

# Improving management effectiveness for the Marine Protected Areas of Rodrigues (Indian Ocean).



## Monitoring the Effectiveness of the Four Northern Marine Reserves: A Preliminary Evaluation

March 2011

Compiled and Edited by:

Emily Hardman, Rebecca Klaus, Sabrina Desiré and Reshad Jhangeer-Khan



## Table of Contents

Table of Contents .....	2
1.0 Executive Summary .....	3
2.0 Introduction .....	4
3.0 Evaluation of current monitoring programmes .....	4
3.1 Shoals Rodrigues.....	4
3.11 Coral Reef Monitoring .....	4
3.12 Lagoon Habitat Monitoring.....	7
3.13 Water Quality Monitoring .....	8
3.14 Seine Net Fishery Monitoring .....	9
3.15 Line and Trap Fisheries Monitoring .....	11
3.16 Octopus Fishery Monitoring .....	11
3.17 Socio-Economic Monitoring.....	11
3.2 Fisheries Research & Training Unit (FRTU) .....	11
4.0 Limitations of the current monitoring programme .....	11
4.1 Coral Reef Monitoring .....	12
4.2 Lagoon Monitoring .....	12
4.3 Water Quality Monitoring .....	12
4.4 Seine Net Fishery .....	13
4.5 Line and Basket Trap Fisheries.....	13
4.6 Octopus Monitoring.....	13
4.7 Socio-Economic Monitoring.....	13
5.0 Preliminary Recommendations .....	14
6.0 References .....	18
ANNEX 1: Shoals Rodrigues Monitoring Reports	



## 1.0 Executive Summary

In recognition of the need to improve the status of the island's marine resources, the Rodrigues Regional Assembly (RRA) has gazetted new MPAs. The new MPAs include four marine reserves in the north (covering 24.2 km<sup>2</sup>), which were selected by the local communities with the support of the local marine NGO Shoals Rodrigues under a grant from the GEF Small Grants Programme implemented by the UNDP, and were formally gazetted in 2007. In addition, a larger multiple-use MPA has been developed on the south coast (covering 43 km<sup>2</sup>) which was co-funded by a Government of Mauritius/UNDP/GEF/Rodrigues Regional Assembly project, and formally gazetted in 2009.

A Marine Reserve Coordination Committee (MRCC) has also been established, composed of representatives of the relevant Government Authorities; representatives of the Fishers Associations; the local marine NGO (Shoals Rodrigues) and other key stakeholders. A preliminary management plan has already been prepared for one of the four northern reserves (Rivière Banane), and other activities such as the demarcation of these reserves have already taken place.

Building on this momentum, this project aims to contribute towards the overall marine conservation vision of the RRA by supporting the next stage in the implementation of the Marine Reserves. The project will provide the MRCC with training to facilitate the development of a new management plan for the effective management of the Marine Reserves in the north.

Monitoring and evaluation is an essential component of any successful management activity. Monitoring programmes are required to assess the status of the key values of the Marine Protected Area and to determine whether management is having its intended impact and is effective. One of the aims of the current project is to develop a revised monitoring programme for the new northern marine reserves to ensure that the biophysical, socio-economic and governance indicators selected are appropriate for monitoring the effectiveness of all of the MPAs.

Monitoring in the marine environment of the northern lagoon is currently undertaken by Shoals Rodrigues and the Fisheries Research & Training Unit (FRTU). Shoals Rodrigues carry out ecological monitoring (coral reef and lagoon habitats), water quality monitoring and fisheries monitoring (seine net, line and basket trap and octopus) and have undertaken baseline assessments for socio-economic monitoring. FRTU monitor catch data (fish and octopus) at the 22 fish landing stations around the island.

The limitations of the current monitoring programme are discussed and some preliminary recommendations are made in order to improve this programme. The monitoring programme will however require further reviewing following the development of the draft management plan.

## 2.0 Introduction

The four Northern Marine Reserves (Rivière Banane, Anse aux Anglais, Grand Bassin and Passe Demi) were originally identified with the support of the local community and they were formally gazetted in 2007. A management plan has since been prepared for one of the four areas (Rivière Banane), the areas have been demarcated, and other activities are underway within Rivière Banane. This project aims to develop a joint management plan for all four of the reserves. Monitoring and evaluation is an essential component of any successful management activity. The principle reasons for developing a monitoring programme are to: (i) assess the status of the key values (biodiversity and socio-economic aspects) of the Marine Protected Area; and (ii) determine whether management is having its intended impact and is effective (IUCN, 2004).

One of the aims of the current project 'Improving Management Effectiveness for the Marine Protected Areas of Rodrigues' is to develop a revised monitoring programme for the new marine reserves to ensure that the biophysical, socio-economic and governance indicators selected are appropriate for monitoring the effectiveness of all of the MPAs. This preliminary evaluation sets out to review the current biophysical and socio-economic monitoring programme in Rodrigues to ensure that the methods are appropriate for collecting data that will inform management. A further review will be required once the draft management plan has been written and appropriate indicators have been identified by the stakeholders.

## 3.0 Evaluation of current monitoring programmes

There are 3 organisations currently undertaking monitoring in the marine environment in Rodrigues: Shoals Rodrigues, the Fisheries Training & Research Unit (FRTU) and the South East Marine Protected Area (SEMPA); SEMPA only carries out monitoring in the southern lagoon and therefore their activities will not be discussed during this report.

### 3.1 Shoals Rodrigues

#### 3.1.1 Coral Reef Monitoring

Coral Reef Monitoring has been carried out by Shoals Rodrigues since 2002 and surveys are undertaken at stations on the reef flat (approximately 1m depth) and the reef slope (6m – 12m depth). Initially, 6 sites (9 stations) were established, including 1 site in the southern lagoon, and these were monitored twice a year during summer (March/April) and winter (September/October); from 2008 onwards however, sites were only surveyed once a year between October and February. In 2005, additional sites were added to allow clearer comparisons between reserve and non-reserve areas. There are now 7 sites (11 stations) in the northern lagoon and 2 sites in the south; of these, there are 4 sites (6 stations) inside marine reserves and 3 sites (5 stations) outside marine reserves (Table 1; Figure 1).

