INSTITUTE OF APPLIED SCIENCES

UNIVERSITY OF THE SOUTH PACIFIC

BASELINE BIOLOGICAL STUDY OF THE YANAWAI RIVER AND THE ADJACENT REEFAL SYSTEM

IAS ENVIRONMENTAL STUDIES
REPORT No. 77

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BASELINE BIOLOGICAL STUDY OF THE YANAWAI RIVER AND THE ADJACENT REEFAL SYSTEM

0.0 SUMMARY

Gold mining can have serious impacts on coastal ecosystems especially on tropical reef areas and on local fisheries. The Yanawai river drains the Mt Kasi region where it is proposed to reopen an old gold mining site. Local village communities have expressed some concern as to the long term effects of the mine. The river drains into a coastal mangrove system eventually entering Savusavu bay towards the Koro sea. The marine area includes several patch coral reef areas.

Preliminary gill netting results and field observations undertaken by the Institute of Applied Sciences gives strong evidence to indicate that the villagers are active fisherfolk and are utilising an important source of protein in the river's fin fish and invertebrate stocks. Their concerns over the possible impacts of the mine are thus understandable.

The health of the reefs covered in the baseline survey was what one would expect of reefs that are in close proximity to freshwater inputs. The most dominant coral species were those most tolerant to high levels of silt in the water column. The high natural silt loadings suggests that impacts of the mining activity can only be assessed through regular monitoring of the established reef quadrats.

The earlier mining activity at Mt Kasi resulted in the tailings from the mine being disposed of directly into the river. This method of tailings disposal is known to have caused serious environmental impacts in other areas of the world (eg PNG-Ok Tedi). The present survey of the coral reef communities and the fisheries resource however, did not reveal any impacts of the previous mine which ceased operation some 50 years ago around 1946).

1.0 INTRODUCTION

Small scale gold mining was first conducted at Mount Kasi between 1932 and 1946. Recently the company, Pacific Islands Gold N.L. have begun exploratory activities and are awaiting mining approval to rework the same area.

As part of the approval process Soil Conservation and Environmental Services (SCES) were contracted by Pacific Islands Gold N.L. to :

- devise an environmental management plan (this plan was produced in December 1993) and

- conduct an environmental impact assessment (this assessment was carried out in early 1994).

The EIA dealt very briefly with the aquatic resources in the surrounding freshwater environ. Nearby villagers at Dawara however, subsequently expressed concern at the possible impacts of the mining activities on their fisheries resources. The concern was because the tailings from the mine are to be stored and treated in a single stage tailings dam in the Vola Creek Catchment. This catchment includes the Nakoi and Karoikeva Creeks which directly drain the mine site and eventually feed into the Yanawai River. The Yanawai at this point is tidal influenced and subsequently drains into Savusavu Bay. The villagers from Dawara are dependant on fish caught in the Yanawai River and the reefal areas in the Bay.

Harrison and Grierson (Fiji) was asked to further investigate the situation with the Institute of Applied Sciences at the University of the South Pacific being subcontracted to:

- conduct a baseline survey of the existing fisheries in the area,
- conduct water quality analysis and
- establish permanent reef quadrats on the surrounding reefs.

The fisheries survey and reef studies were carried out between 1st December and the 3rd December,1994 by a team of three researchers from the Biology Department, School of Pure and Applied Sciences, USP. The water quality analysis will be the subject of another report.

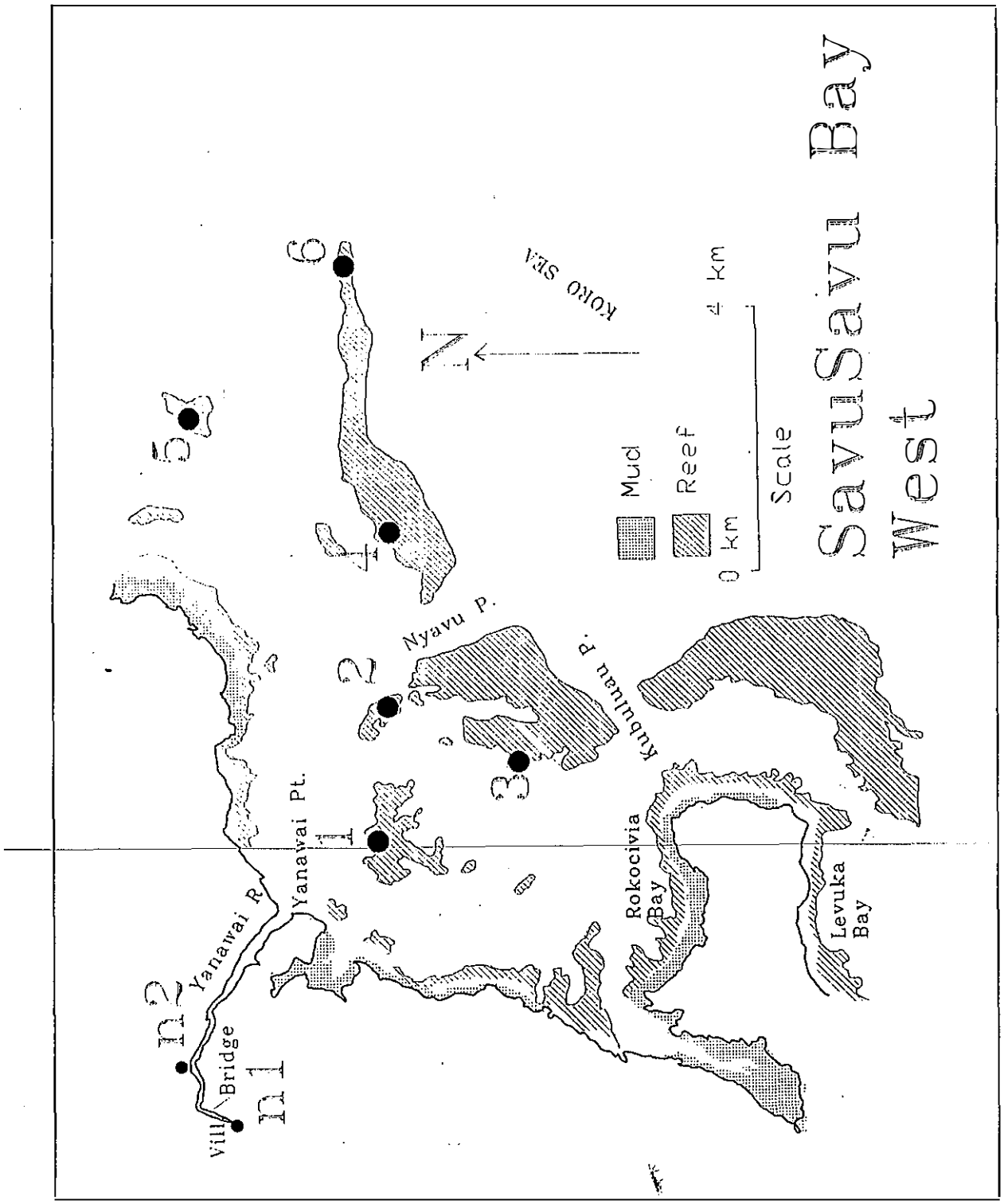
2.0 METHODOLOGY

The study team, consisting of 3 IAS/USP personnel, (Naqasima, Whippy and Qereqeretabua) were accommodated at Na Koro Resort on the eastern side of Savusavu bay with daily trips to the study site by boat. The boat trips (departing at 8am and returning at 5pm) took 1.5 hours each way which meant that a good part of the day was spent getting to and from the study area. The boat was handled by the resort's resident divemaster who also arranged for the use of SCUBA tanks. The weather conditions on the first day were ideal with clear skies and calm seas. There were two dives conducted on the first day with a reconnaissance trip up the Yanawai River. There was a change in weather on the second and last day with fine conditions in the morning and thunderstorms in the afternoon. Dives were thus conducted in the morning and gill netting in the early afternoon of both days.

