Biological Survey Report

Mali District, Macuata

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INTRODUCTION

In spite of having one of the best-developed coral reef systems in the Pacific (Biodiversity Conservation Network, 1999), Fiji has reefs that are under severe pressure. The bleaching event for instance, of 2000, provided an interesting starting point, in that coral health was affected across the country with 40% to 80% loss of hard coral (Sykes, 2007). Other research has shown that there has been a high level of pressure on the local coastal fisheries in the past few decades (Teh et al. 2009). Whilst little can be done about natural disturbances, human or anthropogenic disturbances can however be controlled and regulated (Koonjul et al., 2003).

Responsive action at the community level is currently and continually being undertaken to identify methods of reducing and replenishing fisheries stocks (Chambers 1992, Veitayaki 2002). Engaging local communities has been a prerequisite for the success of community-based management systems particularly because of the immense dependence of local communities on environmental resources and because of their ownership of these resources.

The establishing of Locally-Managed Marine Areas (LMMAs) or Marine Protected Areas (MPA), was therefore officially developed in 2001 as a tool to help in the sustainable management of coastal fisheries resources; where resident communities collaborate with local government and/or partner organizations (Tawake et al., 2007) in formulating and implementing resource management programmes. The setting-up of the Fiji LMMA (FLMMA) network work promotes and advocates the use of an adaptive management approach as the basis of improving marine conservation efforts (Tawake et al., 2005). Communities are thus empowered and assisted to evaluate the effectiveness of their management actions and adapt their approaches accordingly.
There are over 217 FLMMA sites to date, distributed throughout the main islands (Figure 1) and of the 400 traditionally managed fishing grounds (qoliqoli), at least 70 are considered over-exploited while a further 250 are fully developed (Hand et al. 2005).

Figure 1: FLMMA sites in Fiji
Mali, is a FLMMA site. A traditional community located on a small island in northern Fiji, off Labasa on Vanua Levu. Half of the Vuata reef (Cakau Vuata) adjacent to the island was set aside as an MPA some years ago by the community with the support of Macuata Province and FLMMA. Voro voro passage was added recently into the MPA area as a fish-spawning aggregation site, with plans to declare the passage a national marine reserve (Figure 2).

Surveys conducted by the Secretariat of the Pacific Community (SPC) in 2004 focused on providing baseline information on the status of reef fisheries, and to fill the information gap with better management of reef fisheries. This was conducted in the Mali district *kanakana*, and comprised of sampling stations located inside both MPAs and harvested areas. Survey work covered three disciplines - finfish, invertebrates and socio-economic.

![Figure 2: Mali site showing MPA boundary](image)
This report therefore provides a:

a) Comparative biological assessment of observable changes in reef-health over time; looking at previous ecological work conducted in the Mali qoliqoli in 2004 by the PROCFish surveys (SPC), and comparing these results against observations in 2014.

b) Comparative analysis on relative abundances of target species between MPAs and harvested areas of the reef.

WWF staff, volunteers and community representatives of the Dreketi and Mali districts conducted fieldwork. Prior to conducting the surveys a short yet thorough training and refresher course was done on important aspects such as, survey objectives, species identification, equipment use, surveys methodologies and data collection.

The intention is to continue to promote community based adaptive management and active engagement in resource protection and monitoring, whilst building local capacity and improving the knowledge base already generated.
METHODOLOGIES

Data collection

For the assessments of benthic habitat, finfish and invertebrate resources, each assigned site (i.e. MPA and Harvested) was divided into three survey stations. Each survey station focused on a reef flat habitat (1-3m), and a reef slope habitat (3-5m) (Figure 3), with a target of three replicate 50 m transects in each habitat for each station. The stations were randomly selected and distributed across the reef area, so as to get a proper representation of the MPA and Harvested areas.

SCUBA gear was used for surveys conducted on the reef slope, and snorkeling gear was used on the reef flat. Transects were laid parallel to the reef crest.

A GPS position was recorded at the beginning of each station (Appendix 1), and transects were laid parallel to the reef. Benthic habitat, finfish and invertebrate assessments were conducted on the same transects.

