

## SEYCHELLES ANNEX IV. AREAS OF CONCERN

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### 2. BIOPHYSICAL ENVIRONMENT

#### 2.1 Description of the coast and distinctive features

There are various biodiversity hotspots throughout the Seychelles that are potentially of concern. Some of these are quite remote places with very little human interference such as some outer islands due to difficulty for landing while others are threatened by various anthropogenic pressures as a result of their proximity to human population. The most threatened habitats are found around the inner islands which are the most populated. Various development pressures along the coast, especially for tourism purposes are currently posing threats to diverse marine habitats located along the coasts.

#### 2.2 General description of the climate

#### 2.3 Marine and coastal geology and geomorphology

##### Coastal erosion

All of Seychelles islands are considered as coastal zones due to limited land area (~455km<sup>2</sup>) and its homogeneity (Shah, 1995; Bijoux *et al.* 2008). The total length of the coastline is 491km (The World Fact Book, 2008) so with increasing socio-economic development and increased pressure on the coastal environment, there is very limited flat land. As a consequence of this, since 1973 until now, major reclamation works off Victoria and the East coast of Mahé have been carried out to meet flatland demands for additional development and urbanization (Bijoux *et al.* 2008). Coral rubble is used as fill during reclamation and this process of extraction causes erosion on one side and accretion on the other, damages the benthic habitat and alters the coastal and nearshore hydrodynamics (Pulfrich *et al.* 2006).

Coastal erosion is a problem caused mostly by the change in wind and wave patterns during the monsoons as well as unregulated coastal development. Other triggering activities include inapt infrastructural development. Synergistic interactions of spring tide and surges further exacerbate coastal erosion. Receding beachfront and high water mark develop as a result of this. Coastal dynamics and geomorphology of some of the beaches have not help to reduce erosive actions on the some parts of the coastal zones. The prevalence of coastal erosion is more likely to follow the existing trend and further escalate as a consequence of global and local natural and anthropogenic changes. As mitigative measures to reduce or lessen these impacts, sea walls and breakwaters were built in low-lying areas to deflect and reduce wave actions and further degrading coastal areas. However, hard erosive barriers provide only a certain degree of protection. Other actions taken included the rehabilitation of coastal vegetation in cleared beachfronts. The Department of Environment initiated the beach profiling and monitoring activity in 2004 (Bijoux *et al.* 2008). This monitoring programme involves the collaboration of various hotel owners, local authorities and NGOs dealing with coastal issues. Data collated is computed using special software which can provide current status trends and likely scenarios for the future.

##### Mineral exploration

The first detailed oil exploration took place in 1969 but nothing concrete was recorded. However, following the successive well and geophysical study carried out in 1973, a noticeable block faulted sequence overlaying a flat-lying sequence similar to rift-drift succession was located (Seychelles Investment Bureau, 2009). By 1994, 23,150km of seismic profile and 27,900km of aeromagnetic lines were accumulated. In another detailed study carried out by Stephens (1992), it was concluded

that minerals found in Seychelles is not strongly mineralized and have low mineralization potential, though there may be significant mineral deposits. Another active oil exploration took place in 1995, but no discovery of commercially important petroleum products even if sightings of tar balls from subsurface seeps were recorded on some of the beaches around Mahé and Coetivy Island (WIO-LAB TDA, 2008). The government of Seychelles is keen however to encourage foreign oil companies to partake in hydrocarbon exploration survey through the Petroleum Mining Act of 1976. Permission to participate in such activity must be sought prior to commencement and this entails a series of economic and legal terms for exploration and production. (Seychelles Investment Bureau, 2009).

## **2.4 Freshwater resources and drainage, including rivers, estuaries, deltas and coastal lakes**

As the population grows, the need for more houses arises and thus development is inevitable. The roof of these houses, being impermeable, convey additional water into the natural drains of these areas, which in-turn, discharge the water into the artificial drains and into the main drainage systems of the lower area. This was a recognized fact when the LTD was carrying out the Victoria Drainage De-siltation Project. Based on that, it is therefore necessary to cater for this increase in the volume of water flowing into the lower drains. Another effect of the upper region developments is the disturbances of soil materials, which is carried by moving water and are deposited into the lower areas, where the flow of water slows down. As a result, excessive silting of the lower part of rivers occurs, which restrict the capacity of these main drains, leading to flooding along the coastal plains during heavy rains.

## **2.6 Chemical and Biological Oceanography**

### **2.6.1 Nutrients**

High nutrient inputs in areas such as Port Victoria can lead to the formation of algal blooms if the conditions are favourable. This can have subsequent effects on the marine life, notably eutrophication.

