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SUMMARY

The benthos cover (which includes coral) and fish were studied at eight fringing reef sites at Rarotonga island. The coral survey was a modified technique based on video transects utilising digital video footage and powerful desktop technology. Information of fish was gathered using an underwater visual census technique. Three of the sites were resurveyed for comparison with a study conducted five years previously.

Turf algal is the dominant benthic cover around the island. Particularly, at the township area where algal cover accounts for about 90% of total cover. Compared to the previous survey it has increased by 20%, accompanied by a similar decrease of live coral cover. A probable cause of turf algal dominance at the township area is the main harbour passages that are major point sources of sedimentation and nutrient runoff in the area. Also contributing to more turf algal could be a decline in herbivorous fishes from fishing pressure. Although other sites around the island still show signs of a relatively diverse benthos cover, all have reported increases in algal coverage and decreases of live coral.

Some eighty species of fish belonging to seventeen families were recorded. The Damselfish (*Katoti*) and Surgeonfish (*Maito* and *Ume*) were the most abundant types (densities being in the order of 1 fish per 2 to 3 square meter). Other common family types included Parrotfishes (*U'u*), Butterflyfishes (*Taputapu*) and Wrasses (*Pakou*). Spatial analysis indicates that the windward sites, (where rough sea conditions prevail), support higher densities of these fishes, perhaps the result of fewer visits by fishers and divers to the area but perhaps also related to the difference in benthos cover. Compared to the previous survey there was a large decline in the number of Parrotfish and Surgeonfish (two common edible fish species) at the township area which could reflect the impact of high fishing pressure in the area. Compared to the earlier survey, the fish populations appear to be less diverse and fish families are often dominated by a single species. This was highlighted by examining the Damselfishes which now only comprises four species compared to ten species, five years ago and is now dominated by *Chromis vanderbiliti* species.

The survey results suggest that Rarotonga had a more similar benthic cover the populated almost atoll of Aitutaki compared to its neighbouring atoll Manuae which is uninhabited. The benthos of the fringing reef of Aitutaki comprises mostly of turf algal whereas at Manuae live coral cover dominates over turf algal. As an uninhabited atoll, Manuae could be representative of benthos cover that has not been subject to human impacts. Aitutaki also has a more diverse and abundant fish population then Rarotonga.

The comparative results of this survey with that previously conducted in 1994 indicate that the coral and fish diversity at Rarotonga has declined rapidly over a relatively short time of five years. It is suggested that the rate of change may be unnatural and could upset the natural equilibrium that maintains a diverse marine system. But, without the benefit of long term baseline data to compare, it is difficult to assess the influence of human impacts on the change occurring. The report highlights the need to continue monitoring of our marine environment and that immediate steps should be taken to minimise impacts whenever possible.

CORAL AND FISH SURVEY AT RAROTONGA ISLAND, JANUARY 1999.

INTRODUCTION.

Rarotonga is a high volcanic island with mountainous peaks to 640 meters and surrounded by a small coastal plain with a circumference of 32 kilometers. It lies almost at the extreme east of Polynesia and in sub tropical latitudes. The island is far from the Papua/Indonesia region that accounts for the origin of much of the flora/fauna in the Pacific.

Rarotonga is the capital island of the nation of the Cook Island and is residence to half of the country's population of about 20 thousand. The economy of the island is based on tourism and coastal development has been widespread. The islands coastal resources are also heavily utilised by the resident population as subsistence food, recreation and small-scale commercial fisheries purposes.

On a global basis and on Rarotonga, it is recognised that coral reef systems are increasingly exhibiting signs of stress. Yet often there is insufficient information to understand its causes. There is a need for reliable and standard information to provide rigorous scientific assessment of the extent of the problem. With this in mind the Ministry of Marine Resources is seeking to maintain a global initiative of monitoring coral and fish cover using an approach developed jointly by ASEAN countries and Australia and adopted widely in the Pacific.

This survey aims to quantify the percent cover of marine benthos (which includes coral cover) and simultaneously to conduct an estimate of fish abundance and diversity. The information collected will add to an ongoing database of which it is hoped to gather a more informed update on the status of the coral reef on Rarotonga and contribute to wise management of this important system.

SITE SELECTION

Seven locations on the fringing reef around Rarotonga were chosen for the survey (Figure 1). The majority of surveys took place during January 1999. Sites were distributed around the island and encompass areas that are influenced by different factors, both natural such as wind and wave action and human factors such as fishing pressure and urban land use where runoff may affect coral and fish recruitment. In addition, three sites previously surveyed (Miller et al, 1994) by the Australian Institute of Marine Science (AIMS) were resurveyed.

1. ***Arorangi site*** – Was located with the Tumunu Resturant as a landmark. This site is on the western (leeward) side of the island where wave action is relatively low.
2. ***Nikao site*** – Located on the northwestern (leeward) side of the island, adjacent to the public "Social Center" beach. This site is popular with SCUBA tour operators. It is located within the Nikao marine reserve (Ra'ui).
3. **Avatiu site** –The Mobil Fuel Depot was used as a landmark for this site. It is on the northern side of the island, adjacent to the Avatiu passage, the entrance to the main harbour. The passage is a point source of terrestrial and industrial runoff. Spear fishers also frequent the area, exiting through the passage.
4. ***Avarua site*** – This site was located next to the old ship wreak close to Avarua passage less then a Kilometer from Avatiu site. It is located within the main township area and is the passage has characteristics similar to Avatiu.
5. ***Ngatangiia site*** – Located on the eastern side (windward) of the island adjacent to Ngatangiia passage, the main channel on that side of the island.
6. ***Tikioki site*** – On the southeastern side of the island opposite the Titikaveka Packing Shed landmark. This site is in the windward area and subject to rough sea conditions. The site is also located within the Tikioki Ra'ui boundary.
7. ***Kavera site*** – Located opposite the Rarotongan Hotel landmark on the southwestern side of the island.