2.1 Fisheries assessment

A fishery is comprised of three main components: the fish stock or resource, the fisherman and the processing/marketing of the resource. This study is mainly concerned with the fish stock and its abundance in the Yanawai River. There are several methods of measuring stock abundance each with their own assumptions. One can either choose to estimate the absolute abundance of individuals in a population (which can be an expensive, tedious exercise) or obtain an estimate of relative abundance which in most cases is sufficient.

Catch per unit effort (CPUE) is the most commonly used index of relative abundance and relates the abundance in one area to that in another or the abundances in the same area but at different times. Catch per unit effort can be expressed as kg caught per unit time (kg/hour) or number caught/unit time(#/h). For the present survey gill netting was performed to estimate abundance and to find out species availibility. Gillnetting is a standard fishing technique that can be used to measure stock abundance.



Map 1: showing the gill net sites and the quadrat sites

No method of assessment however, is totally efficient since all fishing techniques show some degree of selectivity. For instance the gillnet will only select for a particular size range of fish. Fish that are smaller or larger than the mesh size will not be accounted for. The CPUE therefore, is related to but usually less than the absolute abundance in the gear's area of influence (King & McIlgorm, 1989).

Spot sampling of a fishing resource for scientific purposes also does not always correlate with long term averages obtained from actual commercial (or subsistence) catches. Local fisherfolk obviously have greater knowledge of the seasons, sites etc. than a contracted scientist. Estimation of the value of the resource for compensation claims in Fiji is usually performed by the Fisheries Division (Fiji Govt.) Padma Lal, in her important study of the economic worth of mangroves as a fishing resource, gave one figure of F$140 per hectare per annum for a study of the fishery at Raviravi (Conservation or conversion of Mangroves in Fiji, East West Centre 1990). She also listed the compensation claims for mangroves in the period 1981-1987. Claims for conversion of mangrove areas (for the same time period) varied between $30/h and $6,000/h with an average for the Northern Division of around $700/h (1988 dollars). It was not the purpose of this study however to complete a study of the economic worth of the fishery resource based around the Yanawai river.

Gill netting was carried out at two sites (n1 and n2 shown in map 1) on the Yanawai River to assess the subsistence catch in the river. A net 50m in length with 3" mesh size was first deployed upstream for a soak time of 3 hours during the day, on an ebb tide. The net was again deployed downstream for a soak time of 23 hours.

2.2 Reef Studies

A total of six sites (see map 1) were selected for description and the establishment of permanent reef quadrats. The sites were chosen to ensure a good coverage of the area likely to be impacted by any effluent/silt coming down the Yanawai. The observations included a photographic record and visual surveys. The visual surveys were conducted by swimming transects of 20 minutes duration at each site with the following details being recorded:

- **name**: as it appears on the marine chart,
- position as determined by chart and geopositional fix (GPS)
- **reef zone**: the general area containing the study site
- **exposure**: the degree of wave action
- **depth**: the depth of the study area and the base of the reef margin
- **profile**: the general topography of the study area
- **substrate**: the substrate composition
- **coral cover**: a subjective measure of the hard and soft coral coverage
- **community type**: the category of biological association based on dominance
- **dominant group**: the most dominant group of organisms seen in the study area
- **other organisms**: other faunal species seen along the transect

3.0 RESULTS

3.1 Fisheries assessment

Table 1 gives a list of all species caught in the netting survey conducted on the Yanawai river. The first set of the net, which was deployed upstream for a soak time of 3 hours, caught a total of four fish. This catch yielded a Catch per Unit Effort (CPUE) of 1.3 fish per net hour. The second set downstream caught nine fish and a single crab over a period of 23 hours which resulted in a CPUE of 0.4 fish per net hour (Photo 1 shows the fish caught).

Table 1: Fish species caught in the gill netting surveys in the Yanawai river

Species Name	Common Name	Local Name	#/site
Meropristes kneri	Orange-Spotted Therapon Perch	qitawaururu	1/n1, 5/n2
Valamugil seheli	Bluetail Mullet	kanace	2/n1
Caranx ignobilis	Great Trevally	saqa	1/n1,1/n2
Pletorhincus nigra	Brown Sweetlip	drekeni	1/n2
Monodactylus argenteus	Silver Batfish	lulu	1/n2
Mugil cephalus	Sea Mullet	koto	1/n2

