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Status Report: Marine ecosystems, fisheries and socio-economic context of Anjouan, Comoros

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1. Executive summary

The outstanding marine biodiversity of the Comoros islands is both poorly studied and subject to high local pressures on resources, especially on the island of Anjouan. In partnership with Comorian NGO Dahari, Blue Ventures aims to address the pressures on the marine ecosystems of the Sima peninsula in western Anjouan (Figure 1), whilst meeting the needs of fishery-dependent communities and conserving the marine resources and biodiversity. To achieve this goal, we need to identify and implement community-centred opportunities for enhancing conservation, fisheries management and livelihoods. However, there are little existing data available on the local ecosystems, socio-economic context or fisheries to inform these activities, so it was necessary to carry out broad-scale baseline research. Our programme of participatory research began in 2015, and we present the initial results in the report as follows:

- Broad overview of coastal ecosystems across the region of our interventions (coastal ecosystem mapping, 3.2.1)
- Broad overview of evidence of anthropogenic pressures (3.2.2)
- Detailed evaluation of coral reef status at several sites in the region (3.2.3)
- Broad overview of the socio-economic context across the region of our interventions (4.3.1)
- Detailed socio-economic assessment of the communities involved in our interventions (4.3.2, 4.3.3, 4.3.4, 4.3.5)
- Results of ongoing catch monitoring carried out at two of the sites involved in our interventions (5)

Key findings:

- There is vast coral reef coverage around the Sima peninsula, though live hard coral cover and fish abundance and richness varies widely.
- Mangroves are present in few locales, but cover appears to be stable.
- There are significant areas of seagrass bed on reef flats.
- Anthropogenic pressures are present, including fishing, erosion and sedimentation, beach excavation and household waste, with varying severity of pressures throughout the intervention region.
- The reefs at intervention sites of Mlongo Muhu (Bimbini) and Hadongo (Vassy) are in relatively good condition with coral cover between 34% and 65% depending on depth.
- The level of infrastructure across the intervention region is basic, and the coastal population depends heavily on fishing for income and food security.
- A total of 22,745 kg of catch was sampled across two sites, with catch per unit effort being lower in Vassy than in Bimbini (1.6 vs 2 kg/fisher hour). Bimbini's fishery is large (many fishers) and widespread (many fishing locations), while Vassy's fishery is relatively small and local.
- Local fisheries target pelagic and reef species using a range of techniques; in Bimbini fishers primarily use nets and target reef species, while in Vassy fishers primarily use hook-and-line methods and target pelagic species (especially tuna).

The majority of this baseline information has been fed back to the communities involved in our interventions and will be incorporated into locally led discussions on ways to manage marine resources and conserve marine biodiversity. Data collection is ongoing, and this report will be updated when the next set of analyses are complete.

2. Introduction

The Comoros archipelago is located in the northern Mozambique Channel about 300 km (186 miles) off the east coast of Africa. Three major islands – Grande Comore (Ngazidja), Anjouan (Ndzuwani), and Mohéli (Mwali) – and many minor islets make up the Comoros Union. With a surface area of 2,034 km^2 (785 sq mi), it is the third smallest African nation. A fourth island of the Comoros archipelago, Mayotte, is claimed by the Comoros but administered by France, and is excluded from figures used in this report. The archipelago is of volcanic origin, though Mount Karthala on Grande Comore is the only remaining active volcano; it has erupted more than a dozen times in the last century. The Comoros climate is tropical, with two distinct seasons: *kashakazi*, a hot rainy season (November–April), and *kusi*, a cool dry season with strong southeast trade winds (May–October).

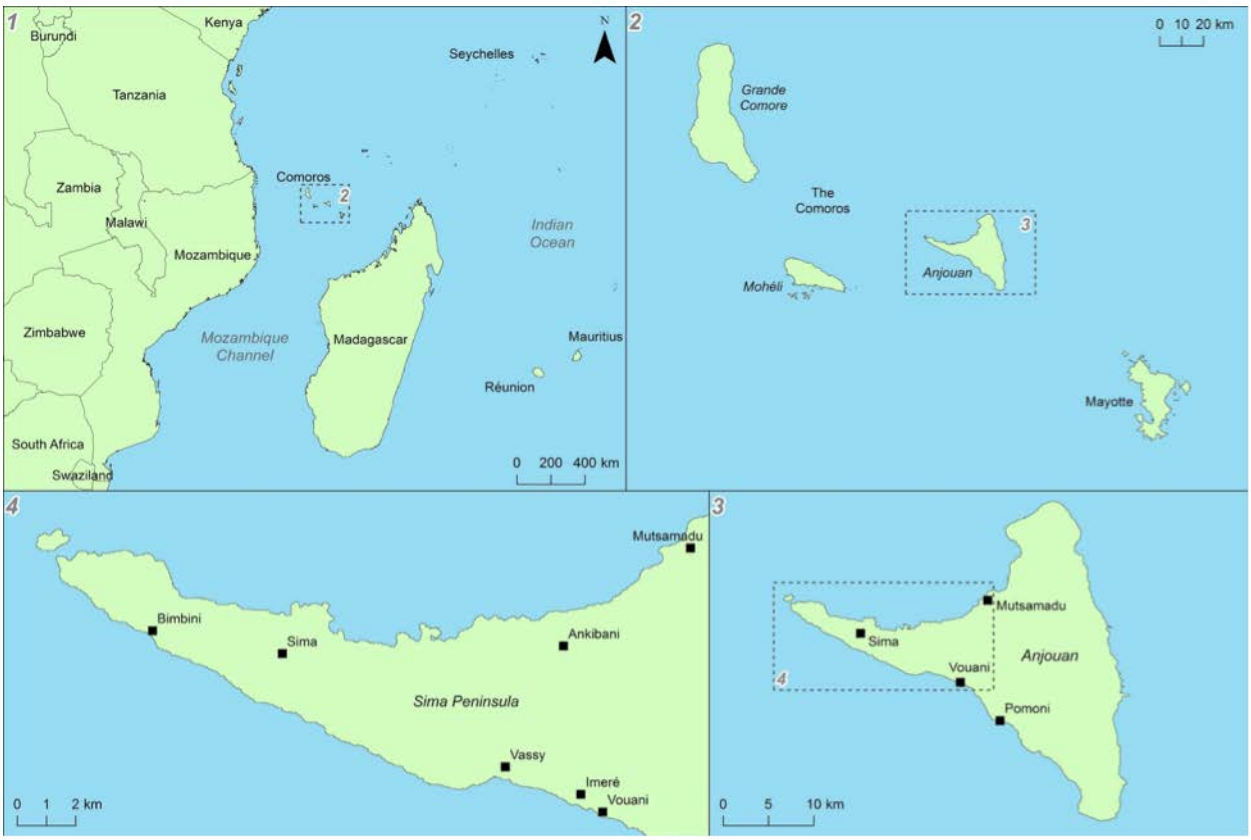

Figure 1. The location of the study region, in the context of: 1. the wider Western Indian Ocean; 2. the Comoros; 3. Anjouan; and 4. the Sima Peninsula.

The Northern Mozambique Channel was recently identified as a hotspot of coral reef biodiversity, second only to the 'Coral Triangle' of Southeast Asia and the Western Pacific (Obura, 2012). These diverse coral reefs underpin the livelihoods of coastal communities in the Comoros, mainly through small-scale fisheries. Artisanal fishing is a cornerstone of national food security and is the main source of animal protein for the rural population. Recent research has shown that the Comoros is vulnerable to the effects of climate change and ocean acidification (Burke, et al., 2011), both of which are likely to become more severe in coming years, and may further threaten the nation's food security.

The Comoros is a low-income country, with a Human Development Index scoring 0.497 in 2016 (Human Development Report, 2016); its economy is hampered by inadequate transport links, a rapidly growing population and few natural resources. The nation and its residents are highly dependent upon foreign aid and international trade, receiving income mainly through export of vanilla, cloves, and ylang-ylang essential oil. Its population of around 795,000 rely heavily on subsistence agriculture and fishing, which accounts for 50% of GDP and employs 80% of the labour force (CIA, 2017).

Of the three major islands, small-scale fisheries are particularly important for densely populated Anjouan (estimated 827 people/km^2 or 2,139 people/sq mi). While there is anecdotal evidence suggesting that marine resources are overexploited, robust and actionable data are lacking. In particular, little is known about the status and extent of artisanal fisheries in Anjouan, nor about the condition of the island's reefs or use of the coastline. To address this data gap, the Comorian NGO Dahari, in collaboration with Blue Ventures, initiated a programme of research in 2015 along the Sima peninsula and southwest coast of Anjouan, a Key Biodiversity Area harbouring diverse and important marine ecosystems. This research is a vital first step towards identifying community-centred opportunities for enhancing conservation, fisheries management and local livelihoods in a marine biodiversity hotspot suffering from unsustainable resource use, growing food insecurity, coastal poverty, climate vulnerability, and biodiversity loss.

In this report we present progress to date, with a summary of preliminary results and conclude with next steps and management recommendations.

2.1 Selection of study sites

The Sima peninsula, located on the northwest corner of Anjouan and within the prefecture of Sima, is densely populated – the 2017 estimated population for the peninsula is 29,905 (Commissariat General 2003), with a population density of 373 people/km^2 (598/sq mi). The peninsula and southwest coastline of Anjouan encompasses 11 villages.

To select suitable sites for research, we used the following three-step process (see also Figure 2):

1. We conducted initial interviews with representatives from seven villages, according to their accessibility by road and level of coastal activity (based on anecdotal reports);
2. We used the initial interview data (not presented in this report) to identify eight reef and coastline sites frequented by fishers from three of the study villages (Bimbini, Vassy and Sima) at which to conduct rapid ecological assessments. One additional site, Mpwaju, lies within the territory of another village, Chitsanga Sheli, but was chosen for study because it is adjacent to Vassy and its reef is frequented by fishers from Vassy;
3. We used the results of the interviews and rapid ecological assessments to choose two of the initial study villages (Bimbini, Vassy) and two additional villages (Dzindri and Salamani, which share use of sea territory with Vassy) at which to carry out the socio-economic assessment, catch monitoring, and in-depth reef survey. Results from the four villages are reported here.

For a summary of the assessments conducted at each village and reef site, see Table 1.

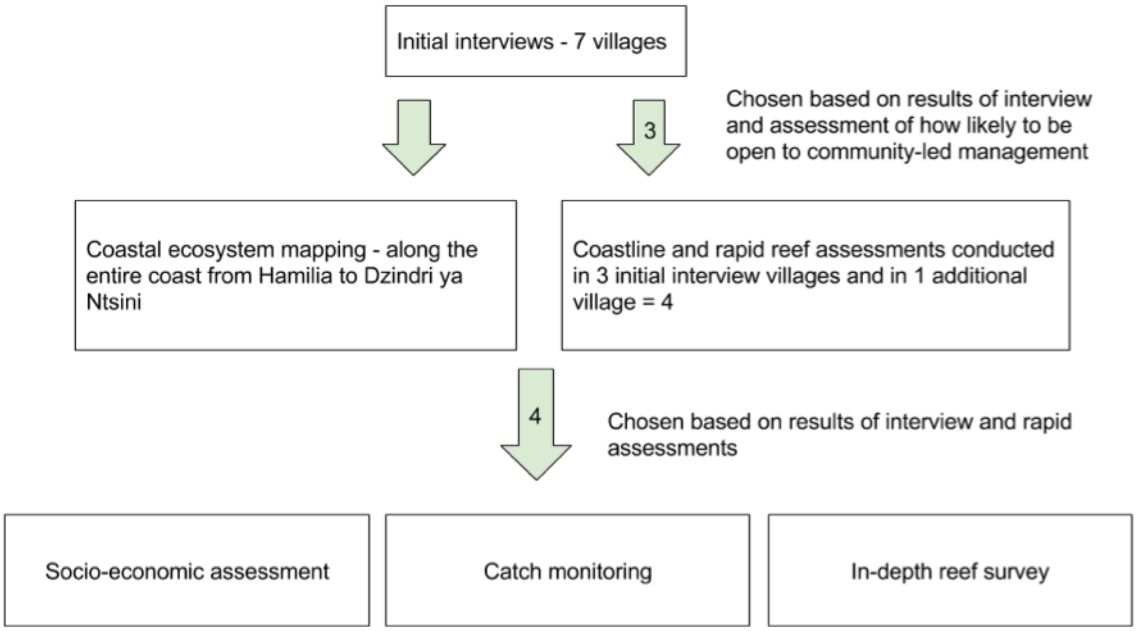

Figure 2. Flowchart for selection process of research villages.

Table 1. Summary of assessments conducted in each village by site as of December 2017. Y = Yes, N = No, RA = Rapid assessment, IS = In-depth survey, NV = no village, NA = not applicable

*** These two villages use the same fishing site**

Village	**Reef site**	**Ecological Assessment**		**Catch monitoring**	**Socio-economic**	**Initial interviews (not reported)**
		Coastline	Reef			
Bimbini	Bimbini	Y	N – too rough	Y	Y	Y
	Suni	Limited assessment, lack of time	RA	NV	NV	NV
	Chisiwani	Y	RA	NV	NV	NV
	Mlongo Muhu	Y	RA and IS	NV	NV	NV
Chitsanga Sheli	Mpwaju	N – not priority	RA – used by Vassy fishers	N – not priority	N – not priority	N – not priority
Hassimpao	Hassimpao	N – not selected based on findings from initial interviews				Y

Maraharé	Maraharé	N – not selected based on findings from initial interviews				Y
Mirongani (inland but use Bimbini coast)	Mirongani	NA – inland (use Bimbini coast)	NA – inland	N – landing sites outside of village so not visited	NA – no longer working in Bimbini area	Y
Mromouhouli	Mromouhouli	N – not selected based on findings from initial interviews				Y
Sima (inland, but has its own associated beaches)	Sima	NA – inland	NA – inland	NA – inland	N – inland	Y
	Hamilia	Y	RA	NA – not a landing site	NV	NV
	Mtsangani Sima	Y – limited, lack of time	RA – limited due to bad conditions	N – not planned due to staff resources	NV	NV
	Mtsanga Mleni	N – lack of time	RA	NA – not a landing site	NV	NV
Vassy *Dzindri/ Salamani	Hadongo	Y	RA and IS	Y	Y	Y
	Dzindri ya Ntsini	Y	RA and IS	Incomplete	Y	N – not part of initial study area

3. Ecological assessment

3.1 Objectives

As small-scale fisheries are particularly dependent on coral reef ecosystems, we conducted a broad-scale ecological assessment across the Sima peninsula and part of the southwest coast of Anjouan in order to identify which coastal ecosystems were present and to assess their general condition. This study also involved an assessment of anthropogenic coastal activity (such as sand extraction for construction), and pressure on the reef from fishing, pollution and litter. The resulting data were used to identify key sites for

ecosystem monitoring (e.g. coral reefs, mangroves and seagrass beds), and to help select sites for in-depth research (reef surveys, socio-economic assessments and catch monitoring). This in-depth research will provide baseline data to inform a long-term community-led management programme.

3.2 Method

The ecological assessment consisted of four parts: coastal ecosystem mapping; coastline assessments; rapid reef assessments; and in-depth reef surveys. We carried out coastal ecosystem mapping along the entire coastline of the study zone, from Hamilia to Dzindri ya Ntsini (Figure 3). Coastline and rapid reef assessments were completed in the fishing zones of four villages (Bimbini, Chitsanga Sheli, Sima and Vassy). We conducted in-depth reef surveys at two sites (Bimbini, and Vassy). The methods used in each part are summarised below (for full descriptions of the methods used, please refer to the Appendices).

3.2.1 Coastal ecosystem mapping

We identified the ecosystems present (mangroves, coral reefs and seagrass) and their locations using a two-step process involving: i) the identification of ecosystems using satellite images; and ii) verification of satellite data via site visits. To accomplish the latter, we toured each site by motor boat or on foot, recording the ecosystem types observed and using a GPS and/or digital camera to record their location. The data were then entered into Google Earth to produce a coastal ecosystem map.

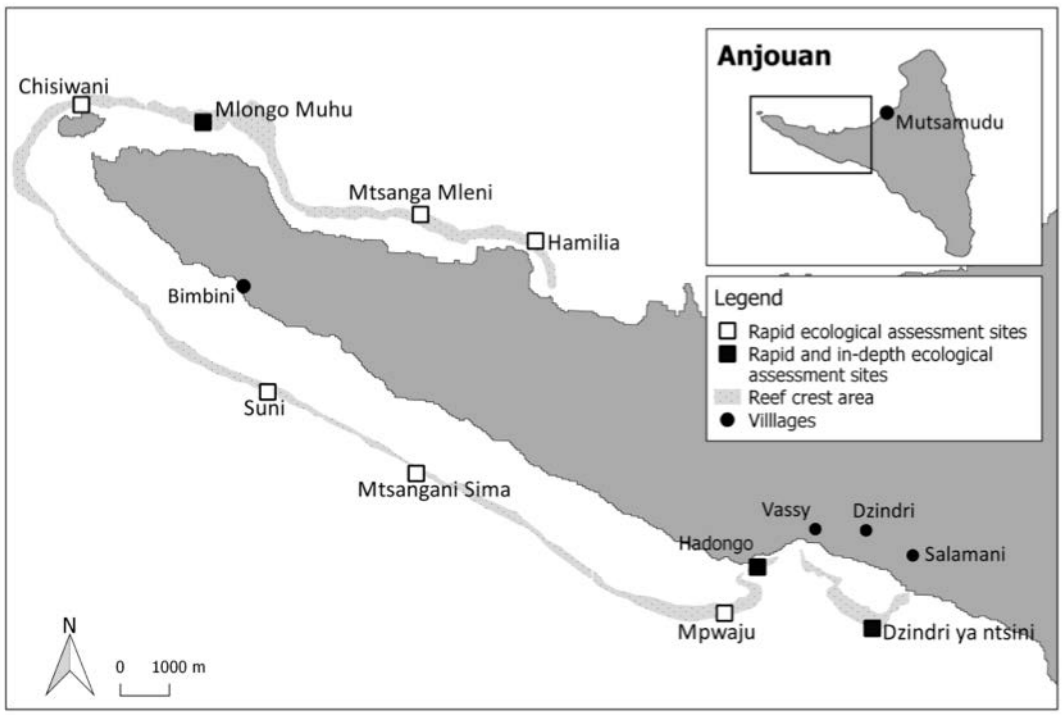

Figure 3. Map of sites for rapid ecological assessment on Sima peninsula.

3.2.2 Coastline assessment

This assessment combined visual site surveys and interviews to provide basic abiotic information and to gain an understanding of the anthropogenic pressures affecting the coast. We gathered observational data on a

range of variables to indicate the structure and health of the coastal environment (Table 2). To complement these data, we conducted semi-structured interviews with all-male and all-female groups of 1–12 participants, with at least one interview per gender group per village. Groups were asked about the history of the coast, the frequency and intensity of storms, what activities take place (net fishing, line fishing, harpoon fishing, poison fishing, small-mesh net fishing, octopus fishing, beach sand/rock excavation for building materials, etc.), and whether they had observed any changes in the local ecosystems.

Table 2. Variables studied during coastline assessment.

Variable	Data categories	Rationale
Beach composition	Sand/rock/silt	Shoreline features and composition can impact offshore habitat (e.g. reef)
Wave exposure	Low/medium/high	Affects coastal ecosystems and erosion
Wind exposure	Low/medium/high	Affects coastal ecosystems and erosion
Evidence of erosion	None/beach erosion/land erosion	Anthropogenic pressure may affect coastal ecosystems
Evidence of beach removal	None/sand removal/rock removal	Anthropogenic pressure may affect coastal ecosystems
Evidence of sedimentation	No/yes	Affects coastal ecosystems and indicates anthropogenic pressure
Evidence of pollution	None/chemical/nutrient	Evidence of fuel in water and/or algal blooms; affects coastal ecosystems and indicates anthropogenic pressure
Presence of household waste	None/little/much	Affects coastal ecosystems and indicates anthropogenic pressure

3.2.3 Rapid reef assessment

We conducted reef assessments at nine sites (Table 1) using the following snorkel survey methodology to gain a baseline understanding of the current health of and pressures acting on the reef. The resulting data allowed us to identify sites where reef health and pressures are amenable to improvement by local management actions. This was also a way to gather information quickly from a broad geographic area to inform decisions on where to conduct in-depth reef surveys, socio-economic assessments and catch monitoring.

