THE MARINE RESERVES OF THE BAY OF RANOBE: 2012 REPORT

THE IMPORTANCE OF MARINE RESERVES

Coastal resources are being impacted by global climate change through episodic events, such as the increase in frequency and severity of cyclonic disturbance, and chronic stressors, such as overharvesting of the near-shore marine environment (Hoegh-Guldberg *et al* 2007). Combined, these stressors can reduce the resilience and recovery of reef systems inducing shifts in abundance and diversity of fish/benthic flora and fauna (Belwood *et al* 2004). As marine researchers, we try to find ways to reduce the negative impact of episodic and chronic stressors to protect diversity and productivity of the marine environment. The formation of no-take marine reserves such as Rose Garden is one of the fisheries management tools used throughout the Western Indian Ocean (WIO) to conserve and also provide sustainable fisheries.

Rose Garden provides a unique underwater experience for divers and snorkelers and is an important economic resource for stakeholders involved in the tourist industry. However, one aspect of the Rose Garden not widely acknowledged is the benefit this reserve has on the productivity of connected ecosystems. Marine reserves not only provide a refuge for species targeted for exploitation by the coastal community, but they are also a reservoir of larvae and juvenile fish (Cowen *et al* 2009) that can potentially be dispersed throughout the area providing a valuable resource for the local fishing community (Figure 1).

