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CONTENTS

STATUS OF THE DEEP BOTTOM FISHERY AROUND EFATE IN 1987 AND IN 1988

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I. STATUS OF THE EFATE'S DEEP BOTTOM FISHERY

Efate island includes the biggest urban center of Vanuatu, namely Port-Vila, and as such, has a high demand for commercial sales of fresh fish. The target species of the deep bottom fishery are the Lutjanidae family and are commonly retered to as snappers. Therefore the fishermen who operate in the deep bottom fishery, benefit from a privileged commercial situation created by the high demand for fresh quality fish from the local fish market, hotels and restaurants.

Two commercial fisheries cohabit in Efate. The first is a structured fishery etablished in 1983 by the V.F.D.P. (Village Fisheries Development Program) and organised in fishermen associations. The second is composed of an informal and uncontrol fishery consisting of private fishermen using private boats, which mainly sell their catches directly to the hotels and the restaurants. The V.F.D.P. associations sell compulsory their catches to the local fish market "Natai".

II.. METHODS OF FISHING ACTIVITY AND STATISTICS RECORDS

As most of the structured fishing projects set around the Pacific (CROSSLAND and GRANDPERRIN, 1980) fishing equipment comprises of vessels of 5 to 6 meters long, powered by 25 h.p. outboard motors and supplied with two or four handreels. Each line is fitted with 3 hooks and a 2 kg weight. The fishing occurs with the motors stopped and the boat anchored above the deep bottom fishing place.

The V.F.D.P. associations can benefy from cheap fuel (reduced duty) if they provide the Fisheries Department with information about the trip's duration, the fishing depth and area, the number of reels in use, the amount of catches and their sales and expenses. In addition the ORSTOM (Institut Français de Recherche Scientifique pour le Développement en Coopération) gives 50 Vatus when the lengths of the fish are also recorded. All these informations are recorded on forms for future statistical analysis.

Efate has been divided into eleven fishing areas (Figure 2). During a fishinf trip, the fisherman can make several fishing sessions at different places in the same area. Because of the difficulties in determining the actual fishing time due to the lack of information on time spent fishing or in transit from one fishing location to another, we have used a unit of fishing effort as the number of trip hours per reel.

III ANALYSIS OF THE INFORMATIONS PROVIDED BY THE EFATE'S V.F.D.P. ASSOCIATIONS

Between January 1987 and December 1988, eleven associations declared 367 trips during which 18,059 kg of snappers were caught using a fishing effort of 19,742 reel trip hours. The average catch is 49.2 kg per trip with a yield of 0.91 kg per trip hour per reel.

The average catch per trip is similar to those obtained in New Caledonia, but they are 2 to 4 times less than the average catches of Papua New Guinea, Fiji and the American Samoa (Table 1). The catches per unit effort in 1987 and 1988 are the same that those observed in Efate in 1986 (SCHAAN and al., 1987).

In 1987, 74 % of the total number of fish caught comprised of deep water snappers ; Etelis carbunculus (18.2 %), Etelis coruscans (14.3 %), Pristipomoides multidens (26.4 %) and Pristipomoides flavipinnis (15.3 %) (Figure 1). In 1988, the same species except for Pristipomoides flavipinnis composed about 69 % of fish caught. Apart from the decrease of the proportion of Pristipomoides flavipinnis, the specific composition did not show any significant change over that recorded for (SCHAAN and al., 1987).

IV. FLUCTUATIONS IN THE FISHING EFFORT AND IN THE CATCHES BETWEEN DIFFERENT FISHING AREAS AROUND EFATE

Figures 2a and 2b respectively show for 1987 and 1988 the level of the fishing effort and the catches per unit effort for each area. It clearly appears the fishing effort concentrates in the north east Efate (Emao and Forari). In 1988 fishing effort increases were recorded in Lelepa and in the south west of Efate.

The catch per unit effort was very similar in most areas. They are marginally higher in Lelepa and in Toukoutouk, approaching the 1 kg per trip hour per reel. The lowest catches per unit effort are made in the south of Efate randy Teouma and Bay of Enam, but as very few trips were made in these areas, we cannot make conclusions about the potential production from these areas. The intensive fishing activity in Emao and Forari does not seem, on figures collected to date, to have a negative influence on the catchyields.

V. ATTEMP TO ESTIMATE THE ACTUAL PRODUCTION OF DEEP BOTTOM FISH IN EFATE

Two reasons lead to think that the V.F.D.P. production's declarations underestimates the real procution :

- all the V.F.D.P. associations do not fill forms.
- some V.F.D.P. associations do not systematically declare their catches.

As each V.F.D.P. association should sell their catches to the local fish market "Natai", we can evaluate the total production of the V.F.D.P. fishing associations, by examining the purchases made by "Natai". In 1988, "Natai" bought 14,352 kg of bottom fish from the Efate's associations. However for the same year, the associations declared 11,268 kg in the statistics forms. This therefore means that the information supplied by the associations to the V.F.D.P. under record production by at least 22 %.

Table 1 - Catches per trip obtained in some Pacific islands

COUNTRIES	PERIODS	CATCH IN KG/TRIP	REFERENCES
AMERICAN SAMOA	23/03 to 2/07 1978	84	MEAD P.-1978
NEW CALEDONIA	9/04 to 3/09 1979	41.4	FUSIMALOHI T. R.GRANDPERRIN- 1979
PAPUA NEW GUINEA	5/09 to 14/12 1979	157.3	FUSIMALOHI T. J. CROSSLAND - 1980
FIJI	8/11-13/12 79 13/03-1/09 80	147.4	MEAD P. - 1980
EFATE	1987-1988	49.2	This study