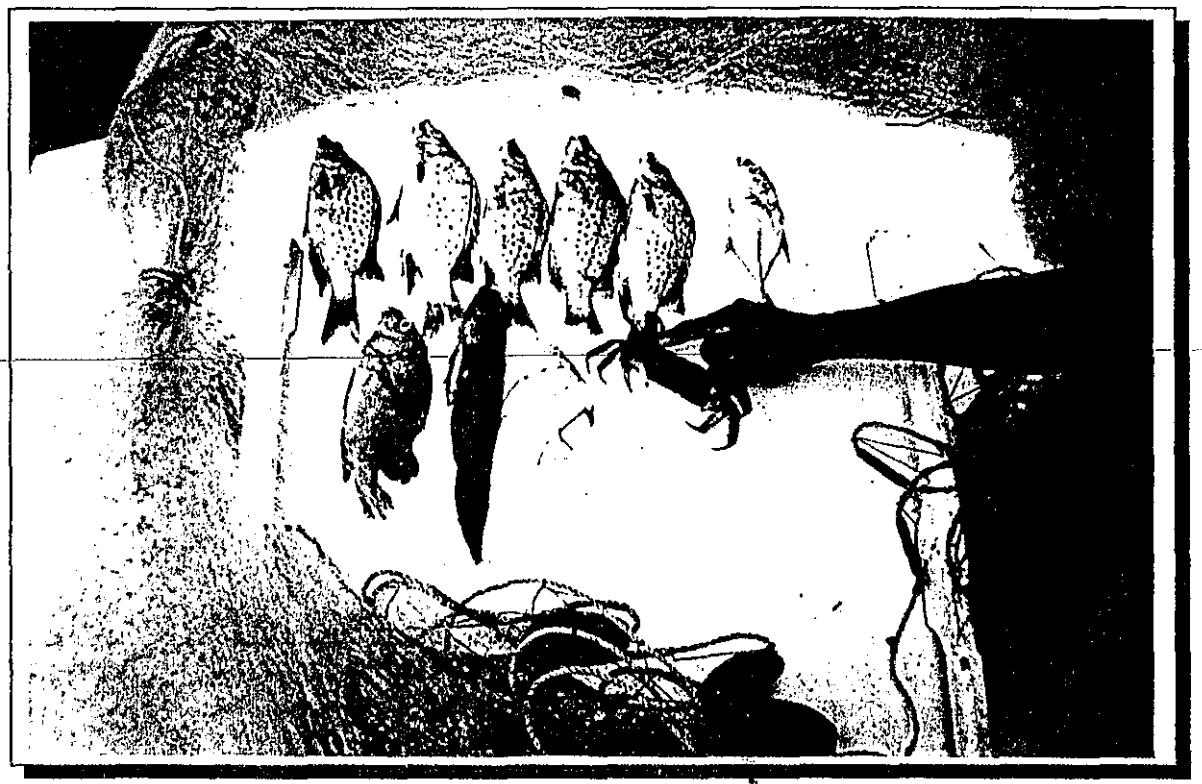


Photo 1: Catch from the second set of the gill net

3.2 Reef Studies

The positions of the quadrats are shown on Map 1, the positions were obtained using a Trimble, *Pathfinder,* Global Positioning System accurate to about ±30m. The characteristics of each site are given below:

SITE 1

Name: Cakau Tibia

Position: Lat. 16° 49.257' S
Long. 179° 03.843' E

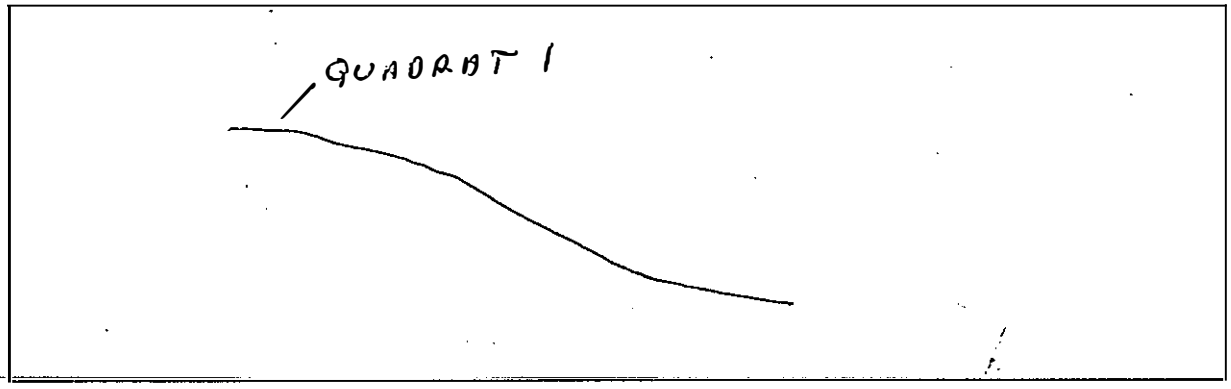
Bearing and distance from river mouth: 126° and 1.27 nautical miles.

Reef zone: Reef flat just before gradual drop-off.

Exposure: Sheltered lagoonal reef.

Depth: The area surveyed was at a depth of 3m at low tide with the slope dropping off to a depth of approximately 15m.

Profile:



Substrate: Predominantly sand and rubble.

Coral cover: General coral cover for the area was roughly 70% and comprised both hard and soft corals. Coral cover in the quadrat was approximately 50%.

Community type: Soft and hard corals co-dominate. There was luxuriant coral growth seen on the reef crest compared to the inner reef flat which had a high percentage of dead coral due to excessive siltation. The visibility was roughly 3m with a high load of suspended sediment. Carpets of Sarcophyton were interspersed with colonies of Acropora species.

There were large patches of the calcified algae Halimeda and Amphiroa.

Dominant groups: Acropora/Fungia/Favites /Millepora spp., Porites lutea Sarcophyton spp.

Other organisms: Lopha cristagelli and the green chimney sponge

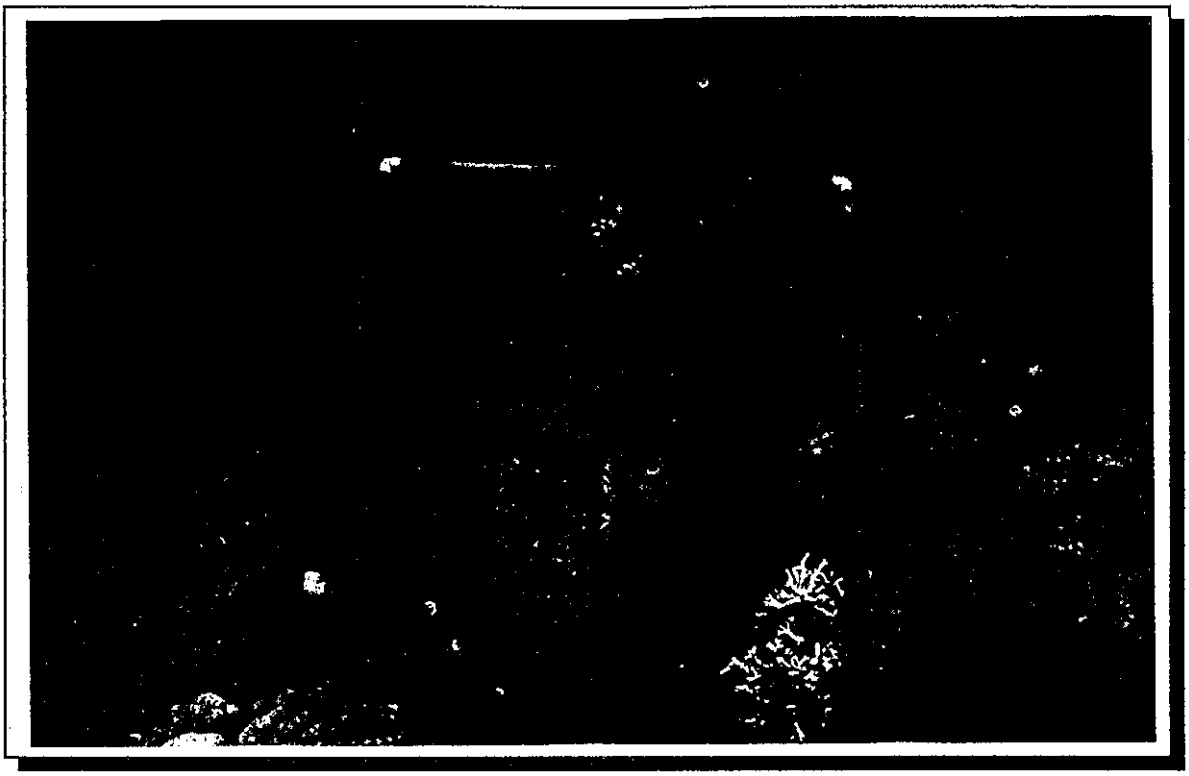


Photo 2: Reef quadrat at site 1

Species identification:

Pocillopora damicornis
Porites lutea
Acropora spp.
Sarcophyton spp.

