Dredging/Sand Mining at the Pangaimotu/Toula Causeway – Impacts on the Environment and Coastal Fisheries

by

'Asipeli Palaki
Tupe Samani
Mafile'o Masi

Technical and Sustainable Division
Department of Environment
October, 2005

1.0 Introduction

Toula community were concerned about possible sedimentation problems that may have triggered the sudden declining of the marine edible fisheries within their fishing ground, the coastal water between Toula and Pangaimotu. The people of Toula have been relying on these fisheries for their everyday food and income for a decade.

It has been identified that the building of the bridge between Toula and Pangaimotu, and the mining of sand around the coast line and near the bridge, cause an effect on the abundance of local fisheries in the fishing ground. Now, the local gleaners from Toula Village have to shift their fishing ground to other areas in Vava'u, which is too far to access.

Demanding for sand for construction and development is paramount in Vava'u, and has been identified as the major reasons for the dredging practices currently running at the fishing ground at Toula.

Dredging operation causes devastating effects on the environment, as well as it's resources. Several mechanisms cause the pollution of the environment from sedimentation effects. Dredging physically disturb the bottom substrata including habitat for benthos, deposit sediment on the substrata, suspend sediment in the water column, reduce light penetration, increase turbidity, change circulation patterns, and can reduce dissolve oxygen and increase nutrient levels in the water column.

The overall aims of this survey are two folds:
:

1. To find out the status of marine resources around Toula fishing ground

2. Whether the depletion of the marine resources from the Toula fishing ground causes by the dredging operation currently running.

2.0 Methodologies and Indicators used

2.1 Line and Point Intercept Transect

The site was selected around the areas of Toula coastal waters. At the site on the reef slope, 5 (transects) replicate 20 meters length were placed haphazardly at 4 meters water depth. At each transect line, divers moved slowly along the transect line recording onto the data sheet the life forms encountered under the tape. The tape was marked at each 0.5 meter, and any life forms touched the 0.5 meter point were recorded on an underwater recording paper using pencil.

Two transect lines were also placed in vertical position running from shore to the edge of the reef. The idea of using this method is to draw up a profile of marine organisms inhabiting the area from shore to reef areas, and to identify any zonation and habitat partitioning in the study areas. It is also important to take note the abundance of marine organisms in the study areas. Application of same procedure as applied above.

2.2 Line belt transect

Line belt transect was used for indicator species (butterfly fish) counting. Placing the same transect line (tape) on the reef, after benthos counting (above), wait for 10 minutes then start the fish counting on the same transect. At each 0.5 meter interval, 1 meter at each sites of the interval, indicator species were counted and recorded on the underwater recording paper.

2.3 Site observation/Underwater video camera

Description of the study sites from onsite observation and video camera were also carried out around the study areas at Toula.

2.4 Indicators

Five indicators used for this study were:

1. % Coral coverage- percentage of coral coverage within the study area. The lower the percentage coverage of live coral indicating the effects of sedimentation.

2. Species indicators (Butterfly fish) Chaetodon spp – All butterfly fish are corallivores, feeding on corals, so no corals no butterfly fish

3. % epiphytes on seagrass – Epiphyte is a good indicator for pollution and sediment being added to the marine environment

4. Abundance of benthic organisms – Any marine environment with low abundance of marine benthos indicating pollution affecting the sites

