Biological Survey Report

Mali District, Macuata

April, 2014

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INTRODUCTION

Inspite 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).

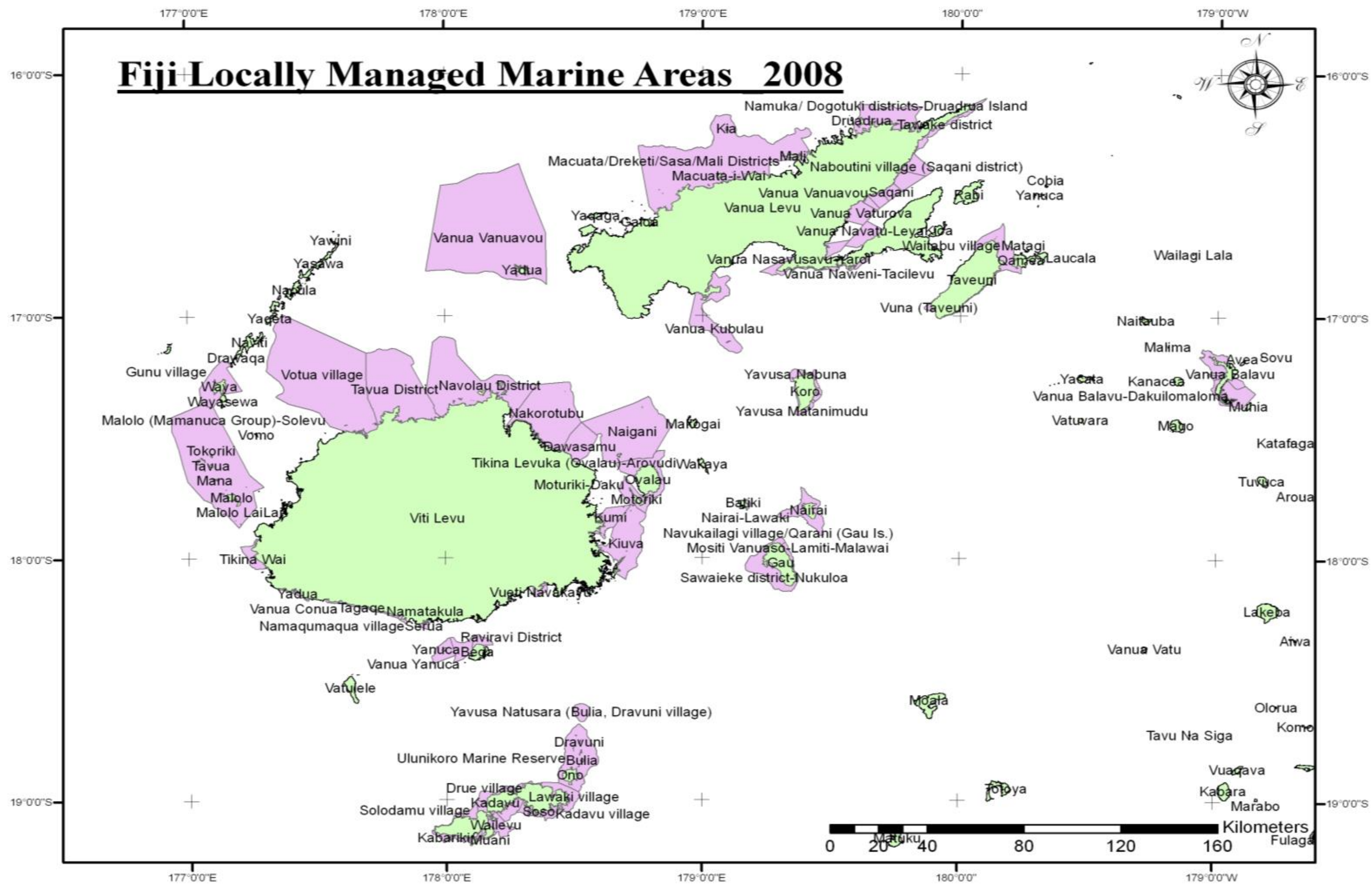

Figure 1: FLMMA sites in Fiji

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.

