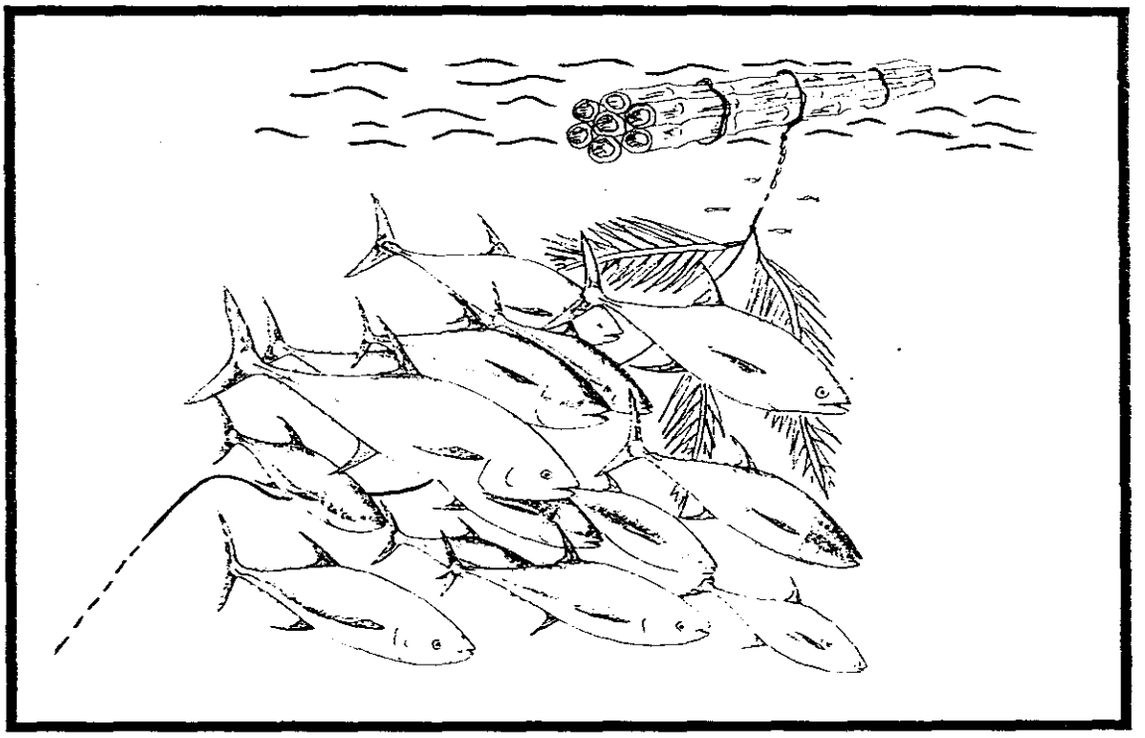
THE ASSESSMENT OF THE INTERACTION BETWEEN FISH AGGREGATING DEVICES AND ARTISANAL FISHERIES

Document 2: Vanuatu Country Report



FISHERIES MANAGEMENT SCIENCE PROGRAMME

OVERSEAS DEVELOPMENT ADMINISTRATION

Project R. 4777

MRAG Ltd

July 1994

DRAFT FINAL REPORT

Project Period: August 1991 to July 1994

Name: Jim Anderson

Signature:

MRAG Ltd
27 Campden Street
London W8 7EP
UK

Contents

Executive Summary

In April, 1990, the Vanuatu Department of Fisheries requested the assistance of the South Pacific Commission (SPC) to prepare a FAD programme proposal and assist in FAD deployments. The basic aim of the programme was to increase landings of fish at the two principle urban centres of Port Vila and Luganville; the SPC programme was targeted towards the deployment of both shallow and deep-water FADs. With the simultaneous development of appropriate fishing techniques the shallow-water FADs in particular would increase the catchability of baitfish resources (*Selar* spp and *Decapturus* spp) and attract artisanal fishing away from more heavily exploited reef and near-shore environments.

The Fish Management Science Programme of the ODA became involved with the project in September 1991 and field-work commenced on Espiritu Santo island (Santo) in March, 1992. The role of the FMSP field officer was to determine the nature of the interaction between the artisanal fishermen and the FADs; were the aims of deployment being met and what effect was the FAD fishery having on traditional inshore fisheries. The scope of the research was extended to include some trial fishing because of the smaller than anticipated contribution into development of fishing techniques from the SPC's Masterfishermen programme.

None of the FADs deployed off Santo proved successful in attracting fishermen although some FADs (notably two off South Santo) did succeed in aggregating baitfish, although not on a regular basis. It became clear shortly after the commencement of fieldwork in March that there was lacking a certain dynamic in the artisanal fisheries of Santo. Given that opportunities to fish in traditional areas and in the traditional manner remain, alternative subsistence activities exist and the relatively low price that baitfish and tunas fetch in local markets, the FADs remained unused by the fishermen. Inshore, shallow-water FADs would, however, appear to be a suitable addition to the fishing gear of such communities because the limited range of the fishing craft has lead to some local depletion of both shallow and deep-reef stocks.

In common with other Pacific nations, Vanuatu is currently undergoing a period of rapid population growth; the demand for FADs to enhance the opportunities for artisanal fishermen and to provide an important source of nutrition is likely to increase over the next decade.

Sections 1 and 2 of this report describe the geography and economy of Vanuatu, the historical context and give a general description of the fishery. In Section 3 the fishery resources and the marketing system of Vanuatu are described. Sections 4 and 5 describe the frame survey undertaken to establish new FAD deployment sites including deployments on the outer islands of Pentecost and Ambrym. Sections 6 and 7 described the reaction of fishermen to the FADs and the trial fishing undertaken by the project on FADs in South Santo. Finally, in Section 8, general conclusions and recommendations are presented.

Acknowledgements

I would like to thank the Director of Fisheries, Wycliffe Bakeo and Senior Fisheries Officer, Graeme Nimoho of Santo Fisheries Department for all their help and cooperation, and for that of their staff during this project. I would also like to thank Mr William Morris and Mr Phil Smith of the Engineering Workshop for keeping 'Savin' afloat; and Simon Maeva, Nare, Patrick Bwei-Bwei and Angus Scotland of the Fisheries Training Centre. Finally, I would like to thank Francis Hickey for inviting me on the 'Outer Islands' tour, and for all his help throughout the project. Hem nomo.

List of Tables

List of Figures

1. Background Information

1.1 Geography and Population

Vanuatu is a nation of 82 islands extending 875 km in a north-south direction from the Torres Islands (at 13° S) to Aneityum in the south (at 21° S) covering a land-area of 12,190 km^2 (See Figures 1 and 2). The majority of islands were formed by volcanic extrusion and subsequent tectonic uplifts have added limestone plateaus; most have a steep shelf descending rapidly into deep water with some fringing reef and there is an estimated 7358 km^2 of shelf between 100 and 400 metres depth (Brouard and Grandperrin,1985). There are active volcanoes on Tanna, Lopevi, Ambrym, Ambae and Santa Maria plus a submarine volcano near Tongoa. The average air temperature in Port Vila, the capital, is 76.3°F with an annual rainfall of 2107 mm; Espiritu Island to the north is both hotter and receives more rain.

The population (127,000 in 1984) is widely spread about the islands, with only two major concentrations; Port Vila on Efate has by far the largest concentration with a population of about 35,000. The only other town (Luganville on Espiritu Santo (Santo)) has a population of about 7,500. Although numerically small, there is an economically-strong community of Chinese in both Port Vila and Luganville.

1.2 Economy

There is little manufacturing industry in Vanuatu and no heavy-industry, the main sources of revenue are from tourism, coffee, cocoa and copra; there is also a thriving market developing for high quality beef. Prior to 1986, the South Pacific Fishing Company operated a transhipment facility for longliners at Palikula on Espiritu Santo; this operation subsequently shut-down and relocated out of the country. Although in its infancy, there has been some discoveries of commercial quantities of gold on both Espiritu Santo and Malakula to the south. A small logging industry has existed in the country for a number of years operating on most of the larger islands; however, in 1994, a number of Malaysian contractors won logging rights and have already commenced operation on Espiritu Santo. Although this is clearly of short-term economic benefit to the nation, fears have been expressed about the potential for ecological damage that may develop through clear-felling in an area of high rainfall. There are also plans for a 'town' of about 15,000 Taiwanese Chinese to be established to the west of Luganville, Espiritu Santo and the affects on the local culture and economy are expected to be significant.

In common with many other Pacific island nations, Vanuatu currently experiences a very high population growth rate (3.7% in the early 1980's (Connell, 1984)). The country has certain tax incentives for investments and is currently enjoying a period of growth in its off-shore banking facilities.The majority of the population are not involved full-time with the money economy and rely on subsistence agriculture and fishing although most are involved with some seasonal employment on copra plantations.

Figure 1: Position of Vanuatu in the South West Pacific

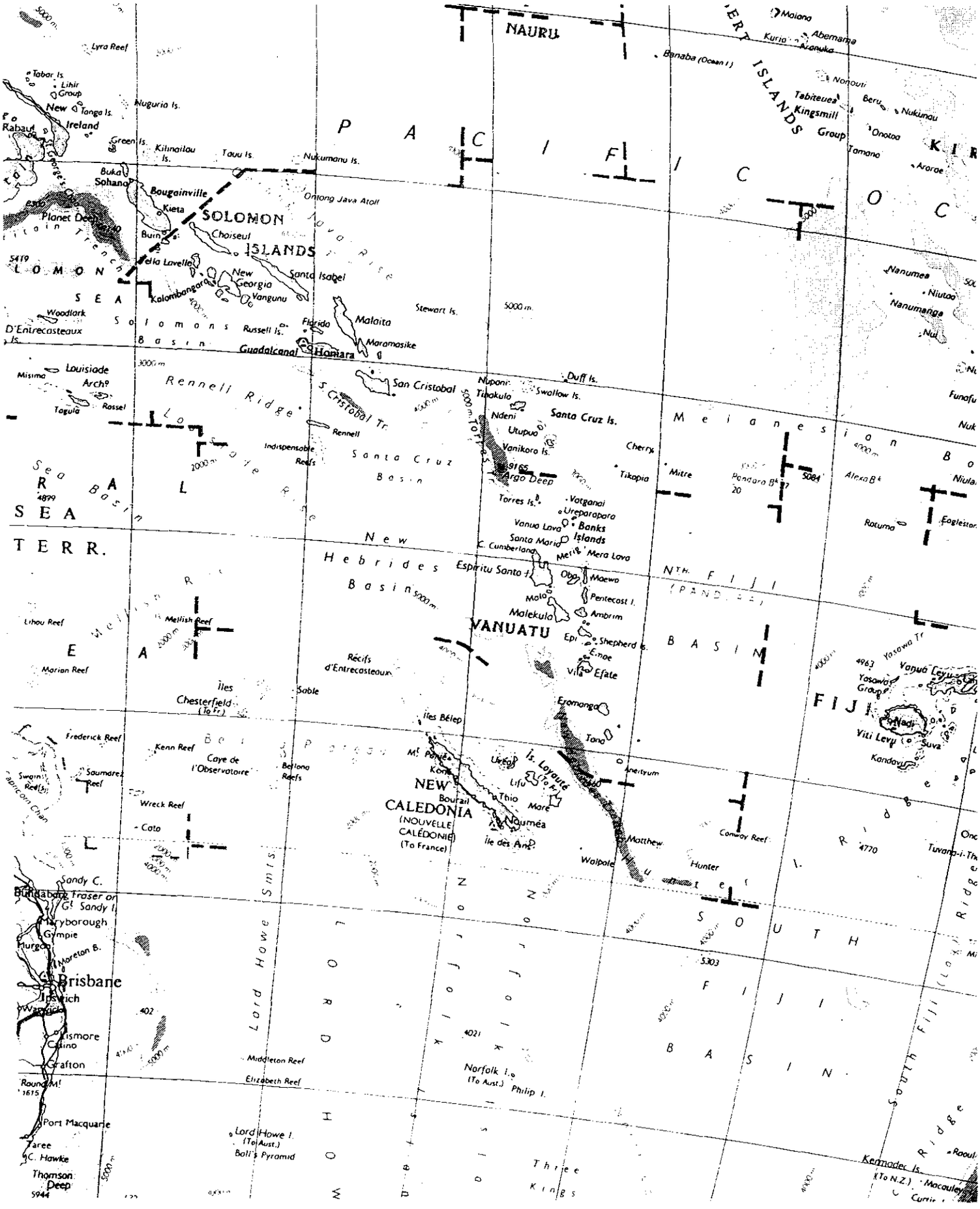
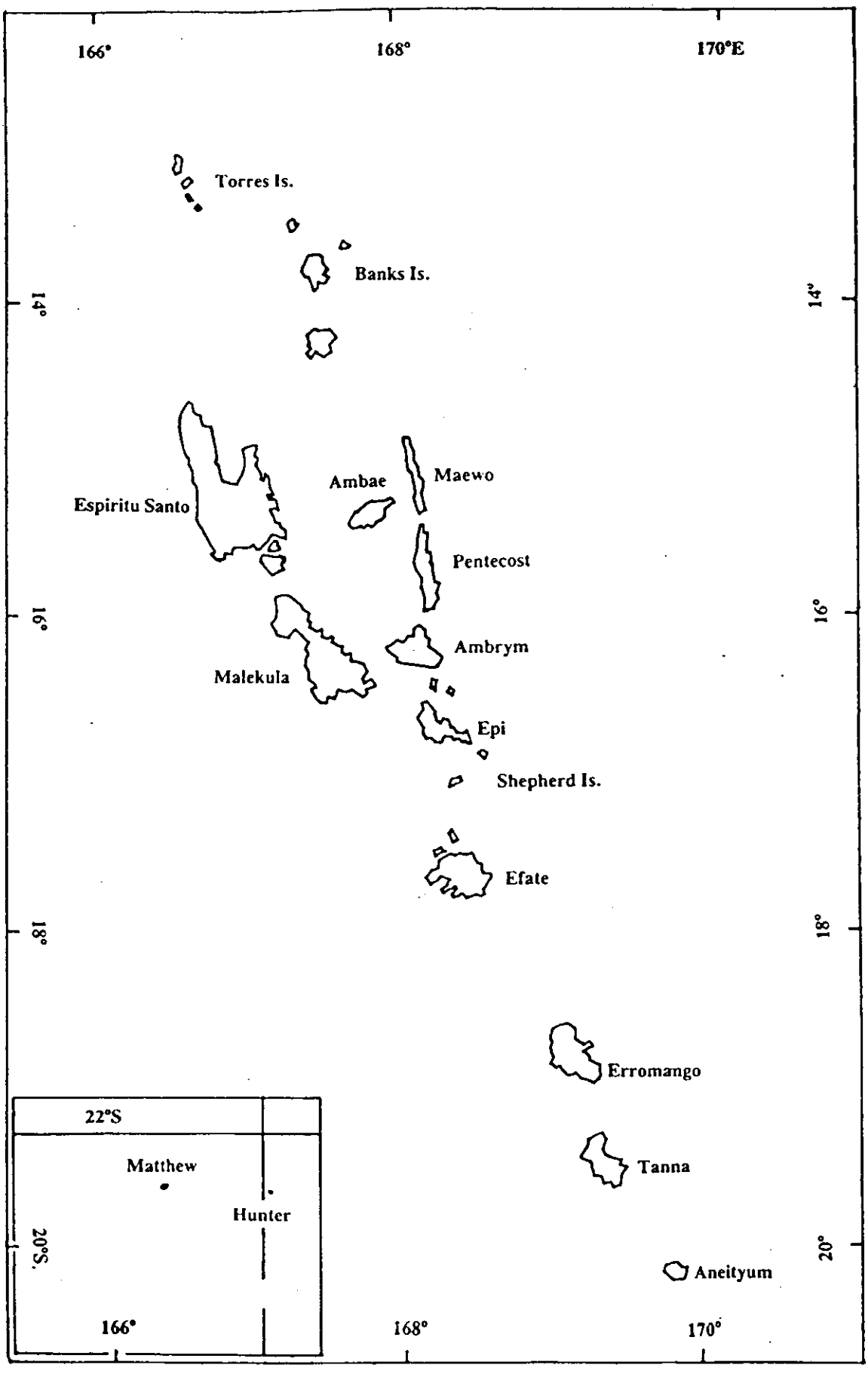


Figure 2: Vanuatu Archipelago



2. General Description of the Fishery

2.1 Historical Context

Given the economic context described above it is important to have some understanding of both the position of fisheries from a socio-economic viewpoint and the organisation of fisheries within the country. Clearly the former dictates the environment in which the latter is framed. One would expect that in a culture with a strong tradition of exploitation of marine resources there would be a dynamic fisheries organisation helping with marketing and fisheries extension work. One would also expect a degree of entrepreneurial spirit to have been developed amongst the fishermen that would not only drive current exploitation but also encourage the investigation of new resources and techniques.