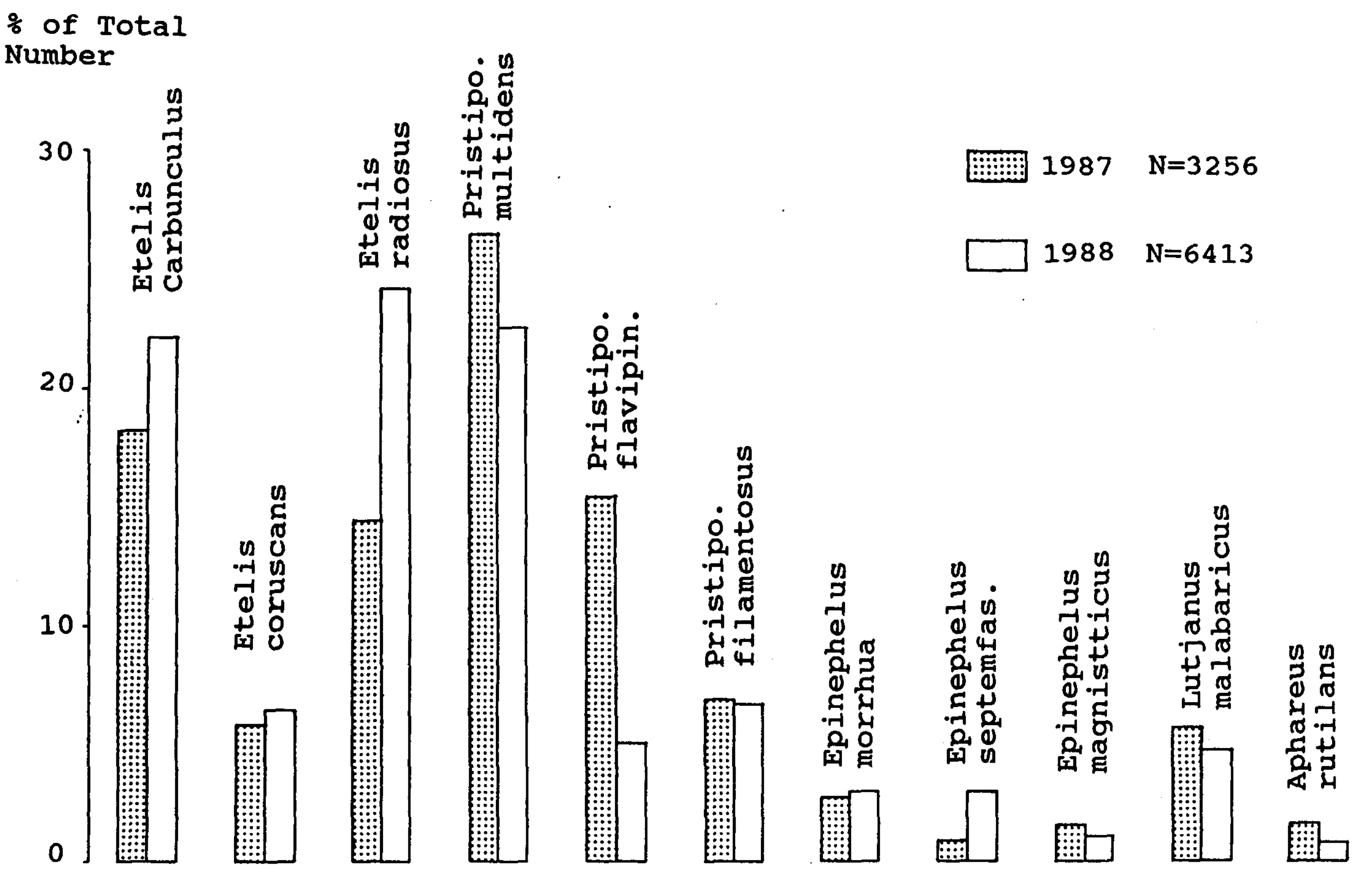

Figure 1 - Proportions of eleven benthic species in the total number of catches.

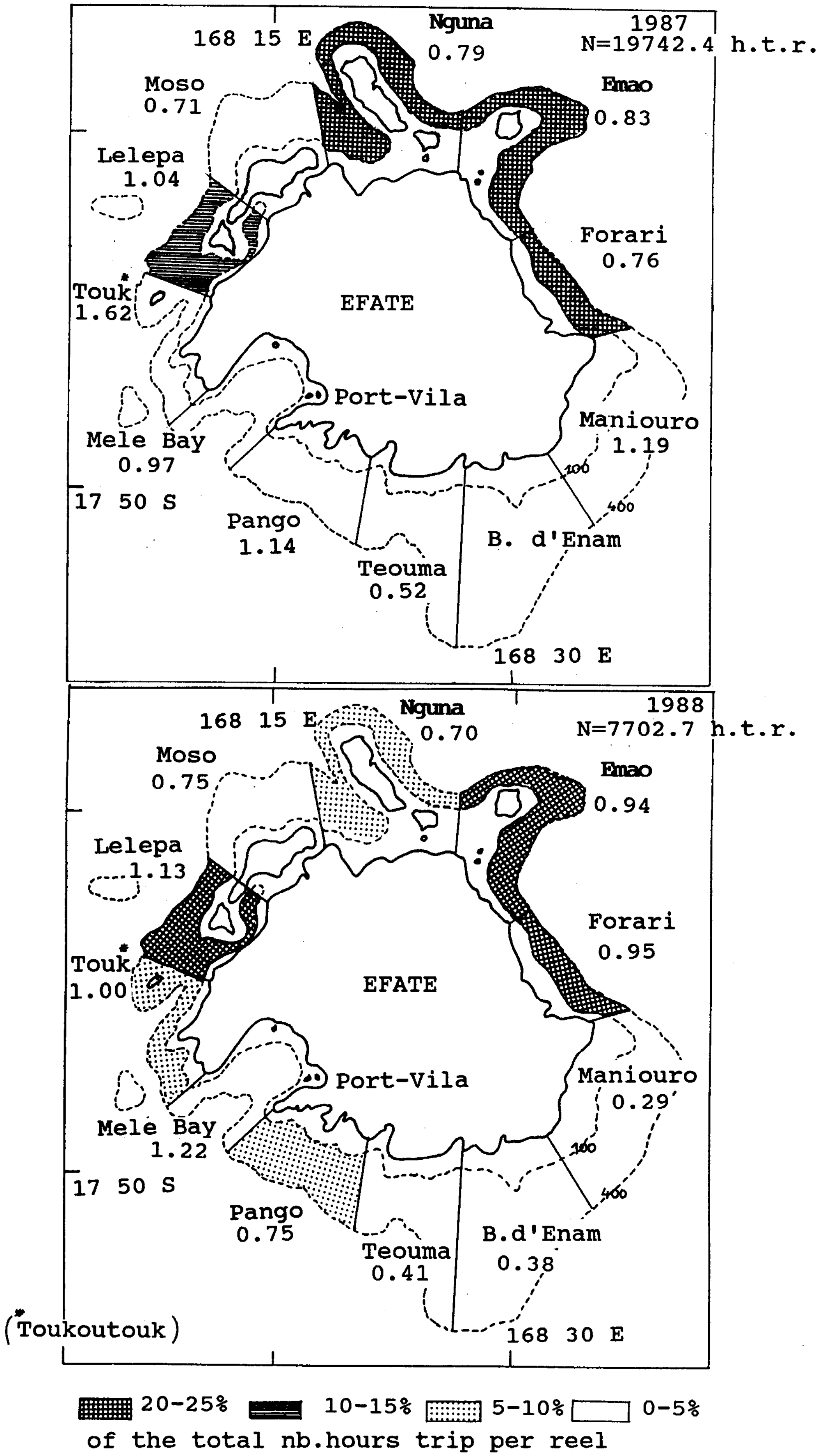

Figure 2 a and b- Distribution of the fishing effort and the catch per unit effort around Efate in 1987 (Fig.1a) and in 1988 (Fig.2b).

We have also estimated the total deep bottom fishery production including with V.F.P.D. activities,the production of the private commercial fishery. In 1988, about 7 boats were estimated to be operating in the deep bottom fishery around Efate (FYRIAM,pers. comm.).On the basis of 49 kg per trip and 100 trips per year, the production of these vessels is calculated to be 34,400 kg per year.Added to the "Nataï"s purchases,the total deep bottom fishery for Efate is estimated at 48,800 kg per 1988. Considering the Maximal Sustainable Yield for Efate is 98,200 kg (estimated on the basis of the 1 kg per hectare between 100 and 400 meters contour (BROUARD and GRANDPERRIN,1984)),this would represent about 50% of the potential production from the deep bottom fishery in Efate.

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DEVELOPMENT PROSPECTS FOR FISH PRODUCTION IN VANUATU - A GEOGRAPHICAL APPROACH

Gilbert DAVID

INTRODUCTION

The research into the prospects follows on from the 1979 population census and the work carried out on village fisheries in 1983 and 1984 under the first Agricultural Census in Vanuatu (DAVID, 1985,1987,1988; DAVID & CILLAURREN, 1989) . This is why 1979 and 1984 have been used as base years in our calculations.

I . DEMOGRAPHIC CONSTRAINTS

Population growth in Vanuatu shows itself to be very strong. Between 1979 and 1984 the population increased by 15%, from 111,250 inhabitants to 127,800 (as estimated by the Vanuatu Department of Statistics). This increase is reflected in a spectacular growth in the density of fishermen in the fishing areas and in an attendant increase in the overall fishing activities, on the basis of gear and individual input per fisherman remaining constant. Tables 1 and 2 show the variations in fishermen density per island. The actual fishing areas have been divided into :

-inter-tidal and infra-tidal zones between 0 and 10 m, which include the mangroves , the shoals and the top edge of the reef cliffs and represent the traditional fishing locations for the coastal population;

-the outer reef slope, between 10 and 400 m deep; so far fishing in this zone has remained fairly limited (SCHAAN et al, 1987), but this is the area of focus for future expansion of small-scale village fishing (ANONYMOUS, 1983, 1985 a).

II. INTER-TIDAL AND INFRA-TIDAL ZONE FROM 0 TO 10 METRES

In five years, the density of the fishermen population in this zone has progressed from 18 to 21 households per sq.km (Table 1). This is an average figure for the whole of the island group and does not, in fact, reflect the numerous variations from one region to another. Out of the 23 islands or groups of islands listed in Table 1, eight show a fishing density equal to or in excess of 40 households per sq.km of exploited area. They include Mere Lava and Mota Lava, in the Banks group (Fig. 1), Ambae, Ambrym and Pentecost, in the northern part of the country; the Tongoa-Tongariki group in the centre; and Tanna and Futuna to the south. As a consequence of this high density, there is often over-exploitation of the marine resources. Therefore, there would appear to be constraints on any increase of the fisheries activities in the inter-tidal and infra-tidal area stretching between 0 and 10 m. The nutritional needs of the population, however, are fairly high. These eight islands comprise 45% of the rural population in the country and the potential proteic supply through fish is very low, per inhabitant, due to population pressure.

