National report of Saint Vincent and Grenadines: fish aggregating device development in Saint Vincent and the Grenadines

by
Shermine Glynn

1. BACKGROUND

In Saint Vincent and the Grenadines, the major fishing activity done by fisherman is line fishing. Trolling, which is done during the months of January to August, is the predominate type of line fishing practised by many of the fishers. This fishing method is employed in order to catch large pelagic species including wahoo, dolphinfish and tunas such as skipjack, yellowfin tuna and blackfin tuna.

Saint Vincent and the Grenadines does not have a long history of FADs deployment. This was first attempted during the early 1990s off the southeastern waters of Saint Vincent. Unfortunately, bad weather and rough seas destroyed these very soon after deployment. It is also suspected that they were cut loose by fishers who were entangled in the mooring ropes of the FADs. In December of 1997, one bamboo FAD was introduced and deployed after consultation with fishers. It was deployed at Latitude 12º 51’ 45” and Longitude 61º 03’15”, approximately 5 nautical miles east of Batowia, at a depth of 50 meters. This new FAD was destroyed after one month of deployment. However, it was proved very successful despite the short life span. One fisher reported that he caught over 690 lbs of fish in one week of fishing around the FAD.

2. OBJECTIVES OF FAD INTRODUCTION

1) To inform fishers of the benefits and proper use of FADs.
2) To demonstrate to fishers how to fish around FADs to yield maximum production.
3) To increase the fishing efficiency of fishers.
4) To increase fish landings.
5) To reduce fuel consumption and the search time of fishing trips so that fishers can land fresher fish.

3. ACTIVITIES

The following activities will be carried out as part of the implementation of the FAD development in Saint Vincent.

3.1 Consultations

These are planned workshops for the fishers. Prior to the re-introduction of FADs, the Fisheries Division will be conducting a series of consultations in the fishing communities of Kingstown Clare Valley, Calliaqua and Barrouallie. These communities have been chosen because most of the fishers who fish for the off shore pelagics live in and operate from these areas.

During the consultations, the following topics will be introduced to the fishers and users of these FADs:

1. fish behavioural pattern;
2. the maintenance and the wear and tear limits of FADs;
3. the management of FADs; and
4. the role of fishers in protecting and managing FADs.

A full understanding of the gear and its performance will lead to a higher catching efficiency, thus increasing fisher’s income.

Budget for consultations

Poster	50 copies	$ 850.00
Pamphlet	150 copies	$2 550.00
Colour ink cartridge	1	$ 180.00
Black ink cartridge	1	$ 190.00
Blue stick	2	$ 20.00
Ream of paper	2	$ 40.00
Printer ink cartridge	1	$ 170.00
Refreshment	60 persons @$12.00	$ 720.00
Venue (Kingstown, Calliaqua, Clare Valley and Barrouallie	4	$ 800.00
Total		$5 520.00

3.2 FAD construction

3.2.1 Construction for spar buoy FAD

The main features of the design are as follows: the use of a spar buoy design with constant tension of the mooring system to avoid slamming and jerking of the surface buoy; liberal use of sacrificial anodes, and maintenance to replace these anodes about once a year; the use of a short anchor chain with depth buoys that do not touch bottom; and a one-piece inverted mushroom anchor. With the spar surface buoy, reserve buoyancy of approximately 800 kg is obtained however, if a chain - as external ballast - is used, about 610 kg of net buoyancy remains.

A spar buoy design is well suited for water with short-length, choppy waves. Such a buoy can be constructed for a reasonable price and can withstand fairly rough weather though not a full hurricane. With a spar buoy design all the loads can be transmitted via the nose cone to the center pole. The buoy will be able to move up and down in the water and adjust to changing loads more gradually than a flat cylinder buoy (see Figure 1).

When properly ballast with chain as external load, the buoy is expected to have a very sea friendly motion. Even in choppy seas, the spar buoy type float will reduce motion and will not jerk or slam, like a flat buoy. The spar buoy would be able to withstand periods of very rough seas. In areas with short waves, the span buoy has obvious advantages, which may be less in areas with long waves, especially during periods of bad weather. In such conditions, a spar buoy design could have a definite advantage.

In Saint Vincent and the Grenadines, it is the intention of the Fisheries Division to construct FADs from materials that are easy to obtain as this will help to reduce costs. A condemned, 45.5 kg gas cylinder with alteration will be used for the spar buoy because it is cheap and readily available.

3.2.2 Mooring system

The life span of FAD is determined mainly by the mooring system. A mooring line with a minimum diameter of about 20 mm should be used for FAD deployment. The strength of such a thick mooring line is not primarily needed to hold the surface buoy but to give protection against fish bites and to help withstand illegal mooring by fishers. The diameter and length of the mooring lines, along with the strength of the prevailing currents, will in turn determine a large part of the total drag. Thus, this will determine the minimum size of surface buoy needed, the reserve buoyancy and the weight of the anchor.

Each end of the mooring line will be attached to 25 m of chain. The surface mooring chain will act as deterrent to fishermen intending to cut away the buoy because a diver would have to dive approximately 25 m in open water to get the rope to cut it. This upper chain will also act as external ballast since it is attached to the end of the center-pole. The pole will function as a lever.

3.2.3 Anchor

Concrete blocks will be used to anchor the FAD. The weight of the anchor should equal twice the reserve buoyancy of the surface buoy. The holding power of block is about half its (submerged) weight. If the buoy were dragged below the surface by strong currents, the anchor is expected to hold the FAD in place. The anchor should not be excessively heavy since this will increase the cost and make it difficult to transport and handle when mooring the FAD.

A heavy block will be used as the inverted mushroom anchor (a one-piece concrete and iron block). The anchor will be approximately 1 200 kg and will be constructed as a low box (0.4 x 1 x 1 $m^{3)}$ made of steel plates (see Figure 2) which will be filled with concrete and steel (340 kg of steel, 900 kgs of concrete). A reinforcement mat will be used. If the concrete cracks from the impact of the anchor hitting the bottom, the concrete will still be in tact in the steel box and the structural integrity of the anchor will be maintained. The bottom side of the anchor will be fitted with 2" (5.08 cm) "U" beams to increase grip on the substrate and to prevent the anchor from sliding on the bottom.

The construction work will be done in the Fisheries Division's yard. The welding of the anchor box will be done at the Saint Vincent and the Grenadines Technical College. The material needed for the construction can be easily sourced from any hardware store.

