

**Baseline and general stock monitoring survey of  
Motunikeasulua Reefs, Cakauvakababa-i-Yata Reef. , Nakubu Reef - East lagoons and reef flat  
Yakauke Reef. off-shore from Lautoka : August 12 - 14 2003**

**Report by**

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## 1.0 Introduction

### Objectives:

- General benthic aquarium products survey of selected central reefs.

### Survey methods:

- Point intercept
- Belt transect
- Swim Transect

## 2.0 Site locations

Reef areas in the center of the Walt Smith International collecting areas. Expanded chart of areas found in (Lovell Sept. 2002).

The survey sites were on the reefs of Cakauvakababa-i-Yata Rf.; Motunikeasulua Rfs.; Nakubu Rf. and Yakauke Rf.

The reef areas of Cakauvakababa-i-Yata Rf. and Motunikeasulua Rfs. are located in the center of the collecting area 11-12 miles from shore. The area surveyed on Nakubu Rf. and Yakauke Rf. are more inshore being 5-6 miles offshore.

The Motunikeasulua Rfs., both west and east are in Zone 4 is the area of highest collection. They are unique in that the reefs are represented by highly elongate reefs, which form narrow reef flats. These extend as two lines of reef of 11 km (western) and 10 km (eastern). At the southwest end of the western reef it breaks up into a series of reef patches. The same occurs at the northern portion of the eastern reef.

Adjacent this area is Zone 5 which is a series of reef areas the largest of which is Cakauvakababa-i-Yata Rf. This is the site of coral farm no.3 and an area of permanent transect. Other reefs in the group are Cakau-ni-Sucuwalu Rf., Yamotuyamotu-i-Cakau Drua, Vunaqiliqili Rf. and north reef area of Nakubu Rf.

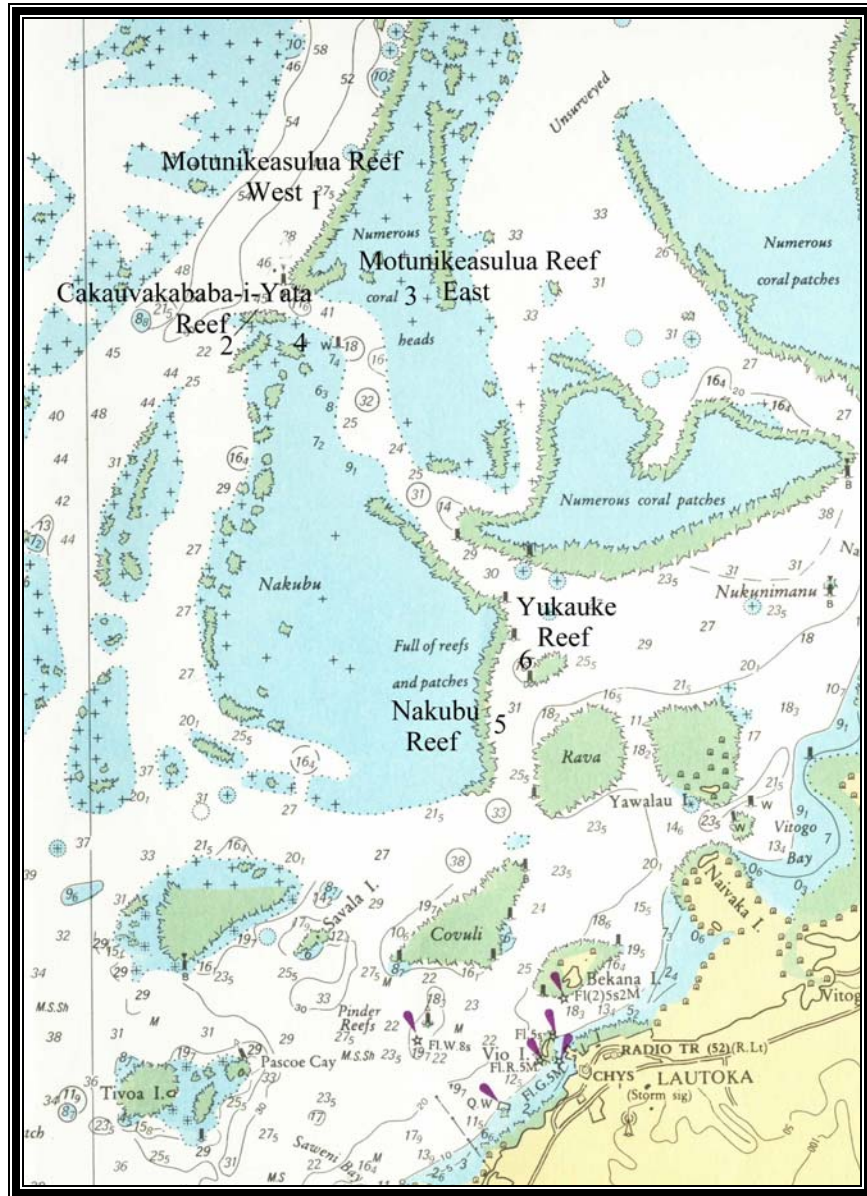
The area survey closest to the mainland is Nakubu Rf. where as part of Zone 6 is comprised of three broad complex reefs with substantial reef flat areas and extensive lagoons containing reef patches and ridges. These large reefs Nakubu Rf., Vakarale Rf. and Cakau Udu Levu Rf.

The last reef surveyed in this session was Yakauke Rf. in Zone 7. This zone is an inshore platform reefs the nature of which is more conditioned by the terrestrial conditions of the Viti Levu represent. Other reefs in this group are Savala I., Covuli Rf., Rava Rf., Yawalo Rf. and island, Nukunimanu Rf., and Malevu Rf. The reefs are characterised by shallow lagoons and broad reef flats. These reefs have a large source of soft coral collecting areas.

In all cases the reef flat areas are probably exposed at extreme low water spring tides. The Nakubu Rf. appears to exhibit more exposure with a boulder strewn reef crest margining small, shallow ponds. Lagoons are present and embedded in the reef flat with greater ponded depth of 1.2m.

The objective of the survey was to assess the general nature of the reefs. Point intercept transects were run to assess reef health.