Insert picture of sample sites

MATERIALS AND METHODS.

Each site consisted of a survey of five replicate 50 meter transects laid out along the 10 meter depth contour. The 10 meters depth was chosen for several reasons. It has a high diversity, is within safe SCUBA depths and the results could be easily compared with previous AIMS survey.

Underwater video footage of the benthos was recorded the length of the transect and a 25 cm belt by a SCUBA diver using a Digital 3-CCD Sony Handycam. Ashore the Handycam was connected to 21" T.V monitor and a *Dell* computer workstation (450 MHz) via a *Miro* Video Card (DV3000). From each transect footage, seventy clear bitmap images were systematically "snapped". The image on the 17" computer monitor was overlaid on a grid and at five set points on the grid the type of benthic cover was categorised according to English et al (1997). All digital images were written to a CD-Rom and stored for future reference.

Fish were assessed in-situ by an underwater visual census (UVC) technique described by English et al (1997). A SCUBA diver swam the transect length and manually recorded all fish species and counts within a 4 meter band. Ashore the species identification was verified using reference books and occasionally, video footage filmed during the dive.

The survey results for benthos cover and fish species were subject to statistical analysis of the Shannon-weiner diversity index (Zar, 1992). This diversity index is proportional to the number of categories of observations (i.e, categories is types of benthic cover or number of fish species) and the evenness of abundance distribution, where maximum evenness is when all species have equal numbers. The maximum diversity is $\log_{10}k$, where k = number of categories (refer to Appendix for equations). Where possible standard errors is included with all average (sometimes referred to as the mean) figures. This error is an indication of the level of variation and is often incorporated into confidence intervals about the mean.

RESULTS.

Benthos (Coral) Cover Surveys.

Turf algal was the most common cover at all survey locations see Figure 2, also refer to Template A for a diagram of common benthos types. It accounted for about 90% of total cover at the two locations Avatiu and Avarua that are within the main township area and adjacent to large passages, i.e Avatiu Passage and Avarua Passage. At other sites Turf algal is responsible for an average total cover of about 60%. There were few instances of other types of algal such as Macro algal or *Halimidea*. Detailed breakdown of coverage was provided in Table 1 of the Appendix.

Non-*Acropora* coral was the second most common cover particularly at Nikao and Arorangi where it is responsible for 34% and 23% of the total, respectively. This was comprised mostly of massive corals (particularly *Leptoria* species) but also encrusting corals (*Goniastrea* species) and to a lesser extent flame coral (*Millepora* species). There was a single instance of coral foliage (*Turbinara* species) recorded at Arorangi. The *Acropora* coral species, comprised mostly of digitate (i.e. finger) and tabulate forms. This category accounted for 11% of the average cover at Nikao and 10% at Tikioki. The presence of Soft coral was relatively high at Tikioki reef where it accounted for 9% of cover. Dead coral (with algal) ranged between 0.5% to 3% at all sites except Tikioki (6%). There was no instance of recently dead coral (i.e still bleached) reported for the total length of 1.4 kilometer of transect tape that was sampled around the island.

Abiotic forms of cover (i.e all non-living categories) was less then 1% at Arorangi and Tikioki but about 5% at other sites. Rubble and sand account for most of the abiotic cover. The percent cover attributed to Other Fauna category was also small, mostly due to *Tridacana maxima* (*Giant clam* or locally known as *Paua*). Notably, at Tikioki three *Acanthuster* (*Crown of thorns* or *Taramea*) were also reported. However, the 6 sampling points attributed to *Acanthuster* cover were a very small percentage of the total points of cover (9,800 points) sampled island-wide.

