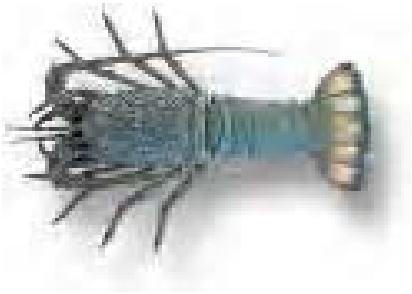
MARINE STOCK ASSESSMENT SURVEY, VANUATU 1998- 2000.

COCONUT CRAB

BECHE-DE-MER

GIANT CLAM

LOBSTER



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Introduction

This report presents the result of the marine stock assessment survey conducted in Vanuatu from the period between 1998- 2000 on the status, abundance, distribution and diversity of beche-de-mer, giant clam, rock lobster and Coconut crab *(Birgus latro)* resources in the Vanuatu archipelago.

These marine resources are socially and economically vital not only to the rural coastal people but also nationally. In remote rural areas of the country some of these resources may be the only form of cash crop available providing much needed cash for daily living and most importantly school fees and health fees.

As the country continues to expand in its population and attempts are being made in the diversification of its economic base, and due to the low prices in the agricultural products particularly copra and cocoa, attention is being diverted to the Marine resources. This may have put a lot of fishing pressure on the marine resources. Because stock assessment is one of the key *information* indicating level of exploitation and resource stock it is therefore of great significant that such surveys be carried out. This could enable fisheries managers and particularly the policy makers to monitor trends of resources stock thus in a better position of formulating effective management regulations concerning the marine resources thus ensuring resources sustainability.

Funding of this assessment survey was made possible through the US treaty Project Development Funds for Vanuatu. The need to carry out this survey was identified by the Director of Fisheries Department Mr. Moses Amos, then, Fisheries Principle Biologist and Head of RAMACIS mainly due to the difficulty faced with in the management of coastal resources such as beche-de-mer, giant clam, rock lobster and coconut crab (*Birgus latro*).

The primary objective of the stock assessment survey is to develop a precautionary principle to sustain the beche-de-mer, giant clam, rock lobster and coconut crab resources and to provide a viable alternative to the rapidly declining of the fishery in Vanuatu.

The objectives of the survey were as follows:

- Find alternative procedures that will help facilitate development and sustainable management of the beche-de-mer, giant clam, rock lobster and coconut crab (*Birgus latro*) resources in the Vanuatu waters.

- Develop a monitoring procedure of beche-de-mer, giant clam, rock lobster and coconut crab (*Birgus latro*) stocks which will enable better assessment of the resources.

To effectively meet the objectives of the survey, three main areas of research were proposed:

- Stock assessment of beche-de-mer, giant clam, rock lobster and coconut crab (*Birgus latro*) resources within the archipelago.

- Awareness program

- Hatchery production of giant clam seeds.

The stock assessment survey was conducted by the staffs of the Research Section within the Fisheries Department. The survey team also comprised of the visiting New Zealand Polytec students. The involvement of the students in the survey was made possible through an arrangement with the Fisheries Department and the Institute of Polytec authority for the students to involve in any Fisheries activity towards their field experiences and assignments. Because of the geographical nature of the islands of Vanuatu, the survey was conducted via the Fisheries vessel MV Lewia.

Although this report may be outdated, the results will provide useful information and aid the Fisheries Department to make realistic management policies and regulations concerning these respective coastal marine resources.

Geography, Geology and Marine Environment

Vanuatu is a Y- Shape archipelago comprising of more than 80 islands. The islands are mostly volcanic and coralline in origin and stretching 1,300 km from north to south. These islands lie between latitude 13 South and longitude 166 East and 172 East in the western Pacific Ocean (Fig. 1). The total land area is approximately 12,190 km^2. Of this total area, 5,500 km^2 is considered arable land. (Done & Navin, 1989, Naviti & Aston, 2000, Preston, 1996).

The combine coral reef area totals to an amount of approximately 408 km^2. Fringing reef comprised the bulk of the total reef area and supports a very limited marine resource. The Exclusive Economic Zone (EEZ) covers an estimated area of 680,000 km^2. Other important reef associated habitats, which includes mangroves, and estuarines amount to total area of 25 km^2. Because of the location of the group on the margin of the Indo- Pacific plates, tectonic uplift and subsidence periodically occur. These tectonic activities have been catastrophic to the coral reefs and sea grass beds and the organism living in them (Done & Navin, 1989, Naviti & Aston, 2000, Preston, 1996).

The climate varies from tropical in the north to subtropical in the south. The country experiences a dry season from May to October and a wet season from November to April. The average annual rainfall of the country is 2,350mm. During the dry season the average rainfall is 848mm and in the wet season it can go as high as 1,500mm. Cyclones are regular with increasing frequency, in average, twice per year. The surface sea temperature in the open ocean is warm ranging from 25- 26°C. During El Nino period annual average sea surface temperature ranges from 27 to almost 30°C. (Climate change office).

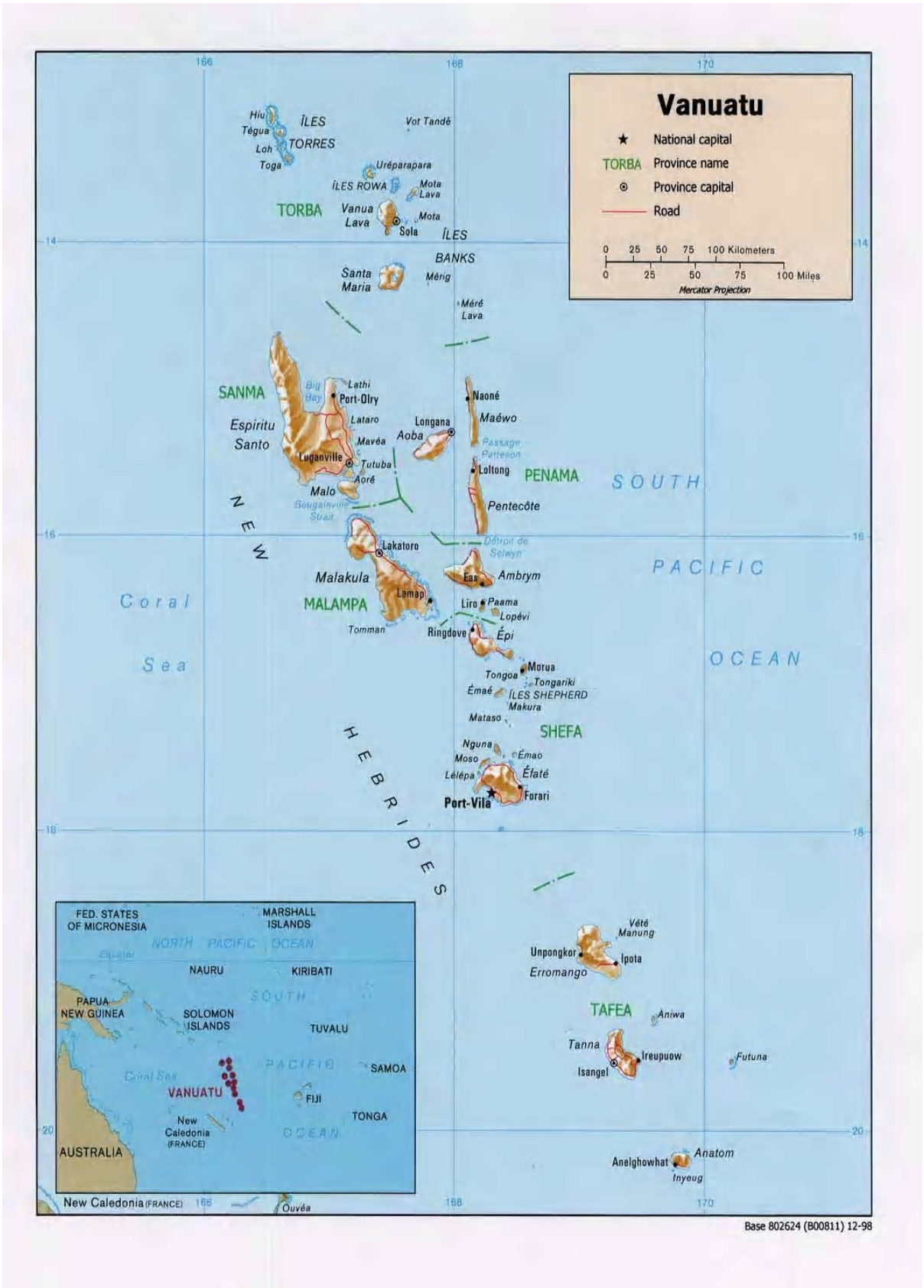

Figure 1: Map of Vanuatu. *Source: www.lib.utexas.edu/maps/australia/vanuatu*

Population

Vanuatu's total population stands at 186,678 according to the 1999 National census with the average growth rate of 2.6 per cent. Of the total population, 78.5 % live in the rural areas, a slight decrease from the last census, which was 81.8 %. The recent urban population is estimated at 21.5 %. According to the 1989 population census, 70 % of the total population of 142,630 have access to the sea and its resources and live within 2 km of the coastline (National Statistics office).

Economy

According to the 1989 census, about 84 per cent of the total population aged 15 and over are economically active and 75 percent of the work force was engaged in agricultural related activities. About 60 percent of these are subsistence farmers. The main sources of
income in the rural areas is derived from agricultural commodities such as copra, cocoa, coffee, kava, and other food crops (National Statistics Office).

In the early 1990s, inshore Fisheries resources have become very important contributing largely to the rural economy. This was due to the decrease of the prices of the agricultural commodities in the world markets especially copra and cocoa and coinciding with the high and consistent price of the inshore fisheries resources. Given the situation, resources have come under very intense harvesting that could threaten their existence in the Vanuatu waters.

The Stock Assessment Survey

Since the last intensive survey was conducted in 1988, there is no consistent program of assessment and monitoring through the Fisheries Department on the entire inshore marine resources of Vanuatu. Assessment and monitoring is done in an ad hoc basis through programs of trochus and giant clam re-seeding and assessment and coral monitoring, thus the current status of most of the resources remains unknown.

The Marine Resources stock assessment survey, 1998- 2000.

This survey is one of the first stock assessment surveys to be carried out by the Fisheries Department on four marine resources throughout the country.

The survey was executed in two parts:

Part 1: Preparation and organization of the survey.
This part consists of organizing and planning the survey. Basically preparation of materials and equipments.

Establish contacts and arranging the trip of the New Zealand students from the Politec Bay of Plenty University who are to help in the execution of the survey.

Part 2: Actual field surveying

The major activity of this part is the actual visiting of the sampling sites via the Fisheries vessel MV Lewia and carrying out the survey.

Table 1: Islands and areas visited and surveyed

Islands	Sites	Site Codes
Aneityum	Anelgouhat Reef	A1
	Anelgouhat West	A2
	Inyeung Reef flat, East	A3
	Inyeung reef flat, South	A4
	Inyeung reef lagoon, North	A5
	Inyeung reef edge, South	A6
	Port Patrick, North	A7
	Port Patrick, Center	A8
	Port Patrick, South	A9
Tanna	Port Resolution	T1
	Port Resolution	T2
Emae	Marae	E1
	Sulua	E2
	Worarana	E3
	Makatea	E4
	Tongamea	E5
	Siwo	E6
	Vaitini	E7
	Sangava	E8
	Makatu	E9
	Cooks Reef	10
Mataso	Na' asang	Ms1
		Ms2
Makira	Malakof	M1
Buninga	Buninga	B1
Malekula	Sakau reef	M1
	Peskarus	M2
	Soucere point	M3
	Lamap reef	M4
	Uri Island	M5
	Tetka Island	M6
	Pinalum	M7
	Vao Reef	M8
	Port Stanly	M9
	Litzlitz Reef	M10
	Lambumbu	M11
	Crab Bay	M12
	Avok island- North	M13
	west	M14
	Avok Island- East	M15
	Avok island- North	M16
Gaua	Losalava	G1
Vanua Lava	Vureas Bay	VL1
	Pakea Island	VL2

	Ravenga	VL3
Mota	Mota	M
Mota Lava	Ra	ML1
	Mili Bay	ML2
Reef Island	Reef island	R1
Ureparapara	Lagoon	U1
Hiu Island	Flat stone	H1
	Yuwutu	H2
	Yawa Bay	H3
Metoma Island	Metoma Is.	MI
Tegua	Tegua Is.	T1
Loh	Loh Is.	L1

For each of the sampling sites for beche- de-mer, giant clams and lobster, a line transects of 40m long and 5m wide is surveyed in major reef habitats. The main habitats where the transects are located are back reef, reef flat and reef crest. For the lobster resource, night surveys were conducted and number of lobster were recorded against each diver. Coconut crab survey was conducted at night using a standard method of coconut crab survey by Fletcher and Amos.