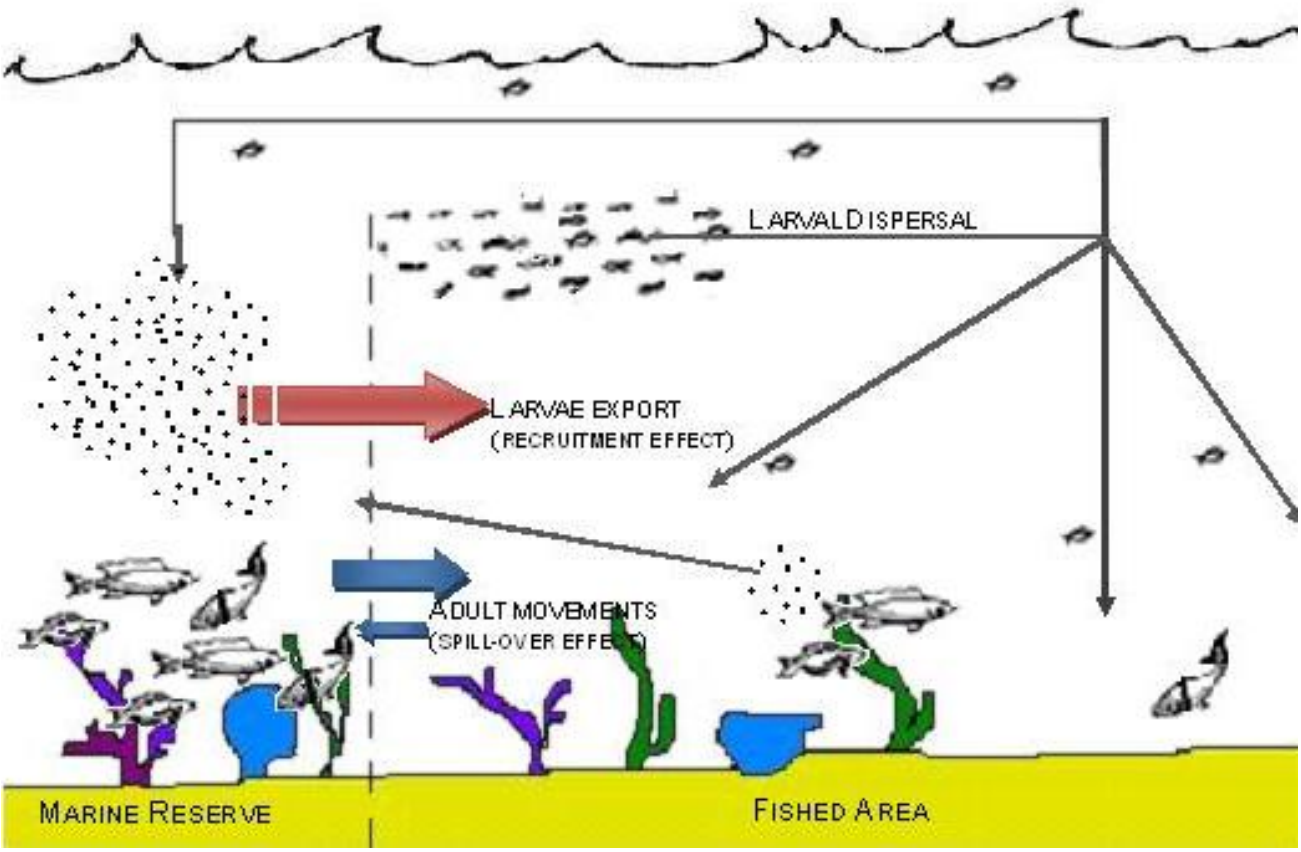

Figure 1: *The figure shows the potential influence of a marine reserve on the surrounding environment; inside the reserve where fish are protected from hunting it is suggested that the population will be allowed to mature, reach a maximum capacity with individuals moving away from the reserve. Movements of fish occur due to the demand for feeding and space. Seasonal and/or annual movements also take place during mating and spawning periods. Large mature adults are also able to lay vast quantities of eggs/young that have the potential to be dispersed throughout the surrounding area.*

ReefDoctor's task of evaluating the effectiveness of the no-take marine reserve Rose Garden is a long and arduous process as seasonal and annual fluctuations can mask ecosystem change and/or recovery. Evaluation before and after the establishment of the marine reserve to assess reef fish abundance and biomass was achieved using underwater visual surveys (UVS), a universally acknowledged methodology. This research is vital as it allows stakeholders to make informed management decisions about the marine reserve. Disseminating the information in a practical way to stakeholders who have a diverse range of knowledge is however a difficult task. Therefore we use distinct fish family groups as indicators of coral reef ecosystem health and recovery from exploitation.

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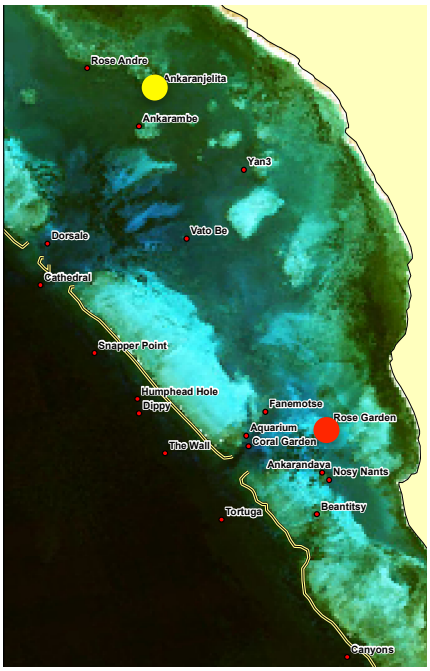

The map illustrates the position of both marine reserves, Ankaranjelita in yellow and Rose Garden in red.

1. Rose Garden

The marine reserve 'Rose garden' in the Bay of Ranobe was established in 2007 and encompasses a 160,000m^2 area. Visitors to this small marine reserve are astonished by the abundance of life, notably the presence of top predators such as the large peacock groupers. Recently, the research dive team at ReefDoctor recorded the appearance of a small juvenile nurse shark (GINGLYMOSTOMATIDAE). Occurrences of sharks in the lagoon are rare as the intensive harvesting of marine products leaves very little to attract these top predators. The sighting of this small shark is a great triumph for all partners involved in the marine reserve project 'Rose Garden' but this also means that we need to redouble our efforts to maintain this unique and valuable resource.

2. Ankaranjelita

The marine reserve Ankaranjelita is larger and has a different diversity of flora and fauna than Rose Garden. It was established in 2009, encompassing approximately 240,000m^2 area. This marine protected area has a high diversity of commercially targeted species, attracting divers and snorkelers.

3. ReefDoctor and FI.MI.HA.RA

Both of the marine reserves are going from strength to strength thanks to all the hard work of the local association FI.MI.HA.RA, the pirogue groups and all the hotels and dive shops in the Bay of Ranobe. Since their establishment, ReefDoctor has delivered support to the fishermen organisation FI.MI.HA.RA, administrators of the marine reserve. Biological evaluations of this patch coral reef system equip FI.MI.HA.RA with the necessary tools to make informed management decisions.

