Seychelles Mariculture Master Plan

Aquaculture Fact Sheet

Emperor Red Snapper

Lutjanus sebae

Compiled September 2015

Revised March 2019

by Advance Africa Management Services

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1. Background

Common names

Emperor red snapper — *English*
Bourzwa — *Seychelles Creole*

Biology and ecology

Emperor red snapper (*Lutjanus sebae*) is a tropical and subtropical reef-associated fish species of the Lutjanidae (snapper) family. It has an Indo-Pacific distribution from the east coast of Africa and the Red Sea to the western central Pacific Ocean, and latitudinally from Japan to southern Australia (Figure 1) (Smith and Heemstra, 1999; Grandcourt *et al*., 2008; Russell *et al*., 2016). It is found in coral and rocky reef habitats at depths of 5 to 180m (Allen, 1985; Anderson, 1986). Juveniles inhabit nearshore and mangrove areas, and coastal and offshore reefs (Allen, 1985; Williams and Russ, 1992), and small juveniles are often observed swimming between the spines of sea urchins as a means of protection against predation (Figure 2) (Allen, 1985). Adults are generally found offshore but do move into shallower waters during winter months in temperate areas of the species' distribution (McPherson *et al*., 1992; Williams and Russ, 1992). Emperor red snapper can be solitary, or form shoals of similar-sized individuals (Allen, 1985).

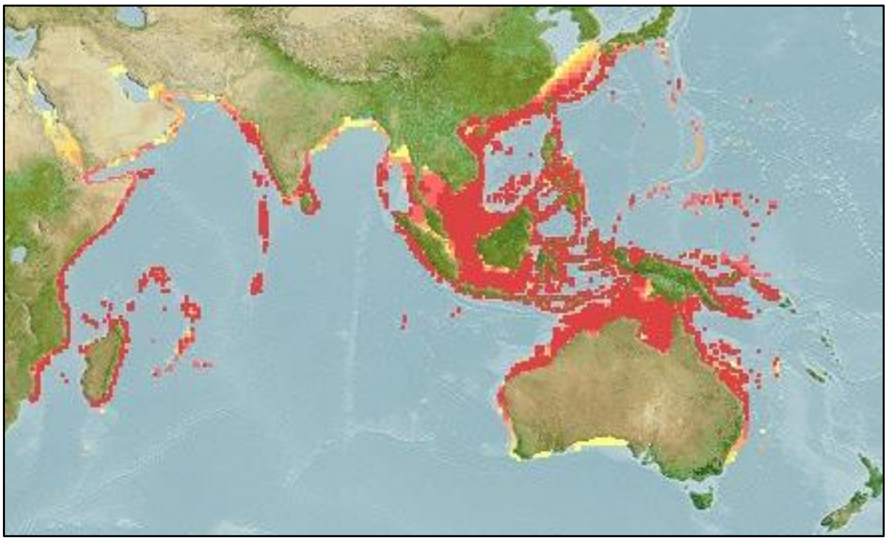

Figure 1: Natural distribution of emperor red snapper (Source: Fishbase, 2015).

Figure 2: Juvenile emperor red snapper amongst sea urchin spines in Indonesia (Source: Flickr.com).

Juvenile emperor red snapper are white with dark red vertical bands along the body, head and caudal fin (Figure 3A). Adults are paler red or pink, with faded vertical bands from the juvenile phase (Figure 3B), and larger adults become uniformly red. Emperor red snapper are long-lived and slow-growing, reaching a maximum length of 116cm total length (TL), a maximum weight of 33kg, and a maximum age of 40 years (McPherson and Squire, 1992; Newman *et al*., 2010). Their diet includes fish, crabs and other benthic crustaceans, and cephalopods such as squid (Anderson and Allen, 2001).

Figure 3: A) Juvenile; and B) Adult emperor red snapper.

Emperor red snapper is a gonochorist; individuals mature either as male or female. Males typically grow more slowly than females, but reach a larger size (McPherson *et al*., 1985; Newman and Dunk, 2002). The species is late-maturing, with an average size at sexual maturity of between 55 and 64cm (McPherson and Squire, 1992; McPherson *et al*., 1992; Mees *et al*., 1992), at an age of 8 to 9 years (Newman and Dunk, 2002; Grandcourt *et al*., 2008). It is a broadcast spawner and forms spawning aggregations (Grimes, 1987; Robinson *et al*., 2004; Russell, 2001). Spawning occurs year-round in equatorial waters, and seasonally during warmer months at higher latitudes (Druzhinin and Filatova, 1981; McPherson *et al*., 1992; Russell *et al*., 2001). In Seychelles, this species spawns year-round with peaks from March to May, and October to November (LaBlanche and Carrara, 1988; MRAG, 1995).

