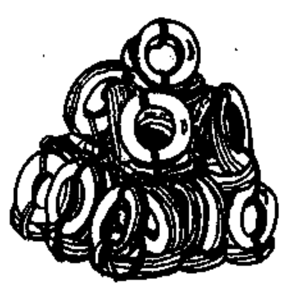
GALVANIZED DRUM PAYAW (After J. Malig et al., 1990)



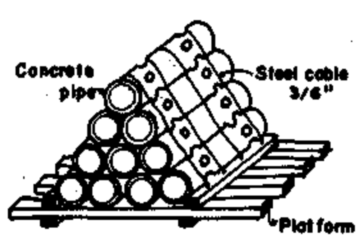
4 TRUCK TYRE TYPE FAD. (After Aleparia, 1990)



Materials used in different modules. (After K. Sinanuwong,1991)



TYRE PYRAMID
(After E. F. H. Wong, 1991)



CYLINDRICAL CONCRETE PIPES/PYRAMID
(After E.F.H.Wong,1991)