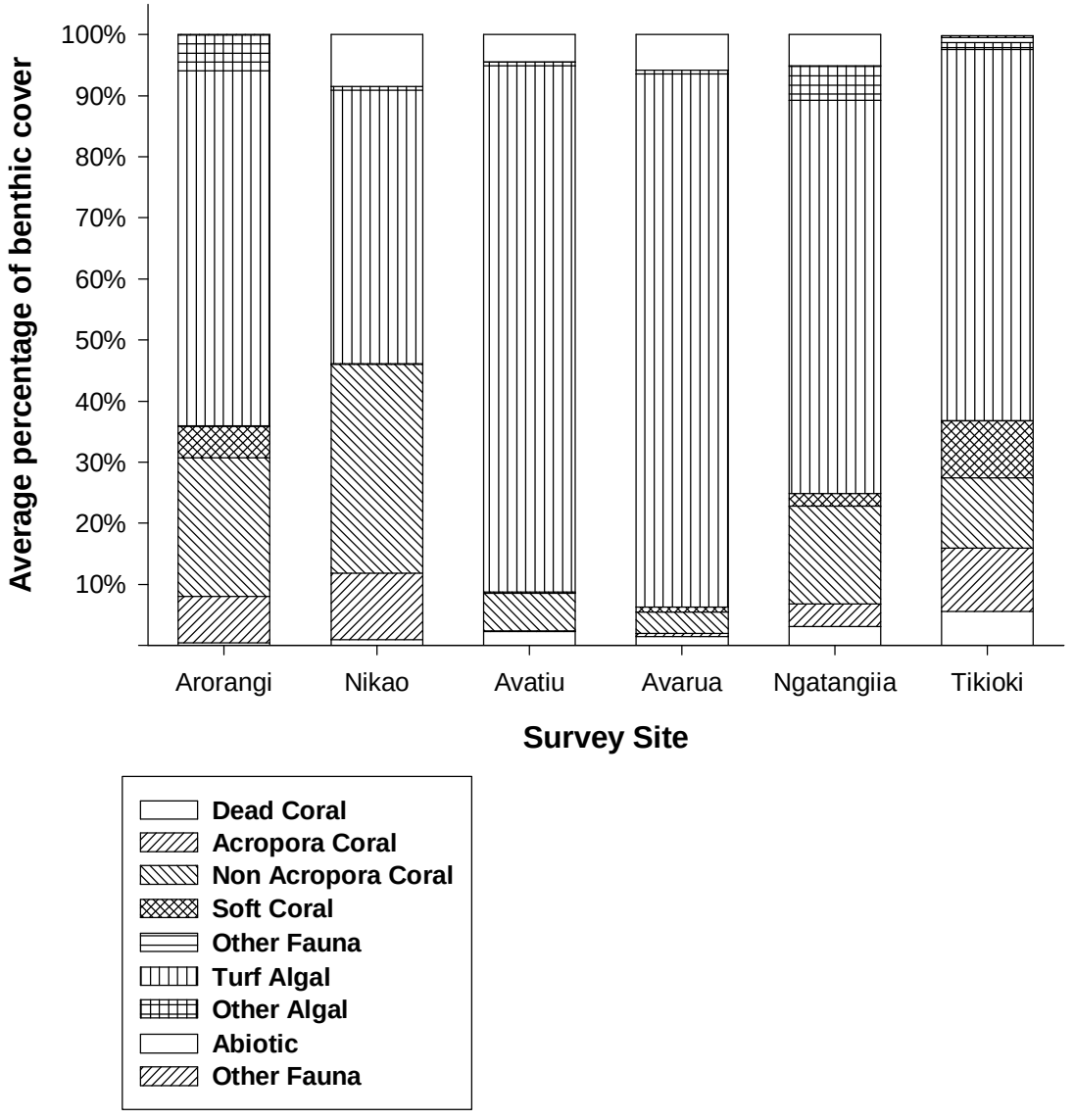

Figure 2 Percentage of Benthic and Coral Cover Type.

The dominance of Turf algal at Avatiu and Avarua sites causes these sites to have the least diverse and most unevenness of cover (Table 1). These sites also reported the lowest number of life-forms categories recorded, 11 and 12 types, respectively. The Nikao location had the highest diversity index. Unlike most sites it had less cover attributed to Turf algal (50%) and in addition had a relatively high proportion of non *Acroporid* cover types. The remaining sites still had relatively high diversity indices compared to Avaitu and Avarua locations. The location with the most number of categories of benthic cover recorded was Tikioki (19 types).

Table 1 Shannon Weiner Diversity and Evenness index of Benthic (Coral) Cover.

Location	**Count of Categories**	**Diversity Index**	**Maximum Diversity**	**Evenness Index**
Arorangi	15	0.671	1.255	0.535
Nikao	13	0.760	1.146	0.663
Avatiu	11	0.287	1.146	0.251
Avarua	12	0.266	1.176	0.226
Ngatangiia	14	0.633	1.204	0.526
Tikioki	19	0.645	1.342	0.480

The Kavera site was not analysed because clear images could not be retrieved from the video footage.

Fish Surveys.

Seventeen fish families were identified during the survey (Table 2, also refer to Template B). The Damselfishes and Surgeonfishes were the most common family types. The Damselfishes had an average density (and a standard error) of 0.6 (0.2) fish.m^2 or inversely, 1 fish per 2 m^2. The Surgeonfish density was 0.3 (0.1) fish.m^2 or 1 fish per 3 m^2. The Parrotfishes, Butterflyfishes and Wrasses occurred in relatively moderate densities, i.e 0.03 to 0.05 fish.m^2 or 1 fish per 20 to 40 m^2. The Dartfish, Goatfishes, Groupers and Triggerfishes all had densities >0.01 fish.m^2 or 1 fish per 100m^2. The remaining families, Angelfishes, Drummers, Emperors, Gobies, Hawkfishes, Moorish Idol, Morays, and Puffers had densities as low as 0.0001 fish.m^2 or 1 fish per 7000 m^2. The power of the survey to detect these low density or cryptic species suggests that future monitoring should utilise a larger sampling area unit or alternative survey techniques.

Table 2 Fish Family Types and Abundance.

Fish Family			**Fish Density**			
Common Name	**Local Name**	**Scientific Name**	**Fish/m^2**	**S.E**	**M^2/Fish**	**S.E**
Angelfishes	Taputapu anera	*Pomacanthidae*	0.003	0.001	333	1449
Butterflyfishes	Taputapu pepe	*Chaetodontidae*	0.019	0.007	52	148
Damselfishes	Katoti	*Pomacentridae*	0.533	0.135	2	7
Dartfishes	O'o	*Microdesmidae*	0.004	0.002	269	561
Drummer	Pipi	*Kyphosidae*	0.0004	0.0003	2333	3363
Emperor	Iro	*Lethrinidae*	0.0001	0.0001	7000	7000
Goatfishes	Koma	*Mullidae*	0.004	0.001	241	845
Goby	Panako	*Blenniidae*	0.0003		3500	
Groupers	Patuki	*Serranidae*	0.005	0.002	189	574
Hawkfishes		*Cirrhitidae*	0.002	0.001	538	1356
Moorish Idol	Tiitii	*Zanclidae*	0.0004	0.0003	2333	3363
Morays	Aa'pata	*Muraenidae*	0.0001	0.0001	7000	7000
Parrotfish	U'u	*Scaridae*	0.008	0.004	132	235
Puffers	Ue	*Tetraodontidae*	0.001	0.0004	1750	2711
Surgeonfishes	Maito, Ume	*Acanthuridae*	0.312	0.091	3	11
Triggerfishes	Kokiri	*Balistidae*	0.003	0.001	389	1278
Wrasses	Pakou	*Labridae*	0.036	0.006	28	179