The Global Coral Reef Monitoring network methodology (English *et al.*, 1994) is used, for which three transects are laid at each station. The transects are marked using metal stakes hammered into

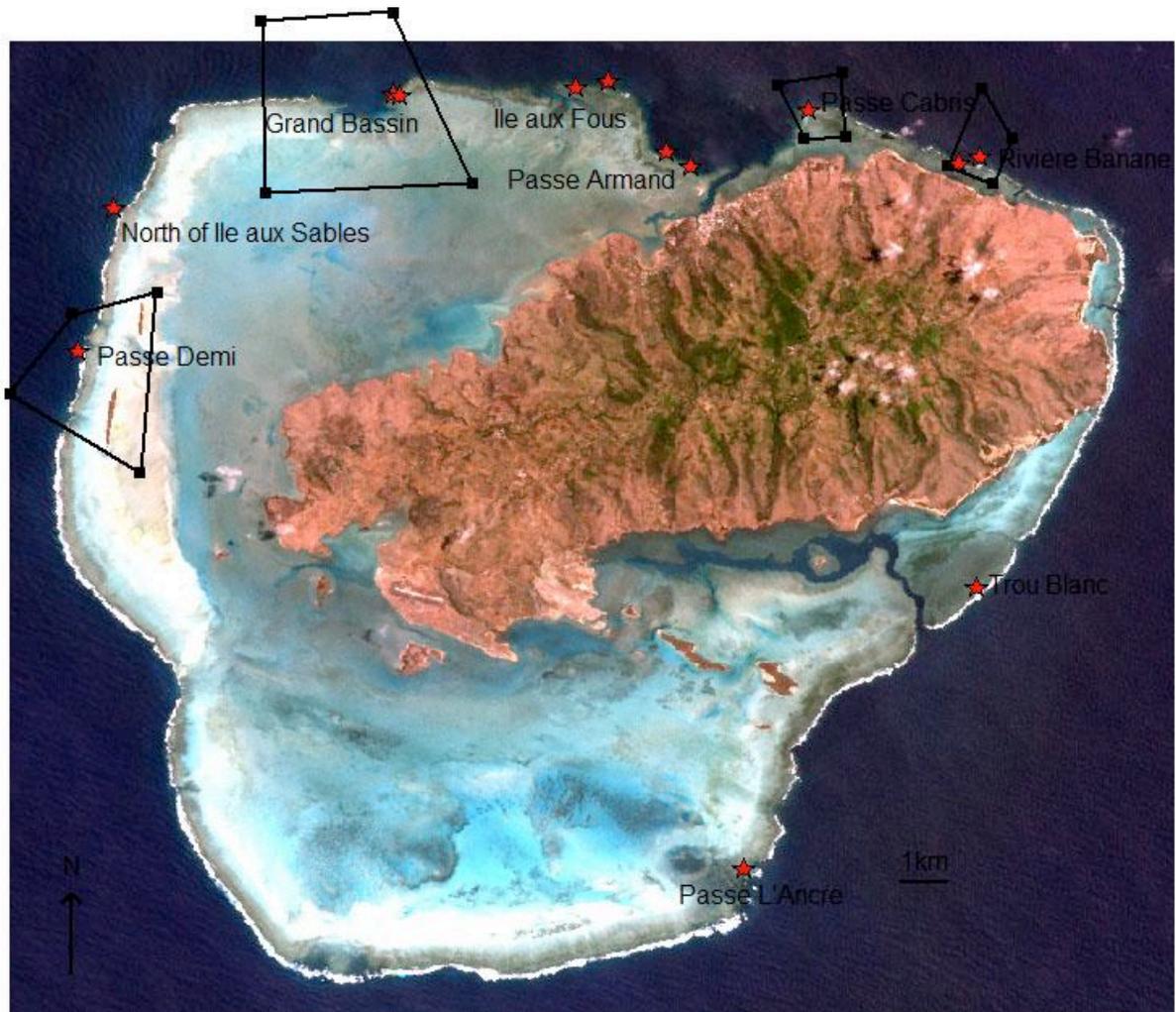
the substrate at 0m, 5m, 10m, 15m, 20m and 50m and the location of the sites are recorded using a hand-held GPS. Reef flat monitoring is carried out by snorkelling, while SCUBA diving is used for the reef slope surveys.

Along each transect, counts of all fish encountered are undertaken along a belt of 50 x 5m by 1 - 2 observers. From 2006 onwards, the lengths of 12 indicator fish species were also estimated at each site. Coverage of benthic species and abiotic features is determined by line intercept along the first 20m of each transect by 1 observer. Surveys of invertebrate species are carried out by a further observer, determining abundance of species over a belt 20 x 5m wide for each transect. The data are analysed using the Coremo III software and compiled into an annual report; data are also sent to the Global Coral Reef Monitoring Network (GCRMN) for inclusion in their status report.

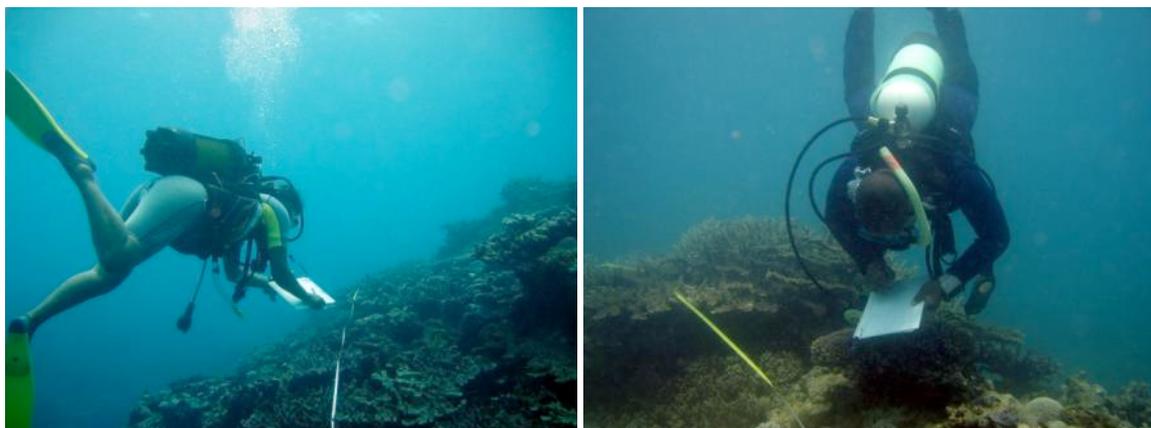
**Table 1.** The coral reef monitoring sites/stations in Rodrigues and the years that surveys were carried out.