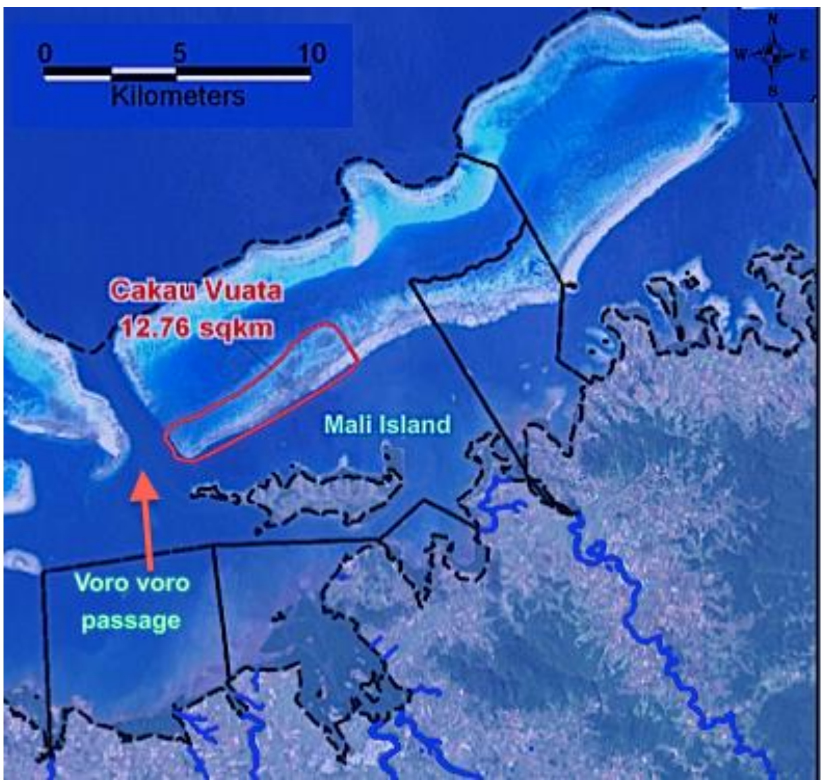

Figure 2: Mali site showing MPA boundary

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.

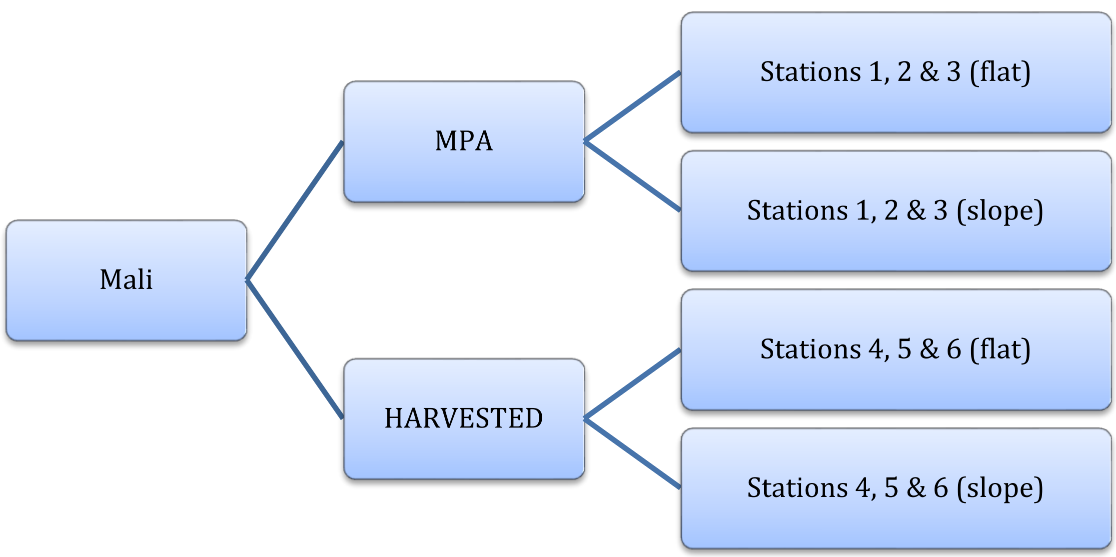

Figure 3: Survey Design

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:

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

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).

