DEVELOPMENT OF SMALL-SCALE FISHING OF PELAGIC SPECIES FOLLOWING THE INSTALLATION OF AGGREGATING RAFTS IN VANUATU

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1. FOREWORD

The use of aggregating rafts, also known as fish aggregating devices (F.A.D.'S) is common to a number of small island nations in the Western Pacific. Built from a variety of materials (bamboo, plywood, metal), these rafts comprise, as a rule, a fairly modest sized float anchored to the seabed at varying depths from 50 to 1000 metres. Their characteristic is to draw fish which swim past them. Among these fish, one particular pelagic species, the Thunidae, shows a definite attraction to these rafts and whole shoals of them will congregate around these devices. This phenomenon is known as "aggregation".

The Thunidae are fish of high commercial value. Because of their migratory nature, as a rule they are reserved for deep-sea fishing. As they congregate around rafts anchored in the vicinity of the coastline, they are becoming a more accessible resource for small crafts engaged in small-scale fishing. The fact that deep-sea shoals are now concentrated in a specific area enables fishermen to save time and fuel costs, because they no longer need to go seeking for fish.

Vanuatu is an island group comprising some 80 islands, situated between latitude 12°S and 23°S and longitude 166°E and 173°E. As part of its fisheries development policy, the Government of Vanuatu has implemented a project for the setting up of fish aggregating devices to enable small fishing vessels to have better access to offshore resources. From September 1982 to July 1985, the Fisheries Department caused some fifteen F.A.D.'s to be set up in the waters around the country. Six of these were anchored off the island of Efate, around Port Vila (Table 1), the country's capital, where the Fisheries Department is headquartered. The Fisheries boats used to go out to these F.A.D.'s almost daily. The systematic follow-up of their outings has been carried out by the ORSTOM (French Scientific Research Institute for Co-operative Development) office in Port Vila, in conjunction with the Fisheries Department (CILLAURREN, 1988). The main object was to analyse the impact of such rafts on the fishing production and some aspects of the aggregation phenomenon of pelagic species. But other aspects, such as fishing strategies and use of marine territory, would also appear to be affected by the anchoring of aggregating rafts. We propose to consider such aspects in this paper.

Table 1 : Fish Aggregating Devices anchored off the south-west of Efate (as at July 25th, 1985)

F.A.D.	Date of Set-up	Date of loss	Depth of anchorage (m)	Distance from the coast (km)	Location
1	17.06.82	06.03.85	500	4.7	17°42S 168°06E
2	13.09.82	13.01.84	700	10.8	17°50S 168°05E
3	16.03.83	30.08.83	780	8.9	17°53S 168°13E
10	12.09.84	11.12.84	800	8.9	17°54S 168°12E
11	27.09.84	still in place	800	10.8	17°50S 168°06E
12	30.08.84	10.03.85	240	0.5	17°46S 168°15E

2. METHODOLOGY

The fish aggregating devices have been anchored off Efate at distances from the coast which vary between 0.5 and 11 km and at depths between 240 and 800 metres. The exploited area is estimated to be between the isobathic 1000 m and the coast, covering an area of 285 km^2. The geographical limits are situated at latitude 17°35N and 17°59S and longitude 168°01E and 168°19E. The fishing space has been divided into several zones according to bathymetric specificity or particular pelagic environmental conditions.

Prior to the installation of F.A.D'S, the marine territory was divided into two zones :

- a coastal zone bordered by the bathymetric 300 metres as the first edge of reef at which the drop becomes sheerer down towards the ocean deeps;
- the offshore zone extending from the isobathic 300 to the isobathic 1000.

Through its power of attraction, the F.A.D. affects the environment in which it is set up (DE SAN, 1982; JESUS, 1982; PRESTON, 1982). The radius of influence of the F.A.D. is estimated to average 500 metres for the rafts anchored off Efate (CILLAURREN, 1987). Following the installation of the F.A.D.'S, we outlined three fishing zones (Figure 1) :

- the coastal zone bordered by the isobathic 300 m,
- the FAD zone ranging over a radius of 500 m from the raft, and
- the open sea zone outside the two previous zones.

