

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 01

MINISTRY OF FISHERIES AND MARINE RESOURCES  
REPUBLIC OF MAURITIUS

**BASIC DESIGN STUDY REPORT  
ON  
THE PROJECT FOR EXTENSION OF  
THE ALBION FISHERIES RESEARCH CENTER  
IN  
THE REPUBLIC OF MAURITIUS**

**MAY 1994**

**Fisheries Engineering Co. Ltd.**

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## PREFACE

In response to a request from the Government of the Republic of Mauritius, the Government of Japan decided to conduct a basic design study on the Project for Expansion of the Albion Fisheries Research Center and entrusted the study to the Japan International Cooperation Agency (JICA).

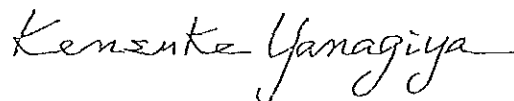
JICA sent to Mauritius a study team headed by Mr. Toru Kumatani, Assistant Director, Office of Overseas Fishery Cooperation, Fisheries Agency and constituted by members of Fisheries Engineering Co.,Ltd., from January 16 to February 6, 1994.

The team held discussions with the officials concerned of the Government of Mauritius, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent of Mauritius in order to discuss a draft report, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Mauritius for their close cooperation extended to the teams.

May, 1994



Kensuke Yanagiya  
President

Japan International Cooperation Agency



May, 1994

Mr. Kensuke Yanagiya,  
President  
Japan International Cooperation Agency  
Tokyo, Japan

Letter of Transmittal

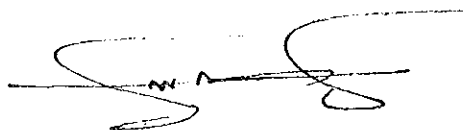
We are pleased to submit to you the basic design study report on the Project for Extension of the Albion Fisheries Research Center in the Republic of Mauritius.

This study was conducted by Fisheries Engineering Co.,Ltd., under a contract to JICA, during the period January 10 to May 31, 1994. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Mauritius and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, and the Fisheries Agency. We would also like to express our gratitude to the officials concerned of the Ministry of Fisheries and Marine Resources, the Embassy of Japan in Madagascar for their cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to further promotion of the project.

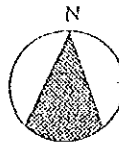
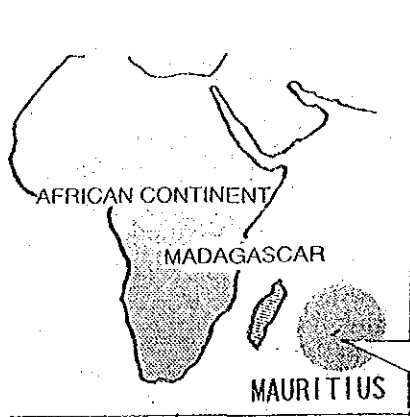
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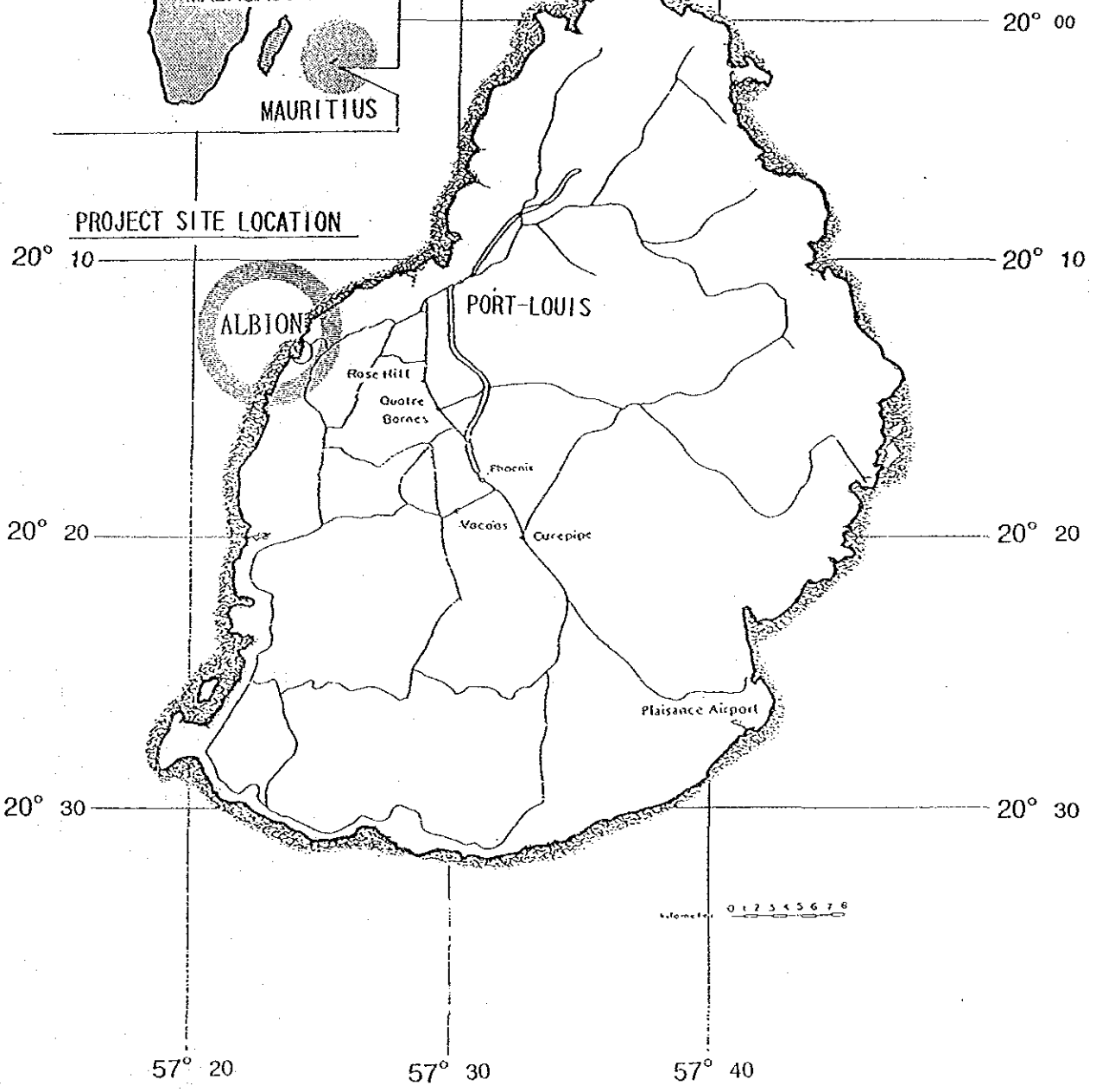
Toshiya Ogasawara  
Project Manager,  
Basic design study team on the Project for  
Extension of the Albion Fisheries Research Center  
Fisheries Engineering Co.,Ltd.







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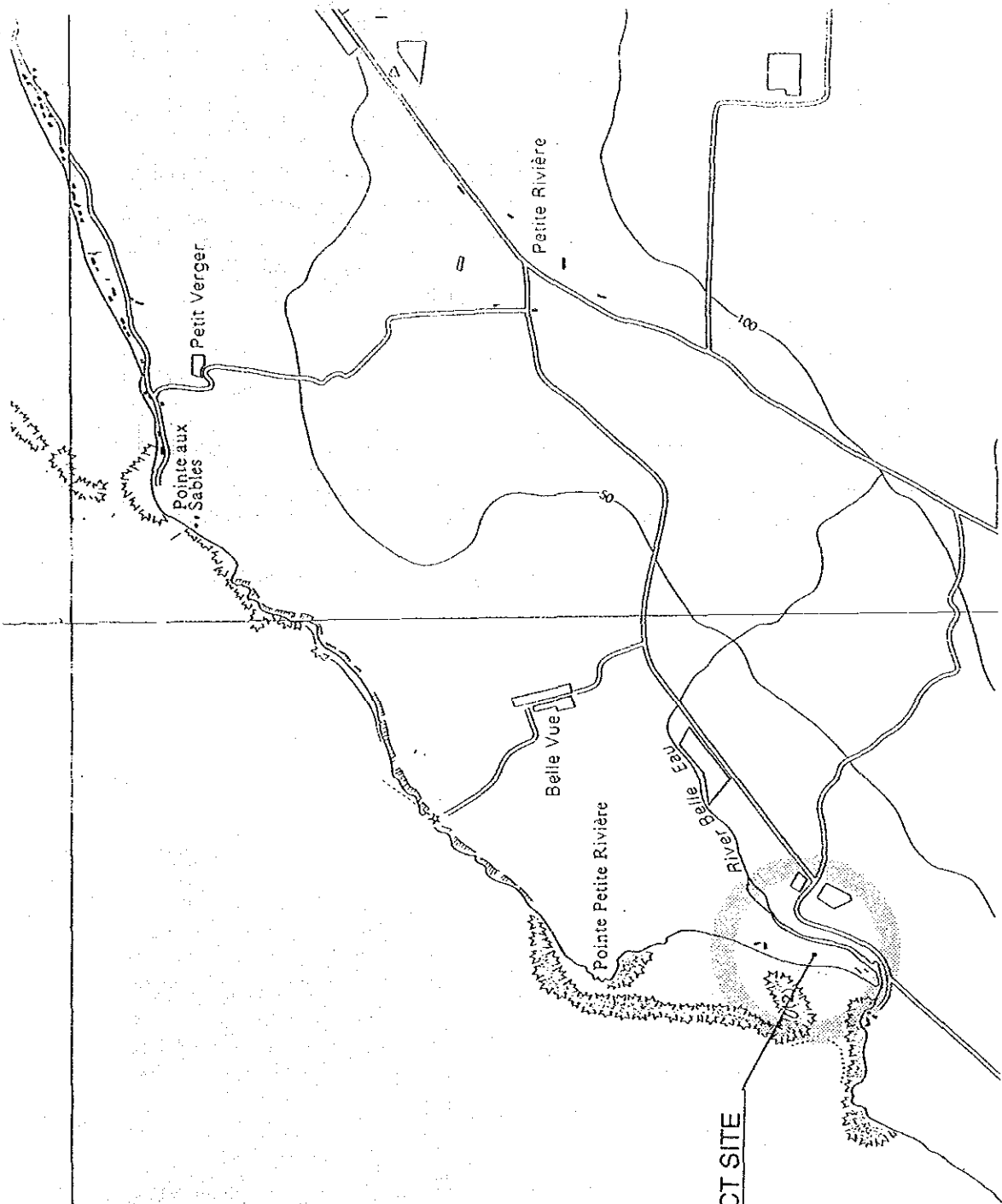
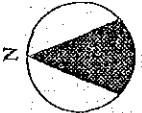