Figure 3: Survey Design
**Benthic Habitat Assessment**

The ‘Point Intercept Transect’ method was used to assess the benthic habitats. Essentially, a SCUBA diver or snorkeler swims along the 50m transect line and records the benthic life-form categories and health directly below the transect line at 0.5m intervals. The transect lines are run across uniform depth, and following reef contours.

The substrate types were grouped into the following categories:

<table>
<thead>
<tr>
<th>Substrata/Life-form</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>SD</td>
</tr>
<tr>
<td>Rock</td>
<td>RC</td>
</tr>
<tr>
<td>Hard Coral</td>
<td>HC</td>
</tr>
<tr>
<td>Rubble</td>
<td>RB</td>
</tr>
<tr>
<td>Sponge</td>
<td>SP</td>
</tr>
<tr>
<td>Recently Killed Coral</td>
<td>RKC</td>
</tr>
<tr>
<td>Dead Coral</td>
<td>DC</td>
</tr>
<tr>
<td>Nutrient Indicator Algae</td>
<td>NIA</td>
</tr>
<tr>
<td>Bleached Coral</td>
<td>CBL</td>
</tr>
<tr>
<td>Soft Coral</td>
<td>SC</td>
</tr>
<tr>
<td>Silt/Clay</td>
<td>SI</td>
</tr>
<tr>
<td>Others</td>
<td>OT</td>
</tr>
</tbody>
</table>

**Table 1: Substrate and Lifeform Categories**

**Finfish and Invertebrate Assessments**

Using the same 50m transect line that was used for sampling benthic habitat composition, target fish and invertebrate populations were counted within a 5m wide corridor (centered on the transect line) along the transect line (Figure 4).
Observers swam at a constant speed and particular care was taken so as not to count the same fish or invertebrates twice, as they can move away from the diver along the transect. Length-size estimations of finfish and invertebrates were also recorded during the survey. Care was also taken to spend the same amount of time observing each part of the transect. The method is non-extractive and as such has no detrimental impact to fish and invertebrate populations in the area.

**Data processing and analysis**

MS Excel was used to store raw data collected as part of this study. The SPC raw data for surveys conducted in 2004 were unfortunately not accessible, so basic result comparisons were made in evaluating the confidence intervals between the two datasets, mean densities and biomass changes over time, through mining results presented in the SPC PROCFish report (2004).

All data were tested formally for normality. All fish, invertebrate and benthic data were found not to have a normal distribution. Therefore all analysis of these data was performed using non-parametric Wilcoxon’s signed-rank test in JMP version 5.0.1.2 statistical software package. These tests determined the probability (or p-values) of data sets being significantly different from each other. Those that exhibited a significant difference had a p-value of ≤ 0.05; and likewise those that showed no significant differences had a p-value of ≥ 0.05. Comparisons were also made between densities in the MPA and harvested areas.
The size, density and biomass of targeted fish and invertebrate populations were estimated and calculated; size was recorded in centimeters, and biomass was calculated using the length-weight relationship, \( a(L^b) \), where \( L \) = length in centimeters, and \( a \) and \( b \) as constants obtained from fishbase.org.

All data were entered and analyzed using JMP software and Microsoft Excel.

**RESULTS**

**Sampling Stations**

Finfish surveys were conducted on the Mali back reef area. A total of 6 stations were sampled on 9-12 of April 2014 (3 stations in MPA and 3 stations in Harvested area; Figure 5). **Note:** For each Station, there was a reef-slope and a reef-flat component; so dots technically represent two stations.

![Figure 5: Sampling stations in the Mali back reef MPA and Harvested Areas](image-url)
Finfish assessment results

A total of 25 families, 61 genera, 147 species and 7890 fish were recorded in the 12 stations and 36 transects of the back reef (See Appendix 1 for list of species). Only selected families were highlighted for analysis; these were families that were most dominant families recorded in the SPC, 2004 surveys of the same reef zone to allow comparative deductions. These families also showed high abundances in MPA and Harvested areas.

Predominant finfish families

Finfish results of the SPC (2004) surveys on the back-reef environment were dominated by three herbivorous families; Acanthuridae, Scaridae and Siganidae. Interestingly, The 2014 finfish trophic structure in the back-reef at Mali was also highly dominated by the same herbivorous fish families (Table 2).