The pre-colonial era is not well documented, missionaries have provided the majority of information on the social structure and activities on various islands from the mid-19th century. What is known is that life was centred on the village community. A village would be dominated by one or more Chiefs, and was (and remains) strongly patriarchal. The progression of an individual through the ranks of the village relied on a series of custom ceremonies centred around the gift of pigs. Land was owned by a number of persons in the village including Chiefs and high-ranking individuals and these ownerships extended out to the reef-flat.

On many islands, the topography and thick vegetation lead to the development of very isolated communities. Distrust and fear between these communities seems to have been the driving force of relations and communication was often only in the form of raiding parties for resources both human and natural. However some limited trade links between islands did occur (such as between villages on south-west Ambrym and south-east Malekula) and this lead to a skilled group of navigators, although no extensive oceanic voyages were necessary due to the proximity of the islands within the group. It is impossible to estimate the importance of fish to this pre-colonial society but what is clear is that with the relatively low level of development of even an island-wide trading economy, production (either agricultural or fisheries) by a community would only need to be on a subsistence level. Indeed, the nature of the climate would necessitate against production of surplus which could not be stored. By the same token, the hot, tropical climate along with rich, fertile soils facilitated highly productive agriculture centred around Kumela (sweet potato), Yams, Manioc and Taro. Today, much of the nations nutrition is still centred on these crops ('41% of Vanuatu is generally regarded as cultivable and 44% of this area is covered with good fertile soils', David and Cillauren, 1991).

With the arrival of missionaries and colonial development of copra plantations at the end of 19th century there was a change in the way the communities and islands interacted. The missionaries, both in an effort to end internecine warfare and in order to 'protect' their congregation (from other religions), actively discouraged the use of sailing canoes leading to the almost complete loss of this skill amongst many islands (although one must not overlook the more recent impact of the outboard engine). Today only the Maskeleyne Islands and Atchin Island off Malekula still maintain a strong tradition of sailing. Missionaries concentrated on bringing tribes in from the bush and this lead to the development of missions along the coasts of many islands, and a community in a new environment.

The opening up of the islands attracted sandalwood traders, blackbirders and land developers; copra plantations and the introduction of beef herds had a dramatic effect with large areas of coastal bush cleared for plantations. This had two major impacts. Firstly, it created the beginnings of a cash economy; the plantations being highly labour intensive, villagers were encouraged to

work for plantation owners. Those that had migrated down from their traditional areas being particularly in need of consumerism having temporarily lost their traditional gardens as a source of food. During the Second World War many hundreds of islanders moved to work the large plantations on Espiritu Santo, particularly from Pentecost Island (Bwei-Bwei, pers comm) again reinforcing the development of a small cash economy. By 1980 approximately 70% of the population of the island of Santo lived within 2km of the coast.

The development of copra plantations meant that traditional 'gardens' were displaced away from the village, and more time was required travelling to and fro the garden. For example, villagers from Port Olry in north-east Santo have to walk for up to two hours each way to reach their gardens, while islanders from Lamen Island paddle in out-rigger canoes for 3 hours to reach their gardens on Epi Island. This development, albeit small, changed the life of many villages, with a concomitant loss of traditional customs and skills. There is no written language for Vanuatu (except the modern lingua-franca, Bislama) but anecdotes from more elderly folk refer to fishing techniques used in their childhood that are not longer seen today (Isidor, pers comm). For example at Port Olry, the entire village would weave a 'net' out of palm fronds, perhaps 200 metres long but only about 2 metres deep. Villagers would swim out to the entrance to the lagoon with the net and then corral the fish into the beach; the ribs of the palm fronds are cut and stick out from the net which prevents fish from swimming through. The entire village would then assist in gathering the catch from the shallows with small fish, turtles and dugong often discarded. Similarly, huge rafts of a particular leaf (which leaf was used has been now been forgotten, (Basil, pers comm)) were sunk in the lagoon and left for a period of a few days (during which time it was forbidden to go to sea); baitfish were aggregated by the leaves (a simple artificial reef) and caught by the villagers.

2.2 The Contemporary Situation

Recent decades have seen a consolidation of the developments of the late 19th and early 20th centuries. There has developed an equilibrium between cash economy and the subsistence economy. Division of labour in village communities has not developed significantly, but an individual will undertake a variety of work to earn cash when required. The garden remains a significant priority to the majority of Ni-Vanuatu (inhabitants of Vanuatu) including those that have full-time employment on a plantation or in town. The notable agricultural events such as preparation of the ground for planting before the wet season sees a significant movement of villagers to their gardens, where they may spend two or three days at a time.

With the development of urban centres and missions, there has been the growth of a small-scale market for agricultural produce. This augments earnings from cutting copra. The 1983 agricultural census found that over 80% of the population are dependent on agriculture for their food and, including copra, for their main source of income (Marshall, 1986).

2.3 Fisheries in the Economy

The development of fisheries has been in response to three main factors; population growth, introduction of modern fishing gears (notably mono-filament), and the increased marketing potential following the growth of an expatriate and tourist population in and around the two urban centres of Port Vila and Luganville. Fishing, however, remains primarily for home consumption and the contribution of village fisheries to the national economy has, until very recently, been seen as insignificant by the Government (David, 1990).

The economy is therefore a two-tier affair; the subsistence economy centred around agricultural production and a small cash economy centred around copra plantations, and the commerce based economy centred on financial services, small business and tourism (with all its accompanying infra-structure).

For a large sector of the economy (and larger sector of the population) the principal driving forces

of any economic activity, the maximisation of profit, is not a significant aspect of community life. Sahlins (1986) suggests that within village life gifts and community exchange remain important in maintaining relations which are constantly under threat from a breakdown in the social fabric. He argues that survival relies on social unity, complex relationships and a spreading of risk; any community programme would be developed from within the community and this inevitably leads to a dilution of responsibility but also to a reluctance to accept the success of others within the community.

3. Fisheries Resources and Marketing

3.1 Large Pelagics

Stocks of tuna are limited and seasonal. The Skipjack Tuna and Baitfish Assessment Survey by the SPC (1983) failed to achieve adequate tag returns to accurately assess the potential fishery in the waters of Vanuatu. However on the basis that similar areas (eg Solomon Islands and Fiji) yield reasonable catches to the industrial fleet, Vanuatu too may hold substantial stocks. However, these may be seasonal as in Fiji and perhaps too far south of the main fishing grounds. There are currently 4-7 Taiwanese vessels operating seasonally, longlining for albacore in the western and southern regions of the EEZ.

The most common vessels in Vanuatu are the traditional 3-5 metre outrigger canoes (which are generally not involved in the pelagic fishery) and (4.7 and 5.6 metre) marine-ply, mono-hulled 'Hartleys'. Currently, the primary exploitation of these resources by the nation's domestic (small-scale) fleet is at four sites; Efate, Craig Cove on Ambrym, southern Malekula (only since the completion of the field-work) and around the islands of Malo and Aese to the south and east of Santo. All sites now enjoy considerable assistance from the Fisheries Extension service which deploy FADs, maintain ice-machines and assist the handful of semi-commercial fishermen with book-keeping and other administration.

The pelagic fishery based on Santo is operated from the Fisheries Department Training Centre. The centre operates three vessels ('Etelis', a 10m Van-1 type built in 1985; 'Tabwemasana', an 8m vessel; and 'Cuso', a 'Kiri-4' fibreglass canoe); there vessels are fished on a share basis, the skipper getting 25% of the value of the net profit of each trip. These vessels fish for both the deep-reef resources as well as pelagics caught around deep-water FADs, but currently are the only vessels operating around the Malo FAD which was first deployed in March, 1992 (and subsequently lost and replaced in September, 1992) and the Aese FAD (deployed after completion of field-work).

3.2 Deep Reef Resources

The major deep-reef fisheries development programme in Vanuatu was the Village Fisheries Development Programme (VFDP) which commenced in 1982. Public authorities argued that village fisheries would be unable to generate a sustainable increase in production due to heavy reliance on the relatively small reef slope resources. A policy was developed to ; a) Improve the diet of the new urban and the rural populations, b) Reduce imports of tinned fish, c) Develop a cash economy in villages, d) Create rural employment, e) Supply the urban market, f) Develop an export industry (Lindley, 1992). The policy was centred around the use of engine-powered vessels to exploit new zones of resource, primarily the deep-reef slope at depths between 100 and 400m using the FAO-designed Samoan reel. The target species were Snappers (Etelidae and Lutjanidae), Groupers (Serranidae), and Emporers (Lethrinidae).

Over the first 3 years of development 25 associations were given financial assistance to buy either Hartleys or catamarans of the Kiri-4 design. Fishing gear and refrigeration facilities were also funded. The purchase of one vessel with engine and fishing-gear cost $10,000 (at 1984 prices). The major aid-donor was the European Community (EC) which provided 51% of the costs with the Government owned Vanuatu Development Bank providing 42% as loans (to be repaid over 3 years). The fishermen themselves were required to pay 7% as cash. The programme was further supplemented by training and equipment maintenance programmes.

The initial results were encouraging, eleven cooperatives produced 49mt in 1983 which equated to a VT500,000 turnover per group. In 1984, there were 25 groups in existence and that figure expanded to 200 groups by 1989. However, assessment of the programme over recent years led David (1990) to argue that the programme was a failure.

Since 1983 the average yield per association dropped from 4.5mt per annum to 1.1mt in 1988; the average life-span of a project was generally only 3 years and the aim of developing a class of professional fishermen was never achieved. Primarily for the cultural reasons alluded to above, there has not been a total commitment to fishing and few enterprises have managed to attain (and more importantly sustain) profitability. Many fishermen started operations full of enthusiasm but soon fell by the way side as the real commitment required to be a professional fisherman proved too much. The situation was exacerbated with the demands of the extended family that profits be shared so leading to a loss of incentive for the fishermen.

Furthermore, despite encouraging signs, there occurred a decline in the quality of the service provided by the Government's fish marketing body (Port Vila Fisheries Limited, PVFL). Prices paid to fishermen did not match the increasing costs of production although retail prices increased leading to ill-feeling between the fishermen and PVFL.

To transport fish of good quality to the urban markets of Port Vila and Luganville, fishermen have had to rely on the domestic airline to transport fish in ice-boxes. It was (and remains) common, however, for freighted fish to be 'put-off' the flight when there are too many passengers and the fish have simply spoiled on the runway, the potential of the domestic (and export) market has been almost impossible to realise. Imports of tinned fish have not been reduced as a result of the VFDP.

VFDP was not, however, a complete failure; it did achieve a number of worthwhile goals. Through the requirement of training and maintenance programmes, a number of Ni-Vanuatu have developed skills in a variety of technical fields; in association with the programme, a boat-building centre and an extension-service fleet has been created and even though few fishermen are truly professional, approximately 400 people have experienced deep-slope fishing (Lindley, 1993).

In 1990, following an ODA/EC review, a new scheme was developed paying heed to all the lessons learnt from the VFDP. A number of recommendations were made and these were incorporated into the Training Centre and Extension Service Project (TCESP). Of significance amongst the recommendations was that fishery development should be more carefully (and realistically) tailored to fit with the socio-economic reality of Vanuatu, especially those of the generally subsistence village fisheries.

There are three major components of the TCESP project that are worth discussing. There was a realisation that because of the behaviour of individuals to spread effort over a range of economic activities it was decided that the entry and running costs of the fishery should be reduced and more appropriate technology recommended to fishermen. This meant in effect encouraging the use of smaller vessels (such as the Kiri-4 canoe) and smaller engines (15hp rather than 25hp). Bearing in mind the problems encountered with fish distribution and the large cost of maintaining ice-machines (and the lack of suitably qualified staff), more importance should have been attached to fostering local markets and to this end a programme of local village fish-markets was initiated under the responsibility of extension staff. The success of the Training Centre and Extension Service Project can be seen in Table 1 which shows the growth in the total of commercially active vessels for Espiritu Santo Island and Vanuatu. Table 2 displays the estimates of commercial catch from 1989.

Table 1: Numbers of commercially active fishing vessels - Vanuatu

Location	1988	1989	1990	1991	1992
Espiritu Santo	11	13	15	24	28
Other Islands	24	33	43	63	78
Vanuatu - Total	35	46	58	87	106

Table 2 : Recorded commercial catch (mt) 1989-1992 (from Lindley 1993).

	1989	1990	1991	To mid-1992
Espiritu Santo	52.76	69.60	80.70	(44.61)
Efate (PVFL)	47.71	39.74	30.07	(21.64)
Other	18.03	16.04	22.60	(29.27)
TOTAL	118.51	125.38	133.37	(95.52)

A second component was the need to generate data on the status and potential of the fishery resources, particularly for the stocks of Etelidae. It was felt that the MSY value of 700mt for the country as a whole was over estimated and that in view of the highly localised fishing more accurate island-specific MSY values were needed and following on from that estimates on total allowable effort could be generated in order to provide a sustainable fishery for the country. Analysis of data by Carlot and Nguyen (1989) revealed a decline in CPUE (measured as catch per trip) of 30%. Based on estimates of biomass made by Carlot and Cillaurren (1990) an average stock density of 0.7 mt per nautical mile (n.mi) was calculated suggesting an overall biomass of 980mt with an MSY of 98 to 294mt. Brouard and Grandperrin (1985) however suggested the MSY lay between 147 and 380mt/year based on comparisons of yields from Hawaii. Finally, Polovina et al. (1990) suggested that the MSY for Vanuatu lay between 113 and 119t/yr.

3.3 Small Pelagics

Coastal pelagics represent an important local source of protein as well as providing bait-fish for the deep reef fishery. All small pelagic species are collectively known as *Mangru* in Vanuatu. The primary small pelagic species landed by artisanal fishermen are the Big-Eye Scad, locally known as shallow-water Mangru (*Selar crumenopthalmus*), with a small contribution from Ox-Eye Scad (*Selar boops*), Mackerel Scad (or Deep-water Mangru, *Decapturus macarellus*), Indian Mackerel (*Rastrelliger kanagurta*), and Island Bonito (*Ethynnus affinis*).

The most common fishing gear used is the surface-set gill-net with mesh-size between 2.5 and 5 cm; other fishing gears used (often in conjunction with the gill-net) are the hand spear, spear-gun, hook and line and occasionally trolling. Fishing begins with the sighting of a school of fish either from the beach or from canoe. The fisherman (or fishermen, they often work together in groups) will then set their nets (usually two 25 metre nets joined together) and then corral the fish school in the direction of the net by shouting and slapping paddle down on the surface of the water. This communal fishing technique probably has its roots in the pre-colonial fishing techniques described previously.

The combined yield of scads and mackerels is probably about 1mt/n.mi of 200m isobath, of which Vanuatu has approximately 1400 nautical miles around its islands, suggesting a potential yield of 1400mt; the actual landings are considerably lower. The major landing site is at Port Olry on Santo but in 1992 only 1.7mt were sold to the fish market in Luganville. It is unusual for the semi-

commercial vessels (Hartley 5.6m) to fish for small pelagics but when they do the preferred gear is again the gill-net (Yang Yako, pers comm). Figure 3 shows the sales of small pelagics from Port Olry for 1991-1993.