MAURITIUS



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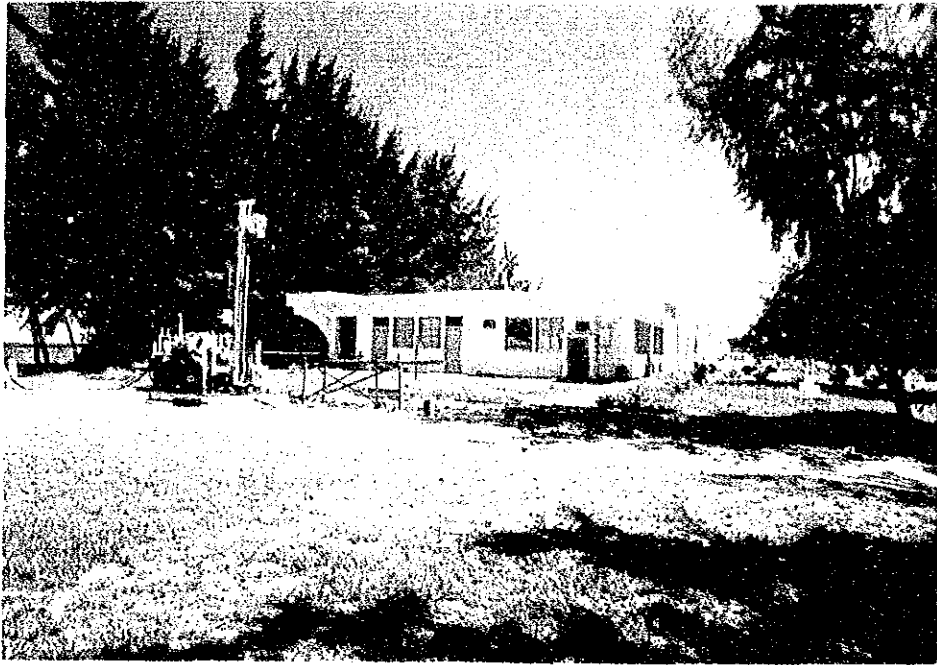
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ALBION  
PROJECT SITE