**Figure 1. Map of the central collecting area and locations of survey sites.**

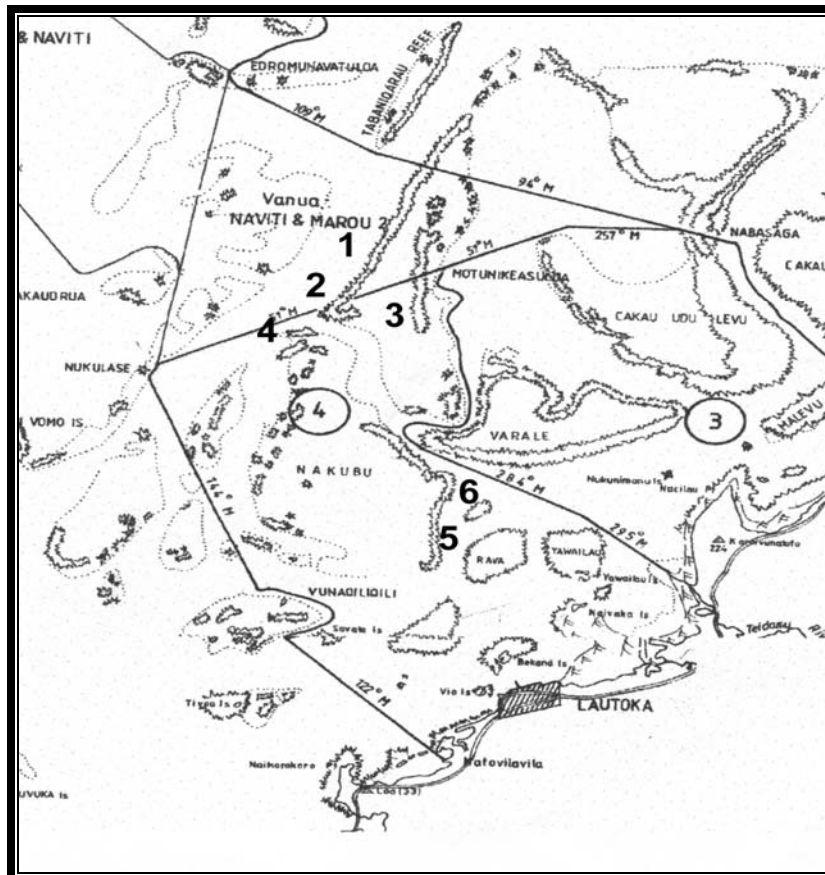


**Table 1. Location of transect assessment**

Chart No.	Reef Zone	Reef No.	Trans. No.	Reef Names	Latitude	Longitude	Date of survey
1	Central	8		Motunikeasulua Reef West	17 <sup>0</sup> 25.29' S	177 <sup>0</sup> 23.31'E	Tues. August 12, 2003
2	“	10	Permanent transect	Cakauvakababa -i-Yata Rf.	17 <sup>0</sup> 26.00'S	177 <sup>0</sup> 21.95'E	Wed. August 13, 2003
3	“	9		Motunikeasulua Reef East	17 <sup>0</sup> 25.42' S	177 <sup>0</sup> 24.58'E	Tues. August 12, 2003
4	“	10		Cakauvakababa -i-Yata Rf.	17 <sup>0</sup> 26.00'S	177 <sup>0</sup> 21.95'E	Wed. August 13, 2003
5	Mid-shore	13		Nakubu Reef - East lagoons and reef flat	17 <sup>0</sup> 32.33'S	177 <sup>0</sup> 25.16'E	Thurs. August 14, 2003
6	Inshore	18		Yakauke Rf.	17 <sup>0</sup> 31.26'S	177 <sup>0</sup> 25.93'E	Thurs. August 14, 2003

