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TABLE DES MATIERES

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.

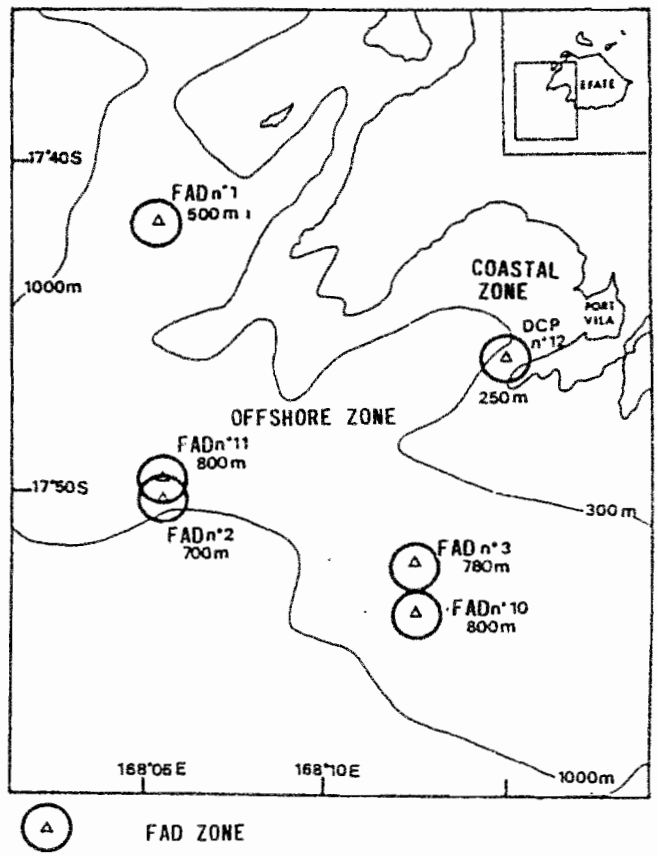

Fig. 1 : Distribution of the fishing zones in south-west Efate and location of the fish aggregating devices set up between June 1982 and July 1985.

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.

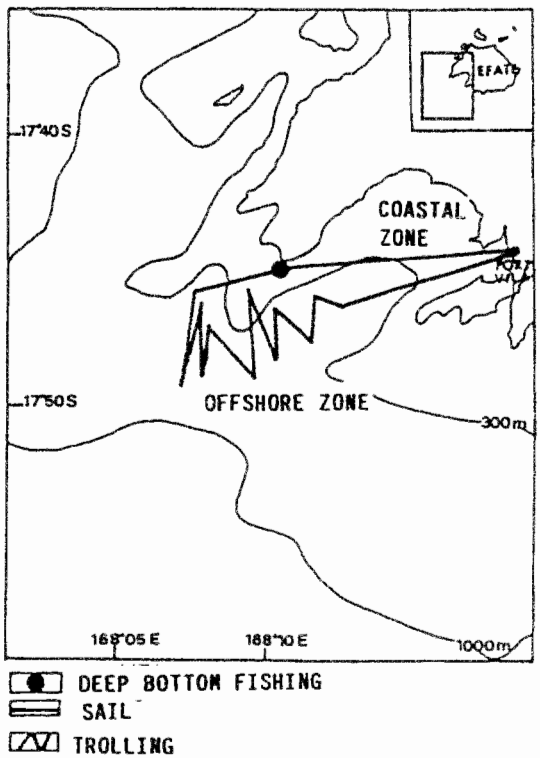

Figure 2 : Strategy used in trolling operations prior to the FAD's

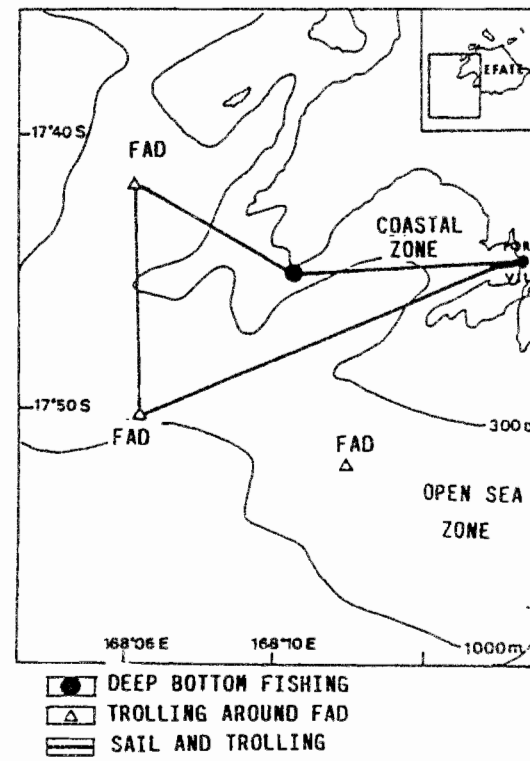

Figure 3 : Strategy used in trolling operations after setting up the FAD's

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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A SURVEY OF VILLAGE SUBSISTENCE FISHING IN VANUATU

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1. GEOGRAPHICAL AND SOCIO-ECONOMIC BACKGROUND

Extending over 12,200 sq.km, the Vanuatu archipelago is made up of a Y-shaped chain of some eighty mountainous islands located in the South West Pacific Ocean (Fig. 1). Most of the islands are of volcanic and coralline origin. They are surrounded by a narrow strip of fringing reefs. There are few lagoons, and the outer reef slope drops rapidly, which means that deep ocean borders the coast.

According to the 1979 population census, 94% of the population (111,250 inhabitants) is of Melanesian origin. Respectively 9,970 and 5,180 inhabitants live in Port Vila and Luganville, the two urban areas of the country. These towns draw in the majority of Europeans, Asians and other ethnic groups from the Pacific region. Although the population is estimated to be growing at 3.1% per annum, the population density is very low (9 persons per sq.km). However, variations can be significant from island to island. The population density can reach over 500 persons per sq.km in the smaller islands of the archipelago, such as Shepherd Islands, where there are signs of severe land pressure. In the larger islands, a distinction can be made between inland areas and the shore areas, most households living along the coastline.

The country is well endowed with soils. About 44% of the total surface area is covered by good fertile soils. It is the reason why traditionally the population of Vanuatu is agriculturally orientated. Over 80% of the population are dependent on agriculture for their food and as the main source of their income (MARSHALL, 1986). In rural areas, each household has a garden which provides a large amount of starchy food such as yan and taro, or green vegetables and fruits. Most of them keep chickens and pigs and have their own small coconut or cocao plantations where they work when they need money. Throughout the archipelago of Vanuatu, agriculture remains almost exclusively subsistence in nature and the cash economy still plays a minor role only in the majority of the rural villages.