The only islands which appear to offer naturally favourable conditions for an increase of the fishing effort are those with a fishermen density below 14 households per sq.km. There are nine of such islands, or groups of islands. Five are located at the northern-most end of the

Table 1 - DENSITY OF FISHERMEN AT THE MANGROVES, SAND BEACH AND SHELVES FISHING GROUNDS

Density equal or superior to 150 households per km2 on 1979

Islands	Surface area of the fishing grounds (ha)	Number of fishermen on 1979 (1)	Fishermen density (1979) (nb.hous./km2)	Number of fishermen on 1984 (1)	Fishermen density (1984) (nb.hous./km2)	General population density by island (nb.households/km2)
Mere Lava	30	165	550	180	600	13,8
Ambae	232	415	179	465	200	4,0
Tongoa-Tongariki	146	225	153	245	168	13,8

Density between 40 and 149 households per km2 on 1979

Islands	Surface area of the fishing grounds (ha)	Number of fishermen on 1979 (1)	Fishermen density (1979) (nb.hous./km2)	Number of fishermen on 1984 (1)	Fishermen density (1984) (nb.hous./km2)	General population density by island (nb.households/km2)
Mota	110	85	77	105	96	6,3
Tanna	1311	635	48	735	56	5,2
Ambrym	703	310	44	365	52	1,7
Futuna	102	45	44	47	46	5,7
Pentecost	1735	700	40	805	46	4,4

Density between 15 and 39 households per km2 on 1979

Islands	Surface area of the fishing grounds (ha)	Number of fishermen on 1979 (1)	Fishermen density (1979) (nb.hous./km2)	Number of fishermen on 1984 (1)	Fishermen density (1984) (nb.hous./km2)	General population density by island (nb.households/km2)
Mota Lava	591	200	39	235	40	6,8
Maewo	781	255	33	310	40	1,3
Santo-Malo (2)	4500	1075	24	1220	27	0,7
Malakula	12025	2230	19	2540	21	1,5
Aniwa	325	60	18	67	21	8,1
Efate (2), Emao, Nguna-Pele	8168	1380	16	1560	19	1,9

Table 1 (cont. 1) - DENSITY OF FISHERMEN AT THE MANGROVES, SAND BEACH AND SHELVES FISHING GROUNDS

Density inferior to 15 households per km2 on 1979

Islands	Surface area of the fishing grounds (ha)	Number of fishermen on 1979 (1)	Fishermen density (1979) (nb.hous./km2)	Number of fishermen on 1984 (1)	Fishermen density (1984) (nb.hous./km2)	General population density by island (nb.households/km2)
Ureparapara	305	40	13	50	16	1,1
Epi,Paama,Lopevi	2557	285	11	310	12	0,5
Erromango	1341	140	10	170	13	0,2
Vanua Lava	1670	170	10	190	11	0,5
Gaua	1511	135	10	165	11	0,5
Emae,Makura	2087	150	7	165	8	0,5
Torres	1814	65	4	80	4	0,6
Anatom	2516	90	3	110	4	0,5
Reef islands (2)	2633	?	?	?	?	0
VANUATU (3)	47253	8600	18	10025	21	

(1) The number of fishermen has been accounted for in relation to households.

(2) The rowa atoll formation (Reef islands) is now 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)

(3) Urban households of Port Vila and Luganville have note been accounted.

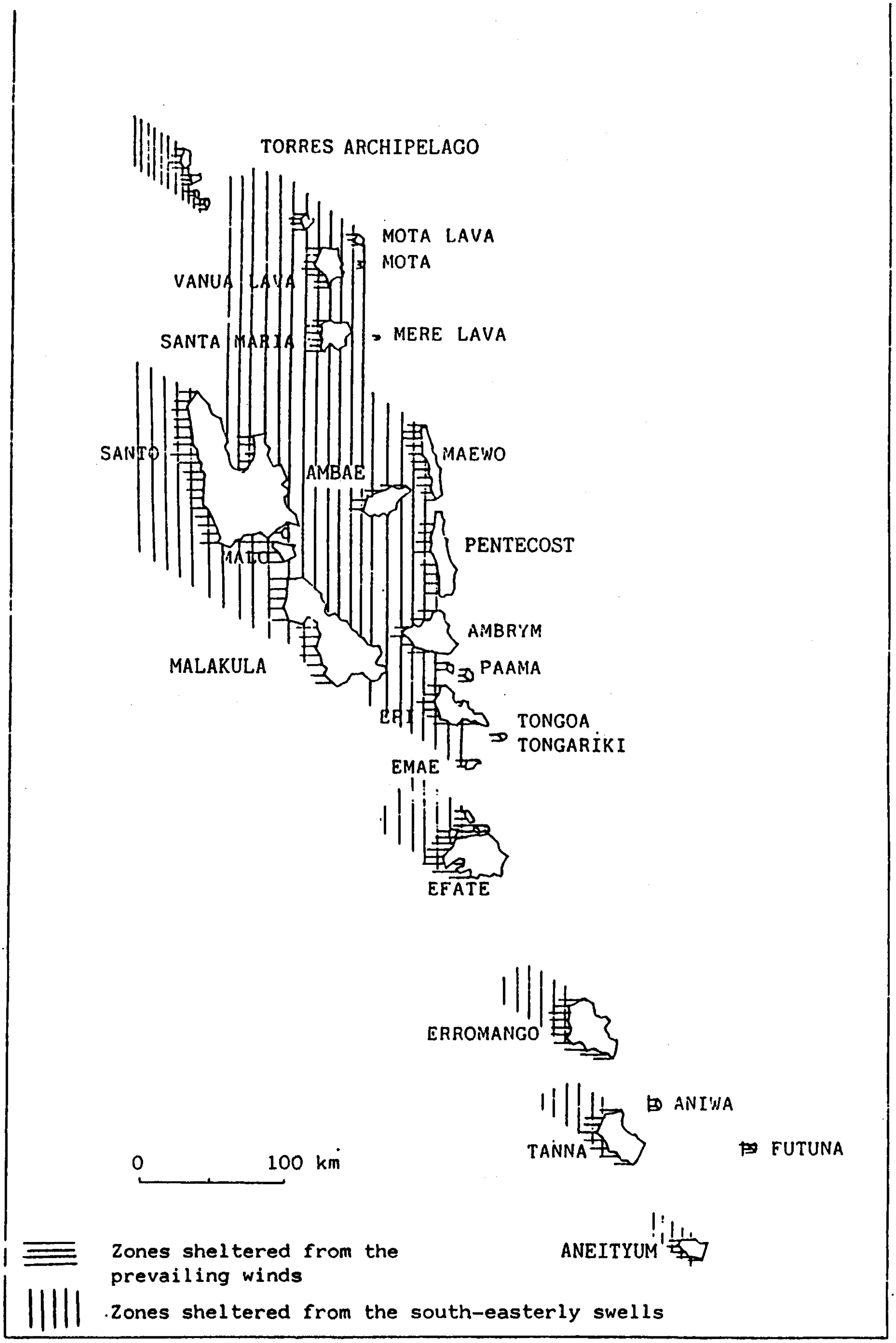

Fig. 1 - The Vanuatu archipelago Fishing zones in relation to swells and prevailing winds.

country, being the Torres Islands, Ureparapara, Rowa, Vanua Lava and Santa Maria. The other islands are situated in the central and southern part of the group, i.e. the Epi-Paama-Lopevi and Emae-Makura groups, Erromango and Aneityum (Table 1).

III. THE REEF SLOPE BETWEEN 100 AND 400 METRES

Considering the limited possibilities of the natural environment, development prospects for fishery activities within the inter-tidal and infra-tidal zones, up to 10 metres deep, would appear to be slight. Under the circumstances, the one way to substantially increase yields of fresh fish would be to develop the resources of the outer reef slope where the density of fishermen is, generally speaking, low (Table 2). For the purpose of efficiency and in order to meet consumer demand, this activity must be run by professionals working within a commercial fisheries undertaking.

