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SMALL SCALE AND SUBSISTENCE FISHERIES IN VANUATU

RESEARCH PROGRAMME UNDERTAKEN
BY ORSTOM IN COLLABORATION
WITH THE FISHERIES DEPARTMENT

REVIEW OF YEAR 1987 - 1990

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REVIEW OF YEARS 1987 - 1990.

GENERAL INTRODUCTION

The programme began in early 1981 when R. Grandperrin was assigned to Port Vila, following the framework agreement between the Vanuatu Fisheries Department and ORSTOM, signed in 1979 and reactivated in 1981. The fisheries research undertaken by ORSTOM during the last nine years is designed to provide the Vanuatu authorities with the biological, ecological, economic and cultural information necessary to enable them to formulate a fisheries development policy with a full knowledge of the strengths and weaknesses of the country and, if appropriate, to revise existing policy so as to enhance the viability of development projects.

The research has focused on five sectors: knowledge of the environment; resources inventory; study of catch techniques; monitoring fisheries exploitation and socio-economic aspects of fisheries (see Figure 1).

- The first three sectors are all designed to examine the ecosystem and the technology used to exploit it, to provide the country with the basic information needed to plan the development of fisheries activities.
- Directly downstream from this basic research is the monitoring of exploitation, a new research phase concerned with resources management.
- Socio-economic research seeks to highlight the human and economic factors underlying the use of fishing techniques and resources management.

Three study environments were identified:

- the ocean,
- the coastal zone and adjacent shore area,
- the deep reef zone including the reef slope to a depth of more than 100m and the underwater.

In each of these environments, in accordance with the first two National Development Plans (1982-1986 and 1987-1991), five priority research topics have been identified for each research sector:

- in the coastal zone: trochus and small-scale village fisheries and the physical and human environment,
- in the reef zone: deep bottom fishing,
- in the ocean zone: fishing in the vicinity of fish aggregating devices (FAD).

The research programme for the period 1982-1988 has been exhaustively documented in David et al. (1989a), David and Cillaurren (1989b) and Cillaurren and David (1990b), as well as in successive reports by the Forum Fisheries Agency (Wright, 1989) and the South Pacific Commission (Dalzell, 1990). A briefer survey was produced for the UNDP Regional Workshop on Environment Management and Sustainable Development held in Fiji in April 1990 (Cillaurren and David, 1990a).

OPERATIONAL FRAMEWORK

The fisheries research by ORSTOM in Vanuatu is carried out in close cooperation with the Fisheries Department and the French Embassy. Since 1988 a joint structure has been in place known as the ORSTOM-Fisheries Department Research Unit. At 31 December, 1990, its composition was as follows:

- E. CILLAURREN, biologist, contract research worker, Foreign Affairs Ministry
- G. DAVID, geographer, locally-recruited ORSTOM staff
- M. AMOS, biologist, Ni-Vanuatu research worker
- F. N'GUYEN, locally-recruited ORSTOM staff
- B. MARCHANDISE, VSNA volunteer.

Table 1 shows research unit staff and funding on and annual basis. It can be seen that the Foreign Affairs Ministry provides most of the financial support for the unit. Its contribution was 1,266,000FF compared to 539,000FF from ORSTOM. It should be pointed out that of the 210,000FF allocated by the Ministry for operating expenditure, 50,000 were used for the construction of ground baskets and 110,000FF for the purchase of SPOT satellite imagery (not covered by agreement). The allocation for "temporary ORSTOM staff" may seem unusually high. This is because it includes the salary of the locally-recruited research worker.