In Vanuatu village fishing is widely considered as being second to agriculture. It is mainly a subsistence occupation concentrated around the reefs. The marine habitat has remained largely untouched thanks to the use of ancestral fishing methods (assegai, bow and arrow) and also to numerous ecological taboos. However, the coastal resources are limited and particularly susceptible to any form of intensive exploitation. The recent introduction of efficient fishing equipment and catching gear such as nylon nets and lines, underwater masks and spear guns and motorboats has resulted in a surge in fishing activity, while new fish-trading systems are beginning to have a significant effect on this traditionally subsistence sector.

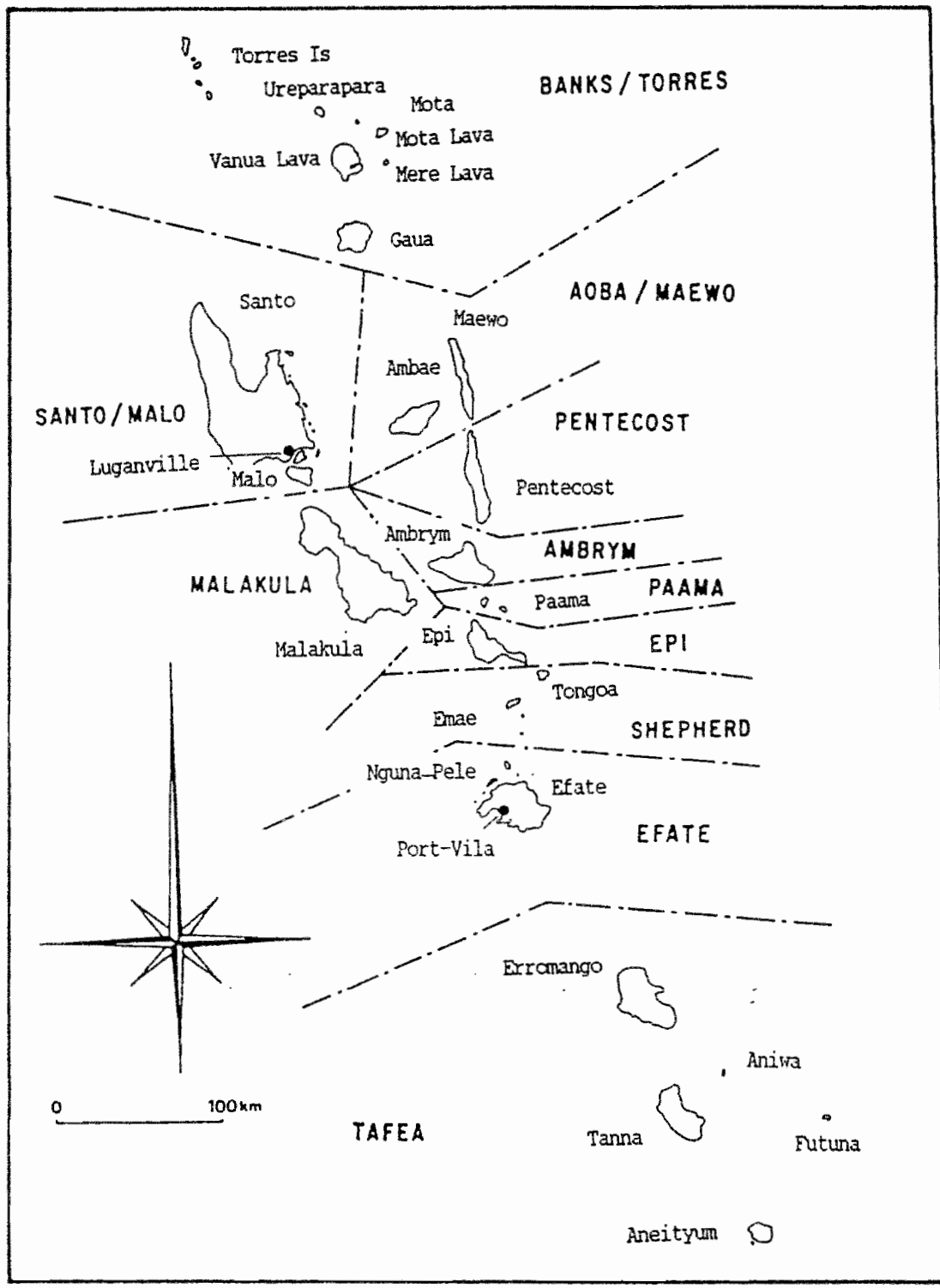

Figure 1 - Vanuatu and its eleven Local Government Regions

There is, however, very little information available on this rapidly changing village fishing activity. The bibliographical data for the most part date back a long way and relate to a few monographs recording the odd short-term, very localised, enquiry. Because of the extremely scattered distribution of the sites concerned, no overall study has yet been carried out. The Fisheries Department of Vanuatu therefore took advantage of the opportunity presented by a very wide-ranging agricultural census to include a survey of village subsistence fishing.

2. THE SURVEY, OJBECTIVES AND METHODS

The survey of village subsistence fishing was carried out during 1983. A fishing enquiry form was prepared jointly by the Fisheries Department, the National Planning and Statistics Office of Vanuatu and ORSTOM. It was designed so that it would fit with the overall agricultural census and could be completed by the rural agriculture census officers who were sometimes unfamiliar with marine matters. The data collected had to be accurate while remaining concise and clear. Three themes were selected : the fishing population, the fishing equipment and the catch (DAVID, 1985). The survey was based on a two-stage stratified random sample using the eleven Local Government regions as the strata (Fig. 1). A total of 126 villages (16% of the rural villages of the country) were selected throughout the country, the number of villages selected in each region being proportional to the number of households in the region (MARSHALL, *op. cit.*). Ten households were selected at random within each village, giving an overall sampling fraction of 1,339 households (7% of the rural population of Vanuatu). The urban areas of Port Vila and Luganville were excluded from the survey. Eleven teams, each consisting of a census officer and his assistant, worked full-time from July 1st to September 31st, 1983. In most cases the census officer was the agricultural field officer for the area concerned, where he had to visit from one to four localities. He spent a week or so in each village, helped by a local assistant chosen by the chief and, on average, surveyed two households per day.