Often less then six species of each family type and a single species dominated the fish distribution (Table 2, Appendix). The Damselfishes were dominated by *Chromis vanderbilti* that typically averaged 80% to 90% of the family counts per location. The species *Ctenochaetus stratius* accounts for most of the Surgeonfish recorded (although this survey failed to differentiate between this species and *Acanthurus nigrofuscus*). The Parrotfish species mostly comprised of *Scarus frenantus, Scarus globiceps*, *Scarus altippinus* and *Scarus sordidus*. The common Butterflyfishes species included *Chaetodon unimaculatus, Chaetodon ornatissimus* and *Chaetodon reticulatel*. Amongst the Wrasses the most common species was *Thalassoma lutescens* but *Labroides dimidiatus* (the cleaner wrasse) was also frequent.

Between sites some broad spatial patterns were apparent. The leeward (western and northern) sites of Arorangi, Avatiu and Avarua have the lowest abundance of the common fish families (Damselfishes, Surgeonfishes, Parrotfishes, Butterflyfishes and Wrasse). The windward (eastern and southern) locations of Ngatangiia, Tikioki and Kavera often had a higher abundance (Figure 3).

Insert map of fish densities

The dominance of *Chromis vanderbiliti* and *Ctenochaetus straitus* was an important factor affecting diversity. For instance, Arorangi had the lowest diversity index because of a combination of low number of species (19 species) and unevenness in distribution caused by large aggregations of *Chromis vanderbilti* (Table 3). Although Ngatangiia and Tikioki had the highest number of species, a low diversity index was calculated as the distribution was dominated by the two species. The high diversity index recorded at Nikao, Avatiu and Avarua, despite only recording a few species, was because there was no species present in large abundance.

Table 3 Diversity of Fish Species.

Site	**Nos Species**	**Diversity**	**Max Diversity**	**Evenness**
Arorangi	19	0.476	1.279	0.372
Nikao	28	0.925	1.447	0.639
Ngatangiia	33	0.523	1.519	0.344
Avarua	27	0.988	1.431	0.690
Avatiu	25	0.795	1.398	0.569
Tikioki	33	0.757	1.519	0.499
Kavera	26	0.820	1.415	0.580

COMPARISON WITH THE 1994 (AIMS) SURVEY.

Compared to the AIMS survey conducted in 1994, the Avatiu site saw an increase in Algal cover by 12% of total cover (Algal cover includes Turf algal) (Figure 4). This was accompanied by a decline in Coral cover (including *Acropora* and non *Acropora* species) by 17% of the total cover. The Dead Coral category was not reported in the earlier survey but accounted for 2% of the cover in the present survey.

Ngatangiia site declined in total Coral cover by 11%. In the previous survey, no cover was attributed to Dead Coral, but in the present survey it accounted for 3%. Whereas previously, Other Fauna was responsible for about 3% of the cover it was not reported in the present survey results.

At Tikioki the largest change in cover was a decline in Coral cover of 28% of the total coverage (i.e from 59% to 31%). Algal cover increased by 19% of the total cover. Dead Coral, which was previously less then 1% of the total cover was found to account for 5% of the cover.