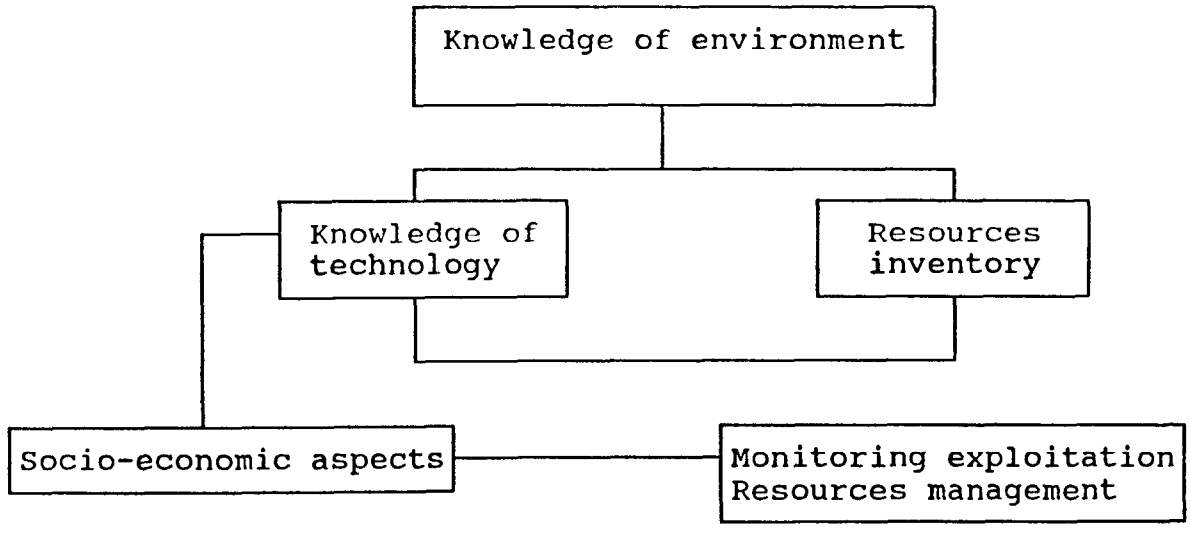

TABLE 1: FINANCIAL AND HUMAN RESOURCES ALLOCATED TO PROGRAMME

YEAR	PLACE	STAFF	RESEARCH ACTIVITIES 1	2	3	4	5	BUDGET FD	ORSTOM	MIN. F. AFF
1987	PORT-VILA	VSNA Min. F. Aff			*		*			
	"	VSNA ORSTOM			*			?	O = 30KF	O = 25KF
	"	ORSTOM Technician			*				S = 148KF	S = 96KF
	BREST	Allocat. ORSTOM (a)	*	*					LS = 10KF	
	"	Allocat. ORSTOM (b)				*				
1988	PORT-VILA	VSNA Min. F. Aff			*		*		O = 20KF	S = 100KF
	"	ORSTOM Technician			*			?	S = 45KF	O = ?
		Allocat. ORSTOM (c)	*	*					LS = 10KF	
1989	PORT-VILA	Min.F.Aff.Researcher	*	*						
	"	VSNA Min. F. Aff			*		*	O = O	O = 60KF	S = 430KF
	"	ORSTOM Local Staff								
		Staff			*	*	*	S = O	S = 18KF	O = 70KF
	"	ORSTOM Technician			*				LS = 52KF	
1990	PORT-VILA	Min.F.Aff.Researcher	*	*				S=24KF		
	"	VSNA Min. F. Aff					*		O = 44KF	S = 430KF
	"	ORSTOM Local Staff			*	*	*		S = 24KF	O = 70KF
	"	ORSTOM Technician			*		*	A=50KF	LS = 78KF	A = 100KF
	"	Fisheries Dept. Researcher					*			

1) Knowledge of Coastal Environment
2) Village Fisheries System
3) Bottom fish of reef slope
4) Fish Aggregating Devices
5) Trocas

a) 4 months allocation, 12 months presence
b) 4 months allocation, 12 months presence + 2 months in 1988
c) 6 months allocation

FD : Fisheries Department
O : Operating expenditure
S : Salaries (approximate sums paid to staff)
LS : Local staff including salary of locally-recruited ORSTOM researher
A : Agreement between ORSTOM and Foreign Affairs Ministry for acquisition of SPOT images and agreement between Fisheries Department and Forum Fisheries Agency on the Trochus Programme
KF : Thousand Francs

RESEARCH TOPICS

1. SUB-PROGRAMME: SURVEY OF COASTAL ENVIRONMENT

Programme supervisor: G. DAVID, Marine Geographer.

1.1. BACKGROUND

The aim of this sub-programme is to extend knowledge of:-

- abiotic factors which may affect fishery production and/or conservation, as well as the distribution and processing of fish; only the climate has so far been studied;
- the biotopes where inshore fishing is practised, in this case mangroves and coral reefs;
- the biotopes adjacent to the reefs which may have a direct or indirect bearing on fishery activity; our main concern here was the mapping of soil occupation in catchment areas by means of remote sensing using the SPOT satellite. This approach involves extending the field of research, usually confined to the aquatic environment This environment will no longer be studied in isolation but as one of three essential elements (air-sea-earth) of a whole, linked by flows of matter. A knowledge of the hydrographic network, the topography, the vegetation cover and the use of soil in catchment areas is of vital importance in studying disturbances of terrigenous origin which may have an impact on the coastal zone, particularly the reef formations.

1.2. DESCRIPTION

1.2.1 *STUDY OF VANUATU CLIMATE*

Operating Framework

- Collection of data: 1986, Port Vila, in collaboration with the Vanuatu Meteorology Department. Analysis: 1987, Brest.

Nature of work

- Analysis of speed and direction of winds recorded in the country's six weather stations in 1983, 1984 and 1985.
- Bibliographical compilation of data on temperatures, sunshine, humidity, rainfall and cyclonic winds from 1961 to 1983.

Results.