The deep-sea fish living at a depth of 100 to 400 metres along the cliff of the reef present promising prospects in this respect. The main species include Etelideae, Lutjanideae, Serranideae and Lethrinideae belonging to such genus as *Pristipomoids, Etelis, Aphareus, Lutjanus, Epinephelus* and *Lethrinus* (BROUARD & GRANDPERRIN, 1984). From a consumer point of view, these species have the advantage of being free of ichtyosarcotoxism, as opposed to the fish which dwell within the first fifty meters of the reef cliff. Deep-sea fishing is fairly recent. It started when the hand-reel appeared and has gradually developed since 1982, when the Vanuatu Fisheries Department implemented the Village Fisheries Development Programme (CROSSLAND, 1984).

From a fisherman's point of view, the main attraction of deep-sea fish is that they are sedentary and available all through the year, allowing for high yields as the majority of the stocks are still untouched (BROUARD and GRANDPERRIN, *op.cit.*). In the first months of exploitation, catches are numerous and large-sized. Nevertheless, regardless of whether the stocks are hardly exploited or not at all, they are delicate, especially in the deeper areas. As BROUARD and GRANDPERRIN (1984) point out on completing their research, "the specific diversity factor indicates clearly a decrease from the superficial layers down towards the deepest ones. In the latter, where the environment's conditions are fairly constraining, although relatively unchanging, there is only a small number of species sufficiently well adapted to flourish there; the local fauna's homeostatic capabilities are probably limited, so that its response to intense exploiting will be fast and strong and this could lead to virtually irreversible situations of over-fishing".

BROUARD & GRANDPERRIN (*op. cit.*) have shown that the maximum balanced catch (MSY) would be in the region of 740 tons per annum for the whole of the country, i.e. an average of 1 kilo per ha per year. Assuming fishing is carried out solely by boats fitted with three reels, operating four to five hours per outing, at the rate of an average CPUE (catch per unit effort) of 3 kg per reel-hour, 120 boats operating on a yearly average of 150 outings for deep-sea fishing would be sufficient for a rational exploitation of these stocks (Table 3). In 1984 there were some 100 vessels belonging to associations operating under the Fisheries Department. They caught approximately 88 tons of fish, a major portion of which were bottom-dwelling fish (ANONYMOUS, 1985b). In addition to this fleet, the main activity of which is normally fishing, some 120 to 200 motorised crafts fitted with reels have to be taken into consideration; these are usually used for carrying passengers and agricultural produce and only fish on occasion. Together these two fleets may possibly yield a yearly average of 90 to 150 tons of bottom-dwelling fish, in other words a supply of 0.7 to 1.2 kg per year per person based on an estimated population of 127,800 in 1984. There is therefore, quite a considerably potential for increasing production of bottom-dwelling fish, especially in Santo-Malo, Malekula and Efate which combine a high MSY with a large population (Table 3).

Referring the MSY as calculated by BROUARD & GRANDPERRIN (*op. cit.*) to the population estimates of the Statistics Office as at 1984, led to working out a figure for the potential supply per person for each of the main islands in the country. Overall, the supply would amount to 5.7 kg per head, which is ten times the present supply of bottom-dwelling fish.

IV. THE REEF SLOPE FROM 10 TO 100 METRES DEEP

Although the Vanuatu Government pins its hopes for commercial development on the exploitation of zones between 100 and 400 metres, the reef cliff between 10 and 100 metres also offers interesting possibilities because of its wealth of species particularly sought after by consumers and its closeness to the shore. Around the leeward slopes in the islands, fishing zones are protected from the offshore swells and the waves (Fig. 1). Fishermen only require an outrigger and a line, 50 to 100 metres long, which they wind around an empty bottle.

Although many of the species thus caught hold a risk of ichtyosarcotoxism, cases of severe poisoning are few and far between; fishermen have a good feel for the most dangerous species, know where they dwell and the season in which their toxicity is at its peak. The threat of fish poisoning would not appear to inhibit to any major degree consumer interest in fish from the upper level of the reef slope, these being considered tastier that bottom-dwelling fish (RODMAN, 1986). These are the species to focus upon for increasing production for self-consumption and developing a small-scale commercial fishing operation, as distinct from fishing for bottom-dwelling fish in that :

-being essentially occasional and unstructured, such commercial activities would remain a side-line compared to agriculture;

-the cost is low, requirements are simple, be it the crafts or the fishing gear or the methods of preserving the catch ;

-a greater number of fishermen could be involved, as a result of the two previous points.

V. PELAGIC ZONE AND FISH AGGREGATING DEVICES

The exploitation of pelagic fish, mainly the skipjack, the yellow-fin tuna and such like, also offers interesting prospects for development. However, the extreme mobility of the shoals constantly on the look-out for food, is a severe constraint due to the amount of time devoted to following up and seeking the fish. The establishment of fish aggregating devices (FAD's) provides an interesting solution to the problem, subject to the FAD's being set up close to the coast in the productive areas. Fishermen are reluctant to use the rafts anchored too far out at sea. CILLAURREN (1988) showed that the viability of fishing around an FAD is closely related to the location of the raft, especially in respect of the time required to reach it. Given the costs involved in manufacturing and installing a raft (US$3,000 in 1983), particular attention has to be devoted to the strength of the materials and their assembly, because the zones frequented by tuna, the most appropriate for FAD's, are always very exposed to the winds and the currents. From 1982 to 1984, fifteen FAD's were set up, of which nine in 1984. As at December 31st, 1984, ten were still operational, the other five having been destroyed by storms.

Table 2 - DENSITY OF FISHERMEN AT THE OUTER-SLOPE FISHING GROUNDS FROM 10 TO 400 M

Density equal or superior to 0,5 households per km2 on 1979

Islands	Surface area of the fishing grounds (ha)	Number of fishermen on 1979 (1)	Fishermen density (1979) (nb.hous./km2)	Number of fishermen on 1984 (1)	Fishermen density (1984) (nb.hous./km2)	General population density by island (nb.households/km2)
Mere Lava	2325	90	3,9	97	4,2	13,8
Tanna	49888	386	0,8	447	0,9	5,2
Malakula	146444	738	0,5	841	0,6	1,5
Mota Lava	6569	38	0,6	45	0,7	6,8

1) The number of fishermen has been accounted for in relation to households.

Table 2 (cont. 1) - DENSITY OF FISHERMEN AT THE OUTER-SLOPE FISHING GROUNDS FROM 10 TO 400 M

Density between 0,15 and 0,49 households per km2 on 1979

Islands	Surface area of the fishing grounds (ha)	Number of fishermen on 1979 (1)	Fishermen density (1979) (nb.hous./km2)	Number of fishermen on 1984 (1)	Fishermen density (1984) (nb.hous./km2)	General population density by island (nb.households/km2)
Ambae	15333	52	0,3	82	0,5	4,0
Efate (2), Emao, Nguna-Pele	123780	407	0,3	460	0,4	1,9
Aniwa	6275	15	0,25	17	0,3	8,1
Gaua	20267	45	0,2	58	0,3	0,5
Maewo	39493	81	0,2	98	0,25	1,3
Tongoa-Tongariki	21255	38	0,2	62	0,3	13,8
Anatom	33266	72	0,2	88	0,25	0,55

Table 2 (cont. 2) - DENSITY OF FISHERMEN AT THE OUTER-SLOPE FISHING GROUNDS FROM 10 TO 400 M

Density inferior to 0,05 households per km2 on 1979

Islands	Surface area of the fishing grounds (ha)	Number of fishermen on 1979 (1)	Fishermen density (1979) (nb.hous./km2)	Number of fishermen on 1984 (1)	Fishermen density (1984) (nb.hous./km2)	General population density by island (nb.households/km2)
Erromango	59908	27	0,04	73	0,05	0,2
Emae.Makura	35474	5	0.01	5	0.01	0,5
Torres	46721	?	?	?	?	0,6
Ureparapara	6799	?	?	?	?	1,1
Rowa	5975	?	?	?	?	0
VANUATU (2)	1018605	2358	0,23	2692	0,26	

(1) THe number of fishermen has been accounted for in relation to households.
(2) Urban households of Port Vila and Luganville have note been accounted.