Fisheries

Snappers are highly regarded eating fishes, and are among the most important species in tropical and subtropical fisheries (Randall, 1995). They are typically targeted with handlines, traps, gillnets and bottom trawls (Anderson and Allen, 2001). A small component of snapper production supplies the Live Reef Food Fish Trade (LRFFT) in southeast Asia, however, snapper value in the LRFFT is relatively low; the average wholesale value of wild emperor red snapper was USD 15.00/kg in 2016, compared to an average of USD 60.20/kg for grouper species (HK Fish Net, 2017). The majority of emperor red snapper products are processed fresh or frozen (Sustainable Fisheries Partnership, 2018).

Globally snapper landings are increasing, with a catch of 229 170 tonnes in 2016 (Figure 4) (FAO, 2018). In the Indo-Pacific, Indonesia accounts for the largest proportion of snapper catches (55% in 2016), followed by Mexico, Philippines, Malaysia and Thailand (FAO, 2018).

The emperor red snapper is an important food and recreational species throughout its distribution (Newman and Dunk, 2002). It is marketed fresh, frozen and dried (Anderson and Allen, 2001). In the Seychelles, the Bourzwa is the most sought after eating fish. There are no global catch data available for emperor red snapper. It is, however, a highly-valued food fish and is probably targeted throughout its distribution. Additionally, emperor red snapper is the most popular snapper species in the global aquarium fish trade, with juveniles being sought after due to their striking red and white pattern.

Emperor red snapper is listed as 'Least Concern' by the International Union for the Conservation of Nature (IUCN), based on a 2015 stock assessment (Russell *et al.*, 2016). Population numbers were, however, found to be declining, and various aspects of its biology (such as its slow growth rate and late maturity) make it susceptible to over fishing (Newman and Dunk, 2002; Marriott *et al.*, 2007; Grandcourt *et al.*, 2008).

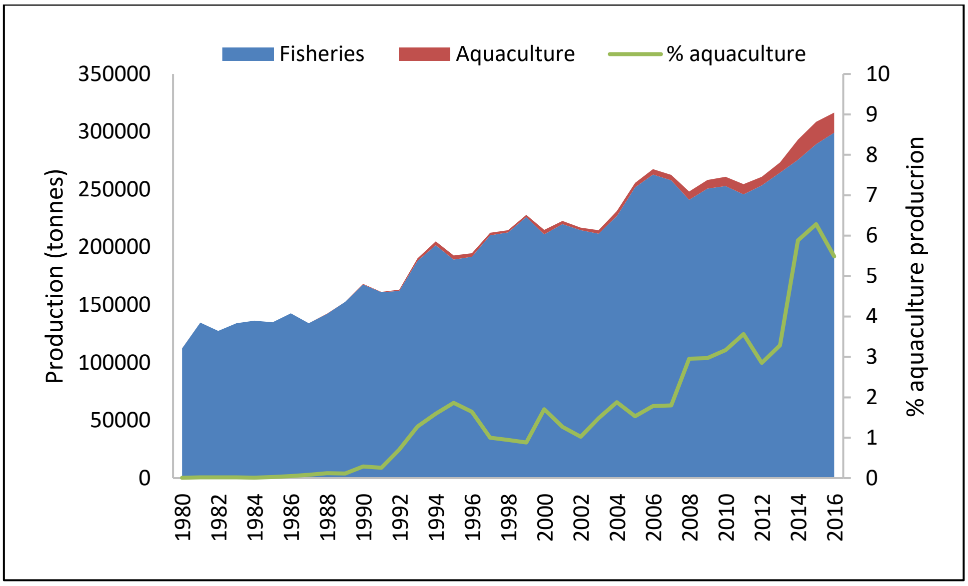

Figure 4: Time-series of global snapper production (FAO, 2018).

Seychelles emperor red snapper fisheries

Emperor red snapper is the most important commercially exploited demersal species in Seychelles, where it is referred to as 'bourzwa' or 'bourgeois', and is caught by artisanal fisheries using demersal handlines and winches (Grandcourt *et al.*, 2008; SFA, 2016; Hecht, 2018). The average catch of this species from 1987 to 2003 was 283 tonnes per annum (tpa) (Grandcourt *et al.*, 2008), which increased to an average of 815 tpa from 2004 to 2007 (SFA, 2014). Catches of this species have however shown a decreasing trend since their peak (1 077 tonnes) in 2007. The catch in 2016 was 200 tonnes (Figure 5) (Gutiérrez, 2015; SFA, 2014, 2016; Hecht, 2018).