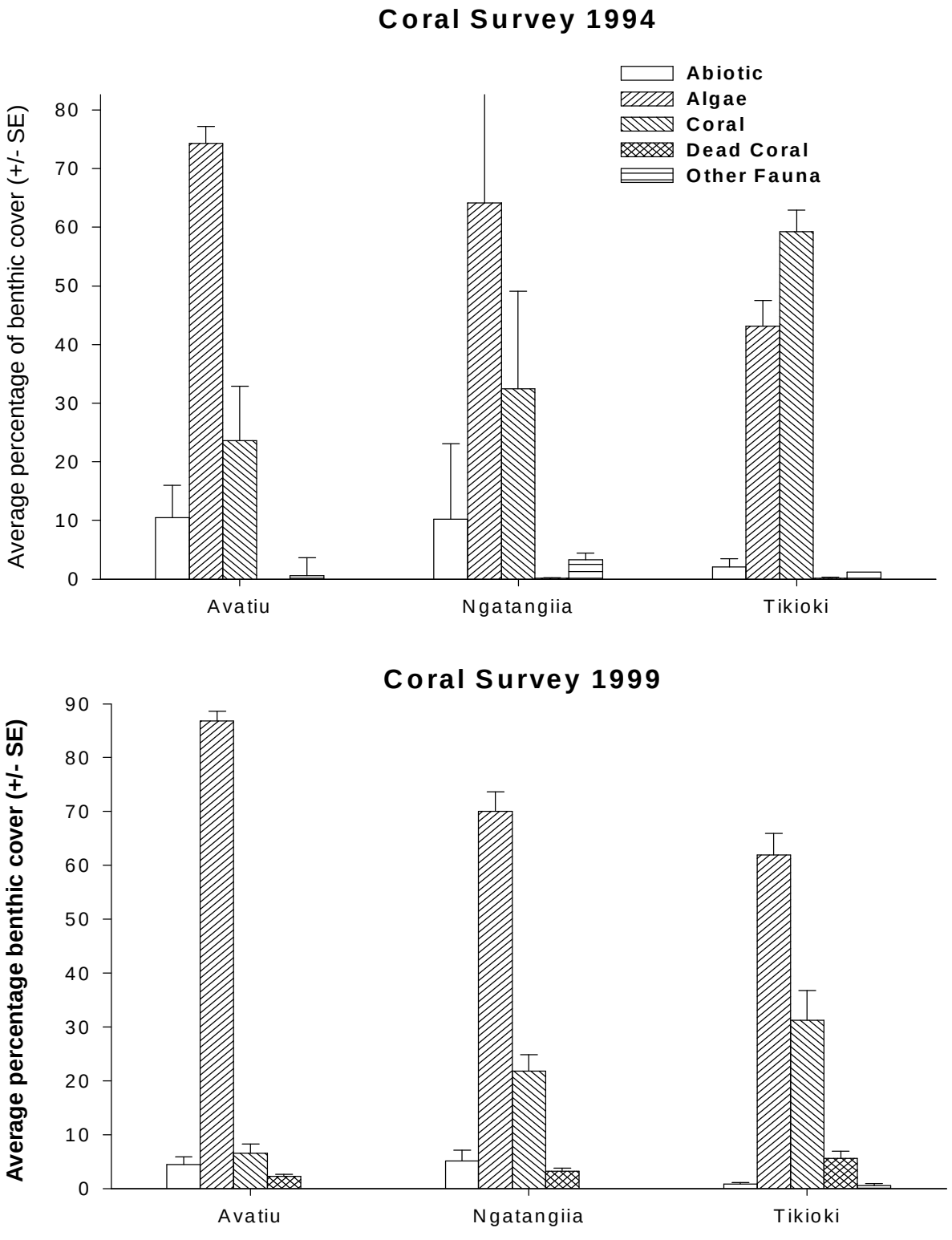

Figure 4 Benthic Cover Results from the 1994 Survey Compared to the Present Survey.

The abundance of fish counts per survey site of dominant fish families was grouped and displayed in Figure 5. Compared to the 1994 result, the Surgeonfish abundance has decreased at Avatiu by about 30% but almost doubled at Ngatangiia and Tikioki. The Butterflyfish abundance decreased by about 70% at Avatiu and Tikioki but remained about the same at Ngatangiia. The Parrotfish abundance declined by 80% to 90% at Avatiu and Ngatangiia (i.e from 28 to 3 fish at Avatiu and 51 to 8 fish at Ngatangiia), but remained about the same at Tikioki.

Further investigation of the Damselfish population revealed that it changed quite dramatically in both abundance and diversity (Figure 6). A total of 10 Damselfish species were reported in 1994 compared to only 4 species found during the present survey. Of the four species presently found the transect fish counts of three species (*Plectroglyphodon dickii*, *Plectroglyphidon imparienni*s and *Stegastus fasciolatus*) has declined in all instances compared to the 1994 results. The forth species, *Chromis viridis* declined from 440 to 60 fish at Avatiu but had a large increase in abundance at Ngatangiia (112 to 970 fish) and Tikioki (320 to 720 fish).

