



*Regional Programme for the Sustainable Management
of the Coastal Zones of the Indian Ocean Countries*

COASTAL MARICULTURE ASSESSMENT MISSION

Final Report

PREPARED BY

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The RCU, appointed by the contractor AGRECO, has prepared this report. The findings, conclusions and interpretations expressed in this document are those of the RCU alone and should in no way be taken to reflect the policies or opinions of the European Commission or the Indian Ocean Commission.

Executive Summary

This report presents the findings of a coastal mariculture assessment mission that was undertaken during the period 12th August to 22nd September 2007. The countries that were visited were Mauritius, Madagascar, Kenya, Tanzania, the Comoros and the Seychelles. Prior to departure, a desktop situation analysis of mariculture in each of the target countries was undertaken, and the information that was acquired was used to inform the final planning of the fieldwork.

There are several commonalities to all the target countries. While there are several good initiatives in most countries, the small-scale mariculture sector in all the countries is at best nascent and un-coordinated. Common to all is a lack of mariculture planning and bio-technical capacity. These issues should be addressed by ReCoMaP, as if they are not, the mariculture sector will be hard pressed to contribute to the overall objectives of the programme. The only sub-sectors that are relatively well managed and coordinated are commercial prawn farming in Madagascar and seaweed farming in Tanzania/Zanzibar. In the absence of sector development plans, small-scale community based mariculture, as well as medium to large scale commercial mariculture, cannot evolve in a mature, orderly and sustainable manner. This shortcoming is common to all countries and needs urgent and specialist attention. All of the proposed mariculture interventions (some simple, and some more complex) require assistance with implementation and backstopping.

In some instances, before interventions can be made, there is a need for more detailed assessments. It is also important to note that the recommended interventions have only been made on the basis of their bio-technical feasibility. Economic assessments are pivotal before any projects are finally recommended for support.

The mission outputs (country survey folders) are identical and for each country comprise the following:

1. Country summary report
2. Country documentation
3. Country photographs
4. Country survey data

The following provides a synopsis of the recommendations that were developed for each country:

Mauritius

On the island of Mauritius, the current legislative framework, combined with potential conflicts with other resource users and the Government's focus on large scale commercial mariculture developments, suggests that the scope for small scale mariculture is extremely limited, and it is recommended that ReCoMap restricts its interventions to Rodrigues. In Rodrigues, the most logical small-scale mariculture interventions are crab culture, polyculture of crabs, milkfish and mullet (plus shrimp) in land based ponds or enclosures, coral (hard and soft) culture, small-scale grouper and siganid cage culture and seaweed farming. All the proposed interventions are based on wild seed and could be rapidly implemented. The biggest constraint to implementation is the complete absence of any sort of mariculture capacity on the Island. Until this is available or imported to oversee implementation, it would not be wise to initiate any of the potential interventions.

Tanzania

In 2006, mariculture production in Tanzania accounted for approximately 8,065 tons of production. Seaweed farming accounted for the majority of this production (8,000 tons) followed by prawns (60 tons) and milkfish (5 tons). Negligible quantities of mud crab and pearl oysters were also produced. While the seaweed industry – although not without its problems – has reached a reasonable level of industrial maturity and is experiencing a countrywide roll-out (production increased from 1,500 tons in 2003 to 8,000 tons in 2006), all other sectors can best be described as at the developmental stages of production, and to date, has largely been driven by donor support. Potential interventions that were identified included milkfish and milkfish polyculture (shrimps, mullet, tilapia), mud crab ranching, pearl oysters, small scale grouper cage culture, aquarium fish, coral culture, sea cucumber culture, small scale prawn culture, artemia cyst production and seaweed farming. With respect to NGOs working in the sector, ACDI-VOCA has developed extensive extension services to the mariculture industry, and would likely provide the most suitable development partner. Other NGOs working in the field (that could also be considered) include the TCMP, WWF and VSO. Government funded research organisations (TAFIRI, IMS and FAST) are all development orientated, and are undertaking demonstration projects that could be supported.

Kenya

Mariculture in Kenya is under-developed and in comparison to freshwater aquaculture is an insignificant activity. In 2003, total estimated freshwater aquaculture production was 1012 tonnes. In contrast in 2006, mariculture production was less than 2 tonnes. Potential ReCoMaP project interventions that were identified include crab ranching, milkfish / mullet / prawn pond polyculture, small-scale grouper cage culture and coral culture. With respect to institutional arrangements, Kwetu was found to be the most suitable NGO partner for mariculture development. The Coast Development Authority (CDA) was deemed the most suitable statutory partner for ReCoMaP to work with – the CDA has a development mandate and has developed extensive experience in the provision of small scale mariculture extension services. It was recommended that the Department of Fisheries (DoF) develops a Mariculture Sector Plan to guide the development of the sector, and considers the development of a marine hatchery to assist in the development of finfish cage culture. The Kenyan Marine Fisheries Research Institute (KMFRI) has a high level of research capacity, and it was recommended that ReCoMaP supports their efforts in technology transfer to farmers.

Madagascar

With the notable exception of the commercial penaeid prawn industry, Madagascan mariculture can at best be described as being in its infancy. Whilst considerable research efforts have focused on the technological development of seaweed, spirulina, artemia and brackish water tilapia farming, to date, there has been relatively little uptake of the technologies developed. Potential interventions that were identified include finfish (tilapia, milkfish and milkfish polyculture, grouper cage culture, cobia and yellowtail and aquarium fish), oysters, mud crab, sea cucumber, artemia, seaweed and small scale prawn culture. Of the identified interventions, it was recommended that ReCoMaP prioritises sea cucumber ranching, mud crab ranching and seaweed culture as these activities were deemed as having the best chances of success. The IHSM is perhaps the primary research establishment and has developed a well established team of mariculture researchers. They are business focused, and through their past programmes have developed excellent project management and extension capabilities. It is recommended that ReCoMaP support their initiatives.

The Seychelles

Mariculture in the Seychelles is under-developed and there is no framework within which the sector is able to develop. Investment in the sector is restricted to a prawn farm on Coetivy Island (owned by a state company - Seychelles Management Board) and a privately owned pearl and giant clam farm on Praslin (Praslin Ocean Farm Ltd). Relative to its potential, the sector is nascent. Nevertheless, the potential for mariculture in Seychelles is substantial. However at present, there is disagreement amongst key statutory role players with respect to recognising and or realising the potential of the sector – in both the inner and outer Islands. Mariculture development in the Seychelles requires a united political front and a tangible commitment by Government, and unless there is a commitment to assess the opportunities presented by mariculture by the organs of state, the sector cannot develop in an orderly and responsible manner. It is recommended that ReCoMaP considers supporting a detailed exploratory assessment of mariculture opportunities and constraints. If the outputs are positive, then support in the form of the preparation of a Sector Development Plan and training and capacity building could follow. At present, it is not recommended that ReCoMaP supports individual farming projects.

The Comoros

The Comoros has neither developed a freshwater or a marine aquaculture sector, and to date, there have been no aquaculture-based interventions. Indeed, according to the Fisheries Department of the Union of the Comoros, there have been no assessments of the potential for aquaculture development. The absence of a detailed bio-technical and financial assessment of the potential for mariculture development, and the poor regulatory, extension, research and technical capacity to develop the sector, suggests that it would be premature to promote farm developments at this time, and it is recommended that ReCoMaP primarily confines its activities to the undertaking of an in-depth needs assessment, and the development of a strategy to promote mariculture development.

Résumé Exécutif

Ce rapport présente les conclusions d'une mission d'évaluation de la mariculture côtière entreprise du 12 août au 22 septembre 2007. Les pays visités sont : l'île Maurice, Madagascar, le Kenya, la Tanzanie, les Comores et les Seychelles. Avant leur départ, les experts ont effectué une analyse au bureau de la situation de la mariculture dans chacun des pays cibles et l'information obtenue a été utilisée pour la planification finale du travail sur le terrain.

Plusieurs points sont communs à tous les pays cibles. Tandis qu'il y a plusieurs initiatives intéressantes dans la plupart des pays, le secteur de la mariculture à petite échelle dans tous les pays en est au mieux à ses débuts et peu coordonné. Tous les pays manquent d'une planification de la mariculture et de capacités bio-techniques. Ces questions devraient être abordées par le ProGeCo car sinon le secteur de la mariculture aura beaucoup de difficultés à contribuer aux objectifs globaux du programme. Les seuls sous-secteurs qui sont relativement bien gérés et coordonnés sont les élevages commerciaux de crevettes à Madagascar et les cultures d'algues en Tanzanie/Zanzibar. En l'absence de programmes de développement sectoriels, la mariculture communautaire à petite échelle ainsi que la mariculture commerciale à moyenne et grande échelle, ne peuvent évoluer d'une façon mûre, ordonnée et durable. Cette défaillance est propre à tous les pays et requiert d'urgence une attention spécialisée. Toutes les interventions proposées dans le domaine de la mariculture (certaines simples, d'autres plus complexes) requièrent une assistance pour la mise en œuvre et le suivi.

Dans certains cas, avant que l'intervention ne puisse avoir lieu, il faudra procéder à une évaluation plus approfondie. Il est également important de noter que les interventions recommandées ont uniquement été effectuées sur base de leur faisabilité bio-technique. Les évaluations économiques sont indispensables avant de soumettre n'importe quel projet à un appui.

Les produits de la mission (analyse par pays) sont identiques et pour chaque pays se composent de:

1. Résumé du rapport par pays
2. Documentation du pays
3. Photographies du pays
4. Données d'enquête par pays

Nous présentons ci-après un résumé de l'analyse et des recommandations établies pour chaque pays:

Maurice

A l'île Maurice, le cadre législatif en vigueur, combiné avec d'éventuels conflits entre utilisateurs des ressources et la politique du Gouvernement se concentrant sur le développement des grandes exploitations commerciales de mariculture, laisse à penser que la place de la mariculture à petite échelle est extrêmement limitée, et il est recommandé que le ProGeCo limite son intervention à Rodrigues.

A Rodrigues, les exploitations de mariculture à petite échelle les plus évidentes sont la culture des crabes, la polyculture des crabes, chanos (ou poissons-lait) et mulets (plus les crevettes) dans des bassins ou enclos piscicoles, la culture du corail (dur et mou), le petit élevage en bassin du mérou ou du poisson siganid et la culture des algues. Toutes les interventions proposées sont basées sur des alevins sauvages et pourraient être rapidement mises en œuvre. La plus grosse contrainte à la réalisation est l'absence

complète de toute expertise en mariculture sur l'île. Tant que celle-ci n'est pas disponible ou importée pour superviser la mise en œuvre, il est déconseillé de commencer des interventions.

Tanzanie

En 2006, la production de la mariculture en Tanzanie représentait approximativement 8.065 tonnes. La culture des algues comptait pour la majorité de cette production (8.000 tonnes) suivie des crevettes (60 tonnes) et des chanos (5 tonnes). Des quantités négligeables de crabe de vase et d'huîtres perlières ont été également produites. Tandis que l'industrie des algues – bien que non sans problèmes – ait atteint un niveau raisonnable de maturité industrielle et expérimente une hausse sensible au niveau national (la production est passée de 1.500 tonnes en 2003 à 8.000 tonnes en 2006), tous les autres secteurs peuvent être décrits au mieux comme étant au stade développemental de la production et à ce jour, ont essentiellement été stimulés par le soutien des bailleurs de fonds.

Les possibles interventions identifiées visent le chanos et la polyculture des chanidés (avec crevettes, mullets, tilapias), l'élevage de crabes de vase, d'huîtres perlières, le petit élevage en bassin du mérou, des poissons d'aquarium, la culture du corail, l'élevage d'holothuries (ou concombre de mer), le petit élevage de crevettes, la production de cystes d'artémia et la culture d'algues. En ce qui concerne les ONG œuvrant dans le secteur, ACIDI-VOCA a développé d'importants services de vulgarisation à l'industrie de la mariculture et représente sans doute le partenaire le plus approprié. Parmi les autres ONG travaillant dans le secteur (et qui pourraient également être considérées) citons TCMP, WWF et VSO. Les organisations de recherches gouvernementales (TAFIRI, IMS et FAST) sont toutes orientées vers le développement et entreprennent des projets pilotes qui pourraient être soutenus.

Kenya

La mariculture au Kenya est sous-développée et représente une activité insignifiante en comparaison avec l'aquaculture en eau douce. Ainsi en 2003, on estime que la production totale émanant de l'aquaculture en eau douce s'élevait à 1.012 tonnes. Par contre, en 2006, la production issue de la mariculture représentait moins de 2 tonnes.

Parmi les interventions possibles identifiées pour le ProGeco citons l'élevage de crabes, la polyculture en bassins de chanos / mullets / crevettes, le petit élevage en bassin de mérou et la culture du corail. En ce qui concerne les modalités institutionnelles, l'ONG Kwetu semble être le partenaire le plus adapté pour le développement de la mariculture. L'autorité du développement côtier (Coast Development Authority - CDA) semble être le partenaire statutaire qui convienne le mieux au ProGeCo – le développement est un des mandats du CDA et il bénéficie d'une grande expérience dans la fourniture de services de vulgarisation de la mariculture à petite échelle. Il a été recommandé que le Département de la Pêche (DoF) développe un Plan Sectoriel de la Mariculture pour guider le développement de ce secteur, et considère le développement des incubateurs marins pour aider au développement de l'élevage en bassin des poissons à nageoires. L'Institut Kenyan de Recherche sur la Pêche Marine (KMFRI) est à la pointe de la recherche et il a été recommandé que le ProGeCo soutienne leurs efforts dans le transfert de leurs technologies aux éleveurs.

Madagascar

A l'exception notoire de l'industrie commerciale de la crevette pénéidée, la mariculture malgache en est au mieux à ses balbutiements. Alors que d'importants efforts dans la recherche ont été consacrés au développement technologique de la culture d'algues, de

spiruline et aux élevages d'artémias et de tilapias des eaux saumâtres, à ce jour les technologies mises en place ont eu relativement peu de succès.

Les interventions potentielles identifiées concernent les poissons à nageoires (tilapia, chanos et polyculture des chanidés, élevage en bassin du mérrou, les cobias, les poissons à queue jaune et ceux d'aquarium), les huîtres, le crabe de vase, le concombre de mer, l'artémia, les algues et les petits élevages de crevettes. Parmi les interventions, il est recommandé que le ProGeCo donne priorité à l'élevage de concombre de mer, de crabe de vase et à la culture d'algues étant donné que ces activités semblent avoir le plus de chance de réussir. L'IHSM est sans doute le principal institut de recherche qui ait dispose d'une équipe de chercheurs en mariculture bien reconnue. Ils sont entrepreneurs et au cours de leurs programmes antérieurs, ils ont fait preuve d'excellentes capacités de gestion de projet et d'expansion. Il est recommandé que le ProGeCo soutienne leurs initiatives.

Les Seychelles

La mariculture aux Seychelles est sous-développée et il n'existe pas de cadre dans lequel elle pourrait se développer. L'investissement dans le secteur se limite à l'élevage de crevettes sur l'île de Coetivy (propriété d'une entreprise d'état - Seychelles Management Board) et un élevage privé d'huîtres perlières et de palourdes géantes à Praslin (Praslin Ocean Farm Ltd). Malgré son potentiel considérable le secteur de la mariculture débute aux Seychelles. Cependant, pour l'instant, il y a un désaccord parmi les intervenants clés statutaires au sujet de la reconnaissance et/ou la réalisation du potentiel du secteur – tant dans les îles intérieures qu'extérieures.

Le développement de la Mariculture aux Seychelles requiert un front politique uni et un réel engagement du Gouvernement. A moins d'avoir un engagement clair de la part des organismes étatiques d'évaluer les opportunités de la mariculture, le secteur ne pourra pas se développer d'une façon ordonnée et responsable. Il est donc conseillé que le ProGeCo envisage d'appuyer une évaluation exploratoire détaillée des opportunités et contraintes engendrées par la mariculture. Si les résultats sont positifs, alors une assistance sous forme de préparation d'un plan de développement de secteur, d'une formation et d'un renforcement des capacités pourrait s'en suivre. Pour l'instant il n'est pas conseillé que le ProGeCo soutienne des projets d'élevage individuels.

Les Comores

Les Comores n'ont mis sur pied ni une aquaculture marine ni en eau douce et à ce jour, on ne relève pas d'intervention dans le domaine de l'aquaculture. En effet, d'après le Département de la Pêche de l'Union des Comores, il n'y a pas eu d'évaluation quant au potentiel pour le développement de l'aquaculture. L'absence d'une évaluation détaillée bio-technique et financière du potentiel que représenterait le développement de la mariculture, et les faibles capacités normatives, de vulgarisation, de recherche et techniques pour développer le secteur laissent à penser qu'il serait prématuré de promouvoir le développement de l'élevage pour l'instant. Il est conseillé que le ProGeCo concentre ses activités dans un premier temps sur une évaluation approfondie des besoins et l'élaboration d'une stratégie pour promouvoir le développement de la mariculture.

1 INTRODUCTION

The Regional Coastal Zone management Programme for the Indian Ocean countries (ReCoMaP) is a programme of the Indian Ocean Commission (IOC). It is a five year programme that aims to enhance sustainable management and conservation of natural and coastal resources with a view to contributing to poverty alleviation among coastal populations. Beneficiary countries include Comoros, Madagascar, Mauritius, Seychelles, Kenya, Tanzania and Somalia. The promotion of sustainable livelihoods for the large number of impoverished people who depend on coastal resources for their survival is at the heart of ReCoMaP's approach to Integrated Coastal Zone Management (ICZM). In addition to the common need for strengthening national and regional ICZM frameworks, coastal mariculture and coastal tourism were identified as having the greatest potential for increased revenue generation in coastal communities as part of improved ICZM in the region.

1.1 Methodology

The ReCoMaP coastal mariculture assessment mission was carried out by two consultants, Prof Tom Hecht and Dr Tom Shipton during the period 12 August to 22 September 2007. Table 1 summarises the timetable for each of the consultants as provided to them prior to the mission (see Annex 1 for Terms of Reference). After discussions on the first day of the mission, at the RCU in Mauritius, the timetable was changed to accommodate an assessment of mariculture opportunities on Rodrigues Island. This assessment was undertaken by Prof. Hecht on 16 and 17 August. At a later stage, on the request of Dr Shipton it was agreed by the RCU that more time was needed in Tanzania, and the mission to that country was thus extended by 2 days. This was justified on the basis of prior knowledge of the mariculture situation in the Comoros. As per the contract the mission was carried out in the allotted time period of 70 calendar days and covered Mauritius, Rodrigues, Madagascar, Kenya, Tanzania, Seychelles and Comoros.

