The Rufford Foundation
Final Report

Congratulations on the completion of your project that was supported by The Rufford Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. The Final Report must be sent in **word format** and not PDF format or any other format. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. Please note that the information may be edited for clarity. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Isabel Marques da Silva
Project title	Conservation and management of reef sharks in the Western Indian Ocean: a conservation area to protect biodiversity and serve community and tourism
RSG reference	17995-2
Reporting period	October -2015 to October 2016
Amount of grant	£4200
Your email address	Fish.isabelmail.com or isilva@fcn-unilurio.com
Date of this report	

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Continue acoustic telemetry monitoring to elucidate the long-term residency and movement patterns of grey reef sharks at Neptunes				No new sharks were tagged, but instead five groupers were tagged and tracked. One more station was deployed.
Provide capacity building to two local residents on acoustic telemetry methods, equipment maintenance and shark tagging procedures				One person from the local community that works at the dive centre, and one UnilLúrio student were trained
Engage the Mozambican Government in the conservation of regional shark populations				In the meetings undertaken with several government organisations we showed them the documentary produced about the area, and we were successful in binding the government with the creation of the MPA
Undertake a field trip to Neptunes with central and provincial government representatives to raise awareness about the site				The field trip happened later than what we desired due to a re-organisation within the Mozambican Government but it was very successful.
Organise a series of meetings between scientists, the government, the lodges and the local communities to plan the implementation of a new marine protected area at Neptunes and approve a management plan				Due to the delay of the field trip, the meetings with the government are behind schedule thus we have not yet arrived at the point of discussing a management plan. But we think that the next set of meetings will push in the right direction.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

Catching and tagging grey reef sharks was difficult because the sharks were not regularly observed on the site during the fieldwork period. The trip to tag the sharks was scheduled for November (October is the best month, but we received the funds at the end of September so we were not able to do this sooner). Normally, November is still a good month to see the sharks in shallower waters at Neptunes, but this time the water temperatures were very high and sharks were not seen until the last 2 days of the expedition. We also realised, by analysing the sea surface temperature data over the last few years around Vamizi island (provided by NOAA), that not only were the sea surface temperatures high this winter, but they were also high and outside normal averages last year. This year was an El Ninõ year with terrible consequences around the globe, including the Indian Ocean. Vamizi and Metundo islands, for the first time in 10 years, were impacted by approximately 10% to 15% coral bleaching. We observed water temperatures of 30ºC at 28-30m depth and at the same time currents with 24ºC coming from the deep. When examining the data from last year's expedition (when both a satellite tag and acoustic tag was deployed on an individual shark), it was evident that the sharks were present at the site during the time of the expeditions but they were in deeper cooler water and consequently very difficult to catch. We adapted our fieldwork to tag groupers, an important species that is commonly fished in the region and one that forms our secondary objectives for this project.

There were considerable changes in the Mozambican Government at the beginning of 2015, as a consequence of the change of leadership in the country which proved challenging for the involvement of government officials in the project. First, this resulted in the directorate of Protected Area, ANAC, changing from the Tourism Ministry to the Fisheries Ministry. Also the Ministry of Fisheries became the Ministry of Sea, Freshwater and Fisheries, with an internal change of the institutions and directorates that were under the previous Ministry. As a consequence it was not possible to have a meeting with ANAC until the beginning of 2016 and then we had to wait until September 2016 for the government staff to be available to visit the islands. At the same time the economic crisis in Mozambique drove the dollar from 30 meticais =1dollar to 75 meticais = 1 dollar resulting in huge increases in all prices. This made it impossible to cover the costs of transportation and accommodation for government officials visiting the island. In the face of these escalating prices it was consequently impossible to fly the ANAC representative from Maputo because the flight price doubled.

3. Briefly describe the three most important outcomes of your project.

The most important outcomes were:

(i) The acoustic monitoring of the tagged sharks and groupers at this unique site provides important information on their space use patterns, the permanence of the sharks at the site, i.e. their residency relative to the size of area requiring protection and their movements in relation to sea surface temperatures. More specifically:
Grey Reef Sharks

The two grey reef sharks tagged in Neptunes Canyon were both pregnant females (Grey Reef 1 [GR1] and Grey Reef 2 [GR2]). We now have tracking data for these sharks for a two-year period and monitoring continues. Currently three monitors are deployed to track the movements of these sharks at the site. These monitors are strategically positioned to detect sharks present within the Canyon, on the outside wall and of the point (Figure 1).

