

## **TABLE OF CONTENTS.**

	Page Nos
<b>SUMMARY</b>	i
<b>INTRODUCTION</b>	1
<b>MATERIALS AND METHODS</b>	2
<b>RESULTS</b>	4
<b>Benthos and Coral Cover</b>	4
<b>Fish Surveys</b>	8
<b>DISCUSSION</b>	18
<b>ACKNOWLEDGMENTS</b>	20
<b>REFERENCES</b>	20
<b>APPENDIX</b>	22

## **LIST OF TABLES AND FIGURES.**

Figure 1 Map of Aitutaki showing survey sites.	3
Figure 2 Benthos and coral cover at fringing reef sites.	5
Figure 3 Benthic and coral cover at lagoon sites.	6
Figure 4 Density of fish family types at lagoon and fringing reef sites.	9
Figure 5 Map of Aitutaki showing distribution of dominant fish species.	10
Figure 6 Average number of dominant Damsel fish species at the fringing reef.	12
Figure 7 Average number of dominant Damsel fish species per transect at lagoon.	13
Figure 8 Benthos in September 1997 compared to the present survey.	16
Figure 9 Fish densities at in September 1997 compared to the present survey.	17
Template A Common benthic and coral cover recorded at Aitutaki.	
Table 1 Diversity indices of benthic cover.	7
Table 2 Fish Family Types and Abundance.	8
Table 3 Diversity indices of fish species at lagoon and fringing reef sites.	14

## SUMMARY

An assessment of the fish and benthos (including coral) cover at Aitutakai was conducted at 4 lagoon sites in June, 2000. Benthos cover was analysed using a technique of digital video transect footage adapted by the Ministry of Marine Resources. Fish information was gathered in-situ from a visual census technique.

The benthos and coral survey indicates that algal, mostly attributed to turf algal is the dominant cover. In the lagoon the range was 12% to 55%. Coral cover was comprised mostly of non-Acropora species with highest average density cover recorded at Maina-2 (35%) compared to Motikitui (9%). The diversity index based on number of cover categories and evenness of distribution was highest at Maina-1 lagoon sites.

Fourteen fish family types were recorded comprising of 26 species. The dominant families (and species) were Damselfishes (*Chromis acares* and *Chromis vanderbilti* *Dascyllus aruanus*, *Stegastus lividus* and *Chromis viridis*), Surgeonfish (*Ctenochaetus stratus*) and Angelfishes. These families had average densities of one fish per 1 to 4 square meters. Other common species includes Butterflyfishes, Goatfishes, Groupers, Parrotfishes and Wrasses. The diversity index of fish species and distribution was highest at Maina-1 than Maina-2 and Motikitui Sites. A comparison with an earlier survey conducted about 3 years previously revealed that fish densities of the common families have remained constant at the lagoon sites.

The survey results suggest that Aitutaki had a more similar benthic cover to Rarotonga (the capital island) compared to Manuae (an uninhabited neighbouring atoll). This suggests that human impacts may be a significant contributing factor to low coral cover and high turf algal at Aitutaki.

This study has demonstrated the need and value to continue with ongoing monitoring of Aitutaki's benthos and fish population. Information of this survey also supports the need for some lagoon management regime such as the proposal to establish marine reserves at

Maina and Motikitui inside the lagoon. To properly assess the status of the health of this island it is essential to have a comprehensive spatial and temporal pattern of key indicators such as benthos and fish. If human induced changes to the ecosystem are forced at too rapid a pace it may result that the natural forces within the ecosystem maintaining equilibrium will be lost. Through a monitoring program we can be alerted to unnatural changes in the ecosystem or the success of remedial action.

## **INTRODUCTION**

Aitutaki Island is located 225 kilometres north of Rarotonga in the Southern Cook Islands. It is described as an "almost atoll" (Stoddart, 1975). This unusual distinction is because Aitutaki possess a main volcanic island (16.8 km area, to a maximum height of 119 m), coupled with a large, shallow lagoon (74 km<sup>2</sup> area, maximum depth 10 m).