A desktop situation analysis of mariculture in each of the countries was carried out prior to departure for Mauritius as prescribed in the contract and this informed the final planning of the fieldwork. Apart from the professional contact persons known to the consultants through previous work in the region, the RCU provided an additional list of stakeholders in each country. Where possible, contact was made with all persons during the country missions. At the time of the mission the Information Management Specialist (IMS) had not been appointed at the RCU, and hence the information data matrix had not been developed and of course the consultants could not liaise and maintain constant contact with him/her during the mission. The consultants did however liaise and maintain contact with the team leader at the RCU throughout their mission. Based on their extensive knowledge of mariculture in the region the consultants developed their own Excel-based, information data matrix that was approved by the RCU prior to departure to the various countries. Although it might be different from a matrix developed by an IMS, the data for each country is standardised and with little effort can be transferred to a database by the IMS when s/he is appointed.

Due to the complexity of the mariculture situation in each country, it was not possible to summarise all the information in one page per country. Instead the reports range in length from 5 to 12 pages per country. All the documentation and other material that was collected by the consultants during their field missions, as per the terms of reference, have been submitted to the RCU. Most of it is in soft copy format.

It was expected of the consultants to meet with the ICZM committees in all target countries. These meetings were to have been arranged by the NFPs. Except for Seychelles this did not happen. However, the consultants did meet with representatives of the respective ICZM committees. Similarly, a mariculture debriefing was only arranged in Seychelles. This debriefing was attended by over 40 people representing the public, NGO and the private sectors and is indicative of the interest in the sector. A copy of the presentation made by the consultant at this debriefing is attached in the Seychelles Survey folder. Draft soft copies of the country reports, country documentation, species specific biotechnical literature, photographs and the spreadsheet data matrices were submitted to the RCU on the last day of the assignment of each consultant. During the field work the consultants remained in constant contact with each other to compare and discuss their findings. The individual country surveys were standardised with respect to contents and headings. This will expedite the work of the IMS and also make it easy for the specialists at the RCU to draw comparisons between and among the target countries.

1.2 Findings

The mission outputs (country survey folders) are identical and for each country consists of -

1. Country summary report
2. Country documentation
3. Country photographs
4. Country survey data

In addition, the output also includes a literature folder that contains pertinent papers on aquaculture technologies for fish, sea cucumbers, giant clams, coral, pearls, crabs, seaweed and sponges as well as on sustainable mariculture and general tropical mariculture issues and an Excel spreadsheet that details the biotechnical requirements of all possible candidate species.

For ease of comparison the country summary reports are structured identically under the following headings –

- (i) Introduction
- (ii) Legislation, administration and facilitation
- (iii) Summary of mariculture activities
- (iv) Approved or proposed interventions
- (v) Site selection
- (vi) Potential interventions identified
- (vii) SWOT analysis of small-scale mariculture
- (viii) Recommendations
- (ix) Supporting research, monitoring and technology transfer needs
- (x) List of persons interviewed

The country visits were very brief and hence the reports should at best be considered as rapid assessments. While trying to be meticulous at all times, it is quite possible that certain information may have been misinterpreted and the consultants take full responsibility for this.

The consultants were well received in all countries, by individual specialists and the respective stakeholder institutions. All were supportive of the mission and of the ReCoMaP programme in general.

There are several commonalities in all target countries. While there are several good initiatives in most countries, the small-scale mariculture sector in all countries is at best nascent and un-coordinated. Common to all is a lack of mariculture planning and bio-technical capacity and this must be addressed by ReCoMaP or the mariculture sector will be hard pressed to contribute to the overall objectives of the programme. The only sub-sectors that are relatively well managed and coordinated are commercial prawn farming in Madagascar and seaweed farming in Tanzania/Zanzibar. In the absence of sector development plans, small-scale community based mariculture as well as medium to large scale commercial mariculture cannot evolve and mature in an orderly and sustainable manner. This shortcoming is common to all countries and needs urgent and specialist attention. All of the proposed mariculture interventions (some simple and some more complex) require assistance with implementation and backstopping, or they will either flounder or fail.

In some instances there is a need for more detailed assessments before interventions can be made. It is also important to note that the recommended interventions have only been made on the basis of their bio-technical feasibility. Economic assessments are pivotal before any projects are finally recommended for support.

Table 1 Itinerary

ReCoMaP Mariculture Consultancy - Indicative Timetable																																																					
Month	August															September																																					
Week	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22											
	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S											
Location																																																					
Both Consultants: RCU/Mauritius	2-14																																																				
Both Consultants: Mauritius	2-4																																																				
Tom SHIPTON: Madagascar	1-9																																																				
Tom SHIPTON: Tanzania	1-10																																																				
Tom SHIPTON: Comoros	1-10																																																				
Tom SHIPTON: RCU	1-10																																																				
Tom HECHT: Kenya	1-10																																																				
Tom HECHT: Seychelles	1-7																																																				
Tom HECHT: RCU	1-7																																																				
Consultant B: RCU	1-7																																																				
Tom SHIPTON:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Tom HECHT:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28																									
Total Man Days	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70											

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2 MAURITIUS

2.1 Introduction

Mariculture in Mauritius dates back to the French Colonial times when juvenile marine finfish were collected from the wild and placed in the Barachois for fattening. Historically, the Barachois have been the focus of the country's mariculture production applying low intensity polyculture technology. It was only during the late 1980s and early 1990s, and the advent of the JICA funded mariculture programme at the Albion Research Centre (MAIF), that intensive commercial mariculture technology was introduced to Mauritius. JICA initially introduced seabream culture for stocking the of the Barachois and stock enhancement of the coastal waters. This was followed by marine shrimp technology. Sadly, neither technology was adopted by the private sector, and while production at the JICA funded Albion Research Centre has ceased, significant infrastructure and capacity remains. In 2002, the Ferme Marine de Mahebourg Ltd. initiated farming operations and now represents the sole mariculture operator in the country. Currently they are farming Goldline Sea bream (*Rhabdosargus sarba*), Red drum (*Scianops ocellatus*), and in the future, anticipate developing Cobia (*Rachycendron canadum*) production.

The failure of Mauritian mariculture sector to realise its commercial potential has clearly been noted by Government structures, and in particular, the Ministry of Agro-Industry and Fisheries (MAIF - Fisheries Division) and the Board of Investment. In recent years there have been significant attempts to develop the sector, culminating in the commission of a Mariculture Sector Development Plan (2006), and the development of a draft Aquaculture Business Activities Act. While there remain a number of issues pertaining to the public acceptance of the Act, and lagoon-based mariculture in general, it is anticipated that the Act will enter into law in 2008. These developments, and in combination with the institutional capacity developed during the JICA interventions, and the example of the Mahbourg fish farm, set the stage for commercial mariculture development in Mauritius.

2.2 Legislation, Administration and Facilitation

Mariculture activities in Mauritius are legislated for under the Fisheries Act (Act 22 of 1998, Supporting Document 1). While the Act is regulatory in nature, to date no policy has been developed. The Act enables the Minister to grant discretionary permit exemptions to individual farmers. Thus, in the absence of clear policy guidelines, proponents can either apply for a permit or an exemption to undertake mariculture – interestingly, as there is no legislation pertaining to the rental of lagoon waters, the Mahebourg farm has been awarded an exemption to farm the lagoon waters, and not a permit. Effectively this means that it cannot legally exclude other resource users from the farming site. This is a major impediment to mariculture investment as few investors will be willing to invest in costly infrastructure at a site at which they have only a tenuous hold, and no legal rights to prevent other resource users entering the area. The proposed Aquaculture Business Activities Act (Supporting Document 2) is primarily designed to legislate for the leasing of the lagoons (hence the public concern), and it is anticipated that the legislation will be used to designate the aquaculture zones that are proposed in the Strategic Development Plan (Supporting Document 3) - which is now viewed as government policy (Mr B. Ramcharrun MAIF, *pers. com.*). It is interesting to note that no mention of small scale mariculture is made in either the Fisheries Act or the proposed Aquaculture Business Activities Act, and discussions with the Board of Investment suggest that the government generally views mariculture development in Mauritius as a large scale capital intensive enterprise following the Mahebourg example. Note: this is

not the case at the Albion Research Centre which has a history of supporting small scale farmer models through seed supply and extension services.

With respect to the administration of mariculture developments, The Board of Investment (BOI) acts as a one-stop shop for commercial applications, and ensures that the relevant permits are obtained from MAIF, and that the environmental legislation is adhered to. The adoption of the Aquaculture Business Activities Act will alter this system somewhat, and an Advisory Council incorporating the relevant government departments will decide permitting issues. While there are no sector specific incentives for mariculture development, the Finance Bill (2006) has been designed to attract foreign investment to Mauritius through the blanket introduction of low corporate taxation and tax breaks.

The country's extension and research facilities are restricted to the Albion Research Centre (MAIF). Sadly, funding at Albion is a major constraint, and the facilities are currently underutilized. Nevertheless, the Albion has excellent research facilities and a research staff that are able to provide assistance to the sector – most notably in respect of research assistance and the provision of water quality monitoring services. MAIF (Albion Centre) ensures that all new aquaculture projects have baseline environmental data collected, and are monitored over the project lifecycle for environmental impacts - e.g water quality degradation, sediment pollution etc. In addition, the Government Veterinary Services (MAIF) is developing protocols for the export certification of aquaculture products. Currently, there are no mariculture research facilities or capacity at the University of Mauritius.

2.3 Current mariculture activities and production

Current mariculture activities are restricted to the Ferme Marine de Mahebourg Ltd who have developed a commercial scale cage culture operation for Red drum and Goldline seabream, and Cobia. Operations were initiated in 2001, and it has now reached a production level of 500 tons per annum. The culture technology has been successfully transferred, and the company is now in the process of developing an EU accredited processing plant, and up-scaling production to 2,500 tons per annum.

Approved and proposed interventions

There are no formally planned mariculture interventions that have been proposed. Nevertheless, the Board of Investment has been approached by two established mariculture producers from South Africa and one Mauritian company (Ms D. Seng, BOI, *pers. com.*). While the details of the potential interventions could not be disclosed for commercial reasons, it was apparent that all three companies are awaiting the passage of the Aquaculture Business Activities Act through the legislature, and a concomitant clarification of the legislative framework within which they would be investing. Clearly, it is of paramount importance to the realisation of the country's commercial mariculture potential that the controversies surrounding the Act are quickly resolved, and the legislation passed into law expeditiously.

ReCoMaP Interventions

The Strategic Development Plan (Supporting Document 3) indicates that future commercial interventions should be considered in the lagoon, the coastal belt and the open sea (multiple species; minimum farm size 300 tons per annum) – clearly, such projects would be beyond the scope of the ReCoMaP programme. With respect to small scale developments that could be considered for ReCoMaP funding, there is some potential for small-scale culture in the Barachois, and indeed, a number of Barachois were identified in the Strategic Development Plan as suitable for small scale

development. There is little doubt that there would be potential to develop some form of polyculture in these areas - depending upon conditions, species such as seabream, grouper, milkfish, brackishwater tilapia and oysters could be considered. However, such interventions are likely to be fraught by user conflicts, be politically contentious and move contrary to current policy that is designed to promote large scale commercial aquaculture. With respect to developing small scale culture in the lagoon areas - these are suitable areas for cage culture operations. Albion (MAIF) has developed an experimental proposal to develop small scale sea bream cage culture in the lagoons (Supporting Document 8). However, by their own admission, they believe that it will fail as the cyclone season limits the grow-out period to nine months of the year (Mr B. Ramcharrun MAIF, *pers. com.*). During cyclone events, fish in small cage systems would have to be harvested and the equipment brought ashore - in contrast, large scale commercial cages can be sunk (with the fish). Thus, the cyclones severely curtail the potential for small-scale mariculture development in the lagoons. Discussions with the Ferme Marine de Mahebourg Ltd (Mr G. Benjamin) suggest that they may consider some form of support for an out-grower programme; however, this would require the farmers to use large scale "cyclone sinkable" submersible cage technology (minimum cage size \pm 8m diameter). While the presence of a private sector mentor would certainly promote sustainability for the project, the investment / operational costs would be considerable, and are likely to be beyond the scope of the ReCoMaP funding paradigm.

Taking these issues into consideration, it is recommended that ReCoMaP focus their Mauritian projects on Rodrigues where there is significantly more scope to develop meaningful interventions (see Rodrigues report).

2.4 SWOT analysis of aquaculture in Mauritius

Strengths

- High quality seawater
- Presence of a Sector Plan
- High level of Government interest in developing the sector
- Research and monitoring support capacity at Albion
- Support for mariculture development from the Bureau of Investments

Weaknesses

- Extension capacity
- Access to the coast
- Poor status of funding at Albion Research Centre
- Institutional perception that mariculture should be restricted to large scale developments
- No research capacity at the University of Mauritius

Opportunities

- Increased government and / or bilateral support for mariculture development
- Greater and dedicated NGO involvement
- Commercial mariculture

Threats

- User conflicts in the marine environment
- Cyclones
- High level of competition for coastal land - particularly with respect to coastal hotel development
- Limited access to the Barachois

- Governance constraints – delays in the adoption of the Aquaculture Business Activities Act
- Theft and vandalism

2.5 Recommendations

In light of the current legislative framework, potential conflicts with other resource users and the Government's focus on large scale commercial mariculture developments, it is recommended that ReCoMap restricts its interventions in Mauritius to Rodrigues. See Rodrigues summary report.

2.6 Supporting research, monitoring and technology transfer needs

See recommendations for Rodrigues

2.7 Contact persons

1. Mr Graham Benjamin. Ferme marine de Mahebourg Ltd. Graham.benjamin@fmm.mu
2. Mr Doris Seng. Bureau of Investments. doris@investmauritius.com
3. Mr B Ramharrun. Ministry of Agro-industries and Fisheries, Aquaculture Division. (230) 259 5336
4. Dr Roshan Ramessur. Universty of Mauritius ramessur@uom.ac.mu
5. Mr Iain Watt. UNDP. iainwatt@intnet.mu
6. Mrs Shyama Rathacharen. Ministry of Agro-industries and Fisheries, Fisheries Division srathacharen@mail.gov.mu

3 RODRIGUES ISLAND (MAURITIUS)

3.1 Introduction

The adoption of ICZM by Rodrigues Regional Assembly and the planned MPAs, coupled with over-fishing of marine resources in the Rodrigues lagoon (>200km²) has led to the need to identify and develop alternative income generating activities for fishers. During the period 1994 to 2006 octopus catches have declined from 880 to 300 tonnes per annum and fish catches also appear to have declined significantly (see Supporting Document 1). It was not possible to establish accurately the rate of decline in fish catches.

Mariculture has been identified as one of the priority alternative opportunities for communities on the Island. While marine mariculture has a long history on Mauritius there have been no previous interventions on Rodrigues. This summary report is based on a rapid (2 day, 15&16 August 2007) assessment of opportunities and the administrative and legal framework for the development of a small scale mariculture sector on Rodrigues. Discussions were held with many people (see list below). All provided me with valuable information and data and in particular I should like to thank all for openly and enthusiastically sharing their insights into how the sector may be developed.

3.2 Legislation, administration and facilitation

Although Rodrigues is autonomous with respect to Environmental Management, fisheries and aquaculture on Rodrigues falls under the Fisheries Act of Mauritius. There is no Island specific policy and or legislation for mariculture development. Contrary to common belief there is no Aquaculture Masterplan for Rodrigues. We assume that the proposed Aquatic Business Bill (still to serve before Parliament) will also provide the legal and incentives framework for mariculture development on Rodrigues. Mariculture opportunities and constraints have been identified in the Strategic Action Plan for Fisheries (Supporting Document 1) and by the IFAD Rodrigues seaweed feasibility study (Supporting Document 5). In addition, several intergovernmental organisations and NGOs have also identified mariculture as an important component of ICZM. These include UNDP, ReCoMaP and Shoals of Rodrigues. The UNDP has recently called for tenders for a comprehensive assessment of mariculture opportunities on Rodrigues (Supporting Document 9). The Island Regional Council (IRA) has also recognised the potential of mariculture on the Island and is actively promoting the development of the sector. The water quality guidelines for coastal waters Class C - Mariculture (Supporting Document 4, GN 620 of 1999) apply and operators have to ensure compliance.

Mariculture administration capacity within the Commission for Fisheries is weak and the Commission relies heavily on support and advice provided by the Albion Fisheries Centre on Mauritius. In mitigation it must be said that under the current framework conditions the Administration is doing its best to assess project applications by the private sector. Most importantly the IRA has simplified the application procedure. Applications are submitted to the Commission for Fisheries, which takes the responsibility of running the application through the relevant and affected departments. It is not known how long the process takes but under normal circumstances this should not take longer than 2-3 months. If it does then investors will take their money elsewhere. Under the current system, applications are screened by the Departments of Environment, the Town & Country Planning Office, Ministry of Agro Industry and Fisheries, and Ministry of Public Infrastructure, Transport & Shipping and must comply with all environmental guidelines.

There are no requirements for an Environmental Impact Assessment. This should be seriously reconsidered by IRA. It is recommended that EIAs become mandatory for mariculture projects above a certain size with respect to surface area and or tonnage. This needs to be determined. Given the size of the lagoon and the efforts to maintain ecological functioning it will also be necessary to determine the maximum carrying capacity of the lagoon for feed-based and non-feed based mariculture. For equitable access it will also be necessary to determine the maximum size of individual aquaculture projects.

There is no bio-technical mariculture capacity on Rodrigues and this is one of the greatest constraints facing the development of the sector on the Island. There is an urgent need for training both at the administrative and bio-technical level.

Most of the fishers on Rodrigues are poorly educated and hence it will be very difficult for them to adopt farming as a new way of making a living. In general this can only be achieved through a long-term education process. To successfully initiate and develop small-scale mariculture on the Island it is recommended that applications should only be considered for funding from communities that are also involved in agriculture in some or other way. Moreover, as mentioned above it is imperative that administrative and bio-technical capacity be developed rapidly. Unless the IRA has capacity and bio-technical capacity in particular, the chances of successful adoption and implementation of small-scale mariculture on the Island is remote. The Commission for Education should develop material for school children such that they can be educated on the employment and wealth creating opportunities presented by alternative uses of marine resources and the environment such as mariculture.

