# Human Dimensions of Madagascar's Marine Protected Areas

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## ABSTRACT

We conducted a socio-economic assessment in thirteen communities within or adjacent to Madagascar's Marine Protected Areas (MPAs); Nosy Atafana MPA in the Mananara Nord biosphere reserve; Tampolo, Tanjona, and Masoala MPAs in the Masoala National Park, and the recently designated Sahamalaza MPA. Socio-economic information was gathered using several techniques, including household surveys, resource user key informant interviews, community leader key informant interviews, and oral histories. Communities varied considerably in regards to their dependence on marine resources. Communities in the Masoala and Tanjona marine parks had a relatively high dependence on fishing and gleaning (particularly for octopus and sea cucumber). Communities in Sahamalaza had moderate dependence on marine resources and Sahasoa, near Nosy Atafana, had a relatively low dependence. We found that fishing effort in several of our study sites was comparable to moderately exploited sites in Kenya (Cinner and McClanahan, 2006). However, it will be necessary to examine fishing effort relative to the size of fishing ground to have a better overall impression of fishing pressure across the study sites. Strategies to improve management in Madagascar's marine parks may include: (1) presenting consistent and transparent socioeconomic and ecological monitoring to communities to clearly demonstrate the effects of conservation on community livelihoods; (2) forming cross-scale linkages between national, provincial, and local governance institutions to promote resilience to social and ecological disturbances.

## INTRODUCTION

Madagascar's high levels of endemic flora and fauna have made the island a key conservation priority site (Myers et al. 2000). In 2003, the Malagasy President announced that Madagascar would create a six million hectare network of terrestrial and marine reserves, effectively tripling the area under protection (Duffy 2006). Yet, there has been little effort to understand the human dimensions of this proposed conservation initiative, particularly in the marine context.

As conservation theory and practice moves away from excluding resource users to creating partnerships with them, it is becoming increasingly clear that conservation is as much about understanding people as it is about understanding ecological processes (Cinner

*Obura, D.O., Tamelander, J., & Linden, O. (Eds) (2008). Ten years after bleaching - facing the consequences of climate change in the Indian Ocean.CORDIO Status Report 2008. Coastal Oceans Research and Development in the Indian Ocean/Sida-SAREC. Mombasa. http//:www.cordioea.org*

et al., 2007). Many conservation projects fail to achieve either biological or social goals because they do not adequately understand, address, and incorporate the socioeconomic needs and concerns of stakeholders (Christie et al. 2003, Christie 2004, Cinner et al. 2007). Here we investigate some key socioeconomic conditions in Madagascar's marine protected areas (MPAs). We examine the intensity and type of resource use, occupational multiplicity, population, settlement pattern, and market influences.

## METHODS

We selected villages within or adjacent to Madagascar's national marine reserves at sites in the northeast (Nosy Atafana MPA in the Mananara Nord biosphere reserve and Tampolo, Tanjona, and Masoala MPAs in the Masoala National Park) and northwest (recently designated Sahamalaza MPA). Villages were chosen to encompass a range of geographical, social, and economic conditions which included population size, development, history/length of settlement, and dependence on marine resources. To gather information within villages, a combination of systematic household surveys (for example, surveying every second or third household), semi-structured interviews with key informants (community leaders and resource users), recording of oral histories, and participant observations. A total of 264 household surveys were collected and analyzed.

Sampling of households within villages was based on a systematic sample design (see Henry, 1990; de Vaus, 1991). In very small communities (<30 households), a whole haul census was generally attempted (but never achieved because of long term absence of specific residents). A household was defined as people living together and sharing meals. Variance from the systematic sample was assumed to be equal to the estimated variance based on a simple random sample (Scheaffer et al., 1996). The number of surveys per park ranged from 43-70. The number of surveys per community (within each park) ranged from 7-44 (Table 1), depending largely on the population of the village, and the available time per site (this was influenced by factors such as weather, the availability and frequency of transportation to certain sites, and budget requirements).

**Figure 1**. Conducting a household survey in Ankitsoko.

The head of the household was interviewed with a structured survey form by a trained research assistant (Fig. 1). If the head of the household was not available, the household was revisited later. If the head of the household was still not available, another adult from the household was interviewed.

Dependence on fishing was determined by having respondents list all the occupations the household engaged in for food or money. Respondents were then asked to rank these activities in order of importance. Those who regularly engaged in fishing estimated the percentage of their fish catch sold or bartered.