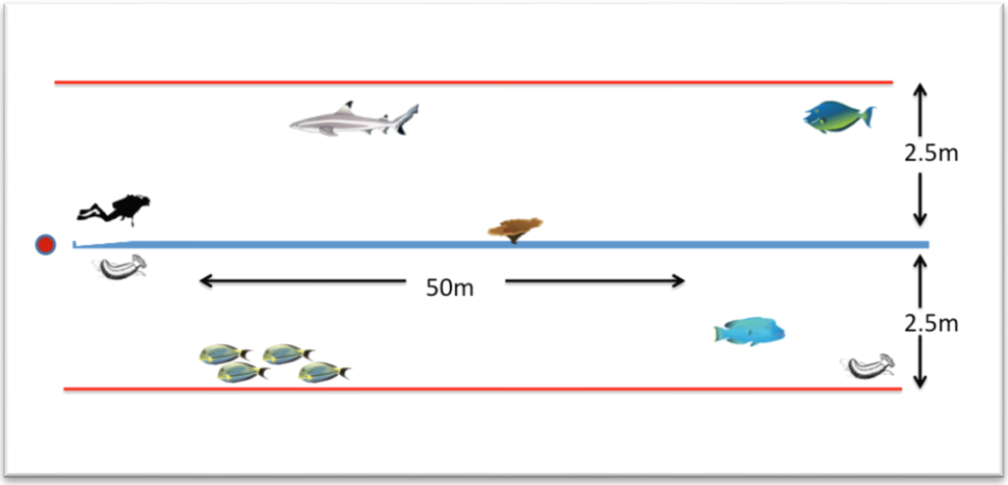

Figure 4: Belt Transect for Finfish, Invertebrates and Habitat Assessment

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). <u>Note:</u> For each Station, there was a reef-slope and a reef-flat component; so dots technically represent two stations.

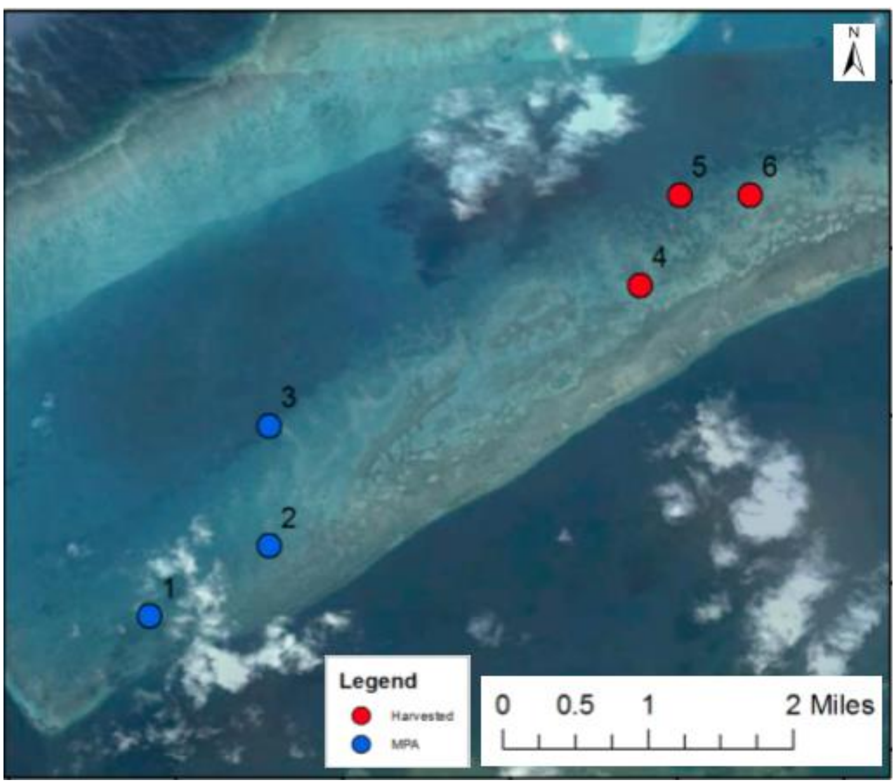

Figure 5: Sampling stations in the Mali back reef MPA and Harvested Areas

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).