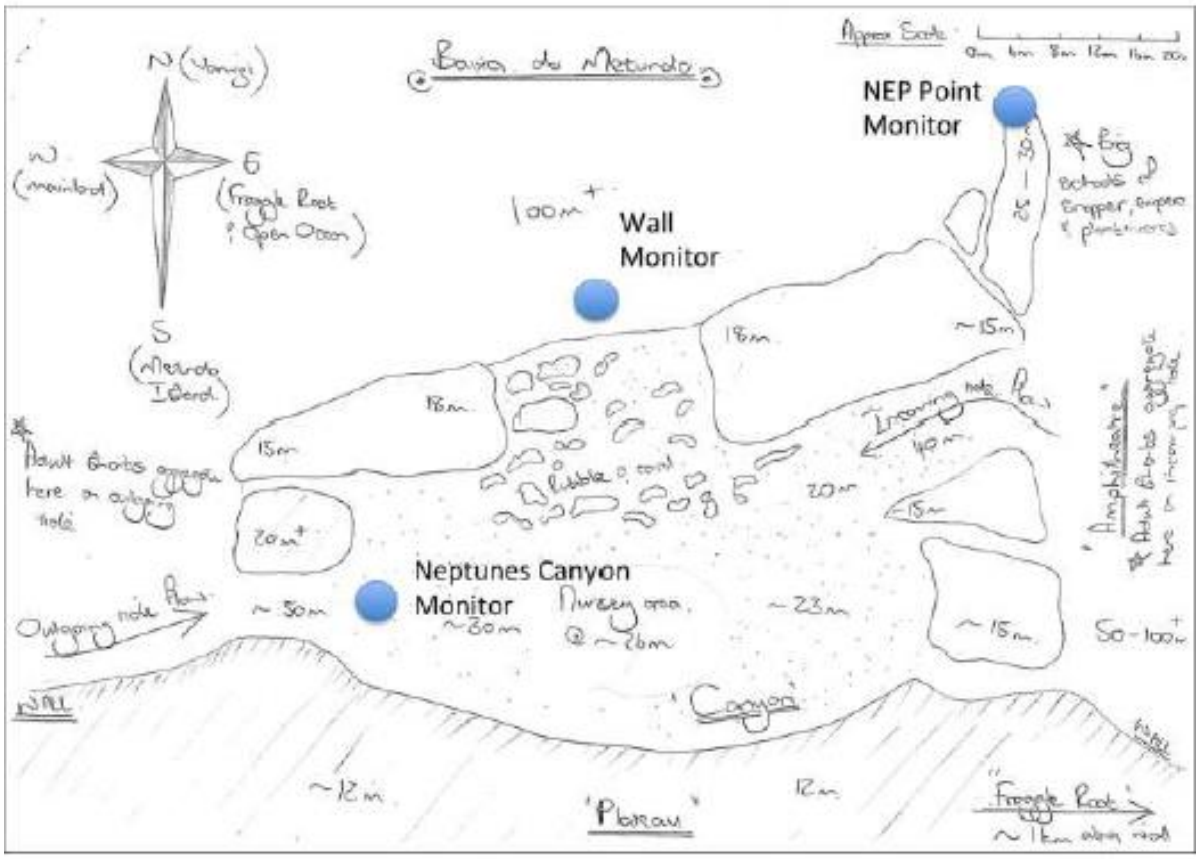

Figure 1: Map of the study site showing the locations of the three fixed monitors recording detections of acoustic tags attached to grey reef sharks and groupers

Interestingly, the two sharks displayed very different detection profiles on the monitors located around Neptune's canyon. Figure 2 displays the individual detections of each shark on the three different monitors in the system (however note the different deployment times of each monitor). Grey Reef 1 tends to be detected on only one monitor at a time, be it either the Neptunes Canyon monitor, or when moving into deeper water, solely on the wall monitor, and never on the shallow NEPPoint monitor. Grey Reef 2 on the other hand is frequently detected on all monitors suggesting it occupies shallower water overall where it would be detected by multiple monitors.