ReefDoctor's long term monitoring program utilizes a generic Underwater Visual Survey (UVS) technique divided into three categories, benthic, invertebrates, and fish. Benthic and invertebrate surveys are used to characterise the flora and fauna of the seabed community. Reef fish assemblages are evaluated through targeting groupings of ecologically and economically valuable species. In order to maintain ReefDoctor's standards for high quality research; surveys are only conducted by international, national and local volunteers who have completed an extensive training program.

Both Rose Garden and Ankaranjelita are an important economical resource for local stakeholders involved in the tourism industry. The revenue generated from the sale of tickets allows FI.MI.HA.RA to manage the protected areas (e.g. employment of a reserve guardian, community-based projects implementation).

ECOLOGICAL MONITORING OF FISH POPUALTIONS

During surveys of reef fish assemblages, ReefDoctor record the number of fish in each targeted groups. These groups of fish have either an economical (e.g. overfished species) or ecological importance (e.g. herbivorous species, species indicator of coral health) or both. To follow up the evolution of fish populations in the marine reserves, surveys have been undertaken at different period of time.

1. Rose Garden

For Rose Garden, the graphs below show the average density of fish within their group. The analysed data are from 12 transect belt of 200m^2 in 2006 and 10 transects belt of 250m^2 in 2011. The comparison of fish density over the years (from 2006 to 2011), demonstrate that it increased.

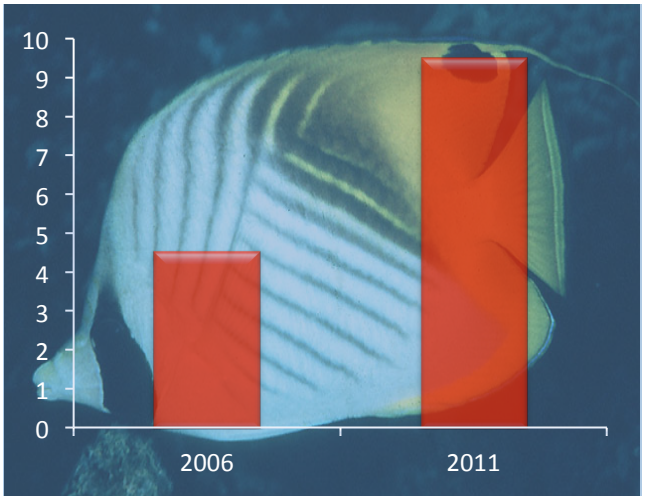

Figure 2: the graph shows the average number of butterfly fish (10 x 20 meters transect) before (2006) and after (2011) the closure of the marine reserve Rose Garden

BUTTERFLY FISH
Chaetodontidae

- Most butterfly fish are corallivores, feeding on the symbiotic algae found in the layer of soft tissues covering the limestone skeleton of reef building corals.
- Butterflyfish are utilised by many researchers as indicators of coral health; it is suggested that an abundance of butterfly fish indicate high coral cover.

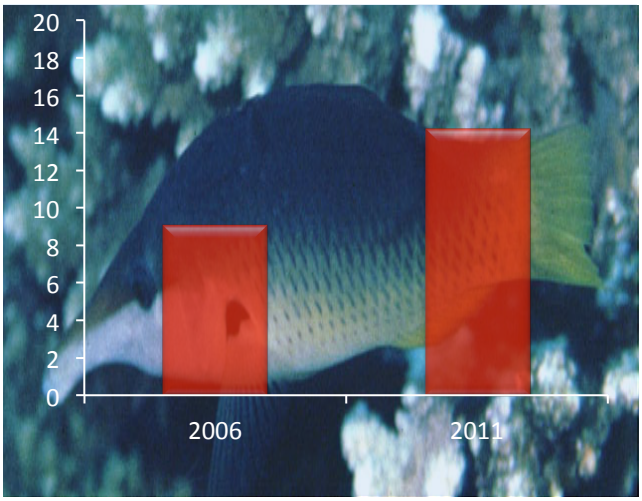

Figure 3: The graph shows the average number of wrasses (10x20meters transect) before and after the closure of the marine reserve Rose Garden

WRASSES
Labridae

- Specialised individuals are fish and mega fauna cleaners and play an important role parasite removal.
- Many wrasse species are targeted by the local fisheries
- Some are important algae grazers and play a role in controlling algae biomass in reef systems.