The three families were represented by 40 species; particularly high biomass and abundance were recorded for *Ctenochaetus striatus, Acanthurus blochii, Siganus spinus, Chlorurus sordidus, Scarus psittacus, A. triostegus, Siganus doliatus* and *S. ghobban* (Table 2).

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>2004</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Density (fish/m²)</td>
<td>Biomass (g/m²)</td>
<td>Density (fish/m²)</td>
</tr>
<tr>
<td>Acanthuridae</td>
<td><em>Ctenochaetus striatus</em></td>
<td>0.11 ± 0.03 (27.5 fish/transect)</td>
<td>16.0 ± 2.9</td>
</tr>
<tr>
<td></td>
<td><em>Acanthurus blochii</em></td>
<td>0.02 ± 0.01 (5 fish/transect)</td>
<td>13.9 ± 4.8</td>
</tr>
<tr>
<td></td>
<td><em>Acanthurus triostegus</em></td>
<td>0.04 ± 0.01 (10 fish/transect)</td>
<td>3.2 ± 1.0</td>
</tr>
<tr>
<td>Scaridae</td>
<td><em>Chlorurus sordidus</em></td>
<td>0.08 ± 0.03 (20 fish/transect)</td>
<td>11.7 ± 3.2</td>
</tr>
<tr>
<td></td>
<td><em>Scarus psittacus</em></td>
<td>0.06 ± 0.02 (15 fish/transect)</td>
<td>9.3 ± 2.3</td>
</tr>
<tr>
<td></td>
<td><em>Scarus ghobban</em></td>
<td>0.01 ± 0.01 (2.5 fish/transect)</td>
<td>5.2 ± 1.7</td>
</tr>
<tr>
<td>Siganidae</td>
<td><em>Siganus spinus</em></td>
<td>0.09 ± 0.04 (22.5 fish/transect)</td>
<td>9.1 ± 3.9</td>
</tr>
<tr>
<td></td>
<td><em>Siganus doliatus</em></td>
<td>0.02 ± 0.01 (5 fish/transect)</td>
<td>3.5 ± 1.9</td>
</tr>
</tbody>
</table>

Table 2: Finfish mean densities in 2004 and 2014
Finnish mean density results suggest that there was a higher abundance of keystone herbivore species such as *Ctenochaetus striatus*, *Acanthurus triostegus* and *Siganus spinus* in 2004 than in 2014. Other species that included *Chlorurus sordidus*, *Scarus psittacus* and *Siganus doliatus* were in greater abundance in 2014. Biomass results of 2014 were higher for the following species; *Ctenochaetus striatus*, *Scarus psittacus*, *Scarus ghobban* and *Siganus doliatus*, possibly indicating larger fish sizes per square metre.

Carnivores were dominated by Serranidae, Mullidae and Labridae but present also were Lethrinidae, Lutjanidae and Haemulidae (see Figure 6 and Table 3). Chaetodontidae (Butterflyfish), which are excellent indicators of good reef health were recorded in very high densities at an average of 27.5 fish/transect (0.11 ± 0.01 fish/m²).

![Figure 6: Mean densities of dominant finfish families](image)
<table>
<thead>
<tr>
<th>Fish Family</th>
<th>Density (fish/m2)</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acanthuridae</td>
<td>32.1</td>
<td>3.9</td>
</tr>
<tr>
<td>Scaridae</td>
<td>45.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Siganidae</td>
<td>13.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Chaetodontidae</td>
<td>26.9</td>
<td>2.1</td>
</tr>
<tr>
<td>Serranidae</td>
<td>9.7</td>
<td>0.4</td>
</tr>
<tr>
<td>Mullidae</td>
<td>9.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Haemulidae</td>
<td>5.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Lethrinidae</td>
<td>6.3</td>
<td>0.8</td>
</tr>
<tr>
<td>Lutjanidae</td>
<td>3.8</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Table 3: Density values of finfish families

**Finfish total abundances: MPA vs Harvested area**

A two tailed t-test produced a high P-value = 0.7 (greater than 0.05) when comparing total abundances between MPA and Harvested areas (Table 4) There was no significant difference between Fish population abundance in the Harvested and MPA areas.

