



***AQUACULTURE IN SEYCHELLES:  
HISTORY, CURRENT STATE OF PLAY AND  
LESSONS LEARNT.***



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## I. BACKGROUND

The decline in traditionally reliable capture fisheries and the rise in demand for fish in Seychelles is cause for concern in terms of economic and food security. In 2007/8 the Government of Seychelles took a decision to assess the potential of aquaculture and to establish a framework that would allow the sector to grow in a sustainable manner, while simultaneously addressing the concerns regarding the future availability of fish.

A rapid assessment of the state of play of mariculture in Seychelles was undertaken in 2007 (Hecht 2007). This study was undertaken under the aegis of IOCs ReCoMaP programme to assess opportunities within the framework of its Coastal Zone Management Programme. Several factors that have constrained the development of mariculture in Seychelles were identified. Nevertheless, the study identified substantial opportunities and it was recommended that a follow up assessment be undertaken to define these opportunities in more detail and to assess the needs for the development of the sector. It was also concluded that the industry could realistically not proceed without a sector development plan.

Following on from the first ReCoMaP rapid assessment (Aug/Sept 2007), a scoping mission to assess the need for a mariculture Master Plan was undertaken in early 2009 (Hecht 2009). The broad aims of the study were;

1. to obtain and collate the necessary information and data to define in greater detail the opportunities for development and constraints facing a mariculture sector in Seychelles and
2. to assess whether Seychelles requires a mariculture Master Plan and, if appropriate, to define the structural and procedural processes to develop such a plan.

To achieve these goals interviews were conducted with all key stakeholders, including the Principal Secretaries of key government departments (Environment, Natural Resources, Employment, National Development), the Principal State Council, parastatals and authorities (Seychelles Fishing Authority, OFCF (Japan), National Parks, Islands Development Company, Seychelles Tourism Board, Seychelles Investment Bureau, Seychelles Bureau of Standards), NGO's (Seychelles Island Foundation, Island Conservation Foundation, Marine Conservation Society) and the private sector (Seychelles Chamber of Commerce and Industry, Indian Ocean Tuna, Oceania, and Seychelles Farmers Marketing Coop.).

The principal findings of the Scoping Study were that

- There was strong institutional support for the development of a mariculture sector in Seychelles. Synergies exist for cooperation between mariculture and other sectors of the economy.
- The support for a new industrial sector was driven largely by socio-economic needs, declining fisheries output and the vulnerability of the tourism industry.
- There is substantial potential for medium and large scale, feed based mariculture around the inner, granitic islands of Seychelles, while the outer Islands lend themselves to extensive sea ranching practices.
- The orderly development of the sector in an environmentally responsible manner and according to international best management practices was principally constrained by human capacity and the absence of an appropriate legislative and regulatory framework.
- The findings argued strongly in favour of a developing a Master Plan (sector plan) and that a Master Plan would provide the vehicle with which to realize the potential of mariculture in the Seychelles and would ensure that the sector develops in an orderly and structured manner.

Amongst other outputs, this study identified approximately 60 km<sup>2</sup> of offshore area around the inner granitic Islands that were highly suitable for net pen culture of fish. Simultaneously, a socio-economic assessment was carried out to identify potential user conflict and to identify the potential social and economic benefits to the country.

Since then the country has started developing a Master Plan for the orderly development of the aquaculture sector. By taking note of experiences of other countries, Seychelles has adopted the Ecosystems Approach to Aquaculture (EAA) whereby its aquaculture sector will be developed in a manner, which takes into consideration the wider ecosystem and all its socio-ecological interactions with other sectors. Moreover, a very transparent consultative approach has been adopted whereby all stakeholders and communities have been engaged and consulted in developing the development plan. This approach will hopefully minimize user conflict and will allow the sector to grow sustainably and achieve its greater social and economic objectives. The aquaculture sector development plan (Mariculture Master Plan) will be completed by mid-2015. Amongst its other objectives this report highlights the progress made to date with the development of the Master Plan and illustrates the benefits of a transparent consultative approach to sector plan development.

Seychelles has a relatively long history of aquaculture going back to around 1988, when prawn farming was planned on one of the outer coral islands. Black pearl and giant clam farming was initiated in the mid-1990s. Pearl farming is currently the only remaining commercial aquaculture activity.

The Seychelles Fishing Authority (SFA) is the responsible authority for aquaculture in the Seychelles. It is a parastatal organization which functions as the executive arm of Government for fisheries and aquaculture. The Authority was created in 1984 by the Seychelles Fishing Authority Establishment Act. The SFA's operations are guided by a Board of Directors, appointed by the President of the Republic of Seychelles. The SFA's functions are to promote fisheries, fishing industries, aquaculture and fisheries resources in Seychelles.

The SFA has played a pivotal R&D role in establishing prawn farming on Coetivy as well as in undertaking the basic research, which ultimately lead to the development of pearl farming in Seychelles. Moreover, since around 2005 the CEO of SFA and his senior staff have also played a focal role in promoting the development of a more cohesive institutional framework for the development of the sector in Seychelles.

## 2. STRUCTURE OF THE REPORT

This report on mariculture in the Seychelles will focus on the institutional and regulatory frameworks that will govern the development of sustainable aquaculture.

The terms of reference for this project were mostly generic and for countries in which aquaculture is a long established sector. Hence, it was not possible to deal with every aspect of the terms of reference as outlined below. Never the less, where there was any data or information the consultant provided a commentary.