3.2.4 Materials for FAD Construction

MATERIAL	QUANTITY	UNIT COST ($)	TOTAL ($)
Radar reflector	1 pc		
Light (solar Power)	1 pc		
Flag	1 pc		
Galvanize pipe ½"ø	1 pc		38.00
Cylinder	1 pc		
Cement	5 pcs	13.50	67.00
Shackles ½"ø (stainless steel)	3 pcs	55.00	165.00
Swivels ½" ø (stainless steel)	5 pcs	63.00	315.00
Chain ½" ø	50m	18.00	3060.00
Stainless steel cable ½"ø	100m		
Steel plate sheet ¼" ø	1 sheet		278.00
Mid water buoy	1pc		
Small mushroom	1pc		
Anchor			
3-m marine adhesive sealant 5200	1pc		41.75
HDPU foam filling	1gal		282.78
Welding rod	2 doz	5.00	120.00
Anodes	4 pc	24.43	97.72
Hacksaw blades	1pk	1.50	18.00
Paint ½ gall	5 tins	45.68	228.40
Total			**4,711.65**

3.3 Deployment of FAD

The shelf east of Battowia extends for about 5 nautical miles at a relatively constant depth of 50 meters. It drops off steeply after this point. Then there is a gentle slope of about 2.4 miles from 100–500 m water depths. The sea currents in this area generally move towards land going from east to west. If the anchor should drag, then theoretically, the FAD should move towards land and to reduced depth. The FAD will be deployed at approximately 12ºN and 61º W, about 5.1 nautical miles north east of Battowia, at a depth 100 of meters.

The FAD will be placed in this area for several reasons:

– The FAD being set not on deep water, the current effect on the FAD is expected to be limited because the mooring line is relatively short.

Although this area is relatively shallow there is an abundance of migratory fishes, and so is a prime fishing area for trollers. In addition, this area is easily accessed by the fishers since they go past it en route to traditional fishing grounds.

– Deploying in this area, should reduced the amount of material used for mooring, and thus reduce costs.

4. BUDGET

ACTIVITY	COST
Consultation	$ 5 420.00
Material for FADs Construction	$ 4 711.65
Deployment of FADs	$ 1 650.00
Total	$11 781.65

5. EXPECTED OUTPUTS

1. Fishing landings will increase.
2. Better economic returns for fishers.
3. Increase in revenue.
4. Improve standard of living for fishers and their families.
5. Fisheries staff and fishers trained in the construction and deployment of FADs.

Fig.2 Improved Bamboo FAD, Type-1 (St. Vincent and the Grenadines)

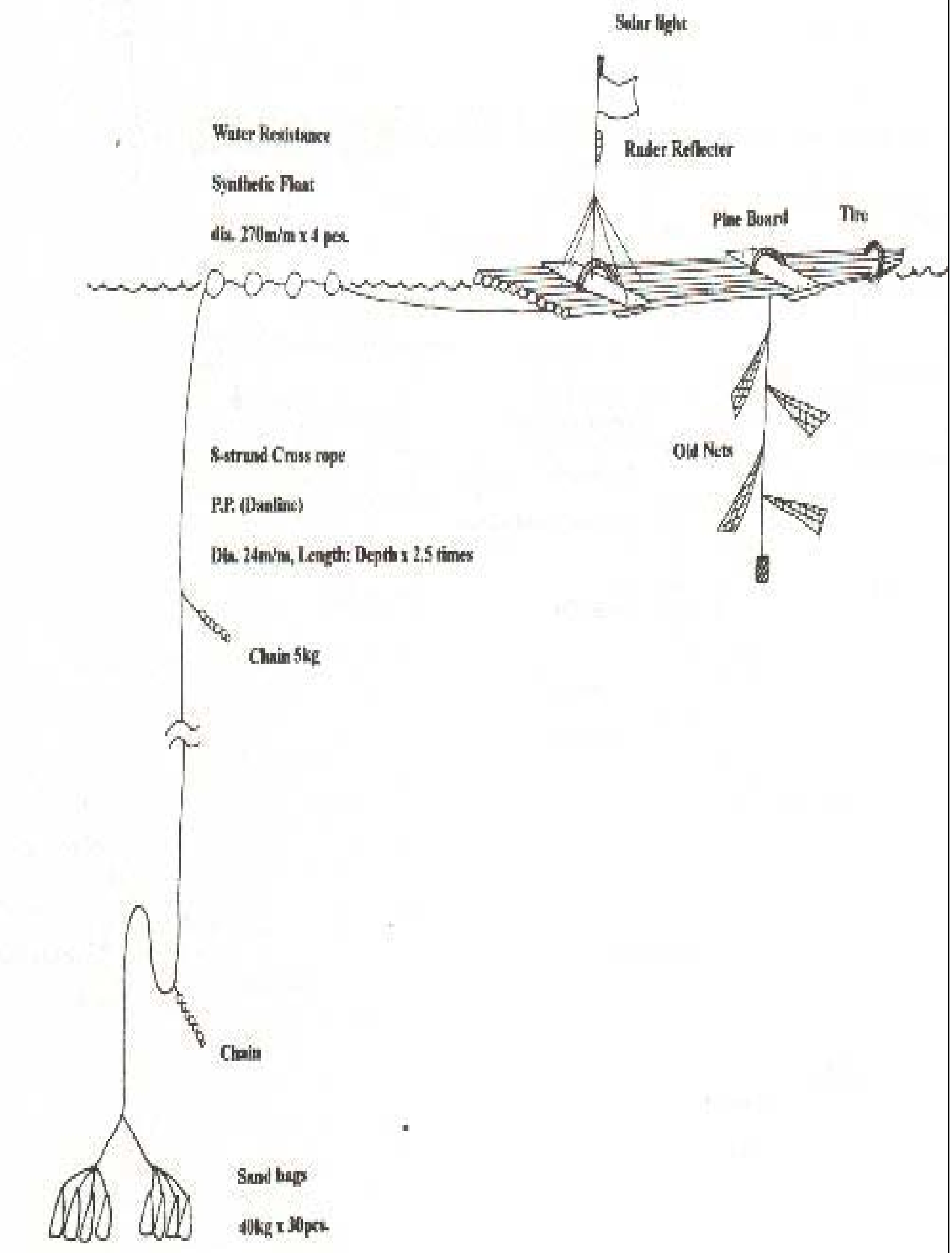


Figure 2 – Improved Bamboo FAD, Type-1 (Saint Vincent and the Grenadines)

National report of Trinidad and Tobago: Summary on site selection, design and mooring of fish aggregating devices

by
Harnarine Lalla

1. INTRODUCTION

Fish Aggregating Devices (FADs) have been traditionally used in the capture of flying fish in Tobago. The flyingfish (*Hirundichthys* spp.) are attracted to rafts of coconut branches, commonly called screeders. A number of other species are exploited which are associated with flyingfish aggregations and may include: dolphin fish (*Coryphaena hippurus*), kingfishes (*Scomberomorus* spp.), wahoo (*Acanthocybium* spp.) billfishes (*Isliophoridae*), tunas *(Thunnus* spp.) and others.