**ALBION FISHERIES RESEARCH CENTER  
PROJECT SITE LOCATION PLAN**





**Albion Fisheries Research Center      Construction Site**



**Borehole tests**





**Albion Fisheries Research Center(AFRC) Main Bldg.**

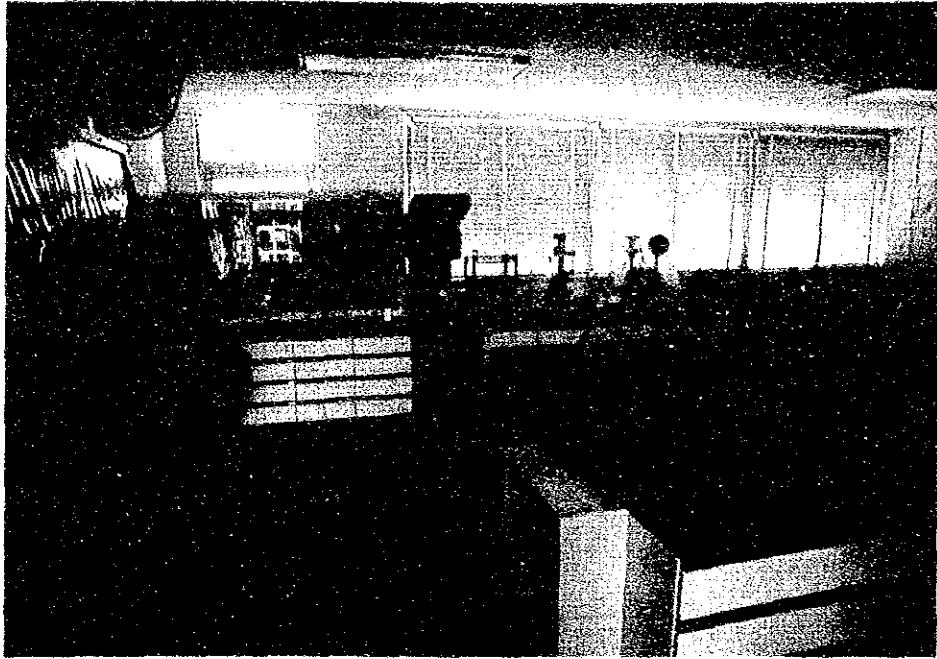


**Marine Shrimp Culture Experimental Station**

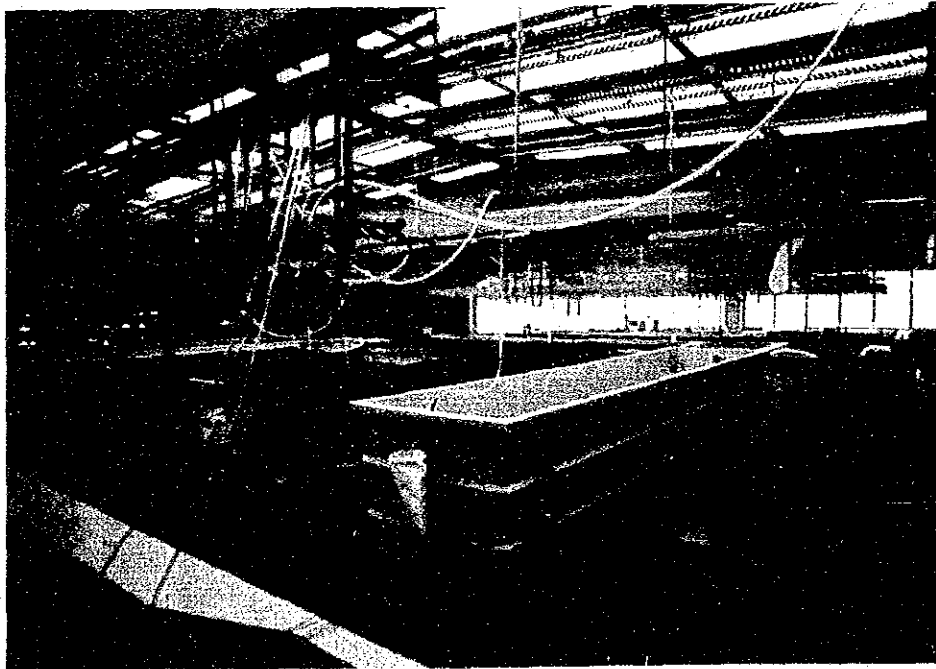
**Technical Office Bldg.**





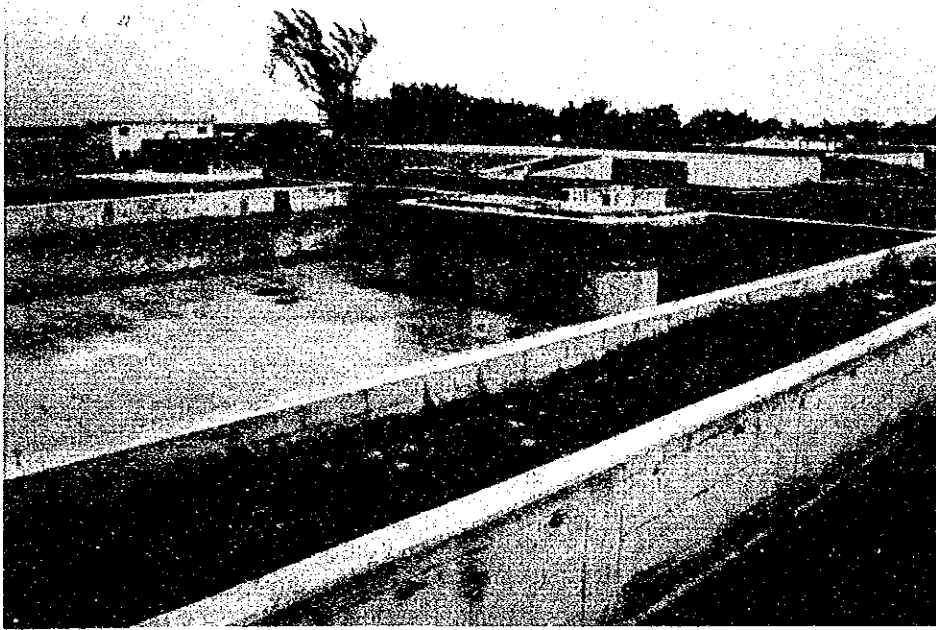


**Technical officer's Room**

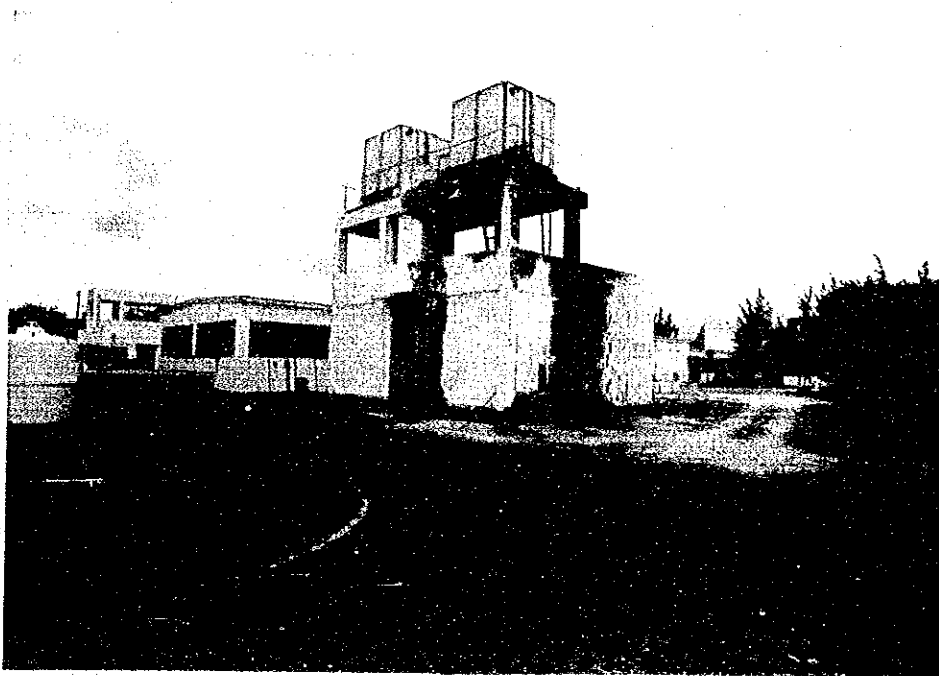


**Culture Tanks in Hatchery Complex**



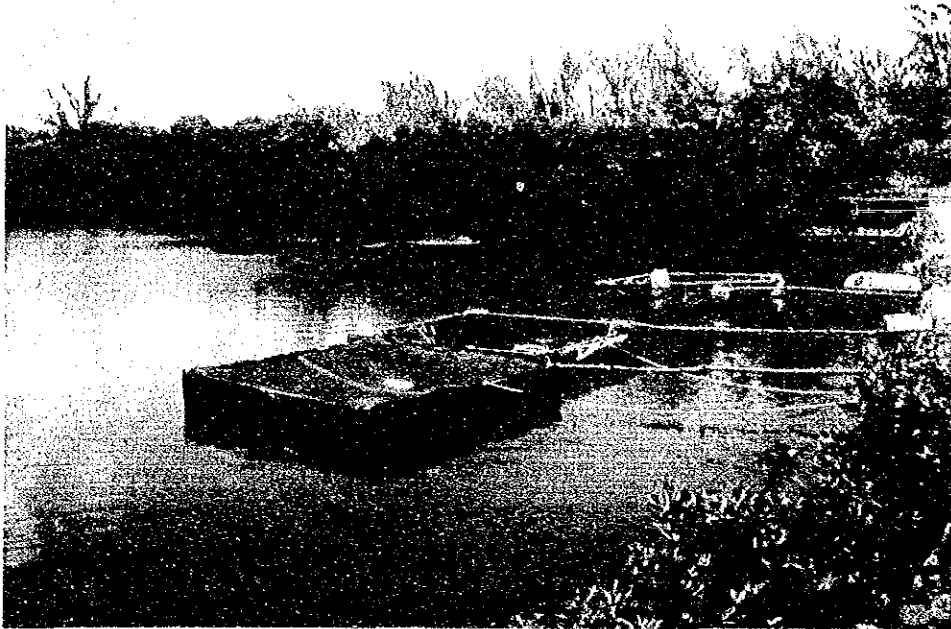


Culture Pond



Machine House





**Barachois**



**Fish Market at Fishlanding Station**



## SUMMARY

While the Republic of Mauritius is a fish exporting nation, canning domestically caught tuna for export, the country relies heavily on food imports, including a large volume of edible fish, and so is also a fish importing country. Imports are composed primarily of foods, refined petroleum products, and capital goods. On the export side of the ledger, shipments of products from its Export Processing Zone, though expanding, plus sugar cannot close the import gap, leaving a chronic trade deficit. A substantial portion of the country's imports are accounted for by food products, with edible fish imports alone comprising some 10% of food import value, hardly a small figure. However, since tourist revenues just about offset the chronic trade deficit, fluctuations in this tourist income are of huge importance to the Mauritius Government.

In the 6th National Development Plan (1992-1994), economic growth has been continuing, supported up to now by a relatively low-wage labor force. However, with the recent rise in wages and a limited labor supply, the country has been compelled to seek out new avenues of economic development. This has led to recognition of a need to look to the effective utilization of domestic resources as the most promising new growth outlet. The National Development Plan emphasizes the importance of solving developmental problems, particularly the trade-off between environment and development and between growth and quality of life. Even for purposes of sustaining economic growth, the country has been forced to take policy initiatives to improve the quality of life, including, by extension, environmental conservation. Thus, in order to effectively utilize national resources while upgrading the quality of life, the Government has designated as vital research objectives raising the quality of manpower resources, preservation of the natural environment, the backbone of the tourism resource, and fishery resource management.

The objectives of the fishery development program in Mauritius is, firstly, to maintain a safe and stable supply of fish products as a source of animal proteins for the people and, secondly, to contribute to foreign exchange earnings through fish exports. The fisheries development plan for Mauritius lays major emphasis on achieving maximum utilization of fish resources, within sustainable levels, while taking steps to preserve marine resources and the environment. Basic research on the ecosystem is an indispensable means of realizing the twin goals cited above.

As the country's only national organ capable of conducting basic research in the fishery and marine sectors, including interdisciplinary projects, Albion Fisheries Research center (AFRC) has come to play a very prominent role in fishery development.

The AFRC has been operating primarily with facilities and equipment dating back to its establishment under grant-aids from Japan (fiscal 1980 and fiscal 1985/86). But research projects have increased more than five-fold since those early days, while the organization too has expanded to 4 research divisions and 1 administrative division. This development has led to a very large increase as well in both research and administrative staff. The result has been that the research demands on the Center have now outstripped its intake capacity, which in turn has begun to impede even its routine research activities.

In addition, in the current National Development Plan, it is suggested that many new projects be undertaken by the AFRC, such as the establishment of marine parks for ecosystem protection in the lagoons and the formulation of environmental protection plans, which underscore the nation's high hopes for major progress in research on the marine environment, as well as studies oriented to resource management, such as the introduction of a permit system for the Banks fishery. It is, therefore, strongly desired that the research facilities at the Center be expanded and that new research equipment be provided.

The Mauritius Government in response to this national requirement, has drawn up an expansion plan for the AFRC and has requested a grant-aid from the Government of Japan for its execution.

Upon receiving this request from the Mauritius Government, the Government of Japan decided to conduct a basic design study on the subject plan and the Japan International Cooperation Agency ( JICA ) sent the basic design study team in January, 1994. JICA also sent another team in April, 1994, for consultation on the contents of the draft report.

The basic design study team validated the request for facilities and equipment for the AFRC, which represents the substance of this Plan. In order to assess the appropriateness of the Plan and the scale of the facility and equipment plans, the team undertook a field survey on the Mauritius fishing industry as a whole, socio-economic conditions in the country, the present state of fisheries research, activity at related facilities, infrastructure conditions at the Plan site, building conditions, natural conditions, the implementing structure for the project, the maintenance plan, and the topography and geology of the building site for the Plan facilities.



As a result of the field survey and discussions with the Mauritius Government, the team reached the conclusion that, in view of the role that the AFRC has been asked to play with respect to development of the country's marine fisheries, aquaculture development, fishery resource management, and ecological protection, it would be appropriate to expand the research facilities within the AFRC compound, which are now quite inadequate, and to provide new research equipment and materials to this Center.

Following is an outline of facilities and equipment deemed to be necessary and optimum for implementing the Plan under a grant-aid from Japan, based on analysis and examination of the findings of our field survey:

Building:

<b>Administration/Research Building</b>	
RC construction, 2-stories	1,180.8 m <sup>2</sup>
<b>Annex Building</b>	
RC construction, single-story	150.0 m <sup>2</sup>
<hr/>	
Total	1,330.8 m <sup>2</sup>
<b>Renovation of existing facilities:</b>	
Dining room/kitchen	80.0 m <sup>2</sup>

Equipment:

- 1) Equipment for ecological lab.
  - Diving suits (5 sets)
  - Diamond saw (1 unit)
- 2) Equipment for chemical analysis
  - BOD measuring equipment (1 unit)
  - Draft chamber (1 unit)
  - Portable water quality analysis set (1 set)
  - Auto analyzer (1 set)
- 3) Equipment for bacteriological research
  - Clean bench (1unit)
  - Incinerator (1unit)
  - Bio-microscope (1set)
  - Inverted microscope (1unit)
- 4) Marine observation instruments
  - Fluorescent photometer (1 unit)
  - Sediment grain-size analysis equipment (1unit)
  - CSTD (1 unit)
- 5) Data processing equipment

- 6) Educational and extension equipment
  - Video projector (1 set)
- 7) Aquaculture equipment and materials
  - Sand filter (2units)
  - UV sterilizer (1 set)
  - Emergency generator (1 set)
  - Fish culture cage (1 lot)
- 8) Workshop equipment
- 9) Boats and vehicles
  - Boat for lagoon research (1unit)
  - boat for shallow water research (1unit)
  - Small van (1unit)
  - Pickup truck (1unit)
  - Minibuses (for 15 passengers) (2units)
- 10) Research furniture

The period required for detail design for the Plan facilities is estimated at 4.5 months from the Exchange of Notes between the two Governments and 10 months from the date of contract for the construction phase. The equipment procurement is expected to take 10 months from the date of contract. The work to be done by the mauritius side are estimated to be Rs.900,000.

The implementing organ for this plan will be the Ministry of Fisheries and Marine Resources. It is estimated that about Rs 900,000 per annum will be required for maintenance of the Plan facilities. Accordingly, the Ministry of Fisheries and Marine Resources will be obliged to secure a budgetary appropriation for this purpose on a continuing basis. The research equipment provided in the subject Plan will contain no sophisticated instruments requiring special technical guidance or operational training and so can be amply handled and supervised by existing research personnel at AFRC. The Center has had no special problems in operating the facilities and equipment provided under previous grand-aids or other equipment grants from Japan, and the administrative structure is firmly established, while budgets have been secured. Based on this history, it has been determined that there will be no problems with operating controls after the grant is completed.

The subject Plan is being positioned as a priority project in the 6th National Developmental Plan. When implemented, it will clearly play a key role in fishery development and marine conservation in Mauritius.

Based on implementation of the subject Plan, it is anticipated that the intake capacity of the AFRC complex will be expanded, while a proper working environment will be provided for conduct of its diversified research programs, thus further enhancing the research capabilities at this Center. In the Aquaculture Division, it will be possible to achieve an increase in water intake capacity as well as a stable supply of breeding water of proper quality and to improve disease control and the breeding environment, leading to increased production of post-larval shrimp. And, based on the expansion of aquaculture equipment, such as water tanks and cage culture facilities, research activity can be expedited to establish aquaculture technology for such species as silver bream and red telapia. With respect to the Marine Conservation Division, the addition of new research equipment will make it possible to conduct in house, on a more efficient basis, a portion of the water quality and other analyses that have previously been contracted to outside laboratories. This will facilitate research projects on the marine environment, including the ecosystems of coral reefs and mangrove areas, oceanographic conditions in surrounding waters, basic reproductivity, and water quality, while also permitting rapid strides in the capacity for basic data collection. This, in turn, should contribute in a major way to maximizing sustainable resource utilization, while preserving marine resources and the marine environment, as well as expediting the design of conservation policies for the marine environment, which constitute the key objectives of the Fishery Development Plan in Mauritius. In addition, it will be possible to expand the scope of educational and information programs designed to deepen understanding among fishermen of the critical need for resource and environmental protection.

From the above assessment, implementation of this Plan should lead to major progress in AFRC activities, increases in aquaculture production, invigoration of programs for fishery resource conservation and environmental protection, and dissemination of information on resource conservation among fishermen and the general public. Through these diverse activities, the Plan can be expected to contribute in a major way to solving the problems raised in the National Development Plan. Accordingly, we have concluded that there is considerable significance in implementing this Plan under a grant-aid from Japan.



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## SECTION ONE: INTRODUCTION

The Government Of the Republic of Mauritius has established the Albion Fisheries Research Center (AFRC) under the jurisdiction of the Ministry of Fisheries & Marine Resources. The Center is in charge of all technical fields related to research and development of the nation's fishery. Utilizing the fisheries research facilities and those of the marine shrimp culture experimental station, constructed on the basis of grant-aids from the Government of Japan, this Center has made major contributions to the development of Mauritius' fisheries and aquaculture as well as to the management of fishery resources and preservation of the ecology. However, as a result of an increase of personnel and the organizational expansion attendant upon progress in R & D programs, the demands on the facilities of the AFRC now exceed the organization's capacity, leading to various functional problems. In addition, in view of the new research projects that have been vouchsafed to the Center in connection with conservation of the marine environment, the Government has formulated a Plan for Expansion of the Albion Fisheries Research Center, incorporating the expansion of research facilities and the provision of additional research equipment, and has requested a grant aid from the Government of Japan for Plan implementation.

