

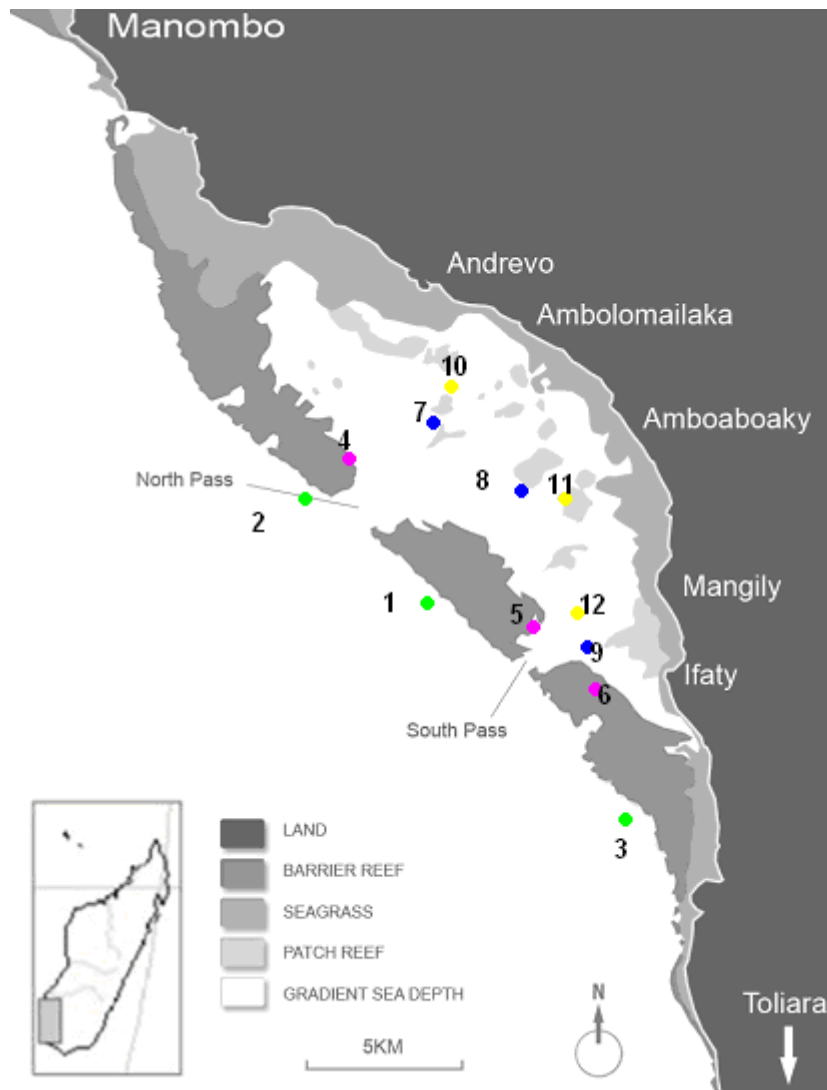
Reef Doctor's Long Term Monitoring of the Bay of Ranobe

The following methodology will be adopted by Reef Doctor to commence a new long term monitoring programme within the Bay of Ranobe (to be implemented in Nov 2008). This will consist of a biannual survey conducted during a one month period in both the summer (November/ December) and the winter (July/August). The methodologies have been adapted from those defined by McClanahan (2008) with the aim of producing data that is comparable to that of other organisations / institutions in the region, who have also agreed to adopt a similar methodology (outcome of a Wildlife Conservation Society workshop, Antananarivo, Sept 2008). This programme will allow the health of the Bay's coral reefs to be effectively and sustainably monitored over time to ensure future management decisions are scientifically well informed. It will also contribute to the assessment of the effectiveness of existing and future planned MPA's.

Survey Sites

The Bay's reef system has been divided into four survey zones to ensure that all reef areas are accurately represented in the programme. The reef zones chosen, defined according to Battistini *et al* (1975), are Reef Flat (including the inner reef slope), Exterior Lagoon (outer reef slope) and Interior Patch Reefs. In addition this programme will include three Marine Protected Areas (MPAs) located in the interior of the lagoon. Table 1 shows the sites that have been selected to represent these areas across the north, middle and south sections of the Bay and the locations are shown in Figure 1. Sites were also selected on the basis of their proximity to existing sedimentation survey sites so that results from both programmes can be correlated in future analyses.

Table 1. Sites to be surveyed in the Bay of Ranobe with GPS coordinates.			
Reef Flat /Inner Slope	Exterior / Outer Slope	Patch Reef	MPA
Beantitsy S 23°01.675 E 43°05.872	Canyons S 23°20.1883 E 43°59.446	Ankarandava S 23°15.748 E 43°58.851	Massif des Roses S 23°14.626 E 43°59.023
Abeakio S 23°06.071 E 43°31.297	Humphead Hole S 23°14.010 E 43°54.480	Riakapombo S 23°05.920 E 43°34.082	Ankaranjelita S 23°03.871 E 43°32.959
Coral Garden S 23°15.118 E 43°57.078	South Sed07 S 23°05.657 E 43°30.168	Ankarambe S 23°04.447 E 43°32.665	Ankarabory S 23°06.157 E 42°34.737



- 1= Humphead Hole
- 2= South Sed 07
- 3= Canyons
- 4= Abeakio
- 5= Coral Garden
- 6= Beantitsy
- 7= Ankarambe
- 8= Riakapombo
- 9= Ankarandava
- 10= Ankaranjelita
- 11= Ankaranbory
- 12= Massif des Roses

Figure 1. Map of the Bay of Ranobe showing the location of Reef Doctors survey sites across the four defined reef zones.