This survey provided a considerable amount of information on village fishing activity, including the number of households which go fishing, fishing equipment, type and number of fish caught. Furthermore, the sample was deemed to be sufficiently representative to enable projections to be made for the whole country. The information gathered forms a very valuable statistical document giving the Government of Vanuatu a clear picture of each island's strengths and weaknesses, and providing the basic data necessary for realistic economic planning in the fisheries development sector. This paper deals with the main findings of this survey.

3. THE FISHERMEN, THEIR EQUIPMENT AND THE FISHING TRIPS

3.1 The fishing population

Throughout the country 8,600 households (confidence interval : 8,250 - 9,000) were estimated as being engaged in some form of fishing activity. Fishing therefore affects half the country's rural population. Apart from a few households which live inland, mainly on Santo and Malakula, all the households that go fishing live near the shore where they account for 70% of the population. Their geographical distribution is closely related to the settlement patterns of the coastal zone. Malakula, the Banks archipelago, Efate, Santo, Pentecost and Tanna are the main centres of fishing population in the country.

3.2 Craft and Motors

Two kinds of craft are used for fishing : the traditional outrigger canoe, propelled by means of a paddle, and the outboard motorboat, normally used to fish and to carry people and goods. A very few canoes are fitted with a motor, mainly in Santo. The total number of craft was estimated at 3,950 units (confidence interval : 3,250 - 4,700), 87% of which are canoes and 13% are boats equipped with outboard motors (Table 1).

Table 1 - Fishing Equipment

			No. of households owning equipment			No. of items or crafts		
			minimum	average	maximum	minimum	average	maximum
		TOTAL	8255	8633	9010			
CRAFT		Boats	330	520	720	330	520	720
		Motors	315	500	700	315	500	700
		Canoes	2390	2805	3245	2915	3420	3960
GEAR	TRADI-TIONNAL	Spears	3815	4315	4845	6405	7250	8145
		Bows-arrows	1590	1940	2315	1590	?	3180
		Pois. Leaves	290	475	675	?	?	?
		Fish Traps	15	130	450	15	130	450
	MODERN	Handlines	7015	7555	8110	18030	19415	20840
		Spearguns	2350	2760	3200	2940	3450	4000
		Gill nets	825	1080	1350	1045	1370	1675
		Cast nets	205	390	585	205	390	585
		Fish fences	10	25	450	10	25	450
		Reels	10	130	450	25	360	1260

Only one third of all fishermen own a craft and some possess two; in particular, boat-owners often also have a canoe. The highest concentration of canoes is on Malakula where one third of all the group's canoes are located. Their users, 900 households (confidence interval : 750 - 1,030), account for 35% to 50% of the island's fishing population. On the other hand, there are few motorboats to be found there, 50 at the most, representing less than 10% of the total number of motorised craft in the country. Generally speaking, the South and the Centre seem to own more motorboats than the North. Epi, Erromango, Tanna and Aneityum contain half the fleet, 270 units (confidence interval : 170 - 370).

3.3 Fishing Gear

The total number of articles of fishing equipment was estimated at 34,800 units (confidence interval : 30,550 - 40,400) which corresponds to an average of four gear per household. Ten different types of fishing equipment were surveyed : assegai or spears, bows and arrows, cast nets, fish fences, fish traps, fishing reels, gill nets, hand lines, leaves used for poisoning, and underwater spearguns. Various criteria can be used in

classifying types of equipment : method of organisation of the production (individual or collective fishing trips); division of work between men and women; method of operation (on foot, diving, fishing at sea on board a craft); whether fishermen are owners or employees; traditional or modern nature. The last criterion is the most significant in the case of Vanuatu, where, over the last twenty years, village fishing has been undergoing a series of major technical changes.

The survey found only 28% of equipment could be termed *traditional* as opposed to *modern*. The assegai is the most common of the traditional equipment (21% of all fishing gear), followed by the bow and arrows (5.5%). They are only used by men and youths either on foot or from a canoe. Throughout the country, half the households involved in fishing own one or two spears and 22% have one bow and arrows. Very few households use such other traditional fishing equipment as small traps or poisonous leaves. Their use is mainly confined to women on foot on the reef flat.

Modern equipment fishing accounts for 72% of all equipment recorded throughout the country. Reels, underwater spearguns and nets are used by men only, while women frequently use fishing lines for fishing on the reef flat. Amongst the modern equipment, nylon hand lines are the most common. They represent more than 50% of all fishing gear (Table 1). Over 85% of households involved in fishing fish by means of the line and they own an average of two or three lines per household. This is not surprising. Lines can be purchased in almost any village for a very small sum of money and they provide a cheap and effective method of catching fish.

Despite their cost, spearguns appear to attract a lot of interest and account for 10% of all equipment. 32% of the households who go to fish use one or, more rarely, two underwater spearguns. Gill nets and cast nets are only on sale in Port Vila and Luganville and therefore their use is not very widespread, especially in the case of cast nets which were mainly recorded on Efate. These two types of nets represent 4% and 1% of all fishing gear respectively (Table 1). Only 13% and 4% respectively of households involved in fishing use the gill net and the cast net.

In contrast to other Pacific countries, fish fences do not belong amongst the traditional equipment. They were introduced only recently by the Polynesians who settled in Vanuatu. Their distribution is almost entirely limited to Efate. These fish fences consist of a few dozen meters of chicken wire, around 1.5 m high, stretched between iron pots hammered into the reef shelf. As the wire oxidises quickly, these nets do not last long. Because of the absence of lagoons in other islands, the relatively high cost of construction, and the rapid deterioration of the finished fence, there does not seem much chance of this situation changing in the next few years.

The fishing reel is not yet a very common piece of gear. They are made in villages from old bicycle pendal assemblies; as there are not many bicycles around, however, neither are there many reels. The first reels were introduced about 25 years ago. As these devices need regular maintenance, the Fisheries Department of Vanuatu has been promoting the distribution of a stronger wooden specimen for the last five years. Fishing reels are used in deep sea fishing and are mounted on motorboats with two to four units per boat. They were recorded on 25% of boats (excluding canoes).

3.4 The fishing trips

Although there is some evidence that modern equipment is replacing traditional equipment, fishing techniques appear to have remained traditional in that 60% of fishing trips are carried out on foot along the shore or by diving in the shallow waters. The total number of fishing trips in 1983 was estimated at 516,000 (confidence interval : 443,000 - 594,000) throughout the archipelago (Table 2). Each of the country's 8,650 fishermen therefore, on average, went fishing sixty times per year.