## RESULTS

### Population and Settlement Pattern

Human population size can affect the pressure placed on reef resources and influence the types of interventions required to manage them. Population and settlement pattern were examined as indicators of potential pressure on reef ecosystems. The villages were relatively small, many of which had populations of less than 100 (Table 2). Sahasoa was the largest village studied. A mean of 4.5 people per household

**Table 1**. MPAs, study communities and number of surveys conducted.

| MPA and Community | Number of surveys | Number of fishers surveyed | Proportion of fishers, % |
|---|---|---|---|
| ***Masoala MPA*** | ***53*** | ***26*** | ***49*** |
| Ambinambe | 7 | 7 | 100 |
| Ankitsoko | 18 | 3 | 17 |
| Ambodilaitry | 28 | 16 | 57 |
| ***Tanjona MPA*** | ***54*** | ***46*** | ***85*** |
| Tanjona | 13 | 9 | 69 |
| Ifaho | 13 | 12 | 92 |
| Andomboko | 9 | 9 | 100 |
| Ankarandava | 10 | 9 | 90 |
| Antsabobe | 9 | 7 | 78 |
| ***Tampola MPA*** | ***43*** | ***19*** | ***44*** |
| Ambodiforaha | 17 | 6 | 35 |
| Marofototra | 26 | 13 | 50 |
| ***Nosy Atafana MPA*** | ***44*** | ***15*** | ***34*** |
| Sahasoa | 44 | 15 | 34 |
| ***Sahamalaza MPA*** | ***70*** | ***38*** | ***54*** |
| Antranonkira | 9 | 4 | 44 |
| Nosy Berafia | 40 | 19 | 48 |
| Nosy Valiha | 21 | 15 | 71 |
| **All sites** | **264** | **144** | **55** |

was recorded for all the study sites. There was considerable variation in household size within parks. For example, at Tanjona, household size ranged from 2.8 in Antsabobe to 5.7 in Ankarandava. At Cap Masoala, there were 3 people per household in Ankitsoko and 4.3 in Ambinambe. Antsobobe, Ankarandava, and Andomboko were the smallest villages studied, each were relatively dispersed and had less than 15 households (Table 2). Nosy Berafia and Nosy Valiha had several sub-village settlements dispersed around the islands. For the purposes of this study, we combined these hamlets into a single study site (i.e. village) for each island.

## Livelihoods

Occupational categories reported included fishing, selling marine products, agriculture, tourism, salaried employment[1], and the informal sector[2]. Most study

*[1] The category "salaried employment" includes salary positions such as secretarial work, teaching, security, etc. Salary jobs in the tourism sector (i.e. hotel security) are considered in the tourism category.*

*[2] The category "informal sector" can include participation in informal markets, such as selling food or clothes from a kiosk, casual work, etc.*

**Table 2.** Population and settlement pattern of study sites (aggregations at the park level in bold and specific villages within each park are indented).

| Indicator | Average people per household | Number of households | Population size | Settlement pattern |
|---|---|---|---|---|
| **Cap Masoala** | **3.5** | **88** | **308*[1]** | |
| Ambinambe | 4.3 | 12 | 51 | C, N |
| Ankitsoko | 3.0 | 25 | 75 | I, N |
| Ambodilaitry | 3.5 | 51 | 180 | C, D |
| **Tanjona** | **4.8** | **66** | **316** | |
| Tanjona | 5.5 | 16 | 87 | C, D |
| Ifaho | 3.4 | 19 | 64. | C, D |
| Andomboko | 4.7 | 11 | 51 | C, D |
| Ankarandava | 5.7 | 10 | 57 | C, D |
| Antsabobe | 2.8 | 10 | 27 | C, D |
| **Tampolo** | **5.1** | **56** | **286** | |
| Ambodiforaha | 4.7 | 20 | 94 | C, N |
| Marofototra | 5.4 | 36 | 193 | C, N |
| **Nosy Atafana** | **5.4** | **244** | **1314*** | |
| Sahasoa | 5.4 | 244 | 1314 | C, N |
| **Sahamalaza** | **4.4** | **133** | **585*** | |
| Antranonkira | 4.8 | 18 | 86 | C, N |
| Nosy Berafia | 4.5 | 70 | 311 | C, D |
| Nosy Valiha | 4.3 | 45 | 192 | C, D |

D = Dispersed settlements that were spread out and contained distinct sub-villages that were geographically separated.
N = Nucleated settlements were communities that were relatively contiguous.
C = Coastal (the majority of houses or town center are located <500 meters from the coast).
I =Inland (the majority of houses are >500 meters from the coast).
*Only includes estimates of study sites- There were more villages in the parks that we were not able to survey, thus these are underestimates of the true populations dependent on the parks.
[1] The population estimate for the entire Masoala park (including Cap Masoala, Tanjona, and Tampolo) are 1,361, suggesting that there may be an additional 451 residents in the Cap Masoala park (Grandcourt et al. 1999).

sites were relatively similar in the occupational diversity (Table 3), but the most rural and remote site (Sahamalaza) had considerably fewer occupations per household (Table 3).