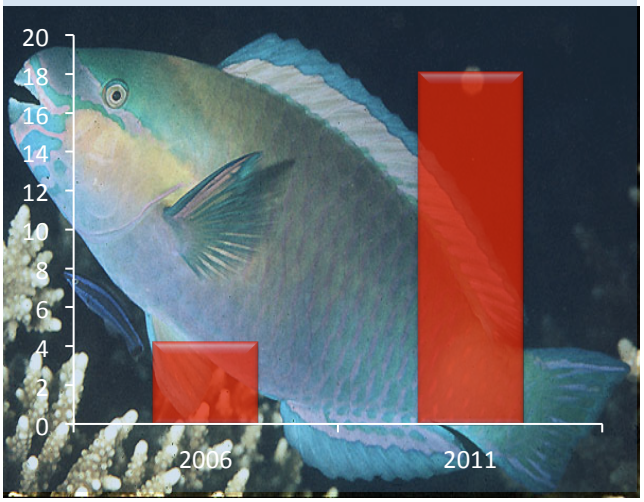

Figure 4: The graph shows the average number of parrotfish observations (10 x 20 meters transect) (2006) and after (2011) the closure of the marine reserve Rose Garden

PARROTFISH

Scaridae

- Parrotfish feed on the algae complexes growing on the exposed seabed.
- Large parrotfish are responsible for algae grazing on reef system.
- They provide a clean substrate on which corals prefer to settle

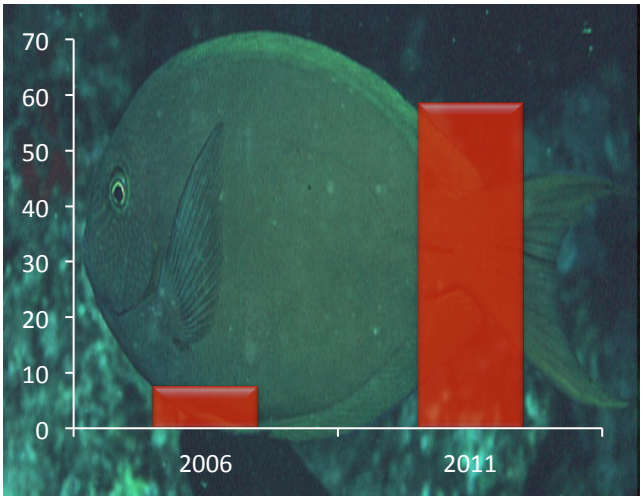

Figure 5: The graph shows the average number of surgeon fish observations (10 x 20 meters transect) before (2006) and after (2011) the closure of the marine reserve Rose Garden

SURGEONFISH

Acanthuridae

- Surgeon fish consume large amounts of algae
- Herbivores are important as they keep algae under control so it does not outcompete coral
- Some species are also targeted by the local fisheries

2. Ankaranjelita

Ankaranjelita marine reserve, an area of 240,000m^2, has been monitored since before its conception in 2010. Comparison of underwater visual surveys (UVS) of fish species in 2007; 4 transient fish belts of 500m^2, and 2011; 10 transient fish belts of 250m^2, reveal that overall fish density of this area has increased (Figure 6).

