REPÚBLICA DE MOÇAMBIQUE

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DEPARTAMENTO DE AQUACULTURA

MISSÃO TÉCNICA

Coastal Aquaculture Surveying for Bivalve Culture

Quirimbas National Park
IBO

Province of Cabo Delgado

Maputo, December 2003

Summary

The aquaculture surveying for development of a project on bivalve culture was requested by WWF in the context of the master objectives of the national park for resource protection and conservation and development of sustainable livelihood production alternatives to fishing.

The coastal aquaculture surveying at reconnaissance level was conducted aiming at evaluating the natural environment and the indigenous bivalve species with particular emphasis on oysters.

This initial study covered the coast of Ibo Island and the west coast of Matemo Island north of Ibo. The surveying on bivalve distribution with particular interest on oysters was extended to the northwest coast of Quilaluia Island and the canals within the Quirimbas Islands.

The coastal marine system of The Quirimbas between Ibo and Matemo islands comprise a network of canals, rocky and coraline shore and extensive sea grass beds. Dense mangroves within the surveyed area are confined mostly to river estuaries near Quissanga and south of Ibo and Quirambo Islands. This shallow coastal system covers an immense potential area in excess of 7000 ha for marine aquaculture, mostly bivalve. This is mostly low depth (2 – 16 m) comprising canals, sand and sea grass beds suitable for suspended culture system in excess of 6000 ha. Intertidal and sub tidal areas west of Ibo and Matemo islands represent further potential for shallow bottom (parks) bivalve culture in excess of 500 ha.

Bivalve culture mostly of local oyster species, *Pinctada capensis* (Cape pearl oyster) and *Sacostrea cuccullata* (Hooded oyster) were identified and recommended for aquaculture. Both species are suitable for aquaculture production in suspended systems (tray and raft), but prospects for extensive shallow bed culture are also recommended. In regard the Cape oyster it is also recommended to develop a stocking system of natural grounds for this species in order to boost the fishing stocks both on Matemo and Quirimba islands were fishing of this oyster species seems to represent an important source of income and trading. Initially the development of oyster culture is recommended to take the form of a pilot project were production and collection of spats (small oysters) is secured and training and extension on culture techniques would be centred. A preliminar framework to develop an oyster culture pilot project is here presented.

The development of oyster culture in Ibo and Matemo will require further studies to assess the size of the stocks of the above referred most potential indigenous species, and to evaluate the socio-economics of the oyster fisheries and trading. Particular attention should be directed to Matemo and Quirimba islands were presumably the main oyster beds and fishing is located. Further surveying is therefore recommended

during the spring tides of March 2004 when oyster fishing reaches its peak. During this fieldwork some experiments with spat collectors can also be tested for both oyster species since the time coincides with the second peak of recruitment (March to May).

1. Introduction

Under the request of WWF, the Department of Aquaculture of the Institute for Fisheries Research of Mozambique conducted a surveying at reconnaissance level for development of bivalve aquaculture in the region of Ibo Island, within the Quirimbas National Park. The study was conducted with the aim to evaluate the environment conditions and to assess the suitability of indigenous bivalve species for aquaculture.

The field mission was conducted between the 7th and the 12th of December 2003 with the following main objectives:

1. Evaluate the natural environment of Ibo region;
2. Identify the potential indigenous bivalve species with particular emphasis to oysters;
3. Identify the most potential sites for aquaculture development.

The terms of reference are in the annex 1. Information on socio-economics of Ibo region initially enlisted in these ToRs was later assigned to Ms. Rouja Johnstone so that this report focuses only on aquaculture and the natural environment.

The surveying was conducted by the head of dept., Dr. Fernando Loforte Ribeiro, (aquaculturist) who was assisted in Ibo by Mr. Peter Bechtel, WWF programme assistant at Quirimbas Park, to whom special thanks are addressed for the support given during the mission.

2. Climatic Conditions

The data in reference was collected from the meteorological station in Pemba, the nearest station to the surveyed area.

2.1 Temperature

The average air temperature is 26ºC with a gentle monthly variation between 23ºC in July over the dry season, and 27ºC during the wet season between December and March. The data presented on Figure 1 from a 5-year period (1998-2002) indicate that for most of the year the average air temperature remains above 25ºC except for June and July. Nevertheless, the daily amplitude remains high during the dry season with temperature above 30ºC at midday and 20ºC at night. During the period of data collected the men monthly temperature remained fairly stable with gentle variation (0.1ºC – 0.80ºC).

The mean air temperature indicates that water temperature may be within the suitable range for bivalve culture for at least 10 months, between August and May. Despite a decrease in temperature over the dry season the coastal system within the Quirimbas islands is confined to relative shallow waters, thus water temperature may still support a fair growth during this period.

2.2 Humidity

Due to the coastal location the humidity is high and remains fairly stable and above 76% between May and November before increasing steadily from December to March (Figure 2). The pick is observed during the rain season and can reach over 85% in March.

2.3 Precipitation

The coast of Pemba and north of the city shows relatively low rainfall for most of the year. Significant rainfall is only observed during the peak of rain season between January and March (>150 mm). The mean precipitation during these months for the period of 1998 and 2002 was 195 mm. However, the rainfall for the last 5 years has been highly variable with a peak of 481 mm in March 2000. This year was particularly wet with over 1400 mm in contrast with an average annual rainfall raging between 700 mm and 1000 mm.

The relatively low precipitation for most of the year is reflected in relatively small river system along the area of study. This indicates that the coastal systems are mostly under marine influence and very little pressure from continental waters is foreseen. This may indicate fairly stable water quality and environment conditions in shallow coastal waters making the system highly suitable for bivalve culture.