Although tempting, it is premature to propose the establishment of a multi-purpose hatchery to kickstart development on Rodrigues. At this early stage there is no need for a commercial hatchery to provide juvenile fish and crabs for grow-out. It may however be necessary to consider a hatchery for the future expansion of the sector. This provides the opportunity and necessary time to consider various strategic and financial options for a hatchery on the Island. For example, a state owned and operated hatchery would most likely be unsustainable, unless staff production incentives can be provided (and this is highly unlikely). Alternative options such as a public / private partnership arrangement would have to be considered, whereby the state provides the land, basic building infrastructure and the private sector is responsible for internal infrastructure and operational costs. Even if development costs are shared we think that the risks are too high to find a private investor at this stage of development. However, the IRA has recently approved the establishment of a sea cucumber farm with an associated hatchery. If this hatchery is successful then in future it may be worthwhile to investigate the possibility of a partnership with the proponent (Rodrigues Marine Products Ltd), as outlined above, to expand this facility into a multi-purpose hatchery.

3.3 Summary of mariculture activities

Current activities and production - None

Historical interventions - None

Approved and proposed interventions

The IRA has received 10 applications for mariculture development, of which 4 have been approved and made available for review by the Chief Commissioners Office. These are:

1. A sea cucumber farm (hatchery and grow out ponds and enclosures with a target production of 3 tonnes per month (dry)).

2. A pump ashore red tilapia farm in D-ended tanks with a production target of 40 tonnes per annum.
3. Fresh / brackishwater farming of *Macrobrachium rosenbergii*, with a production target of 18 tonnes per annum.
4. A shrimp and sea cucumber farm proposed by Ocean Fish Ltd., that has requested a 7ha lease of lagoon space from IRA.

Moreover, in 2002 the Ministry of Fisheries commissioned a study, through the FAD Fishery Development Sub-Programme (IFAD Loan 504-MU: Rural Diversification Programme) on the feasibility of seaweed farming in the Rodrigues lagoon. A very comprehensive and detailed feasibility report was submitted in October 2002 (Supporting Document 5). It was recommended to establish a demonstration farm and IFAD is currently in the process of developing the business plan and the implementation strategy for the farm. This project will, amongst others, provide the necessary technical back-up and extension capacity for the development of seaweed farming on Rodrigues. It is recommended that ReCoMaP supports this initiative fully and opens lines of communication with the Department of Fisheries and IFAD (Dr. Gary Morgan – see contact details below). A review of the feasibility study suggests that the Rodrigues lagoon is ideally suited for the farming of *Gracillaria* (agarophyte) and *Euचेuma* (carageenophyte) and that seaweed farming has substantial potential. However, given the complexities of the dry seaweed trade in the region (see Tanzania report) it is important that a marketing strategy for the product is developed.

Site selection

Time constraints did not permit a detailed assessment of potential mariculture sites and we hasten to point out that these suggestions are based on visual observations only. Proper site selection is a complex exercise and is pivotal for species selection and the successful implementation of any small or large-sale mariculture operation. For example, for seaweeds this would include an assessment of nutrient (N and P) values, BOD, COD, bathymetry and temperature profiles and for fish cage culture would include information on bathymetry, DO, temperature and current speed. It will also be pivotal to ground truth sea conditions at these sites during cyclonic events.

The following sites were provisionally identified as suitable for mariculture:

- Oyster Bay (seaweeds, crab polyculture with fish, or crab monoculture in bottom cages).
- North Bay (Seaweeds, enclosure culture of sea cucumbers, crab polyculture with fish or crab monoculture in bottom cages).
- Diamond Bay (enclosure culture of sea cucumbers, mudcrab and fish or crab monoculture in bottom cages).
- A site in the lee of Fregate Island for small-scale cage culture of grouper and siganids.
- Milkfish pond culture in the proposed expanded piggery at Bay of Topaz.

In addition there are suitable deepwater sites for small-scale finfish cage culture in Grande Passe but we are of the opinion that this area may be too exposed during cyclonic events. It may however be possible if fish are harvested before the beginning of the cyclone season and the cages removed for the duration of the season. A similar practise may have to be adopted at other sites as well.

Potential project interventions identified

The potential interventions are based purely on bio-technical considerations. We therefore recommend that applicants be requested to undertake an analysis of the market (and perhaps ReCoMaP could assist them) before any grants are made available. Undertaking any aquaculture intervention without a business plan that includes a market analysis is a fatal flaw.

We have split the potential interventions into those with high potential for implementation in the short term and those with future potential.

High potential

1. Monoculture of crabs in battery cages in mangroves.
2. Coral farming for the international aquarium trade (Site can be selected on the basis of the Lagoon GIS, which includes coral distribution data).
3. Pond-based milkfish farming using pig manure at the Bay of Topaz piggery (impact of possible consumer resistance on market to be assessed).
4. Small-scale grouper and siganid cage culture in the lee of Fregate Island.
5. Seaweed farming (North Bay, Oyster Bay).
6. Polyculture of crabs and fish (milkfish and mullet) in tidal ponds or enclosures in Oyster Bay, North Bay, Diamond Bay

Detailed technical guidelines for each of the potential interventions are not provided. Instead we briefly summarise some of the technologies. Juvenile or sub adult crabs and fish will be harvested from the wild. However, it would be necessary to assess recruitment patterns and variability to ensure sustainability. Juvenile crabs and fish can be caught in traps and or purchased from trap fishermen. Crabs are stocked individually in cage pens. Number of pens per cage = 20. Pen dimension = 35x35X 35cm. Cages can be made from local material (bamboo or other timber). Crabs are fed once a day (ca. 5-8% bodyweight per day) with trash fish or gastropods or farm made feeds. Fattening periods will vary depending on size at stocking. Crabs with initial weight of 150 to 300 g can be fattened up to 600g in 2-4 months. Alternatively crabs can be on-grown in ponds with refugia, to prevent cannibalism and damage caused by fighting (see literature in Crustacean folder and Crab farming in Madagascar). Juvenile fish are initially stocked into nursery ponds and reared to identifiable size and then stocked into ponds and or net pen enclosures. Ponds are fertilised to stimulate algal and lab-lab growth. Growth in ponds is faster than in non-fertilised enclosures. Tidal flushing will also result in recruitment of juvenile penaeid shrimp and hence another saleable commodity. Small scale grouper and siganid culture will also initially be dependent on wild caught juveniles. Grouper to be fed trashfish and siganids fed on seaweed. Detail provided in extension manual for small-scale cage farming (see Fish literature folder). Supporting Document 5 provides detailed information on the technical and economic aspects of seaweed farming (see also Tanzania report and Seaweed literature folder).

A piggery (belonging to the Dept. of Agriculture) at Bay of Topaz has been earmarked for expansion and it is intended to use part of the effluent to fertilise ponds for the production of koi carp. This is a nonsensical idea. Producing high value koi is technically demanding and requires expert knowledge. We are of the opinion that it would be more appropriate to produce milkfish in the proposed ponds. If the use of pig manure as fertilizer does not affect the market for the product then this is a project with high potential and creates linkages between stakeholders.

Further bio-technical requirements of the approved and potential interventions are summarised in the Survey data spreadsheet.

Possible future interventions (not in order of priority)

1. There may be potential for the farming of marine ornamental fish (see hatchery manual in Fish literature folder). However, the technical and hatchery investment requirements are high and in the absence of private sector participation this activity would not be suitable for community based mariculture. The establishment of a multipurpose, private sector fish hatchery on Rodrigues would open the field for small-scale out-growers.

2. Sea cucumbers are produced and ranched commercially in Madagascar and elsewhere (see Madagascar report and Sea Cucumber literature folder). The lagoon of Rodrigues seems ideally suited for beche de mer and is also identified as one of the alternative species in the seaweed feasibility study (Supporting Document 5). However, large scale ranching requires an efficient hatchery and technical capacity and the investment costs are high. Sea cucumber farming can only take place on Rodrigues once and if a private sector commercial hatchery is established. Depending on the success of the proposed commercial sea cucumber farming project, opportunities may arise for communities to participate in sea cucumber ranching. Sea cucumbers are stocked at a low density (4 juveniles / m²). This may in fact force commercial investors to seek community participation as the areas required for commercial farming are immense and if owned by a single company would unquestionably result in serious resource/user conflict.

3. Environmental conditions on Rodrigues seem ideally suited for conch farming. However, this would require a comprehensive economic feasibility study and the establishment of a high-tech hatchery, similar to those used for abalone farming in South Africa. At this stage it is on the distant horizon. In addition we are of the opinion that conch farming would initially have to be a private sector driven initiative before any form of community out-grower programmes could be considered.

Oyster culture is not recommended. The growth rate of *Saccostrea cuculatta* (that apparently did occur on Rodrigues), is too slow in tropical seas and may take 3-5 years before reaching market size. It is also not recommended to introduce a faster growing oyster species.

3.4 SWOT analysis for small scale mariculture on Rodrigues Island

The analysis presented below is based on the premise that mariculture on Rodrigues will only be adopted if the sector can be demonstrated to provide better and more sustainable incomes than from fishing.

Strengths

- Large lagoon (>200km²).
- Lagoon over-fishing and need for change.
- Good water quality.
- Critical need for alternative income and business opportunities.
- Regional Assembly supportive and eager to develop mariculture sector.
- Incentives and loans are available to initiate alternatives to in-lagoon fishing.
- Ecology of lagoon relatively well studied (University of Wales, Bangor and Shoals of Rodrigues).
- Multilayer GIS of lagoon available (School of Ocean Sciences, University of Wales, Bangor).

Weaknesses

- No defined mariculture zones.
- No mariculture infrastructure.
- Complete absence of mariculture technical and extension capacity.
- Low level of administrative and evaluation capacity for mariculture.
- No mariculture policy, legislation and development plan.
- Low level of education of fishers.
- Availability of freshwater.
- Having to change livelihoods focus from fishing to farming.
- Inadequate knowledge of bio-geochemical cycling in lagoon, e.g. nutrients (P and N), Chl-a, SS, TDS, DO, BOD, COD) and flushing rates.
- No apparent knowledge of pollutants in lagoon water e.g. pesticide & herbicide residuals, heavy metals, total and faecal coliforms.
- No institutional capacity in food testing.
- Cold chain logistics (possible weakness)
- Marketing opportunities and constraints of mariculture products on Rodrigues unknown.

Opportunities

- Harmonising mariculture development and integrated coastal zone management objectives from zero base.
- Alternative business opportunities.
- Job creation.
- Value adding.
- Developing a new sector from scratch.
- Establishing a multi-purpose PPP hatchery and mariculture development centre to drive the sector (future development).
- Educating school children in alternative uses of marine resources and environment.

Threats

- Cyclones and sea conditions.
- Inappropriate site selection.
- Uncontrolled development and environmental consequences (need monitoring and management control systems – sizes and lagoon carrying capacity).
- Property rights issues (consider establishing TURFs).
- User conflict with tourism, sand mining and fishing.
- Soil erosion and impact on water quality.
- Sewerage run-off and seepage.
- Unrealistic expectations.
- Jealousy resulting in theft and vandalism.

3.5 Research, monitoring and technology transfer needs

1. Formulation and testing of farm made feeds

Small-scale finfish cage culture is a feed based activity. It will be difficult for farmers to rely on trash fish as feed. Farm made feeds must be developed to sustain the activity. Research on the availability and nutrient composition of agricultural by-products and alternative marine resources is necessary to formulate and test various combinations for profitable farming of grouper in cages.

2. Water quality monitoring

Mariculture on Rodrigues will be lagoon based. A water quality monitoring programme must be set up to ensure biosafety of mariculture products as well as the environmental health of the lagoon. The number of stations and their locality would be determined by the FTRU. In particular it is necessary to monitor coliform bacteria (there are no sewerage treatment plants on Rodrigues), total N and total P, heavy metals and temperature.

3. Milkfish culture technology transfer

For milkfish culture to develop on Rodrigues there is a need for technology transfer from the Philippines. The most appropriate and cost effective method would be for expert volunteers to be seconded to the proposed milkfish/piggery project.

3.6 Conclusions and Recommendations

There is an urgent need for the various ICZM role players to cooperate with respect to the development of mariculture on the Island. Given the lack of administrative capacity in mariculture, failure to do so will result in uncoordinated development that may have serious environmental repercussions and also bedevil the development of the entire sector because of mixed messages.

Based on our rapid assessment the most logical small-scale mariculture interventions at this stage are crab culture, polyculture of crabs, milkfish and mullet (plus shrimp) in land based ponds (at the piggery) or enclosures, coral (hard and soft) culture, small-scale grouper and siganid cage culture and seaweed farming. All interventions are based on wild seed and could be rapidly implemented. The biggest constraint to implementation is the complete absence of any sort of mariculture capacity on the Island. Until this is available or imported to oversee implementation it would not be wise to initiate any of the potential interventions. ReCoMaP should liaise with other mariculture stakeholders on Rodrigues and develop a jointly funded training programme.

The proposed seaweed demonstration farm is probably the most appropriate concept to stimulate mariculture development on the Island, particularly since it will be developed as a self sustaining economic unit. Hence it will demonstrate the biotechnical feasibility of marine farming as well as the economic benefits. It is recommended that ReCoMaP makes contact with IFAD through Dr. Gary Morgan to explore how ReCoMaP can contribute towards this initiative, particularly with respect to capacity building. This may contribute towards the adoption of seaweed farming by other Island groups.

ReCoMaP should establish whether the Human Resource Development Council in Mauritius could facilitate capacity building in mariculture (aquatic business) administration and management or identify other institutions and then provide the necessary support to train at least one senior person within the Department of Fisheries.

In addition we recommend that bio-technical capacity in crab, fish and coral culture is developed at the Fisheries Research and Training Unit (FRTU). Once this is accomplished then ReCoMaP should support the development of a CBO based crab farming project. Furthermore, we recommend that ReCoMaP makes contact with the Department of Agriculture and provides the necessary support to develop a joint venture pond-based milkfish farm at Bay of Topaz. However, ReCoMaP must be assured that the necessary capacity is in place within the Department of Agriculture. An idea would be for the Dept. of Agriculture to approach Albion for a secondment to Rodrigues to set up the ponds, the required infrastructure and provide the necessary technical advice and training to Agriculture staff and CBO members during the set-up phase. If this can be set up then we would recommend that ReCoMaP provides the necessary support.

Without capacity and successful demonstration projects there is very little chance that mariculture initiatives on Rodrigues will succeed. Finally we would like to suggest that all stakeholders and or proponents of the sector tone down the hype with respect to mariculture on Rodrigues. At this stage it unjustifiably raises expectations that may not materialise. We further urge all stakeholders to liaise and work together. In the first instance we recommend that a workshop be held to plan the way forward and to define who does what, such that duplication and mixed messages are avoided.

3.7 Contact Persons

1. Mr Matadin – Assistant to Commissioner Grancourt (Organiser of mission)
2. Chief Commissioner: Mr Johnson Roussety
3. Mr F. Grancourt – Commissioner for the Environment.
4. Mr Singh P. Mattan – Departmental Head, Chief Commissioners Office and Acting Head Fisheries.
5. Mr G. Jabeemissar, Deputy Chief Commissioner of Education, Arts, & Culture, Museums, Historical Sites & Buildings, Consumer protection, Library Services and Vocational Training.
6. Mr Jean Rex Pierre Louis (Marine Protected Area Project)
7. Mr A. Ravanne – Training Instructor (FTRU)
8. Mr A. Jean Lindsay - Training Instructor (FRTU)
9. Officer in Charge (Agriculture Station, Bay of Topaz)
10. Head of Agriculture Department (Telephone interview re. Integrated pig cum fish project (Bay of Topaz)
11. Dr Gary Morgan (Fisheries Consultant to International Fund for Agricultural Development, garymorg@hotmail.com, 3 Edward Av. Crafers West, SA 5152, Australia, Tel: +61(0) 419 842273 mobile, +61 (08) 83393448)
12. Dr Neil Sati (Western Australia Department of Fisheries and TAFE and IFAD).
13. Mr Iain Watt – UNDP

4 TANZANIA

4.1 Introduction

In 2006, mariculture production in Tanzania accounted for approximately 8,065 tons of production. Seaweed farming accounted for the majority of this production (8,000 tons) followed by prawns (60 tons) and milkfish (5 tons). Negligible quantities of mud crab and pearl oysters were also produced. While the seaweed industry – although not without its problems – has reached a reasonable level of industrial maturity and is experiencing a countrywide roll-out (production increased from 1,500 tons in 2003 to 8,000 tons in 2006), all other sectors can best be described as at the developmental stages of production.

To date, mariculture development has largely been driven by donor support, identifying key issues and areas for development. USAid through its support of the Tanzanian Coastal Management Partnership (TCMP), the SUCCESS and current SEMMA programmes (operated by ADCI-VOCA), has and continues to play a major role in this regard. Other major role players include the WWF through its RuMaKi programme, and to a lesser extent WIOMSA, and the VSO that is working in Zanzibar. The GEF funded MASEMP project has the potential to make considerable input into sector development, and while it is providing some technical assistance to seaweed farmers in Zanzibar (through TASAF), it has yet to realise its potential. From an institutional perspective, the Fisheries Division (Ministry of Natural Resources and Tourism) has recognised the role that mariculture can play in alleviating coastal poverty, and in recent years, has expanded their Aquaculture Section. Institutional research, and in many cases pilot trials and extension work are being carried out by TAFIRI, the IMS and FAST. With respect to the institutional research that is being undertaken, it is fair to say that it is appropriately developmental orientated but constrained by a poor funding environment, and to a lesser extent, and only in some cases, by a lack of capacity.

The involvement of so many NGOs and institutions running different programmes has inevitably led to the sector being developed in an *ad hoc* fashion that in some cases has led to a duplication of effort and the sending of mixed messages to the recipient farmers. Nevertheless, in general both government and NGOs alike recognise the need for a more structured approach to mariculture development, and in this regard a strategic framework for sustainable aquaculture development is under development – essentially this will be a masterplan for the development of the sector that can be adopted by the Fisheries Division as policy, and guide future interventions. The masterplan should include the following:

- Developing actionable strategies for sector development.
- Defining institutional roles (governmental, research institutes, NGOs).
- Identifying development programmes (R&D requirements, extension and commercialisation).
- Reviews of policy and legislation.