Site	Location	Reef Flat	Reef Slope
Riviere Banane	Inside Reserve	2002 – 2007, 2010	2002 – 2008, 2010
Passe Armand	Outside Reserve	2002 – 2008, 2010	2002 – 2008, 2010
Ile aux Fous	Outside Reserve	2005 – 2007, 2010	2002, 2005 – 2008, 2010
Grand Bassin	Inside Reserve	2002 – 2007, 2010	2002 – 2008, 2010
Passe Demi	Inside Reserve	N/A	2002, 2004 – 2008, 2010
North of Ile aux Sables	Outside Reserve	N/A	2005 – 2008, 2010
Passe Cabri	Inside Reserve	2005 – 2008, 2010	N/A
Trou Blanc	Southern lagoon	2002 – 2007	N/A
Passe l’Ancre	Southern lagoon	2003 - 2007	N/A





**Figure 1.** The location of coral reef monitoring sites around Rodrigues and the position of the 4 proposed marine reserves.



Coral Reef monitoring surveys

### 3.12 Lagoon Habitat Monitoring

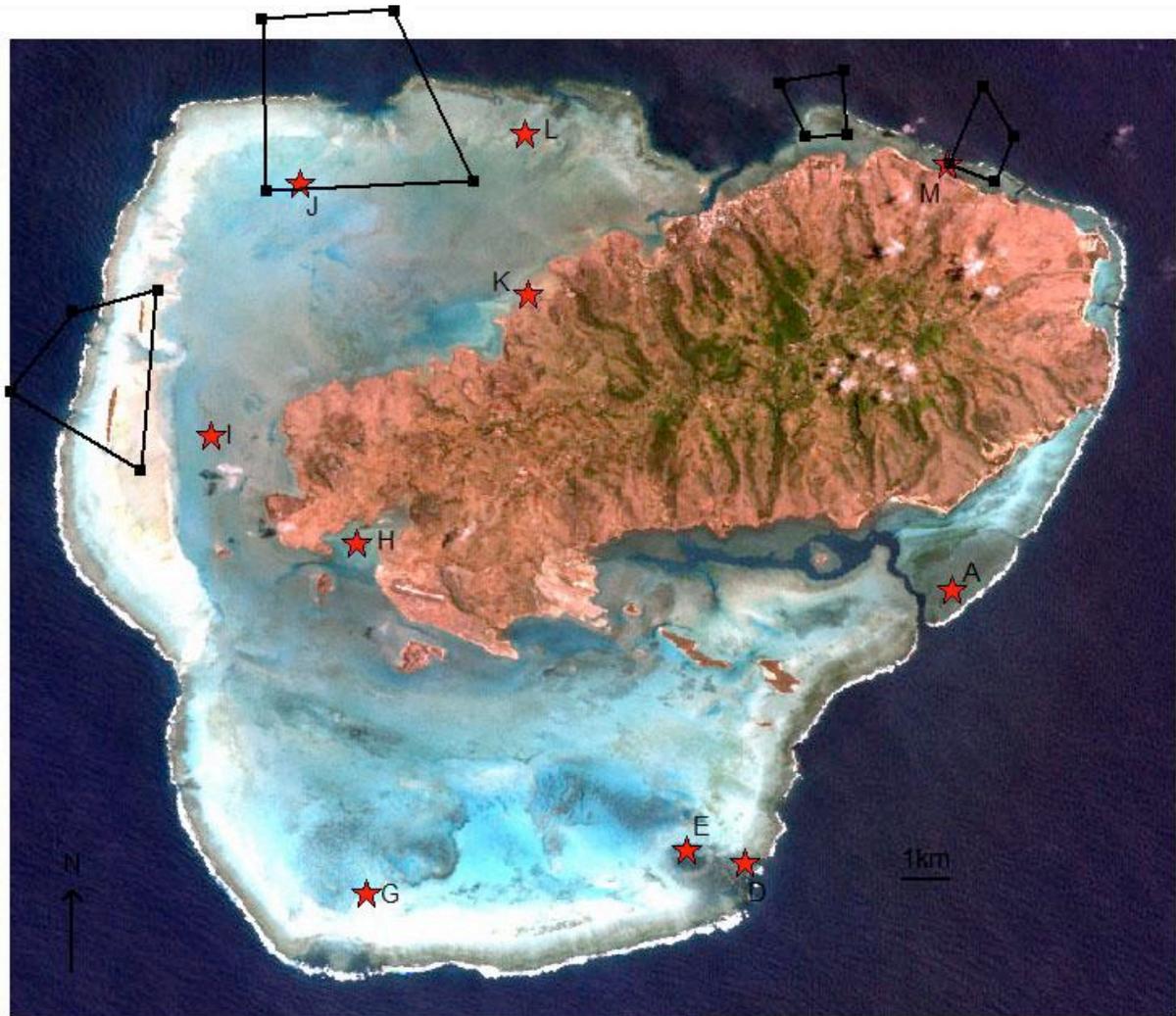
Monitoring of lagoon habitats commenced in 2003. Four different habitat types were initially selected for monitoring: (a) lagoon coral on a consolidated limestone platform (2 sites); (b) isolated coral blocks within a generally sandy area (3 sites); (c) beds of algae and/or seagrass (3 sites) and; (d) areas with a fine sediment substrate (2 sites). From 2006 however, the 2 fine sediment sites were no longer surveyed. Four sites (excluding the fine sediment sites) are within the northern lagoon; site J is within the Grand Bassin Marine Reserve, whilst Site M falls just outside the Riviere Banane Marine Reserve (Table 2; Figure 2).