### **2.6.2 Persistent organic/ inorganic pollutants**

Port Victoria has been affected by industrial pressure, especially with the fishing industry namely as a result of activities of the tuna canning factory and the loading, unloading and transshipment of goods. There are three main rivers flowing into Port Victoria, which alter the water quality and sediment in this area.

Furthermore, the Ste Anne Marine National Park is an area of significant importance with regards to environmental issues and the tourism industry. Its proximity to the Port Victoria means that the park can potentially be affected by the pollutants from the port area.

### **2.6.3 Primary production**

With the increasing concern over the process of climate change and its effects around the world, especially on small island states such as the Seychelles, there is a need for studies examining the shifts in phytoplankton distribution and assemblage that as a result of changes in the normal proliferating conditions. Such changes can lead to shifts in ocean's primary productivity which might have subsequent effects on the distribution of pelagic fishes, thus potentially affecting the fishing industry. Such impacts and have both top-down and bottom up setbacks of the ecosystem. The occurrence of harmful algal blooms (HABs) leads to oxygen depletion in the water column, thus resulting in extensive deaths of fish and macro-benthos due to eutrophication. Such events can have short term adverse effects on the marine organisms and subsequent effects on coastal fisheries and livelihoods.

#### **2.6.4 Secondary production**

With the increasing concern over the process of climate change and its effects around the world especially on small island states, there is a need for studies examining the possibility of shifts in the distribution and assemblage of zooplankton. It is believed that evidence from climate change in marine communities will first appear in the zooplankton with respect to species range and population. Hence, there is a need to closely follow species diversity in the zooplankton as it may have repercussion on fisheries and on many other marine habitats.

### **2.7 Coastal zone and continental shelf**

#### **2.7.1 Description and extent of coastal and marine habitats**

##### **Bleaching**

The most common threat to the Seychelles reef system is coral bleaching (Sheppard, 2003). As was the case with many tropical areas around the world, the bleaching of corals in the Seychelles took place following the El Niño's event of 1997/1998. (Ahamada, 2004). The event was more apparent around both the inner (granitic) and outer (coralline) islands of the Seychelles (Bijoux *et al*, 2008). Prior to the El Niño event, most corals around Seychelles were in a healthy state (Salm *et al*, 1998). The recovery of corals in Seychelles has been slow in comparison to other regions (Ahamada, 2004). In Seychelles, some areas have been faring better than others with the inner islands doing much better than the outer islands (Bijoux *et al*, 2008). It must be noted that the inner islands were much more affected than the outlying islands of whereby the bleaching was variable (Spencer *et al*, 2000; Turner *et al*, 2000).

##### **Acidification**

Not much work and studies has been carried out in Seychelles where acidification is concerned. Brief studies conducted in the late 90's to date suggest that the ph level around the coastal hotspot areas around the main island of Mahé to be within the normal expected range as defined by regional guidelines. The ph level was found to be around 7.7 and 8 (Seychelles Bureau of Standards, 2009).

##### **Destructive fishing methods**

Destructive fishing methods are illegal in Seychelles waters. This has been the case since the introduction of the Fisheries Act which became operational in 1986. Even before the introduction of the act, destructive fishing methods were not commonly practiced in Seychelles. For instance, it is illegal to be in possession of and use explosives such as dynamites here in Seychelles, thus the local fishermen have never been inclined to opt for such fishing method. As for trawling, given that Seychelles economy relies heavily on tourisms, environmental protection and conservation are of crucial importance. Bottom trawling damages coral reefs and other substrates hence is highly prohibited in Seychelles. Pelagic trawling is a very unselective fishing mode with a high level of by-catch which may include charismatic species such as dolphins, turtles and sharks. Other destructive fishing methods such as spear guns and pelagic drift nets are also prohibited. On the other hand, due to Seychelles having an extensive Exclusive Economic Zone of ~1.30million km<sup>2</sup>, and with limited surveillance resources, illegal, unreported and unregulated (IUU) fishing activities occur, up to a certain extent, in the Seychelles water. In the past, some fishing vessels have been confiscated and fined for illegal activities; however, the resources required for monitoring and surveillance are astronomical for a developing state with a small economy like Seychelles (Seychelles Fishing Authority, 2009).

##### **Coral mining**

Coral mining was practiced in the Seychelles long ago, mostly to be used in construction. Some coral were also removed for curio trade. These practices ceased to exist about forty to fifty years ago with

the introduction of new, cheaper and readily available building materials on the local market. It is highly prohibited to leave the country with any form of corals due to the different conventions protecting corals to which Seychelles is party to, for example, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The only movement of corals, of any sort these days, is through coral transplanting which is used to re-populate areas whereby the original corals have died.