The island climate is generally uniform (averaging 25 degrees Celsius) and has high humidity and rainfall in the warmer months from December to March. It is subject to severe storms and hurricanes during the cyclone season.

The population of Aitutaki is approximately 2,300 persons (1996 census). The people rely heavily on local seafood. It is estimated that 83.4% of households are engaged in fishing activities, of which 85% of the catch is for home consumption (Baronie, 1995). The frequency of fishing per household is 2.25 times per week and based on this estimate the average consumption of fish meat per head is 100 kg per annum (Adams et al, 1996).

In recent times harvest pressure has been attributed to a notable decline in many of the fish and invertebrate resources of Aitutaki lagoon, even the diversity of live coral cover.

The aim of this survey was to assess the coral cover and simultaneously to conduct an estimate of fish abundance and diversity of Aitutaki island. Such information is essential to better understand the islands marine ecosystem and will enable better management (through programs such as marine reserves) of the islands marine resources.

## **MATERIALS AND METHODS.**

Benthic (coral) cover and fish surveys were conducted at four random locations around Aitutaki (Figure 1). The field work was carried out in June, 2000.

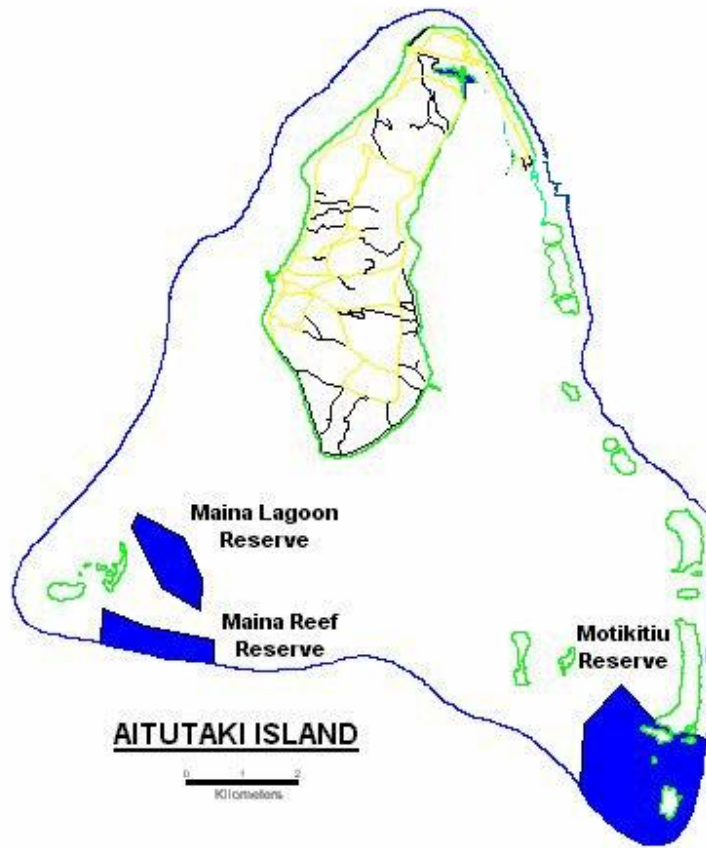
Benthic cover was studied at five replicate 50 meter transects laid along the 10 meter (30 foot) contour. The depth chosen was selected because it represents a fairly high diversity zone and is within safe SCUBA depths. Alongside the transect video footage of the benthos was recorded by a SCUBA diver using a 3-CCD digital Sony handycam. Inside the lagoon the same equipment and techniques were used. However the 50 meter length transects were replaced by a 20 meter transects which were laid at about 1 meter depth along the edge of the patch reefs.

