Preliminary report of the Live Rock Assessment in the Vatukarasa Collection Area

2nd–5th May 2005

Survey team Members;
Christopher Beta[1], Cherie Morris[1], Gregory Bennett[1], Priti Singh[2]

1 Marine Aquarium Council P.O Box S23 Mh Superfresh Tamavua, Suva Fiji

2 Project Officer Aquarium Fisheries, Department of Fisheries Fiji

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1.0 Introduction

Vatukarasa lies within the province of Nadroga, Navosa and Tikina (district) of Conua. It is situated along the Coral Coast, which is on the Southwestern side of Viti Levu, the largest island of Fiji. According to the 1996 census, Vatukarasa village had a total population of 275 people with 39 households. Data collected in 2002 by Bureau of Statistics showed that the current population is around 450 people with 74 families. The villagers rely on subsistence farming of crops (cassava, taro, taro leaves, fruit) and livestock (cows, pigs, chicken) as well as fishing (fin-fish, sea urchins, octopus, shellfish) for daily sustenance. Farming is done mainly by men and fishing by both men and women. Men usually spear fish on the reef crest while women and children fish on the reef flat and inner lagoon using their hands and hand-lines.

1.1 History of harvesting within the collection area

Live Rock extractions from the Vatukarasa qoliqoli commenced in early 1990. In 1991 following a base-line reef survey by the Fiji Fisheries department, the villagers decided to become involved in the marine aquarium trade. As a large number of the villagers were young people most of whom were unemployed and since economic opportunities were few, they eagerly took up this opportunity to earn an income.

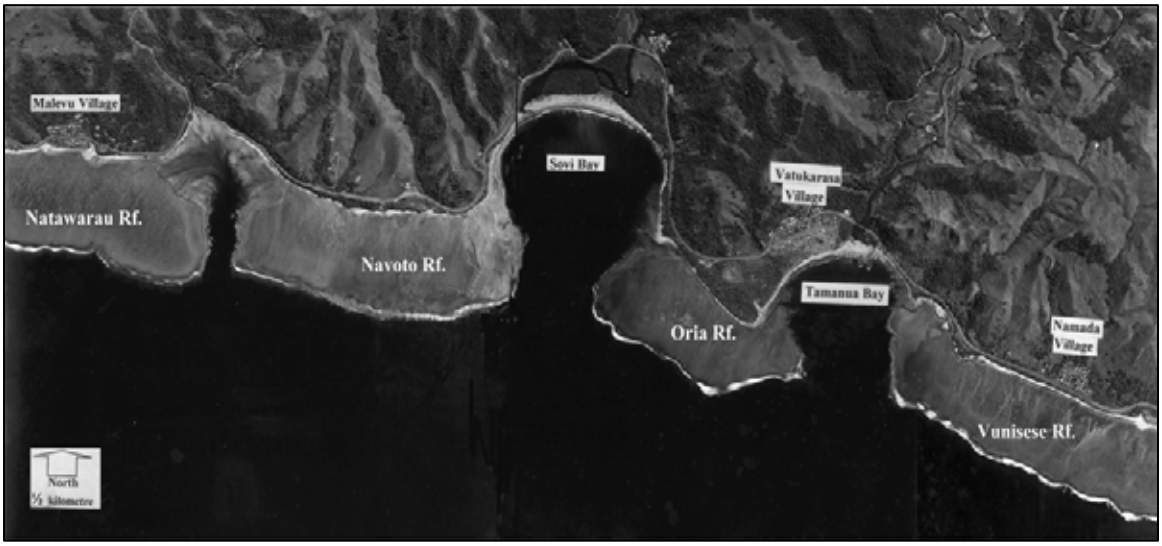
In 1992 the South Seas Export Company started collecting live rock in the area for 4 years where about 30 men working in groups were taught to collect using un-gloved hands and iron rods.

In 1996 a year after South Seas Export stopped harvesting, Walt Smith International (WSI) began collecting from Vatukarasa with about 30 collectors. WSI introduced a code of conduct, which the collectors were trained to follow when it was realized that they needed proper training to be able to provide a high quality, healthy product with minimum mortality. WSI harvesters are now well equipped and trained on the collection methods.