Upon receiving this request from the Mauritius Government, the Government of Japan decided to conduct a basic design study on the subject Plan. Accordingly, the Japan International Cooperation Agency (JICA) dispatched a basic design study team to Mauritius from January 15 to February 7, 1994, headed by Mr. Toru Kumatani, Deputy Director, Office for Overseas Fishery Cooperation, International Department, Marine Fisheries Division of the Fisheries Agency.

For purposes of validating the contents of the Plan relating to the refurbishing of the AFRC, which forms the substance of the Plan, as well as assessing the appropriateness of the Plan and the scale of the facilities and equipment requirements, the basic design study team conducted a field survey on the current status of the Mauritius fishing industry, socio-economic conditions in the country, marine research activity at the AFRC and related facilities, infrastructure conditions at the Plan site, construction conditions, natural conditions, the organization structures for project implementation, and maintenance together with a topographical and geologic survey of the planned construction site.

The basic agreements reached in the course of the discussions between the basic design study team and the Mauritius Government during the field survey were summarized in the

Minutes of Discussions, which was signed and exchanged by the two parties. After returning to Japan, the study team analyzed and examined the survey findings, evaluated the benefits that the subject Plan could be expected to bring to marine research and conservation of the marine environment in Mauritius, prepared a basic design on the nature and optimum scale of the facilities required along with a project budget and evaluation. This was organized into a draft basic design study report. In order to explain and consult on the draft report, another team headed by Mr. Noboru Tazoe, Office for Overseas Fishery Cooperation, International Department, Marine Fishery Division of the Fisheries Agency was sent to Mauritius from April 10 to 16, 1994.

This report, based on the above findings, contains a basic design of the facilities and research equipment deemed optimum for the subject Plan, a project implementation plan, a project evaluation, and suggestions. The composition of the study team, the names of discussants, survey itinerary, and the Minutes of Discussions are included as Appendices at the back of this report.



## SECTION TWO : BACKGROUND OF THE PLAN

### 2.1 Overview of Mauritius:

#### 2.1.1 Geographical and Meteorological Characteristics:

Mauritius is located in the middle of the Indian Ocean and is composed of two main islands, Mauritius and Rodrigues, as well as four smaller islands. Since Mauritius Island is situated at 20°S latitude, it is part of the sub-tropical climatic belt within the area of the southeast trade winds. Geologically, the island is volcanic in nature, having been formed as a result of past volcanic activity, and even today, craters are found in the interior. The soil formation too is typical of a volcanic island and is widely distributed throughout the island. Mauritius Island runs 61km lengthwise and 47km in width, with a total area of 1,865 km<sup>2</sup>. Since the central portion of the island is characterized by highlands 800 meters above sea level, it comes under the influence of the prevailing southeasterly trade winds throughout the year, which brings heavy rainfall to the central and eastern sections. The western side, on the other hand, is relatively dry, with low rainfall. During the summer season (November - April), there is heavy rainfall, and the island is assaulted by cyclones but, during the winter months (May - October), rainfall is light. With the exception of the area around the capital, Port Louis, the island is surrounded by coral reefs and so attracts many tourists.

#### 2.1.2 Socio-Economic Conditions:

After successive colonial rule by France and Great Britain, Mauritius gained its independence in 1968. At the time of the changeover from French to British rule, under the Treaty of Paris (1814), the French colonists were permitted to retain their own language, religion, customs, and laws and so, even today, French is widely used, while the Napoleonic Code is reflected in the country's laws.

Sugar cane was actively cultivated under British rule but, with the abolition of slavery in 1834, a labor shortage developed, leading to the immigration of a large number of Indian workers. As a result, the present population is a mixture of people of Indian, Creole, and Chinese descent, with ethnic Indians most numerous. The estimated population, as of July, 1993, totaled 1,098,100, with a density of 538 persons per km<sup>2</sup>. The annual rate of population growth during 1992 was 1.3%. Under British rule, some 100,000ha of land were opened to cultivation with a view to developing a dynamic and self-sustaining sugar industry. In the

1976s, sugar was the nation's key industry, accounting for 20.8% of gross domestic product (GDP) and 72% of exports. However, as a result of the severe fluctuations in international sugar prices -- the cruel destiny of primary products -- as well as damage from cyclones and other meteorological forces, the growth of the sugar industry has been unavoidably unstable. As a consequence, the Mauritius Government, with a view to freeing the country from a mono-culture economic structure heavily dependent on sugar cane and sugar products, established an Export Processing Zone (EPZ) in 1971 in a bid to attract a steady inflow of foreign capital, while also developing an apparel and textile industry and nurturing the tourist industry. As a result, the share of agriculture in the nation's GDP has been lowered to 10.0%. Reciprocally, the importance of industrial production, particularly in the EPZ, has increased apace, with exports from the Zone alone now accounting for 12.5% of GDP. The tourist industry has also shown spectacular growth, with restaurant and hotel revenues alone now accounting for 3% of GDP. Trends in GDP, by major sector, are summarized in Table 2-1.

Table 2-1: Distribution of GDP by Major Section (%)

	1976	1983	1987	1989	1991	1992	1993
Agriculture	22.5	13.8	14.6	12.4	11.4	11.1	10.0
(Sugar cane)	(20.8)	(9.5)	(10.8)	(8.7)	(7.4)	(7.2)	(6.1)
Manufacturing	15.2	15.8	24.6	23.5	23.1	22.8	23.0
(Sugar)	(5.5)	(2.5)	(3.4)	(2.4)	(2.0)	(1.9)	(1.7)
(EPZ)	(2.6)	(5.2)	(13.1)	(12.7)	(12.2)	(12.1)	(12.5)
Construction	8.0	6.2	5.3	6.4	7.2	7.4	8.0
Wholesale/retail trade, services	11.3	13.7	15.0	16.8	17.0	17.1	18.0
(Restaurants/hotels)	(1.8)	(2.6)	(2.7)	(3.0)	(3.3)	(3.5)	(3.6)

Source: Ministry of Economic Planning and Development

Exports of products fabricated in the EPZ are increasing smoothly; by 1985, they had collectively overtaken sugar exports. And against the luxuriant setting of the country's natural environment, particularly the exquisite scenery woven from its coral reefs and seas, the tourist industry has been steadily growing in importance, with revenues from this source now standing at 23% of total exports. However, exports of EPZ products and sugar, though expanding year by year, have not been able to keep up with imports of foods, petroleum products, and capital goods, thereby giving rise to a chronic trade deficit. But, since this trade deficit is now covered by tourist receipts, fluctuations in tourist revenues are of paramount importance to the Mauritius Government. Trends in the foreign trade balance and tourist receipts are shown in Table 2-2.

Table 2-2: Trends in the Foreign Trade Balance, by Major Sector, and Tourist Receipts

	Unit	1976	1983	1987	1989	1991	1992	1993
Total exports	(Rs million)	1,835	4,637	11,927	15,517	19,300	20,744	23,522
(Sugar)	%	72.0	57.8	36.3	31.8	27.9	28.0	24.5
(EPZ)	%	11.0	28.2	55.0	58.4	62.9	63.6	67.2
Total Imports	(Rs million)	2,409	5,175	13,042	20,217	24,383	25,280	30,319
(Foods)	%	24.0	25.0	12.8	13.1	12.5	12.0	12.8
(Petroleum products)	%	9.0	18.0	7.3	7.5	8.4	7.6	6.9
(Capital goods)	%	24.1	12.0	22.0	22.9	24.0	22.6	22.4
Trade balance	(Rs million)	-574	-538	-1,115	-4,700	-5,083	-4,536	-6,797
Tourist receipts	(Rs million)	184	503	1,786	2,796	3,940	4,655	5,400

Source: Ministry of Economic Planning and Development

The dynamic industrial promotion policy of the Mauritius Government has resulted in high economic growth and virtually full employment (with less than 2% unemployed). While consumer prices rose considerably by over 10% in 1989, 1990, and 1992, price levels have been relatively stable in the other years. Based on the above, estimated GDP in 1993 totaled Rs 54,650 million, with GNP at Rs 54,700 million, while per capita GNP stood at Rs 51,361 (1Rs = about ¥6), placing the country at a per capita level just behind the Asian NIEs. The Government has set the target of having Mauritius enter the ranks of the Asian NIEs by the year 2000.

## 2.2 Outline of the Fishing Industry:

### 2.2.1 Marine Environment in the Vicinity of Mauritius:

The Indian Ocean current in the vicinity of Mauritius is dominated by seasonal winds in the southwestern portion of this ocean. These seasonal winds are definitely influenced by the distribution of pressure system in the country's surrounding area during both winter and summer. In Mauritius, easterlies blow throughout the year. Currents continually flow toward the southwest or south, influenced by the rise and fall of the Southern Equatorial and Mozambique Currents.

The waters in the vicinity of Mauritius, being far removed from the continent, belong to a nutritionally poor salt belt, and so basic productivity is small during both winter and summer. Accordingly, production of marine species is considered to be small throughout the country's Exclusive Economic Zone (EEZ). Targeted waters for offshore fishery in Mauritius are situated considerably to the south of the northern Seychelles waters, which are said to be among the best fishing grounds in the western Indian Ocean and thus are not endowed with the benefits of these waters. Nevertheless, the waters northeast of Mauritius Island do include several banks about 1,000 m depth, in the vicinity of which production is high, making them a good fishing ground for bottom fish. The bottom currents in these banks become upwelling currents, carrying nutrient salts from the bottom to the surface layer, thereby creating highly productive waters directly above these banks and in surrounding surface layers. The fishing grounds in and around the banks have a potential for modest expansion, in tandem with the future development of fishing methods. Figure 2.1 shows the locations of these banks around Mauritius Island.

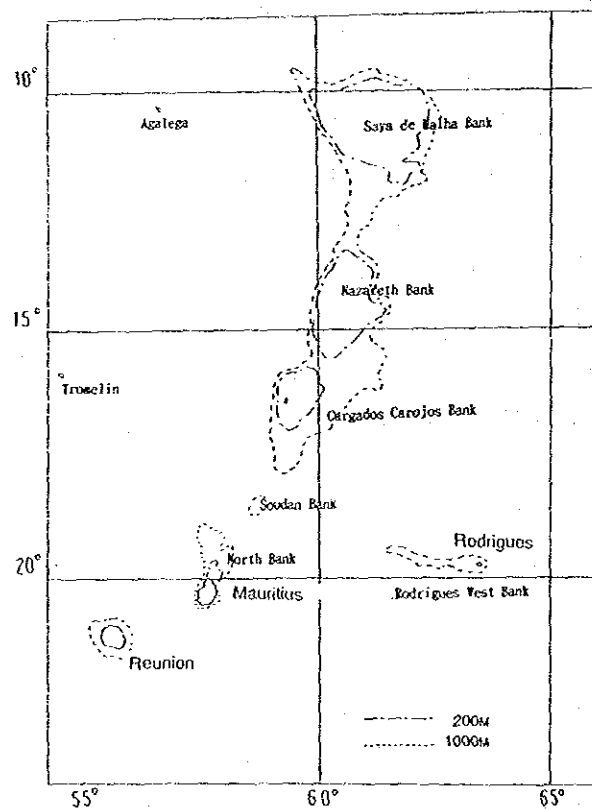


Figure 2.1: Location of Banks in the Vicinity of Mauritius Island

Average annual temperature on Mauritius Island is 23.5°C, with normal annual precipitation of about 1,800mm. The surface water temperature around the lagoon is in the range of 21 - 29°C. Since the island resulted from upheavals of the sea bed plateau, as a result

of volcanic action, as shown in Figure 2.1, the northern side has numerous sea bed shelves, but the seabed topography in other directions deepens abruptly, with the 1,000m isobath reaching only about 15km from shore.