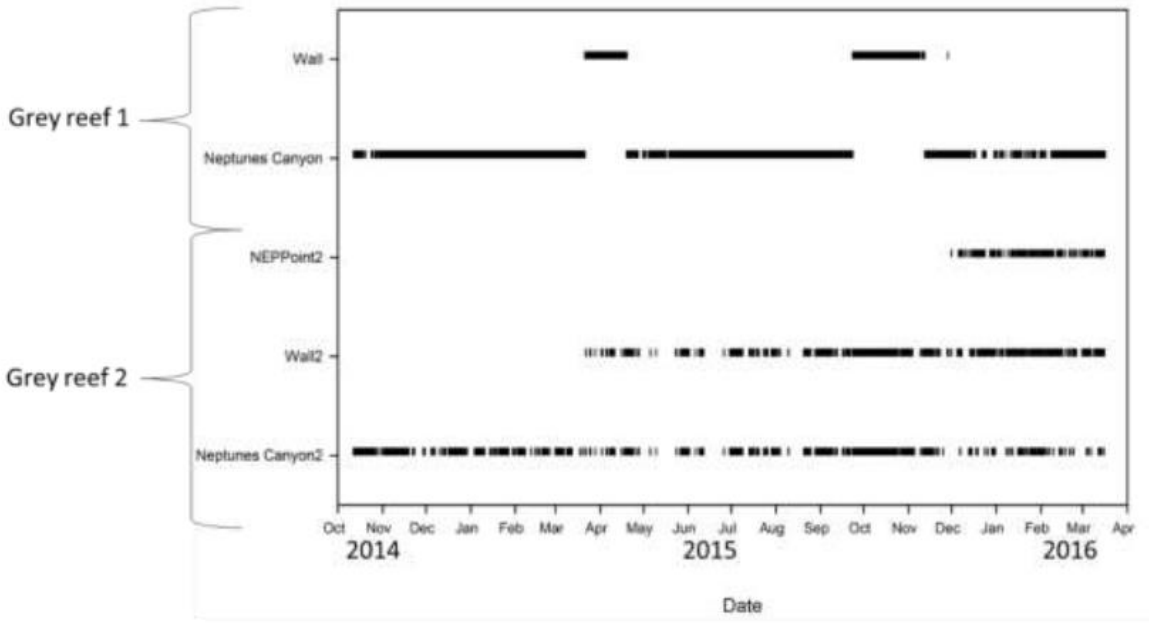

Figure 2: Detections of the acoustic tags surgically implanted or externally attached to two pregnant female grey reef sharks. Neppoint, Wall and Neptunes Canyon refer to the location of the three monitors at the site located on the pinnacle, on the outside of the deep wall on the drop off and within Neptune's Canyon, respectively (see Figure 1).

GR2 from in the above plot was also equipped with a satellite tag that remained attached to the shark from 2014-10-09 to 2014-11-08. During this same time frame, the monitor in Neptunes Canyon was detecting the acoustic tag surgically implanted in this shark. Figure 3 displays the entire time series recorded by the satellite tag for depth (m) and temperature (°C) where the shark occurred (black line), while the vertical blue lines indicate individual acoustic detections on the monitors located at the study site. It would therefore appear that the shark was highly resident at Neptunes, but there was a notable change in diving behaviour over the period the satellite tag recorded data. At the start of the month the shark occurred in ~20 m depth of water and this behaviour was constant, but as the water

temperature started to increase from around 26 to 27 °C; the shark started undertaking deeper dives. This diving behaviour is likely associated with thermal regulation as the shallower Canyon area at Neptunes becomes warmer, driving the sharks into deeper waters off the wall.