1.2 Geographical description of the collection area

The live rock collection area is located beside Vatukarasa Village (see Map 1). Marine jurisdiction is 3 nautical miles from the shoreline.

Map 1: Reef area on the Coral Coast of the WSI live rock collection with Qoliqoli boundaries



1.3 Features of Collection Area

The Vatukarasa collection area is characterized by fringing reef types, which extends over an area of 218 hectares (2.18k $m^{2)}$ and comprises Oria (64ha) and Navoto reefs (154ha). Oria reef has an inner lagoon that is characterized by a reasonably good growth of coral. It is surrounded by an algal crest or flat, which forms the western margin of Sovi Bay and the seaward edge of the reef. There are two rivers, the Sovi and Tamanua Rivers that empty into bays on either side of Oria reef. The presence of the rivers create a cycle of periodic coral settlement, growth and death due to flooding with subsequent deposition and consolidation by coralline algae which forms the source of live rock. The Navoto reef also has a shallow inshore lagoon with a general lack of relief over the reef flat, which extends onto the outer algal crest.

1.4 The Collectable Live Rock Material

Prior to conducting the survey, the survey team met with an experienced collector and former field supervisor, Mr.Orisi Kuribola, of WSI, at the field site to get familiar with the collectable material. With years of experience as a live rock collector, Orisi assisted the team in identification of the collectable rock and in categorization of the product. The team spent time weighing the rocks on site in order to help quantify the mass of each rock during the actual survey.

At the WSI warehouse, live rocks were later screened, cured and weighed by the warehouse workers before export overseas. The team witnessed this process and

assisted in weighing the rocks to get a better idea of estimating the mass of rocks during the survey.

In Vatukarasa, the collectable material involved progressively removing consolidated reef pieces by breaking it from the substrate. The environment is vigorous and the nature of the reef substrate is continuous or interconnected. The “live” part of the live rock refers to the coralline algae covering the surface, and any fauna or flora residing on or within it.

1.5 Objectives

The objectives of this survey were to:

- test the modified MAQTRAC live rock methodology and determine whether it was applicable for the reef type found along the Coral Coast
- assist the Fiji Government’s requirement for CITES NDF resource base quotas

2.0 Methodology

The survey method was based on modified MAQTRAC using the following steps:

Pre-assessment of Collection area

Prior to the survey, an aerial photograph of the area was carefully studied as it is noteworthy to first know the size of the collection reef area. The reef area can be determined by placing a 2mm grid over the aerial photo. If the scale is 1:50,000 each grid square is 1 hectare or 10,000m^2. The transect sizes and number will give the sample size.

Point intercept Transect (PIT)

Point Intercept Transect (PIT) was used to describe the reef and how the substrate (see Table 1) changes over time. The method assessed the substrate every 0.5m over a 20m length. To prove comparison of the reef structure, PIT were positioned to sample the environment among the reef systems under consideration. Readings were taken along the tape every 0.5m intervals and the underlying benthic attributes were recorded.

Table 1. Substratum categories and abbreviations

HC	Hard coral
SC	Soft coral
RKC	Recently killed coral
NIA	Nutrient indicator Algae
FS	Fleshy seaweed
SP	Sponge
RC	Rock
RB	Rubble
SG	Sea grass
SD	Sand
SI	Silt/clay
OT	Other

Belt Transect

A belt transect was used to quantify and estimate the weight of collectable rock in each site. The method assessed the reef on a 5m diameter over a 20m length. Each transect consisted of four replicates of 5 m wide x 20 m length segments. Each segment was separated by a 5m gap along a 100m transect line.

Swim Transect

Swim surveys are the most important of all survey techniques for assessing the occurrence of organisms suitable for aquarium collection due to their dispersed nature. Metered or timed swims are the preferred method for gathering information about a wider number of species than occurs using set transects. Swim searches and collecting is what the collectors do, so this method is more indicative of the nature of the resource which can be both dispersed or clumped depending on the species or habitat. This is important in assessing abundance, which was used to extrapolate to the larger collection area.

