FAO Fisheries Report No. 683, Supplement SLAC/FIIT/R683 Suppl.

ISSN 0429-9337

WESTERN CENTRAL ATLANTIC FISHERY COMMISSION

National reports and technical papers presented at the

FIRST MEETING OF THE WECAFC AD HOC WORKING GROUP ON THE DEVELOPMENT OF SUSTAINABLE MOORED FISH AGGREGATING DEVICE FISHING IN THE LESSER ANTILLES

Le Robert, Martinique, 8–11 October 2001

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Island of Curacao FAD programme

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INTRODUCTION

In many countries a large number of people derive either full-time or part-time income from artisanal fisheries. In addition to the fishers themselves, some people market the fish, fishing vessels are built and maintained locally etc. thus adding a considerable multiplier effect. Even though the fisheries sector is seldom of great importance in terms of its contribution to the Gross National Product (GNP), it does have a substantial social impact. In many countries a considerable amount of foreign exchange is being saved which would have had to be spent on food imports. Because of those reasons, efforts to develop fisheries, within the framework of responsible use of existing resources, make economic sense.

The use of FAD can improve the production of artisanal fishers, lowering fuel costs and reducing the time spent loitering at sea looking for fish. The FAD act as a habitat for juvenile fishes which otherwise might have perished and probably have some positive influence on fish production. Nevertheless the enhancement role of FAD is of very limited importance. Basically FAD do not "produce" fish, but only aggregate dispersed fish making it easier to catch them. As with all fishing methods however there are certain drawbacks. There are limitations where FAD can be placed. Conflicts can arise between fishers from competition for space around the FAD and in some area's FAD are known to attract large numbers of juvenile fish, thus creating the problem of over-harvesting a part of the population which has not yet reached its reproductive potential.

Design Parameters

In Curacao FAD have been in use since 1993. During these years several somewhat different FAD have evolved, which however all have the same basic design. Key elements of this design are the following:

- Use of a spar buoy. A spar buoy design is well suited to waters with short-length, choppy waves. Use of a sparbuoy design, with constant tension on the moving chain will avoid slamming and jerking of the surface buoy.

Such a buoy can withstand fairly rough weather although may be not a full-blown hurricane passing directly overhead. With a spar buoy design all the loads can be transmitted via the nose cone to the centre-pole (a three-chain bridle can be avoided). The buoy can move up and down in the water and adjust to changing loads more gradually than a flat cylinder buoy. When properly ballasted with chain as external load, the buoys have a very seaworthy motion. Even in choppy waters, the spar buoy type float will dampen motions and will not jerk or slam like a flat tyre-type buoy.

Divers on a spar buoy type FAD used in Curacao confirmed this through observations. The spar buoy was able to withstand periods with very rough seas; we believe that the fact that this type of design was used is a decisive factor in determining the survival of these buoys in the open seas. In areas with short waves such as the Caribbean the spar buoy has an obvious advantage, which may be less pronounced in areas with long waves. Nevertheless in areas with long waves short waves are often superimposed on the long waves, especially during periods of bad weather. In such conditions a spar buoy design could hold a decisive advantage. One of the disadvantages of a spar-buoy design is that quite some ballast is needed. Using the mooring chain as ballast can reduce this need for ballast. The chain acts as external ballast and is more effective in keeping the buoy upright than the internal ballast since it is attached at the end of the centre-pole, which works as a lever. The internal ballast can thus be reduced somewhat, making it easier to tow the buoy behind the ship in a horizontal position and leaving more reserve buoyancy since the buoy can be kept fully upright with less total ballast.

There is only one mainline, attached to a single chain, a three-way bridle is avoided. Liberal use of sacrificial anodes (at least 3 anodes of 2 kg or 2,5 kg each), and maintenance to replace these anodes about once every 1,5 years.

Use of buoys with submersible top-lights.