5. Socio survey – Questionaire and interview

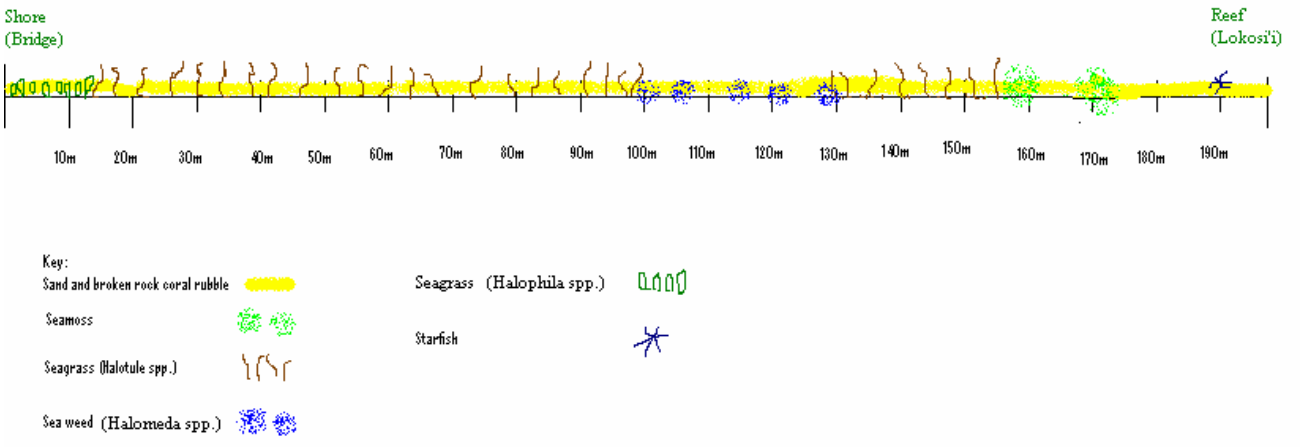
2.6 Equipment List

1. Measurement Tape (100m)
2. Waterproof paper/pencil
3. Digital Camrecorder
4. Snorkelling gear

3.0 Results

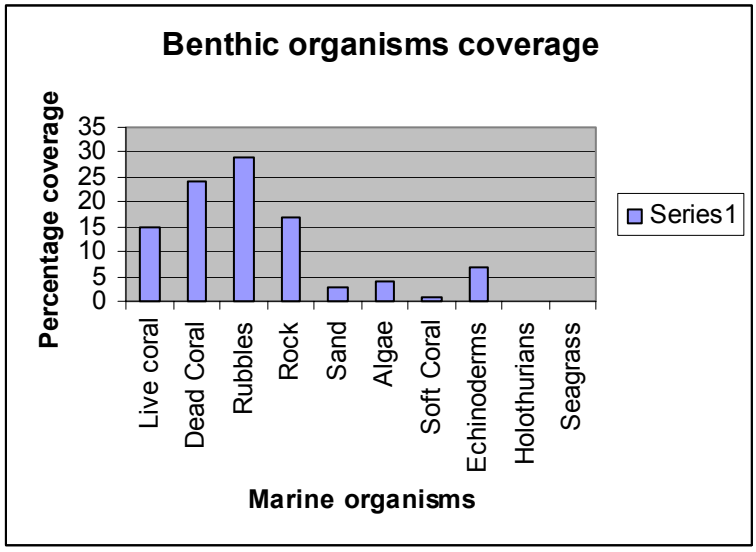
3.1 Profile Transect

The profile shows an abundance of seagrass species dominated by *Halodule* and *Halophila* species. Good coverage of algal species *Halomeda discoidea* was found in the study area.