Moored FAD fishing trials were conducted in Tobago in 1999 by the Caribbean Fisheries Training and Development Institute (CFTDI), of the Fisheries Division (Ministry of Agriculture, Land and Marine Resources) and the Japan International Cooperation Agency (JICA). Three bamboo FADs were deployed in 1999. Results in terms of ease of capture and number of fish caught appeared from all reports highly encouraging but fishermen were not forthcoming with information. They were apparently very sceptical of what the information would be used for despite being coaxed and given prepared forms to fill out and return to Fisheries personnel. This would have greatly assisted in ascertaining maintenance regimes, efficiency and effectiveness of the FADs. Partly because of this "non-cooperation" and other commitments, no other FADs were deployed. The three bamboo FADs eventually deteriorated and were not replaced.

Other deployments have been done as part of the Regional Technical Cooperation Promotion Programme (RTCPP) conducted by CFTDI and JICA. These fisheries training programmes are conducted annually in Trinidad and involve participants from other Caribbean countries.

From recommendations made after attendance of the first Lesser Antilles meeting on the Sustainable Development of Moored FAD fisheries held in Martinique, October 8–12 2001, there was renewed interest in moored FAD fishing in Trinidad and Tobago.

FAD fishing development formed a part of the work programme of CFTDI and in conjunction with JICA, (under the Project for the Promotion of Sustainable Utilisation of Marine Resources), the Department of Fisheries and Marine Affairs (Tobago House of Assembly) and the Fisheries Division of Trinidad initiated an experimental moored FAD fishing programme in Tobago and, in 2002, ten FADs were deployed at two sites in Tobago waters. Very little monitoring was carried out. Some of these were of bamboo and some were of the Macintosh type (made of nylon filament and plastic buoys).

In 2003, eleven FADs were deployed at two (2) sites in Tobago waters (Figure 1). This forms part of an experimental moored FAD fishing project. Monitoring and evaluation is ongoing.

The experimental status will be maintained until guidelines, policies and legal instruments can be developed which will be used to manage FAD fishing.

2. MOORING OF FADs OFF TOBAGO

The sites chosen were East and West of Tobago where sea conditions are different with the West being calmer than the East. These sites are relatively close to communities where fishers, who are interested in FAD fishing, reside. The distance from the coastline of the nearest FAD is approximately 2.5 nautical miles (Figure 1).

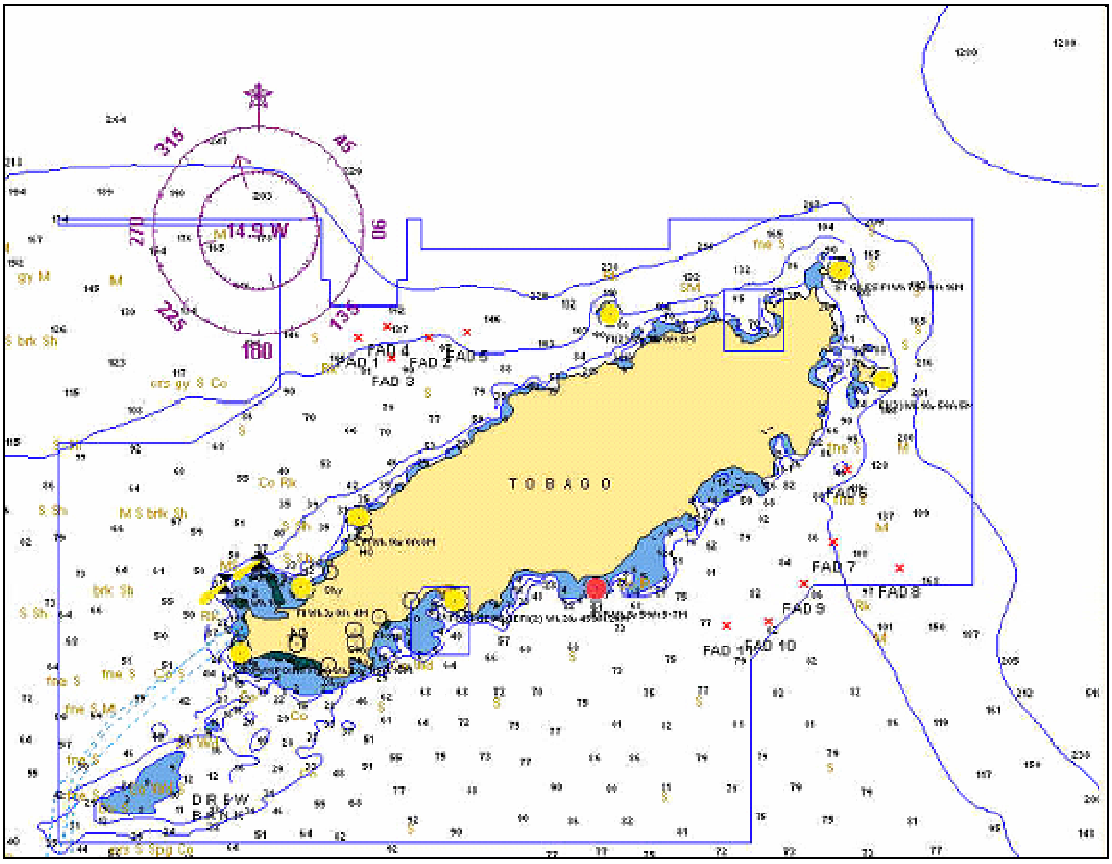


Figure 1: FAD positions.

The prevailing current on the Eastern side of the Tobago is stronger (averaging 4 knots) than on the West Side (averaging 2 knots). Use of the area with the FADs by fishers has increased, with some of the fishermen conducting their activities exclusively around the FADs. Maintenance of the FADs is done on a weekly basis following observations from fisheries personnel or reports by fishermen.