The terms of reference require the report to provide --

1. An evaluation of past and present practices, production systems, supporting facilities (e.g. hatcheries), consideration for available technologies and environmental practices, including disease control mechanisms, genetic engineering, environmental sustainability and lessons to be drawn from these practices
2. An assessment of roles of relevant collaborating institutions in the country, policy and institutional frameworks involved in aquaculture sector. This should include evaluation of institutional capacities (including human) to support sustainable aquaculture development
3. A review of existing strategies, policy and legislative frameworks in place that underpin aquaculture development noting regulations covering movement of genetic materials, disease controls, use of additives, EIA, etc. etc. and implementation of international instruments or guidelines for sector development.
4. An evaluation of roles of private and public sector in sector development and lessons to be drawn in

the sector development in the country. This should review indicate levels of public and private sector investments in the sector, prevailing enabling environment, incentives and any factor stimulating or impeding investments in the sector

5. A review of harvesting, processing, marketing and distribution systems and their effectiveness
6. A review of data collection and record keeping at farm level and across the reporting hierarchy [optimizing data resources] to advise on improvements;
7. Identification of areas where improvements [level of adoption of sustainable environmental practices and available technologies] can be made, or gaps requiring research along the production side of the value chain and recommendations for best practices including implementation of international guidelines or instruments for sustainable aquaculture development

The concluding section will attempt to draw all of this together in terms of lessons that can be learnt from the Seychelles for the benefit of other Small Island Developing States. Collectively the information provided will hopefully contribute towards the formulation of a Pan African Aquaculture Strategy.

### 3. SEYCHELLES MARICULTURE: EVALUATION OF PAST AND PRESENT OPERATIONS

#### 3.1 Prawn farming

A prawn farm on Coetivy was established in 1989 (Figure 1) by the Seychelles Marketing Board (SMB) and the Island Development Company and later taken over by the SMB. The farm closed its doors in 2008. In its latter years the farm was operated mainly by foreign technicians and labour (only 18% Seychellois). The farm was large, consisting of two hatcheries and around 200 plastic lined ponds (4800 m<sup>2</sup>) and occupying an area of around 96 ha, with a workforce of around 350 people (mainly Thai and Sri Lankan nationals). Prawn feed was produced on Mahe by SMB Feeds in association with VDS Feeds from Belgium and this feed was also exported to Madagascar and elsewhere. Annual production of *Penaeus monodon* (Black Tiger Shrimp) peaked at 1175 tonnes in 2004, but since then has declined to just under 400 tonnes (Fig. 2). Broodstock was imported from Madagascar and Mozambique. Because the entire production cycle was completed in seawater (35-36 ppt) the product was held in high esteem internationally and locally. Most of the product was exported to Japan.



Figure 1. Prawn ponds on Coetivy Island (Seychelles)

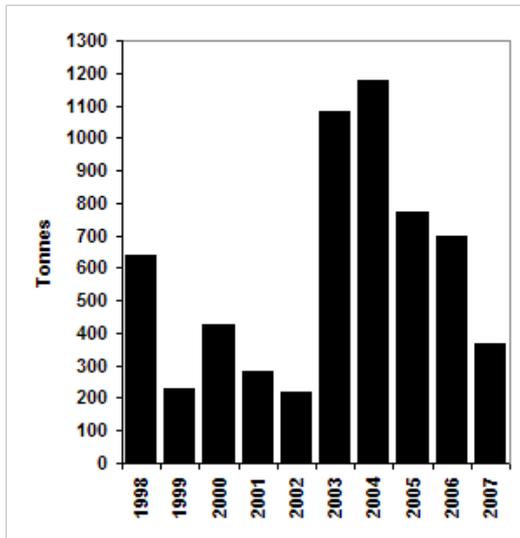


Figure 2. Prawn production Coetivy (1997 to 2007)

The water in the ponds was replaced by pumping in between 10 to 30% of total volume per day, depending on stocking density. Drainage occurred by way of gravity to the other side of the island. The ponds were stocked with PL 15s at a rate of between 20 to 66 PL/m<sup>2</sup>. The prawns were fed 6 – 8 times per day at between 10 to 2.5% of body weight per day. FCR ranged between 1.6 and 2.5, an average a growth cycle was around 160 days and production tonnes/ha/cycle ranged between 6.6 and 17.1 tonnes.

For several reasons the prawn farm ceased operations in 2008. High operational costs (Coetivy is approximately 300 km away from the inner islands), meeting post larval production targets for the grow-out ponds and poor management.

The importation of disease free broodstock from Mozambique and Madagascar was of great benefit to the farm as no incidents of disease were reported. The feed used was fresh and was always consumed within one month of manufacturing. As is standard practice the prawns were inspected regularly for white spot and other nutrition related diseases.

During its time of operation the farm disposed of its effluent water on one side of the Island. Observations have shown that this created a certain degree of enrichment of the seagrass community, suggesting that some form of post-production effluent treatment plant would have been required had the farm continued. The lesson learnt from the Coetivy farm is that the production of high quality prawns on a large commercial scale is physically and biologically possible but that financial planning is pivotal for sustainability.

There is interest in the revival of the prawn farm, but all activities have been put on hold until such time as the Regulatory Framework is in place.