Density between 0,05 and 0,14 households per km2 on 1979

Islands	Surface area of the fishing grounds (ha)	Number of fishermen on 1979 (1)	Fishermen density (1979) (nb.hous./km2)	Number of fishermen on 1984 (1)	Fishermen density (1984) (nb.hous./km2)	General population density by island (nb.households/km2)
Mota	4025	5	0.12	6	0.15	6,3
Vanua Lava	22891	25	0,11	28	0.12	0,55
Epi,Paama.Lopévi	95637	105	0,11	115	0.12	0,45
Pentecôte	33950	34	0,10	39	0.11	4,4
Futuna	5100	5	0,09	5	0,09	5,7
Santo-Malo (2)	208945	165	0,08	180	0.09	0,7
Ambrym	33900	25	0,07	30	0,09	1,7

(1) The number of fishermen has been accounted for in relation to households.

(2) Urban households of Port Vila and Luganville have note been accounted.

Table 3 - Development potentials of the deep bottom fishing activities in the main islands or group of islands in Vanuatu

Islands	Maximum substainable yield MSY (tonnes/year) (1)	Number of boats to reach the MSY (1), (2)	Population in 1984 (nb. of people)	Potential supply by people (kg/year)
Santo-Malo	143	24	21,080	6.8
Malekula	101	17	17,300	5.8
Efate	95	16	21,910	4.3
Paama,Epi,	77	13	5,280	14.6
Erromango	54	9	1,140	47.4
Banks	46	8	5,450	8.4
Sheperds (3)	45	7	3,740	12
Tanna	42	7	17,850	2.6
Maewo	33	5	2,200	15
Ambrym	27	4	7,290	3.7
Pentecost	25	4	10,770	2.3
Torres	21	3	390	53.8
Anatom	15	2	630	23.8
Aoba	12	2	8,700	1.4
All country	736	121	127,800	5.7

1) from BROUARD and GRANDPERRIN (1984)
2) Boats are catamarans Alia, fitted with three reels, operating for to five hours per trip, at the rate of an average CPUE of 3 kg per reel hour on a yearly average of 150 trips.
3) The archipelago of Sheperds is located in the center of the country; it is composed by the islands Tongoa, Emae, Tongariki, Makura, Mataso and Buninga.

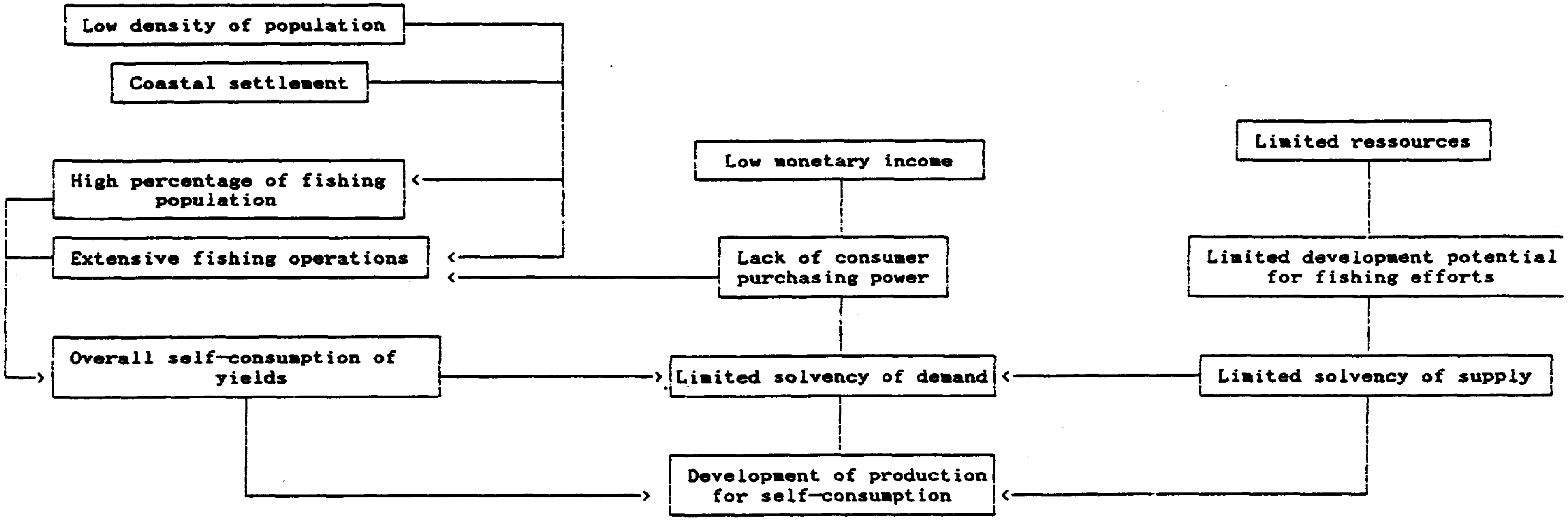

Figure 2 - Factors of constraint on commercial production leading to a tendency towards production for self-consumption in the inter-tidal or infratidal zones up to 10 m deep where fisheries is below 14 households per sq.km.

The most commonly caught species around FAD's are the skipjack (*Katsuwonus pelamis*) and the yellow-fin tuna (*Thunnus albacares*). So far, a large proportion of the skipjack caught by the village fishing associations was kept for fishbait stock to be used for fishing bottom-dwelling fish. The skipjack costs 50 vatu per kilo for this purpose, so it is an economically depreciated fish, although of great nutritional value. If the landings of skipjack could be increased for urban markets, the price maintained at its low level and a campaign launched to explain its nutritional qualities, this could be a way of developing popular consumption of fresh fish in Port Vila and Luganville.

VI. . CONCLUSION : THE CONSTRAINTS ON DEMAND

There can be no effective increase in the production of fish unless the demand, which is the main constraint inhibiting fishing activities in the islands, increases in the same way. An information campaign on the nutritional importance of the produce from the sea run by the local government councils and the churches could certainly have a positive impact on non-monetary demand. However, it would be pointless to expect a sizeable increase in the monetary demand which is related to strongly constraining factors such as, in particular, the low income of the rural population, the coastal nature of settlements, the high percentage of fishermen among the coastline communities and, consequent upon that, the predominance of production for self-consumption (Figure 2).

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EXPERIMENTAL TRAP FISHING IN VANUATU

Jean-Michel GUERIN

Being used traditionally and successfully in other parts of the world (Philippines, Caribbeans, (MUNRO 1974, PAULY et al in KULBICKI et MOU-THAM, 1987)), fish traps were tried in Vanuatu as an alternative for deep bottom fishing. This method was considered a potential development towards more intensive fishery, after the common bottom line fishing techniques.

This research programme was carried out at the Vanuatu Fisheries Department, funded by the French Ambassy in Port-Vila, with the assistance of three successive French Volunteers (VSNA): Michel BLANC, Didier TOURREL and Jean-Michel GUERIN). This paper gives an analysis of the results of all the campaigns.

I - METHODS

The traps used were of the type presented at Figure 1. This Z-trap was designed by FAO. It is made of a metal frame (bars 10 mm diam.) and of metal galvanized mesh (150 x 25 mm) with two symetric entrances. Those traps were weighted and the rig is made of a polypropylene rope (12 mm diam.) and 3 buoys. Two differents boats were used to set the traps, the only requirement for the boat being to have some hydraulic powered line-hauler to lift the traps from the water.