### 3.0 Area of sample

**Figure 2. Qoliqoli boundaries**

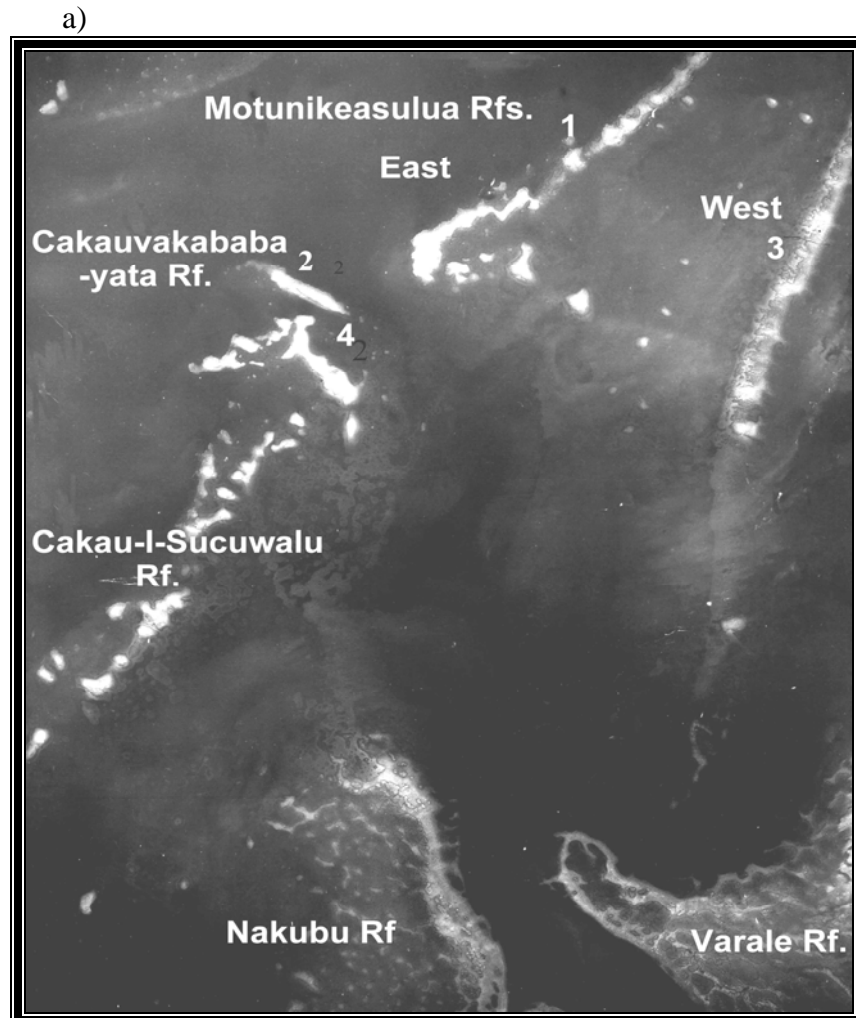


**Table 2. Area assessment of the central collection area reefs sampled.**

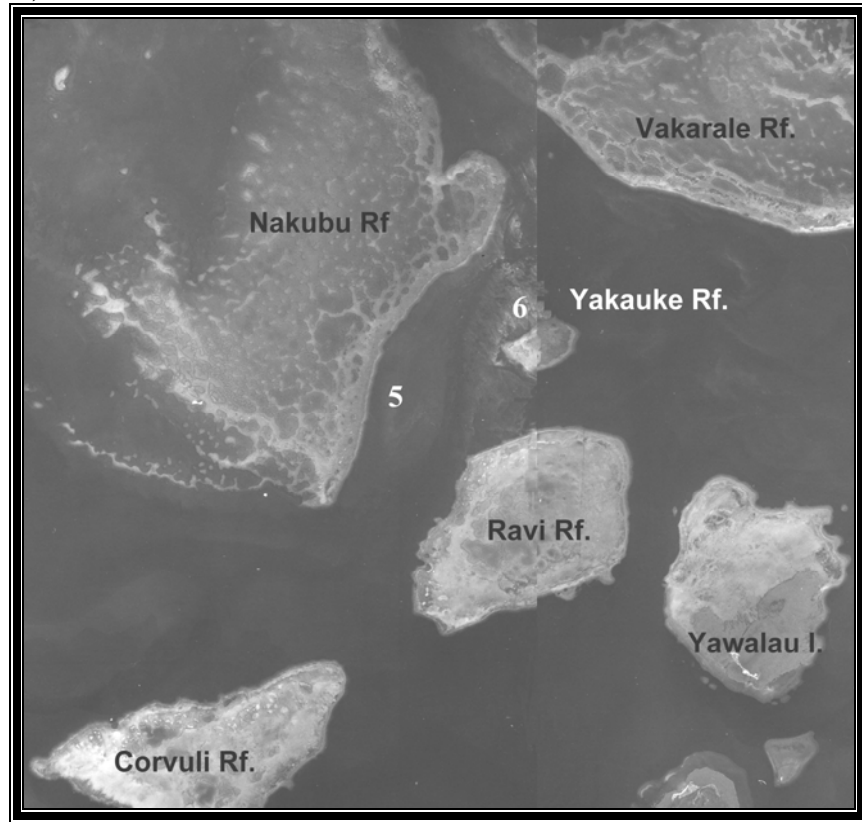
Name	Total reef area (ha)
Motunikeasulua Rf. west	210
Motunikeasulua Rf. east	99
Cakauvakababa-i-Yata Rf.	19
Nakubu Rf.	2,142
Yakauke Rf.	62
<b>Total</b>	<b>2,532</b>

The area calculation in Table 4 was done by measuring the reef surface as determined by aerial photography. This reef is only exposed at low water spring tide. Aquarium products are collected across the reef service.

**Figure 3a,b. Aerial photos of the central Walt Smith International collecting with survey site numbers.**



b)



## 4.0 General survey results

Table 3. Table of survey results for Motunikeasulua Rf. West (colony count are those which qualify for collection).

Transect	Acropora	Chlorodesmis	Echinopora	Favia	Favites	Fungia	Galaxea astreata	Goniastrea	Goniopora	Hydnophora rigida	Lobophyton	Merulina sp.	Montastrea	Montipora	Mycedium	Pavona	Porites cyclindrica	Platygyra	Pocillopora	Seriatopora	Symphylia	Turbinaria	Tubipora	Xenia spp.	Zooanthid	Total colonies
<b>Sum</b>	53	13	9	7	0	10	24	8	0	15	4	16	5	13	1	15	36	3	23	6	1	3	0	14	16	295
<b>Max.</b>	0	3	3	2	0	3	4	2	0	3	1	11	1	2	1	3	6	1	4	3	1	1	0	3	5	
<b>Min.</b>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Mean</b>	2.9	0.7	0.5	0.3	0	0.5	1.3	0.4	0	0.8	0.2	0.8	0.2	0.7	0.1	0.8	2.0	0.1	1.2	0.3	0.1	0.1	0.0	0.7	0.8	
<b>St. dev.</b>	1.7	1.0	0.7	0.6	0	0.9	1.7	0.7	0	1.0	0.4	2.6	0.4	0.7	0.2	1.1	2.3	0.3	1.5	0.8	0.2	0.3	0.0	1.2	1.5	

Sample 20x 2.5 transects (20m) =1000m<sup>2</sup>

Figure 4. Benthic assessment of Montunikeasulua Rf. west.

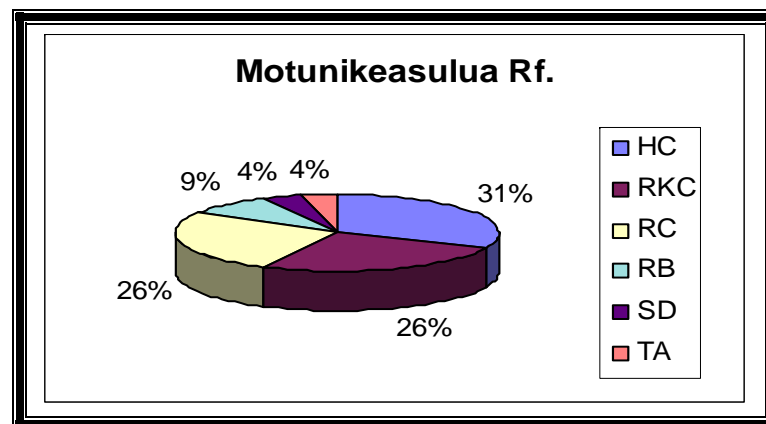


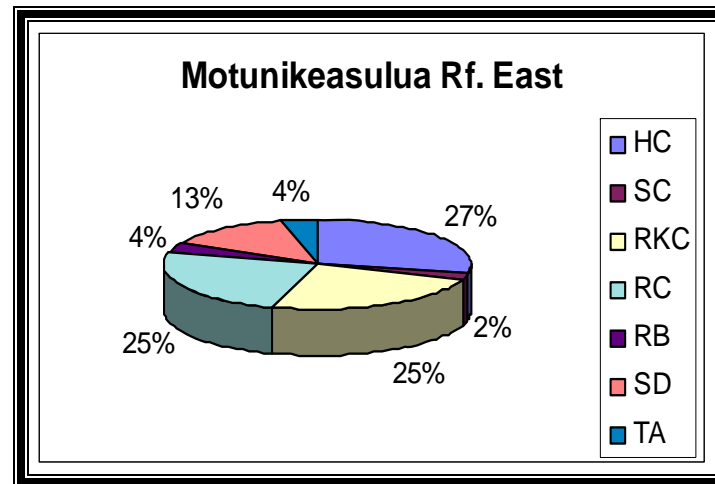


Table 4. Survey results for Motunikeasulua Rf. Eastern line reef west (side) Transect 3