### 3.2 Pearl Oyster Farming

The Seychelles Fishing Authority undertook preliminary studies on pearl oyster growth and spat settlement in the early 1990s. This provided the impetus for the establishment of pearl farming in Seychelles on a commercial footing in 1995. Black pearls have now been farmed successfully in the Seychelles for 19 years. The Black Pearl Farm, a family owned business, located in the Curieuse Marine National Park on Praslin Island, was established by Mr Roald Nilsen of Norway in 1995. Two oysters are produced. The Black Lipped oyster (*Pinctada margaritifera*) for pearls (Figure 3), and the winged Oyster (*Pteria penguin*) for half pearls.



Figure 3. Black pearls

Young of the year oysters are collected by spat collectors (Fig. 4) and ongrown for a period of 2 years on long lines (Fig. 5) before they are seeded. Nuclei are imported from Japan and Australia and appropriately sized oysters are implanted annually by Japanese experts. Harvesting occurs 3 years after implantation and the size of the round pearls vary from 8 to 12mm. Implant success rate at Black Pearl Farm is around 60%. The thickness of the nacre varies between 1.2 ~ 1.5mm and the colour varies from black, greenish-black to grey. Spat are collected naturally throughout the year but October appears to yield the best

results. The concession covers an area of around 19ha.

The farm currently (as at 28 December 2013) has a stock of around 14,000 oysters at various stages of growth. To be profitable on exports of pearls the farm needs to increase its stock to over 20,000. Currently pearls are sold on the farm to tourists and are set into jewelry in Western Australia. It would not be possible to increase the stock to > 20,000 with the use of spat collectors alone, so a hatchery would have to be built and developed. Capacity in hatchery technology would have to be imported and then developed locally.



Figure 4. Spat collecting lines in Seychelles



Figure 5. Pearl oyster lines in Seychelles

Several techniques are employed to grow the oysters. They are either ear clipped (Fig. 6 and 7) and suspended on ropes attached to long lines or are inserted into the pouches of “kangaroo nets” (Fig 8 and 9). The latter is the most common technique. The “kangaroo nets” are suspended vertically or horizontally from floating or submerged long-lines. During the grow-out period the oysters as well as the HDPE mesh of the kangaroo nets are subject to bio-fouling, the severity of which varies seasonally and with locality. In addition the oysters are exposed to boring organisms and predators. To combat the negative effects of bio-fouling in Seychelles, the kangaroo nets are lifted and cleaned and the oysters are removed and cleaned every three months, throughout the three year growth cycle.



Figure 6. Black pearl oysters in Seychelles.



Figure 7. Ear clipped black pearl oysters in Seychelles



Figure 8. Typical HDPE “kangaroo” net

As elsewhere in the world, bio-fouling severely affects the growth of the oyster and depending on the fouling species may even inhibit growth altogether and may lead to mortalities. Bio-fouling impacts on the quality of both the oysters and the pearl, the lifespan of the farming equipment and profitability. Bio-fouling is one of the most difficult and costly production issues facing the industry. It has been estimated that the removal of fouling organisms from pearl oysters and

the terminal farming equipment contributes around 26% of the operating costs of the farm. Removal of bio-fouling organisms remains a manual operation (Figure 9).



Figure 9. Oysters are cleaned by hand every 3 months.

The most prevalent fouling organisms in the Seychelles include bryozoans, barnacles, ascideans, molluscs, sponges hydroids and algae. The principal boring organisms that settle on the oysters are sponges (mainly *Cliona*) and polychaete worms (mainly *Polydora* and *Cirratulus*).

In recent years the farm has suffered from vandalism (cutting of ropes). The underlying reason appears to be jealousy by fishermen who are not allowed to fish in the Curieuse National Park and the fact that the Pearl Farm is allowed to operate a commercial venture in a Marine Protected Area. There is also some measure of discord between the authority responsible for marine protected areas and the farm and the SFA. This issue will hopefully be settled through the Mariculture Master Plan and the revision of the different types of marine protected areas.

The vandalism problem is now being addressed by changing from surface to submerged grow – out systems. The submerged systems consist of 5m x 5m buoyant frames that are anchored off the bottom. Each frame with spat oysters has 100 drop lines that can carry 1200 ear clipped oysters. Frames with adults have 60 drop lines and carry a total of 600 ear clipped oysters each.

### **The potential of the pearl farming in Seychelles**

There have been two other attempts to develop pearl farms in Seychelles. For various reasons these were not successful. Given the current revival of pearls in international fashion we are of the opinion that pearl farming holds great promise for Seychelles. The development of more farms would also stimulate investment in a Black Lip Oyster hatchery. The SFA should take the lead to identify suitable sites among the inner Islands and in association with the Island Development Company should look for appropriate sites on the outer islands.

### **3.3 Giant clam farming (Figure 10, 11 and 12)**

From 1994 to 2003/4, Giant clams (*Tridacna maxima*) were produced on the Black Pearl Farm for export into the international aquarium trade. Exports have decreased from ca. 1960 units in 1994 to around 300 units in 2003. Apparently this was due to the demand for more colourful species from elsewhere in the world and the decreasing price for Seychelles clams and increasing cost of air freight. It is highly unlikely that the farming of *T. maxima* can be revived unless ways are found to transport the animals in high humidity / high oxygen environments (without water).



Figure 10. Giant Clam, *Tridacna maxima*.



Figure 11. Giant clam raceways in Seychelles



Figure 12. Giant clam broodstock in Seychelles.

### 3.4 Previous and present applications

Two previous attempts were made to establish pearl farms on Platte and Alphonse but these were not successful. Other applications that have been received by SFA included applications for tuna fattening, aquarium fish culture based on collecting wild eggs and larvae, grow-out of fish in cages using fish purchased from artisanal trap fishers etc. However all of these were poorly researched and were rejected.