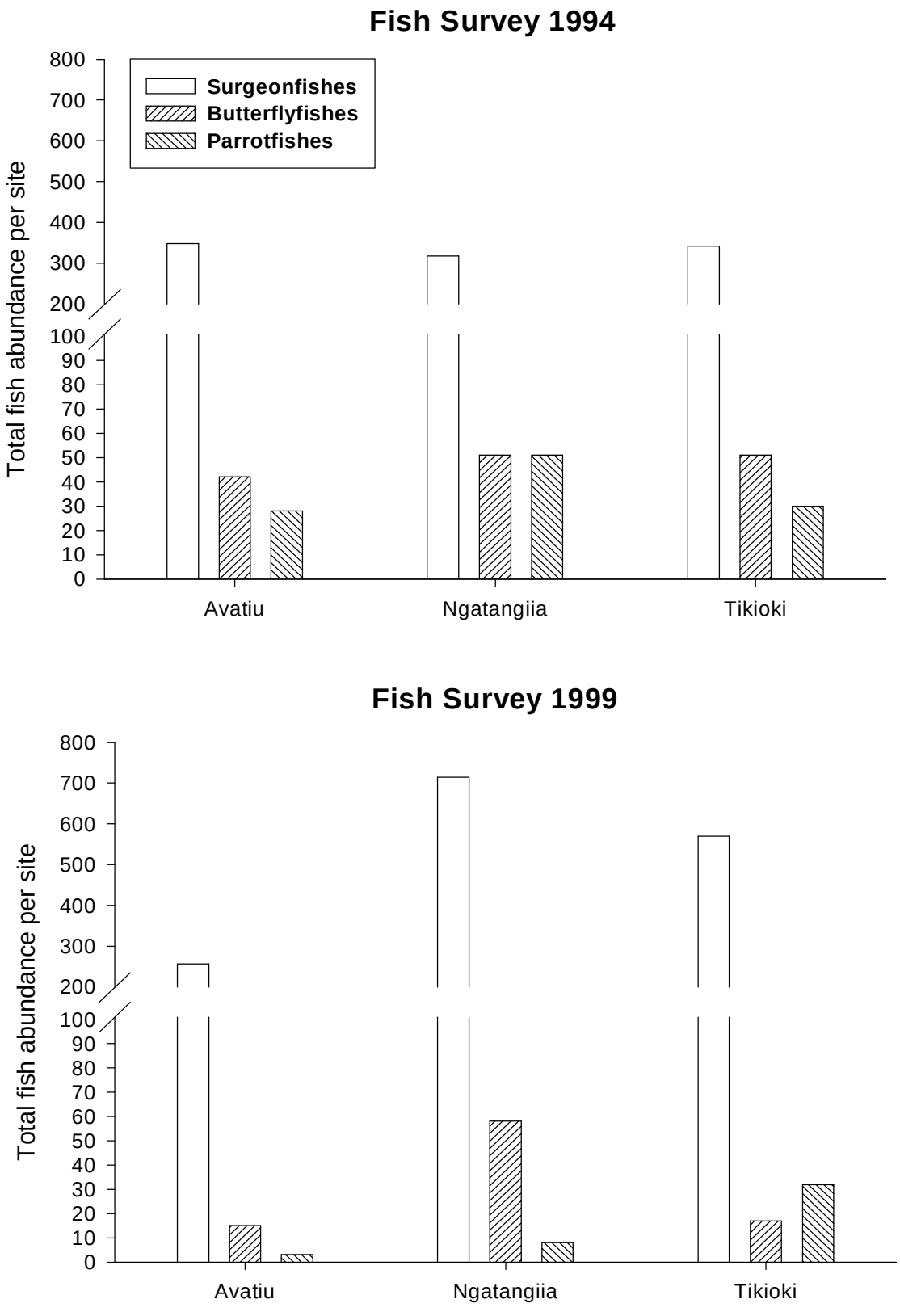

Figure 5 Dominant Fish Families of 1994 Compared to the Present Survey.

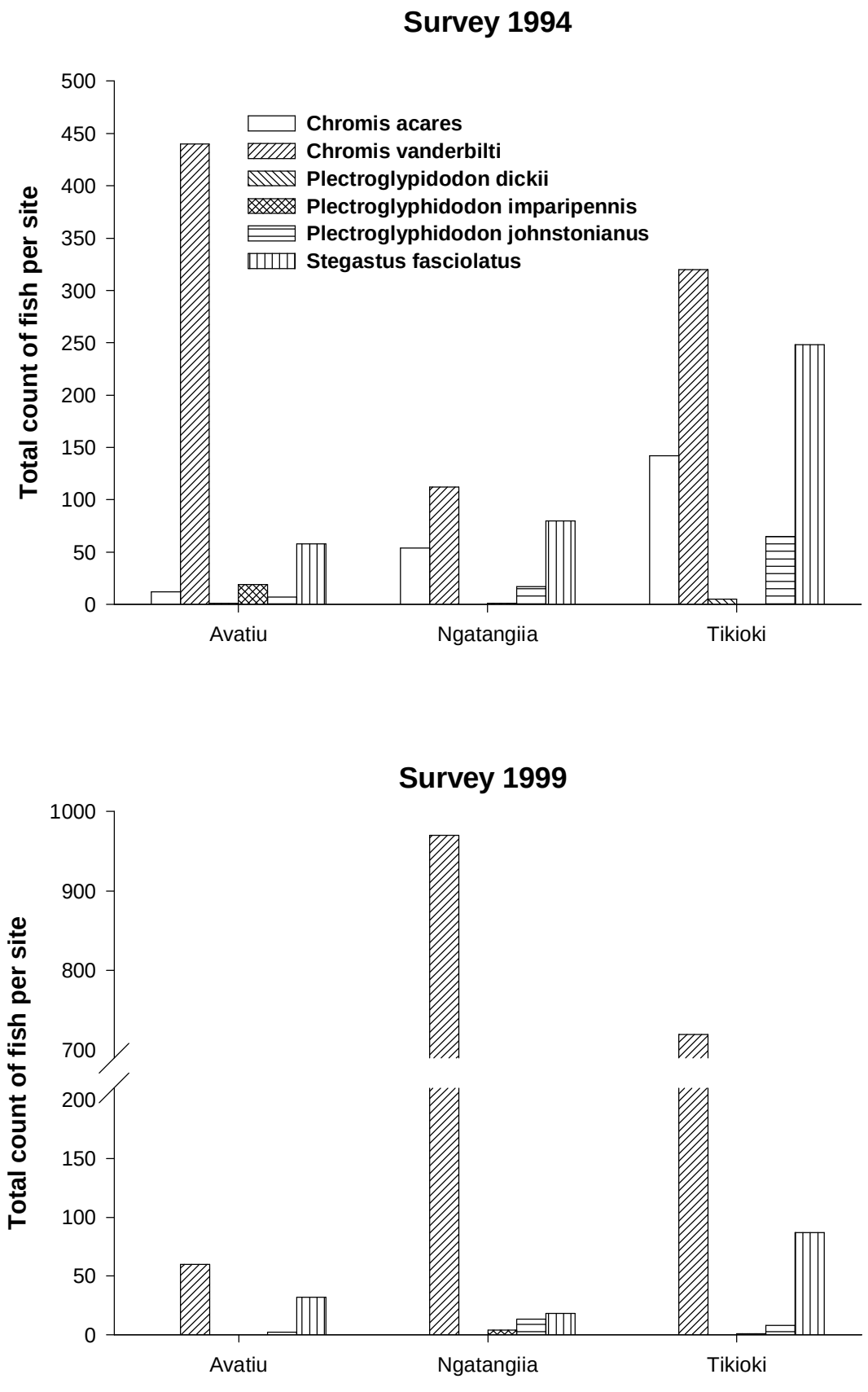

Figure 6 Dominant Species of Damselfishes in 1994 Compared to the Present Survey.