Evidence suggests that the coastal pelagics are fairly resistant to high fishing mortality. Hillborn and Walters (1992) refer to work suggesting a daily turnover of 5% of the population of herrings and sardines caught by beach-seining in Fiji. But the highly localised nature of fishing in Vanuatu must pose a threat to local populations despite the high turnover rate suggested. Anecdotal reports around various islands of Vanuatu comment on the loss or decline of the local 'mangru' population, but this is balanced by reports that some locations have had sustained exploitation over the last 10 years at least (eg Port Olry).

There are very limited and highly seasonal resources of traditional pole & line baitfish in Vanuatu, Anchovies (*Stolephorus heterolobus, S.devisi*) and the Sprat (*Spratelloides gracilis*) occur but are not found in the quantities found in PNG or the Solomon Islands (SPC, 1992).

3.4 Inshore Reef Resources

Vanuatu is characterized for its relatively small fringing-reef zone and generally lacks barrier reefs and lagoons. Regular cyclonic activity tends to produce ciguatoxic fish in some areas, limiting their marketability. The present landings of shallow-reef fish are estimated at 2000mt (both commercial and subsistence sectors), which tend to originate from highly localised sources. Accurate estimates of catch are very difficult to obtain due to shortage of funds to initiate a labour-intensive field survey.

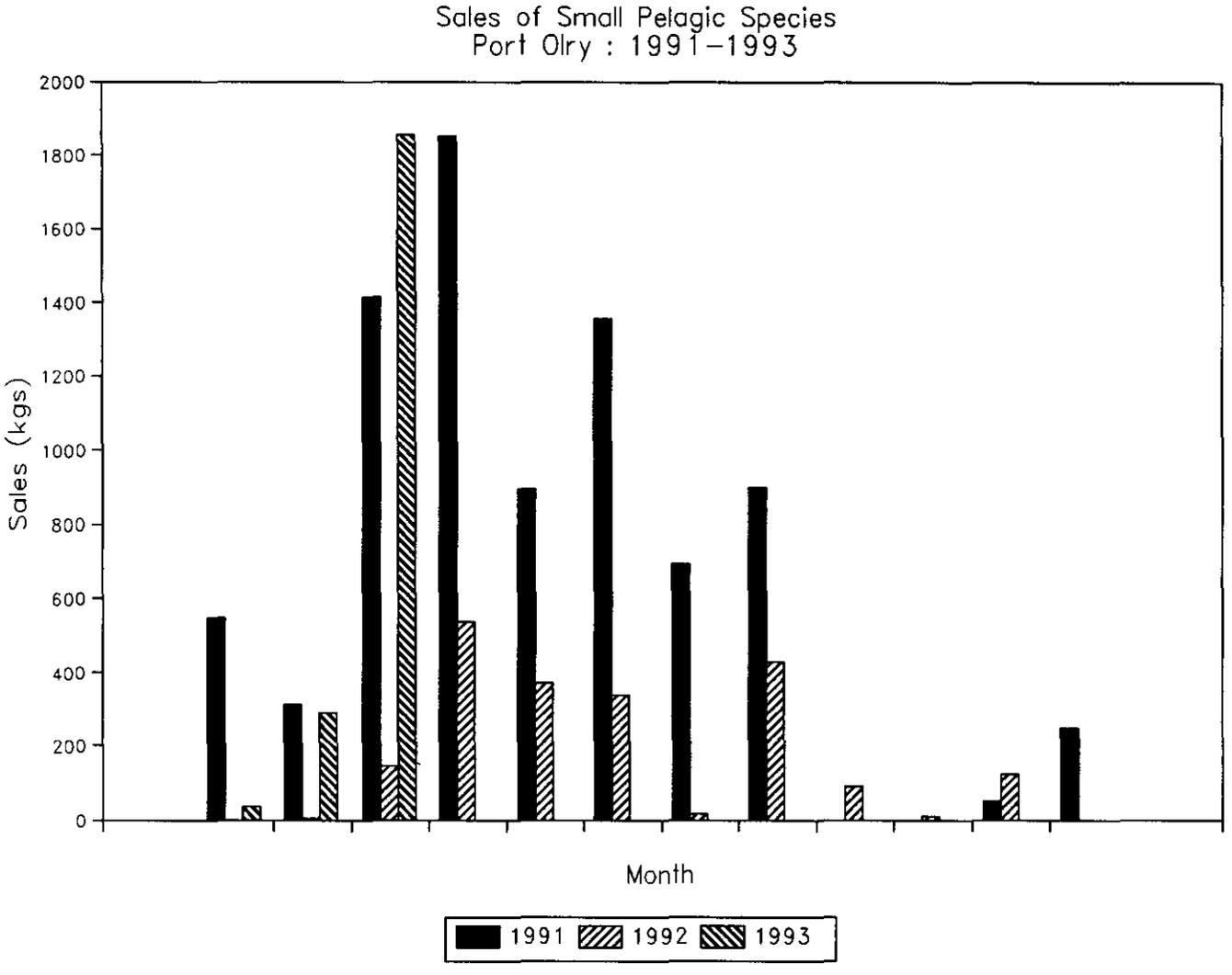
Records from the fish market in Santo show catches of 4.9mt of reef fish sold in 1992 from the primary site of Port Olry. Visual observations of the area using SCUBA indicate a high level of exploitation with very low densities of reef fish compared with neighbouring un-exploited regions. The reliance on small out-rigger canoes will inevitably lead to localised fishing effort and it is unlikely that the ecosystem as a whole is over-exploited, a scenario typical of Pacific nations.

3.5 Fisheries Marketing

Marketing is undertaken by both private and Government bodies; the Government owns two markets, Natai in Port Vila and SantoFish in Luganville on Espiritu Santo, the organisation is Government owned. These markets are reported to purchase an estimated 40% of the total volume of fish sales in Vanuatu (Lindley, 1991). However, following the contraction of the domestic air-service in the late 1980's supply of fish to Natai has declined, much of the fish is now by-passing Natai and is transported and marketed by private interests and being sold at higher prices to restaurants and hotels.

SantoFish undertakes to provide an ice-delivery and fish pick-up service on Monday, Wednesday and Friday of each week. However, this service is often interrupted because of delays in payments for fish from Natai to SantoFish. Other problems have developed with this delivery/collection service because of the perception by fishermen that the Fisheries Department and the (Government-owned) Santo Fish Market are one and the same body. In fact, the extension service of the Fisheries Department have made strenuous efforts to promote the capture and marketing of fish and because prices offered by the SFM are high, they have encouraged use of this marketing body. The extension service itself has offered pick-up facilities to the fishermen (notably in Tasiriki, on the west coast of Santo). Disputes between fishermen and the truck-driver over the prices offered or whether the catch is bought at all, has led to the SFM and Fisheries Department being tarred with the same brush. Some hostility has been described by all parties and has led to a reluctance amongst some fisheries extension workers to spend time at some sites (most notably Port Olry).

Figure 3


Sales of Small Pelagic Species
Port Olry : 1991–1993
Sales (kgs)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Month
1991
1992
1993

A important source of data on catches are the Goods Received Notes (GRN) which were introduced, in their current form, in 1991. GRN forms must be completed if fishermen are to receive duty-free fuel. The GRN records name of vendor, total weight by species and price paid per kilogramme by species (there are various grades of fish quality, an aspect that the extension service is addressing). Although the village of the fisherman is noted, the GRN forms issued at SantoFish and Natai do not have any provision for the recording of effort data, despite their potential as a passive data-collection system. No biometric data is collected when the fish arrive, either at market or at the Fisheries Training Centre on Santo.

4. Frame Survey and Choice of Study Sites

Two study sites were chosen during the course of this field research in Vanuatu. Site choice was determined in part by the necessity that there be sufficient fishing effort taking place on a regular and frequent basis and, in the case of the South Santo site, because FADs had already been deployed at the time that field-work got under-way in February, 1992.

In addition, the study sites had to offer the requisite environmental conditions for aggregation of small pelagics, and also the presence of small-pelagics whether seasonal or permanent inhabitants.

A frame survey was undertaken around the East and South coasts of Santo to discover more sites suitable for the placement of FADs. This was undertaken by both collation and analysis of sales data from the various villages along the coast and a number of sites were visited and interviews with local people held when possible. Questions were asked about the nature of fishing;

i) Are there any individuals who are regular and frequent fishermen?
ii) Is the village serviced by the fisheries pick-up service?
iii) What are the primary species caught and where and how are they caught?
iv) What is the approximate distribution of fishing through the year?
v) What is the extent of local marketing?
vi) What is the division of labour between men and women within the fishery?

In addition, a number of simple empirical observations were made; numbers and condition of canoes, types of fishing gear etc.

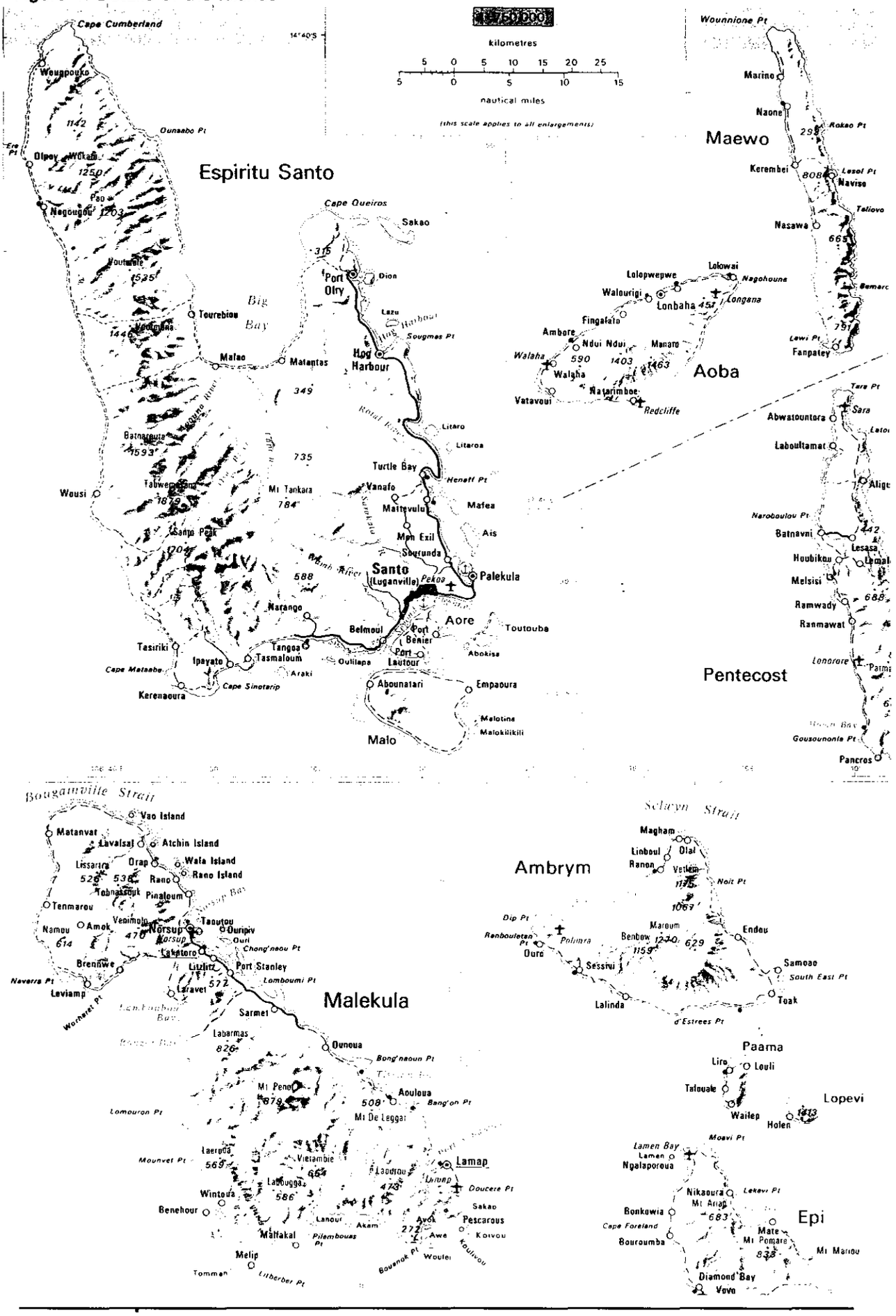
It became clear from discussions and observations that there were few villages that had regular or frequent fishing activity. With the highly ephemeral nature of fishing in these villages and the diverse economic activities, development of a worthwhile approach to data-collection was always going to be difficult and necessitated choice of the most dynamic village possible for future deployments of FADs.

The first site visited was Surunda (See Figure 4). This village is located inside the Nichiku Copra Plantation and Cattle Project; the majority of the population relies on the plantation for work and much of the housing in the village is provided by the plantation owners. The village faces onto a shallow semi-enclosed lagoon which is well protected by a number of small islands and patch reefs. 20 canoes were counted on the beach, with the majority containing at least one mono-filament gill-net. Discussions with a number of individuals around the village suggested that the fishing was of very low priority; plantation workers would fish after their return from work but generally on an occasional basis and purely for subsistence consumption.

The second site visited was Shark Bay (see Figure 4), again the majority of the population of this village worked on the plantation and showed little interest in fishing apart from for subsistence.

To the north of Shark Bay is the village of Hog Harbour (See Figure 4), this is a large site located in a well protected bay. There are two semi-commercial fishermen operating 'Hartleys' but there was little in the way of a canoe fishery. Only one canoe was seen and this was in a bad state of repair; the beach had been severely depleted by cyclone activity. The individuals interviewed reported that much of the subsistence fishing carried out was restricted to the narrow reef-zone with the exception of the two semi-commercial fishermen, with a considerable quantity of gleaning and shallow spear-fishing.