SITE 2

Name: Cakau Ba

Position: Lat. 16° 49.257'S
Long. 179° 03.843'E
Bearing and distance from river mouth 102° and 2.08 nautical miles.

Reef zone: Reef flat

Exposure: Sheltered lagoonal reef adjacent to Nyavu Passage.

Depth: The depth on the reef flat was 1.5m at mid-tide. The reef slope extended to a depth exceeding 18m in the passage.

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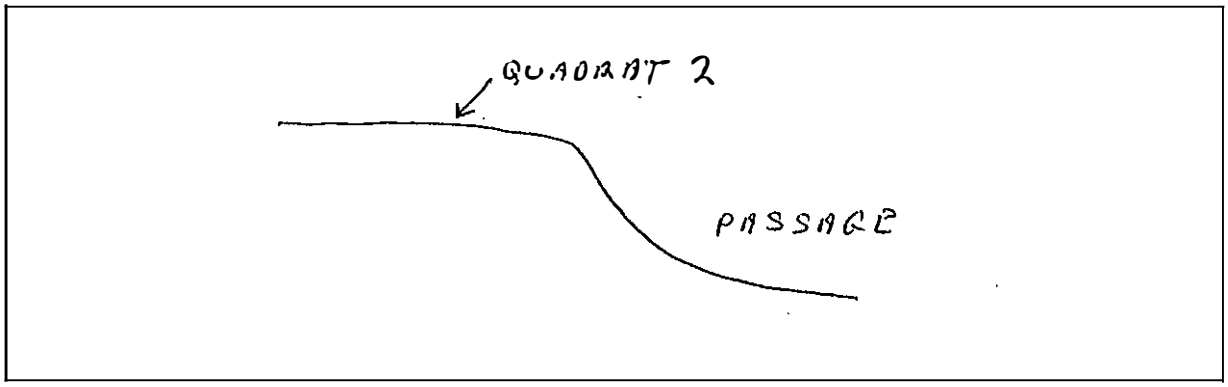


Substrate: Predominantly rubble with a proliferation of filamentous algae forming a top layer.

Coral cover: General coral cover on the reef flat was roughly 40% and was largely made up of soft corals. The coral coverage in the quadrat was also around 40%.

Community type: The area had extensive carpets of Sinularia and Sarcophyton and as one approached the reef crest the two species constitute 75% of the live coral cover. There was luxuriant growth on the crest with 100% live coral cover in some places. The rich growth on the crest and slope could probably be attributed to it's proximity to the passage which would ensure good circulation and nutrient supply. There were large thickets of Acropora spp. on the slope and stands of Pavona clavus. The visibility on the reef flat was less than 2m due to the high load of suspended sediment. The calcareous algae, Galaxaura and Halimeda are also abundant.

Dominant group: Sinularia/Sarcophyton spp.
Porites/Goniopora/Acropora/Favites/Favia/Platygyra/Pocillopora/Goniopora/Millepora spp.

Other organisms: Stichopus chloronotus, Bohadshia spp.,

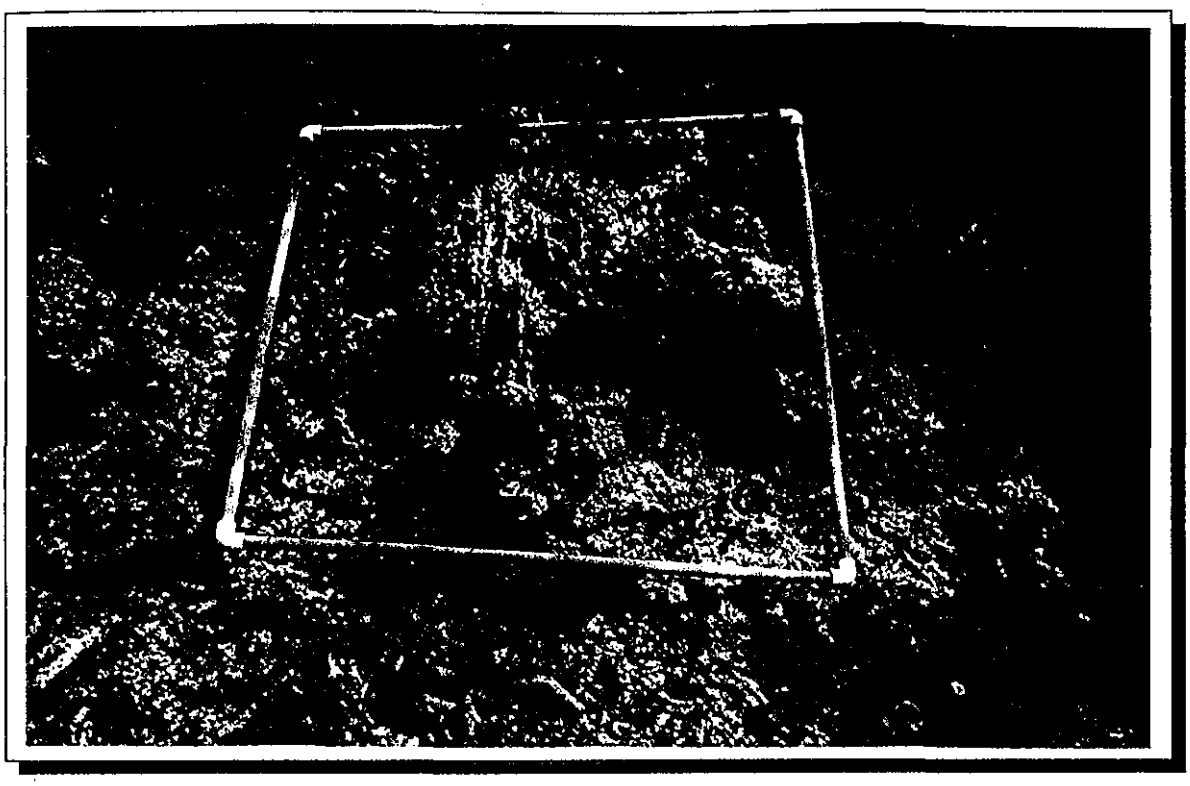


Photo 3: The reef quadrat at site 2

Species identification:

Millepora spp.
Pocillopora damicornis
Porites lutea
Lobophyton spp.
Sarcophyton spp.