FINFISH		2004		2014	
Family	**Species**	**Density (fish/m2)**	**Biomass (g/m2)**	**Density (fish/m2)**	**Biomass (g/m2)**
Acanthuridae	*Ctenochaetus striatus*	0.11 ±0.03 (27.5fish/transect)	16.0 ±2.9	0.03 ± 0.009 (7.5fish/transect)	17.6±0.03
	Acanthurus blochii	0.02 ±0.01 (5fish/transect)	13.9 ±4.8	0.01±0.004 (2.5fish/transect)	0.25±0.001
	Acanthurus triostegus	0.04 ±0.01 (10fish/transect)	3.2 ±1.0	0.02±0.005 (5fish/transect)	2.9±0.03
Scaridae	*Chlorurus sordidus*	0.08 ±0.03 (20fish/transect)	11.7 ±3.2	0.14±0.036 (35fish/transect)	3.35±0.01
	Scarus psittacus	0.06 ±0.02 (15fish/transect)	9.3 ±2.3	0.180±0.075 (45fish/transect)	17.6±0.05
	Scarus ghobban	0.01 ±0.01 (2.5fish/transect)	5.2 ±1.7	0.02±0.005 (5fish/transect)	21±0.06
Siganidae	*Siganus spinus*	0.09 ±0.04 (22.5fish/transect)	9.1 ±3.9	0.02±0.007 (5fish/transect)	4.8±0.05
	Siganus doliatus	0.02 ±0.01 (5fish/transect)	3.5 ±1.9	0.06±0.015 (15fish/transect)	16.3±0.07

Table 2: Finfish mean densities in 2004 and 2014

Finfish 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).

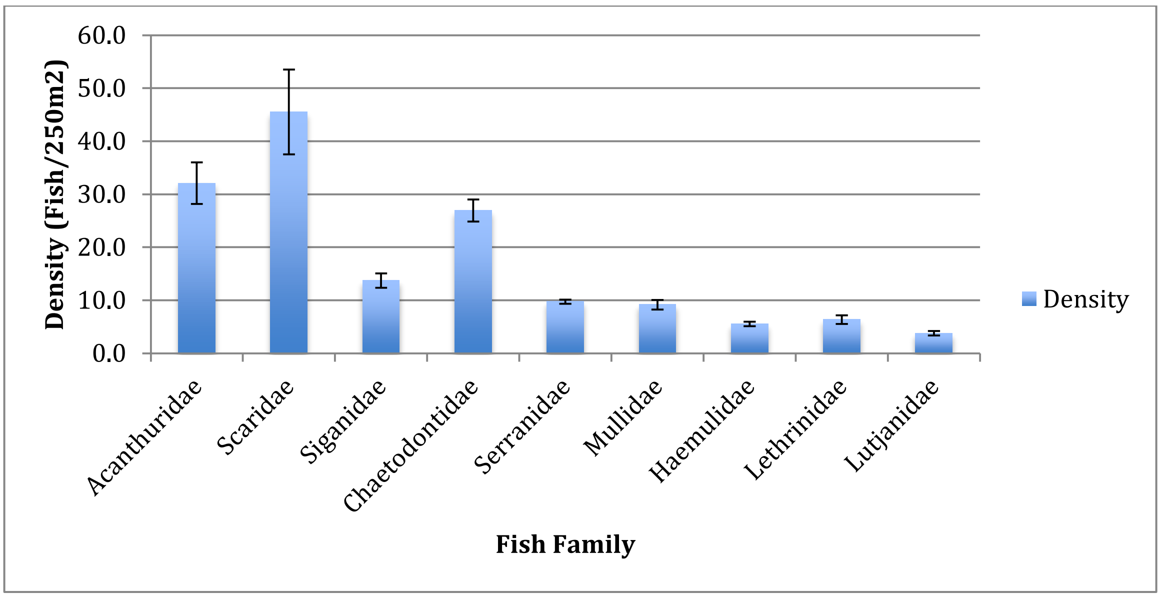

Figure 6: Mean densities of dominant finfish families

Fish Family	Density (fish/m2)	SE
Acanthuridae	32.1	3.9
Scaridae	45.5	8.0
Siganidae	13.7	1.4
Chaetodontidae	26.9	2.1
Serranidae	9.7	0.4
Mullidae	9.2	0.9
Haemulidae	5.5	0.4
Lethrinidae	6.3	0.8
Lutjanidae	3.8	0.4

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.

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

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

Species Group	2004	2009	2014
Crustaceans	1	1	1
Bivalves	7	8	3
Gastropods	14	15	4
Seacucumbers	14	11	8
Starfish	4	3	2
Urchins	3	2	1
Total No.	**43**	**40**	**19**

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).

Year	***Tridacna maxima (Ind/ha)***	***Tridacna squamosal (ind/ha)***
2003	143.9 ±40.3	67.7 ±15.6
2009	83.3 ±41.7	83.3±41.7
2014	0.008±0.003	Highly insignificant value

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).