- Results published in "Naika", review of the Vanuatu Natural Sciences Society (David, 1990d, e, f). A brief outline was given of the impact of climate on fisheries.

a) The country's climate is marked by dominant South-easterly trade winds during most of the year. The southern islands fell the effects more than the northern ones where the influences of the equatorial climate is greater. This influence is reflected in the greater incidence of calm weather and weaker winds, particularly in summer. Consequently, the archipelago can be divided in terms of latitude between a Southern region dominated by winds, where the seas are frequently heavy and unsuitable for small vessels, and a Northern region less exposed to the trade winds and thus enjoying more propitious seagoing conditions. A further distinction can be made for the individual islands between the Eastern and South-Eastern sides of the island and the leeward sides. Exposed to the trade winds and battered by heavy seas, the former are less suited to fishing activity than the latter, with their more sheltered location.

b) The Northern part of the archipelago experiences much higher rainfall than the south. In addition to the distinction made in terms of latitude, there is also a difference between the leeward and windward coasts, the latter being much more humid. The method of conserving fish by drying or salting/drying, which requires good ventilation and the lowest possible level of hygrometry, seems much more suited to the north of the country than the south and to the leeward rather than the windward coasts. Similarly, the conservation of smoked, salted or dried fish will be more effective in the south of the country and on the leeward sides of the islands.

c) In view of the considerable risk of cyclones in Vanuatu, fisheries development infrastructures should be built only in sheltered locations. Bearing in mind that minimizing the danger from cyclones is the principal factor in determining the location of an expensive installation such as a fisheries processing unit or a shipyard, preference should be given to the north of the country over the south, which is more vulnerable to cyclones.

Objectives

- To highlight the influence of meteorological factors (speed and direction of wind, rainfall) on the frequency of small-scale fisheries activity.

Results

- The findings of this survey, the only one of its kind on the Vanuatu climate, have been widely disseminated among the country's secondary schools.

1.2.2. *STUDY OF MANGROVES AND REEFS*

OPERATION 1 - Nature of work

- Thematic mapping of mangroves in centre-east region of Malekula and adjacent reef formations by remote-sensing using the SPOT satellite, a satellite image having been acquired by the Fisheries Department in 1987 with funding from the Foreign Affairs Ministry. This work represents an extension of the study of mangroves in Vanuatu and their value for fisheries (David, 1985b).

Operational framework

- Study undertaken in 1987 and 1988 at the IFREMER Centre in Brest;
- Collaboration between IFREMER and ORSTOM-Fisheries Department in Vanuatu

Results

- Memorandum submitted to the 26th congress of the International Geographical Union, Sydney, 21-26 August 1988 (David and Caillaud, 1988);
- Poster and summary submitted to the Third International Conference on Humid Zones, Rennes, 19-23 September 1988 (David et all., 1988 and 1989).
- Contribution to "Remote-sensing" Workshop, held by the UNDP and ESCAP, Port Vila, August 1989 (David, 1989a).

These findings show that large-scale inventory mapping (1/20 000)o the main mangrove formation by use of SPOT satellite imagery is possible using simple procedures (of XS3 channel, automatic contouring, filter) and the visual detection of homogeneous zones from colour, texture, form and structure.

OPERATION 2 - Nature of work

- Thematic mapping of North Efate reefs by remote-sensing using SPOT satellite. Only a preliminary feasibility study has been done.

Operation framework

- Collaboration between ORSTOM Port Vila and LATICAL; year: 1989.

Results

- The preliminary study having proved satisfactory a full study will be carried out in 1991-92. An XS image acquired in 1987 and a P + XS image acquired in 1989 will be used.

1.2.3. *STUDY OF SOIL OCCUPATION OF CATCHMENT AREAS*

Operational framework

- Collaboration LATICAL-ORSTOM Vanuatu Ministry of Agriculture and Forestry Vanuatu-FAO (South Pacific Forestry Development Programme). Year: 1990.

Nature of work

- Mapping of surface conditions by automatic classification and visual interpretation of a P and XS SPOT image of North-west Efate.

Results

- Presentation to "Pix'iles" seminar, Noumea, 19-22/11 (David et al., 1990)

- Planning and development proposals to meet the need of population growth - intensification of agriculture in densely populated humid valley zones (pepper, vanilla), cultivation of semi-arid plains (sweet yams), cattle raising on arid plains, plantation of sandalwood in association with *Acacia Spirorbis* as host plant on arid slopes.

1.2.4. *CLIMATE AND SOIL OCCUPATION OF CATCHMENT AREAS*

OPERATION 1 - Nature of work

- Study of damage caused to the western part of the island of Efate (Vanuatu) by cyclone UMA using SPOT satellite imagery.

Operation framework

- Collaboration ORSTOM Port Vila - LATICAL; year: 1990.

Results

- Presentation to "Pix'iles" seminar, Noumea, 19-22/11 (David and Lille, 1990).
- Study highlighted the role of relief as a factor worsening or limiting the impact of the cyclone; the filter role played by the forest; the poorer resistance of modern as compared to traditional crops planted with trees on small plots within the forest.