At Rarotonga the video handycam was connected to 21" T.V monitor and a Dell (450 MHz chip) computer workstation via a Miro DV3000 Video Card. At each 20 meter transect footage, 70 clean bitmap images were systematically "snapped" (or 50 images at the 20 meter transect). Then the image on 17" computer monitor was overlaid on a grid. At five present points on the grid, the type of benthos cover was assessed according to categories described by English et al (1997). The digital images were then written to a CD-Rom and stored for future reference.

Fish surveys were collected at the equivalent coral transects. Information was recorded using a visual technique whereby a SCUBA diver swam the transect length and manually recorded all fish species and counts within a two meter band. On shore the species identification was verified using reference books and occasionally, video footage filmed during the dive.

The results were not subject to rigorous statistical analysis but the Shannon-weiner diversity index was calculated. This diversity index is proportional to the number of categories of observations (i.e, coral life-forms or fish species) and the evenness of abundance distribution, (maximum evenness is when all species have equal numbers).

Insert map of Aitutaki sites



## RESULTS.

### **Benthos and Coral Cover.**

In the lagoon the dominant coral cover was turf algae ranging in total cover from 52% at Maina-1 to 9% at Motikitiu (Figure 2, Table 1 in Appendix). This includes some relative common algae e.g coralline algae. Coral cover (*Acropora* and non *Acropora* sp.) accounted for 35% to 37% of cover. *Acropora* corals were mainly comprised of the digitate, submassive and coral massive mainly in both Maina sites between 3% and 8%. While non-*Acropora* coral was mostly of massive forms (35% at Maina Sites, mainly *Leptoria phrygia* and *Symphyllia* species) and to a lesser extent submassive forms. Dead coral with algal cover was most common at the southeastern sites (Motikitiu) where it accounted for up to 65% of cover. There were no instances of recently dead (or bleached) coral recorded.

Figures of the common benthos and coral cover types are presented in Template A.