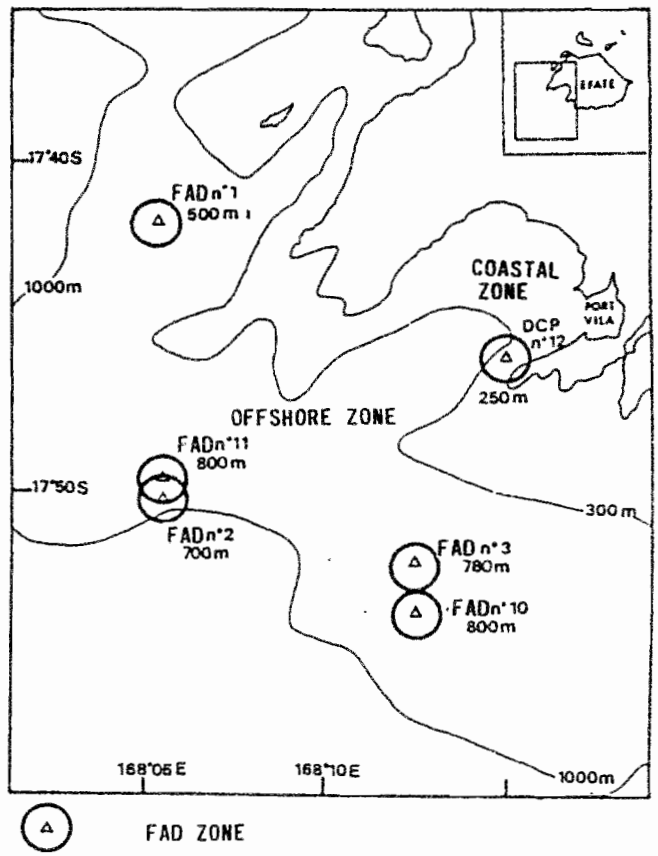

Fig. 1 : Distribution of the fishing zones in south-west Efate and location of the fish aggregating devices set up between June 1982 and July 1985.

In the south-west of Efate, village fishing is undertaken with catamarans of the Alia type, driven by 25 HP engines and equipped with two to four reels mounted with lines. The same vessels pursue two types of fishing alternatively :

- in the coastal zone, fishing for benthic species which live on reef slope,
- further out at sea, fishing for pelagic species.

In the case of the first type of fishing, the vessel is held stationary above the fishing zone. Fishing is by vertical line fitted with a baited hook anchored at depths ranging mostly between 200 and 300 meters. This art of fishing is called "bottom fishing". In the case of the second type, the vessel cruises through the fishing zone at a speed of 7 knots, with lines fitted with hooks and lures which are launched in the water and trailed by the vessel; this is known as "trolling".

Thanks to regular surveys, we have been able to collect from the masters of the vessels information about the fishing effort as expressed in trolling hours and the number and weight of the catch taken in each zone.

3. RESULTS

The coastal zone extends over 30% of the prospected space, the open sea covers 68% and the FAD's 2%. Half of the fishing time is spent on the coast, a quarter in the open sea and a quarter around the FAD's. In relation to the square kilometers, the raft zone

would monopolise 85% of the fishing effort (Table 2). However, it must be noted that, although the vessels cover the FAD zone fairly extensively, they simply cruise through the open sea and the coastal zone to reach the FAD'S or zones favourable for fishing benthic species.

Table 2 : Area of respective zones exploited between September 1982 and July 1985 and fishing effort (in trolling hours) expended on each

ZONES	Area (km^2)	Trolling hours	Trolling time per km^2
COASTAL	84.6	1535	18.1
OPEN SEA	194	735.5	3.8
FAD's	5.7	743	130.5

Prior to the installation of the rafts, a fishing vessel used to sail out to the open sea towards zones known to be the location for passing shoals of tuna. Once arrived there, the fishermen launched an active search for these fish, relying on visible manifestations, such as flights of birds following the movements or jumps of the skipjack. Once the shoal had been located, the vessel would approach the area and start trolling (Figure 2).

Now that the rafts have been set up, the vessels leave the harbour, drop their lines in the water as soon as day breaks and motors directly towards the FAD. The intensive fishing is carried out around the FAD for an average period of two hours (CILLAURREN, 1988), after which the vessels head either straight for another FAD or return to port, trailing their lines all the way (Figure 3).