#### Sand mining

Sand mining is a process which was previously practiced in Seychelles to be used in the construction industry. However, this is no longer the case. With the introduction of crusher dust (crushed granite), the use of sand has declined dramatically. This is due to the fact that the crusher dust is much better for construction purposes. However, with the ever increasing prices of the crusher dust, it has been proposed (not yet approved) to dredge a certain amount of fine sands along the sea bed for local construction use. When sand mining was practiced, the sand was taken from dedicated areas along the coastal plateaus and never on the beaches. There were between five to ten sites. Although the practice has ceased, sand is still being used for certain activities whereby crusher dust cannot be used. This includes tourism display, certain type of sports (inland beach volleyball, etc). The amount of sand used in such cases is less than a metric ton per year. The removal of sand is controlled and governed by the Sand and Gravel Act. Any transport seen transporting sand without a permit would be stopped and the driver or owner fined (Ministry of National Development, 2009).

#### Seagrass clearing/beach cleaning

Seagrass clearing is an activity which is neither encouraged nor practiced extensively in the Seychelles. Exceptions have however been made for the removal of small patches of seagrasses to create bathing areas close to a few hotels. Permissions were sought from the Department of Environment and the areas verified before permissions were given. With regards to beach cleaning, the Landscape and Waste Management Agency is the main body responsible for this task on the main inhabited islands of Seychelles. They oversee the beach cleaning on the island of Mahé, Praslin, La Digue and Cerf Island. All of these islands are contracted out to private firms. Works include the removal of litter, all sorts of debris, dead animals and dried up algae washed up on the beach. The seaweed is stockpiled on the sand dunes and left to rot. All of the beaches of these inner granitic islands are covered in the contracts. The beaches are cleaned three times a week, depending on the location, number of beach users, number of hotels in the immediate vicinity and the beach size. As for the other private islands, especially those with hotels, the hotels and/or island owners normally take care of the beach cleaning. Depending on the sizes, it is mostly the beaches in the vicinity of the hotels and owners' property that are cleaned more regularly. As for the other Seychelles islands, especially the outer islands, these are mostly administered by the Island Development Company (IDC). The IDC workers posted on these islands are responsible for the upkeep of the islands. As most of these islands are uninhabited (apart from the workers), seldom visited and quite big relative to the number of workers, the cleaning of beaches is done less frequently and methodically than on the inhabited islands. Debris from the sea is the main cause of pollution on the outer islands' beaches (Department of Environment, 2009).

#### Urban expansion

With our expanding population, as is the case with most developing countries, urban expansion in Seychelles is also taking place fairly rapidly. However, there are only two areas which could be considered "urban" in Seychelles. Both are located on the main island of Seychelles, Mahé. The first being the capital Victoria and the second being a proposed town, Anse Royale. Victoria, which has long been in existence as the country main and only town (until recently) and port, has seen its expansion heading inland. However, Anse Royale, which has until recently been considered urban has undergone more environmentally sustainable development. Areas for residential, tourism,

commercial and educational purposes have been clearly identified so as not to put additional stress on the coastal zones, thus preventing and minimizing any environmental impact on the coastal areas. Due to the populated islands' geomorphologic features (mountainous with coastal plateaus) and protection plan (mountainous parts normally falling into National Parks), local residences or rural expansions are taking place along the coast. This albeit, non urban and controlled expansion should still be taken into account for it could cause additional stress on the coastal areas if not monitored and controlled accordingly (Ministry of National Development, 2009).

#### Nutrient loading

According to recent studies carried out around a few coastal areas of Mahé, it was found that the amount of nutrients in those areas is lower than the regional guidelines. This may be due to the fact that the quality of waste water that is discharged in the sea is controlled by the effluent regulation under the Environment Protection Act. Nutrient loading does not seem to be causing any stress on the coastal and marine habitats in Seychelles (Seychelles Bureau of Standards, 2009).