The land area throughout the island has a gently sloping plateau configuration but, in the southwest portion, it becomes an area of steep mountains and hills. A total of 24 rivers flow into the sea along the 240km shoreline. Some 65% of the shoreline (155km) is surrounded by a coral reef, forming a lagoon 1-4 km wide with an area of 243km<sup>2</sup>. This reef is better developed along the east coast, where lagoon depth along the southeast shoreline exceeds 30m in certain locations. However, lagoon depth in general is shallow, mostly 2-5m. Sea grass beds are relatively numerous in the southern section. Very little information is available on tidal action within the lagoon but, outside the lagoon, currents are quite fast, reaching 1-3 knots.

### **2.2.2 Fishery Production:**

Fishing operations in Mauritius may be broadly classified into three categories: coastal fisheries, making one-day trips and based on Mauritius and Rodriguez Islands; "bank" fisheries, conducted in the reef areas of the Mascarene Ridge and the Chagos Archipelago; and offshore fisheries, directed at tuna, operating primarily in the western part of the Indian Ocean.

#### **(1) Coastal Fisheries:**

The coastal fisheries, based on Mauritius and Rodriguez Islands, are generally operated with small fishing boats making one-day trips. Their grounds are in waters not over 200m in depth, both within and outside the lagoon. There were 2,796 registered fishermen in 1992, an increase of 124 from 1991. Many of these fishermen formerly were engaged in sea sand harvesting. 2,037 are full-time fishermen, using mainly hand lines and baskets but, reflecting the increase of new entrants, the number of fishermen relying only on hand lines has been rapidly increasing, as opposed to those using both hand lines and baskets. Only a relatively small proportion (no more than 100) use gillnets.

There are 1,022 fishing boats, called "pirogues", of either wooden or FRP construction, with lengths in the order of 6-7m. As of 1992, 671 boats were equipped with outboard motors and 27 with inboards; the remaining 324 boats were non-powered sail boats. The outboard-powered fleet showed a 17% increase from the previous year (485 boats), indicating that motorization is proceeding at a rapid pace. The main catch species comprise

bottom fish such as goatfish, parrotfish, surgeonfish, rabbitfish, mullet, and octopus, pelagic species such as horse mackerel, mackerel, and sardines, and other highly migratory species such as dolphinfish, needlefish, wahoo, and small tunas and skipjack. There are also very slight catches of shrimp and spiny lobsters as well as tiny catches of oysters. There are large variations in catch volume, depending on the source of the figures. Table 2.3 shows trends in the volume of coastal catches, based on data from the AFRC.

Table 2-3: Catch Volume of the Coastal Fisheries (1983-1992) (in tons)

Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Catch Volume	1,370	1,375	1,334	1,327	1,597	1,479	1,544	1,637	1,568	1,775

Source: Coastal Fisheries Yearbook: 1992, published by the Statistical Department of AFRC.

Catch volume had been stagnant until the mid-1980s but has shown rapid expansion since 1987. Volume in 1992 came to 1,775 tons, representing a 13% gain over the previous year. The FAO estimates the area's Maximum Sustainable Yield (MSY) to be 1,699 tons (RAF/79/065/WP/41/88/E) but, with the actual catch already exceeding this level, the Government, is now accelerating the development of fishing grounds outside the lagoon, which had previously been neglected, in with Overseas Fisheries Cooperation Foundation of Japan (OFCF) had extended its technical cooperation.

Catch per individual fisherman averages 5.9kg per fishing day but reveals a notable diversion between fishery operations inside the lagoon (4.8kg) and outside the lagoon (8.1kg). For this reason, fishermen are very eager to switch their operations from inside to outside the lagoon but, owing to a shortage of capital, the changeover is not progressing well. Many of the coastal fishermen are sport (recreational), as opposed to full-time fishermen, whose boats are tailored to this activity. The number of these sport fishing boats has already reached 100 vessels. They run about 10m in length and are fitted with 120ps diesel engines, using mainly trolling lines. The recreational catches include billfishes, dolphinfish, wahoo, needlefish, skipjack, tuna, and shark. Tropical species are also taken live from coral reef areas and exported to Europe for exhibition or hobby purposes.

## (2) Bank Fisheries:

What are generally termed "bank fisheries" in Mauritius are mother-ship pelagic fishing enterprises operating on the various banks scattered along 1,000km of waters to the north of

Mauritius. The main banks, from north to south, are Saya de Malha, Nazareth, St. Brandon, Chagos, and the Albatros. At present, 8 such companies, with 14 motherships, are engaged in fishing operations off Mauritius Island. Each freezer mothership (20-50m in length -- most are used tuna longliners, with an average age of 15 years) carries 10-20 catch boats equipped with 8-15ps. outboard motors for operations in the bank fishing grounds. After reaching the grounds, about 3 fishermen board each catch boat and hook bottom fish on the bank using hand lines. Operations are in two shifts of 6 hours each between the hours of 6 a.m. and 6 p.m., with no operations conducted at night. Trip length is normally about 2 months. The major catch species are grouper, emperor, rabbitfish and trevally, which are frozen on board the mothervessel. Most of the catches are shipped to domestic markets in frozen form for local consumption, with a certain portion exported to Reunion. This fishery was started in the 1970s, growing from 8 vessels in 1983 to 13 in 1986-89. Paralleling this expansion, catches rose to 5,451 tons in 1987. But, when the fleet was cut back to 10 mothervessels in 1990-91, catch volume again fell to the 3,000 ton level. In 1992, however, there was a rapid recovery, with catches rebounding 40% from the previous year to 4,762 tons. Figure 2-4 shows data on trends in frozen fish production by the bank fishery.

Table 2-4: Frozen Fish Production by the Bank Fishery (1983 - 1992) (in tons)

Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Catch Volume	2,284	2,303	3,860	4,427	5,451	5,140	3,535	3,238	3,314	4,762

Source: Coastal Fisheries Yearbook: 1992, published by the Statistical Department of AFRC.

Total size of crews serving in the bank fishery, including those on mothervessels, comes to 1,075 persons. Catch volume per crew member ranges from 51 - 94kg per man /operating day. In addition to the frozen fish catches by the fleet shown above, the production includes 70 tons of salt-preserved fish, 5 tons of octopus, and 1 ton of lobster during 1992. The major fishing ground for the bank fishery is the Saya de Malha Bank, where catch effort doubled from the preceding year, resulting in a decline in catch per crew member.

### (3) Offshore Fishery:

The offshore fishery in Mauritius is directed at tuna; the major factor is a joint venture between a private Japanese company and the Mauritius Government: TFCE (Mauritius Tuna Fishing and Canning Enterprise Ltd. Co.), which was established in 1978. KGKK(kaigai

Gyogyo K.K.) has also set up and operates a fishing base to handle transshipments from tuna fishing vessels. The tuna fishery started with just one purse seiner of 50m, but later added 2 vessels, which resulted in a rapid increase in catch volume. TFCE has a cannery on Mauritius Island with a production capacity of 20,000 tons. 95% of total catches are canned, while 5% are exported in frozen form or consumed on the domestic market. Since the present catch volume does not yet approach the capacity of the canning line, the current task is to increase catches. Trends in the catch volume of the offshore fishery are shown in Table 2-5.

Table 2-5: Catch Trends in the Offshore Fishery (in tons)

Year	1988	1989	1990	1991	1992
Catch volume	6,795	8,364	6,576	11,218	11,117

Source: Economic Development Plan, Ministry of Economic Planning and Development

(4) Aquaculture:

The Mauritius Government has also been putting a major effort into the development of aquaculture, both in inland waters and in seawater. AFRC's Marine Shrimp Culture Experimental Station and the La Ferme Freshwater Farm are promoting seed production and aquaculture research along with improvements in culture technology, mainly for giant freshwater prawns, red telapia, carp, silver bream and black tiger prawns. However, as this technology has not yet been generally propagated, present production of cultured fish is only 125 tons in all -- 100 tons of freshwater and 25 tons of seawater fish. The potential area for seawater aquaculture in Mauritius is comprised of 500ha of convertible area that had originally been converted from mangrove to sugar cane plantations, and another 300ha, known as Barachois, where a portion of the lagoon is enclosed by volcanic rock, and the flow of the tides induces an exchange of seawater. Within the Barachois area, aquaculture, using traditional methods, is being conducted on such species as spine fish, mullet and oysters, though current productivity is still quite low. For this reason, high hopes are being focused on achieving progress in aquaculture research at AFRC as well as in the diffusion of the results of their research efforts.



### **2.2.3 Distribution, Processing, and Foreign Trade:**

There are a total of 64 landing areas for the small-size coastal fisheries, distributed as follows: 15 in the northwest portion of the island, 14 in the western portion, 11 in the southwest, 12 in the southeast, and 12 in the eastern portion. The bulk of the catches are sold to retailers through brokers, with the fish being sold at retail stores in public markets in the vicinity of these landing areas. A portion of the catches is stored in cold storage facilities operated by the fishing association and gradually released to sales outlets. However, since settlement of accounts is deferred under this method, the fishermen prefer to sell their catches through private brokers based on cash settlement.

The motherships of the bank fishery land their frozen fish at Port Louis, where it is purchased by cold storage companies and stored in their facilities. The fish is then sold to retailers through brokers. While the retailers sell the fish at public markets, retailers come to market from outlying towns carrying insulated boxes, which are used for storage until the fish can be sold in their home localities. Offshore catches are almost entirely composed of skipjack and tuna, which is transported to the cannery for canning upon unloading at Port Louis. 95% of cannery production is exported to the EU, with a portion of the balance consumed domestically. While virtually all of the fish from small-scale fisheries is consumed locally, about 10% of the frozen bank fish is exported to Reunion. Since fish can be eaten without regard to either religion or caste, it is a popular food, with fish prices quite high relative to other foods. Notwithstanding the higher prices, per capita fish consumption has been growing remarkably, along with the rise in income levels resulting from economic development -- from 16.0kg in 1990 to 19.2kg in 1991, and 21.5kg in 1992 (based on data from AFRC).

Mauritius exports tuna that has been canned and processed from local catches. The country depends heavily, however, on imports of foodstuffs, importing large quantities of edible fish products. In this respect, it is a fish importing as well as exporting country. As was shown in Table 2-2, Mauritius has a chronic trade deficit, with foods accounting for a considerable share of imports. Edible fish imports are no means small, representing about 10% of food imports. Thus, high hopes are placed on further development of the country's fish and aquaculture production. Table 2-6 shows trends in Mauritius exports and imports of foods and fish products.