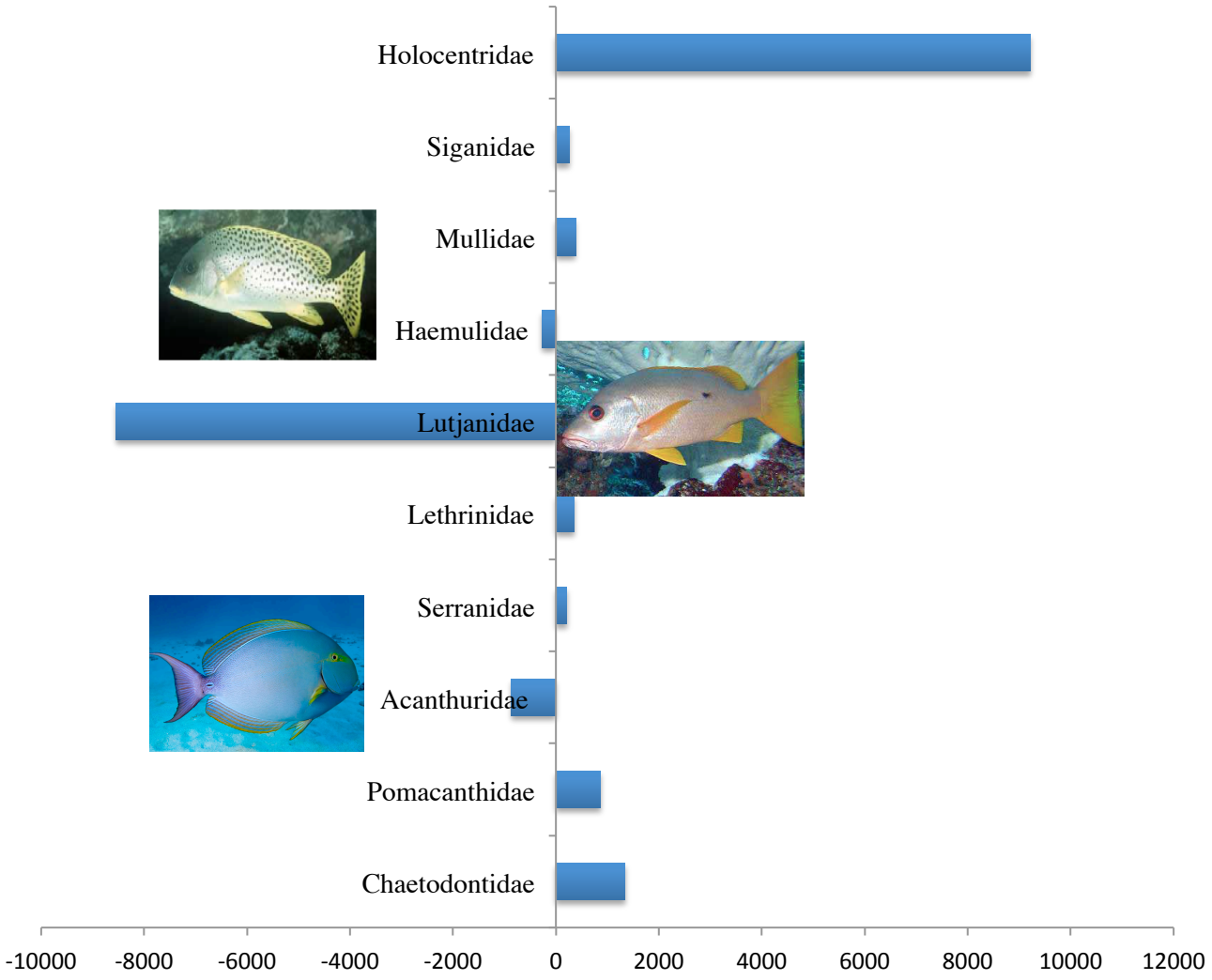

Figure 6: *The graph shows the fish density difference in Ankaranjelita in 2007 from before the establishment of the marine reserve in 2007 to 4 years after its establishment in 2011. Three fish families show a negative difference.*

The fish families *Lutjanidae*, *Acanthuridae* et *Haemulidae* show a negative difference in density between 2007 and 2011, suggesting that these species frequently targeted by the Vezo for the commercial fishery may be subject to illegal exploitation in the marine reserve.

EVALUATION OF SCLERACTINIAN CORAL

Initial surveys conducted in 2010 suggest that Rose Garden exhibited 60 - 70 percent absolute coral cover; species diversity was regarded as low with between 10 and 16 genera and fewer than eight hundred colonies recorded. During this survey period Rose garden was described as a mono-specific patch coral reef system exhibiting high coral cover dominated by one specific genus *Montipora* of the *Acroporidae* family. In June 2010 a disease outbreak at Rose Garden was reported to be affecting the genera *Montipora*, by May 2011 absolute coral cover had fallen to around 40 percent (Figure 7). However, during this period of disturbance results indicate that species diversity increased with > 20 genera and > 2000 colonies observed (Figure 7), higher diversity is suggested to increase resilience to future stressors. Recent evaluation of Rose Garden to assess the recovery of scleractinian corals suggest percent cover is increasing although it has not reached pre-disturbance levels.