Transect	Acropora	Chlorodesmis	Echinopora	Favia	Favites	Fungia	Galaxea astreata	Goniastrea	Hydnophora rigida	Lobophyton	Merulina sp.	Montastrea	Montipora	Mycedium	Pavona	Porites cyclindrica	Platygyra	Pocillopora	Seriatopora	Symphylia	Turbinaria	Tubipora	Xenia spp.	Zooanthid	Total colonies
Sum	42	5	2	7	2	7	29	1	4	0	1	0	9	0	2	97	6	21	2	1	1	0	6	2	247
Max.	0	2	1	3	1	3	10	1	2	0	1	0	2	0	1	20	2	6	2	1	1	0	4	2	
Min.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mean	2.0	0.2	0.1	0.3	0.1	0.3	1.6	0.1	0.2	0.0	0.1	0.0	0.5	0.0	0.1	4.9	0.3	0.9	0.1	0.1	0.1	0.0	0.3	0.1	
St. dev.	1.5	0.7	0.3	0.9	0.3	1.0	2.6	0.2	0.6	0.0	0.2	0.0	0.7	0.0	0.2	5.7	0.6	1.6	0.5	0.2	0.2	0.0	1.0	0.5	

Sample 20x 2.5 transects (20m) =1000m<sup>2</sup>

Figure 5. Benthic cover of Motunikeasulua Rf. East

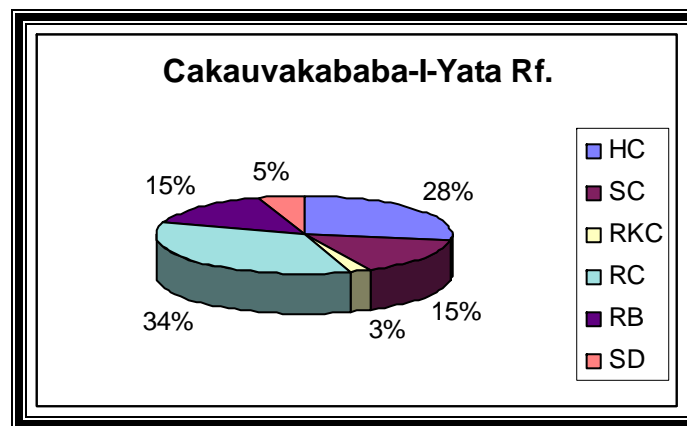


**Table 5. Table of survey results for Cakauvakababa-i-Yata Rf. - Transect 4**

Transect	Acropora	Chlorodesmis	Echinopora	Favia	Fungia	Galaxea astreata	Goniastrea	Hydnophora rigida	Lobophyton	Merulina sp.	Montastrea	Mycedium	Pavona	Porites cylindrica	Platygyra	Pocillopora	Seriatopora	Symphylia	Turbinaria	Tubipora	Xenia spp.	Zooanthid	Total colonies
<b>Sum</b>	142	0	15	4	9	54	1	11	7	11	0	1	1	0	1	30	0	0	1	0	1	10	299
<b>Max.</b>	20	0	6	2	2	8	1	2	2	8	0	1	1	0	1	6	0	0	1	0	1	10	38
<b>Min.</b>	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
<b>Mean</b>	7.9	0.0	0.9	0.2	0.5	3.0	0.1	0.8	0.4	0.7	0.0	0.1	0.1	0.0	0.1	1.7	0.0	0.0	0.1	0.0	0.1	0.6	
<b>St. dev.</b>	4.9	0.0	1.7	0.5	0.9	2.9	0.2	0.9	0.6	2.1	0.0	0.3	0.2	0.0	0.2	1.5	0.0	0.0	0.2	0.0	0.2	2.4	

Sample 18 x 2.5 transects (20m) =900m<sup>2</sup>

**Figure 6. Benthic cover of Cakauvakababa-i-Yata Rf.**



**Table 6. Survey results for Nakubu Rf. (SE margin).**

Transect	Acropora	Chlorodesmis	Echinopora	Favia	Favites	Fungia	Galaxea astreata	Goniastrea	Goniopora	Hydnophora rigida	Lobophyton	Merulina sp.	Montastrea	Montipora	Mycedium	Pavona	Porites cylindrica	Platygyra	Pocillopora	Seriatopora	Symphyllia	Turbinaria	Tubipora	Xenia spp.	Zooanthid	Total colonies
<b>Sum</b>	221	0	5	1	1	12	2	0	10	0	0	0	0	0	0	0	5	3	2	0	1	0	0	0	30	293
<b>Max.</b>	0	0	4	1	1	6	2	0	6	0	0	0	0	0	0	0	5	3	2	0	1	0	0	0	30	
<b>Min.</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Mean</b>	12.3	0.0	0.3	0.1	0.1	0.7	0.1	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.1	0.0	0.1	0.0	0.0	0.0	1.7	
<b>St. dev.</b>	22.7	0.0	1.0	0.2	0.2	1.5	0.5	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.7	0.5	0.0	0.2	0.0	0.0	0.0	7.1	

**Figure 7. Benthic cover on the reef flat of Nakubu Rf.**

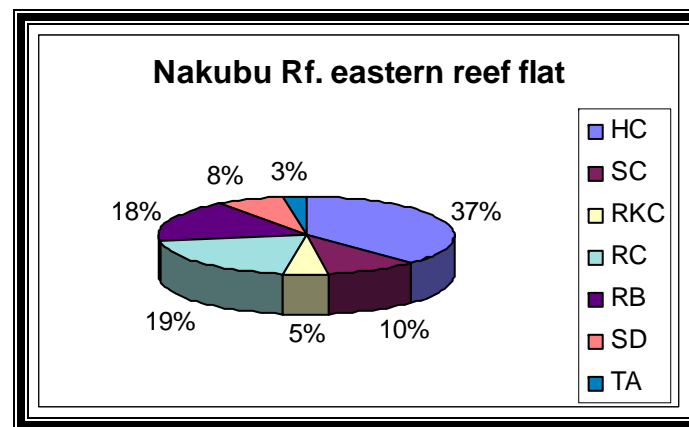


Table 7. Survey results for Yakauke Rf.