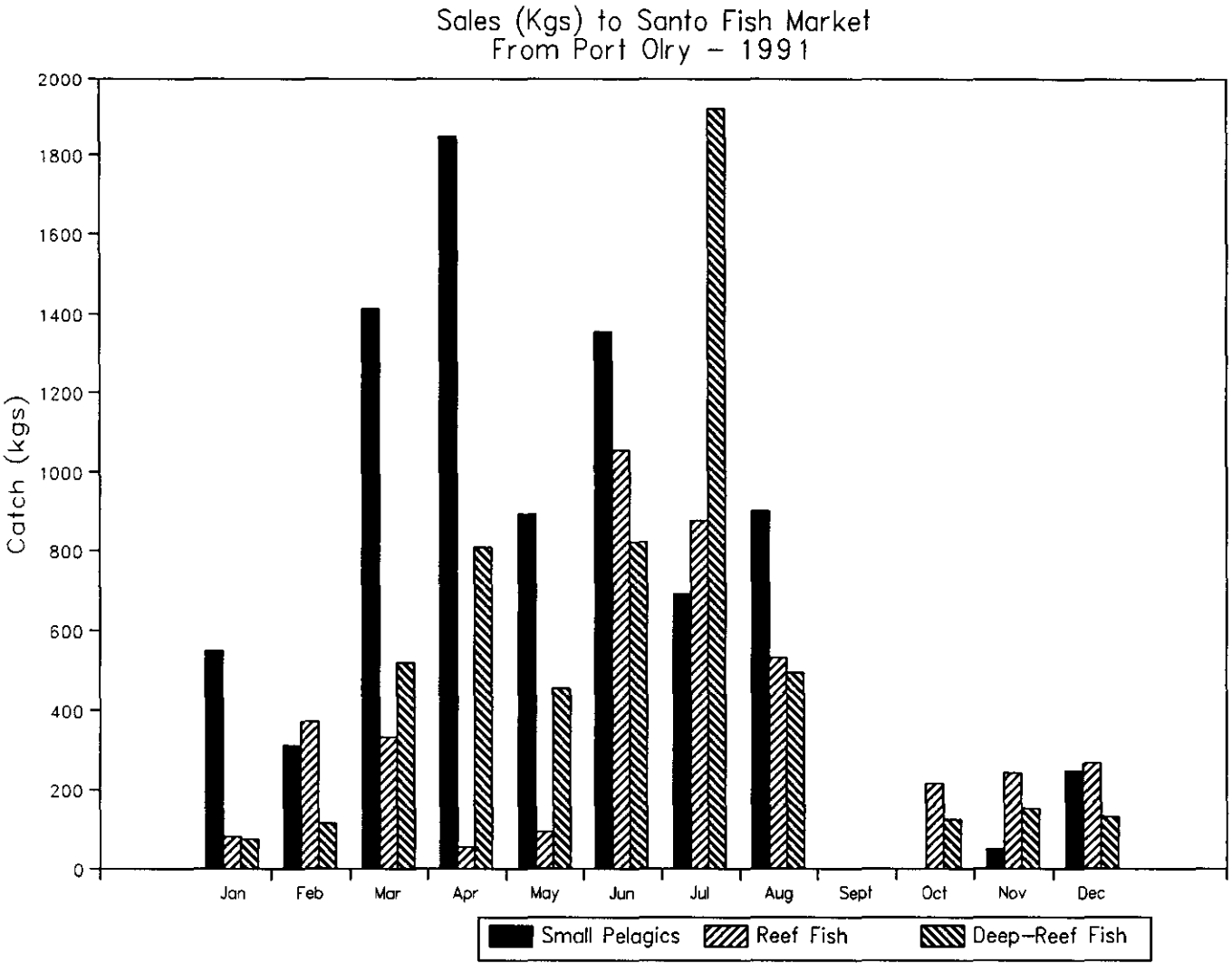
Figure 4: Details of the Islands



None of the first three sites suggested themselves as suitable for FAD deployments; there was neither the need nor the demand for increased landings of small pelagics and the importance of the plantation economy was significant in affecting other economic behaviour of the villagers. The fourth site, off Port Olry on the north-east coast of Santo was visited and seemed to offer an ideal situation (see Figure 4). This beach-side village has a population estimated at 200 families and includes a mission school and a fleet of 54 canoes. The village is served by the SantoFish truck three times per week and analysis of market records confirmed a relatively high activity level in the fishery and its pre-eminence in the provision of small pelagics (for bait) to the fish market in Luganville. Discussions with various senior members of the community reinforced the view that this would be a suitable site. A meeting was held, for all those interested, to outline the aims of the project and the work the project wished to carry out. The aims of the project were disseminated to the gathering and were well received by most of the villagers who attended. Reference to the market data records indicates the relatively high landings (See Figure 5) and a degree of dynamism within the village in general. This site appeared ideal for a pre-deployment survey and this was initiated in July, 1992.

In addition to identifying a village to be involved with the socio-economic aspects of the study, more sites were required to assess the actual aggregating ability of FADs around Santo. This aspect of the project again concentrated on the South Santo area because of its proximity to the Fisheries Department (one hour by boat). Two of the original three deployments were in relatively deep-water (100 metres) and some distance from shore. Although the criteria on which the new deployments were based were similar to the original deployment criteria, the new sites were chosen specifically to exploit a more near-shore environment than the Urelaber and Elia FADs in order to attract the canoe-based fishermen. There was a risk that the FADs would not aggregate fish because of their proximity to the shore but deployments were undertaken working on the premise that the FADs provided shelter from predators and therefore could function as aggregators. Given the epi-pelagic niche the target species inhabited and from observations with SCUBA gear it was not felt that there would be competition from 'natural' aggregators such as coral heads. The prime motivation now was to find sites that successfully aggregated fish, to this end a degree of portability was introduced to the FAD design so that they could be moved if required to a new site without the requirement of using a large vessel such as the Fishery Department's vessel 'Etelis'.

Figure 5


Sales (Kgs) to Santo Fish Market
From Port Olry - 1991
Catch (kgs)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
Small Pelagics
Reef Fish
Deep-Reef Fish

5. FAD Deployments

5.1 Historical Deployments

Deep-water FADs have been deployed in Vanuatu since 1980 (off Efate Island), with a further 15 deployed between 1982 and 1985; no shallow-water FADs had been deployed prior to the commencement of the SPC FAD programme.

5.2 Initial Deployments

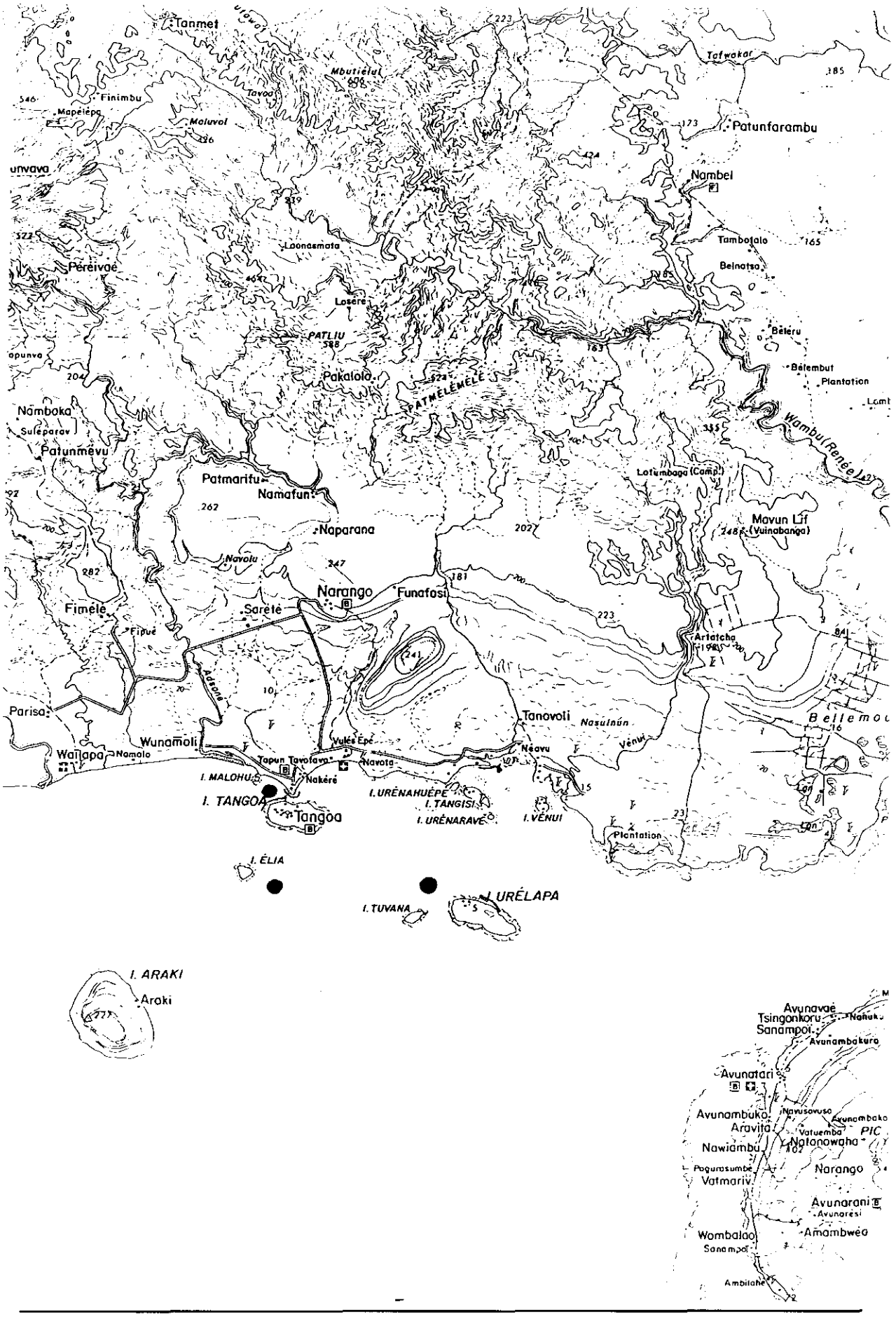
During the first phase of the project a site locally known as South Santo (see Figure 6) was chosen and three inshore FADs were deployed by the SPC Masterfisherman (See Table 3). Ideally, a frame survey should have been carried out to assess all potential sites in the area, but logistical problems hampered the original project field officer preventing such a survey. It was clear to the Masterfishermen, from his knowledge of local fisheries (he had worked in Santo in 1985), that the South Santo site had potential.

Pre-deployment fishing and detailed interviews with local fishermen could have yielded more precise information as to the spatial distribution, importance to the community and the species composition of the pelagic catch. Pre-deployment work would also have permitted a description of local fishery characteristics (temporal distribution of effort etc) and thus aided in the decision on where exactly to deploy the FADs. In reality initial deployment criteria only extended to whether there existed a local canoe fleet and the presence of fishing activity and these criteria were met at the South Santo village of Tangoa (located on Tangoa island). Despite the lack of pre-deployment survey data, analysis of market data provided a broad insight to the nature of the fishing in South Santo and this view was confirmed following discussions with fisheries department personnel and local fishermen. The area appeared to support small populations of a number of small pelagic species (primarily Island Bonito (*Ethynnus affinis*); Deep-water Mangru (*Decapturus macerellus*); shallow-water Mangru (*Selar* spp) and Indian Mackerel (*Rastrelliger kanagurta*) as well as semi-pelagic species especially two genus of Fusiliers (*Caesio* spp and *Pterocaesio* spp). The location of the fourth FAD, at Melcoffe, was determined by its proximity to the Fisheries Training Centre, although close to the urban centre of Luganville it was not expected to attract fishermen, rather it was to permit easy assessment of trial fishing techniques. Appendix 2 details the design of all FADs placed during the project.

Table 3 : First-Phase FAD deployments - South Santo.

FAD Name	Date Deployed	Position (Lat/Long)	Depth (Metres)	Metres To Shore	Lost? Date of Loss
Urelaber	21/12/91	15° 36.23' S 167° 00.96' E	130m	2.0km	Raft Replaced
Elia	20/01/92	15° 36.37' S 166° 59.54' E	150m	1.5km	No
Tangoa	24/01/92	15° 35.32' S 166° 58.62' E	23m	100m	No
Melcoffe	01/04/92	15° 31.93' S 167° 08.78' E	12m	50m	Moved

Figure 6: Map of South Santo and Position of First Phase Deployment



5.3 Second Phase Deployments

Visual observations and anecdotal reports from a variety of sources had identified a number of new sites with potential as successful FAD sites. Of the four new sites chosen, three were in the Segond Channel (The Canal) and one site at Baldwin Cove, South Santo (approximately 0.5 nautical miles from the Urelaber FAD (See Figure 6). The sites were initially surveyed from the project vessel 'Savin' in order to obtain a picture of the bottom topography (using a simple leadline) and, where appropriate, with SCUBA gear. FADs were then constructed according to this information and deployed from the Fisheries Department vessel 'Etelis' (See Table 4).

Table 4 : Second-Phase FAD deployments - South Santo.

FAD Name	Date Deployed	Position (Lat/Long)	Depth (Metres)	Metres To Shore	Lost? (Date)
Baldwin Cove	08/09/92	15° 35.64' S 167° 02.70' E	20m	25m	No
Wambu River	24/09/92	15° 34.11' S 167° 08.77' E	25m	100m	Yes 26/10/92
President Coolidge	28/10/92	Not Recorded	10m	50m	Yes 03/93
Aore Island*	16/08/92	Not Recorded	11m	100m	No

* The FAD placed at Aore Island was originally located at the Fisheries Training Centre at Melcoffe, across the Canal. The FAD had proved to be largely unsuccessful and was moved to Aore in an attempt to improve its performance.

5.4 Port Olry Pre-Deployment Survey

A pre-deployment survey was undertaken at Port Olry from July to October 1992. The approach taken was to gather data on the spatial and temporal distribution of the fishing effort in the village and details of the catch were recorded with the view of comparing these data with the situation following the deployment of the FAD. With the help of local fishermen the effective fishing area (created by the limited range of the canoes) was sub-divided into 7 sub-areas.

Although reportedly a busy fishery, the ephemeral nature of the fishery soon became apparent, many mornings there would be little, if any, fishing activity. There were, however, a number of fishermen who appeared regularly in the market sales record books throughout most of the year and these individuals generally comprised the majority of the recorded trips. The visiting schedule was weekly, and the beach monitored from dawn to mid-day. Although data could be collected on most visits, this was not always the case due to a variety of problems such as the fish-truck not turning up (causing the fishermen not to fish or not to have any ice), poor weather and alternative seasonal activities (such as preparation of gardens for Yam planting and the Christmas and New Year period which extended over one month). Finally, there were problems recorded with some fishermen who, after sometimes hours spent on the water, were not particularly interested in cooperating and preferred to take their fish and leave the beach. In October, 1992, the SPC Masterfisherman requested a survey of the area for FAD deployment which was undertaken from an outrigger canoe using a handline to gather information on the profile of the sea-bed in the area chosen by the local fishermen. A FAD was placed on October 8th,1992 using the Fisheries Department's vessel 'Etelis' (See Table 5).

Table 5 : FAD deployment - Port Olry.

FAD Name	Date Deployed	Position (Lat/Long)	Depth (Metres)	Metres To Shore	Lost? (Date)
Port Olry	08/10/92	15° 02.19' S 167° 05.31' E	40m	150m	No

Prior to the FAD deployment, the site was visited on 13 occasions. It was hoped that more visits could be made but there existed a number of logistical problems that hampered travel to the village. The distribution of effort recorded over 95 fishing trips by fishing zone can be seen in Table 6.

Table 6 : Distribution of Effort (Trip Length) for monitored trips, July - September, 1992

Fishing Area	July	August	September	TOTAL
Dionne Island	5.5	57.7	6.3	69.5
Central Bay	6.1	13.3	5.1	24.5
Fighter Reef	6.6	9.2	0.5	16.3
Northern Bay	0	3.8	0	3.8
Open Ocean	0.7	0	13.7	14.4
The River	7.3	5.8	0	13.1
South Bay	10.8	0	2.4	13.2
TOTALS	36.9	89.8	28.0	154.7

Table 6b : Distribution of Catch (Kilogrammes) from monitored trips, July - September, 1992. Carangids only.

Fishing Area	July	August	September	TOTAL
Dionne Island	0.37	13.15	0.14	13.66
Central Bay	4.16	1.46	5.1	10.72
Fighter Reef	4.69	5.42	0	10.11
Northern Bay	0	0	0	0
Open Ocean	0	0	0	0
The River	34.33	2.8	0	37.13
South Bay	0	0	0	0
TOTALS	43.55	22.83	5.24	71.62

The value of these landings sold to the SFM fish-truck would be VT9668.7 (£52.26), sold at a rate of VT135/kilogramme. The total landings of small pelagics during this period of three months were 539.9 kilogrammes, with a beach-side value of VT72,886.5 (£393.90).

The deployment of the FAD was based on conversations with the local fishermen, the FAD is near

a small island in the northern bay close to Dionne Island which appears to be an important area for the local fishermen, 45% of total effort recorded during the pre-deployment visits. In terms of total weight from the recorded fishing trips, the most productive area was The River. One must be careful with these figures however due to the problems of monitoring the movement of the fishermen once out at sea, and due to the fact that on a number of trips the fishermen were observed to fish in a number of different zones. Furthermore, of the 95 trips that were observed prior to deployment, the data for 20 trips could not be completed for a variety of reasons.

The highly variable nature of fishing at Port Olry obviously necessitated a resident data-collector, and the weekly visits were deemed to be inadequate. On two occasions, attempts were made to employ a local data-collector who could record daily catches from fishermen. The village site is small and this facilitated data collection, with much social activity centred around the 'Nakamal' or meeting-house. On the first attempt, the villager employed was the local school's head-master. He provided one weeks data, which was of poor quality before leaving the village for two months to attend a course in Luganville. A second villager was employed (a trainee Catholic Priest), but again proved ineffective due to the quality of the data collected.