Results of field data were pooled into groups based on habitat and entered into Excel program. Data was presented using pie charts. The belt transect result was quantified and the weight of the collectable material in the collection area estimated. Thus from the survey data, the following calculation was made:

Density (Kg/m^2) of the collectable material equals the total weight (kg) of the collectable material assessed divided by the total area surveyed (m^2)

The standing stock of the collectable live rock in the collection area was calculated as:

Total size of the collection reef area (m^2) multiplied by the density (Kg/m^2) minus the total amount of live rock extracted from day one from the collection area

3.0 Results

A total of 21 transects were laid in the 4 days of survey (see Table 2).

Table 2: Survey site description

Day	Site description	Site	Current Status of Harvest	No. of Transect
1	Located slightly toward the western end of the fringing reef towards Sovi bay, closer to the reef crest than to the shoreline, sargassim dominated area *Point 1 on the Map*	Oria	Harvesting took place while we did the survey	4
2	Located slightly to the East side of the fringing reef just in front of the proposed Hotel site but towards the crest. *Point 2 on the Map*	Oria	Collectors were collecting while we did the survey	6
3	Located towards the western end towards the crest. *Point 3 on the Map*	Navoto	No harvesting done at present	5
	Located slightly to the East side of the fringing reef *Point 4 on the Map*	Navoto	No harvesting done at present	6

Map 2: Site description of the transects

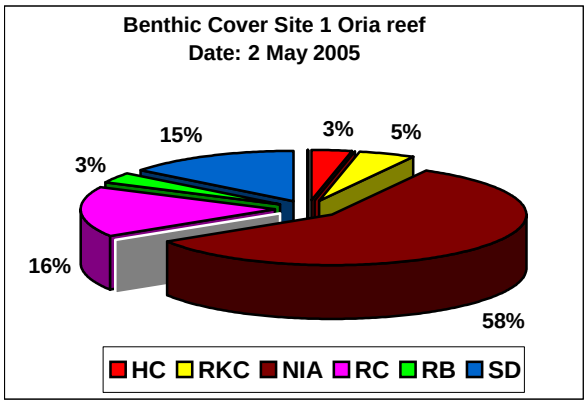
Table 3: The GPS coordinates of the transects

Day 1 Oria reef			Day 2 Oria reef		Day 3 Navoto reef		Day 4 Navoto reef	
	Transect 1		**Transect 1**		**Transect 1**		**Transect 1**	
Start	s18^{0}11.273	E177^{0}35.788	s18^{0}11.190	E177^{0}35.551	s18^{0}11.059	E177^{0}34.293	s18^{0}11.116	E177^{0}34.442
End	s18^{0}11.288	E177^{0}35.838	s18^{0}11.205	E177^{0}35.579	s18^{0}11.050	E177^{0}34.262	s18^{0}11.126	E177^{0}34.472
	Transect 2		**Transect 2**		**Transect 2**		**Transect 2**	
Start	s18^{0}11.289	E177^{0}35.781	s18^{0}11.216	E177^{0}35.579	s18^{0}11.079	E177^{0}34.280	s18^{0}11.115	E177^{0}34.478
End	s18^{0}11.309	E177^{0}35.832	s18^{0}11.208	E177^{0}35.546	s18^{0}11.094	E177^{0}34.308	s18^{0}11.125	E177^{0}34.570
	Transect 3		**Transect 3**		**Transect 3**		**Transect 3**	
Start	s18^{0}11.277	E177^{0}35.783	s18^{0}11.216	E177^{0}35.579	s18^{0}11.104	E177^{0}34.352	s18^{0}11.101	E177^{0}34.520
End	s18^{0}11.249	E177^{0}35.730	s18^{0}11.208	E177^{0}35.546	s18^{0}11.092	E177^{0}34.317	s18^{0}11.092	E177^{0}34.489
	Transect 4		**Transect 4**		**Transect 4**		**Transect 4**	
Start	s18^{0}11.283	E177^{0}35.777	s18^{0}11.226	E177^{0}35.588	s18^{0}11.105	E177^{0}34.364	s18^{0}11.093	E177^{0}34.541
End	s18^{0}11.262	E177^{0}35.725	s18^{0}11.233	E177^{0}36.019	s18^{0}11.114	E177^{0}34.396	s18^{0}11.108	E177^{0}34.571
			Transect 5		**Transect 5**		**Transect 5**	
Start			s18^{0}11.232	E177^{0}36.027	s18^{0}11.084	E177^{0}34.355	s18^{0}11.096	E177^{0}34.587
End			s18^{0}11.276	E177^{0}36.058	s18^{0}11.078	E177^{0}34.321	s18^{0}11.107	E177^{0}35.017
			Transect 6				**Transect 6**	
Start			s18^{0}11.219	E177^{0}36.036			s18^{0}11.093	E177^{0}35.041
End			s18^{0}11.198	E177^{0}36.061			s18^{0}11.077	E177^{0}35.070