DISCUSSION

This survey result has demonstrated the need for continued monitoring of the coral and fish resources. It compliments other surveys of the Rarotonga marine baseline surveys (Ponia et al, 1998) and inshore invertebrates resources (ibid, 1999).

Benthic cover attributed to turf algal is widespread and common around Rarotonga. The predominance of this benthos type is most evident in the township area where the Avarua and Avatiu passages occur. It is most likely the result of nutrient and sediment runoff exiting the passages that can lead to a mortality of live coral and enhance the colonisation of turf algal. Compared to the township area most other sites had a relatively healthy and diverse coral (benthic) cover.

Compared to the AIMS survey conducted five years ago, the percent cover attributed to algal (which includes turf algal) has increased up to 20% at the township area and Titikaveka side. This has been accompanied by a decline of up to 30% of live coral cover in these respective areas. Whereas at Ngatangiia the coral cover has declined about 10%.

Of the seventeen fish families recorded during the survey the Damselfishes (Katoti) and the Surgeonfishes (Maito and Ume) were the most common with densities in the order of 1 fish per 2 to 3 square meters. Other common families (with densities in the order of 1 fish per 20 to 40 square meters) included Parrotfishes (U'u), Butterflyfishes (Taputapu) and Wrasses (Pakou). The Damselfishes was dominated by the species *Chromis vanderbilti* whilst *Ctenochaetus stratius* was the dominant Surgeonfish species. Among these families there appear to be some broad spatial patterns in abundance with higher densities on the windward side of the island. The rough sea conditions on the windward areas of the island may explain higher abundance of fish as a result of lesser usage of the area by spear fishers, SCUBA divers or SCUBA aquarium fish collectors.

The two edible fish species Surgeonfishes and Parrotfishes have declined at Avatiu site by 30% and 80%, respectively. This is an area that spear fishing is quite common and likely to have been significant factor. The decline of these herbivorous fish may also

contribute to the increase of turf algal reported. At Ngatangiia and Titikaveka sites the Surgeonfish population has doubled, probably partially as a result of less fishing (for fear of fish poisoning of this species often reported in the area). But also possibly as a result of increasing turf algal cover. Ngatangiia site also had a large decline in Parrotfish numbers while Tikioki populations stayed about the same, that again could be related to change in algal and coral cover in the area.

Many species of Butterflyfish feed on live coral whilst others consume a mixed diet including small invertebrates and algal. The decline of Butterflyfish numbers compared to the previous survey may be partially attributed to the decline in coral cover around the island.

The diversity and abundance of the Damselfish population has also changed. Fewer species of Damsels were recorded (4 compared to 10 species five years ago). The present population is almost totally comprised of *Chromis vanderbilti*. The Damselfish are selective of their habitat and the low number of species and abundance may be the result of change of the benthic cover – particularly the loss of live coral cover to turf algal. The drab coloured species such as *Stegastus* sp feed on benthic algal, but it is unsure whether this includes the predominant turf algal species, if not, it may account for their decline of numbers. The brightly coloured species such as *Chromis* typically feed on current borne phytoplankton and will be less affected. The increase in numbers of *Chromis vanderbilti* is probably a reflection of the decline of its predatory fish species and vacuum caused by fewer Damselfish species.

APPENDIX

List of Statistical equations.

Diversity.

A. Shannon-Weiner diversity index, H' is

$$H' = \frac{n \log n - \sum_{(i=1)}^{(k)} f_i \log f_i}{n}$$

where: n = sample size; f_i = number of observations in category i.

B. Where maximum possible diversity for k categories is

$$H'_{max} = \log k$$

C. Evenness J' may be calculated as

$$J' = \frac{H'}{H_{max}}$$

Standard Error s.e, or (variance of mean)

Standard error, s.e = square root (standard deviation) / n

where n = number of samples.

Confidence intervals, C.I (95% confidence)

95% Confidence Interval (CI) = (s.e) $t_{2,0.05}n\text{-}1$

with t value derived from t table with n - 1 degrees of freedom.

Table 1 Detailed Results of Benthic and Coral Survey.

SITE	**Arorangi**			**Nikao**			**Avatiu**		
LIFEFORM	Average	S.E	C.V	Average	S.E	C.V	Average	S.E	C.V
Dead Coral	0%			0%			0%		
Dead Coral with Algal	0.5%	0.3%	73%	1%	0%	23%	2%	0.4%	20%
Acropora	8%	3%	37%	11%	3%	26%	0.2%	0.1%	74%
Non *Acropora*	23%	6%	26%	34%	7%	20%	6%	2%	25%
Soft Coral	5%	2%	31%	0.1%	0.1%	58%	0.2%	0.1%	47%
Other Fauna	0.1%	0.1%		0%			0%		
Turf Algal	58%	8%	14%	45%	2%	5%	86%	2%	2%
Other Algal	6%	2%	42%	1%	0.3%	50%	1%	0.3%	51%
Abiotic	0%			9%	7%	87%	4%	1%	31%
Other	0.1%	0.1%		0%			0%		