Three types of FADs have been deployed: bamboo type; boif flor (*Ochroma pyramidale)*, a lightweight buoyant wood type; plastic buoy type.

Six, made of bamboo, were moored on the East Coast and five on the West Coast, two made of bamboo, two made of boif flor and one of the plastic buoy.

Fish are known to pass in these areas and it is expected that the mooring of FADs in these locations would serve to concentrate them so that fishers could save costs and time in locating fish in a predetermined fishing area. At this stage, the project is not expected to extend fishing zones or intensify fishing effort but merely to provide an alternate fishing methodology.

First experiences show that fishing is better if FADs are deployed in groups of 3 or 4 approximately 3 nautical miles apart.

3. MOORING OF FADs OFF TRINIDAD

A moored FAD fishing project had been envisaged for Trinidad but only the North Coast would have been suitable and even then there may have been conflicts with the net fishers as their nets would become entangled with the anchor lines of the FADs. The distance to the Venezuelan coastline on the South and West of Trinidad average only three nautical miles, whilst the East coast is occupied by oil installations and the sea space is heavily traversed by oil service vessels and exploratory activities.

The FADs have been anchored off Trinidad at a depth of approximately 100 metres on substrate consisting of a combination of rock, sand and mud. Only flags have been used as markers. Radar reflectors have not been used since the area is traversed by fishing vessels and not larger ocean going craft so chances of accidents involving the FADs and vessels are minimal.

National report of Aruba, Curaçao, Bonaire 1993–2004

by
Gerard van Buurt

1. INTRODUCTION

The first FAD in the Netherlands Antilles was deployed on 9 March 1993 in Curaçao. In June, 2002 the programme was extended to Bonaire and in December, 2002 to Aruba. The Curaçao programme has been described in considerable technical detail in earlier publications: Buurt, G. van, 1995, 2000 and 2002. During the years, three basic designs of surface buoys have been tested.

2. EXPERIENCES WITH FADs

2.1 Currents

The strength of the currents has originally been underestimated and this has been one of the main problems encountered. These strong currents are probably caused by the fact that the large mass of water moving to the west between the islands and the Venezuelan coast is gradually being forced to flow through a narrower cross section. The GRP MKII design has more than twice the reserve buoyancy of some of the Pacific designs that are moored in waters of 1 500–2 000 m depth (using a similar mooring system). We now do not moor these buoys in waters exceeding 600 m depth anymore and this decision seems to work out well. When the program was extended to Aruba, this was done with the expectation of encountering currents of similar strength to the ones in Curaçao. This expectation proved to be wrong, the currents in some locations turned out to be stronger than in Curaçao and seem to run deeper, not diminishing much in strength with depth and probably maintaining their full strength almost to the bottom. The mass of water going West suddenly encounters the continental plateau between Aruba and Venezuela and moves over it, going West, causing very strong currents in an east to west ”channel” south of Aruba. As a result even though the mooring depth of the FADs around Aruba is much less, plenty of reserve buoyancy and a heavy anchor (1 200–1 500 kg) are still needed. In Aruba a somewhat lighter anchor of around 900 kg instead of 1 200 kg was used in all but the last FAD. In view of the much shallower mooring depths, this turns out to have been a mayor mistake, 900 kg being insufficient.

2.2 Buoys

MKII buoys

Although the design of the GRP MKII buoys was functioning very well we had to build these buoys ourselves and this was taking much too long. Nowadays modern management philosophies consider that it is not a task of government or government departments like ours, to build things like buoys themselves and that this task should be outsourced and done by outside contractors. A number of MKII buoys were built for us by an outside contractor. However, it took almost as long to build as ours and the experience shows that the buoys we built ourselves were of much better quality.

Used at the beginning of the programme, the buoys manufactured by an outside contractor turned out with experiences to have serious defects. A surface buoy of FAD GRP9 that had been moored at Boca Spelonk in Bonaire broke loose. It turned out that the lower mast gave way because of corrosion caused by welding a normal steel internal anchoring rod to the Stainless steel mast where, of course, Stainless steel should also have been used. This also turned out to be the case in another series of 4 MKII surface buoy constructed by this contractor and could very well have been a cause of failure of FAD GRP7 as well. The surface buoy GRP9 was recovered and repaired, as was the case with the surface buoy that had not yet been used. It also turned out that the contractor did not use a flexible sealing compound where the mast enters and exits the GRP body of the buoy. This was probably the cause of some leakage that in turn caused the corrosion mentioned above in the first place. In the first MKI buoys we had many problems with leakage, which were solved by using the flexible sealing compound in the MKII buoys. Not using the flexible compound was thus a very frustrating throwback to an earlier stage of the programme, completely disregarding a lesson already learned at great expense of money and effort. Later, because of the previously mentioned defects and late delivery by the contractor, alternatives were explored.

PVC buoys

We decided to build two cylindrical, PVC FADs. A 3 m and a 5 m model were built using 50 cm diameter PVC standard pipe. These buoys were much cheaper and also much easier to construct than the MKII or RVS buoys. Since PVC is not as strong as GRP the intention was to use these buoys in less exposed areas and shallower mooring depths. The 3 m PVC buoy was lost after 582 days (260 m mooring depth), but its loss was clearly related to very rough sea conditions caused by hurricane Lenny. This FAD disappeared 3 weeks after these rough sea conditions; it survived the waves, but was probably weakened by it. The anchor may have been pulled to deeper water nearby, by strong currents coming from a direction different from normal. In any case the cause of its disappearance did not seem to be related to the buoy. The 5 m PVC buoy lasted 322 days (350 m mooring depth) and the buoy was seen drifting away. The cause of failure of this FAD was thus not related to the surface buoy. Because of the strength of the currents we instinctively tended to shy away a bit from the use of PVC buoys. However, the results obtained with these two buoys were not too bad and indicated that in view of their much lower price maybe this aspect of the programme should get more attention and that these PVC buoys could be a viable alternative to more expensive GRP or RVS buoys in less exposed areas and at shallower mooring depths.

Cylindrical RVS (stainless steelbuoys)

It was decided to have a contractor in the Netherlands built 13 Cylindrical buoys made of Stainless steel (we call them RVS buoys, which is an abbreviation of Roest Vrij Staal, which means stainless steel in Dutch). The buoys were paid for by the Marcultura foundation. The buoys arrived in due course. One was deployed near Westpunt/Playa Kalki, Curaçao.