Table 4: Summary of the estimated live rock (Kg) using the belt transect

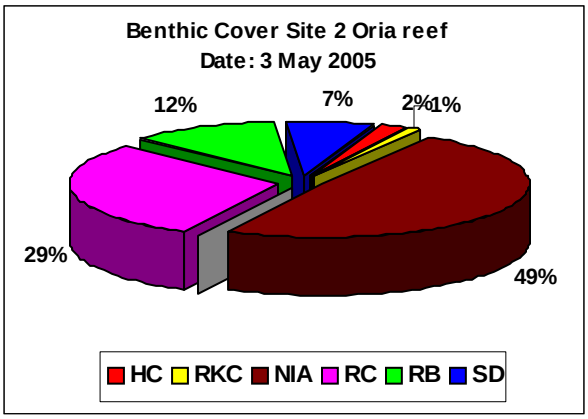
2nd-05- 005	**Day 1**	**Segment 1**	**Segment 2**	**Segment 3**	**Segment 4**	**Total (Kg)**	**Mean**	**STDEV**	**Density kg/m^2**
	Transect 1	192.2	282.5	331.4	266.1	1072.2	268.05	57.67	2.68
	Transect 2	251.9	240.9	213.2	320.2	1026.2	256.55	45.45	2.57
	Transect 3	231.9	192.1	282.1	286.5	992.6	248.15	44.83	2.48
	Transect 4	153.5	164.1	160.9	129.6	608.1	152.03	15.60	1.52
	(4x400m^2)				***Total***	***3699.1***	924.78		***2.31***
3rd-05- 2005	**Day 2**	**Segment 1**	**Segment 2**	**Segment 3**	**Segment 4**	**Total (Kg)**	**Mean**	**STDEV**	**Density kg/m^2**
	Transect 1	214.3	248.8	129.6	158.3	751	187.75	53.79	1.88
	Transect 2	286	275.4	324.5	321.5	1207.4	301.85	24.83	3.02
	Transect 3	215.6	207.5	189.1	199.7	811.9	202.98	11.30	2.03
	Transect 4	269.8	268.8	199.2	130.5	868.3	217.08	66.51	2.17
	Transect 5	172	169.4	143.1	159.1	643.6	160.90	13.11	1.61
	Transect 6	64.4	33.4	30.6	89	217.4	54.35	27.72	0.54
	(6x400m^2)				***Total***	***4499.6***	1124.90		***1.87***
4th-05- 2005	**Day 3**	**Segment 1**	**Segment 2**	**Segment 3**	**Segment 4**	**Total (Kg)**	**Mean**	**STDEV**	**Density g/m^2**
	Transect 1	165.9	99.9			265.8	132.90	46.67	1.33
	Transect 2	104.1	118.7	154.7	167.62	545.12	136.28	29.81	1.36
	Transect 3	187.3	168.7	74.9	63.9	494.8	123.70	63.32	1.24
	Transect 4	147.6	143.5	171.9	146.6	609.6	152.40	13.12	1.52
	Transect 5	138.6	103.8	177.8	149.9	570.1	142.53	30.63	1.43
	(6x400m^2)-200m2				***Total***	***2485.42***	687.81		***1.13***
5th-05- 2005	**Day 4**	**Segment 1**	**Segment 2**	**Segment 3**	**Segment 4**	**Total (Kg)**	**Mean**	**STDEV**	**Density kg/m^2**
	Transect 1	207.2	238.9	243.7	267.8	957.6	239.4	24.91	2.39
	Transect 2	133.8	94.7	40.9	44.4	313.8	78.45	44.34	0.78
	Transect 3	103	163.5	144.4	205.1	616	154	42.41	1.54
	Transect 4	125.5	221.8	150.3	140.4	638	159.5	42.77	1.60
	Transect 5	112.1	96.9	113	196	518	129.5	44.94	1.30
	Transect 6	145.1	206	200.7	174.4	726.2	181.55	27.95	1.82
	(6x400m^2)				***Total***	***3769.6***	942.4		***1.57***