In fact, not all fishermen go out on a regular basis. In an average week, 42% (confidence interval : 38% - 45%) of the households engaged in fishing make at least one trip on foot or by diving and 26 percent (confidence interval : 20% - 29%) use a boat or a canoe. The latter category is particularly frequent on Tanna and Malakula. The latter island is also the main centre for fishing on foot in Vanuatu. Most households only make one fishing trip a week, with very few making more than three trips a week.

Table 2 - Fishing Trips

	No. of households going fishing in an average week			Annual number of fishing trips		
	minimum	average	maximum	minimum	average	maximum
BY BOAT	1874	2244	2640	163700	196500	230600
ON FOOT, DIVING	3161	3626	4118	279400	320550	364000

3.5 Diagrammatic Summary

As an adjunct to Table 1 and 2 which deal with Vanuatu as a whole, we have produced for each island in Figures 2 and 3 an extract of information relating to the various kinds of fishing equipment owned and patterns of use.

Figure 2 shows the general geographical distribution of fishing equipment throughout Vanuatu. In the North of the group, fishing equipment is fairly uniform because lines hold a dominant position in eight of the eleven surveyed islands. Fishing on foot or by diving is more frequently recorded almost everywhere than trips in boats. The Centre of the group, to which Malakula and Erromango are attached, is, on the other hand, a very mixed region as far as gear is concerned as it can be modern or traditional. Fishing trips are made on boats or canoes as well as on foot or by diving. Modernity is a feature of the South and traditional equipment is infrequent there. The number of crafts is high everywhere and fishing on foot or by diving only accounts for 10% of all fishing activity on average.

In Figure 3 we have altered the island classification by giving priority to the type of equipment rather than the geographical distribution. The following observations can be made from reading this figure : a) traditional fishing is still alive and well in five islands, Gaua, Malakula, Epi, Emae and Erromango, where the bow and the spear are used; b) traditional and modern fishing can exist alongside each other (Epi, Emae, Efate); c) modern equipment, gill nets, cast nets and underwater spearguns are often used in association with each other; d) underwater spear-gun fishing is conducted throughout the group; f) nets are mainly used in the southern and central parts of the country; g) the distribution of cast nets is more restricted than with other nets, particularly in the north of the group; i) as they are relatively expensive, nets are only used by relatively wealthy fishermen who also often own a boat; boats and nets often go together; j) very few reels are used in the outer islands; k) canoes, the traditional craft, are almost always used with modern equipment (lines and nets) whereas traditional equipment is usually used when fishing on foot; the introduction of this modern material has therefore helped to increase the efficiency of canoes and thereby extend the fishing area beyond the reefs which, together with the beach, form the custom fishing territory.

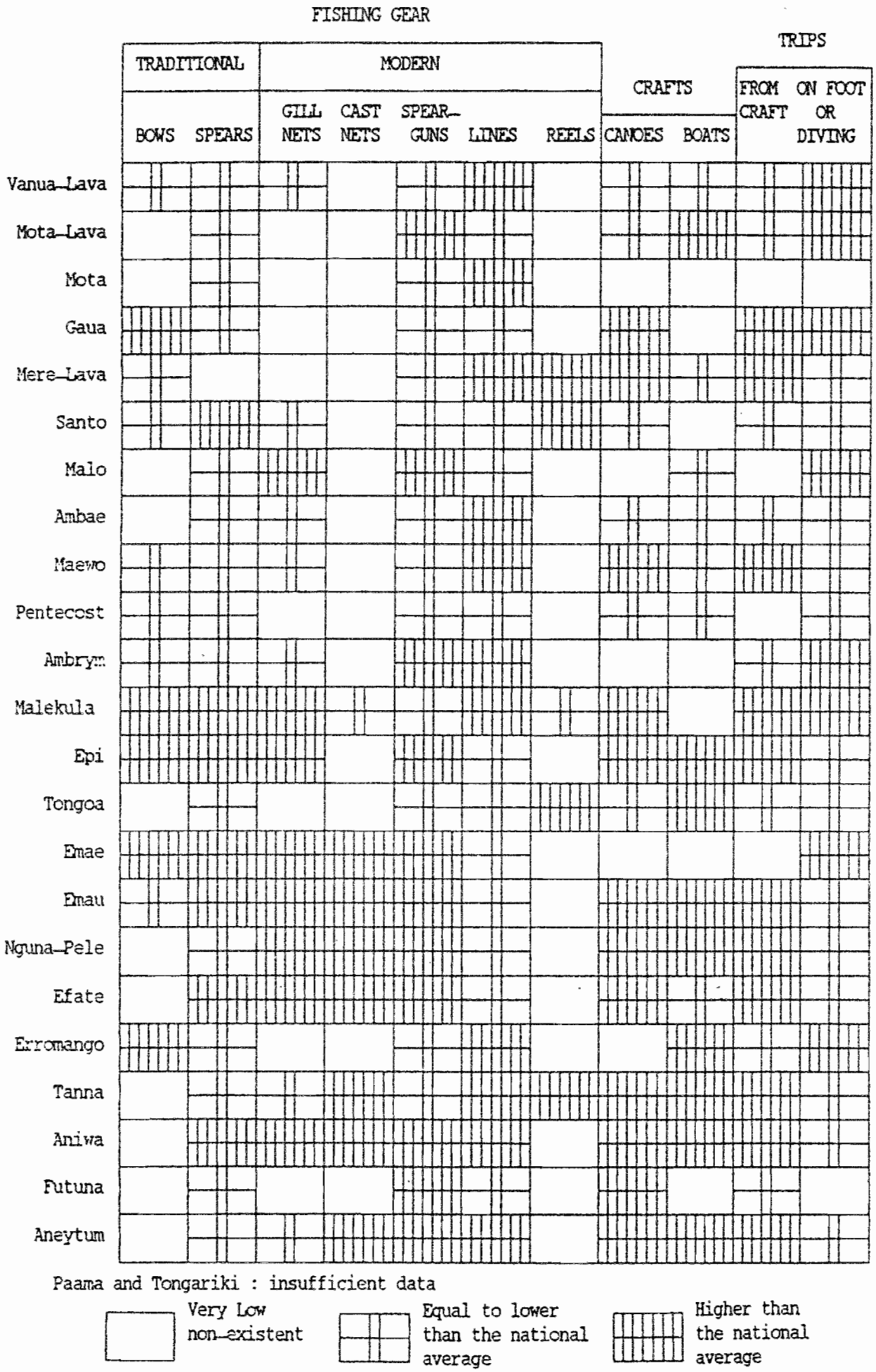

Figure 2 - Geographical Distribution of the Catching Equipment and its Patterns of Use