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Beche-de-mer Survey, 1998- 2000.

Abstract

Fifteen beche-de-mer species were recorded in forty eight sampling sites of shallow water reefs, lagoons and seagrass beds of Vanuatu. The abundance and diversity of species varies from sites with slight increase in abundance to the previous survey. However more surveys should be done to substantiate these findings and in addition establish a better monitoring system of the beche-de-mer stock in Vanuatu.

Introduction

Beche-de-mer is a sedentary species from the Phylum echinoderm and class Holothuroidea. In Vanuatu, the resource is not consumed, however it is being utilize for commercial purposes. The resource is widely distributed throughout the country and it's easy to harvest from reefs, lagoons and deeper coastal waters. They are harmless, move slowly and do not resist being collected. Given the situation, combine with the high prices of certain commercial species, they can be easily over-exploited from areas that support sufficient density of the commercial species.

The last survey conducted on the resource was done by the Australian Institute of Marine Science (AIMS) in 1988. In that survey, eighteen species of Beche-de-mer were recorded. These includes *Actinopyga echinites, A. mauritiana, A. miliaris, A. palauensis, Bohadschia argus, B. similis, B. vitiensis, Holothuria coluber, H. atra, H. edulis, H. leucospilota, H. scabra, H. nobilis, H. fuscopunctata, Stichopus chloronatus, S. variegatus, Synapta. maculata,* and *Thelenota ananas* (Chambers, 1989)

This report presents a brief summary of beche-de-mer stock from the Marine resources stock assessment survey conducted by the Fisheries Department in the islands of Vanuatu archipelago in 1998- 2000. It details the abundance, diversity and distributions of beche-de-mer resources within the four provinces of Vanuatu.

Method

In all the sampling sites visited data were collected using the Line- Transect method. About 30- 60 minutes were spent at each sampling sites. Surveys were conducted from depths up to six meters. Information collected includes number of species of beche-de-mer, habitat and substrate and water depth.

Sampling sites were chosen based on the previous marine resources survey that was conducted by AIMS in 1988. Other sites apart from those surveyed by the AIMS were chosen basically for the assessment of the resource stock.

Line- Transect

The length and width of the Transects in each sampling sites is forty meters by five maters. However the number of transects in each sampling sites ranges from three to sixty depending on the size of the area being surveyed and the occurrences of the resource. As a matter of constancy, all areas are

standardized to 100m^2. The transect lines were laid parallel to the shoreline with an interval of 40 meters. An imaginary 5 meter corridor was surveyed in all the Transect- lines.

Fishery/ Production

Beche-de-mer is a very important cash crop generating income both locally and nationally. The main commercial species of beche-de-mer found in Vanuatu are *Holothuria scabra, Holothuria nobilis,* and *Thelenota ananas.*
In Vanuatu, beche-de-mer is not consume thus, harvesting of the resource is a non- tradition to the people. Also there is no local market; however it is being harvested and exported to Hong Kong, Singapore and Australia. The end product is priced very highly and considered to be a delicacy and a traditional food in the Southeast Asian countries.

Harvesting, processing and exporting of beche-de-mer in Vanuatu have been reported to occur in the 20th century (Dalzell, 1990 cited in Chamber, 1989) however was abandon for unknown reasons until the early 1970s (Baird, 1973 cited in Bell and Amos, 1994). After the revival of the activity it has been yet again hindered with a termination due to consistently poor product being exported (Dalzell, 1990 cited in Bell and Amos, 1994). Nevertheless after a training course conducted by the SPC, several interested local exporters were involved and able to recommence the industry until todate.

Annual export figures of beche-de-mer from the Fisheries Department annual reports shows that production has been relatively low rarely exceeding 10 tons in the 1980s however has increase from the year 1990 and rarely falls below 20 tons up to this date with an estimated annul average value of over 4 million vatu (Table 3).

Status of beche-de-mer stocks

During the 1988 survey conducted by the Australian Institute of Marine Science (AIMS), it was reported that eighteen species of beche-de-mer were recorded. Of the eighteen species, the most common species recorded were *Holothuria atra* and *Stichopus chloronatus*. The densities of these species were reported to be notable in some localities; however these are non- commercial species. Generally the report stated that the density and diversity of the species throughout the country was low. Although this was so, Chambers (unpublished data, Baker, 1929 cited in Chambers, 1989),) reported that there were high densities in some localities but Chamber (1989) further said that these high density localities would not sustain a continuous harvest.

Harvesting of beche-de-mer has been reported to be concentrated on the Cooks Reef, the Maskelyns, Atchin and Port Vila. In addition it was reported that harvesting is done intermittently so as to allow for recovery of the stock (Chambers, 1990). However areas of harvest have been diversified to almost all the provinces in the country due to inconsistent supply from limited areas.

It is apparent according to the Fisheries Department annual figures (Table 3), that there is a general increasing trend of beche-de-mer production yearly however it seems that the quota is rarely met. This could mean that the resource stock in the country is not big enough to meet the set quota.

Results/Discussion

The summaries of the sites details together with the total number of beche-de-mer at each site are given in table 1. A total of 48 sites were surveyed, of which 20 had four or more beche-de-mer. Table 2 presents the total density of beche-de-mer as well as the densities of each species per $100m^2$ in all the sampling sites.

Occurrence and distribution of species

During this survey fourteen of the eighteen species reported by Chambers (1989) to have occurred in Vanuatu have been recorded. There was no new discovery of species in this survey. The four species that are not recorded during this survey are *Actinopyga palauensis, Holothuria (Mertensiothuria) Leucospilota, H. (Microthele) fuscopunctata and synapta maculata.*

The most common species recorded in this survey are *H. atra, S .chloronatus, H. edulis, A. mauritiana, B. argus, H. scabra, B. vitiensis,* and *S. variegatus*. Of particular significant is the species *H. scabra*; this is one of the species in high demand because of its high commercial value.

Apparently the diversity of beche-de-mer species at each sampling sites was generally high (Fig. 2). The most diverse sites are in Malekula where 5- 9 species were recorded in several single sites. In average seven species occurred in more than 50% of the sampling sites. In other sampling sites it is lower often exceeding 3 species per site (Fig. 3). By and large this survey shows a greater diversity of beche-de-mer species throughout the sites compare to Chambers (1989).

Abundance of beche-de-mer

It was also apparent that there were very high densities per $100m^2$ of total beche-de-mer species in several of the sampling sites. This was evident in several sampling sites where over 70 beche-de-mer per $100m^2$ were recorded (Fig. 1). These high densities correspond to the following species: *H. atra, S. chloronatus, A. mauritiana, B. similis, H. scabra, S. chloronatus, H. endulis, B. argus, B. vitiensis and S. variegatus* (Table 2).

Similarly there are significant high species density per $100m^2$ in several localities, however, generally it was low throughout the country often exceeding 1 per $100m^2$ (Table 2). Chambers (1989) concluded a similar finding but said this would not sustain a recommended harvest quota.

The results may indicate that the resource stock has recovered since the last survey however due to the large variability of the data there should be more surveys carried out at least annually to further substantiate these results.

Management of beche-de-mer

In Vanuatu the management of the resource has been very poor attributed to the non- traditional harvest of the resource in the country and also of the limited scientific information available (Jimmy, 1996).

Presently, there are two legal policies or management regulations of the Fisheries Department concerning the exploitation of beche-de-mer resource. Firstly, the Fisheries Subsidiary Act of 1988 Cap. 158 Part 4 Section 23 prohibits the export of beche-de-mer without a written permission from the minister concern and in accordance with the sets of conditions given. Secondly, A Ministerial order of 1991limits the export of dried beche-de-mer to 35t per annum.

From the Fisheries Department annual export figures the legal 35t quotas was rarely met. Bell and Amos (1993) reported that the 35t quotas applied was unjustified and further argued that it could be well above the level of sustainable exploitation of the resource or it could illustrate that the resource is not big enough to meet the present quota.

Recommendations

As stated previously, currently there are two legal policies regarding the exploitation of beche-de-mer resource in Vanuatu. However there are policy options available that could be applied. Chambers (1990), Conand (1989) & Preston (1993) quoted in Bell & Amos (1994) described several management options available. This includes size limits, enforcement of closures according to customary marine tenure fishing zones but the best strategy recommended by Chambers (1989) with regards to exploitation of the resource would be to collect intermittently from sites which are large enough and support sufficient densities of commercial species in order to be economically sustainable. The authors also noted that other options such as seasonal bans and closures are difficult to apply since it will hinder export. There are also views from different authors that the current policies should be altered. Preston (1996) recommended that:

> "…for the resource to generate regular income on a sustainable basis the rate of harvesting needs be lowered. The best way to achieve this is to encourage resource custodians to put in place local harvesting bans to allow resource to regenerate… Since it appears that the resource is being overharvested without the current national quota even being approached, the quota should be reduced to a suggested level of 20t per year, nationally".

Given the above condition, the Fisheries Department should take necessary steps to prevent the over-exploitation of the resource. For example to reduce the quota or to carry out more studies on the resource stock in an annual basis in order to come up with a more realistic set quota.

Conclusion

In this survey, fourteen species of beche-de-mer were recorded throughout the country. Species diversity is high and is evident in the sampling sites in Malekula. Generally the results indicated that species abundance was low throughout the sampling sites however there were several significantly high densities in certain localities. It is recommended that more surveys to be carried out to substantiate this findings.

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8.0. Tables & Figures

Table 2: Details of sites surveyed during the Marine Resources Survey of beche-de-mer together with the number of beche-de-mer observed in each sites. Vanuatu. 1998.

Island/Sites	Codes	Habitat-Substrate	No. of Transect	Area covered (m^2)	No. of BDM	Water depth (m)
Aneityum	A1					
Anelgouhat Reef	A2					
Anelgouhat West	A3					
Inyeung Reef flat, East	A4					
Inyeung reef flat, South	A5	Reef flat: course sand and sea grass bed Reef flat: rocky bottom and live corals	9	3000m^2 2400m^2	89 1850	1- 2m
Inyeung reef lagoon, North Inyeung reef edge, South	A6	Reef flat: rocky bottom, live coral and course sand	9	7 200m^2		
Port Patrick, North	A7					
Port Patrick, Center	A8					
Port Patrick, South	A9					
Tanna						
Port Resolution	T1	Reef flat: Rocky bottom, live corals	5	3000m^2	362	
Port Resolution	T2	Reef flat: Rocky bottom and live corals	3	1800m^2	932	
Emae						
Marae	E1	Reef slope	41	8200m^2	20	
Sulua	E2		21	5250m^2	205	
Worarana	E3		14	3500m^2	2506	
Makatea	E4	Reef flat: sea grass bed	23	5750m^2	146	
Tongamea	E5	Reef flat: sea grass and rocky bottom	20	5000m^2	1560	1.0m
Siwo	E6	Back Reef and Reef flat	22	7250m^2	19587	
Vaitini	E7	Back Reef: , Reef margin.	15	2500m^2	134	
Cooks Reef	E10	Reef flat: Rubbles and sand; Lagoon: Rocks, sand and life corals; Reef crest: Rocks and life corals.	18	600m^2	83	
Makira						
Malakof	M1					
Mataso						
Na'sang	Ms1	Reef flat				
	Ms2					
Malekula						
Sakao Reef	M1	(All data for Malekula missing).				
Peskarus Is.	M2					

Soucere Pt.	M3					
Lamap Reef	M4					
Uri Is.	M5					
Tetka Is.	M6					
Pinalum	M7					
Vao Reef	M8					
Port Stanly	M9					
Litzlitz Reef	M10					
Lambumbu	M11					
Crab Bay	M12					
Avok Is. Northwest	M13					
Avok Is. East	M14					
Avok Is. North	M15					
	M16					
Gaua	G1	Back reef: rubbles and live corals, Reef flat: sandy, reef patches and rubbles	6	2600m^2	284	2m
Losalava						
Vanua Lava	VL1	Reef flat: rocky bottom	6	2600m^2	284	2m
Vureas Bay	VL2	Back reef: fine sand, reef flat: live & dead corals, rubbles and sand	21	3800m^2	140	0.5- 10 m
Pakea Island						
Ravenga Is.	VL3		6	6000m^2	96	0.3- 10m
Mota Lava						
Ra	ML1	Reef slope: rocks, live corals and rubbles	10	3400m^2	436	0.2- 15m
Mili Bay	ML2	Reef flat: Rocky, sandy, rubbles and sea grass				
Reef Is.						
Reef Is.	R1	Back reef: boulders, live corals, reef flat: rubble and sand, Reef slope: patch reef.	33	6300m^2	256	1.0- 12m
Ureparapara						
Lagoon	U1	Fringing reef slope: Large boulders, sand, rubbles and live corals.	34	300m^2		0.2- 1m
Hiu	H1					
Flat stone						
Metoma Is.	MI					
Tegua Is.	T1					
Loh Is.	L1					

Table 3: Densities (nos/100m^2) of beche-de-mer during the marine resources stock assessment survey in Vanuatu. 1998.