During the next week we went to Bonaire with the M/V Mermaid to deploy four FADs in Bonaire. While deploying the buoys it turned out that the radar reflectors were to large and heavy and that the buoys were catching too much wind, thus necessitating lots of extra ballast. Extra chain was bought in Bonaire and these problems were solved. Then disaster struck.

On the day before the last day of the work in Bonaire news came in from Curaçao that the Westpunt/Playa Kalki buoy had disappeared, Next day the last FAD was placed West of Klein Bonaire. All in all five buoys (one in Westpunt and four on Bonaire were lost between 4 and 11 days of their deployment). Luckily one buoy was recovered. The (thick-walled) lower mast was broken off, at the junction with the cylinder. According to the manufacturer his calculations showed that a force of at least 20 tonnes is needed to break the mast. The failures were probably caused by metal fatigue caused by resonance. The lower mast, of the remaining buoys, was strengthened with baffles. After this we had no more buoy failures. If this type of buoy is built with a larger diameter mast, going through the buoy and if the lower mast is supported by baffles, it would certainly be a very sturdy, fully leak-proof buoy. Alternatively, the upper mast could retain the original diameter but with a smaller and lighter radar reflector. However the cylindrical buoys catch more wind and need more external ballast than expected to keep them upright, which adds to cost and reduces reserve buoyancy.

The need for more expensive chain as external ballast and the reduced reserve buoyancy as a result of this extra ballast reduces most of the advantages that this cylindrical design theoretically has compared to the MKII design. With the added costs of extra ballast chain and the costs of strengthening the lower mast, these buoys turned out to be not much cheaper than the MKII buoys after all, as originally expected. The MKII buoys have more seakindly behaviour, riding the waves in a more "relaxed” way. On the other hand the RVS buoys are absolutely leak-proof.

2.3 Data for catches around FADs

There are not enough catch data available to properly evaluate the functioning of the FADs and the different locations at which they are/were deployed. Although otherwise the level of cooperation is good, fishers do not co-operate very well in providing catch data. This may be primarily due to a fear of competition and to a lesser extent fear of tax inspectors. Sometimes this lack of cooperation may also be to camouflage ignorance. The level of cooperation in Aruba and Bonaire in this respect seems somewhat better than in Curaçao; this could be related to lower levels of competition between fishers on these islands.

This lack of data is now the Achilles heel of the project. Considerable money and effort has been and is being expended on this FAD programme, with clear documentable results only available for the technical aspects but not for the effectiveness of the FADs. We have some indications that locations are best but it is not possible to evaluate the different locations in an objective manner. The evaluation is based on fairly subjective tid-bits of information. Now that the programme has to some extent outgrown its experimental phase, it is necessary that a much better view of its effectiveness be obtained.

It seems that some of the earlier FADs attracted more fish than some of the newer ones in the same locations and in the case of the very long-lived FAD that lasted for 1 584 days it seems that it attracted more fish during its early years. Catches of both pelagics and demersals have declined, especially during the last three years and if fewer fish swim around, then of course the FADs can attract less fish. It is also quite probable that now the FADs are not a new phenomenon anymore, this has tended to reduce reporting of catches around FADs. Nevertheless there has almost certainly been a real decline. The decline in the availability of pelagic fish could be a result of over-fishing on the high seas and/or oceanographic factors. Local fishers claim that during the last few years the current has been running in a more southerly direction, running "away" from the coast, and they claim that for good catches the current has to run toward the shore. This in turn could have to do with El Niño and La Niña cycles. The years 2000–2003 have also been exceptionally dry years with little rainfall. It also seems that the occurrence of fish around FADs is very seasonal; sometimes there are lots of baitfish, other times almost none. We have no data to quantify this seasonality.

3. EVALUATION OF THE FAD PROGRAMME

Looking back on an eleven year period in which a total of 24 FADs were deployed with 5 (3 MKII and 2 RVS) more still available to be deployed we can try to evaluate the programme as follows:

<u>On the positive side</u>

– It has been shown that FADs do attract fish and in some cases catches were very good.

– Some FADs have lasted 1 117 and 1 584 days (respectively) in the water, which are very long periods of time.

– Compared to the generally placid waters of the Eastern Caribbean the sea conditions in this area are difficult: short wavelengths, strong choppy waves and strong currents. Rough seas with much longer wave periods are less of a problem.

– Certainly many of the designs which are used in the Pacific Ocean could not have withstood these conditions for even a much shorter time.

– These experiences may hold lessons that can be used to improve the longevity of FADs elsewhere.

– Only one FAD was wrongly deployed, due to a communication error where there was a mix up and the length of the mooring rope was confused with the target depth (RVS 9, Seru Colorado, Aruba).

– The deployment techniques used, with a portable ramp that can be fastened to various boats, are usually much cheaper than renting of an expensive vessel with crane (unless of course such vessel is already available free of charge).

– FADs have been accurately deployed in difficult, even dangerous weather conditions.

– Much experience was gained with three different designs. The designs have matured and we now know what the designs should be and what their limitations are for example: to which maximum mooring depth and in which locations they can be deployed.

– We have some indications which locations are best and which ones should be avoided.

<u>On the negative side</u>

– There are not enough catch data available to properly evaluate the functioning of the FADs and the best locations for FADs.

– Crews have gained considerable experience deploying FADs. Difficult operations have been accomplished smoothly. Everyone knows what to do and this has created considerable professional pride, bordering on overconfidence. On at least two occasions buoys were (successfully) deployed during heavy seas when it would probably have been better to abort the operation. This attitude could someday cause a serious accident. This attitude has also affected quality control.

4. RECOMMENDATIONS REGARDING THE PROGRAMME AS A WHOLE

It has been decided to use all remaining available buoys and construct a few more of the cheaper 5 m cylindrical PVC type which will be tested in less exposed locations in Aruba. More effort should be made to obtain catch data around FADs. Snorkelers should be used to take dated underwater pictures of baitfish around several FADs at regular intervals. Using divers would be substantially more expensive. All FADs should use at least a 1 500 kg anchor; this size weight can still be managed. Some FADs could probably use lighter anchors (but not less than 1 000 kg). The extra cost of the heavier anchors is negligible; no real savings are realised by constructing different sizes of anchors. An anchoring scope of around 1.4 should be used on all FADs.