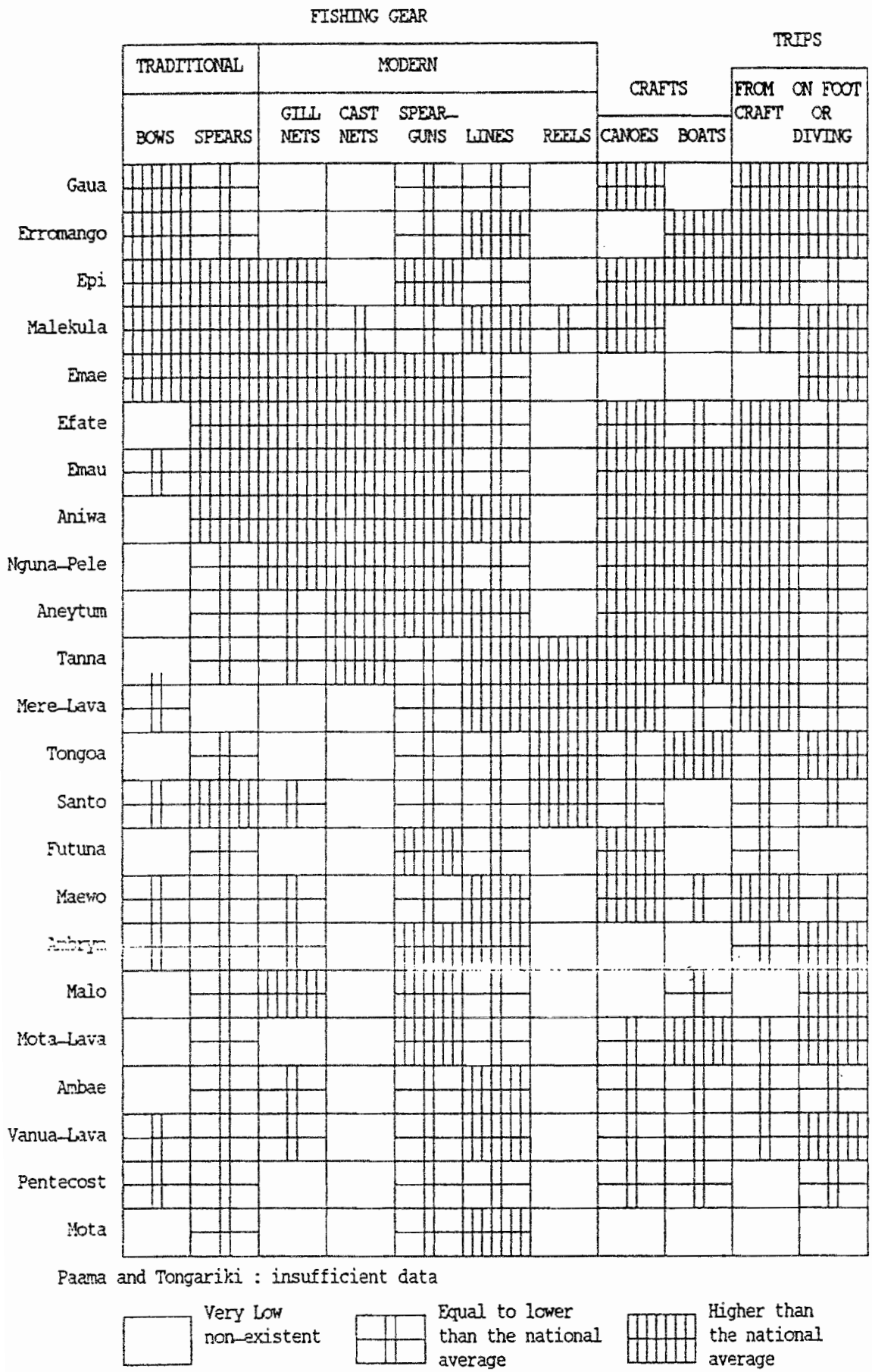

Figure 3 - The Catching Equipment and its Patterns of Use

4. FISHING GROUNDS AND PATTERNS OF USE OF FISHING GEAR

4.1 Fish habitat and fishing grounds

The mouths of rivers, mangroves and reefs are the main fishing grounds. The mouths of rivers owe their abundance to the mineral salts carried along by the fresh water following soil erosion. Throughout the archipelago, there are 288 rivers where the flow would appear to be strong enough to fertilise the coastal area surrounding the river mouth. The most favoured islands in the country are Santo and Malakula (CILLAURREN & DAVID, 1986). Table 3 indicates the main areas of mangroves and their ratio to the overall area of the respective islands. Malakula and Hiu, in the Torres group, hold 86% of the country's mangroves, but Emae and Aniwa are also well endowed, since they represent 2% of the emerged area of land.

Table 3 - Area Distribution of the Main Mangroves in Vanuatu

ISLANDS	MANGROVE AREA (ha)	MANGROVE AREA %	AREA OF ISLANDS (ha)	MANGROVE AREA TO ISLAND (%)
Malakula	1,975	78	205,300	1
Hiu	210	8.5	5,280	4
Efate	100	4	92,300	0.1
Emae	70	3	3,280	2.1
Epi	60	2.5	44,500	0.1
Vanua Lava	35	1.5	33,100	0.1
Ureparapara	30	1	3,900	0.8
Mota Lava	25	1	3,100	0.8
Aniwa	15	0.5	800	1.9
Total	2,460	100	391,560	0.6

Table 4 shows the distribution by island of reefs and their proportion to the land. A reef consists of two different zones :

- the shelf, which is revealed during low tide, and which contains only small fish, except during high tide when small predatory fish come up to hunt there;

- the reef slope, which may drop steeply towards ocean depths, and which is the richest section of the reef, and hence the most interesting for the fisherman who has hopes of catching fish down to 400 metres, the zone between 100 to 400 metres being that of deep-sea fish such as the red snappers (*Etelidae* family). These fish are particularly liked because they are free of ciguatera toxin.

In all, out of the 23 islands or groups of islands mentioned in Table 4, 14 are surrounded by reefs extending over a larger area than the actual island, which is a particularly strong factor in favour of fishing operations. From this point of view, the Banks-Torres group, the Shepherds and the Paama-Epi group, together with the southern islands (Aniwa, Futuna, Aneityum) would appear to be the best; they represent only 7%, 4.5% and 1.5% respectively of the emerged surface of the whole country, but they also contain respectively 12%, 14% and 4.5% of the reef areas.