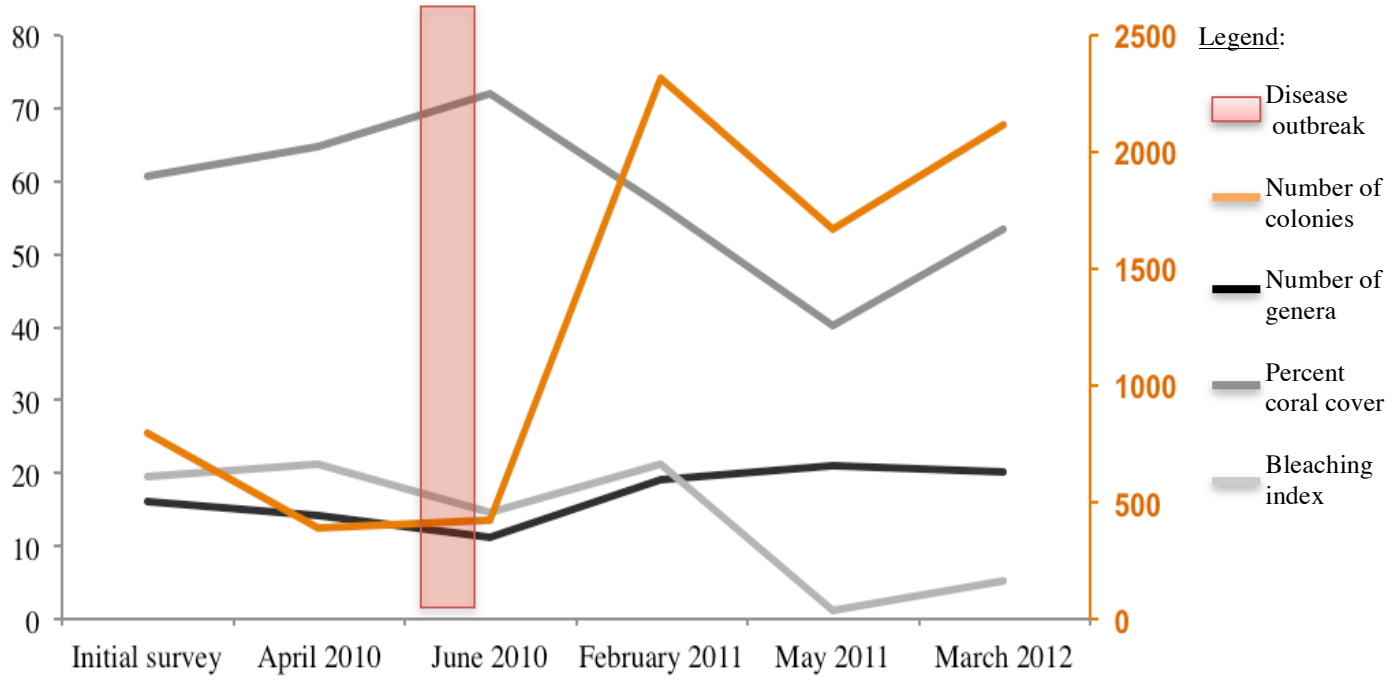

Figure 7: *The graph shows the evolution of scleractinian coral in the Bay of Ranobe over 2011 and 2012 and during the disease outbreak at Rose Garden.*

Coral bleaching is a major concern to researchers, conservationists and the general public worldwide. It is defined as the process by which the coral-algae mutualistic symbiosis breaks-down resulting in a loss of pigmentation (Wild *et al* 2004). Bleaching typically corresponds with extended periods of Sea Surface Temperatures (SST) above the suggested bleaching threshold of 27.5°C (Donner *et al* 2005). Resistance and resilience of coral to bleaching has been linked to local stressors (Carilli *et al* 2009). ReefDoctor's environment and climate change management strategy includes a long-term bleaching monitoring program. Research technicians record temperature and light level information using permanent HOBOware lite® temperature sensors placed at strategic sites throughout the lagoon. Scleractinian coral responses to temperature in the Bay of Ranobe are evaluated through the bleaching index (BI) surveys. BI surveys commence during the peak of summer temperatures (January/March) with surveys to assess recovery rates of effected corals initiated in May/July. Quantification of the bleaching response is achieved by evaluating and categorising colour expression by coral colonies within the survey area. Results show that temperature data recorded at Rose Garden during the summer period of 2010 to 2011 (Figure 7) exhibit periods of sustained sea temperatures over the suggested bleaching threshold of 27.7°C. During this period occurrences of scleractinian coral bleaching intensifies displayed in the increase of the bleaching index (Figure 7).

