



Reshad Jhangeer-Khan, Henri Agathe and Yann Yvergniaux

---

## Managing octopus fisheries through seasonal closures: A case study from the island of Rodrigues

October 2015

**blue ventures**  
beyond conservation

39 – 41 North Road,  
London  
N7 9DP, UK  
[research@blueventures.org](mailto:research@blueventures.org)

**blue ventures**  
beyond conservation



© **Blue Ventures 2015**. Copyright in this publication and in all text, data and images contained herein, except as otherwise indicated, rests with Blue Ventures.

**Keywords:** Rodrigues, closed season, octopus, fishery, closure, fishery management, alternative livelihood

**Acknowledgements:** This report was commissioned by Blue Ventures Conservation with support from the Western Indian Ocean Marine Science Association. The authors, representing donor and government stakeholders involved in working with the Rodrigues octopus fishery, are grateful for the assistance and information provided in the preparation of this report by diverse partners supporting the improved management of the fishery.

**Recommended citation:** Jhangeer-Khan R., Agathe, H. & Yvergniaux, Y. (2015) Managing octopus fisheries through seasonal closures: A case study from the island of Rodrigues. *Blue Ventures Conservation Report*. Available to download at [blueventures.org/publications](http://blueventures.org/publications).

**Authors' affiliations:**

Jhangeer-Khan, R. and Agathe, H.: Economic Planning and Monitoring Unit, Chief Commissioner's Office, Rodrigues Regional Assembly, Mauritius

Yvergniaux, Y.: Commission de l'Océan Indien Programme SmartFish, Mauritius

**Front page:** Fishing boat and octopus drying rack in Rodrigues lagoon; photo by Reshad Jangheer-Khan 2012.

## Table of Contents

<b>List of abbreviations and acronyms</b> .....	<b>5</b>
<b>Executive Summary</b> .....	<b>6</b>
<b>1. The Rodrigues <i>Octopus cyanea</i> fishery</b> .....	<b>10</b>
1.1 Rodrigues in context.....	10
1.2 The lagoon .....	10
1.3 History of octopus exploitation .....	11
1.4 Socioeconomic factors .....	13
1.5 The post-harvest sector.....	16
<b>2. Biological status of <i>Octopus cyanea</i></b> .....	<b>18</b>
2.1 Stock assessments .....	18
2.2 Population dynamics .....	19
<b>3. Marine resource management</b> .....	<b>21</b>
3.1 Legislation .....	21
3.2 Marine Protected Areas .....	21
3.3 Evidence to support management .....	22
<b>4. Seasonal octopus fishery closures</b> .....	<b>24</b>
4.1 Preparation and awareness raising .....	24
4.2 Closure management and governance.....	24
4.3 Monitoring the closures .....	25
4.4 Consultation and communication .....	26
4.5 Surveillance and enforcement .....	27
4.6 Capacity building and education programmes.....	29
<b>5. Impacts of the closures</b> .....	<b>29</b>
5.1 Fisheries impacts (catch, effort, CPUE) .....	29
5.2 Socioeconomic impact .....	31
5.3 Stakeholder perceptions/support .....	32
<b>6. Alternative livelihoods</b> .....	<b>33</b>
6.1 Rationale .....	33
6.2 Establishment .....	34
6.3 Organisation and planning .....	35
6.4 Financing and budgetary measures.....	36
6.5 Managing alternative activities .....	37
6.6 Sustainable alternative livelihoods.....	38

---

<b>7. The way forward .....</b>	<b>39</b>
7.1 Lessons learned .....	39
7.2 Strengths and limitations of the seasonal closure .....	42
7.3 Broader conservation impacts of the closures .....	43
<b>8. Funding Partners .....</b>	<b>44</b>
<b>9. Acknowledgements.....</b>	<b>44</b>
<b>10. References .....</b>	<b>45</b>
<b>11. Appendix 1.....</b>	<b>47</b>

## List of abbreviations and acronyms

AFRC – Albion Fisheries Research Centre

ALP – Alternative Livelihood Programme

BWA – Bad Weather Allowance

CPUE – Catch per Unit Effort

CRAC – Anti-drug group

CSR – Corporate Social Responsibility

EPMU – Economic Planning and Monitoring Unit

FAO – Food and Agriculture Organisation of the United Nations

FLS – Fish Landing Station

FPS – Fisheries Protection Service

FRTU – Fisheries Research and Training Unit

GIS – Geographical Information system

IOC – Indian Ocean Commission

MPA – Marine Protected Area

MPF – Mauritius Police Force

MWF – Mauritian Wildlife Foundation

NCG – National Coast Guard

NEF – National Empowerment Foundation

NGO – Non-Government Organisation

PES – Payment for Ecosystem Services

PSC – Project Steering Committee

RCSS – Rodrigues Council of Social Services

ReCoMaP – Regional Coastal Management Programme of the Indian Ocean Countries

RRA – Rodrigues Regional Assembly

SEMPA – South East Marine Protected Area

TMR – Ter-Mer Rodriguez

VRS – Voluntary Retirement Scheme

## Executive Summary

This report introduces the octopus fishery of Rodrigues, an autonomous outer island of the Republic of Mauritius in the western Indian Ocean. The focus of the report is the implementation of a series of seasonal closures carried out between 2012 and 2014, and gives an overview of the history, sociology, management and catch monitoring of the fishery. In particular, it details how a collaborative governmental and non-governmental effort managed this process, including communicating with relevant stakeholders, ensuring compliance and organising alternative livelihoods for fishers affected by the closures.

### The Rodrigues *Octopus cyanea* fishery

Rodrigues is a subtropical volcanic island situated 560 km east of Mauritius at 19°43'S; 63°25'E. The island is surrounded by a fully developed, asymmetric, peripheral fringing reef system, forming an almost continuous band around a lagoon and measuring approximately 90 km in circumference. The maximum tidal range is around 1.90 m and, because the average water depth in the lagoon is less than 2 m, most areas are exposed during spring tides. These conditions make the Rodrigues lagoon an ideal habitat for the mollusc *Octopus cyanea*, and provide octopus gleaners with a highly accessible fishing ground.

Historically, octopus was not fished in large quantities for local consumption, as fish were plentiful in the lagoon and cheap to buy, and were therefore the preferred source of protein. However, octopus fishing and processing became an important economic activity in the 1960s due to the increasing demand on the Mauritian market for sun-dried octopus. The advent of freezing technology, combined with more consistent shipping links with Mauritius, made octopus fishing an easy source of income for Rodriguan fishermen, sparking a significant increase in pressure on the fishery. Initially, the fishery was mainly operated by men, but in the early 1980s women received boots thanks to assistance from the Mauritian Government's Ministry for Women, and were encouraged to engage in octopus fishing in order to gain financial independence.

Fishing, agriculture, and forestry activities are traditionally the largest employment sectors in Rodrigues. They account for over 35% of employed individuals. The fishing sector in Rodrigues operates in a highly developed welfare state where there exists a considerable array of social aids devised to support various vulnerable groups in the population. There was a major increase in the number of registered fishers in the early 1990s, rising by more than 100% between 1988 and 1998. Government incentives to reduce pressure on the lagoon by phasing out seine nets and encouraging the development of off-lagoon fishing have not been successful. Fishing is the sole form of employment for most octopus fishers, with between 48% and 86% of each local fishing population dependent on fishing alone.

### Marine resource management

In 1994, the Albion Fisheries Research Centre of Mauritius introduced the Fisheries Statistical System in Rodrigues, which is based on a stratified sampling methodology and is still in use today. Catch data are recorded from fishing boat landings and individually registered fishers, fishmongers and recreational fishers. Estimates generated by the Fisheries Research and Training Unit using this system indicate that octopus landings have declined linearly from 774.5 to 268.7 tonnes between 1994 and 2010 (CSO 1999–2011), suggesting a possible collapse of the fishery between 2015 and 2020.

Data collected by Shoals Rodrigues and South East Marine Protected Area (SEMPA) prior to the first seasonal octopus fishery closure in 2012 indicated a decline in Catch per Unit Effort (CPUE) at sampling sites and that the majority of female octopus landed was below the weight at first maturity. Further studies suggested the existence of a brooding peak between October and January and the occurrence of a recruitment pulse into the lagoon during the following months. The direction of larval flow suggests that entry of larvae from other areas into Rodrigues is unlikely, indicating that natural recovery would be almost impossible in the event of a stock collapse.

Two types of closure were considered, the first protecting female octopuses during the migration phase (i.e. during the winter months in Rodrigues), and the second protecting juveniles during the recruitment phase (i.e. during the summer months). Due to the 18-month lifespan and exponential growth rate of *O. cyanea*, a closure set during the female migration phase would allow female octopuses to gain weight, reach maturity and increase their reproductive success. It was predicted the increase in the recruitment of juveniles resulting from this improved reproductive migration would contribute to the rehabilitation of the stock and, therefore, increase landings. A closure at the beginning of their lifecycle, however, would not lead to important increases in weight and catch landings, but could allow young octopuses to recruit more successfully to the reef substrate. This report is primarily concerned with the first type of closure.

### Seasonal closures of the octopus fishery

There was clear evidence for the need to adopt a precautionary approach to the management of the octopus fishery in Rodrigues. Seasonal closures were thus implemented and managed through a collaborative effort between local administrations, NGOs and international donors. This was formalised within a Project Steering Committee.

To evaluate the effects of the seasonal closures on the octopus stock, four monitoring programmes were set up. The first assesses octopus landings immediately after the fishery is reopened; the second evaluates mean weights of male and female octopuses immediately after the reopening; the third evaluates the level of juvenile recruitment in the summer following the closure; and the fourth estimates rehabilitation of the stock in the long-term.

Appropriate and timely communication was vital to ensure public acceptance of the first closure in particular and the smooth running of the closures in general. Initial steps were taken to engage fishers and reflect on the issues around octopus fisheries and the efforts needed to move towards a more sustainable fishery. Most were supportive of engaging in various innovative measures, such as regulating access to resources, regulating the octopus market and export channels, and organising community surveillance to ensure the sustainability of the fishery closure. The stakeholders understood that collaboration between all groups would be essential for the successful implementation of the closure.

A surveillance programme was set up with 50 checkpoints around the island, each manned by two fishers over two shifts. The principal weaknesses in surveillance during the 2013 closed season were: limited human resources within the Fisheries Protection Service (FPS); an insufficiently coordinated and coherent approach to enforcement by the institutions concerned; and insufficient community involvement. At the beginning of the third closure in 2014, a community-based participatory surveillance plan was implemented that was designed to complement and support the



surveillance efforts of the FPS and SEMPA rangers by ensuring the active engagement and commitment of the octopus fishers and the local community.

### Impacts of the closures

The first three closures had measurable short-term effects on the fishery. Following the 2012 closure, the average weights of both male and female octopuses almost doubled compared with 2011 levels, pushing the females well above weight at first maturity (i.e. more than 700–800 g). CPUE figures tripled on reopening, and the first day, week and fortnight landings were also much greater than pre-closure levels, though catches dropped rapidly thereafter. Overall, the annual landings rose by 188 tonnes compared to 2011, representing an increase of 49%.

After the 2013 closure, average male and female weights dropped slightly compared with 2012 post-closure figures, but still far exceeded 2011 values. CPUE remained the same as in 2012. While catches on the first day after the fishery reopened were considerably greater compared with 2012, the first week and fortnight landings dropped slightly. This was attributed to widespread poaching during the second closure. The average female weights following the 2014 closure were close to twice first weight at maturity, and the average CPUE rose by 0.48 kg/fisher/hour, a 26% increase compared with 2012 and 2013.

Based on an average first sale price of MUR 90/kg (USD 2.57/kg), the increase in landings from 2011 to 2012 (estimated at 188 tonnes) resulted in an increase of MUR 16,920,000 (USD 483,912) to fishers' income. This corresponds, approximately, to twice the total amount of stipends paid to fishers for their participation in the alternative activities programme during the first closure. Benefits were also seen at the buyer and exporter level – there was a 101 tonne increase in frozen octopus export between 2011 and 2012, equivalent to MUR 6,060,000 (USD 173,316).

The success of the temporary closures of octopus fishery has convinced the vast majority of fishers of the advantages of having closures.

### Alternative livelihoods

The primary aim of the Alternative Livelihood Programme (ALP) was to facilitate the acceptance of the new regulation by introducing income-generating activities while moving away from the National Government's compensation policy. The ALP was organised to occupy octopus fishers in work or educational activities during low spring tides to ensure the octopus stock remained safe.

Reports on the socio-economics of the fisheries sector in Rodrigues have highlighted several key factors: the fisher community is highly dependent on fishing; the diversity of livelihood opportunities for fishers is limited; fishing effort is concentrated inside the lagoon; and lagoon resources are overexploited. Clearly, reducing overall fishing pressure in the lagoon is essential in order to build on the success of the octopus closure. With a view to achieve this objective, it is imperative to develop sustainable alternative opportunities for fishers that will reduce their dependence on fishing. While the alternative activities component is vital for ensuring the success of the closure, its sustainability in the long run is a big challenge given the enormous financial and human resources required for its management. Furthermore, it remains a compensation mechanism that is more of a burden on the shoulders of the local authorities rather than a means to empower fishers and reduce pressure on the lagoon.



From the outset, the Rodrigues Regional Assembly's policy decision was to move away from the system of compensation for non-action, (namely the Bad Weather Allowance or the Closed Season Allowance), towards a Payment for Ecosystem Services scheme. Given the large number of persons engaged in the closure programme, a sizeable set of activities is necessary each year to keep the fishers busy during their scheduled alternative workdays.

### The way forward

The closure is having strong impacts on stakeholders' attitudes. It is fostering a sense of stewardship of the resources, whereby fishers and the population at large are calling for improvements to certain weaker aspects in the management process of the closure. It is also generating an institutional learning process whereby stakeholders work together and strive to find new solutions to address the various issues and challenges they must confront. It is through this process of institutional learning that Rodrigues is building its own model of octopus fishery management.

### Key learning points

The following actions were vital to achieving a successful octopus fishery closure:

1. On-going and accurate monitoring of the resource
2. Consulting with all stakeholders before decision-making
3. Communicating with all stakeholders before, throughout and after the closure
4. Awareness raising amongst the fisher community and general population
5. Resource surveillance throughout the closure, day and night
6. Enforcement of all octopus-related regulations during and out of closed seasons
7. Managing price, competition and standards
8. Developing sustainable alternative/complementary income-generating activities
9. Providing participants with training and capacity building sessions
10. Regulating access to the resource

The 2012 closure led to increased landings, revenue and octopus abundance as indicated by elevated CPUE values, and is generally viewed as a success. Closures were repeated in 2013 and 2014 with similar success. Further consultation with fishers suggests they want longer winter closures as well as a summer closure, probably motivated by increased revenue from improved post-opening catches and by the compensation they receive during the closures.

## 1. The Rodrigues *Octopus cyanea* fishery

### 1.1 Rodrigues in context

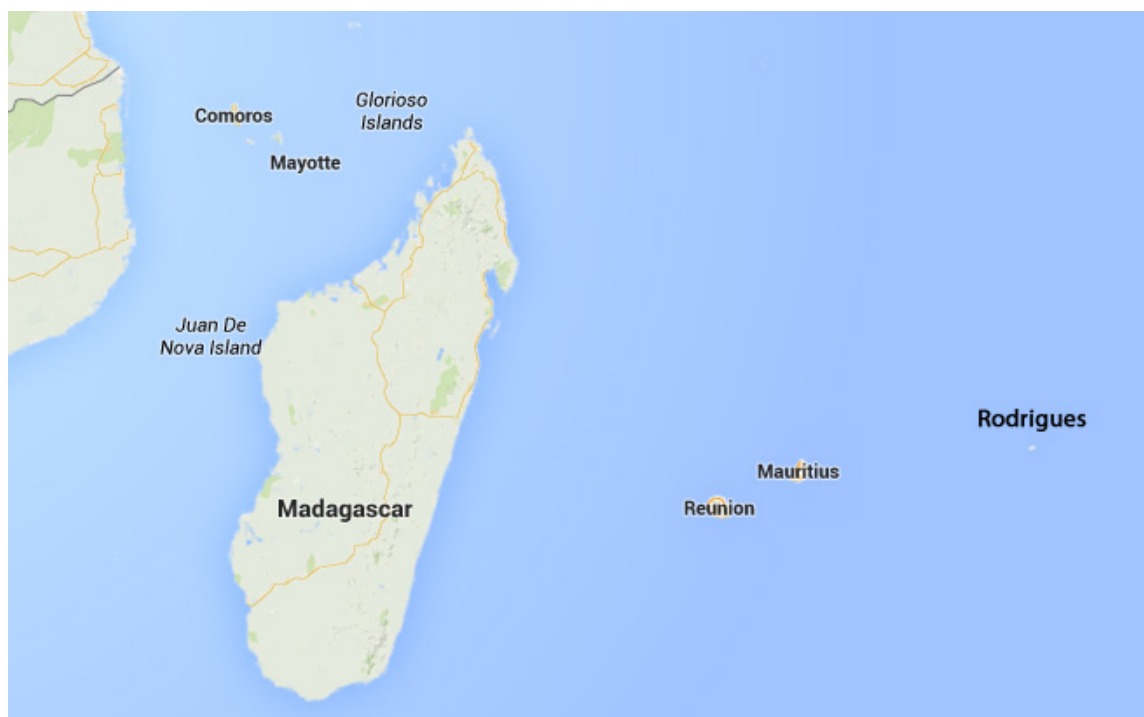
Rodrigues is an autonomous outer island of the Republic of Mauritius in the western Indian Ocean, located 560 km east of Mauritius at 19°43'S; 63°25'E. Measuring just 109 km<sup>2</sup> (one-sixth the size of Anglesey, UK), it is a volcanic island rising from a ridge along the edge of the Mascarene Plateau. It is the youngest of the Mascarene Islands, having formed just 1.5 million years ago. Its climate is subtropical, with a warm wet summer from November to May and a mean temperature of 25.9°C, and a cool dry winter between June and October with a mean temperature of 22.3°C.