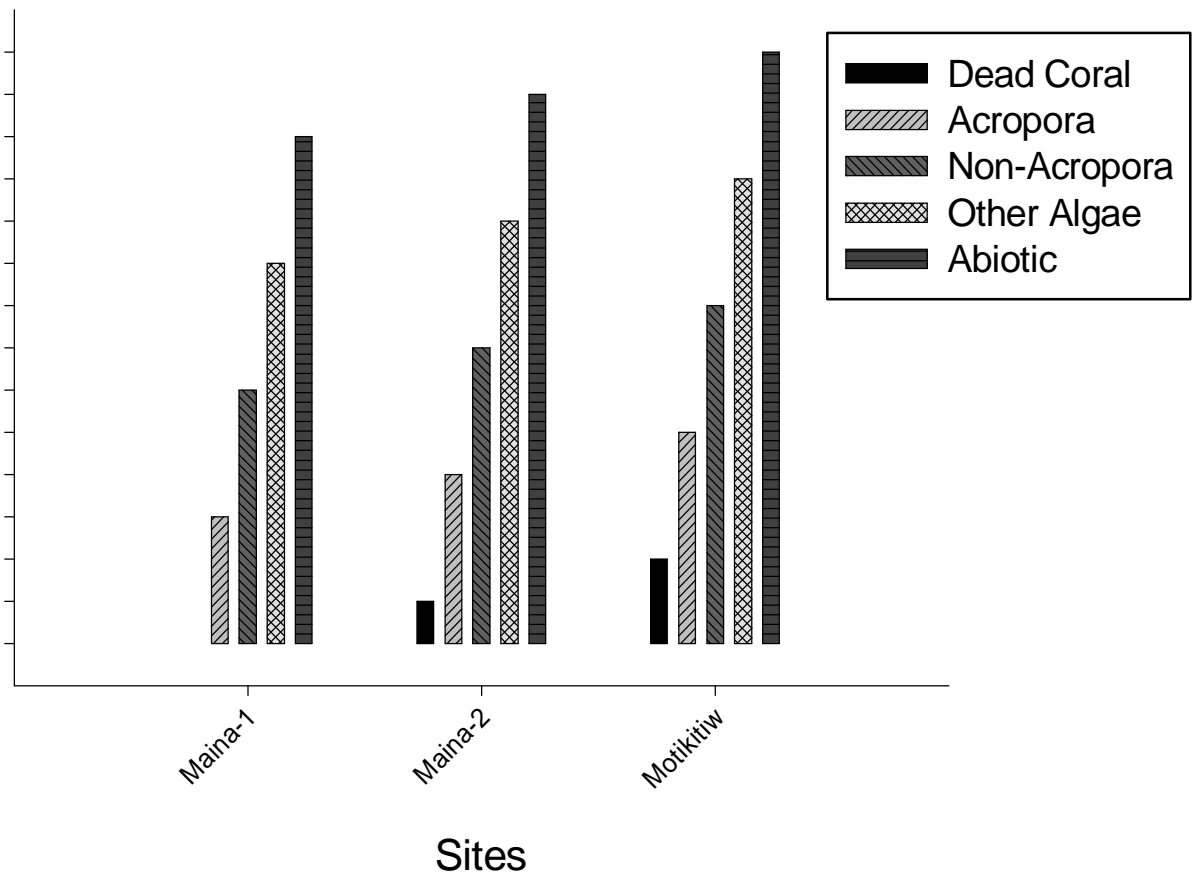


Figure 2 Benthos and coral cover at the three sites surveyed



Turf and coralline algal are the most significant factors influencing diversity and evenness of coverage at the fringing reef. The Shannon-diversity index suggests that Maina-2 to be the most diverse whilst Motikitiu site is the least diverse (Table 1). Similarly in the lagoon it is turf algal that influences diversity factors. Maina sites have the highest coverage of turf algal and the lowest diversity compared to the other two sites.

Table 1 Diversity indices of benthic cover.

	<b>Categories Cover</b>	<b>Diversity Index</b>	<b>Maximum Diversity</b>	<b>Evenness</b>
<b>Maina-1</b>	14	2997	1.150	2614.9
Maina-2	17	0	1.230	0.0
Motikitiu	13	0	1.112	0.0