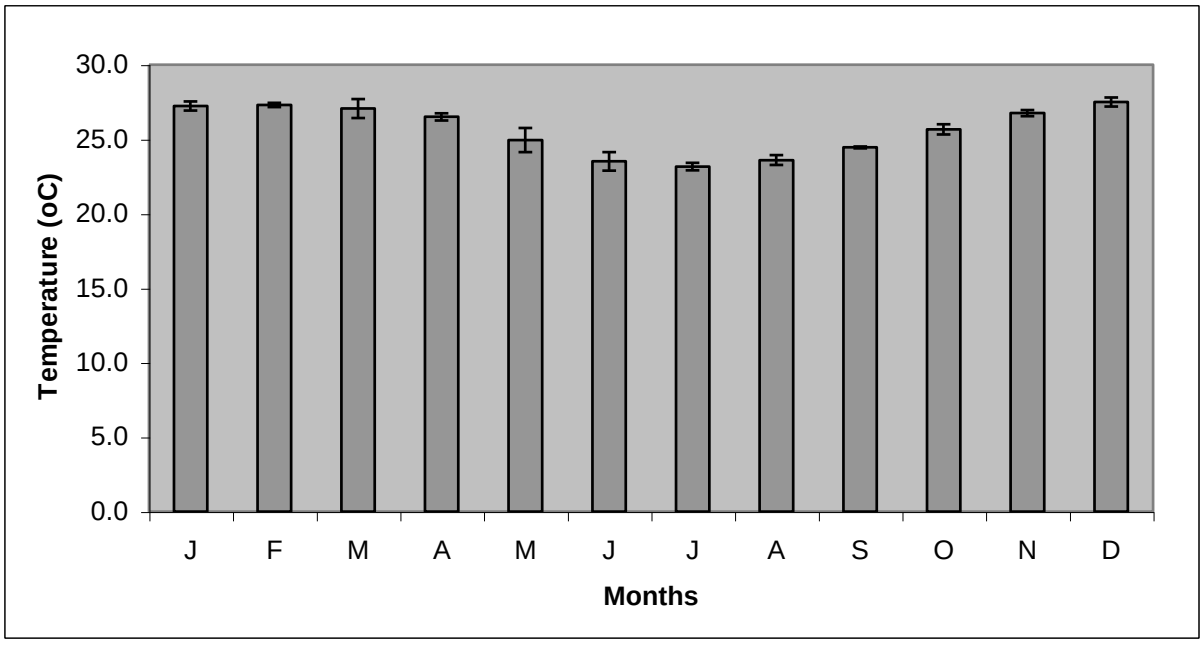


Figure 1 Mean air temperature (°C) observed in Pemba in the last 5 years (1998-2002). Source: Instituto Nacional de Meteorologia.

3. Water Quality

Water samples were collected in three main sites surveyed in the coastal system between Ibo and Matemo islands. These include the east coast of Ibo near the Island of Mujaca mostly exposed to ocean waters, the canal access to Ibo port (west coast) and northwest of Matemo island (Table 1).

The salinity in all sites was similar and remained stable at 35‰. From the results obtained from Ibo's canal there seems no difference on water quality between low and high tide which confirms that the coastal system is highly marine and of ocean quality, and no significant change in salinity is foreseen during the rain season. The physical configuration of the system foresees good water circulation and oceanic inflow at high tide. Similar results were also observed for pH (8.5, high tide) and dissolved oxygen (6.8 – 7.0 mg/l). The level of nitrogen metabolites remained fairly similar and within suitable levels in all sites, though the level during high tide at Ibo's canal almost double for ammonia-nitrogen as the result of flushing from the surrounding mangrove forest south of the island. The water near Matemo island showed the lowest levels for all nitrogen compounds. Phosphorus content was high and similar in all sites during high tide indicating again the prevalence of oceanic quality but the level dropped significantly during low tide in the main Ibo canal possibly associated with the higher nitrogen loading flushed from the mangroves. Copper level was low and similar for all sites and not different for low or high tide.

The water quality in all sites is of oceanic quality at high tide. The higher nitrogen compounds observed at low tide on Ibo canal possibly due to proximity of dense mangrove forest south of the island may not be reflected in Matemo island west coast, distant from the mangrove fringe on the continent side. The predominance of oceanic water quality reflects on the diversity and abundance of bottom fauna and flora, and is highly suitable for bivalve aquaculture.

Table 1 Water quality from 3 sites within the area of study between Ibo and Matemo islands. Samples were collected at peak of high tide and low tide (only for Ibo).

Parameter	Mujaca	Matemo	Ibo Canal	
			High tide	Low tide
Sanility (‰)	35.5	35.5	35.0	35.0
Ph	8.5	8.5	8.5	8.1
Oxygen (mg/l)	6.9	6.8	7.0	6.8
Ammonia (NH_3-N) mg/l	1.34	0.63	1.24	2.28
Nitrate (NO_3-) mg/l	<0.01	<0.01	<0.01	<0.01
Nitrite (NO_2) mg/l	<0.001	<0.001	<0.001	<0.01
Copper (µg/l)	2.12	2.22	2.43	2.4
Phosphate (PO_4^{3-}) mg/l	2.83	2.72	2.75	0.04