Rodrigues is the smallest, least developed and most isolated island in the Mascarenes. It has a growing population of more than 42,000 (CSO 2015), and is relatively densely populated at 404 persons per square kilometer. The majority of inhabitants are of mixed African and French descent, and the island's economy is largely based on fishing, farming, handicraft and tourism.

Rodrigues was first colonised by people in the 1600s, although passing sailors had used the island and its resources for several centuries before this. Human activities have devastated the terrestrial environment, though the effects were less extreme in the marine environment. Indeed, the island's corals have been described as amongst the most pristine in the western Indian Ocean (Fenner *et al.* 2004), but it is also one of the many South Mascarene Islands that rank highly in terms of threats to marine endemism (Hardman *et al.* 2006). Biological surveys of the lagoon have revealed high levels of marine diversity, including 498 coastal fish species (Heemstra *et al.* 2004) and 130 corals (Fenner *et al.* 2004).

### 1.2 The lagoon

A fully developed, asymmetrical, peripheral fringing reef system surrounds Rodrigues, forming an almost continuous band measuring approximately 90 km in circumference. The reef encloses a lagoon with a surface area of approximately 240 km<sup>2</sup> (more than double the land area of Rodrigues), and within which lie 18 small islets (Chapman and Turner 2004). The distance between the reef flat and coastline varies considerably, ranging from about 13 km in the southwest to 0.05 km in the northeast. The reef is divided by three major channels: two are natural – one in the south adjacent to Port Sud-Est and one in the east in the St Francois bay area – and a third was created to provide access for Port Mathurin harbour in the north. Numerous smaller reef passes are scattered along the 90 km periphery, many of which are used by small boats to access off-lagoon fishing areas beyond the fringing reef. Lagoon substrates vary from soft muddy sediment in the near shore embayments, to sand and coralline rubble closer to the reef, and consolidated substrates on the reef flats and slopes. The maximum tidal range is around 1.90 m, and since the average water depth in the lagoon is less than 2 m (Lynch *et al.* 2002), most areas are exposed during spring tides. These conditions make the Rodrigues lagoon an ideal habitat for the mollusc *Octopus cyanea*, and provide octopus gleaners with an accessible fishing ground.



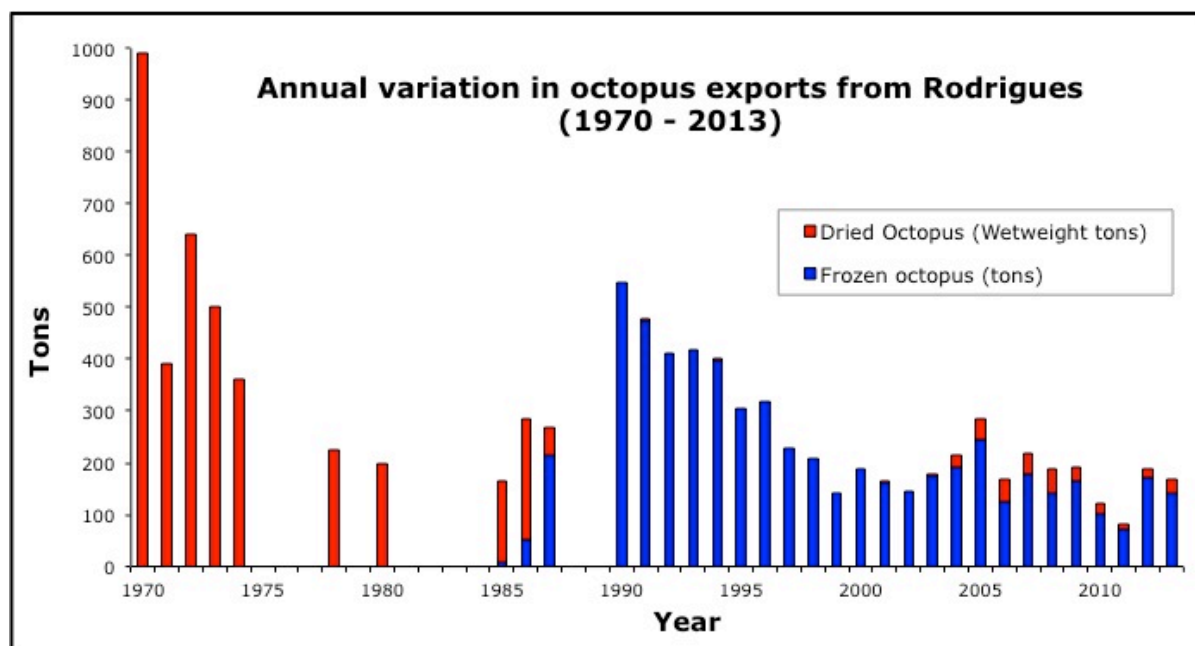
**Figure 1. Rodrigues is a subtropical volcanic island situated approximately 560 km east of Mauritius at 19°43'S; 63°25'E.**

### 1.3 History of octopus exploitation

The Rodrigues octopus fishery dates back to the 18th century, though it progressed to a commercial-scale fishery during the 1960s. Historically, octopus (known locally as 'ourite') was only fished in small quantities for local consumption, as fish were plentiful in the lagoon and cheap to buy, and were therefore the preferred source of seafood protein. Octopus fishing and processing became an important economic activity in the 1960s due to increasing demand for sun-dried octopus in Mauritius (North-Coombes 1971). Unfortunately, the data from this decade represent the combined export figures for dried octopus and salt fish, without any indication of the proportion of each. The first specific octopus catch records date back to 1970, when 990 tonnes of octopus (wet weight) were exported, in dried form, to Mauritius (Pearson 1988) (see *Figure 2*).

Initially, fishers mainly targeted large octopuses in the inner areas of the lagoon whilst foraging for crabs (Davila Cupidon *pers. com.*). This form of octopus fishing was carried out by fishers aboard wooden boats called 'pirogues', using two-pronged, barbed steel harpoons mounted on a long wooden pole, known locally as 'la fouine'. In the absence of electricity, and thus lacking the ability to freeze the catch, virtually all octopuses were sun- or air-dried and exported to Mauritius. Fishers did not target small octopuses because they lose 75% of their weight on drying, making them too small for consumers and therefore were not favoured by buyers or exporters.

The octopus fishery and processing sector underwent radical changes in the 1970s due to two factors, 1) the electrification of Rodrigues in the mid-1970s allowing octopus to be frozen (North-Coombes 1971), and 2) an increasing demand for frozen octopus from the Mauritian market. Data collected by Pearson (1988) indicate that the shift from



**Figure 2. Annual exports of dried and frozen octopus from Rodrigues between 1970 and 2013. Data courtesy of Pearson (1988) and the Mauritius Revenue Authority.**

sun-dried to frozen octopus exports occurred progressively during the 1980s. With the advent of freezing and more regular shipping links, many Rodriguans turned to octopus fishing as an easy source of income, which, in turn, increased pressure on the fishery.

This new wave of fishers adopted a novel fishing technique. They waded onto the reef flat at low tide, inserting a short length of bamboo into holes in the reef to locate the octopus. Upon contact with the bamboo the octopus would extend a few tentacles, which the fisher would promptly take hold of to pull the octopus from its den. The fisher would then stun it by turning its mantle inside out, thread it on a rope, and then drag it along in the water as he continued to fish. Later, a 1 m long iron spike, known as the ‘tatée’ (feeler) or ‘aiguille’ (needle), replaced the bamboo pole as the octopus gleaners’ tool of choice.

Men mainly operated the octopus fishery until the early 1980 when, thanks to assistance from the Mauritian Government’s Ministry for Women, women were issued with boots and began to engage in the activity. This was part of an initiative to encourage women to become financially independent. Women preferred to glean for octopus in the north-eastern, eastern and south-eastern sectors where the lagoon is narrower and the reef easier to reach on foot. The Mauritian Government also assisted cooperatives of fisherwomen in the south-eastern sector by providing life-jackets, boats and engines.

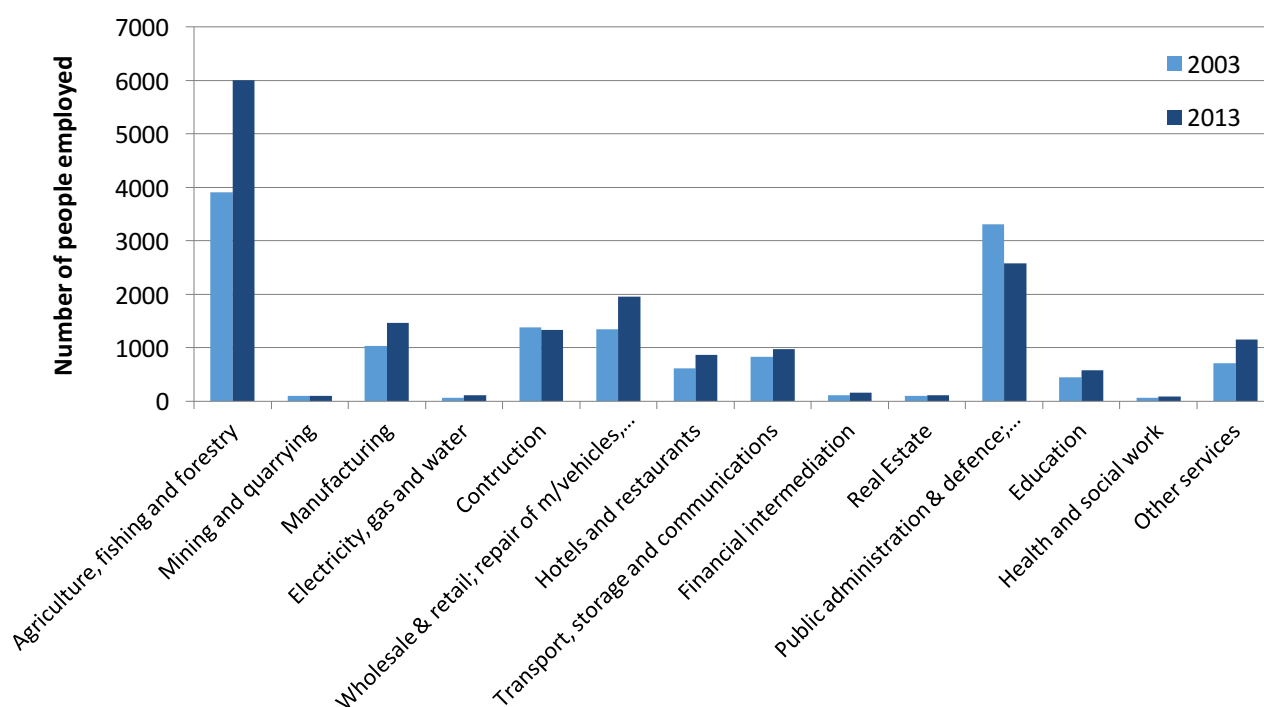
By the early to mid-2000s, annual octopus catches had declined to around 200 tonnes a year (see *Figure 2*). Around this time, the octopus fishery came under even greater pressure as spearfishing using snorkelling gear became more popular, allowing the fishery to operate during high tides and even at night with the use of underwater torches (R. Jhangeer-Khan *pers. obs.*), despite this latter practice being illegal.

More recently, wading fishers have begun spreading emulsified liquids (consisting of a mixture of used cooking or motor-engine oil and soapy water) on the sea surface in choppy conditions to improve visibility and help locate octopus dens. This activity, mostly practiced by younger octopus fishers, is also illegal and is being tackled by enforcing authorities.

## 1.4 Socioeconomic factors

Traditionally, fishing, agriculture and forestry have been the largest employment sectors in Rodrigues, as they are today (CSO 2008–2013) (see *Figure 3*). They now account for more than 35% of employed individuals. Despite the decline of the fisheries sector since the 1960s, these activities continue to make a significant contribution to the Rodriguan economy through export, food production and employment.

Rodrigues is a well-developed welfare state with a considerable range of social aids devised to support various vulnerable groups in the population, including fishers. A government-run fisher registration programme for full-time fishers, introduced in 1965 in Mauritius, was extended to Rodrigues in 1984. The registration system allowed professional fishers to benefit from a Bad Weather Allowance (BWA), a compensatory stipend for the days they are unable to go fishing due to poor weather conditions. This registration system has provided valuable data about the changing dynamics of the fishery over the past three decades (see *Table 1*). There have been three major shifts in the industry over this period.



**Figure 3. Relative importance of sectors in Rodrigues, in terms of numbers of persons employed. Data courtesy of the Central Statistics Office, Rodrigues Office.**

One of the major changes that occurred in the fishery was the large fluctuation in the number of registered fishers. Following a steady increase in the early 1990s, the number of registered fishers peaked in the late 90s, representing growth of more than 100% from 1988 to 1998. The numbers stabilised over the following decade, and then began to fall steadily following the introduction of the Voluntary Retirement Scheme (VRS) in 2009. The VRS is a programme designed to reduce fishing pressure in the lagoon by encouraging fishers to relinquish their registration card in return for a single payment. In 2014 the number of registered fishers was 1,221; this figure does not, however, represent the total number of persons that depend on fishing to earn a living, given that the sector remains characterised by an open access regime without any obligation for fishers to register.

The second major change was the considerable decrease in the number of large net (seine) fishers. In 1988, fishers using large nets dominated the lagoon fishery, in terms of the number of registered fishers (32%) and probably also in terms of catch though we do not have this data. However, by 2013 only 32 (2.5%) fishers were using large nets. This change was brought about by a central government policy to phase out the use of large nets in the lagoon through a voluntary buy-back programme in order to reduce the negative environmental impact of net fishing on the ecosystem. While the programme may have achieved its primary aim of reducing the impact of net-fishing on lagoon fish stocks, it has not yet met its secondary aim of reducing the number of fishers who practice lagoon fishing. Although the number of registered lagoon fishers has declined dramatically, many former net fishers who relinquished their registration permits are now part of the cohort of unregistered fishers who still fish in the lagoon.

	1988	1998	2008	2013	2014
<b>No. of registered fishers</b>	951	1914	1891	1227	1221
- Total lagoon	644	no data	1566	593	558
- Fisherwomen	no data	786	714	190	190
- Large net	307	116	51	32	31
- Total off-lagoon	46	no data	325	634	623
<b>Fish caught (tonnes)</b>	937.6	1756.8	1757.6	2604.9	2024.5
- Lagoon (a) octopus	no data	560.3	281.3	561.1	502.6
(b) other fish	900	1010.5	1078.1	1750.6	1158.3
- Off-lagoon	39	186	398.2	293.2	363.6
<b>No. of registered fishing boats</b>	no data	1061	1748	1873	1973

**Table 1. Status of Rodrigues' fisheries 1988–2014. Source: data from 1988 are sourced from Pearson (1988), while data from 1998–2014 are sourced from the Central Statistics Office and Fisheries Protection Services in Rodrigues.**

The third significant change that occurred in the fishery sector was the increase in the number of off-lagoon fishers. In 1988, there were only 46 fishers operating off lagoon – less than 5% of registered fishers. Today, the 623 off-lagoon fishers represent more than half of the fishery. This is mainly due to public authorities trying to address overfishing in the lagoon by encouraging the development of the off-lagoon fishery through training and measures to support the acquisition of suitable fishing boats. However, despite these encouraging figures, the number of lagoon fishers has not been effectively reduced as most of these off-lagoon fishers continue to operate in the lagoon on an informal basis (R. Jhangeer-Khan *pers. obs.*).

Thus far, the VRS, buy-back schemes and development of off-lagoon fishing have not been as effective at reducing the fishing pressure on the lagoon as was expected; in addition to the registered fishers, who fish as their primary source of livelihood, there are thought to be an equivalent number of Rodriguans practicing fishing as a supplementary or recreational activity (Pearson 1988). This heavy dependency on the fishery, and the apparent inadequacy of the various government schemes to reduce this dependency, is related to a number of socio-economic factors that were identified by three studies conducted in fisher communities (Lynch *et al.* 2000; Stead *et al.* 2009, 2010).

Firstly, there are relatively few employment sectors in Rodrigues, so octopus fishers rely almost completely on fishing for their income; between 48% and 86% of each local fishing population is dependent on fishing alone (Lynch *et al.* 2000). Overall, only 24% of fishers have an additional source of income; agriculture is the most common secondary occupation. This is corroborated by Stead (2009) who stated that “diversity in the number of livelihoods pursued is relatively low, with fishing activities, animal husbandry and planting crops being the main types of work done. On average, each household was involved in four jobs”.