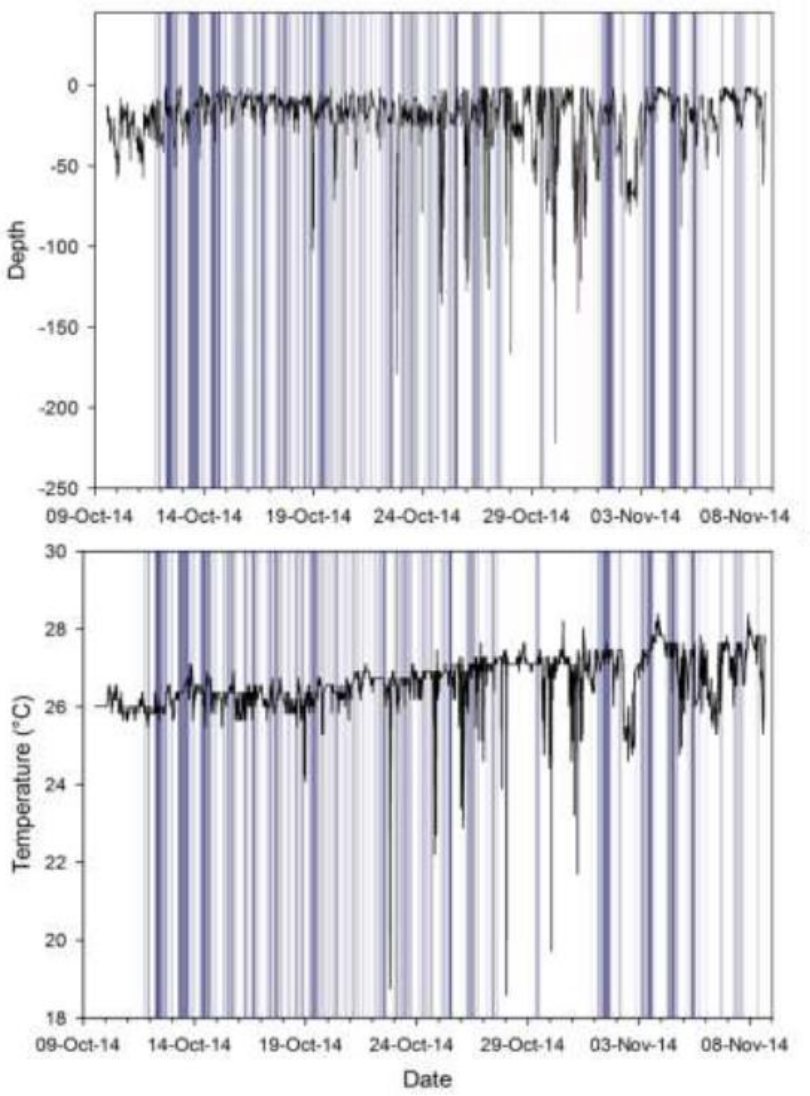

Figure 3 – Vertical sharks movements (depth) and temperatures during the one month satellite track (black lines) and individual acoustic detections of the shark on the Neptunes Canyon monitor (blue line) over the same period.

Groupers

Cephalopholis sp. & *Aetholperca rogaa*

These two grouper species were detected very few times within the system, with the *Cephalopholis* being detected on the Wall monitor on Nov 26 and 27th 2015, then on the Canyon monitor on the 27 and 28th. The *Aetholperca rogaa* was detected

on both the Wall and Canyon monitors from the 16th Nov to the 22nd. It would seem these fish then left the study area. We have recently recovered the monitors and will examine these new data to see if these fish returned to the site in 2016.

Plectropmus sp.

This grouper was highly resident within the Neptunes Canyon area, as the vast majority of its detections were recorded on one monitor throughout the monitoring period. Arguably, its time was mostly spent near the sea floor in the canyon or shallower in the water column over the Canyon, as the majority of detections of this fish were in fact double detections recorded on both the Wall monitor and the Neptunes Canyon monitor (Figure 4). It is therefore unlikely the fish inhabited deeper waters where the Wall monitor is located, otherwise it would have only been detected on this monitor.