4.2 Legislation, administration and facilitation

Mariculture in Tanzania falls under the jurisdiction of the Fisheries Act (2003, Supporting Document 8) and the Fisheries Regulations (2005, Supporting Document 11). The Fisheries Act (2003) broadly outlines the regulatory framework within which aquaculture can be developed. In contrast and as would be expected, the Fisheries Regulations (2005) are more specific and identify permit requirements, the translocation of exotic species, and other sector-specific regulations to control farming operations. As far as

regulations are concerned, they are relatively formulaic and cover the basic issues that are usually found in such legislation. What is however missing is the policy, and while it is true to say that the personnel at the Aquaculture Section (Fisheries Division, Ms R. Malay, *pers. com*) are development orientated, to date there is little actionable policy. In 2000, a National Fisheries Sector Policy and Strategy Statement was produced (Supporting Document 9). It outlines a number of basic strategies and policies to develop the sector, but falls short of the actionable interventions that would be included in a masterplan. While the Fisheries Division see a need for a masterplan and with the help of the FAO are developing a technical framework for aquaculture development (see above), no documentation has been released, and the framework is currently being workshopped. The document will be based on the strategic framework for sustainable aquaculture that was developed for the Cameroon (Dr B. Natunga, *pers. com.*, TAFIRI, Supporting Document 10).

With respect to the administrative facilitation for mariculture development, the Fisheries Division is the responsible government agency for issuing permits. A proposal / business plan is developed and submitted with the relevant permit application (Supporting Document 11) to the Fisheries Division for technical assessment. The Fisheries Division sends the details to the National Environmental Management Council (NEMC) for the EIA, and if approved, the proposal goes to the Tanzanian Investment Centre (TIC) to assist in the funding (if required). If approved, the Fisheries Division provides a permit. Permitting only applies to commercial operations and not to small scale subsistence operators. Subsistence operators consult their District Fisheries Officer who provides a permit, registers the activity, and monitors the project. To facilitate the process, Tanzanian Mariculture Guidelines Source Book (TCMP, 2001, Supporting Document 13) has been developed. The guidelines outline issues pertaining to site and species selection, environmental impact procedures, land acquisition, water rights issues, and project review and approval procedures. With respect to potential investors, the document outlines the current regulatory environment and the statutory requirements that must be met to enter the sector. The manual has been prepared by the Tanzanian Coastal Management Partnership (TCMP) through its Mariculture Working Group (MWG).

The facilitation and extension networks that are available to the sector are available from within government, the research institutions and NGOs. The Aquaculture Section of the Fisheries Division now has seven employees - a significant improvement on 2004 levels, and while there are still some capacity concerns, the increased resources demonstrate a governmental commitment to the sector. On the extension side, there are 15 government funded extension posts (Ms R. Malay, *per. com*), and while they require some training themselves, many have been, or are currently being, trained by ADCI-VOCA (NGO – USAid funding). With respect to government funded research institutions, TAFIRI has an aquaculture section, and is in a position to advise the Fisheries Division on technical matters. Nevertheless at present, the government institutions are under resourced and are not in a position to monitor aquaculture activities – particularly with respect to the environmental impacts accruing to developments - and thus at present, issues of compliance with permit regulations are likely to be unenforceable.

Tanzania has an active NGO community that has in many respects been the driving force behind much of the country's mariculture development. Current NGOs active in the field include:

- ACIDI-VOCA – (USAid – SEMMA programme). Based in Tanga, they are developing crab fattening and milkfish production and providing support for seaweed extension. They have developed extensive extension capabilities that have been used to train government extension officers and other NGOs.

- WWF – RuMaKi programme. The programme focuses on Rufigi, Mtwara and Kilwa provinces. Developments focus on crab fattening, milkfish farming, pearl oysters, and in the past rabbit fish (ceased operations due to theft and unprofitability).
- TCMP – Based in Dar es Salaam, the TCMP is involved in providing assistance to the seaweed industry.
- VSO – Based in Zanzibar. Involved in seaweed extension activities.

4.3 Summary of mariculture activities and production

Current mariculture production is based on five sectors, viz:

Seaweed (*Spinosum* and *Cottonii* strains) – Seaweed farming is the dominant mariculture activity. It can be cultured throughout all coastal provinces, and in 2006, production reached 8,000 tons. On the mainland, production is based on buyers contracting at the village level. “Developers” provide the farming materials and extension services and purchase the product at a fixed price (currently between US\$0.11 - 0.18 / kg). Typically, “Developer” / Village contracts are for a five year period, and during this period, the farmers have to sell to the “Developer” and are not able to sell to other buyers. In contrast in Zanzibar, there has been a certain degree of deregulation that has allowed farmers to sell product on the open market – this has resulted in a discontinuation of some of the “developers” to provide farming materials and extension services which has in turn, resulted in local declines in production. With the aid of government, NGOs and Industry stakeholders, a Seaweed Development Strategic Plan has been formulated (Supporting Document 4). It outlines the issues facing the industry and provides strategies to overcome constraints. It is evident that it has been widely accepted, and ReCoMap would be well advised to take cognisance of this document when developing interventions in this sector.

Milkfish (*Chanos chanos*) – Milkfish farming is at the developmental stage of production, and in 2006, less than 5 tons were produced (current market price US\$1.6 / kg; fish are usually marketed at 500-750g). Commercial production is currently underway at the Kirago milkfish farm (Mkuranga) and the Regent Enterprise Farm (Bagamoyo). Current farming models are semi-extensive / extensive using 1ha ponds stocked at a rate of 3-5 fish per m². Fingerlings are sourced from the wild and feeding is normally via natural pond productivity (lab-lab), or in some cases supplemented with farm made feeds.

Mudcrab (*Scylla serrata*) - small scale mud crab fattening is at the developmental stage of production. Developmental projects are being undertaken by various NGOs in Tanga, Rufiji, Mafia and Kilwa. Juvenile mud crabs of approximalty 300-500g are collected from the wild, placed in intertidal holding pens and grown to 700-1kg for marketing (market value: US\$2-4 local market; US\$6-10 FOB). To date, projects have developed in an *ad hoc* manner and with the notable exception of the ADCI-VOCA project running in Tanga have not been accompanied by resource assessments, and value chain analyses. Generating sufficient economies of scale to warrant production, feed supply and the potential to exhaust the supply of seed stock are the major issues that could limit the development of the sector.

Pearl Farming (*Pinctada Margaritefera*, *Pinctada penguin*) – Half pearl farming has been pioneered by the WWF in Mafia Island (RuMaKi Programme). To date, approximalty 1,000 half pearls have been produced. Current prices range from US\$5-10 per piece and are targeted at the tourist markets. The ISM recently initiated a programme to develop half pearl culture on Zanzibar, but to date, no pearls have been produced. The major constraint to both projects is the supply of wild spat for grow-out and seeding.

The WWF indicate that while they are considering extending their programme to Kilwa, they are also considering developing a hatchery on Mafia Island to resolve the spat supply issue (estimated cost US\$100,000, Jason Ruben *pers.com*). Potentially this could supply the region with spat. There are however concerns about the size of the local tourist market, the quality of the pearls with respect to penetrating the international markets, and the potential to develop high quality whole pearl culture (see Kenya summary report).

Prawns (*Penaeus monodon*) – Tanpesca Ltd operates the only commercial scale prawn farm (Mafia Island). Although it was not visited during the current assignment, it was estimated to produce in the region of 160 tons per annum. In addition Prawnto Ltd. operates a small broodstock holding facility that is used to export disease free (not certified) broodstock to India. There is the potential to expand the commercial prawn farming industry, and to introduce small scale low density prawn farming to the region (based on low intensity farming techniques developed for the Indian subcontinent).

Potential interventions identified by project

Potential interventions are either based on discussions with potential applicants for ReCoMap funding (in which case they are included in the Survey matrix), or alternatively are based on bio-technical considerations. The principle species interventions that were identified include the following:

- Milkfish and milkfish polyculture (shrimps, mullet, tilapia)
- Mud Crab
- Pearl oyster
- Finfish – grouper
- Aquarium fish
- Coral culture
- Sea cucumber culture
- Small scale prawn culture
- Artemia cyst production
- Seaweed

Milkfish and milkfish polyculture (shrimps, mullet and tilapia)

There are opportunities for farming on the salt-flats behind the primary mangrove forests, and it is estimated that 10,000 ha of suitable habitat is available (Dr A. Mmochi, *pers.com*). To date, demonstration ponds are being constructed in Tanga, Bagamoyo, Zanzibar, Mafia, Rufiji, Kilwa and Mtwara (possibly in Lindi and the Central Region). There is considerable scope for ReCoMap to assist in the roll-out of the sector, particularly with respect to the policy, institutional, technical and extension constraints that are currently constraining the development of the sector. In addition, there is the possibility of developing polyculture systems with either shrimps, mullet or tilapia.

Mud Crab

There is scope to assist in the roll-out of crab fattening operations – particularly in the Rufiji delta area that is likely to have the largest standing stock of crabs. There is a need for sector guidelines, financial feasibility and production studies, trash fish supply and the development of farm-made feeds studies, and stock assessment studies. ReCoMap could consider allocating resources into any of these areas.

Pearl oyster

The pearl oyster culture industry is in its infancy in Tanzania. While the technical capacity to develop half pearls has been transferred to the country, there are still concerns about

the long term economic viability of the operations, marketing and spat supply. Potentially, ReCoMap could become involved in resolving these issues. In addition, the development of high value pearls could be considered; however, it is likely that this will require significant foreign donor support (See Kenya / Seychelles country reports).

Finfish – grouper (serranid species) cage culture

The development of grouper culture in small cages is a possibility. The technology for developing both small scale hatcheries and cage culture is available (see species literature). It should however be noted that currently, there are no marine finfish cage farming operations in Tanzania, and as such, an intervention should be considered as a technology transfer. In the first instance, grouper juveniles could be collected from the wild (mangroves) and grown-out in small cages. While this approach would preclude the need to develop a hatchery, there would be a need to undertake a stock assessment to establish the sustainability of removing juveniles from the wild. Nevertheless, such an intervention will require significant technical experience. Thus, in addition to a financial analysis, the technical and extension capabilities of the project proponent should be heavily scrutinised.

Aquarium trade fish

Tanzania has extensive coral reef systems that could provide broodstock for the production of high value aquarium fish for export. At the outset, it should be noted that there is no history of such activities in Tanzania. The technical nature of the operations and the need for an in-depth understanding of the dynamics of the global aquarium fish trade indicates that only a project that includes an experienced private sector operator should be considered.

Coral culture

The economic potential for coral culture needs to be established. FAST is currently investigating coral culture in Mafia (FAST could not be visited during the rapid assessment to discuss the progress). While the technical capacity at FAST needs to be assessed, it could prove a suitable technology partner.

Sea cucumber culture

Tanzania has large areas of lagoon area that could potentially be used to ranch sea cucumbers. Unconfirmed reports suggest that the sea cucumber stocks are depleted; however no stock assessment appears to have been undertaken to confirm this. As a first step a stock assessment and an assessment of potential culture sites needs to be undertaken. This should be followed by a business planning exercise. Assuming that there is scope for development, the ISM (Tulear in Madagascar) could be approached to provide the technology. A private partner should be sought to implement the hatchery component of the project.

Small scale prawn culture

Small scale prawn culture could be supported by the ReCoMap project, brief discussions with Prawnto Ltd (Mr Glen Bieber), suggest that they are considering introducing low density prawn culture technology from the Indian subcontinent. It should be noted that small scale prawn culture is a difficult activity to develop, and ReCoMap should view an intervention into this sector with caution. In this regard, it is vital that technical and economic viability studies are undertaken. Importantly, it must be demonstrated that there is “buy-in” for the development at the Governmental / administrative levels. Alternatively, some form of low-intensity polyculture with the milkfish farms could be investigated.

Artemia cyst production

There is significant scope for artemia production in the extensive salt pans along the coast. A similar intervention has been proposed for Kenya, and the developmental issues that apply to Kenya also apply to Tanzania (see Kenya country report).

Seaweed

There is considerable scope for ReCoMap to assist in the development of this sector. The Seaweed Development Strategic Plan (Supporting Document 4) provides a blueprint of the issues facing the industry, and every effort should be made to ensure that interventions follow the plan. Major issues include improving farming technology, farmer dependency and access to micro-finance, extension, marketing, post harvest treatment and quality, and environmental protection. Of particular import is the development of a value chain analysis to assess marketing issues and generate a better understanding of the supply chain. In this regard, ACIDI-VOCA and the University of Colombia (US) are interested in developing a project of this nature that could be considered. Note: other role players such as the TCMP and MACEMP have indicated their intention to undertake this work, but to date no progress has been made.

4.4 SWOT analysis for small scale mariculture interventions

Strengths

- High quality seawater.
- Research support capacity at TAFIRI, IMS and FAST.
- Fisheries Division – Aquaculture Section are keen to support the development of the sector.
- Large areas of intertidal lagoon and mud flats that are suitable for seaweed farming and pond culture respectively.
- High number of potential candidate species.
- Presence of established NGOs with mariculture experience.

Weaknesses

- Lack of a strategic aquaculture plan (Sector Development Plan).
- Extension capacity at the Fisheries Division – Aquaculture Section.
- Absence of fin-fish culture capacity, and hatchery facilities.
- Lack of private sector involvement in the sector (the exception being the prawn and seaweed industries).
- Lack of environmental monitoring facilities and procedures.
- Poor understanding of farm-made feeds.

Opportunities

- Development of species specific guidelines.
- Development of demonstration projects and improved extension networks.
- Potential diversification into novel species.
- Greater NGO involvement.
- Providing support to develop a sector plan.

Threats

- Poor environmental management oversight.
- Potential overexploitation and unsustainable harvesting of juveniles for culture.
- Governance constraints.
- Theft and vandalism.

4.5 Recommendations

1. Support and elicit proposals from the existing NGOs that have been instrumental in Tanzania's mariculture development. These include the TCMP, WIOMSA, WWF, VSO and ADCI-VOCA. With respect to individual support the TCMP and WIOMSA focus more on the strategic / policy issues. ADCI-VOCA is arguably the most extension orientated of the NGOs and has developed close ties with the Fisheries Division, training many of their extension workers. ADCI-VOCA is doing excellent extension work (especially in the seaweed and mudcrab field), and is in many respects the leader in the extension field. However, it is currently severely under-funded. It is likely that ReCoMap funding to ADCI-VOCA projects would pay dividends.

2. The GEF / MACEMP programme is the overarching development programme in operation. The programme will be focusing on mariculture issues; however, to date they have not decided which avenues to pursue. To prevent duplication of efforts, it would be advisable to tie in interventions with their programme. Note: MACEMP have indicated that they plan to address many of the mariculture issues outlined in this report. To date, delivery has been slow, and there is a general consensus within the NGO community that the programme is not sufficiently focused on mariculture issues.

3. Support the Mariculture Section of TAFIRI. TAFIRI is development orientated, and their mariculture section although small, is undertaking demonstration projects. However, it is clearly under-funded. With appropriate funding, TAFIRI could play a much greater role in mariculture development, and most notably, provide technical advice to the Fisheries Division (Aquaculture Section), and provide support services such as assisting in the long term water quality monitoring of aquaculture installations.

4. Provide assistance to the research community. The research community (IMS and FAST) is involved in both technology development and transfer. While FAST was not visited during the current assessment, the IMS is doing some excellent milkfish research under what appears to be a relatively difficult funding paradigm. In particular, a major constraint to finfish culture is the absence of experimental culture facilities.

4.6 Supporting research, monitoring and technology transfer needs

1. Stock assessment and recruitment variability of mud crab

The seed stock required to operate the nascent crab fattening industry is derived from wild stocks. To ensure the long term sustainability of the activity it will be necessary to assess the current status of the stocks as well as recruitment variability. ADCI-VOCA has undertaken a stock assessment in Tanga region (Supporting Document 3), however, further stock assessments are required in the other regions.

2. Abundance and temporal recruitment of juvenile grouper in mangrove forests

As with mudcrab, small-scale cage grouper culture will also rely on wild caught juveniles. For sustainable small-scale cage culture it is necessary to establish whether adequate numbers of juvenile grouper recruit into mangrove swamps, their seasonal recruitment patterns and variability.

3. Formulation and testing of farm made feeds

Mudcrab as well as finfish cage culture are feed based practices. As the sectors grow it is unlikely that there will be enough trash fish for feed – this is already an issue for the crab fattening operations in Tanga, and is likely to be the case for other regions. Farm made feeds must therefore be developed to sustain the farming activities. Research on the availability and nutrient composition of agricultural by-products and alternative marine resources is necessary to formulate and test various combinations for profitable farming.

4. Water quality monitoring

A water quality monitoring programme should be set up along the coast of Tanzania to ensure biosafety of mariculture products, the number of stations and their locality to be determined by TAFIRI. In particular it is necessary to monitor coliform bacteria, total N and total P, heavy metals and sea surface temperatures.

4.7 Contact persons

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5 KENYA

5.1 Introduction

Mariculture in Kenya is under-developed and in comparison to freshwater aquaculture is an insignificant activity. Total estimated freshwater aquaculture production in 2003 was 1012 tonnes (Supporting Document 28, Table 3), while the contribution by mariculture in 2006 was less than 2 tonnes (KMFRI and DoF personnel, pers.comm.). The National Aquaculture Sector Overview (Supporting Document 29) makes no mention of mariculture, suggesting further that mariculture does not receive the attention it should. Moreover, in contrast to freshwater aquaculture, there have been no previous bi-lateral support programmes for mariculture development. Despite a substantial research drive by KMFRI, past and present mariculture initiatives have been mainly driven by NGOs that focus on various aspects of ICZM including Coral Reef and Mangrove Conservation and the Coast Development Authority.