4.1 Subjective assessment of the prevailing height of waves and the strength of the currents at the following locations:

Curaçao: Boca xx/xx; Hambraak xxx/xxx; Lagún xx/xxx (deeper water); Lagún x/xx (more inshore); Port Marie/Dingo x/xx; Sta. Barbara xx/xx; Sta. Cruz x/x; Westpunt/Playa Kalki xx/xxx

Bonaire: Klein x/x; Slagbaai xx/xx; Spelonk xxxx/xxx

Aruba: Malmok xxxx/xxxx; Seru Colorado xx/xxxx; West of Manchebo xx/xx

Height of waves (x low, xx medium, xxx high/ Strength of the currents (x low, xx medium, xxx high; being evaluated by the wear of the sacrificial anodes on the mast of the buoys)

Technical conclusions and recommendations

– The cylindrical buoys catch more wind and need more external ballast than expected to keep them upright which adds to cost and reduces reserve buoyancy. The need for more expensive chain as external ballast and the reduced reserve buoyancy as a result of this extra ballast reduces most of the advantages that this cylindrical design theoretically has, compared to the MKII design. The MKII buoys also have a more seaworthy behaviour, riding the waves in a more “relaxed” way. In deeper waters MKII buoys should be used from now on, the length of the cone should be increased somewhat and a flexible compound used at the juncture of the GRP top and cone with the SS mast. Nevertheless in view of their much lower cost Cylindrical PVC buoys could be a viable alternative to more expensive GRP or RVS buoys in less exposed areas and at shallower mooring depths.

– In the MKII buoys it is desirable to use 2 1/2" diameter pipe (if available) for parts of the lower mast instead of 2”. The mast would then be composed of thick-walled 2 and 2 1/2" pipe for the lower mast and 2" thin-walled for the upper mast.

– The weight of the anchors has now been increased from 1 200 to 1 500 kg. The MKII buoys will not be moored deeper than 600 m, to avoid them being pulled under by the currents, which can be very strong occasionally. This is based on calculations done by Mr Alain Lebeau, IFREMER, assuming a maximum surface current strength of 2.7 knots, which is reduced to 1/3 of its strength at 150 m depth and from there linearly reduced to zero at the bottom. South of Seru, Colorado in Aruba, the currents can be even stronger and may well reach 3 knots or more. Furthermore it seems likely that these currents run all the way to the bottom, without diminishing much in strength (it is reported that this has been observed in a small submarine diving to the bottom at 180 m). As a result even though the mooring depth of FADs around Aruba is much less, plenty of reserve buoyancy and a heavy anchor (1 200–1 500 kg) are still needed. In Aruba a somewhat lighter anchor of around 900 kg instead of 1 200 kg was used in view of the much shallower mooring depths, this turns out to have been a mayor mistake, 900 kg being insufficient.

– It is problematic to obtain Nylite connectors. The galvanised connectors used in some of the later buoys are probably not as dependable. A larger diameter galvanised connector has to be used and the rope passed through a plastic hose before passing it through the connector.

– Longevity of the FADs is significantly better at less exposed locations

– Out of 12 GRP buoys 3 were recovered, The 2 PVC buoys were not recovered, one RSV (= Stainless Steel) buoy was recovered.

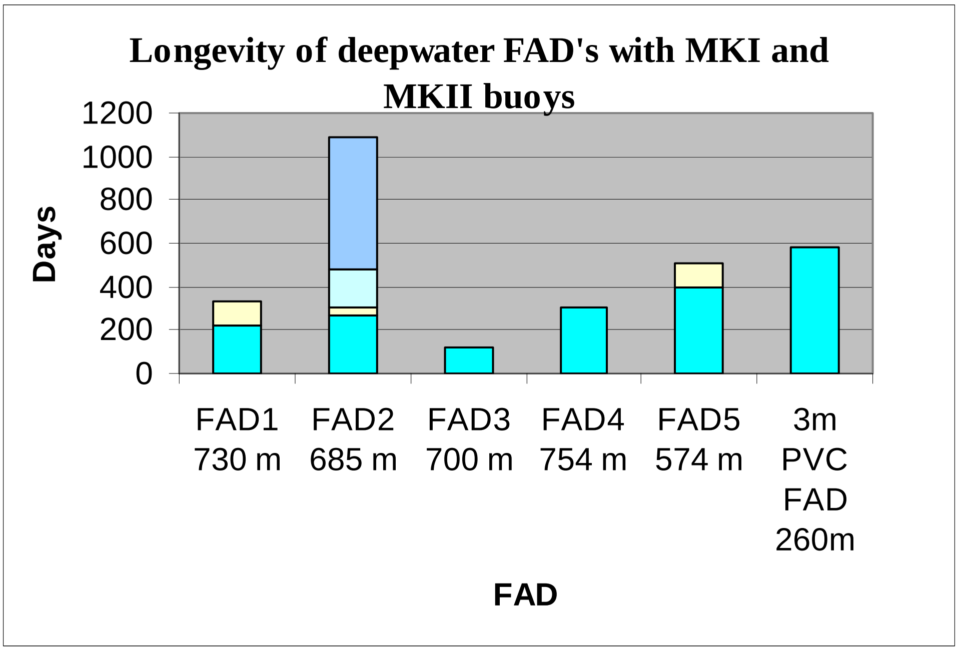
– Because of the strength of the currents the scope has been increased from 1.25 in earlier FADs to 1.4. According to the South Pacific Commission Handbook (Boy and Smith, 1984) larger scopes in this range can cause entangling of the line around the intermediate weight during periods without current, or with weak reversing currents. However this situation does not seem to occur in our area, even when the weather is very calm, there was always some current which would prevent the line from getting entangled.