The majority of octopus fishers fall within the age classes of 31–40 and 41–50 years old, and women represent about 16% of the total number of registered fishers (Economic Planning and Monitoring Unit (EPMU) and Fisheries Protection Service (FPS), unpublished data). In general, octopus fisher households have three to five members, including school-aged children whose school costs need to be covered. On average the monthly income of the coastal communities’ households surveyed was MUR 5,396 (USD 179.6), though income varied widely between MUR 200 (USD 5.72) to MUR 40,000 (USD 1,144).<sup>1</sup> This average income is insufficient for households with school-aged children. According to Stead *et al.* (2010), 73% of households claim that they cannot adequately cover the costs associated with sending their children to school. As a result, a sizable component of the Rodrigues coastal population is self-employed in the fisheries sector.

Lagoon fishing in Rodrigues is small-scale and artisanal in nature. It targets multiple species of finfish, octopus, shelled molluscs and shrimps and is therefore multi-gear. Most fishers employ a combination of basket traps, harpoons, spears, lines and hooks, which do not require high investment or training costs. This attracts young fishers with inadequate education, experience or resources to obtain jobs in other sectors, and keeps older fishers active within the same

---

<sup>1</sup> Information on household income from different income sources shows that fishing, the dominant activity, earns an average monthly income of MUR 2,171 (USD 61.80). The Mauritius National Empowerment Foundation (NEF) aims to empower the poor to integrate themselves in mainstream society. To be eligible for the various programmes of the foundation, households must have an income of less than MUR 6,000 (USD 171). By cross-checking the list of fishers enrolled on the octopus closure programme with household income, we have found that more than 50% of the fishers are eligible to join the NEF programme.



sector for decades. The Bad Weather Allowance scheme encouraged this further when fishers were still being registered for lagoon fishing. Despite the growing interest in the more lucrative off-lagoon fishery, its development is happening at a slow pace due to lack of capacity in terms of both training and investment.

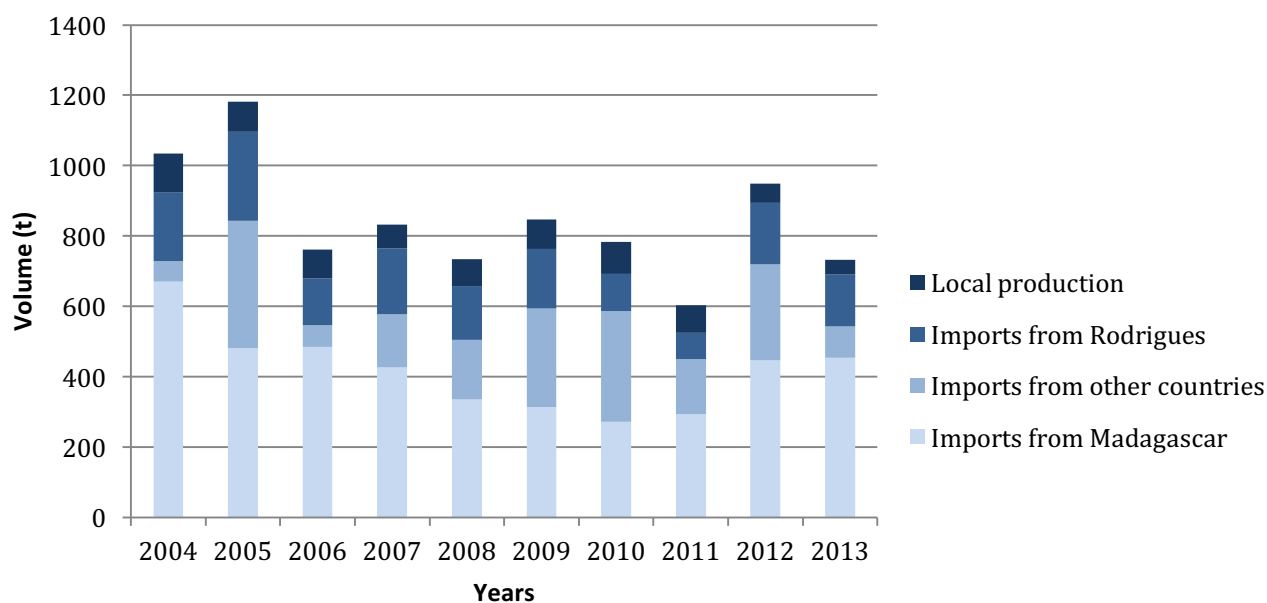
Fishers do not fish purely to make money – they also rely heavily on their catch to feed themselves and their families. More than 80% of octopus fishers engage in additional forms of fishing, usually line fishing for subsistence purposes. Seafood consumption in the coastal villages surveyed was relatively high, with households “eating on average seven seafood meals per week, though only 65% of households will buy seafood. Over 80% of households responded that a household member does some sort of fishing activity and registered fishers were identified in 52% of households” (Stead 2010). Fishers sold an average of just over half (57%) of their catch, meaning that a substantial proportion of the fishery operates on a subsistence basis (Stead 2009).

These studies have shown that a combination of factors, including lack of viable alternative livelihoods, poverty, low levels of education and literacy, and a need for food security and an assured income all contribute to the high numbers of people dependent on fishing in general, and the octopus fishery in particular.

## 1.5 The post-harvest sector

One of the direct consequences of the general trend from sun-dried to frozen octopus export is the development of pyramidal marketing channels across the island, from shore-based buyers to mobile collectors and long-established wholesalers. Large volumes of fresh octopus are landed and channelled to the three main exporters on the island through a network of fishmongers (known locally as ‘bayan’) based at each landing site. Most of these bayan operate as representatives of the three export companies, though they are not directly employed by them. Wholesalers’ agents then collect octopus from the bayan and load them onto pick-up trucks for transport to the exporters. The export companies have their own cold storage facilities (blast freezer and cold room), which enable them to ship containers of frozen octopus to Mauritius on a monthly basis, where it is then delivered to local seafood marketing companies. According to a recent value chain analysis (Sweenarain 2012), the price at first sale for fresh octopus averaged MUR 60/kg (USD 1.71/kg), which was then purchased by export companies at an average price of MUR 90/kg (USD 2.56/kg), and then sold frozen at around MUR 150/kg (USD 4.28/kg) (Free on Board, i.e. no charge to buyer for shipping costs at port of loading). In 2013, 142 tonnes of frozen octopus were exported to Mauritius, out of a total production estimated at 561.1 tonnes (around 25%) (CSO 2013).

Historically, Mauritius has been the sole export market for octopus products from Rodrigues (although they are not recorded as imported goods when entering Mauritius, since Rodrigues is part of the Republic of Mauritius). However, Rodrigues’ octopus exports are facing increasing competition on the Mauritian market from other countries; for example, Madagascar’s octopus exports to Mauritius were significantly higher in 2012 and 2013 compared to the previous four years (see *Figure 4*). This is mainly because depressed market conditions for octopus products in Europe since 2011 have driven Madagascar exporters to move into the Mauritian market (GEXPROMER, a Malagasy export company, *pers. com.*). Retail price in Mauritius for whole frozen octopus from Rodrigues ranges from MUR 250 to MUR 300/kg (USD 7.12–8.55/kg), whereas similar products from Madagascar can be purchased for as little as MUR 150/kg (USD 4.28/kg). Similar price differences also exist between the two countries for chopped and diced frozen octopus.



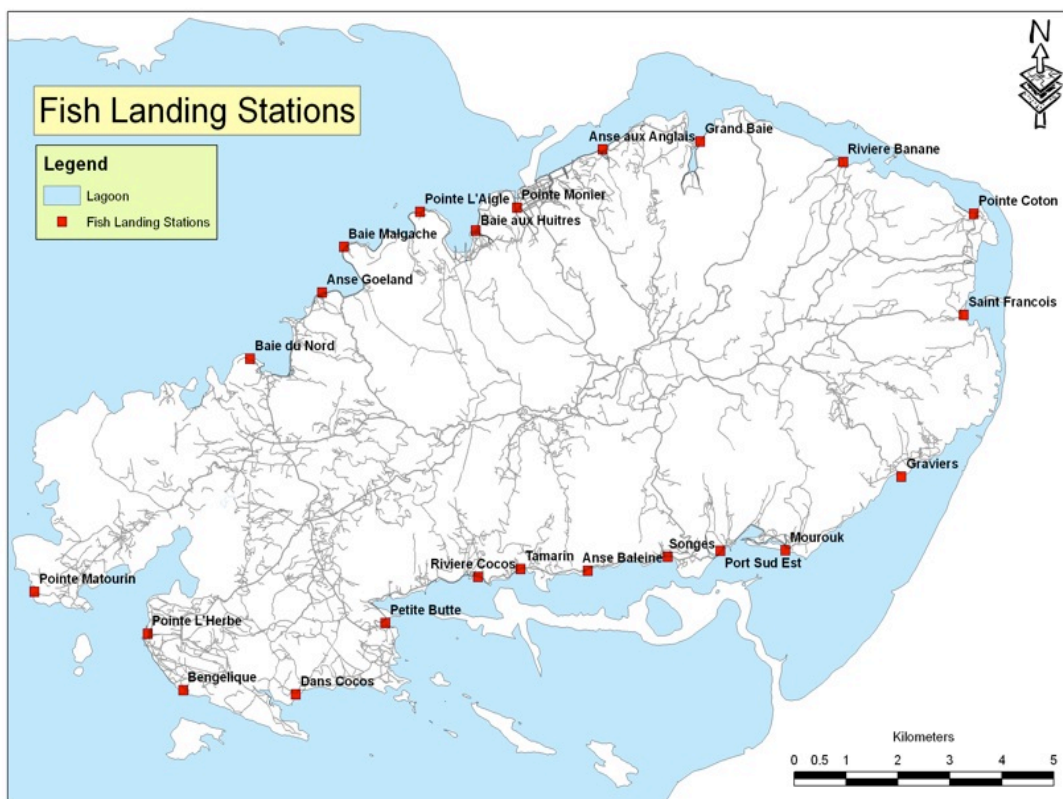
**Figure 4. Mauritius octopus market: local production and imports 2004–2013.** Sources: CSO 2013; ITC Trade Map based on COMTRADE statistics (goods from Rodrigues arriving in Mauritius are not recorded in national import statistics and therefore do not appear in COMTRADE statistics); Albion Fisheries Research Centre. The main countries exporting octopus to Mauritius from 2004 to 2013 are Madagascar, China, Indonesia, India and the Philippines, with occasional imports from Taiwan, South Africa and Chile.

Local consumption of fresh and frozen octopus has also grown due to the increasingly widespread use of small refrigerators and freezers in local shops and households in Rodrigues. As a consequence, production of traditional sun-dried octopus has decreased, turning this iconic Rodriguan delicacy into an expensive product (average retail price of MUR 600/kg (USD 17.10/kg)). It is, however, difficult to estimate the amount of sun-dried octopus processed on a local scale and sold directly to end consumers. Although still highly appreciated locally and deeply rooted in the Rodriguan culinary tradition, sun-dried octopus products are no longer a major component of Mauritian cooking habits. Just five tonnes of sun-dried octopus products (20 tonnes in live weight equivalent) were exported to Mauritius in 2013 (CSO 2013), compared to 200 tonnes in 1980 (Pearson 1988). However, this figure does not take into account the potentially significant amounts carried by passengers aboard domestic flights. Small quantities of sun-dried octopus are processed into other value-added products such as smoked and sliced octopus (average retail price of MUR 1,000/kg (USD 28.50/kg)) or used in the preparation of other food products such as pickles.

## 2. Biological status of *Octopus cyanea*

### 2.1 Stock assessments

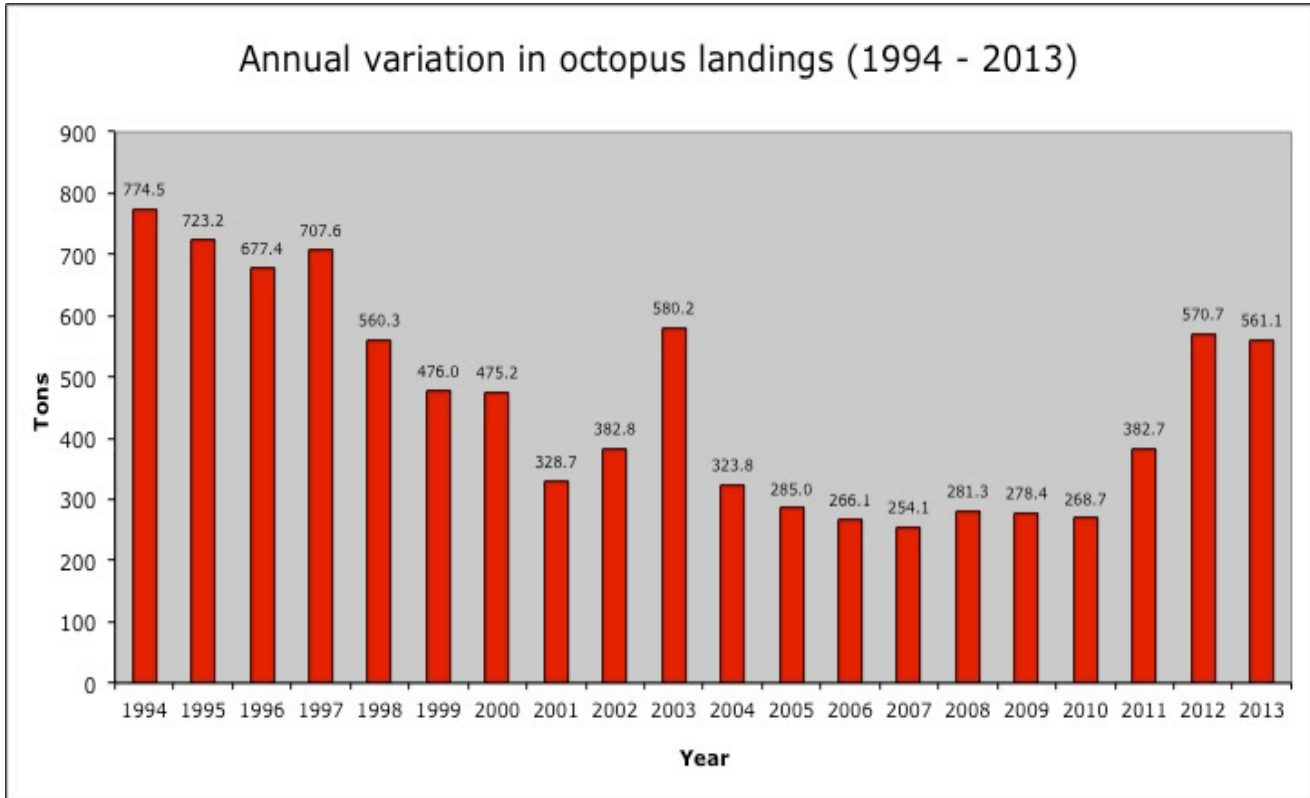
In 1994, the Albion Fisheries Research Centre (AFRC) of Mauritius introduced the Fisheries Statistical System in Rodrigues to gather data on the health of the fishery. The system is based on a stratified sampling methodology: the island was divided into three strata (see *Figure 5*), each with a dedicated enumerator who records data on catch landed, gear used, number of active fishermen, number of active boats, number of fishing days and price of fish both at producer and consumer levels. These data are collected at 23 fish landing stations (FLS) and are analysed in order to estimate the total monthly catch within each stratum and, subsequently, for the whole island.



**Figure 5.** Distribution of the 23 Fish Landing Stations (FLS) around Rodrigues, and the three strata sampled during the Fisheries Research and Training Unit (FRTU) stock assessment field surveys.

This system assesses many commercially important species, including *O. cyanea*. Catch data are recorded from fishing boat landings and individually registered fishers, fishmongers and recreational fishers. Since landings occur throughout the day and across several tides, the enumerators capture data across three shift systems (06:00–12:00 hrs, 12:00–18:00 hrs and 08:00–14:00 hrs). The enumerator spends one week at each FLS and, in order to avoid bias, the FLS sampled in each stratum is selected randomly (Nallee 2012).

Estimates generated by the Fisheries Research and Training Unit (FRTU) between 1994 and 2010 using the Fisheries Statistical System indicate that octopus landings have declined linearly from 774.5 to 268.7 tonnes (CSO 2011), suggesting a possible collapse of the fishery between 2015 and 2020 (see *Figure 6*).