Three stations are surveyed within each site and a 500m transect is surveyed by snorkelling at each station, with the length of the transect being determined using a GPS. Fish and invertebrates in a 2m wide belt are counted continuously along the transect by separate observers. The benthos is assessed by evaluating a 5m x 5m area at one minute intervals along the transect. The surveys are semi-quantitative, to reflect the lack of absolute precision in the dimensions of the transects. Initially, monitoring was undertaken twice a year in February/March and September/October, but in 2005, was reduced to once a year (May/June). The data are analysed and compiled into an annual report.

**Table 2.** The lagoon monitoring sites in Rodrigues and the years that surveys were carried out.

Site	Habitat	Years Surveyed
A	Lagoon Coral	2003 – 2007, 2009
D	Lagoon Coral	2003 – 2006, 2009
H	Fine Sediment	2003 – 2005
K	Fine Sediment	2003 – 2005
E	Coral Blocks on Sand	2003 – 2007, 2009
G	Coral Blocks on Sand	2003 – 2004, 2006 – 2007,
J	Coral Blocks on Sand	2003 – 2007, 2009
I	Algae/Seagrass	2003 – 2007, 2009
L	Algae/Seagrass	2003 – 2007, 2009
M	Algae/Seagrass	2003 – 2007, 2009





**Figure 2.** The location of lagoon monitoring sites around Rodrigues and the position of the 4 proposed marine reserves.

### 3.13 Water Quality Monitoring

Water quality monitoring has been carried out only sporadically. Temperature and salinity measurements were made at the coral reef monitoring survey sites during 2002, 2003, 2006, 2008 and 2010 using a Valeport MkII CTD. In March 2006, permanent temperature loggers were placed at 10 of the coral reef monitoring sites to record temperature every hour over a 21-month period and in 2010, a further temperature logger was deployed for 1 year at Totor, near to the channel mouth. Nutrient concentration (nitrates, nitrites and phosphates) was determined at the coral reef monitoring sites using the Palintest system in 2002, 2006 and 2007. The data are analysed and included within the annual coral reef monitoring report.