Table 4 - Area Distribution of the Reefs in Vanuatu

ISLANDS	SURFACE AREA OF					TOTAL REEF AREA IN RELATION TO THE AREA OF LAND
	ISLAND (ha)	SHELF (ha)	SLOPE (ha)		TOTAL REEF AREA (ha)	
			10 - 100m	100 - 400m		
Torres	12,000	1,600	26,130	20,600	48,330	4
Ureparapara	3,900	280	1,650	5,150	7,080	1.8
Vanua Lava	33,000	1,640	6,500	16,390	24,530	0.7
Mota	1,500	110	850	3,170	4,130	2.8
Mota Lava	3,100	570	2,450	4,120	7,140	2.3
Mere Lava	1,500	30	550	1,780	2,360	1.6
Gaua	33,000	1,510	3,280	16,990	21,780	0.7
Rowa	10	2,630	1,700	4,270	8,600	860
Santo-Malo	424,800	4,500	60,000	142,970	207,470	0.5
Ambae	41,000	230	3,850	11,840	15,920	0.4
Maewo	28,000	780	6,030	33,470	40,280	1.4
Pentecost	49,000	1,730	8,950	25,000	35,680	0.7
Malakula	205,300	10,110	45,100	101,350	156,560	0.8
Ambrym	66,500	700	7,250	26,650	34,600	0.5
Epi-Paama-Lopevi	47,800	2,500	19,130	76,510	98,140	2.5
Tongoa-Tongariki	5,000	150	4,720	16,530	21,400	4.3
Emae-Makura-Mataso	3,600	2,020	4,660	30,820	37,500	10.4
Efate	92,300	8,070	28,450	95,330	131,850	1.4
Erromango	88,700	1,340	4,250	55,660	61,250	0.7
Tanna	56,100	1,310	7,450	42,440	51,200	0.9
Aniwa	800	310	1,150	5,120	6,580	8.2
Futuna	1,100	100	1,400	3,700	5,200	4.7
Aneityum	16,000	2,580	18,450	14,820	35,850	2.2
Vanuatu	1 218,900	44,800	263,950	754,680	1 063,430	0.9

4.2 Fishing operations at the fishing grounds

As a rule outings to the fishing grounds depend on two factors : the distance to the grounds from the fishermen's village, and the sheltered or exposed nature of the location in relation to weather, especially wind and sea conditions. Actually, the question of fishing is considered from a different angle than for coastline fishing grounds, i.e. the mouths of rivers, in mangroves and on the reef shelf, which are usually less affected by weather conditions, and that of the reef slope, sometimes located several nautical miles from the coast.

Like the mouths of rivers, which are mostly protected by a sand bank or by a bar of pebbles, the mangrove area is sheltered as mangroves require fine sidements to grow, which are only deposited in places sheltered from ocean swells and from the waves whipped up by the prevailing winds. The shelves are always accessible on foot at low tide, and at high tide the fishing equipment used is of a sufficiently broad range to allow for at least one or two fishing methods to be adopted, irrespective of weather and sea conditions. The main deterrent therefore is the distance between the fishing grounds and the fishermen's village. It should be noted that in many parts of the archipelago, particularly on Pentecost, the customary traditions which prohibit fishing of the reefs

within the village territory, for periods of several weeks or even years, are a far more powerful deterrent than any of the physical factors.

As for the reef slope, the determining factors are south-easterly swells and atmospheric conditions, especially the direction and force of the prevailing winds, the trade winds. Throughout the whole of the cool season the trade winds blow from east to west in the southern part of the country, and in the north, from the south-east to the north-west. On the eastern and the southern coasts of the islands, the seas are often rough and fishing outings are less frequent than on the leewards coasts, which are sheltered from the winds. Whilst the degree of exposure to the elements is of far greater importance, the distance of the fishing grounds from the villages cannot be ignored.

In Tables 5 and 6 the density of fishermen and the number of fish caught per year and per hectare were used to measure the fishing activities at the fishing grounds. In Table 5, the density of fishermen was calculated firstly in relation to the areas of reef shelf and mangroves, being the most popular fishing grounds, and then, secondly, in relation to the total area of the reef slope between 10 and 400 metres. Over the whole archipelago, the density of the fishermen on the reef shelf and in the mangroves is 19 per sq.km. Out of the 23 islands or groups of islands included in the table, eleven show a density above average : 600 to 100 fishermen per sq.km at Mere Lava, Ambae, Tongoa, Tongariki; 50 to 35 fishermen per sq.km at Tanna, Futuna, Ambrym, Pentecost; and 35 to 20 fishermen per sq. km at Mota Lava, Maewo and Santo-Malo. On an average the density in the reef slopes is 80 times less : 0.2 fishermen per sq.km for the whole country. Mere Lava, Tanna and Mota Lava show the highest density.

Table 6 shows that fish yields per hectare in the shelf areas and mangroves are 60 times more than on the reef slope. These results do not indicate that there is a difference in the productivity of the areas, but that fishing activities vary considerably. In decreasing order of importance : Mere Lava, Tongoa-Tongariki, Ambae, Malakula and Tanna are the five islands with the highest rate of return in the shelf areas and mangroves, which is understandable as they have the highest density of fishermen, apart from Malakula where the high level of production per hectare is due, we feel, to the productivity in the environment, higher than in other islands because of the wide expanse of mangroves and the number of rivers. Mere Lava, Tanna, Mota Lava, Ambae and Malakula and Efate are recorded as having the highest rates of return on the reef slope.

5. FISH PRODUCTION AND MARKETING

The annual production of the village fishing sector was estimated at 2,403 tonnes (confidence interval : 1,920 -3,011). This figure consists of 42.5% fish, 33.5% shellfish, 20.5% lobster, 30% octopus and 0.5% freshwater prawns. Table 7 gives these results in detail and also shows the trading data. The yield was expressed in terms of number of individual catches or baskets and in tonnage. The average weight used in the extrapolation is 0.1 kg for shallow water fish, 0.4 kg for deep=sea fish, 0.05 kg for freshwater fish, 0.2 kg for octopus, 0.5 kg for lobster, 4 kg for baskets of shell-fish and 2 kg for baskets of fresh water prawns.