## 2.9 Macrofauna (state of biological knowledge)

### 2.9.2 Fish and fish resources

#### Overfishing

The artisanal fishery is an open access fishery and with the lack of management controls these poses a threat for the sustainability of demersal fish resources. *Lutjanus sebae* is the most important commercially exploited demersal species in the Seychelles. It is caught mainly offshore on the Seychelles Bank by hook and line, although catches are also made with traditional heart-shaped bamboo traps set in coastal waters. The average annual landings of 282.9 Mt during the period 1987–2003 have approximated the sustainable estimate of annual yield at 380Mt (Lablache and Carrara, 1988). However, there has recently been a dramatic increase in annual landings to an average of 692.8 Mt between 2004 and 2006, associated with increased targeting by the artisanal fishery. Recent assessment of the Emperor red snapper (*Lutjanus sebae*) stocks showed that the stock is overexploited and that the sustainable annual yield of 380Mt is likely to have been over estimated. Recent artisanal catches is around four times higher than the new maximum sustainable yield (MSY) estimated at 208Mt (Grandcourt *et al.* 2008). The Emperor red snapper, which is considered a delicacy by both locals and tourists, is continually targeted by fishers since it fetches a higher price than other species on both the local and international market. It is clear that urgent management action needs to be introduced for *Lutjanus sebae* fishery. Recent attempts to introduce management measures for the fishery have failed mainly as a result of disapproval of the stock assessment results by fishers. Similarly, increased targeting in recent years has resulted in the stocks of inshore sharks being under threat of overfishing. In 2007, a National Plan of Action (NPOA) for the conservation and management of sharks was produced. The NPOA indicated that the shark fishery is substantially data deficient but that significant historical, anecdotal and fisheries-independent information suggest that inshore populations continue to be severely depleted (Seychelles NPOA Sharks 2007). Moreover, stocks of inshore sharks have been described as being depleted in recent fisheries reports (FAO Fisheries and Aquaculture report No. 899 2009). As part of the implementation of the NPOA several stakeholders meeting has been organized. Several research programmes are about to get underway with the aim of improving fishers knowledge and participation in the collection of catch data. Furthermore, the research will improve our knowledge on the ecology, biology and spatial dynamics of sharks.

The *Siganus sutor* stocks have also been described as being overfished (Fisheries and Aquaculture report No. 899, 2009). Relatively recent assessments of the stock showed that current fishing mortality greatly exceeded the optimal or limit reference values of fishing mortality. Research is ongoing to get a better understanding of the spatial dynamics of *Siganus sutor* at

spawning aggregations and in marine protected areas, so as to improve the management of this resource. Management of this species will also be addressed as part of a wider co-management project for the trap fishery under the GEF-UNDP Mainstreaming Biodiversity programme, which was finally approved by GEF in 2007 and began implementation in 2008. On the industrial side, there is major concern on the stock status of yellowfin and big eye tuna. Recent stock assessment conducted by the IOTC working party on Tropical Tuna in 2009, incorporating recently obtained data from the Regional Tuna Tagging Programme – Indian Ocean (RTTP-IO) revealed that over recent years the stock of yellowfin tuna has been over-exploited with catches averaging 343,000t (1992-2002 period). It was recommended that catches should not exceed the MSY (250,000 and 300,000t) levels estimated by the current assessment. The results of the stock assessments conducted for big eye tuna in 2009 were broadly similar to previous work. The 2008 exploitation levels for this stock (107,000 t) were within the range of estimated MSY levels (100,000 -115,000 t), however catches in the past (1997-1999) have significantly exceeded MSY. The Working Party on Tropical Tuna recommended that catches of bigeye tuna should not exceed MSY levels and that effort should be maintained at or below that of 2006 (IOTC-2009-WPTT-R)

#### Conflict between fishers and tourism activity

Inshore fishing activities often conflicts with tourism activities, in particular, dive operators and glass bottom boat excursionists. One such example is the conflict between the inshore shark fishers and dive operators. Both parties rely on sharks for their livelihood. Dive operators often have special sites where they take clients to observe shark in its natural environment. However, with the increasing fishing pressure, it has become increasingly difficult and rare to observe sharks in its natural environment. As part of the Seychelles NPOA on sharks, stakeholder meetings were organized and areas designated for fishing and diving were delineated. However, this remains an over the table agreement between the two parties which has not been formalized into any law or management plan.

#### Destructive fishing methods

Seychellois have long been environment conscious people and very early in the development of the fishing industry, destructive fishing practices have been prohibited. Dynamite and cyanide fishing has never been an issue in the Seychelles and spear fishing using propelled spears, and all type of trawling are banned.