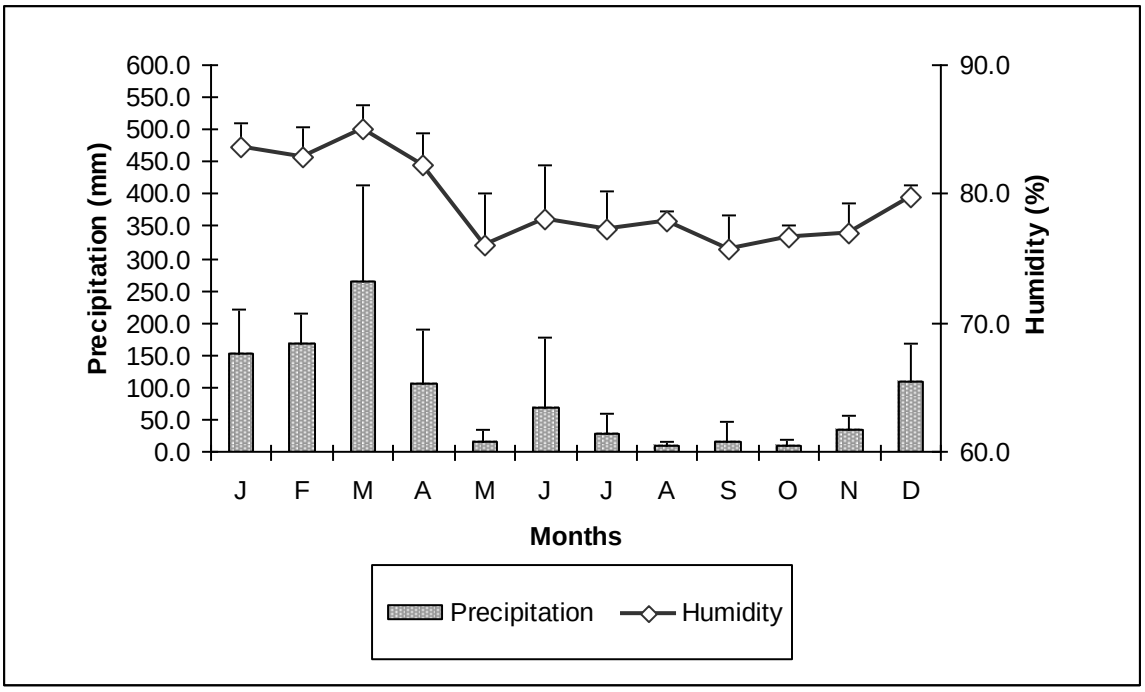


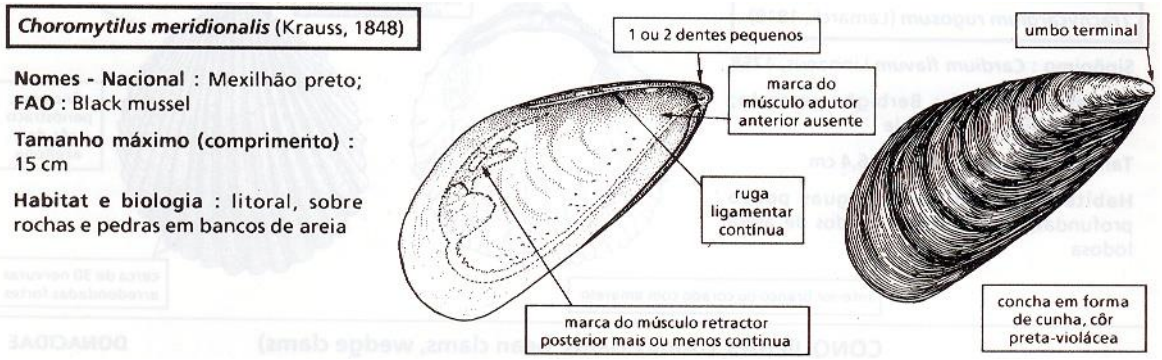
Figure 2 Mean precipitation (mm) and relative humidity (%) observed in Pemba in the last 5 years (1998-2002). Source: Instituto Nacional de Meteorologia.

4. Identification of Bivalve Indigenous Species

Bivalves are very diverse and found from rocky shore to sand and sea grass beds on shallow waters. The main and abundant species identified include the black mussel *Choromythilus meridionalis*, Hooded oyster *Saccostrea cucullata*, Comb pen shell *Atrina pectinata* and the Cape pearl oyster *Pinctada capensis*. Amongst these only the two oyster species present potential for aquaculture, in particular the pearl oyster.

Choromythilus meridionalis

Dense Black mussel beds were observed along the northern and western rocky shore of Ibo, and in less extent on Matemo East coast. This species settles in high densities in exposed shallow intertidal and sub tidal.



FAO, 1990

Atrina pectinata

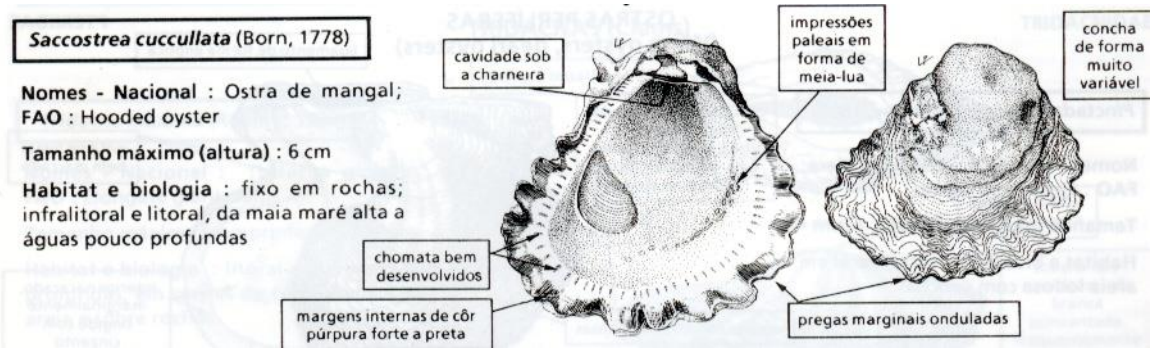
This species is confined to the muddy bottom shore of Ibo southwest coast. According to local fishermen stocks of this species have been intensively exploited in the past and no fishing is currently conducted on this species. Due to easy access to the area of this species distribution, it is possible that the stock has been reduced significantly making this species less attractive for small-scale aquaculture development in the short term.

FAO, 1990

Saccostrea cucullata

The Hooded oyster is commonly observed attached to rocks and mangroves. Some stocks were observed in Quilaluia west rocky shore intertidal and sub tidal, and it is possible that settlements of this species are also found on the mangroves south of Ibo.

This species presents some potential for aquaculture in suspended systems both for tray system and raft or long line suspension, although growth in captivity is relatively slow and reaches mid sizes. Its potential for aquaculture development in Ibo region will depend mostly on the size of natural stocks to provide spats through the use of artificial collectors.

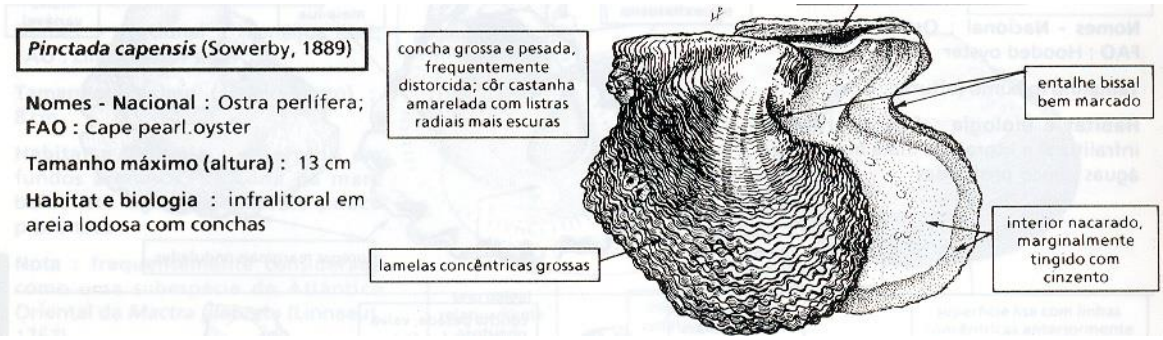


FAO, 1990

Pinctada capensis

This Pearl oyster occurs in sandy sea grass beds, which are very extensive and cover most of the shallow areas amongst the Quirimba islands. The main stocks according to information from fishermen are located on the northwest Coast of Matemo Island and between Quilaluia and Quirimba islands. Due to shallow distribution of this species stocks are currently under intense exploitation. This oyster is the main bivalve species being collected and traded by local fishing communities. Considerable fishing is currently being practice in Matemo. The size of the stocks in the region could not been assessed, nor fishing was being in operation during the field mission. Further studies are required to evaluate the size of the stock, its status, and to confirm if the breeding stock is big enough to provide spats by using artificial collectors.