Snorkel surveys were carried out at low tide to record abiotic conditions, benthos, fish, invertebrates, and threats (Table 3). Two ≥300 m long transects were conducted parallel to the coast at each site, one on the reef flat (maximum depth of 6 m) and one on the reef slope (maximum depth of 10 m) to account for the variation often observed between the two zones. If a particular site was not easily accessible by snorkel, an abbreviated version of the assessment was conducted. The data generated by this sampling method are not suitable for statistical analysis as the objective was to gather qualitative data for a broad overview of many different sites.

Fish richness was assessed by recording all observations of species from a list of 27 regional species (Table 16) of ecological and/or fisheries importance, plus any others observed from the following four families: groupers (subfamily Epinephelinae), parrotfish (subfamily Scaridae), snappers (family Lutjanidae) and triggerfish (family Balistidae).

3.2.4 In-depth reef surveys

In-depth reef surveys were carried out at two sites in 2016: Mlongo Muhu (frequented by fishers from Bimbini) and Hadongo (frequented by fishers from Vassy). These sites were chosen to represent the two main study areas, Bimbini and Vassy, and so complete the broad spectrum of baseline data for these villages, which also includes catch monitoring and socio-economic assessments. Due to time constraints, no more than two sites could receive in-depth surveys in 2016. In 2017, reef surveys were carried out at four sites (Hadongo, Mabamboni, Dzindri ya Ntsini flat and crest) to represent the reef complex used by fishers from Vassy, Dzindri and Salamani (Figure 4).

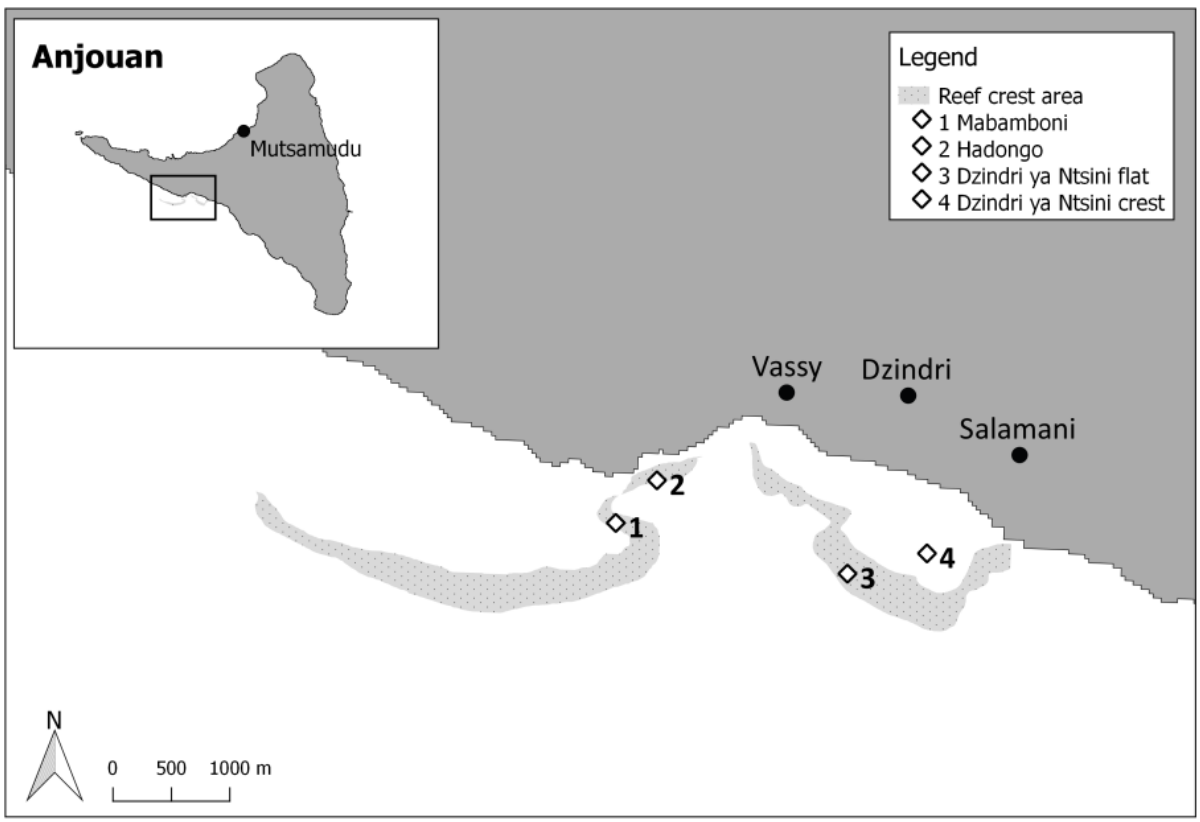

Figure 4. Map of reef monitoring survey sites with the location of villages of Vassy, Dzindri and Salamani.

The surveys were conducted during low tide and at depths of 0.5–3 m to provide quantitative data on the same five variables that were assessed in the rapid reef survey method. The survey was conducted on the crest between the reef flat and slope, with only one site located on the reef flat (Dzindri ya Ntsini flat). In 2016 we conducted six transects per site; each transect was 10 m in length and separated by at least 5 m. In 2017 we conducted three transects at each site, each 30 m long and separated by a minimum of 50 m.

Abiotic parameters such as cloud status, temperature and current strength were recorded at the beginning of each survey. Fish abundance and diversity were recorded visually in a belt of 2.5 m on either side of the transect line. Benthos categories such as hard coral, soft coral, and algae growth were recorded every 0.2 m along the first and last 10 m portion of the transect line. Invertebrate abundance and diversity was recorded in a belt of 5 m (2.5 m on each side of the transect line). Few modifications in the target fish, benthos and invertebrate taxa occurred between 2016 and 2017 to standardise the methodology following GCRMN standards (see Appendix A). Target fish families include common reef fish and different feeding guilds with critical ecosystem functions, as well as common fisheries targets (e.g. Scaridae, Serranidae, Lutjanidae, Lethrinidae), enabling assessment of fish community composition and potential fishing impacts.

These data will provide an important baseline against which to measure the impact of future management efforts, through statistical comparison with annually repeated assessments at the same sites for as long as management initiatives are in place.

Table 3. Variables and data categories recorded during rapid reef assessment and in-depth surveys.

Variable	Sub-variable	Data categories	Rationale
Abiotic conditions		Weather, reef length and width, presence and location of rivers, depth of observations, tide (high, low, mid), horizontal visibility	Shoreline features and composition can impact offshore habitat (e.g. reef)
Benthos	Dominant habitat	Coral, algae, seagrass, sand, rubble, hard substrate, and the proportion of each (%)	Identifies coastal ecosystem composition
	Dominant reef cover	Live hard coral, bleached coral, dead coral, soft coral, macroalgae, crustose coralline algae, turf algae, debris, and the proportion (%) of each	Indicates quality of the reef
	Coral bleaching	Proportion (%) of bleached, pale, and normal corals	Indicates susceptibility of reef to warming sea temperatures
Fish	Richness	All species observed	Provides data on biodiversity of coral reef
	Size	Record all individuals >30 cm long	Indicates fishing pressure
	Abundance	Average number of fish in 100 m^2 area	Indicates fishing pressure
Invertebrates	Richness and abundance	Counts of giant clams, crown-of-thorns starfish, lobster, sea cucumber, sea urchin patches	Provides data on biodiversity; can also indicate reef health (i.e. overabundance of sea urchins can erode a reef)
Threats	Household waste	Quantity and type	May affect reef health, indicates anthropogenic pressure
	Abandoned fishing gear	Quantity and type	Indicates high fishing pressure, possible overharvesting

3.3 Results

3.3.1 Coastal ecosystem mapping

Using the satellite images and site survey data we generated a coastal ecosystems map showing the two dominant ecosystem types, mangroves and coral reefs (Figures 5 and 6). In general, mangroves are located near Bimbini village and Chisiwani, while coral reefs are distributed along the external slopes of the lagoon that surrounds the Sima peninsula. The mangroves of Bimbini are currently stable in terms of coverage, as they are not harvested for local use and previous mangrove replanting programmes in areas adjacent to mangrove patches were of limited success and had little impact on overall cover.

Seagrass was observed in patches throughout the reef flat, but the current programme did not involve the detailed surveys required to determine which species are present at different locations, so these data are not shown on this map.

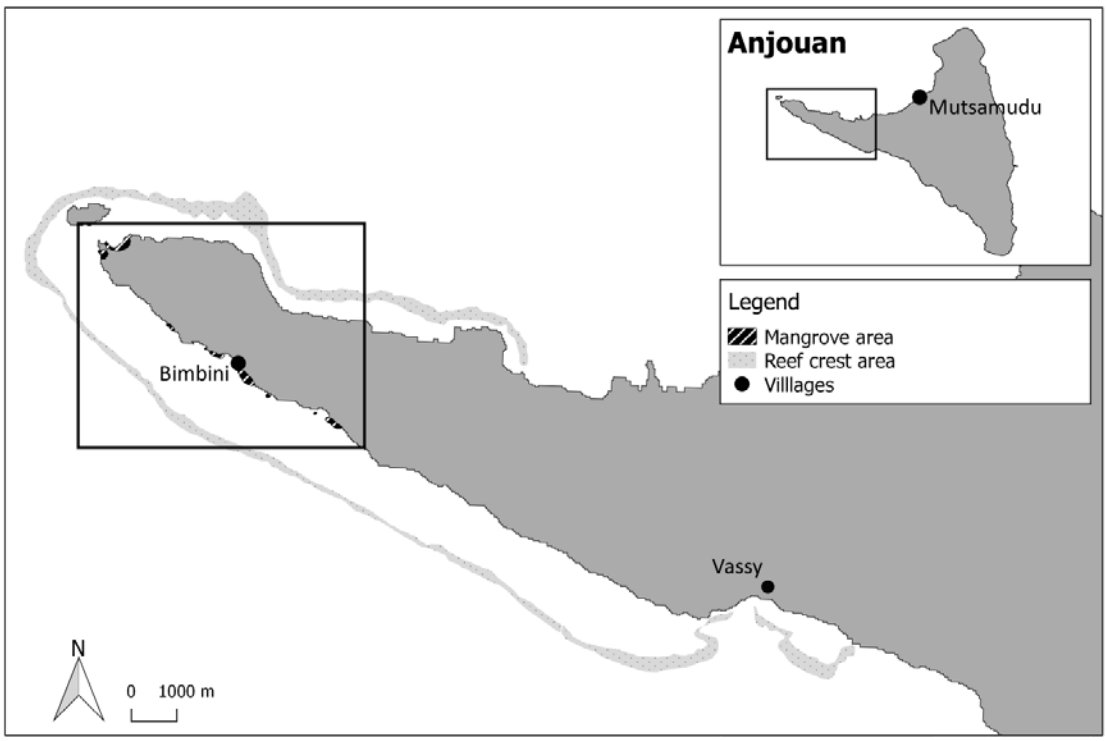

Figure 5. Mangrove and coral reef ecosystems of Sima peninsula and nearby southwest coast identified by coastal ecosystem mapping. The left hand black rectangle represents a map section enlarged in Figure 6.

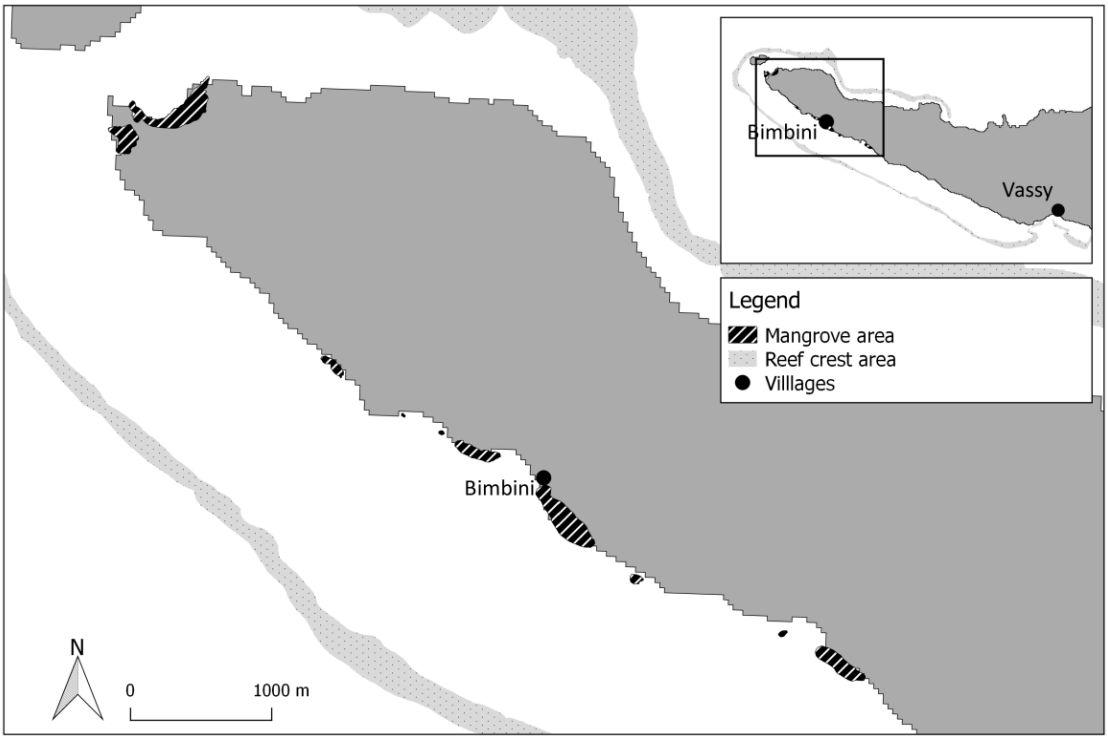

Figure 6. Detailed view of mangrove ecosystems location of Sima peninsula identified by coastal ecosystem mapping.

3.3.2 Coastline assessment and rapid reef assessment

In total, we conducted coastal assessments at eight sites and rapid reef assessments at nine sites around the peninsula between February and April 2016. We also held 15 group interviews with 74 fishers from seven villages (interview data are not presented here). The coastline assessment revealed substantial variation in the physical composition of the coastline and exposure to waves. Overall there was little evidence of pollution, sedimentation, erosion, or of human activities (beach removal, waste or abandoned fishing gear) (see Table 4 for a summary of these data). The results of the rapid reef assessment are discussed in more detail on a site by site basis (for a summary, see Table 5).

Table 4. Results of coastline assessments for eight sites around the Sima peninsula. x = none observed.

Site	Beach composition	Wave exposure	Erosion	Beach removal	Evidence of sedimentation	Pollution	Household waste	Notes
Hamilia	x	Strong	x	x	x	x	x	No village present
Mlongo Muhu	Sand and rock	Medium	x	x	x	x	x	No village, frequented by Bimbini fishers
Chisiwani	x	Strong	x	x	x	x	x	No village, frequented by Bimbini fishers, agriculture present on islet
Bimbini	Silt	Sheltered	x	x	Some	Prolific filamentous algae	Much	Bimbini village adjacent, landing site for Bimbini fishers
Suni	Not yet assessed	Strong	Not yet assessed	Not yet assessed	x	x	x	No village, frequented by Bimbini fishers
Mtsangani Sima	Sand and Rock	Medium	Not yet assessed	Sand removal	Not yet assessed	x	x	No village, landing site for Sima fishers
Hadongo	Rock above a sandy layer	Medium	x	Rock removal	Some	x	x	No village, reef gleaning commonly practised
Dzindri ya Ntsini	Rock above a sandy layer	Medium	x	Rock removal; sand removal	x	x	x	Some houses present, reef gleaning commonly practised

Table 5. Results of rapid reef assessments for nine sites around the Sima peninsula.

Site	Dominant habitat	Dominant reef cover	Invertebrates observed	Fish richness (no. spp. observed)	Individuals >30 cm (no. observed)	Household waste (no. observed)	Abandoned fishing gear (no. observed)
Hamilia	Reef	Live hard coral	Sea cucumber	16	1	0	0
Mtsanga Mleni	Reef	Live hard coral	Giant clam Sea cucumber	16	1	0	3
Mlongo Muhu	Reef	Debris	Sea cucumber Sea urchin bed	16	5	10	0
Chisiwani	Reef	Crustose coralline algae	Giant clam Sea cucumber Sea urchin bed	15	12	0	0
Suni	Reef and hard substrate	Not yet assessed	Not yet assessed	Not yet assessed	Not yet assessed	Not yet assessed	Not yet assessed
Mtsangani Sima	Reef/hard substrate	Not yet assessed	Not yet assessed	Not yet assessed	Not yet assessed	Not yet assessed	Not yet assessed
Chitsanga Sheli	Reef	Turf algae and bleached-pale coral	Giant clam	10	3	2	0
Hadongo	Reef	Live hard coral	Giant clam Sea cucumber	13	2	0	0
Dzindri ya Ntsini	Reef	Live hard coral	0	11	5	0	0

Site 1: Hamilia

Located on the northern face of the Sima peninsula, Hamilia has a rocky coastline with no beach, and there are no nearby villages. A fringing reef dominates the subtidal area with a high proportion of live hard coral cover. Sea cucumbers were observed, along with a variety of fish species (n=16). Fishing pressure appears to be moderate with one large (>30 cm) fish and no abandoned fishing gear observed. Other anthropogenic pressures appear to be low with no household waste, erosion, or sedimentation observed, but beach rock excavation occurs at the nearby beaches of Mjamawe.

Figure 7. Photos of the reef at Hamilia showing live hard coral as dominant cover, and reef fish.

Site 2: Mtsanga Mleni

Mtsanga Mleni is located on the northern edge of the peninsula and has a sandy beach coastline with no village. A fringing reef dominates the subtidal area with a high proportion of live hard coral cover, harbouring a variety of fish species (n=16), giant clams and sea cucumbers. Although coastal observations were not completed for this site, we were able to ascertain that the sandy beach provides some protection from coastal erosion and indicates that sand excavation is not a predominant activity. However, there was evidence of high fishing pressure with only one observation of a large fish and three observations of abandoned fishing gear, the most recorded at any of the nine sites.

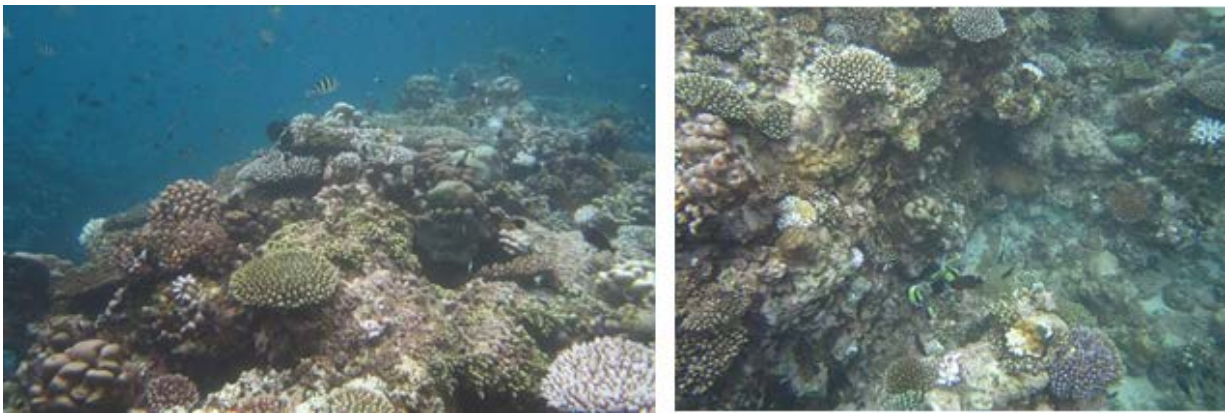

Figure 8. The reef at Mtsanga Mleni showing coral reefs dominated by live hard coral and presence of reef fish species.