Species	Site Codes A1	A2	A3	A4	A5	A6	A7	A8	T1	T2	E1	E2	E3	E4	E5
Actinopyga echinites	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0
A.mauritiana	0	15.3	0	0	0	0	0	0.04	0.70	0.05	0	0.08	0.02	0	0
A.miliaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. palauensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bohadschia argus	0.10	0	0.35	0	3.75	0	0	0	0	0	0.19	0.42	0.26	0.11	0.13
B. similis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. vitiensis	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0
Holothuria (Acanthotrapeza) coluber	0	0	0	0	0	0	0	0	0	0		0	0	0	0
H. (Halodeima) atra	0	0.07	171.06	3.14	0.75	304.7	0.50	18.47	2.12	8.83		1.12	24.59	1.14	156.43
H. (Halodeima) edulis	0	0	0	0	0	0	0	0	0	0	0.01	0.21	0	0	
H. (Mertensiothuria) Leucospilota.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H. (Metriatyla) scabra	0	0	0.19	0.12	0	0	0	0	0	0	0	0	0	0	0
H. (Microthele) nobilis	0	0	0.12	0	0.08	0	0	0.07	0.80	0	0	0.01	0	0	0
H. (Microthele) Fuscopunctata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stichopus chloronatus	0	0	0.48	17.62	0.67	1.83	0.39	0	0	0.44	0	0.21	0.16	0.19	0.04
S. Variegatus.	0	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0
Synapta maculata.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thelenota ananas.	0	0	0	0	0.25	0	0	0	0	0	0	0	0	0	0

Table 3 continues...

Species	Site codes E6	E7	E10	Ms1	Ms2	M1	M1	M2	M3	M4	M5	M6	M7	M8	M9
Actinopyga echinites	0.01	0	0.05	0.02	0	0	0	0	0	0	0	0	0	0	0
A.mauritiana	0	0	0	0	0	0	0	0	0	0.03	0.09	0.05	0.38	1.81	1.34
A.miliaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
A. palauensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bohadschia argus	0.18	0.06	0.13	0	0	0	0	0.40	0	0.03	0.19	0.46	0.14	0.28	0
B. similis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
B. vitiensis	0	0	0.08	0	0	0	0.05	0.49	0.11	0	0	0.09	0	0	0
Holothuria (Acanthotrapeza) coluber	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H. (Halodeima) atra	158.23	0.69	0.07	1.21	9.46	0	1.23	8.56	0.39	0.38	0.56	6.48	0.08	1.0	53.10
H. (Halodeima) edulis	0	0.51	0	0	0	0	0	0	0	0	0	0	0	0	0
H. (Mertensiothuria) Leucospilota.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H. (Metriatyla) scabra	0	0.04	0	0	0	0	0.02	2.61	0	0.03	0.46	0.37	0	0	0
H. (Microthele) nobilis	0.10	0	0.03	0.08	0.03	0	0.51	0.01	0	0.16	0.46	0.65	0		1.71
H. (Microthele) Fuscopunctata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stichopus chloronatus	37.35	0	0.19	0.4	0.03	0	0.04	0.01	0.22	0	1.57	6.48	5.93	0	18.80
S. Variegatus.	0	0	0	0	0	0	0.02	0.11	0	0.11	0	0.19	0	0.14	0.09
Synapta maculata.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thelenota ananas.	0	0.04	0.04	0	0	0	0.01	0	0	0	0	0.19	0	0	0

Table 3 continues...

Species	Site codes						
	M10	M11	M12	M13	M14	M15	M16
Actinopyga echinites	0	0	0	0	0	0	0
A.mauritiana	3.10	0.24	0	0	0	0	0
A.miliaris	0	0	0	0	0	0	0
A. palauensis	0	0	0	0	0	0	0
Bohadschia argus	0.16	1.94	1.48	0.74	0.93	3.52	0
B. similis	0	0	0	0	0	198.89	0
B. vitiensis	0.32	0	0.83	0	1.11	3.33	0
Holothuria (Acanthotrapeza) coluber	0	0	0	0	0	0	0
H. (Halodeima) atra	39.05	1.39	0.56	1.48	32.41	137.96	10.74
H. (Halodeima) edulis	0	0	0	5.19	2.04	19.44	2.59
H. (Mertensiothuria) Leucospilota.	0	0	0	0	0	0	0
H. (Metriatyla) scabra	0	0	1.81	0	0.91	11.11	0.37
H. (Microthele) nobilis	0.48	0	0	0	0	0	0
H. (Microthele) Fuscopunctata	0	0	0	0	0	0	0
Stichopus chloronatus	35.32	0	0	0	0.37	0.74	1.48
S. Variegatus.	0.71	0	2.22	0	1.48	0.56	2.78
Synapta maculata.	0	0	0	0	0	0	0
Thelenota ananas.	0.24	0.14	0	0	0	0	0

Table 4: Annual beche-de-mer production.

Year	Quantity (tones)	Value (VT)
1980	-	-
1981	-	-
1982	-	-
1983	6	3,121,000
1984	3	1,707,000
1985	4	5,251,000
1986	4	2,837,000
1987	1	938,000
1988	15	3,291,000
1989	24	9,377,000
1990	11	37,000,000
1991	-	-
1992	-	-
1993	26.4	23,000,000
1994	2.9	1,500,000
1995	24.4	12,300,000
1996	8.3	3,900,000
1997	38.1	-
1998	21.7	9,409,855
1999	24.3	11,521,677
2000	20	3,983,743
2001	-	-
2002	-	-

Source/ notes: 1983- 1989 & 1997-2000: Fisheries Department annual reports.
1990- 1996: Fisheries Department annual reports, cited in Preston (1996).

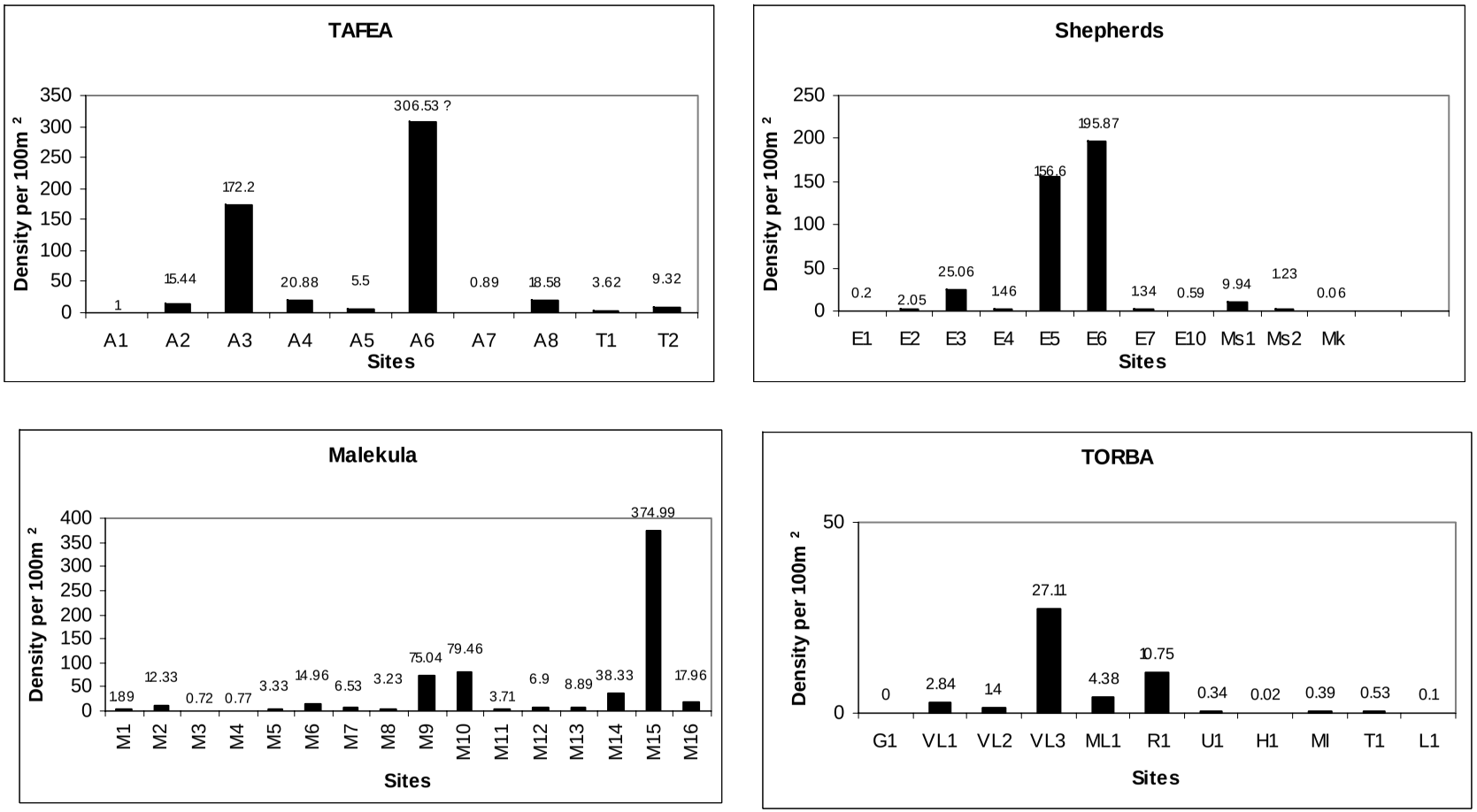
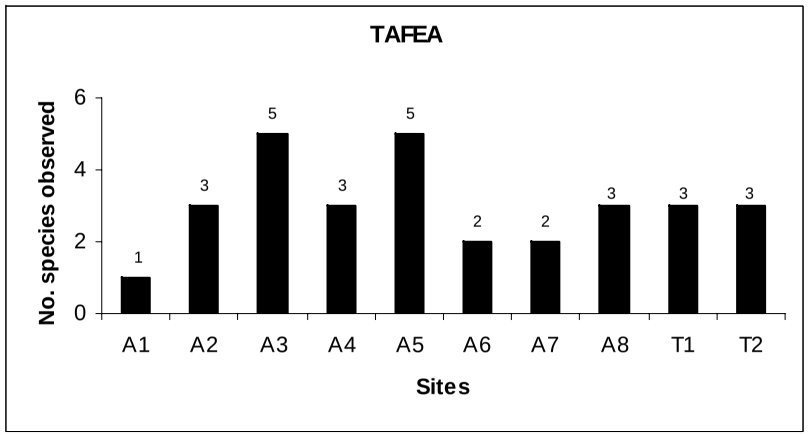
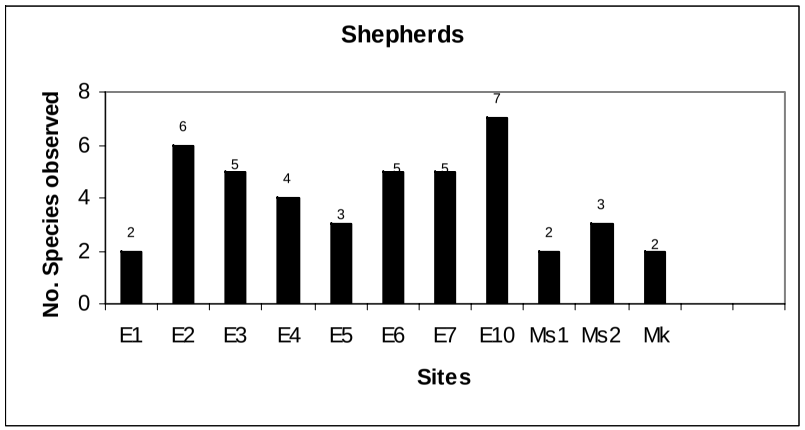
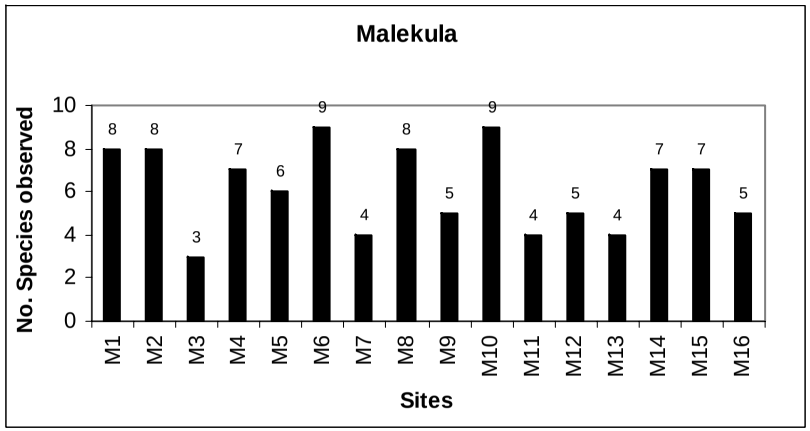


Figure 2: Total density per 100m² of beche-de-mer in all the sampling sites surveyed.