3.2 Percentage Benthos Coverage

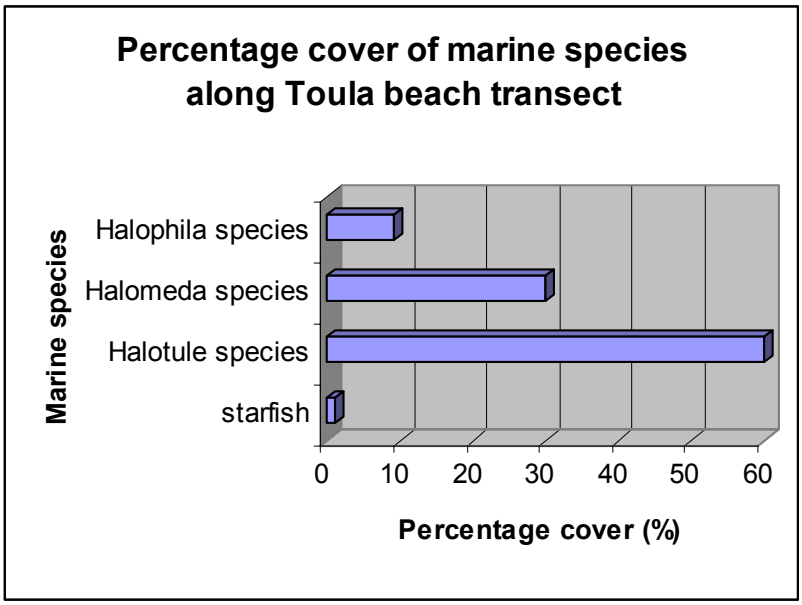
Graph 1: Benthic organisms at Toula



Graph 1 shows that live only 15 % coverage which is fairly low. Other life forms very low coverage, except for abiotic resources such as rubbles and rocks are high.

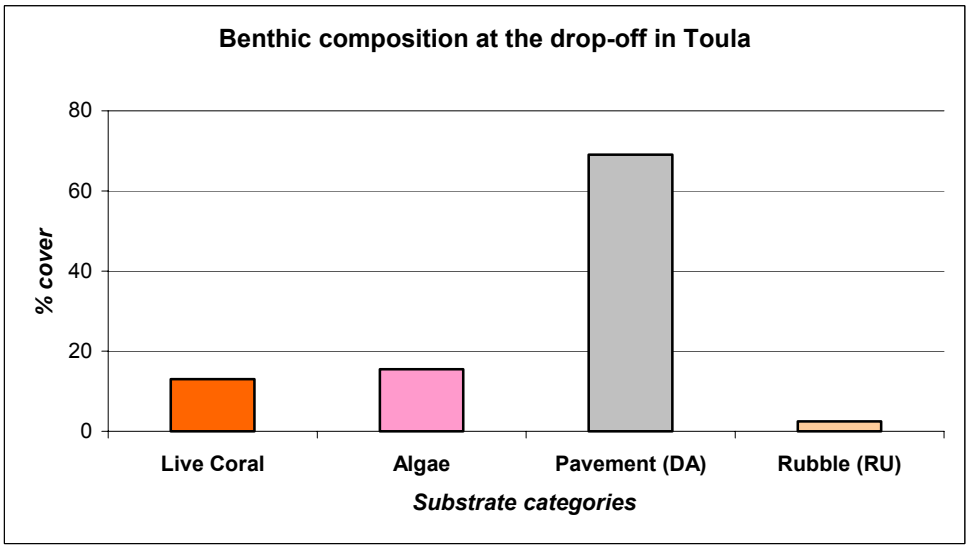
3.3 Benthic organisms coverage on the lagoonal areas

The only benthic species that were found along the transect line were starfish *diadema hydrix,* and were low in numbers, and scattered in the last 10 meters of the transect nearest to the reef.



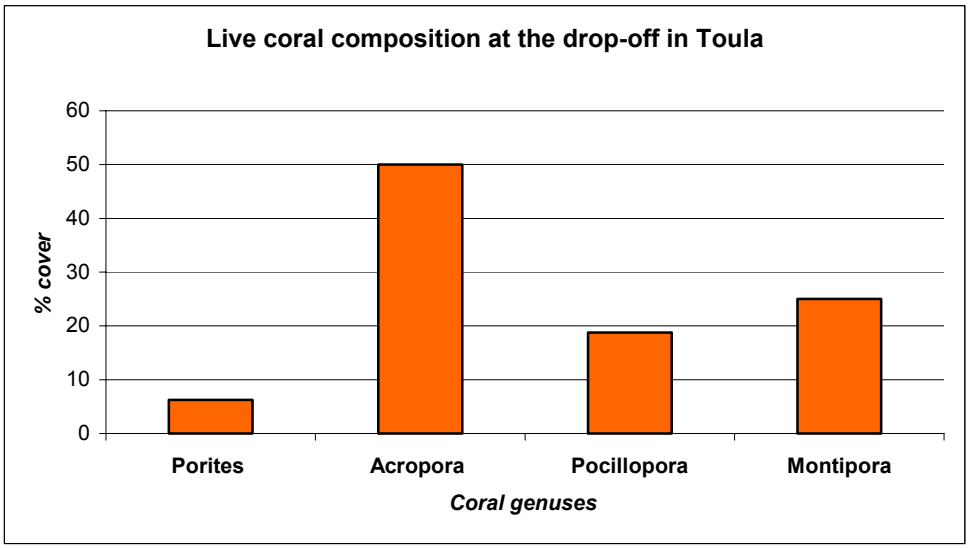
Common local fisheries such as holothurians (hulali), shellfish, gastropods and etc are not found or are in very low abundance in the study area.