This species grows very fast and is very suitable for farming both on suspended systems and on bottom shore parks. Due to the wide distribution, abundance and economic importance for the small-scale fisheries this species is also highly recommended for further re-stocking and fisheries enhancement.



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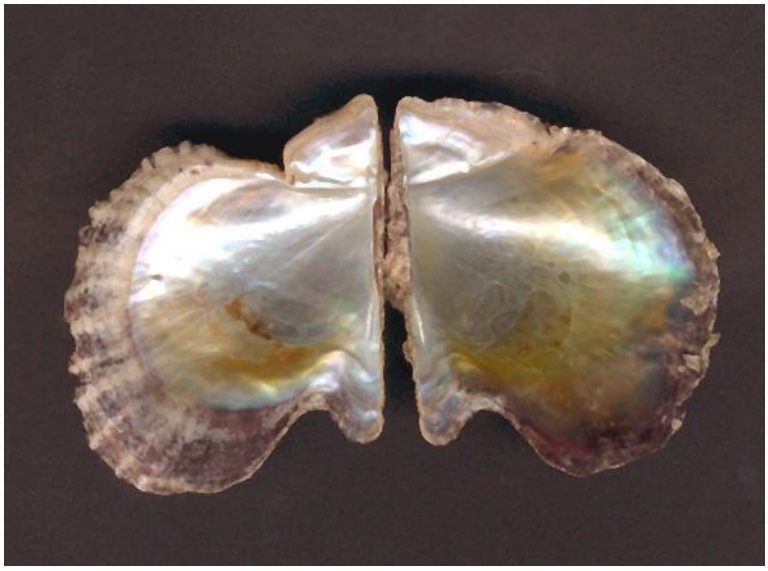

F. Ribeiro

Figure 3 Overview of an empty shell of Cape pearl oyster, *Pinctada capensis,* collected on Matemo sea grass beds.

5. Potential Sites

The area surveyed covers the coast of Ibo (Figure 4) and the west coast of Matemo islands (Figure 5). These two islands are fringed with rocky shore creating well-protected bays and canals between them and the continent. The shallow waters between these two islands are well protected and composed of sand and sea grass banks that make the area very suitable for bivalve culture in suspended systems as well as inter-tidal and sub-tidal bottom parks. Sea grasses are highly abundant that creates a suitable environment for sand/bottom bivalves like the pearl oyster and the pen shell listed above. The potential sites for bivalve culture are located on the west coast within the bay created by these two islands. A preliminary assessment estimates in over 7000 ha the gross potential of shallow and protected waters. Most of this potential is for suspended systems but bivalve culture can also be developed in bottom parks particularly southwest and north of Ibo.

On Ibo island, the potential sites for bivalve culture are located on the northern coast in a shallow sandy bottom area estimated in around 190 ha, southwest along the sand banks fringing the canals between this island and Quirambo (100 ha). A large area for suspended systems extends from north of Quissanga canal to the mouth of Ibo canal, for over 800 ha.

The island of Matemo seems to present the greatest potential for pearl oyster culture due to abundant sea grass beds and shallow waters. This species seem to be

abundant on the west coast but stocks could not be observed during the mission due to unfavourable tides. The shallow waters between Punta Ucáio (north) and Riuéculo (south) are roughly estimated in over 120 ha form bottom culture and over 900 ha for off bottom culture in suspended systems.