SITE 3

Name: Cakau Nasue

Position: Lat. 16° 50.744'S
Long. 179° 03.482'E

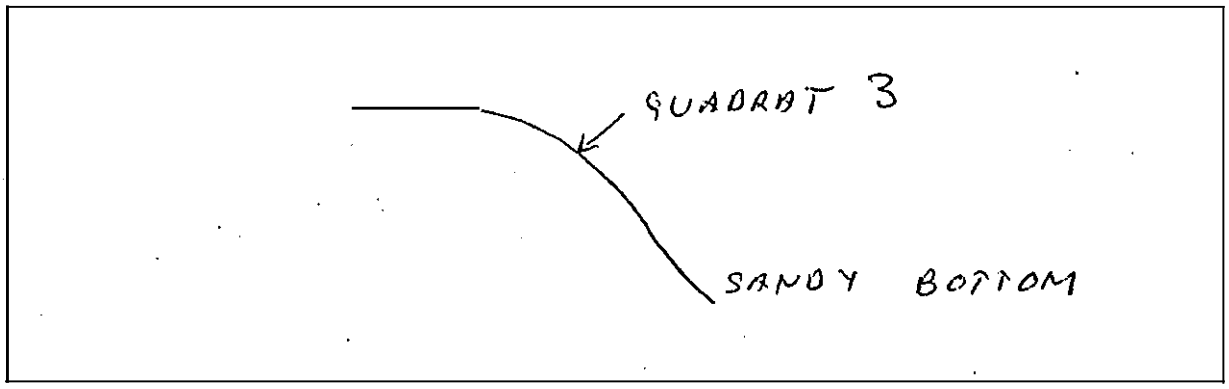
Bearing and distance from river mouth :158° and 2.16 nautical miles.

Reef zone: Reef slope

Exposure: Exposed to heavy wave action during periods of rough weather.

Depth: Base of the reef margin was at 18m however the quadrat was placed at a depth of3.6m.

Profile:



Substrate: A large volume of rubble was evident on the reef flat whilst the slope was predominantly sandy with scattered rock outcrops.

Coral cover: General coral coverage in the area was roughly 20% and was significantly less than that at Sites 1 & 2. The live coral cover in the quadrat was approximately 60%.

Community type: This quadrat was a sponge-dominated community with live coral cover being drastically reduced due to the high silt load in the water and lack of appropriate substrate. Although coral diversity was the lowest at this site, species diversity of other invertebrates was high. The large volume of rubble and freshly broken colonies would suggest that the area sustains heavy wave action in periods of rough weather. The visibility was around 5m which was attributed to the persistence of suspended sediments. The reef flat was largely made up of dead coral colonies and algal consolidated reef rock. There was a proliferation of the orange and purple encrusting sponges on the dead colonies. A sandy slope was evident extending to depth with scattered colonies of Fungia spp., Pocillopora damicornis and Porites lutea growing on rock outcrops. Clumps of Halimeda spp. were also seen widespread on the slope.

Dominant group: Orange and purple encrusting sponges

Other organisms: Lopha cristagelli/Linckea laevigata/Culcita spp./Panulirus spp./ Trochus niloticus/Tridacna spp./Octopus spp.

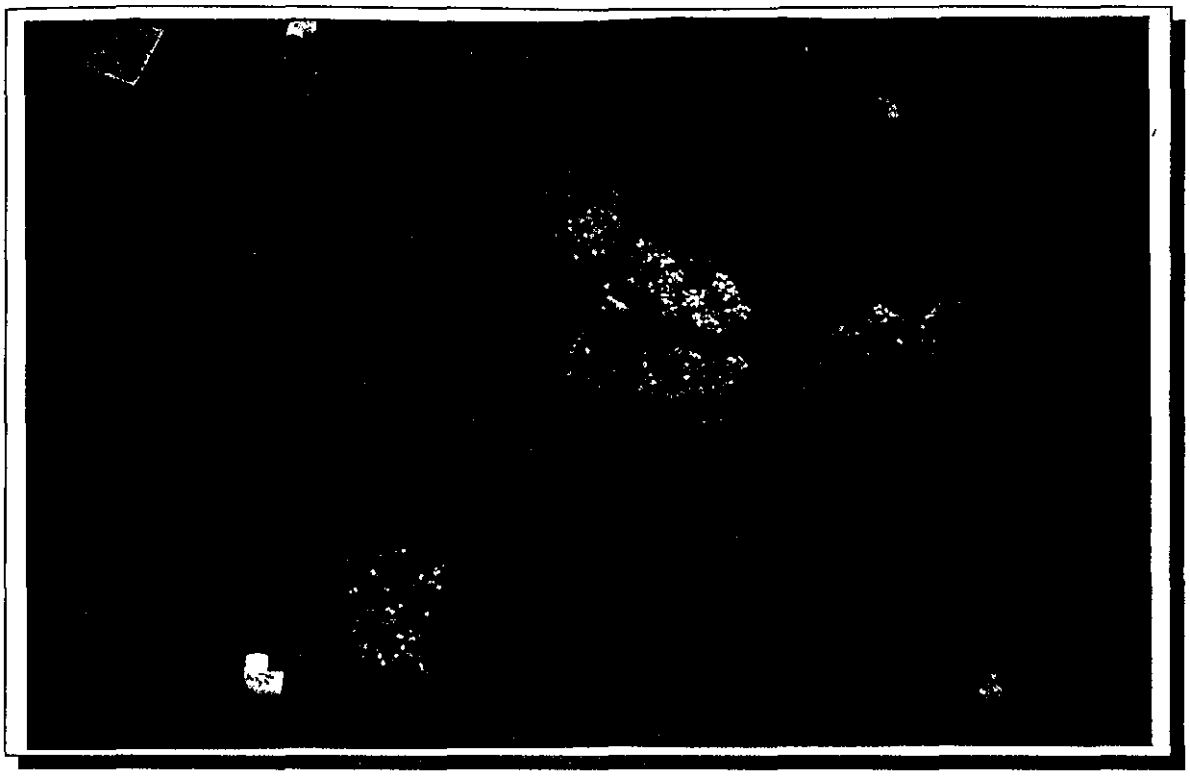


Photo 4: Reef quadrat at site 3

Species identification:

Porites spp.
Diploastrea spp.
Acropora spp.

SITE 4

Name: Patch reef inside lagoon of Cakau Balavu

Position: Long. 179° 07.037'E Lat. 16deg 50.040'S

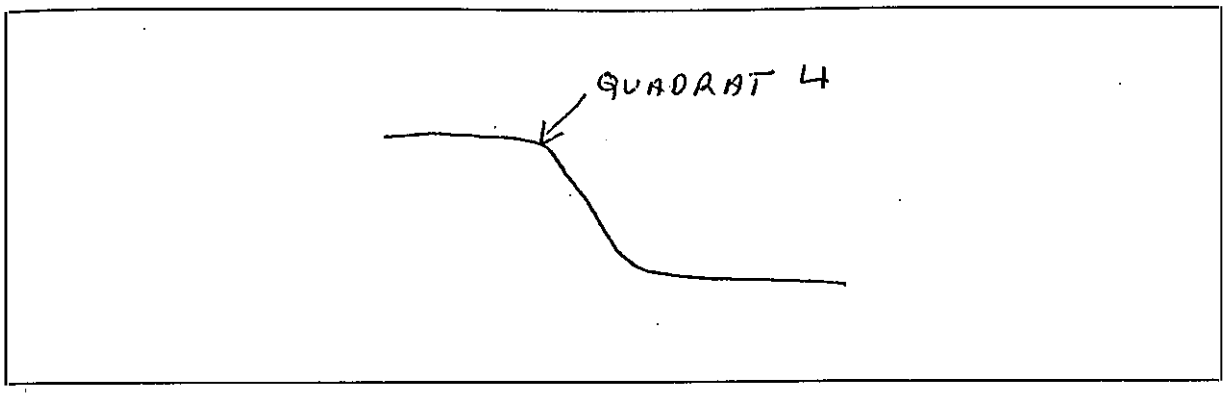
Bearing and distance from river mouth: 098° and 4 nautical miles.