A high percentage of sea urchins was observed in another area of the beach with densities increasing as it nears the reef. However, no sea urchins was observed along the transect.



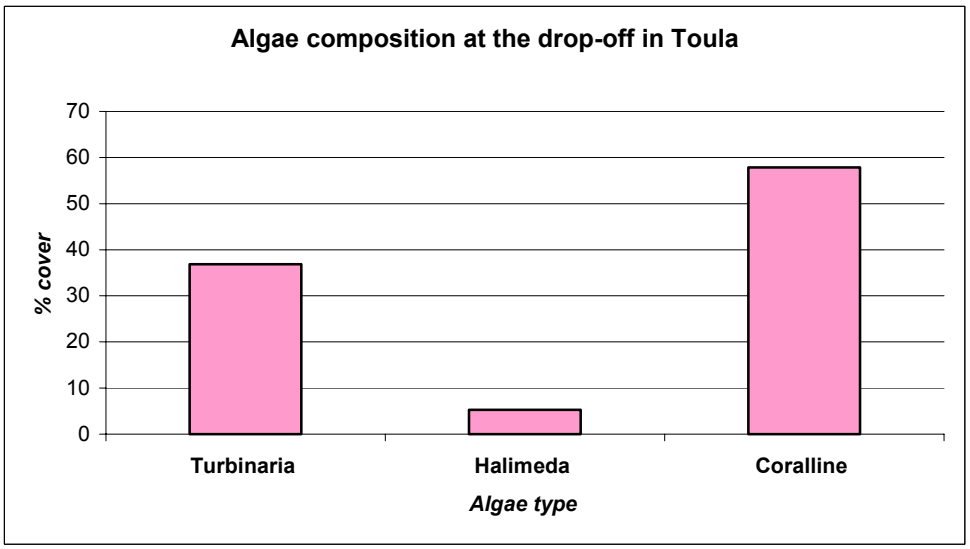
Graph 4 : Benthic composition at the drop-off in Toula

As described in the introduction, the site surveyed is a large pavement area representing 70% of the substrate composition. Few live coral (13%) and algae (15%) are scattered over this pavement.



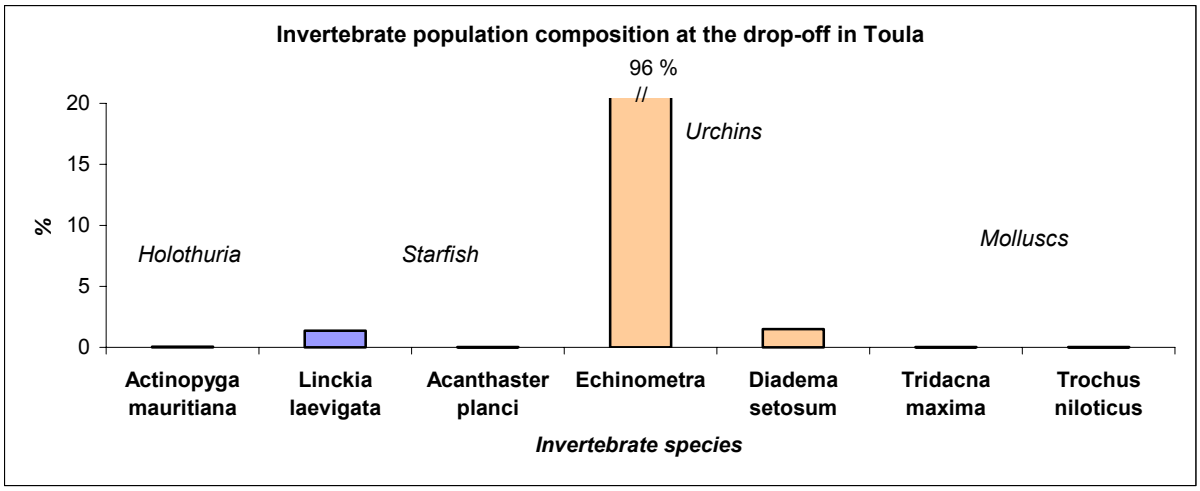
Graph 5 : Live coral composition at the drop-off in Toula