The agricultural and cash crop sectors had the broadest participation, with over 92% of respondents being involved. Slash and burn practices for both agriculture and cattle (to provide green grass shoots after the burn) were widespread and potentially are a concern for both terrestrial and nearshore marine environments (see Kull 2000). In Sahamalaza, the terrestrial environment appeared to be particularly

**Table 3**. Occupational Multiplicity per household (+ 95% CI).

| MPA Study site | Average number of different occupations | ± |
|---|---|---|
| Cap Masoala | 3.1 | 0.1 |
| Tampolo | 3.0 | 0.1 |
| Tanjona | 3.2 | 0.1 |
| Nosy Atafana | 3.2 | 0.3 |
| Sahamalaza | 2.2 | 0.1 |

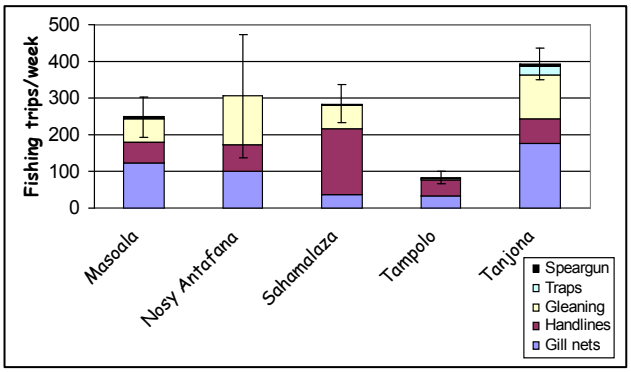


**Figure 2**. Estimated number of fishing trips per week per community and associated gear type (+ 95% CI).

degraded and terrestrial conservation will be an important component of long-term coastal zone conservation. As the terrestrial environment becomes increasingly degraded, it is expected that there will be increasing pressure on marine environments. In the Mananara and Masoala peninsula regions, a high primary dependence on cash crops (particularly vanilla) and secondary dependence on fishing suggest that fluctuations in international prices of cash crops could have repercussions on the use of marine resources. For example, in Marofototra, community leaders explained how the drop in vanilla prices has led to an increased reliance on fishery resources.

Fifty four percent of all respondents were engaged in traditional fisheries. The highest participation was at Tanjona, where 98% of households were involved in the fishery and 87% considered fishing a primary occupation. Participation in the fishery was relatively low in Nosy Atafana, where less than 36% of households were involved and only 7% ranked fishing as a primary occupation. Many of those who participated in the fishery considered it their most important occupation, particularly at Cap Masoala, Sahamalaza, and Tanjona. This suggests that fisheries management regulations in these areas will have a direct impact on a high proportion of peoples' livelihoods. Gleaning at all sites was less important than fishing, but did comprise a significant livelihood activity with the exception of Tampolo. Gleaning activities generally focused on octopus and sea cucumbers.

The salaried employment sector, and "other" sector (which included remittances, traditional healing arts, etc.) made up 3% and 9%, respectively. Tourism is an important economic activity in parts of coastal Madagascar. However, only 1% of respondents were involved in the sector informally as porters or local guides.

## Fishing and Markets

### *Fishing effort*

To determine the intensity of fishing effort in the communities, respondents were asked the average number of trips per week that they and other members of their family participate in for each gear type. Figure 2 examines total fishing effort across the parks[3]. These estimates do not include the areas of the parks that we were unable to survey and are an underestimate for Cap Masoala, Sahamalaza, and Nosy Atafana. Tanjona exhibited the highest overall fishing pressure, and Tampolo exhibited the lowest. Gill nets were the

*[3]It should be noted that when respondents used more than one gear type in a trip, they were considered separate trips if at least one gear was "passive" (e.g. traps which are set and returned to after some time). However, when multiple gears were used, but more than one gear was "active" (e.g. a seine net or handline), they were considered partial trips (depending on how many gears were used).*

**Figure 3.** Fish trap construction in Tanjona.

most frequently used gear, followed by handlines, gleaning, traps, and spearguns. Gleaning consisted of collecting octopus and sea cucumbers from intertidal or shallow subtiddal reef flats. Spears were frequently used in octopus collection. Traps were constructed out of local materials and generally had mesh gauge of approximately 3 inches (Fig. 3).