<table>
<thead>
<tr>
<th>Family</th>
<th>Harvested</th>
<th>MPA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butterflyfish</td>
<td>437</td>
<td>506</td>
<td>943</td>
</tr>
<tr>
<td>Emperor</td>
<td>90</td>
<td>132</td>
<td>222</td>
</tr>
<tr>
<td>Goatfish</td>
<td>142</td>
<td>179</td>
<td>321</td>
</tr>
<tr>
<td>Grouper</td>
<td>163</td>
<td>178</td>
<td>341</td>
</tr>
<tr>
<td>Parrotfish</td>
<td>747</td>
<td>847</td>
<td>1594</td>
</tr>
<tr>
<td>Rabbitfish</td>
<td>223</td>
<td>257</td>
<td>480</td>
</tr>
<tr>
<td>Snapper</td>
<td>56</td>
<td>74</td>
<td>130</td>
</tr>
<tr>
<td>Surgeonfish</td>
<td>500</td>
<td>623</td>
<td>1123</td>
</tr>
<tr>
<td>Sweetlips</td>
<td>105</td>
<td>88</td>
<td>193</td>
</tr>
<tr>
<td>Wrasse</td>
<td>422</td>
<td>423</td>
<td>845</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2885</strong></td>
<td><strong>3307</strong></td>
<td><strong>6192</strong></td>
</tr>
</tbody>
</table>

Table 4: Finfish family total abundances
Invertebrates assessment results

The fine-scale assessment of invertebrate populations were conducted on the same belt transects used for the finfish survey. 36 transects in total, divided between the MPA and Harvested area of the Mali back reef. Primary comparisons were made against SPC PROCFish (2004) invertebrate survey results, to assess observable change over time (Table 5).

Note that due to project time restrictions and inaccessibility to the SPC PROCFish (2004) original invertebrate raw data, comparative analysis was limited to only comparing WWF (2014) survey results against results and values presented in the PROCFish report.

An additional invertebrate survey was conducted by SPC in 2009 in Mali, these results are also available in the 2004 report, so comparisons will also include these results.

Number of species recorded

<table>
<thead>
<tr>
<th>Species Group</th>
<th>2004</th>
<th>2009</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crustaceans</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Bivalves</td>
<td>7</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Gastropods</td>
<td>14</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Seacucumbers</td>
<td>14</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Starfish</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Urchins</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total No.</strong></td>
<td><strong>43</strong></td>
<td><strong>40</strong></td>
<td><strong>19</strong></td>
</tr>
</tbody>
</table>

Table 5: Number of species recorded in the three datasets

In 2014, sixteen species groupings (groups of species with a genus) were counted in the Mali back reef area, significantly lower than the other 2 datasets. Main comparisons were made between Bivalves and Seacucumber groups; these results are briefly presented below.
**Bivalves**

The elongate clam, *Tridacna maxima*, and the fluted clam, *T. squamosa*, were both noted in the 2003 and 2009 surveys. 2014 surveys also records the presence of *Tridacna maxima* and *Tridacna squamosa* in the fine-scale assessments (36 transects), but in lower abundances (Table 6).

<table>
<thead>
<tr>
<th>Year</th>
<th><em>Tridacna maxima</em> (Ind/ha)</th>
<th><em>Tridacna squamosa</em> (Ind/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>143.9 ±40.3</td>
<td>67.7 ±15.6</td>
</tr>
<tr>
<td>2009</td>
<td>83.3 ±41.7</td>
<td>83.3±41.7</td>
</tr>
<tr>
<td>2014</td>
<td>0.008±0.003</td>
<td>Highly insignificant value</td>
</tr>
</tbody>
</table>

Table 6: Relevant densities of dominant bivalve species

Although *Tridacna maxima* counts were made in the 36 transects (n = 25), these were highly insignificant compared to the two previous surveys. Broad-scale sampling also noted the presence of these clam species; results are available in the BDM (2014) report.

**Seacucumbers**

Species presence and density were determined through broad-scale (refer to Mali BDM report, 2014) and fine-scale assessments. In 2003, despite the wide range of environments found in the vicinity of Mali, only 11 species of commercial sea cucumber and one indicator species were recorded during in-water assessments. In 2009, the same numbers of 11 species of sea cucumbers were recorded.