Figure 1. Assessment of the reef substrate and general health –site 1



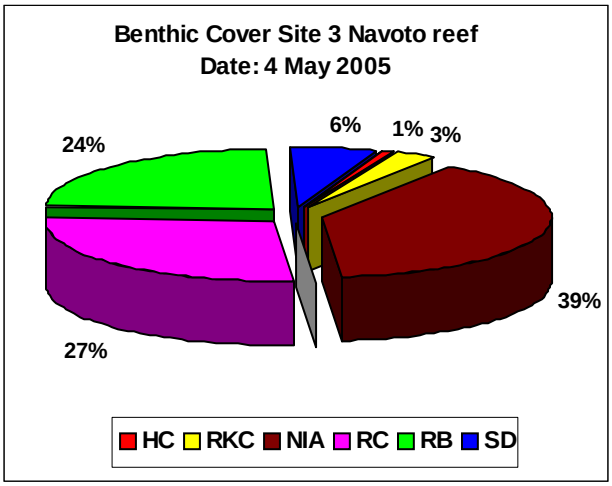
The Nutrient Indicator Algae (NIA) found at all sites were predominantly *Sargassum*. Results indicated that the *Sargassum* was present in high abundance on Vatukarasa reef. Literature shows that *Sargassum* is more abundant on hard substrate with little sand cover (Umar, McCook & Price 1998). At site 1, 50% of the *Sargassum* was growing on top of the collectable live rock, 41% was on the dead rock, 6% on rubble and 3% on sand. The Rock (RC) referred to at each site was the non- collectable material characterized by dead coral or rock without coralline algae.

Figure 2. Assessment of the reef substrate and general health –site 2



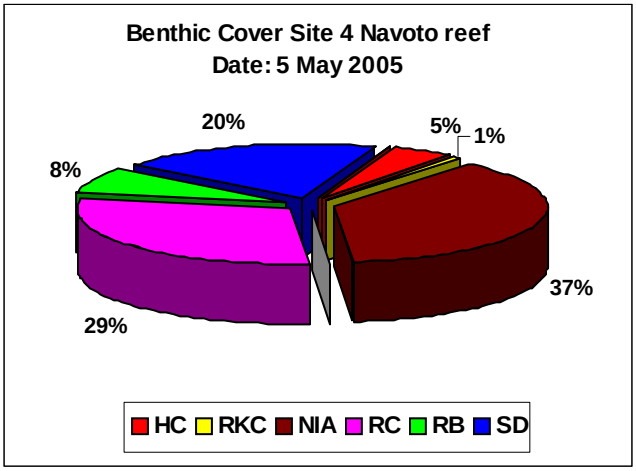
At site 2, 53 % of the NIA were found growing on top of the collectable live rock, 37% were on rubble, 8% were on dead rock and 2% were on sandy patches.

Figure 3. Assessment of the reef substrate and general health –site 3



Sargassum was present in high abundance at site 3. At this site, 53% of the NIA was growing on dead rock, 30% were on collectable live rock, 15% were on rubble and 2% on sand.

Figure 4. Assessment of the reef substrate and general health –site 4



At site 4, 40% of NIA were growing on top of collectable live rock, 29% on dead rock, 21% on sand and 10% on rubble.