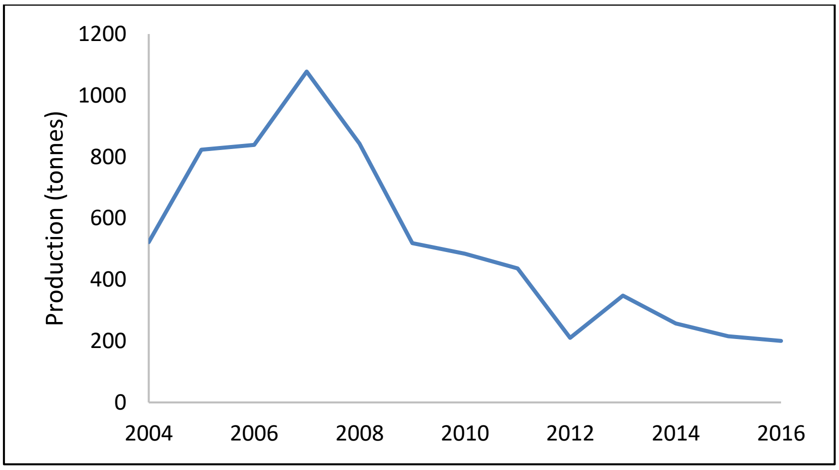

Figure 5: Seychelles emperor red snapper fisheries production, 2004 to 2015 (SFA, 2014, 2016; Hecht, 2018).

Emperor snapper is overexploited in Seychelles (Hecht, 2018). This is indicated by the declining catches of the species despite the expanding fishing grounds (Figure 5), the change in species composition (8% of artisanal catches in 2016, compared to 26% in 2007), and the high proportion of immature fish smaller than 65cm fork length in catches (43% in 2013) (Gutiérrez, 2015; SFA, 2016; Hecht, 2018). It was estimated by Gutiérrez (2015) that a maximum catch of between 148 and 162 tpa is sustainable to prevent stock depletion or collapse.

Aquaculture

Snappers are highly valued food fishes and, as such, attempts have been made to establish aquaculture technologies for a number of species since the mid-1980s, including:

1. John's snapper (*L. johnii)*
2. Common bluestripe snapper (*L. kasmira)*
3. Star snapper (*L. stellatus)*
4. Northern red snapper (*L. campechanus)*
5. Grey snapper (*L. griseus)*
6. Mutton snapper (*L. analis)*
7. Mangrove snapper (*L. argentimaculatus)*
8. Emperor red snapper (*L. sebae)*

Currently, snapper aquaculture production contributes a small percentage to total snapper production, with the majority still being obtained from wild fisheries; in 2016, only 5.5% of global snapper production was derived from aquaculture. However, aquaculture production has increased in recent years (Figure 4).

Snappers are currently farmed in Southeast Asia and Australia. Malaysia is the dominant producer of cultured snappers followed by Indonesia (Figure 6) (however data reporting to the FAO may contain some inaccuracies; Kongkeo *et al*., 2010) (Emata and Borlongan, 2003; Sanil *et al.*, 2011; FAO, 2018). Snapper production in southeast Asia is generally small-scale; many grouper-producing farms in southeast Asia have a small component of snapper production, and grow-out of snapper to market size is mostly in wooden marine cages and brackish water ponds (Sanil *et al*., 2011). This relies largely on the grow-out of wild-caught fingerlings; this is a constraint to successful and stable aquaculture ventures, and places further fishing pressure on wild stocks (Emata *et al*., 2003; Chi and True, 2017).