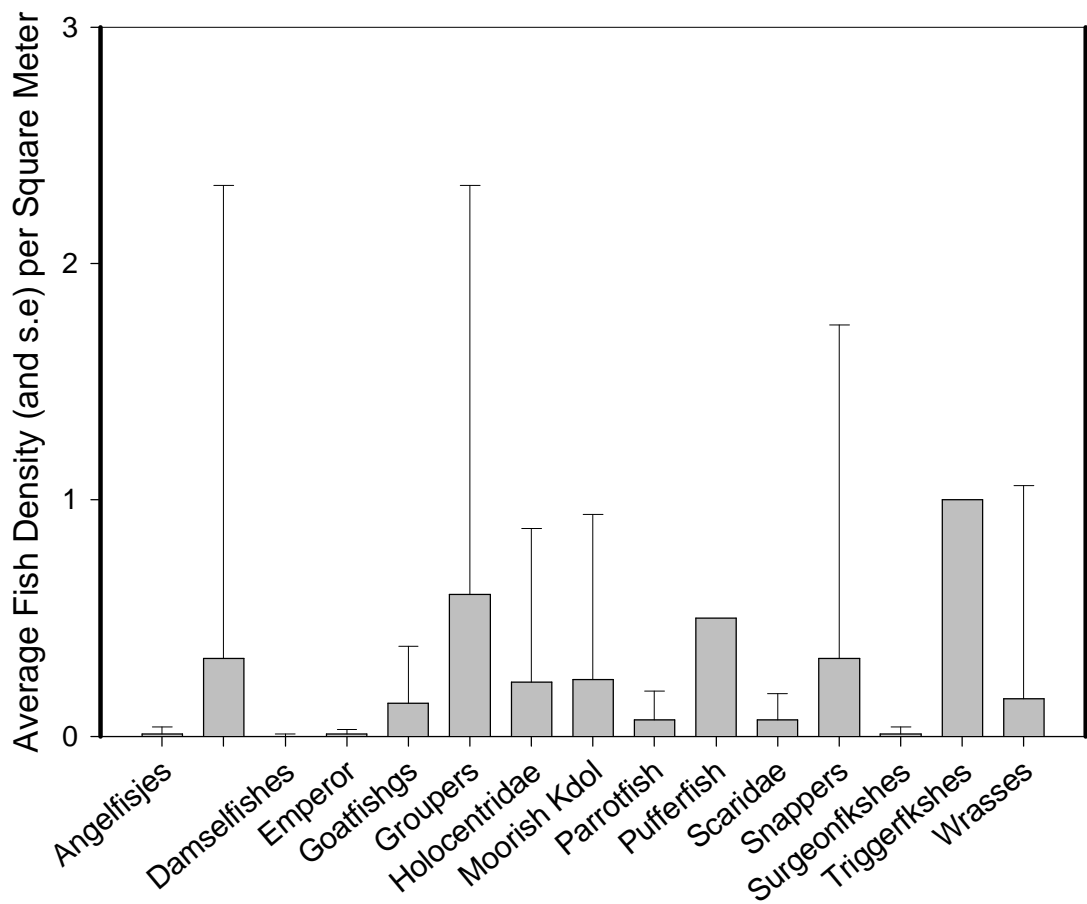


## Fish Surveys.

Both surveys inside and outside the reef surveys recorded 14 fish family types and 26 species of which are commonly found in the lagoon of Aitutaki. The Damsel-fishes and Angelfishes were found to be the dominant types. Other abundant fish family types (in densities ranging from 0.1 to 0.01 fish.m<sup>-2</sup>) include the Butterflyfishes, Goatfish, Groupers, Parrotfishes and Wrasses.

Table 2 Fish Family Types and Abundance.

<b>Fish Family</b>	<b>Local Names</b>	<b>Avg. Density</b>	<b>S.E</b>	<b>m<sup>2</sup>/Fish</b>	
Angelfishes	<i>Taputapu angera</i>	115.8	0.03	0.01	
Butterflyfishes	<i>Taputapu pepe</i>	3	2	0.33	
Damsel-fishes	<i>Katoti</i>	301.5	0.01	0.00	
Emperor	<i>Iro</i>	87.5	0.02	0.01	
Goatfishes	<i>Koma, Vete</i>	7	0.24	0.14	
Groupers	<i>Patuki</i>	1.7	1.73	0.60	
Holocentridae		4.3	0.65	0.23	
Moorish Idol	<i>Tiitii</i>	4.3	0.7	0.24	
Parrotfish	<i>Pakati</i>	15	0.12	0.07	
Pufferfish	<i>Ue</i>	2	0	0.50	
Scaridae		13.5	0.11	0.07	
Snappers	<i>Paru</i>	3	1.41	0.33	
Surgeonfishes	<i>Maito, Ume</i>	108	0.03	0.01	
Triggerfishes	<i>Kokiri</i>	1	0	1.00	
Wrasses	<i>Pakou</i>	6.3	0.9	0.16	



Density of Fish Family types at both lagoon sites

Among the lagoon sites, *Motikitui-2* had the highest number of species recorded (29 species) (Table 3). At the remaining sites there was an average of 25 species. Diversity indices at all sites were high with values exceeded 0.9. The site with the most even distribution of numbers was *Maina1*. This result was because there was less dominance of the Damselfish species.

Table 3 Diversity indices of fish species at lagoon sites.