Currently there are several applications waiting to be screened. These include cage farming of fish, revival of the prawn farm on Coetivy, Sea cucumber farming / ranching. The applicants have been informed that their applications will be screened once a call for proposals is made towards June/July 2014.

## 4. COLLABORATING INSTITUTIONS

Seychelles has developed a “one stop shop” for aquaculture license applications. In developing this procedure it was necessary to align all institutions that would have to collaborate in either assessing an application or recommending certain procedures during the application process. The nine collaborating institutions involved in the process and their functions are listed below.

	Authority	Function
1	Seychelles Fishing Authority	License allocation and management, lease of land and sea areas in Aquaculture Development Zones.
2	Ministry of Land Use and Housing	Leasing of Public Land not associated with Aquaculture Development Zones
3	Department of Environment	EIA management and approval and Effluent discharge authorization and monitoring.
4	Seychelles Agriculture Authority (Veterinary Section)	Approval of biosecurity plan.

	Authority	Function
5	Seychelles Bureau of Standards	Aquaculture food safety standards, Aquaculture processing safety and aquaculture feed imports and aquaculture fish exports. Chemical and biological monitoring and analysis.
6	Public Utility Corporation	Supply of bulk services (Electricity and water).
7	Island Development Company	Outer Island aquaculture permit conditions.
8	Seychelles International Business Authority (SIBA)	Business license and concessions if more than 85% of product is exported
9	Seychelles Investment Board (SIB)	Business license and concessions if less than 85% of product is exported

## 5. CONSIDERATION OF POLICIES, REGULATORY FRAMEWORKS AND ENVIRONMENTAL PRACTICES

A comprehensive scoping of opinions of ALL public and private stakeholder institutions and civil society was undertaken in 2009. The general conclusions drawn from the findings were that there is strong and wide spread support from all arms of government, the private sector and NGO's for the development of mariculture in Seychelles. However, the potential environmental impact of mariculture was of grave concern to all stakeholders. This provided the *raison d'être* for the development of strict and enforceable environmental guidelines such that the sector is forced to develop in an environmentally responsible manner and in accordance with the principles of "Ecosystems Approach to Aquaculture" (Soto et al. 2008). The three general principles of "Ecosystems Approach to Aquaculture" are:

1. Aquaculture should be developed in the context of ecosystem functions and services with no degradation of these beyond their resilience
2. Aquaculture should improve human well being and equity for all relevant stakeholders.
3. Aquaculture should be developed in the context of other sectors, policies and goals

These principles provide the fundamentals upon which Seychelles is now developing a framework for an environmentally responsible mariculture industry that will contribute towards social and economic development and export earnings.

The development of the concept of sustainable aquaculture in Seychelles can be summarized as follows; ---- Mariculture in the Seychelles is recognized as a new industrial sector that must be developed to meet national socio-economic goals. In keeping with the environmental ethos of the Seychelles Government the sector will be developed in an environmentally responsible and sustainable manner. The sector will produce products of the highest international standards under conditions that will ensure the welfare of the animals and the environment. The sector will be developed using only indigenous species under conditions that will ensure the genetic diversity of the farmed species.

The above, and in particular the environmental concerns of stakeholders, were some of the key drivers during the pre-planning phase of the Mariculture Master Plan (MMP) in 2010. The Master Plan is the tool for the responsible development and management of mariculture in Seychelles and the process addresses the following broad objectives;

1. Increasing the recognition and understanding of the benefits of mariculture in the country.
2. Developing the human resources to develop, manage, monitor and provide scientific support to the industry.
3. Promoting the establishment of a mariculture R&D unit at SFA

4. Understanding and defining demand and supply projections
5. Developing a policy and regulatory framework for a responsible mariculture sector in Seychelles
6. Providing an enabling legislative and investment environment for mariculture development.
7. Promoting aquaculture as an important supplementary source of fish on the domestic market
8. Providing a roadmap to establish mariculture as an export industry
9. Developing an aquaculture sector that is compatible with responsible stewardship of the coastal and off-shore environment and resources.

Because of financial constraints the MMP was split into five phases. Phase 1 of the MMP, comprising a Stocktaking and Diagnostic Survey and the Inception Report was completed in 2011. Phase 2 commenced in June 2013. The five phases are shown in the text box below:

**Phase 1.** Stocktaking and Diagnostic Survey and Inception Report (completed November 2011)

**Phase 2.** The key pillars (completed December 2013)

**Phase 3.** Outer Islands mariculture assessment (to commence January 2014)

**Phase 4.** Policy, legal and institutional integration and harmonization, incentives and environmental baseline studies (to commence July 2014)

**Phase 5.** Addressing outstanding issues and peer review (including peer review workshop, economic feasibility studies, risk assessment, EIA guidelines, training, marketing, international collaboration, R&D at SFA) (to commence January 2015 and complete in June 2015)

Phase 2 comprised developing the six principal pillars upon which calls for commercial aquaculture proposals and investment will be made. These were:

1. Drafting the **Marine Aquaculture Regulations** that will guide the development of the sector in the Seychelles. The Regulations provide the guidance for how the sector will be managed and by whom, the conditions under which an aquaculture right and license are issued, the associated fees, the environmental, genetic, disease and animal welfare operating rules and biosecurity regulations, licence conditions and the general operating standards including monitoring mechanisms and compliance with quality standards and international best management practices.
2. Developing a comprehensive **application and evaluation procedures** with a single entry and exit point and develop license conditions for various forms of aquaculture (commercial large scale, SME commercial aquaculture, ornamental aquaculture, restorative aquaculture, bioprospecting aquaculture and experimental aquaculture).
3. Identification and securing of a **suitable site for a landbased hatchery cluster**, including design criteria and plans.
4. The **final coordinates of open ocean cage sites** around the inner Islands of the Seychelles, and recommended sites for small and medium scale inshore farms.
5. **BMP guidelines** for commercial farming operations and biosecurity protocols
6. **Capacity needs assessment** to build the administrative, managerial, and bio-technical capacity of the Seychelles Fishing Authority and make necessary arrangements for training.