Site 3: Mlongo Muhu

Mlongo Muhu is situated on the northwestern edge of the Sima peninsula. The coastline is beach, composed of sandy areas and rocky faces that descend into the water. A high proportion of coral debris dominates the subtidal area, mainly located between coral reef spurs that are largely covered by bleached corals and secondarily by healthy live hard corals. While a variety of fish species (n=16) and sea cucumbers were observed, the presence of sea urchin beds and abundance of coral debris indicates the reef is in a state of decline. Mlongo Muhu is a popular fishing site for fishers from Bimbini, though pressure appears to be moderate with five large fish and no abandoned fishing gear observed. Sand excavation does not occur at this site. The coast is moderately exposed to waves, but no evidence of erosion or sedimentation was observed. Although there are no nearby villages, ten observations of household waste were made, which could indicate high anthropogenic pressures or tidal influences bringing rubbish from nearby villages or boats.

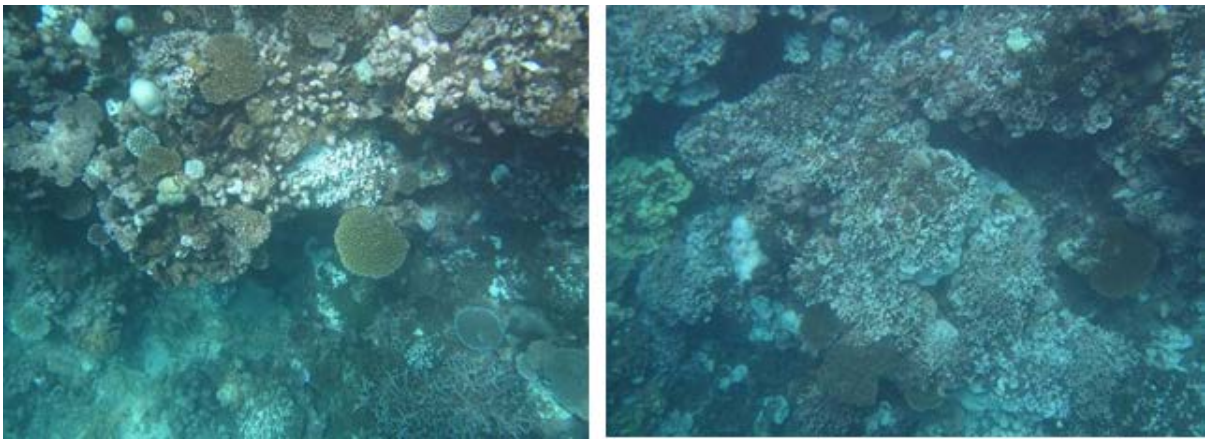

Figure 9. Reef at Mlongo Muhu showing bleached and healthy live hard coral cover.

Site 4: Chisiwani

Chisiwani, the uninhabited islet located at the northwestern tip of the peninsula, has a rocky coastline with no beach. The fringing coral reef of the subtidal area is predominantly covered by crustose coralline algae and harbours a variety of fish species (n=15), giant clams, and sea cucumbers. We also observed sea urchin beds, which indicate reef degradation most likely caused by a lack of grazing herbivorous fish due to high fishing pressure. Despite this, we observed 12 large fish (the most recorded at any site during this survey) and found no abandoned fishing gear. There is no nearby village and we did not record any household waste, but farmers do practice agriculture on the islet and its reef is frequented by fishers from Bimbini. Villagers report that beach sand removal takes place nearby, and we observed moderate wave exposure on the beach, so erosion and sedimentation may be a threat although none was directly observed during the assessment.

Figure 10. Reef at Chisiwani showing live hard coral, turf algae, and crustose coralline algae.

Site 5: Bimbini

Bimbini is located along the southwestern shore of the peninsula with a mudflat coast, a large reef flat with small isolated lagoons, and a steep slope. Bimbini village sits along the coast between patches of mangrove forest and is the landing site for Bimbini fishers. We could not assess the reef along the slope due to heavy wave action, but the large flat serves as a barrier between the coastline and the waves. The reef flat is dominated by crustose coralline algae and is mostly devoid of coral cover; it is a popular site for reef gleaning for fishers from Bimbini and neighbouring villages. The lagoons harbour live hard coral along the sloping walls. Beach excavation does not take place here, but we observed some sedimentation. There are large pressures from Bimbini village: household waste covers the beach and is tangled amongst the mangrove roots and branches. At the time of the assessment, filamentous algae was prolific in the subtidal/intertidal area, possibly due to large presence of household waste.

Figure 11. Mudflat and filamentous algae present along coast at Bimbini.

Site 6: Suni

Suni is located on the southern face of the peninsula and has a beach coastline with no adjacent village, though fishers from Bimbini frequent this site. We did not make coastal observations at Suni, and strong wave action prevented full rapid reef assessment. The subtidal area harbours patches of hard substrate and coral reef with bleached and healthy live hard corals.

Figure 12. Reef at Suni showing bleached and healthy live hard corals.

Site 7: Mtsangani Sima

Mtsangani Sima is located on the southern coast of the peninsula. It has a rocky beach with no adjacent village and is a landing site for fishers from Sima. The subtidal area is hard substrate with patches of crustose coralline algae and coral reef composed of bleached, pale, and healthy live hard corals. Strong wave action prevented a complete rapid assessment of the coral reef. The beach is exposed to moderate wave action, though no erosion or sedimentation was observed during the assessment. Beach excavation occurs at this site.

Figure 13. The reef at Mtsangani Sima showing bleached and pale corals and crustose coralline algae.

Site 8: Chitsanga Sheli

Chitsanga Sheli is located on the southeastern edge of the peninsula. It has a sandy beach coastline with an adjacent village. The subtidal area is dominated by coral reefs with turf algae and bleached and pale coral, supporting a moderate variety of fish species (n=10), and giant clams. It is a popular site for reef gleaning (across shallow areas of the reef flat) and fishing (everywhere else). Fishing pressure is moderate, with just three observations of large fish but no observations of abandoned fishing gear. Although additional coastal observations were not made, anthropogenic pressure is most likely moderate as villager interviews indicate

beach sand extraction occurs locally, and two observations of household waste were made during the rapid reef assessment.

Figure 14. Portions of the reef at Chitsanga Sheli, showing the presence of pale coral and turf algae.

Site 9: Hadongo

Hadongo is located at the southeastern edge of the Sima peninsula within the fishing zone of Vassy. It has a rocky beach with no adjacent village. The subtidal area is dominated by coral reefs with live hard coral, and harbours a variety of fish species (n=13), giant clams, and sea cucumbers. The beach is exposed to wave action, with evidence of moderate sedimentation present in the water. The reef flat is frequented by reef gleaners primarily from Vassy and Dzindri and fishing occurs offshore. Fishing pressure is moderate with just two observations of large fish but no observations of abandoned fishing gear. We observed no household waste, but interviews revealed that rock excavation occurs at this site.

Figure 15. Portions of the reef at Hadongo showing the dominance of live hard coral and presence of reef fish.

Site 10: Dzindri ya Ntsini

Dzindri ya Ntsini is located just south of the Sima peninsula within the fishing zone of Vassy. It has a rocky beach with several nearby houses. The subtidal area is dominated by coral reefs with live hard coral and

harbours a moderate variety of fish species (n=11), but no invertebrates were observed during the rapid reef assessment. Fishing pressure on the reef flat is high as it is a popular site for reef gleaning with fishers from several communities including Vassy, Dzindri, Salamani, Maruntruni and Iméré. Offshore fishing pressure is moderate with five large fish observed and no abandoned fishing gear observed. Although we observed no erosion, sedimentation or household waste, beach sand and rock extraction occurs intensively here (sand is found below the rock layer).

Figure 16. The reef at Dzindri ya Ntsini showing dominance of live hard coral.

3.3.3 In-depth reef survey

Bimbini's waters contain a fringing reef on the northern side of the Sima peninsula that is frequented by fishers, especially from Bimbini village. Corals are present on the flat and on the slope to depths of at least 20 m. The reef is characterised by the coral spurs and sand–debris beds that dominate the subtidal area. We assessed the reef using the rapid reef assessment method at depths of 2–10 m in March 2016, followed by an in-depth reef monitoring survey in April at depths of 1–3 m during low tide.

Live hard coral is the most abundant benthic cover, followed by crustose coralline algae and turf algae at shallow depths, and coral debris and crustose coralline algae at greater depths (Figure 17). Live hard coral was observed to be greatly affected by the warm temperatures during the study period, with high proportions of coral either bleached (45%) or pale (30%), while the remaining 25% retained its normal appearance (Table 6).

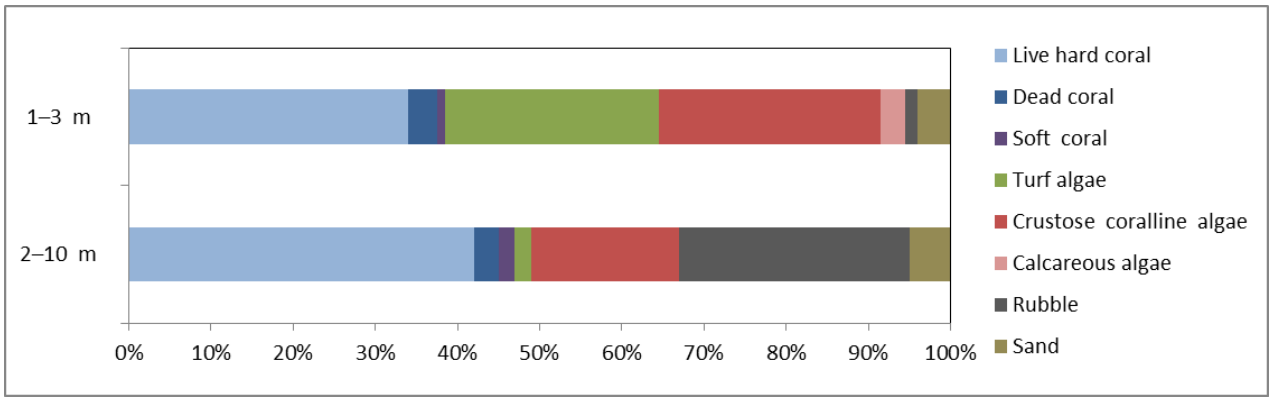

Figure 17. Benthic cover at Bimbini observed at depths of 1–3 m (April 2016) and 2–10 m (March 2016).

Table 6. Coral bleaching at Bimbini observed during April 2016 assessment.

Coral status	Proportion (%)
Normal	25
Pale	30
Bleached	45

Average fish abundance was 80 (± 7.4) individuals/100 m^2. Thirteen species and three of the families were observed, with striated surgeonfish *Ctenochaetus striatus* and convict surgeonfish *Acanthurus triostegus* the most commonly observed species (average of 65 (± 7.9) individuals/100 m^2 and 6 (± 7) individuals/100 m^2, respectively). Sea urchin abundance was 8 (± 5) individuals/100 m^2 at depths of 1–3 m (Table 7). Sea urchin beds were also observed at depths of >3 m. No sea cucumber, lobster, giant clam, or crown-of-thorns starfish *Acanthaster plancii* were observed at depths of 1–3 m, but sea cucumber was observed at >3 m.

Table 7. Mean invertebrate abundance (individuals (standard deviation) per 100 m^2) at Bimbini at depths of 1–3 m (April 2016) and 2–10 m (March 2016). * Indicates number of urchin beds not individual urchins.

Invertebrates (ind/100 m^2)		1–3 m	2–10 m
Black spine sea urchins	Individuals	8	2
	Beds	No	Yes (2)
Sea stars		0	0
Sea cucumbers		0	3
Lobsters		0	0
Giant clams	0–10 cm	0	0
Crown-of-thorns (*Acanthaster plancii*)		0	0

Although we found no abandoned fishing gear during the assessment, informal interviews with Bimbini fishers revealed that nets are regularly set on the reef. Net setting is a clear pressure on the reef, evidenced by the large quantities of coral debris observed at this site. We observed household waste during the rapid assessment despite the absence of any adjacent villages along the shore, indicating that waste can affect reefs at large distances from the nearest human habitation.

Vassy's waters contain a fringing reef with a relatively narrow flat and a steep slope. The reef flat is frequented by gleaners at low tide, largely by fishers from Vassy, Dzindri and Salamani. Corals are present on the flat and on the slope to depths of around 20 m.

Hard coral cover was highest in 2016 in Hadongo with 64.67% (±3.92). In 2017, hard coral cover averaged 41.99% (±7.92) across all sites with the highest coral cover at Hadongo with 51.96% (±3.25) and lowest coral cover at Mabamboni 34.31% (±5.59). Following hard coral in dominance are turf algae with overall 29.25% (±3.69) coverage and calcareous algae with 15.77% (±3.14) cover. Turf algae and calcareous algae cover was lower in 2016 in Hadongo with 21.33% (±2.57) and 7.33 (±2.17) coverage respectively. Macroalgae, coral debris and invertebrates represent less than 5% average cover for each category and other benthic categories are rare and represent less than 1% cover (Figures 18 and 19).

For 2017, macroalgae are most abundant on the reef flat at Dzindri ya Ntsini (8.50 ±2.61%). Tabular coral growth forms are most frequent in Hadongo (9.80 ±1.43%), where the lowest cover of macroalgae is found (0.33 ±0.33%). Rubble is most frequent in Mabamboni and Dzindri ya Ntsini reef flat (respectively 6.21 ±2.75 and 4.90 ±0.84%) (Figure 19).

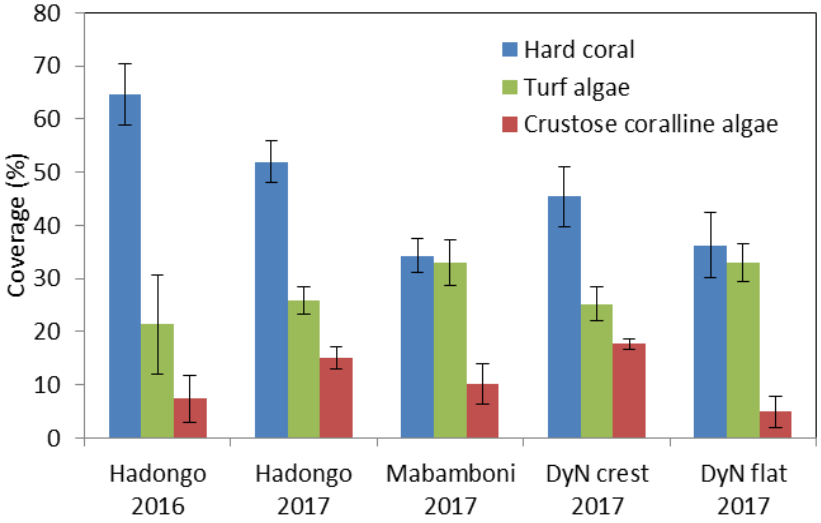

Figure 18. Coverage of hard coral, turf algae and crustose coralline algae (%): for Hadongo site in 2016 and 2017; for Mabamboni, Dzindri ya Ntsini reef crest (DyN crest) and Dzindri ya Ntsini reef flat (DyN flat) in 2017.

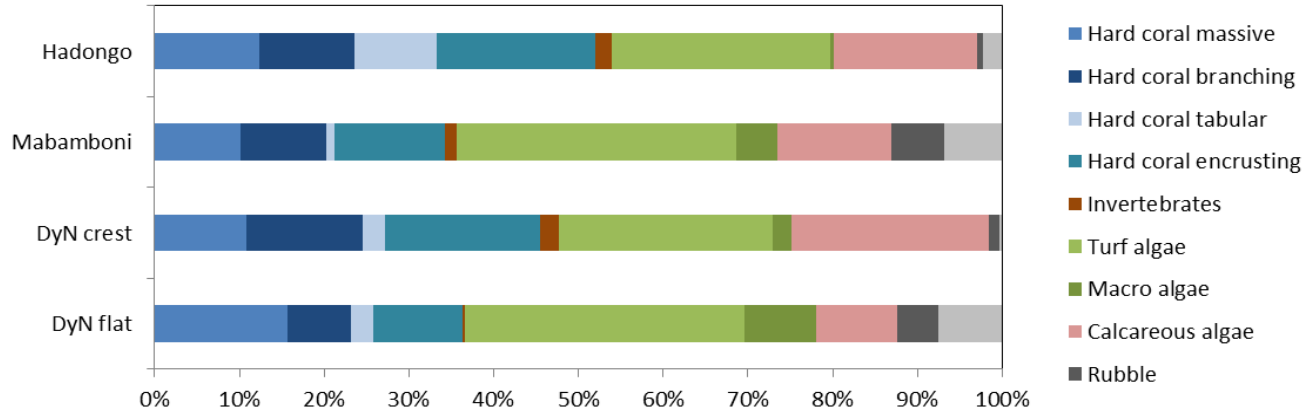

Figure 19. Coverage of various benthic categories (%) among the four study sites: Hadongo, Mabamboni, Dzindri ya Ntsini reef crest (DyN crest), Dzindri ya Ntsini reef flat (DyN flat).

Live hard coral cover was observed to be greatly affected by the warm temperatures in March/April 2016, with 74% of the coral either bleached or pale (41% and 33% respectively) (Table 8). Few occurrences of bleaching were spotted during the November surveys (only once on the transects).

Table 8. Coral bleaching at Hadongo observed during April 2016 assessment.

Coral status	Proportion (%)
Normal	26
Pale	33
Bleached	41

Fish abundance was not assessed in Hadongo in 2016 due to poor visibility. In 2017 over the 12 transects, 805 fish were spotted for a density of 44.72 ±8.01 ind/100 m^2. The surgeonfish (Acanthuridae) is the most abundant family with 277 individuals (15.39 ±2.60 ind/100 m^2), followed by the damselfish (Pomacentridae) with 261 individuals (14.5 ±7.23 ind/100 m^2) and the wrasses (Labridae) with 181 individuals (10.06 ±2.47 ind/100 m^2). Butterflyfish (Chaetodontidae) and angelfish (Pomacanthidae) are less abundant with 49 and 28 individuals spotted (respectively 2.72 ±0.79 and 1.56 ±1.03 ind/100 m^2) (Figure 20).

Fish density was highest in Hadongo with 183.33 ±19.01 ind/100 m^2, followed by Mabamboni (152.67 ±10.71 ind/100 m^2), Dzindri ya Ntsini crest (108.67 ±4.81 ind/100 m^2) and lowest in Dzindri ya Ntsini flat with 92 ±16.26 ind/100 m^2.

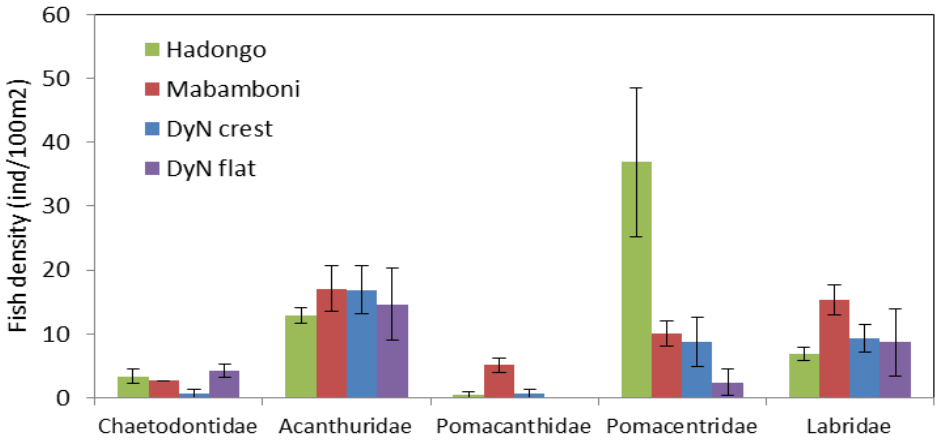

Figure 20. Fish densities of most frequent families (individuals/100 m^2) among the four study sites: Hadongo, Mabamboni, Dzindri ya Ntsini reef crest (DyN crest), Dzindri ya Ntsini reef flat (DyN flat).