Transect	Acropora	Chlorodesmis	Echinopora	Favia	Favites	Fungia	Galaxea astreata	Goniastrea	Goniopora	Hydnophora rigida	Lobophyton	Merulina sp.	Montastrea	Montipora	Mycedium	Pavona	Porites cyclindrica	Platygyra	Pocillopora	Seriatopora	Symphylia	Turbinaria	Tubipora	Xenia spp.	Zooanthid	Total colonies
1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	4
2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
4	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
5	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
6	0	0	0	0	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
7	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4
8	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	5
9	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	5
10	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3	8
<b>Sum</b>	10	0	2	3	0	14	2	1	0	0	0	0	0	2	0	4	0	0	2	0	0	2	0	0	4	46
<b>Max.</b>	0	0	1	1	0	7	2	1	0	0	0	0	0	1	0	2	0	0	1	0	0	2	0	0	3	
<b>Min.</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Mean</b>	1.0	0.0	0.2	0.3	0.0	1.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.4	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.4	
<b>St. dev.</b>	0.8	0.0	0.4	0.5	0.0	2.5	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.8	0.0	0.0	0.4	0.0	0.0	0.6	0.0	0.0	1.0	

Figure 8. Benthic cover on Yakauke Rf.

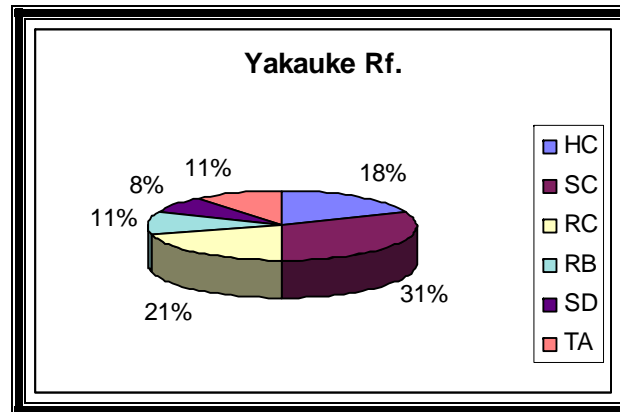


Table 8. Survey results for reef areas of Motunikeasulua Rf. (West and East), Cakauvakababa-i-Yata, Nakubu and Yakauke.

Transect	Acropora	Chlorodesmis	Echinopora	Favia	Favites	Fungia	Galaxea astreata	Goniastrea	Goniopora	Hyunopora rigida	Lobophyton	Merulina sp.	Montastrea	Montipora	Mycedium	Pavona	Porites cylindrica	Platygyra	Pocillopora	Seriatopora	Symphyllia	Turbinaria	Tubipora	Xenia spp.	Zooanthid	Total colonies
Sum	473	13	9	7		10	24	8		15	4	16	5	13	1	15	36	3	23	6	1	3	0	14	16	715
Max.	90	3	6	3	1	7	10	2	6	3	2	11	1	2	1	3	20	3	6	3	1	2	0	4	30	
Min.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mean	5.4	0.2	0.4	0.3	0.1	0.6	1.3	0.1	0.1	0.4	0.1	0.3	0.1	0.4	0.0	0.3	1.6	0.1	0.9	0.1	0.0	0.1	0.0	0.3	0.7	
St. dev.	11.2	0.6	1.0	0.6	0.2	1.3	2.2	0.4	0.8	0.7	0.4	1.5	0.3	0.6	0.2	0.7	3.4	0.5	1.4	0.5	0.2	0.3	0.0	0.8	3.4	

## **5.0 Environmental Influences: Coastal pollution sources and other issues in the Walt Smith Aquarium Fishery Area**

### **5.1 FSC Sugar Mill effluent**

The process of refining sugar yield substantial sugar-rich effluent which is discharged into the inshore water adjacent the small boat harbour. Weekly cleaning of the facility with caustic soda is discharged into the adjacent waters.

### **5.2 Natabua Sewage Outfall**

The grey water from the sewage treatment plant is discharged via an outfall at a depth of 20m. near the shipping channel 1km from the coast. The grey water is pretreated through a series of settlement ponds so is largely liquid. Assessment of the characteristics of this discharge is one of rapid dilution to ambient levels of nutrients and coliform levels.

### **5.3 South Pacific Distillery Effluent disposal**

The South Pacific Distillery effluent resulting from distillation called dunder is discharged through the Natabua sewage outfall. As above assessment of the characteristics of this discharge is one of rapid dilution to ambient levels of nutrients. Pollution from this source is confined to a relatively small of the coast.

### **5.4 Arsenic pollution**

Assessment of the coastal waters adjacent the Navutu area has revealed elevated levels of arsenic. The source has not been determined but the infusion of the metal into a milling company may be a likely source. This is an area of periodic fish kills.

### **5.5 Lautoka sewage outfall**

Grey water is discharged into the coastal waters to the west of the Lautoka Wharf.

### **5.6 Lautoka industrial effluents**

Periodic fish kills have occurred as the result of toxic discharges into the creek to the east of the city.

### **5.7 Other fish kills**

Periodic mass fish kills occasionally occurs to the west of the Lautoka wharf. The reason for these kills is uncertain but indicates a toxic pollution source.

In summary all of the above effects are coastal in origin and subject to a large dilution factor as there are long-shore currents. None of the effects of these pollutions are thought to extend into the offshore waters of the Walt Smith collecting area. Because of these pollutions, the Walt Smith International aquarium facility has to go well off-shore to obtain suitable water which is then treated through filtration and other purification.

## 5.8 Sensitive Areas

The reef areas within the Walt Smith collecting area range from inshore reefs to the off shore reefs which extend to the Yasawa island of Naviti. Within this range there are a series of reef types from nearshore patch reefs to open water line reefs. Some are reticulated with lagoons. All have interesting features and are luxuriant to varying degrees. None, however, would be considered sensitive in the sense that they are being damaged by the collection of aquarium products.