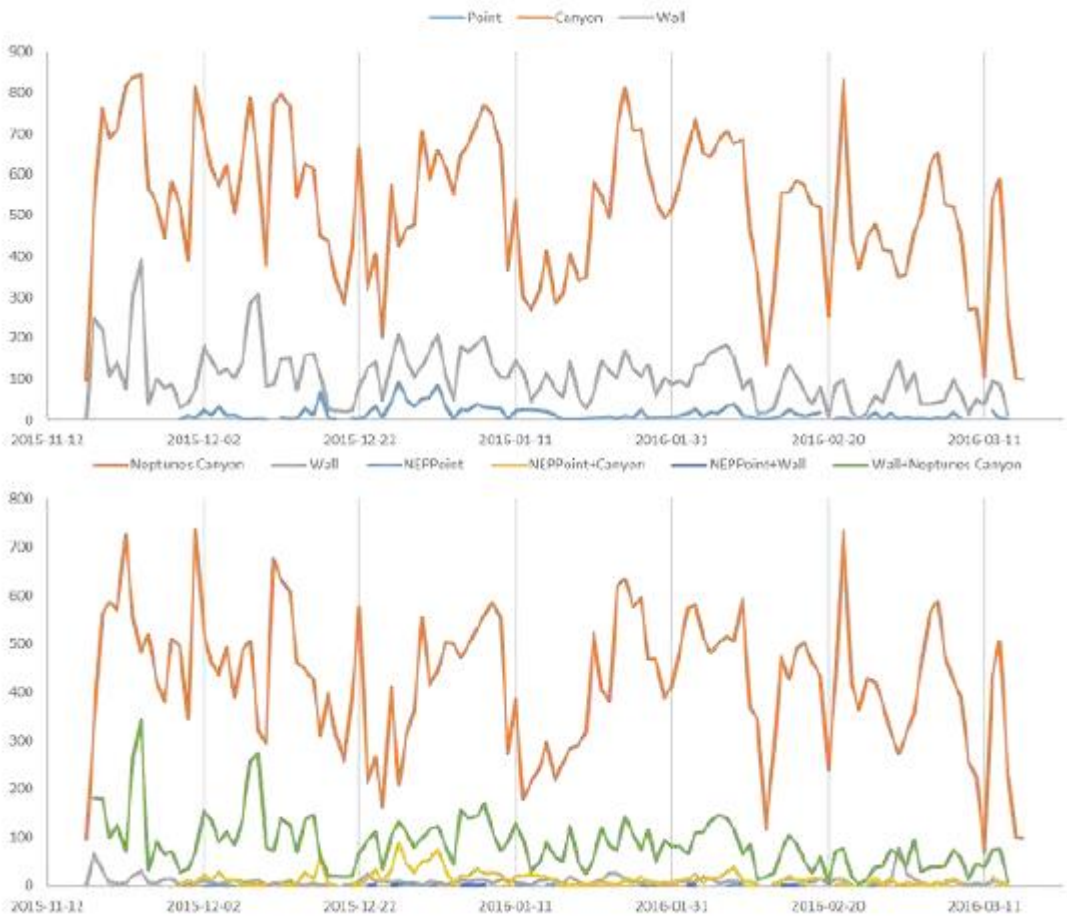

Figure 4: Detections of the *Plectropomus* sp. on the 3 deployed monitors at the site (a) and detections of this fish when they occur on more than one monitor (b). By examining detections on more than one monitor we can determine the likely habitat of the animal, i.e. within the canyon or occurring in deeper waters off the wall

Variola louti

Two of these species were tagged, and interestingly they appear to be utilizing different areas of the study site. Unlike the *Plesctropmus* sp. there were no significant differences in the detection profile of these species when considering multiple detections at individual stations. It is however important to note that there was a significant number of double detections, i.e. a single animal recorded on two monitors, indicating that these fish are often detected within the water column, and are not remaining exclusively on the bottom like GR1.

From the daily detection graphs in Figure 5, it is clear that *Variola louti* number one [VL1] prefers the deeper-water wall area over any others (indicated by the highest number of detections on the wall monitor), whereas *Variola louti* number two [VL2] was detected on both the Wall and Canyon monitors, with a slightly higher preference for the Canyon. This comparison can also be seen in Figure 6 where the detections for each station are compared between the two fish.