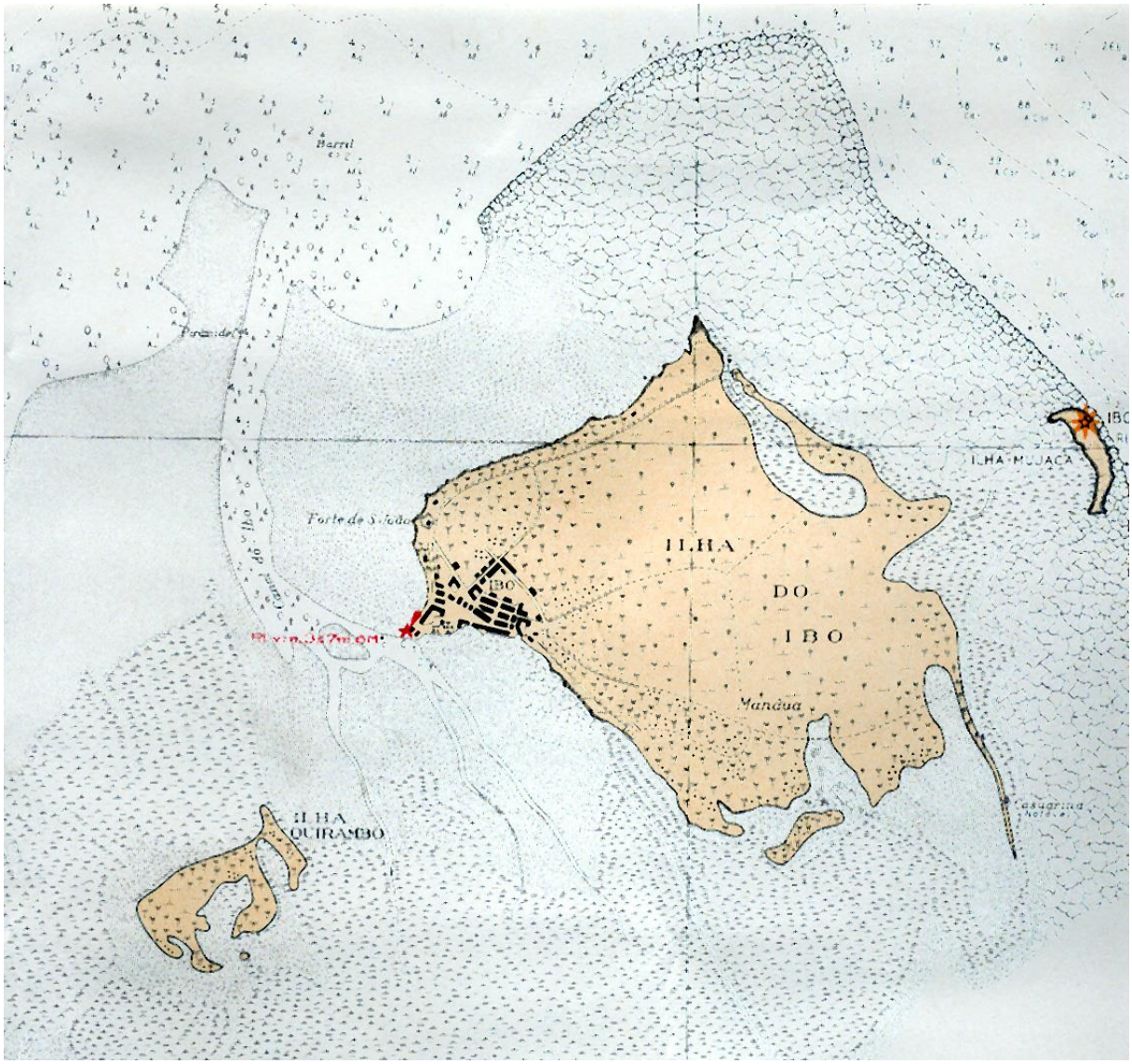

Figure 4 Maritime layout view of Ibo island with extensive mangrove forest doted along the southern region, around Quirambo island and some on the west coast. The rocky shore extends along the north and northeast coast and sand banks on the northwest and west of the island.

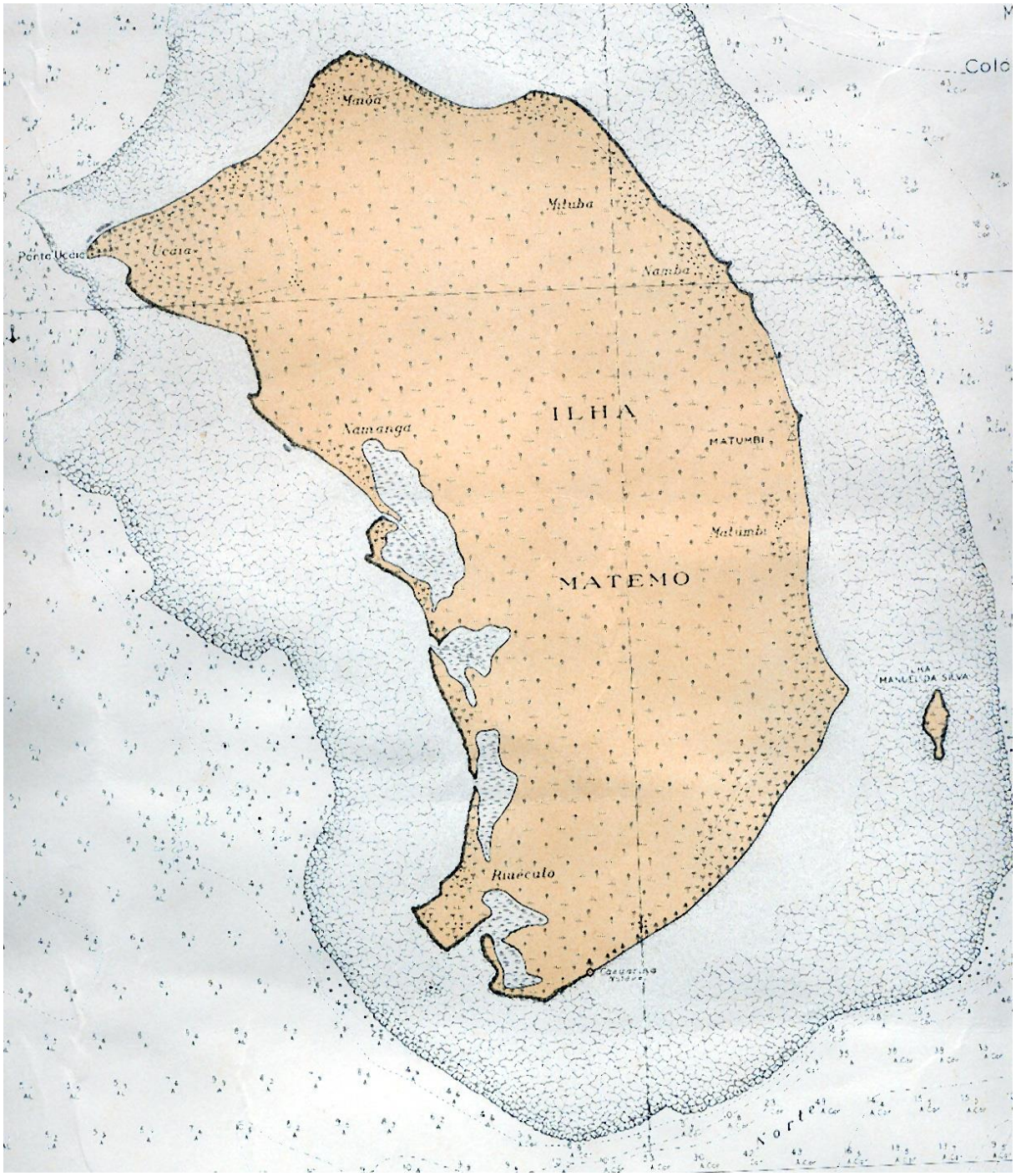

Figure 5 Maritime layout view of Matemo island with extensive rocky shore around the island. Some mangrove occurs in small bays on the west and south coast. Sea grass beds are very extensive on the west side shallow waters off the rocky shore.

5. Conclusions and Recommendations

The shallow coastal waters of Ibo and Matemo islands present a great potential for bivalve culture. The environment is mostly under marine influence with stable water quality at oceanic standards. This is mostly notorious along the west coast of Matemo. Very little pressure was observed from continental waters and the short and low rainy season does not foresee a major change in water quality over this period. The occurrence of dense mangroves south of Ibo reflects in slightly higher nitrogen compounds during low tide. However, due to the high tidal flux, strong oceanic influence and large canals, marine conditions prevail in the entire large bay formed by these islands.

The potential area is mostly for development of bivalve culture in suspended systems but bottom culture can also be developed, both on the west coast of Matemo and North and southwest of Ibo.

It is recommended that future development of bivalve culture in particularly of pearl oyster is extended to stocking and re-stocking of natural sea grass fishing grounds, as a measure to sustain this important small-scale fisheries, contributing to stock enhancement and overall biodiversity.