**Figure 6.** The annual octopus landings statistics in Rodrigues between 1994 and 2013. Data courtesy of the FRTU.

## 2.2 Population dynamics

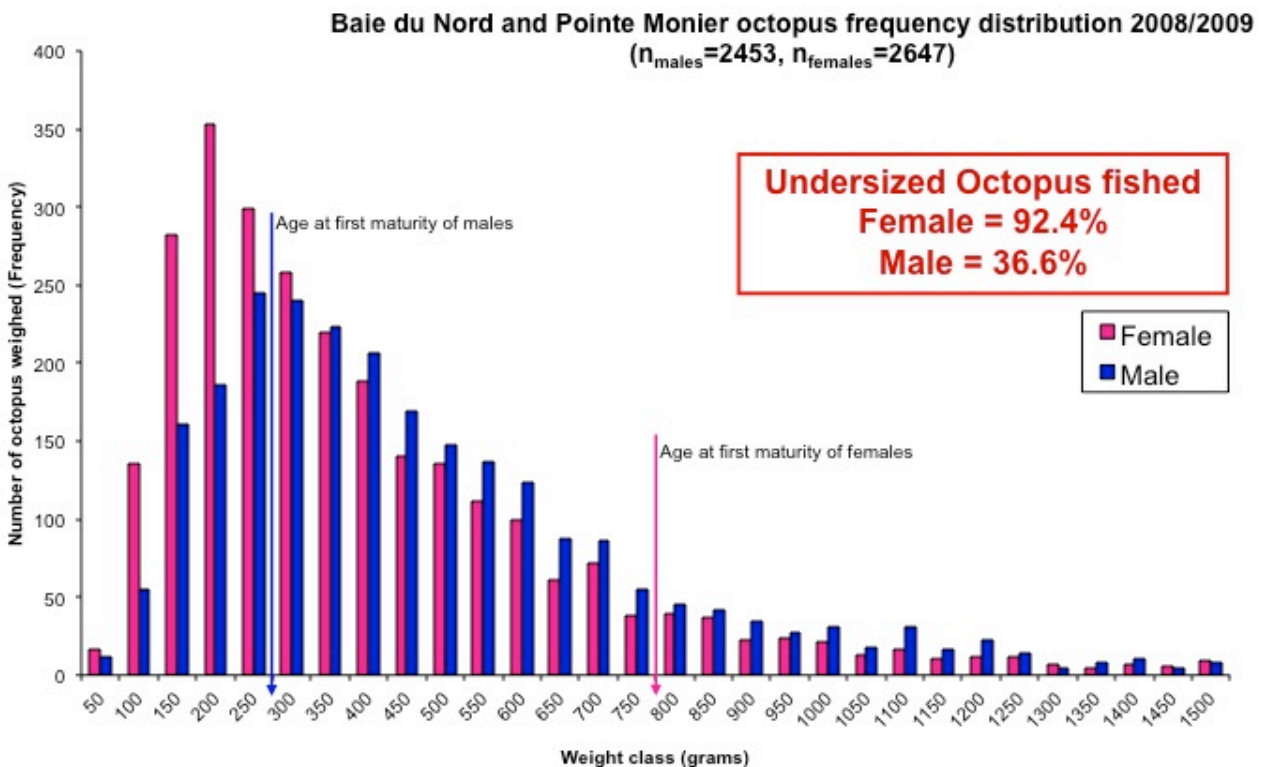
Shoals Rodrigues has carried out a number of discontinuous scientific studies specifically looking at *O. cyanea* population dynamics, starting with a baseline study between January and October 2000 at 14 of the 23 FLS. Interviews were also conducted with fishers and their catches assessed. Fishers were asked what time they started fishing, and return times were noted along with the length, weight and sex of each octopus caught. At Pointe Monier, octopus gonads were also sampled to determine maturity levels, as this site has the largest and most regular landings. Since then, no other gonad maturity studies have been carried out, though further octopus fishery studies were carried out between January 2004 and February 2005 at Baie du Nord and Grand Baie (Lynch *et al.* 2005), and between August 2008 and October 2010 in Baie du Nord and Pointe Monier (Jhangeer-Khan *et al.* 2010).

In November 2010, a Microsoft Access database was created and the number of sampling sites was raised to five FLS (Pointe Monier, Baie du Nord, Port Sud Est, Graviers and Rivière Banane) with the technical and financial assistance of the Regional Coastal Management Programme of the Indian Ocean Countries (ReCoMaP), an initiative of the Indian Ocean Commission (IOC). This study continued until October 2012. As part of the Rodrigues South East Marine

Protected Area (SEMPA) project, the Access database was reworked to accept data from eight FLS (from Mourouk to Dans Cocos) within the SEMPA boundary, plus another site (Ile Michel) where octopus is regularly landed. Data were collected at these sites for ten months between May 2011 and February 2012, and Shoals Rodrigues continues to collect this data at seven FLS (the original five sites, plus Dans Cocos and Tamarin) around the island.

Data collected by Shoals Rodrigues and SEMPA prior to the first seasonal octopus fishery closure in 2012 indicate: 1) a decline in Catch per Unit Effort (CPUE) at sampling sites and 2) that the vast majority of female octopuses landed was below the weight at first maturity (less than 700–800 g, i.e. pre-breeding age); see *Figure 7* for example data from two landing stations in 2008 and 2009. Reports based on these datasets (Lynch *et al.* (2000), Lynch *et al.* (2005), Jhangeer-Khan *et al.* (2010), Jhangeer-Khan *et al.* (2012), and Sauer *et al.* (2011)) attribute this decline to the following factors:

- 1) an increase in the number of fishers and thus pressure on the stock
- 2) recruitment overfishing (catch of sexually immature individuals)
- 3) growth overfishing (catch of undersized but mature individuals)
- 4) use of the metal spear
- 5) habitat damage by trampling, the use of metal spikes and emulsified liquids.



**Figure 7. Weight frequency distribution of male and female octopuses landed at Baie du Nord and Pointe Monier in 2008/2009, indicating the percentage of individuals landed that are under the weight at first maturity. Courtesy of Shoals Rodrigues.**

## 3. Marine resource management

### 3.1 Legislation

As an autonomous island in the Republic of Mauritius, the regulation of Rodrigues' fishing sector falls under the authority of the Mauritian Ministry of Fisheries, with the Rodrigues Regional Assembly (RRA) also having the authority to draw up local laws. Two pieces of legislation, still in force today, are of relevance to the octopus fishery:

1) The Undersized Fish Regulation Government Notice No. 54 of 2006 sets the minimum size for all species of octopus at a mantle length of 7 cm (measured from the tip of the mantle to the level of the eye), which is equivalent to approximately 350 g (wet weight). This regulation, however, is poorly enforced and significant amounts of undersized octopus continue to be harvested and marketed.

In the absence of any documents or reports supporting this management decision, personal communications with a number of current and former staff of the AFRC suggest the mantle length of 7 cm is the length at which 50% of male or female individuals sampled have reached sexual maturity. This minimum permissible size was based on a range of octopus maturity data, including mantle length and weight frequencies and gonad weight (maturity stage) gathered over 10 years of sampling, though there is no indication that any octopus samples for the study came from Rodrigues. This minimum size was recently verified using more modern methods during the re-evaluation of the Fisheries Regulations in 1983 and 2006, and was again found to be appropriate for managing octopus stocks. However, the minimum size at first maturity of female *O. cyanea* in Rodrigues according to the gonad maturity study carried out by Lynch *et al.* (2000) is between 700 and 800 g, suggesting that the minimum octopus catch weight set by the government is far too low to maintain stocks. The study's sample size of 70 individuals is considered to be low, however, so this figure merits further verification.

2) The Fisheries and Marine Resources Act 2007 section 13 states "no person shall carry out underwater fishing without the written authorisation of the Permanent Secretary". Though not specifically aimed at octopus fishing, this regulation can protect the octopus stock if enforced.

Apart from these two national regulations (and the MPA regulations discussed in the following section), there was no other legislation in place to help manage the octopus fishery prior to the 2012 Octopus Closed Season local regulations.

### 3.2 Marine Protected Areas

There are two types of Marine Protected Areas (MPA) in Rodrigues: a network of four Marine Reserves in the north and a multiple-use zoned MPA in the southeast, totalling c. 67.7 km<sup>2</sup>. *Figure 8* shows the location and extent of these MPAs.

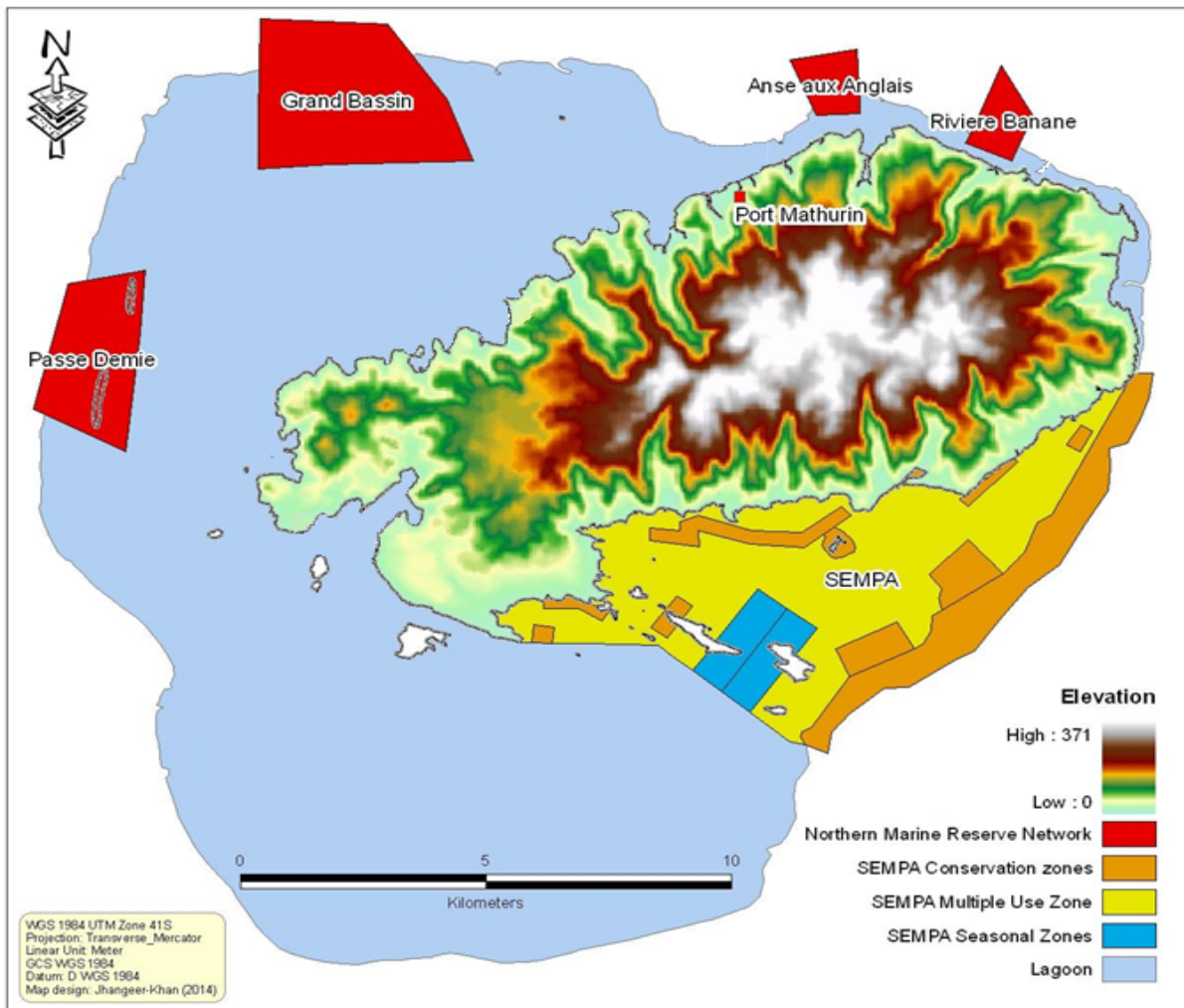
The four Marine Reserves include Rivière Banane, Anse Aux Anglais, Grand Bassin and Passe Demie, and cover a total of c. 24.3 km<sup>2</sup>. These reserves are 'no-take zones' and were gazetted in 2007. All four reserves encompass sections of the lagoon, reef flat and reef slope that are ideal octopus foraging areas, den habitat and brooding grounds, respectively.

A large multiple-use zoned MPA in the southeast sector named the South East Marine Protected Area (SEMPA) covers c. 43.4 km<sup>2</sup> from coast to reef. Its boundary was first gazetted in 2009, with zoning regulations introduced in 2011 to include 11 no-take conservation zones (covering 12.5 km<sup>2</sup>) as well as two seasonal multiple-use zones (3.1 km<sup>2</sup>) which



are opened and closed on a six-month rotational basis. The remaining 27.8 km<sup>2</sup> of the MPA is open to octopus, line and basket fishing; the government banned seine net fishing in 2012.

The FPS is responsible for enforcing the Marine Reserves and MPA regulations, with the support of nine rangers working exclusively in the SEMPA.



**Figure 8.** Distribution of gazetted Marine Protected Areas (MPA) around Rodrigues, including four Marine Reserves and the South East Marine Protected Area (SEMPA) in the southeast.

### 3.3 Evidence to support management

Around the turn of the millennium, several studies on the declining status of the Rodrigues octopus fishery were published, concluding that, if urgent measures were not taken to reduce pressure on the octopus stock, the fishery would continue to decline and may lose its viability in the near future (Genave, 1997, 2000; Lynch *et al.* 2000). This in turn would have a detrimental effect on hundreds of fishers and their communities, as well as the island's economy.

Between 2009 and 2011, the IOC's ReCoMaP project, in parallel with similar work undertaken in southwest Madagascar, initiated two studies that contributed to improved knowledge and understanding of larval ecology and recruitment dynamics of *O. cyanea* in Rodrigues.



The first study (Sauer *et al.* 2011) consisted of the analysis of data collected by the FRTU and Shoals Rodrigues between 2004 and 2009 (catch-and-effort data, catch composition and weight distribution). This study suggested the existence of a brooding peak between October and January and the occurrence of a recruitment pulse into the lagoon during the following months. It concluded that management efforts should therefore focus on implementing a seasonal three-month closure for octopus fishing during the period preceding peak recruitment. The study also recommended a new data collection system in collaboration with the RRA and SEMPA.

The second study (Shaw 2011) tested genetic differentiation between populations of *O. cyanea* across the western Indian Ocean. Analysis of DNA samples from southwest Madagascar and Rodrigues demonstrated a very low level of differentiation between the two populations and suggested that larval gene flow from Rodrigues to Madagascar may occur occasionally due to the prevailing westward current. The unidirectional nature of this flow suggests that the entry of larvae from other areas into Rodrigues is unlikely, indicating that natural recovery would be almost impossible in the event of a local stock collapse.

Due to the short lifespan and rapid growth rate of *O. cyanea* (see Figure 9), a closure at peak migration phase (i.e. during the winter months) would allow female octopuses to rapidly gain weight, reach maturity more quickly, and improve their chances of reproductive migration without being targeted. It was envisaged that the increase in the recruitment of octopus juveniles resulting from the closure would in turn contribute to rehabilitating the stock and increasing landings. Previous studies had shown that octopuses are, on average, larger during the winter season when they are approaching the end of their life cycle, in comparison to summer when individuals are at the beginning of the cycle (Shoals Rodrigues, unpublished data). Since *O. cyanea* growth increases exponentially, a two-month fishery closure at the end of its life cycle in winter would allow a far greater increase in weight and thus greater landings than would be possible with a summer closure at the beginning of its life cycle. The findings of these studies on *O. cyanea* life cycle and genetics and the subsequent discussions with the Indian Ocean Commission helped to build evidence and raise awareness of the need to adopt a precautionary approach to the management of the octopus fishery in Rodrigues.

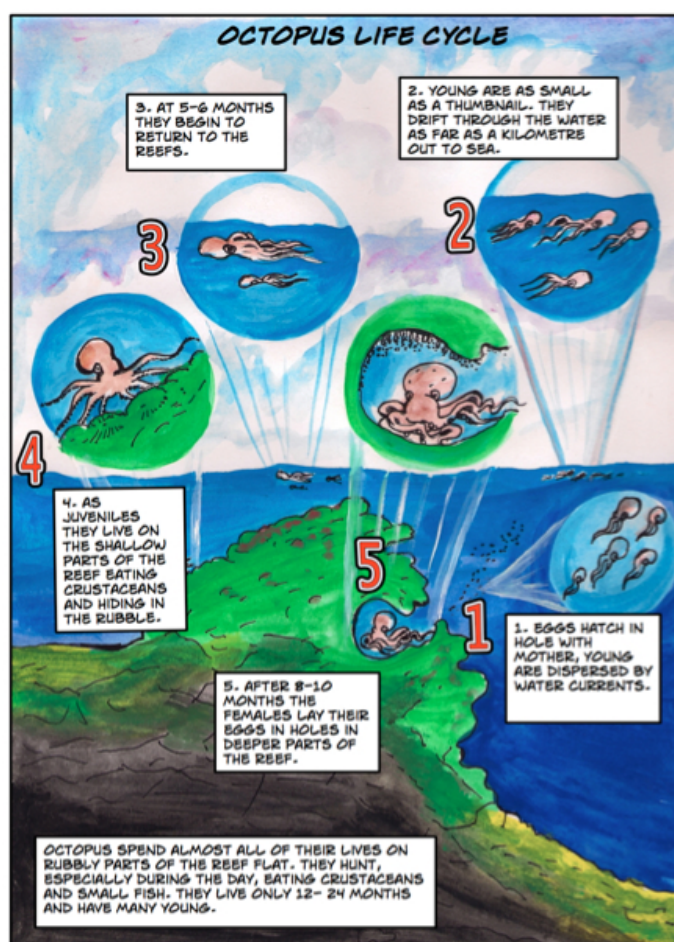


Figure 9. Octopus life cycle, taken from an educational comic adapted from a Blue Ventures publication.