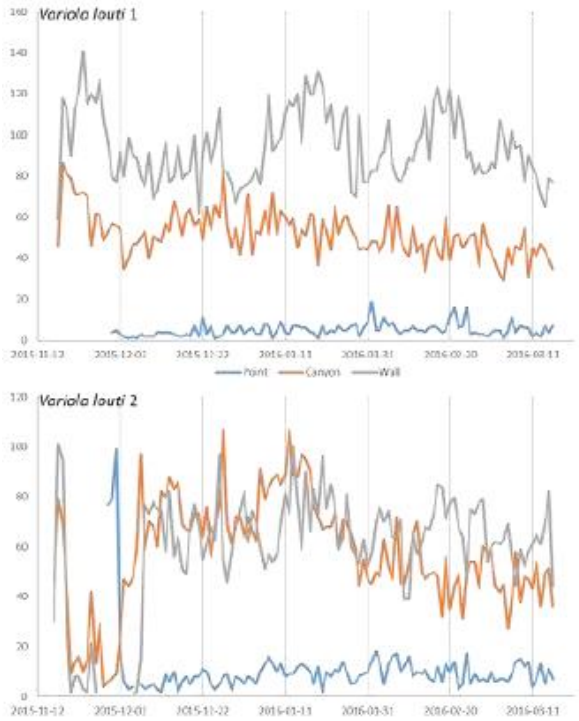

Figure 5: Detections of the two groupers, Variola louti on the three monitors located at the site showing differences in detection profiles.

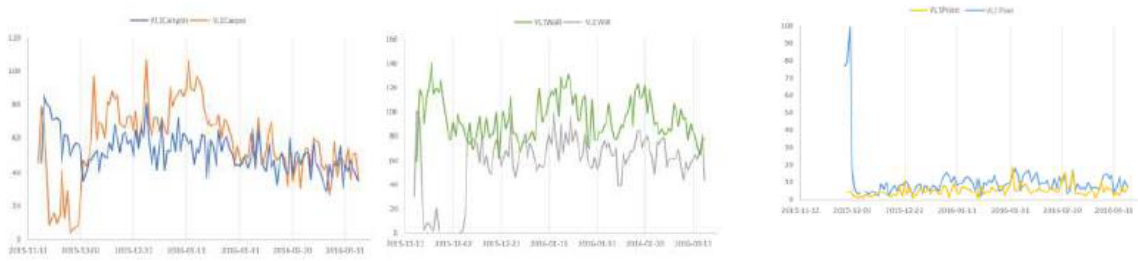

Figure 6. Comparing the Space use of the two groupers Variola louti detected by the 3 stations

(ii) The engagement of the government in the proclamation of a MPA for Neptunes.

The Government, ANAC and the fisheries department were presented with the findings of the project. The" Vamizi the cradle of the coral" a 50 minute documentary about Vamizi Island especially devoted to the shark aggregation in Neptunes was shown to delegates from these government bodies. They were very supportive of the reserve at Neptunes and suggested that besides the involvement of the communities in the process, that the UniLúrio should also be involved because of their important research being conducted at the site. But they also stated that because the reserve is far away from the communities (15 km from Vamizi Island and 13 km from Kifuki Island) there was reduced interest in the site by these communities. However there were concerns over the ease of access to the site by migrant fishermen with motorised boats, because they have better gear and boats to fish at the site. For these reasons the fisheries department and ANAC felt that the two island lodges and the UniLúrio should play a greater role, without forgetting to involve both communities, in designating a new reserve at the site. They also required that the Vamizi island community fishing sanctuary should become a marine reserve before starting the Neptunes process. This will be the first time in Mozambique that a local management reserve is confirmed based on the Protected Area Legislation of 2015.

(iii) The engagement of a larger community in the Protection of Neptunes

The arrival of the documentary "Vamizi the cradle of coral" helped to reach more people in Mozambique and engage them on the importance of Vamizi and Neptunes for the region. The UniLúrio student's engagement on the education of school children (four activities in the school) and fishermen (theatres and songs for the sharks were produced). The value of keeping these sharks alive and education on safety procedures when in the presence of sharks were important issues conveyed in the education program.

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

Local communities benefited in several ways from the overall project: (i) the skipper from the lodge (from the community) was trained in acoustic telemetry and participated in all field operations. A UniLúrio student was trained in telemetry and another in undertaking an education programs specially dedicated to sharks in Vamizi island; (ii) Meetings with local communities (Vamizi and Kilfufi) were organised to discuss the implementation of a MPA, the answers of the community were very positive; (iii) the showing of the documentary "Vamizi the cradle of Coral" to government officials had a huge impression and resulted in them strongly considering an MPA in the area. They realized the importance of Neptunes for sharks and marine animals in general. They are including the project findings in a national policies document for sharks in Mozambique.