Methodology

The chosen sites will be surveyed by scuba buddy teams using 20m transects. Each buddy pair should aim to complete two 20m transects so that on a standard survey dive of two buddy pairs the replicate output is four. The allocated minimum and maximum number of replicates per site in each biannual period is 6 and 10 retrospectively. At each survey site the location of replicates are chosen randomly but should allow the transect to remain at a specific depth contour and never exceed a depth of 15m. Where logistically possible, the surveying team should focus on completing one site at a time so that the replicates obtained are within in the same time period to reduce potential variability. Table 2 shows the physical parameters that need to be recorded for each survey replicate.

Table 2. Physical parameters to be recorded for each transect replicate.

Water temperature / °C Air temperature / °C Visibility / m Depth / m Sea State (Beaufort Scale) Wind speed / kn and direction Current speed / kn and direction Cloud cover / oktas Precipitation GPS coordinates Direction of transect Position of transect within site
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Fish

Reef fish diversity, abundance and biomass will be determined using an Underwater Visual Census (UVC) method, along a belt transect. The fish surveyor will swim slightly ahead of its benthic buddy whilst the benthic surveyor lays the 20m transect. The fish surveyor is to record all larger, transient species that can be seen 2.5m either side of the transect and 2.5m above / below the surveyor, so the total volume surveyed is 500m³ (20x5x5m). The surveyor should swim at a constant speed and ensure that they do not record the same fish twice. The benthic surveyor will signal the end of the 20m transect by a fin tug. On the return journey, which commences the benthic survey, the fish surveyor should then record all resident / cryptic fish species which are less readily disturbed than the transient species. All fish species are to be recorded and their size estimated (to later determine biomass) using the following size classes:

1. 1-8 cm
2. 9-25cm
3. 26-50 cm

Benthic

The benthic cover will be assessed by the Point Intercept Transect (PIT) method. This method allows estimations to be made of the percentage cover of different substrate types found in the survey area. At every 25cm point along the 20m transect the benthos that lies directly below the tape measure will be recorded. Benthos will be recorded according to Table 3. All hard corals are to be identified to the minimum of family level and where possible genus and species level using Veron (2000) as an identification aid. An underwater camera will be taken along each dive to aid in this coral identification. The benthic surveyor is also required to take note of any evidence of coral diseases in the survey area and any other observations of factors that may be impacting on coral reef health (e.g. anchor damage, destructive fishing practises).

Table 3. Benthic criteria to be recorded along each 20m transect and abbreviations to be used for data entry.

Coral	Coral Morphology	Substrate	Algae	Other
Live Coral (LC)	Branching (CB)	Rock (RCK)	Filamentous (FA)	Bryozoan (OTB)
<i>Millepora</i> (CME)	Digitate (CD)	Dead Coral (DC)	Turf (TA)	Sponge (OTS)
<i>Heliopora</i> (CTU)	Encrusting (CE)	Bleached Coral (BC)	Coralline (CA) branching or encrusting	Tunicate (OTT)
<i>Tubipora</i> (CTU)	Massive (CM)	Rubble (RU)	Fleshy Macro (FMA)	Gorgonian (OTG)
Soft Coral (SC)	Submassive (CSM)	Sand (SD)	Hard Macro (HMA)	Anemone (OTA)
	Tabulate (CT)	Silt (SI)		Hydroid (OTH)
	Foliaceous (CF)			Corallimorph (OTC)
	Mushroom (CMR)			Zooanthid (OTZ)

Invertebrates

Upon completion of both the fish and benthic surveys one surveyor should begin the invertebrate survey while the other reels the tape measure back in. Table 4 displays the macro invertebrates that are to be recorded 1m either side of the 20m transect so that the total survey area for invertebrates is 40m² (20x2m). In addition the invertebrate surveyor should make notes of any sea urchin predation (i.e. broken tests) within this belt transect.

Table 4. Macro invertebrates to be recorded along each 20m transect and justification for selection (Identification reference: Richmond 1997)

Giant Triton Shell <i>Charonia tritonis</i>	Predator of the Crown of Thorns starfish
Elongate Giant Clam <i>Tridacna maxima</i>	Collected for the curio market
Fluted Giant Clam	Collected for the curio market

<i>Tridacna squamosa</i>	
Crown of Thorns Starfish <i>Acanthaster planci</i>	Adults feed voraciously on live coral, responsible for large areas of coral mortality at large densities
<i>Holothuria scaber</i>	Commercially important species
<i>Holothuria nobilis</i>	Commercially important species
<i>Holothuria parva</i>	Commercially important species
Cowries <i>Cypraea spp</i>	Collected for the curio market
Conch Shells <i>Strombus spp</i>	Collected for the curio market
<i>Diadema savignyi</i>	Important reef herbivore
<i>Diadema setosum</i>	Important reef herbivore but also have potential to cause reef bioerosion in large numbers (Lam <i>et al</i> 2007)
<i>Echinothrix diadema</i>	Important reef herbivore
<i>Parasalenmia</i>	Important reef herbivore
<i>Tripneustes gratilla</i>	Gonads of the species are consumed and sold on local markets (Gabri� <i>et al</i> 2000)
<i>Echinometra mathaei</i>	A bioeroding species (McClanahan and Muthiga 1988)
<i>Echinostrephus molaris</i>	Bioeroding species (Richmond 1997)

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