#### Effects of Aquaculture

The aquaculture sector is not well developed in the Seychelles. Currently (2009) only one small scale aquaculture farm, the Ocean Farm Ltd, is in operation and produces black pearls from black lip oyster (*Pinctada margaritifera*) and giant clams (*T. maxima*) for the aquarium trade. The Coëtivy Prawn Farm for tiger prawns (*Penaeus monodon*), stopped its operation in 2008. However as demand for marine living resources increases and natural stocks diminish, the Seychelles Government has found it necessary to promote the development of the aquaculture /mariculture industry in the Seychelles. In early 2009, a scoping exercise to assess the potential for mariculture development was conducted and one of the recommendations from this exercise was the need for the Seychelles to develop a Master plan to drive such initiative. Seychelles is opting for caged mariculture because of the scarcity of land for based aquaculture.

The Master plan will guide existing and potential aquaculture/mariculture operations by identifying specific species, suitable sites and technologies which can then be used to set up aquaculture/mariculture operations.

#### Habitat Destruction

Coral bleaching events brought about by climate change which leads to changes in habitat complexity has had major effects on coral reef fish diversity in Seychelles. Studies by researchers from the University of Newcastle-upon-Tyne, Australia and the Seychelles have shown that the coral bleaching event in 1998 has altered the reef ecosystem. They reported local extinctions, substantial reductions in species richness, reduced taxonomic distinctness and a loss of species within key functional group of reef fish (Graham et al. 2007). The main families of fish that have been heavily impacted are the monacanthids, chaetodontids and pomacentrids. Species which they observed possible local extinction were *Labrichthys unilineatus*, *Chaetodon lineolatus*, *Plectroglyphidodon johnstonianus*, and *Thalassoma hardwicke*. In contrast species which they observed a reduction in abundance to critically low levels were *Oxymonacanthus longirostris*, *Chaetodon trifascialis*, *Chaetodon melannotus*, *Chaetodon meyeri*, *Plectroglyphidodon dickii*, and *Chromis ternatensis* (Graham et al. 2007). Research is ongoing to monitor the changes in reef fish assemblage and the recovery of coral reefs.

Dredging and reclamation in the marine environment has been and still is a controversial issue. A large part of Victoria as is known today is built on reclaimed land. There has been extensive reclamation since the early 1980s on the east coast of Mahé to create flat land which is a necessity caused by the small terrestrial area of the main island of Mahé coupled with its steep mountainous terrain which makes building on higher ground difficult. At present there are still small amount of land reclamation that are taking place mainly by individuals and far away from coral reef ecosystem.

### **2.9.3 Mammals**

- Over harvesting – All marine mammals are protected under the law in eth Seychelles and therefore harvesting is not a major threat. However, there are several incidents of poaching of dolphins every year but the number of occurrences is on the decrease.
- Pollution – Marine pollution is also not a major threat for marine mammals in the Seychelles. There may the odd occurrence of a minor spill of hydrocarbons in the open oceans but these are quite rare and their effect not too significant. However, with the increase in expeditions for oil exploration, there is an increase in the amount of sound pollution which can pose great danger to the cetaceans.
- destructive fishing methods – No form of destructive fishing method are allowed in eth Seychelles
- Habitat destruction – Most habitat destruction in eth Seychelles has occurred on the inhabited Inner Islands of the Seychelles archipelago and have mostly affected the immediate coastal marine environment. These include reclamation, sedimentation from runoff and alteration of the coastline. These however have minimal effect on the cetaceans.
- Effects of tourism – To date there are no tourism activities where viewing of dolphins and whales are being offered as a product. There has been one proposal for a dolphinarium but this was rejected.

### **2.9.4 Reptiles**

All marine turtles are protected under the law in eth Seychelles and as mentioned most the important nesting grounds also have protective status under the law. Although there are still incidents of poaching, especially of the greens in the outer islands and the hawksbill around the inner islands. Pollution is not a major issue but there has been various instances where marine debris has been swallowed by turtles or found entangled around the animals. There is also a major threat by coastal developments especially tourism related ones where habitats are either being destroyed or there are increased activities on beaches which were previously undisturbed. Sea level rise also poses a threat to the nesting habitats.

### 2.9.5 Birds

Prior to human settlement on the islands, it is likely that breeding populations were limited by habitat availability rather than food (Bijoux *et al.*, 2003). However, within the past hundred years, several factors have been considered to play a role in the declines in the population of seabirds in the Seychelles. These threats include human exploitation for food, habitat destruction/loss from land use changes such as coconut plantations, guano harvesting and the introduction of alien predators such as cats and rats (Feare, 1978; Bijoux *et al.*, 2003).