5.5 Outer Island FAD deployments

In late November, 1992, it was possible to join a field-tour undertaken by the Senior Extension Advisor based in Santo; four outer islands were visited over a period of two weeks aboard the Fisheries Training Centre vessel 'Cape Folan', the islands visited were Ambae, Pentecost, Ambrym and Malekula (See Figure 4).

The principle reason for the extension advisor's visit was to assist a number of communities in the development of sailing-canoe projects which were identified as being of significant relevance to Vanuatu (and in any event were part of the cultural heritage of the islands) by the Training Centre and Extension Service Project which superseded the VFDP.

It appeared to be an ideal opportunity to assess the needs of outer island communities for small pelagics and FAD programmes. A common feature observed on this tour was that many communities' fishing activities were limited by the availability of baitfish (for example Mecam and Ranon on Ambrym; Bulhak on Pentecost and Lolowai on Ambae). This in turn limited the potential success of the sail-fish canoe projects being promoted by the extension advisor.

The designs of FADs placed in the outer islands were all of a similar nature and were tailored to locally available resources. The FAD comprised between 2 and 3 long bamboo poles (5-7m), each one was separately anchored with large rocks, and deployed in the vertical position. Before deployment, coconut palm fronds were tied onto the bamboo and the FADs deployed, using the anchor last technique.

Two deployments were made at :

- Bulhak, Pentecost Island :

  This village has a single fishing canoe, an 8 metre sailing vessel which dates from 1991. The fisherman who runs the canoe has a large potential demand for his fish at the Mission village of Melsisi, a few kilometres to the south. The local fisherman reported that the area around the village does not have a resident supply of baitfish, and he relies generally on reef-fish. A site for a FAD was identified by the fisherman and a composite FAD deployed (from the canoe) in 21 metres of water. Despite deployment difficulties caused by the canoe capsizing leading to loss of the anchor, two individual FADs were placed some 25 metres apart and 10 palm fronds attached to each FAD at depths down to 10 metres.

- Mecam and Ranon, Abrym Island :

  These two villages were also the sites of canoe projects; each village had built one large canoe to be run as a cooperative of fishermen who fished in rotation, with a crew of 2 or

3. Both villages reported that there were local stocks of small pelagics, but that they appeared highly migratory along the shore. They were very excited about the placement of FADs, and hoped that the FAD would help stabilise sources of baitfish. In the absence of baitfish, the villagers use 'Blackfis' (a generic term for small reef fish, *Abudefduf* spp) or freshwater crayfish called 'Naura', neither of which was particularly satisfactory as bait. A group of 3 Bamboo FADs were placed in 10 metres of water off Ranon on November 25th. The sea-bed was black sand but the water had excellent visibility, the FADs were deployed well and the fronds were held horizontal in the current.

Mecam is situated on a hill, there is a beach with a narrow channel between it and a long fringing reef. The village possesses only 6 canoes of which one large (5 metre) canoe was fitted out as a sailing canoe during our visit. There was no ideal site for FAD deployment, there being a strong long-shore current in the area, but a FAD was placed outside the fringing reef in a small bay, and consisted of three individual bamboo FADs anchored with heavy volcanic rocks.

6. FAD Fishing Activity

6.1 South Santo

A local school-leaver was employed to monitor beach landings every morning and evening (villagers generally seemed to spend the day at their gardens). Forms were issued upon which the date, name of fisherman, time and location of effort and details of the catch were to be recorded. A simple map was also issued to help identify the location of the effort. In addition, the data-collector was instructed to obtain a list of names of all currently active fishermen, including the three semi-commercial vessels active in the area.

The site was visited twice per week when data forms were collected and any comments or problems discussed with the data-collector. This process seemed to be going well, there was a lot of fish being landed (both on and off FADs) which was reported to be sold both within the village and (especially by the semi-commercial vessels) to the fish market in Luganville. There were also some ad hoc reports of local sales to the adjacent Talua Bible College Attempts were made to quantify these but this proved impossible due to the very occasional nature of the sales. During this first period of data collection there was some concern that the data was being falsified, primarily due to the large quantity of fish reportedly landed from the FADs even though during observations while undertaking trial fishing, only two fishing events were witnessed. Furthermore, the level of alleged fishing seemed to be at odds with the decision of the SFM fish-truck to abandon their pick-up service. Confirmation of the data-collector's failure to collect data coincided with the data-collector moving to another island. Another data-collector was hired but he too proved unable to collect real data and when caught concocting a data-set the entire data-set was discarded and that approach to data-collection at the Tangoa site abandoned.

A new scheme was devised following discussions with village elders and the Fisheries Department whereby in exchange for the provision an ice-box, regular supplies of ice and an undertaking to buy fish from the village, catch and effort information would be provided. The first delivery of ice was made on August 20th and a local store agreed to act as a base for the operations.

Table 7 shows the landings of fish from the Tangoa market. It is clear that there was a less-than enthusiastic response to the market by fishermen, the majority of the catch was made by a single individual (a semi-commercial fishermen). Problems persisted and interest continued to wane, disagreements developed over the pricing structure and over whose weighing-scales were accurate. On September 9th the ice-box was recovered and the market facility abandoned.

Table 7 : Landings from Tangoa.

Pick-up Date	Weight of Fish
21/08/92	4.4kg
22/08/92	4.4kg
26/08/92	8.0kg
28/08/92	47.7kg
31/08/92	3.0kg
03/09/92	16.0kg
07/09/92	25.0kg
09/09/92	0.0kg
TOTAL	108.5kg

6.2 Port Olry

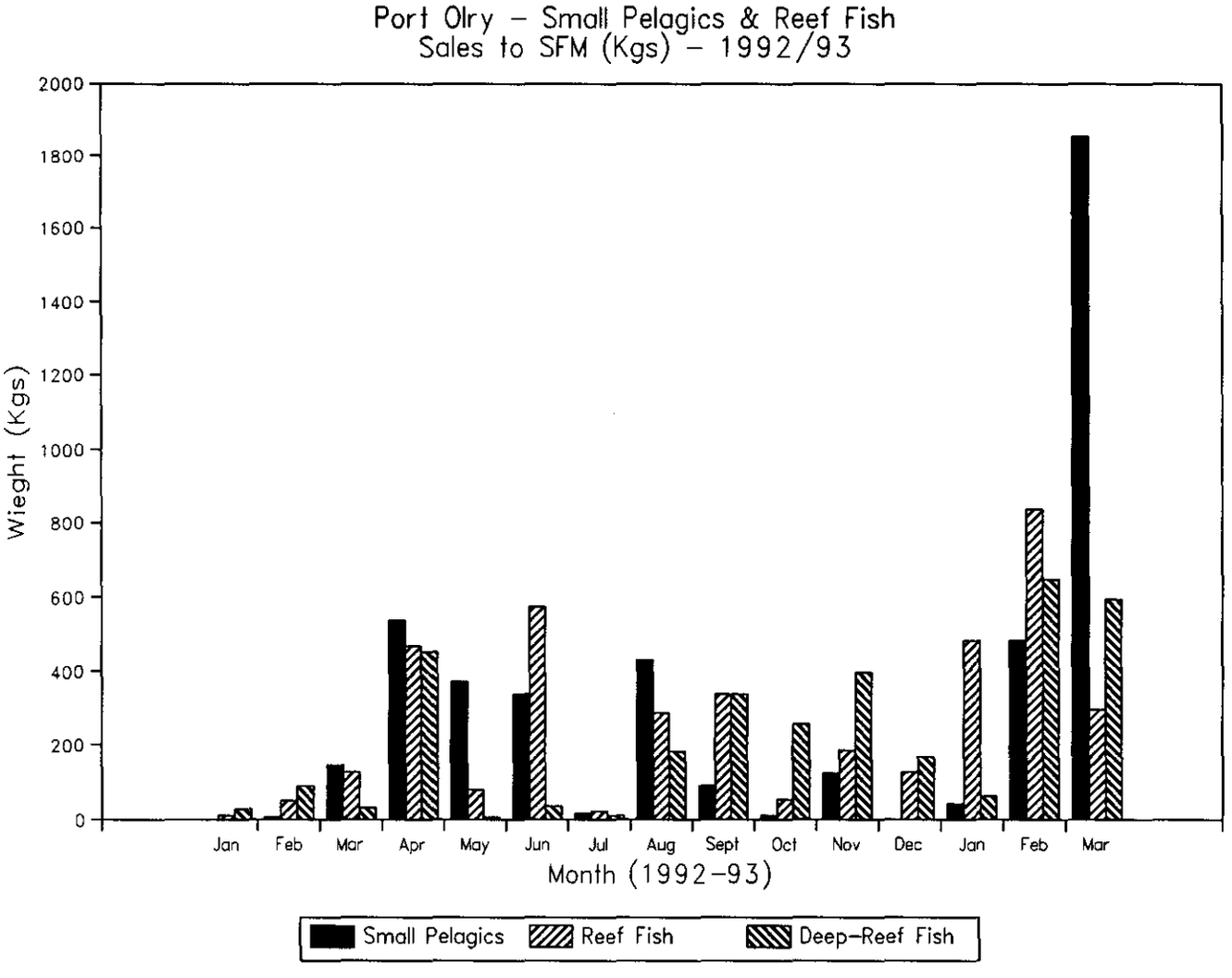
Port Olry was visited on 15 occasions following deployment of the FAD. However, following the deployment of the FAD the amount of fishing targeted at small pelagics remained insignificant (see Figure 7). It is believed that the low level of effort resulted from a number of factors including seasonality and the continuing problems with the PVFL in Port Vila on Efate. Severe financial problems created a cash-flow problem for SFM which in turn could not pay fishermen for their catch, or indeed the driver of the fish-truck. This made working at the site very frustrating, with little fishing activity on the majority of visits post-deployment. Observations were made (from outrigger canoe) of the FAD on each trip. Each week's visit witnessed an increase in the number of juvenile Golden Trevally (maximum length of approximately 10 cm). By March 1993, there were estimated to be 200 fish below the FAD, but no larger individuals or other species present. In January a fish-trap was suspended (3 m) below the surface from a floating rope some 2 metres from the FAD buoy. This trap was demonstrated to the villagers, and its construction described. However, there was not a single known visit to the trap by the fishermen, and no fish were recorded captured during observations by project staff, although the Golden Trevally were observed to enter and exit the trap freely.

With the onset of the wet season in February, the landings of small pelagics dramatically increased. The latter visits to Port Olry witnessed a large increase in the number of fishing trips being undertaken by the fishermen. The FAD however did not attract fishermen and the majority of the catch in this period was taken in the Central Bay area. The last visit to Port Olry witnessed 7 trips in the morning fishing period (0630-0930) with a total of 431 small pelagics landed, catch rates varied from 1.23 kg/hour to 2.43 kg/hour.

6.3 Outer Island Deployments

None of the outer island sites were visited again after deployment by project staff although fisheries extension officers did pay a number of visits to the sites.

Figure 7


Port Olry – Small Pelagics & Reef Fish
Sales to SFM (Kgs) – 1992/93
Wieght (Kgs)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Month (1992–93)
Small Pelagics
Reef Fish
Deep–Reef Fish

- **Pentecost Island**

No reports indicated that the FAD had aggregated small-pelagics or at least that the fishermen had actually caught fish at the FAD. However, aggregations of flying-fish were reported but these were found to be very short-lived.

- **Ambrym Island**

Reports from Ranon are few but it appears that no substantial aggregation has occurred around the FADs, although as with Pentecost, there have been small aggregations of Flying-fish. The villagers expressed some doubts on how to catch pelagic fish and were given instruction on how to build a simple fish-trap and advised to try a gill-net. A return visit by a Fisheries Extension worker in January, 1993 found that nothing had been tried, but the extension officer built a fish-trap with the villagers. No reports were forthcoming from Ranon during the remainder of the project. In fact the village does not seem to have undertaken much fishing activity since the FADs (and the new sailing canoe) were deployed during our visit.

7. Field Observations and Trial Fishing

7.1 Development of FAD Fish Communities

Visual observations were made on every trip to South Santo and in fact were sometimes the only source of data when poor weather prevented deployment of fishing gear.

The most commonly observed species were those normally associated with reef environments such as Pomacentrid Damsel-fish (*Chromis* spp; *Abudefduf* spp; *Dascyllus* spp). These species were constantly observed in amongst the aggregating material below the FAD's surface component, maintaining close station with the FAD. With the approach of a boat the fish would generally move, in a loose school, out to the boat but when it left the fish would follow for a short distance (10-50m) before returning back to the FAD. The numbers of fish appeared to fluctuate but quantitative assessment of changes in numbers of these species were not gathered due both to time-constraints, and technical difficulties. If the FAD's surface component had been detachable the use of gill-netting or of a modified small purse-seine would have been appropriate. In terms of individual FADs, there were differences between the numbers and variations in numbers between FADs. The Elia FAD, with the larger 'vertical profile' of aggregating material, initially had the largest population of reef-species which found shelter within the aggregator. Numbers peaked at an estimated 150. As the aggregator became burdened with marine growth so the effective niche size decreased and with this was seen a reduction in the numbers of the reef-species. On Urelaber FAD there was no sub-surface aggregator, only the shelter given within the bamboo raft structure. Numbers of reef-species appeared to be limited by the space available to retreat into in the presence of predators. By December, 1992, the original raft had began to disintegrate and sink and with this came a large increase in the number of fish (and species of fish) associated with the FAD; there is also likely to be a seasonal aspect to this phenomenon. By February the species included such semi-pelagics species as juvenile Rainbow Runner (*Elagatis bipinnulatus*), Sea Chubb (*Kyphosus gibbus*) and Golden Trevally (*Gnathodon speciosis*).

Observations of small pelagics associated with the FADs did not suggest any consistent pattern. A school might be observed below the FAD on one day, only to be missing the following day; on a number of occasions small pelagics (primarily Scads and Island Bonito) were seen to be migrating past the FAD, where they would circle and feed for a short while (10-15 minutes) before moving off. On one occasion a school was seen to be tightly circling the Urelaber FAD while a Dogtooth tuna (*Gymnosarda unicolor*) made repeated rushed into the school. After some 30 minutes observation the tuna left and the school moved away west of the FAD but could not be followed as they dived deep out of site. Observations using SCUBA on Elia FAD witnessed the behaviour of a school of Scad as they were threatened by a large Wahoo (*Acanthocybrium solandri*). Again, the large predator made repeated rushes at the school as they were feeding some 50-100m from the FAD mooring line. As the Wahoo approached the school became compact and swam close around the mooring line, after a number of unsuccessful attempts by the Wahoo, the school moved away from the FAD and were not observed to return during the length of the dive (made to recover an entangled net). Sharks were rarely seen near any of the shallow-water FADs but juvenile individuals (Carcharinid requiem sharks) were caught in the gill-nets. On one occasion, two large Pilot Whales were observed close to the Urelaber FAD for some minutes before diving.

7.2 Experimental Fishing

Experimental fishing was restricted, for logistical reasons, to the Segond Channel and South Santo FADs. The primary fishing gear used in the trial fishing was nylon mono-filament gill-nets (5cm mesh-size) which were strung from the FADs for an average soak time of 12 hours. The mono-filament nets were all lost or severely damaged and were replaced on December 15th by cotton multi-filament nets provided by the Fisheries Department. All nets were generally set at dusk and hauled soon after dawn the following day. Nets were generally set at the surface, but trials were carried out with nets set at 5m and 10m. In addition to gill-netting, a variety of other gears were trialled. These included trolling, vertical longlining, jigging with a kerosene pressure lamp and the use of a variety of fish-traps.

In general experimental fishing was not successful and the results are presented in Table 8, the figures in parentheses represent the number of occasions where fish were caught.

Table 8: Number of fishing events by gear-type and FAD.