Grunts (Haemulidae), emperors (Lethrinidae), rabbitfish (Siganidae) and jacks (Carangidae) were absent from the survey sites. Soldierfish and squirrelfish (Holocentridae), groupers (Serranidae), snappers (Lutjanidae), triggerfish (Balistidae) and parrotfish (Scaridae) were very rare:

- In Hadongo, one soldierfish and one squirrelfish were observed on one transect (0.44 ±0.44 ind/100 m^2) and one grouper in the size class 10–30 cm (0.22 ±0.22 ind/100 m^2).
- In Mabamboni, two snappers were spotted in the size class 0–10 cm (0.44 ±0.44 ind/100 m^2), one triggerfish in the size class 0–10 cm (0.22 ±0.22 ind/100 m^2)
- In Dzindri ya Ntsini reef flat three parrotfish were spotted on one transect (0.67 ±0.67 ind/100 m^2)

Invertebrates are not abundant amongst survey sites except for several species of black-spined sea urchins (*Diadema sp.* and *Echinothrix sp.*). Dense sea urchin beds were present in Mabamboni and Dzindri ya Ntsini reef crest preventing effective counting of individuals. Mabamboni has the highest density of counted sea urchins (larger individuals) with 20 ±12.62 ind/100 m^2. For the other invertebrate taxa, one seastar was spotted in Hadongo, Mabamboni and Dzindri ya Ntsini crest, one sea cucumber in Dzindri ya Ntsini crest and one lobster in Mabamboni. In total, three giant clams in the size class 10–20 cm were spotted in Mabamboni and Dzindri ya Ntsini crest and two of the size class 0–10 cm (Table 9).

No discarded fishing gear or household waste was observed during the assessments. The most pronounced pressures on the reef are sand extraction (which may contribute to the poor visibility observed on the reef and, potentially, sedimentation), and the collection of juvenile fish on the reef flat with the use of *Tephrosia vogelii*, an ichthyotoxic plant known locally as *uruva* (Figure 21).

Table 9. Invertebrate densities (individuals per 100 m^2) for Hadongo, Mabamboni, Dzindri ya Ntsini crest and flat. Black-spine sea urchins are presented as individual counts and presence of sea urchin beds (>100 individuals).

Invertebrates (ind/100 m^2)		**Hadongo**	**Mabamboni**	**Dzindri ya Ntsini crest**	**Dzindri ya Ntsini flat**
Sea urchins (*Diadema sp*. and *Echinothrix sp.*)	Individuals	15.78	20.00	7.33	9.78
	Beds	No	Yes	Yes	No
Sea stars		0.67	0.67	0.67	0
Sea cucumbers		0	0	0.67	0
Lobsters		0	0.67	0	0
Giant clams	0–10 cm	0	0.67	0.67	0
	10–20 cm	0	0.67	1.33	0
Crown-of-thorns (*Acanthaster plancii*)		0	0	0	0

Figure 21. The ichthyotoxic plant *Tephrosia vogelii*, known locally as *uruva*.

3.4 Discussion and recommendations

The coastal ecosystem mapping reveals that coral reefs and seagrass ecosystems are widespread throughout the Sima peninsula, while mangroves occur only near Chisiwani and Bimbini village. The coastline assessment found relatively little evidence of pollution or household waste overall, though the latter was common at Bimbini and Mlongo Muhu. The waste at Bimbini can be seen hanging from mangroves. We did not identify the source of the waste observed at Mlongo Muhu. While there was little evidence of beach excavation (which facilitates coastal erosion and sedimentation on coral reefs) at assessment sites on the peninsula, it is regularly observed at Vassy and Dzindri ya Ntsini and is a widespread problem along much of the rest of Anjouan's coastline.

Although mangrove cover on the peninsula appears to be stable, we recommend monitoring coverage and health of the mangroves at both Bimbini and Chisiwani to ensure the small habitat remains intact.

The rapid reef assessment indicates that the coral reefs in best ecological condition were those at Hamilia, Mtsanga Mleni, Hadongo, and Dzindri ya Ntsini. The other sites with poorer reef quality may be subject to heavy anthropogenic pressure (i.e. dominant reef cover was not live hard coral, most likely due to fishing pressure and/or sedimentation). For ongoing coral reef monitoring, Hadongo and Dzindri ya Ntsini will be monitored as they are now within the intervention zone for community-based marine management initiatives. We recommend selecting additional sites outside intervention zones for monitoring as control sites: one on the northern side of the peninsula with reefs in good condition (Hamilia or Mtsanga Mleni), and a second that is more heavily fished. Further data collection on fish abundance, richness, and size is needed in order to verify whether the results of the rapid assessment accurately represent fish status. If substantial discrepancies are found, the rapid assessment methods for fish should be modified to provide more accurate estimates of fish richness, abundance, and size.

The in-depth reef survey reveals that Mlongo Muhu retains a healthy coral reef with reef-building and facilitating species (live hard corals and crustose coralline algae) dominating the benthic cover. However, it is

a popular fishing site with evidence of anthropogenic pressure (e.g. household waste); the abundance of coral debris and sea urchins and low abundance of fish indicate the potential for degradation. While coral debris comprised only 1.5% of cover at 1–3 m depths, it comprised 28% of cover at greater depths, and was most notable in the beds between coral spurs. Similarly, sea urchins were found sparsely at 1–3 m depths, but were present in dense beds at depths of 2–8 m. These signs indicate the reef is overfished, and is particularly suffering from destruction by net-setting and low abundance of herbivorous fish which have allowed sea urchins to become abundant in some areas. If the area continues to be overfished, it is likely that live hard coral cover will decline and will be replaced by turf algae at shallow depths and debris at greater depths. The presence of a variety of fish species, including both herbivores and carnivores, indicates that it is not too late to encourage re-establishment of ecologically balanced fish populations for a healthier coral reef. This indicates the site would be responsive to management interventions such as gear restrictions for fishing.

Vassy's waters harbour relatively healthy coral reefs with abundant live hard coral (34–52% cover). The presence of crustose coralline algae (9–23% cover), as a facilitating taxa for coral recruits settlement, indicates a resilient reef. Nevertheless, the high algal cover and presence of debris indicates potential for degradation especially in Mabamboni and Dzindri ya Ntsini reef flat, characterised by flatter substrates. Dzindri ya Ntsini reef flat is also a fishing ground frequently visited by reef gleaners. The topography of these two sites also influences rubble density, preventing it from being washed into deeper areas as occurs at the other sites. In Mabamboni, the high density of sea urchins could also indicate a degraded reef. Overall, sites located on a slope (Hadongo, Dzindri ya Ntsini reef crest) show a higher coral cover, possibly explained through higher wave action increasing water clarity and preventing sedimentation, therefore favouring coral growth. The decrease in coral cover from 2016 to 2017 in Hadongo might result from the 2016 bleaching event, highlighting yet another factor affecting coral reef resilience in the area.

High algal cover and density of sea urchins, and presence of debris, along with low abundance of fish, indicate the reefs at these four sites are overfished. The low abundance of herbivorous fish appears to have allowed sea urchins to become abundant in some areas. The Dzindri ya Ntsini reef flat is particularly suffering from destruction caused by reef gleaner activities. If fishing pressure continues to impact fish stocks, it is likely that live hard coral cover will decline and be replaced by turf algae.

The algal cover is possibly partially controlled via grazing by high densities of surgeonfish (Acanthuridae). The Scaridae (parrotfish) also have an important grazing role; their absence – probably due to overfishing – may reduce algal grazing pressure on the reef, but this is possibly compensated for by the activity of Acanthuridae. The fish diversity is low with a critical absence of carnivorous species and other groups, indicating unbalanced fish communities with potential negative impacts on the wider reef ecosystem in the future, if management measures are not put in place. However healthy the corals may appear to be, they will be impacted by unbalanced fish communities, which might result in cascading effects. These baseline datasets will be used to assess the effect of future management measures through comparison with ongoing monitoring at these sites.

4. Socio-economic assessment

4.1 Objectives

The objectives of the marine socio-economic assessment were to gain qualitative understanding of how the community functions and how it uses marine resources, what importance marine resources have for local livelihoods, and to gather a history of the community and its resource use. This overview will be followed up with a more detailed socio-economic study at a later stage, involving a simplified census and household interviews.

Of the Sima peninsula's 11 villages, our initial study focused on two coastal villages, Bimbini and Vassy. We chose the latter as the target for in-depth studies to prepare for potential management interventions. The villages of Dzindri and Salamani were therefore included in our studies as they belong to the Vassy administrative area and share the same reef complex area and resources.

4.2 Methods

This assessment provides an overview of socio-economic conditions on the Sima peninsula. We gathered information on a wide range of variables, including how many fishers there are, what type of fishing they are practising, what percentage of income comes from fishing, and poverty levels. Information was gathered via participant observations of fishing and sand extraction activities and interviews, which were conducted during time spent with fishers and other community members at home and during work activities. This method provides a broad understanding of the local socio-economic conditions (see Table 17 in the Appendices for the full range of topics discussed). Although wealth and income data was collected, these are sensitive subjects and so are not reported here in order to protect the communities involved.

We will use these data to set up appropriate participatory monitoring of key indicators and form the basis of community discussions on ways to improve management of marine resources by the communities themselves.

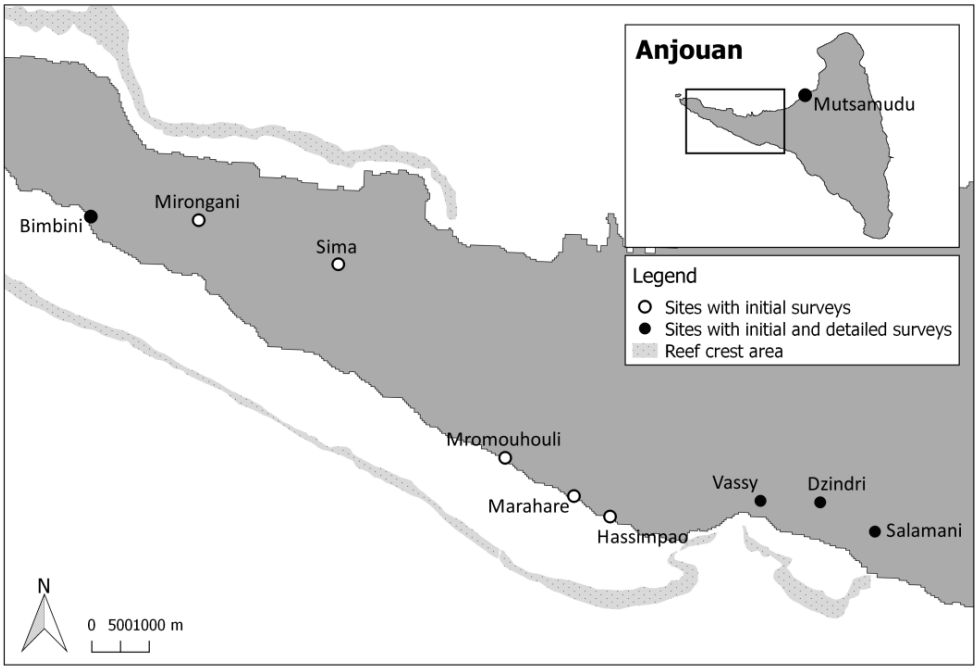

Figure 22. Map of villages where socio-economic information was collected. White circles indicate sites that received initial surveys, and sites with black circles received both initial and detailed socio-economic surveys.

4.3 Results

4.3.1 Sima peninsula

Infrastructure:

The villages of the peninsula were all connected to the national electricity supply, Electricité d'Anjouan (EDA), between 2009 to 2011, apart from Sima which has received power from EDA since the 1990s. According to interviewees, the hours without power still outnumber the hours with power and the villages sometimes have two days in a row without power. Mobile phone coverage is also variable; although there is coverage in all villages, in some it is minimal.

There has been access to mains water in all villages for several years, with water connections having been established by a project supported by the government or an NGO, or by the village itself. A new water line has been installed for the villages in the Sima commune by l'Union des Comités de l'Eau d'Anjouan (UCEA), but the inhabitants say that the fees for connecting their homes to the main line is expensive, so many are reluctant to use it.

The peninsula is divided into two communes for administrative purposes. The mayors of the two communes are located in the town of Sima (serving five villages) and Vouani (serving six villages). Of the two towns, only Sima has a police headquarters, but the villages of the Vouani commune also make use of the police headquarters at Pomoni if needed.

There is at least one public primary school in each village, while the public middle schools are located in Bimbini, Sima and Vassy.

Fishing:

The Sima peninsula (2017 estimated population of 29,905, Commissariat General 2003) is home to many fishers. Based on the population size and number of fishers for each village, we estimate there is at least one fisher per household, including both professional and occasional fishers (i.e. fishers who practise only during low tides, or in seasons when fish are abundant).

Throughout this zone, artisanal fishing is conducted from small vessels. Two main types of vessel are used: the *pirogue* (a non-motorised vessel constructed from wood with an outrigger and driven by paddles, Figure 23.a.) and the *vedette* (a fibreglass boat with an outboard motor, Figure 23.b.). Fishers using pirogues mainly fish using lines with some net use. However, vedettes are gradually replacing the pirogues, especially since the introduction of fish aggregating devices (FAD), as these vessels can travel further out to sea to take advantage of large pelagic species (principally tuna (*Thunnus sp.*) and skipjack tuna (*Katsuwonus pelamis*)) attracted by FADs, or to fish in open waters.

Reef gleaning (Figure 24) is mostly carried out by women; the target species include octopus and small fish. The former are caught using spears, sometimes breaking the substrate to access the octopus' hideout (both practices can damage the reef flat), while the latter are harvested using *uruva*. The destination of a fisher's catch varies: for male fishers, the majority of catches are destined for sale, with consumption a secondary use. In contrast, catches by female fishers are primarily for consumption, with sale a secondary destination.

Figure 23. The two main types of fishing vessel on the Sima peninsula: a) pirogue, b) vedette.

Figure 24. Reef gleaning on Sima peninsula.

Figure 25. ***Bottom left*** **octopus harvest;** ***bottom right*** **juvenile fish harvest.**

4.3.2 Bimbini

History:

Bimibini's population has diverse origins from across the island. The founding family came from Ankibani; they worked for King Houmedi who lived at Milémbéni (east of Bimbini on the Sima peninsula) during the colonial period, and the wife asked the king for permission to live near the sea to be able to fish with her spouse. A second lineage is the Shirazi family, who settled in the region called Foumbani (on the northern side of the Sima peninsula) and later came to join the inhabitants of Dindrini (Bimbini). The third lineage originated from Grande Comore and settled in the zone called Ntsajou during the war of Sultan Moussa Foumo (the Sultanic period was 1800–1900), later joining the inhabitants of Bimbini. These three groups came together to form the village of Bimbini.

Key events:

- 1950: a large cyclone affected most of the island and razed the village (including loss of homes, livestock, and crops)
- 1967: vote for opposing deputies Saïd Ali Mohamed from Bimbini and Saïd Ali Youssouf from Sima
- 1997: a fire was set in the village by inhabitants of Sima
- 1998: construction of a community school
- 2000: cholera epidemic
- 2009: village conflict, the cause of which was the seizure of a plot of land for construction of a football field
- 2010: arrival of power from EDA

Infrastructure and development:

- One public primary school
- One private preschool
- One community school (middle and high school) constructed by inhabitants of Bimbini in 1998 so that their children would not have to go to Sima, following the village fire set by inhabitants of Sima. This fire was set because the inhabitants of Bimbini were against the secession of Anjouan in 1997
- Four mosques
- An electricity network powered by EDA, although the lines had been installed in the village many years ago
- Two water lines, the most recent one provided by UCEA

The village has benefitted from several development projects, including:

- A mains water line provided by UCEA, though this has encountered a problem connecting homes because the connection fee is expensive and inhabitants are reluctant to pay
- Improved agriculture initiatives by NGO Dahari which are progressing well

Several projects have been carried out by inhabitants using their own funds and village contributions and aid from the diaspora, including:

- The construction of four mosques
- Construction of a community school in 1997 so that students could attend secondary school in the village
- Purchase of four generators and cable to provide power in the village
- Construction of a wash basin in the village centre to provide easy access to water for washing in the village as there is no nearby river (the water source for the basin comes from nearby hills)
- Improvement of roads

UMAMA (a marine resource management organisation) is the only NGO of its kind operating in the village. It has taken over activities initiated by OPAS (Offensif pour l'Action Sociale), a women's association that received funding for mangrove planting from UNDP in 2010. UMAMA organises beach cleaning events and the planting of young mangroves where they have been deforested.

The village leader resolves small conflicts in the village, for example thefts in agricultural plots and marital conflicts, but large problems such as conflicts over property boundaries are directed to the mayor or police station. Religious power also exists, as the *fundis* (religious educators within the village) are mediators, especially for marital conflicts.

Village decision making has become very difficult since the time inhabitants became active in politics. Before this time, elders, religious leaders, and dignitaries played an important role in village decision making.

Resources and fishing

The ocean provides the villagers with several resources including: products that provide revenue and food, such as fish and octopus; and items for construction, including sand, mangroves and corals, although the latter two are no longer used.

The number of pirogues is estimated to be around 25, while vedettes number around 50. Everyone has free access to Bimbini's fishing zone; it is only a matter of deciding to fish. According to several interviewees, the inhabitants understand that the sea belongs to no-one, so anyone with the means and strength to fish may do so and no-one needs permission, even non-inhabitants, which is why fishers from other villages can be found in Bimbini's zone.

Most fishers prioritise sale (rather than consumption) of their catch; sales are generally carried out at landings sites in the village, but are sometimes made on the water as well.

Resellers sell catch in their respective villages, including Nyoumakélé, Mirontsy, Mutsamudu and Pomoni. They prefer to buy catch in Bimbini because it is a source of good quality reef fish.

Fishing is the primary livelihood of many fishers, but there are some who also cultivate crops, especially during seasons of low catch.

Fishers' concerns for the local fishery include:

- Difficulty of entering and leaving the landing site for vedettes due to the expansive reef flat with few areas for safe passage
- Disappearance of fish
- Increase in the number of fishers
- Lack of means of preserving catch
- Overexploitation of resources

4.3.3 Vassy

History:

The population of Vassy originates from different areas in Anjouan, including Mutsamudu, Bandrani ya Maweni (north of Vassy on the opposite side of the ridge that separates the northern and southern sides of the peninsula), and Makilouki, a village in the hills northeast of Vassy that no longer exists. Waziri Mari, a merchant from Mutsamudu during the colonial period (known locally as *Mawana*), thought Vassy was an ideal place to rest before continuing his journey and he ended up settling there with his wife. He was followed by others from Bandrani ya Maweni as well as inhabitants of former Makilouki.

Key events:

- 1950: a large cyclone struck the peninsula and razed the village
- 1995–1996: construction of the water cistern and plumbing for the village by Fonds d'Appui de Développement Comorien (FADC)
- 2009: the construction of a small port began, which was to facilitate landing of fishing vessels, and for vedettes transporting crops and passengers between Anjouan and Moheli. The project was financed by the state but never finished; the villagers do not know why the project stalled
- 2010–2011: electricity was installed in the village by EDA
- 2012–2014: construction of a dyke to retain the river which flooded the village during the rainy seasons

Infrastructure and development:

The population of Vassy was 963 at the last population census in 2003. According to our household census in 2017 there are 874 inhabitants with a majority of young people under 30 years old (148 people originally from Vassy have left, with the majority now residing in Mayotte). The majority of the remaining population practises fishing and agriculture as their primary livelihoods; a smaller proportion is made up of business owners and state employees (Table 10).

Table 10. Main livelihoods of men and women in Vassy according to our 2017 household census. In the case of two activities, the first mentioned is the principal livelihood.