Two indigenous oyster species, Hooded and Pearl oysters represent some potential for aquaculture. However, further studies are required to assess the size of the natural stocks and to confirm the possibility to collect natural spats by using artificial collectors. Small scale community based development of oyster culture will depend on this, since the alternative source of spats for farming will require hatchery production capacity in place, representing this a considerable investment and cost of operation.

The considerable fishing for pearl oyster may indicate that the breeding stock is still beg enough to populate the natural grounds but this needs to e confirmed during the next spring tide.

A framework plan for development of oyster culture in Ibo is therefore recommended, structured in 2-phase implementation:

Phase 1 – resource study and pilot project development
Phase 2 – extension and development of small-scale culture

The pilot project will centre on the development of a pilot farm were culture systems and techniques would be developed and adapted, and training of extensionists and farmers could initially take place. The west coast of Matemo and Ibo seem more favourable to establish the pilot unit but selection of the final sites is recommended

to take place during the next stage of studies. The pilot farm would be the basis of support for the next phase of extension and small-scale production development.

Further studies on the environment and bivalve resource assessment for the oyster species are required to take place prior to pilot project formulation.

A preliminary framework for a pilot project development on oyster culture in presented next.

Project framework outline for the introduction of oyster culture as sustainable livelihood in Ibo and Matemo Islands, Quirimas National Park

Objective

The overall objective of the project is to create a reliable and sustainable new source of income for the coastal fishing communities of Ibo and Matemo Islands. This new activity to be introduced, is represented by the commercial small-scale aquaculture of local indigenous oyster species, initially identified for farming, the Cape pearl oyster *Pinctada capensis* and the Hooded oyster *Saccostrea cucullata*. Production of these two species will be a complement to the current small-scale fisheries. Culture of the pearl oyster is also foreseen extensively to re-stock the natural fishing grounds in an effort to enhance the fisheries and to secure sustainable resource use.

When fully implemented, the pilot operation will foment the small-scale oyster culture contributing this way to reduce the pressure over fish stocks, and as a result, create an alternative source of income and livelihood for the local fishing communities.

The pilot project is designed to develop and adapt culture techniques testing both off bottom and bottom systems and to provide training for extensionists and farmers. Furthermore, the project will aim at achieve a demonstration production output of 50 t/year by the end of Year 3 of a 3-year project implementation scheme. The project would involve local families to be selected from coastal villages, as direct beneficiaries of the pilot operation. Under favourable conditions the pilot project may increase initial producers and expand the operations during the period of project implementation.

The project will also set up a staff of local extensionists to promote and teach oyster farming among coastal communities, where oyster fisheries is mostly common, to provide technical assistance, to monitor farming conditions and to control the quality of the final product.

Justification

The introduction of alternative sustainable production system to fisheries contributing to better livelihood and poverty alleviation, is in line with conservation and resource protection defined in the development strategy for the Quirimbas National Park.

Almost the entire coastal region of Quirimbas is poor and underdeveloped, and its population concentrated in fishing communities rely entirely on coastal fishing resources, highly stressed by intense small-scale fishing. All these problems make artisanal fishery a livelihood that is barely sufficient to survive, with an estimated

income of less than USD1.00 per day for ordinary fishermen, who represent the bulk of the community. Most of the fishing is by beach trawling or shallow water trawling is tide dependent, with very little income during neap tides. This meagre output has to be integrated with some subsistence agricultural production on the traditional family land plot, and by the gleaning of the sea bottom at low tide to provide some food, mainly molluscs and crabs. Women and children mostly conduct collection of bivalves at low tide and these resources are the most under intense exploitation and represent limited recourse for considerable population and food needs. These communities lack most of standard living conditions, and live without power and often with poor water supply.

Artisanal fishery represents the only economic activity of the coastal communities who would be the beneficiaries of the oyster project. No other sustainable activities are easily recognizable in this coastal area, except perhaps tourism and semi-industrial fisheries, which however require huge investments and sophisticated know-how, and are for long-term development and less social impact on coastal communities.

Aquaculture of indigenous oyster species represents a potential social development activity complementary to small-scale fisheries, as a reliable income source for coastal populations without the aforementioned drawbacks.

Oyster production is potential to develop on a small-scale system provided that natural spats can be collected on the natural socking grounds. Some of the favourable aspects of oyster culture under these conditions are:

- ✓ Capitalization is low as for some other aquaculture activities and less than fisheries (and during the project life it is almost nil);
- ✓ When planned under a framework resource use management, oyster culture does not pollute the environment since it does not require inputs that are potentially harmful to it;
- ✓ Oysters, as most bivalves are filter feeders, primary consumers utilizing the basis of the food web, thus maximizing energy transfer and food production;
- ✓ It is not such a labour intensive activity as fishing and mostly involves women particular on bottom culture;
- ✓ Neither sophisticated technical knowledge nor any particular school education is required;
- ✓ Suspended systems provide shelter and food for numerous fish, thus increasing their presence as well as that of their predators, which is good for fishing activities and biodiversity enhancement;
- ✓ It is a sound way to increase awareness of coastal populations to the protection of the environment, whose quality is directly linked to a good oyster production;
- ✓ Small-scale aquaculture is a gender promoting job, where women and young

unemployed people often form the bulk of farmers and beneficiaries, enhancing family income;

- ✓ It represents a real and fully sustainable livelihood alternative to other coastal activities, often performed in a non-sustainable form such as non-selective fishing, reef gleaning, turtle egg collecting and over fishing, and mangrove cutting;
- ✓ The local market seems well developed on oyster products and the development of the tourism industry in the region will also represent a potential market for fresh oysters.

Oyster farming, as demonstrated in similar environments, can represent a real alternative source of revenues for coastal people reducing their dependence from fishery. This activity is also relevant because it does not hamper other traditional jobs, including fishing, and can be started in a short time without large efforts. All members of the family, in particular women can participate, having therefore a good chance to benefit most from this activity as other traditionally assigned activities to the female role.

Location of the project

The west coast of Matemo and Ibo have been selected preliminary because of the natural water quality, physical potential and pearl oyster resource along extensive sea grass beds. Matemo island in particular has also a considerable community whose primary activity is on oyster fishing. These communities rely on artisanal fishery based, with yields tending to reduce due to a number of problems, including over fishing and the use of non-selective fishing gear disturbing the bottom shore and exploiting larval and juveniles fish. Moreover, tourism development in Matemo will represent potential market in future for fresh products.