Table 2-6: Foreign Trade in Food and Fish Products (in Rs millions)

	1991	1992	1993 (Jan.-June)
Total food imports (CIF)	2,692	2,915	1,742
(Fish imports)	241	221	148
Total food exports (FOB)	339	341	218
(Fish exports)	296	295	162

Source: Ministry of Economic Planning and Development

## 2.3 Related Plans:

### 2.3.1 National Development Plan (1992 - 1994):

The Mauritius Government is presently in the midst of its 6th National Development Plan (1992 - 1994). In previous Plans, the Government is credited with having achieved reasonable success in fostering labor-intensive industries geared to export, which diversifying the country's economic structure. In the 5th Plan (1988 - 1990), in particular, rationalization of the textile and apparel sectors was accelerated through mechanization, with a consequent strengthening of their international competitiveness.

In the current 6th Development Plan as well, primary emphasis is being placed on continued industrial diversification and concentration, with a view to achieving higher levels and stabilization of quality. At the same time, the rise in general living standards has been positioned to contribute to economic growth. The need has been recognized for policies designed to further infrastructure development in the areas of education, medical care, and eradication of poverty.

During the present Plan period, the growth in GDP is targeted at an average 6% per annum, and the following development policies have been adopted to realizing this goal:

- 1) Promotion of rationalization
- 2) Accelerating the privatization of public enterprises
- 3) Promotion of a free market economy

- 4) Establishment of public agencies for foreign trade promotion and consumer protection
- 5) Administrative reform and removal of out-dated and unnecessary regulations
- 6) Raising productivity within the constraints of a limited supply of natural resources and labor
- 7) Improving the quality of life; strengthening environmental protection, and the social security system

The Mauritius economy has been undergoing a relatively smooth transition from one dependent on primary products to a high-level industrial structure, as evidenced by manufacturing activity in the EPZ and tourism. While the country, therefore, is economically stable, this stability has thus far been achieved in large part through a good supply of relatively low-cost labor. Thus, in light of recent wage increases and the limited labor supply, it has become vital to seek out new avenues of economic development. Considerable interest has been shown in progress with international trade agreements, such as the Uruguay Round, while an urgent need has been identified in the Development Plan for effective utilization of domestic resources.

Special emphasis in the country's development programs has been given to the resolution of developmental problems, particularly the delicate trade-off between environment and development and between growth and quality of life. With the continuation of virtually full employment, reflecting the sustained economic growth, and the steady increase in per capita incomes, the public is evidencing mounting concern over the quality of life, which is rapidly becoming a national issue. With respect to environmental protection, while the actual degree of pollution is still quite low, and can hardly be compared with that in the more developed countries, environmental protection movements have become a potent social and political force. Thus, policy-making efforts must now be directed at raising the quality of life, including environmental protection, as a basic premise for continued economic growth.

In order to achieve effective utilization of domestic resources and improve the quality of life, the Government is encouraging further research activity in various sectors. Development scenarios by sector are being prepared on the basis of these research findings, while the viability of official policies is being tested in the search for optimal economic growth. The Government will, therefore, have to address, as formal research themes, issues related to the public interest in achieving equality and social justice as well as environmental conservation. Speaking more concretely, improvements in the quality of the country's manpower resources,

preservation of the natural environment, which constitutes the essence of the tourism resource, and management of fishery resources are all being pursued as major policy initiatives.

### **2.3.2 Fishery Development Plan:**

The objectives of Mauritius' Fishery Development Plan are two-fold; firstly, to maintain a safe and stable supply of animal proteins for the people; and secondly, to contribute to foreign exchange earnings through exports. By the concluding year of the Plan (1994), the goal is to increase annual per capita fish consumption from the present level of 18kg to 20kg.

Since the increase in catches from small-scale fisheries is believed to have reached the limit of MSY, future expansion from this source is unlikely. On the other hand, the country seeks to export catches by commercial fisheries targeted at tunas and other highly migratory species as well as to achieve a recovery in the catches of the bank fisheries, which have been on a declining trends in recent years. Fishing effort, accordingly, is to be redirected to pelagic species outside the lagoon, deep-water shrimp, bank fisheries, skipjack and tuna, and seawater and freshwater aquaculture. It is expected that fish supplies for the local market can be increased through expansion of fish production, the development of freshwater and seawater aquaculture, and an increase in imports.

In the Fishery Development Plan, the following policies have been formulated with a view toward attaining the twin objectives of increasing fish supply and developing exports within the context of appropriate resource management and conservation:

- Development of offshore fisheries targeted at deep-water fish species or deep-water shrimp along with small-scale pelagic fisheries on the banks.
- Promotion of the tuna fishery and aquaculture geared to exports.
- Maintaining a suitable level of fish prices and developing a distribution strategy for local catches
- Strengthening regulations and controls for purposes of fishery management and preservation of fishing grounds, including fishing vessel registration.
- Strengthening research and extension programs.

With regard to environmental protection, which is a key item in the National Development Plan, the following policies have been set forth in the Fishery Development Plan:

- Strengthening of measures to preserve the marine ecology.
- Establishment of marine parks;
- Collection of marine data.
- Formulation of a management plan for the marine environment.

The main thrust of the Mauritius Fishery Development Plan is to achieve maximum utilization within the constraints of sustainable yields while preserving marine resources and the marine environment. An indispensable measure for attaining this goal is basic research on the ecology. The Government is, accordingly, establishing research and monitoring organs, such as the Marine Conservation Center, to strengthen the manpower base for fishery management and improve ecological controls. The AFRC is the only national organ for implementing basic research in the fishery and marine sector, including interdisciplinary studies, and so it plays a most critical role in this connection. For this reason, the Government has formulated a plan within the 6th National Development Plan, to expand the existing research functions of AFRC and enable it to function effectively as a nerve center for marine protection.

#### **2.4 Role of the AFRC:**

Although agriculture remains one of the major pillars of the Mauritius economy, since production in the past has been skewed toward the single product, sugar, the country has been forced to rely on imported foodstuffs. Imports of fishery products in 1990 were 11,104 tons, outstripping fish exports, which comprise principally exports of skipjack and tuna by the foreign joint venture companies. In 1992, while exports narrowly exceeded imports, the nation continued to rely heavily on imports for its essential animal proteins. The Government expects the demand for fishery products to increase substantially in the years ahead, fueled by the continuing economic development. However, while planning to increase fish production, overfishing has developed in lagoon fisheries, which will no longer be able to secure adequate supplies to meet future fish demand. The Government is, therefore, putting particular effort into effective use of aquaculture as well as bank and offshore resources.

Research on aquaculture and breeding as well as fishery stocks is conducted by AFRC. With respect to aquaculture, the Center is engaged in research and propagation programs for the cultivation of giant freshwater prawns, black tiger prawns, and red telapia. These activities have been carried out principally through grant-aids and technical cooperation from the Government of Japan. Objectives have been largely achieved in the areas of cultivation

technology for adult giant freshwater and black tiger prawns, seed production technology, improvements in aquaculture techniques, and the transfer to the Center staff of technology for large-scale seed production and intensive aquaculture. The stage has thus been reached for diffusing these techniques in the private sector.

With respect to research on offshore resources, particularly tuna, the AFRC, taking advantage of its natural geographic position in the center of the Southwest Indian Ocean, has been receiving intensive technical cooperation from experts from FAO/UNDP and other international organizations which has helped it to assume a central role vis-a-vis neighboring countries, such as Madagascar, Mozambique, Kenya, Tanzania, and the Seychelles. And, based on technological assistance from ORSTOM in France, AFRC has become a core facility for the collection and analysis of data on the Indian Ocean region. The facility has also made important contributions as a prime venue for various types of professional conferences, workshops, and seminars related to the fishery sector.

With respect to the coastal and bank fisheries, thanks to cooperation from the FAO/UNDP and other organizations, the Center has been conducting research on fish stocks and has also been collecting data on fish catches while paying special attention to the development of a fishery management system involving seasonal restrictions and the introduction of a permit system for selected fisheries. In this way, it has been coming to grips with the difficult task of expanding catch volume while conserving fish stocks. And, with respect to fishery resources outside the lagoon, the Center has been conducting experiments with establishing artificial floating reefs and with developing new fishing grounds, based on cooperation from the OFCF.

In this manner, the AFRC, as the sole research organ in the fishery and marine sector in Mauritius, under the jurisdiction of the Ministry for Fisheries and Marine Resources, is not only charged with the full panoply of research, development, and technical projects relating to the nation's fishing industry but, as a core facility for research work on fishery resources for all countries in or bordering on the Indian Ocean, has also been contributing significantly to the regional development of marine fisheries, aquaculture, stock management, and ecological protection.

The major portion of the Mauritius coastline is composed of coral reefs and mangrove forests, which provide breeding grounds for coastal fishery resources, while the natural beauty created by the coral concentrations has become a precious tourism resource. Tourism, as

already noted, has developed into one of the four major pillars of the Mauritius economy, and preservation of a superb natural environment is, therefore, of major importance, not only to fish stocks but also to the country's overall economic development. Furthermore, since the Mauritius people have now achieved a reasonably satisfactory standard of living, their desire has strengthened for improvement in the quality of life, particularly for maintaining the country's rich and beautiful environment in pristine condition. This popular desire has become a major national issue, and the AFRC, in turn, is being asked to respond effectively to these problems and desires. The Center, thus, has been saddled with the extremely difficult task of promoting aquaculture and fishery development while maintaining a sound environment and avoiding any adverse impact on the ecosystem of coral reefs and mangrove areas, which are poised in a delicate and precarious balance.

## **2.5 Background and Nature of the Request:**

### **2.5.1 Background of the Request:**

Since its founding, the AFRC has been engaged in a continuing series of research programs, using equipment and facilities provided under grant-aids from the Government of Japan covering the construction of research facilities (Plan for the Establishment of a Fishery Research Center -- Fiscal 1980) and a pilot aquaculture operation for marine shrimp (Plan for a Marine Shrimp Culture Experimental Station -- Fiscal 1985/86). However, the number of research projects undertaken by the Center has increased, and organizationally as well, the Center has expanded to four research divisions (covering artisanal fisheries, offshore fisheries, aquaculture, and marine conservation) along with an administrative division. Pursuant to this expansion, the research and administrative staff has also burgeoned to 54 persons from the original 11, about five-fold from the time of its establishment. Clearly, the facility has outstripped its intake capacity for new projects, and this situation has even hindered its routine research activities as well. Furthermore, under the current National Development Plan, the Center is committed to a number of new research programs for which expectations are very high, including the establishment of Marine Parks to preserve the lagoon environment, formulation of a plan to protect the environment against marine pollution and development of other projects related to the marine environment, together with research on the introduction of a licensing system for the bank fishery geared to resource management. Given these demands and expectations, there is an urgent need to expand the Center's facilities and provide new research equipment.

With a view then to coping more effectively with the enlarged and diversifying research demands on the AFRC, the Mauritius Government has formulated a Plan for Expanding the AFRC which incorporates both the expansion of research facilities and the provision of new research equipment.