Site	Number of Species	Diversity Index	Maximum Diversity	Evenness
<b>Maina-1</b>	26	0.902	1.415	0.638
<b>Maina-2</b>	27	0.908	2.770	0.328
<b>Motikitui-1</b>	24	0.844	3.110	0.271
<b>Motikitui-2</b>	29	0.961	2.900	0.331

## **DISCUSSION**

Algal coverage is the dominant benthos type at both lagoon patch reefs. Most algal cover is attributed to turf algal but in addition coralline algae is also relatively common on the fringing reef. In general, those sites with a high coverage of algal have relatively lower cover of live coral. Some rather interesting relationships are apparent among cover types. For instance, the fringing reef sites with high coverage of dead coral also support higher soft coral cover. Whereas lagoon sites had an inverse relationship with turf algal and non *Acropora* cover.

While the southern fringing reef sites recorded the highest diversity of cover one of those sites also has the lowest (Motikitui). This suggests that large differences in coral coverage can occur over a small spatial scale. In the lagoon, Maina had a higher diversity compared to Motikitui and may reflect physical differences in reef structure and its surrounding environment. The reefs at Maina are larger and occur in deeper waters compared to Motikitui. The most apparent change in benthos cover since the last survey of 1997 is an increase in algal cover. However a decrease in abiotic cover and increase in coral cover between the two surveys suggests the results are influenced by a difference in the two sampling techniques (manual recordings insitu versus video footage). Normally one would expect abiotic (non living forms or gaps between lifeforms) to be relatively consistent. The survey results reflect a decrease in the cover of other lifeforms such as Paua and this was also noted in the fish surveys that also recorded fewer Paua.

A total of 26 fish species in the lagoon from 14 families were recorded. Diversity was greatest at the lagoon sites although this was largely the result of large aggregations of Damselfish at the fringing reef affecting the evenness of fish distribution. More Damselfish species were recorded at the lagoon. As Damselfishes tend to be territorial and diet specific their presence is an indicator of the diverse habitat within the locality. The Damselfish and Surgeonfish dominated fish abundance. Angelfish, Butterflyfish,

Parrotfish and Wrasse also occur in relatively large abundance. The most common species was *Ctenochaetus stratus*. The Damselfish species differed in distribution. At the lagoon the *Dascyllus aruanus*, *Stegastus lividus* and *Chromis viridis* species were the most abundant whilst at the fringing reef it was the *Chromis acares* and *Chromis vanderbilti* that were predominant. This could well reflect the different benthic and water quality conditions between the lagoon and reef. Aside from the species abundance there was in fact few differences in density between and among the fringing reef and lagoon sites of fish families. A comparison of fish abundance with a survey conducted in September 1997 (Ponia et al, 1998a) revealed that fish numbers in the lagoon have not changed significantly.

The recent survey results of Rarotonga and Manuae Islands allow a comparison with the benthos cover at Aitutaki (Ponia et al, 1999, 1998b). Turf algal dominates the reef at Aitutaki (ranging from 36% to 52%) on Rarotonga it accounts for up to 90% at the township area and 60% elsewhere. At Manuae it only accounts for 12% of cover. Live coral was the most dominant cover on Manuae (50% to 65%) but only accounted for 5% to 45% cover at Rarotonga and 3% to 8% at Aitutaki. At Manuae lagoon the dominant cover is non-*Acropora* corals responsible for 45% to 65% of cover which is about twice the coral cover at Aitutaki. Whereas algal cover ranging from 25% to 40% was almost half the coverage at Aitutaki. As Manuae is an atoll similar to Aitutaki (yet uninhabited) it is interesting that the benthic cover of Aitutaki is more characteristic of the populated high island of Rarotonga (high algal cover, low coral cover) and suggests that human impacts is a significant influence on benthos.

There were 14 fish families, 78 species recorded on the fringing reef of Rarotonga (ibid, 1999) compared to 14 families and 26 species at Aitutaki. In most instances the abundance of fish families exceeded that of Rarotonga. These results may reflect a more diverse range of habitats at Aitutaki but also less fishing pressure compared to Rarotonga.