## 6. MARINE AQUACULTURE REGULATIONS

The draft Marine Aquaculture Regulations were peer reviewed and completed in December 2013. The Regulations are now in the process of being prepared for approval by the Council of Ministers before being Gazetted in 2014.

The Marine Aquaculture Regulations have been specifically developed to:

- to ensure quality control in terms of meeting the ‘triple bottom line’ objectives of ecologically sustainable development (economic prosperity, environmental quality and social justice).
- create a single regulatory authority for the management, licensing and administration of the aquaculture industry;
- support research into the development of responsible aquaculture technologies and practices;
- promote farming of indigenous species and to prohibit farming of alien species
- maintain the genetic diversity of farmed aquatic species;
- monitor and regulate all aquaculture facilities licensed to carry on operations in terms of these regulations;
- establish norms and standards to guide environmental impact assessments.

## 7. POLICY

Seychelles does not yet have an aquaculture policy. Instead, the development of the Regulatory Framework for the development of the sector was drawn up on the basis of the very comprehensive stakeholder scoping exercise undertaken in 2009 and a socio-economic survey undertaken in 2013. The SFA took a policy decision that the Mariculture Master Plan process will have to be undertaken in a fully participatory and transparent manner. This has been ensured by establishing a Mariculture Liaison Committee that meets once every two months and where all stakeholders are updated on progress and requested to provide input into the process and into the content of the framework. This process has been most satisfactory.

A mariculture policy for Seychelles will be developed as part of Phase 4 in the second half of 2014 and will most likely form part and parcel of the planned new Fisheries Policy.

## 8. ENVIRONMENTAL, ANIMAL HEALTH AND GENETIC CONSIDERATIONS

The environmental and animal health and genetic considerations and proposed practices are contained in Parts 4 (Sustainability and Ecosystem Integrity), Part 5 (Animal Welfare) and Part 6 (Monitoring, Reporting and Enforcement) of the Regulations.

Part 4 stipulates that aquaculture shall be undertaken in an ecologically sustainable manner guided by various international codes of conduct as well as guidelines issued by the Regulator, the development of Standard Operating Procedures by operators that will be approved by the Regulator.

Preemptively, the following guidelines have already been prepared for operators;

**Fish Health Management Guidelines** that include the following elements:

- Biosecurity
- Maintaining good fish health
- Monitoring for water quality and fish health
- Proper fish handling
- Minimizing risk of spreading disease
- Handling of drugs/chemicals

- Reporting obligations for fish health and biosecurity
- Feed and nutrition management
- Provide guidelines on Standard Operating Procedures for operators
- Reference to relevant regulations

**Guidelines for Finfish Farming in Seychelles** that include the following elements:

- Selection of appropriate genotypes and technology
- Site selection
- Pollution control
- Fish Health
- Fish Welfare
- Food Safety
- Human and social issues

All fish cage farmers will be required to fallow their sites once every second year for period of not less than 12 months or until the seabed has recovered.

The Regulator will not permit the farming of alien species in Seychelles and all operators shall be required to implement an approved comprehensive genetic diversity management protocol using only indigenous species.

Pollution causing incidents must be remediated by the operator.

Operators are only allowed to use approved chemo-therapeutants. Operators of hatcheries shall be required to install post-use water treatment plants so that water is returned to the sea in a state as stipulated by legislation. The use of anti-biotics will be limited to the early life history stages in hatcheries.

To ensure fish welfare and to minimize the effect of farming on the benthos, fish density in cages will be limited to a maximum of 12 kg per cubic metre. Moreover, operators will have to develop and implement an approved biosecurity and fish health management plans for their operations.

Operators will be required to submit a monthly fish health report. As a signatory to the World Animal Health Organization (OIE) the Regulator is obliged to report notifiable diseases to the OIE. To assist new operators the Regulator will ensure that veterinarians are appropriately trained to deal with fish health matters.

Aquaculture in Seychelles will be run on a user pays principle by imposition of a levy on production. This levy will be used for environmental monitoring, fish health monitoring and industry led R&D.

Finally, the operator will be responsible for implementing a prescribed, comprehensive monthly environmental monitoring programme of the water column and the sediment, the results of which have to be submitted to the Regulator. The Regulator will undertake a random sampling programme.

## **9. BIOPHYSICAL SCOPING OF MARICULTURE SITES AND OPPORTUNITIES**

Land based as well as offshore Aquaculture Development Zones will be established and prospective operators will be encouraged to operate within these designated zones and this will be supported by fiscal incentives. The zones have all been identified and will be Gazetted with GPS coordinates in 2014.

The offshore ADZs were delimited using oceanographic data such as wind speed, current direction and speed, significant wave height and dissolved oxygen, sediment typing data, location of marine protected areas,

location of coral reefs, shipping lanes, recreational dive sites, fishing areas (traps and longlines), yachting channels and visual impact.