In 2014, only eight species of seacucumbers were recorded. This does not mean that other species were absent from the back reef area, but that their density was too low to ensure detection during the survey. Generally, seacucumber diversity and abundance was found to be higher inside the MPA (Figure 7).
Results from the invertebrate surveys conducted on the Mali back reef in 2014 show an overall decrease in relative abundances of most invertebrate families, when compared to results of the 2003 and 2009 surveys. Slight improvement in density was recorded inside the MPA compared to the harvested zones, which is positive; however, the stock level is still too poor for fishing. A continued decline in stock is bound to occur if no proactive management approach is taken.
Habitat assessment results

Benthic composition of the back reef habitat suggested that the dominant life-form consisted of hard coral cover (0.25±0.01), followed by rubble (0.19±0.02), sand (0.09±0.01) and rock (0.08±0.01). Recently killed coral and dead coral was also recorded (Figure 8).

![Graph showing benthic lifeform density](image)

**Figure 8: Benthic composition of lifeforms on Mali back reef**

Comparing 2014 and 2004 benthic habitat data, it is evident that there are changes in percentage cover over the ten years; particular decrease in percentage cover was noted in rubble and rock. A slight increase in percentage cover was recorded for hard coral cover, soft coral and sand (Table 7).
Table 7: Percentage habitat cover in 2004 and 2014

Percentage habitat cover in the 2014 survey of the Mali back reef area show that there is a higher cover of hard coral (HC) and (SC) in the MPA than in the harvested area. Similarly there is a corresponding higher percentage of cover dead coral (DC), recently killed coral (RKC) and nutrient indictor algae (NIA) in the harvested area, than in the MPA (Table 8). The high P-value = 0.96 (greater than 0.05) nevertheless indicated that there is no significant difference in benthic habitat cover between MPA and harvested areas.

Table 8: Percentage habitat cover in MPA and Harvested area
DISCUSSION & CONCLUSION

The assessment indicated that the overall status of the finfish resources in the Mali back reef area has changed very little over the past 10 years. Comparative analysis also implies that there was no significant difference between fish population abundances (p = 0.7) in the MPA and Harvested area. Notable observations nevertheless show that herbivorous families that were dominant in 2004 were also dominant in 2014; these were Acanthuridae (Surgeonfish), Siganidae (Rabbitfish) and Scaridae (Parrotfish). Targeted food species such as Ctenochaetus striatus, Acanthurus triostegus and Siganus spinus decreased in relative density over time, probably suggesting continuous fishing pressure (regardless of size).

Biomass of Ctenochaetus striatus, Scarus psittacus, Scarus ghobban and Siganus doliatus was relatively higher in 2014 than in 2004 which may possibly be attributed to the higher coral cover, which is obviously food and shelter for most species - and possibly an indicator of MPA effectiveness. High coral cover could also be related to the high presence of Chaetodontidae (Butterflyfish) (27.5 fish/transect) in the Mali back reef, as the abundance and species richness of Chaetodons are usually highly correlated with coral cover.

Carnivores such as Serranidae (Grouper) and Mullidae (Goatfish) were dominant in the 2014 survey, probably due to the predominant hard bottom habitat (coral, rubble and rock) and MPA presence. Lethrinidae (Emperor) together with Lutjanidae (Snapper) were among the most frequently caught fish throughout the four villages (Mali CPUE report, 2010) and therefore showed the lowest relative densities.

With the exception of a few species, the low overall finfish relative abundances and insignificant changes over time could also be indicative of poor MPA management and enforcement.

Invertebrate survey results showed a significant decrease in species abundance and diversity in 2014, when compared to 2004 and 2009 figures. Particular targeted and highlighted groups from the previous surveys were bivalves, namely Tridacna maxima and Tridacna squamosa and seacucumbers and both groups were represented but in significantly low densities, in 2014.

Habitat complexity and niche availability have a crucial role in affecting the distributions and relative abundances of invertebrates in a reef area; this may have affected invertebrate distribution in the Mali qoliqoli. SPC surveys (2004 and 2009) were conducted in three different
reef zones; coastal reef, back reef and outer reef compared to the 2014 surveys, which just focused only on the back reef area (due to time restrictions, site accessibility, personnel training etc.); this may have influenced the overall low abundance and diversity of invertebrates in the area.