Livelihood	Men	Women
Fishing	48	4
Fishing and agriculture	1	2
Fishing and other	3	1
Agriculture	38	86
Agriculture and fishing	0	0
Agriculture and other	3	3
Fish reseller (and other)	4	0
Business owner (and other)	15	0
Cattle owner (and other)	1	0
State employee	6	1
Masonry (and other)	15	0
Cleaning	0	86
Other	27	19
Unknown	18	2

The village infrastructure consists of:

- Two mosques, of which the largest (the Friday Mosque) has undergone renovations from the time of Saïd Mohamed Cheikh's presidency (1962–1970) until the present day. This mosque was found by early inhabitants but they did not know who constructed it, although some say it was constructed by Shirazi (an ethnic group believed to originate from the southwest Persian coast and possibly

southern Arabian peninsula), while the second mosque was constructed at the time of Saïd Mohamed Djohar's presidency (1990–1995)
- One public primary school
- One secondary school built at the time of Ali Soilihi (1976–1978)
- An electricity network installed by EDA in 2010
- One health clinic constructed by President Ali Soilihi, though it did not function until the time of President A. A. Abdérémane (1978–1989)
- One madrasa (a religious school or college) under construction since 2013
- A plumbing network for water access which has existed for a long time and was renovated by FADC

There were no development or marine resource management projects underway in the village while this study was carried out, though representatives from certain institutions such as the fisheries ministry and fisheries syndicate occasionally come to Vassy to gather information or give advice. The organisation best known in the village is the commune fishery syndicate from which the members receive information, either from the fishing school (Ecole de Pêche established with aid from Japan) or other institutions. The syndicate assisted the fishers of the commune to install FADs in order to increase catch. There is also a committee made up of three villages (Vassy, Salamani, and Dzindri) that was created to assure surveillance of net use as this practice is forbidden in Vassy's fishing zone.

The Vassy community has achieved the following infrastructure improvements, through contributions from within the village and from diaspora:

- The renovation of the existing mosque and construction of the new one
- The purchase of pipes to carry water to the village
- Construction of an arena for cultural events (1997)
- Cementing of the main road (2006–2008)
- Construction of a madrasa which began in 2011 but is not yet finished for financial reasons

Political power in the village resides with the village leader who arbitrates small conflicts between inhabitants. There is no true familial power structure in the village, and larger problems are therefore taken to the mayor or directly to the police stations in Sima or Pomoni.

Village decisions are made by first consulting the most trusted village leaders and dignitaries, and then voting to decide by majority rule.

Resources and fishing:

The inhabitants harvest and use many marine resources in their daily lives, including fish, molluscs, and octopus for consumption, as well as sand and coral for construction.

The primary stakeholders in sand extraction are the inhabitants of Vassy, primarily the women. If someone needs sand, the entire family, including children, work to extract it during the night. Wealthier families often pay someone to do it for them, so it is the poorest in the village who most often extract sand. Sand extraction has been banned since August 2017 in the district of Vouani and sand extractors now have to register at the local authorities to get a permit (2,500 KMF for 2–3 truck loads). This regulation is not well received by the local communities who still regularly extract sand as enforcement is very low or absent. Coral extraction stopped in the 1980s mainly due to a switch to cement use, however it is still commonly used to make cosmetic facial masks (*mawe ya msindzano*).

The vedettes outnumber the pirogues in the village. The means of obtaining a vedette depend on the means of the fisher: some are able to purchase one with their own funds, while others take out a loan from Sanduk or Meck (mutual savings designed as micro-credit) or a private party. Pirogues are not sold but are built by the fisher or are commissioned.

As with all fishing zones in the Comoros, the fishing zone of Vassy is open access. The only restrictions relate to net use and fishing near the FADs located in or near Vassy's fishing zone. The fishing syndicate of the commune of Vouani installed a FAD offshore from Vassy's fishing zone with the help of the Ecole de Pêche. Each fisher owning a vedette contributed 50 EUR (53 USD) for the FAD, which cost 2,000 EUR (2,114 USD) in total. Each fisher that contributed to the purchase of the FAD has the right to fish in the zone where it is installed. If a fisher who did not contribute is caught fishing in the zone, he will pay a fine of 50–150 EUR (53–159 USD). Since the installation, seven people have been fined, but only a few have actually paid it because they recognised their mistake and asked to be excused. Fishers that want to become a member and fish in the FAD zone pay 50 EUR (53 USD) if they have just bought a vedette, but if they owned a vedette at the time of the FAD installation they must now pay 80 EUR (85 USD).

Vassy's own FAD was installed at a depth of 300 m in Vassy's near shore zone so that the pirogues could also fish there. The contribution was set at 10 EUR (11 USD) per vessel for a total of 1,500 EUR (1,586 USD). To manage use of the FAD, each contributing fisher also monitors the zone. According to the fishers, they did not purchase a ready-made FAD, but collected used buoys and line to make their own FAD. They refurbished it twice but it became detached and the buoys were lost. They are currently searching for materials and when they have collected them, they will all make the necessary contributions to build another FAD. The village's FAD lasts up to two years (it stopped functioning in 2016), while the commune's FAD can last up to four years (it stopped functioning in June 2017).

A three-village committee (for Vassy, Salamani, and Dzindri) was created to assure surveillance on net use in Vassy's zone. Nets are forbidden in the zone, except in special circumstances (see below). Surveillance is carried out by members of the three villages; Salamani and Dzindri are located on higher ground which facilitates surveillance. If someone in Salamani or Dzindri sees a net fisher, they quickly call a community member in Vassy where there is quick access to the fishing zone. Vassy community members can quickly pursue the rule breaker who must sign an agreement to not return to Vassy's fishing zone and pay 20 EUR (22 USD) for each vedette instead of the fine set in the formal rules. The fines collected are shared between the three villages in the committee. Since the creation of the committee seven net fishers have been caught in Vassy waters and all of them have paid a fine. A fishers association was also created for Vassy but it is inactive.

Net fishing is only permitted in the zone for three days during the month of Ramadan, organised as follows: the members of the committee contact net fishers from other villages, Sima in particular, and the committee is responsible for the vedettes used for fishing; the catch is divided into two between the net owner and the committee. The committee members divide their portion into three (one share for each village) after paying the expenses, and Vassy's share is saved for use for village projects.

The Vassy community – and particularly the members of the three-village committee – think that reef gleaning is a fishing practice that requires management because nearly all women participate, whether they are wealthy or poor. In particular, the committee wishes to implement management of the use of the poison *uruva* and destruction of the reef flat for octopus fishing during low tides. The committee also considers sand extraction to be an activity in need of management.

Male fishers prioritise sale of their catch, which is conducted at the landing site. Consumption is the primary use of female fishers catch, with sales taking place if they have a large catch, and this is carried out at the beach or from home.

Some resellers from the village and other villages buy catch to sell in their respective villages. Resellers come from Nyoumakélé (southern Anjouan), Pomoni, Dzindri, Iméré, and Vouani. They choose to buy catch at Vassy because the fish are plentiful and favourably priced.

Fishing is the principal activity for professional fishers, but agriculture and livestock raising are important secondary activities, especially during periods of poor catch. Sale of dried whole cloves for export is also a source of revenue for everyone in the village: cloves are a primary crop for landholders, and those who don't hold land with cloves can still earn revenue from harvest and trade activities.

Fishers cite several concerns for the local fishery, including:

- The season of strong winds during which the sea becomes rough
- Ineffective fishing materials and vessels (vedettes, pirogues)
- Lack of safety measures at sea
- Dependence on other fishers

4.3.4 Dzindri

History

Villagers from Dzindri originate from a place called Makilouki (located higher up on the hill above Dzindri). Later, part of the population installed itself on a lower part of the hill called Bandra Oupepe (now a neighbourhood of Dzindri). They remained there for years until deaths became frequent (unknown cause) so the population moved higher on the hill again (now the village centre), while others went to settle in Vassy. The village is now expanding on the lower hill sides, with the neighbourhood abandoned because of the deaths now re-inhabited.

Key events:

- 1950: a large cyclone affected the whole island
- 1997: an Italian NGO (AIFO) built the primary school
- 1999: FADC built stairs to facilitate access to the village (Dzindri village expands in length on a steep hill)
- 2006: installation of phone cabins by the government
- 2010: government installed electricity through EDA

The memory of CADER (Federal Centre for Agricultural Development) projects after independence stays very vivid as well. People would receive food items in exchange for practising agriculture.

Infrastructure and development

According to the 2003 population census, Dzindri population was 2,500 inhabitants with a majority of young people. There are currently 1,891 inhabitants following our 2017 household census. Population appears to be decreasing with a significant proportion of people moving to Mayotte, mainly for economic reasons (Mayotte is a French department and offers better livelihood opportunities). The Dzindri community has a

strong interest in the field of education, including professional training, in contrast with other neighbouring villages.

The village contains the following infrastructure:

- A primary school built in 1997
- An unreliable telephone network installed in 2006. A second network company has been available since 2017 (TELMA)
- Electricity network installed in 2011 by EDA
- Stairs throughout the whole village to facilitate access
- Six mosques including the Friday Mosque
- Water catchment in 1998 by FADC

Engaging the community in development projects is difficult, slowing down the accomplishment of projects such as the mosque (four in cement and two in metal sheets) and concrete road building.

Political power in the village resides with the village leader who arbitrates small conflicts between inhabitants. There is no true familial power structure in the village, and larger problems are therefore taken to the mayor, or directly to the police stations in Sima or Pomoni. Religious power is respected and represented by the *fundis*, but is questioned by young people. The village has not had any conflicts with other villages.

There are several cultural associations in the village, including three male and four female associations organising events for the community and providing financial support in wedding organisation or funerals. There is a mixed gender association for Dzindri intellectual students aiming at improving education and developing the village, planning to build a library and providing free educational support.

Resources and fishing

Agriculture, artisanal fishing, small business and masonry are the main livelihoods. Sea products are fish, octopus, shrimps, shells and oysters for consumption, sand for construction, corals previously for construction but now for cosmetic facial masks only.

On the reef flat at low tide, women target juvenile fish with the ichthyotoxic plant *uruva*, octopus with a metal stick (*ntsontso*) and collect shells and oysters by hand. This activity is primarily for consumption with some sales if there is a surplus.

Boat fishermen use pirogues (wooden boats) and/or vedettes (motorised boats). In Dzindri, the number of pirogues is higher than the number of vedettes (24 and eight respectively). Fishing with pirogues is conducted close to the coast as far as 2 km from Dzindri's main landing site (located downhill of Dzindri village, Figure 6). Vedette fishers, however, go as far as Moheli and Grande Comore. It is exclusively carried out by men and oriented towards selling to buyers from the village and beyond (Mutsamudu, Pomoni and Nioumakele area on the southwest coast of Anjouan).

Dzindri belongs to the three-village committee with Vassy and Salamani.

Table 11. Main livelihoods of men and women in Dzindri according to our 2017–2018 household census. Where two activities are listed together, the first is the principal livelihood.

Livelihood	Men	Women
Fishing	44	26
Fishing and agriculture	5	72
Fishing and other	4	0
Agriculture	35	60
Agriculture and fishing	11	76
Agriculture and other	12	2
Fish reseller (and other)	5	0
Business owner (and other)	26	1
Cattle owner (and other)	25	0
State employee	27	5
Masonry (and other)	23	0
Cleaning	0	119
Other	76	17
Unknown	39	8

Income from fishing is not sufficient for daily needs, so fishermen engage in other occupations such as agriculture. This activity is practised by the majority of the population and sometimes contributes to the household income; however, it is primarily aimed at providing goods for personal consumption. Additionally, the clove harvest is an important activity from August to December during the flowering season and generates high financial benefits.

Dzindri's fishers have identified several issues and constraints for local fisheries and marine conservation:

- Lack of local organisation – there is no village management structure to implement regulations and manage marine resources (other than the existing net ban)
- Decrease in fish stocks
- Overexploitation and increase in fisher numbers
- Destructive fishing methods such as use of *uruva*, harpoon and metal sticks

4.3.5 Salamani

History

Salamani's population originates from Dzindri. The first settler, Check Mari, was fleeing from the colonial taxes and settled with his family in the Gnambo neighbourhood of Salamani. Mwe Boina Ali, the first person born in the village, was around 90 years old at the time of our survey.

Key events:

- 1950: a large cyclone devastated the whole village
- 1996/7: construction of the water cistern and plumbing for the village by FADC
- 2006: villagers started tracing a road for village access, supported by the government in 2012 with a machine. The government also supported the road retracing in 2016
- 2009: construction of the primary school initiated by the Sambi fondation and FADC and construction of latrines by FADC

Infrastructure and development

Salamani population was estimated at 306 (2003 government census) with a majority of young women. The household census conducted in 2017 indicates 79 households (total 405 inhabitants) in 2017.

The village contains the following infrastructure:

- Two mosques
- One primary school with three rooms
- One plumbing network
- One electricity network from EDA
- One public square

There is strong cohesion among the villagers who organise themselves to develop village infrastructure (through contributions and manpower): they built two mosques, a new water catchment structure and started cementing the road to the village. They also contributed to the building of the primary school and road tracing.

There is a village leader to manage small conflicts and to represent the community. The decision-making in the village takes place through a committee representing the different age groups. Two women's associations offer financial support to organise social events and one men's association works towards village development.

Resources and fishing

The principal livelihoods are agriculture, cattle/poultry farming and artisanal fishing practised by all villagers. Women participate more than men in the fishery (there were just six male fishers recorded in our household census) (Table 12).

The main sea resources harvested by villagers are: fish, octopus, shrimps, shells, sand, rocks and corals. Women are the main stakeholders involved in sand extraction.

Table 12. Main livelihoods of men and women in Salamani according to our 2017 household census. Where two activities are mentioned, the first is the principal livelihood.

Livelihood	Men	Women
Fishing	4	14
Fishing and agriculture	1	3
Agriculture	12	23
Agriculture and fishing	1	1
Agriculture and other	5	7
Business owner (and other)	3	0
Cattle owner (and other)	3	4
State employee	8	1
Masonry (and other)	15	0
Cleaning	0	18
Other	11	7
Unknown	5	0

The most common fishing methods for fish are line fishing, harpoon and the poisonous plant *uruva*; for octopus, women use a metal stick at low tide and divers use a harpoon. Except for the three-village committee (of which Vassy and Dzindri are also members, as detailed in Dzindri section above), there is no fisheries management organisation.

Most women are involved in reef flat fishing at low tide, for juvenile fish or octopus, either on an occasional or regular basis. Their catches are primarily destined for private consumption with some octopus sold if enough is caught.

There are six fishermen and five pirogues, no vedettes. Fishing is conducted close to the coast as far as 2 km from Dzindri's main landing site (located downhill of Dzindri village, Figure 6). Catch is primarily destined for direct sale, with private consumption secondary. Fishers sell at the landing site to consumers directly. Fishers from other villages (using vedettes, pirogues, gleaning) are numerous here as there are no regulations limiting access in the zone.

Fishermen do engage in other activities such as agriculture and cattle/poultry farming as fishing alone does not provide enough to live on. Clove harvest during the flowering season is the main activity for all villagers.

Fishers identified the main constraints for fisheries in Salamani as:

- Decrease in fish stocks
- Lack of safety measures at sea for pirogue fishermen
- Long distances separating the village from the sea
- High number of outside fishers increasing overexploitation
- Lack of technical knowledge on effective/sustainable fishing methods

4.4 Discussion and recommendations

Small-scale fisheries are exploited by a range of different users, including professional and occasional fishers, men, women, and children, local and 'foreign' fishers (fishers from communities outside those that 'own' a fishing zone). Women reef gleaners dominate in Dzindri and Salamani, while in Vassy professional vedette or pirogue fishers are in the majority. Any decision-making process and management initiative needs to consider the impact of all groups exploiting an area, and ideally consult all groups throughout the process. The fishers use different methods (e.g. nets, line, poison) and target different types of catch (e.g. juvenile reef fish, mature reef fish, mature pelagic fish and octopus). They also may have multiple objectives for fishing, including to generate income, or provide food security. The various methods, catch targets, and objectives also need to be accounted for during decision making.

Despite the large variation we observed across the local fisheries, there are some generalities. The pelagic fisheries are relatively homogenous in terms of catch methods and target species. Entry into the pelagic fishery often requires investment (for a vedette with a motor, and in some areas contribution to FAD cooperatives). Almost all professional fishermen using a vedette and line practise fishing as their main source of income. In contrast, the reef fisheries are much more variable, especially in areas where the reef is easily accessed from the coast, facilitating reef gleaning (for fishers who do not have a vessel) and occasional fishing which is conducted principally for food security. Reef fisheries are also exploited by professional fishers using a variety of techniques (e.g. nets, line, *uruva*).

Local laws and state actors – including village leaders, mayors, commune-level authorities and police – should be taken into consideration when planning management actions to ensure formal recognition of management measures. If communities wish to establish resource use rules, they should be formalised through the proper channels to secure local decisions and enable enforcement. Other sources of leadership and influence should be recognised within the communities, including *fundis* representing religious power and other decision makers who can greatly affect community functioning and perceptions. At the very least, these leaders should be informed of the decision-making process used to initiate local management activities.

The results of the socio-economic assessments have helped identify the next steps towards local marine management in these villages. In Bimbini, much groundwork is still required to reconcile community divisions and conflicts which would create the necessary environment for developing cooperative practices for decision-making and management initiatives. The Bimbini community will also need support in improving relations with state agencies including the mayor and regional police. Special consideration should be taken for the large numbers of fishers using nets on the reef, who are likely to need alternatives in order for the fishery to be effectively managed.

Among the three villages of Vassy, Dzindri and Salamani, the latter presents greater social cohesion whereas cooperation is lower in Dzindri and Vassy. However, structures such as cultural associations have been developed to achieve community objectives in these two villages, including fisheries management in the form of net use prohibition through the three-village committee. With some support and reinforcement, these community practices and structures could be harnessed for further decision-making and management initiatives. The next steps will include supporting the reef gleaners (women) to self-organise and develop reef flat management measures, with the aim to integrate the two types of fisheries (male-dominated vedette and pirogue fishery, and women-dominated gleaning fishery) in a collaborative management of marine resources.

As management initiatives are implemented, there are several factors that should be monitored. Firstly, assessment of revenue and food security from fisheries can provide information on progress towards the achievement of community management goals, but will need to take into consideration certain co-factors such as the total number of fishers (occasional and professional), the number of fishers included in cooperative efforts, the quality of cooperation, coverage of fishing practices by cooperative efforts, and non-local fisher use of fishing sites. If any rules are put in place, it is important to assess effectiveness through the evaluation of cooperation in terms of surveillance and enforcement, number of infractions, and the results of sanctions.

5. Catch monitoring

5.1 Objective

We initiated community-based catch monitoring to better understand the current state of the fishery, including the number of fishers, fishing methods and effort, species targeted and their size and weight, and variation in these factors over a period of 12 months. These data will also provide a baseline to facilitate evaluation of changes in the fishery following management activities.

5.2 Method

The fishery surveys took place in two stages. First, data were sampled from boat-based fishers from June 2015 until May 2016 in Bimbini and from April 2016 to March 2017 in Vassy (the main landing site for Vassy and Dzindri). The entirety of these data have been analysed and are presented in this report (see section 5.3 below). Secondly, surveys began at Dzindri in March 2017 and Vassy in June 2017 to sample data from fishers practising reef gleaning. Preliminary results from March to September 2017 and full methodology are presented in the Appendix D. All surveys were conducted by community members who had been trained as survey technicians.

Survey protocols to sample boat fishers' catch were designed to collect data on fishing effort and catch composition through a calendar year, but not to estimate total catch. All landing sites for each village sampled were included in the survey, using sufficient technicians to cover the sites and all catch landed on a survey day. Survey technicians for Bimbini and Vassy collect data two days each week, recording approximately 25–30% of total catch. They record the number of fishers, the type of vessel or means of travel (pirogue, vedette, or diving), fishing method and time spent fishing. For catch landings, technicians

record species by local name (96 in Bimbini and 117 in Vassy, plus octopus), the weight of each species, and sample a few individuals from each species to record lengths. These data allow us to calculate the total weight of sampled catch, weight and average size for each species, and catch per unit effort (CPUE).

Figure 26. Catch surveys in a) Bimbini, b) Vassy.

5.3 Results

The fisheries of Vassy and Bimbini differ in many respects. Bimbini fishers frequent more fishing sites than those from Vassy (Table 13) and the majority of Bimbini fishers use nets as their main fishing gear, while lines are the gear most commonly used by Vassy fishers. Harpoon guns are used by a few Bimbini fishers but no Vassy fishers, while cages are used by one fisher at Vassy but not used at all in Bimbini.