Among the type of corals recorded, half was the braching Acropora, then encrusting Montipora (25%), branching Pocillopora (19%) and very few massive Porites (6%).



Graph 6 : algae composition at the drop-off in Toula

Most of the algae recorded was the pink calcareaous algae, coralline with more than 50% of the overall algae cover and then 37% Turbinaria, a brown macroalgae and another calcareous algae, Halimeda with 5%.



Graph 7 : Invertebrate population composition at the drop-off in Toula

The invertebrate population is dominated by the urchin Echinometra found in thousands and some *Diadema setosum* as well. The purple starfish, *Linckia laevigata* was also relatively abundant as 46 of them have been recorded along the three transects.
Density for Echinometra (3 000 ind. recorded) is about 25 per squaremeter (**3** transects x **20m** long x **2m** wide = 120 squaremeter).

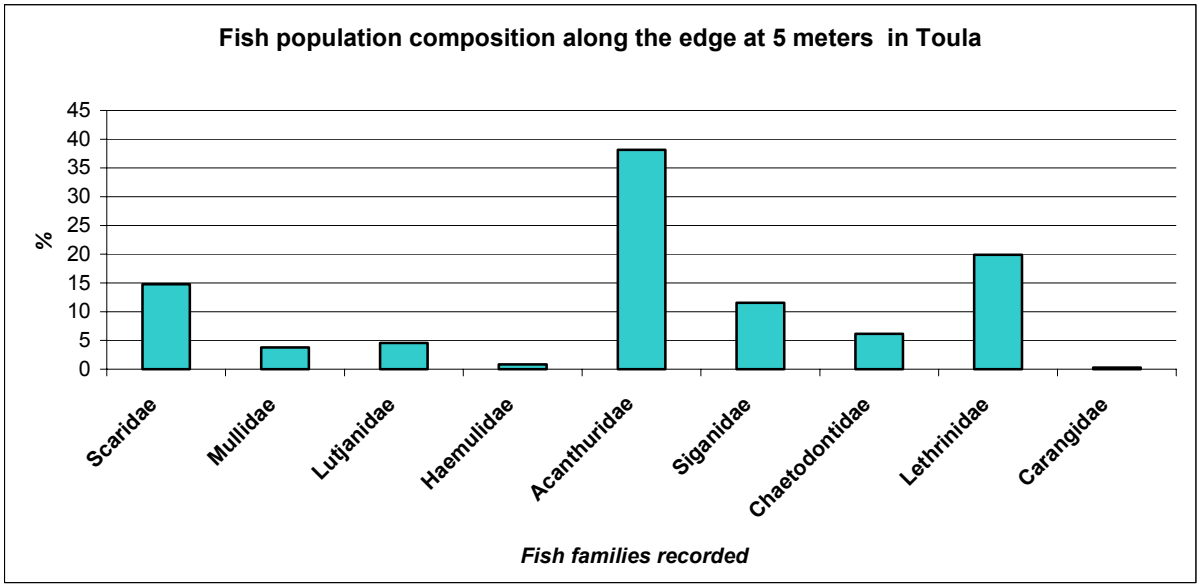
Density for Linckia laevigata is 0,4 per squaremeter, same for the black urchin with long spines *Diadema setosum*.