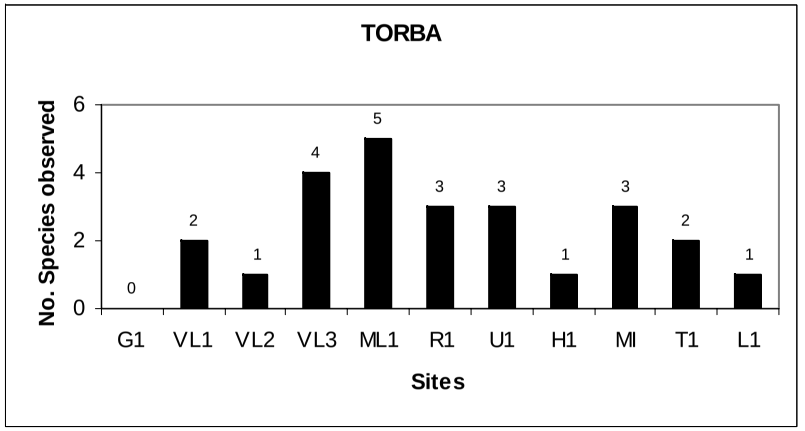


Figure 2: Number of beche-de-mer species observed in all the sampling sites.

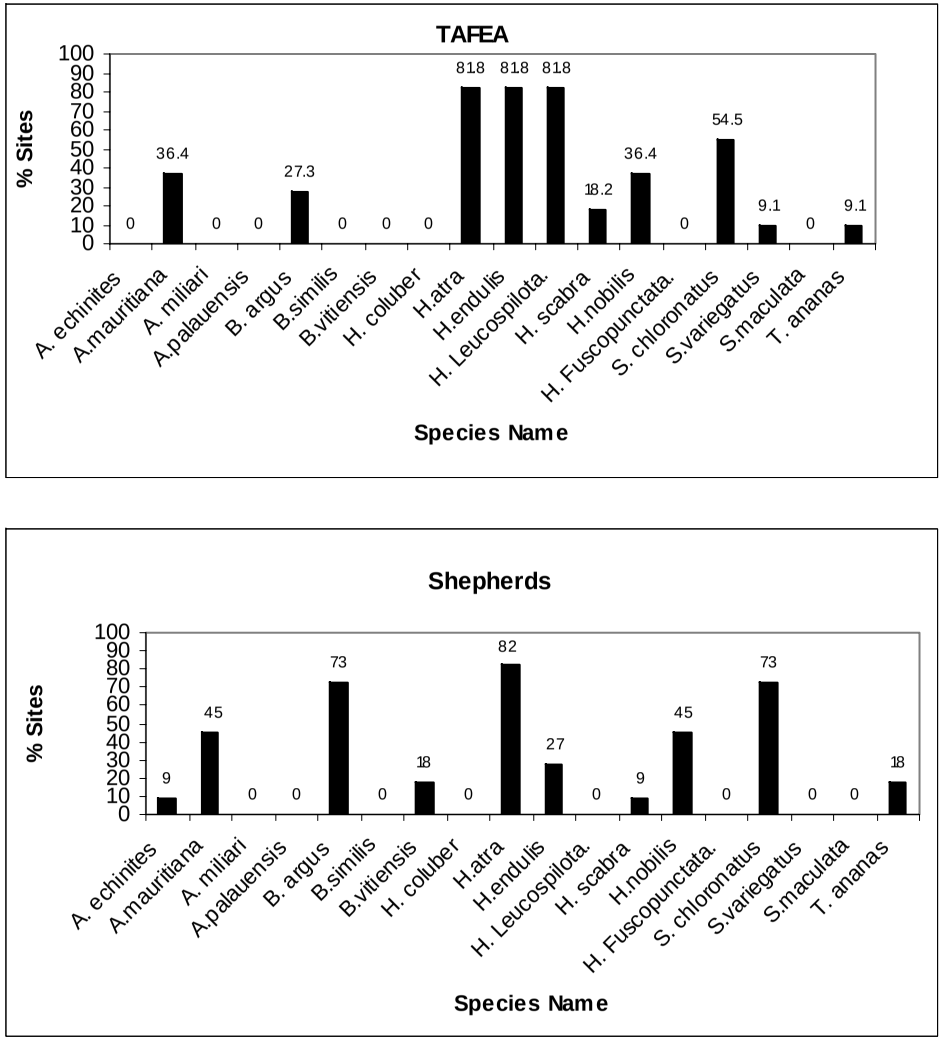
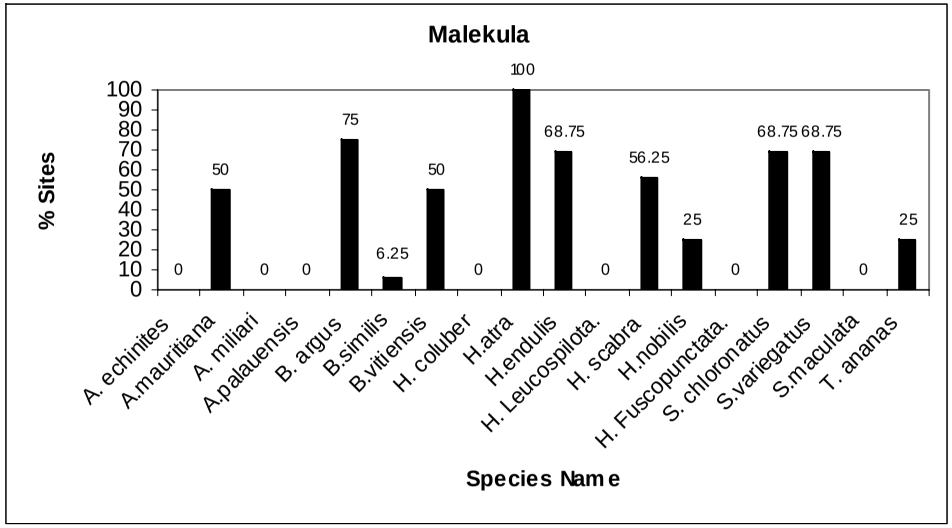


Figure 3: Percentage of all the sampling sites at which each species occurred at.



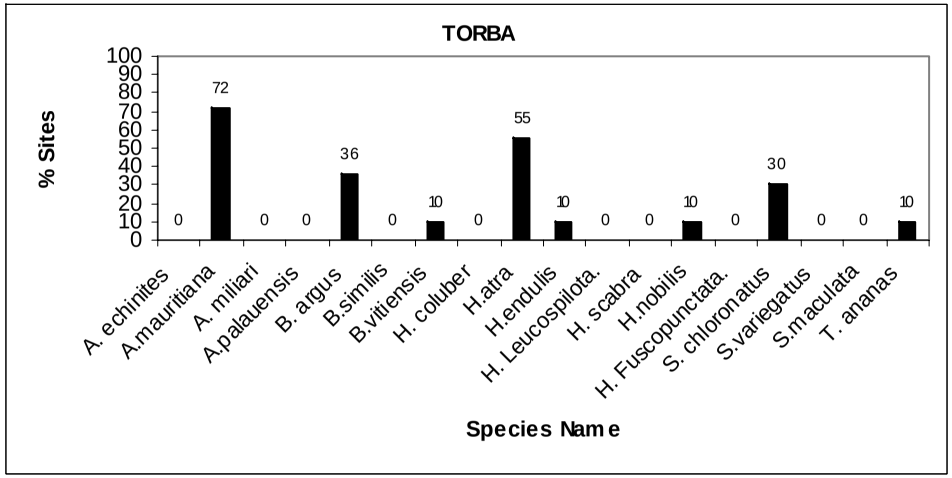


Figure 3 continues...

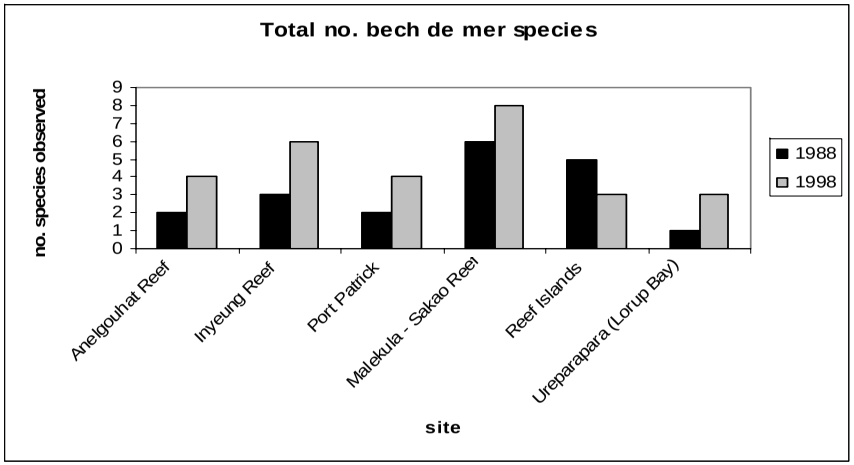


Figure 4: Total number of beche-de-mer species observed during stock assessment surveys in 1988 and 1998.

Coconut Crab (*Birgus latro*) survey, 1998- 2000.

Abstract

The coconut crab (*Birgus latro*) survey was conducted in nine sampling sites in the island of Emae in the Shepherds group and the Torres islands in the TORBA province. In Emae, the stocks were found to be over- exploited and in danger of being totally wiped out. In the Torres islands, there is a slight increase in the CPUE of the sampling sites compare to the previous surveys and results indicate that there is recruitment taking place. Despite that, it is recommended that extra measures be put in place to sustain the stock from further declining.

Introduction

Coconut crab or rubber crab (*birgus latro*) is a very important resource in Vanuatu. It is a food item and an imperative cash crop in some remote areas. The crab is one of the largest land dwelling crustaceans. It is a marine related crab in that its early life cycle is spent in the sea but most of its adult life is spend on land, typically along the coastal areas but returns to sea during breeding seasons.

Coconut crab is widely distributed throughout the Vanuatu archipelgo however in most of the islands stocks have been over- exploited or depleted. The only areas which still have healthy stocks are in the TORBA and SANMA provinces.

The resource is being harvested locally both for subsistence and commercial purposes. The demand locally is very high with markets both in Port Vila and Luganville in Santo. Because of its high demand, vulnerability to harvesting and no capital investment involved in harvesting and equipment involve, stocks in areas where they occur can be easily over- exploited (Fletcher 1991).

This report aims to provide a brief profile of the status of the stock based on the marine resources stock assessment survey conducted on the resource by the Fisheries Department in year 1998-2000. In addition it will outline the socio- economic importance of the crab resource in country.

Method of survey

A total of eight sampling sites have been examined during this survey. Two in Emae island in the Shepherds group and six in the islands of TORBA province (Fig 1). The six sampling sites in the TORBA province were basically those previously sampled in 1985, 86, 87, and 1991). The obvious area that was omitted during this survey is SANMA province.

Sampling of the coconut crab was conducted by placing half open coconut baits during the day along a trail cut through the jungle and visiting the baits after dark. The baits were placed in areas near the coast where the vegetation and geology were consistent to crab habitat and in areas where it is known that they occur. Detail description of the sampling method on coconut crab is outline in "*A Manual for the Stock assessment of Coconut Crab (Birgus latro*)" by Fletcher and Amos.