Sea Surface Temperature logger

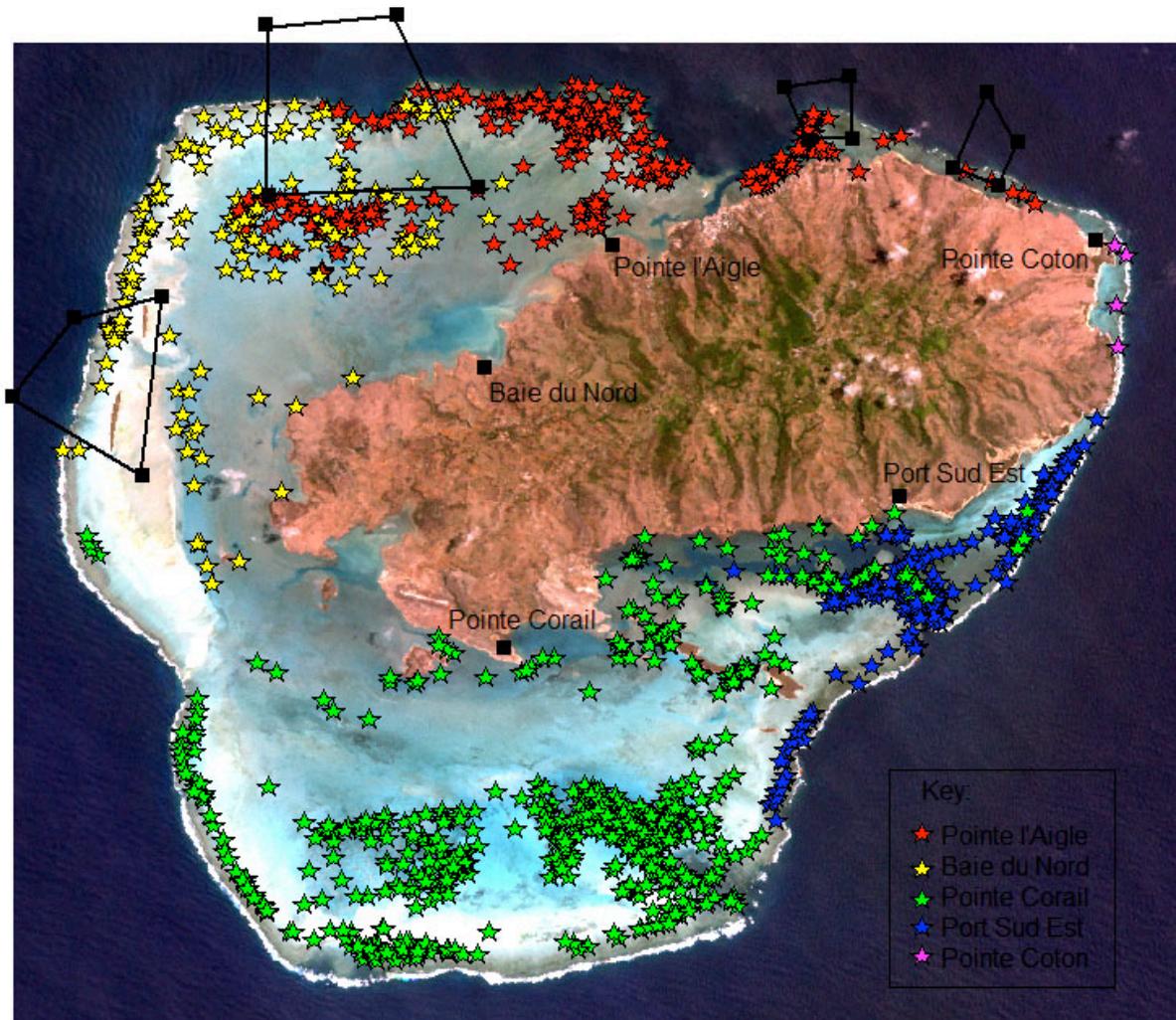
### 3.14 Seine Net Fishery Monitoring

Assessments of the seine net fishery have been undertaken by Shoals Rodrigues since 2002 during the fishery’s open season (1<sup>st</sup> March – 30<sup>th</sup> September). Catch assessments are undertaken by following a seine net team during the course of a fishing day. The GPS position and time of each haul are noted, and all fish caught are transferred to the survey boat, where the species and total length of each individual is determined. The weight of each individual is then estimated using published length-weight relationships. From 2003 onwards, a selection of fish were returned to the laboratory where they were weighed and measurements made of total length, fork length, standard length, body depth and girth; gonads were also removed and weighed. The large net teams involved in the study were initially those from Port Sud Est, Pointe l’Aigle, Baie du Nord and Pointe Coton; in 2003, surveys were discontinued with the Pointe Coton team and instead a team from Pointe Corail was surveyed (Table 3). The teams from Pointe l’Aigle and Baie du Nord fish within the 4 northern Marine Reserves, with 10% of Pointe l’Aigle’s and 20% of Baie du Nord’s hauls being inside the reserves (2002 – 2006); the teams from Pointe Corail and Port Sud Est fish in the southern lagoon (Figure 3).

The data are entered into an Access database, analyses made of the catch composition, Catch per Unit Effort, length frequency for the most commonly caught species, gonad development (length at maturity) and mortality rates and the results are compiled in an annual report.

**Table 3.** The seine net fishery team and the years that surveys were carried out.

Team	Years surveyed
Pointe l’Aigle	2002 – 2007
Baie du Nord	2002 – 2007
Port Sud Est	2002 – 2007, 2009
Pointe Coton	2002
Pointe Corail	2003 – 2007, 2009



**Figure 3.** The location of the 5 seine net teams' hauls during the 2002 – 2007 surveys and the position of the 4 proposed marine reserves.



Measuring the total length of fish during seine net fishery monitoring



### **3.15 Line and Trap Fisheries Monitoring**

Assessments of the basket trap line fishery were made at 15 fish landing stations in 2002. As the fishers returned with their catches, the total length of all fish caught was measured and the weight calculated from the length-weight relationship for the species. Further attempts to commence a monitoring programme for the trap and line fisheries was made in 2006/2007 (6 fish landing stations) and 2009; however due to logistical problems very little data were collected and the monitoring was not continued.

### **3.16 Octopus Fishery Monitoring**

An initial baseline survey of the octopus fishery was undertaken in 2000; catch assessment studies took place at 14 fish landing stations and the length and weight of each octopus caught was measured. Catch assessments were also undertaken during 2004/2005 at 2 fish landing stations (Grand Baie and Baie du Nord) and in 2008/2009 at Pointe Monier and Baie du Nord. In 2010, a monitoring programme for octopus catches was commenced with support from ReCoMaP. Surveys are undertaken at 5 landing stations (Pointe Monier, Baie du Nord, Riviere Banane, Port Sud Est and Graviers) and the sex and weight of every octopus landed is recorded on 3 days during each spring tide. Two fishers from each landing station have been trained to undertake the survey work and the data are then collated by Shoals Rodrigues.

### **3.17 Socio-Economic Monitoring**

Socio-Economic Monitoring was initiated in 2006 within the Riviere Banane area using the SocMon methodology (Malleret-King *et al.*, 2006). During the survey, 41 socio-economic variables were assessed using a combination of Household Surveys, Focus Group Interviews and Key Informant Interviews. No further SocMon surveys have been undertaken since this date. In 2009, a baseline socio-economic study was carried out by researchers from Newcastle University, UK during which surveys were undertaken with 254 households from 9 villages along the north coast of Rodrigues.

### **3.2 Fisheries Research & Training Unit (FRTU)**

FRTU employs enumerators who have been collecting catch data at the 22 fish landing stations around the island on a regular basis since at least 1994. For the seine net fishery, data are collected for 13 categories (species, or groups of species) plus a miscellaneous category and summed for each month of the fishing season (March - September). The data are published in the Government of Mauritius' annual fishery statistics which state the total annual lagoon catch for Rodrigues, the total catch of octopus in the lagoon and the total off-lagoon fish catch.

## **4.0 Limitations of the current monitoring programme**

The coral reef, lagoon and seine net fisheries monitoring programmes were reviewed during the Darwin Initiative-funded project 'Developing marine reserves for biodiversity conservation and

sustainable fisheries in Rodrigues' between 2005 and 2008 and training and advice were provided to improve the quality of data collected.

#### **4.1 Coral Reef Monitoring**

Despite action taken in response to the 2005 review, a number of the logistical problems still remain with the Coral Reef Monitoring programme including the loss of permanent markers and difficulty in re-locating sites; there are also particular issues with respect to reef flat monitoring at Rivière Banane, Passe Armand and Grand Bassin, where strong waves and currents cause a great deal of movement of the tape and also make work difficult. A range of alternative methods were tested which used random or fixed quadrats and did not rely on tapes. These methods were shown to be feasible but suffered from the same problem of an inability to revisit same area on the reef on subsequent surveys (Edwards, 2005).

The 2005 review suggested increasing the number of monitoring sites in order to allow clearer comparisons between reserve and non-reserve areas, however there are still insufficient sites to adequately assess the effectiveness of each of the reserves. At a minimum, additional reef flat sites would be needed within the Passe Demi Reserve and at North of Ile aux Sables (control) and a reef slope site would need to be added within the Anse aux Anglais Reserve. Additional reef flat and reef slope stations are required as controls at a site on the north-east coast, potentially at Baladirou.

#### **4.2 Lagoon Monitoring**

The current lagoon monitoring programme is not adequate to assess the effectiveness of the Marine Reserves having only 1 monitoring site (Site J, coral blocks on sand) within the reserves. The 2005 monitoring review also raised concerns about the appropriateness of the methodology being used. In particular, the methodology for benthos assesses cover in a 5m x 5m area, which may not be possible in very shallow water or when the visibility is low (Edwards, 2005). The data collected are also semi-quantitative which makes analysis difficult. The South East Marine Protected Area (SEMPA) uses quadrat surveys to assess benthos in areas of seagrass/macro-algae and this may be a more appropriate methodology to use in the north. Rapid assessments and previous MSc theses could be used to identify appropriate monitoring sites in seagrass/macro-algae areas inside and outside the 4 Marine Reserves.