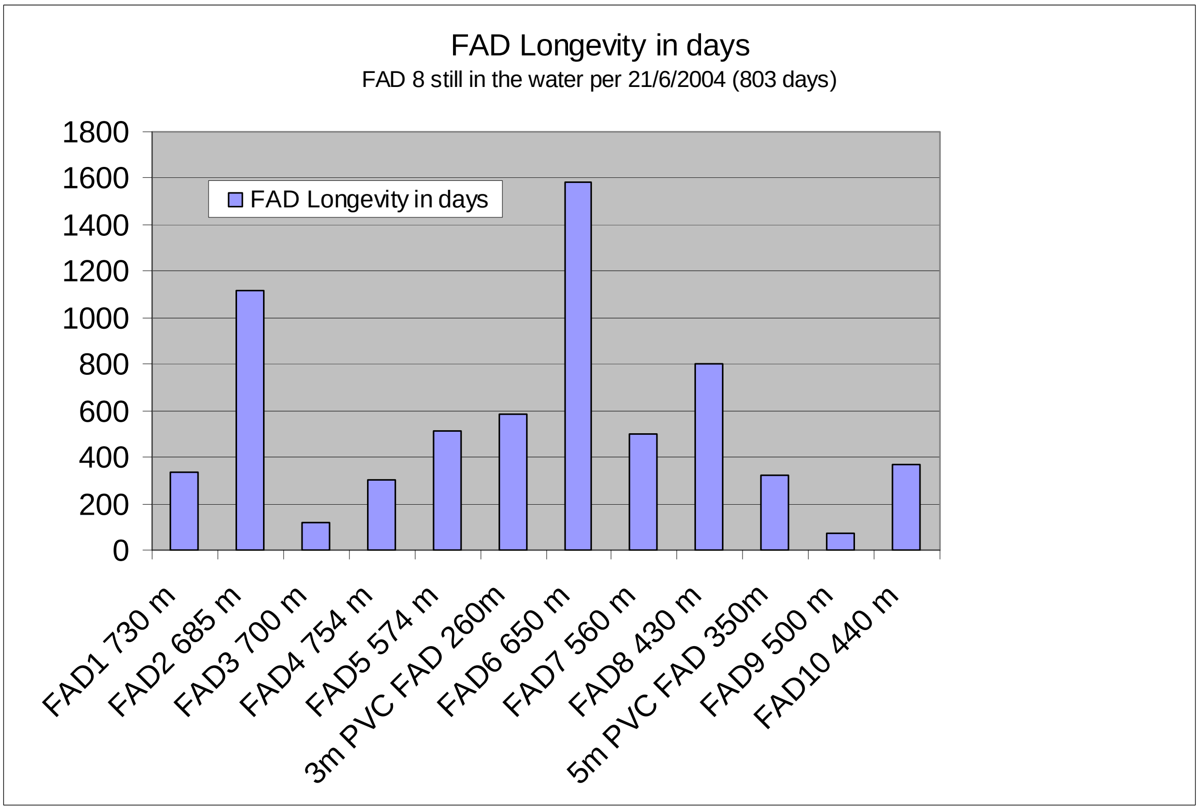
GRP MKI and MKII FADs and PVC FADs, Curaçao, Bonaire

FAD	Model	Cause or probable cause of failure	Mooring depth in meters	Longevity in days	Location exposure to waves and currents
GRP1	MKI	Surface buoy sank because of leaks, leaking buoy with reduced reserve buoyancy, pulled down by currents	730	334	Hambraak xxx/xxx
GRP2	MKI	Surface buoy sank because of leaks, leaking buoy with reduced reserve buoyancy, pulled down by currents	685	1 117	Sta.Barbara xx/xx
GRP3	MKII	Surface buoy not leaking, the anchor was probably pulled to deeper water by strong currents	700	118	Hambraak xxx/xxx
GRP4	MKII	Surface buoy walking with anchor (1 200 kg), during period with very strong currents, Surface buoy recovered for reuse.	754	301	Lagún xx/xxx
GRP5	MKII/ MKI	FAD started with MKII buoy, which was replaced with MKI buoy because of broken mast (improper weld). Cause of failure with MKI buoy unknown	574	512	Sta.Barbara xx/xx
PVC1	3 m	Disappeared 3 weeks after the bad sea conditions due to hurricane Lenny, it survived these waves, but was probably weakened by it, the anchor may have been pulled to deeper water nearby, by strong currents coming from a direction different from normal	260	582	Sta. Cruz x/xx
GRP6	MKII	Unknown (old age)	650	1 584	Sta.Barbara xx/xx
GRP7	MKII	Buoy leaking, see GRP 9	560	496	Boca xx/xx
GRP8	MKII	Still in the water at the time of writing	430		Lagún x/xx
PVC2	5 m	Buoy was seen drifting away, but not recovered	350	322	Playa Kalki xx/xxx
GRP9	MKII	Mast gave way because of corrosion caused by welding normal steel internal anchoring rod to the SS mast. This was also the case in another Surface buoy, which had not yet been used, of a series of 4 MKII buoys constructed by a contractor and could very well be a cause of failure of GRP7. The Surface buoy was recovered and repaired for reuse	500	70	Spelonk xxxx/xxx
GRP10	MKII	Connector at end of chain chafed through rope (For this buoy we did not have Samson Nylite connectors). The Surface buoy was recovered for reuse	440	370	West of Slagbaai xx/xx

5 m Stainless Steel Cylindrical FADs, Aruba, Curaçao, Bonaire

FAD	Model	Cause or probable cause of failure	Mooring depth in meters	Longevity in days	Location exposure to waves and currents
RVS 1		Metal fatigue due to resonance (diameter of mast insufficient)	360	11	Westpunt/ Playa Kalki xx/xxx
RVS 2		idem	530	6	Slagbaai xx/xx
RVS 3		idem	440	4	Spelonk xxxx/xxx
RVS 4		idem	387	5	West of Pink Beach xx/xx
RVS 5		idem	247	8	West of Klein Bonaire x/x
RVS 6	Strengthened	Still in water at time of writing, since 19 July 2002	430		Boca xx/xx
RVS 7	Strengthened	Still in water at time of writing, since 3 December 2002	185		West of Manchebo xx/xx
RVS 8	Strengthened	Anchor probably pulled to deeper water by the very strong currents, in these conditions anchor of approx 900 kg is of insufficient weight	185	approx 2 weeks	West of Malmok xxxx/xxxx
RVS 9	Strengthened	insufficient scope due to error	285	approx 3 weeks	South of Seru Colorado xx/xxxx
RVS 10	Strengthened	Still in water at time of writing, since Febr 21, 2003	200		Port Marie /Dingo x/xx
RVS 11	Strengthened	Still in water at time of writing, since 25 March 2003	240		West of Klein Bonaire x/x
RVS 12	Strengthened	Still in water at time of writing, since 28 November 2003	304		South of Seru Colorado xx/xxx


Longevity of deepwater FAD's with MKI and MKII buoys
Days
1200
1000
800
600
400
200
0
FAD1 730 m
FAD2 685 m
FAD3 700 m
FAD4 754 m
FAD5 574 m
3m PVC FAD 260m
FAD