The main pelagic species caught around the FAD's are the skipjack (*Katsuwonus pelamis*) and the yellow fin tuna (*Thunnus albacares*). As opposed to the yellow fin tuna, the skipjack is considered by fishermen to be an excellent bait for fishing benthic species (BROUARD & GRANDPERRIN, 1984) which are the most lucrative species on the Port Vila market. Fishing for pelagic species, therefore, serves two purposes : the first is to provide bait for catching benthic species; the second is to supply the consumer markets with fresh fish.

Prior to setting up the rafts, 22% of the number and weight of the catch was achieved in the coastal zone and 78% in the open sea. In this zone, the yearly yields averaged 11.2 kg per trolling hour. Because the pelagic fish drifted, they were far less accessible to the small fishing craft which then and to devote a lot of time seeking them in order to catch anything.

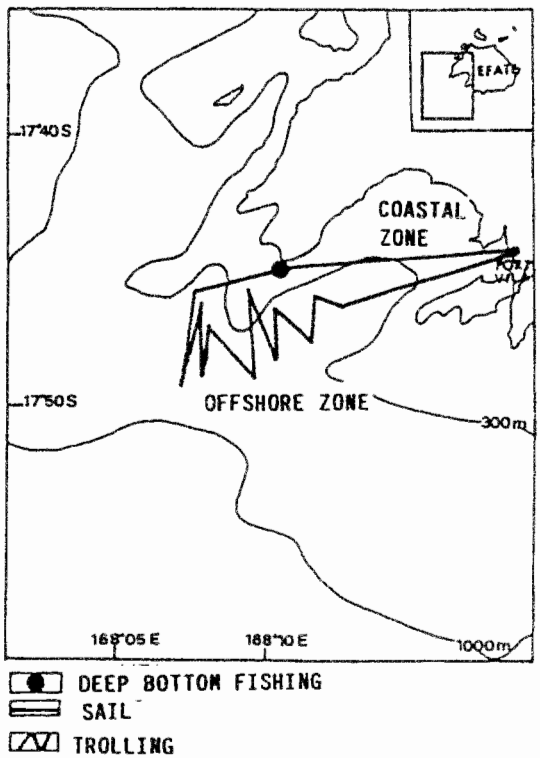

Figure 2 : Strategy used in trolling operations prior to the FAD's

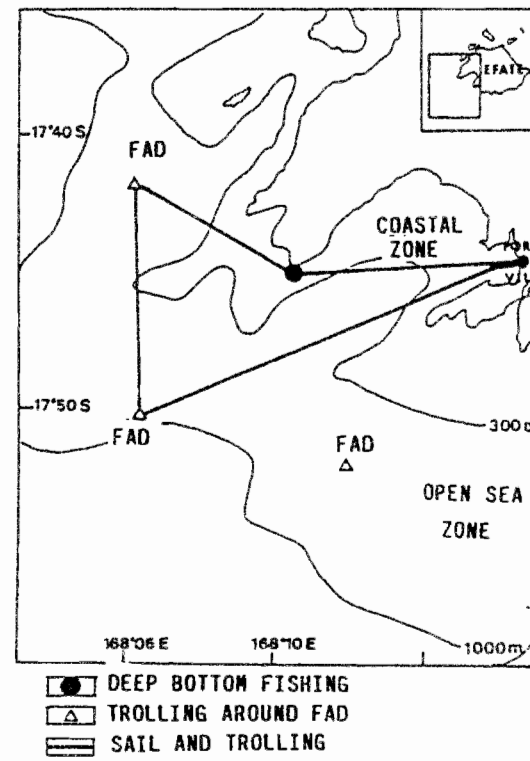

Figure 3 : Strategy used in trolling operations after setting up the FAD's

With the setting up of the rafts, 90% of the catch is obtained around the FAD's, 2% in the open sea and 8% in the coastal zone. The fishing yield from the FAD zone varies between 20 and 27 kg per trolling hour, which is close to the better yields of commercial fishing (PRESTON, 1982). By comparison, the yields achieved in the same time span in the open sea are insignificant, averaging as they do 0.3 kg per trolling hour (Table 3).