Reef zone: Reef crest

Exposure: Sheltered lagoonal reef

Depth: Base of the reef margin was at 12m which extended onto a sandy lagoonal floor

Profile:



Substrate: The reef flat was comprised of reef rock that was covered largely by hard and soft corals. This flat area dropped vertically to a sand/rubble slope that extended to the sandy lagoonal base at 12m.

Coral cover: The general coral cover in the area was roughly 50% with the same percentage of coral coverage in the quadrat sampled.

Community types: The quadrat was a coral-dominated community with the reef flat having extensive carpets of Lobophyton and Sinularia interspersed with large colonies of Porites lutea. The slope had large stands of staghorn coral Acropora spp. and scattered colonies of Pocillopora damicornis. At the base of the slope were robust colonies of Porites cylindrica. Calcareous algae were seen overgrowing the rubble and boulders. The visibility again was very low due to the large volume of suspended sediments.

Dominant group: Porites lutea/Acropora spp.
Lobophyton/Sinularia spp.

Other organisms: There were none recorded.

Species identification:

Porites lutea
Sandalolitha spp.
Lobophyton spp.
Acropora spp.

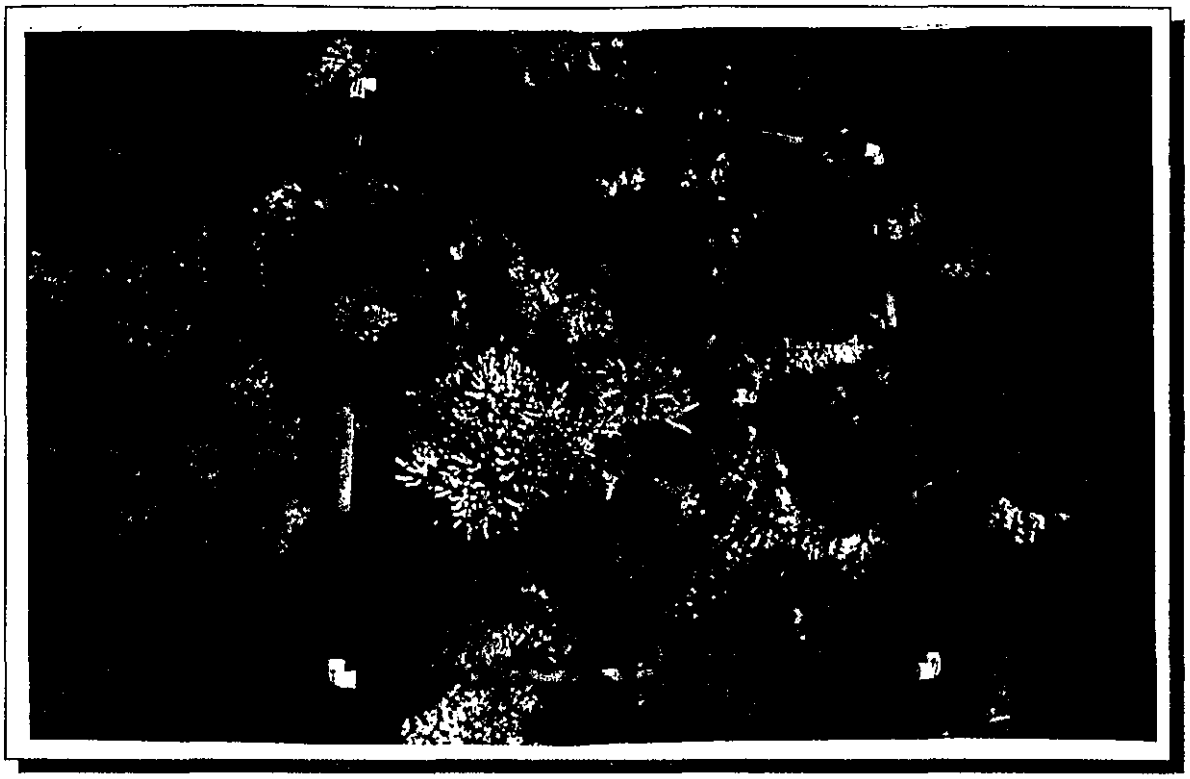


Photo 5: Showing the quadrat at site 4

SITE 5

Name: Patch Reef roughly 1.25 miles from Natovatu Point

Position: Lat. 16° 48.040'S
Long. 179° 08.568'E

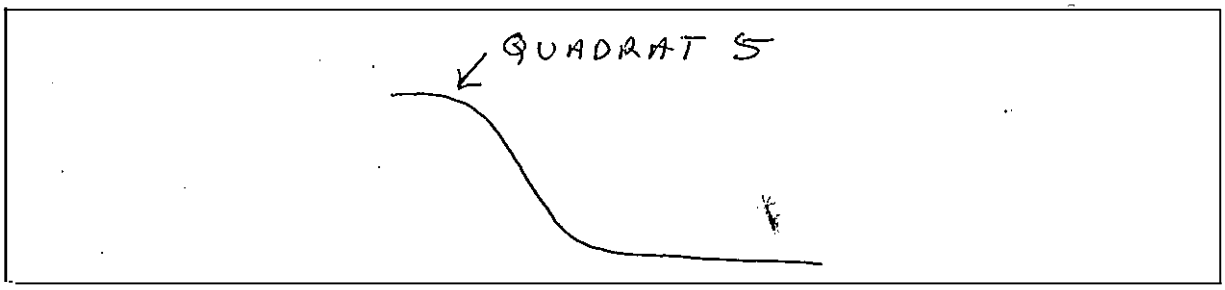
Bearing and distance from the river mouth: 071° and 5.23.

Reef zone: Reef crest.

Exposure: Exposed to heavy wave action during periods of rough weather.

Depth: Base of the reef slope was at 9m.

Profile:



Substrate: The reef flat was comprised of algal consolidated reef rock that dropped to a sand/rubble slope finally levelling off at 9m.

Coral cover: The reef flat had a live coral coverage of around 70% which increased to 90% over the reef crest. Live coral cover in the quadrat was 80%.

Community type: This quadrat was a coral-dominated community with tabulate Acropora spp. corals and the soft coral Sinularia spp. being the most abundant. The reef flat was made up predominantly of large tabulate Acropora colonies that were in equal proportions of dead and live colonies. There was an increase in both species diversity and abundance near the crest margin. Colonies of Sarcophyton, Sinularia, Pocillopora and Acropora were seen to abound on the crest. Feeding scars of the Crown of Thorns starfish (Acanthaster planci) were evident on several Acropora colonies (Plate 6). The presence of dead tabulate corals strewn near the crest would suggest that the area experiences heavy wave action in times of rough weather.