### **2.5.2 Nature of the Request:**

The contents of the request from the Mauritius Government, as validated through discussions, are as follows:

(1) **Plan Site:**

The Plan site, with a usable area of about 1.4ha, is to be located within the existing premises of the AFRC in Albion, Petite Riviere, in Riviere Noire Ward, about 10km southwest of the capital, Port Louis.

(2) **Implementing Organ for the Plan:**

The implementing body for the Plan is to be the Ministry of Fisheries and Marine Resources.

(3) **Contents of the Request:**

1) **Research Facilities**

a) **Administration and Research Building**

1. Marine Physical Laboratory
2. Marine Bacteriology Laboratory
3. Marine Ecological Laboratory
4. Chemical Research Laboratory
5. Sterilization Room
6. Administrative Office
7. Reception area and waiting room
8. P.F.O. room / secretarial room
9. Study rooms (7)
10. Expert's Office
11. Conference room
12. Conference hall
13. Data room
14. Dining hall and kitchen
15. Utility room, rest rooms, storage area



b) Annex

1. Wet lab for research on marine ecology
2. Compressed air room/ laboratory for underwater equipment
3. Generator room
4. Workshop
5. Store

2) Research Equipment

1. Equipment for ecological research
2. Equipment for chemical analysis
3. Bacteria culture and test equipment
4. Equipment for marine observations
5. Data processing equipment
6. Educational and extension equipment
7. Aquaculture equipment and materials
8. Boat and vehicles

(A more detailed equipment breakdown is provided in the ANNEX 6 Equipment list.)



## SECTION THREE: NATURE OF THE PLAN

### 3.1 Plan Objectives:

This Plan, which is based on the 6th National Development Plan of the Government of the Republic of Mauritius, will contribute to the effective utilization and management of the country's fishery resources by further developing the basic research activities of the Albion Fisheries Research Center (AFRC) relating to coastal and offshore resources, experimental work in aquaculture, and marine and coastal ecology. While bringing about an increase in the domestic supply of fish products through breeding and aquaculture development, the Plan will also provide the Center with new facilities and equipment that will help to expedite meaningful legislation, in response to the people's strong desire for preserving a sound marine environment.

One of the most pressing problems facing the AFRC is of a functional nature: as a result of the steady development of research programs and the corollary expansion of personnel and organization, the Center has clearly exceeded the limits of its research capability. In addition, in tandem with the relatively smooth growth of the Mauritius economy, popular expectations have been rising for improvements in the quality of life and for preservation of a proper environment, which in turn have placed ever increasing research demands on the Center in connection with the marine environment and the coastal ecology. As a result of these developments, an acute deficiency has developed in the Center's research facilities, and this is, in turn, impeding progress in the overall research program. Secondly, the research equipment that had been donated to the AFRC under previous grant-aids have become inadequate in terms of the new research horizons, and so additional equipment must be provided that conforms to these ambitious new requirements.

Accordingly, the purpose of the subject Plan is to furnish the requisite facilities and research equipment to remove existing deficiencies and impediments to the Center's activities within the new research environment and, by further vitalizing its research programs, to attain the objective, as set forth in the National Development Plan, of achieving maximum sustainable utilization of marine resources while protecting these resources along with the marine environment. This, in turn, may be expected to contribute to a stable supply of fish products for the people of Mauritius as well as to increased foreign exchange earnings through exports, while also helping to preserve the natural environment, which constitutes a most valuable tourism resource.

## 3.2 Consideration of the Plan:

### 3.2.1 Current Status of the AFRC:

#### 3.2.1.1 Research Activities:

The research activities of the AFRC are organized into four divisions: the Aquaculture Division, Artisanal Banks Fisheries Division, Marine Conservation Division, and Offshore Fisheries Division. Let us now review the organization and principal research programs of each Division.

##### (1) Aquaculture Division:

The Aquaculture Division comprises two facilities: the Marine Shrimp Experimental Station, built adjacent to the Center in 1987 on the basis of a grant-aid from the Government of Japan, and the Le Ferme Fish Farm, constructed in 1985 with assistance from the EU. The former facilities targets its activities at such species as black tiger prawns, silver bream, and red tilapia domesticated in seawater, while the Le Ferme freshwater facilities targets primarily giant freshwater prawns, red tilapia, and carp. The latter facilities conduct research on identifying species suitable for cultivation, establishing technology for seed production and the large-scale culture of live bait, feed development, and technology for aquaculture in Barachois.

##### 1) R&D on the breeding and cultivation of black tiger prawns

Production technology is now being established for commercial sizes of black tiger prawns, and the present production capacity at the Experimental Station for this species is now about 400g/m<sup>2</sup>. Further research themes will involve the collection of adult shrimp, improving cultivation technology for adult shrimp, large-scale seed production technology, measures to combat fish diseases, and development of suitable feed. In addition, with regard to marine shrimp, experiments are being conducted on selection of appropriate species for local Penaeid prawns for cultivation (e.g., Indian prawns, Western king prawns, speckled shrimp).

##### 2) R&D on the breeding and cultivation of silver bream

Research on experimental production of silver bream seed is being conducted between June and September, the spawning season for this species, when water temperatures are too low

for the production of prawn seeds, Recent themes include the experimental cultivation of adult fish, establishment of mass seed production technology, combating disease, and large-scale breeding experiments to enrich nutrition for rotifers and artemia, and developing proper feed blends.

3) Research to improve breeding technology for giant freshwater prawns

Giant freshwater prawns were introduced from Hawaii to Mauritius in 1972. The freshwater experimental farm established aquaculture technology for this species, and this technology was then diffused among private farms. At present, the dissemination of this technology to the private sector has been largely completed, and intensive culture is now being carried out on a commercial basis. Research projects are focused on experiments to improve larval rearing technology.

4) Research to improve breeding technology for red tilapia

Red tilapia, the most important species in research and development, were first introduced from Malaysia to Mauritius in 1990. Since 1991, adult fish have been raised at the freshwater farm for reproductive purposes, and the seed produced has been furnished to private aquacultural facilities. Research activities for this species include experiments on seawater domestication, male sex reversal experiments based on hormone treatment, and pilot development of suitable feed formulation.

5) Experiments on net cage culture and pen culture in Barachois

In order to assess the potential for the new Barachois aquaculture method, experiments are being conducted in three Barachois with net cage culture and pen culture facilities for the cultivation of silver bream and red tilapia. Seed for silver bream and red tilapia domesticated to sea water, produced at AFRC's Marine Shrimp Experimental Station, are being distributed without charge. Research themes focus on intermediate rearing experiments, pilot cultivation, pilot commercialization, and development of suitable feed blends.

(2) Marine Conservation Division:

This Division is composed of 4 laboratories: Marine Ecological Laboratory, Marine Chemical Laboratory, Marine Bacteriology Laboratory, and Marine Physical Laboratory. Studies are regularly implemented at the 8 monitoring locations shown in Figure 3.2.1 on the ecology of coral reefs, and marine pollution and physics in lagoons and surrounding areas to gain an understanding of the state of the marine environment. The findings accumulated from these studies are laying the foundation for development of environmental regulation on the country's coral reef areas. Research is being simultaneously conducted on mangrove reforestation and the establishment of marine parks.

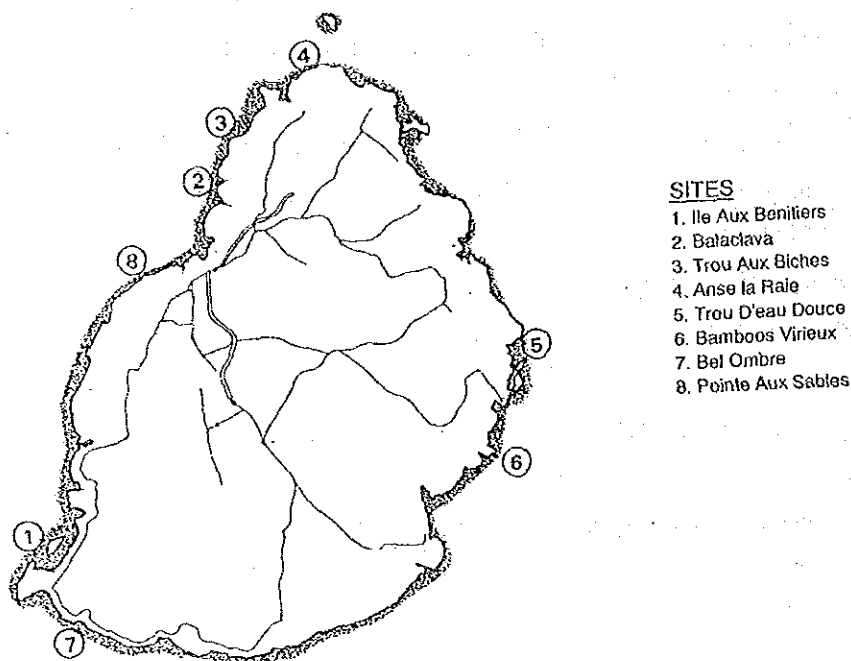


Figure 3.2.1: Monitoring Sites Operated by the Marine Conservation Division

The following studies are being conducted ;

- 1) Studies on the ecosystem in coral reefs

On the basis of ecological methodology including underwater photography and collection of specimens at the various monitoring stations, an understanding is being developed of marine flora and fauna and coral concentrations in reef areas. Research themes concern classification and coverage of observed coral species, growth rates for coral species, and the appearance rate of fish and sea urchins.

- 2) Marine pollution surveys in and around lagoons

Studies are being conducted on marine pollution through on-the-spot measurements of water temperatures, ocean currents, and weather as well as such indicators as BOD (Biological Oxygen Demand), Nitrate-Nitrogen, Phosphate-Phosphor, and chromium (VI) compound. The degree of pollution is also studied from a bacteriological standpoint, based on coliform bacilli and streptococci counts.

3) Marine physics studies in and around lagoons

Basic studies are carried out to compile detailed coastal charts and determine the physical diffusion patterns of marine pollution, based on the entry of measurements taken at the above locations on the speed and direction of lagoon currents, conductivity, water temperatures, and water depths.

4) Data collection and management

Data gathered in these studies are accumulated and managed.

5) Studies on mangrove reforestation

The requisite technology is being developed for mangrove research and reforestation.

6) Research in connection with the establishment of marine parks in designated areas

Plans for the establishment of marine parks are being advanced through the established of conservation areas, the drafting of supports rules and regulations, and preparation of explanatory materials as a means of securing the agreement of concerned local parties. Two areas -- Balaclava and Blue Bay-Le Chaland-- are candidate locations for such marine parks, owing to the fine state of coral reef preservation and the rich variety of marine fauna and flora.

(3) Artisanal Banks Fisheries Division:

The main responsibility of this Division is to manage the coastal fisheries, including those in the lagoon, and to collect catch data. The following studies are being conducted:

1) Resource evaluation and resource management studies

Catch data and biological data (size, weight, gonad weight, sex, stomach contents) are collected on representative species (black-tipped grouper, emperor, yellowbrow emperor, rabbitfish, black mullet, unicorn fish, and octopus) for use in resource maintenance and management and for drafting legislation in support of fishery development policies.