Where an operation falls outside of an Aquaculture Development Zone it is recommended that an EIA is required for any operation producing more than 250 tonnes per annum. To encourage farming in the ADZs the SFA will undertake and also carry the cost of the required EIA in these zones.

Land based ADZs for development of “aquaculture hatchery clusters” have also been identified on the basis of water and sediment chemistry and access to bulk services. Given the scarcity of land on Seychelles biosecurity becomes a serious issue. As a mitigating measure a “Hatchery Biosecurity Protocol” has been drawn up for the land based ADZs as part of the Mariculture Master Plan.

Several food and ornamental finfish species as well as several shellfish species have been identified as candidate aquaculture species. The foodfish species include 5 grouper species, 2 carangids, 3 lutjanids and a rachicentrid, a sparid, a scombrid and a siganid species. These species were selected on the basis of their value and the extent of knowledge of the culture technologies of each. All identified candidate species are relatively high value species. Sea cucumber farming and ranching on the outer Islands have great potential and this will be evaluated in the first half of 2014. In addition there are several crustaceans such as mudcrab and coral shrimp that have potential for farming as well as several molluscs and corals.

## 10. HUMAN CAPACITY

Marine aquaculture is a diverse farming activity and requires human capacity in a multitude of scientific disciplines. A national survey was undertaken in 2009 and updated in 2011 and 2013 to determine the number of diplomands and graduates in all disciplines that have a bearing on marine aquaculture. The findings are shown in Table I and show that the country has an impressive number of people with hard science qualifications that could make a contribution to the development of the aquaculture sector. However, there is a clear need for more people that have advanced degrees and / or training or technical qualifications in marine aquaculture, particularly in the fields of fish breeding, husbandry, nutrition and fish health management. It should be noted that these skills requirements have been identified and are currently being addressed very seriously by the CEO and the HR division of the Seychelles Fishing Authority. It is anticipated that the SFA will be fully skilled in aquaculture disciplines within five years to fully support the development of the sector.

**Table I.** Science graduates in Seychelles and their distribution by employment sector.

Qualification	Government	Private sector	International Programme	NGO / Other	Total
Higher Diploma	2	3	1		6
BSc	25	2	3	6	36
BSc Honors	1				1
MSc	2	2		4	8
PhD	1			2	3
BVS	6				6
<b>Total</b>	<b>37</b>	<b>7</b>	<b>4</b>	<b>12</b>	<b>60</b>
<b>Percent</b>	<b>61.7</b>	<b>11.7</b>	<b>6.7</b>	<b>20.0</b>	<b>100</b>

## **11. AQUACULTURE AWARENESS / EDUCATION STRATEGY**

In developing any new sector the responsible authority has to be mindful of public perceptions and how this might impact on the proposed development. This is particularly important for SIDs in which artisanal fishing plays a major role in the life of many islanders. Moreover, stakeholder support has to be maintained to reduce the potential for conflict, raise awareness among other food producers (e.g. fishers, farmers) and users of the maritime and coastal environments (e.g. dive tourism operators, fishermen).

For this reason an aquaculture awareness/ education plan has been developed that will be rolled out even before a call for investment is made. The plan was developed in November / December 2013 and is based on the outcomes of a comprehensive socio-economic study under the leadership of the chief economist of SFA.

The educational programme will focus on all sectors of society and will be implemented through the development of education material and transferred to society through youth groups, educational institutions, at festive occasions, community meetings, vocational promotions, civil society organizations, NGOs, the world wide web, social media as well as through newspapers and radio and television.

## **12. ROLE OF PRIVATE AND PUBLIC SECTOR IN SECTOR DEVELOPMENT**

As mentioned elsewhere in this report, the establishment of the Mariculture Liaison Committee has created the space in which to develop the Master Plan in a fully transparent manner. The Mariculture Liaison Committee is representative of all possible public and private sector stakeholders. On completion of the Master Plan a new committee, called the Mariculture Steering Committee (MSC), will be formed. The members of this committee will be appointed by the Minister and the CEO of SFA will be the Chair. The MSC shall be comprised of ten members as follows:

1. the CEO of SFA,
2. the SFA Principal Aquaculture Officer,
3. the SFA Chief Economist,
4. two representatives of mariculture operators,
5. a representative of the Chamber of Commerce,
6. a representative of the Island Development Company (for matters pertaining to the regulation of aquaculture on Islands managed by the IDC),
7. a representative of the Ministry of Environment and Energy,
8. a representative of the Ministry of Finance,
9. a representative of the Environmental NGO's.

and the MSC will have the following functions;

- advise the Minister on matters relating to aquaculture;
- keep any aquaculture plan approved by the Minister under continual review;
- keep aquaculture policy approved by the Minister under continual review;
- advise the Minister on any policy changes that may be required;
- advise the Minister on the establishment of Aquaculture Development Zones;
- Promote continual improvement of better aquaculture practices and prepare and update guidelines;
- Inform the Minister on the issuing of codes of practice for sustainable aquaculture;
- Where required, the MSC may assist the Regulator in the evaluation of applications to conduct aquaculture.

The composition and functions of the MSC appear as Regulation 6 and 7 of the Marine Aquaculture Regulations. The SFA attaches great importance to a transparent process for the development of the aquaculture sector.

### 13. CREATING AND ENABLING ENVIRONMENT

Creating an enabling environment is probably one of the most important ways in which to attract investors. Based on this premise, a new, streamlined application system has been developed with a single entry and exit point. While there may be some generic similarities with application processes in other countries the system has basically been custom designed on the back of a system that is unique to the Seychelles.