#### **4.3 Water Quality Monitoring**

Water quality assessments have only been made sporadically, mostly due to equipment failures. For example, out of the 10 temperature loggers deployed in 2006, only 4 provided data due to problems with loss of the logger and logger malfunction. Continuous data such as these are however invaluable and loggers should be installed at each monitoring site. Market research may be required to identify the optimum types and makes of logger for the monitoring needs and the environmental conditions.

Measurement of nutrients is of increasing importance with new tourist and residential developments on the coast and the increased use of fertilisers in agriculture. Although, nutrient concentrations were measured on a weekly or fortnightly basis between March and December 2002, this was not continued and only one-off measurements were made in 2006 and 2007. These spot assessments provide very limited information and measurements are required throughout the year in order to account for variations in environmental conditions.

#### **4.4 Seine Net Fishery**

The seine net team from Pointe l'Aigle gave up fishing in 2009 and therefore only the Baie du Nord team fishes within the northern Marine Reserves. Monitoring of this team's activities should be continued on an annual basis. The Head Fisher of this team can however be uncooperative and difficult to work with and some work may be required to rebuild this relationship. This could include holding a social evening for the team at which a presentation is given about the monitoring programme explaining why we need to do it, the results obtained so far and what this means for them. Surveys should also be continued with the Pointe Corail team as a reference as they fish mostly outside of the current MPAs.

#### **4.5 Line and Basket Trap Fisheries**

There have been significant logistical problems with the line and trap fisheries monitoring namely the difficulty in knowing when fishers will return from sea and the fact that very few return to a fish landing station. As a result, very little data have been collected. Sea-based surveys are likely to be more productive, however due to the size of the lagoon this would be very expensive in terms of staff time and fuel costs. Following recommendations in the 2005 monitoring review, attempts were made to work with the FRTU enumerators during their fish landing station surveys to develop a joint monitoring programme, however this was marred by the 85% non-appearance of FRTU enumerators at sites they were supposedly monitoring (Edwards and Hardman, 2008). An approach similar to that being used during the octopus surveys, when fishers themselves are trained to undertake the monitoring, may be the most successful method of obtaining data on these fisheries. This will also increase the level of community involvement in the monitoring programme.

#### **4.6 Octopus Monitoring**

The current octopus fishery monitoring programme includes the landing stations of Baie du Nord and Riviere Banane where octopus caught in and around the Marine Reserves of Riviere Banane, Grand Bassin and Passe Demi are likely to be landed. Ideally, monitoring should be undertaken at all 10 landing stations in the north of Rodrigues and therefore training should be provided to 2 octopus fishers from the additional 8 landing stations.

#### **4.7 Socio-Economic Monitoring**

Baseline socio-economic surveys have been undertaken at the 10 main villages along the north coast. A monitoring programme now needs to be implemented to assess the impact of the Marine

Reserves on these communities. A combination of the SocMon methodology (Malleret-King et al., 2006) and the methods developed by Stead et al (2009) may be most appropriate.

## 5.0 Preliminary Recommendations

The following preliminary recommendations have been made based on an initial evaluation of the current monitoring programme in Rodrigues. Once the draft management plan has been written, this will set-out the goals and objectives of the Marine Reserves and during the MPA Effectiveness Evaluation Workshop appropriate indicators will be identified to assess whether the reserves are meeting these objectives. Consultations and further workshops may also highlight areas where other user groups (fishers and tour operators) may become responsible for certain aspects of monitoring and where joint monitoring programmes can be developed with Government institutions (FRTU and/or FPS). The monitoring programme will therefore require further reviewing to ensure that indicators are being adequately monitored, that methods are appropriate and that all stakeholders are in agreement.

1. Increase the number of coral reef monitoring sites, adding sites at: Passe Demi reef flat, North of Ile aux Sables reef flat, Passe Cabri reef slope and Baladirou reef flat and slope (Table 4).
2. Undertake video transects at each monitoring station for archiving and later analysis (possibly by volunteers/MSc students).
3. Include an octopus fisher in the survey team for the ecological monitoring (coral reef and lagoon habitats) to count just octopus, whilst a 2<sup>nd</sup> team member counts all other macro-invertebrates.
4. Discontinue the current lagoon monitoring programme and implement quadrat surveys to monitor seagrass/macro-algae areas inside and outside of the 4 Marine Reserves.
5. Install temperature loggers at the coral reef monitoring sites and implement monthly assessments of nutrient concentrations.
6. Continue the seine net fishery monitoring, working with the Baie du Nord and Pointe Corail teams.
7. Implement a line and trap fishery monitoring programme with the data collected by fishers from each of the 10 northern landing stations. Training and collation of data to be undertaken by staff from Shoals Rodrigues.
8. Collect octopus catch data from all 10 landing station in the north of Rodrigues. At least 2 fishers from each of the 8 additional landing stations should receive training in the methodology by staff from Shoals Rodrigues.
9. Implement a socio-economic monitoring programme using a combination of the SocMon methodology and methods developed by Stead et al (2009).

**Table 4.** Suggested sites for ecological monitoring in the northern lagoon. Those that are highlighted in blue are suggested new sites.

Site	Level of Protection	Habitat
Riviere Banane	Inside Reserve	Reef Flat
Riviere Banane	Inside Reserve	Reef Slope
Riviere Banane	Inside Reserve	Seagrass
Baladirou	Outside Reserve	Reef Flat
Baladirou	Outside Reserve	Reef Slope
Baladirou	Outside Reserve	Seagrass
Passe Cabri	Inside Reserve	Reef Flat
Passe Cabri	Inside Reserve	Reef Slope
Passe Cabri	Inside Reserve	Seagrass
Passe Armand	Outside Reserve	Reef Flat
Passe Armand	Outside Reserve	Reef Slope
Passe Armand	Outside Reserve	Seagrass
Grand Bassin	Inside Reserve	Reef Flat
Grand Bassin	Inside Reserve	Reef Slope
Grand Bassin	Inside Reserve	Seagrass
Ile aux Fous	Outside Reserve	Reef Flat
Ile aux Fous	Outside Reserve	Reef Slope
Ile aux Fous	Outside Reserve	Seagrass
Passe Demi	Inside Reserve	Reef Flat
Passe Demi	Inside Reserve	Reef Slope
Passe Demi	Inside Reserve	Seagrass
North of Ile aux Sables	Outside Reserve	Reef Flat
North of Ile aux Sables	Outside Reserve	Reef Slope
North of Ile aux Sables	Outside Reserve	Seagrass