GearType	Urelaber	Elia	Melcoffe	Wambu
Gill-Net	23 (9)	13 (1)	31 (6)	
Trolling	15 (2)	18 (6)	1 (0)	3 (1)
Jigging	10 (5)	9 (2)		5 (1)
Long-Line	5 (0)	3 (0)		
Fish-Trap	29 (2)	9 (4)	10 (0)	
Lift-Net*	1 (1)			
TOTAL	82 (18)	52 (13)	42 (6)	8 (2)

* The lift-net was used aboard the Fisheries Division's 'Etelis', using a portable generator and a 1000 Watt under-water light.

It can be seen from Table 8 that the majority of effort was concentrated on the two original FADs located at Urelaber and Elia. This was not only because they were the first to be deployed but because visual observation and experimental fishing indicated that the other FADs were simply not functioning. Wambu FAD was fished after deployment, but it was lost soon after. The prevailing conditions in that area of the Channel were far from ideal for FAD placement with very strong currents; steep bottom topography and generally very poor visibility. The known presence of small pelagic species however suggested that the placement of a FAD could have been worthwhile; however, the FAD was not replaced. All other FADs were regularly checked by simple visual observation, but no small pelagics were seen at either Tangoa FAD, President Coolidge FAD, Wambu FAD, or Baldwin Cove FAD. Small pelagics were reported to be present at the Aore FAD, but they were never witnessed over 45 visits to the site and no fishermen could be located who had fished on the FAD.

Figure 8 shows the numbers of fish caught by week (from the start of the project) by experimental fishing. These results were very disappointing and confirm the low number of positive visual observations of fish. The main gears used were gill-nets (See Table 8) and accounted for the majority of the catches; the two primary species caught were Mackerel scad and Big-Eye scad. In fact two nets were lost when they became entangled with the FAD anchor line, a problem often encountered with that particular fishing gear; subsequent recovery, using SCUBA, revealed upwards of 50 Mackerel scad trapped in each net. There were also incidental catches of juvenile carcharinid sharks, Barracuda (*Sphyraena fosteri*), and Wolf-Mackerel (*Chirocentris dorab*). Table 9 below shows the numbers of the principle species caught by gear-type and FAD.

Figure 8

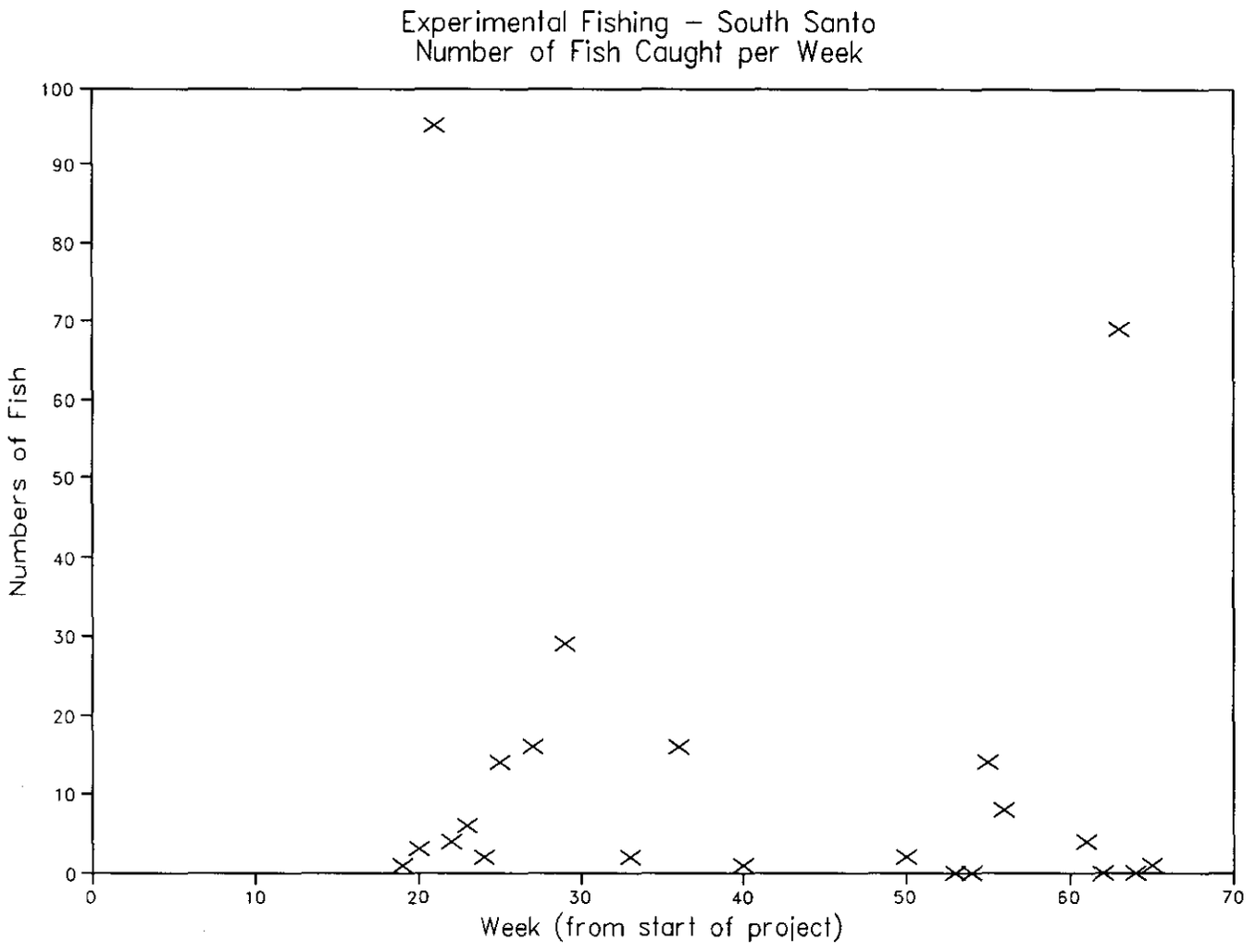

Experimental Fishing – South Santo
Number of Fish Caught per Week
Numbers of Fish
Week (from start of project)
0
10
20
30
40
50
60
70
80
90
100

Table 9: Catch of Small Pelagic Species by FAD and Gear-Type

Gear-Type	Urelaber	Elia	TOTAL
Gill-Net	112	2	114
Trolling	3	28	31
Jigging	27	8	35
Lift-Net	50		50
Fish-Trap	0	18	18
TOTAL	192	56	248

In terms of suitable shallow-water FAD fishing gear (bearing in mind the level of technology if the fishery in general) a number of qualitative observations can be made resulting from the experience in Santo. The most frequently used gear (gill-nets) have two main faults; firstly there was a tendency for the net to become entangled in either the mooring-line or the FADs surface component, notable with the change of tidal stream. Secondly, if the FADs had been used more extensively by fishermen there was potential for conflict between individuals wishing to set nets or between fishermen operating different gears that would interfere with the gill-netters (eg trolling).

Trolling proved successful on a number of fishing trips and is a simple and cheap gear for artisanal fishermen (although fuel costs are a consideration as is the practicality of trolling by paddle-canoe). It is of course very low intensity fishing but effective nevertheless and is the most commonly used gear on Deep-water FADs by semi-commercial fishermen.

Much hope was held for the use of Fish-traps, a traditional fishing gear in many parts of the Pacific (eg Rainbow Runner (*Elagatis bipinnulatus*) traps, common in Rabaul, P.N.G.; and Milkfish traps in Indonesia). In fact, the Runner trap of Rabaul acts as a simple FAD; small leaves are placed inside and the 'Malambur' which seek shelter inside are then preyed upon by the Runner (Anon, 1968). There were three designs of trap used in this project; a design from Papua New Guinea was used to construct a 2 metre, cigar-shaped trap using fine mesh net fastened over a split-bamboo frame. Initially used without success on Melcoffe FAD, it was subsequently moved to Urelaber FAD and strung at a depth of 10m where a number of successful sets were achieved although the trap was found to be difficult to manipulate from the Hartley, notably in poor sea-conditions and fish often decomposed before they could be recovered. The trap was lost after one month at Urelaber, although subsequently found washed up on the nearby Tubana Island.

The problems encountered handling the PNG fish-trap (the PNG villagers fish together as a team of 4-6 canoes and thus can manipulate the trap) demanded a smaller, lightweight trap that could easily be hauled by one man from a canoe but would provide a suitable catch of small pelagics that could be used for bait or for personal consumption. Cylindrical traps made of fine-mesh net (replacing the original 1 cm wire frame which rapidly corroded) and these traps were placed on Melcoffe, Baldwin Cove, Urelaber and Elia FADs and a slightly modified version on the Port Olry FAD. As can be seen in Table 9, this design was also far from successful. However, 5 traps were lost which may have contained fish. Furthermore, on a number of occasions either fish were inside but severely decomposed following attack by predators or signs of entry was clear but the fish had managed to escape. A third design of trap was built by a Pentecost Islander and again this trap showed signs of being suitable and 18 fish were recovered from the trap when it was first set under Elia FAD (at a depth of 5 metres), and again there were numerous signs of entry of fish, and associated small predators. The FAD was made of woven lianas and soon became too water-logged to be easily manipulated.

In terms of potential, it would seem that fish-traps offer the most, despite lack of success in this project. This is for a number of reasons. Firstly, if a suitable design is chosen the trapped fish remain alive until harvest, thereby increasing the potential value or suitability for use as bait. Secondly, the presence of fish in fish-traps may attract predators (as was witnessed in this project), these predators may then be harvested by fishermen while recovering traps. Finally, fish-traps are unlikely to interfere with other traps or fishing gear. In fact, a number of traps may benefit other fishermen by effectively increasing the FADs profile and attracting ability.

It was not possible to draw any conclusions from the sparse data generated with the various gear-types used in this project. Observations during this research and FAD literature suggests that schools of pelagic fish are not permanent residents of FADs but transient visitors. The ideal gear to use would therefore be one which remains at the FAD permitting the capture of fish whenever schools visit the FAD. When fish were present all fishing gears were successful to varying degrees.

8. General Conclusions and Recommendations

8.1 Conclusions

The principal aim of the project was to assess the impact of the deployment of shallow-water FADs on small-scale artisanal fishing villages in terms of socio-economic criteria such as increased revenue, more time available for alternative economic activity or increased numbers of fishermen. In addition, factors relating to aggregation of fish around FADs were to be addressed by experimental fishing and through monitoring biological parameters of fish landed by the fishermen themselves. It was quickly apparent that Santo was perhaps not the ideal fishery in which to base the study. This was due to the very low level of fishing activity in the area and the lack of a structured economy at the village level. Work in the cash economy is not strongly developed in villages, much of village life is focused on small-scale agriculture, generally for subsistence. Fishing, on the whole was important to only a handful of individuals and even these individuals were not 'dedicated' fishermen. In general the project was well received by villagers on all the islands visited and there seemed to be a real interest in experimenting with FADs; however once a village was left, little or no FAD fishing occurred. The fishermen obtain what they regard as satisfactory yields for their effort, and it seems more important that fishing can be conducted in the 'traditional' way and as a joint effort between fishermen rather than as an exercise in maximising catch per unit effort or total catch. Generally fishing was a result of sighting of schools from the beach and little exploratory fishing seemed to occur amongst the canoe fishermen.

There was, in all villages, an informal marketing of fish but this again was very difficult to observe and even harder to quantify. The 'randomness' of fishing and the local economy thus presented problems with quantification, and while much thought was given to try and counter this, these efforts were in vain. Without villagers or the fishermen themselves completing logbooks there was little chance of accurately assessing catch and effort. The log-book approach had been attempted by ORSTOM on Efate Island, but again the ephemeral and unstructured nature of fishing did not permit collection of good quality data, quantification of effort proved especially difficult when a fishing 'trip' could be 2 days spent visiting family on a nearby island with only a small amount of actual fishing effort during the trip. There was also a problem with the low level of education that many of the fishermen (generally older men) had received and thus their ability to complete log-sheets satisfactorily was limited.

As it transpired experimental fishing was almost the only fishing effort expended on the FADs and data-collection from this was always therefore going to be small scale compared with that possible had a number of fishermen utilised the FADs.

Extension work, in the form of advice, meetings and informal conversation was constantly putting forward the FAD message, yet fishermen remained with their 'traditional' techniques and fishing areas. Cultural inertia, lack of entrepreneurial spirit (to drive exploratory fishing) and apparently low density of suitable pelagic species were all important factors that account for this. Many fishermen suggested that the lack of interest in FADs resulted from their fear of sharks which they believed were attracted to FADs, but much of this fear is (at least for villagers at Port Olry) a result of previous fishing experience on a deep-water FADs where sharks can be a problem for a fisherman operating out of a 3 metre outrigger canoe. Indeed fishermen in Kiribati have cut away FADs for fear that they attract sharks which have been known to overturn canoes (Preston,1991).

8.2 Recommendations

Bearing in mind the problems encountered with the project, what recommendations can be made in terms of future work on FADs? What is clear is that these FADs did not aggregate large quantities of small pelagics although small schools were observed and occasional catches were made. Although hard data is lacking, the waters of Vanuatu do not possess large stocks of fish and this is the likely reason for the failure of FADs to aggregate consistently. Compare this situation with the observations of Rountree (1989), who found that shallow-water FADs placed off South Carolina attracted large schools (thousands of fish) of Scad (*Decapturus* spp). Anecdotal information from the Solomon Islands also suggests that shallow-water FADs can attract fish and fishermen. Kiniora (pers comm) reported that village communities on Malaita had requested FADs to be placed by the Fisheries Department and had then successfully fished small and larger pelagics for sale to local markets and on to the capital, Honiara.

The main recommendation of the report is that research be continued, particularly the development of more appropriate fishing gears. For small fishing communities as found in Vanuatu with a relatively restricted fishing ground (both because of custom ownership of sites and due to the small canoes that still predominate); an aggregated (if small) baitfish resource should prove a valuable enhancement of their fishery. However because inshore FADs are designed to enhance the catchability of small pelagics suitable for baitfish they are unlikely to attract fishermen away from potentially over-exploited reef resources, indeed increased availability of bait-fish may actually increase exploitation.

Before any further FAD deployment programmes go ahead, more careful consideration of site should be taken; the existence of a more dynamic fishery than that found in much of Vanuatu is essential both for fishermen to explore the new opportunities and from the perspective of gathering sufficient data to assess the success of the project, especially the most suitable fishing gears. Clearly the major problem found during this study was assessing the potential of alternative sites for FAD deployments, both from the perspective of aggregating potential and the likelihood of use by fishermen.

What therefore are the important criteria that are likely to determine the success of a FAD deployment, and are any of these criteria universal in their application? The criteria listed below are based on the results from this research as well as being an amalgam of criteria recommended by other workers in field (eg Cayre, 1991).

Fishery Conditions

- Are oceanographic conditions suitable for FAD deployment and are there suitable resource of pelagic fish to be exploited following FAD deployments?
- What is the extent of current exploitation of species to be aggregated by FADs?
- What are the reasons for this level of exploitation?
- Is there, or is there likely to be, over-exploitation of currently utilised fishery resources?
- Does the fishery exhibit growth or stagnation in development?
- Does the necessary infra-structure exist (including the presence of suitable fishing vessels) and are there present fishermen who are likely to exploit the aggregated species?

Marketing Conditions

- What is the current contribution of fishery products to the local economy?

- What will be the reception of new species in the market?
- Can the local markets absorb an increase in landings?
- What options are available for the export of aggregated fish out of the target area?

Bearing in mind these points there is clearly a need to develop a planning guide that explicitly incorporates these criteria into a more analytical framework which would also incorporate an actual assessment 'tool' that would permit choice between sites and estimate returns from the investment in the programme. For fishery managers operating under budgetary restrictions and possibly without time to keep up to date on the latest fisheries research, a useful output would be in the form of a guide to FAD programmes. A handbook has been produced as a separate document during this research programme and has been jointly published by the South Pacific Commission and the ODA.