There are many advantages if the surface buoy can be completely submersible. Such a buoy can be towed behind the vessel. When the buoy is launched the vessel will only have to carry the anchor and mooring lines. Most top-lights with solar panels and battery boxes are not submersible. If such a light is attached to the buoy this will greatly complicate the deployment of the buoys. In areas with choppy waves it is next to impossible to attach a light, solar panel and battery box to the unit when it is already moored in the water. The solution is to either using a fully submersible top-light with solar panel and battery in a plastic unit or not to use a top-light at all.

The use of a short anchor chain, with depth buoys, that does not touch bottom.

A one-piece inverted mushroom anchor, a heavy iron block and a one-piece concrete and iron block was used. The anchor is constructed as a low box (0,5 x 1 x 1 m^3) made of steel plates, which are filled, with concrete (approx.1 550 kg: 400 kg of steel, 1 150 kg of concrete). A reinforcement mat can also used. If the concrete cracks from the impact of the anchor hitting the bottom, the concrete would still be contained in the steel box and the structural integrity of the anchor would be maintained. The bottom side of the anchor is provided with two 2" (5.08 cm) U beams to increase grip on the substrate and to prevent the anchor from sliding

Having ample reserve buoyancy

The strength of the currents had originally been underestimated and this has been one of the main problems encountered. In view of the strength of the current in Curacao the maximum mooring depth for the deepwater FAD with the MKII surface buoy should probably be limited to around 600 meters. Under such conditions and with some maintenance a lifetime of three years or more for each FAD can be realised.

Use of nylon strands as underwater attractors

The ideal underwater attractor should provide a sizeable shelter structure while minimizing drag. Its durability and drag characteristics are very important. A main problem is that, while they can hold out for a considerable time in calm or moderate seas, most underwater attractors do not last very long in rough seas. Plastic fibres can be used which are enmeshed in the mooring chain or mooring line of the FAD. In the newer Curacao FAD, strands made of 14 mm nylon rope, which were fastened to the mooring chain, were used. Up to now these have outlasted all previous underwater attractors, which were tested

Deployment

To deploy a medium or Deepwater FAD a fairly accurate estimate of depth is needed. In some areas where accurate nautical maps exist and depth contours are far apart, which is the case where a broad underwater shelf exists, the use of an echo-sounder is less critical and the depth could be taken from the map, using one's position. In areas with a sloping bottom topography the nautical maps give depth contours which have been extrapolated from a grid of fairly dispersed readings, and thus cannot be relied upon for the precise positioning of a Deepwater FAD. It is necessary to adjust or correct for variations in sound velocity. When launching the buoys two vessels were used. One served as the launching vessel and the other as marker vessel. The "anchor last" method was used. The techniques for deployment of the FAD and calibration of the echo sounder were extensively described in earlier papers (van Buurt 1995, 1999).

Main Problem Encountered

The strength of the currents was initially underestimated. On some days with strong currents the MKI buoys which were first used were leaving a wake and if approached by boat it would seem as if they were slowly moving ahead under power. On such days the buoy would be drawn down considerably and waves would sometimes wash over the top cover. In Curacao the Curacao Port Authority measures currents at the South coast near the harbour entrance. Current meters are situated at a depth of 5 and 10 m below the surface and are attached to a platform, which stands in 12 m of water. A mean current value of 0,5 knots is recorded with maximum values up to 2,5 knots. Almost every year there will be some days when the strength of the current ranges from 2 to 2,4 knots. About once every two or three years the current will be above 2,4 knots. Usually this will last for only a few hours. Once a current of 2,6 knots was recorded.