Bimbini line fishers bring in about 50% more catch per trip than Vassy fishers on average, and CPUE for line fishers at Bimbini is higher than for those at Vassy (Table 14). Net use was recorded only four times in Vassy, but the average catch per trip and per fisher hour were more than three times higher than captures from nets in Bimbini. Despite these differences, a similar number of species are recorded in catches at both sites and the top three species caught at each site are the same, although not in the same rank order (Table 15). At Bimbini, fishers reported that three fish species are no longer easy to find. For these three species the total weights captured during the survey period are as follows:

- Ndziache/emperor red snapper (*Lutjanus sebae*): 98 kg
- Mole/jobfish *(Aphareus rutilan*s): 20 kg
- Mdungi/snapper (*Lutjanus* spp.): 4 kg

Table 13. Catch monitoring statistics for Bimbini and Vassy

Category	Bimbini	Vassy
Fishing trips sampled	573	611
Fishers sampled	77	88
Fishers or teams using nets	51 teams (66%)	2 fishers (2%)
Fishers using hook and line	37 (48%)	80 (91%)
Fishers using harpoon	4 (5%)	11 (13%)
Fishers using traps	0 (0%)	2 (2%)
Fishing locations sampled	64	24
Fish species (identified by local name) sampled	96	117
Fishing trips per day	7 on average	1 to 16

Table 14. Fishing effort (CPUE) calculated from catch monitoring data for Bimbini and Vassy.

Average catch:	Bimbini	Vassy
per trip (all gear types) (kg)	33	24
per trip for nets (kg)	27	102
per trip for hook and line (kg)	36	23.5
per trip for harpoon (kg)	6	11
per trip for traps (kg)	NA	2.5
per fisher hour (all gear types) (kg)	2	1.5
per fisher hour for nets (kg)	1	3
per fisher hour for hook and line (kg)	2.5	2
per fisher hour for harpoon (kg)	1	2
per fisher hour for traps (kg)	NA	0.5

Table 15. The top five species by sampled weight and total catch sampled in Bimbini and Vassy

Rank	% of total catch	Bimbini		Rank	% of total catch	Vassy	
		Scientific name	Catch sampled (kg)			Scientific name	Catch sampled (kg)
1	49	*Katsuwonus pelamis* (skipjack tuna)	9333	3	6.2	*Katsuwonus pelamis* (skipjack tuna)	910
2	7.7	*Thunnus* sp. (tuna)	1465	1	69	*Thunnus* sp. (tuna)	10032
3	6.7	*Decapterus* sp. (mackerel/scad)	1267	2	7.3	*Decapterus* sp. (mackerel/scad)	1066
4	5.1	*Myripristis* sp. (soldierfish)	972	4	2	*Myripristis* sp. (soldierfish)	290
5	3.1	*Calotomus carolinus* and similar species (parrotfish)	591	5	1.31	*Sphyraena forsteri* (barracuda)	192
TOTAL			18841	TOTAL			14614

5.5 Discussion and recommendations

The data from catch monitoring provides insight into both fisheries practices (including fishing techniques, locations and effort) and catch composition (including species composition, size classes and capture weights), all of which is meaningful for management decision making. Results from Bimbini and Vassy reveal that each location has its own specific challenges to fisheries management.

In Bimbini, the fishery is large (many fishers) and widespread (many fishing locations). The techniques include methods that can damage reef habitat, such as net setting. The size of Bimbini's fishery, and the techniques used, put relatively large pressure on the coral reef ecosystem and its fish populations. The challenges for management include facilitating decision making among a large group of fishers, and addressing destructive fishing techniques upon which many fishers depend for their livelihood and/or food security.

In Vassy, the fishery is small (few fishers), mainly local (primarily using fishing locations within or near Vassy's fishing zone), and probably places relatively low pressure on coral reef habitats and fish populations (i.e. the use of destructive techniques is uncommon and most effort is on pelagic species). However, CPUE is lower than in Bimbini (1.5 vs. 2 kg/fisher hour), indicating that there are other pressures on the coral reef ecosystem and its fish populations. Catch monitoring of reef gleaning has begun and may reveal a source of

pressure on coral reef habitat and its fish populations. Other potential sources of pressure include habitat degradation from sand extraction, or the net use that occurs 3–6 days/year during the temporary opening of net fishing at Ramadan and which is yet to be well studied.

The challenges for management in Vassy include identifying sources of pressure on reef habitat and fish populations as well as finding strategies to augment livelihood and food security without increasing pressure on overexploited populations. Ongoing catch monitoring will provide information on the effectiveness of chosen management strategies and help the community to identify ways to adapt and improve them.

6. Conclusion

Since 2015, Blue Ventures and Dahari have completed a rapid assessment of coastal habitats for the Sima peninsula on Anjouan, as well as in-depth coral reef assessment for five sites. Five community members were trained as technicians to monitor fisheries landings. These technicians have recorded data from 1,184 fishing trips and 33,455 kg of landings, including the species caught, fish size and weight, and the fishing method used. By adopting this collaborative approach to data collection with local communities, we aim to ensure strong buy-in to this research and the co-discovery of appropriate solutions.

To complement this approach, the results from the initial studies were presented to communities to further engage them in the catch monitoring process and stimulate discussion. From 2015 to 2017, community members reported the results of the fisheries data collection to more than 250 people through seven meetings in two villages. The baseline information gathered to date will be used to facilitate collaborative reflection on, and analysis of, the status of the communities' marine areas, including existing problems and potential solutions. These discussions will inform the next phase of participatory assessments and monitoring of reef gleaning catch, which will then feed into the development of community-led management initiatives.

As progress is made towards local marine management, assessments of ecological, socioeconomic, and fisheries factors will continue to take place to facilitate evaluation of management effectiveness and the adaptation of strategies to achieve desired ecological, socioeconomic and fisheries outcomes.

7. Acknowledgements

We are grateful to CEPF, the Tusk Trust and WWF who have been essential partners in this project, and we look forward to continuing our work with them as we take this exciting project forward.

We thank all Dahari staff and community members of the Sima peninsula for their assistance in this research. We especially thank community catch monitors S. Ahmadi, Y. Mohamed, N. Bacar, and B. Moustadiran.

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9. Appendix A. Ecological assessment methodologies

Objective

The purpose of the rapid ecological assessment is to identify presence and general status (healthy, poor) of ecosystems across a large area, such as the Sima peninsula. This broad-scale information will be used to identify key sites for monitoring of various ecosystems.

A.1 Coastal ecosystem mapping

This assessment provides the most generalized ecological information in an area of interest – it identifies which ecosystems (mangroves, coral reefs, seagrass) are present and where they are located.

Equipment list

- Map with villages, as many coastal landmarks as possible, and room for writing
- GPS
- Speedboat
- Pen/pencil
- Camera
- Computer for data entry

Method

Start with Google Earth – create polygons of visible habitats (mangrove, coral reef, seagrass).

Ground truth with a visit along the coast. Mark landmarks and mangroves on the map and take GPS coordinates.

Tour the area in a vedette, staying close enough to the coast to identify landmarks. Make sure to cover multiple depths – this can be done by travelling in a U-shape pattern. Where coral or seagrass is spotted underwater, mark their general location on the map and take GPS points while the boat is directly above the the reef or seagrass bed.

While identifying and recording the ecosystems, take photographs of the coast visible from each ecosystem to assist others in relocating them.

Rapid Reef Assessments (below) can be done during this tour or at a later date.

Data should be entered into Google Earth. GPS coordinates or approximate locations can be used to mark pinpoints in the 'Coastal Ecosystem' file. Polygons may be created from estimated ecosystem area or more precisely if GPS coordinates were taken along ecosystem edges.

Photographs should be saved in a separate file and titles should include the name of the ecosystem and location where it was taken.

A.2 Coastline assessment

This assessment provides the most generalized information about anthropogenic influences on the coast. It also provides basic geographic and abiotic information. If interview data are already available or if time allows for further interviews, it is best to include interview information along with the observations.

Equipment list

- GPS
- Map of coast (optional)
- Notebook or printed data sheet
- Pencils/Pens
- Camera
- Computer for data entry

Method

Visit the coast on foot. Take at least one GPS point to record your location. Record observations on (scoring in parentheses):

- Presence of trash (none, little, much-including washed up from sea)
- Presence of rivers (no, yes – record number observed),
- Evidence of erosion (none, beach erosion, land erosion),
- Evidence of sedimentation in the water (no, yes),
- Evidence of removal of coastal sand, rock or other material (none, sand removal, rock removal),
- Evidence of chemical or nutrient pollution – for example, oil slicks or fuel on water surface, presence of floating algae (no, yes – name evidence observed),
- Coastline orientation – this can be from a map or Google Earth (record in degree equivalents for North (0), Northeast (45), East (90), Southeast (135), South (180), Southwest (225), West (270), Northwest (315))
- Coastline shape – this can be from a map or Google Earth (straight, concave, convex)
- If at a beach, note the length and width of the beach (can be estimated in m or take GPS points at each corner) and tide level (high, low, or mid-tide),
- Beach composition (sand, rocks, silt, etc.),
- Wave exposure (low, medium, high)
- Wind exposure (low, medium, high)
- Visible coastal habitats (mangrove, coral reef, seagrass).

Take photographs of the coast as you observe to allow comparisons at later dates. Include familiar landmarks such as boulders or trees and capture both seaward and inland views.

For interviews, ask about the history of the coast, whether any changes in the ecosystems have been observed, how frequent and intense storms are, and what activities take place (net fishing, line fishing, harpoon fishing, poison fishing, small-mesh net fishing, octopus fishing, beach sand extraction, etc.).

Enter all of the data in the 'Site Descriptions' excel file. Save photographs on the computer in a file titled with the site name and date of visit.

A.3 Rapid reef assessment

This assessment provides an overview of the condition and threats to a particular reef. It is not a sampling method appropriate for statistical analysis, but is designed to help identify key locations and activities for management. The reef assessment assumes the Coastline Assessment was already conducted. If it was not, include observations following the procedures above.

Equipment list

- GPS (with time function or also bring underwater watch)
- Masks and snorkels
- Dive slates and waterproof data sheets
- Camera with waterproof housing
- Computer for data entry

Method

Two to three observers will snorkel along the reef for this assessment. Distance to cover should be at least 300 m parallel to the coast along at least two transects, one on the reef flat and one on the reef slope. Observations will be made and recorded for five categories (abiotic conditions, benthos, fish, invertebrates, and threats). Record the information on the dive slate or the relevant data sheet. Save the location of fish and coral transects by taking GPS points at the beginning and end of each transect. Photograph the benthos at several locations to provide reference for future visits. Photograph any unknown benthic cover or fish. One observer will film the area by swimming slowly with camera for three minutes of recording after data collection. Save photographs and films on the computer in a file titled with the site name and date of visit.

Abiotic conditions to survey include:

- Weather (sun, cloud cover, wind, rain)
- Reef length & width (m),
- If river mouth is present along coast, approximate distance from reef (m)
- Depth of observations (m – should be at two depths) and tide (high, low, mid),
- Horizontal visibility – One observer remains stationary and holds the end of a measuring tape and a white dive slate about 1 m below the water surface and perpendicular to the bottom. The second observer holds the handle on the measuring tape and swims away from the first observer, watching the dive slate. When the slate is no longer visible, the observer records the distance (m) from the measuring tape.
- Record these data under a dated visit in the 'Site Descriptions' excel file.

Fish:

- The fish observer makes observations during a timed swim of 20 minutes, covering as much of the study area as possible by traveling in an S-shaped pattern parallel to the coast.
- List each species observed during the swim. Depending on experience, this can be Comorian names of species, scientific names from a list of 27 species (Table 15), or scientific names of all species observed. Record separate lists for each site on a dive slate or 'Poisson' data sheet.
- Count groups and fish size observed. The categories include: large groups (>30 individuals of similar species) of mostly large individuals (>30 cm), large groups of medium individuals (>10–30 cm), large groups of small individuals (10 cm or less), medium groups (>10–30 individuals) of mostly large individuals, medium groups of medium individuals, medium groups of small individuals, small groups (5–10 individuals) of mostly large individuals, small groups of medium individuals, and small groups of small individuals.

- Record species lists and the numbers of groups and sizes in the 'Rapid Reef Assessment' excel file.
- Report fish richness (the total number of species observed), and the predominant group and individual sizes observed at each site.

Threats:

- Fish observer counts and records observations of trash and discarded fishing gear.
- Record the counts in the 'Rapid Reef Assessment' excel file.
- Report the total counts for each site.

Benthos:

- Along the length and width of the survey area, note habitats present (coral, algae, seagrass, sand, rubble, hard substrate) and proportion of each (0–10%, >10–33%, >33–50%, >50–66%, >66–100%)
- Record major features in survey area and which habitat they occur in (channels, sand beds, car-sized corals, sinkholes, overhangs, slope, etc.). For slopes, estimate the degree.
- Record the depths where corals are present – if all at one depth, record the depth; if multiple bands occur at different depths, record each depth; if coral cover is continuous to a certain depth record the depth where cover stops.
- For areas inaccessible by snorkel, note whether corals are present, what makes them inaccessible (depth, overhang, etc.), and quality of coral habitat if possible.
- Coral quality: for patches smaller than 500 m^2, note the dominant cover (can note up to two co-dominant) from the following categories: live hard coral (LHC), bleached coral (BL), dead coral (CX), soft coral (CMOU), macroalgae (MA), crustose coralline algae (CCA), turf algae (AA), debris (DEB). For reefs >500 m^2, swim two transects, one each along the longest part of the reef at two depths. Record the depth and length of each transect and take GPS points at each end. Every six kicks, pause and observe the benthos. Record the dominant cover directly below the observer from the same categories as above. If two types of cover are equally dominant at one observation point, record both types.
- Record data in a benthos spreadsheet in the 'Rapid Reef Assessment' excel file. For the transects of reef cover, tally the number of observations of each benthic category for each transect.
- Report dominant benthic cover, the size of reef patches and numbers of each, and the dominant quality of coral habitat for each site.

Invertebrates:

- The benthos observer observes invertebrates during the benthos transects.
- Count numbers of each of the following invertebrates observed: giant clams, crown of thorns starfish, lobster, sea cucumber.
- For sea urchins, count number of urchin patches observed. For three patches, record the area (m^2) and number of urchins in a 30 cm x 30 cm square.
- Record the invertebrate counts, sea urchin patch counts, areas, and urchin densities in the 'Rapid Reef Assessment' excel file.
- Report total abundance of each invertebrate, the number and average area of sea urchin patches, and average urchin density observed at each site.

Sample survey slate for rapid reef assessment

BENTHOS Site: Coordonnées: Date :
météo: soleil du vent nuages pluvieux longueur du récif: largeur : rivière:

visibilité: _____ marée: haut baisse moyen

Corail 0–10% >10–33% >33–50% >50–66% >66–100% **Algue** 0–10% >10–33% >33–50% >50–66% >66–100% **Herbiers** 0–10% >10–33% >33–50% >50–66% >66–100% **Sable** 0–10% >10–33% >33–50% >50–66% >66–100% **Debris** 0–10% >10–33% >33–50% >50–66% >66–100% **Subs. dur** 0–10% >10–33% >33–50% >50–66% >66–100%

PROFONDEUR DES CORAUX:
_____

CARACTERISTIQUES chenaux lits sables gros coraux puits falaises pentes endroits inaccessibles

PARCELLES CORALLIENS :

taille__ LHC BL CX CMOU MA CCA AA DEB taille__ LHC BL CX CMOU MA CCA AA DEB

taille__ LHC BL CX CMOU MA CCA AA DEB taille__ LHC BL CX CMOU MA CCA AA DEB

taille __ LHC BL CX CMOU MA CCA AA DEB taille__ LHC BL CX CMOU MA CCA AA DEB

taille__ LHC BL CX CMOU MA CCA AA DEB taille__ LHC BL CX CMOU MA CCA AA DEB

profondeur T1: profondeur T2 :

1_____ xx_____ xx _____ 1_____xx_____ xx _____

2_____ xx_____ xx _____ 2_____ xx_____ xx _____

3_____ xx_____ xx _____ 3_____ xx_____ xx _____

4_____ xx_____ xx _____ 4_____ xx_____ xx _____

5_____ xx_____ 30 _____ 5_____ xx_____ xx _____

Acanthaster	Benitiers	Concombres	Langoustes	Lits Oursins

LITS OURSINS : SUPERFICIE 1_____ 2_____ 3_____ DENSITE 1_____ 2_____ 3_____

POISSON Site: coordonnées: date :

h. commenc. : h.fin : visibilité :

	Groupe	10–30	>30

_____

Long 5–10 cm			
>10–30 cm			
>30 cm			

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Déchets	Matériaux de pêche abandonnés

Table 16. List of fish taxa for identification in rapid reef assessment

Fished taxa	Fish-eating predators	*Lutjanus kasmira*
		Cephalopholis miniata
		Epinephelus merra
		Lethrinus harak
		Aethaloperca rogaa
		Cephalopholis argus
		Epinephelus fasciatus
		Subfamily Epinephelinae
	Carnivore (zooplankton, fish eggs, crustaceans)	*Acanthurus thompsoni*
		Family Lutjanidae
	Herbivore (filamentous/benthic algae)	*Acanthurus lineata*
		Acanthurus triostegus
		Subfamily Scaridae
	Herbivore (leafy brown algae)	*Naso lituratus*
		Naso unicornus
	Omnivore	*Acanthurus gahhm/A. nigricauda*
		Ctenochaetus striatus
		Ctenochaetus strigosus
		Rhinecanthus aculeatus
		Balistapus undulates
Non-fished species	Herbivore (Filamentous/benthic algae)	*Acanthurus leucosternon*
	Phytoplanktivore	*Chromis viridis*
	Exclusive corallivore	*Chaetodon trifasciatus*
	Exclusive corallivore Omnivore	*Chaetodon meyeri*
		Chaetodon trifascialis
		Chaetodon auriga
	Omnivore	*Chaetodon lunula*
		Dascyllus aruanus
		Abudefduf sexfasciatus
		Pomacentrus sulfureus

A.4 In-depth reef survey (2017 methodology)

This monitoring protocol provides data that can be used to evaluate change on a reef and is appropriate for statistical analysis. With adequate analysis and summary, it can also be used to provide information for management decision-making.

The reef monitoring methods assume the Coastline Assessment and Rapid Reef Assessments were already conducted. If they were not, include observations from those assessments.

Equipment list

- GPS (with time function or also bring underwater watch)
- Masks and snorkels
- Dive slates and waterproof data sheets
- Measuring tape
- Camera with waterproof housing
- Computer for data entry

Training and tests

To ensure accuracy and consistency of data collection, some training and testing is required.

Identification training: Observers should practice accuracy in identification of benthic cover and fish species through accompaniment of a trained observer and/or use of Blue Ventures training software. Observers must obtain 100% accuracy in identification prior to conducting data collection.

Biomass training: Fish observers should practice fish size estimation using six sets of PVC pipe (cut to different lengths, completing a normal distribution). A trainer holds the pipe 2–5 m from the observer, noting the length of each in order while the observer notes his/her length estimates. In order for observers to conduct data collection, a T-test on the data must find no significant difference between the estimated and actual lengths, and frequency of estimates falling within 5 cm of the actual pipe length must be ≥95%.

Tests for multiple observers – when data collection is conducted by different observers across sites, verification of accuracy and consistency among observers is required. All observers will conduct surveys at each site. The duplicate data collected will be compared for agreement. When observers have reached 95% or greater agreement in data collection for at least two sites, the observers may work independently at separate sites. Each year, 95% or greater agreement should be verified through testing at one. Full testing should resume whenever a new observer is recruited or when any observer has a lapse of more than one year in conducting data collection.

Methods

Two to three observers will snorkel along the reef for this assessment. Observations will be made and recorded for five categories (abiotic conditions, benthos, fish, invertebrates, and threats). Record the information on the dive slate or the relevant data sheet. Save the location of your transects by taking GPS points at the beginning and end of each transect. Photograph any unknown benthic cover or fish. Save photographs on the computer in a file titled with the site name and date of visit.

Abiotic conditions to observe include:

- Weather (sun, cloud cover, wind, rain)
- Reef length & width (m)
- If river mouth is present along coast, approximate distance from reef (m)
- Depth of observations (m – should be at two depths) and tide (high, low, mid)

- Horizontal visibility – One observer remains stationary and holds the end of a measuring tape and a white dive slate about 1 m below the water surface and perpendicular to the bottom. The second observer holds the handle on the measuring tape and swim away from the first observer, watching the dive slate. When the slate is no longer visible, the observer records the distance (m) from the measuring tape.
- Record this data under a dated visit entry in the 'Site Descriptions' excel file.