OPERATION 2 - Nature of work

- Mapping of soil occupation of northern coastal plain of Guadalcanal (Solomon Islands) and marking out of areas susceptible to flooding and rain erosion by visual interpretation of a SPOT XS satellite image.

Operational framework

- Collaboration LATICAL-ORSTOM Vanuatu-survey Department of Solomon Islands; year: 1990.

Results

- Poster and summary presented to "Pix'iles" seminar, Noumea, 19-22/11 (Fuata and David, 1990).
- Three maps were produced: soil utilization, organization of space and zones at risk. The last map is accompanied by recommended measures to minimize damage caused by erosion on slopes and floods in the coastal plain.

1.3 FUTURE PROSPECTS

The emphasis will be placed squarely on remote sensing using the SPOT satellite. In 1989 and 1990, eight SPOT images were purchased using the 140 000 FF allocation by the French Foreign Affairs Ministry. In December 1990, following the signing of an agreement between ORSTOM and the Ministry and the allocation of 100 000 FF, a further seven images were acquired. In 1991, a further 100 000 FF are to be made available, which will make it possible to cover the main islands of the group. This information will be used to draw up a coastal development plan, an outline of which has been submitted to the Vanuatu Planning and Statistics Office and to the Director of the Fisheries Department (David, 1990k). LATICAL, where the images are to be processed, will be extensively involved in this project.

2. SUB-PROGRAMME: FISHERIES AND FOOD SECTORS

Supervisor: G. David, Marine Geographer.

2.1. BACKGROUND

Given that the marine environment, fishery resources, fishermen, the market for fishery products. consumers and the public authorities are all interconnected at a variety of different levels, a global analysis of Vanuatu fisheries and its future outlook is needed. This analysis should see the fisheries and food sectors as being closely intertwined, with the complex relations between the two making it possible to comprehend the developments and trends in both sectors. From this standpoints, it is possible to work through the fisheries sector and gradually take in all its main elements. Three complementary approaches were used: a study of relations between the sectors, functional analysis of the system and study of networks.

2.2 DESCRIPTION

2.2.1. *ANALYSIS OF UNSTRUCTURED SMALL-SCALE VILLAGE FISHERIES*

Nature of work

- An inventory of production facilities having been made in 1983 (David, 1985a), the aim was to study fishing activity, yields obtained by fishing gear, fishing strategies and production by means of surveys of landings over a period of weeks in 1984 in about 50 coastal villages. The work was done in Brest (1987-88 and Vanuatu (1989).

Results

- 943 fishing trips were studied, of which 254 were during week-ends;
- Fishery activity is more intensive during the week-end than in the week;
- 39 different techniques were identified. Several techniques may be employed during the same trip and 97 different combinations were noted. Use of handlines in shallow water without a boat was the most widespread technique, used in 16% of cases.
- Catches covered 32 families of fish, 4 types of mollusc and 3 types of crustacean. Catches were counted by trip and by technique. The average CPUE was 3 kg (10.7 fish).
- The final analysis has not yet been published.

2.2.2. *ANALYSIS OF MARKET IN FISHERY PRODUCTS, FISHERY CONSUMPTION AND ITS ROLE IN MEETING PROTEIN REQUIREMENTS*

Nature of work

- The aim was to compare production data from the 1983-84 agricultural census and the budget and nutrition surveys carried out in rural and urban areas in order to estimate the role played by fishery products in meeting the protein requirements of the population in different areas (towns, rural areas, coastal areas, interior, regions, islands).

Results

- Demand is equal to the interval "4296-4877" tonnes for limit values of 3854 tonnes. Supply is slightly higher at 4322-4885 tonnes.
- Three modes of consumption can be identified, characterized by specific dietary habits: rural coastal, rural interior and urban.

(a) Urban consumption patterns have five main features:

- the existence of tourist consumption, in the form of local restaurant clientele, and of local consumption;
- the importance of shellfish to the tourist market, where consumption is 4-7 times higher than fresh fish;
- the scarcity of molluscs and shellfish in local consumption compared to fresh fish, where consumption is 4-9 times higher;
- the dominant role of consumer income and selling price in limiting or encouraging local consumption;
- the significance of canned fishery products on the local market, where consumption is equivalent to that of fresh fish.

(b) Rural coastal consumption patterns differ from urban ones in three ways:

- general consumption of fishery products caught locally;
- substantial consumption for tinned mackerel, equal to 27-30% of fresh fish consumption;
- insignificance of consumer income as a factor limiting or encouraging consumption; nevertheless, income does affect the choice of product and the consumption of bottom fish, for example, is contingent on the existence of solvent demand, whereas exclusive subsistence fishing is generally indicative of low income levels.