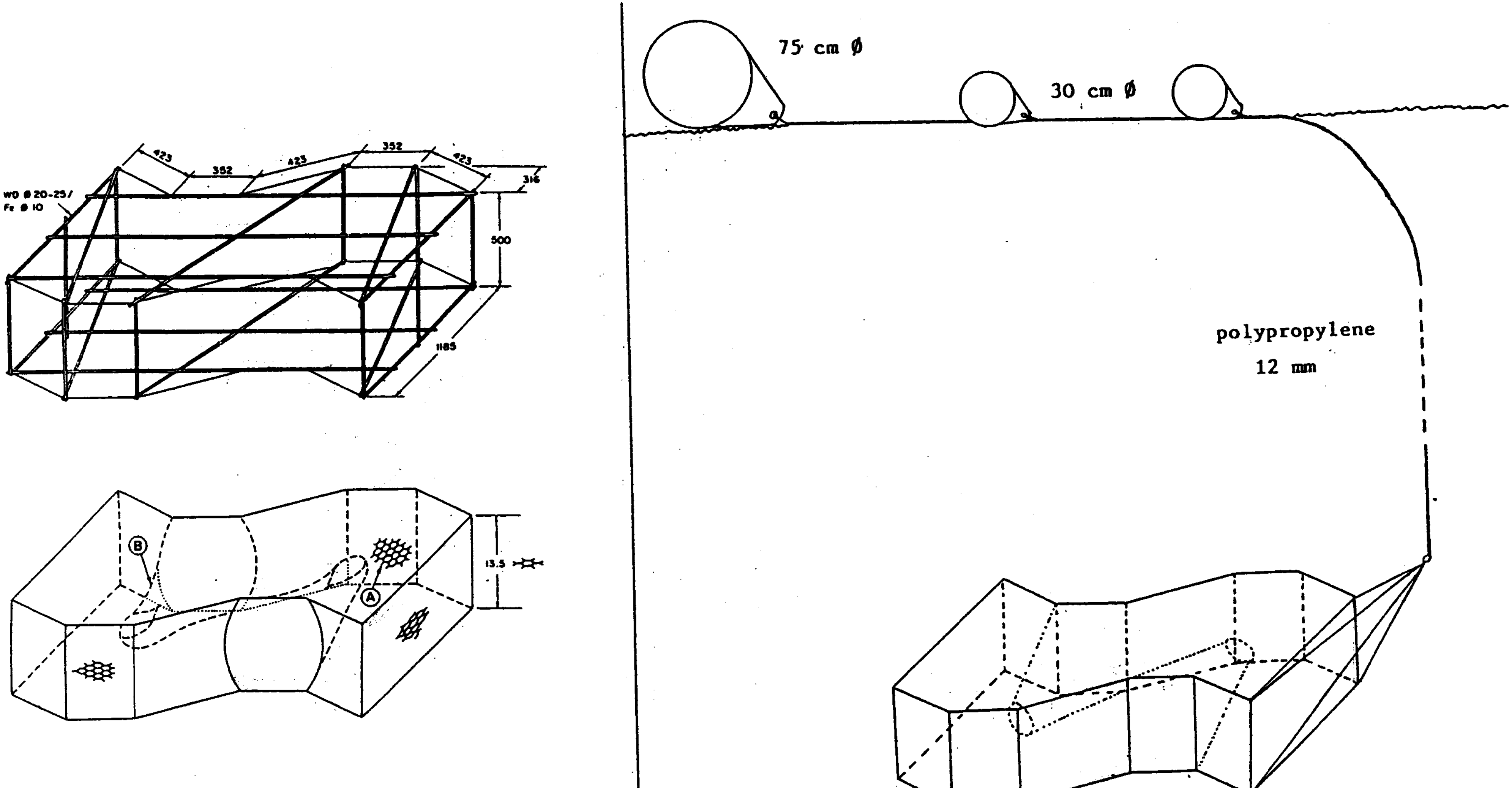
The experiment started in April 1987 and lasted until October 1988. A total of 169 traps sets were made in various spots around Efate island (reef fishing zones on figure 2). The traps were baited at the best with fresh skipjack (Katsuwonus pelamis) or sardines (Herklotsichtys punctatus) which proved to be in preliminary studies (BLANC, 1987), the most efficient bait for that kind of fishing. When those baits were not available, other types of fresh or frozen fish were used. The traps were left in the water for different soaking times (from 4 to 240 hours) at depth varying between 17 and 430 m. The traps were then taken back on board, the fish and nautilus collected and some new bait put in, prior to another soak.

For each trap set, the data collected were: soaking time, depth, type of bait used, number of nauti lus caught, total weight of fish caught, number of fish of commercial species caught. From the 169 sets, two traps were lost, so a total of 167sets were analysed.

II-RESULTS

A total of 526 kg of fish and 252 nautilus were caught for a total soaking time of 4,988 hours. The average catch per set was 3.15 kg of fish and 1.51 nautilus.

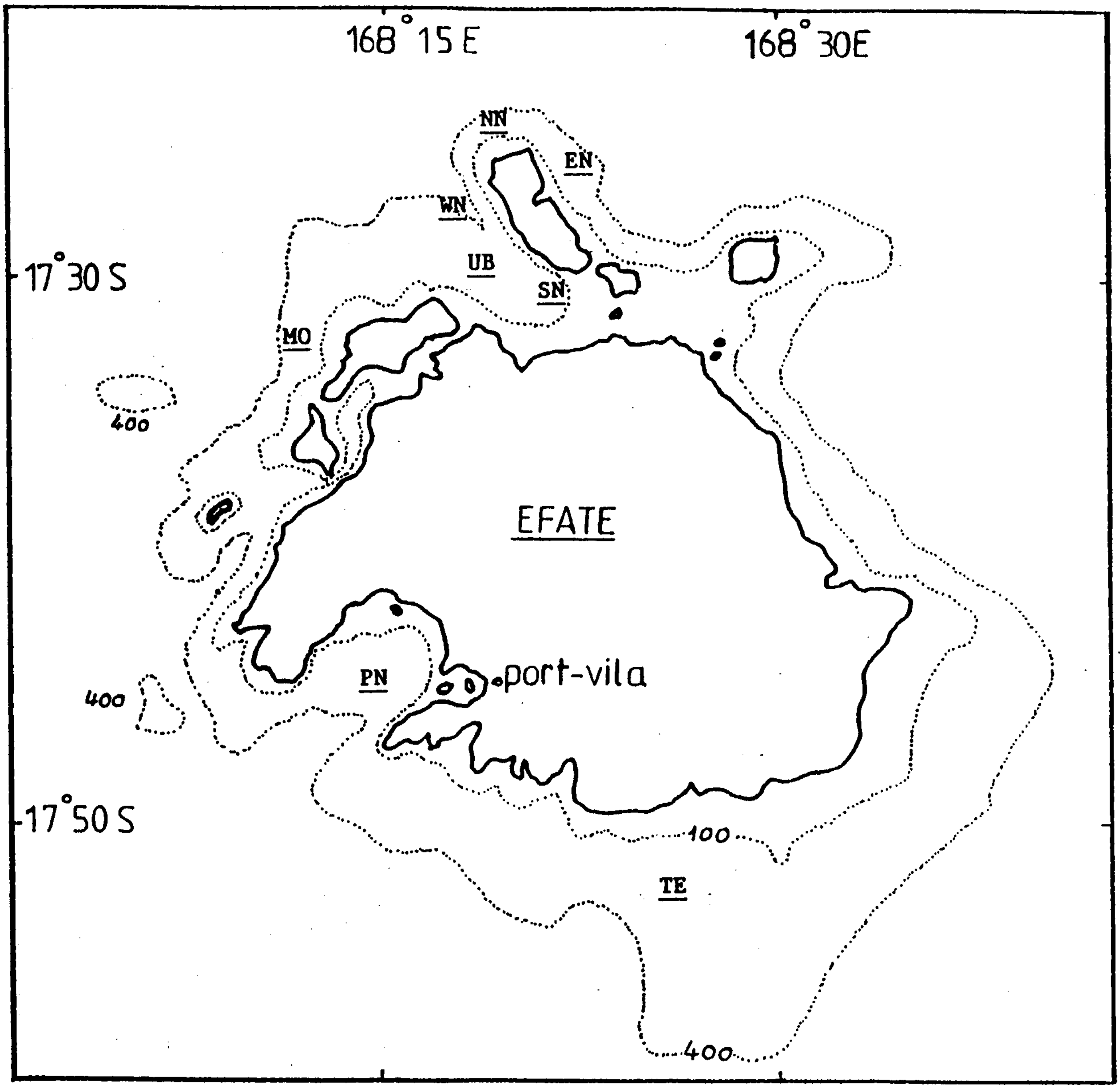
This being for an average soaking time of 29 hours per set. Taking a closer look to the data, the important heterogeneity has to be emphasized. As shown on figure 3, very little traps made good catches (over 10 kg) but the majority of them made very poor catches (between 0 and 2 kg). Due to this very high level of dispersion in the catches observed in similar conditions, some of the results turned to be not statistically significant (example: total fish catch vs depth). In the following sections, only the statistically significant results are presented.



length in mm.

Source: FAO small fishing gears catalog.