When FADs are considered for an area the fishery manager would apply the devised framework to assist him in the development of the programme, to choose between sites, to discard clearly unsuitable sites and to be able to present a rational explanation for the programme to budget managers and Ministerial staff, and fishing communities.

Appendix 1: Bibliography

Anon. 1968. Fish-Traps in Papua New Guinea. Australian Fisheries Newsletter, December, 1968.

Brouard, F., and R. Grandperrin. (1985). Deep-bottom fishes on the outer reef slope in Vanuatu.SPC/Fisheries RTMF 17/ Working Paper 12.

Carlot, A.H., and F. Nguyen, (1989). Preliminary study of populations of Vanuatu deep bottom fish after seven years of exploitation. USAID and NMFS workshop on Tropical Fish Stock Assessment, Hawaii.

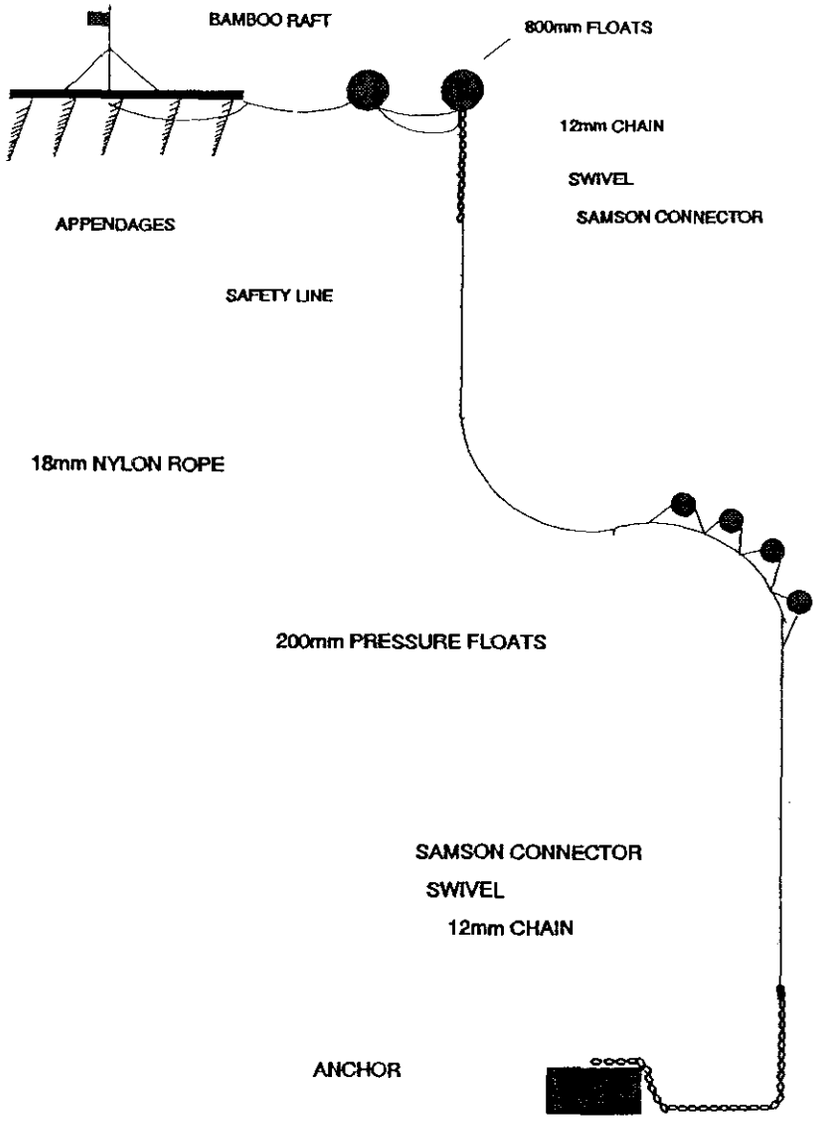
Carlot, A.H., and E. Cillaurren. (1990). Yield assessment of the deep-bottom fishery in Vanuatu. USAID and NMFS workshop on Tropical Fish Stock Assessment, Hawaii.

Hilborn, R. and C. Walters, 1992. Quantitative Fisheries Stock Assessment. Routledge, Chapman and Hall Inc. pp. 570.

Lindley, R., 1990. FAD Project Proposal. Vanuatu Fisheries Department.

Rountree, R.A. 1989. Association of fishes with fish aggregation devices: Effects of structure size on fish abundance. Bulletin of Marine Science, 44(2): 960-972.

Appendix 2: FAD Data Sheets and Designs



FAD DATA SHEET - URELABER FAD

FAD 1

DATE DEPLOYED: Dec. 12, 1991

PLACE: North of Tubana Isl. and Urelapa Isl., So. Santo

POSITION: 15° 36.23' S SITE DEPTH: 130 METRES
167° 00.96' E DEGREE OF SLOPE: 0°
SPECIFICATIONS

BUOY TYPE: Bamboo raft; constructed by lashing bamboo to timber cross pieces to form a raft 3 metres by 1.5 metres.appendage is 5 weighted lines that have coconut fronds attached so as to hang horizontally. The raft is attached to two 800mm floats, which are part of the permanent mooring. If the raft breaks up, the mooring is not lost.

MOORING TYPE: Catenary curve mooring system.

UPPER CHAIN: 3 metres 12mm gal. chain

NYLON ROPE: 160 metres 18mm, 8 strand

LOWER CHAIN: 5 metres 12mm gal. chain

THIMBLE/CONNECTOR8: Samson Nylite, 3/4"

SWIVELS: 16mm forged eye and eye

SHACKLES: 12mm screw pin, seized with s/s wire

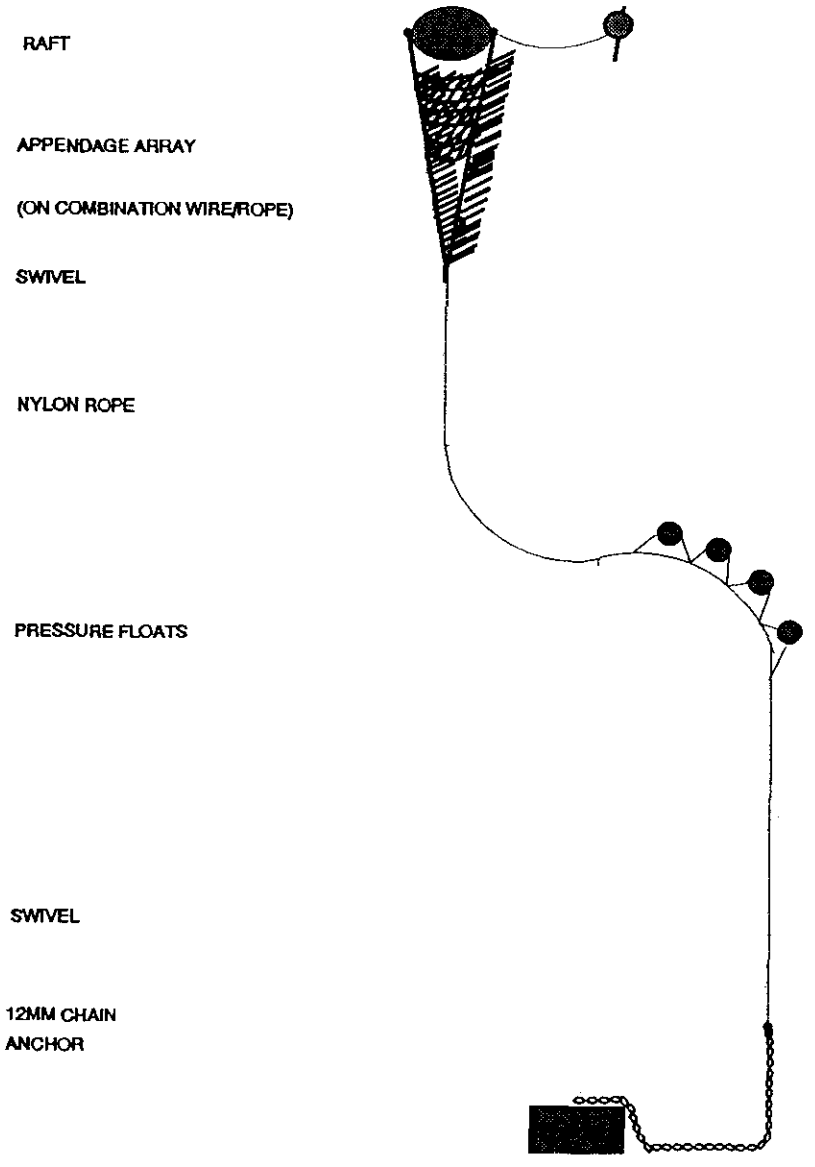
ANCHOR:
1/2 drum filled with concrete and one Lister engine. Approximate weight of 400 kgs. Connected to mooring with 4 metres of 22mm stud link chain.

COMMENTS:

Four 200mm pressure floats (rated to 300 metres) were spiced in to the nylon rope at 80 metres from the bottom, their total buoyancy is 24.8kgs. which will lift chain and hardware 3.5 metres off the bottom.

A safety line was shackled from the top chain to the 2nd mooring buoy in the event one of the buoys is damaged, the mooring will not be lost.

Position was found using a GPS Navigator. The WPS-72 datum was used.
The position should be moved 0.26' South and 0.43' West to agree with the chart, Plans on Espritu Santo, when charting the position.



FAD DATA SHEET - ELIA FAD

FAD 2

DATE DEPLOYED: Jan. 20, 1992

PLACE: South of Tangoa Isl., West of Elia Isl.
South Santo

POSITION: 15° 36.37' S SITE DEPTH: 150 METRES
166° 59.54' E DEGREE OF SLOPE: 15°
SPECIFICATIONS

BUOY TYPE: 250 litre mussel float, painted orange and white. Connected to mooring by 2, 15 metre lengths of wire/rope. aggregator attached to wire/rope ; made from mussel rope and plastic strapping.

MOORING TYPE: Catenary curve mooring system.

UPPER MOORING: Combination wire/rope

NYLON ROPE: 180 metres 18mm, 8 strand

LOWER CHAIN: 4 metres 12mm gal. chain

THIMBLE/CONNECTOS: Samson Nylite, 5/8"

SWIVEL8: 16mm forged eye and eye

SHACKLES: 12mm screw pin, welded closed

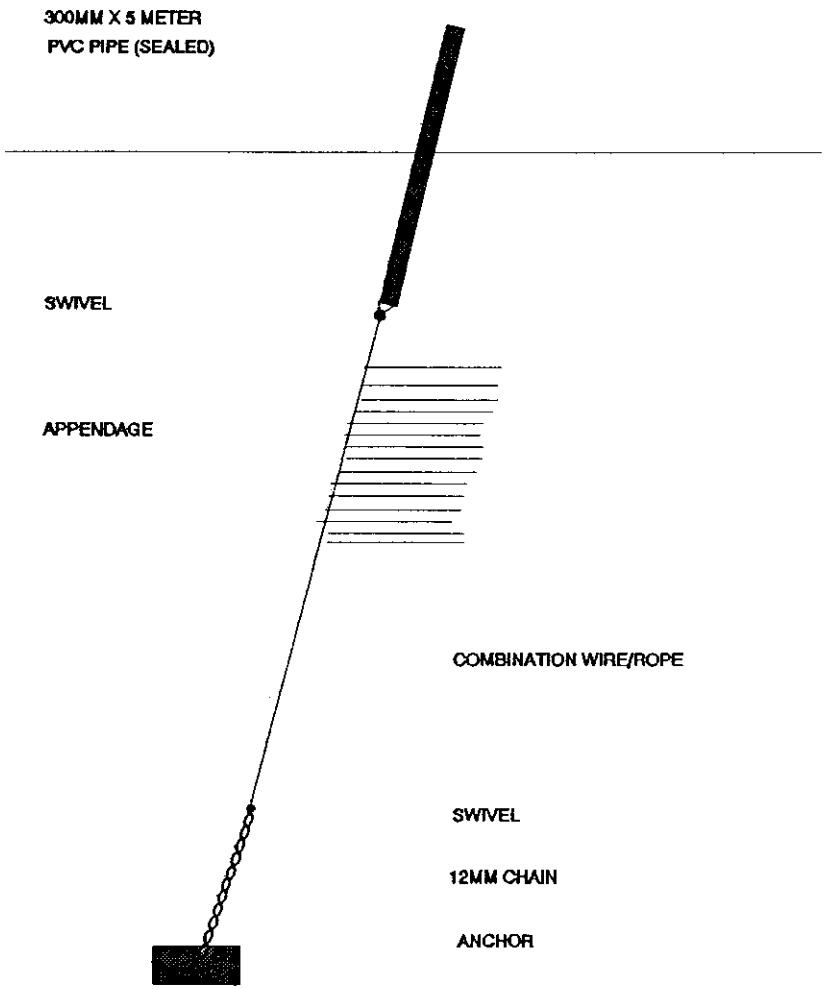
ANCHOR: Engine Blocks. Approximate weight of 500kgs.

COMMENTS:

Four 200mm pressure floats (rated to 300 metres) were spiced in to the nylon rope at 90 metres from the bottom, their total buoyancy is 24.8kgs. which will lift chain and hardware 3.5 metres off the bottom.

A small flag buoy was attached to the mussel float with arrangement for a small boat to tie up to it.

Position was found, using a GPS Navigator. The WPS-72 datum was used.



FAD DATA SHEET - TANGOA FAD

FAD 3

DATE DEPLOYED: Jan. 24. 1992

PLACE: Channel between Tangoa and Malnland.

POSITION: 15° 35.32' S 166° 58.62' E

SITE DEPTH: 23 METRES DEGREE OF SLOPE : 0°

BUOY TYPE: 300mm x 5 metre PVC pipe, closed at both ends. Painted yellow. Connection fiberglassed to bottom end for attachment of mooring. Aggregator made from plastic strapping.

MOORING TYPE: Taut Mooring

MOORING: Combination wire/rope

LOWER CHAIN: 2 metres 12mm gal. chain

THIMBLE/CONNECTORS: Samson Nylite, 5/8"

SWIVELS: 16mm forged eye and eye

SHACKLES: 12mm screw pin, welded closed

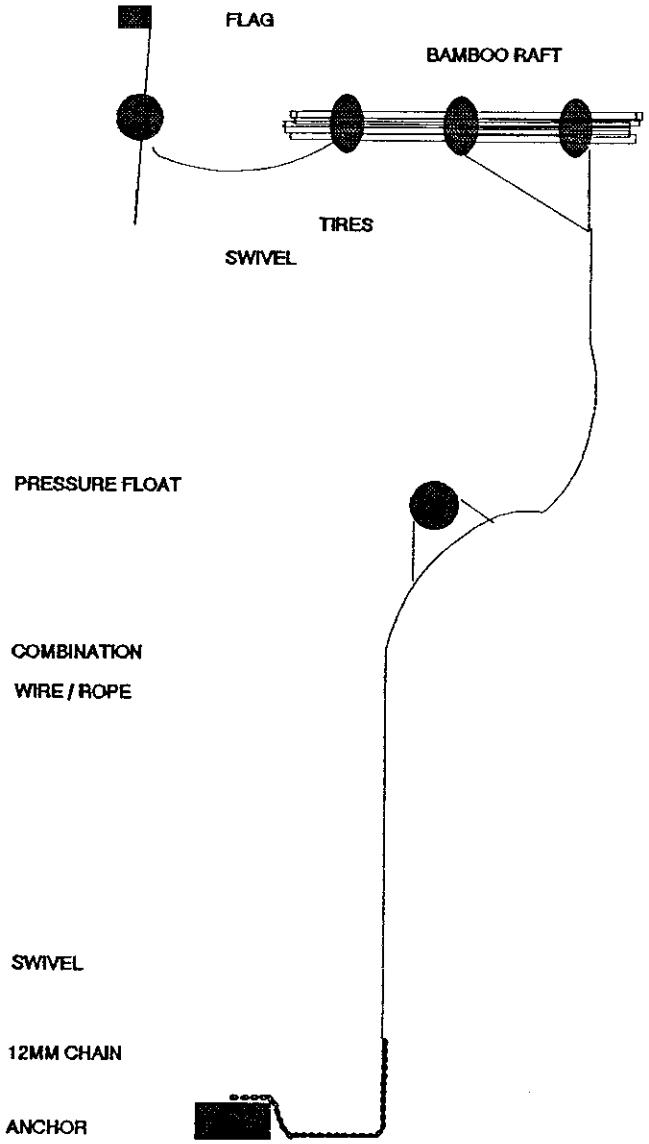
ANCHOR: Engine Blocks. Approximate weight of 350kgs.