**Table 5.** Potential indicators for Monitoring and methods to assess them.

	Indicator Type	Indicator	Measure	Method
<b>Ecological Monitoring Programme</b>				
	Biophysical	Coral, Seagrass, Algae	% Cover	Quadrats/LIT
	Biophysical	Macro-invertebrates	Abundance	Belt transects
	Biophysical	Macro-invertebrates	Diversity	Belt transects
	Biophysical	Fish	Abundance	Belt transects
	Biophysical	Fish	Diversity	Belt transects
	Biophysical	Fish (indicator species)	Size	Belt transects
<b>Water Quality Surveys</b>				
	Biophysical	Temperature (time series)	Degrees Celsius	Temperature loggers
	Biophysical	Temperature (point)	Degrees Celsius	CTD
	Biophysical	Salinity (point measure)	PSU	CTD
	Biophysical	Nitrate	Concentration (mg/l N)	Palintest
	Biophysical	Nitrite	Concentration (mg/l N and NO <sub>2</sub> )	Palintest
	Biophysical	Phosphate	Concentration (mg/l PO <sub>4</sub> and P)	Palintest
<b>Fisheries Monitoring</b>				
	Socio-economic	Number of fishers	Number of fishers	All Fisheries Surveys
	Socio-economic	Mode of fishing	Boat, Engine, Foot	All Fisheries Surveys
	Socio-economic	Method of fishing	Harpoon, Line, Spear	All Fisheries Surveys
	Socio-economic	Total time fishing	Time per fisher (Hours and minutes)	All Fisheries Surveys
	Biophysical	Catch location	Area on map / GPS point	All Fisheries Surveys
	Biophysical	Total catch weight	Weight octopus / fish (kg)	All Fisheries Surveys
	Biophysical	Octopus weight	Weight (g)	Octopus Catch Surveys
	Biophysical	Octopus sex	Male / Female	Octopus Catch Surveys
	Biophysical	Fish length / weight	Total length (cm) / Weight (g)	Fish Landing Station / Seine Net Surveys
	Biophysical	Catch Per Unit Effort	CPUE (kg/person hour)	All Fisheries Surveys
<b>Socio-economic Surveys</b>				
	Socio-economic	Population	Number of people	Household Surveys

Improving management effectiveness for the Marine Protected Areas of Rodrigues (Indian Ocean).

	Socio-economic	Education	Number of years of schooling	Household Surveys
	Socio-economic	Material Style of Life	% Households with modern appliances	Household Surveys
	Socio-economic	Household expenditure	Rupees per month	Household Surveys
	Socio-economic	Occupation	Number & type per household	Household Surveys
	Socio-economic	Method of fishing	Harpoon, Line, Spear	Household Surveys
	Socio-economic	Mode of fishing	Boat, Engine, Foot	Household Surveys
	Socio-economic	Total Catch	Weight (kg) per day	Household Surveys
	Socio-economic	Value of Catch	Rupees per day	Household Surveys
	Socio-economic	Seafood Consumption	Number seafood meals per week	Household Surveys
	Socio-economic	Environmental Awareness	% Respondents	Household Surveys



## 6.0 References

- Edwards, A. (2005). Review of the status of fisheries and habitat monitoring programmes at Rodrigues with recommendations for development following establishment of marine reserves. Developing marine reserves for biodiversity conservation and sustainable fisheries in Rodrigues. Report on initial visit to Rodrigues, 28 February to 15 March 2005. Unpublished report, Newcastle University, UK, 30pp.
- Edwards, A. and Hardman, E. (2008). Final Report. Developing marine reserves for biodiversity conservation and sustainable fisheries in Rodrigues. Unpublished report, Newcastle University/Shoals Rodrigues, 29pp.
- English, S., Wilkinson, C. & Baker, V. 1994. Survey manual for tropical marine resources. 2<sup>nd</sup> edition. Australian Institute of Marine Science.
- IUCN (2004). Managing Marine Protected Areas: A Toolkit for the Western Indian Ocean. IUCN Eastern African Regional Programme, Nairobi, Kenya, 172pp.
- Malleret-King, D., Glass, A., Wanyonyi, I., Bunce, L., Pomeroy, B. (2006). Socio-economic Monitoring Guidelines for coastal Managers of the Western Indian Ocean, SocMon WIO. CORDIO East Africa, pp108.
- Stead, S., Peterson, A., Mill, A. and Rushton, S. (2009). Marine Socio-economic Scoping Study of the North Coast of Rodrigues. Newcastle University, 26pp.



**ANNEX 1: Shoals Rodrigues Monitoring Reports**



## **ANNEX 1 Shoals Rodrigues Monitoring Reports**

### *Coral Reef Monitoring*

Jhangeer-Khan, R., Raffin, J. S. J., Desiré, M. S., Perrine, S. and Migale (2009). Annual report of benthos, reef fish and invertebrate surveys for reef slope and reef flat areas in Rodrigues 2008. Shoals Rodrigues report, 48pp.

Hardman, E. R., Blais, F. E. I., Desiré, M. S., Raffin, J. S. J., Perrine, S. and Taylor, L. (2008). Annual report of benthos, reef fish and invertebrate surveys for reef slope and reef flat areas in Rodrigues 2007. Shoals Rodrigues report, 40pp.

Hardman, E. R., Blais, F. E. I., Desiré, S. M., Raffin, J. S. J., Perrine, S., Chinien-Chetty, M. and Towill, J. (2007). Annual report of benthos, reef fish and invertebrate surveys for reef slope and reef flat areas in Rodrigues 2006. Shoals Rodrigues report, 51pp.