#### - *Human disturbances:*

A good example of a seabird affected by human disturbances is the red-footed Booby (*Sula sula*). Massive and continual declines in the global population have been observed (Burger & Lawrence, 2003). Although the Sooty tern *O. fuscatus* is the most abundant seabird that breeds in Seychelles (Burger & Lawrence, 2003), its eggs are also commercially exploited. The effects of this harvesting in Seychelles and management options have been investigated and are part of ongoing research in Seychelles (Feare & Doherty, 2004). Despite enforcement efforts to control the amount of eggs harvested, poaching still remains an issue, especially on the outer islands (Feare *et al.*, 1997; Rocamora & Skerrett, 2001). This is largely due to logistical and economical constraints.

This issue of poaching also applies to the population of Roseate Terns (*Sterna dougalii*) in Seychelles which also appears to be in decline (Burger & Lawrence, 2003). There have been several hypotheses on the causes of these declines. They include competition with the more abundant Lesser Noddies for food and egg poaching at the African Banks (Rocamora & Skerrett, 2001). Studies have shown that not only disturbances from poachers but uncontrolled, mass tourism can also affect breeding success of seabirds (Rocamora & Skerrett, 2001). Fortunately this is not an issue in Seychelles as of yet, as eco-tourism is promoted at length.

#### - *Pollution:*

Pollution problems with regards to seabirds within the Seychelles' EEZ are yet to be described in the literature.

#### - *Habitat loss:*

Habitat loss is a threat, especially in the inner granitic islands due to the ever growing human population coupled with the tourism industry (Rocamora & Skerrett, 2001). This includes land clearing and drainage of wetlands for developments such as housing. This can be exacerbated by the additional threat from global warming and sea level rise which can particularly affect the outer low-lying coralline island and the African banks where breeding colonies occur, as well as Bird and Denis Island (Rocamora & Skerrett, 2001).

#### - *Introductions and alien invasive species:*

Another threat to bird populations in the Seychelles is that of introduced plants and animals. Some introduced animals such as *Rattus spp.*, *Felis catus*, *Tyto alba* and *Acridotheres tristis*, have caused severe reductions in breeding populations through the predation of eggs, chicks and adult birds (Rocamora & Skerrett, 2001). For example, the Barn owl, *Tyto alba* particularly favours seabird colony islands and feeds on terns (Neville, 2009). Some seabird species such as *Gygis alba* are restricted on mostly rat free islands such as Cousin, Cousine and Aride (Burger & Lawrence, 2003). Introductions of other birds can also cause a problem through competition for food and other resources (Rocamora & Skerrett, 2001). The introduction of invasive plants can also have a secondary, indirect effect through habitat modification. For example, populations of *Sterna fuscata*



have suffered declines due to the replacement of indigenous vegetation on the islands where they breed with cultivations such as coconuts *Cocos nucifera* (Feare *et al.*, 1997).

- *Fisheries and fishing methods:*

The threat caused by the expansion of the commercial fishery within the Seychelles' EEZ is one that should not be ignored. This threat is yet to be quantified. However, the hypothesis is that industrial fishing will reduce the abundance of predatory fish which in turn will affect the food supply of seabird species (Rocamora & Skerrett, 2001). A good example is the Wedge-tailed Shearwater, *Puffinus pacificus* which feeds on schools of fish brought to the surface by predatory fish such as tuna (Burger & Lawrence, 2003).

- *Effects of fisheries:*

Procellariiformes species are most vulnerable to being caught by by-catch in longline fisheries (IOTC, 2009). These include albatrosses and petrels. Mitigation measures used within the IOTC to reduce seabird by-catch include night setting with minimum deck lighting, bird-scaring lines (tori lines) and weighted branch lines (IOTC, 2009).

However, it is important to note that within the Seychelles' EEZ, commercial fishing vessels are prohibited from fishing within the vicinity of multiple IBAs as these are already protected areas, e.g. Aldabra WHS. In addition, the universal method of using a tori line is used to deter feeding seabirds from longliners (*pers comm.*, Vincent Lucas, 7<sup>th</sup> Dec 2009).

- *lack of knowledge:*

The status of knowledge of seabirds for the granitic inner islands is generally quite sound, however, for the outer islands the quality of data is lower and in many cases out of date (Bijoux *et al.*, 2003). This is largely due to their remoteness and difficulty of access.

### **Conservation infrastructure:**

The Ministry of Home Affairs, Environment and Transport (MHAET) is the government agency responsible for all environmental matters and the conservation of fauna and flora in the Seychelles. The main laws covering the protection of nature in the Seychelles include;

- The Wild Animals and Birds Protection Act (1961) defines the basic regulations for protection and laws covering the exploitation of species and includes
  - The wild Birds Protection Regulations (1966)
  - The Wild Birds Protection (Nature Reserve) regulations (1966)
- The National Parks and Nature conservancy Act (1969)
- The Animals Disease and Imports Act (1981) which regulates the importation of exotic species.
- The Environment Protection Act (1994).