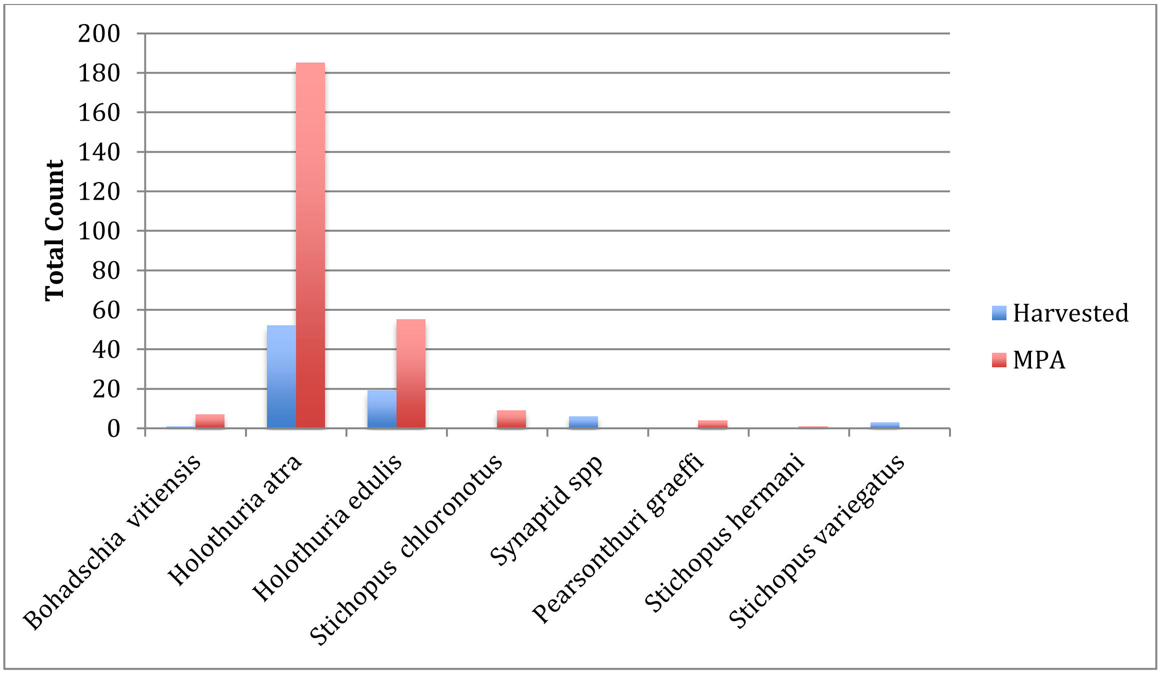

Figure 7: Total abundance of seacucumber species in MPA and Harvested area

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).