## 4. Seasonal octopus fishery closures

### 4.1 Preparation and awareness raising

Once it was decided that an octopus fishery closure was to be implemented, the RRA, EPMU, SEMPA, FPS, FRTU and Shoals Rodrigues embarked on a varied programme of consultations, awareness raising and organisation amongst fishers, buyers and other stakeholders. ReCoMaP organised study tours for Rodrigues stakeholders in southwest Madagascar, where seasonal octopus closures had been trialled by Blue Ventures since 2004. Two tours took place in 2008 and 2009 with fisheries officers and private sector representatives, and an official government mission was undertaken in 2010, attended by the Chief Commissioner and the Minister of Fisheries and Rodrigues. A delegation of fishers from Rodrigues also visited southwest Madagascar in 2009 with support from the European Union's Decentralised Cooperation Programme and Shoals Rodrigues, which allowed them to experience at first hand the on-going management efforts and subsequent economic and environmental benefits of the closures.

To promote the temporary closure of the octopus fishery, a series of local consultations took place in Rodrigues in May 2011 with the participation of RRA officials, fishers and buyers. In August 2011, 11,000 comic books on the octopus life-cycle and conservation issues, originally published by Blue Ventures, were translated into Creole and French and delivered by ReCoMaP to the Commission for Education, Shoals Rodrigues and SEMPA for dissemination to children and fishers through schools and village committees. In September, a memo calling for a seasonal closure was prepared by ReCoMaP and officially presented during a meeting with the Minister of Fisheries and Rodrigues, who assured that the initiative would be fully supported by the Ministry and by the RRA. However, the upcoming regional elections disrupted the process and the closure was not supported at this time.

In early 2012, just after the regional elections, the IOC-SmartFish Programme (henceforth IOC-SmartFish) took over from the ReCoMaP project (which ended in late 2011) and contacted the newly elected RRA administration. They requested technical and financial support from IOC-SmartFish and started preparations for the first Octopus Closed Season. This took place in 2012, and since then two subsequent closures were implemented in 2013 and 2014, building on the successes of the first.

### 4.2 Closure management and governance

The Rodrigues Octopus Closed Seasons were an initiative of the RRA led by the Commission for Fisheries that were coordinated and monitored by the EPMU under the Chief Commissioner's Office. The following partners were involved in the seasonal octopus closures: IOC-SmartFish; UNDP/GEF-SGP; National Empowerment Foundation (NEF); several commissions of the RRA; the Mauritius Police Force (MPF); and non-state actors including Rodrigues Council of Social Service (RCSS), Mauritius Wildlife Foundation (MWF), Shoals Rodrigues and Ter-Mer Rodriguez.

The Project Steering Committee (PSC), comprising representatives of all the local partners, had a major role in the implementation of the closures and in ensuring their success. The PSC, which is chaired by the Commissioner for Fisheries, held regular meetings during the preparatory and delivery phases. The management of the closure was fully participatory right from the start, and all major decisions regarding the implementation of the closure were taken at

the committee level. There were also sub-committees dedicated to developing specific action plans regarding surveillance, training and marketing.

During the second closure, challenges with surveillance and supervision of alternative livelihood activities needed to be addressed in order to ensure the sustainability of the closure and its associated goal of improving the management of the octopus fishery. A symposium was held in Rodrigues in December 2013, bringing together 99 primary stakeholders including octopus fishers, buyers, processors, wholesalers, FPS and MPF officers, and institutional stakeholders including NGOs, RRA commissions and IOC-SmartFish, to identify and assess the issues related to the closure and devise solutions to address them. The symposium generated a comprehensive report (Chellapermal 2014) synthesising solutions to issues raised, while consolidating the co-management approach of Rodrigues' closures.

### 4.3 Monitoring the closures

To evaluate the biological effects of the seasonal closures, four monitoring programmes were set up. The first assesses landings immediately after the closure; the second evaluates mean sizes immediately after the closure; the third evaluates the level of recruitment in the summer following the closure; and the fourth estimates rehabilitation of the stock in the long-term.

**Short-term evaluation of landings:** In 2012 landings data were collected for one month following the reopening of the fishery by a team of ten enumerators consisting of FRTU and FPS personnel and SEMPA rangers. Total catch at the 23 FLS was recorded using a random rotation methodology. In 2013 the same methods were used, however the evaluation duration was reduced to two weeks. This was partly due to staffing constraints and partly due to the fact that landings were observed to drop rapidly after the first closure in 2012. In 2014 landings data collection was carried out for two months following the closure by a team of 40 enumerators (RCSS youths) as a two-part strategy: 1) to improve the quality of landings estimates and 2) to better document catch and effort with a view to move towards a better regulation of the fishery via a licencing system (see section 7.1.10). The 2014 evaluation involved recording catch per fisher at all 23 FLS as well as a number of other sites where landings are important. The evaluations were carried out in close collaboration with the c. 60 octopus buyers operating around the island.

**Short-term evaluation of mean sizes:** As part of the current Shoals Rodrigues octopus population dynamics study, catches are recorded at seven FLS by a team of 14 ex-fishers on the reopening of the octopus fishery after each closure. With these data the average sizes of males and females can be compared against baseline data stored in the octopus fishery database for the same sites over the equivalent period prior to closure implementation.

**Medium-term evaluation of recruitment levels:** As part of the on-going Shoals Rodrigues octopus population dynamics study, during the summer months following closures octopus fisher catches are recorded at the same seven FLS. Weight frequency distributions derived from these data are compared to the relevant distributions of both male and female individuals for the same periods prior to closure implementation using baseline data from the same sites.

**Long-term evaluation of stock rehabilitation:** As part of the stock assessment carried out year round by the three FRTU enumerators at the 23 FLS (method described in section 2.2), these data are used to evaluate total annual octopus landings in Rodrigues.

## 4.4 Consultation and communication

Appropriate and timely communication was vital to ensure the acceptance of the first closure in particular and the smooth running of the closures in general. The communication strategy was collaborative, benefiting from the participation of many stakeholders. Several media were employed including presentations, press conferences, interactive radio shows, information meetings, coverage of key steps by the press, television programmes, and consultation meetings.

The octopus closure communication strategy aimed to raise awareness of issues related to unsustainable octopus fishing and to foster support for the closure project with several audiences, including the fisher community, school children and the general public. It also aimed to communicate important information to those engaged with the alternative activities programme.

Certain groups of fishers did not fully support the closure, which led to a politically polarised situation. In this context, the decision for closure could have been introduced, contested and rejected – so appropriate and timely communication was crucial. A radio interview with the Commissioner for Fisheries took place at the very beginning of the project, during which he explained the status of the octopus fishery and the need for a closure to address the situation. He stated the approximate dates and duration of the closure and requested support for the project. The consultation phase with fishers took place after the Commissioner's announcement. This pro-active approach minimised the basis for opposition. The Commissioner arranged press conferences to make official and important announcements, such as the dates of the closure, and to communicate the results of the closure.

A communication guide, developed by the PSC with the support of IOC-SmartFish, was an important tool in supporting the awareness raising campaign. The guide provided clear and accurate information about the closure rationale, the new regulations and other specifics. It was designed for use in the consultation phase with the fisher community and for school children, and was also used as a reference document for the preparation of interactive radio programmes to inform and discuss the closure with the general public. Consultations with the fishers began with a summary of the status of the fishery, followed by a presentation of the communication guide and a feedback session.

Several 45-minute interactive radio shows took place before, during and after the first closure. The panels of participants consisted of leaders and stakeholders of the closure project, including various departments of the RRA (EPMU, Department of the Environment, SEMPA and FRTU), the Environment Police, fishers, community resource observers, and fisheries experts from IOC-SmartFish.

Most of the communication to fishers took place via the radio, as this was the most efficient way to convey information to such a large and widely-dispersed group. These communications included invitations to consultation meetings, and announcements of the registration and payment days for the alternative activities programme.

Local and national newspapers provided good coverage of the closure. Newspapers were also used by the RRA to convey official messages such as the official closure and opening dates, as well as coverage aimed at promoting public participation in preventing poaching by reporting any cases to the MPF or the FPS.

IOC-SmartFish funded the production of posters and T-shirts for all three closures. The posters were widely distributed in schools, businesses, government offices and public places. Quality T-shirts printed with a conservation message were distributed to officers responsible for specific zones, supervisors and all collaborators. They were worn proudly, boosting the visibility of the closure, its stakeholders and funders.

A 21-minute documentary commissioned by IOC-SmartFish on the closure in Rodrigues was produced in 2012 by Blue Ventures. The documentary was used in Rodrigues as an educational tool for the subsequent closures and will be used for future awareness raising work.

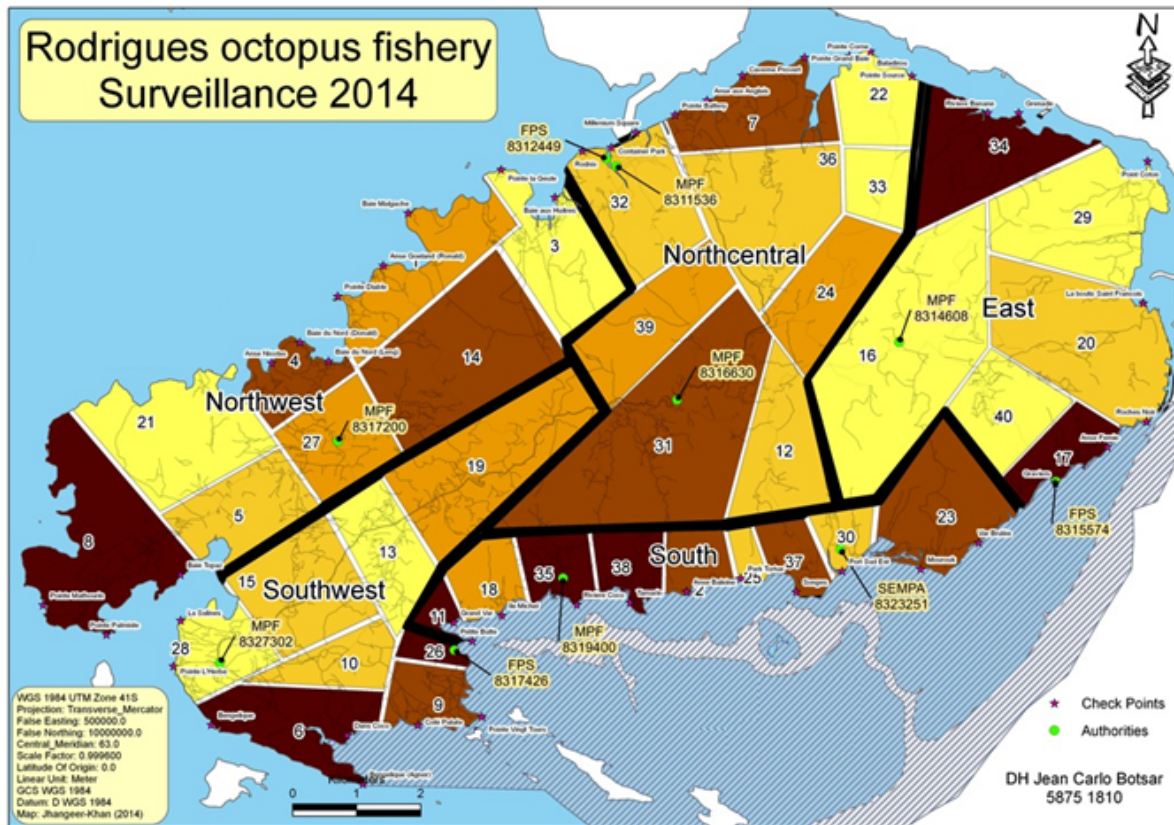
For the third closure in 2014, with the shift towards a strengthened co-management approach, a new consultation campaign was carried out amongst the fisher community. With the successes of the previous two closures, there was no longer a need to convince fishers of the benefits of the closure, so the meetings were no longer based around a communication guide. The new consultation campaign was launched in February 2014, with meetings structured around fishers' views on the strengths and weaknesses of the previous closures, followed by discussions based on their grievances. This was an opportunity to reflect on the efforts needed to move towards a more sustainable fishery. A deeper understanding of the issues was achieved, and collaborative decisions were reached through discussion and interaction with fishers. This was another step towards engagement of fishers in the co-management of the octopus fishery. Many of them were supportive of engaging in innovative measures such as regulating access to resources, controlling marketing channels and community surveillance to ensure the sustainability of the fishery. During this round of consultations, the fishers developed a better understanding of the need to collaborate fully with all other stakeholders.

#### **4.5 Surveillance and enforcement**

The purpose of surveillance is to ensure compliance with fishing rules and regulations. The Rodrigues context exhibits a high degree of endemic noncompliance (North-Coombes 1971, Peterson *et al.* 2011). There was, therefore, a need to establish a surveillance plan to enforce the Octopus Closed Season Regulations. For that purpose the FPS, whose mission is to protect fisheries resources through enforcement of fisheries and related legislation, was tasked with preparing a surveillance plan. This initial plan, however, was not implemented due to a lack of human resources and equipment within the FPS. Subsequently, the PSC decided to set up a surveillance/enforcement technical sub-committee consisting of the FPS, SEMPA, MPF and an officer of the Department for Environment. The sub-committee decided to involve the fishers enrolled in the alternative activities programme in surveillance work under the care of 'zone supervisors'. A surveillance system was set up whereby 50 checkpoints around the island were each manned by two fishers for a morning and afternoon shift (see *Figure 10*).

For the 2013 closure, an updated surveillance plan was drawn up using the lessons learned during the 2012 closure, and was founded on a collaborative effort between the FPS, SEMPA Rangers, MPF, and National Coast Guard (NCG). However, due to inadequate management of the fisher surveillance programme, participation by fishers was considerably lower than expected. Following reports of poaching, a surveillance committee was setup to deal with the issue via a participatory approach in the last two weeks of the 2013 closure, wherein the same 50 checkpoints were manned.





**Figure 10. Location of the 50 checkpoints distributed around Rodrigues from which participatory surveillance was carried out by fishers enrolled in the alternative activities programme.**

During the multi-stakeholder Symposium on Octopus Fishery Management held in December 2013, it was recognised that the principal weaknesses in surveillance during the 2013 closed season were: limited human resources within the FPS; an inadequately coordinated and incoherent approach to enforcement by the FPS, MPF, NCG and SEMPA Rangers, and insufficient community-involvement in surveillance.

It was also recognised that a significant level of day and night underwater harpooning of octopus occurred during the closed season, and that inadequate verification of declared octopus stock at retailers across Rodrigues opened the door to the establishment of a black market, which thus promoted poaching.

A community-based participatory surveillance plan was implemented at the beginning of the third closure in 2014, which was intended to complement and support the surveillance efforts of the FPS and SEMPA rangers by ensuring the active engagement and commitment of the octopus fishers and the local community. In addition, Ter-Mer Rodriguez received a grant from IOC-SmartFish to implement a participatory surveillance plan for the coastline from Baie Lascar to Anse Femie, where octopus can be caught easily and where there were low landings on the reopening days of the first two closures. A system of three shifts a day for two fishers was put in place at 13 checkpoints. For the remaining portion of the coast, a two-shift system was put in place under the responsibility of RCSS regional and zone supervisors, which also involved fishers who had registered in the alternative activities programme for the entire two months of the closure.

As problems with enforcing the closures had been faced in 2013, the Environment Police was engaged in early 2014 to assist in the field. A rapid intervention unit was set up to intervene in the case of illegal activity. Presumed cases of poaching or other illegal activities were immediately reported to the unit leader who would then dispatch the unit to investigate and take action if necessary.

## 4.6 Capacity building and education programmes

Prior to the first closure, a policy decision was made to incorporate a capacity building and education programme for the octopus fishers as an integral component of the closure programme. This was implemented through a collaborative effort with the Deputy Chief Commissioner's office and the Commission for Health, together with a number of NGOs, notably Shoals Rodrigues, MWF and CRAC (anti-drug and alcohol group). This programme aimed to provide four hours of capacity building and education for each fisher during each closure. Sessions have included first aid courses, boat engine maintenance demonstrations, marine and terrestrial conservation talks, and lessons on drug and alcohol abuse prevention, HIV/AIDS awareness, self-esteem, contraception, non-communicable diseases and family planning.

The sessions were organised by trainers communicating directly with the zone supervisors, and were then implemented by the various RRA and NGO officers during the fishers' alternative activity hours. In terms of the resources required to carry out these sessions, the RRA departments delivered the talks as part of their normal scheme of duties, as did the CRAC association, whereas Shoals Rodrigues and MWF, supported by IOC-SmartFish, carried out their sessions either at their facilities or in situ.

The impact of these sessions has not yet been quantified. As fishers work irregular hours dictated by the tides, are widely dispersed, difficult to group and therefore difficult to reach, they form a relatively inaccessible subset of the Rodrigues population. However, the education programmes held during the closure were and continue to be an excellent way to target and reach this section of the community since the fishers have to be present on-site to be eligible for their compensation.