Further out from the coast a mean current of about 1-1.5 knots flowing W-NW is usually encountered. It is not known how the strength of this current is related to the current measured at the harbour entrance. We now assume that in the areas where our FAD are moored a 2,7 knots (approx. 1,35 m/s) surface current can be reached, if only for a few hours once every two or three years. We also assume that this current will affect the whole layer of surface water above the thermocline, say the upper 150 m of depth. During any year there will be currents of about 2,4 knots (approx. 1,2 m/s). It could very well be that currents in Curacao could be much stronger, if only for a short peak period of time, than anything similar FAD would have encountered out in the open sea near oceanic islands in the Indo-Pacific. This observation draws us back to the observation in the 1984 South Pacific Commission Handbook on deep-water FAD (Boy, R.L. and Smith, B.R, 1984). The handbook stated that "the passage of typhoons in the Pacific Area has been a major problem - making it difficult to achieve the goal of developing permanent deepwater FAD". According to the handbook even the best designs do not fare too well when a typhoon passes. When a typhoon passes short wavelength and choppy waves are suddenly superimposed on the long-waves.

It is also likely that a passing hurricane or typhoon can generate surface currents of abnormal strength, if only for a relatively short period of time. Several of the designs discussed in the SPC handbook and also those in the later (1996) Vol II of the Manual (Gates, P.D., Cusack, P., and Watt, P., 1999) would certainly have insufficient reserve buoyancy for the Curacao environment. They would probably not be expected to last more than a few months at most, probably less, in our waters. The Curacao MKII design has more than twice the reserve buoyancy of some of the pacific designs that are moored in waters of 1500 - 2000 m depth. We now do not moor buoys in waters exceeding 600 m depth anymore and this decision seems to work well. The strength of the currents has originally been underestimated and this has been the main problem encountered. We have estimated that under such conditions and with some maintenance a lifetime of three years or more for each FAD can probably be realised.

Once a cylindrical buoy is drawn below the surface, the drag increases and the hydrodynamic forces will usually pull it down to its collapsing depth (communication by M.Taquet). Thus usually the buoy will not resurface. It is thus important to moor the buoys at such a maximum depth that it is unlikely that currents could ever pull them down.

It should be possible to calculate the maximum mooring depth for each type of FAD at the maximum current strength that can occur at a given site over say a five-year period. Each FAD can than be "rated" to a certain maximum depth, and one would make sure not to moor the FAD any deeper. In practice however it is difficult to do this. Too many assumptions are involved; such as the exact maximum current strength, the current strength with depth and the actual drag of the surface buoy and its mooring chain. Even though computer simulations cannot thus be used to determine a precise maximum mooring depth "rating", they are nevertheless very useful since they do give a basic idea of the operating limits of the FAD.

Economics

There are few detailed discussions on the economic performance of FAD. Usually there are not sufficient data available to justify a detailed discussion of economic performance. Economists are trained to always ask questions on economic performance. Those who have to fund projects want to arrive at estimates of economic performance even when crucial data are not available. The idea is that an estimate, of certain parameters (cq. which is an educated guess) can nevertheless help to give a basic idea of the margins within which economic performance must lie. The problem with this approach, which is quite sensible in itself, is that it is often carried to ridiculous extremes. Estimates which one is forced to give in order not to be deemed uncooperative, turn up as fixed reference points in reports by others 20 years later. Although the early experimental stage is now over, FAD design and techniques are still being developed. It is very difficult to apply economic analysis to a programme that is still to a large extent experimental. Since the effectiveness of FAD depends to a large extent on their location it is very difficult to measure economic performance, and the catch capacity of different designs. It will be possible to measure performance of a system of FAD once the optimum locations have been determined. Once a FAD programme in a particular area reaches a mature stage. Economic performance depends, among others, on the following factors:

Location

The location of a FAD is very important. The FAD should be placed in an area where fish are known to occur. A FAD cannot aggregate fish if these fish are not present. A deepwater FAD should be situated in an area where migrating pelagics are known to pass.

Catches Around FAD

For a proper evaluation of the effectiveness of FAD monitoring of catches is necessary. Accurate catch and effort data around FAD are often lacking. Then to be able to make a meaningful comparison it is also necessary to have a basic idea of catches before the FAD were installed. One of the main problems with FAD used in artisanal fisheries is that it is usually quite costly to collect such data. In the Caribbean Ifremer in Martinique (Battagglia, A., Lagin, A., Reynal, L., 1991) and Guadeloupe (Lagin, A., Ledouble, O., Reynal, L. 1993) made the most extensive studies in this field. In St. Kitts and Nevis, Goodwin (1986) collected data on the performance of FAD. Feigenbaum *et al* collected data around a FAD in Puerto Rico. These studies all indicated that the FAD does increase catches significantly. Another problem is that even if catch data are collected at considerable costs, they may not give a good idea of actual economic performance possibilities unless the FAD programme has already matured; that is unless FAD are moored in the right locations and a suitable design is used.