One crown-of-thorn starfish was found in the transect.

Fishes have not been recorded along the 2-meter wide transect because most of them were at the bottom of the drop-off, obviously presents, but not inside the transect. In order not to skip this parameter, it was decided to perform a 5-minute swim three times along the edge and record the commercial fish families as well as the butterfly fishes.

Table 1: Abundance of commercial fishes in Toula

	Swim 1	Swim 2	Swim 3	Total
Scaridae	33	8	14	55
Mullidae	14	0	0	14
Lutjanidae	13	0	4	17
Haemulidae	3	0	0	3
Acanthuridae	53	50	39	142
Siganidae	2	24	17	43
Chaetodontidae	2	18	3	23
Lethrinidae	1	37	36	74
Carangidae	0	0	1	1



Graph 8 : Fish population composition along the edge at 5 meters in Toula

Three hundred and seventy two fishes representing nine commercial families have been observed during these swims. The most abundant is the surgeon family, Acanthuridae with 38% of the fishes recorded followed by Lethrinidae (20%), parrot fishes or Scaridae (15%), rabbit

or Siganidae (12%), butterfly or Chaetodontidae (6%), snapper or Lutjanidae (5%), goatfishes or Mullidae (4%), sweetlips or Haemulidae and jacks or Carangidae (1%).

This site obviously needs to be monitored as dredging activities have recently started and local fishermen said they have had an impact on their fishing grounds. The urchins Echinometra did not seem to be in such high abundance last year and their evolution should be watched.

There are also other organisms to be monitored such as Crown-of-Thorns, one was recorded on the transect but two others were spotted during the timed swim. The purple starfish *Linckia laevigata* is also worth being monitored as it can prevent coral growth by grazing the young recruits.

Socio-Economic Survey

Interviewing of village women gleaners

Results from questionnaires and interviews targeting Toula's gleaners who frequently fish in the shallow inshore water, found that the most of edible fishery resources that were easily found in the past are absent or very rare at present.

The decline of fisheries in the Toula coastal environment has led to the villagers moving to new fishing grounds in the villages of Okoa and Makave.

Table 2: List of edible fisheries used to find in the Toula fishing ground before dredging operation start

Tongan name	English name
Hulali	Horothurians
Lomu	Holothurians
Muli'one	Sea slug
Kaloa'a	Anadara spp
To'o	Gafarium spp
Kuku	Modiolus spp
Tekanoa	Tridacna spp
Limu fuofua	Caulerpa spp
Ika	Fish
Te'epupulu	Horothurians
Paka	Crab

Mehingo	Bivalves
Kele'a	Trocus

% epiphytes

A 100% epiphyte such as algae covered all seagrass species along transect.

4.0 Discussion:

The practical use of biological indicators in marine organisms to evaluate the health of marine ecosystems has been studied extensively.

The survey conducted in Toula used the species indicators such as sea urchins, % epiphytes growing on seagrass, butterfly fish (chaetodon species), % coral coverage as indicators to determine the existence of pollution in the marine environment, and therefore determining the health of the Toula coastal resources.

It is a known fact that sea urchins thrive in polluted waters (Li, 2003). It is a vicious cycle: pollution leads to extensive growth of algae which fuels growth of sea urchins. Because of this link, scientists regard sea urchins as a biological indicator of water pollution – if there is an abundance of sea urchins, it means a polluted marine environment.

The green-tinted water instead of clear blue is a sure sign of high sedimentation. Sedimentation from nearby dredging of sand to deepen causeway under the bridge has been noted by the village gleaners as having a high impact on the decline in marine species in the Toula beach.

Picture: Causeway that dredging took place to deepen channel for water exchange

Picture: Green tinted water indicates the high sedimentation by nearby dredging of sand operation

The lack of benthic organisms along the transect line except the small scattered numbers of starfish points out that benthic organisms that were identified by gleaners as having existed abundantly in the past, having migrated to other less stressful areas or have died.