Fish:

- The fish observer will conduct at least three belt transects depending on size of reef. Record the depth for each transect.
- Belt transects are 5 m x 30 m.
- Move slowly along the transect, making observations within 2.5 m of each side of the transect (for 5 m total width).
- Record counts of fish by species and size category (10 cm increments) from a list of species (Table 17) on a dive slate or on the 'Poisson' data sheet. Counts are recorded separately for each transect.
- If time allows or if another observer with experience is available, travel along the transect making a list of all fish species observed. These observations are not limited to the belt, but can be observed at any distance.
- Record the number of counts per species and size category in the 'Reef Monitoring' excel file. If a species list was generated, record the list in the Reef Monitoring file under a species list spreadsheet with the site name and date at the top.
- During data analysis, calculate the average abundance/100 m^2, as well as abundance by fished and non-fished taxa. Use FishBase to convert size estimates to biomass estimates and calculate the average biomass/100 m^2, as well as biomass by fished and non-fished taxa. Calculate average fish size (kg/fish) for all fish and by fished and non-fished taxa. Report the total number of species/taxa observed.

Benthos:

- The benthos observer will conduct at least six 10 m point-intercept transects depending on size of reef, following the same transects as for the fish census. Transects will be conducted from the 0–10m mark, and 20–30m marks. Record the depth for each transect.
- Moving along the transect, pause and observe the benthos directly under the transect at 20 cm intervals. Record the dominant cover from the categories presented on Table 18.
- Record the raw data in a benthos spreadsheet in the Reef Monitoring excel file. Tally the number of observations of each benthic category for each transect.
- During data analysis, calculate percent cover of each benthic category for the site using the combined transect data.

Invertebrates:

- The invertebrate observer will conduct at least three belt transects depending on size of reef, along each fish transect.
- Belt transects are 2 m x 30 m.
- Move slowly along the transect, making observations within 1 m of each side of the transect (for 2 m total width).

- Record counts of the following invertebrates (giant clam, crown of thorns starfish, lobster, sea cucumber, sea urchin, sea stars) on a dive slate or on the 'Benthos' data sheet. Counts are recorded separately for each transect.
- Record the number of counts per invertebrate in the Reef Monitoring excel file.
- During data analysis, calculate the average abundance/100 m^2. Report the total number of species/taxa observed.

Threats:

- One observer counts and records observations of trash and discarded fishing gear.
- Record the counts under a dated visit entry in the 'Site Descriptions' excel file.
- Report the total counts per site.

Sample survey slate for In-depth reef survey 2016

BENTHOS Site: coordonnees: date :
météo: soleil du vent nuages pluvieux longueur du récif: largeur : rivière:
visibilité: marée: haut baisse moyen rugosité 1: 2: 3:

profondeur T1:		profondeur T2:	
0.20_____	5.20_____	0.20 _____	5.20 _____
0.40_____	5.40_____	0.40_____	5.40_____
0.60_____	5.60_____	0.60_____	5.60_____
0.80_____	5.80_____	0.80_____	5.80_____
1_____	6_____	1_____	6_____
1.20_____	6.20_____	1.20_____	6.20_____
1.40_____	6.40_____	1.40_____	6.40_____
1.60_____	6.60_____	1.60_____	6.60_____
1.80_____	6.80_____	1.80_____	6.80_____
2_____	7_____	2_____	7_____
2.20_____	7.20_____	2.20_____	7.20_____
2.40_____	7.40_____	2.40_____	7.40_____
2.60_____	7.60_____	2.60_____	7.60_____
2.80_____	7.80_____	2.80_____	7.80_____
3 _____	8_____	3_____	8_____
3.20_____	8.20_____	3.20_____	8.20_____
3.40_____	8.40_____	3.40_____	8.40_____
3.60_____	8.60_____	3.60_____	8.60_____
3.80_____	8.80_____	3.80_____	8.80_____
4_____	9_____	4_____	9_____
4.20_____	9.20_____	4.20_____	9.20_____
4.40_____	9.40_____	4.40_____	9.40_____
4.60_____	9.60_____	4.60_____	9.60_____
4.80_____	9.80_____	4.80_____	9.80_____
5_____	10_____	5_____	10_____

POISSON Site: coordonnees: date :

h.commenc. : h.fin : profondeur: profondeur: visibilité:

		5-10 cm	>10-30 cm	>30 cm
Predateurs	L. kasmira *Hazi*			
	Lutjanidae			
	C. miniata Mzusi nyoche			
	C. argus			
	E. merra Ntsehele			
	E. fasciatus			
	Epinephelinae			
	L. harak			
	A. rogaa			
Papillons Bawa lakozi /Shikozi	C. trifasciatus			
	C. meyeri			
	C. trifascialis			
	C. auriga			
	C. lunula			
Demoiselles	C. viridis			
	D. aruanus			
	A. sexfasciatus			
	P. sulfureus			
Chirugiens	A. thompsoni			
	A.gahhm /nigricauda Nkudu			
	A. triostegus Mpimbi /Bibi			
	A. leucosternon			
	A. lineata Shimazi mirari			
	C. striatus *Shimazi*			
	C. strigosus			
	N. lituratus Shivwivwintre			
	N. unicornus Mpuju gnonga			
	B. undulates			
Balistidae	R. aculeatus Shikandra /Shikada			
	Scaridae Mrenu /Pono			

Déchets	Matériaux de pêche abandonnés

Table 16. List of fish taxa for identification in the In-depth Reef Survey 2016

Fished taxa	Fish-eating predators	*Lutjanus kasmira*
		Cephalopholis miniata
		Epinephelus merra
		Lethrinus harak
		Aethaloperca rogaa
		Cephalopholis argus
		Epinephelus fasciatus
		Subfamily Epinephelinae
	Carnivore (zooplankton, fish eggs, crustaceans)	*Acanthurus thompsoni*
		Family Lutjanidae
	Herbivore (Filamentous/benthic algae)	*Acanthurus lineata*
		Acanthurus triostegus
		Subfamily Scaridae
	Herbivore (leafy brown algae)	*Naso lituratus*
		Naso unicornus
	Omnivore	*Acanthurus gahhm/A. nigricauda*
		Ctenochaetus striatus
		Ctenochaetus strigosus
		Rhinecanthus aculeatus
		Balistapus undulates
		Family Balistidae
Non-fished species	Herbivore (filamentous/benthic algae)	*Acanthurus leucosternon*
	Phytoplanktivore	*Chromis viridis*
	Exclusive corallivore	*Chaetodon trifasciatus*
		Chaetodon meyeri
		Chaetodon trifascialis
	Omnivore	*Chaetodon auriga*
		Chaetodon lunula
		Dascyllus aruanus
		Abudefduf sexfasciatus
		Pomacentrus sulfureus

Table 17. Modified target fish species for 2017 in-depth reef surveys.

Family	Common name	Scientific name	Feeding guild
Chaetodontidae	Big longnose butterflyfish	*Forcipiger longirostris*	C/I
	Redfin butterflyfish	*Chaetodon trifasciatus*	C
	Threadfin butterflyfish	*Chaetodon auriga*	C/I
	Meyer's	*Chaetodon meyeri*	C
	Chevroned	*Chaetodon trifascialis*	C
	Klein's	*Chaetodon kleinii*	C/I
	Racoon	*Chaetodon lunula*	C/I
	Indian teardrop	*Chaetodon interruptus*	C/I
	Saddleback	*Chaetodon falcula*	C/I
	Spotted	*Chaetodon guttatissimus*	C/I
	Other		C/I
Zanclidae	Moorish idol	*Zanclus cornutus*	I
Acanthuridae	Powderblue surgeonfish	*Acanthurus leucosternon*	H
	Striped surgeonfish	*Acanthurus gaahm*	H
	Convict surgeonfish	*Acanthurus triostegus*	H
	Blackstreak surgeonfish	*Acanthurus nigricauda*	H
	Orangespine unicornfish	*Naso lituratus*	Pi
	Bluespine unicornfish	*Naso unicornis*	Pi
	Striped bristletooth	*Ctenochaetus striatus*	H
	Goldring bristletooth	*Ctenochaetus strigosus*	H
	Dusky surgeonfish	*Acanthurus nigrofuscus*	H
	Brushtail Tang	*Zebrasoma scopas*	H
	Other		H/Pi
Pomacanthidae	Many spined angelfish	*Centropyge multispinus*	V
	Regal angelfish	*Pygoplites diacanthus*	V
	Semicircle angelfish	*Pomacanthus semicirculatus*	V
	Other		V
Pomacentridae	Choc dip chromis	*Chromis dimidiata*	O
	Scissortail sergent	*Abudefduf sexfasciatus*	O
	Indo-pacific sergent	*Abudefduf vaigiensis*	O
	Sulphur damsel	*Pomacentrus sulfureus*	O
	Baensch's damsel	*Pomacentrus baenschi*	O
	Jewel damsel	*Plectroglyphidodon lacymatus*	O
	Ternate chromis	*Chromis ternatensis*	O
	Bronze reef chromis	*Chromis agili*	O
	Scaly chromis	*Chromis lepidolepis*	O

	Weber's chromis	*Chromia weberi*	O
	Other		O
Holocentridae	Tailspot squirrelfish	*Sargocentron caudimaculatum*	Pl
	Bloodspot squirrelfish	*Neoniphon sammara*	Pl
	Other squirrelfish		Pl
	Other soldierfish		Pl
Mullidae	Dash-dot goatfish	*Parupeneus barberinus*	I
	Other		O
Labridae	Bluestreak cleaner wrasse	*Labroides dimidiatus*	I
	Indian ocean bird wrasse	*Gomphosus caeruleus*	I
	Other		I
Scaridae	**Parrotfish**		H
Tetraodontidae	Puffers		I
Serranidae	Coral hind	*Cephalopolis miniata*	Pi
	Peacock grouper	*Cephalopholis argus*	Pi
	Other		Pi
Lutjanidae	Blue lined snapper	*Lutjanus kasmira*	Pi
	Brown striped snapper	*Lutjanus vitta*	Pi
	Black snapper	*Macolor niger*	Pi
	Other		Pi
Lethrinidae	Thumbprint emperor	*Lethrinus harak*	I
	Other		I
Haemulidae	Oriental sweetlips	*Plectorhinchus orientalis*	Pi
	Other		Pi
Siganidae	Rabbitfish		H
Balistidae	Picasso triggerfish	*Rhinecanthus aculeatus*	I
	Titan triggerfish	*Balistoides viridescens*	I
	Other		I
Carangidae	Jacks and trevallies		Pi

Note on feeding guilds : C : Corallivorous ; H : Herbivorous ; I : Invertivorous ; O, Omnivorous ; Pl : Planktonivorous ; Pi : Piscivorous ; V : Varied diet (soft corals and sponges).

Table 18. Benthos categories and sampling codes

Category (French)	Sampling code	Category (English)
Corail dur massif	CDM	Hard coral massive
Corail dur branchu	CDB	Hard coral branching
Corail dur table	CDT	Hard coral tabular
Corail dur encroutant	CDE	Hard coral encrusting
Corail dur solitaire	CDS	Hard coral mushroom
Corail mou	CM	Soft coral
Invertébré	INV	Invertebrates (tunicates, zoanthids, anemones, echinoderms, giant clams)
Macroalgue	MA	Macroalgae
Algue calcaire encroutante	ACAL	Crustose coralline algae
Algue calcaire branchue	ACALBR	Branching coralline algae
Algue tapis	ATAP	Turf algae
Débris	DEB	Rubble
Roche	ROC	Rock
Sable	SAB	Sand
Herbier	HER	Seagrass
Corail mort recent	CMR	Recently killed coral
Autre	AU	Other
Inconnu	INCO	Unknown

10. Appendix B. Marine socio-economic assessment methodology for the Comoros

Objectives

The purpose of the socio-economic assessment is to gain qualitative understanding of how the community functions, how they are using marine resources, what importance marine resources have for their livelihoods, and community and resource use history. After gaining a broad understanding through participant observations, more specific information will be gathered through a simplified census and household interviews, including how many fishers there are, what type of fishing they are doing, what % of income comes from fishing, and poverty levels.

This information than can be used to set up appropriate participatory monitoring systems of key indicators and/ or as the basis for exploring ways of improving management of marine resources.

Participant observations

Spend time with fishers and other community members during their work activities to make observations and ask questions about the topics listed on Table 1. When discussing with more than one person, use visual techniques such as mapping, ranking, or timelines to illustrate and gain participation. Collected data will be recorded in the Participant Observations excel file.

A few other recommendations:

- Think about the strategy to collaborate effectively with the village: how do community members identify themselves? What are the groups and key informants? Who are the marginalized ones? Who are the influential people, how did they become so and how do they make use of that influence?
- Make use of visual explanations/support if possible, metaphors and sense of humor during the discussions, understand local communication and jokes and participate, use local expressions or words even not properly pronounced (for the foreigners, locally known as “wazungu”)
- Trips to the agriculture fields and informal discussions in the village to gain a good understanding of the local issues (productivity and resource availability, seasonal calendar)
- Establish a cartography of the different marine zones and fishing sites
- Keep on improving the understanding of the local context by filling up the analysis grid (Table 17)

Table 19. Analysis grid to understand socio-environmental and fisheries context in the villages (in French).

Informations Génériques	**Détails du site et d'utilisation des ressources marines**	**Historique**	**Analyse sociale**	**Analyse de richesse**	**Perspectives et utilisations de la mer et sa biodiversité**	**Zonage de la mer**	**Modes d'exploitation de la mer**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
a. Nom b. Divisions (quartiers etc.) c. Infrastructures d. Nombre de maisons et types e. Nombre de personnes dans les différents couches sociales (femmes, hommes, <15 ans) f. Impressions générales (niveau de pauvreté, spécificités, situation environnementale, systèmes de l'utilisation des ressources marines)	a. Délimitation du terroir villageois pour la pêche et le littoral (l'historique) b. Zonage marine par rapport à : - voies d'accès, - cours d'eau, - habitats, - modes de pêche et d'extraction de sables et coraux - marchés	a. Historique de l'implantation du village et des villageois (lignages, alliances, dépendances, colonisation) b. Histoire des évènements marquants c. Histoire des projets de développement et gestion des ressources marines, raisons d'échecs et réussites, méthodologie, organisation, comités crées d. Histoire de réalisations faites par les villageois eux-mêmes, raisons d'échecs et réussites e. Evolutions en méthodologies et taille de la pêche et extraction de sable et coraux f. Histoire des conflits avec autres villages, entre villageois	a. Les structures existantes et historiques (associations, comités etc.) b. Les structures de pouvoir officiel existantes et historiques (religieux, gouvernementale, politique, chefs) c. Les réseaux d'influence (lignées familiales puissantes, source de pouvoir, courtiers et non-adhérents) d. Importance de tous ces différents groupes et les relations entre eux – surtout les conflits e. Réalisations faites par toutes ces différentes groupes, raisons de réussite et d'échec f. Les sources d'informations jugées fiables g. Prise de décision villageois et la réalité du pouvoir – comprendre à partir des exemples ou résiliation des conflits h. Mouvements migratoires et diaspora	a. Les sources d'entrée d'argent b. Les repas pendant l'année c. Type et taille de maison d. Type de pêche ou d'extraction des ressources (à pied, à main, etc.) e. La famille et autres liens sociaux – travaux collectif, entraide, modes de transmission f. Liens de patronage h. Les marginalisés i. Niveau d'éducation j. Migrations faits k. Droits d'utilisation	a. Tous produits de la mer b. La fréquence de l'extraction de sables et coraux – et la logique c. Les acteurs engagés dans l'extraction de sables et coraux, le fonctionnement du système d. Les normes, règles et suivi en place pour l'extraction de sables et coraux et la peche e. C'est quoi la mer ? Histoire et définition de la mer. f. Les valeurs de la mer identifiés/ les leviers potentiels pour la protection, les valeurs ou problèmes identifiées pour la biodiversité	a. Formes des accords préexistants (traditionnel, religieux, légal) b. Conflits de zonage (entre villages, pecheurs, etc.) et processus de resolution c. le patrimoine sur lequel ils se considèrent des droits d. Comment le zonage de la mer est-elle conçue et enregistrée ?	a. Cartographie des zones de la mer b. Accès à la mer c. Accès aux pirogues et vedettes et répartition dans le village d. Calendrier des extractions, d'espèces attrapées e. Contraintes locales de la pêche et de l'exploitation des ressources f. Les normes en place pour la gestion des ressources naturelles marines

Table 20. Leading questions for socio-economic interviews (in French)

Questions pour pêcheurs	Questions pour extraction de sable/rochers/coraux
Qui fait la pêche ? (couches sociales - hommes, femmes, enfants, vieux, pauvres, etc.) :	Qui fait l'extraction ? (couches sociales - hommes, femmes, enfants, vieux, pauvres, etc.) :
Nombre des pêcheurs (hommes, femmes, enfants):	Nombre des participants (hommes, femmes, enfants) :
Dans l'historique du village, y-a-t-il des changements de nombre des pêcheurs ou de qui fait la pêche ?	Dans l'historique du village, y-a-t-il des changements de nombre des participants ou de qui le fait ?
Comment on appelle le(s) lieu(x) de pêche du village et où se trouve-t-il(s) ?	Comment on appelle le(s) lieu(x) d'extraction du village et où se trouve-t-il(s) ?
Combien de sites de débarquement ? Ou se trouvent-ils ?	Autres lieux d'extraction fréquentés en dehors du village? Où ?
Autres lieux de pêche fréquentés en dehors du village? Où ?	Méthodes actuels d'extraction au village (notez si un est dominant) :
Association de pêche (nombre des membres – hommes, femmes, fréquence des réunions, activités):	Fréquence d'extraction :
Nom du président de l'association et numéro :	Changements des méthodes ou des matériaux d'extraction au village ?
Etes-vous membre de l'association de pêche ? Pourquoi (ou pourquoi pas) ?	Est-ce que la plupart d'extraction est pour l'utilisation personnelle ou pour vendre ?
Méthodes actuels de pêche au village (notez si un est dominant) :	Ou est-ce qu'on vend ?
Fréquence de la pêche par méthode :	Y-a-t-il des revendeurs qui achètent au village ? Ou est-ce qu'ils revendent ?
Changements des méthodes de pêche au village (y-a-t-il des méthodes disparues ou nouvelles) ?	Est-ce que les participants font d'autres activités ? Lesquelles ? Activité principale?
3-5 espèces les plus capturés au village:	Y-a-t-il des participants étrangers (origine, methodes, nombre) ?
Est-ce que la plupart de capture est pour manger ou vendre ?	Gestion actuelle pour l'extraction (méthodes, d'endroit, ou de temps, etc.) ? Pourquoi ?
Ou est-ce qu'on vend ?	Qui a décidé le règlement ? Depuis quand ?
Y-a-t-il des revendeurs qui achètent les captures du village ? Ou est-ce qu'ils revendent ?	Qui ne respecte pas le règlement ? Sont-ils nombreux ?
Est-ce que les pêcheurs font d'autres activités ? Comme quoi ? Quel est l'activité principale (la pêche ou autre) ?	Comment on assure que le règlement est respecté ? Qui surveille ?
Y-a-t-il des pêcheurs étrangers ? Venant d'où ? Quelles méthodes utilisent-ils ? Est-ce qu'ils sont plus nombreux que les pêcheurs du village ?	Si on trouve quelqu'un qui n'a pas respecté le règlement, qu'est-ce qu'on fait ?
Gestion actuel pour la pêche (interdiction des méthodes, d'endroit, ou de temps, etc.) ? Pourquoi on gère ?	Y-a-t-il de soutien autoritaire ? De qui (mairie, gendarmerie, etc.) ?

Qui a décidé le règlement ? Depuis quand ?	Quel est l'état actuel de sable/rochers/coraux ?
Qui ne respecte pas le règlement ? Sont-ils nombreux ?	
Comment on assure que le règlement est respecté ? Qui surveille ?	
Si on trouve quelqu'un qui n'a pas respecté le règlement, qu'est-ce qu'on fait ?	
Y-a-t-il de soutien autoritaire ? De qui (mairie, gendarmerie, etc.) ?	
Quel est l'état actuel des poissons et de la pêche ?	