Moreover, the mariculture sector is largely un-coordinated and all past and present projects are, at best, *ad hoc* developments. However, and most importantly, the potential for mariculture in Kenya is substantial and the key statutory role players are cognisant of its potential and are committed to its development. To realise the full potential of the sector from a broader perspective, there are several fundamentals that should be put in place. These are:

1. Developing a mariculture sector plan (which should form part of a wider Aquaculture Masterplan for the country).
2. Clearly defining the function and role of the key statutory role players and NGOs. Amongst others, these include the Department of Fisheries (DoF), Kenya Marine Fisheries Research Institute (KMFRI), Coast Development Authority (CDA), Department of Forestry, National Environmental Management Authority (NEMA), Parks and Wildlife etc. The DoF, CDA and KMFRI have previously tried or are trying to play a development role to a greater or lesser extent, without substantial impact.
3. Upgrading the facilities and capacity of the mariculture sector at the Kwetu Training Centre for Sustainable Development.
4. Coordinating the current initiatives with a greater focus on key development areas.
5. Zoning of the coast for specific activities, including mariculture. The outputs of the KenSea project (Supporting Document 11, and see maps in Supporting Document 19) provide the platform upon which coastal zoning can be undertaken. Several sections of the coast (see below) have enormous potential that could support the profitable farming of several species. However without some measure of security of tenure from Hotel strip development this potential will not be reached.

To establish and develop large-scale mariculture in Kenya, coastal zoning is a key prerequisite. In addition the DoF, in collaboration with other key role players, would have to be proactive and compile a packaged investment profile in collaboration with the Kenya Investment Bureau.

Without these fundamentals mariculture in Kenya will not and can not reach its full potential for alternative income generating opportunities, poverty alleviation, improving food security, and wealth and job creation. It is of interest to note also that mariculture is not mentioned in the Poverty Reduction Strategy Paper (Supporting Document 6).

There is however a lot of potential for the state actors (DoF, KMFRI and the CDA) to play a more effective and positive support-role in mariculture development. And this process is to a certain extent already underway with KMFRI, for example, contributing significantly towards the establishment of a knowledge base through research and the Department of Forestry plays an important supportive role in developing silviculture.

This summary report is based on a rapid assessment of the structure and was undertaken during the period 20-29 August 2007. It is therefore by no means comprehensive but attempts to put the current structure, opportunities and needs of the sector into some sort of perspective. Discussions were held with many people (see list at end of the report). The enthusiasm shown by all for the development of the sector was remarkable and illustrates the political will that exists in the Coast Province to put the sector on the map. I sincerely thank all who assisted me during the assessment.

5.2 Legislation, administration and facilitation

The Public Sector

Aquaculture in Kenya falls under the jurisdiction of the Fisheries Act of 1991 (Supporting Document 1). As is universally common, fisheries legislation is geared more towards control than development. The Fisheries Policy is currently being revised. Chapter 8 of the draft policy deals with issues pertaining to the development of mariculture in the coastal zone and these are highlighted in red (Supporting Document 2). The suggested amendments and changes are welcome additions. What is lacking from the policy document (in its current form) is a clear statement of intent by Government to tangibly commit itself to the development of the sector.

The over-arching legislation is the Environmental Management Act of 1999 (Supporting Document 9), as administered by the National Environmental Management Authority (NEMA) and silviculture is controlled largely by the Forests Act of 2005 (Supporting Document 30). The Forestry Department is very supportive of sustainable and environmentally responsible mariculture initiatives in mangrove forests. Other Acts that impact on mariculture are the Local Authority and Planning Act (for land based operations), the Water Act (abstraction of water and water quality standards), the Maritime Authority Act and the Kenya Ports Authority Act (for seabased mariculture activities)

The Department of Fisheries is mandated by the Fisheries Act to manage and administer the mariculture sector and the responsibility of KMFRI is to provide research based decision support (Drs. Johnson Kazungu and Renison Ruwa, KMFRI, *pers.comm.*). KMFRI has impressive aquaculture capacity (see spreadsheet). It is difficult to tease apart the delegated and respective roles of the CDA and the Department of Fisheries with respect to mariculture development. Basically the DoF does not have an express directive for mariculture development, while the CDA (see Supporting Document 18) has a mandate to “develop the wise use of the unique coastal resources of Kenya”. Hence to a certain extent mariculture falls into the proverbial legislative cracks, whereby no single department or authority is expressly delegated to develop the sector. This needs to be rectified. The CDA has made substantial contributions to mariculture development and has the necessary networks to facilitate applications and to make the necessary recommendations to relevant departments for assistance. The CDA has also supported small scale mariculture initiatives and as with Kwetu (see below) also provides extension and management advice. CDA currently has one Fisheries (Aquaculture) Officer and is in the process of appointing a second fisheries person.

Apart from the mariculture research facilities of KMFRI there are no government-supported demonstration facilities, such as those that exist for freshwater aquaculture

(e.g. Sagana Fish Farm) and/or agriculture. This is a major shortcoming. The only available farmer-oriented demonstration facilities (although rather limited) are those at Kwetu (see below). It is important to note that the facilities at KMFRI are research facilities and hence are not currently appropriate for farmer demonstration.

A permit is required to undertake mariculture and this is issued by the DoF. Theoretically the DoF acts as a one-stop shop, but it was suggested that it is far better to walk it through the various structures by oneself in a bottom-up manner - local community, district and then through departmental structures. According to the Environmental Management Act an Environmental Impact Assessment (EIA) is required for small and large-scale aquaculture operations. It would be appropriate to amend the Act such that projects below a certain size are granted an exemption from the provisions of the Act. This would facilitate development.

Apparently there is no active and continuous marine water quality monitoring programme. If this is indeed the case then KMFRI should initiate such a programme as part of their core function to facilitate larger scale mariculture development.

As far as could be ascertained there has been no previous bi-lateral support for mariculture development in Kenya and this is regrettable. By way of comparison, the sector in Tanzania is much further down the road and this is largely due to the various forms of bi-lateral support.

The NGO Sector

It is important to note that there is no single NGO that focuses solely on mariculture development in Kenya.. However, there are several NGOs in the field of marine conservation, education, health and alternative livelihoods and some of these are:

- Coastal Oceans Research and Development -Indian Ocean (CORDIO);
- Coral Reef Conservation Project;
- Ecoethics (Kenya Chapter);
- WWF;
- Kwetu Training Centre for Sustainable Development.

Fortunately the Kwetu Training Centre for Sustainable Development has recognised the value of mariculture as an alternative income generating activity (Supporting Document 17), within its wider sphere of community development, health and training objectives and projects. The Centre has one aquaculture development officer and two aquaculture assistants. Despite limited resources Kwetu's impact on small scale mariculture development has been astounding and also illustrates how receptive local communities are towards the opportunities provided by the sector. However, inadequate support has constrained progress (see Supporting Document 22). Kwetu is of the opinion that they could have achieved more with appropriate funding and having seen their achievements this consultant supports that opinion. CORDIO has been Kwetu's staunchest supporter in these initiatives in Kenya. Kwetu is interesting in that it provides a full package in terms of project management, extension and M&E and has good working relationships and links with all statutory stakeholders, NGO's, CBO's, individual farmers, farmer groups and associations as well as with the Institute of Marine Science in Zanzibar. It also hosts the Secretariat for Community Mariculture Development and the Coast Silviculture Forum. It is not known how active these wider CBOs are but they exist and Kwetu is championing their cause. Moreover, through lobbying hotel groups Kwetu has managed to raise the price for farmed crabs from KShs 100 to 350 / kg. Kwetu's other activities within the sphere of sustainable development include bee-keeping, organic farming, small scale agricultural product development and marketing.

5.3 Summary of mariculture activities

The summary provided below was developed on the basis of discussions with senior aquaculture personnel in DoF, KMFRI, CDA and Kwetu and on the information provided in Supporting Documents 3 and 22.

Crab and fish polyculture are the only current operational community based mariculture activities. Despite eight years of intervention mainly by CDA and more recently by Kwetu the sector is still far from self sustaining because of technical and financial constraints. Small-scale mariculture and ecotourism operations fail because of a lack of start-up capital and resources but mainly because of inadequate business management capacity. It is estimated that some 500 to 750 crabs were fattened in cages and sold in 2006/7. We are of the opinion that with appropriate and adequate support, crab fattening can grow into a relatively large endeavour along the coast. We were not able to estimate the quantity of fish produced in ponds but it would be safe to say that the total did not exceed 250 kg. Private sector prawn farming has been re-started at Ngomeni and 300 kg prawns and 400 kg of Tilapia were sold in 2006.

Approved and proposed interventions

There are no currently approved and/or proposed commercial mariculture projects.

Site selection

Time constraints did not permit a detailed assessment of sites. As mentioned elsewhere, proper site selection criteria are rigorous and site selection requires substantial bio-physical information.

Based on discussions with senior scientists at KMFRI and senior officers at DoF and limited field work, three main areas were identified for mariculture development:

1. The section of the coast northwards of the Malindi “hotel strip development line”, and inclusive of the mangrove forests of the major estuaries for silviculture to the Kenya/Somali border (prawn culture, finfish cage culture, pearl culture, coral culture, marine ornamentals, giant clam {depending on species and colouration} and sea cucumbers). Seasonal floods could be a problem in the larger estuaries of the Lamu and Tana rivers.
2. The section of the coast southwards of the southern Mombasa “hotel strip development line” , and inclusive of the mangrove forests for silviculture to the Kenya / Tanzania border (prawn culture, finfish cage culture, pearl culture, Artemia, coral culture, marine ornamentals, giant clam, sea cucumbers).
3. The upper areas of the creeks between Mombasa and Malindi (crab, fish and prawn culture, small scale cage culture of grouper and snapper).

Specific sites within these areas must be identified and assessed according to established criteria.

Given existing user conflicts it would be most appropriate to establish multiple user zones along the coast between Mombasa and Malindi such that more equitable access to the coast is assured for fishermen and future aquaculturists. In the absence of legislated multi-user zones it would be too risky for small, medium or large scale operations to invest in mariculture between Mombasa and Malindi. The number of coastal properties for sale along the coast from Mombasa to Malindi is indicative of the pace of land privatisation and development of the tourism sector. This has already led to user conflicts because access to the coast and fish landing sites has been blocked (Dr M. Mukira, Ass. Director, DoF, Mombasa, pers.comm. and Supporting Document 20).

During all discussions the potential conflict between tourism and mariculture was highlighted. This issue must be addressed and resolved by NEMA and the DoF.

Kenya has four National Marine Parks and six National Marine Reserves (see Supporting Document 15). The National Marine Parks are no-take zones (which by implication would also exclude their use for mariculture). The National Marine Reserves on the other hand are multiple user reserves in which environmentally sustainable aquaculture is permitted, e.g. Dabaso Mangroves.

The DoF has undertaken a survey of previous interventions on the south coast (Kwale district) (Supporting Document 3). The evidence from this survey suggests only very limited success and reflecting the absence of sustained extension and management capacity. It was not possible to visit these sites to assess their suitability and this should be done before any interventions are supported in the area.

An assessment of potential prawn farming sites was undertaken in 1986 but these findings are largely no longer applicable (see Supporting Document 32) and a new assessment would have to be undertaken. Based on soil types, most of the suitable areas are in the Kilifi and Kwale districts. Small scale prawn farming is not a viable option. For full report go to www.fao.org/docrep/field/003/AC574E/AC574E00.htm

Potential interventions identified

Several possible mariculture interventions have been identified and defined for Kenya. The interventions that could be supported immediately are detailed in the Kenya Survey spreadsheet and these are:

- Bottom-cage crab (*Scylla serrata*) farming
- Pond based polyculture of milkfish, mullet (and shrimp as a by-product)
- Coral farming
- Small scale grouper (various serranid species) and snapper (*Lutjanus argentimaculatus*) cage culture.

There are several other bio-technically feasible small and large scale opportunities but because of several constraints or the need for private sector capital and/or high level capacity are not detailed in the spreadsheet. These include: Community-based prawn farming, Artemia cyst and biomass production in salt works, freshwater/brackishwater fish production in the coastal zone, seaweed farming, pearl farming, ornamental fish farming as well as large-scale farming of cobia or yellowtail (*Seriola* sp).

Community based prawn farming

Extensive prawn farming in small ponds is not feasible. The only opportunity for community-based prawn farming is at the Ngomeni prawn farm (north of Malindi). However the land tenure situation at Ngomeni is anomalous and needs to be resolved before community based prawn farming could be considered. Apparently a part of the prawn farm was built on private land, which amongst other reasons, contributed to the collapse of the farm in 1985. The land owner has now refurbished two ponds, which he has been farming since 2006. Until now the land ownership issue was not entirely known to the Department. Several ponds theoretically belong to the Department of Fisheries, which in future could be leased to the local community, at a nominal rent. The community would simply have to copy the activities as practised by their neighbour and to whom they could also sell their product (hence circumventing the need to develop their own market).

Sea cucumber

Kenya has vast tracts of lagoons in which sea cucumber could be ranched, but suitability for ranching must first be assessed. Moreover, in the absence of data on the beche du mer fishery we cannot decide whether sea cucumber is a good option at this time or not. If it is then the technology for seed production can be imported from Madagascar.

Artemia cyst and biomass production

There are 6 large-scale salt works on the coast of Kenya, with a total area of 3750 ha.

- | | |
|---------------------|--------|
| 1. Mombasa salt | 800 ha |
| 2. KenSalt | 800 ha |
| 3. Malindi Salt | 500 ha |
| 4. Crystalline salt | 800 ha |
| 5. Korawa salt | 450 ha |
| 6. Kemu salt | 400 ha |

These operations offer substantial opportunity for harvesting *Artemia* cysts and biomass, but would require a full economic assessment in the light of cyst quality, hatchability, fatty acid content particularly DHA and EPA, and appropriate technologies would have to be developed by KMFRI and DoF. Both institutions in Mombasa have expertise in *Artemia* biology and cyst production (Dr Betty Nyonye (KMFRI) and Charles Gatune in DoF). Further expert advice can be obtained from Professor Patrick Sorgeloos (*Artemia* Reference Centre, Gent University, Belgium) who is the acknowledged world expert on *Artemia* and also on small-scale cyst production, harvesting and marketing.

Freshwater fish farming in the coastal zone

The demand for fish along the coast is extremely high such that there are opportunities for developing Tilapia and catfish farms. The price of Tilapia (KShs 350/kg) is higher than marine fish (KShs 200/kg) and the price of catfish (*Clarias gariepinus*) is higher than that of Tilapia (DoF and CDA pers.comm.). Considerable volumes of Tilapia and catfish are imported to Mombasa from inland. Culture technologies for Tilapia and catfish are well established in Kenya (see Regional review of Aquaculture in Sub Saharan Africa in Fish literature folder).

Tilapia farming in ponds is a simple exercise. However, experience elsewhere in Africa has shown that small-scale farmers are severely constrained by poor fingerling quality (stunting). Fortunately the Bamburi Fish Farm (formerly Baobab) in Haller Park in Mombasa (though no longer a commercial undertaking) still maintains an *Oreochromis niloticus* broodstock and could, if required, be a source of fingerlings for small-scale farmers. The CDA Fisheries Officer (Ms Agness Mkazalla) is currently assessing the feasibility of small-scale tilapia farming using fingerlings obtained from Bamburi.

Clarias production requires a hatchery for fingerling production. Appropriate hatcheries have been developed in Kenya, which now produce over 1 million fingerlings per year. Several of the Fisheries and Research Officers in the Department of Fisheries, KMFRI and CDA in Mombasa have the necessary experience and background to develop and set up a catfish hatchery.

Seaweed farming

There are conflicting views on the potential for seaweed farming in Kenya. On the basis of their experimental results at three sites on the south coast of Kenya, Wakibia et al (Supporting Document 25) concluded that the Kenya coast has good potential for seaweed (*Eucaema* spp) farming. Subsequent commercial trials by a private company (SeaHarvest) at Shimoni, Bondo & Funzi Island Gazi Bay, using *Eucaema denticulatum* introduced from Pemba (Tanzania), were a complete failure. It has been suggested that this was partially due to unfavourable environmental conditions (except for Gazi Bay), high rates of predation on a new food resource by rabbit fish and sea urchins,

inadequate planning, training and inappropriate community involvement (see Supporting Document 3).

For several reasons we are hesitant to recommend seaweed farming as a possible intervention on the Kenya coast. The natural northward distribution of *E. denticulatum* ends along the Kenya south coast (Supporting Document 3), where its occurrence is patchy. The previous SeaHarvest intervention was based on seed imported from Pemba in Tanzania and the KMFRI trials were based on material introduced from Zanzibar that originally came from Bohol in the Philippines. The possible long-term ecological consequences of developing permanent, large scale farming of *E. denticulatum* using seed introduced from Pemba Island and/or Zanzibar (ex Philippines) needs to be evaluated such that it is pursuant with the Code of Conduct for Responsible Fisheries, the Convention on Biological Diversity, the Nairobi Declaration (see Supporting Document 27) as well as the national legislation on species translocations. Until this is resolved it would be unbecoming of ReCoMaP to support seaweed farming in Kenya. We suggest that ReCoMaP puts this matter to and seeks advice from NEMA, KMFRI and DoF. If the introduction of seaweed seedstock were to be approved by NEMA then it would be wise to re-assess the potential of seaweed farming in Gazi Bay and perhaps further south.

Pearl culture

The coast north of Malindi provides excellent opportunities for pearl culture. However, because of costs (e.g. grafting) this would have to be a private business, unless linked to small-scale outgrowers.

Coast Province Hatchery

We recommend that a multipurpose marine hatchery be established in Mombasa. The establishment of such a hatchery would provide the required impetus and stability to boost finfish farming along the coast. Without a national facility finfish aquaculture along the coast will remain at the micro / small scale level. Sagana has been one of the few examples of a successful demonstration fish farm in sub-Saharan Africa. If the proposed Mombasa hatchery is developed using the same approach it would boost community based and private fish farming along the coast. There are unconfirmed reports that the Fisheries Department is currently considering a marine hatchery. If this is the case it should be supported.

Oysters

Oyster culture in Kenya has been a failure and should not be promoted again. The local species *Saccostrea cucullata* is simply not suitable for aquaculture in the tropics (slow growth, small size, marketing problems).

5.4 SWOT analysis of small scale mariculture in Kenya.

Strengths

- High quality seawater.
- Enthusiasm and dedication of community-oriented training centres such as Kwetu.
- Research support capacity at KMFRI.
- Willingness of the DoF (Coastal and Marine Branch) to develop the sector.
- Willingness and eagerness of coastal communities to adopt mariculture.
- High number of potential candidate species for small (and large) scale mariculture.
- Development mandate of the CDA and their active participation in assisting mariculture groups.

- Support of silviculture by Forestry Department.