## 5. Impacts of the closures

### 5.1 Fisheries impacts (catch, effort, CPUE)

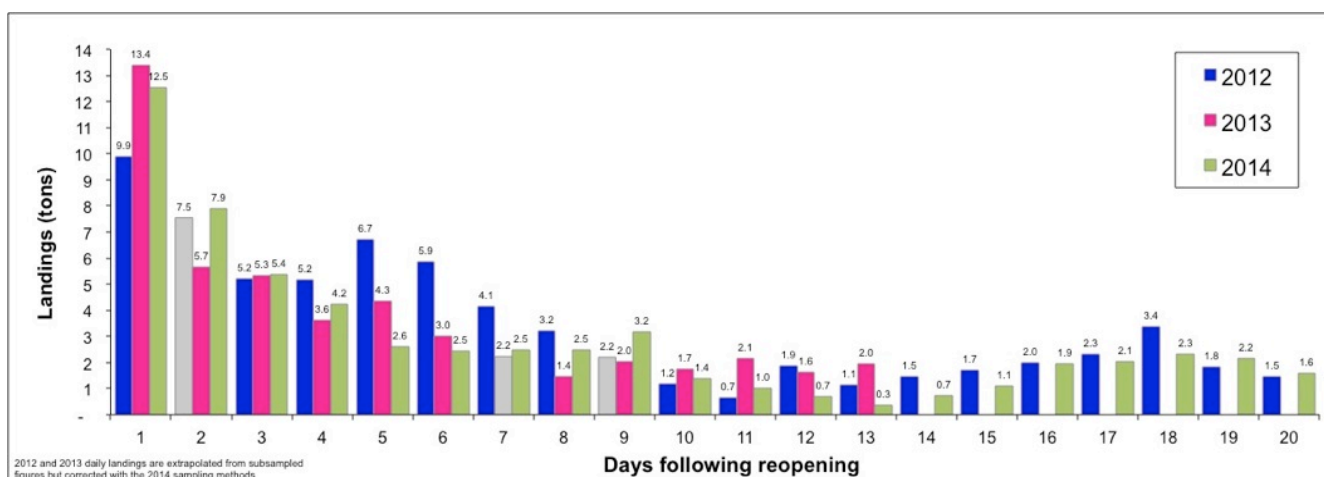
The first three closures had measurable short-term effects on the fishery. Indicators include the total annual catch as measured by the FRTU, male/female octopus weights and CPUE at reopening, as well as first day, first week and fortnight landings immediately after reopening of the fishery. Results for these indicators can be seen in *Table 2* and daily landings in *Figure 11*.

The 2011 figures (prior to the first closure) show low average female weight, CPUE and annual landing values. Following the 2012 closure, the average weights of both male and female octopus almost doubled compared with 2011 levels, pushing the females well above weight at first maturity (i.e. more than 700–800 g) based on the gonad analysis by Lynch *et al.* (2000). Catch per Unit Effort figures tripled on reopening, and the first day, week and fortnight landings were also much greater than pre-closure levels, though catches dropped rapidly thereafter. Despite this, the 2012 annual landings figure increased by 188 tonnes compared to the previous year, representing an increase of 49%.



Variable	Unit	2011	2012	2013	2014
Average male weight <sup>1</sup>	Grams	988	1,668	1,391	1,605
Average female weight <sup>1</sup>	Grams	828	1,543	1,306	1,513
CPUE <sup>1</sup>	kg/fisher/hour	0.54	1.83	1.83	2.31
First day landings <sup>2</sup>	Tonnes	-	9.9	16.3	12.5
First week landings <sup>2</sup>	Tonnes	-	40.4	35.5	35.1
First fortnight landings <sup>3</sup>	Tonnes	-	54.8	48.5	46.7
Annual landings <sup>4</sup>	Tonnes	382.7	570.7	560.0	-

**Table 2. Short-term impact of closures on the fishery in figures.** Notes: <sup>1</sup> October data recorded at seven Fish Landing Stations around the island, courtesy of Shoals Rodrigues and SEMPA. <sup>2</sup> 2012 and 2013 data collected at a subsample of FLS around the island, extrapolated to the whole island and corrected for comparison with 2014 data, courtesy of the FRTU/FPS/SEMPA. <sup>3</sup> Data collected from all landing points around the island including the 23 FLS, courtesy of RCSS. <sup>4</sup> Annual landings statistics courtesy of the FRTU.



**Figure 11. Octopus landings for the first three weeks following the reopening of the Rodrigues octopus fishery 2012–2014.**

After the 2013 closure, average male and female weights dropped slightly compared with 2012 figures; this decline however was not statistically significant and females were still well above weight at first maturity. Post-closure CPUE remained the same as in 2012, but while catches on the first day after the fishery re-opened were considerably greater, the first week and fortnight landings also dropped slightly compared with 2012 figures. This was attributed to widespread poaching during the second closure. Overall, despite having dropped by 10.7 tonnes, the annual octopus landings of 2013 were still almost double the baseline landings in 2011.

Octopus landings following the 2014 closure again showed an increase in average female weights that were almost twice the weight at first maturity. Catch per Unit Effort increased by 0.48 kg/fisher/hour compared to the first and

second years. While the first day landings were equivalent to those of the 2012 closure, the first week and fortnight landings dropped.

The decrease in post-closure landings observed in 2013–2014 could have resulted from a number of natural and anthropogenic factors. Fluctuations in the abundance or size of octopus present in the lagoon prior to and during the closure could be due to natural variations in environmental conditions that can modify prey abundance and growth rate. However, environmental conditions were not monitored. In addition, if a large number of females successfully migrated out of the lagoon to spawn and did not return, this would also have reduced landings on reopening. Anthropogenic stressors such as overfishing and unregulated fishing of undersized octopus in the months leading up to the closure may also have resulted in a reduced octopus stock dominated by small-sized individuals. Poaching during the closure would have had a detrimental effect on post-closure catches.

## 5.2 Socioeconomic impact

Following the first octopus closure in 2012, annual landings (570.7 tonnes) were almost back to 2003 levels (580.2 tonnes), after having decreased annually since 1994 (see *Figure 6*). Half of this volume was landed during the first three months following the closure (fourth quarter 2012). Octopus exports to Mauritius (which had steadily decreased from 278 tonnes in 2005 to 74 tonnes in 2011 – the lowest on record) reached a volume of 175 tonnes in 2012.

Based on an average first sale price of MUR 90/kg (USD 2.57/kg), we calculate that the increase in landings from 2011 to 2012 (estimated at 188 tonnes) resulted in an increase of MUR 16,920,000 (USD 483,912) to fishers' income – which corresponds approximately to twice the total amount of stipends paid to fishers for their participation in the alternative activities programme during the first closure. Benefits were also seen at the buyer and exporter level, with a 101 tonne increase in frozen octopus export between 2011 and 2012, representing an increased revenue of MUR 6,060,000 (USD 173,316).

Increased catches were also made following the second closure in 2013, with total annual landings estimated at 561.1 tonnes, of which 147 tonnes were exported to Mauritius – a slight decrease compared to 2012. Annual figures for 2014 were not available at time of writing; however, landings for the first six days and the first fortnight following reopening for all three years are shown in *Figure 12*. While a decreasing trend is apparent, the first six-day and first fortnight landings are significantly greater than landings in non-closure years for the same period. However, these figures must be read with caution as data were collected using an increased sampling intensity in 2014. Data corrected to account for this sampling bias tend to show a shallower decline.

Catch-per-fisher data collected by RCSS following reopening in 2014 show that the average daily revenue per fisher was MUR 813 (USD 23.25) during the first week and MUR 558 (USD 15.96) during the second week, which corresponds respectively to more than three times and more than two times the average daily revenue estimated by SEMPA and Shoals Rodrigues prior to the first seasonal octopus fishery closure (MUR 250 or USD 7.15).

This increase of individual fishers' income is even more compelling as we know that fishing effort (expressed in catch per outing on each tide) is abnormally high during the first week following reopening and remains higher than usual during the second and third weeks following reopening (see *Figure 13*).

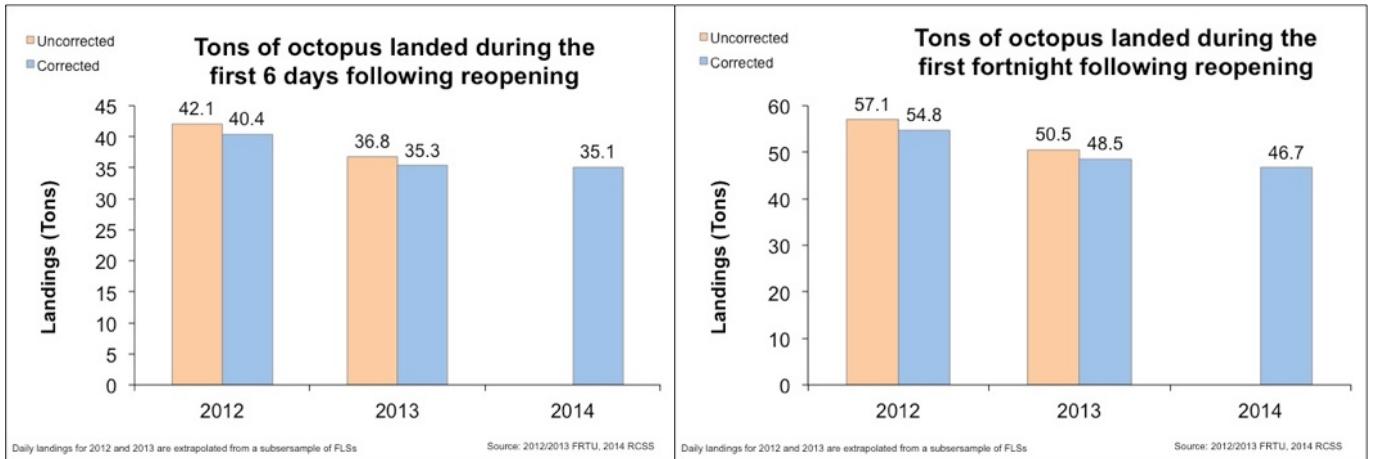


Figure 12. Showing corrected and uncorrected landings data (tonnes) for a. (left) first week landings and b. (right) first fortnight landings from 2012 to 2014. Data courtesy of FRTU, SEMPA, FPS (2012/2013) and RCSS (2014).

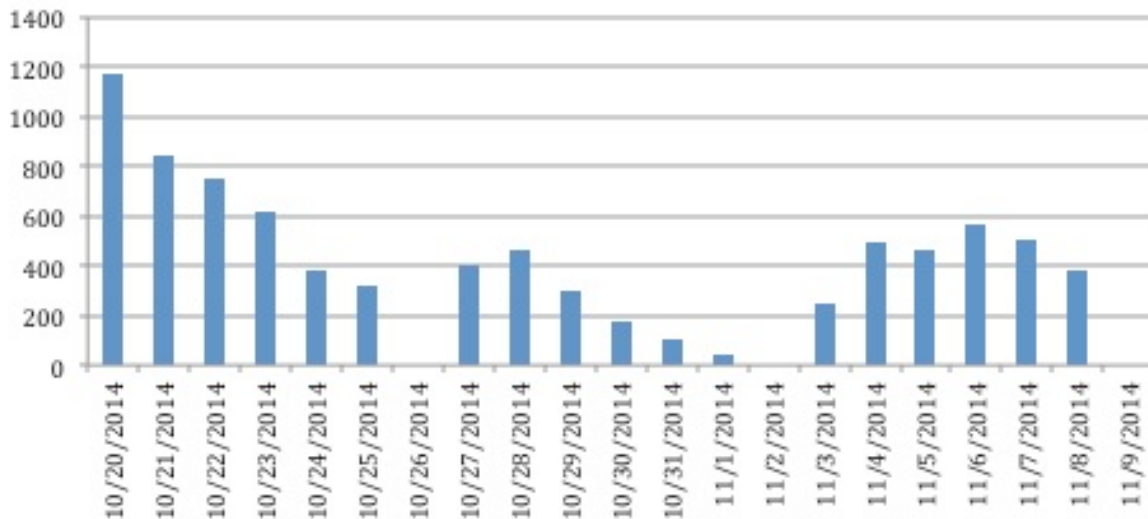


Figure 13. Fishing effort during the first three week following reopening of the octopus fishery in 2014. Data courtesy of RCSS.

### 5.3 Stakeholder perceptions/support

Thanks to the emblematic status octopus holds in the Rodriguan culture and the desire of the population to see better management of marine resources, the octopus fishery closure is gaining widespread support and the reopening of the fishery has become a major cultural event. The successes of the first three closures, in terms of landings and increased octopus sizes, have convinced the vast majority of stakeholders of the advantages of this method of fishery management. The awareness raising and capacity building sessions have been lauded by both fisher participants and organisations delivering the sessions. Anecdotally, there is almost universal support amongst fishers for the closure and many are even requesting a second closure each year to protect the newly recruited young octopus. Regular octopus

fishers claim that many of those enrolled on the closure programme are not fishers. Consequently, they ask for tighter controls on who can qualify to enrol on the programme so that the stipend provided for professional fishers can be increased.

There is a perception amongst many fishers that poaching is serious problem. During the 2012 and 2013 closures, the octopus stock in the narrow lagoon from the northeast to the east was reported by fishers to be depleted due to poaching. Most stakeholders believe that poaching is mainly carried out by off-lagoon fishers. There is a general view that poor enforcement is a major factor affecting the level of poaching. The FPS, despite its limited resources and capacity, has rejected the idea of using fishers as part of a participatory surveillance programme as proposed by the PSC and supported by IOC-SmartFish. Feedback from some members of the FPS and the fisher community reveals there are some mixed feelings about the effectiveness of participatory surveillance.

Many fishers are also concerned about the rise in uncontrolled fishing at the reopening of the fishery; the high, post-closure octopus yields attract a large number of amateur fishers who are not registered in the closure programme, many of whom already have jobs in other industries. This leaves the registered octopus fishers feeling unhappy as they receive less overall benefit from the closure. However, the law prescribes open access to marine resources so nothing has yet been done about the situation.

The perception that the closure was giving rise to price decreases is losing credibility. Following the 2014 closure, the arrival of a new wholesaler with blast freezing capacity ensured a more stable market price. Although fishers generally rely on public authorities to provide solutions to the different challenges faced by the sector, they are also in favour of creating fisher committees whose role will be to contribute to the improved management of the fishery and in particular to develop projects to reduce dependence on fishing.

Based on feedback meetings held, the majority of public officers working as supervisors for the 2012 and 2013 closures found their roles challenging and felt that their contribution was not sufficiently appreciated or remunerated.

## 6. Alternative livelihoods

### 6.1 Rationale

From the outset, the RRA policy decision was to move away from a system of compensation for non-action, (namely the Bad Weather Allowance or the Closed Season Allowance), towards a Payment for Ecosystem Services (PES) scheme. Given the large number of persons engaged in the closure programme each year, a sizeable set of activities was necessary to make the fishers productive during their scheduled alternative activity days.

One of the primary aims of the Alternative Livelihood Programme was to facilitate the acceptance of the Octopus Closed Season Regulations by introducing income-generating activities while moving away from the National Government's compensation policy, which Rodrigues had inherited. This National policy, in many ways, encouraged people to become fishers. The Alternative Livelihood Programme was designed to keep octopus fishers out of the lagoon by organising work activities during low spring tides (the optimal octopus gleaning period). During Project

Steering Committee meetings, the heads of the various commissions and NGOs were invited to propose alternative activities for the fishers. Activities that have been put forward so far are shown in Appendix 1.

## 6.2 Establishment

The number of days of alternative activities was based on the tidal prediction tables issued by the Mauritius Meteorological Services each year. These tables indicated that the spring tides ideal for octopus fishing occur for approximately 15 days per month, and therefore the total number of alternative activity days was set at 30 for the two-month closure period. This has remained the same for all three closures. Workdays were initially trialled as four-day blocks during 2012 and 2013; however, this led to discontentment amongst fishers as they wanted to work five days, and it made financial and administrative arrangements more complex. A five-day week was therefore implemented during the third closure.

Shoals Rodrigues and SEMPA octopus fishery datasets showed a considerable amount of variation in the start time and end time of fishing due to shifting tide times; however, on average, octopus-fishing outings began around 7 am and ended at around 11 am. The fisher workday was set accordingly at four hours or a half-day. This has been adopted by the fishers and remained the same during all three closures. The half-day system also allows the fishers to continue with their other daily activities, such as gardening, farming, housework, hook-and-line or basket trap fishing.

During the three closures, alternative activities took place between 7 am and 11 am, bar a few exceptions when fishers agreed to change the work times for specific activities. For the purposes of participatory community surveillance, a number of fishers agreed to work from 11 am to 3 pm, i.e. the second surveillance shift. During the first two closures an afternoon shift was not readily accepted by the fishers as it was not stated in their agreement; for the third closure, a new clause was inserted, stipulating the possibility of an 11 am to 3 pm shift. Feedback obtained during consultation and awareness raising sessions with the fishers, regarding the issue of poaching during the 2013 closure, encouraged the majority to engage in participatory surveillance.

So far, the closure and opening dates have been in August and October, respectively (see *Table 3*), as this is believed to coincide with peak migration of *O. cyanea* in Rodrigues from shallow to deeper waters. Since the impact of the closures has been positive, the closure dates have remained almost the same; however, it is likely that the short- and medium-term results could be improved by timing the closure period better with peak octopus migration, and therefore more accurate data on migration patterns are required.