For the purpose of this survey, in all the sampling sites surveyed information collected include the total number of coconut crab, number of coconut crabs per baits, percentage of under size and legal size, and whether or not the area is open access or protected.

Fishery

Harvesting of coconut crab is for both subsistence and commercial purposes. Coconut crab is a delicacy and could fetch a very lucrative prize in hotels and restaurants (tourists) in Vila with an average plate price of 2,000vt per crab (Fletcher, 1992). In remote areas such as in the Torres group coconut crab is sometimes the only available cash crop providing major incomes to the people particularly in times when prices of agricultural commodities such as copra have been significantly low (Fletcher, 1992 cited in Bell and Amos, 1994).

Reports have shown that most of the crabs which end up in the markets in Vila originated from the TORBA province particularly the Torres islands.

Production

As previously stated, the crab resource is being harvested for both subsistence and commercial use. And the level at which the resource is being exploited both for subsistence and commercial for the whole country remains unaccounted for (Bell & Amos, 1994).

Increase harvest of the resource is due to several factors including delicate flavor, high demand and easy access of market and improvement of air services to the remote areas. The crabs are being sold to super markets, restaurants and hotel owners both in Luganville and Port Vila. Currently there is no export of the resource. The Fisheries Department issues certificate for individual person traveling overseas with coconut crab. The certificate is a Ministerial order of 1983 that limits the number of crab to 2 or 5kg per person per travel.

Commercial

A survey conducted in 1991 by Fletcher (1992) on 23 restaurants in Vila on the number of crab sold per week found that a total of at least 250 crabs are sold per week which is equivalent to 12-15000 crabs per year at an average of 2,000vt per crab per plate This would generate a total of 25-30 million vatu annually. Even though information on the overall commercial production for the whole country cannot be substantiated, in some extend this figure illustrates the economic importance and also the degree of utilization of the resource.

Subsistence

Because of the delicate flavor of its flesh *Birgus* is considered as a much flavored food item. Given its large size and terrestrial habitat with no capital investment in harvesting it makes it easier to be exploited. In areas where they occur, subsistence exploitation has been going on since time imemorable. However, the level of subsistence exploitation for the whole country remains unknown (Bell & Amos, 1994). The estimated subsistence level of exploitation for 1991 by Fletcher (1992) in the islands of Santo and Torres Islands stands at 2,990 crabs per year. As it stands, these two areas throughout the country have the healthiest stocks.

Status of coconut crab stock

By and large reports indicated that there is a constant decrease in the CPUE in all the sites surveyed since 1985 (Table 2) which means that there a fewer number of crabs left. An exception was Kole in the island of Santo where there was a slight increase in the CPUE for the undersize crabs in a survey in 1991 (Fletcher, 1992). The CPUE is directly related to the number of crabs which means that the lower the CPUE the lower the number of crabs left.

In the Torres islands the decline in the number of crabs is evident by the change of the method of capture by the locals. Previously a whole coconut would be used as bait with a circular hole made on the side. If the baits were open entirely and left for too long a large number of crabs would have taken the baits away or consumed almost all the coconut. With the old method the baits would be set an hour before dark and checked very shortly after dark. Today the coconut bait is split in two or three pieces and the baits were not re- visited until almost midnight so as to give enough time for the big crabs to come out (Fletcher, 1992).

Results/ Discussions

The names of the Islands visited, sites and site codes are given in Table 1together with the total density of crabs in each sites and the CPUE of all the sites. In addition the CPUE of the undersize and legal size crabs are also provided in the same table. Figure 1 shows the densities of crabs per $100m^2$ of each site.

Calculations

The catch per unit effort of crab abundance is calculated using the equation below:

CPUE = Number of crabs caught/ Number of baits set.

Emae

These sites have never been surveyed before and the status of crab population is unknown, however it is evident that the crab population here is very much over- exploited as only one crab is observed at each site. Drastic measures should be put in place to protect the resource being totally wiped out in this area.

Torres Islands

Apparently the CPUE of each sites surveyed has slightly increase compare to the last survey in 1991 by Fletcher (1992) (Table 1). These are sites where hunting occurs except for H1.2, Yawa Bay where it is a protected area. In most of the sites, it is obvious that very little or no recruitment has occurred. In Yawutu Bay, results have shown that there was a higher percentage of undersize crabs compare to the legal size. This could be an indication that there was recruitment in that area. Fletcher (1988); Fletcher *et al*., (1991) previously reported that it appears that little or no

recruitment have occurred. However, Fletcher (1992) said that it is incorrect according to a study in 1991 and similarly this survey where results indicated that there is recruitment taking place.

In Picot Bay (open access) and Yawutu Bay (recently protected) the apparent low CPUE of legal size indicated that there was heavy fishing pressure occurring on the larger crabs. Harvesting in these areas should be done such that to allow larger crabs to breed in ensuring continuous recruitment. Given their slow growth rate and the long larval stages in the sea (Fletcher *et al*., 1991& King, 1999), the current practice of harvest where by once a crab crosses the threshold it is removed very quickly, would not sustain harvesting in a long run.

The average CPUE value of all the sampling sites in the Torres islands is 2.11. According to Fletcher & Amos, at such a value, crabs would be rarely found walking around during the day but can still be found without baits at night. Although it may seem unlikely that the crabs are in danger of being over- exploited at this stage, measures should be put in place to sustain the current level of stock.

A corresponding CPUE value to abundance is detail in Fletcher and Amos. In brief, a CPUE value of 4 is considered a high abundances, a slightly lower abundance is equivalent to a CPUE value of 3. At CPUE value of 2, crabs are rarely found during the day and a CPUE value of 1 or less means crabs are never found during the day and night without baits.

Abundance

Crab density per 100 m^2 varies from sites surveyed. H1 and MI recorded the highest densities per 100m^2. In general the density of crab per 100m^2 was low in all sampling sites rarely exceeding 0.45.

Management Regulations/ Recommendations

Currently the regulations regarding the exploitation of coconut crabs are that of the Fisheries (Coconut crab) Regulations No. of 1991. It controls and regulates the exploitation and sale of crabs in Santo/Malo and Banks/Torres regions.

In brief this includes a closed season and a quota set for both regions. The closed season for Santo/Malo region is from October to April and the quota stands at 2000 crabs per year. Similarly the Banks/Torres closed season is set from August to November and the quota stands at 5000 crabs per year. In addition a minimum size limit of 9cm of the cephalothoracic was imposed together with a ban on the collection of berried females.

Any person found to have break or contravene these management regulations and is guilty of the offence is liable to pay a fine of not more than VT100,000.

These regulations if adhered to would have a significant impact on the level of exploitation and therefore the sustainability of the crab population in the country. Never the less, it appears that despite that, stocks have continuously declined.

For any management policy to be effective, enforcement and policing is a major part thus ensuring the full effectiveness of the policy. However there are uncertainties on the effectiveness or the suitability of the current management regulations that are in place.

Given that it could indicate that there needs to be changes and additions to be done to the current management regulations after much studies have been done on the resource in the country. Fletcher (1992) in one of his studies recommended the following:

> "one change to the regulations is to have a quota imposed for the remainder of the country. This should be in a vicinity of 1000 crabs with (perhaps?) a similar closed season to that of Santo/Malo. A further alterations could be the shifting or increase in the closed season at the Banks/Torres region to include November. Given the main spawning season is in December- February and the gestation period for the eggs is three to four weeks (Schiller et al, 1991), it is likely that some mating must occur in November. Therefore, allowing a month for uninterrupted reproductive behavior for the crabs may result in better spawning success".

Very briefly, several other recommendations have been suggested by the same author. These include an alteration to the quota set for the Banks/Torres. The quota should be divided into smaller units such that Hiu and Tegua have 2000 crabs each; Loh, Toga and the Banks each have 350 crabs per year. One major recommendation is to change the quota system to weight instead of numbers.

These recommendations are made base on research findings on the coconut crab resource over a number of years. Given the time and money invested in these research studies it is strongly advisable that the government through the Fisheries Department take these seriously and act upon them to stop the continuous declining and the possible extinction of the crab resources throughout the country.

Conclusion

Overall there was a slight increase to the number of crabs found during this survey than the previous ones. This could mean that the stock may have recovered since the last survey. However it must be noted that this survey was conducted in 1998- 2000 and the results may not depict the current status of the crab population. In addition it is recommended that there should be more research carried out at least on an annual basis on this important resource.

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Tables and Figures

Table 1: Islands, Sites and site codes, densities and CPUE (No. of crabs per bait) of each sites surveyed.

Island	Sites	Site codes	Density	CPUE		
				All	Undersize	Legal size
Emae	Makatu	E8	0.01	-	-	-
	Sangava	E9	0.01	-	-	-
Hiu	Flatstone	H1	0.47	3.13	0.73	2.4
	Yawa Bay (open)	H2	0.16	1.07	0.24	0.8
	Yawa Bay (protected)	H2.1	0.21	1.4	0.2	1.2
	Yawutu Bay (Protected)	H3	0.28	1.87	1.2	0.67
Metoma	Rival bay	M1	0.45	3	1.53	1.45
Tegua	Tegua	T1	0.33	2.2	0.8	1.4
Loh Is.	Loh Is.	L1	0.03	-	0.2	-

Table 2: Total CPUE (No. of crabs per bait) at each sites sampled since 1985. Source: 1985-1991, Fletcher, (1992)

Islands/Sites	Year				
	1985	1986	1987	1991	1998
Emae					
Makatu	-	-	-	-	-
Sangava	-	-	-	-	-
Hiu					
Flatstone	5.0	3.6	2.4	1.3	3.13
Yawa Bay (open access)	-	-	0.5	0.4	1.07
Yawa Bay (protected)	-	-	-	-	-
Yawutu Bay (recently protected)	-	-	1.4	1.3	1.8
Metoma					
Rival bay	-	-	-	-	3
Tegua	-	-	-	-	2.2
Loh Is.	-	-	-	-	-

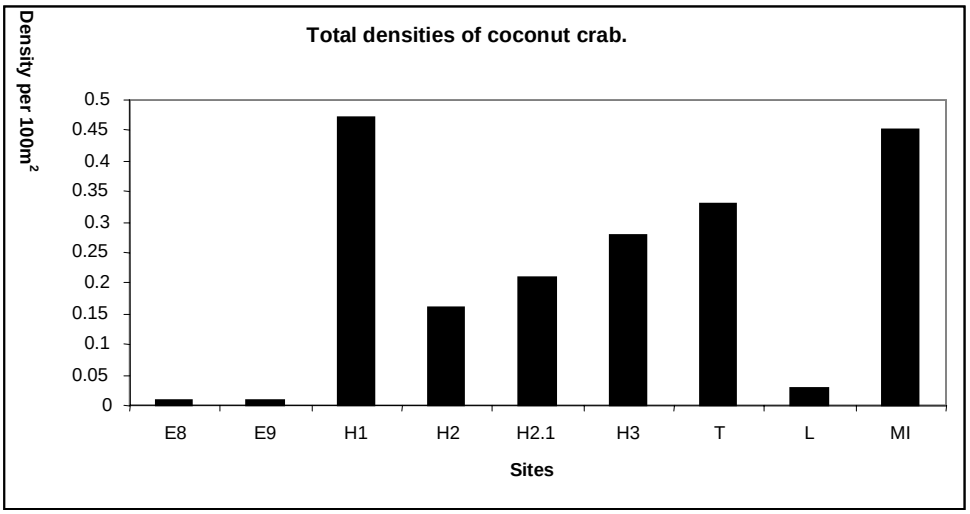

Table 1: Total densities per 100m^2 of each site surveyed in 1998- 2000 in both Emae

and TORBA province.

Rock Lobster survey, 1998- 2000

Abstract

During 1998, the stock abundance and diversity of rock lobsters was surveyed at twenty-three sites in the SHEFA and TAFEA provinces of Vanuatu. Four species; *Panulirus penicillatus*, *Panulirus versicolor*, *Panulirus longipes fermoristriga*, and *Parribacus caledonicus*, were found to occupy these waters. Abundance was not found to be uniform with many sites uninhabited or occupied at low densities. Species of the *Panulirus* genus were more commonly found than *Parribacus caledonicus*. A lack of definitive results advocate that surveying techniques, and the quantity of observation records, needs to be strengthened before any conclusive synopsis on the status of rock lobster in Vanuatu can be obtained. It is recommended that further surveying of stock biomass, in all provinces, be paralleled with the implementation of catch records to ensure that any future research is comparable after inherent changes in fishing techniques, effort, and success.