Weaknesses

- Absence of a sector plan.
- The absence of a one-stop shop (for applications).
- Extension capacity.
- Access to the coast.
- Absence of marine fish farming capacity at KMFRI, DoF and CDA (all available fish farming expertise is in freshwater fish culture).
- Poor understanding of farm-made feeds.
- CBO organisational capacity.
- High soil porosity in coastal zone.

Opportunities

- Dedicated government and/or bilateral support for mariculture development.
- Greater and dedicated NGO involvement.
- Expansion of farmer appropriate demonstration facilities, such as those at Kwetu.
- Bamburi fish farm for high quality tilapia fingerlings.
- Hands-on training of trainers in Kenya.
- Providing support to develop a sector plan

Threats

- Hotel strip development.
- Land tenure.
- Privatisation of state land for tourism development.
- High cost of coastal land hence restricted to communal areas.
- Governance constraints.
- Theft and vandalism.
- Possible water quality problems in creeks (coliform bacteria).

5.5 Recommendations

Institutional interventions

- Kwetu is currently the most suitable NGO partner for mariculture development along the coast and everything possible should be done to improve and build more hands-on extension capacity and to assist the organisation to develop their farmer appropriate demonstration facility. The organisation has high-level project management experience, although given their staff complement, they are stretched to the limit. ReCoMaP support to Kwetu (and other similar organisations when they are identified) for infrastructure development and capacity building would pay major dividends and is recommended.
- CDA clearly has the appropriate development mandate and is therefore is a crucial statutory partner. CDA manages the Coastal Micro-enterprise Development Programme and has extensive experience in the provision of small-scale mariculture extension services, high capacity in project management, M&E and farmer training. It is recommended that CDA be considered for a key role in the coordination of coastal and marine aquaculture.
- It is recommended that the DoF (coast & marine) makes a strong appeal for government commitment to mariculture development. It is recommended that the DoF seeks support for and initiates the process to develop a mariculture sector plan. In addition, if DoF is considering a marine hatchery (see above) then it should be supported by ReCoMaP as a means to set up fish cage culture on a sound footing.

- KMFRI has high level research capacity and the mariculture section is well staffed (see spreadsheet). Though research quality should never be compromised it is recommended that ReCoMaP should support efforts by KMFRI to transfer research results in farmer appropriate ways. It is also recommended that KMFRI instates a marine water quality monitoring system along the coast of Kenya. If possible this should be linked to sea temperature monitoring.

Project interventions in order of priority

1. Crab culture
2. Milkfish/mullet/prawn polyculture
3. Small-scale grouper cage culture
4. Coral culture

ReCoMaP support for specific interventions should be structured such that a small number of target groups are selected (on the basis of past performance) and provided with the necessary support and training to act as catalysts for other groups. It has already been proposed that key partners that should be supported include Kwetu and CDA.

ReCoMaP may wish to consider soliciting specific proposals; if this is agreeable to ReCoMaP then we recommend to:

1. Request the DoF to submit a proposal for the development of a mariculture sector plan. Sector planning is considered as one of the top priorities for Kenya although the fisheries sector could benefit from technical assistance to prepare such a plan.
2. Request Kwetu (and other similar organisations that can be identified) to submit a prioritise needs assessment proposal of its mariculture division, which can then be assessed and a decision can be made on funding some of their specific farmer orientated needs.

All project proposals must be assessed rigorously in line with framework conditions on the ground. All of the above recommendations would require serious backstopping.

5.6 Supporting research, monitoring and technology transfer needs

Apart from the assessment needs that were identified for each of the potential interventions the following research, monitoring and technology transfer requirements were identified.

1. Stock assessment and recruitment variability of mud crab

In the short term mud crab fattening in cages using wild caught animals provides the greatest opportunity for community based mariculture in Kenya. To ensure the long term sustainability of the activity it will be necessary to assess the current status of the stocks as well as recruitment variability. It is recommended that such a study be undertaken in Mtwapa creek and in the Kwale district.

2. Abundance and temporal recruitment of juvenile grouper in mangrove forests

As with mudcrab, small-scale cage culture will also rely on wild caught juveniles. For sustainable small-scale cage culture it is necessary to establish whether adequate numbers of juvenile grouper recruit into mangrove swamps, seasonal recruitment patterns and variability.

3. Formulation and testing of farm made feeds

Mudcrab as well as finfish cage culture are feed based practices. As the sectors grow and in view of the curtailment of prawn trawling in Kenya it is unlikely that there will be enough trash fish for feed. Farm made feeds must therefore be developed to sustain the activities. Research on the availability and nutrient composition of agricultural by-products and alternative marine resources is necessary to formulate and test various combinations for profitable farming.

4. Water quality monitoring

A water quality monitoring programme must be set up along the coast of Kenya to ensure biosafety of mariculture products. The number of stations and their locality must be determined by KMFRI. In particular it is necessary to monitor coliform bacteria, total N and total P, heavy metals and sea surface temperatures.

5. Milkfish culture technology transfer

For milkfish culture to develop in Kenya there is a need for technology transfer from the Philippines. The most appropriate and cost effective method would be for expert volunteers to come to Kenya.

6. Pearl grafting technology transfer

For pearl farming to develop in Kenya and in Tanzania there is a need to train local grafters. The most appropriate way might be to approach JICA for assistance to train two Kenyans and two Tanzanians in Japan.

5.7 Contact persons

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5. Mr Charles Gatune, Fisheries Officer, Department of Fisheries, Regional Office (Coast & Marine), Mombasa (072 0202 161) (kgatune@yahoo.com)
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7. Dr David Obura, Coordinator, CORDIO, Mombasa and Vice Chairman Kwetu Training Centre for Sustainable Development. (073 8516 656)
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15. Mr Elijah Mokaya, Librarian, KMFRI, Mombasa.(emokaya@kmfri.co.ke)
16. Mr Fisheries Officer (Prawn farm D Department of Fisheries,
17. Mr Foreman, Prawn Farm.
18. Mr M.Mwinga, Technical manager, KenSalt, PO Box 683, Malindi, Gongoni. (072 5633 278)
19. Mr Benjamin Karisa, Dabaso Creek Conservation Group, Watamu
20. Mr Lucas Fondo, Fish farmer, Mtwapa Creek

6 MADAGASCAR

6.1 Introduction

With the notable exception of the commercial penaeid prawn industry, Madagascar mariculture can at best be described as being in its infancy. Whilst considerable research efforts have focused on the technological development of seaweed, Spirulina, Artemia and brackish water tilapia farming, to date, there has been relatively little uptake of the technologies developed.

6.2 Legislation, administration and facilitation

Madagascar has developed comprehensive environmental management legislation within which fishing and mariculture are legislated for. Unfortunately, repeated attempts to obtain a copy of the primary legislation (The Act) were unsuccessful, and it was not available for this analysis (arrangements have been made to have it delivered to the National Focal Point and passed on to ReCoMaP). Nevertheless, Ordinance N°93-022 (Supporting Document 14) articulates the regulatory framework for mariculture development. In order to engage in mariculture, proponents must obtain a permit from the Ministry of Agriculture, Livestock and Fisheries. Environmental Impact Assessments (EIAs) are a prerequisite. The EIA process falls under the remit of the Ministry of the Environment and Forestry (Ordinances 99-954, Supporting Document 10; 2004-167, Supporting Document 13). The regulatory framework for mariculture development (Supporting Document 14) is proscriptive in nature, and outlines amongst others, the various permitting requirements, compliance and sanitary requirements and fines.

The Department of Fisheries (Ministry of Agriculture Livestock and Fisheries - MAEP) is the responsible government agent for mariculture development. The department acts as a “one-stop shop” for mariculture permitting. Incentive programmes are available to the industry, however, these are generic in nature and are not tailored to the promotion of the mariculture sector development *per se*. Incentives include export zone and tax concessions on investments, and are targeted at the larger commercial producers - they are unlikely to be of use to small-scale operators.

MAEP / FAO developed a masterplan for fishing and aquaculture development (2004-2007, Supporting Documents, 1,2,3,6,15,16). Themes included improving technical capacity at MAEP and developing governance structures between institutions, and improving aquaculture legislation. Development strategies include protocols to promote sustainable small-scale commercial and family based prawn culture, and the identification of appropriate culture and biosecurity technologies and protocols. Other issues addressed included site identification, feed development and artemia production. Plans to develop and promote eel and tilapia, Damba, Saroy, Marekely (finfish) and mussel culture through the development of appropriate technological and economic models are discussed. To date, the plan has not been implemented. The reasons why the plan has not been implemented were not apparent, and from discussions at both MAEP and the FAO it could not be established whether there was insufficient political interest to continue the process, or insufficient funds to support the process.

Limited aquaculture extension services are available from the Aquaculture Department (MAEP). In the past, large bi-lateral Donor / NGO programmes have operated extension services; these include USAID (brackish water tilapia), JICA (small-scale prawn culture) and NORAD (seaweed culture). Of these programmes, only the NORAD funded seaweed culture (IBIS Madagascar) remains operational. While this is not to say that the other programmes were necessarily unsuccessful, the closure of the programmes is

more a function of project funding cycles. For example the recent JICA programme has resulted in significant infrastructure and training developments at the CDCC (Mujanga). There are no government diagnostic services available to the industry, and all such services will either have to be sought from the country's universities, or from abroad. Mariculture research is currently being undertaken by the Institute Halletique de Science Marine (IHSM), Tulear University, and the Department of Biology (FOFIFA), University of Antananarivo. Current research programmes focus on sea cucumbers, Spirulina, mussels, oysters and brackishwater tilapia. The IHSM represents a dynamic research group that has developed close ties with Belgian and French universities and donor groups. Under their Director (Prof Man Wei), they are development orientated and are the first research group to develop sea cucumber culture in the region. In this respect it is recommended that where appropriate, ReCoMap support their efforts, and should ReCoMaP decide to support sea cucumber culture, they should ensure that IHSM are included as the technical partners. Unfortunately, time constraints precluded a visit to assess the capacity at FOFIFA. However, it was established that they are working on brackishwater tilapia farming – a research field that shows promise for small-scale mariculture.

6.3 Current mariculture activities and production

Current commercial mariculture operations are restricted to prawn (*Penaeus monodon*) and seaweed culture (*Euchema striatum*; *Euchema denticulatum*). In 2006, only one commercial seaweed farm was in operation and produced 948 tons of product. With respect to prawn production, it was not possible to obtain up to date production data. Nevertheless, in 2004, 7,007 tons of product was produced from six farms. Since 2004, additional production capacity has been installed and it is likely that total production has also increased.

Historical interventions

While a number of historical interventions were reported during the study, there were only two major interventions for which there was sufficient data available for analysis. Of the interventions that were reported and could not be analysed, one was a seaweed farm (BioMar Seaweeds) in the Tulear region. One was a small-scale brackishwater tilapia operator, and three were small-scale prawn farmers (>10ha) around Magunja. It was evident that the small-scale prawn farmers failed as a result of technical problems associated with the maintenance of pond water quality, and that the high price of compound feeds made the operations uneconomic, due to small economies of scale.

The single attempt to commercialise *Artemia* production in 1994 failed. The company Saline d'Ifaty was established to commercialise artemia production in the Tulear region. Initially the project was financially self-sustaining, however, technical problems and a breakdown in relations with their technical partners (IHSM) resulted in the closure of the project in 1998 (Prof. Man Wei, IHSM. *pers com.*).

Between 2003 and 2006, JICA successfully developed a hi-tech *Penaeus monodon* hatchery that could be used to produce in the region of 6 million Post larvae (PL) per annum. The infrastructure has been donated to the government and the long term viability of the facility now depends upon how the MAEF manage the facility. At present, it would appear they have retained the technical capacity to operate the facility. JICA continues to fund repairs to the facility, however, it could not be established for how much longer they would provide this support. The MAEF would like to make the facility financially self-sustaining by selling PLs to the existing commercial operators and an emergent small-scale and artisanal sector (Ms M. Ravaonasolo. Director CDCC, *pers. com.*). There are concerns that this strategy may not be sustainable as the major prawn

farms have developed their own hatcheries and will only use the CDCC facilities when they are having production problems of their own. Furthermore, due to biosecurity considerations, support for developing small scale prawn culture may not be forthcoming from the MAEP (Mr M. Andriantsoa, *pers com.*). Nevertheless, the CDCC facilities represent excellent generic fish farm facilities (tanks, pumps, filters etc), and provide an excellent opportunity to diversify into other areas of research / production - there are plans to develop a cucumber hatchery in the facility to supply the Majunga region with juveniles for grow-out, and to investigate the possibility of finfish culture. In this regard, ReCoMaP could consider supporting the activities in the Centre.

It should be noted that there is also one mud crab (*Scylla serrata*) ranching operation near to Majunga. The farm is at the start-up phase of production, and unfortunately, it was not possible to visit or obtain data to assess this operation. Nevertheless, crab prices are relatively high and range between 0.4-1.2US\$/kg (local market) and 1.2-1.8US\$/kg (FOB frozen). Notably, JICA have also expressed an interest in supporting mud crab ranching in the country, however, the status of the proposal could not be established.

Potential interventions identified by the project

Potential interventions are either based on discussions with potential applicants for ReCoMaP funding (in which case they are included in the Survey matrix), or alternatively are based on bio-technical considerations. The principal species interventions that were identified include the following:

- Finfish – Tilapia (*Oreochromis* spp.) Milkfish (*C. Chanos*) grouper (*serranid* spp.), cobia and yellowtail (*Seriola* sp) and aquarium fish
- Oysters
- Mud Crab
- Sea cucumber
- Artemia
- Seaweed
- Small scale prawn culture

Of these interventions, sea cucumber, seaweed, artemia and small scale prawn farming were identified as potential projects and discussed with potential applicants for ReCoMaP funding (see below). The other potential interventions are technically feasible, but will require varying degrees of support.

Finfish

Madagascar has large areas of estuarine habitat and marine salt pans that could be used for brackishwater tilapia and milkfish production. To date, brackishwater tilapia trials have been undertaken by USAid and FOFIFA. With respect to milkfish culture, there have been no historical interventions and the technology, while relatively simple and suitable for small scale farmers, will have to be transferred to Madagascar. Prior to supporting either brackishwater tilapia or milkfish farming, ReCoMaP should consider the technical and financial feasibility of developing the sectors, and identify who would be in a position to provide the technology transfer. Of import is the supply of fingerlings – small scale tilapia production is usually restricted by the supply of good quality fingerlings, and thus a secure supply must be identified. In this regard, FOFIFA could be approached for support. With respect to milkfish production, juveniles could be caught from the wild. However, no previous studies have focused on the milkfish stocks, and the availability of fingerlings will need to be established.

With respect to cobia, yellowtail and aquarium fish production, these sectors require relatively complex hatchery facilities, and in some cases compound feeds and complex cage systems – thus these interventions are probably more suited to private sector developments.

Oysters

During the Mid 1980s, the MAEF undertook some research into oyster culture. Funding constraints curtailed the activities, and they failed to develop the sector. Recently, the IHSM revived the project. The project is designed to identify suitable local oyster and mussel species and develop the hatchery technology. In the past, the IHSM have done work to commercialise the local species and these have failed - the collection of natural spat proved too difficult and they could not recruit sufficient numbers of spat for commercial production. If successful, the grow-out technology would be suitable for small-scale mariculture development. It is likely that the hatchery technology that will be developed will be too complex for rural farmers. While it may be premature for ReCoMaP to assist in this sector, there may in future be opportunities for extension programmes to roll out the grow-out technology to small scale farmers.

Mud Crab

There is scope to assist in the role out of crab fattening operations – particularly in the Majunga and Tulear regions that have extensive mangrove habitat that could supply juveniles for fattening. Current FOB prices for frozen crab are in the region of US\$2.5 - 3.5 /kg (live prices will be higher), and there are established export companies that have developed the export channels for the product. There is a need for sector guidelines, financial feasibility and production studies, trash fish supply and the development of farm-made feeds studies, and stock assessment studies. ReCoMap could consider allocating resources into any of these areas.

Sea Cucumbers

Collaboration between the IHSM (Tulera University), The University of Bruxelles and The University of Mons Hainaut has successfully developed the hatchery and juvenile grow-out technology for the sandfish (*H. Scarbra*). The IHSM have developed an experimental farm which, with funding from a local fish exporter Copefrito will be expanded - the terms of the relationship between Copefrito and the IHSM are outlined in Document 8. A dedicated hatchery and nursery will be built approximalty 20km South of Tulear. The plan is to produce in the region of 2.5 million adults per annum. Grow-out will employ enclosure technology and will have to incorporate the local community. As the density of grow-out cannot exceed 5 animals per m², large areas of lagoon habitat will be required - estimated at at least 200ha. At present there are already issues with the local population stealing cucumbers from the experimental farm, and so it is likely that there will be serious community issues, and issues of ownership arising from the project. The proponents indicate that they wish to supply the cucumbers to the local villages along the coast and then buy them back for processing and sale. Clearly there are many community / livelihood / training issues associated with the grow-out operation that ReCoMap could assist in resolving. Copefrito have contacts with two local NGOs (<http://www.transmad.org> and <http://www.blueventures.org>) and would like them to assist in the community development aspects of the project.

Artemia

Artemia production technology is low-tech and well-suited to small scale production techniques where the technology could be transferred to local communities. Although it was not possible to determine the investment costs for a small scale producer, they are likely to be relatively low. While the commercial viability of a farm needs to be established through a business planning exercise, the product is high value (US\$100-200 / kg). Assuming that a producer has a half ha pond in operation for 9 months of the

year, and that it yields an average of 10kg cysts / ha / month (a conservative production figure), production would be in the region of 45kg cysts per annum. Assuming that the cysts are of a reasonable quality and are sold at US\$100/kg, the income generated would be US\$4,500 per annum. Clearly, this would not all be profit as development / running costs would need to be taken into consideration. It should be noted that emergent farmers will require training and long-term monitoring, and this could be an aspect that ReCoMaP could consider supporting.

Seaweed

The IHSM (Tulear University) has transferred seaweed culture technology to Madagascar, and successfully adapted it to local conditions. Globally, seaweed farming is a well established and simple technology that can be transferred to isolated impoverished communities. The grow-out structures are simple to operate and inexpensive to construct. There are no feed requirements and as long as the farms are appropriately located, growth should be in the region of 5-8% per day (depending upon species and grow-out conditions). Processing is via simple sun-drying. While a full business planning exercise would need to be undertaken to investigate the commercial viability of a project, at the country's only commercial producer, each farmer produces in the region of 4 tons of seaweed per annum, and after operating expenses receive in the region of US\$400 (farming is a part-time activity). Clearly other developmental models could be considered.