TICKETS SALES TO THE MARINE RESERVES

Since their conception guests visiting the marine reserve paid an entrance fee of 2000 Ariary (around 0,70€) per person, since October 2010 park entrance fees have been increased to 5000 Ariary (around 2,50€) per person.

1. Rose Garden

Evaluation of the admittance logs for Rose Garden illustrates the number of guests visiting the marine reserve (Figure 8) and the revenue generated from the sale of tickets (Figure 9) since 2009. Initial attendance number of Rose Garden were low, however there has been a gradual increase over the years peaking in 2012. It must be noted that upon instigating a price increase in October 2010 attendance levels dropped but quickly recovered. Profit obtained from entrance fees has significantly augmented by increasing the entrance price to the marine reserve in October 2010, even with the short drop in attendance (Figure 9).

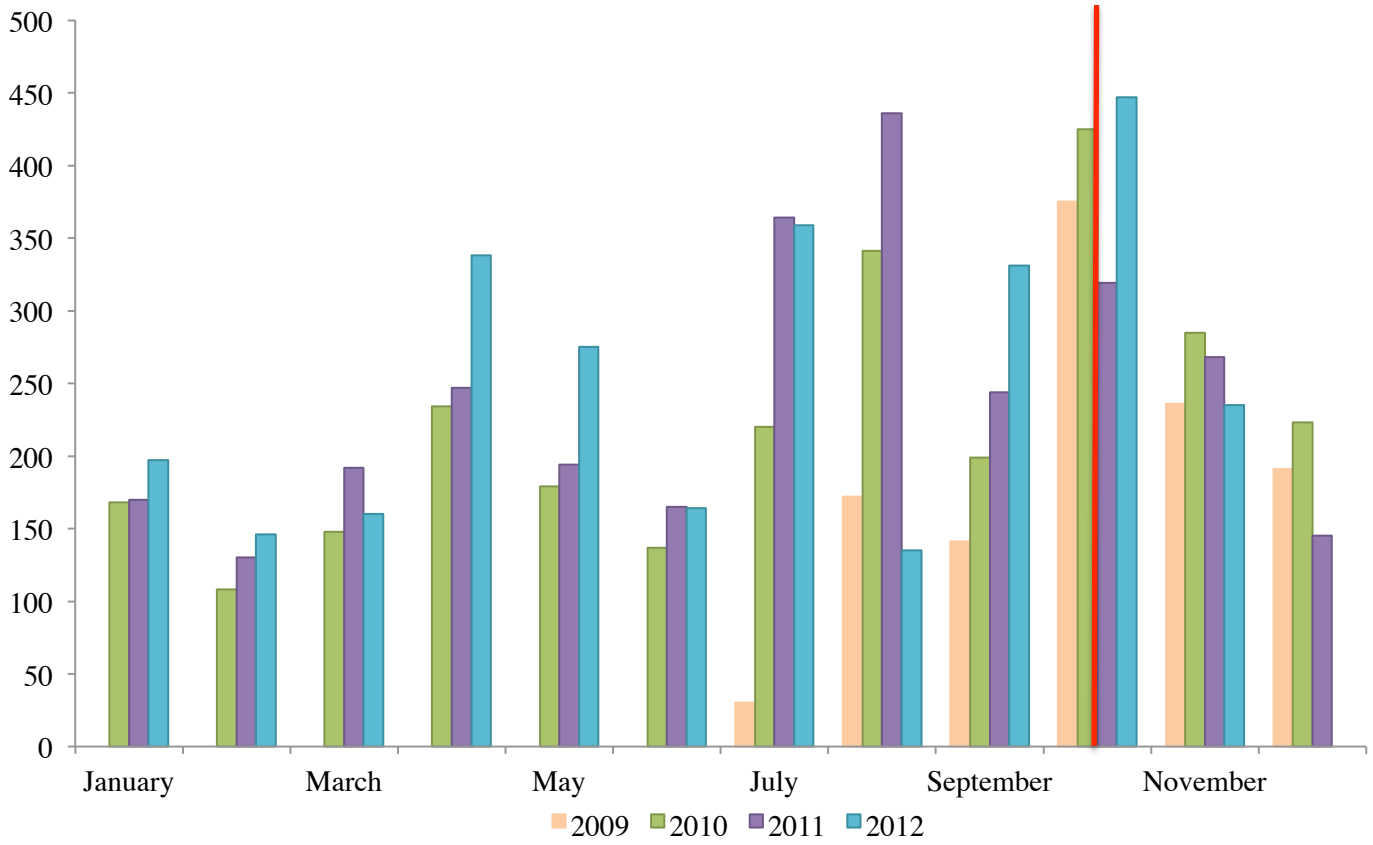

Figure 8: *The graph shows the ticket sales for the marine reserve Rose Garden. The red line indicates the period in which ticket prices increased from 2000 to 5000 Ariary.*