	2012	2013	2014
Closure date	13 August	5 August	18 August
Reopening date	12 October	6 October	19 October
Duration (days)	60	62	62

**Table 3. The start and end dates and durations of the first three octopus fishery closures.**

In terms of remuneration, the fishers engaged in the Alternative Livelihood Programme drew MUR 250 (USD 7.15) per four hours of work for all three closures. This figure was established using Shoals Rodrigues and SEMPA octopus fisher survey data, which showed that, on average, fishers around Rodrigues landed approximately 2.5 kg of octopus per four-hour fishing trip, valued at MUR 100/kg (USD 2.86/kg). The figure brought about much debate at first, as some fishers claimed this was far lower than what they usually earned. It was explained how the figure had been determined and they had little other choice than to accept, especially given most of the Shoals Rodrigues and SEMPA data collection had been done by fishers. It was also explained to fishers that octopus catches vary considerably around the island and, as it was not realistic to pay some fishers more than others, all fishers would be given the average catch value.

### 6.3 Organisation and planning

In 2012, the Commission responsible for Fisheries invited all persons depending on the octopus fishery, via radio-broadcasts several days beforehand, to register for the closure programme. For the first closure, fisher registration took place over two days at all 23 FLS around the island, to allow enough time to process the large number of fishers who attended the consultation sessions, including data collection.

To better understand the spatial distribution of registered fishers and to help organise alternative activities, a GIS (Geographical Information System) was built by EPMU in 2012 containing all the fishers' data. Forty zones were drawn around groupings of fishers, based on the number of fishers in each village and their proximity to one another. Slight changes were made to the zone boundaries during subsequent closures to improve the organisation of fishers and alternative activities. In 2014, five regions were also defined (see *Figure 14*).

Efforts were made to ensure that fishers did not have to leave their respective zones to carry out their alternative activities, to prevent them incurring transport costs or logistical problems. In order to do this, information about fishers' location and the location, duration and tools required for the activity were used to tailor activities to the different fisher groups.

A meeting point in each zone was selected in consultation with the fishers prior to the first closure, which were then adjusted if necessary during subsequent closures. The meeting points are necessary to assemble the fishers, share information, sign agreements, record attendance and make payments. Each year, octopus fisher attendance sheets are produced using the finalised registration lists for the fishers to sign at the beginning and end of each work day. Fishers absent are not paid for that day; this ensures fishers are present each day. Initially there is one sheet per zone, then work group attendance sheets are produced by the EPMU once the work groups have been established by the zone or activity supervisors. The sheets are distributed to regional or zone supervisors and returned once a week during subsequent meetings. Attendance sheets are processed by the RRA accounts department for fisher payment.

The RRA prepared an agreement prior to the first closure and was signed by the fishers and the Departmental Head of the Commission for Fisheries; the document was subsequently updated each year in light of emerging issues and lessons learned. The conditions defined within the agreement between the fishers and the RRA include work hours, mode of payment, absence, equipment use and actions in case of misconduct.



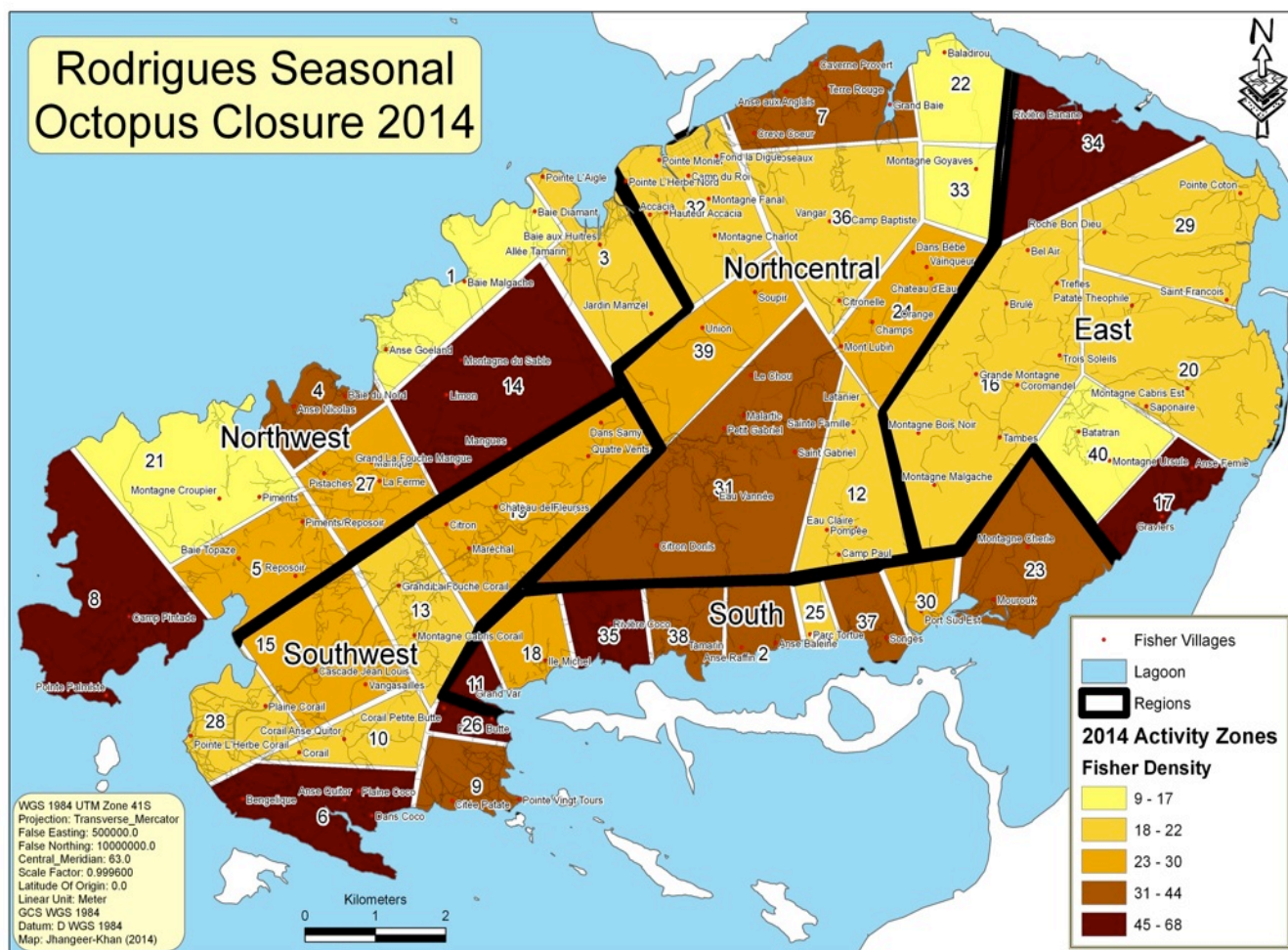


Figure 14: Octopus fisher village distribution and fisher density map consisting of 40 zones and five regions, generated from the GIS for the 2014 alternative activity planning.

### 6.4 Financing and budgetary measures

The RRA committed to funding the Seasonal Octopus Closure project. The bulk of the funding was dedicated to financing the Alternative Livelihood Programme, i.e. paying the fishers during the closure. The RRA adopted this strategy to mitigate the hardship a two-month closure would cause to those fishers who depend on the octopus fishery for their livelihoods. It would also ensure support from the fisher community and forestall political opposition to the project.

For the first closure the RRA financed the alternative livelihood stipends for 1,316 of the eligible octopus fishers and processors with a total of MUR 9,707,500 (USD 277,634). For the second closure, a similar amount was spent, while the funding for the third closure was sourced from within the Commission for Environment, Forestry, Tourism, Marine Parks and Fisheries. Recognising the positive results of the closure, the Ministry for Finance has agreed to the creation of a dedicated item of MUR 10 million (USD 286,000) under the budget for the promotion of sustainable fisheries and the funding of the 2015 closure.



Fisher payments were effected no later than one week after the work had been completed. During the first closure payments were made in cash, which involved a sizeable commitment of staff and resources. Prior to the second closure, efforts were made to shift payment from cash to direct bank transfer by collecting bank details; however, only a minority of fishers provided their bank details, so payments during the second closure were also made in cash. During registration for the third closure, a considerable number of additional fishers' bank details were collected and the first payments were made via bank transfer for the first three weeks, before reverting to cash payments again as a result of an unresolvable issue with the bank detail database. Most fishers now use the bank payment system, though a small minority who don't have bank accounts or access to the main town (Port Mathurin) are still paid in cash.

## 6.5 Managing alternative activities

For all three closures, the various RRA Commissions and NGOs proposed a range of alternative activities, as seen in Appendix 1. Given the proposing bodies' experience in running activities in their own fields, RRA and NGO officers were responsible for the direct supervision and management of their proposed activities and the fishers involved throughout the 2012 and 2013 closures. In 2012 some 40 officers served as supervisors, i.e. one per zone, whereas in 2013 approximately 75 officers served as supervisors to run the far larger number of proposed decentralised activities. This additional workload was not followed by a rise in remuneration, and a number of officers were dissatisfied with the situation.

In response to the lack of support from officers, a new initiative was proposed to fill this gap by recruiting a number of school-leavers to supervise the fishers during the 2013 closure; however, a lack of funds and political will prevented this from becoming a reality. Well ahead of the 2014 closure, the idea was re-visited and a mechanism ultimately found to implement this innovation in close collaboration between the RRA and the Rodrigues Council of Social Services (RCSS), with the financial support of the National Empowerment Foundation (NEF) and IOC-SmartFish.

The RCSS, a registered association consisting of representatives from each village committee, was responsible for the recruitment of 44 youths, 39 of whom would be zone supervisors while the remaining five would be regional supervisors. The recruitment was implemented at the village committee level so that one youth in each zone would be responsible for the fishers living within that zone. The zone supervisors were all holders of a secondary cycle education certificate. Five unemployed degree holders were recruited to serve as regional supervisors. To prepare them for their new roles, the 44 recruits followed a two and a half week training course consisting of five modules: the Octopus Fishery and its Management; Integrated Coastal Zone Management (ICZM); Community Led Local Development (CLLD); Project Cycle Management; and Supervisory, Leadership and Management skills.

While the zone supervisors were responsible for the day-to-day management of the fishers, the RRA commissions and NGO officers remained responsible for overseeing the alternative activities they had respectively proposed. This system was welcomed by the fishers who had requested closer supervision during prior closures, and by the RRA/NGO officers who appreciated not having to manage the fishers.

## 6.6 Sustainable alternative livelihoods

Previous reports on the socio-economics of the fisheries sector in Rodrigues have highlighted several key factors: the high dependence of fisher community on fishing, the limited diversity of livelihood opportunities for fishers, the concentration of fishing effort in the lagoon and the overexploitation of resources in the lagoon. Reducing overall fishing pressure in the lagoon is essential in order to build on the success of the octopus closure. To achieve this objective it is imperative to develop sustainable alternative opportunities for fishers that will reduce their dependence on fishing. The alternative activities component is vital for ensuring the success of the closure, but its management requires enormous financial and human resources. Furthermore, it remains a compensation mechanism that is more of a burden on the shoulders of the local authorities than a means to empower fishers and reduce pressure on the lagoon.

Addressing these issues required a major shift away from the way activities were planned in 2012 and 2013, with a move towards a co-management approach where responsibilities are more widely shared among stakeholders. Following the symposium in 2013, a two-pronged approach was adopted with a view to empower fishers by: 1) working closely with fisher communities to identify and develop sustainable alternatives or complementary livelihoods (a target of 200 fishers was defined for the 2014 closure); and 2) integrating alternative activities within the RRA's active programme of sustainable livelihood development, to transcend the limits of the octopus closure project.

During consultation meetings fishers were invited to come up with ideas for alternative livelihood projects they would be interested in and that could be undertaken as a group. The group was urged to move away from the existing individual approaches and to incorporate greater co-operation. Fishers were encouraged to discuss and agree upon potential projects. The RRA then promised to raise decentralised funds for the project on the condition that the fishers agreed to opt out of the closure programme and rescind their licence.

A visit was organised in Mauritius in May 2014 to raise funds for the 2014 octopus fishery closure which would incorporate improved co-management and development of alternative livelihood projects. Meetings were held with the Corporate Social Responsibility (CSR) Foundation, the National Empowerment Foundation (NEF), the Ministry for Economic and Social Empowerment and IOC-SmartFish, all of which showed interest in supporting the innovations proposed for 2014. Funding was secured for two alternative livelihood projects as well as for the recruitment of supervisors from the community to improve the supervision of works.

The second approach was to integrate the short-term alternative activities into a broader programme of sustainable livelihood development that would extend beyond the octopus closure. In this context, the village is seen as local geographical zone for the implementation of alternative activities and for the mobilisation of the villagers in the local development process. Using the existing experience of the RCSS and the potential role of village committees, it was possible to design a new approach that promotes alternative activities as a contribution to the welfare and sustainable livelihood of the villagers including the fishers and their families.

At the 2013 symposium, participants proposed the following activities to be undertaken with the support of Commissions of RRA, CSR foundations as well as other funders: rehabilitation of terraces, gardening and planting in order to contribute to increased agricultural production; development of community pastures through the RCSS and technical support of MWF; and development of community forests.

## 7. The way forward

### 7.1 Lessons learned

Given the initially polarised political opinion of the octopus closure and the socio-economic importance of the octopus fishery, both political and social management of the closure were necessary to ensure its smooth implementation. The success of the first closure, in terms of increased catches and landing of larger individuals after the reopening, promoted a higher level of compliance for the seasonal closures than other management strategies. However, many challenges still have to be addressed to ensure that temporary closures contribute towards more sustainable fishery management in Rodrigues: improving surveillance and enforcement, setting up access control to marine resources, developing added value and marketing, and creating sustainable alternative livelihood opportunities.

The closure is having strong impacts on stakeholders' attitudes. It is fostering a sense of stewardship of the resources and therefore greater interest in their management; for example, fishers and the population at large are calling for an improvement in certain weaker aspects in the closure management process. It is also stimulating an institutional learning process whereby stakeholders work together to find new solutions to address the various challenges they are confronted with. It is through this process of institutional learning that Rodrigues is building its own model of octopus fishery management.

This is the first time that a comprehensive effort has been undertaken to improve the management of a fishery in Rodrigues, so organisations are learning and improving each time. Successful closures rely upon a number of key learning points:

1. On-going and accurate monitoring of the resource
2. Consulting with all stakeholders before decision-making
3. Communicating with all stakeholders before, throughout and after the closure
4. Awareness raising amongst the fisher community and general population
5. Resource surveillance throughout the closure, day and night
6. Enforcement of all octopus-related regulations during and out of closed seasons
7. Managing price, competition and standards
8. Developing sustainable alternative/complementary income-generating activities
9. Providing participants with training and capacity building sessions
10. Regulating access to the resource

#### 7.1.1 On-going and accurate monitoring of the resource

Assessment of the success of the closures was aided by the long term catch data that had been collected at stations around the island. The current monitoring system involves gathering data on monthly and annual landing statistics, CPUE, sex ratios, weight-frequency distributions, gear types, permit status, fishing location, grid location, boat use, propulsion type, weather and sea condition. A comprehensive, long-term monitoring study should be setup prior to closing a fishery to serve as a baseline, and from the outset it should include all the variables necessary to assess change whilst controlling for external factors.

One common difficulty faced in monitoring is the cost of human resources, which increases linearly with an increase in the number of fish landing stations. Solutions involve stratification to reduce sampling and the use of a participatory approach where octopus fishers are trained to collect the data. Employing fishers in monitoring can have other benefits, such as overcoming the reluctance certain fishers have regarding giving data to strangers, helping to reduce pressure on the lagoon by providing fishers with alternative work during optimal tides, and helping to raise awareness amongst other fishers and the general community on the importance of closures and reducing undersized catches.

### **7.1.2 Consulting with all stakeholders before decision-making**

For the 2014 closure, a strengthened consultation approach was adopted to support a more robust approach to the management of the octopus fishery. Supervisors were recruited and trained to act as facilitators to support and motivate stakeholders to work together in order to respond to the many challenges of the closures. It has proved to be fruitful as a number of projects have been formalised and financial commitment obtained for their funding as a result. However, a consultative approach requires more time and resources compared with a top-down approach.

### **7.1.3 Communicating with all stakeholders before, throughout and after the closure**

Despite the wide public support for the programme, there is still a need to communicate very actively to raise awareness, educate and enable the participation of fishers, other stakeholders and the population at large.

### **7.1.4 Awareness raising amongst the fisher community and general population**

Education was a vital component of the preparations for the first closure. An island-wide awareness-raising programme took place with schools, the fisher community and the general public in 2011. It is likely this contributed to the success of the first closure by highlighting the social and environmental impact of illegal fishing. Prior to the 2013 closure, however, there was less focus on awareness raising, and this lack of effort may have contributed to the increase in poaching seen during the second and third closures. While it is difficult to find a direct cause of the decrease in landings, maintaining an adequate level of awareness is a well-established means of ensuring that the population is informed of the urgency and need for the closure and the importance of strong compliance.