(c) Rural interior consumption patterns are marked by:

- absence of subsistence fishing and prevalence of income as a factor affecting all consumption decisions;
- poor level of fishery products consumption, the purchasing power of the population being very low;
- consumption of tinned fish products as substitute for fresh fish, distribution to the interior often being difficult.
- In 1984 the amount of protein supplied by unstructured small scale village fisheries was 228-263 tonnes, the equivalent of 1303.5 to 1504.2 tonnes of tinned fish. Had this amount of tinned fish been imported, it would have increased Vanuatu's balance of trade deficit from 6.3 to 7.4%.
- The preliminary results of this study were published in Nos 15 and 18 of the series "Notes et Documents d'Oceanographie de la Mission Orstom de Port-Vila (David, 1987, 1988a).
- The final results are the subject of a thesis which is now under preparation.

2.2.3 *STUDY OF FISHERIES DEVELOPMENT AND THE BALANCE BETWEEN TRADITIONAL AND MODERN METHODS*

Nature of work

(a) systematic analysis of small-scale fisheries development policy and balance between objectives, means and results.

(b) Analysis of geographical, economic, political and socio-cultural constraints affecting the development.

(c) Study of the prospects for fisheries development.

Results

- Paper presented to the International Fisheries Conference, Rimouski, 10-15 August 1986 (David et al., 1987);
- Article submitted to the "Nouvelle Revue Maritime" for a special issue on the Pacific (David, 1989b);
- Information paper presented to the 21st Regional Technical Fisheries Conference of the SPC (David, 1989c);
- Paper presented to the UBO/CNRS seminar on "Island territories and societies", Brest, 15-17 November 1989 (David, 1989b);
- Paper presented to the congress of the International Society for Reef Studies, Noumea, 14-18 November 1990 (David, 1990g).

The example of Vanuatu shows that any policy for the exploitation of reef resources needs to be flexible and adaptable. The adoption of a rigid centralized strategy based on deep bottom species alone has resulted in costly failures. Given the socio-cultural and economic features specific to the small island countries of the Pacific, the massive injection of capital is insufficient in itself to ensure the success of a development policy of this kind.

Any innovation proposed by "developers" will only be accepted if it can be incorporated into the personal or community strategy followed by the indigenous population. These strategies usually make no provision:

- overall increase in fisheries production and identification of maximum sustainable yields or optimum economic production, although these are the main objectives of any fisheries development policy.

This disparity should be a fruitful area for future research touching on fisheries, socio-economics, anthropology and geography and could lead to a change of direction in fisheries development policy in the island states of the Pacific aimed at taking greater account of the true socio-cultural context of the region.

Contribution to development

- Information paper on fish smoking presented to:
  (a) the meeting of the commonwealth Secretariat devoted to the role of women in fisheries (Tonga, 11/1989)
  (b) the ESCAP seminar on the development of appropriate technology for food storage, Port Vila, April 1990 (David 1990h) and widely disseminated around the country (schools, churches, women's groups).
- In this connection, the research unit lobbied for and financed the construction of a smokehouse on the island of Aoba. In the light of the success of this initiative, the Canadian Government has offered to finance a smoking workshop at the Fisheries Training Centre in Santo.

2.3 PROSPECTS

The main emphasis will be on comparing statistical data relating to fisheries, diet and the socio-economic environment with numerical data derived from the processing of SPOT images under the Geographical Information System which will form part of the above mentioned coastal development plan.

3. SUB-PROGRAMME: DEEP BOTTOM FISH OF THE OUTER REEF SLOPE

Research supervisor: E. Cillaurren - Fisheries Biologist

3.1 BACKGROUND

The aims of this sub-programme, which is based on a study of statistics from village and commercial fisheries, are as follows:

- to structure and extend the data collection system to all stages of the fisheries process, from production to marketing,
- to monitor historic trends in fisheries activities,
- to obtain data on production and activity over a long-term period in order to determine dynamic parameters to balanced exploitation of resources (maximum sustainable yield),
- to obtain information on the biology of the most frequently caught species in order to estimate the parameters for breeding growth and mortality of each species.

3.2. DESCRIPTION

3.2.1 *DATA COLLECTION*

- A data collection system has been in place since 1983 at village fisheries associations. The fishermen fill in the questionnaires and in return are given tax-free petrol and a sum of money.
- After 1987, at the request of the VFDP (Village Fisheries Development Programme) of the Fisheries Department, a joint ORSTOM-VFDP questionnaire was drawn up grouping together the socio-economic and biological data.
- In 1983 a data collection system was set up at Natai, the government fish sales outlet in Port Vila. In 1989 a questionnaire to obtain information of fish sales in rural areas was introduced in cooperation with the Extension Officers of the Fisheries Department.
- In 1990 we also received monthly reports on fish sales produced by the second official sales outlet in Luganville (Santo), Vanuatu's other urban centre. Beginning in 1990, the data collection system as a whole operates at three levels: landings, rural fish sales and the urban market.
- In addition, all experimental intensive fishery operations are monitored and the data collected are analyzed.