COMMENTS:

Deployed in the west side of the channel, seperating Tangoa from mainland Santo.

At mid tide, the buoy is 2.5 metres above water level.

This type of buoy should present no problems to navigation.



FAD DATA SHEET - MELCOFFE FAD

FAD 6

DATE DEPLOYED: May 24, 1992

PLACE:500 metres from Fisheries, in the canal.

POSITION: 15° 31.93' S 167° 08.78' E

SITE DEPTH: 12 METRES DEGREE OF SLOPE: 2° SPECIFICATIONS

BUOY TYPE: Bamboo raft..... . . . Held together in a bundle by 3 tires.
The length of the bamboo is 3 metres.

MOORING TYPE: Catenary curve mooring system.

MOORING: 17 metres Combination wire/rope

LOWER CHAIN: Z metres 12mm gal. chain

THIMBLE/CONNECTORS: Galvanised thimbles

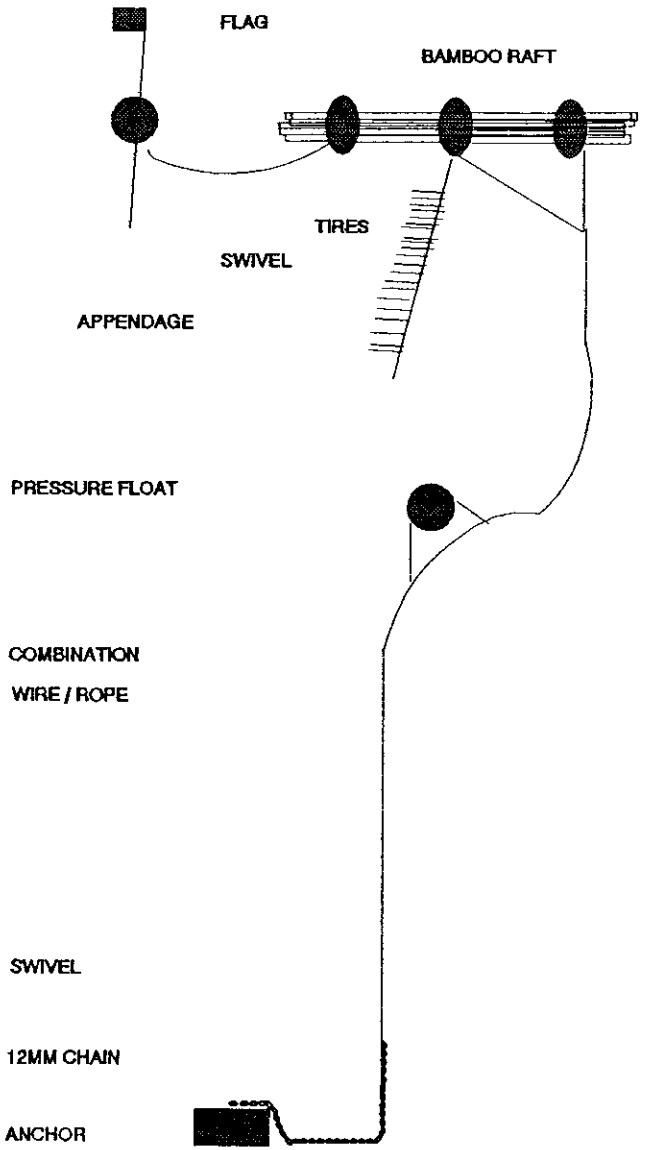
SWIVELS: 16mm forged eye and eye

SHACKLES: 12mm screw pin, welded closed

ANCHOR: Engine Blocks. Approximate weight of 300kgs.

COMMENTS:

Fad was placed close to fisheries to place fish trap on it so as to be able to monitor trap closely.



FAD DATA SHEET - AORE FAD

FAD 8

DATE DEPLOYED: Aug.16, 1992

PLACE: In the canal, close to Aore Isl. across from Fisheries

POSITION: Not Recorded

SITE DEPTH: 11 METRES
DEGREE OF SLOPE: n/a

SPECIFICATIONS

BUOY TYPE: Bamboo raft..... . . . Held together in a bundle by 3 tires.
The length od the bamboo is 3 metres.

MOORING TYPE: Semi taut mooring

MOORING: 17 metres Combination wire/rope

LOWER CHAIN: 2 metres 12mm gal. chain

THIMBLE/CONNECTORS: Galvanised thimbles

SWIVELS: 16mm forged eye and eye

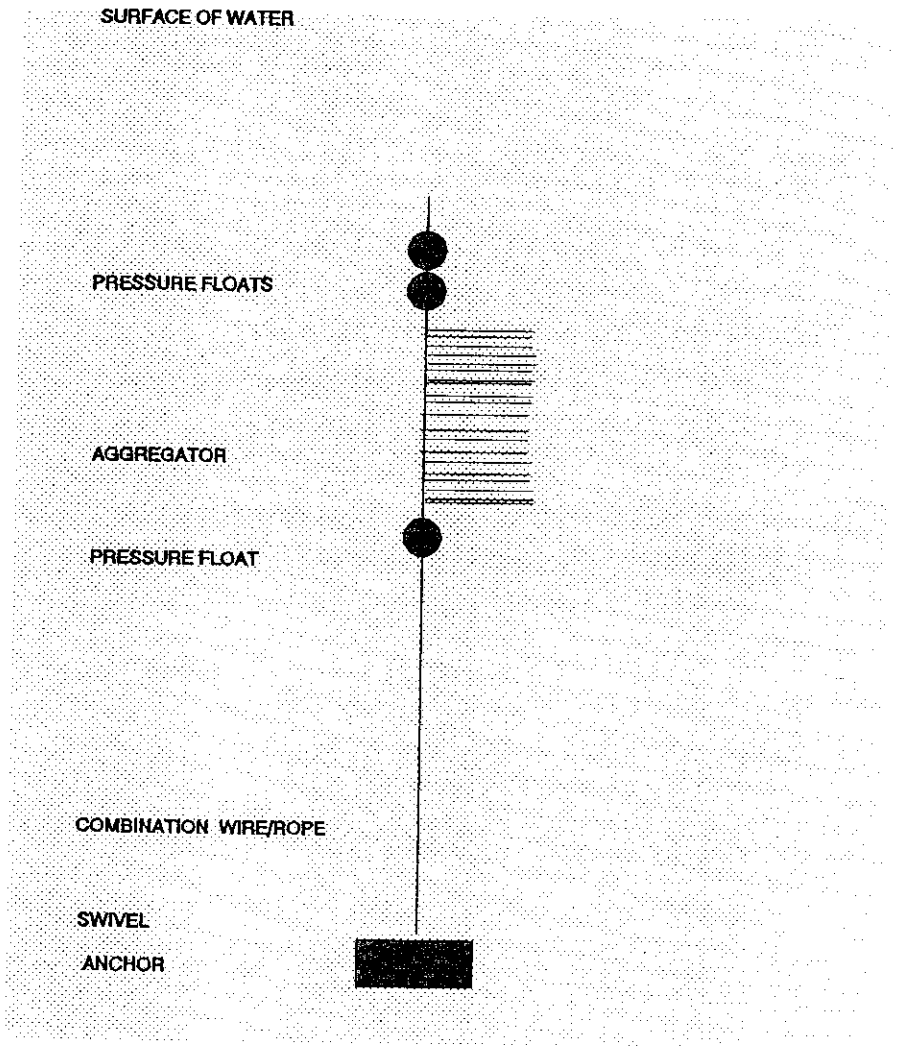
SHACKLES: 12mm screw pin, welded closed

ANCHOR:
Engine Blocks. Approximate weight of 300kgs.

COMMENTS :

Fad was "FAD NO. 6". Moved across the Canal to try another site. Was placed on top of a reef, located out of the main strength of the current in the area.

An aggregator, made from plastic strapping was added to the hA mh ~ r ~ f t



FAD DATA SHEET - BALDWIN COVE

FAD 9

PLACE: Baldwin Cove, South Santo.

POSITION: 15° 35.64' S 167° 02.70' E

DATE DEPLOYED: Sept 8, 1992

SITE DEPTH: 20 METRES DEGREE OF SLOPE : N/A

SPECIFICATIONS

BUOY TYPE: Sub-surface Fad. Nothing showing on the surface.
Three pressure floats rigged on the mooring and plastic
strapping tied to the mooring for an aggregator.

MOORING TYPE: Taut mooring.

MOORING: 15 metres Combination wire/rope

THIMBLE/CONNECTORS: Galvanised thimbles

SWIVELS: 16mm forged eye and eye

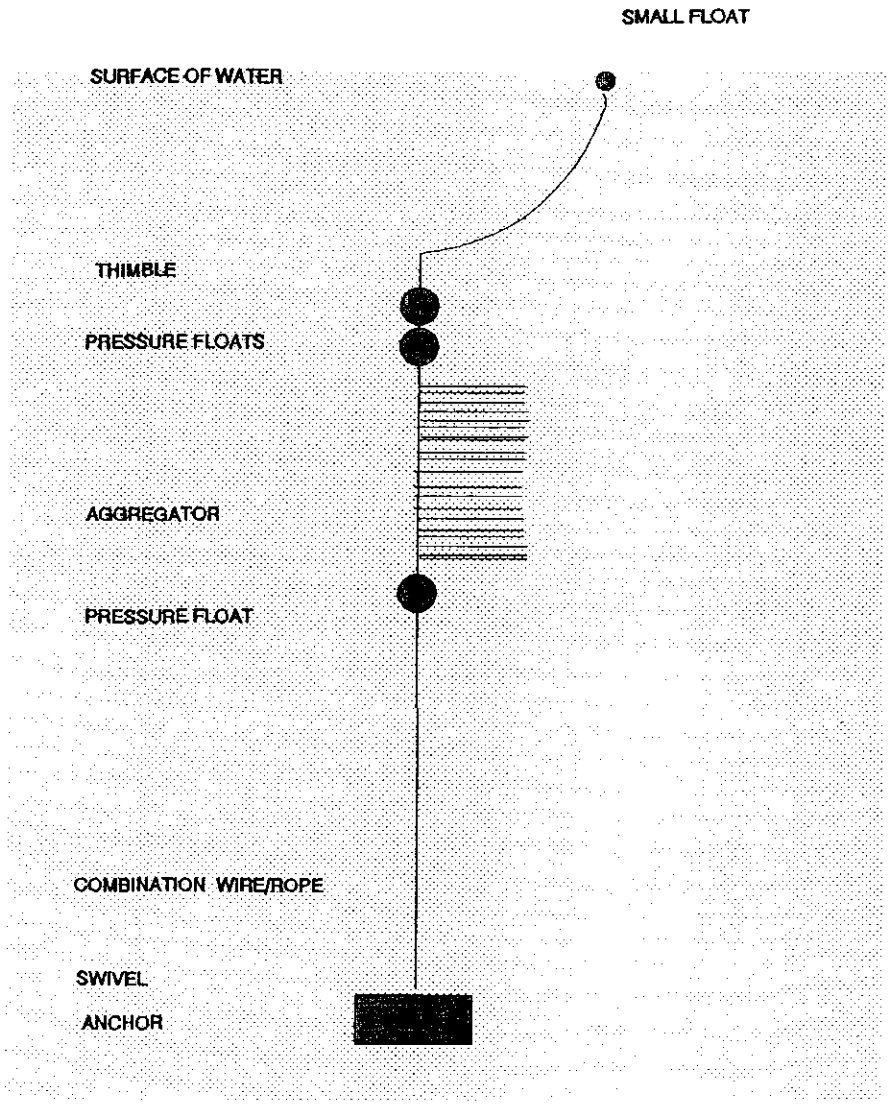
SHACKLES: 12mm screw pin, welded closed

ANCHOR: 1 Engine Block. Approximate weight of 50kgs.

COMMENTS:

Set in Baldwin Cove in an area reported to have an abundance of small pelagic fish.

Made very light so as to be able to move it with a small boat if needed. A thimble was spiced into the top end for ease of moving or for attachment of a marker float.



FAD DATA SHEET : WAMBU RIVER

FAD 11

DATE DEPLOYED: Sept 24, 1992

PLACE: In Canal, at the outlet to Wambu River

POSITION: 15° 34.11' S 167° 08.77' E

SITE DEPTH - 25 METRES DEGREE OF SLOPE: N/A

SPECIFICATIONS :

BUOY TYPE: Sub-surface Fad. Nothing showing on the surface except a small float. Three pressure floats rigged on the mooring and plastic strapping tied to the mooring for an aggregator.

MOORING TYPE: Taut mooring.

MOORING: 20 metres Combination wire/rope

THIMBLE/CONNECTORS: Galvanised thimbles

SWIVELS: 16mm forged eye and eye

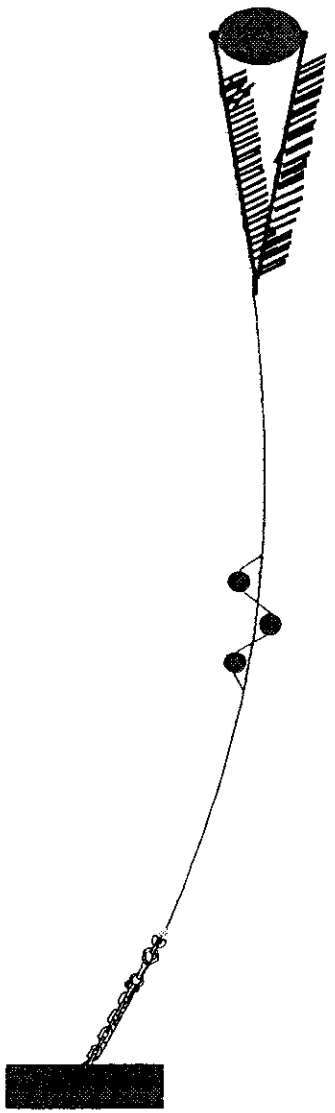
SHACKLES: 12mm screw pin, welded closed

ANCHOR: 1 Engine Block. Approximate weight of 50kgs.

COMMENTS:

Set at mouth of the Wamb River, in an area reported to have an abundance of small pelagic fish.

Made very light so as to be able to move it with a small boat if needed.



FAD DATA SHEET : PORT OLRY

PLACE: Port Olry

POSITION: 15° 02.19' S 167° 05.31' E

FAD 12

DATE DEPLOYED: Oct. 08, 1992

SITE DEPTH: 40 METRES DEGREE OF SLOPE: N/A

SPECIFICATIONS :

BUOY TYPE: 250 litre mussel float. Connected to mooring by 2, 15 metre lengths of wire/rope. aggregator attached to wire/rope ; made from plastic strapping.

MOORING TYPE: Semi-taut mooring system.

UPPER MOORING: Combination wire/rope

LOWER CHAIN: 4 metres 12mm gal. chain

THIMBLE/CONNECTORS: Samson Nylite, 5/8"

SWIVELS: 16mm forged eye and eye

SHACKLES: 12mm screw pin, welded closed

ANCHOR: 1 large Engine Block. Approximate weight of 200kgs.

COMMENTS:

Three 200mm pressure floats (rated to 300 metres) were spiced in to the combination rope at 20 metres from the bottom to lift chain and hardware off the bottom.

Position was found, using a GPS Navigator. The WPS-72 datum was used.