Detailed guidelines have been prepared to assist potential investors in the preparation of their business plans, the headings and contents of which are shown below. Given the high international failure rate of many start up aquaculture operations the guidelines have been drawn up in such a manner that applicants will have to show due diligence in the development of both the technical and financial components of their business plans.

#### *Executive summary*

The Executive summary must provide a brief description and summary of all aspects of the business plan (including farm production forecasts and business profitability). (Maximum length = Three A4 pages).

#### *Technical component*

The technical component of the business plan shall give consideration to:

- A. Species, farming technologies, bioplanning, processing and personnel requirements
  1. The species of interest
  2. An explanation why a particular species have been chosen as candidate species, a description of the species and a summary of what is known about the farming of this / these species.
  3. The intended scale of production
  4. A detailed description of the farming techniques to be employed.
  5. A detailed description of all sea based and land based infrastructure and equipment requirements
  6. Planned broodstock holding facility and its reticulation
  7. Detailed description of hatchery operation (including production targets and forecasts)
  8. Description of the movement of seed stock from hatchery to cage/ growout facility
  9. Type and source/producer of feed for various life history stages as well as detailed FCR forecast at each stage of the farming operation
  10. A detailed bioplanning schedule that provides forecasts of fish production in tonnes, mortality, FCR, fish growth, stocking densities etc. for the first five years of operation.
  11. Description of processing procedures and facilities.
  12. Description of staff requirements for the operation (the applicant and an a detail the number of staff the operation will employ at each level and distinguish between local and foreign employees and indicate their respective skills requirements and proposed payment levels) including:
    - a. Senior management positions (qualifications and skills required).
    - b. Middle management requirements (qualifications and skills required).
    - c. Scientific staff (qualifications and skills required).
    - d. Operational staff (qualifications and skills required)
    - e. General workers
  
- B. Animal health, food safety and public health
  1. The technical component of the business plan must demonstrate that the design and layout of the aquaculture facility is such that it will accommodate the environmental requirements of the species applied for and that there is a low risk of unforeseen incidents resulting in damage or distress for the farmed animals to occur.

2. The technical component of the business plan must show a system of internal operational control routines, setting out how operational responsibilities and key parameters will be monitored, logged, documented and kept on record, including (but not confined to) –
  - i. Ensuring that regulations pertaining to fish farming are easily available to and understood by all staff.
  - ii. Ensuring that all staff is adequately trained in and familiar with the internal operational control system.
  - iii. Ensuring that all staff members are familiar with the organizational structure of the operation and with their respective roles and responsibilities therein, including (but not confined to) –
    - a. Inspection, cleaning and other maintenance of aquatic and terrestrial operational infrastructure/ equipment;
    - b. Introduction of fingerlings/juveniles into the farm;
    - c. Feeding of fish (if applicable);
    - d. Sorting of fish including the removal of dead fish;
    - e. Harvesting and killing/slaughtering of fish for marketing;
    - f. Processing of fish;
    - g. Transporting of fish;
    - h. Monitoring of animal health;
    - i. Monitoring of water and sediment quality;
  
3. The technical component of the business plan must describe an emergency plan specifying preventative or mitigating measures and their practical implementation to deal with events of e.g. outbreak/spreading of infectious disease, mass mortality, breakdown of moorings, cages, nets or other operational infrastructure, changes in water quality, or other critical situations

#### C. Environmental integrity

1. The technical component of the business plan must demonstrate how the fish-farming operation will –
  - i. Result in minimal or least possible conflict with other legitimate users or interest groups.
  - ii. Not significantly compromise the environmental integrity of the water column or the seabed. Information that must also be specified for sea based areas not within designated Aquaculture Development Zones includes (but is not confined to) –
    - a. Data on current direction and speed;
    - b. Bottom topography, type and condition;
    - c. Planned annual production of fish and its distribution over a twelve-month calendar;
    - d. Planned feed type and annual use thereof, and distribution of the use over a twelve-month calendar period.

#### **Financial component**

The financial component of the business plan must be as detailed as possible and must give consideration to -

1. Detailed cost per component, land, building, equipment, seabased equipment, etc.
2. Cashflow projections for the first five years and financial indicators (IRR and NPV). **All spreadsheets must be submitted in soft copy and must be active**
3. Projected profit and loss accounts for first 5 years. **All spreadsheets must be submitted in soft copy and must be active.**
4. Investment, equity and loan/ financing plan for the first five years of operation.
5. Financial and other guarantees for the development of the operation.

## 6. Description of proposed markets, detailed information on product price and verifiable offtake agreements.

On condition that the application has been prepared with due diligence, it is anticipated that the entire application process will take in the region of 4 months from acceptance of a properly completed application to final allocation of the license.

## 14. FISCAL INCENTIVES

Aquaculture is a globally competitive space. There are numerous countries within the WIO region (Western Indian Ocean) vying for the same international aquaculture investor base. The Seychelles recognizes that it will need to present a strong investment case including attractive Fiscal Incentives, if it wishes to compete for these investors.

By employing only 10 and 20% of the identified suitable offshore aquaculture sites it is estimated that the potential production volume of fin-fish around the inner islands of the Seychelles ranges between 21 600 and 78 700 tonnes per annum. Based on a suite of input variables the sector would be valued at between 10% and 38% of the 2012 GDP, respectively. At these levels the sector has the potential to create between 880 and 2700 new jobs, depending on how fragmented or consolidated the new sector is. These estimates exclude further increments related to potential investments within and extraneous to the value chain, such as in feed manufacture, technology and logistics.