3.2.2. *DATA ANALYSIS*

- In 1987 a study of the history of fishery associations revealed that fishery activity had not been extensive enough to make it possible to determine how stocks were responding to fishing (Schaan et al., 1987).

- In 1988 an experimental deep trap fishing programme advocated the vertical distribution of resources and the efficiency of fishing techniques. The results were presented to the 21st Regional Technical Fisheries Conference of the SPC (Blanc, 1987; Guerin, 1989a and Guerin and Cillaurren, 1989).

- In 1989, following participation in a workshop in Hawaii organized by the USAID and NMFS, the maximum sustainable yields for the archipelago was revised. The findings were published in Carlot and Cillaurren (1990) and then in the proceedings of the NMFS/USAID Tropical Fisheries Assessment Workshop.

- In 1990 a change in data dissemination methods prompted the creation of a new series, entitled Scientific and Technical Documents, intended or the publication of fisheries statistics accompanied by a brief analysis. Shortly to the published are fisheries statistics by island for monthly catches and activity by fishery associations between 1983 and 1989.

3.2.3. *RESULTS*

- After five years of village fisheries exploitation, it appears that fisheries activity is in decline and that stocks are generally under-fished (Schaan et al., 1987).

- Given the catch yields and operating costs, trap fishing is less viable than line fishing. There is a clear distribution of stocks by depth: *Lutjanus rufolinatus* is caught at depths of 100-200 m and *Pristipomoides* at depths of more than 200 m.

- The nautilus, *Nautilus pomilius* is found at depths of 150-200 m and below 300 m (Blanc, 1987, 1989; Guerin, 1989a; Guerin and Cillaurren, 1989).

- After seven years exploitation, fishing activity is still limited by socio-economic constraints rather than the scale of resources available. In Port Vila, the country's main urban centre, the level of production is equivalent to 50% of the maximum sustainable yield (Cillaurren, 1989; Carlot and Cillaurren, 1990).

- The maximum sustainable yield, as estimated from statistics provided by village fisheries, is 40% lower than initial estimates. Thus between 113 and 603 tonnes per year could be fished in Vanuatu at the 200 m isobath. The stock abundance index seems to be correlated on the surface area available for stocks. The effects of concentrated on facility of capture remain to be determined (Carlot and Cillaurren, 1990).

- Extending the data collection system results in a stratification of part of the fisheries sector between production, rural marketing and urban marketing. Together the three systems provide information on stocks biology (Cillaurren, not yet published).

- The entering and processing of statistics is centralized and is organized as follows: entry, correction, detection of biases, classification, evaluation of dynamic parameters, adaptation to existing models, choice of appropriate predictive model (Cillaurren, not yet published).

3.3 PROSPECTS

There are two problems to be dealt with at present:

- the first concerns the representative nature of the fisheries activity reflected in the statistics gathered since 1983. A statistical analysis is needed to highlight the systematic and random biases so as to filter the statistics collected by ORSTOM.

These would then be compared to the marketing statistics so as to calculate the extrapolation factors applicable to our sample in order to estimate overall production.

- the second is the question of whether determining a maximum sustainable yield for the archipelago is a satisfactory method of resource management. In fact, the benthic nature of these resources, located in an environment of high islands separated by deep seas limiting their extension, may be the reason for the existence of separate stocks each wit distinct features dependent on the area which they have colonized (Carlot and Cillaurren, 1989).

This hypothesis needs to be tested, but its implications for resource management are clear. Although overall fishing activity may have decreased over the years, paradoxically, occasional intensive periods of activity have been recorded. These may lead to localised over-fishing due to insufficient renewal of stock, which exhibits a limited migration pattern.

4. SUB-PROGRAMME: PELAGIC RESOURCES OF THE OCEAN

Research supervisor: E. Cillaurren, Fisheries Biologist

4.1 BACKGROUND

The installation of fish aggregating devices in the waters off Vanuatu has made it possible to make pelagic resources more easily accessible to small independent vessels engaged in inshore fishing. The aim of the sub-programme in question are:

- assessing the effectiveness of FAD in terms of production and economics,
- studying the parameters governing aggregation,
- detailing stocks aggregated and studying biological features (mainly growth).

4.2 DESCRIPTION

4.2.1 *DATA COLLECTION*

Most of the data were collected between 1981 and 1985 from surveys involving the captains of vessels of the Fisheries Department. The daily fishing trips studied were to FAD in the waters around Efate, the island where the country's capital, Port Vila, is located.

- Consequently, despite the limited area studied, systematic surveys over a long period of time made is possible to identify the factors influencing the fishing of the species aggregated. An analysis of the landings from each trip made it possible to supplement the information obtained from the surveys.

This kind of research is probably unique in the Pacific. However, it has the drawback of being based on the results of a single technique, dragnet fishing, which is able to sample the upper section of midwater schools.

In 1989 a new data collection system was set up at the game fishing club, whose members frequently fish around FAD. The gear used by the club's boats (rods or deep drag lines) should make it possible to sample a greater proportion of the midwater schools.