FAD Longevity in days
FAD 8 still in the water per 21/6/2004 (803 days)
1800
1600
1400
1200
1000
800
600
400
200
0
FAD Longevity in days
FAD1 730 m
FAD2 685 m
FAD3 700 m
FAD4 754 m
FAD5 574 m
3m PVC FAD 260m
FAD6 650 m
FAD7 560 m
FAD8 430 m
5m PVC FAD 350m
FAD9 500 m
FAD10 440 m

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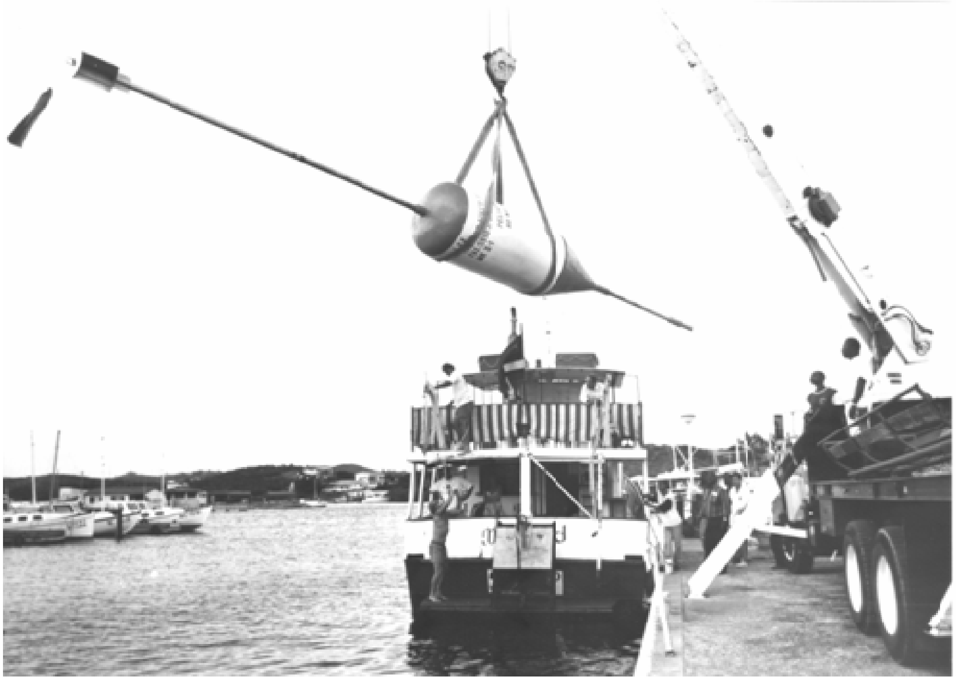
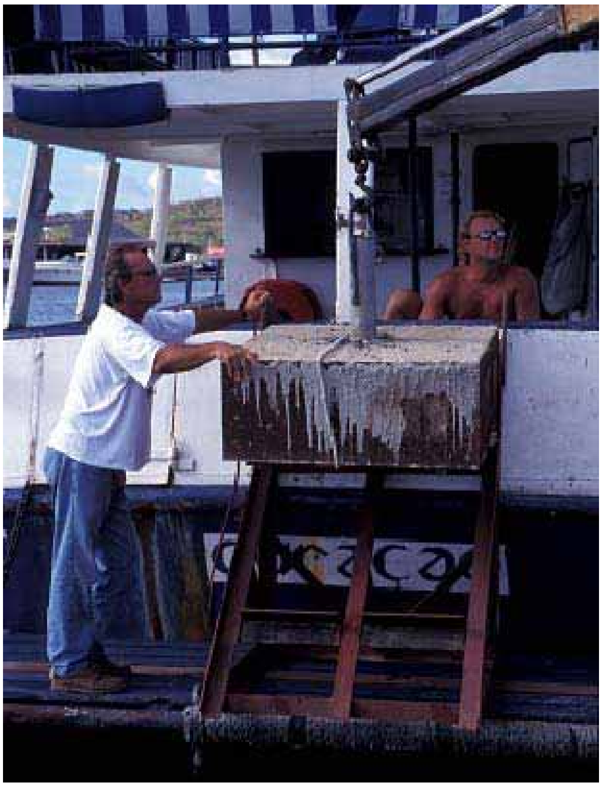
MKII FAD-GRP3,
700 m mooring depth

MKII-GRP7
Medium strength current
560 m mooring depth

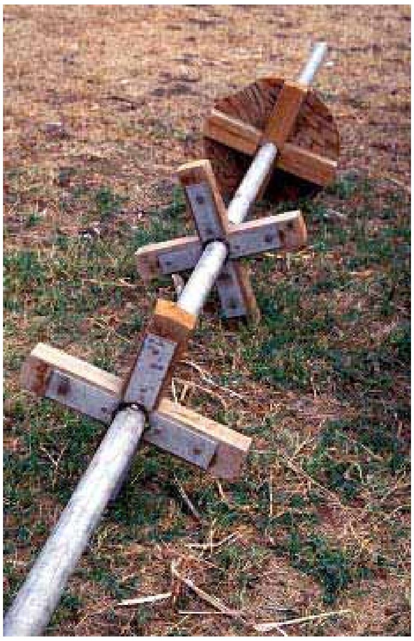
MKII-GRP8
Weak current
430 m mooring depth
Considerable reserve buoyancy remaining





Old type anchor (1 260 kg)
Being lowered on ramp

1 500 kg anchor
The weight of the anchor has been increased from 1 260 kg to approx. 1 500 kg
The underwater weight of the anchor is approx. 1 000 kg



Interior supports of 3 m PVC buoy

3 m PVC FAD, PVC 1,
260 m mooring depth

FAD RVS3 at Spelonk, Bonaire, 440 m mooring depth

4 days later, Sic transit gloria mundi

RVS strengthened FAD, RVS 6
Smaller and lighter radar reflector, shortened lower mast with baffles

Diver going down to change anodes on SS buoy (RVS 10) on a calm day. This buoy is moored in water of 200 m depth. Note remaining reserve buoyancy. In Aruba an identical buoy moored at 185 m depth dragged its 900 kg anchor and was pulled down by the currents.

Anodes on the GRP MKII buoy, On the GRP buoy anodes will last for more than two years, even in areas with strong currents. On the stainless steel buoys anodes eat away much more rapidly and have to be replaced within a year. When the anodes are gone the shackles corrode very rapidly**.**

Samsom Ocean Company
Nylite connector

Intermediate swivel with Nylite connectors

Galvanized connector, of inferior quality

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