## **ACKNOWLEDGEMENTS**

Grateful acknowledgements are extended to Ministry of Marine Resources staff members Metu Koroa and Jason Marurai for their field support.

## **REFERENCES**

Adams, T. (1996). Aitutaki lagoon fishery. Unpublished report by the South Pacific Commission Integrated Coastal Fisheries Management Project with the Ministry of Marine Resources. South Pacific Commission (SPC), Noumea.

Baronie, F. (1995). Aitutaki Fish and Fishing Survey: January February 1995: A report on the state of reef fish populations, community fishing practices and tourist attitudes to lagoon issues at Aitutaki. Unpublished report to the Cook Islands Conservation Service under the Tourism Master Plan.

English, S., Wilkinson, C. and V. Baker. (1997). Survey Manual for Tropical Marine Resources. (2<sup>nd</sup> Edition). Australian Institute of Marine Science. 390 pp.

Morton, J. (1990). The Reefs of the Cook Islands. In *The Shore Ecology of the Tropical Pacific*. (1<sup>st</sup> Edition). UNESCO, Indonesia: 113-124

Ponia, B., Raumea, K., Turua, T. and M Clippingdale. (1999). Coral and Fish Survey at Rarotonga Island, January 1999. Ministry of Marine Resources. Report in press: 21 pp.

Ponia, B. (1998a). Aitutaki Island Marine Baseline Assessment. Ministry of Marine Resources. Report No. 98/02:

Ponia, B. (1998b). Manuae Island Marine Baseline Assessment. Ministry of Marine Resources. Report No. 98/04: 37 pp.



Stoddart, D. R. And P. E. Gibbs, Eds (1975) Almost atoll of Aitutaki: Reef studies in the Cook Islands, South Pacific. Atoll Research Bulletin, 190: 158pp.

Sims, N.A and N. Howard. (1988). Indigenous Tridacnid Clam Populations and the Introduction of *Tridacna derasa* in the Cook Islands. In Copland, J. W. and Lucas, J. S. (Eds.). Giant Clams in Asia and the Pacific. Australia. ACIAR Monograph No. 9: 34-40

Zar, J. H. (1992). Biostatistical Analysis. (2<sup>nd</sup> Edition). Prentice Hall, N.J.

B.Ponia, K. Raumea, T. Turua and Clippingdale M. (1999) Aitutaki Lagoon and Fringing Reef Fish and Coral Monitoring Survey, April, 1999

## APPENDIX

Table 1 Percentage of benthos and coral cover categories in the lagoon

Lifeform	Maina-1		Maina-2		Motikitiu	
	Avg	S.E	Avg	S.E	Avg	S.E
Acropora Coral Digitate	0%	0%	1%	1%	0%	0%
Acropora Coral Encrusting	0%	0%	4%	4%	3%	0%
Acropora Coral Submassive	3%	1%	4%	4%	2%	0%
Coralline Algae	1%	0%	1%	1%	0%	1%
Coral Encrusting	5%	1%	4%	4%	1%	2%
Coral Massive	7%	1%	7%	7%	3%	1%
Coral Massive Encrusting	0%	0%	1%	1%	0%	0%
Coral Submassive	21%	2%	23%	23%	6%	0%
Dead Coral Algae	6%	4%	6%	6%	1%	11%
Hallimeda	0%	0%	0%	0%	0%	1%
Macroalgae	2%	1%	0%	0%	0%	0%
Other	0%	0%	1%	1%	11%	0%
Rubble	0%	0%	2%	2%	1%	0%
Rock	0%	0%	20%	20%	16%	1%
Sand	3%	0%	9%	9%	6%	3%
Soft Coral	0%	0%	0%	0%	0%	0%
Turf Algae	52%	3%	36%	36%	6%	0%
Water	3%	1%	3%	3%	1%	1%

Table Percentage of lifeforms of benthos and coral cover inside the lagoon.