Other areas for further development during the extension phase of the project will include the northwest and southwest coast of Quirimba and Quilaluia.

Methodology and resources

Oyster culture on small-scale will require the provision of natural spats for transfer and culture. Further studies prior to project implementation are required to confirm existence of enough breeding stocks of the indigenous species selected.

The activity is broadly divided in two stages: first collection of spats using artificial suspended collectors, and secondly on-growing of juveniles either on bottom parks under controlled stocking density, or on suspend systems (raft, tray or long line).

Two species locally occurring were initially identified with some potential for aquaculture, the Hooded oyster and the Pearl oyster, this last more abundant and extensively exploited and consumed amongst the local communities.

Implementation strategy

To achieve its goals on introduction of oyster culture and development of small-scale culture as a new income generating activity, the project will follow two main lines of implementation.

First it will transfer and adapt the farming techniques both for spat collection and on growing of oysters on a pilot farm to develop with selected coastal communities. The pilot unit will be the basis for training an initial group of extensionists from a group of skilled villagers, as technicians in oyster production. Although definitely not highly demanding in terms of technical knowledge and infrastructures, oyster farming requires a good command of its basic principles. The project will foresees initial technical and coordination expertise and local technicians who will received specific training for the extension work to pursue in the next phase of project implementation.

Second, it will develop an extension plan to develop small-scale production systems on selected coastal communities, securing initially technical assistance and supply of spats and materials. Assistance will also be provided for a local counterpart to set up a business oriented venture for marketing fresh oysters and expanding the marketing system by providing expertise, specialized training to local staff, immovable and movable assets. A reliable commercial viability will arguably be reached beyond the 3-year project implementation but most of the marketing development will initially rely of the current dry and fresh trading system for wild oysters.

The detail studying for selection of sites suitable to commercial production is a basic step for the successful farming, thus further study of the Ibo and Matemo Islands is required prior to design of pilot project proposal.

Human resources

Human resources include both expatriate and local staff as described below. The costs detailed are indicative in this initial project framework.

The project is aimed at introducing a new source of income for the coastal population through the small-scale culture of local species of oysters. To this purpose the project will set up a pilot unit for adaptation of techniques and training extentionists to form a local structure able to develop commercially the marketing at the end of the project operations.

The project will foresees the following staff:

Management:

- Local technician;

Technical staff:

- 2 extensionists in oyster farming.

The technical staff will be trained in oyster culture and extension techniques. Consulting expertise (oyster culture expert) is foreseen during the project implementation to overview the technical implementation and other experts are foreseen to orientate the socio-economic integration and project development.

The expert on oyster culture will be recruited for two months per year to plan and supervise all technical aspects relating to oyster spat collection and on-growing production, whereas the local trained technicians will be in charge of transferring the culture techniques and of training the local fishermen.

Consultancies

Local experts will be recruited to staff the following actions:

- ✓ Computer programming for project management;
- ✓ Socio-economic study;
- ✓ Site surveying;
- ✓ Marketing and management training.

Main resources for project implementation

The introduction of oyster culture and implementation of pilot project will require immovable and movable assets, representing these the core of investment.

Property for office use and staff accommodation will be limited and possible share with other current project implementation schemes currently going on in Ibo.

The equipment and supplies required to set up an oyster pilot project relying on natural spat collection will include office equipment, one vehicle, two boats, some special equipment and consumables for oyster farming (spat collection and on growing).

Consumables for oyster farming are mainly represented by different kinds of ropes made of PE and PP, boys and anchoring systems for long line suspended system, construction of wood and bamboo tray and raft systems. Local available alternative materials for spat collectors and rope culture will be tested in order to reduce dependence form imported materials. Other consumable items include locally made concrete anchors, trays and raft culture structures foreseen in case of adoption of suspended farming system. Water quality monitoring and biological studies will require water analysis kit and some laboratory tools. Training and extension didactic printing material for training courses will be required.

Description of activities

Project activities can be summarized as follows in order of implementation:

- ➢ Site survey, identification of coastal communities and stock evaluation of selected oyster species for farming;

- Socio-economic study of current oyster fisheries;
- Project formulation and process for approval;
- Staff recruitment;
- Project installation and demarcation of pilot sites;
- Purchase of project equipment, consumables and vehicles;
- Start up of first pilot farm and test plots in other locations;
- Start up of pilot oyster production;
- Selection and training of the extensionist technicians;
- Training of first batch of farmers;
- Increasing of the number of trained farmers to reach the production target;
- Starting oyster marketing and commercial venture development.

Oyster culture

Oyster culture can be developed at small-scale by transplanting spats collected from the wild stocks. In case breeding stocks are proved small to provide spats for on growing culture the project will need to be re-designed including a possible hatchery for spat production. Oyster culture based on natural spat collection is developed in 2-phase operation being the first the collection of spat and the second the transfer of spats for on growing culture. These can be off bottom, suspended, or developed on the bottom, in the case for the pearl oyster. The hooded oyster can only be developed in off bottom systems.

The off bottom method can be the long line system anchored to the bottom and kept submersed near the surface, with ropes attached to oyster aggregating devices or baskets, or lines anchored to stakes fitted in the sea bottom in a way that culture lines do not touch the bottom. This last is common in sheltered sites. In the raft method the culture a floating wooden frame anchored by means of stakes or anchors, stones or sand bags suspends lines. Lines must be kept submersed to avoid air and direct sunlight; preferred system in calm waters (< 7 m) with steady current.

Parks can be established for pearl oyster on sandy sea grass beds by stocking juvenile oyster at relatively low density. However, growth and survival is normally lower than in off bottom systems.

Extensive culture for re-stocking can also be developed to enhance natural stocks and sustain current pearl oyster fishing.

Education and training

The main component of the project is represented by the educational activities aimed at creating a strong base of extentionists and future farmers. To this purpose the

project will foresees three level of training activities, each focused on a different target:

- Level A: training of farmers on basic spat collection and oyster production techniques;
- Level B: training of extension technicians in advanced spat collection, oyster culture and monitoring;
- Level C: training in oyster marketing.

In this way the project will fulfil the need of trained staff to support the local activity at the end of the project operations.

The potential farmers will be selected by the village elders following the community based participatory approach model. Women will be encouraged to participate particularly in areas where women mostly dominate oyster fishing.

Duration and action plan

The project is foreseen for a maximum duration of three years including the initial phase for studies and project formulation. A small production capacity of 50 tons is foreseen at the end of project, which will be the basis for assessing the economic viability of farming and develop a strategic marketing and business system.