Certain species of sea cucumbers are edible and considered a delicacy in many local communities. The decline in the fishery across most of the Mali back reef area may reflect uncontrolled harvesting of stocks and poaching from neighboring communities (Pers comm.: Leone, SCUBA dive operator and community member, 2014); in fact the most targeted invertebrate species are *Stichopus chloronatus*, *Holothuria edulis* and *Holothuria atra* (Mali CPUE report, 2010) followed by bivalves and rock lobsters. Low levels of recruitment may also be a contributing factor to the low levels of distribution and abundances of populations; sampling and observer error could also have influenced survey results. For future work, Sea cucumber declines could be investigated through creel and market surveys, which would help with management efforts and explaining decreasing populations.

General observations indicate that inspite of insignificant changes in species density over time, relative abundances of finfish, invertebrates and hard coral cover recorded during the back reef surveys in April 2014 are comparatively higher in the MPA than in the adjacent harvested area. The MPA seems to have a positive impact on the Mali back reef area on a spatial scale; however in assessing change over time it is clearly evident that changes in species densities are too low to confirm MPA effectiveness.
OVERALL RECOMMENDATIONS

Based on the survey results, the following general recommendations are suggested for more effective and sustainable marine resource management for the Mali community:

1. Clear demarcation of MPA boundaries and consistent policing of the qoliqoli would potentially reduce poaching activity and unregulated harvesting.

2. Harvesting of marine resources for family income is high priority for communities in the Cokovata qoliqoli. Perhaps, developing potential alternative income generating opportunities, such as developing Ecotourism projects based on available resources such as Dive tours, snorkeling trail in the MPAs, coral/mangrove planting programmes, home stays, handicraft etc. will help reduce harvesting pressure on the qoliqoli.

3. Some coastal communities in Nadroga and other sites in Fiji have implemented ‘temporary’ MPAs that allow for rotational harvest of marine resources. During special occasions such as feasts, and village ‘soli’ the ban on the temporary MPAs are lifted, usually for 2 or 3 days, and fisherfolk harvest in these areas. This temporary MPAs are usually adjacent to the permanent MPAs, so fish and invertebrates usually spillover into the temporary MPAs, ensuring a good supply of stock for harvest. This method reduces poaching and harvesting pressure on the permanent MPAs; perhaps one worth adopting at Mali.

4. Good governance and firm leadership probably needs to be revived in the Mali district because this affects the entire system. The success of community management objectives relies heavily on the degree and strength of governance. The vision and purpose of establishing MPAs needs to be clearly communicated and accepted by all communities in the Cokovata qoliqoli, to ensure effective management.

5. In addition, communities need to know their rights to their resources and their ownership boundaries. Awareness and reviews of current environmental, land management, and fisheries law for Fiji legislation should aid local communities in reducing environmental threats, providing the legislative framework within which
resources can be managed. A critical step in this process is explaining the reasoning behind the respective legislations to the communities.

6. Threat reduction assessments (TRA) may not necessarily be qualitative, it can nevertheless be used as a tool that assists communities in identifying acute and chronic stresses to the environment, so that appropriate responsive actions could be taken for mitigation and adaptation.

7. Encourage and create awareness in other coastal communities on the findings of this work, lessons learnt and the importance of effectively establishing, monitoring and managing MPAs. The use of this dataset though limited, may be used towards improving resource management in other coastal communities around Fiji.

8. Proper outlining of MPA management objectives and policies need to be documented, gazetted and circulated throughout relevant communities, stakeholders and authorities for recognition and endorsement. This would strengthen the enforcement procedures.

9. This research is a comparative survey of the 2004 survey conducted by SPC in Mali; taking into account the magnitude of this survey this work is therefore only the second of its kind, building from the baseline survey established in 2004. The results of this survey may therefore be preliminary because of limited time, replication and a limited comparison to a single dataset. A recommendation for future research would be for the use of more replicates, and the comparison of more datasets for greater statistical confidence in the outcomes.
REFERENCE


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**Grand Total**  
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