There are three main categories of protected areas relevant to seabird conservation in the Seychelles;

1) Special Reserves:

This category provides the highest level of protection to wildlife and its habitat as it bans all human activities except nature conservation and restricted ecotourism (Rocamora & Skerrett, 2001). There are four Special reserves in Seychelles. Three are in the inner granitics; Aride Island, Cousin Island (declared in 1975) and La Veuve Reserve on La Digue (declared in 1991). Aldabra atoll which was declared a Special Reserve in 1981 is found in the outer island group.

2) Marine & Terrestrial National Parks:

The main aim of the 6 Marine National Parks is to protect marine life, but they also protect seabirds and shorebirds. Fishing is banned in these parks and other human activities are controlled. The Morne Seychellois and Praslin terrestrial park are the largest protected areas of land in the inner granitic and can serve as a sanctuary to some birds.

3) Nature Reserves:

There are seven additional Nature Reserves, 2 in the Amirantes and 5 in the granitics that were declared under The Wild Birds and Protection Regulations (1966) for the protection of breeding seabirds. Unfortunately enforcement in these sites is lacking and are subject to poaching and disturbance.

4) Other Protected Areas: The African Banks was designated as an area of restricted access in 1987. This site is an important breeding area for some seabirds such as *Anous stolidus* and *Sterna dougalii*.

Other areas that are privately owned but unprotected by law, such as Cousine and Frégate, are carrying out rehabilitation projects and can offer protection to breeding seabirds (Rocamora & Skerrett, 2001).

## 4. COASTAL LIVELIHOODS

### 4.1 Small-Scale Fisheries

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• The geographical location of Seychelles in the migratory path of tuna in the Western Indian Ocean</li> <li>• Quick access to and from all major tuna fishing grounds</li> <li>• Large continental plateaux rich with demersal and pelagic fishery resources</li> <li>• Well developed infrastructures</li> <li>• Located outside the cyclonic belts for almost all- year- round fishing</li> <li>• Well connected by major airlines for export market</li> <li>• Stable economic/investment environment</li> <li>• Marine living resources are being managed in a sustainable manner</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Involve high capital investment and relatively high operating costs</li> <li>• Low economic return in some sectorsLack of experienced and reliable labour force</li> <li>• Low recruitment factor and aging workforce</li> <li>• Wrong perception of fishermen as a low status job</li> <li>• Low level of education of most fishers hence inability to properly manage their business</li> <li>• Occasional lack of materials</li> <li>• Lack of initiatives with regard to value added products development</li> <li>• Lack of effective marketing strategies</li> <li>• Limited processing and exporting companies</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• Potential for further exploitation of resources in deeper waters and offshore banks</li> <li>• Good potential to venture into resources of small pelagic currently underexploited</li> <li>• Great potential to develop anchored FAD fishery for medium and large pelagic</li> <li>• Potential to develop more vigorous marketing strategies</li> <li>• Great potential to expand fish processing facilities (value added products)</li> <li>• Potential to tap into grading and labelling of Seychelles fish products</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• Over exploitation of high value species</li> <li>• Increasing competition from other countries for the export market</li> <li>• Piracy in the WIO (Somalian pirates)</li> <li>• Climate variability</li> <li>• Oil spills, (Seychelles lies close to a major shipping channel in the WIO)</li> <li>• Increase in oil prices</li> <li>• Reduce investment in the sector as government subsidies and incentives erode</li> </ul>

### 4.2 Tourism

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Tourism development has always been in the hand of the private sector</li> <li>• Some products such as small hotels with less than 10 rooms, tourist guide, taxi business, car hire to name a few are reserved for Seychellois only</li> <li>• The Department of Environment is well respected and executes its mandate relatively effectively</li> <li>• Environmental public awareness has been highly promoted and much increased over the last 15 or so years</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Limited understanding of local operators of the importance and advantage of sustainable practices in the industry</li> <li>• Limited engagement of communities to further the process towards sustainable tourism</li> <li>• Limited number of NGO's in promotion of sustainable tourism and practices in the industry</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• The small size of the country allows for relatively effectively administration of the sector</li> <li>• The Seychelles Tourism Board (STB) has well-established links with the private sector and the SHTA</li> <li>• A recent study to analyse the value chain links in tourism has identified gaps and made recommendations on how best to address these.</li> <li>• A sustainability label for the tourism sector has been developed and is ready for implementation</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• The 'carrying capacity' of the community in regards to tourism is limited and will affect the social fabric as well as the natural environment if not respected.</li> <li>• Sustainable practices in the tourism sector are only marginally integrated in operation</li> <li>• Capacity of the government is drastically reduced to monitor and evaluate tourism developments as much as operations</li> </ul>