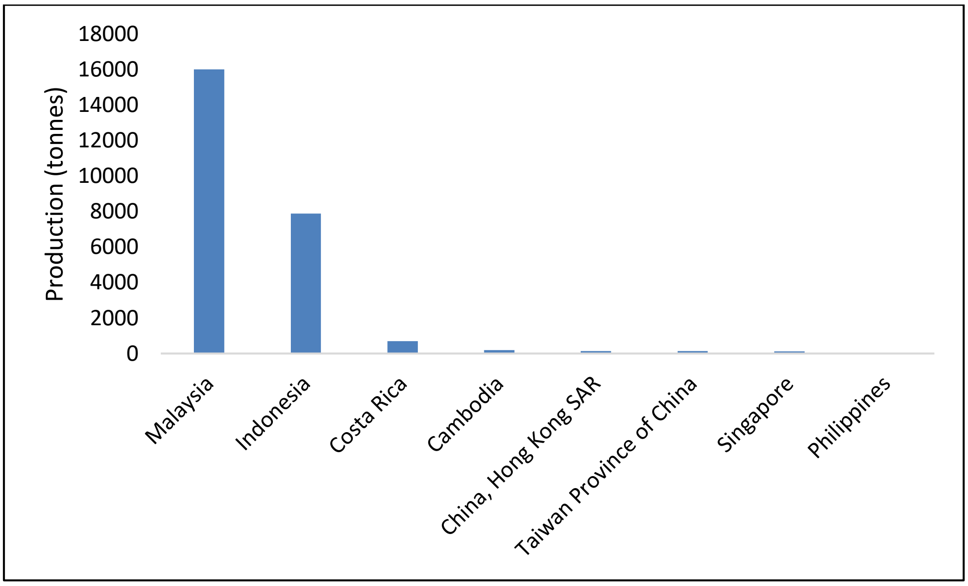

Figure 6: Snapper aquaculture per country in 2016 (Indonesian Fisheries Statistics, 2017; FAO, 2018).

2. Technical approach to aquaculture production

Production cycle

Emperor red snapper can be farmed entirely on land or, as will be the case in Seychelles, through a combination of land- and sea-based phases (Figure 7). Adult fish (broodstock) are captured from the wild and held in land-based tanks, where they spawn and produce eggs. After hatching, fish remain in a land-based facility during their larval and juvenile phases, after which they are transferred to cages in the sea for their grow-out phase, where they remain until they reach market size and are then harvested (Figure 7).

The land-based tank systems are typically a combination of pump-ashore Recirculating Aquaculture Systems (RAS) and flow through systems. The water that is pumped ashore is filtered before entering the tanks to remove pathogens and to provide optimal water quality for the fish. Similarly, effluent water leaving the tanks is cleaned in accordance with the relevant Seychelles Aquaculture Standard and global best practice.