FIGURE 1: TRAP DESIGN AND OPERATIONS



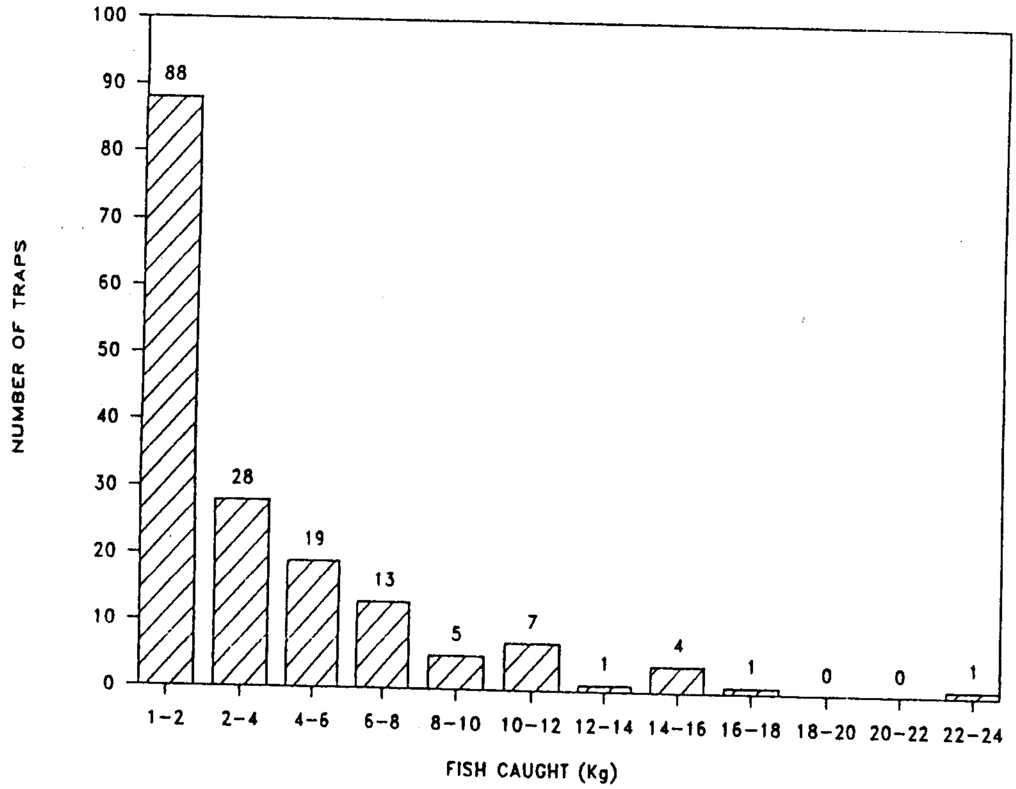
NN:North Nguna	EN: East Nguna	WN: West Nguna
SN: South Nguna	UB: Undine Bay	MO: Mosso
PN: Pango North	TE: Teouma	

FIGURE 2: FISHING ZONES.

TABLE 1: TOTAL FISH CATCH vs SOAKING TIME.

soaking time from	hours to	average catch Kg/trap	trap sets
0	12	1.62	13
12	24	3.30	111
24	48	3.15	31
48	78	0.26	7
78	+	7.76	5

FISH CATCH DISTRIBUTION



NAUTILUS CATCH DISTRIBUTION

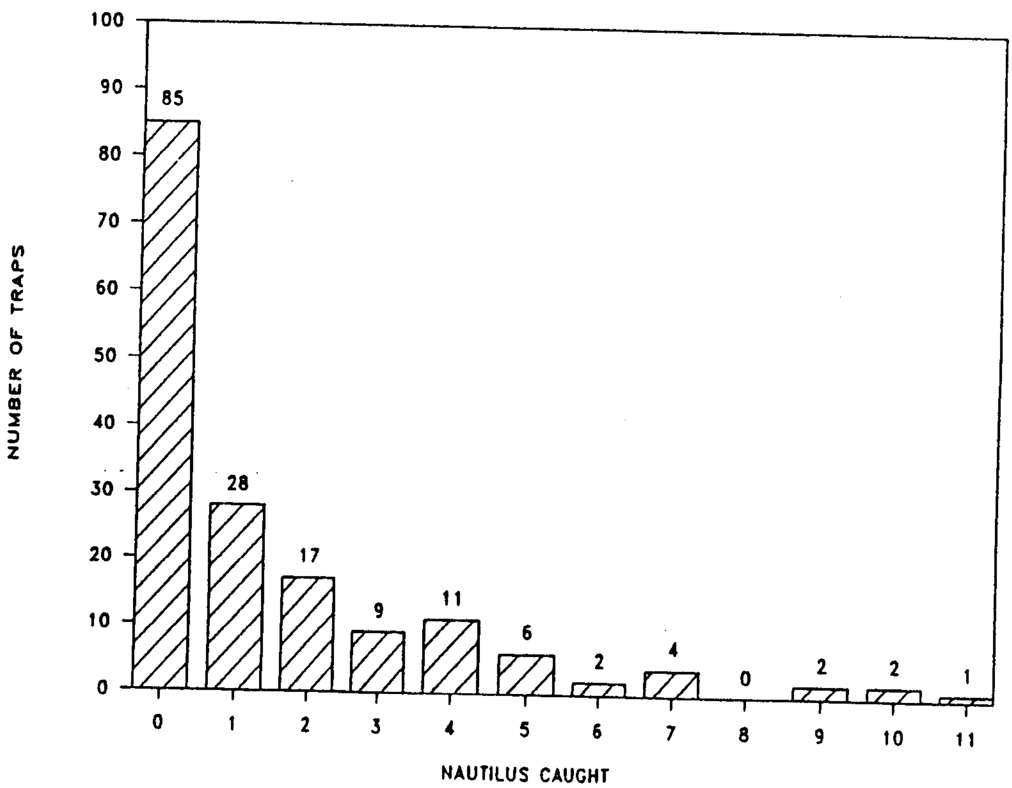


FIGURE 3: CATCHES DISTRIBUTIONS

II-1 : Influence of soaking depth

Only two types of results were significant, the depth showed an influence on the species composition of the catches and on the catch of nautilus.

I-1-a: Nautilus catch.

The nautilus catch was analysed by comparing the catch per unit effort (CPUE, here being the number of nautilus caught per hour of soaking time) at different soaking depth. The total depth range was divided in eight 50 m ranges and the average CPUE for each range is plotted at figure 4. Those results being statistically significant; it seems that the distribution of the nautilus is bi-modal. This could be related to the behaviour of the nautilus that moves to different depths during night and day. This is only an hypothesis and it would be necessary to re-design an experiment to find out the reasons for such a bi-modal distribution.

II-1-b: Species composition in trap catches.

The species recorded in the catch were:

*Pristipomoides filamentosus:	11.8%
*Pristipomoides flavipinnis:	21.0%
*Pristipomoides multidens:	3.3%
*Lutjanus malabaricus:	6.0%
*Lutjanus rufolinatus:	32.8%
*Epinephelus sp.:	6.2%
*Gymnocranius sp.:	7.7%
*Seriola sp.:	3.3%

With the percentage in total number of fish caught; these were the most important catches of commercial fish species.

96% of the fish were caught between 100 and 300 meters. The statistical analysis of these data was made comparing the distribution of CPUE for each species at four different depth ranges. These CPUE (in kg of fish caught per hour of soak) are all very low, ranging from 0 to 0.747 These results are shown at figure 5 where the importance of Lutjanus rufolinatus has to be noticed. The four distributions were found being significantly different. .

Comparing these results with the droplines fishery, the absence of Etelis sp. is noticeable. Lutjianus rufolinatus is usually not caught with droplines (BROUARD et GRANDPERRIN, 1984), but it turned to be quite abundant in the traps. The other important results are the importance of Lutjianus rufolinatus between 100 and 200 meters and the abundance of Pristipomoides flavipinnis between 200 and 250 meters.