Dominant group: Sinularia spp.
Acropora spp.

Other organisms: Acanthaster planci

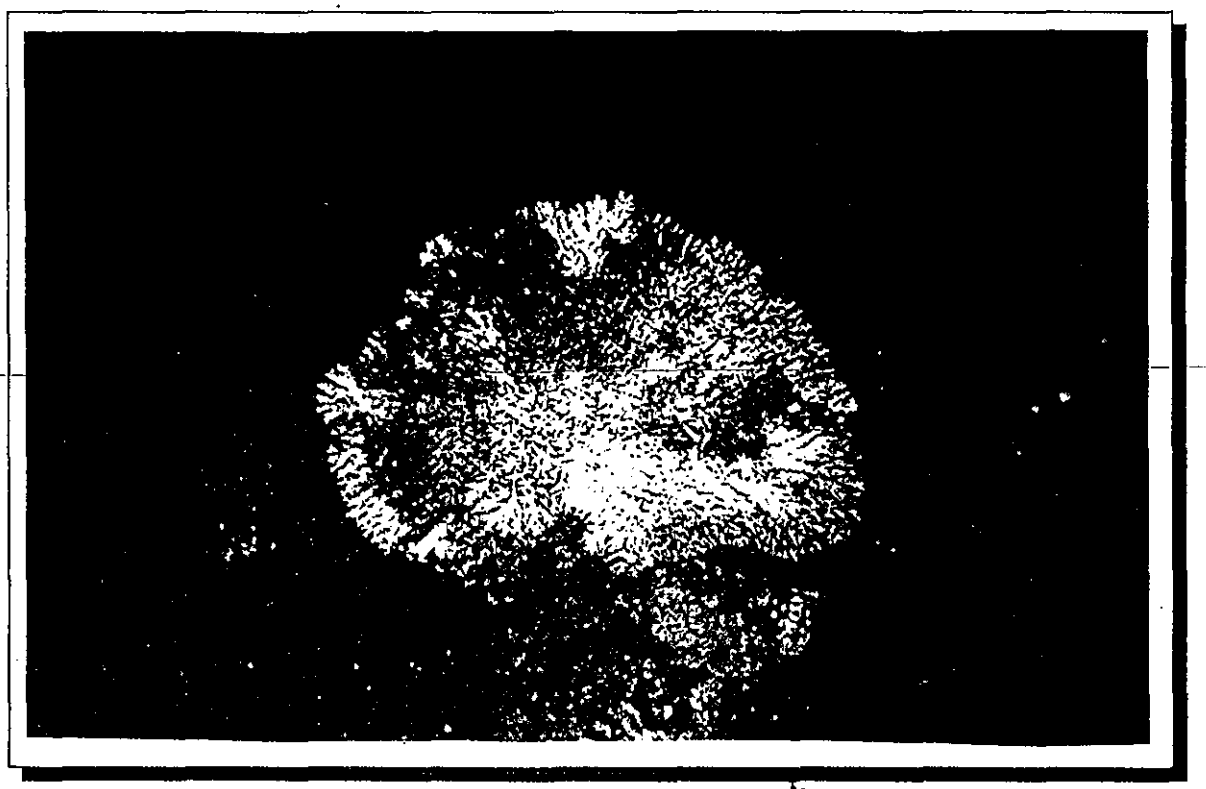


Photo 6: Evidence of feeding scars on acropora colonies caused Crown of Thorns starfish.

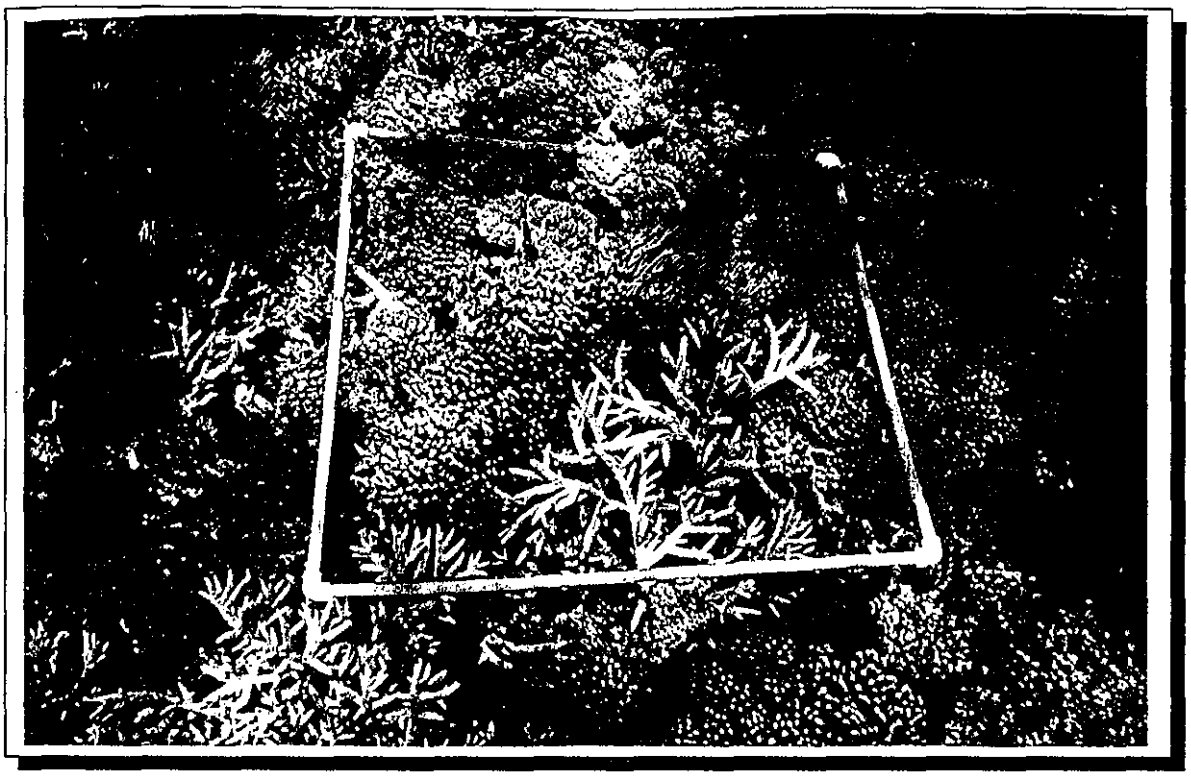


Photo 7: Quadrat 5

Species identification:

Lobophyton spp.
Sinularia spp.
Acropora spp.
Pocillopora spp.