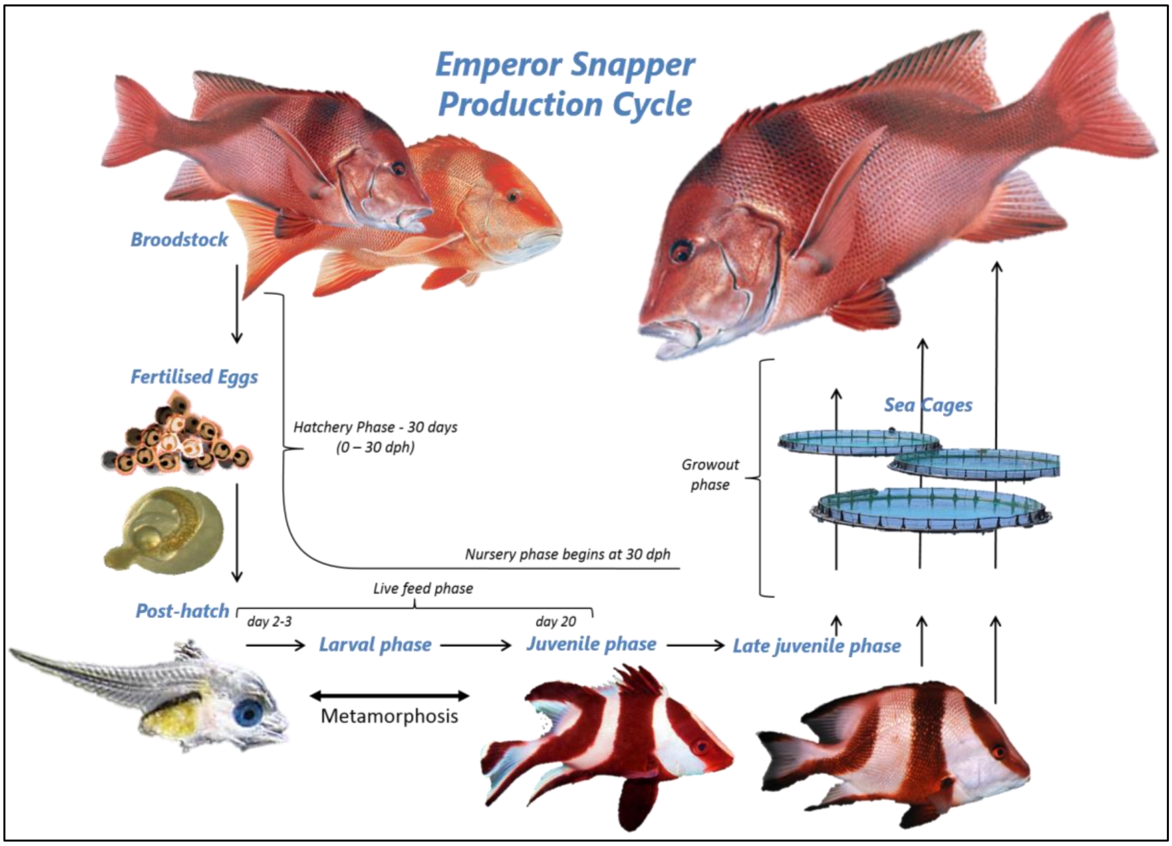

Figure 7: Production cycle of emperor red snapper

Broodstock

Emperor red snapper broodstock are captured from the wild and transported back to the broodstock acclimation and quarantine facility in specially designed broodstock transport tanks. They are placed first into quarantine tanks for one to four weeks to ensure that no disease or parasites enter the system and infect other fish (Madhu *et al*., 2013). When the quarantine process is complete, broodstock are moved into broodstock holding tanks. These fish are fed a nutritious diet for successful production of high-quality eggs and healthy larvae, which can consist of a combination of artificial pellets and fish and squid, which can be enriched with vitamins to maintain their health (Emata and Borlongan, 2003).

Once broodstock have acclimated to captivity, they are transferred to spawning tanks, with a sex ratio of one female to one or two males. Spawning can occur naturally within spawning tanks based on lunar cycles, or can be artificially induced, for example by using human chorionic gonadotropin (hCG) (Melaniawati and Suastika, 2006; Chi and True, 2017). During spawning, eggs and sperm from mature fish are released into the water where eggs become fertilised and float to the surface (Imanto *et al*., 2006). Fertilised eggs can be collected from the surface using fine-meshed skimming nets, and are transferred to larval rearing tanks for hatching (Emata, 2003). Emperor red snapper are able to produce eggs in captivity throughout the year under the correct environmental conditions, and can spawn every 14 days (Melaniawati and Suastika, 2006; Imanto *et al*., 2006).

Broodstock and spawning tanks are cleaned regularly to maintain a high level of water quality and prevent disease or infections in broodstock and eggs (Madhu *et al*., 2013).

Larviculture and nursery phase

Fertilised eggs are stocked into larval rearing tanks (Figure 8A). Larvae hatch from eggs approximately 22 hours after fertilisation, and are between 2 and 3mm in length at hatching (Melaniawati and Suastika, 2006; Imanto *et al*., 2006; Meliniawati and Aryati, 2012).

At 2 to 3 days after hatching, emperor red snapper larvae begin to feed. It is important that the correct nutritional food source is available in their rearing tanks, and a diversity of live feed is provided from the beginning of the larviculture stage (Emata *et al*., 2003; Meliniawati and Aryati, 2012). The live feed organisms are introduced in overlapping phases to meet nutritional requirements as larvae develop and grow. Live feeds include microalgae, rotifers, copepod nauplii and artemia (Figure 10) (Leu *et al*., 2003; McKinnon *et al*., 2003). Formulated pellet feeds are introduced together with the live feed towards the end of the nursery phase at day 30, as fish are fed only pellets during the grow-out phase, and by day 40 fish have typically been weaned onto a diet of only pellets (Leu *et al*., 2003;). By day 30, larvae have metamorphosed into juveniles of 17 to 18mm in length, and are transferred to nursery tanks (Figure 9, Figure 8B) (Emata, 2003).

Figure 8: A) Larval rearing; and B) Nursery tanks in a land-based facility.

Figure 9: Emperor red snapper fingerlings in a nursery tank (Source: southchinafish.ac.cn).

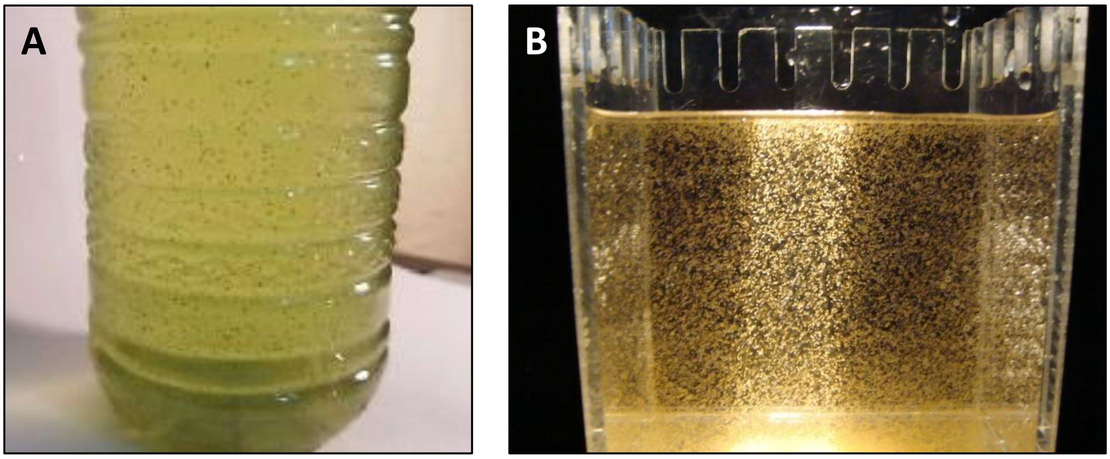

Figure 10: Live feed for larviculture rearing phase: A) Rotifers; and B) Artemia nauplii (Source: Aquaculture Nursey Farms).