SITE	**Avarua**			**Ngatangiia**			**Tikioki**		
LIFEFORM	Average	S.E	C.V	Average	S.E	C.V	Average	S.E	C.V
Dead Coral	0%			0%			0%		
Dead Coral with Algal	2%	1%	39%	3%	1%	19%	6%	1%	25%
Acropora	0.4%	0.3%	80%	4%	1%	25%	10%	2%	20%
Non *Acropora*	4%	1%	41%	16%	2%	11%	12%	2%	18%
Soft Coral	1%	1%	76%	2%	0.4%	17%	9%	1%	15%
Other Fauna	0%			0%			0.1%	0.1%	100%
Turf Algal	87%	2%	2%	64%	2%	3%	61%	4%	6%
Other Algal	1%	0.4%	64%	6%	2%	27%	1%	1%	86%
Abiotic	6%	2%	36%	5%	2%	39%	1%	0.3%	36%
Other	0%			0%			0.3%	0.2%	49%

Table 2 Average Density (per Square Meter) of Fish Species Abundance.

	Avarua	Nikao	Arorangi	Kavera	Tikioki	Ngatangiia	Avatiu
Acanthurus achilles				0.007	0.047		
Acanthurus albipectoralis					0.002		
Acanthurus nigricans							
Acanthurus nigricauda			0.002				
Acanthurus nigroris		0.001					
Acanthurus triostegus							
Calotomus carolinus							
Canthigaster ambinensis						0.002	0.002
Centropyge flavissimus	0.002	0.006	0.002		0.002	0.005	0.003
Centropyge loriculus				0.001		0.001	
Cephalopholis argus			0.001	0.004	0.006	0.001	
Cephalopholis urodeta	0.01	0.002	0.001	0.001	0.004	0.007	
Chaetodon (one blue spot) unidentified					0.013		
Chaetodon auriga	0.001	0.001			0.001	0.001	0.004
Chaetodon bennetti							
Chaetodon citrinellus							0.002
Chaetodon ephippium							
Chaetodon flavirostris							
Chaetodon lunula	0.001						
Chaetodon ornatissimus		0.003		0.005	0.004	0.008	
Chaetodon pelewensis	0.002						
Chaetodon quadrimaculatus				0.002		0.014	
Chaetodon reticulatel	0.002	0.003		0.005	0.005	0.006	0.005
Chaetodon trifascialis		0.001			0.002	0.01	0.004
Chaetodon ulietensis							
Chaetodon unimaculatus		0.002	0.003	0.006	0.005	0.014	
Cheilinus fasciatus		0.001	0.001		0.002		
Chelinus chlorourus							0.001
Chromis vanderbilti	0.225	0.16	0.710	0.555	0.72	0.97	0.06
Coris aygula	0.001	0.001			0.003		
Ctenochaetus stratius	0.167	0.272	0.030	0.163	0.521	0.713	0.255
Damsel (blue/white spotted) Unidentified	0.016						
Damsel (yellow tail) unidentified							0.002
Epibulus insidiator					0.003		
Epinephelus merra					0.001	0.001	
Forcipiger flavissimus						0.005	
Forcipiger flavissimus				0.002			
Forcipiger longirostris							
Gnathodentex aurolineatus	0.001						

Goby (unidentified)						0.002	
Gomphosus varius		0.002	0.001	0.006	0.007		0.002
Halichoeres hortulanus				0.005	0.01		0.006
Heniochus shrysostomus			0.003				
Kyphosus cinerascens							
Kyphosus vaigiensis	0.002				0.001		
Labroides bicolor				0.002			
Labroides dimidiatus	0.002	0.005	0.004	0.003	0.002	0.005	0.016
Melichthys niger			0.002		0.001		
Melichthys vidua	0.002			0.002			
Moray unidentified	0.001						
Mulloides vanicolensis						0.001	
Naso lituratus			0.002	0.002		0.002	0.001
Nemateleotris magnifica	0.007					0.01	0.009
Paracirrhites hemistictus		0.003	0.005			0.002	0.003
Paracirrihites forsteri							0.001
Parapensus multifasciatus	0.006			0.01			
Parupeneus bifasciatus		0.002	0.002		0.003	0.005	0.005
Plectroglyphidodon imparipennis			0.054	0.012	0.001	0.004	
Plectroglyphidodon johnstonianus		0.016		0.009	0.006	0.013	0.002
Pomacentrus vaiuli	0.01	0.004		0.001			
Rhinecanthus aculeatus						0.001	
Scarus altippius	0.001						
Scarus forsteni						0.001	
Scarus frenantus	0.006						
Scarus globiceps	0.001			0.001	0.004	0.003	
Scarus juvenile		0.004		0.004	0.026	0.003	0.003
Scarus oviceps					0.001		
Scarus psitticus							
Scarus schlegeli	0.001						
Scarus sordidus	0.001	0.007			0.001	0.001	
Stegastes fasciolatus	0.001	0.018		0.026	0.087	0.018	0.019
Sufflamen bursa	0.014	0.007		0.008	0.001	0.008	0.003
Thalassoma lunare	0.019	0.001				0.002	0.001
Thalassoma lutescens	0.022	0.01	0.010	0.022	0.026	0.02	0.027
Wrass (blue/white striped) unidentified			0.002				
Zanclus cornutus		0.002					0.001
Zebrascoma scopas							
Zebrascoma veliferum		0.001					

APPRECIATION

Appreciation is extended to Ministry of Marine Resources staff members Tainu Aporo, Joshua Mitchell, and Nooroa Roi for assistance in the field. Also included are volunteer university researchers Steven Lyons and Lara Trott who provided field assistance.

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