Ability to see the bottom on the fishing grounds is the factor used to differentiate shallow-water fish and deep-sea fish. Shallow-water fish are found in areas where the bottom is visible, such as reef flats, upper parts of reef slopes, beaches and mangroves, whereas deep-water species are those caught over seabeds deeper than the eye can see, ranging from just a few meters to several hundred meters. In Table 7, the proportion

Table 5 - Density of Fishermen at the Fishing Grounds

ISLANDS	MANGROVES AND SHELVES			OUTER SLOPE – 10 to 400 m		
	Number of fishermen (1)	Surface area (ha)	Households density/km2	Number of fishermen (2)	Surface area (ha)	Households density/km2 OF LAND
Torres	65	1,820	4	?	46,720	?
Ureparapara	40	300	13	?	6,800	?
Vanua Lava	170	1,670	10	25	22,890	0.1
Mota	85	110	77	5	4,020	0.1
Mota Lava	200	590	34	40	6,570	0.6
Mere Lava	165	30	550	90	2,330	4
Gaua	135	1,510	9	45	20,270	0.2
Rowa (3)	?	2,630		?	5,970	?
Santo-Malo	1,075	4,500	24	165	202,970	0.1
Ambae	415	230	180	50	15,330	0.3
Maewo	255	780	33	80	39,490	0.2
Pentecost	700	1,730	40	35	33,950	0.1
Malakula	2,230	12,030	19	740	146,440	0.5
Ambrym	310	700	44	25	33,900	0.05
Epi-Paama-Lopevi	285	2,560	11	105	95,640	0.1
Tongoa-Tongariki	225	150	150	40	21,260	0.2
Emae-Makura-Mataso	150	2,090	7	5	35,470	0.01
Efate	1,380	8,170	17	405	123,780	0.3
Erromango	140	1,340	10	25	59,900	0.04
Tanna	635	1,310	48	385	49,890	0.8
Aniwa	55	320	17	15	6,280	0.2
Futuna	45	100	45	5	5,100	0.1
Aneityum	90	2,580	3	70	33,270	0.2
Vanuatu	8,850	47,250	19	2,355	1018,240	0.20

(1) The number of fishermen has been accounted for in relation to households.
(2) Those fishermen households taking regular trips in outriggers or boats have been categorized as fishing on the outer reef incline.
(3) The rowa atoll formation is now no longer inhabited. 20 people were recorded as living there in 1944. They have settled on the island of Ureparapara where they held customary land rights (VIENNE, 1984).

sold was also expressed in terms of its monetary value. We estimated the average price of a kilo of lobster at VT.500, a kilo of fish at VT.80, a kilo of octopus at VT.150, and a kilo of shellfish at VT.130. Around 23% of the production was sold, a total of 555 tonnes (confidence interval : 405 - 746). Lobsters represent 45% of the amounts sold (250 tonnes) and fish 34% (240 tonnes). Throughout the year, the total amount of sales was estimated at 147 million vatu (confidence interval : 106 - 193), 85% of which was generated by lobster sales and 13% by sales of fish. This sum corresponds to approximately 1,470,000 US Dollars and 1,617,000 A$.

Table 6 - Returns on Fish Production

ISLANDS	MANGROVES AND SHELVES		OUTER SLOPE – 10 to 400 m	
	Annual Fish Production (number)	Production in number per ha	Annual Fish Production (number)	Production in number per ha
Vanua Lava	127,700	80	11,700	0.5
Mota Lava	25,000	40	31,800	5
Mere Lava	38,100	1,270	26,700	6
Gaua	77,400	30	?	?
Santo-Malo	179,000	40	3,400	0.05
Ambae	93,300	400	29,000	2
Maewo	87,400	110	26,700	0.5
Pentecost	67,000	40	19,500	0.5
Malakula	1841,600	150	591,500	4
Ambrym	32,000	50	27,600	1
Epi-Paama-Lopevi	140,800	60	87,300	1
Tongoa-Tongariki	78,100	530	20,200	1
Emae-Makura-Mataso	32,800	20	?	?
Efate	656,800	80	230,000	2
Erromango	154,100	110	11,400	0.2
Tanna	195,000	150	287,300	6
Aniwa	3,700	10	12,900	2
Futuna	?	?	5,500	1
Aneityum	133,400	50	24,800	0,5
Vanuatu	3963,200	80	1447,300	1.5

Table 7 - Village Fishing Production in Vanuatu

	TOTAL PRODUCTION		PRODUCTION SOLD			
	Number	Weight (tonnes)	Number	Weight (tonnes)	% total production	Value 10^6 vatus
Shallow-water fish	3980,000 (3494,000 - 4490,000)*	398 (349 - 449)*	1114,000 (940,000 - 1306,500)*	111.5 (94 - 130)*	28 (27 - 29)*	8.9 (7.5 - 10.5)*
Deep-sea fish	1430,000 (1172,500 - 1705,500)*	572 (469 - 682)*	307,500 (232,000 - 396,000)*	123 (93 - 158)*	21.5 (20 - 23)*	9.8 (7.5 - 12.5)*
Freshwater fish	963,500 (707,500 - 1240,000)*	48 (35 - 72)*	132,000 (87,000 - 197,000)*	7 (4 - 10)*	14 (12 - 16)*	0.5 (0.3 - 0.8)*
All fish	6373,500 (5370,000 - 7450,000)*	1,018 (850 - 1,200)*	1553,000 (1250,000 - 2000,000)*	241 (190 - 300)*	24.5 (23 - 26)*	19.3 (15 - 24)*
Octopus	331,800 (267,200 - 382,700)*	66 (53 - 76)*	52,000 (32,600 - 71,200)	10.5 (6.5 - 14)*	15 (12 - 18)*	1.5 (1 - 2)*
Lobster	981,000 (742,000 - 1237,000)*	490 (371 - 719)*	498,400 (359,900 - 363,600)	250 (180 - 328)*	51 (49 - 53)*	125 (90 - 164)*
Marine shell fish (baskets)	202,600 (167,600 - 240,100)*	810 (670 - 960)*	13,400 (6,700 - 26,400)	53.5 (27 - 105.5)*	6.5 (4 - 11)*	1.6 (0.8 - 3.2)*
Fresh water prawns (baskets)	9,000 (830 - 31,000)*	18 (2 - 62)*	** -	** -	** -	** -
Total	- -	2,402 (1,900-3,050)*	- -	555 (400.5 - 750)*	23 (15 - 32)*	147 (106 - 193)*

* Confidence interval ** As no sales were recorded in the survey, it is impossible to estimate the actual quantity sold.