It was also observed during the survey that majority of the bivalve species found in the Toula beach were dead due to sediment depositing on seafloor therefore making it higher and consequently exposing these bivalves leading to their desiccation. This was supported by the observations of Toula's women gleaners who noted the decline in bivalve species that were mainly fished for food.

The decline of Toula's holothurians (***hulali)*** species, both have social and economic impacts on the village inhabitants. The ***hulali*** is a species that is identified with the Toula people as evidenced by a folk story based on this species, and its link to Toula. It was also a main source of food and small scale sales in local markets.

Overfishing is not ruled out as a contributing cause for the decline in marine species in the Toula coastal water. As was stated by the village women gleaners that were interviewed, in the past easy access and close location of the fishing ground near the village made it a suitable source area to gather edible marine species. It was also noted that at least one gleaner from each households in the village regularly fished from these grounds.

The high percentage (100%) epiphyte mainly algae cover on all seagrass species is another indicator of declining health status of a marine environment. Algae growth is fueled by excess of nutrient sediments in the water.

It was observed during the survey that sand has accumulated near the opening of the causeway that allow water exchange and flushing process to occur. This sand accumulation makes the opening of the causeway smaller and therefore less water exchange and flushing occurs. The residence time which is the duration period that a body water remains in a certain area before it is flushed or exchanged naturally in the Neiafu Harbour is observed to be increasing.

Picture: Sand accumulation around opening of causeway

Recommendations:

1. Widen up causeway channels to increase the water flow in and out of Neiafu Harbour Areas

2. Build new causeway to enable more exchange of water flow and a more adequate flushing

3. Consider offshore dredging site in Vava'u

4. Include Toula in the Department of Environment's monitoring program conducted annually.

References

1. Crosby,M.P and Reese, E. S. 1996. *A manual for Monitoring Coral Reefs with Indicator Species.* Office of Ocean and Coastal Resource Management, National Oceanic and Atmosphjeric Administration, Silver Spring, MD.

2. Kaly et al. 2001. *Neiafu Harbour Areas Study*. Department of Environment, Tonga.

3. English E, Wilkinson c, Baker V. 1997. *Survey Manual For Tropical Marine Resources. 2nd Edition*. Australian Institute of Marine Science.

4. Veron J.E.N 1986. *Corals of Australia and the indo-Pacific*. University of Hawaii Press. Honolulu

Appendices

Table 1: data recorded along the three transects set up in Toula

	Transect 1	**Transect 2**	**Transect 3**	**Total**
SUBSTRATE				
Live Coral				**16**
Porites (POR)	1	0	0	1
Acropora (ACR)	4	3	1	8
Pocillopora (POC)	1	1	1	3
Montipora (MONTI)	1	3	0	4
Algae				**19**
Turbinaria (TURB)	1	3	3	7
Halimeda (HAL)	0	1	0	1
Coralline (CA)	0	5	6	11
Pavement (DA)	30	25	30	**85**
Rubble (RU)	3	0	0	**3**
INVERTEBRATES				
Holothurian				**2**
Actinopyga mauritiana			2	2
Starfish				**43**
Linckia laevigata	4	24	14	42
Acanthaster planci			1	1
Urchins				**3046**
Echinometra	1500	500	1000	3000
Diadema	28	9	9	46
Molluscs				**2**
Tridacna maxima			1	1
Trochus niloticus			1	1

Table 2: abundance of commercial fishes in Toula

	Swim 1	**Swim 2**	**Swim 3**	**Total**
Scaridae	33	8	14	55
Mullidae	14	0	0	14
Lutjanidae	13	0	4	17
Haemulidae	3	0	0	3
Acanthuridae	53	50	39	142
Siganidae	2	24	17	43
Chaetodontidae	2	18	3	23
Lethrinidae	1	37	36	74
Carangidae	0	0	1	1