The buffer area established by Walt Smith International is from the southwest border of their collection area and extends into the Tui Vuda's qoliqoli to include Tivoa I., Vomo I. and Waya I., and south to Levuka and Tai Is. In this area only the collection of fish is allowed but there is no coral collection. ##### Check the validity of this#####.

There are no dive sites in the coral collection areas.

Fishing for food fish occurs throughout the collection area. Traditional arrangements for fishing permission as well as licensing through the Fisheries Department are required.

## 6.0 Status of the reef and the aquarium fishery stocks

The coral reef areas in the Walt Smith International collection area are in good health. There is no evidence of coral bleaching, coral disease, crown of thorns starfish proliferation or storm damage.

The collection areas were subject to moderate coral bleaching in 2000 but the coral assemblage appears to be healthy with no evidence of the bleaching death. The last cyclones to affect the collecting were : Joni 6-13 Dec. 1992; Kina Dec. 26- Jan. 5 1993; Oli 15-18 Feb. 1993; Gavin 4-11 Mar. 1997; June 3-5 May 1997.

Coral bleaching occurred during April-May 2000, and to a lesser extent during the same period in 2002.

The reef areas can be considered healthy on the basis of the lack of recently dead coral in the transect information. The variability in the percentage of living cover is expected given the normal variation in reef habitats. The predominance of the Acropora colonies is considered characteristic of a reef area recovering from the disturbance caused by coral bleaching.

Lovell E.R. (2002). Development of an Aquarium Fisheries Management Plan (AFMP) for live rock, corals and other benthos in the Walt Smith International collection areas.

## 7.0 Appendix: Survey results

Appendix 6.1: Table of survey results for Motunikeasulua Rf. West

Transect	Acropora	Chlorodesmis	Echinopora	Favia	Favites	Fungia	Galaxea astreata	Goniastrea	Goniopora	Hydnophora rigida	Lobophyton	Merulina sp.	Montastrea	Montipora	Mycedium	Pavona cylindrica	Platygyra	Pocillopora	Seriatopora	Symphylia	Turbinaria	Tubipora	Xenia spp.	Zooanthid	Total colonies	
<b>1</b>	8	0	1	0	0	0	4	0		0	1	0	0	1	0	0	0	3	0	0	0	0	0	1	19	
<b>2</b>	4	2	0	1	0	1	0	1		1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	12	
<b>3</b>	5	0	0	1	0	0	0	2		0	0	11	0	0	0	1	4	0	2	0	0	0	0	3	1	30
<b>4</b>	3	0	0	0	0	0	0	0		0	0	0	0	1	0	0	0	0	0	0	1	0	0	5	10	
<b>5</b>	4	0	1	0	0	1	0	0		1	0	0	1	0	0	0	0	1	0	2	0	0	0	0	11	
<b>6</b>	4	0	1	0		2	0	0		2	0	0	1	0	0	0	4	0	3	0	0	0	1	0	18	
<b>7</b>	3	1	0	1	0	0	0	0		2	0	0	0	1	0	0	0	0	0	0	0	0	0	1	9	
<b>8</b>	3	0	1	0	0	1	0	2		0	0	0	0	1	0	0	4	0	4	0	0	0	3	4	23	
<b>9</b>	2	3	0	2	0	0	4	0		0	0	1	0	0	0	2	0	0	3	0	1	0	0	0	18	
<b>10</b>	1	0	0	1	0	0	0	1		0	0	1	0	2	0	3	0	2	0	0	0	0	3	0	14	
<b>11</b>	4	1	1	0	0	0	0	1		2	0	0	0	1	0	0	5	0	0	0	1	1	0	2	19	



<b>12</b>	2	0	0	0	0	2	3	0		3	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	17
<b>13</b>	1	3	3	0	0	0	4	0		0	1	0	1	2	0	1	0	0	0	1	0	0	0	0	3	20
<b>14</b>	1	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<b>15</b>	2	0	0	1	0	3	4	0		0	1	0	0	1	0	2	4	0	4	0	0	0	0	0	0	22
<b>16</b>	2	1	1	0	0	0	3	1		2	0	0	1	2	0	2	4	0	3	0	0	0	0	0	1	23
<b>17</b>	3	0	0	0	0	0	2	0		0	1	0	0	1	1	0	5	0	0		0	0	0	2	0	15
<b>18</b>	1	2	0	0	0	0	0	0		2	0	3	0	0	0	3	0	1	2	0	0	0	0	0	0	14
<b>19</b>	2	0	1	1	0	0	3	0		0	0	0	1	2	0	0	3	0	0	1	0	0	0	2	1	17
<b>20</b>	3	1	0	0	0	0	1	0		0	0	0	0	0	0	2	0	0	3	0	0	0	0	0	0	10
<b>1000</b>	0																									
<b>Sum</b>	53	13	9	7	0	10	24	8		15	4	16	5	13	1	15	36	3	23	6	1	3	0	14	16	29 5
<b>Max.</b>	0	3	3	2	0	3	4	2		3	1	11	1	2	1	3	6	1	4	3	1	1	0	3	5	
<b>Min.</b>	1	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Mean</b>	2.9	0.7	0.5	0.3	0	0.5	1.3	0.4		0.8	0.2	0.8	0.2	0.7	0.1	0.8	2.0	0.1	1.2	0.3	0.1	0.1	0.0	0.7	0.8	
<b>St. dev.</b>	1.7	1.0	0.7	0.6	0	0.9	1.7	0.7		1.0	0.4	2.6	0.4	0.7	0.2	1.1	2.3	0.3	1.5	0.8	0.2	0.3	0.0	1.2	1.5	

Appendix 6.3. Table of survey results for Motunikeasulua Rf. Eastern line reef west (side)