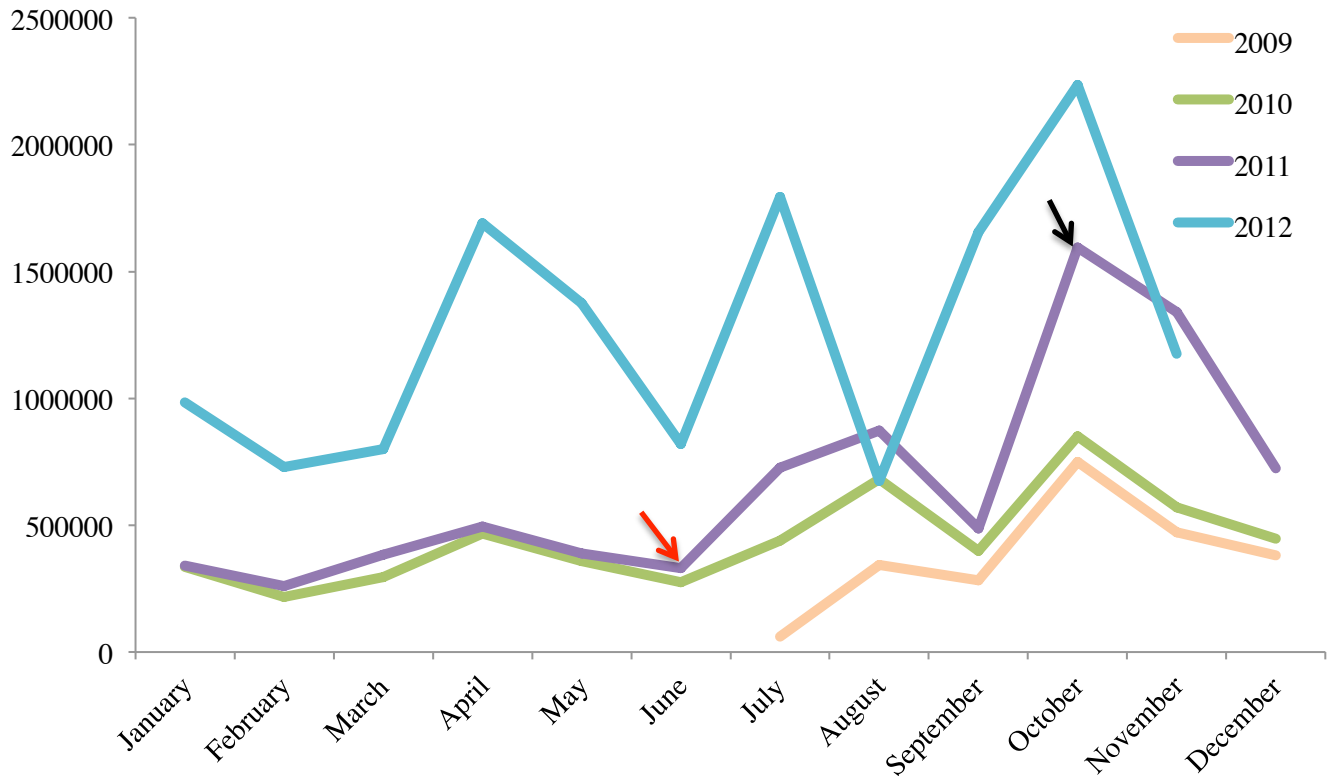

Figure 9: *The graph shows the yearly revenue generated by the ticket sales of Rose Garden. The red arrow indicates the formation of the management committee for the marine reserves of the Bay of Ranobe. Le black arrow indicates line indicates the period in which ticket prices increased from 2000 to 5000 Ariary.*

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