Depending on whether they are expressed in number of fish caught, in weight or in vatu, the amounts brought ashore and the proportion sold vary greatly in composition. Freshwater fishing activity therefore appears to be very limited when accounted for in weight, whereas it becomes significant when is is quantified in number of fish caught. In the latter case, the production of fresh water fishermen represents two thirds of that of deep-sea fishermen. In fact, even if these units lead to apparently contradictory results, each of them reflects an aspect of fishing activity. The number of fish caught and the tonnage show in two different ways the effect of fishing on the fish population. Tonnage also has the advantage of clearly showing the quantities of food available for consumption and sale, the amount in vatu is the fishermen's income. In the case of fresh water fish, stating the annual production in terms of numbers (963,500 fish, an average of 500 fish per household) show how intensively the down-stream parts and the mouths of rivers are worked, whereas to express it in weight (48 tonnes, an average of 58 kg per household) shows its limited nutritional impact.

In the same way as production, trading varies greatly from island to island, as shown in Figure 4. In the north of the country, fishing activity is entirely a subsistence matter. This is particularly marked in the Banks group where most of the population goes fishing. There is therefore no market to sell the catch and fishermen only take what they need. The main area for fish production and marketing is in Central Vanuatu, particularly Efate and Malakula. The two main southern islands, Erromango and Tanna, can be added to this area. On the other hand, the three other southern islands produce only a low tonnage, mostly consumed on a subsistence basis. Sales of lobster from Aneityum to Port Vila and occasional sales of mother-of-pearl shellfish are the only commercial activities in these islands.

This survey has shown the existence of a commercial attitude amongst fishermen, although it had previously been thought that village fishing was purely a subsistence activity. It is now realised that some fishermen clearly wish to produce for commercial purposes. Although this profit drive is not yet very widespread, it is gradually increasing. It does not concern all fish products, for the moment only lobster and certain reef and deep-sea fish are affected. This profit incentive is expressed in increased productivity, to a much higher extent than households only conducting subsistence fishing. This is the case particularly on Malakula, Nguna-Pele and Efate. The productivity of fishermen selling shallow-water fish is three to five times higher there respectively than that of other fishermen consuming all their catch. The productivity gaps are slightly less marked in the deep-sea fishing sector. The major sales of shallow and deep-water fish are generally made by these households. Apart from a few commercial fishermen, trading in fish is limited, occasional and only concerns the surplus fish left over after subsistence needs have been met.

6. CONCLUSION

In Vanuatu village fishing is widely considered as being very much a secondary activity in relation to agriculture. This survey has proved that this idea is very much open to question. Fishing activity is in fact far from being negligible, in terms both of production and the number of people involved. The reef flat is the most intensively fished area. This area can easily be reached on foot and contains many species which can be caught using simple techniques, including shellfish, lobster, fish and octopus. These represent around two thirds of the total annual production. Production from the outer slope of the reef is not very varied as only fish are caught there. Fishing there is only possible using modern gear, often on small boats and so fishing there is often a male prerogative. This activity is constantly expanding at the prompting of the Fisheries Department of Vanuatu.

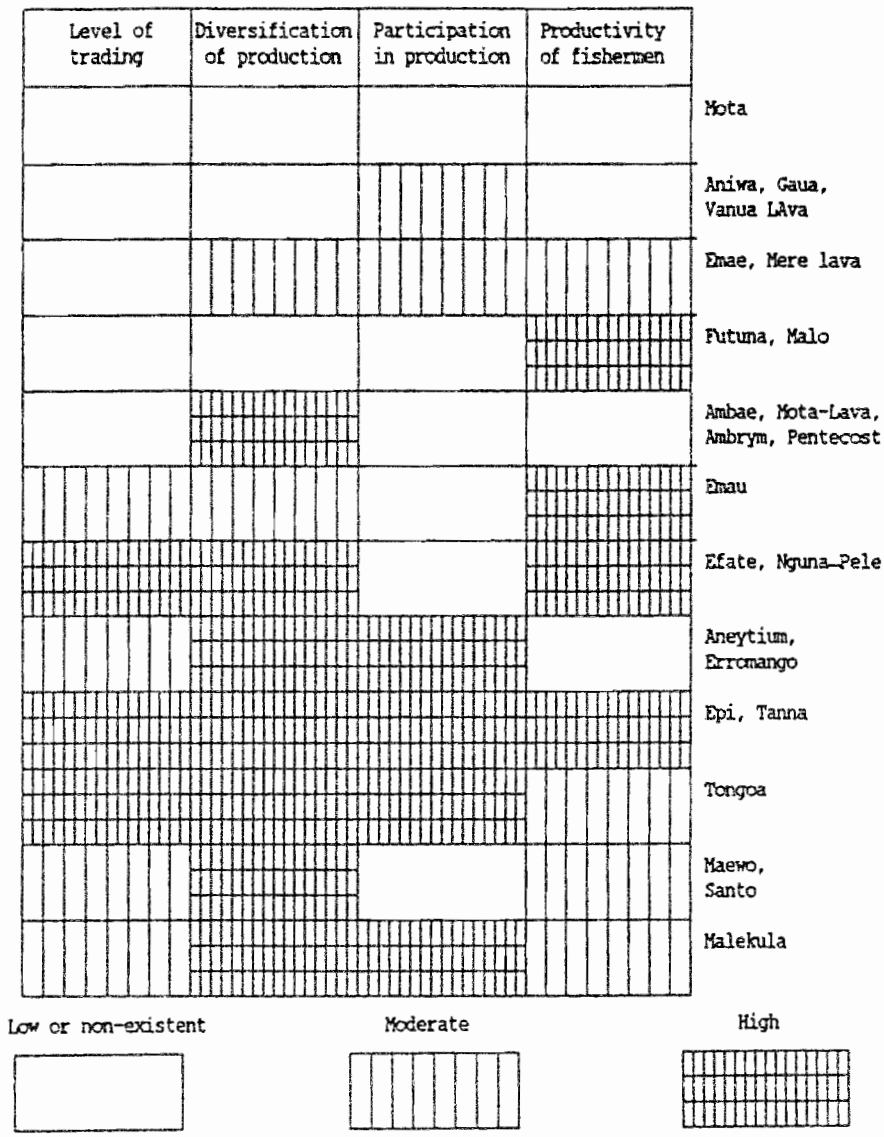

Figure 4 - Fish Production and Trading :
Diagramme of Summarized Classification Island by Island

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