Transect 3

Transect	Acropora	Chlorodesmis	Echinopora	Favia	Favites	Fungia	Galaxea astreata	Goniastrea	Hydnophora rigida	Lobophyton	Merulina sp.	Montastrea	Montipora	Mycedium	Pavona	Porites cylindrica	Platygyra	Pocillopora	Seriatopora	Symphyllia	Turbinaria	Tubipora	Xenia spp.	Zooanthid	Total colonies
1	3	0	0	0	0	0	5	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	14
2	4	2	0	3	0	0	3	0	0	0	0	0	2	0	0	4	1	3	0	0	1	0	0	0	23
3	3	0	1	0	0	3	0	1	0	0	0	0	1	0	0	9	0	0	0	0	0	0	0	0	18
4	3	1	0	0	0	0	3	0	1	0	0	0	1	0	0	0	2	0	2	0	0	0	0	0	13
5	1	0	0	1	0	0	0	0	2	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	6
6	3	2	0	0	0	0	0	0	1	0	1	0	2	0	0	0	1	1	0	0	0	0	2	2	15
7	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	4
8	2	0	0	1	0	3	1	0	0	0	0	0	1	0	0	6	0	0	0	0	0	0	4	0	18
9	2	0	0	0	0	0	10	0	0	0	0	0	0	0	0	20	0	2	0	0	0	0	0	0	34
10	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	12	0	1	0	0	0	0	0	0	15
11	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	10
12	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	15
13	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	11
14	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	8	0	2	0	0	0	0	0	0	13
15	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
16	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
17	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	2	0	1	0	0	0	0	8
19	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	0	0	0	0	0	0	7

<b>20</b>	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	1	0	0	0	0	0	0	13
<b>1000</b>																									
<b>Sum</b>	42	5	2	7	2	7	29	1	4	0	1	0	9	0	2	97	6	21	2	1	1	0	6	2	24 7
<b>Max.</b>	0	2	1	3	1	3	10	1	2	0	1	0	2	0	1	20	2	6	2	1	1	0	4	2	
<b>Min.</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Mean</b>	2.0	0.2	0.1	0.3	0.1	0.3	1.6	0.1	0.2	0.0	0.1	0.0	0.5	0.0	0.1	4.9	0.3	0.9	0.1	0.1	0.1	0.0	0.3	0.1	
<b>St. dev.</b>	1.5	0.7	0.3	0.9	0.3	1.0	2.6	0.2	0.6	0.0	0.2	0.0	0.7	0.0	0.2	5.7	0.6	1.6	0.5	0.2	0.2	0.0	1.0	0.5	

Appendix 6.4 Table of survey results for Cakauvakababa-i-Yata Rf. - Transect 4

Transect	Acropora	Chlorodesmis	Echinopora	Favia	Fungia	Galaxea astreata	Goniastrea	Hydnophora rigida	Lobophyton	Merulina sp.	Montastrea	Mycedium	Pavona	Porites cylindrica	Platygyra	Pocillopora	Seriatopora	Symphylia	Turbinaria	Tubipora	Xenia spp.	Zooanthid	Total colonies	
1	20	0	6	1	1	7	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	38
2	7	0	1	0	2	2	0		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	13
3	5	0	0	0	0	7	0	2	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	17
4	3	0	2	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	7
5	19	0	0	1	2	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	26
6	9	0	0	0	0	2	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	16
7	10	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	27
8	5	0	3	0	2	2	0	1	1		0		0	0	0	1	0	0	0	0	0	0	0	15
9	7	0	0	0	2	8	0		1		0		0	0	0	3	0	0	0	0	0	0	0	21

<b>10</b>	9	0	0	0	0	1	0	1	0	1	0		0	0	0	0	0	0	1	0	0	0	13
<b>11</b>	3	0	3	0	0	1	0		2		0		0	0	0	1	0	0	0	0	0	0	10
<b>12</b>	8	0	0	0	0	1	0		0	1	0	0	1	0	0	1	0	0	0	0	0	0	12
<b>13</b>	9	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	12
<b>14</b>	9	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	12
<b>15</b>	8	0		2		2	0	2	1	0	0	0				3	0	0	0	0	0	0	18
<b>16</b>	4	0	0	0	0	5	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	12
<b>17</b>	2	0	0	0	0	7	0		0	0	0	1	0	0	0	6	0	0	0	0	0	0	16
<b>18</b>	5	0	0	0	0	0	0	0	0	8	0	0	0	0	0	1	0	0	0	0	0	0	14
<b>Sum</b>	142	0	15	4	9	54	1	11	7	11	0	1	1	0	1	30	0	0	1	0	1	10	299
<b>Max.</b>	20	0	6	2	2	8	1	2	2	8	0	1	1	0	1	6	0	0	1	0	1	10	38
<b>Min.</b>	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
<b>Mean</b>	7.9	0.0	0.9	0.2	0.5	3.0	0.1	0.8	0.4	0.7	0.0	0.1	0.1	0.0	0.1	1.7	0.0	0.0	0.1	0.0	0.1	0.6	
<b>St. dev.</b>	4.9	0.0	1.7	0.5	0.9	2.9	0.2	0.9	0.6	2.1	0.0	0.3	0.2	0.0	0.2	1.5	0.0	0.0	0.2	0.0	0.2	2.4	

Appendix 6.5 Table of survey results for Nakubu Rf. (SE margin)

Transect	Acropora	Chlorodesmis	Echinopora	Favia	Favites	Fungia	Galaxea astreata	Goniastrea	Goniopora	Hydnophora rigida	Lobophyton	Merulina sp.	Montastrea	Montipora	Mycedium	Pavona	Porites cylindrica	Platygyra	Pocillopora	Seriatopora	Symphylia	Turbinaria	Tubipora	Xenia spp.	Zooanthid	Total colonies
1	14	0	1	0	0	2	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	22
2	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	30
3	26	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	58
4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
5	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
6	9	0	0	0	1	2	0	0	6	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	23
7	90	0	4	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98
8	6	0	0	1	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

<b>20</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Sum</b>	221	0	5	1	1	12	2	0	10	0	0	0	0	0	0	0	5	3	2	0	1	0	0	0	30	293
<b>Max.</b>	0	0	4	1	1	6	2	0	6	0	0	0	0	0	0	0	5	3	2	0	1	0	0	0	30	
<b>Min.</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Mean</b>	12.3	0	0.3	0.1	0.1	0.7	0.1	0	0.6	0	0	0	0	0	0	0	0.3	0.2	0.1	0	0.1	0	0	0	1.7	
<b>St. dev.</b>	22.7	0	1.0	0.2	0.2	1.5	0.5	0	1.7	0	0	0	0	0	0	0	1.2	0.7	0.5	0	0.2	0	0	0	7.1	