Introduction

Four species of rock lobsters are known throughout Vanuatu; *Panulirus penicillatus* (the pronghorn spiny lobster), *Panulirus versicolor* (the painted spiny lobster), *Panulirus longipes femoristriga* (the longlegged spiny lobster), and *Parribacus caledonicus* (the slipper (Caledonian mitten) lobster). *P. penicillatus* is the main species of commercial value reported to be known all around Aneityum, Futuna, Tanna, Erromango, the south and east coasts of Efate, Epi, Ambrym, Pentecost, Maewo, and south and east coast of Malekula and Espiritu Santo. Only along the west coast of Malekula and Espiritu Santo is *P. penicillatus* a less abundant species, with *P. longipes* in proliferation.

This report details the first assessment of rock lobster stock abundance, diversity and distribution in two provinces of the Vanuatu archipelago. As the scope of the data is limited, a synopsis of further assessment and management progression is given.

Method

Twenty three sites within two provinces, SHEFA and TAFEA (Appendix 1).

Fishery/ Production

Rock Lobsters are currently fished for subsistence purposes with surplus increasingly being sold to restaurants in Port Vila and Luganville. The current level of exploitation of the resources throughout the country remains unknown.

Status of stock

Bell and Amos (1994), reported a seeming abundance of lobster in Vanuatu waters, however, accurate research is needed to determine an appropriate management strategy as the increasing importance of lobster as a local resource could rapidly lead to over-exploitation.

Results

Abundance

All four previously recorded rock lobster species were observed during surveying. Abundance was not uniform with a concentrated occurrence of lobster at particular sites (Appendix 2). A high proportion of sites were also uninhabited; 50% in the Shepherd Islands and 80% in TAFEA. At its highest, lobster density was 0.5 per $100m^2$, observed at one site on Emae, Mataso, and Aneityum (at night) respectively. Remaining observed densities were much lower; 0.1 to 0.35 per $100m^2$.

Diversity

Where rock lobsters were observed it was more common for three, or all four, species to occur (Appendix 3). At only one location, where total density was less than 0.10 per $100m^2$; site A7 in TAFEA province, was *P. penicillatus* the sole species observed.

Distribution

In the Shepherd Islands *P. penicillatus* and *P. versicolor* were observed at 50% of the areas surveyed. *P. longipes* was recorded nearly as frequently at 40% (Figure 3, Appendix 4). Again within the TAFEA province *P. penicillatus*, *P. versicolor* and *P. longipes* occupied a comparable percentage of sites; 10 to 20%. *Parribacus caledonicus* however, was consistently less frequent and scarcely observed (Appendix 4).

Densities of rock lobster did not differ markedly between surveying at night or during the day, in TAFEA province. At one site, numbers were increased by the night time assessment, but at a second, lobsters were observed only during the day (Figure 2, Appendix 2 and 3). The type of species did also not show considerable disparity (Figure 2, Appendix 4).

Discussion

The occurrence of rock lobsters within a concentration of areas indicates the influence of one, or multitude of, site specific characteristics. *P. penicillatus* and *Parribacus caledonicus* are known to inhabit the “weather” sides of islands amongst the surf, surge channels and undercut *Porolithon* alga reef, where there is good water circulation and shelter away from light (Bell and Amos, 1994). *P. longipes* and *P. versicolor* however, occupy reefs with moderate wave action, and calmer waters respectively. The common occurrence of these species in tandem with *P. penicillatus* may infer that some other mediating factor is influencing local and broad scale community structure. This result may also indicate higher catch rates of lobster in the areas where overall densities are low, and low or negligible catch rates where lobster are concentrated. Without knowledge of the level of stock being taken from the sites surveyed, and surrounding areas, this can not however, be justified.

Recommended actions

It is the primary task of stock assessment to determine which aspects of production are driving a fishery. Inferences from impartial research however, formally restrict statistical outcomes to these limits (Quinn and Keough, 2002). For example, if we sample from a population of lobster at a certain location in December 2003, then our inference is restricted to that location in December 2003. We cannot infer what the population might be like at any other time or in any other place, although we can speculate or make predictions. Annual stock assessment of rock lobster at a diverse range of sites, and in all provinces, would be the most feasible way to gain a comprehensive understanding of the factors that structure a population and the seasonal and annual changes it may undergo. Incorporating an estimation of how many lobster were taken from these areas, both commercially and recreationally, would determine whether the local stock is being depleted or maintained, and would give some indication as to the maximum sustainable yield of the sample, and similarly structured populations.

In a recent survey of the Tasmanian recreational rock lobster fishery a diary method was used over the span of a season to record: the date, fishing location, method used, start and finish times (including any significant breaks from fishing), the number of rock lobster kept (harvested) and numbers released or discarded, and when rock lobster were released or discarded the reason for doing so (Forward and Lyle, 2002). A similar method could be readily used to establish a database of information for rock lobster fishing in Vanuatu. Individual fisherman, or villages, who resource rock lobster stocks could be sourced to keep a record of information similar to that above. Although anomalous and incomplete data will undoubtedly arise, a small accumulation of diligently recorded and accurate data could be advantageous in identifying some key issues regarding rock lobster harvesting and the effect of varied catch levels on biomass. From their figures, Forward and Lyle (2002) used the bootstrap method to estimate effort and harvest with percentile determined confidence limits. This process would be pertinent in analyzing data attained from future stock assessments as; “bootstrap methods are used to estimate a parameter of an unknown population by summarizing many parameter estimates from replicate samples derived from replacing the true population by one estimated from the population (the original sample from the population)” i.e., if it is not known what the underlying distribution of a parameter is then bootstrapping techniques are recommended over simple parametric statistics (Haddon, 2001).

Future stock assessments, preferably on an annual basis, would provide the complementary data necessary to determine the general structure of rock lobster populations (age and sex ratios) and the perturbations induced by fishing. By studying the impacts on a stock of different levels of fishing intensity it is possible to assess its productivity through surplus-production and age-based models (Haddon, 2001). Continued stock assessment through manual recollection however, would take a large amount of funding and many participants. It is important at this time to document the fishing practices used, how these vary over time and location, their catch efficiency, and where possible the catch per unit effort (Michael Roberts, School of Technology (Aquaculture), Flinders University of South Australia, *pers. comm.*). This will ensure that future researchers will be able to equate the advancements in fishing techniques and make accurate comparisons between catch rates at this time and in the future.

Management Regulations

The current management regulation regarding the exploitation of lobster resource is the Fisheries Regulations for lobster catch. Under the Fisheries Act 1982, it prohibits taking, possessing, selling or purchasing of:

a). any rock lobster carrying eggs; or

b). any rock lobster which is less than 22cm in length from the rostral horns to the rear edge of the telson, when laid flat, or less than 7.5cm in carapace length.

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Appendix 1

Table 1: Sites, location codes, and survey areas,
of the Marine Resources Stock Assessment Survey for Rock Lobster (1998-2000).

Shepherd Islands, SHEFA Province	*code*	TAFEA Province	*code*
Emae #1	E1	Aneityum #1	A1
Emae #2	E2	Aneityum #2	A2
Emae #3	E3	Aneityum #3	A3
Emae #4	E4	Aneityum #4	A4
Emae #5	E5	Aneityum #5	A5
Emae #6	E6	Aneityum #6	A6
Emae #7	E7	Aneityum #7	A7
Mataso #1	Ms1	Aneityum #8	A8
Mataso #2	Ms2	Aneityum #9	A9
Makira	M	Tanna #1	T1
Buninga #1	B1	Tanna #2	T2
Buninga #2	B2		

Appendix 2

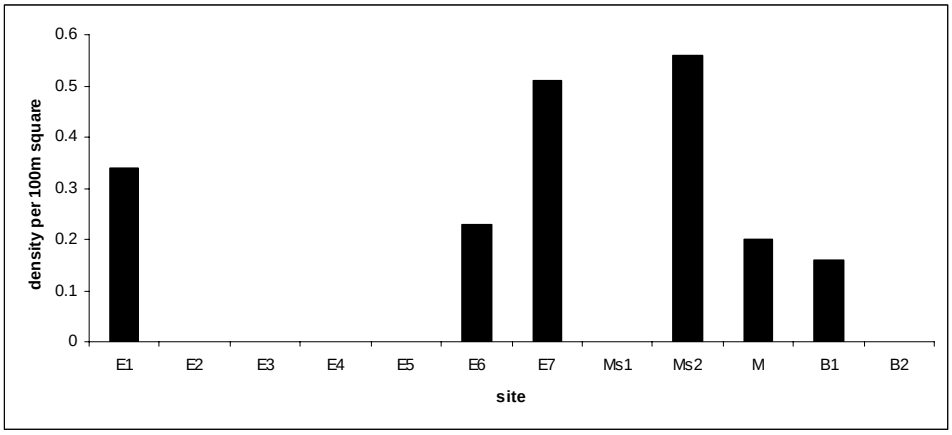

Figure 1: Total density of rock lobster per 100m^2 in the Shepherd Islands, SHEFA Province, during the Marine Resources Stock Assessment Survey (1998-2000).

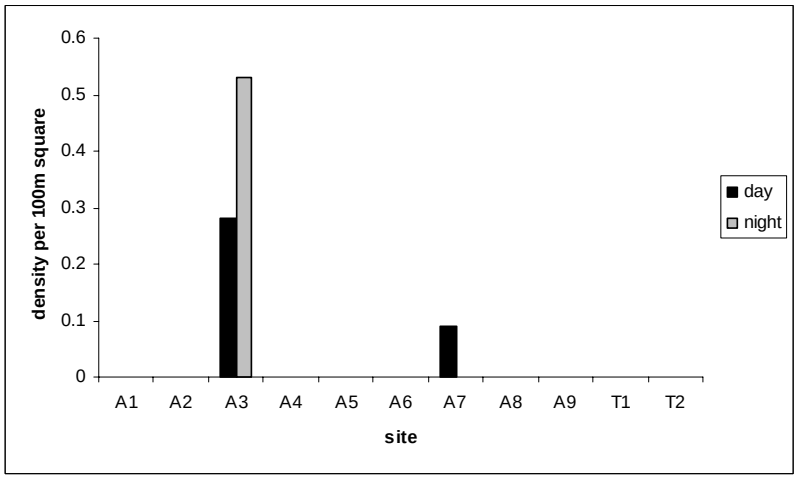

Figure 2: Total density of rock lobster per 100m^2 in the TAFEA Province, during the Marine Resources Stock Assessment Survey (1998-2000).

Appendix 3

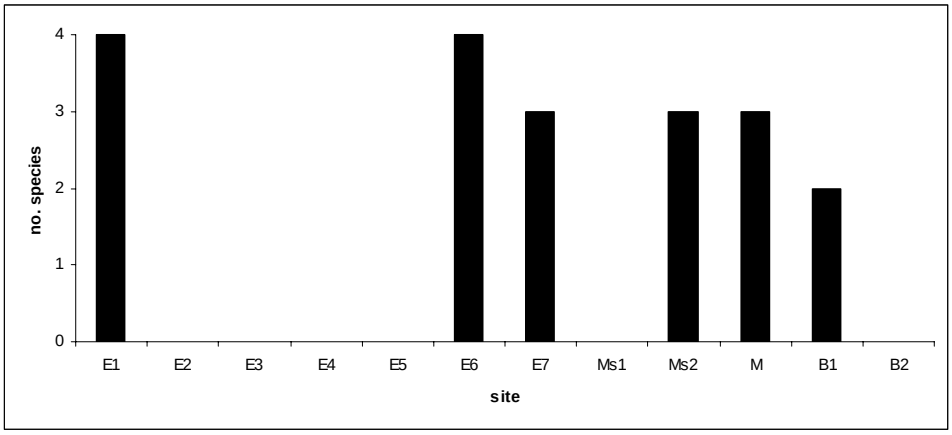

Figure 1: Total number of rock lobster species at each site surveyed in the Shepherd Islands during the Marine Resources Stock Assessment Survey (1998-2000).