Small-scale prawn culture

As a component of a larger development project, JICA (2003-2006) investigated the potential for small-scale prawn farming in the region. Their project investigated the types of technology / farming systems that could be used to promote the sector, and while it was not possible to review the project documentation, it was reported at the CDCC that the technology had been successfully developed and applied at the experimental level. Nevertheless in the past, the small number of commercial small-scale operators that have been supported by the CDCC have failed – reasons were not provided during the visit to the CDCC; however, it was established that one of the major constraints to success was maintaining suitable water quality in the ponds for optimal growth. Any intervention in this sector would be technically difficult to perform and should be viewed with caution. ReCoMaP should only consider involvement if it receives support from the EU Commission (Madagascar) and MAEP – both organisations have indicated that they may not support this type of development. Essentially it is an issue of maintaining biosecurity with respect to the development of viral diseases that have the potential to devastate the commercial prawn farming industry - as has been the case in the Far East and the Americas.

6.4 SWOT analysis for small scale mariculture in Madagascar

Strengths

- High quality seawater.
- Research support capacity at IHSM / FOFIFA, and research support from European Universities.
- Historical presence of bilateral donor agreements to support mariculture development.
- Willingness of the MAEP to develop the sector.
- Strength of the private sector in the prawn industry – providing trained workers to the rest of the industry.
- Willingness and eagerness of coastal communities to adopt mariculture.
- High number of potential candidate species for small (and large) scale mariculture.

- Large areas of coastline suitable for mariculture.
- Private sector willing to invest in mariculture.

Weaknesses

- Sector plan – existing plan needs to be funded.
- Extension capacity could be enhanced.
- Funding issues concerning the CDCC.

Opportunities

- Dedicated government and or bilateral support for mariculture development.
- Greater and dedicated NGO involvement.
- Potentially, the CDCC could become a major fish hatchery / research centre for the development of new species.
- Development of sea cucumber ranching – a first in the Western Indian Ocean.
- Hands-on training of trainers in Madagascar.

Threats

- Unsustainable farming practices.
- Theft and vandalism.
- Resource conflicts.
- Potential biosecurity issues if small scale prawn farms are allowed to develop.

6.5 Recommendations

Institutional

- The IHSM at Tulear is perhaps the primary research establishment with a well established team of researchers. They are business focused and through their past programmes have developed excellent project management and extension capabilities. It is recommended that ReCoMaP support their initiatives. In particular, any sea cucumber programmes that are developed (in Madagascar or other recipient countries) should involve the IHSM as the technical partners. The development of sea cucumber hatchery technology is complex, and they are the only regional research facility that has succeeded. From a technical perspective, to enter into a sea cucumber intervention without their technical assistance would likely result in the failure of the intervention.
- Where appropriate, assist the CDCC to become financially self sustainable. The MAEP has provided the CDCC with a mandate to become financially sustainable, however, the plans to become so are problematic (see above). The facility represents a major asset, which could potentially, and among other things, become a major research centre / supplier of fingerlings to small scale farmers. In the first instance, discussions with the MAEP could be used to establish whether they would like assistance.
- Sector development Plan – The MAEP / Sector Development Plan should be reviewed, updated and where appropriate, components of the plan funded and adopted by Government. Note: the MAEP should be consulted with respect to their views on the existing FAO plan, and the reasons why it was not originally funded, identified. ReCoMaP should only proceed with the plan if it has full governmental backing.

6.6 Supporting research, monitoring and technology transfer needs

1. Mapping and stock assessment and recruitment variability of mud crab

There is a need to establish those areas that are suitable for crab fattening. This could be undertaken as a GIS study. The seed stock required to operate the nascent crab fattening industry is derived from wild stocks. To ensure the long term sustainability of the activity it will be necessary to assess the current status of the stocks as well as recruitment variability. No stock assessments have been undertaken.

2. Sea Cucumber grow-out techniques and development of nursery feeds

The grow-out techniques (lagoon based ranching) need to be optimized in terms of stocking densities and enclosure systems. There is a need to develop a farmer / ranching model of production. Feed requirements, particularly nursery feeds need further research as does stocking density studies in the nursery system

3. GIS of appropriate sea cucumber ranching areas

Assuming that sea cucumber ranching is successful, there will be a need to map the areas that are suitable for farming. In addition to the bio-physical environment, overlays of human population density need to be added – the product is of high value and the best areas would be those that are both biologically suitable and are geographically far from settlements (theft issues are likely to be a major problem in this industry).

6.7 Contact persons

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2. Dr Richard Rasolofonirina. Researcher Institut halieutique et des sciences marines
3. Mr Honore Razafimbelo Assistant to the programme representative FAO honore.razafimbelo@fao.mg
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5. Mr Jaco Chan Kit Waye Director General Copefrito jaco@copefrito.com
6. Mr Jean Paul, Biologist, Amborovy Centre.
7. Mr Bernard Rey. EU Commision Bernard.rey@ec.europa.eu
8. Mr Mamy Andriantsoa, Director General of Ministry of Agriculture, Livestock and Fisheries (MAEP) mamy.andriantsoa@wanadoo.org
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14. Director of Fisheries (MAIF)
15. Head of Aqculture Division (MAIF)

7 SEYCHELLES

7.1 Introduction

Mariculture in Seychelles is under-developed and there is no framework within which the sector is able to develop. Investment in the sector is restricted to a prawn farm on Coetivy Island owned by a state company (Seychelles Management Board) and a privately owned pearl and giant clam farm on Praslin (Praslin Ocean Farm Ltd). Relative to its potential the sector is nascent.

All past attempts and present projects were and are considered at best, ad hoc developments, without any form of sector coordination or planning. Many of the past applications have been handled without apparent due process and without clear procedural channels. The potential for mariculture in Seychelles is constrained by various factors but is never the less substantial. There is disagreement amongst key statutory role players with respect to recognising and or realising the potential of the sector on the inner and outer Islands. For example, the Department of Agriculture and Natural Resources and Seychelles Fishing Authority recognise the need for developing this sector because of the over-fished and or depleted status of most demersal fish stocks (Supporting Document 14) and a foreseeable future imbalance between fish supply and demand. Similarly the Department of Environment recognises the opportunities and seems supportive of developing the sector. The Marine Parks Authority in principle also recognises the opportunities provided by the sector as alternatives for trap fishermen. On the other hand the Island Development Company is of the opinion that mariculture has no potential on the outer Islands and that it would not be able to develop on the inner, populated Islands of Mahe, Silhouette, Praslin and LaDigue because of user conflict. The constraints as expressed by the IDC amongst others are: conflict with tourism sector, availability of land and sea areas, abundance of high value fish at a low price (this may however change because of the doubling in the price of diesel in September 2007), labour constraints, opportunity costs, past experiences. These views largely echo those listed in a report entitled "Existing and potential employment opportunities in the Fisheries Sector" prepared by a consultant in 2005. These opinions are highly valued and many may indeed be valid. However, it must be recognised that there has never been an independent and comprehensive assessment of aquaculture opportunities on Seychelles including analyses of biotechnical and economic feasibility, spatial requirements, availability and suitability and an evaluation of perceived constraints. An assessment such as suggested above would provide Seychelles with the information upon which to take an informed and rational decision whether to commit to the development of the sector or otherwise. While there have been several reports on aquaculture in Seychelles the most recent (2004) assessment of aquaculture needs is contained in the final report (Chapter 7, Supporting Document 13) of a consultancy entitled: Preparation of a long term plan assessment of the needs of the Fisheries Sector in Seychelles (prepared by ITTAS Consultancy). The section on aquaculture is rather elementary and fails to provide a clear future scenario on whether Seychelles should promote or curtail future investment in the sector.

Mariculture development in Seychelles requires a united political front and a tangible commitment by Government. The first step would be to explore in detail the specific opportunities presented by mariculture (see above). If the identified opportunities are attractive and viable then it would be necessary to develop a sector development plan, to ensure its orderly and sustainable development (see step wise schedule in Mariculture debriefing presentation (PowerPoint presentation in Seychelles folder).

7.2 Legislation, administration and facilitation

Mariculture in Seychelles falls under the jurisdiction of the Fisheries Act of 1991 Chapter 82 (Supporting Document 1). The Seychelles Fishing Authority (SFA) is mandated to administer, manage, develop aquaculture and undertake appropriate research to facilitate the development of the sector.

The Fisheries Policy of 2005 (Supporting Document 8) is supportive of mariculture development and in paragraphs 4.1.5 and 5.1.4 states that:

4.1.5 “Aquaculture research and development will focus on consolidating the actual production and facilitate development in new breeding techniques for suitable species”.

and

5.1.4 “The Government will promote responsible research and development of aquaculture and ensure that this development is ecologically sustainable, and allows the rational use of resources shared by aquaculture and other activities. Aquaculture will be promoted with the aim of minimizing adverse environmental changes and related economic and social consequences”.

Any new mariculture venture is subject to an environmental impact assessment (Supporting Document 6) as prescribed by the Environmental Protection Act (Supporting Document 12). Mangrove mariculture in Seychelles is a remote possibility but if crab culture were to be considered then the Forest Reserves Act of 1967 (Chapter 185) would apply. Other acts that are of relevance for mariculture are:

National Parks and Nature Conservancy Act of 1969 (Chapter 141) – for mariculture in Marine Parks

Town and Country Planning Act of 1972 – for land based mariculture

Maritime Zones Act, No. 2 of 1999 – for sea based mariculture

(all acts available at www.seychelles.gov.sc)

Within its limited capacity SFA does all it can to facilitate development. It is also responsible for scrutinizing applications, although not all proposals are channelled through the organization. All recent applications have been rejected, because most were conceptually poor and ill defined. Those that were approved in the past (except for the pearl farm) either did not materialize or were scuppered soon after start-up.

Mariculture capacity at SFA is limited and consists of 1 scientist (MSc level) and 2 technicians that attended short courses in China. The scientist has now been moved out of research and put in charge of fisheries and aquaculture development. From a sector development perspective this is a positive move as the person involved is willing and able to champion the cause of the sector. If the state commits to the development of the sector it would have to do so tangibly by recruiting and appointing expatriate experts. Except for the owners of the pearl farm and the expatriate experts employed by the SMB prawn farm there are no other trained and or experienced mariculture practitioners on the Islands. The Seychelles Centre for Marine Research & Technology under the auspices of the Department of the Environment has no research capacity *per se*, but actively facilitates research initiatives of foreign research organisations and universities and this should be further encouraged.

7.3 Summary of mariculture activities

There are three ongoing mariculture projects in Seychelles and these are Coetivy Prawn Farm, the Pearl Oyster Farm and the associated Giant Clam Farm on Praslin. The summaries below were extracted from a report by J.N. de Lestang (2005). Unfortunately, because of time constraints it was not possible to visit Coetivy or Praslin.

The prawn farm on Coetivy (300 km from Mahe) is owned and managed by Seychelles Marketing Board. The operation started in 1989 and now occupies ca. 50% of the Island (incl. staff housing and other facilities). There are 200 ponds (96 ha). *P.monodon* is the main species and broodstock is imported from Mozambique and Madagascar. It employs ca. 350 people mostly from Thailand and Sri Lanka, only 18% are Seychellois. Production has decreased from 1175 tonnes in 2004 to 704 tonnes in 2006. The decrease in production suggests that the farm is either poorly managed or has financial difficulties or both. The farm has two hatcheries and PL production techniques are well established. Feed is obtained from the SMB owned animal feed mill in Victoria that makes a formulated prawn feed. The major problem is high Seychellois labour turnover.

The Praslin Ocean Farm Ltd (pearls) was established in 1995 and is located in the National Park between Praslin and Curieuse and covers an area of about 19 ha. Underwater longlines are used, demarcated by surface buoys. Growth is rapid and it takes about 2 years before the oyster can be grafted. Grafting is done by Japanese experts. It takes a further two years before pearl harvesting. Production figures are not available and may also be misleading. Pearls are exported to Japan and Australia for setting and some are re-imported for sale. Labour includes the owner, and 2 Seychellois divers.

The Giant Clam production facility is a subsidiary of Praslin Ocean Farm Ltd and was established in 1993. Clams are reared in raceways and on the seabed and are exported for the aquarium trade. FOB prices are unknown. Exports have decreased from ca. 1960 in 1994 to around 300 in 2003. Apparently this is mainly due to increasing demand for more colourful species or varieties on the market and the reported absence of these varieties and or species on Seychelles.

In the past there has been an unsuccessful attempt to produce oysters (*Crassostrea gigas*) at Anse le Moshe. Given the low nutrient and Chl-*a* levels this is not surprising. An attempt was also made to establish another pearl farm on Platte and Alphonse but both are no longer in existence. Reasons provided for failure were divergent but interesting. There have been several other applications, e.g. tuna fattening, aquarium fish culture based on wild eggs and larvae, cage culture using fish purchased from artisanal trap fishers etc. However all of these were rather far fetched and not appropriate.

Approved and currently proposed interventions

None

Site selection

To be determined during exploratory assessment of biotechnical and economic opportunities

Potential opportunities identified

- Sea cucumbers
- Prawns
- Pearls
- Finfish
- Aquarium fish and crustaceans

7.4 SWOT analysis

Strengths

High quality sea water;
Most demersal stocks over-fished;
Recognition by fishermen of future problems with respect to local fish supply;
Private sector recognition of future potential;
International linkages and research cooperation established by SFA;
High level capacity to screen and evaluate applications; and,
Excellent investment incentives (Supporting Document 5).

Weaknesses

Low level bio-technical aquaculture capacity;
Absence of a comprehensive assessment of opportunities;
Low level appreciation and understanding of future fisheries scenarios by some statutory bodies; and,
Absence of future fish demand analysis (particularly in view of increasing tourist numbers).

Opportunities

Sea cucumber ranching (culture based fisheries) on outer Islands – if feasible could make significant contribution to GDP;
Expansion of pearl culture;
Sale of Coetivy prawn farm to private sector;
Fin fish cage culture for local and hotel trade - small (50 tonne) to medium scale (200 tonne per annum ventures; and,
Aquarium fish and crustacean farming for export market.

Threats

Organs of state not fully aware of the writing on the wall (future fish supply / demand scenarios); and,
Controlling interests and dominance of public sector in business.

7.5 Recommendations

Seychelles is a difficult case and in some instances there is scant appreciation of long term trends and needs. Perceived constraints to mariculture must be assessed and evaluated.

Unless there is tangible commitment to assess the opportunities presented by mariculture by organs of state, the sector cannot develop orderly and responsibly. It is recommended that ReCoMaP considers supporting the three following avenues. However, support should only be provided on the pre-condition that Government commits itself to the process and provides tangible support to the initiatives. If not then support is not recommended.

1. A detailed exploratory assessment of mariculture opportunities and constraints on the outer and inner islands. If the outputs are positive then support the preparation of a
2. Sector development plan (putting the framework in place)
3. Training and capacity building

Seychelles does not have the capacity to undertake Tasks 1 and 2 and this would require expert support.

7.6 Supporting research, monitoring and technology transfer needs

1. GIS based assessment of available area for sea cucumber ranching.

Seychelles is composed of over 150 Islands. The sea cucumber fishery on Seychelles is substantial and all valuable species are either fully exploited or over-fished (Supporting Document 14). A culture based fishery could contribute significantly towards GDP. A GIS based assessment of available areas on the outer and inner Islands must be undertaken before this potential can be realised.

2. Pearl grafting technology transfer

For pearl farming to develop in Seychelles there is a need to train local grafters. The most appropriate way might be to approach JICA for assistance to train two Seychellois in Japan.

7.7 Contact Persons

1. Mr Didier Dogley – Permanent Secretary, Ministry of Environment, Botanical Gardens, Box 445, Victoria. Mahe (+248 670512) d.dogley@env.gov.sc
2. Mr Walter Talma, Permanent Secretary, Natural Resources.
3. Mr Ronnie Rennaud, CEO, Seychelles Centre for Marine Research & Technology and Marine Parks Authority (Ministry of the Environment).
4. Mr Rondolh Payet, Managing Director, Seychelles Fishing Authority, PO Box 449, Mahe. (+248 714874), rpayet@sfa.sc
5. Mr Glennly Savy, CEO, Island Development Company, Victoria.
6. Mr John Neville, CEO, Green Island Foundation (NGO), Victoria.
7. Mr Joel Nageon de Lestang, Ministry of Environment, Natural Resources, j.nageon@env.gov.sc
8. Mr Philipp Michaud, Ministry of Foreign Affairs and ex MD of SFA. pmichaud@mfa.gov.sc
9. Sedrick Nicette – Conservation Officer (Ministry of Environment).
10. Ms Jude Poijoux – Marine Parks Authority.
11. Mr Riaz Aumeeruddy – Manager, Fisheries Development Section, Seychelles Fishing Authority raumeeruddy@sfa.sc (+248 513578)
12. Mr Jan Robinson, Manager, Fisheries Research, Seychelles Fishing Authority, jrobinson@sfa.sc (+248 582605).
13. Dr David Boule – ex fisheries research scientist, SFA..
14. Mrs Begum Nageon, Country Focal Point, ReCoMaP. (+248 723010)

The Mariculture debriefing at 13.30 on 5 Sept. was attended by 40 people from the public sector, conservation NGOs and the private sector.

8 COMOROS

8.1 Introduction

The Comoros has neither developed a freshwater or a marine aquaculture sector, and to date, there have been no aquaculture-based interventions. Indeed, according to the Fisheries Department of the Union of the Comoros, there have been no assessments of the potential for aquaculture development. Fishing activities in the Comoros is restricted to a small scale artisanal fishery that operates in the near-shore areas, and the large scale pelagic tuna fisheries that are operated under bi-lateral fishing agreements. Product from the pelagic fishery are not landed on the Comoros, and the country has no commercial processing plant, and currently, the country's fish storage facilities are restricted to one freezer / ice making plant. The artisanal fishery has a compliment of approximalty 5,000 vessels, of which 1,500 are motorised. While long term catch data was not available, it has been estimated that 16,000 tons of fish are caught in the fishery per annum, the majority of which (60%) is caught off Moheli (Supporting Document 3). The inshore demersal stocks are reported to be depleted (Mr A. Alloui, DoF, Union of Comoros, *pers com.*), and while there is scope to move fishing effort into the deeper waters outside the lagoon fringes (to target the pelagic stocks), the fishermen are restricted by gear limitations and high fuel costs (petrol price €1.5 /l, kerosene €0.5 /l). A comparison of regional market prices suggests that fish prices are significantly higher in the Comoros – for example in the Comoros, fishermen receive in the region of €3 - 4.5 / kg for grouper, while in Madagascar, these items fetch market prices of €2 - 3.3 / kg. The differences in price are likely due to the higher cost structures in the Comoros.