Table 3 : Yearly Fishing Yields (in number and weight of fish per trolling hour) achieved in each zone prospected between September 1982 and July 1985)

	COASTAL ZONE		OFFSHORE ZONE		FAD ZONE		OPEN SEA	
	Number/ trlg hr	Kg/ trlg hr	Number/ trlg hr	Kg/ trlg hr	Number/ trlg hr	Kg/ trlg hr	Number/ trlg hr	Kg/ trlg hr
9.81-8.82	1.6	4.6	4	11.2				
9.82-8.83	0.4	1			9.8	20.8	0.05	0.3
9.83-8.84	0.4	1.2			12.7	24.5	0.3	0.9
9.84-8.85	0.6	1.3			10.1	27.2	0.2	0.4

The anchoring of FAD's, which have turned out to be good aggregators, has not had the only consequence of concentrating the catch in 2% of the exploitable marine space. The need to look for the pelagic shoals having been removed, the utilisation of the

marine space has changed with the installation of FAD's. The fisherman, knowing that the greatest likelihood of catching any fish is around the FAD's, now heads straight for them and concentrates his operation to the immediate vicinity of the FAD. The coastal zone and the open sea have turned into zones of passage where trolling lines are dropped as a matter of routine during the crossing to the FAD's. The efficiency of this particular trolling is fairly limited.

SAMPLES & SPROUL (1984/5) believe that the good fishing results obtained around the rafts induce an increase of commercial fishing efforts. Such an increase may lead to disputes among raft users, as DEPOUTOT (1987) and BLANCHET *et al* (1987) noted in Tahiti, where the *poti marara* (small craft with outboard engines) and the skipjack fishing vessels compete against each other when fishing around the FAD's.

In Efate no such effect has been noticed. One of the consequences of setting up the aggregating rafts has been a drop in the fishing effort due to the fact that the trolling time in open sea has decreased. From 5.3 hours of trolling per outing beyond the isobathic 300 m prior to the FAD's, the average duration of trolling per outing has dropped to 3.8 hours after the implementation of the FAD system. Given that the only profitable trolling operations are those conducted around the rafts, i.e. in 2% of the overall available space, it is hardly surprising that the fishing figures related to the whole area beyond the isobathic 300 m show no significant change since the setting-up of the FAD's (Table 4).

Table 4 : Comparison of fishing yields beyond the isobathic 300 m point prior and subsequent to the installation of FAD's
Periods selected for the comparison :
prior to the FAD's : December 1981 to May 1982
after the FAD's : December 1982 to May 1983

	SITUATION PRIOR F.A.D.		SITUATION POST F.A.D.
Number of outings	30		100
Number of trolling hours	158.4		377
Trolling time/outing	5.3		3.8
Number of fish	740		1922
Kilo weight	1907		4029
Number/trolling hour	4.7		5.1
Kilo weight/trolling hour	12		10.7
Wilcoxon Test (catch/trolling hr)	PRIOR F.A.D.	=	POST F.A.D.
Meaning of test		at 5%	
Weight		0.423	
Number		0.238	

In Efate, an asesment of the viability of an outing has shown that an average of two and a half hours of trolling around the raft are sufficient to cover costs (CILLAURREN, 1988). Most trolling operations, however, last between one and two hours. For the

purpose of developing surface fishing, the activity around the FAD's should be optimised by cutting back the amount of time for travel. This could be done by anchoring the FAD's closer to port. The situation at present in Vanuatu is one of mixed fishing, consisting of pelagic fishing activities and benthic fishing. However, the major effort is based on the exploitation of benthic species which have proved to be the most lucrative on the Port Vila market.

4. CONCLUSION

The zones affected by the fish aggregating devices can be considered as man-made micro-fishing spaces. This system has resulted in a change in the approach to the marine space on the part of fishermen who now devote their attention, when at sea, to the rafts, representing 2% of the exploitable surface for pelagic fishing. Although it is possible for them to increase their catches per outing by spending more time trolling around the rafts, they opt to turn their efforts toward the fishing of more lucrative species which live on the outer reef slope. Pelagic fishing would appear, on the main, to be a source of good bait for benthic fishing because these species fetch the highest prices on the Port Vila market.

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