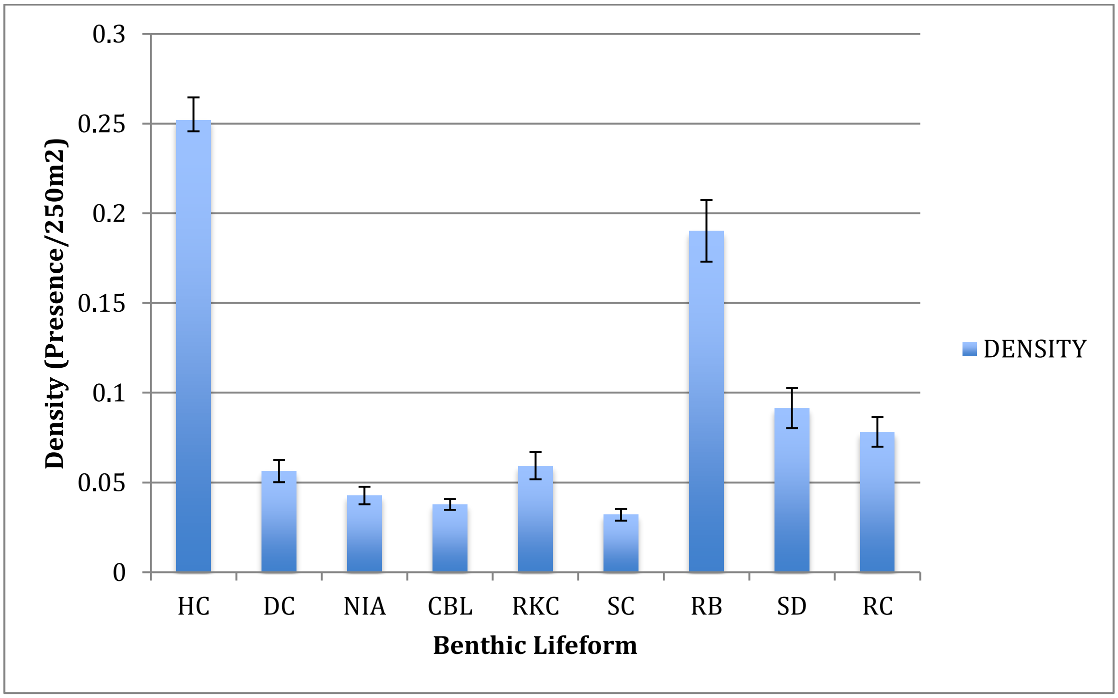

Figure 8: Benthic composition of lifeforms on Mali back reef

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).

Habitat (% cover)	2004	2014
SD (Sand)	17 ± 3	25.2±7.6
RB (Rubble)	30 ±3	19±1.7
RC (Rock)	43 ±4	7.8±0.8
HC (Hard Coral)	9 ±2	9.2±1.1
SC (Soft Coral)	1 ±0	3.2±0.3

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.

Benthic Habitat (% cover)	MPA	Harvested Area
HC	7.13	5.47
SC	0.51	0.47
DC	1.03	1.16
RKC	1.32	1.48
NIA	0.57	1.33

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.

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APPENDIX

Count of Family	Column Labels		
Row Labels	HARVESTED	MPA	Grand Total
Amberjack	18	18	36
Seriola rivoliana	18	18	36
Angelfish	54	54	108
Centropyge bicolor	18	19	37
Centropyge flavissmus	18	18	36
Pygoplites diacanthus	18	17	35
Blenny	21	17	38
Plagiotremus flavus	21	17	38
Butterflyfish	437	506	943
Chaetodon adiergastos	21	19	40
Chaetodon auriga	41	46	87
Chaetodon baronessa	20	17	37
Chaetodon citrinella	18	25	43
Chaetodon ephippium	43	70	113
Chaetodon falcula	20	17	37
Chaetodon lineolatus	23	17	40
Chaetodon lunula	18	18	36
Chaetodon lunulatus	34	43	77
Chaetodon mertensii	18	21	39
Chaetodon ocellicaudus	20	17	37
Chaetodon rafflesi	20	23	43
Chaetodon semeion	18	37	55
Chaetodon trifascialis	19	17	36
Chaetodon uluitensis	20	25	45
Chaetodon vagabundus	25	29	54
Heniochus acuminatus	21	26	47
Heniochus chrysostomus	20	21	41
Heniochus monoceros	18	18	36
Damselfish	455	344	799
Abudefduf beagalenus	22	17	39
Abudefduf sexfasciatus	20	17	37
Amphiprion chrysopterus	18	19	37
Chromis alphs	18	17	35
Chromis caudalis	37	17	54
Chromis fumea	18	20	38
Chrysiptera brownriggii	18	31	49
Chrysiptera talboti	21	17	38
Chrysiptera cyanea	23	17	40
Chrysiptera triancta	28	17	45
Dascyllus aruanus	18	17	35
Dischistodus pseudochrysopoecilus	18	36	54

Plectoglyphidodon melas	54	17	71
Pomacentrus littorale	55	17	72
Pomacentrus similus	22	17	39
Pomacentrus yoshii	20	17	37
Stegastus higricans	27	17	44
Stegastus obreptus	18	17	35
Emperor	90	132	222
Lethrinus harak	18	19	37
Lethrinus microdon	18	17	35
Lethrinus obsoletus	18	20	38
Monotaxis grandoculis	18	55	73
Monotaxis heterodon	18	21	39
Goatfish	142	179	321
Mulloidichthys flavolineatus	18	20	38
Parupeneus barberinoides	20	31	51
Parupeneus barberinus	25	41	66
Parupeneus cyclostomus	18	29	47
Parupeneus indicus	18	23	41
Parupeneus multifasciatus	25	18	43
Parupeneus pleurostigma	18	17	35
Grouper	163	178	341
Cephalopholis miniata	18	21	39
Epinephelus areolatus	18	17	35
Epinephelus caeruleopunctatus	18	18	36
Epinephelus corallicolla	18	18	36
Epinephelus hexagonatus	18	19	37
Epinephelus maculatus	19	17	36
Epinephelus merra	18	34	52
Epinephelus polyphekadion	18	17	35
Plectropomus areolatus	18	17	35
Jack	38	35	73
Carangoides ferdau	19	18	37
Caranx papuensis	19	17	36
Moorish idol	18	17	35
Zanclus cornatus	18	17	35
Parrotfish	747	847	1594
Chlororus bleekeri	40	101	141
Chlororus sordidus	149	110	259
Hipposcarus longiceps	55	38	93
Scarus dimidiatus	52	53	105
Scarus flavipectoralis	43	17	60
Scarus frenatus	22	66	88
Scarus ghobban	18	26	44
Scarus globiceps	22	20	42
Scarus koputea	19	17	36