#### 4.3 Mariculture

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• High quality sea water</li> <li>• Most demersal stocks over-fished</li> <li>• Recognition by fishermen of future problems with respect to local fish supply</li> <li>• Private sector recognition of the potential of the sector</li> <li>• International linkages and research cooperation established by SFA</li> <li>• High level capacity to screen and evaluate applications</li> <li>• Excellent investment incentives</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Low level bio-technical aquaculture capacity</li> <li>• Absence of a comprehensive assessment of opportunities</li> <li>• Low level appreciation and understanding of future fisheries scenarios by some statutory bodies</li> <li>• Absence of future fish demand analysis (particularly in view of increasing tourist numbers)</li> </ul>
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<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• Sea cucumber ranching (culture based fisheries) on outer Islands – if feasible could make significant contribution to GDP</li> <li>• Expansion of pearl culture</li> <li>• Sale of Coetivy prawn farm to private sector</li> <li>• Fin fish cage culture for local and hotel trade - small (50 ton) to medium scale (200 ton) per annum ventures</li> <li>• Aquarium fish and crustacean farming for the export market</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• Organs of state not fully aware that in future depleted fish stocks are likely to limit supplies, and that demand for fisheries products will not be met by the traditional capture fisheries</li> <li>• Controlling interests and dominance of public sector in business</li> </ul>
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#### 4.4 Agriculture and Forestry

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Very rich biodiversity and marine resource base, including World Heritage Sites, means awareness already exists of importance of marine and resource conservation for local dependence.</li> <li>• Strong tourist sector supports the economy, based around the natural resource base.</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Policies and legislation starting to come into place and improved coordination under the EMPS.</li> <li>• Projects and tourist interest in sustainable development can help support improved environment and natural resource management by communities, including capacity development.</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• Policies and legislation starting to come into place and improved coordination under the EMPS.</li> <li>• Projects and tourist interest in sustainable development can help support improved environment and natural resource management by communities, including capacity development.</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• Vulnerability of coral reefs to climate change threatens the main driver of tourism development and thus overall long term economic growth, including from unexpected phenomenon such as El Nino incidents.</li> <li>• Overall vulnerability to climate change means that Seychelles strongly affected by what happens in other countries, yet it is a small country (in terms of people and economy) so has little voice in international debates on mitigating climate change.</li> </ul>

#### 4.5 Energy

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Strong Government willing to develop upstream oil and gas activities</li> <li>• Transparent and clear GOS mandates and responsibilities</li> <li>• Wealthy African nation</li> <li>• Strong coastal management program</li> <li>• Special regulation for Oil&amp;Gas activities</li> <li>• Strong willingness to protect environment</li> <li>• Rich biodiversity</li> <li>• Economy dependant on tourism</li> <li>• Willingness to strengthen the workforce</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Seychelles consists of many separated islands.</li> <li>• Human Resource shortage</li> <li>• Weak capacity in EIA</li> <li>• GDP growth/capita&lt;1%</li> <li>• Public participation is weak</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• Existence of Investment facilitator</li> <li>• ICZM implemented</li> <li>• Policies and legislation starting to come into place and improved coordination under the EMPS</li> <li>• Future ecotourism development</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• Oil exploration side effects on marine ecosystem</li> </ul>

#### 4.6 Ports and Coastal Transport

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Stable government.</li> <li>• Good planning framework.</li> <li>• Strong fishing and tourism sectors.</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Relatively low GDP.</li> <li>• International competition for declining fish populations.</li> <li>• Proximity to Somalia.</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• Development of port for cruise ships.</li> <li>• Expansion of offshore financial sector.</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• Impacts of Somali piracy on shipping and cruise and fishing activities.</li> <li>• Reduced spending by main tourist sources.</li> </ul>

#### 4.7 Coastal Mining

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Strong coastal management program</li> <li>• Special regulation for sand and</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Seychelles consists of many separated islands.</li> </ul>
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gravel mining <ul style="list-style-type: none"><li>• No onshore mineral potential</li></ul>	
<b>Opportunities</b> <ul style="list-style-type: none"><li>• Existence of Investment facilitator</li><li>• ICZM implemented</li></ul>	<b>Threats</b>