Grow-out and harvesting

The total grow-out phase for snapper generally ranges from 6 to 22 months, for fish to reach a market size of 400g to 2.5kg. Grow-out systems are typically sea-based cages or earthen ponds. The size of snapper grow-out cages can vary widely; small 3 to 5m diameter cages are used in smaller operations (Chaitanawisuti and Piyatiratitivorakul, 1994; Castillo-Vargasmachuca *et al*., 2007) although those used in large-scale commercial farms are circular, 15 to 30m diameter structures with depths ranging from 5 to 20m (Figure 11). The net mesh size of the cages ranges from 5mm to 40mm depending on the size of the fish during the production cycle. Continuous monitoring, cleaning and maintenance of the cages is performed to maintain their safety and functionality (Cardia and Lovatelli, 2015).

Snapper stocking densities in grow-out net cage systems can range from 5 to 12 fingerlings per m^3 for small-scale farms (Guerrero-Tortolero *et al*., 1999; Kongkeo *et al*., 2010), to 20 to 50 fingerlings per m^3 for large-scale farms (Chen *et al*., 2007; Kongkeo *et al*., 2010; Castillo-Vargasmachuca *et al*., 2007).


Figure 11: Sea-based cages for grow-out phase (Source: Bigstock).

During the grow-out phase, artificial pellets (Figure 12A) are the preferred feed for snapper species in sea-based cages (Catacutan *et al*., 2001; Emata and Borlongan, 2003; Emata *et al*., 2003). Fish are generally fed twice daily (Castillo-Vargasmachuca *et al*., 2007), either by hand (Figure 12B) or using automated devices. Feeding is done in such a way as to allow all individuals to reach the food; additionally, commercial pellets are formulated to sink slowly, allowing all fish to reach food and reduce the amount of uneaten feed. Feeding is stopped when all fish are satiated and no longer feeding. Pellets are formulated to meet the nutritional requirements of snapper species, which require a diet relatively high in protein and fatty acids (Catacutan *et al*., 2001; Bell and Sargent, 2003), and the nutritional value of pellets can be enhanced with additions of vitamins and minerals to maintain fish health (Ghulam *et al*., 2005). By using pellets instead of fish, the possibility of transfer of disease is also greatly reduced (Ismi *et al*., 2012). Pellets tend to have a long shelf-life, reducing food waste.

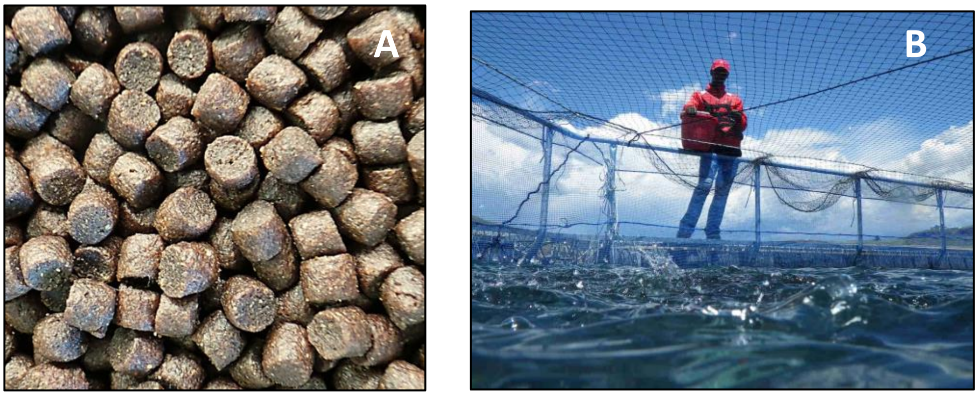

Figure 12: A) Artificial pellet feed for grow-out phase; and B) Hand-feeding of cage fish.

Fish health

At all stages of the production cycle, care is taken to ensure fish health and welfare. Minimising stress in land-based systems is key to reducing susceptibility to disease and infections, and is done by maintaining optimal production and environmental parameters including stocking densities, feeding regimens, water quality and temperatures among others (Helfrich and Libey, 1991; SCAAH, 2016). A very high level of biosecurity and cleanliness is also maintained to alleviate the likelihood of disease outbreaks (Helfrich and Libey, 1991; SCAAH, 2016).