### **7.1.5 Resource surveillance throughout the closure, day and night**

It is widely recognised that poor enforcement has been the weak link of the closures. Enforcement efforts must be pursued on several fronts. The sub-committee on surveillance (NCG, MPF, SEMPA, FRTU and EPMU) has to become more effective, with a clearer definition of respective responsibilities and improved coordination of their actions. Since the NCG and Environment Police have proved to be more effective in catching fishers who are breaking the law, their role could be reinforced. Reinforced participatory surveillance during the third closure improved compliance but needed to be backed up by enforcement.

In order to strengthen the co-management approach for future closures, a new initiative is planned in the form of a Local Surveillance Committee comprising local stakeholders (especially the village committees) to support and motivate the fishers to participate in surveillance activities. Participatory surveillance should be carried out around the clock. Cooperation has to be developed between the local committee and the enforcement institutions. Consideration should be given on how to overcome certain legal barriers such as, for example, the rule that excludes non-government

persons from boarding FPS surveillance vessels at sea, or how fishers could put their boats at the disposal of the formal institutions when required. The Commission for Fisheries is currently designating strategic checkpoints across the island as observatory points for surveillance.

#### **7.1.6 Enforcement of all octopus-related regulations during and out of closed seasons**

Effective fishery management requires both compliance and enforcement. Strong enforcement had a positive effect on discouraging poachers: in 2012 two fishers in the closure programme were caught fishing and were expelled from the programme. The news spread rapidly and, while it is unfortunate for the fishers, the action had the effect of instilling a stronger respect for the legislation. It is understood that on small islands with close family and community links, enforcement of the law is not always easy; however, taking firm action is a necessary measure to encourage compliance.

#### **7.1.7 Managing price, competition and standards**

Another challenge is the market distortion caused by the closure. The combination of sudden abundance and increased effort at reopening had the effect, in 2012 in particular, of driving prices down during the first days of fishing (sometimes decreasing by 30%) and saturating the storage capacity of wholesalers. The RRA is considering various solutions for the future, including the setting up of a mechanism to keep control over prices at reopening. It seems however that this situation is only temporary, and prices tend to get back to normal when landings stabilise after a few weeks. Promoting product diversification and value addition could contribute to absorbing the excess production at reopening. However, value addition initiatives leading to an increase of fishers' revenue in an open access context are likely to exacerbate the existing problem of there being too many fishers operating in the lagoon. Therefore, value chain developments need to be gradual and linked to progress made in the sustainable management of the fishery.

Rodrigues will not regain its status of leading octopus exporter to Mauritius overnight; however, the process of progressively recovering market shares needs to go hand in hand with a campaign for promoting local octopus products in Mauritius. This idea was initiated by the RRA when it launched the 'Origine Rodrigues' label during the 'Semaine rodriguaise' (Rodriguan week) in Mauritius in 2013. To facilitate this process, a market survey should be undertaken in Mauritius in order to assess if consumers would be willing to pay a premium for octopus products that are caught in a sustainably managed lagoon on the neighbouring island. Capitalising on proximity with consumers while restoring the privileged trading relationship between the two islands would certainly be more rewarding for Rodrigues than aiming at international markets, such as the EU, where quality-related standards are likely to be a major obstacle in the short term, and where it has no competitive advantages.

#### **7.1.8 Developing sustainable alternative/complementary income-generating activities**

The fisheries sector has undergone many reforms over the past thirty years, including the VRS, buy-back of seine nets and redeployment (promoting off-lagoon fishing), but sadly they have not succeeded in reducing fishing pressure in the lagoon. This objective may be achieved, in part, by providing sustainable complementary or alternative livelihood opportunities to fishers. This requires an integrated approach and new forms of partnership amongst fishers, specialised NGOs, funders and the public authorities to initiate and implement projects. An example of such an

integrated approach can be seen in the reforestation project implemented by the MWF and Shoals Rodrigues in Grenade where fishers have voluntarily agreed to work on a project which will bring complementary revenue.

### 7.1.9 Providing participants with information, training and capacity building sessions

The majority of octopus fishers in Rodrigues have a low level of education and they are also inherently difficult to reach and often out at sea. This often causes difficulties with communication, training and capacity building amongst the fisher community. During the implementation of the octopus closure programme in 2012, it was found that octopus fishers could be reached by integrating training and capacity building during the alternative livelihood hours and this has enabled fishers to receive much needed lessons on (amongst other subjects) swimming, first aid, boat engine maintenance, marine and terrestrial conservation, drug and alcohol abuse, HIV/AIDS transmission and its prevention, self-esteem, contraception, non-communicable diseases and family planning.

### 7.1.10 Regulating access to the resource

By law, the Rodrigues lagoon is open to fishing by everyone and there are currently no regulations on catch quota. Naturally this poses a problem to sustainable management of the octopus stock. The rationale to move towards access regulation is understood; however, the mechanism required is not yet in place. There was a need, therefore, to collect data from all octopus fishers on their fishing frequency and their dependence on the resource, and a programme was set up after the 2014 closure, in collaboration with the RCSS (financially supported by IOC-SmartFish), to gather this information. Zone supervisors were posted at the various octopus landing stations to record the names of every fisher landing octopus, each day, for a period of two months. These fishers were recorded under the following nine categories: Alternative Livelihood Fisher, Registered Off-lagoon Fisher, Under-18 Fisher, New Octopus Fisher, Voluntary Retirement Scheme Fisher, Seine Net Fisher, Currently Employed Fisher, Registered Lagoon Fisher and Buyer Fisher. These data will be inputted into a database and will be used to generate the information required to identify those fishers who depend on the octopus fishery and those who fish on a more casual basis.

This information could be used by the RRA, if resource access was regulated, to provide 'professional' licences to those fishers who are dependent on the resource and 'amateur' licences to part-time or recreational fishers. Under such a licence system, badges would accompany the licences and would have to be carried by all octopus fishers to help enforcement officers and octopus buyers to identify them. A fee would be levied for each type of licence, and the funds raised would be used to provide financial support to professional fishers during seasonal closures. In addition, the identification of professional fishers would allow the RRA to reduce the large number of persons registered in the closure programme, since it is believed that a significant proportion are not fully dependent on the resource and therefore should not qualify for the compensation programme during closures. The threshold of fishing frequency required to qualify for a 'professional' licence would still need to be established.

## 7.2 Strengths and limitations of the seasonal closure

The 2012 closure led to increased landings, revenue, increases in CPUE and was generally viewed as a success. Closures were repeated in 2013 and 2014 with similar success. Further consultation with fishers suggests they want longer



winter closures as well as a summer closure, probably motivated by improved post-opening catches, increased revenue and by the compensation they received during the closures.

Although the Rodrigues administration understands that more frequent and longer closures would mean more effective rehabilitation of the stock, greater catches and more alternative work accomplished by fishers, the decision to continue with one two-month winter closure has mainly been due to the large cost associated with the compensation of fishers for their services during the closure. The present cost, both financially and in terms of human resources, is unsustainable and any increase in closure duration or in the number of closures using the current model would make the management strategy less viable.

### **7.3 Broader conservation impacts of the closures**

Increased finfish catches were reported in the lagoon in 2014, possibly as a result of octopus fishers exerting less pressure on lagoon resources during the closure (Richard Payendee, Commissioner responsible for Fisheries, pers. com.). A multi-gear fishery is practised in Rodrigues, and many of the fishers engaged in the closure programme also temporarily stop hook-and-line and basket-trap fishing. As these fishers receive compensation in the form of payment for alternative activities, a proportion of them are less inclined to go fishing after their half-day of physical terrestrial work, thereby reducing pressure on the finfish fishery. It is worth noting, however, that the octopus closure is a single-species measure designed to manage a short-lived, fast growing species and not for longer-lived reef finfish species.

The public, being (for the most part) well aware of the decline in lagoon catches, are highly in favour of additional closures, of protection of marine resources in general, and of improvements in the work ethics of enforcement officers and therefore better enforcement of regulations. During radio shows, members of the public have called in to support the closure effort and to encourage further and improved actions such as establishing more marine reserves and MPAs. Similarly, during the local symposium in December 2014, the success of previous closures was highly praised, but concerns were raised about the paucity of surveillance efforts and lack of enforcement of regulations.

This report has discussed in detail how the measure has been implemented in the Rodrigues context; those adopting the seasonal closure approach elsewhere, such as in Zanzibar and mainland Mauritius where closures are currently being piloted, will need to carefully consider the specific geographical, social and economic conditions in each location.

## 8. Funding Partners

### Funders

European Union–Indian Ocean Commission: ReCoMaP/IOC-SmartFish

Food and Agriculture Organization of the United Nations

United Nations Development Programme GEF-SGP

National Empowerment Foundation

Government of Mauritius

Rodrigues Regional Assembly

Substantial funding from the European Union under the Indian Ocean Commission’s IOC-SmartFish programme was crucial for the success of the closure. For the first and second closures, the IOC-SmartFish programme financed alternative livelihood activities managed by MWF. For all three closures, IOC-SmartFish financed training through the capacity building component and octopus stock monitoring activities carried out by Shoals Rodrigues and the communication support materials. They also financed the technical assistance of several consultants who supported the process before, during and after the first and second closures, and supported the recruitment of youth leaders as an innovation for the third closure with a view to improving supervision of alternative activities and the monitoring of post-closure catches and fishers. Additional donations were obtained from private sector businesses for the purchase of tools and other equipment necessary for the ecosystem-based activities carried out by the fishers during the first closure in particular.

### Collaborators

Economic Planning and Monitoring Unit (EPMU), Indian Ocean Commission (IOC), United Nations Development Programme (UNDP), Food and Agricultural Organisation (FAO), Rodrigues Council of Social Services (RCSS), Roman Catholic Education Authority (RCEA), National Empowerment Foundation (NEF), Shoals Rodrigues, Mauritian Wildlife Foundation (MWF), Ter-Mer Rodriguez (TMR), South East Marine Protected Area (SEMPA) and Fisheries Research and Training Unit (FRTU), Fisheries Protection Service (FPS), Mauritius Police Force (MPF), National Coastguard (NCG), Forestry Services and Agricultural Services.

## 9. Acknowledgements

This report was commissioned by Blue Ventures Conservation with support from the Western Indian Ocean Marine Science Association. The authors, representing donor and government stakeholders involved in working with the Rodrigues octopus fishery, are grateful for the assistance and information provided in the preparation of this report by diverse partners supporting the improved management of the fishery.

## 10. References

- Central Statistics Office - CSO (1999) Digest of Statistics on Rodrigues 1998. Ministry of Finance and Economic Development, Mauritius.
- Central Statistics Office - CSO (2009) Digest of Statistics on Rodrigues 2008. Ministry of Finance and Economic Development, Mauritius.
- Central Statistics Office - CSO (2011) Digest of Statistics on Rodrigues 2010. Ministry of Finance and Economic Development, Mauritius.
- Central Statistics Office - CSO (2012) Digest of Statistics on Rodrigues 2011. Ministry of Finance and Economic Development, Mauritius.
- Central Statistics Office - CSO (2013) Digest of Statistics on Rodrigues 2012. Ministry of Finance and Economic Development, Mauritius.
- Chapman B. and Turner J.R. (2004) Development of a Geographical Information System for the marine resources of Rodrigues. *Journal of Natural History* 38 (23–24): 2937–2957
- Chellapermal A. (2014) A co-management approach, Octopus Fishery Symposium Report.
- Fenner D., Clark T.H., Turner J.R. and Chapman B. (2004) A checklist of the corals of the island state of Rodrigues, Mauritius. *Journal of Natural History*, 38(23e24):3091e102.
- Genave J.T. (2000) Abundance and distribution of *Octopus cyanea* in the Rodrigues lagoon. MSc Thesis, University of Wales Bangor.
- Genave J.T. (1997) Growth, reproductive biology and stock assessment of *Octopus cyanea* off the coast of Rodrigues Island. BSc Thesis, University of Mauritius.
- Hardman E.R., Blais F.E.I., Desiré M.S., Raffin J.S.J., Perrine S., Chinien-Chetty M. (2006) Survey of endemic coral & fish species on the coral reefs of Rodrigues. Pointe Monier, Rodrigues: Shoals Rodrigues. p. 8.
- Heemstra E., Heemstra P., Smale M., Hoopers T. and Pelicier D. (2004) Preliminary checklist of coastal fishes from the Mauritian island of Rodrigues. *Journal of Natural History*. 38: 3315–3344
- Jhangeer-Khan R., Perrine S., Joseph A. and Raffin J.S.J. (2012) An improved and continuous data collection system for the octopus fishery in Rodrigues for improved management. Final IOC-SmartFish Report.
- Jhangeer-Khan R., Perrine S., Desiré M.S., Raffin J.S.J., Francois L. and Raffaut R. (2010) Report on the octopus fisheries at two major landing stations 2008–2009. Unpublished Shoals Rodrigues Report.
- Lynch T.L., Hooper T.E.J., Blais F.E.I., Meunier M.S., Perrine J.S. and Ravanne A. (2000) Status of the octopus fishery in the Rodrigues lagoon. Shoals of Capricorn Report.
- Lynch T.L., Hooper T.E.J., Meunier M.S., Blai, F.E.I., Raffin J.S.J., Perrine S., Raffaut R. and Hardman E.R. (2005) A feasibility study to investigate the use of octopus traps in Rodrigues. Shoals of Capricorn Report.

- Lynch T.L., Uncles R.J., Bale A.J., Stephens J.A., Harris C., Raffin J.S.J., Perrine S., Begué T., Meunier M.S., Blais F.E.I. and Raffaut R. (2002) Accumulation and behaviour of suspended sediment in the Rodrigues Lagoon. Shoals of Capricorn Report.
- Nallee M. (2012) Rapid Assessment of the Fisheries Statistical System – Rodrigues. IOC-SmartFish Consultant Report.
- North-Coombes (1971) The Island of Rodrigues. Book Printing Services Ltd, Mauritius.
- Pearson M.P. (1988) Rodrigues. Rapid survey of the status of exploitation and environmental damage of the lagoon and coral reefs off Rodrigues. Report prepared for the project 'Assistance to artisanal fishermen and development of outer reef fishery'. Food and Agriculture Organisation of the United Nations, Rome.
- Peterson J. and Stead S. (2011) Rule breaking and livelihood options in marine protected areas in *Environmental Conservation* 38(3): 342–352.
- Sauer W.H.H., Potts W., Raberinary D., Anderson J., and Perrine M.J.S. (2011) Assessment of current data for the octopus resource in Rodrigues, Western Indian Ocean. *African Journal of Marine Science* 33: 181–187.
- Shaw P. (2011) Analysis of population structure of *Octopus cyanea* from the Western Indian Ocean using analysis of microsatellite variation. ReCoMaP Report.
- Stead S., Peterson A., Mill A. and Rushton S. (2009) Marine socio-economic scoping study of the north coast of Rodrigues, Newcastle University.
- Stead S., Peterson A., Mill A. and Rushton S. (2010) Analysis of the 2008 Socioeconomic Baseline Survey of the South East Marine Protected Area in Rodrigues, Newcastle University.
- Sweenarain S. (2012) Value chain analysis of fisheries sector for Rodrigues, SmartFish Programme, Indian Ocean Commission, Mauritius.

## 11. Appendix 1

Proposing Bodies	Proposed Activities
Chief Commissioner's Office (Agriculture, Education)	Cleaning, weeding and planting in nurseries, cleaning animal stations, planting and weeding on pastureland, compound cleaning, removal of invasive plants and debris on pasturelands, cleaning and assistance in potting of coffee plants at nursery. Work in school vegetable and endemic gardens, cleaning, upgrading, and general maintenance work.
Deputy Chief Commissioner's Office (Social Security, Employment, Labour and Industrial Relations)	Office and garden maintenance, children's shelter garden work, assisting in agricultural cooperative projects, assisting vulnerable people (garden maintenance, track road construction, wall construction), Maintenance of the senior citizen centre, respite centre and integrated family centre.
Commission for Public Infrastructure, Water Resources, Housing and Transport	River rehabilitation, water tank construction, reservoir maintenance, compound maintenance, road maintenance, drain cleaning, laying of water pipes, maintaining and silt removal of dams.
Commission for Environment, Tourism, Forestry, Fisheries and Marine Parks	Upgrading and maintaining tourist sites and terrestrial reserves, exotic plant removal, planting endemics, cleaning and embellishing coastal areas, collection of windblown plastic bags, collection of glass bottles for recycling, circle weeding and recruiting, nursery work, river rehabilitation, roadside cleaning and forestry land clearing.
Commission for Youth, Community Development, Library Services and Archives	Youth centre, youth advisory bureau, reading and cultural activity centre, cultural and leisure centre, community centre and Atelier du Savoir cleaning and general maintenance.
Commission for Health, Sport and Markets	General cleaning and maintenance of health centres, hospitals, sport infrastructure (sport stadium & football fields) and market facilities.
NGOs: Rodrigues Council for Social Services, Mauritian Wildlife Foundation, Shoals Rodrigues, Ter-Mer Rodriguez	Various community based work, rehabilitation work at two terrestrial reserves (weeding, exotic and invasive plant removal), nursery work, coral reef rehabilitation, and resource surveillance.