4.2.2 *DATA ANALYSIS*

- The analysis undertaken at the ORSTOM centre in Brest made it possible in 1989 to summarize the impact of FAD on small-scale fisheries and the behaviour of schools aggregated around FAD (Cillaurren, 1989a). Some of these findings were presented to the SPC seminar on inshore fisheries resources (Cillaurren, 1988a). An analysis of the impact of the installation of rafts on the marine environment was presented in 1988 to the 26th Congress of the International Geographical Union in Sydney (Cillaurren and David, 1989).
- The findings of an analysis by otolimetry of the growth of aggregated thunidae performed by the ORSTOM Centre in Noumea in 1985 are to be published shortly.
- In 1989 an analysis of tuna fishing in the Pacific and the impact of the installation of FAD appeared in the "Nouvelle Revue Maritime" (Cillaurren, 1990a).

- In 1990, in the light of the lessons drawn from the socio-economic analysis of small-scale fisheries development, consideration was given to a policy to diversify fishing techniques and target resources. With this in view, a project was developed in collaboration with the SPC for the installation of nine FAD in the waters of the archipelago. An updating of the previous study made it possible to identify the most appropriate locations for the installation of rafts and the environment and economic constraints on their use. Two papers presenting the findings were given to the 22nd Technique Regional Conference on Fisheries of the SPC (Cillaurren, 1990b and c).

4.2.3 RESULTS

- The installation of fish aggregating devices (FAD) had the effect of concentration catches (95% of total weight) and fishery activity on 1% of the fishing grounds (Cillaurren, 1988a; Cillaurren and David, 1988, 1989).

- The installation of FAD alters the distribution and quality of fishery activity deployed outside the zone of influence of the FAD; as a result, no conclusions can be drawn concerning the impact of aggregation on the abundance of pelagic fish in areas situated away from the direct influence of FAD (Cillaurren, 1988a, 1990b).

- The diversity and size of catches decrease following installation of FAD; at surface level, for example, 95% of catches consist of yellowfin tuna, invariably immature, and bonito. They are concentrated within a radius of 500m around the FAD (Cillaurren, 1988a).

- Aggregation reveals the existence of clear seasonal and annual fluctuations: skipjack are abundant between December and March, while immature yellowfin tuna appear in April or May and remain in the vicinity of the FAD if a phenomenon such as the El Nino current has occurred in the previous year (Cillaurren, 1988b).

- Two types of behaviour were evidenced:
  * skipjack behave in a mainly predatory manner,
  * yellowfin tuna are seeking shelter but compete with bonito for food (Cillaurren, 1988b, 1990c).

- Dragnet fishing around FAD located more than two hours from the coast is not economic for small-scale fishing vessels (Hartley or catamarans with 25 horsepower motors), (Cillaurren, 1988b, 1990c).

- The choice of location is crucial to the success of FAD. Nine sites have been selected in Vanuatu for a raft installation programme in 1991. The factors determining the choice of site are productivity and the existence of fishery-related infrastructures (Cillaurren, 1990b).

- For an island state like Vanuatu with limited resources available for creating an industrial fisheries sector, the fishing of species aggregated around rafts has the advantage of developing local consumption and reducing imports of tinned fish. In addition, the development of non-destructive fisheries methods helps improve the quality of catch and opens up possibilities for the development of commercial fisheries producing high-quality fish (Cillaurren, 1990a).

4.3 PROSPECTS

Together with the installation of new FAD, a new data collection system incorporating various fishery techniques should make it possible to study the dynamic parameters governing the concentration of midwater schools. It should be possible to determine some aspects of the aggregation behaviour of these schools, such as their rate of renewal and length of residence.

5. SUB-PROGRAMME - TROCHUS

5.1 BACKGROUND

The value of trochus lies in the intensive commercial exploitation to which it is subject. Indeed, the processing of mother of pearl is one of the country's main industries. Preliminary research has made it possible to set a legal size for trochus caught and to establish a growth curve for the species *Trochus niloticus* (Bour and Grandperrin, 1985). At the same time, experiments in the field of aquaculture have been undertaken by the Fisheries Department in Port Vila. The current research programme is designed to:

- undertake a historic survey of trochus fishing,
- define biological parameters (size on sexual maturity, growth, etc.) as affected by variations in environmental factors,
- estimate the parameters for the development of trochus stocks and identify areas where over-fishing is likely,
- provide information useful for the purposes of legislation,
- determine the conditions under which aquaculture is possible and attempt to renew stocks in the natural environment.

5.2 DESCRIPTION

5.2.1 *DATA COLLECTION*

Since 1984, Melanesian Shell Products, the main shell processing company in Vanuatu, has provided details on request of the quantities it has processed ad the rate of processing (number of buttons) per size category. We therefore have statistics concerning the production and, indirectly, the distribution of size frequency for trochus processed since 1979.