2) Quality inspection and statistics on fishery exports and imports

In addition to quality checks on fresh fish and shellfish and processed fish products, and issuance of import permits to fish dealers, statistics are collected on foreign trade in fishery products.

3) Analyzing catch data on lagoon and banks fisheries

Based on annual catch data, principally on black-tipped grouper, emperor, rabbitfish, unicorn fish, and octopus, trends are monitored in stocks for the artisanal fisheries.

4) Trends in fishermen and fishing fleets

Studies are carried out on trends by type of fishery, to establish trends in the number of artisanal fishermen and the number of fishing vessels, classified by type and power.

5) Surveys on monthly landings

Surveys are conducted to show fluctuations in catch volume on the basis of monthly landings by the artisanal fisheries, broken down by processing method (fresh, frozen, salt-preserved).

6) Studies on Ciguatera toxin

Research has been carried out on fish catches throughout the country, using mangoose as the test animal, to pinpoint species carrying Ciguatera toxin as a means of preventing poisoning from this source.

7) Developmental study on artisanal fisheries



A fishing ground development study, including fishing methods, had been conducted from 1991 to 1994 on the bank fishery, based on technical cooperation from the Overseas Fisheries Cooperation Foundation of Japan (OFCF).

(4) Offshore Fisheries Division:

This Division is engaged in the following programs, principally related to the development of new species and resource management for tunas.

1) Fishery development for deep-water shrimp and snapper

Developmental feasibility studies have been conducted, with the cooperation of the UNDP, on utilization of *Heterocarpus* sp., a species with a high commercial value, whose habitats have been confirmed over an area of more than 2,000km<sup>2</sup> in deep waters (600 - 1,000 m) in the vicinity of Mauritius and Rodrigues Islands. Development work has also been done of the resources for deep-water snapper.

2) Development of FAD fisheries

Using fish aggregating devices (FAD) at 12 locations on Mauritius Island and 5 locations in Rodrigues Island, introduced on the basis of assistance from the FAO/UNDP, developmental surveys have been carried out on FAD fisheries.

3) Tuna resource studies and resource management

Based on the EU-funded Skipjack/Tuna Regional Project in which Mauritius, Madagascar, Reunion, Comoro, Seychelles, and other island nations in the Indian Ocean participated, studies have been initiated in the following areas: collection and analysis of biological data for purposes of tuna resource management; tag-and-release surveys; studies on the effective utilization of tuna stocks; stock surveys on tuna in the southwest Indian Ocean, and training programs for the development of the tuna fishing industry.

4) Developmental survey on stocks of small pelagic fish

Based on Fishery Resource Evaluation Surveys on archipelagoes in the southwest Indian Ocean, as carried out by FAO/UNDP from 1976 to 1977, the total fishery resource mainly horse mackerels was estimated at between 13,000 - 26,000 tons, concentrated on the Saya de

Malha and Nazareth Banks. Exploratory studies are now underway on the development and utilization of these pelagic stocks.

### **3.2.1.2 Present Condition of Facilities and Equipment at the AFRC:**

#### **(1) Utilization Conditions of Research Facilities:**

The main facilities at AFRC comprise a Fisheries Research Center, a Marine Shrimp Experimental Station which were built in fiscal 1980 and fiscal 1985/86 on the basis of grant-aids from the Government of Japan, and certain other facilities.

##### **1) Fishery Research Center**

This facility is composed of a Center main building and a Hatchery/Experimental Building. The former comprises: an experimental research block, including a researchers' room, experiment room, post-larval tanks, and an administration block, including offices, director's office, meeting room, and library, a research block, comprising a machine room and operational block, and the various functions required in support of research activities; 3 research divisions: Artisanal Bank Fisheries Division, Marine Conservation Division, and Offshore Fisheries Division., plus an Administration Division.

Turning now to usage patterns , as a result of additional research and administrative personnel needed to cope with the diversified and growing range of research subjects, the current staff at the 3 research Divisions and Administration Division has reached 50 persons, which exceeds the actual intake capacity of the facility. This has produced a serious inadequacy in facility capacity. The Marine Conservation Division, in particular, which was newly established in 1989, has been unable to secure adequate space, a factor which has seriously handicapped the progress of its research programs.

The Hatchery/Experimental Building is positioned as a hatchery and experimental facility for marine and freshwater shrimp and other freshwater species, such as red tilapia. However, with the construction of the Le Ferme Fish Farm in 1984 and the Marine Shrimp Experimental Station in 1985, this building is currently being used as a spare facility for breeding experiments on seawater domestication of red tilapia.

##### **2) Marine Shrimp Culture Experimental Station**

This facility is composed of a Technology and Administration Building, a Hatchery Building, and outdoor culture ponds. The Technology/Administration Building is made up of an experimental research block containing researchers' rooms, a hatching research laboratory, a bait culture laboratory, a functional block, containing a working space with storage area and power room, and other functions required for research activity. While the primary emphasis is on hatching experiments for marine shrimp, experiments will also be run on silver bream and other species.

Three types of aquaculture tanks are installed in the Hatchery Building: culture tanks for post-larval shrimp (3 of 12.5 tons and 3 of 25 tons), culture tanks for adult shrimp (3 units of 27 tons each), and plankton culture tanks (6 units of 12.5 tons each).

Seed production experiments on marine shrimp and bait culture experiences are carried out under the guidance of an expert from JICA. Aquaculture experiments on black tiger prawns are conducted in the outdoor culture ponds. Experiments are carried out on a production basis twice a year, with recent harvest reaching 400g/m<sup>2</sup>. The facility is under the control of the Aquaculture Division, which has a staff of 15 researchers plus the JICA expert mentioned above.

### 3) Other facilities

The Storage/Operations Building was funded by the Mauritius Government. It comprises a 130m<sup>2</sup> workshop/materials warehouse and a 90m<sup>2</sup> experimental animal feed room. The former section is presently being used as a repair and storage facility for the equipment, while, in the feed room, mongoose are raised as a medium for toxicity tests.

### (2) Equipment and Present Conditions:

The present equipment may be broadly divided into equipment for breeding and aquaculture use; measuring and physical/chemical equipment; communications equipment; office equipment, research vessels, and vehicles. The bulk of the equipment was donated by the Government of Japan under the cooperation program; the other equipment was self-procured.

Although the present complement of equipment is being effectively used and the research programs are being properly implemented, there are certain equipment items that are needed for

new research projects and some other equipment that are no longer able to respond functionally to the new research demands. In addition, the newly established Marine Conservation Division has suffered, from the start, from a shortage of equipment.

Equipment is being carefully handled and generally well prepared before use. Maintenance is quite good, with locally available equipment and disposable procured with the facility's own funds, which indicates a clear commitment to routine maintenance. In response to the improvement in the country's industrial infrastructure, the technology levels for equipment maintenance also appears to be rising, while the scope of maintenance programs is also broadening.

### **3.2.2 Need and Appropriateness of the Plan:**

Although all of the facilities and equipment used in the various divisions of AFRC have been obtained under grant-aids from the Government of Japan, as a result of the increase in research staff owing to the expansion and diversification of the research program, the space for research projects in the present facilities is extremely tight. Particularly in the case of the Marine Conservation Division established in 1989, working areas have been most inadequate. In addition, the shortage and impending replacement of research equipment are placing serious constraints on overall research activity. As a consequence, it has become necessary to expand the research facilities and provide new research equipment.

As the only research organization in Mauritius operating in the fishery and marine sector, AFRC is responsible for the entire technical spectrum of fishery research, including the development of marine fisheries, promotion of aquaculture, management of fishery resources, and preservation of marine ecosystems. In addition, the Center plays a core role in research on fish stocks for the various countries in the Indian Ocean area, hosting a variety of international conferences in related fields. In terms then of continuing an effective research program at AFRC, the expansion plan for this Center, which is intended to remove the present space bottlenecks and remedy equipment deficiencies, will surely be of enormous benefit, not only to Mauritius but to neighboring countries as well. It has, therefore, been determined that implementation of the subject Plan under a grant-aid from the Government of Japan is both necessary and appropriate.

### 3.2.3 Implementation Plan:

#### 3.2.3.1 Implementing Body:

The implementing body for the subject Plan will be the Ministry of Fisheries and Marine Resources, which was detached in November, 1993 from the Ministry of Agriculture, Fisheries and Natural Resources. The new Ministry is headed by a Minister and a Permanent Secretary and is divided into a Research Division and an Administration Division. The AFRC has overall jurisdiction over the Research Division. It has been confirmed that, after implementation of the Plan, the facilities and equipment will be managed by the AFRC.

The organization chart for the Ministry of Fisheries and Marine Resources is shown in Figure 3.2.2 below:

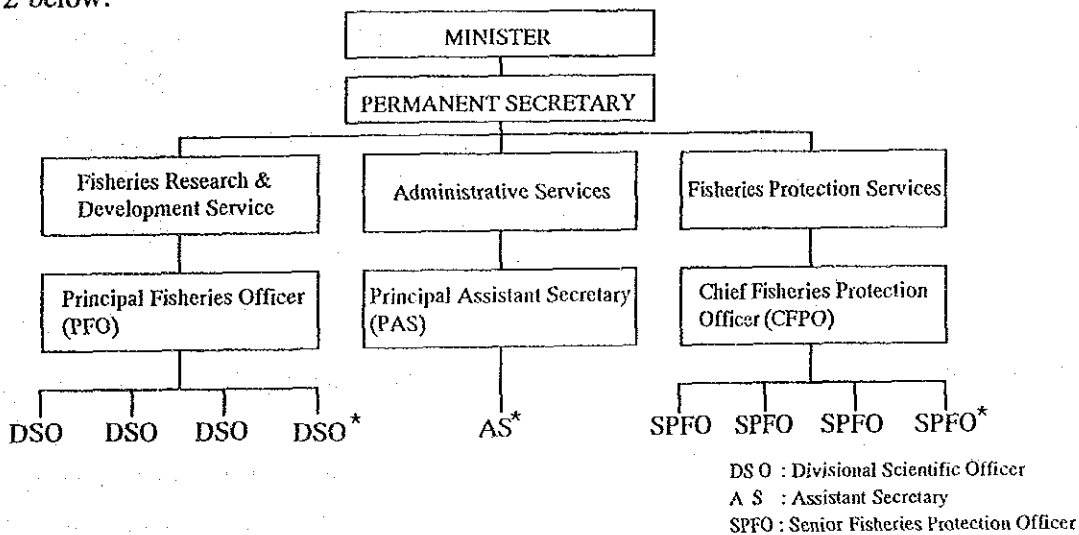


Figure 3.2.2: Organization Chart for the Ministry of Fisheries & Marine Resources

#### 3.2.3.2 Operating Budget:

Since the Ministry of Fisheries and Marine Resources has only just started independent operation as a new Ministry, its budget has not yet been finalized. However, the ordinary budgets for the former Fisheries Division of the Ministry of Agriculture, Fisheries, and Natural Resources were as shown in Table 3.2.2. It may be presumed that this sum will be the minimum budget allocated to the new Ministry.