SITE 6

Name: Sand Cay Reef

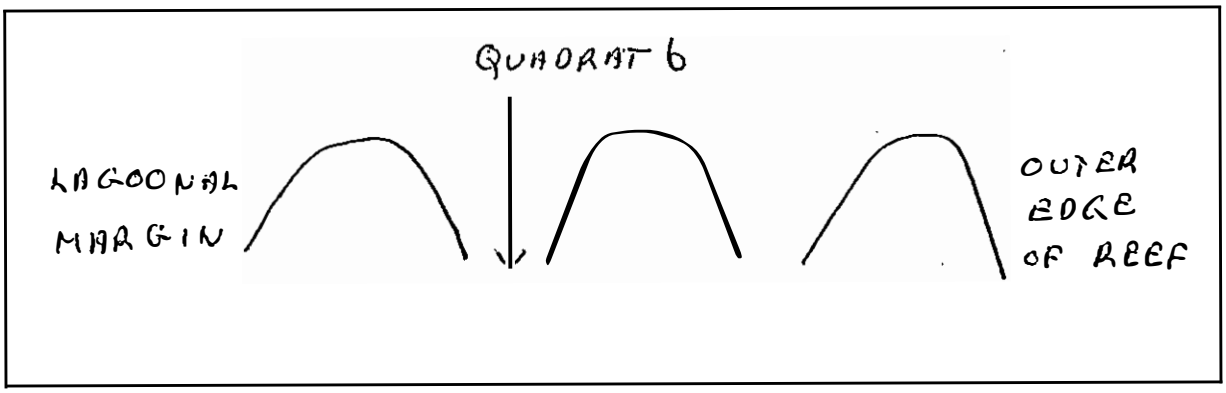
Position: Lat.16° 49.715'S
Long.179° 10.331'E
Bearing and distance from river mouth: 086° and 6.98 nautical miles.

Reef zone: Reef slope.

Exposure: Because this fringing reef was located on the outer edge of the Cakau Balavu barrier reef complex, it was more exposed and subject to surge.

Depth: The reef flat was exposed at low tide. There were a series of grooves or ravines on the reef front which descended to a sand/rubble base at 17m.

Profile:



Substrate: The reef flat consisted of algal-consolidated reef rock with a luxuriant coral cover extending to a sand/rubble base at 17m.

Coral cover: The live coral cover on the reef flat was about 75% which consisted of almost exclusively hard corals. The live coral coverage increased to 100% on the crest and slope. The quadrat which was sampled at 8m had an 80% live coral cover.

Community type: This quadrat was a coral-dominated community with an abundance of calcareous algae observed. This site was the richest of all six reef sites in terms of coral species abundance and diversity. The exposed location of the reef with evident considerable wave action would lead to drastically reduced amount of suspended sediments in the water column compared to other sites in the area. The visibility was consequently the highest at this site at around 20m. The luxuriance was impressive which again can be attributed to the effective tidal flushing that replenishes nutrient supply and prevents siltation. Tabulate Acropora corals were the dominant life form however there was a profusion of other corals including Galaxea, Pocillopora, Pachyseris, Fungia, Diploastrea, Lobophyton, Lobophyllia, and Favites species.

Dominant group: Acropora species.

Other organisms: Bohadschia spp.

Species identification:

Platygyra spp.
Acropora spp.
Lobophyton spp.
Favites spp.
Favia spp.
Fungia spp.
Podabacia spp.

Photo 8: Quadrat 6 showing the luxuriant coral growth

4.0 DISCUSSION

4.1 Fisheries Assessment

It was evident from the number of men and women observed fishing in the river and estuary that the villagers were very active in subsistence fishing in the area. The men were seen using gillnets whilst the women used scoop nets, beach seines and handlines. An interview with a Dawara villager revealed that the villagers fish an average of three to four days a week and catch an average of 70-100 fish per week (Sefo, pers.comm.). The most common methods employed include gillnet, handline, spearfishing, and hand-held nets. The finfish caught in the river include marine species proving the strong tidal influence in the estuary. Those caught in the gillnet survey were species commonly found in rivers and estuarine areas. A fisheries study of the Nadi River and the adjacent mangrove delta (Seeto et al, 1989) listed the same species caught in the Yanawai. The species most commonly caught are listed in Table 2.

The men often used outboard motor powered punts for fishing in the river whilst the women were observed using small wooden punts which they would row (see photo 9). The Yanuwai river at this point is mangrove-lined with thick stands of Bruguiera gymnorrhiza and Rhizophora samoensis. Mangal-associated invertebrates were also caught by the villagers including the mangrove crab (Scylla serrata), and the black mangrove crab (Metopograpsus messor). The freshwater clam Batissa violacea was also actively collected further upstream.

Table 2: Fish species commonly caught in the Yanawai River

Latin name	Common name	Fijian name
Mugil cephalus	Sea Mullet	Koto
Rastrelliger kanagurta	Striped Mackerel	Salala
Caranx ignobilis	Great Trevally	Saqa
Valamugil seheli	Bluetail Mullet	Kanace
Sphyraena barracuda	Barracuda	Ogo
Cephalophalis miniatus	Coral Cod	Kaseledamu
Lethrinus harak	Thumbprint Emperor	Kabatia
Tylosurus crocodilus	Long Tom	Saku

Photo 9: showing a woman on a fishing expedition

The preliminary gill netting results and observations of villagers catching fish would indicate that the villagers are active fisherfolk and are utilising an important source of protein in the river's fin fish and invertebrate stocks. Their concerns over the possible impacts of the mine are therefore understandable.

According to the Environmental Management Overview Strategy prepared by SCES (1993), the villagers of Dawara obtain their freshwater supplies from creeks that belong to totally different catchments from those that drain the Mount Kasi region. The present survey

however, found some evidence that kai were taken from rivers that formed part of the Mt Kasi catchment area. The cyanide tailings from the mine will be contained in the Vola Creek Catchment whilst the mine site and waste rock sediment will drain into the Vuci Creek Catchment. Both of these catchments eventually drain into the Yanawai River. So although the freshwater supply of the villagers may be protected, their fishery in the river may well be impacted.

4.2 Reef Studies

The sites that were examined were generally exposed to high silt loads coming down the Yanawai and so these sites tended to host fauna and flora that were adapted to living in silty environments. With the exception of Site 6, which was on the outside of the barrier reef, all other sites were lagoonal reefs and therefore subjected to influxes of terrigenous sediments transported via the rivers. Soft corals which were dominant at most of the sites prefer sheltered silty environments, such as the back reef. The mushroom corals, which were also present at practically all the sites, also prefer a similar environment.

The coral growth at Sites 5 & 6 was impressive both in terms of abundance and diversity. Site 3 had the lowest species diversity and the greatest volume of rubble which would suggest that it has sustained considerable damage from rough weather conditions. Edible invertebrates were very few in numbers possibly due to overfishing.

The health of the reefs covered in this baseline survey was what one would expect of reefs that are in close proximity to freshwater inputs. The most dominant coral species were those most tolerant to high levels of silt in the water column. The high natural silt loadings suggests that impacts of the mining activity can only be assessed through regular monitoring of the reef quadrats.

In terms of further monitoring it would be suggested that the quadrats be examined six months after the mine begins operation and yearly thereafter.

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