Appendix 6.7 Table of survey results for WSI central collection area

Transect	Acropora	Chlorodesmis	Echinopora	Favia	Favites	Fungia	Galaxea astreata	Goniastrea	Goniopora	Hydnophora rigida	Lobophyton	Merulina sp.	Montastrea	Montipora	Mycodium	Pavona	Porites cylindrica	Platygyra	Pocillopora	Seriatopora	Symphylia	Turbinaria	Tubipora	Xenia spp.	Zooanthid	Total colonies
Motunikeasulua Rf. West																										
1	8	0	1	0	0	0	4	0	0	0	1	0	0	1	0	0	0	0	3	0	0	0	0	0	1	19
2	4	2	0	1	0	1	0	1	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	12
3	5	0	0	1	0	0	0	2	0	0	0	11	0	0	0	1	4	0	2	0	0	0	0	3	1	30
4	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	5	10
5	4	0	1	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	2	0	0	0	0	0	11
6	4	0	1	0	0	2	0	0	0	2	0	0	1	0	0	0	4	0	3	0	0	0	0	1	0	18
7	3	1	0	1	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	9
8	3	0	1	0	0	1	0	2	0	0	0	0	0	1	0	0	4	0	4	0	0	0	0	3	4	23
9	2	3	0	2	0	0	4	0	0	0	0	1	0	0	0	2	0	0	0	3	0	1	0	0	0	18
10	1	0	0	1	0	0	0	1	0	0	0	1	0	2	0	3	0	0	2	0	0	0	0	3	0	14
11	4	1	1	0	0	0	0	1	0	2	0	0	0	1	0	0	5	0	0	0	1	1	0	2	0	19
12	2	0	0	0	0	2	3	0	0	3	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	17
13	1	3	3	0	0	0	4	0	0	0	1	0	1	2	0	1	0	0	0	1	0	0	0	0	3	20
14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
15	2	0	0	1	0	3	4	0	0	0	1	0	0	1	0	2	4	0	4	0	0	0	0	0	0	22
16	2	1	1	0	0	0	3	1	0	2	0	0	1	2	0	2	4	0	3	0	0	0	0	0	1	23

17	3	0	0	0	1	0	2	0	0	0	1	0	0	1	1	0	5	0	0		0	0	0	2	0	15
18	1	2	0	0	0	0	0	0	0	2	0	3	0	0	0	3	0	1	2	0	0	0	0	0	0	14
19	2	0	1	1	0	0	3	0	0	0	0	0	1	2	0	0	3	0	0	1	0	0	0	2	1	17
20	3	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	3	0	0	0	0	0	10	
1000																										

Motumikeasulua  
Rf. East

1	3	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	14
2	4	2	0	3	0	0	3	0	0	0	0	0	0	2	0	0	4	1	3	0	0	1	0	0	0	23
3	3	0	1	0	0	3	0	1	0	0	0	0	0	1	0	0	9	0	0	0	0	0	0	0	0	18
4	3	1	0	0	0	0	3	0	0	1	0	0	0	1	0	0	0	2	0	2	0	0	0	0	0	13
5	1	0	0	1	0	0	0	0	0	2	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	6
6	3	2	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0	1	1	0	0	0	0	2	2	15
7	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	4
8	2	0	0	1	0	3	1	0	0	0	0	0	0	1	0	0	6	0	0	0	0	0	0	4	0	18
9	2	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	20	0	2	0	0	0	0	0	0	34
10	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	12	0	1	0	0	0	0	0	0	15
11	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	10
12	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	15
13	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	11
14	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	8	0	2	0	0	0	0	0	0	13



<b>15</b>	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
<b>16</b>	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
<b>17</b>	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
<b>18</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	2	0	1	0	0	0	0	8
<b>19</b>	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	0	0	0	0	0	0	7
<b>20</b>	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	1	0	0	0	0	0	0	13
<b>1000</b>																										

Cakauvakababa-i-  
Yata Rf.

<b>1</b>	20	0	6	1	0	1	7	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	38
<b>2</b>	7	0	1	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	13
<b>3</b>	5	0	0	0	0	0	7	0	0	2	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	17
<b>4</b>	3	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	7
<b>5</b>	19	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	26
<b>6</b>	9	0	0	0	0	0	2	0	0	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	16
<b>7</b>	10	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	27
<b>8</b>	5	0	3	0	0	2	2	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	15
<b>9</b>	7	0	0	0	0	2	8	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	21
<b>10</b>	9	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	13
<b>11</b>	3	0	3	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	10

12	8	0	0	0	0	0	1	0	0		0	1	0	0	0	1	0	0	1	0	0	0	0	0	12
13	9	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	12
14	9	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	12
15	8	0		2	0		2	0	0	2	1	0	0	0	0				3	0	0	0	0	0	18
16	4	0	0	0	0	0	5	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	12
17	2	0	0	0	0	0	7	0	0		0	0	0	0	1	0	0	0	6	0	0	0	0	0	16
18	5	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	1	0	0	0	0	0	14
900																									

Nakubu Rf.  
(SE margin)

1	14	0	1	0	0	2	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	22
2	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	30
3	26	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	58
4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
5	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
6	9	0	0	0	1	2	0	0	6	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	23
7	90	0	4	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98
8	6	0	0	1	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
500																											

Yakauke  
Rf.

1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	4
2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
4	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
5	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
6	0	0	0	0	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
7	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	4
8	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	5
9	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	5
10	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	3	8

<b>Sum</b>	473	19	34	23	3	52	115	11	10	30	11	28	6	26	2	24	141	13	81	9	3	7	0	23	63	1207 Total colonies
<b>% species</b>	39.2	1.6	2.8	1.9	0.2	4.3	9.5	0.9	0.8	2.5	0.9	2.3	0.5	2.2	0.2	2.0	11.7	1.1	6.7	0.7	0.2	0.6	0.0	1.9	5.2	
<b>Max.</b>	90	3	6	3	1	7	10	2	6	3	2	11	1	2	1	3	20	3	6	3	1	2	0	4	30	
<b>Min.</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Mean</b>	5.4	0.2	0.4	0.3	0.0	0.6	1.3	0.1	0.1	0.4	0.1	0.3	0.1	0.4	0.0	0.3	1.6	0.1	0.9	0.1	0.0	0.1	0.0	0.3	0.7	
<b>St. dev.</b>	11.2	0.6	1.0	0.6	0.2	1.3	2.2	0.4	0.8	0.7	0.4	1.5	0.3	0.6	0.2	0.7	3.4	0.5	1.4	0.5	0.2	0.3	0.0	0.8	3.4	