Initial expectations should be deliberately kept low, preferring to promote the creation of a strong foundation in the project staff and initial farmers. The recruitment of a capable, well trained and motivated technical crew to work closely with village people is deemed essential to the success of the project.

It is imperative that the initial efforts focus on those communities, which have the greatest chances to successfully implement the commercial production of oysters. Their output will represent the best advertisement to spread this new activity along the coast to other villages willing to add this activity to their traditional livelihoods.

Tentative action plan

Year 1

1. Site survey along Matemo and Ibo to identify two sites with the best bio-ecological conditions for oyster culture under off bottom and bottom culture. Selection of the most suitable farming system.
2. Socio-economic survey of the communities living in the selected sites (Matemo island). Assessment of the present forms of livelihoods with emphasis on oyster fisheries and their seasonal patterns, trading, as well as those cultural, political and religious concerns which may prevent the successful implementation of oyster culture. Family income, workforce, coastal area uses and conflicts have to be ascertained.

3. Pilot project formulation and approval by local mandated authorities.
4. Survey to assess the supply of all material and equipment required to collect oyster spats and on-growing culture and marketing. Local suppliers will be preferred. The formation of local producers could be envisaged and promoted.
5. Preparation of educational material such as illustrated handbooks.
6. Purchase of project movable and non-movable equipment and materials. Purchase of the initial farming material.
7. Set-up of experimental culture systems
8. Training of the first group of extensionists at the pilot farm.

Year 2

1. Training farmers and upgrading of technicians.
2. Provide technical assistance to farmers.
3. Implementation of the commercial aspects of the project.
4. Experimental production to reach 20 t y the end of Year 2.

Year 3

1. Training of new farmers at the pilot farms. Provide technical assistance.
2. At the end of Year 3 production will reach 50 t.
3. Training course on oyster marketing.
4. Socio-economic survey to assess the impact of oyster culture on local communities.
5. Project auditing.
6. Evaluation of the project results.

Table 2 - Project Budget **(currency: USD)**

Financial expenditure	Year 1	Year 2	Year 3	Total
1. Human resources				
1.1 Salaries				
1.1.1 Coordination & Technical	19.200,00	19.200,00	19.200,00	57.600,00
1.1.2 Consultancy support	12.600,00	6.300,00	6.300,00	25.200,00
1.3 Per diems for missions/travel				
1.3.1 On the spot (project staff)	5.000,00	5.000,00	5.000,00	15.000,00
1.3.2 Seminar/conference participants	4.500,00	0,00	0,00	4.500,00
Subtotal Human Resources				**102.300,00**
2.Travel				
2.1 International travel (consultant)	1.750,00	1.750,00	1.750,00	5.250,00
2.2. Local transportation	500,00	500,00	500,00	1.500,00
Subtotal Travel				**6.750,00**
3. Equipment, materials and supplies				
3.1 Purchase of materials	20.000,00	25.000,00	25.000,00	70.000,00
3.2 Furniture, computer equipment	5.000,00	0,00	0,00	5.000,00
3.3 Maintenance, machinery and tools	0,00	4.000,00	4.000,00	8.000,00
3.4 Transport, boat running costs	5.000,00	5.000,00	5.000,00	15.000,00
3.5 Improved local dhow (with motor)	10.000,00	0,00	0,00	10.000,00
Subtotal Equipment, Materials and Supplies				**108.000,00**
4. Local office/project costs				
4.1 Consumables - Office supplies	1.000,00	1.000,00	1.500,00	3.500,00
Subtotal local office/project costs				**3.500,00**
5. Investments				
5.1 Construction of culture systems	5.000,00	10.000,00	10.000,00	25.000,00
5.2 Other (government licences, bureaucratic	1.000,00	1.000,00	1.000,00	3.000,00
Subtotal investments				**28.000,00**
6. Other costs, services				
6.1 Design costs	5.000,00	0,00	0,00	5.000,00
6.2 Evaluation costs	5.000,00	5.000,00	5.000,00	15.000,00
6.3 Audit costs	0,00	0,00	8.000,00	8.000,00
6.4 Financial services	0,00	0,00	0,00	0,00
6.5 Publications	0,00	0,00	0,00	0,00
6.6 Studies, research	0,00	0,00	0,00	0,00
6.7 Translation, intepreters	0,00	0,00	0,00	0,00
6.8 Costs of training activities	3.000,00	5.000,00	5.000,00	13.000,00
Subtotal Other Costs, Services				**41.000,00**
12. Total cost	103.550,00	88.750,00	97.250,00	**289.550,00**

REPÚBLICA DE MOÇAMBIQUE

MINISTÉRIO DAS PESCAS
Instituto Nacional de Investigação Pesqueira

Anexo 1

Termos de Referência

Prospecção Aquícola da Ilha do Ibo, Parque Nacional das Quirimbas, Cabo Delgado

i) Cliente: WWF Mozambique Programme Office

Objecto

Prospecção da zona costeira da Ilha do Ibo e avaliação das condições ambientais para o desenvolvimento de maricultura a nível familiar. Identificação preliminar dos locais com condições naturais favoráveis, identificacão das culturas e espécies potenciais a desenvolver, determinação do potencial de produção e apresentação dum plano de desenvolvimento da actividade aquícola comunitária.

Termos de Referência

1. Prospecção cartográfica da zona costeira das Quirimbas e pré-identificação dos locais favoráveis.
2. Identificação e descrição natural dos locais favoráveis à actividade aquícola.
   a) Avaliação da zona litoral, estrutura do fundo marinho, correntes, amplitude de maré;
   b) Avaliação da qualidade da água (temperatura, salinidade, pH, amónia, nitiritos, fosfatos;
   c) Estimação da superfície potencial de desenvolvimento;
3. Identificação da fauna e flora marinha indígena com potencial para aquacultura extensiva familiar;
4. Descrição e caracterização socio-económica e logística dos locais favoráveis.

a) Actividades económicas, composição social, nível de desenvolvimento e infraestruturas.

5. Descrição do tipo de instalação aquícola e dos sistemas de cultura das espécies aquícolas com potencial de desenvolvimento na Ilha do Ibo.
6. Apresentação da proposta de plano indicativo de desenvolvimento da actividade aquícola familiar na Ilha do Ibo.

Prazo de Execução

O trabalho técnico de campo e de laboratório será realizado em 12 dias. O relatório final será apresentado 15 dias após a missão de campo.