Scarus niger	23	36	59
Scarus oviceps	29	17	46
Scarus psittacus	159	177	336
Scarus quoyi	18	22	40
Scarus rivulatus	25	57	82
Scarus schlegeli	73	90	163
Pufferfish		1	1
Arothron nigropunctatus		1	1
Rabbitfish	223	257	480
Siganus argentus	18	17	35
Siganus doliatus	56	72	128
Siganus guttatus	30	35	65
Siganus punctatissimus	18	21	39
Siganus punctatus	19	23	42
Siganus spinus	19	29	48
Siganus stellatus	27	17	44
Siganus vermiculatus	18	26	44
Siganus virgatus	18	17	35
Shark	18	17	35
Carcharinus melanopterus	18	17	35
Snapper	56	74	130
Lutjanus ehrenbergii	20	18	38
Lutjanus gibbus	18	32	50
Lutjanus semicinctus	18	24	42
Soldierfish	36	59	95
Myripristis berndti	18	27	45
Myripristis hexagona	18	32	50
Spinecheek	43	41	84
Scolopsis bilineatus	25	22	47
Scolopsis lineatus	18	19	37
Squirrelfish	62	82	144
Neoniphon opercularis	20	17	37
Sargocentron microstoma	18	22	40
Sargocentron spiniferum	24	43	67
Surgeonfish	500	623	1123
Acanthurus auranticavus	78	143	221
Acanthurus nigrofuscus	49	53	102
Acanthurus blochii	18	29	47
Acanthurus grammoptilus	29	17	46
Acanthurus pyroferus	18	24	42
Acanthurus thompsoni	23	17	40
Acanthurus triostegus	18	27	45
Acanthurus xanthopterus	27	28	55
Ctenochaetus striatus	126	147	273
Naso lituratus	19	22	41

Naso thynnoides	18	17	35
Naso unicornis	18	30	48
Zebrasoma rostratum	19	17	36
Zebrasoma scopas	19	22	41
Zebrasoma veliferum	21	30	51
Sweetlips	105	88	193
Plectorhinchus gibbosus	18	17	35
Plectrohichus vittatus	19	17	36
Plectrohinchus chaetodonoides	32	19	51
Plectrohinchus pinchus	18	18	36
Plectrohinchus vittatus	18	17	35
Tetradontidae	18	16	34
Arothron nigropunctatus	18	16	34
Trevally	18	18	36
Scomberoides commersonnianous	18	18	36
Triggerfish	72	73	145
Balistapus undulatus	18	19	37
Balistoides conspicillum	18	19	37
Pseudoballistes flavimarginatus	18	17	35
Rhinecanthus aculeatus	18	18	36
Trumpetfish	18	17	35
Aulostomus chinensis	18	17	35
Wrasse	422	423	845
Cheilinus chlorurus	27	21	48
Cheilinus fasciatus	21	30	51
Cheilinus undulatus	24	27	51
Cheilinus lunulatus	18	18	36
Cheilinus trilobatus	21	31	52
Epibulus insidiator	22	21	43
Gomphosus varius	19	17	36
Halichoeres hortulanus	22	22	44
Halichoeres melanochir	18	19	37
Halichoeres nigrescens	18	19	37
Halichoeres podostigma	18	19	37
Halichoeres rubricephalus	18	19	37
Halichoeres solorensis	25	17	42
Halichoeres trimaculatus	20	17	37
Hemigymnus melapterus	33	30	63
Labroides dimidiatus	22	17	39
Oxycheilinus celebicus	18	21	39
Oxycheilinus pimaculatus	22	17	39
Thalassoma hardwicke	36	41	77
Grand Total	**3774**	**4116**	**7890**