Costs Versus Longevity

The ratio of costs vs. longevity of a FAD is one of the most important economic factors, once we assume that a suitable location has been found. On one hand we have the costs of construction, deployment and maintenance on the other hand the expected longevity. The longevity will also depend on the depth at which the FAD is moored. The cost of deployment would depend in a large measure on the price of the vessel used. The weight of the FAD and its anchor will influence the size of the vessel needed and thus the deployment costs.

New Developments

Five new MKII FAD and two 5 m PVC FAD have been under construction since 1998 and are now almost finished. Due to financial and organisational difficulties as a result of the severe economic crisis on the island and IMF imposed measures there have been numerous delays in constructing these buoys. The project was based on matching funds and due to some of the budget cuts, some of these matching funds were not available anymore, leaving us saddled with half finished buoys.

The Curacao FAD programme will now be extended to the islands of Aruba and Bonaire. Funds from the sale of the Marcultura aquaculture facilities in Bonaire will be used to pay for this new FAD program. The Marcultura facilities were privatised, these were owned by the Marcultura foundation in which the three islands of Aruba, Curacao and Bonaire participate. To avoid endless delays in constructing the buoys ourselves, which we have experienced in the past, buoys will be bought in the Netherlands, completely finished, made to our specifications. 12 additional buoys will be constructed (four for each island). Even so it has been difficult to find anyone interested to construct just a few buoys. The new buoys will be made of stainless steel 216-L.

References

Battagglia, A., Lagin, A., Reynal, L., 1991. Implantation de dispositifs concentrateurs de poissons en Martinique. Premiers resultats obtenus et objectifs pour 1991. IFREMER, Martinique.

Boy, R.L and Smith, B.R., 1984. Design improvements to Fish Aggregation Device (FAD) Mooring Systems in General Use in Pacific Island Countries. South Pacific Commission, Noumea, New Caledonia.

Feigenbaum, D., Friedlander, A. and Bushing, M., 1989. Determination of the Feasibility of Fish Attracting Devices for Enhancing Fisheries in Puerto Rico. Bull. Mar. Sci. 44(2): 950-959.

Gates, P.D., Cusack, P., Watt, P., 1996. South Pacific Commission Fish Aggregating Device (FAD) Manual. Vol.II Rigging Deep-water FAD Moorings, South Pacific Commission, Noumea, New Caledonia.

Goodwin, M.H., 1986. Evaluation of Fisheries Enhancement Technology for the Eastern Caribbean. Report to USAID Regional Development Office/Caribbean Grant No 538-000

Lagin, A., Ledouble, O., Reynal, L. 1993. Les DCP en Guadeloupe, Premières données, IFREMER, Martinique.

van Buurt, G., 1995 - The Construction and Deployment of Deepwater Fish Aggregating Devices in Curacao. FAO Regional Office for Latin America and the Caribbean, RLAC/95/14-PES-25, Santiago, Chile.

van Buurt, G., 1999 - Implementation of an ongoing FAD programme in Curacao (Netherlands Antilles) during the period 1993-2000.
In: Pêche thonière et dispositifs de concentration de poissons. Ifremer, Actes de Colloques, 28, pp.230-249 Colloque Caraïbe- Martinique, Trois-îlets, 15-19 Octobre 1999.

van Buurt, G., The Construction and Deployment of Deepwater Fish Aggregating Devices in Curacao. FAO regional Office for Latin America and the Caribbean, RLAC/95/14-PES-25, Santiago de Chile, Chile, 1995.