11. Appendix C1. Catch monitoring methodology: boat fishery

Objectives

- To understand the state of the fishery in detail, including number of fishers, fishing effort, methods and sites, target species, weight and size, and seasonal trends.
- To allow analysis of changes in the fishery following implementation of management strategies.

Equipment

- Species identification table
- Measuring tape
- Scales of 20kg and 100kg
- Weighing bag (eg. Large rice bag)
- Watch/telephone (to record time)
- Notebook
- Pens/pencils
- Ruler
- Camera
- Computer for data entry

Methods

Fishing will be monitored impartially and with an effort to collect the maximum possible samples.

- Monitoring days will be selected randomly using an Excel sheet.
- As many fishers as possible should be sampled during survey days.
- If a fisher refuses to participate in part of the survey, try to get the most participation possible (for example, if they refuse to allow sampling of their catch, ask the questions about their fishing trip).
- During the surveys, if you must choose between two fishers who arrive on the beach at the same time, choose the fisher who is least represented in the data.

When a fisher arrives on the beach (vedette or pirogue):

1. Record **arrival time** in the notebook.
2. Approach the fishers and ask if you can measure their catch. If they don't have any catch, continue with step 5.
   - If the fisher is not aware of the project activities, objectives have to be explained.
3. If the fisher doesn't allow catch measurements, ask the questions on their fishing trip including time of departure, number of fishers in the group, method, etc.
4. If the fisher allows for catch measurements:
   a. Assemble all captures on the rice bag and sort per species
   b. Identify each species (Comorian name) and weigh the total catch per species (kg)
   c. Select randomly a sample of 5 individuals per species (if there are less than 5 individuals, all are sampled)
   d. Measure total length (TL) (Fig. A) for each individual sampled. Record weight per individual.

OPTION B - *if there is not enough time for the method above*

Record total catch weight (in subsamples if necessary) and count the number of individuals per species

OPTION C – *if there is not enough time and there are many individuals*

Record total catch weight, take a subsample of the total catch in a container. Record the number of individuals per species in the subsample. Estimate or measure the number of subsamples in the total catch, and for each species multiply the number of individuals by the subsamples number.

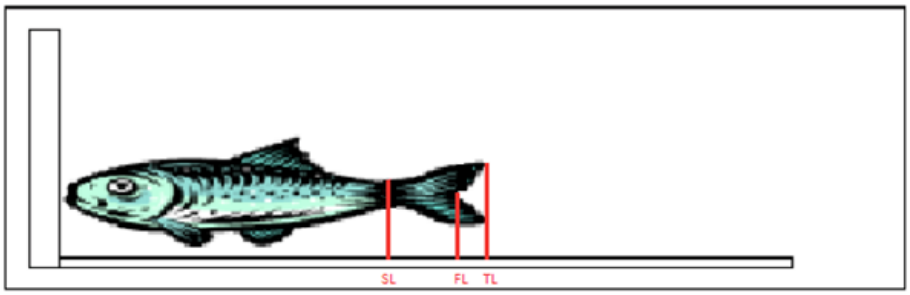


Figure A. Measuring fish. SL = Standard Length, FL = Fork Length, TL = Total Length.

5. Ask the fisher if she/he **sought other types/species** in addition to what was caught. If the fisher sought but did not catch a type/species, record the name of the type/species and enter 0 for weight and length.
6. After measuring the catch, ask and record the fishers' answers to the following questions:
    a. Name (and type of boat)
    b. Type of gear (record several if used). If they used a net, record net measurements (length and width, mesh size)
    c. Time spent at sea
    d. Time spent fishing (eg. How many times did you put the net in the water ; average time you left the net in the water)
    e. Fishing sites visited (record several if several visited)
    f. How many boats left at the same time?
    g. How many fishers worked together (men and women)?
    h. Village of origin
    i. Catch destination (consumption or sale)
    j. If they went fishing yesterday or the day before yesterday (except if these informations are known). If the answer is no, record the reason for not going fishing. These informations should be recorded in the following table:

Date	Fisher	Boat type	Reason for not going fishing

NOTES

- Do not forget to thank the fisher for his participation!
- Remember to place the scale on a plane surface to weight the catch. To record the weight, position yourself facing the scale and at the same height for accurate measurements.
- Take pictures of individuals that cannot be identified. The picture must include the whole fish (mouth and tail end included), taken in appropriate light conditions (shade) and directly above the fish to enable later identification. Pictures will be used to compile a species list with Comorian and English synonyms
- Calibrate the scale: place a full 1.5 litre bottle on the scale. If necessary, adjust the needles so that it reads 1.5 kg. This calibration should be done regularly, at least every three months.

12. Appendix C2. Catch monitoring methodology: reef gleaning fishery

Objectives

- Understand the current state of the fishery, including number of fishers, fishing effort, methods, species targeted and their size and weight, and variation over a period of 12 months.
- Establishment of a baseline to facilitate evaluation of changes in fishery following management activities

Equipment

- Measuring tape
- Hanging scale
- Watch / téléphone (tool for time)
- Notebook (format A4)
- Pencils/Pens
- Ruler
- Camera
- Computer for data entry

Methods

Fishing will be monitored impartially and with an effort to collect the maximum possible samples.

- As many fishers as possible should be sampled during survey days.
- If a fisher refuses to participate in part of the survey, try to get the most participation possible (for example, if they refuse to allow sampling of their catch, ask the questions about their fishing trip).
- During the surveys, if you must choose between two fishers who arrive on the beach at the same time, choose the fisher who is least represented in the data.

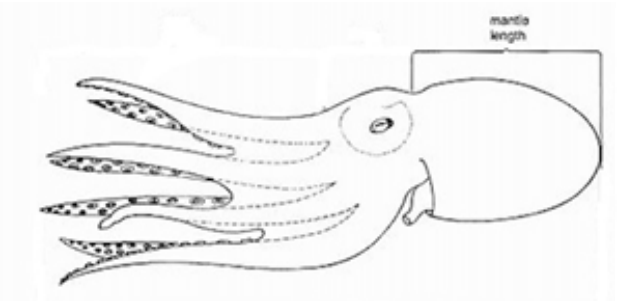
When a fisher arrives on the beach:

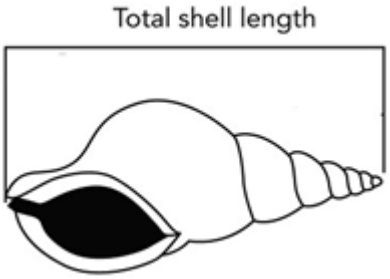
1. Record **arrival time** in the notebook.
2. Approach the fishers and ask if you can measure their catch. If they don't have any catch, continue with step 6. *See note A if the fisher has catch but refuses to participate.*
3. Record the **weight and length of each individual** (up to 5 individuals) by type of catch (octopus, shells, squid, lobster, sea cucumber, etc.) and by species (Comoran name) for fish. *See note B for length, notes C and D for fish.* Each type/species should be entered in a new row in the notebook.
4. If there are more than 5 individuals for a type/species, gather all of the individuals to measure **total weight by type/species.**
5. For octopus, identify and record the **sex**.
6. Ask the fisher if she/he **sought other types/species** in addition to what was caught. If the fisher sought but did not catch a type/species, record the name of the type/species and enter 0 for weight and length.
7. Ask the following **questions** and record the responses in the notebook:
   - Time fishing began (can estimate if exact time is unknown)?
   - Method for each type/species?
   - If catch is shared, how many fishers are in the group?
   - Name of fisher and village?

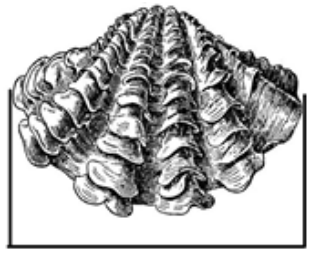
NOTES

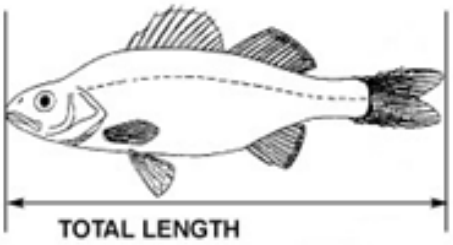
A. If the fisher doesn't allow catch measurements, ask the questions on their fishing trip including time of departure, number of fishers in the group, method, etc.
B. Length: for octopus and squid the length is measured for the mantle only. For other types including fish, total length is measured (as presented in the illustrations below).
C. If fish are too small to weigh individually, record the total weight and number of individuals.
D. If there is a large catch of small fish with many species :

Record the total catch weight, take a subsample in a small bowl or other measuring device, count the number of individuals of each species in the subsample, estimate or measure the number of subsamples in the total catch, and for each species, multiply the number of individuals by the number of subsamples.









13. Appendix D. Preliminary results for reef gleaning fisheries monitoring

Objectives

The catch monitoring for reef flat fishing provides information on catch, effort, target methods and species, providing a baseline for evaluation of effectiveness of future management initiatives.

Methods

Data has been collected since October 2016 in Dzindri, from March 2017 in Salamani and we started collecting data in Vassy in June 2017. Survey technicians collected data every day the reef flat fishery was active, according to tide levels (approximately 12 days every moon cycle). They count the number of fishers present at the site. For each fisher, gear, fisher origin and time spent fishing is recorded, as well as following information on the catch:

- For octopus: total catch weight, number of individuals and individual weight and size of a subsample;
- For juvenile fish: total catch weight, number of individuals and catch weight per species (subsampling if necessary);
- For shells: total catch weight, species present and size of individuals is recorded if time allows.

Results

Catch monitoring from March until September 2017 is presented below for the villages of Vassy, Dzindri and Salamani. The data from October onwards is still being analysed and will be included in the final status report on reef flat fisheries to be produced after 12 months of data have been collected.

During the period analysed, 2,176 fishing trips have been sampled at six monitoring stations amounting to 3,567.95 kg of landings from over 500 fishers, 100 different species of fish and invertebrates. 115 fishers refused to allow their catch to be sampled over the six months.

Juvenile reef fish caught with the ichthyotoxic plant *Tephrosia vogelii* and octopus are the main targets in the reef flat fishery with some fishers targeting both. In total, 1,187 and 1,108 outings included juvenile fish and octopus respectively. In March, juvenile fish were caught most frequently (on 512 outings) whereas octopus was caught most frequently in August (on 272 outings) (Figure 27). Dzindri shows the highest number of fishers for both categories with 998 and 900 outings for juvenile fish and octopus respectively, followed by Salamani with 193 and 201 outings and Vassy with two outings for juvenile fish and 45 for octopus (surveys started in June in Vassy). Other villages in the area account for 23 outings for juvenile fish and six for octopus.

Considering the octopus catch in more detail, average catch per fisher is 1.07 kg/fisher. It is highest in August with 1.52 kg/fisher and lowest in June with 0.56 kg/fisher (Figure 28). Catch per unit effort has not been calculated as data on time spent fishing is not yet readily available. Total octopus landings over the six months amount to 1128.89 kg.

Average individual weight of octopus is 806 g (719 g for females and 904 g for males). Average individual weight is highest in July at 970 g and lowest in March at 602 g (Figure 29). Of a total of 1776 individual octopus, 57% weigh less than 1 kg (Figure 30).

For juvenile fish, 2439.06 kg were caught from March to September. Average catch per fisher is 1.40kg; it is highest in March with 2.96kg/fisher and lowest in September with 0.96 kg/fisher (Figure 31). The most

abundant fish taxa are the surgeonfish and soldierfish, being present in 88.2% and 62.7% of the catches respectively. Wrasses, goatfish, cardinalfish and butterflyfish are also common (present in 18–27% of the catches).

Data on shell landings is still being analysed. The most common types collected are the spider conch (Strombidae family, present in 166 catches), followed by the top shells (Tegulidae family, present in 86 catches) and the vase shells (Vasidae family, 73 catches).

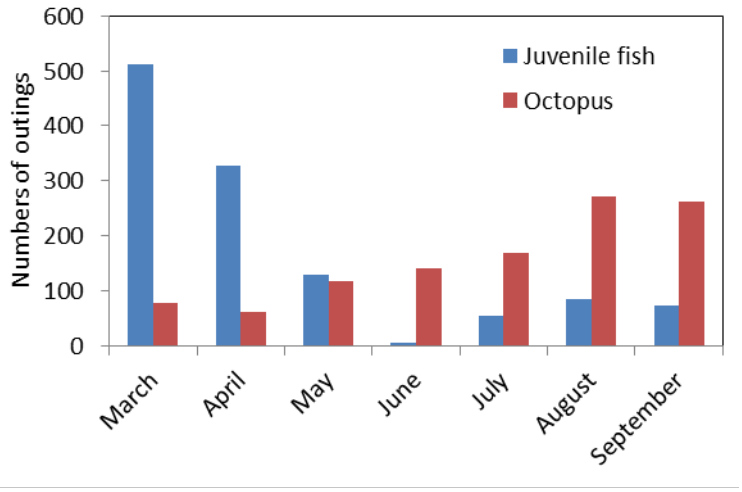


Figure 27. Number of fishing outings from March to September across the communities of Vassy, Dzindri and Salamani split by catch composition (juvenile fish or octopus).

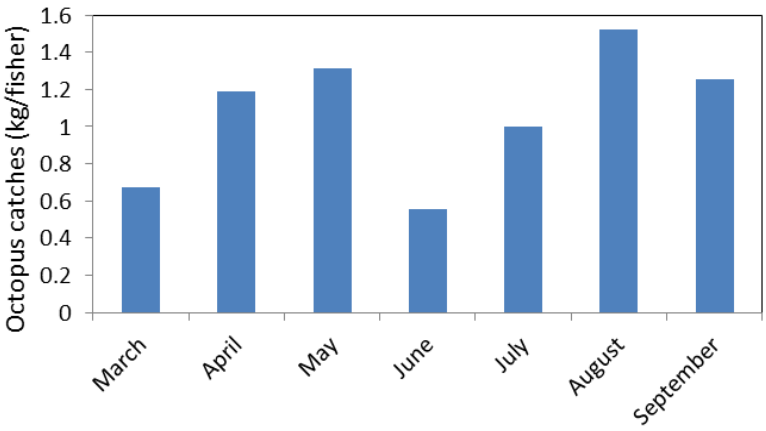


Figure 28. Average octopus catches per fisher per month from March to September.

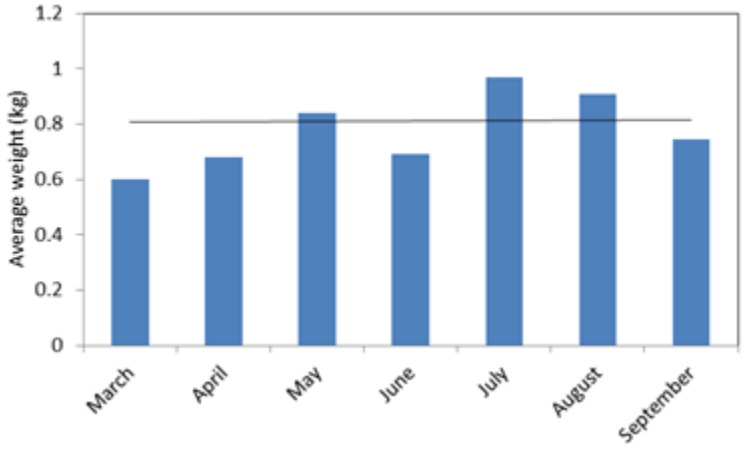


Figure 29. Average individual octopus weight from March to September, the black line represents the average individual weight across all months at 806 g.

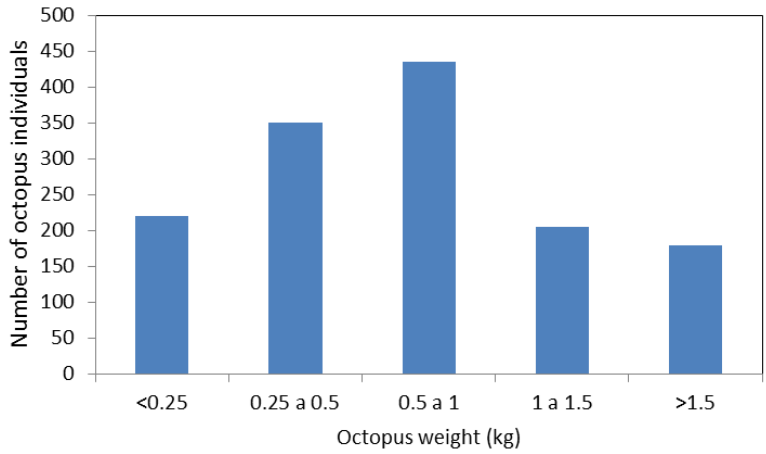


Figure 30. Octopus individuals split into weight categories (<0.25 kg; 0.25–0.5 kg; 0.5–1 kg; 1–1.5 kg; >1.5 kg).

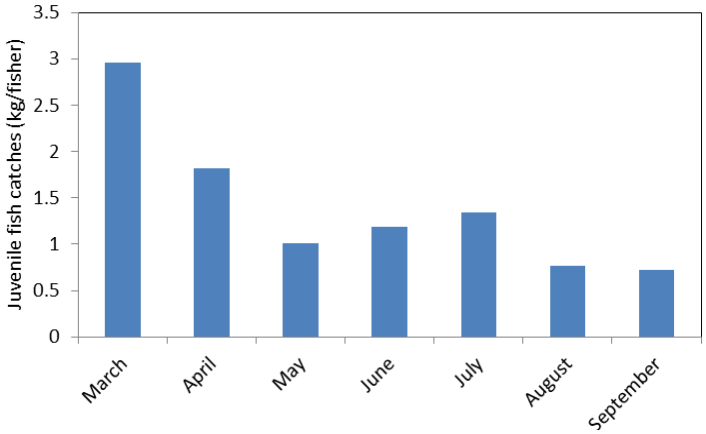


Figure 31. Average catch of juvenile fish per fisher in kilograms from March to September.

Discussion

The data from the catch monitoring reveal a seasonal pattern for juvenile fish and octopus catch. March is well known among communities for its extreme spring tides and reef fish (especially surgeonfish) abundance. Juvenile fish are targeted by all women during low tide as the use of *uruva* is relatively easy. However, octopus requires more specialist skills with the use of metal sticks and fewer women target it specifically. If not done correctly, this fishing method can be destructive: the use of metal sticks (and sometimes rocks) to break the reef and reach the octopus, coupled with trampling the reef, cause habitat damage and therefore proper training in sustainable fishing practices is needed to improve the octopus fishery. These results are indicative, as for 115 fishing trips (around 5% of all fishing trips) the women refused to have their catch sampled over the six-month period.

Considering the potential impacts on successful reef fish recruitment, the large quantities of juvenile fish caught are of concern. The use of the *uruva* plant is a delicate topic among female fishers and boat fishers, perhaps highlighting the perceived impact on adult fish stocks. With a move towards the implementation of octopus fishery management (sensitively embedded within reef flat management measures to facilitate enforcement), the communities hope that this will have positive consequences on juvenile fish numbers. With a complete 12-month dataset, we will also aim to raise awareness of the magnitude and negative impacts of juvenile fish catches on the wider ecosystem to trigger the development of management strategies.

August and September show the highest octopus catch rates, highlighting a productive season for octopus. Mean individual weights are highest in July, followed by August possibly indicating a brooding peak at that period. The average individual weight for females is below weight at first maturity (around 800–1,000 g depending on sources for the Western Indian Ocean), an indicator of potential “recruitment overfishing” (characterised by a decrease in mature individuals in the catches, resulting from decreased brooding stock and subsequently low recruitment), contributing to the decline in the fishery.

When 12 months of catch monitoring data have been collected, the data set will allow more conclusions to be drawn from seasonal patterns. It is fundamental to gain knowledge on octopus stocks and juvenile fish populations, as well as to develop management strategies such as defining the best timeframe for an octopus closure. On-going catch monitoring will provide information on the effectiveness of chosen management strategies and help the community to identify ways to adapt and improve them.