5. Are there any plans to continue this work?

Yes, given the success of the first 2 years of work, it is absolutely necessary to continue this monitoring. Through using modified fishing methods, and hopefully with no complex effects of El Ninõ, we will increase the number of acoustically tagged sharks (including attaching the remaining three satellite tags) at the site to gain more information on both the aggregation site and how sharks use the regional reef system. In particular, long term monitoring of the pregnant female reef sharks will show how long they remain resident (the acoustic tags have 10 year lifespan) and we aim to elucidate where they drop their pups, i.e. the location of the nursery ground. To achieve this, we need to tag more individual animals and deploy more monitors around the region. We also need to tag sharks with depth-temperature sensors so we can obtain long-term data on their vertical and thermal behaviours to complement the short-term satellite tag data. Overall, this preliminary data has raised regional and national awareness on the importance of the sharks at this site, but long term data is needed to convince local and government people of the need for protection. The process for implementing protection has been initiated and we hope that by next year a management plan will be achieved.

6. How do you plan to share the results of your work with others?

Project results were presented at the Western Indian Ocean Marine Science Symposium (WIOMSA) in South Africa in September 2015. In addition, we are producing a scientific report in Portuguese and aim to publish two scientific papers in a peer reviewed journal once we have the means to deploy the remaining tags and have more comprehensive telemetry data (e.g. a larger sample size).

7. Timescale: Over what period was The Rufford Foundation grant used? How does this compare to the anticipated or actual length of the project?

The projects followed the schedule presented to the Rufford Foundation. The project was completed within the 1-year period accepting that not all activities could be included due to government problems.

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Boat fuel costs for deployment/tagging	2100	2012.42	87.58	The trip was shortened because of the absence of sharks, less gasoline used
Maputo ANAC (representatives of the conservation areas from the government) flight	600	0	600	The ANAC felt that they didn't need to be present at this part of the process only the fisheries department
Flight researchers	860	2002.79	-1142.79	We were expecting that Vamizi island lodge would support one of the scientist travelling for fieldwork
Pemba Provincial government meetings and trip to Vamizi	320	0	320	The national ANAC representative didn't travel. So we didn't pay this per diem
Meetings	800	457.89	342.11	We use resources from Vamizi lodge that allows to save some money
Transport meetings	320	266.13	53.87	We use resources from Vamizi lodge that allows to save some money
Moorings		278.69	-278.69	It was necessary to change some of the moorings due to corrosion of the materials
TOTAL	**5000**	**5017.92**	**-17.92**	

9. Looking ahead, what do you feel are the important next steps?

The most important next steps are as follows:

(1) Finance a third shark tagging campaign in September/October 2017 to tag additional sharks with both acoustic and satellite transmitters. It is extremely important to increase the sample size and tag more pregnant female sharks plus smaller individuals (juveniles are present). We will modify fishing methods and extend the field season as detailed above to improve capture rates. We will also use live bait for the fishing.

(2) Expand tagging to include more groupers species and also other large threatened fish species, such as Napolean wrasse. We aim to tag individuals of these species to develop a multi species tagging programme to provide data to support a regional community protected areas programme.

(3) Expanding on stations to determine the spatial limits of the species we want to protect.

(4) Continue engaging the local community members in the overall project to ensure its long-term sustainability and community commitment to its overall conservation goals.

(5) Further mobilise the government to have a management plan for the area and involve the communities, the tourism companies and also the university in the process.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the RSGF receive any publicity during the course of your work?

Yes: (i) in the Wiomsa presentation, (ii) in the Portuguese and English reports on the project, (iii) in the presentation to the government, and (iv)in all the presentations about the faculty of natural science and the achievements of the staff.

11. Any other comments?

We believe that the continuation of this work funded by the Rufford Foundation is a very important step to study and protect an extremely rich area – the Neptunes Pinnacles – in a remote region of northern Mozambique. This site is unique to the WIO in terms of the aggregation of grey reef sharks and overall diversity and biomass of fish including many globally threatened species, as the documentary "Vamizi the cradle of Coral" shows. There is exceptionally few data for this region, but oil and gas developments and developing fisheries will impact this ecosystem and this threat continues to grow further. Continued funding for this project, will enable expansion of the on-going tagging work to include other threatened species, continued community involvement in the overall programme and will facilitate the expansion of marine reserves and no take areas.