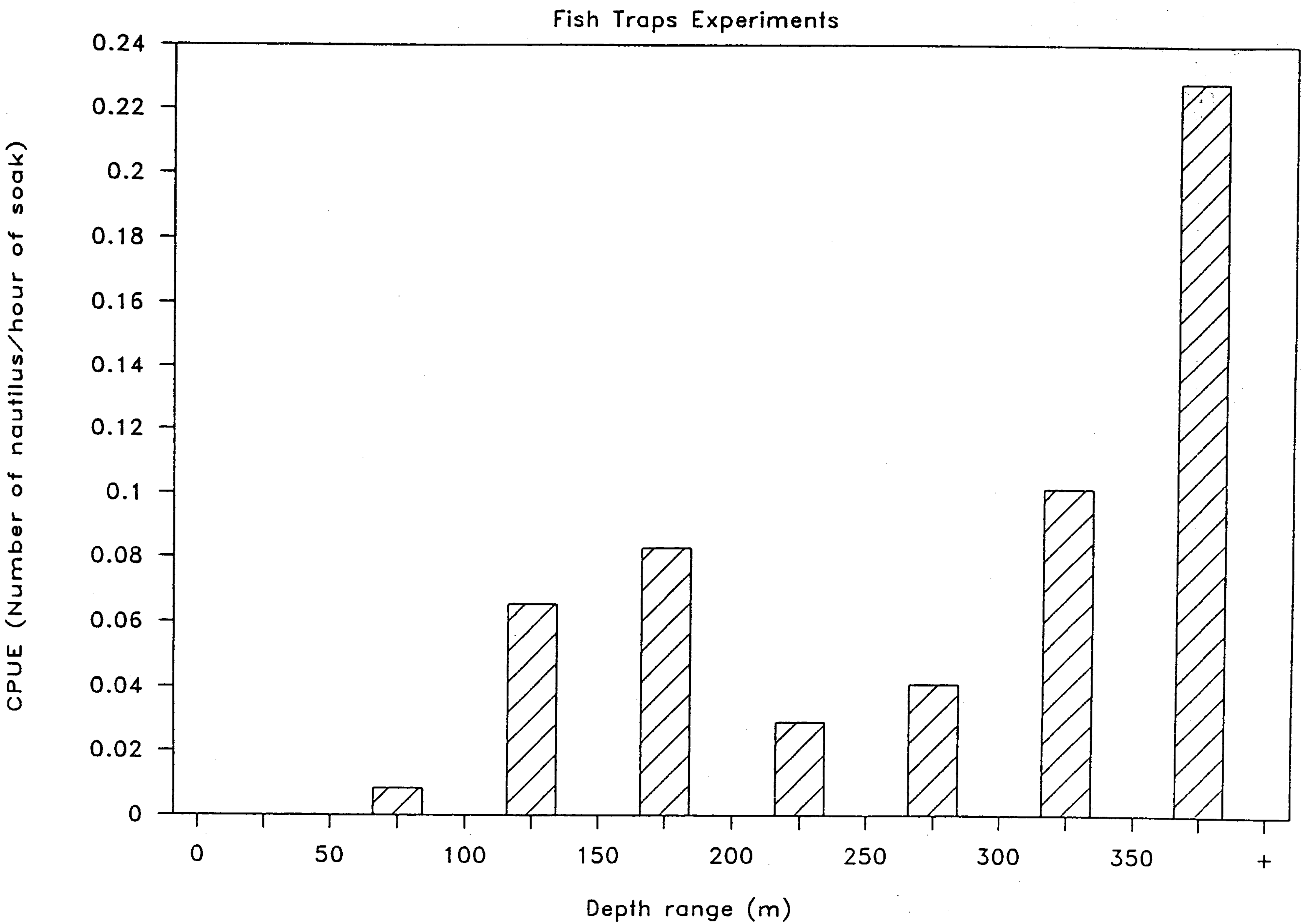


FIGURE 4 : NAUTILUS CATCH vs DEPTH.

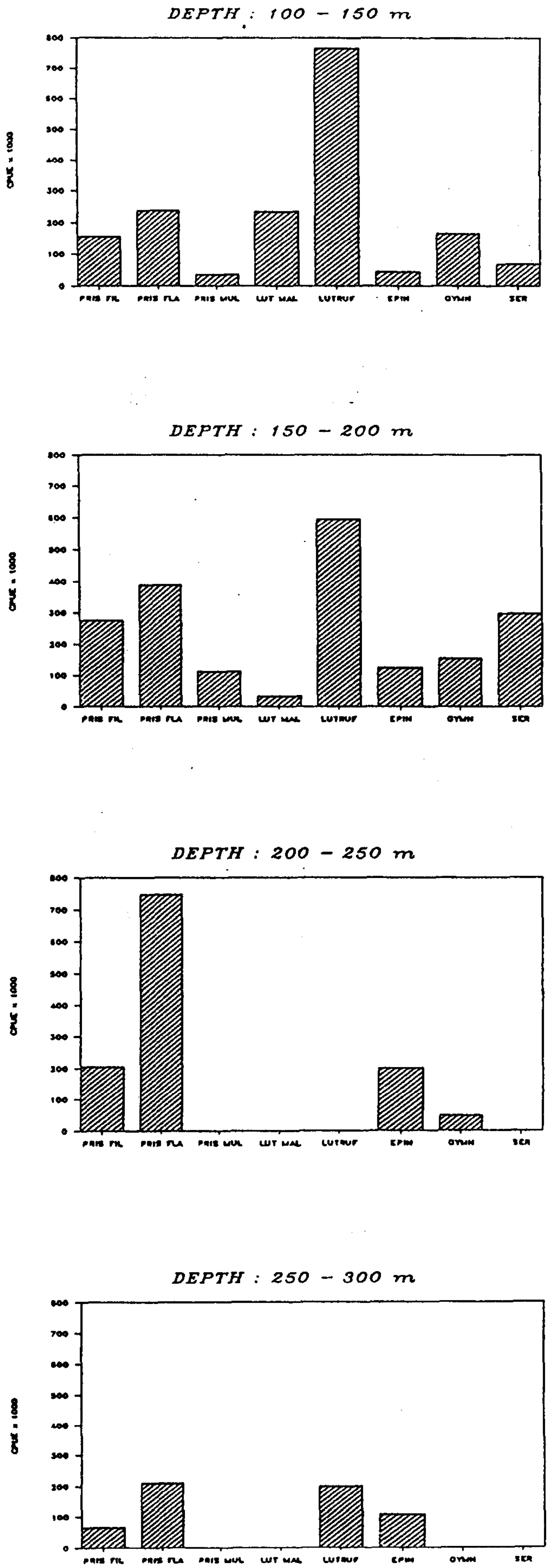


FIGURE 5: SPECIES DISTRIBUTION AT DIFFERENT DEPTH RANGES.

II-2: Influence of soaking time.

The soaking time showed to have a significant influence on the total fish catch for each trap set. The results are indicated in the table 1. There is an increase in fish catch between the two last ranges (48-78 hrs and over 78 hrs). Only 5 trap sets were made for more than 78 hours, and in the same place that might as well have been a very productive one. It could be necessary to redesign an experiment so that with more homogenous data, it would be possible to say if the soaking time is or not significant.

III- DISCUSSION

A private fisherman experience in New Caledonia consisted of traps set at depth between 90 and 140 m., the average catch was 8.9 kg/set (SPC, 1985). This is well above the results obtained in Vanuatu which were of 3.15 kg/set of fish. This difference was also observed with the nautilus catch.
The Vanuatu fish trapping results are still comparable to the expectations for fish-trap fishing in the reef zone in the Caribbeans (4 kg/trap.day - MUNRO, 1980). The fish traps in Vanuatu were set in much deeper waters. This resulted in long and costly operations that makes it difficult to appear of a commercial interest. The same catch, if it is made in reef zones (< 30 m) or in deeper zones (100-200 m.) cannot make the same profit. A major difference, from the economical point of view is that in the case of shallow waters fish-trapping, there is a lobster by-catch that is very important as far as profit is concerned, no crustaceans being caught in our experiment.

Comparing with the longline fishing, where the same boat and crew were used, the catch was 18 kg of fish caught per hour of bottom longline fishing (FYRIAM A. pers. comm.).This would suggest the longlines being much more productive especially considering the lower investment cost of longlines compared to fish trapping were each trap built and fully rigged costed ca 50 000 vt.

There was a strong variability in the results of the trap fishing, 53 % of the trap set have been catching between 0 and 2 kg of fish and some few others caught up to 15 or 22 kg (Figure 3). This variability had already been emphasized by other authors (DALZELL and AINI, 1987). In order to give more useable data for the next fish trapping experiments, wherever this might happen, a special attention should be paid to the experimental plan, evenly setting the traps in different places, at different depths and for different soaking times. This would allow the use of multi-factor variance analysis that would, for the same experimental cost, provide much more accurate informations.

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