Vaccines and treatments are available for common diseases and parasites affecting farmed snapper. Snapper can be infected with viral diseases, such as Indoviral GIV, bacterial diseases (such as those caused by *Vibrio*, *Aeromonas* and *Streptococcus* spp.), and various parasites (such as *Tenuiproboscis* and *Haliotrema* spp.) (Seng and Seng, 1992; Seng, 1997; Liang *et al*., 2011; Sanil *et al*., 2011). Prophylaxis treatments can be administered to prevent viral dieases (Seng, 1997). Fish can be vaccinated against bacterial diseases affecting snapper in culture environments (Liang *et al*., 2011). These vaccines are highly effective and preclude the use of antibiotics. Quarantine of infected fish and water treatments can be used to treat parasitic infections, such as freshwater baths and formalin baths (Seng, 1997).

3. Market for emperor red snapper products

Snapper species are popular food fish, and the majority of snapper produced globally is processed into products such as fresh, chilled or frozen whole fish and fillets (Figure 13, Figure 14). Snapper products are consumed locally in producing countries, such as Malaysia, and exported to foreign markets in the USA, Europe and Asia This market is supplied by both wild-caught and aquaculture products, with the global wild-caught production currently exceeding aquaculture production. The demand for snapper is increasing, creating an opportunity for aquaculture production without putting greater pressure on wild populations. Emperor red snapper is also known to be an important and valued food species in Australia, where it is an important component of the tropical snapper fisheries (Newman and Dunk, 2002).

Figure 13: Whole fresh emperor red snapper (Source: oceanwideimages.com).

Figure 14: Emperor red snapper fillets A) Fresh; and B) Prepared (Source: Scales Seafood; passionatefoodie.blogspot.com).

There is a high global demand for snapper products, and as a result it fetches a high retail price. In relation to other popular finfish species, snapper ranks highly in terms of both retail value and market demand (Figure 15).

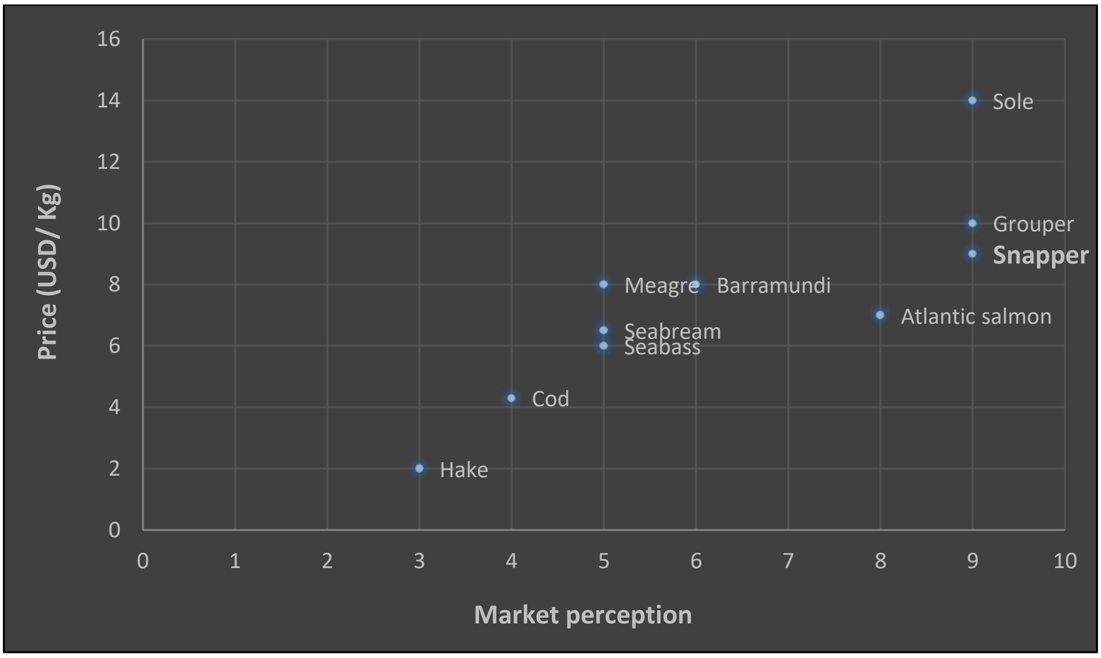

Figure 15: Market price and perception of snapper in relation to other marine finfish products.

Demand for snapper food products is expected to increase in domestic and export markets. The USA has imported an increasing amount of snapper products in recent years (Figure 16), with an average cost of USD 6.36/kg from 2014 to

2017 (NOAA, 2018). The main countries supplying this market include Mexico, Nicaragua, Panama and Brazil (NOAA, 2018).