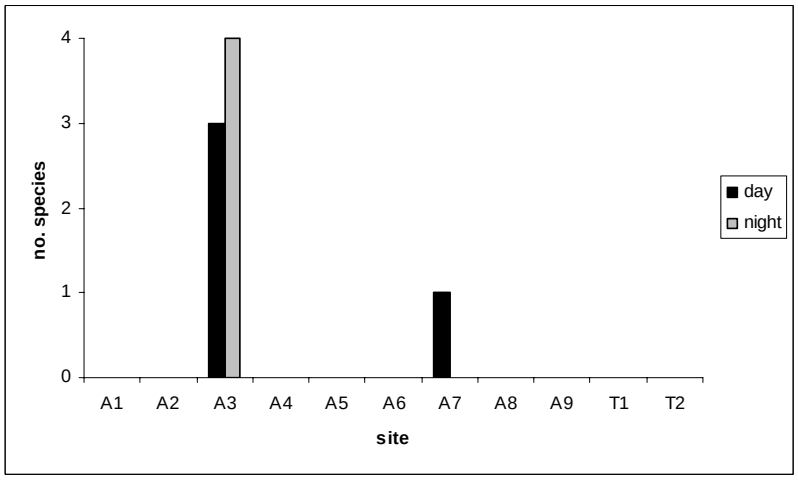

Figure 2: Total number of rock lobster species at each site surveyed in the TAFEA Province during the Marine Resources Stock Assessment Survey (1998-2000).

Appendix 4

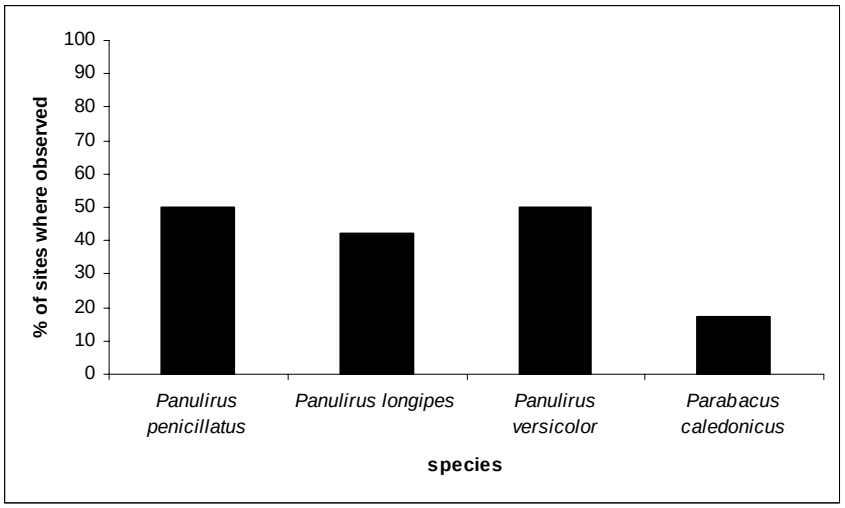

Figure 1: Percentage of sites occupied by each rock lobster species in the Shepherd Islands; surveyed during the Marine Resources Stock Assessment Survey (1998-2000).

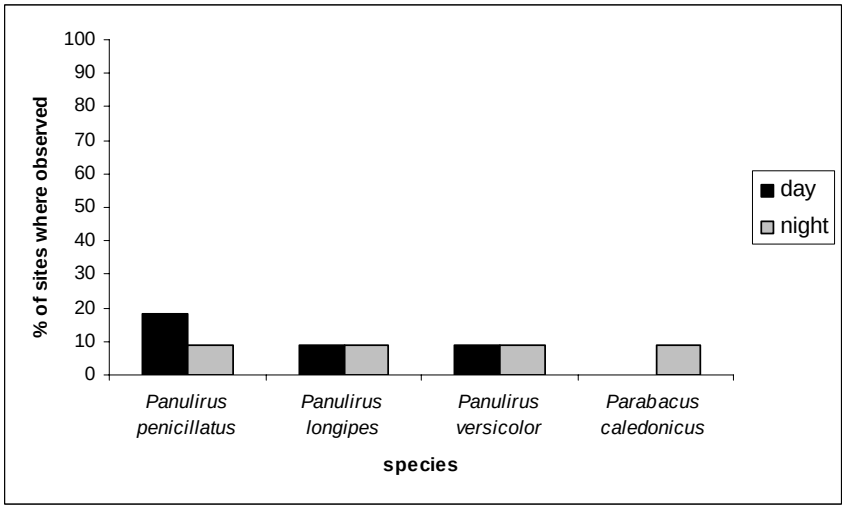

Figure 2: Percentage of sites occupied by each rock lobster species in the Shepherd Islands; surveyed during the Marine Resources Stock Assessment Survey (1998-2000).

Giant Clam Survey, 1998- 2000

Abstract

The abundance and diversity of giant clams within the Vanuatu Archipelago was assessed in 1998. Three *Tridacnidae* and one *Hippopus* species were observed with the absence of previously recorded species, *Tridacna gigas* and *Tridacna derasa*, noted. *Tridacna maxima*, *Tridacna squamosa*, and *Tridacna crocea*, occurred at comparable densities with all locations on Malekula Island, and two locations in TAFEA and TORBA provinces, presenting a higher proliferation. *Hippopus hippopus* was noted for its overall scarcity. These results were compared to similarly surveyed sites during the Vanuatu Marine Resources Survey in 1998 by the Australian Institute of Marine Sciences. Only six locations were assessed at both times however, with no trends observed and results inconclusive. The need for a time comparison of giant clam stock abundance and diversity is marked and it would be advantageous to replicate surveying from this report in the near future.

Introduction

There are four species of Tridacnidae in Vanuatu. These include *T. maxima, T.* squamosa, *T. crocea* and *H. hippopus*. In Vanuatu giant clam is mostly fished for subsistence purposes however recently has been one of the major fishery product for aquarium trade.

Current knowledge of the distribution and abundance of giant clams in Vanuatu waters is limited to observations made during Phases 2 and 3 of the Vanuatu Marine Resources Survey, March – April 1988, by the Australian Institute of Marine Science (AIMS).
This report is an addition to the synopsis provided by the Marine Resources Survey in 1988 and describes the most recent observations of abundance, diversity, and distribution of giant clam species within the Vanuatu archipelago. Direct comparisons of organism densities were made, where possible, with data taken from Zann and Ayling (1989).

Method

Forty five sites in four provinces were surveyed during the Marine Resources Stock Assessment Survey (Table 1, Appendix 1).

Fishery/ Production

Giant clam is a food item and contribute largely as a protein source to the coastal people of Vanuatu. According to Dalzell (1990) cited in Bell and Amos (1993) Ni- Vanuatu consumes in average 19.1kg of shellfish/capita/year.

Giant clam flesh is sometimes seen sold in the market house in Vila from the villages in the vicinity of Port Vila. Clam shells mostly *H. hippopus* are also sold as souvenir to tourist. In the rural areas giant clam is mainly collected for subsistence use.

Recently the resource has become a major Fisheries products involve in aquarium trade. Annual figure for 2000 shows that a total of 130,185 pieces of giant clam was exported live for aquarium purpose generating a total value of Vt10,154,367.

Status of stock

During this review, four species of Tridacnidae were recorded: *Tridacna maxima*, *Tridacna squamosa*, *Tridacna crocea*, and *Hippopus hippopus*, with the absence of two previously observed species *Tridacna gigas* and *Tridacna derasa* noted. The absence and rarity of several species was concluded as partially attributable to a lack of suitable habitats. *Tridacna maxima*, the most common species, were found on all islands surveyed in the archipelago. A specific distinction between *Hippopus hippopus* was also empirical with this species common in uninhabited reef areas; such as Cook's Reef and Reef Islands. It was recommended that these reefs be accorded special protection (Zann and Ayling, 1989) however very little effort has been made.

Results

Four Tridacnidae species were observed: *Tridacna maxima* (the elongated or rugose giant clam), *Tridacna squamosa* (the scaley or fluted giant clam), *Tridacna crocea* (the boring or crocus clam) and *Hippopus hippopus* (the horse's hoof, rolling clam, bear paw or strawberry clam). *Tridacna gigas* and *Tridacna derasa*, two species previously recorded in Vanuatu waters were not observed at any appraisal locations.

Abundance

Total densities, per $100m^2$, of these four species combined, indicated a higher proliferation in Malekula and in two specific sites in Tafea and Torba provinces (Appendix 2, Figures 1 – 3). Overall clam abundance in the Shepherds Islands was comparatively very low (Appendix 2, Figure 4).

Diversity

Within all provinces the presence of clams was generally contributed to by two or more species. Few sites had only one species; three sites in the Shepherds Islands and three sites in Tafea Province (Appendix 3, Figures 1 and 2), with only four of the sites occupied by all four (Appendix 3, Figure 3 and 4). In correspondence to the high overall abundance of giant clams in Malekula, densities in this area were consistently contributed too through a multitude of species.

Distribution

With the exception of *H. hippopus*, which was not observed in Tafea, all four species were found within the four provinces (Appendix 4, Figure 1 – 4). *T. maxima* consistently occupied the highest percentage of sites; from 45% in TAFEA to 80% in Malekula. *T. squamosa* had an equally high rate of occurrence as *T. maxima* in Malekula and TAFEA. Contradictory to some reports, *T. crocea* was found in all provinces and up to 50% of sites in TORBA.

Abundance comparisons over time

Parallel data was obtained from the preceding Vanuatu Marine Resources Survey in 1988 (Zann and Ayling, 1989) to compare total giant clam abundances. Unfortunately, only six locations in total were surveyed both in 1988 and 1998, and the following synopsis is based on these sites only (Appendix 4, Figures 1 – 4). Shifts in the occupation of sites for *T. maxima* appear to have

occurred within the TAFEA province, although with a marked increase in abundance at Port Patrick. *T. squamosa* were not observed at any sites in 1988, but two locations in Aneityum in 1998. At all sites for *T. crocea* abundance counts were negligible over time. *H. hippopus*, although observed at two sites in 1988, was absent from all sites in 1998.

Discussion

The continued absence of *Tridacna gigas* and *Tridacna derasa* supports the conjecture in Bell and Amos (1994) that these species are now locally extinct from the archipelago. It is likely that a reduction in suitable habitats, the naturally very low and erratic recruitment of these giant clams (Braley, 1988), and the vulnerability of *T. derasa* due to its large size and valuable nature (Lewis *et al*., 1988), has led to their disappearance from previously occupied areas. Given the previous inhabitance of local reefs by these two species, their re-introduction could be established with a locality concentrated influx of clams, and careful management to ensure the critical density threshold is maintained. In other areas of the Pacific, from Fiji to the Great Barrier Reef, *T. derasa* and *T. gigas* are still present, or common and widespread (Lewis *et al.,* 1988).

From the 1988 Marine Resources Survey, the restocking of *Hippopus hippopus* clams was recommended for consideration. It would appear from data obtained in this report that stocks are holding or at least have not considerably declined over the last ten years. Both in Malekula and TORBA province this species was recorded at approximately 30% of sites, and only in TAFEA province was its absence in entirety noted; low level densities were recorded at one location on Aneityum in 1988 (Zann and Ayling, 1989).

The three species of Tridacnidae were observed in similar abundances. *T. squamosa* and *T. crocea* were of medium occurrence, with *T. maxima* occurring in the largest proportion of sites surveyed. As with *H. hippopus*, the total species and stock abundance were highest in Malekula and the TORBA province. Estimates of abundance, diversity and distribution are however, disconcerting for the Shepherd Islands and TAFEA province. *Do these lower densities correspond to areas of higher population density and more heavily impacted areas?*

Locations comparable between the Vanuatu Marine Resources Survey and current data indicates that of the four giant clam species, only *T. maxima* and *T. squamosa* have maintained a consistent density. The distribution and occurrence of *T. maxima* by location has undergone a major shift, but abundance has remained consistent. *T. crocea* and *H. hippopus* were not recorded in any notable density over time, however; this data is inconclusive given the lack of overlap between sites surveyed and discrepancies in densities through alterations in the sampling method and participants.

Management Regulation/ Recommendation

Currently, the management regulation regarding the giant clam exploitation is a Ministerial order of 2001. The order bans the harvest for export of *T. crocea* throughout the country and in addition a total ban of harvest for export is imposed in all the species on the island of Efate.

There are management options available such as size limits, seasonal closures and quota that can be used however there is a need for more studies and surveys to be carried out on the resource so that a more realistic and effective management regulations is drawn.

Recommendation

Future research

Due to a high degree of variation in residual and new data, conclusions are tentative and insubstantial. A beneficial step to ratify these assessments would be to clarify the population dynamics of *T. maxima*, *T. squamosa*, *T. crocea*, and *H. hippopus* individually and on a regular basis. As giant clam reproduction in the central tropics does not seem to show seasonality, and therefore a lack of generational cohorts, it would be hard to fit a discrete time model to the data with an age-structured model being more applicable. Clams form seasonal growth bands in their shells, and it is therefore possible to age sections of dead shells (Lucas, 1988). Although growth rates and sizes are species specific, individual taxonomic knowledge of the approximate clam length per age class could be used to estimate the age of clams during surveying. This would add an important element to future analyses as age ratios structuring a population could be determined with more flexible and applicable size limits being attributable to giant clam harvesting.