Hardman, E. R., Blais, F. E. I., Desiré, S. M., Raffin, J. S. J., Perrine, S., Raffaut, R. and Chinien-Chetty, M. (2006). Annual report of benthos, reef fish and invertebrate surveys for reef slope and reef flat areas in Rodrigues 2005. Shoals Rodrigues report, 43pp.

Lynch, T. L., Meunier, M. S., Blais, F. E. I., Raffin, J. S. J., Perrine, S., Raffaut, R. and Perry, A. C. (2004b). Annual report of benthos, reef fish and invertebrate surveys for reef slope and reef flat areas in Rodrigues 2004. Shoals Rodrigues report, 48pp.

Lynch, T. L., Meunier, M. S., Hooper, T. E. J., Blais, F. E. I., Raffin, J. S. J., Perrine, S., and Raffaut, R. (2004a). Annual report of benthos, reef fish and invertebrate surveys for reef slope and reef flat areas in Rodrigues 2003. Shoals Rodrigues report, 52pp.

Lynch T.L., Meunier M.S., Hooper T.E.J., Blais F.E.I., Raffin J.S.J, Perrine S., Félicité N., Lisette J., Grandcourt J.W. (2002). Annual report of benthos, reef fish and invertebrate surveys for Rodrigues 2002. Shoals Rodrigues report, 30pp.

### *Lagoon Monitoring*

Jhangeer-Khan, R., Raffin, J. S. J., Perrine, S and Desiré, S. M. (2009). Annual report of benthos, reef fish and invertebrate surveys for lagoon areas in Rodrigues 2009. Shoals Rodrigues report, 30pp.

Hardman, E. R., Blais, F. E. I., Desiré, S. M., Raffin, J. S. J. and Perrine, S. (2008). Annual report of benthos, reef fish and invertebrate surveys for lagoon areas in Rodrigues 2007. Shoals Rodrigues report, 20pp.

Hardman, E. R., Blais, F. E. I., Desiré, S. M., Raffin, J. S. J., Perrine, S. and Chinien-Chetty, M. (2006b). Annual report of benthos, reef fish and invertebrate surveys for lagoon areas in Rodrigues 2006. Shoals Rodrigues report, 20pp.

Hardman, E. R., Blais, F. E. I., Raffin, J. S. J., Perrine, S., Raffaut, R. and Chinien-Chetty, M. (2006a). Annual report of benthos, reef fish and invertebrate surveys for lagoon areas in Rodrigues 2005. Shoals Rodrigues report, 25pp.

Lynch, T. L., Desiré, M. S., Hooper, T. E. J., Blais, F. E. I., Raffin, J. S. J., Perrine, S., Raffaut, R. and Hardman, E. R. (2005). Annual report of benthos, reef fish and invertebrate surveys for lagoon areas in Rodrigues 2004. Shoals Rodrigues report, 31pp.

Lynch, T. L., Meunier, M. S., Hooper, T. E. J., Blais, F. E. I., Raffin, J. S. J., Perrine, S. and Raffaut, R. (2004c). Annual report of benthos, reef fish and invertebrate surveys for lagoon areas in Rodrigues 2003. Shoals Rodrigues report, 44pp.



### *Seine Net, Line and Trap Fisheries*

Jhangeer-Khan, R., Raffin, J. S. J., Desiré, M. S., Perrine, S. and Raffaut, R. (2009). Annual report on the status of the artisanal seine net fishery of Rodrigues 2009. Shoals Rodrigues report, 33pp.

Hardman, E. R., Blais, F. E. I., Desiré, M. S., Raffin, J. S. J., Perrine, S. and Meunier, S. (2008). Annual report on the status of the artisanal seine net fishery of Rodrigues 2007. Shoals Rodrigues report, 46pp.

Hardman, E. R., Blais, F. E. I., Desiré, M. S., Raffin, J. S. J., Perrine, S., Chinien-Chetty, M. and Meunier, S. (2006b). Annual report on the status of the artisanal seine net fishery of Rodrigues 2006. Shoals Rodrigues report, 59pp.

Hardman, E. R., Blais, F. E. I., Desiré, M. S., Raffin, J. S. J., Perrine, S., Raffaut, R. and Chinien-Chetty, M. (2006a). Annual report on the status of the artisanal seine net fishery of Rodrigues 2005. Shoals Rodrigues report, 56pp.

Lynch, T. L., Hooper, T. E. J., Meunier, M. S., Blais, F. E. I., Raffin, J. S. J., Perrine, S., Raffaut, R. and Hardman, E. R. (2005). Annual report of the status of the artisanal seine net fishery of Rodrigues 2004. Shoals Rodrigues report, 74pp.

Lynch, T. L., Hooper, T. E. J., Meunier, M. S., Blais, F. E. I., Raffin, J. S. J., Perrine, S. and Raffaut, R. (2004). Annual report on the status of the artisanal seine net fishery of Rodrigues 2003. Shoals Rodrigues report, 79pp.

Lynch, T. L., Edwards, A. J., Gell, F. R., Hooper, T. E. J., Gaspard, R., Blais, F. E. I., Raffin, J. S. J., Perrine, S., Milazar, G. and Pierre Louis, J. R. (2003). Preliminary report of the status of artisanal large net, basket trap and line fisheries of Rodrigues. Shoals Rodrigues report, 50pp.

### *Octopus Fishery*

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. Shoals Rodrigues report, 17pp.

Lynch, T. L., Hooper, T. E. J., Meunier, M. S., Blais, 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 Rodrigues report, 12pp.

Lynch, T. L., Hooper, T. E. J., Blais, F. E. I., Meunier, M. S., Perrine, J. S. and Ravanne, A. (2001). Status of the octopus fishery in the Rodrigues lagoon. Shoals of Capricorn report, 59pp.

### *Socio-economic Assessments*

Stead, S., Peterson, A., Mill, A. and Rushton, S. (2009). Marine Socio-economic Scoping Study of the North Coast of Rodrigues. Newcastle University, 26pp.

Hardman, E. R., Bunce, M., Blais, F. E. I., Desiré, M. S., Raffin, J. S. J. and Perrine, S. (2006). Report of Socio-economic Monitoring in Rivière Banane, Rodrigues. Shoals Rodrigues report, 23pp.