This report is based on a rapid assessment of the potential for mariculture development in the Comoros (12th – 20th September 2007). Discussions were primarily held with the Central Government of the Union of the Comoros, and the Island Governments of Grande Comore and Moheli. At the outset, it was established that while the concept of mariculture development would be well received at the administrative level, there was minimal understanding of the issues that would need to be addressed to develop the sector – in terms of legislative frameworks, biotechnical constraints, financial, research and extension requirements.

8.2 Legislation, administration and facilitation

The legislative framework for aquaculture development has been included as a component of the fisheries legislation (Supporting Document 1). The legislation is relatively standard aquaculture legislation covering issues such as permitting, environmental protection, the statutory requirements for developing a facility, and compliance. Environmental impact assessments are mandatory prerequisites for aquaculture developments (Supporting Documents 6, 7).

The administrative responsibility for the development of the aquaculture sector lies with the Fisheries Division of Ministry of Agriculture, Fisheries and the Environment (Union of the Comoros). While each island has a level of autonomy from central government, and have their own government structures and respective Fisheries Departments, they take their lead from the Union Government structures. Government structures (particularly at the Island Government level) are clearly under-resourced and lack aquaculture capacity.

Applications to engage in Mariculture are made through the Fisheries Department of Ministry of Agriculture, Fisheries and the Environment (Union of the Comoros). While the issuing of permits is a legislative prerequisite, there is some doubt as to whether permit application forms / procedures have been developed – certainly they were not

forthcoming from the discussions with the relevant authorities. While aquaculture is defined as an activity requiring an EIA, there is no “one-stop shop” for applications, and the applications process itself has never been tested.

With respect to capacity, at the Union Government level, the Fisheries Department have two MSc grade aquaculture graduates. However, while well intentioned, these graduates are under-resourced, lack technical and regulatory experience, and are not in a position to drive the sector. Neither the National Institute for Agriculture, Fisheries and the Environment nor the University of Comoros has aquaculture capacity, and no NGOs are active in the sector. It is therefore fair to say that there is no credible technical, research or extension capability in the country to assist in the development of the sector.

8.3 Current mariculture activities and production

There are no mariculture activities in the Comoros.

Historical interventions

There are no historical mariculture interventions in the Comoros.

Site Selection

Mariculture site selection is a complex process requiring amongst others, an in-depth analysis of a site’s location, oceanographic and physio-chemical and biological status and carrying capacity. Due to time constraints, detailed site inspections were not possible, and the following analysis is therefore based on initial observations. It is therefore imperative that this analysis is viewed as a preliminary assessment, and that prior to commissioning interventions at any of the sites identified, comprehensive site assessments are undertaken.

Grande Comoros

Grand Comoros is typified by a larval coastline, a short shallow lagoon shelf and fringing reef system (approximalty 5-30m deep, running 50-300m offshore). Past the fringing reef, there is a precipitous drop off into deep oceanic waters (+100m depth). There are no extensive mangrove areas and accompanying salt flats that could be used for pond culture. Mariculture interventions in the deep oceanic zone are an unrealistic proposition, and therefore the only areas that could provide suitable culture sites are in the lagoon areas. The fringing reef / lagoon system on Grand Comoros is discontinuous, and the principal areas where this habitat exists are:

- Iconi to Voidjou on the West Coast.
- South of Mitsamiouli in the North West to Chomoni on the East Coast (North of the island).
- The Southern Tip of the Island between Sima Amboini and Fomboni.

Initial observations indicate that in the majority of locations, the fringing reef is too close to shore to provide meaningful areas for mariculture development. Those areas that hold the most promise are located at the Northern areas (Mitsamiouli to Bouni) and the Southern areas (Sima Amboini and Fomboni).

Moheli

Moheli is surrounded by fringing reef. On the North Eastern Coast, much of the reef is close to shore and therefore there are very limited opportunities for mariculture development in this area. In contrast, the South West Coastline, and in particular the Parc Marin de Moheli provides perhaps the best potential of all the sites in the Comoros group. The area is characterised by extensive lagoon areas (area undefined) and encompasses the Chissioua archipelago. There are a number of areas in the lagoon with water depths of 20-30m (Mr Kamardine Boinali, Fisheries Director, Moheli. *pers. com*) which could be suitable for some form of cage culture operation. In addition, the presence of the Island archipelago could also provide some shelter for “in-water structures” from the prevailing South-Westerly swells.

There are very limited mangrove areas in the marine park, and it is of some concern that there have been discussions within the local communities and the park management to develop small-scale prawn farming operations behind the mangrove areas. The discussions have led to the support of the UNDP to fund a pilot project (Mr A. Hamada, UNDP, *pers. com.*). The proposed farming sites are around villages Ouallah 1 and Ouallah 2. A preliminary assessment of these areas suggests that they provide little scope for development – the areas are small in size (a few hectares at most) and are located in sensitive areas behind the mangroves. The areas are not the low-biodiversity salt pan areas that are typically targeted for these types of development. Notwithstanding the technical difficulties and financial implications of developing prawn culture under the conditions in Moheli, the potential to negatively affect what represents the limited mangrove resources in the park should cause the park authorities to seriously consider the wisdom of allowing such a development.

Potential culture species

In light of the limited areas of lagoon that are available for mariculture, the lack of suitable land based pond sites, the lack of locally available feed materials (particularly trash fish / offal and maize) to develop nutritionally balanced farm-made feeds, and the absence of mangrove nursery areas to supply seed stock, it is recommended that finfish (e.g grouper, milkfish), prawns and mudcrab fattening are not developed. Likewise proposals to develop the seaweed sector should also be treated with caution. Principally this would be due to the combination of the relatively small area available for seaweed farming and the potential difficulties in attaining the production volumes required for export. In addition, Comorian labour costs are high (Comorian unskilled labour costs €3 a day as opposed to €0.7 a day in Tanzania), and potential user conflicts exist with the turtle nesting sites (on both Grande Comoros and Moheli). Finally, there is the issue of importing alien seaweed species.

Taking these issues into consideration, the species that have the greatest potential would be the high value species that do not require artificial feeds, are lagoon based, and can either be ranched, or cultivated on longline and raft or rack systems. These include:

- Sea cucumber
- Coral culture
- Clam culture
- Top shell
- Pearl oyster

Note: ReCoMaP would be advised not to fund any developments in these areas until full bio-technical and financial viability appraisals have been undertaken. Furthermore, the lack of suitably qualified NGOs to provide support structures to such developments

should be viewed as a major impediment to sustainability, the exception perhaps being Mr Soifa Soilih from AIDE (a local NGO) who has undertaken extensive work on sea cucumber ecology and has liaised with the IHSM (Tulear, Madagascar) to develop a collaborative sea cucumber farming throughout the Comoros. The proposed project requires funding to the tune of approximately €3 million, and it is therefore probably beyond the funding paradigm of the ReCoMaP programme.

Potential interventions identified by project

In the absence of a detailed bio-technical and financial assessment of the potential for mariculture development in the Comoros, combined with the poor regulatory, extension, research and technical capacity to develop the sector, it would be premature to promote farm developments at this time, and it is recommended that ReCoMaP primarily confines its activities to the undertaking of an in-depth needs assessment, and the developing of a strategy to promote mariculture development (see recommendations).

8.4 SWOT Analysis

Strengths

- Reduction in lagoon fisheries and a concomitant need to supply more fish to consumers.
- Good water quality.
- Critical need for alternative income and business opportunities.
- Central and Island governments support the development of the sector.

Weaknesses

- No defined mariculture zones.
- No mariculture infrastructure.
- Absence of mariculture technical and extension capacity at all levels.
- Absence of mariculture research capacity.
- Low level of administrative and evaluation capacity for mariculture.
- No strategic development plan.
- Low level of education of fishers.
- Limited freshwater resources. Limited areas suitable for mariculture (this needs to be established).
- Having to change livelihoods focus from fishing to farming.
- Relatively high fuel price and labour costs.
- Poor cold chain logistics in the fisheries sector.
- Marketing opportunities and constraints of mariculture products on Grand Comore and Moheli unknown.
- Limited potential to develop farm-made feeds - low levels of fish production in the fisheries, resulting in low levels of trash fish for feed. Terrestrial plant sources limited (this needs to be confirmed).

Opportunities

- Harmonising mariculture development and integrated coastal zone management objectives from zero base.
- Alternative business opportunities.
- Job creation.
- Value adding.
- Developing a new sector from scratch.

Threats

- Inappropriate site selection.
- Uncontrolled development and environmental consequences (need monitoring and management control systems).
- Access issues to sites in the Moheli marine park
- User conflict with tourism.
- Unrealistic expectations.

8.5 Recommendations

In the short term, the development of mariculture activities in the Comoros will be difficult to achieve, and prior to farm developments there is a need for a detailed assessment of the country's mariculture opportunities and constraints. In many respects, the situation is similar to that found in the Seychelles (see Seychelles country report) - the primary differences being that the Seychelles should it so wish, could likely afford to develop its sector. This would certainly not be the case in the Comoros where significant foreign aid would be required. On a more positive note, while lacking resources, there is strong institutional support for sector development from all levels of government, and feedback from the project's debriefing session held at the Fisheries Division of Ministry of Agriculture, Fisheries and the Environment (20th September), indicate that there is strong governmental support for the development of the sector.

It is therefore recommended that ReCoMaP considers supporting the following process:

Task 1. Undertake a detailed bio-technical and financial assessment of the opportunities and constraints to mariculture development on Grande Comore and Moheli.

Task 2. Support a Sector Development Plan (assuming that the results from Task 1 prove positive).

Task 3. Develop capacity at all levels of government to support the roll-out of the sector development plan.

Note: Due to the absence of mariculture capacity at all levels of government and civil society, external technical assistance will be required for all three tasks.

The development of a UNDP funded small scale prawn farm in Moheli is of concern (see Moheli Section above). Discussions with the National Coordinator (UNDP, Mr A Hamadi) suggest that funding has already been allocated to this project. It would appear that funding was allocated without proper due diligence, and that there has been no bio-technical or financial analysis of the project. The site is in the Marine Park, and there is a clear need to undertake a technical assessment of this project, and where appropriate mitigate against potential impacts. This is an issue that ReCoMaP could consider supporting.

8.6 Supporting research, monitoring and technology transfer needs

Research, monitoring and technology transfer requirements will become apparent during the proposed sector development strategy development process.

8.7 Contact persons

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3. Mr Ali Hassami Mohamed (Ministry of Environment and Fisheries, Grande Comores)
4. Mr Kassim Msaidie. Technical Advisor to the Minister. (Ministry of Environment and Fisheries, Grande Comores)
5. Mr A. Said Omar. Director General of the Environment (Ministry of Environment and Fisheries, Grande Comoros)
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11. Mr Mohamed Mindhir. Director of Moheli Marine Park.
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13. Mr Aboubacar Ben Allaoui. Director of Fisheries, Union of the Comoros. Benailaoui@hotmail.com
14. Mr Abacar Bounou Salim. Minister of Rural Production, Moheli.
15. Mr Charaf-Eddine Msaidie. Director of Environment (Ministry of agriculture, fish and the Environment, Union of the Comoros).
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Annex 1: Terms of Reference

Promoting Sustainable Livelihoods in the Context of ICZM: Coastal Mariculture Assessment Mission

Regional Programme for the Sustainable Management of the Coastal Zones of the Indian Ocean Countries (ReCoMaP)
(9.ACP.RSA.020)

1. General Introduction to the Programme

In most coastal zones of the SWIO, human population growth, economic development, and concomitant increases in unregulated natural resource use are leading to severe ecosystem deterioration and damage to ecological productivity. This is having the effect of intensifying coastal resource use competition and creating conflicts between the stakeholders that exploit the increasingly crowded coastal zone. However, coastal zones are also dynamic and complex areas, both environmentally and in terms of their use by human societies. This complexity demands the development of effective *integrated* natural resource-use management systems i.e. Integrated Coastal Zone Management (ICZM).

The Regional Coastal Zone Management Programme for the Indian Ocean Countries (ReCoMaP) is a programme of the Indian Ocean Commission (COI) financed by the European Union (EU). It is a five-year programme, which aims to enhance sustainable management and conservation of natural coastal and marine resources **with a view to contributing to poverty alleviation among coastal populations**. The beneficiary countries are Comoros, Kenya, Madagascar, Mauritius, Seychelles, Somalia and Tanzania. ReCoMaP is implemented through a Regional Coordination Unit (RCU) based in Quatre Bornes, Mauritius. The RCU is currently composed of six international multidisciplinary experts.

ReCoMaP works with partners in the SWIO to support and facilitate ICZM capacity development towards national and regional institutional arrangements that can promote integrated decision-making and, ultimately, effective Integrated Coastal Zone Management. ReCoMaP recognises that there is a wealth of information, data, experiences and lessons learned relating to coastal mariculture in the region. It is one of the core objectives of this Coastal Mariculture Assessment Mission to make this information more accessible and to convert it into a form that will enable improved access for all coastal management stakeholders (e.g. Government institutions, NGOs, Private organisations) at regional, national and local levels.

The promotion of sustainable livelihoods for the large number of impoverished people who depend on coastal resources for their survival is, in fact, at the heart of ReCoMaP's approach to ICZM as it is considered a key condition for its success. Thus, in addition to the common need for strengthened national and regional ICZM Frameworks, two groups of Sustainable Livelihood Opportunities, i.e. Coastal Mariculture and Coastal Tourism, were identified as having the greatest potential for increased revenue generation in coastal communities as part of improved ICZM in the region. Both opportunities were identified during intensive stakeholder consultations and National Strategic Planning Workshops.

This document is the TOR for one of two thematic assessment missions focused on promoting sustainable livelihoods in the context of ICZM: the present thematic assessment mission is concerned with assessing opportunities for achieving sustainable livelihoods through coastal mariculture.

ReCoMaP has seven major result areas and this mission directly relates to two of them. Result 1 includes the aim of promoting sustainable livelihoods in the coastal zones of the focus countries; the mission will address this by producing an assessment of opportunities for promoting Coastal Mariculture in the region.

The second relevant result area is Result 6, relating to the improved involvement of non-state actors in the implementation of ICZM action plans. This will be largely achieved through a Call for Proposals (CFP) Scheme due to be launched by the RCU in September 2007. The outputs from this consultancy

will improve the overall CFP strategy as well as identify its geographical and thematic focus by country.

2. Strategy and General Introduction to the Consultancy

The current mission will be carried out in two phases by a team of two Coastal Mariculture Consultants; it will commence with a desk study of 12 man-days, to be followed by a 58 man-day field work phase to validate and supplement the desk study findings. In addition to the principal objectives of an improved understanding of the opportunities that exist for coastal mariculture and how those opportunities can be successfully developed by the CFP, the mission will also contribute to the establishment of a regional ICZM Knowledge Management System (ICZM-KMS).

The Consultants will receive a detailed briefing and de-briefing at the beginning and at the end of their missions. The content of the briefing will include a detailed list of sites to be visited, issues to be covered, and the stakeholders to consult. Key documents to be taken into account are:

1. Strategic National Workshop Planning Reports (available on the *Publications* menu of ReCoMaP's website)
2. Other relevant workshop/meeting minutes and reports
3. Definitions and specifications of the ReCoMaP Call for Proposals Scheme
4. Specifications of the proposed Knowledge Management System in terms of Data/ Information Types and Structures

3. Task Descriptions

The key tasks of the Coastal Mariculture Consultants are

Phase 1: Desk Study

The desk study will require the collection and review of information and lessons learnt on Coastal Mariculture activities in each of the focus countries. Issues to be studied include:

- the types of Coastal Mariculture practiced (intensive and extensive practices, but with particular emphasis on those involving local communities);
- the main species utilised;
- policies, legislation and institutional arrangements;
- organisational responsibilities;
- post-harvest processing and marketing;
- training facilities and extension services available;
- technology (in use, or required);
- geographical areas of relevance (both actual and potential); and,
- relevant socio-economic issues.

Phase 2: Field work

- Visit each partner country to update the information gathered during the desk study and to validate and cross-check its findings;
- Collect (hard copies, soft copies, notes, audio, photo, video) relevant data and information in a form specified and defined by the RCU. For this purpose, each Consultant will be equipped with an information entry matrix;
- Where practical, liaise with and brief/de-brief national/sub-national ICZM Committees or their equivalent;
- Visit a small number of relevant case-study sites identified during the desk study and evaluate their performance;

- Assess the needs for training of relevant national and local line agencies towards their provision of viable extension services to small-scale mariculture operators;
- Identify priority research needs for the development of small-scale coastal mariculture.

4. Outputs

The following outputs are requested from the Coastal Mariculture Consultants:

1. After each country visit a draft report (2 pages) as well as one draft matrix of already acquired information shall be provided to the RCU;
2. On the basis of the desk-study and field work produce an analysis of the constraints and prospects for the development of Coastal Mariculture as a sustainable livelihood for poor coastal communities, and provide recommendations for the promotion of Coastal Mariculture by ReCoMaP;

All documents will be accompanied by electronic copies. All written outputs will be of a reasonable length (*plus annexes*), and if needed, preceded by a summary highlighting the main conclusions and recommendations.

5. Activities

1. The Consultants will begin their missions in Mauritius where they will be briefed on the programme by the RCU;
2. The desk study will be undertaken at the RCU where the ReCoMaP RCU Sector Specialists (Fishery, ICZM, M&I, CFP) will further brief the Consultants on the details of the missions, the expected outputs and the methodology and reporting scheme to be applied;
3. The Consultants will then deploy to the field visiting all countries covered by the Programme according to a specific programme being devised by the RCU;
4. On completion of their missions the Consultants will return to Mauritius for de-briefing;
5. The Consultants are expected to have their own laptop computer for this mission.