Table 5: Total collectable live rock surveyed

	Day 1 Oria	***Day 2 Oria***	***Day 3 Navoto***	***Day 4 Navoto***	***Total***
Total Live Rock Surveyed (Kg)	3699.1	4499.6	2485.42	3769.6	***14453.7***
Total Area Surveyed (m2)	1600	2400	2200	2400	***8600***
Density (Kg/m^2)					***1.68***

Table 6: Total size of collection area within the Vatukarasa Qoliqoli (Oria and Navoto reefs)

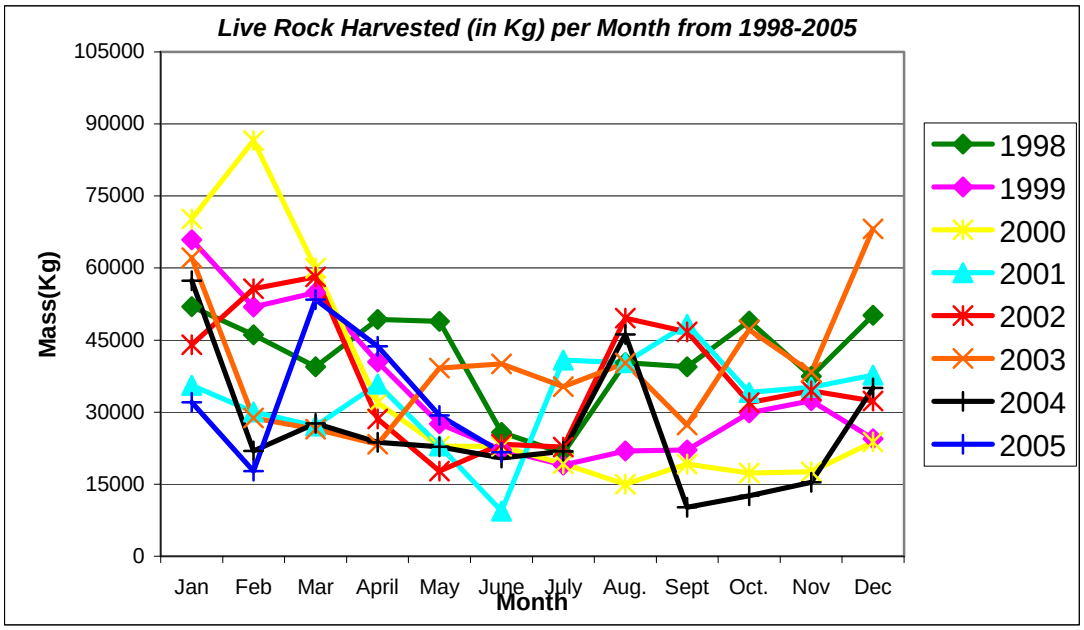
Zones	Area Surveyed (ha)	Area in hectare (Calculated from Arial Map)	The collectable Live Rock (extrapolative) from the survey	
			In Kilograms	In tonnes
Oria reef	0.4	64	***1075200***	1075.2
Navoto reef	0.46	154	***2587200***	2587.2
Qoliqoli of Vatukarasa (Oria +Navoto)	0.86	218	***3662400***	3662.4

Table 7: Quantities of live rock harvested by month for Years 1998-2005

Live Rock Harvested (Kg) per Month														
YEAR	**Jan**	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**Aug.**	**Sept**	**Oct.**	**Nov**	**Dec**	**Total (Kg) per year**	**Average (Kg) per month**
1998	51967	46120	39411	49301	48930	25780	21459	40275	39465	48973	37441	50200	499322	41610.2
1999	65916	51897	54878	40461	27614	22153	19015	21897	22141	29817	32386	24481	412656	34388.0
2000	70234	86559	59975	31952	22931	22861	19236	14992	19205	17306	17581	23758	406590	33882.5
2001	35580	30068	27088	35876	23018	9369	40849	40276	48322	34128	35161	37735	397470	33122.5
2002	44064	55668	58186	28579	17691	23312	22723	49583	46709	32000	34468	32316	445299	37108.3
2003	62180	28814	26437	23324	39165	40011	35299	40236	27303	47165	38276	68152	476362	39696.8
2004	57373	21950	27661	23694	22776	20439	21840	46156	10199	12592	15412	35061	315153	26262.8
2005	32022	17738	53443	43684	29326	21660							197873	16489.4

Source: Walt Smith International

Figure 5: Graph showing the pattern of the harvested rocks by month for Years 1998-2005



4.0 Discussion

General Reef Characteristics

What became evident was that the reefs diversified substantially in their basic composition. The site where extraction currently occurred was closer to the crest than to the shoreline. Some areas were characterised by sand and rubble. Literally, the reef was subjected to nutrient and sedimentation runoff. Areas in the proximity of creek outfalls exhibited a predominance of algae. The area was characterized by a reef flat that had been filled in by the skeletal fragments of the corals killed by the periodic flooding.