The significant economic and export contribution that an aquaculture industry would make, justifies some “breathing space” in order to establish a new sector. It has therefore been recommended that the investment incentives listed by Seychelles International Business Agency will go a long way to portraying the Seychelles as an attractive and competitive investment destination for export orientated aquaculture.

With business plans for large aquaculture investments traditionally being run over a 10 year period, it was further recommended that the incentives be applicable for a minimum for the first 10 years of operation of a new aquaculture business. The incentives should not differentiate between the various components of an aquaculture business and the incentives should be equal for hatcheries, nurseries, grow-out facilities and processing centres, since they will all be required in order to have a successful industry.

Consideration should further be given to how strategic investments in key inputs and services required for a competitive aquaculture industry, can also be incentivised to establish in the Seychelles.

These proposals have been put forward to the Ministry of Finance for approval.

## 15. HARVESTING, PROCESSING, MARKETING AND DISTRIBUTION SYSTEMS

The semi-industrial fishing sector in the Seychelles is well organized and is export orientated. There are several processing factories on the Island and an additional 9 factories under construction. At this stage it is envisioned that finfish produced on farms would be processed under joint ventures in these factories. High value fish from Seychelles are exported to several countries in Europe, the UK, Mauritius, Japan and the Middle East.

## **17. IMPLEMENTATION OF INTERNATIONAL GUIDELINES OR INSTRUMENTS FOR SUSTAINABLE AQUACULTURE DEVELOPMENT**

In drawing up the Regulations and the Guidelines for Finfish Farming in Seychelles as well as the Fish Health Management Guidelines, the Hatchery Bio-security Protocol and the Guidelines for Business Plan development and for Environmental Monitoring we drew heavily on the outputs of similar exercises elsewhere in the world. In particular, the regulations and guidelines as proposed and or which are in force in the UK (Scotland in particular), Canada, Norway, South Africa, Australia, New Zealand and Oman. It should however be mentioned that the regulations of any one country do not exactly fit the Seychelles shoe, such that the Regulations as well as the Guidelines had to be custom crafted to fulfil certain frame and legislative conditions and to ensure that aquaculture is practised under Best Management Practices. Detail as to the contents of the Guidelines and Protocols have been provided elsewhere in this report.

## **18. DATA COLLECTION AND RECORD KEEPING AT FARM LEVEL AND ACROSS THE REPORTING HIERARCHY**

Data collection and record keeping is recognized as being pivotal for individual farm management as well as sector management. For this reason an entire part of the Marine Aquaculture Regulations has been devoted to Monitoring and Reporting. It remains to be seen whether the proposed system will work or whether it needs to be adjusted.

## **19. LESSONS LEARNT**

- Essentially Seychelles finds itself in the fortunate space where it is able to develop a Master or Sector Development Plan prior to the development of small, medium and large-scale commercial aquaculture. This has several advantages, most important of which is that it provides the responsible authority with the space to think carefully as to how the sector should look like in future, how to get there and how to attract sustainable investments. This process, as opposed to post hoc sector development planning, also allows the responsible authority to reflect on the mistakes made by other countries and to conceive mitigating strategies to avoid similar mistakes happening in its own back yard. Moreover, the ability to plan prior to large-scale investment means that there is no pressure from an existing sector. Small Island Developing States are, by the very nature of their size and the need to provide for growing populations, fragile ecosystems. Seychelles is no different and this juxtaposed with the economic importance of the tourism industry means that any new industrial sector must be planned and ultimately developed in an environmentally responsible manner that does not jeopardize other economic sectors. This can only be achieved if planning precedes development.
- In drafting the Marine Aquaculture Regulations the Seychelles has learnt from the mistakes made by others and the shortcomings of regulations elsewhere in the world. Examination of such shortcomings has revealed that in most instances planning was done in a top down manner. It was for this reason that Seychelles decided to make the Mariculture Master Planning process as participatory and transparent as possible. The benefits of this approach have been enormous and the public as well as the private sector and civil society have made significant contributions in developing the Regulations.
- In developing the regulatory framework Seychelles has drawn heavily from the frameworks developed in other countries in Europe, North America, Australasia and other countries in Africa. This allowed for the extraction of “the good” and the rejection of the “not so good” and the drafting of a custom designed development plan and regulatory framework that falls within the desired environmental guidelines of society.

- Operating any commercial venture in common public space without clearly defined rules must lead to discord. The case in point from Seychelles is the Pearl Farm on Praslin. The regulatory framework that is currently being finalized will hopefully resolve the issue. The lesson learnt is that - to allow an industry to develop in a space where planning is inadequate and in the absence of a regulatory framework must “end in tears”. This in turn illustrates the importance of participatory and transparent planning.
- Finally, there is perhaps a lesson to be learnt from the prawn farm. Seychelles was one of the pioneering countries to produce top quality tiger prawns in full strength seawater ponds. This happened at a time when the price of prawns was favourable. Change occurred in about 2004 when India was able to outcompete any other prawn producing country on price and this had a major impact on the Coetivy prawn farm. There are other contributing reasons why the farm was closed but the low price of Indian prawns took its toll on tiger prawn farms globally and Seychelles was no exception. The principle lesson to be learnt here is the need for management to plan and adapt to predictable realities and to undertake rigorous sensitivity analyses in the development of business plans.





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