### *Market influences*

At the sites examined, fish marketing was entirely by small-scale traders for local consumption (Fig. 4). Very few respondents reported being involved in buying and selling fish or marine products. The exception to this is involvement in the sea cucumber industry, particularly in Sahamalaza and Tampolo (Masoala peninsula). In contrast to Kenya, where small-scale traders bought fish at landing sites, did some processing (scaling, gutting, and possibly cooking), and either sold fish in local open air markets or transported fish to urban centers (i.e., Mombasa or Malindi) for sale in retail fish shops, fish marketing in Madagascar was done primarily by the fishers and their family. Poor transportation and low fish prices meant that many communities were not heavily integrated into provincial or national markets. There were no medium-scale (i.e. traders with freezers or refrigerated storage capacity) or large scale (i.e. traders with exporting facilities) fish sales or processing at any of the sites assessed in this study.

**Figure 4.** Regional fish market (in Maroantsetra).

## CONCLUSIONS & RECOMMENDATIONS

Although there appeared to be considerable variation in socioeconomic conditions between the communities examined, this was less so than in similar studies conducted in Kenya, Papua New Guinea, and Indonesia (Cinner et al, 2006, 2007; Cinner et al 2005, McClanahan et al 2006). This was mainly due to the establishment of the marine parks in remote and rural areas of Madagascar, compared to urban and peri-urban areas such as Malindi and Mombasa MPAs in Kenya and Bunaken MPA in Indonesia. Our study sites were all small (<250 households), remote sites with little access to infrastructure, services, or markets. However, there was considerable variation in peoples' dependence on marine resources. Some areas, such as Sahasoa village (near Nosy Atafana MPA), had low

dependence on fishing, while residents in and adjacent to Tanjona MPA had extremely high dependence on fishing.

Despite the small human population size and remoteness of the study sites, fishing intensity at some sites was high (approximately 400 trips/week) and comparable with the intensity encountered in the smaller study sites in Kenya (Cinner and McClanahan, 2006). Gill nets were the most frequently used gear in the study sites, which may pose a considerable threat to reef resources through both direct damage to corals and their species and body length selectivity (McClanahan & Mangi, 2004; Cinner & McClanahan, 2006).

In the Sahamalaza region, pressure on marine resources is currently moderate and dispersed over a very large area. However this pressure may increase significantly as terrestrial habitats become increasingly degraded and unusable for agricultural purposes. Consequently, it will be crucial to develop integrated management of the terrestrial environment outside of designated park areas, particularly in the islands and peninsular regions where deforestation and subsequent erosion is severe. This will require considerable reforestation efforts and livestock management initiatives. One of the main issues in the islands region is that people do not have ownership of the land and their insecure tenure may promote practices that favor short-term gain at the expense of long-term sustainability.

There are multiple natural and social disturbances that may threaten coral reefs in Madagascar. For example, there have been six major cyclones in the 2006-7 season alone (Reuters 2007). Preliminary results of ecological surveys suggest that reefs in the region were adversely affected by the natural disasters (S. Harding pers. comm.). Coral reefs in Madagascar are also highly susceptible to social events that may alter marine resource use patterns. For example, due to the high dependence on cash crops such as vanilla, marine resource use is dependent on external (i.e. international) economic factors such as price fluctuations. Many respondents described changes in marine resource use after the drop in vanilla prices in 2003 (which decreased to 1/10 the value). One respondent noted "after the drop in vanilla prices, many people are now fishing". There is a need to develop management regimes that will promote resilience to both social and ecological disturbance events. While the decentralization associated with the 'transfer de gestion' policies may help to improve the adaptive nature of management systems in Madagascar, resilience to social and ecological events will require that conservation organizations devote considerable attention to strengthening the social networks that promote social capital and ensure cross-scale interaction with local, provincial, and national institutions.

One of the goals of this research project was to establish and expand monitoring at the sites. As part of the establishment of regular socioeconomic monitoring, it will be very important to provide feedback to the communities in terms of results and outcomes of both the socioeconomic and ecological monitoring. Socioeconomic monitoring every 3-5 years (or sooner if there is a large event such as a cyclone or dramatic fluctuation in the price of cash crops) will be important. Understandably, respondents in several communities expressed considerable frustration that the results of previous studies were not shared with them.

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