Coral reefs are dynamic ecosystems. They are continuously changing in a response to their changing environment. Natural disturbances have affected coastal environments for thousands of years. Biological communities can be considered robust systems that can recover from acute disturbances over geological time scales.

Benthic Cover

The results showed that the substrate in the Vatukarasa collection area consisted of a high percentage of NIA, dead rock, sand and rubble. The survey targeted only the area where the collectors were currently extracting the collectable live rock material. These sites were closer to the crest. By general observation and talking to the collectors it was realized that there was less collectable material near the shore, compared to what it was like when live rock harvest began. The macro algae, *Sargassum* was a dominant feature in the Vatukarasa collection area. It persisted as far as the reef crest. According to Vuki *et.al* (1994), *Sargassum* is an opportunistic beneficiary that proliferates due to degraded reef conditions. It may not be a cause for the degradation but a response to the conditions that made the reef environment more suitable for algal growth.

Although the NIA was dominant in the survey results (see figure 1-4), deliberation was taken to re-examine and quantify the substrate that the NIA was growing on top of which included, dead rock (non- collectable), rubble, sand or collectable live rock.

Results showed that in total, 43.25% of the *Sargassum* surveyed were growing on top of live rock or the collectable material, 32.75% were dead non-collectable rock, 17% were on rubbles and 7% were on sand.

Collectable Live Rock

The collectable material was taken from the hard surfaces of the fringing reef with the aid of a crow-bar and thereby potentially deepening the reef flat environments and making shallow channels. The extraction of live rock in Vatukarasa has been practically done over a decade now and it is conspicuous through site observation, survey data and interviews with the collectors that there has been a dramatic decline in live rock standing stock. In addition, the lack of monitoring and information on the bio-accumulation rate of rock makes this a contentious issue.

From the historical data it was calculated that an average of 32.8 tonnes of live rock was harvested per month between years 1998- 2005. This equates to an average of 393.6 tonnes of live rock per year for the past 5 years. Using the survey data (sees Tables 4 & 5), the collectable live rock material is estimated at 3662.4 tones in the current collection area. However, from the historical data, a total of 3150.73 tonnes had been harvested from the collection site between the years 1998-2005 (see table 8). Hence assuming that this was the total amount of live rock that had been removed from the collection area, (ie. not considering the quantity previously harvested by other companies), then the following can be deduced:

Total standing stock equals the extrapolated collectable live rock (from survey) minus the total weight of the rock harvested between the years 1998-2005.

In addition, there were more collectable live rock material in Navoto reef than on Oria reef (see table 6).

Table 8: *Summary of data gathered*

Average tonnes of rocks harvested per month for the 8 years	Average tonnes of rocks harvested per year	Total live rock harvested from years 1998-2005	Extrapolated collectable standing stock from resource Survey	Standing stock (in tonnes) in the collection site
32.8	**393.8**	**3150.73**	**3662.4**	**511.67**

5.0 Conclusion

It has been determined from this survey that the live rock assessment methodology (as proposed in the modified MAQTRAC protocol), is applicable to the consolidated reef type as found in the Coral Coast.

For the purpose of resource- based quota of live rock in the Vatukarasa collection area, it was found that there would be no more collectable live rock in the next 1 year and 4 months. This is based on the live rock extraction rate of 32.8 tonnes/month, calculated

from historical and survey data although not considering the recruitment of coralline algae on rock.

6.0 Recommendations

1. More research is needed on the recruitment of coralline algae in this area
2. Precautionary management measures should be adopted in light of reports of over-harvesting and in response to the experiences of other locations. Furthermore, we lack information on what constitutes sustainable harvesting levels for this area. Management should be adaptive to respond to additional information obtained on the fishery from monitoring efforts.

7.0 References

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Umar, M.J., McCook,L.J.& Price,I.R., 1998,' Effects of nutrient deposition on the seaweed Sargassum on a fringing coral reef', Coral reefs, Vol.17,pp169-177, Available:CSA/Aquatic Science &Fisheries Abstracts [1 September, 2004].