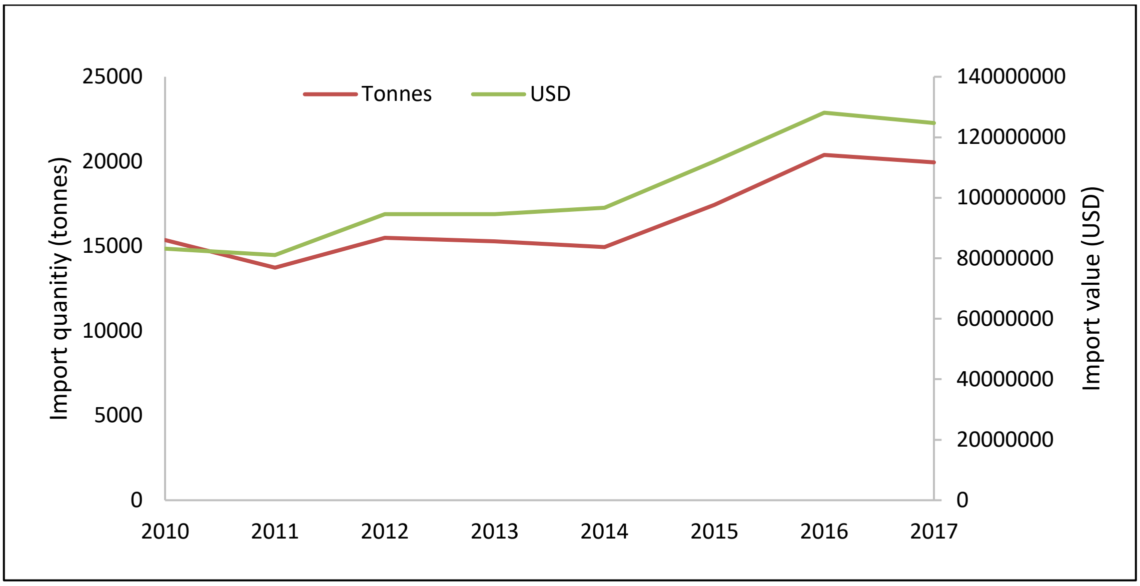

Figure 16: USA imports of snapper products over time (NOAA, 2018).

4. Suitability for aquaculture in Seychelles

The species

Emperor red snapper is indigenous to Seychelles. Broodstock can be readily obtained from local waters for use in aquaculture facilities. Technologies and feeds for snapper production have been developed, and it has proven to be a successful candidate species for land- and sea-based aquaculture (Catacuan *et al*., 2001). Snapper species are highly fecund, robust and tolerant of cage culture conditions (Estudillo *et al*., 2000; Leu *et al*., 2003; Sanil *et al*., 2011; Abbas and Siddiqui, 2012). Emperor red snapper is able to spawn consistently year-round in captivity (Melianawati and Suastika, 2006), and has a high market demand and market value.

Environmental and oceanographic conditions

The environmental conditions of Seychelles waters, such as temperature and salinity, are optimal for the survival and growth of emperor red snapper.

A number of factors have to be considered when selecting an area and sites for cage culture (Cardia and Lovatelli, 2015). The Seychelles inner islands, in particular, provide a suitable marine environment for cage culture of naturally occurring species. This region falls outside of the cyclone belt, and is less affected by the strong seasonal south east monsoon than the outer islands (Chang-Seng, 2007; ASCLME, 2012; UNEP, 2004). The oceanographic conditions are well within the optimum range for successful cage culture. Wave height, including during the SE and NE monsoons, is below the maximum swell height of 6m that such cages can withstand. Average current speeds are high enough to ensure water circulation within cages and dissolving of particles, without being too strong for the cage structure. Dissolved oxygen levels are above the threshold required for cage culture (Hecht, 2016).

Within this region a number of specific sites have been identified which will provide the conditions for optimal fish growth and minimal environmental and social impact. These zones are located such that they do not interfering with other activities such as tourism, artisanal fisheries and transport routes, and are far enough offshore to allow optimum water quality for fish health and to further ensure they do no conflict with land-based activities. These sites are characterised by ideal depth and sea-floor structure (relatively flat and soft or sandy) for cage culture, and a lack of coral reef or seagrass below cages to minimise the impact on marine ecosystems (Hecht, 2016).

Access to markets

Seychelles' level of transport infrastructure and location in the middle of the western Indian Ocean makes it ideal for aquaculture production; It has access to markets in Europe, the USA, Africa and Asia, via air and sea transport, and is able to receive imports of supplies, such as feed and technical equipment, from high-quality suppliers around the world. It also has access to local markets as products can be transported within and between islands.

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