- In 1985 France financed an aquaculture station at the Fisheries Department in Port Vila. A series of data concerning growth were collected during 1986.
- In 1989, aid from the FAO made it possible to reopen the aquaculture station, which had been destroyed by cyclone Uma in 1987. The growth of the larvae born in 1990 from the first hatching is being monitored. The water temperature in the tanks is measured twice a day. At the same time the sea temperature is measured and the information passed on to the Meteorology Department.
- Since January 1990 a programme of measures financed by France and the Forum Fisheries Agency has been under way aimed at collecting information on the biology (growth and sexual maturity) of the trochus populations of the archipelago and on the biotopes favourable to concentrations of trochus.

5.2.2 *DATA ANALYSIS*

- The analysis performed in 1987 on the hatching periods of trochus in aquaculture highlighted the influence of the lunar cycle (Tourel and Carlot, 1987). An internal report on the preliminary analysis of the fishery statistics collected from Melanesian Shell products was produced in 1989 (Guerin, 1989c).

- In 1990 a report on the aquaculture experiments and the initial findings was distributed within the Fisheries Department (Amos, 1990a and b).

- An information paper describing the methodology for studying trochus stocks was given to the 22nd Regional Technical Fisheries Conference of the SPC (Marchandise, 1990b).

5.2.3 *RESULTS*

- Trochus are hatched all year round in Vanuatu in line with the lunar cycle (Tourel and Carlot, 1988).

- The growth of the young in aquaculture is faster in Vanuatu than in New Caledonia, the temperature being an influential factor (Tourel and Carlot, 1988).

- Annual fluctuations in trochus production up to 1988 varied in line with demand and legislation (Guerin, 1989c); the risk of overfishing was first identified in 1989, when demand for mother of pearl increased. This situation prompted the introduction of a trochus stock evaluation programme in Vanuatu. A methodology for assessing trochus stocks at different points in the archipelago was outlined (Marchandise, 1990b), which was tied in with the monitoring of trochus fishing in the areas under study. The initial findings will be published in 1991.

5.3. PROSPECTS

The research programme funded by the Forum Fisheries Agency and France from 1990 to 1993, which is also receiving ORSTOM support in terms of staff and the analysis and publication of results, should make it possible to determine the response of the trochus population to the intensification of fishing activity. Part of this programme should also be devoted to a socio-economic study of trochus fishing. In aquaculture, there is still much to be done in the field of biology of the juveniles (especially diet, physical contraints on the growth, adaptability to bad conditions, etc..) the influence of physical and chemical aspects of the environment on hatching and the survival and growth of the larvae and young.

6. TRAINING - DISSEMINATION OF RESEARCH

6.1 TRAINING

In addition to their research work as part of the ORSTOM - Fisheries Department Research Unit, E. Cillaurren and G. David have been responsible for the teaching of biology and geography respectively at the University Centre in Port Vila, which is attached to the University of the south Pacific in Suva. Copies of their lecture notes on human geography (David, 1988i) and biology (Cillaurren, 1990i) have been published. At the request of the USP Ocean Resources Management Programme, E. Cillaurren gave

a week's seminar in Fiji on tropical fisheries, the expenses for which were borne by the FFA and FAO. The seminar was aimed at degree-level students in ocean resources management (Cillaurren, 1990j). A similar training can be made in the Fisheries Department.

In addition to teaching at USP, they are also responsible for the in-house training of research unit members in data processing and the drafting of scientific articles.

- Among those to have benefited from this training are the VSN volunteer and the new fisheries biologist at the unit, who holds a degree in marine biology from the University of Dunedin, New Zealand.

- A second - year student in marine biology, Wiliam Naviti, from the same University was also taken on as a trainee during the University vacation.

6.2 DISSEMINATION OF RESEARCH FINDINGS

In 1989 an information system was introduced to meet the needs of a wide range of users:

- small - scale fisheries associations collaboration with ORSTOM, through the creation of a quarterly fisheries newsletter in Bislama aimed at explaining the work carried out by the research unit and explaining its findings in simplified form;

- the public authorities, through the publication of a series of activity reports;

- development workers, through a structured distribution of internal notes and technical documents within the Fisheries Department;

- the technical departments of neighbouring countries and regional development and research bodies (SPC, FFA, FAO), by means of regular participation in the Regional Technical Fisheries Conference of the SPC;

- the scientific community, by means of the series "Notes et Documents d'Oceanograhie de la Mission ORSTOM de Port-Vila" and participation in international conferences.

GLOBAL OUTLOOK

Aside from the prospects for the five individual research sectors and with a view to a possible withdrawal by ORSTOM from fisheries research in Vanuatu within 2 - 3 years, it would be useful to produce a summary of the research undertaken by ORSTOM since 1979. This could be published in a special edition of the collection "Etudes et Theses de l'ORSTOM" or published outside the ORSTOM framework with the aid of the ACCT, for example.

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