	Abiotic		Algae		Coral		Dead Coral		Other	
	avg	se	avg	se	avg	se	avg	se	avg	se
Maina-1	0.06	-	0.56	0.04	0.03	0.01	0.06	0.04	0.34	-
Maina-2	0.44	0.25	0.37	-	0.08	0.04	0.06	0.01	0.35	0.09
Motikitiu	0.20	0.05	0.12	-	-	-	0.65	0.11	0.10	0.02

Table 5 Fish species density inside the lagoon.

Site	Maina- North	Maina- South	Motikitui -North	Motikitui -South
Fish Species	Ind.m <sup>-2</sup>	Ind.m <sup>-2</sup>	Ind.m <sup>-2</sup>	Ind.m <sup>-2</sup>
<i>Abudefduf sexfasciatus</i>	0.005	0.0075	0.03	0.0025
<i>Acanthurus achilles</i>		0.0025	0.0075	
<i>Acanthurus triostegus</i>	0.005	0.0025		
<i>Acanthurus (yellow color)</i>			0.0025	0.0025
<i>Arothron stellatus</i>		0.015		0.005
<i>Canthigaster ambinensis</i>			0.01	
<i>Centropyge flavissimus</i>	0.0075	0.0125	0.0125	0.03
<i>Chaetodon auriga</i>	0.0175	0.02	0.0125	
<i>Chaetodon citrinellus</i>				0.0025
<i>Chaetodon ephippium</i>	0.0225			0.005
<i>Chaetodon ornatissimus</i>	0.005			
<i>Chaetodon pelewensis</i>	0.005			
<i>Chaetodon trifasciatus</i>	0.0275	0.005	0.0025	0.0025
<i>Chaetodon ulietensis</i>	0.0025			
<i>Chromis viridis</i>			0.35	0.325
<i>Coris aygula</i>	0.0025	0.2925	0.0125	
<i>Ctenochaetus stratus</i>	0.17	0.05	0.2	0.45
<i>Damsel (black with white below)</i>			0.015	0.0025
<i>Dascyllus aruanus</i>	0.1575	0.0025	0.55	0.1
<i>Epinephelus merra</i>		0.005	0.005	0.0025
<i>Forcipiger flavissimus</i>		0.0025	0.0025	
<i>Gnathodentex aurolineatus</i>			0.005	0.0075
<i>Gomphosus varius</i>	0.0025		0.01	0.005
<i>Heniochus chrysostomus</i>	0.0025			
<i>Halichoeres hortulanus</i>		0.0025	0.0025	
<i>Heniochus chrysostomus</i>		0.0075		
<i>Kyphosus cinerascens</i>		0.01		
<i>Labroides bicolor</i>	0.0025			
<i>Labroides dimidiatus</i>			0.0075	0.0025
<i>Lutjanus fulvus</i>		0.05	0.0075	
<i>Monotaxis grandoculus</i>			0.005	0.0075
<i>Mulloides vanicolensis</i>			0.0275	
<i>Myripristis sp.</i>			0.0075	0.025
<i>Parupeneus bifasciatus</i>			0.005	0.0075
<i>Parupeneus indicus</i>	0.0025			0.0125
<i>Plectroglyphidon dickii</i>	0.0025			
<i>Pomacentrus coelestis</i>		0.005	0.125	0.1375
<i>Pomacentrus vaiuli</i>		0.0025	0.0025	0.0125
<i>Rhinecanthus aculeatus</i>	0.0025			
<i>Scarus altippius</i>		0.0925		
<i>Scarus juvenile</i>	0.09	0.01		0.045
<i>Stegastes albifasciatus</i>		0.275		
<i>Stegastes lividus</i>	0.11	0.035		0.4125
<i>Thalossoma hardwicke</i>			0.0025	
<i>Thalassoma lutescens</i>	0.0175	0.07		0.0125
<i>Tridacna maxima</i>	0.135	0.01	0.005	0.0175

Insert template of common benthos cover