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Lucas, J.S. 1988. *Giant Clams: Description, Distribution and Life History*. (eds.) Copland, J.W. and J.S. Lucas. Giant Clams in Asia and the Pacific. Australian Centre for International Agricultural Research. A.C.T.

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Appendix 1

Table 1: Sites, location codes, and survey areas, of the Marine Resources Stock Assessment Survey for Giant Clams (1998-2000).

TORBA Province	*code*	Shepherds Islands, SHEFA Province	*code*
Gaua	G	Emae #1	E1
Vanua Lava #1	VL1	Emae #2	E2
Vanua Lava #2	VL2	Emae #3	E3
Vanua Lava #3	VL3	Emae #4	E4
Mota Lava #1	ML1	Emae #5	E5
Reef Island	R	Emae #6	E6
Ureparapara	U	Emae #7	E7
Malekula, MALAMPA Province	*code*	Mataso #1	Ms1
Malekula #1	M1	Mataso #2	Ms2
Malekula #2	M2	Makira	M
Malekula #3	M3	Buninga	B
Malekula #4	M4	TAFEA Province	*code*
Malekula #5	M5	Aneityum #1	A1
Malekula #6	M6	Aneityum #2	A2
Malekula #7	M7	Aneityum #3	A3
Malekula #8	M8	Aneityum #4	A4
Malekula #9	M9	Aneityum #5	A5
Malekula #10	M10	Aneityum #6	A6
Malekula #11	M11	Aneityum #7	A7
Malekula #12	M12	Aneityum #8	A8
Malekula #13	M13	Aneityum #9	A9
Malekula #14	M14	Tanna #1	T1
Malekula #15	M15	Tanna #2	T2
Malekula #16	M16		

Appendix 2

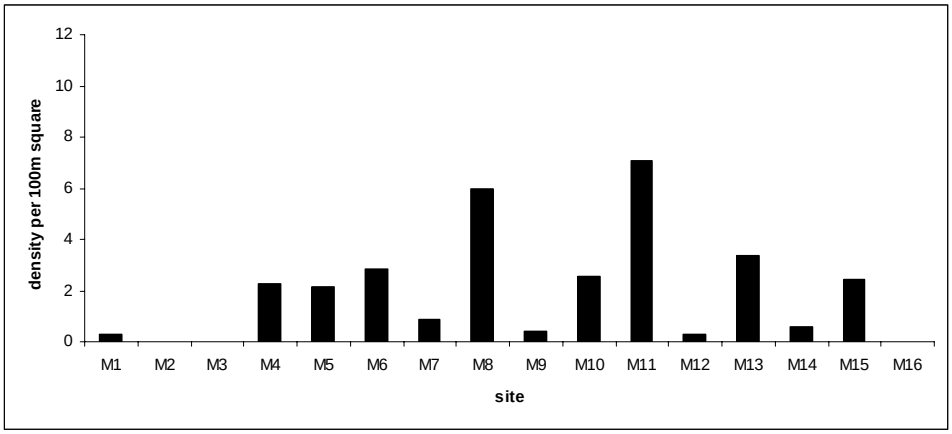

Figure 1: Total density of giant clams per 100m^2 in Malekula, MALAMPA Province, during the Marine Resources Stock Assessment Survey (1998-2000).

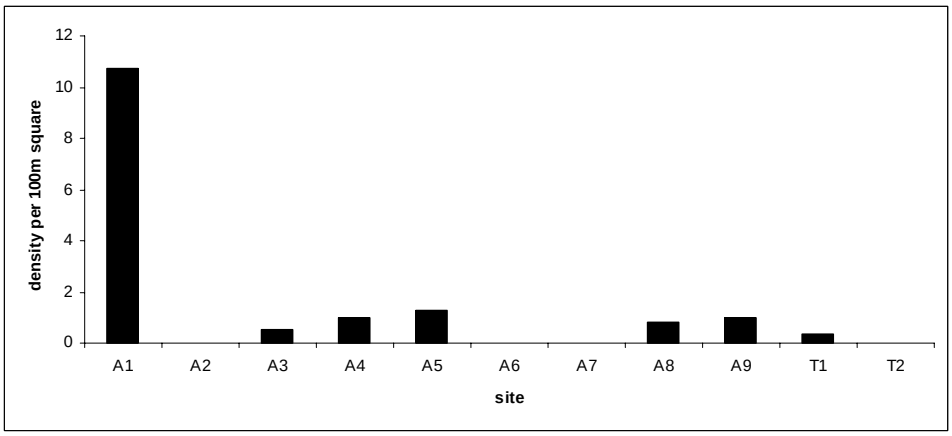

Figure 2: Total density of giant clams per 100m^2 in TAFEA Province during the Marine Resources Stock Assessment Survey (1998-2000).

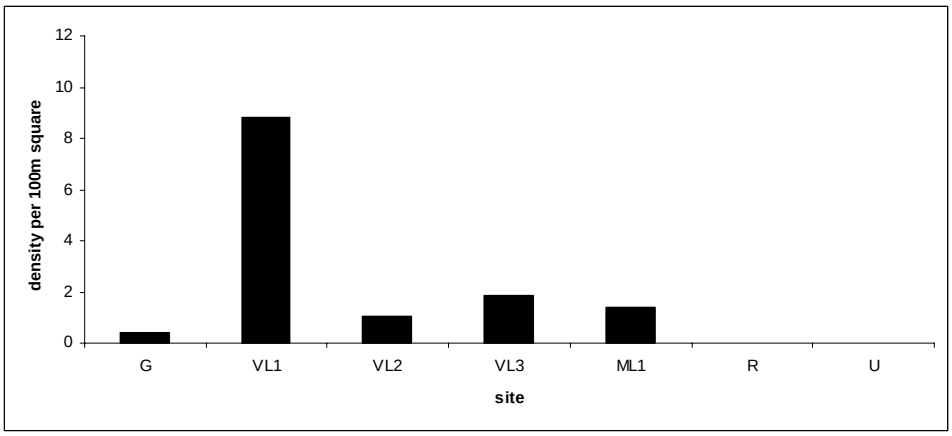

Figure 3: Total density of giant clams per 100m^2 in TORBA Province during the Marine Resources Stock Assessment Survey (1998-2000).

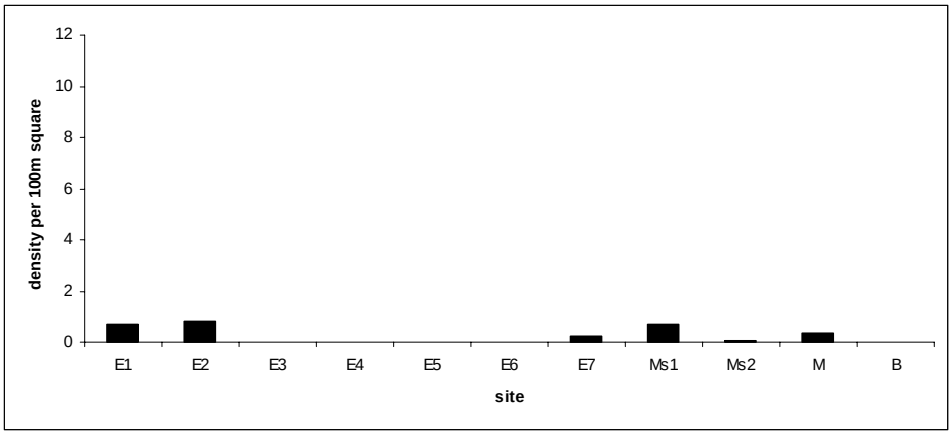

Figure 4: Total density of giant clams per 100m^2 in Shepherd Islands during the Marine Resources Stock Assessment Survey (1998-2000).

Appendix 3

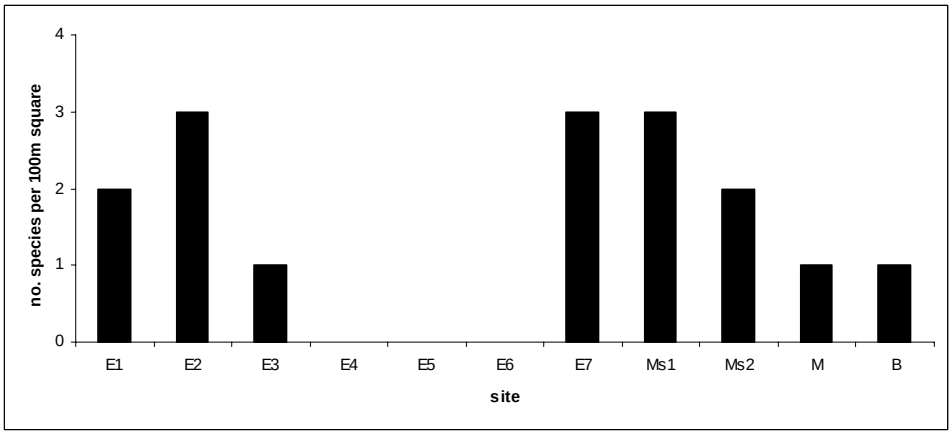

Figure 1. Total number of giant clam species at each site surveyed in the Shepherd Islands during the Marine Resources Stock Assessment Survey (1998-2000).

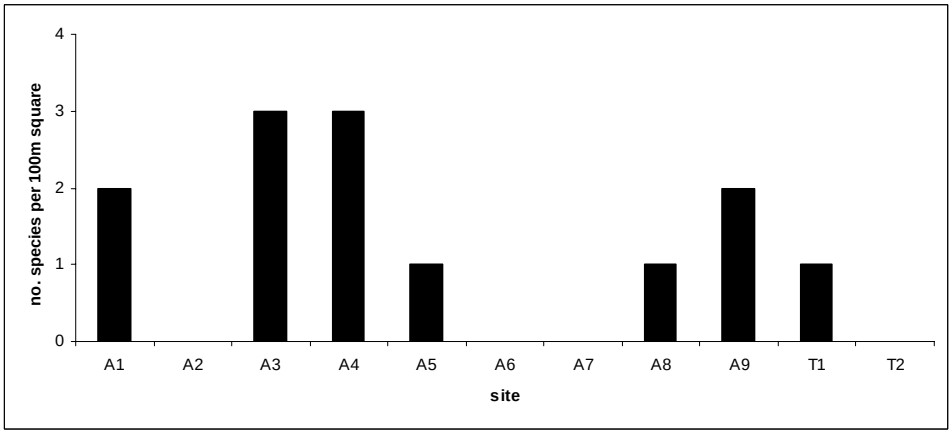

Figure 2: Total number of giant clam species at each site surveyed in the TAFEA Province during the Marine Resources Stock Assessment Survey (1998-2000).

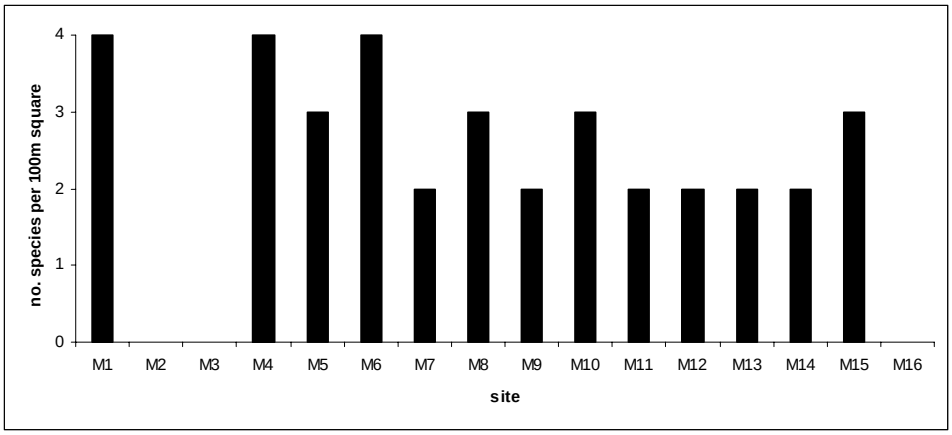

Figure 3: Total number of giant clam species at each site surveyed at Malekula, MALAMPA Province, during the Marine Resources Stock Assessment Survey (1998-2000).

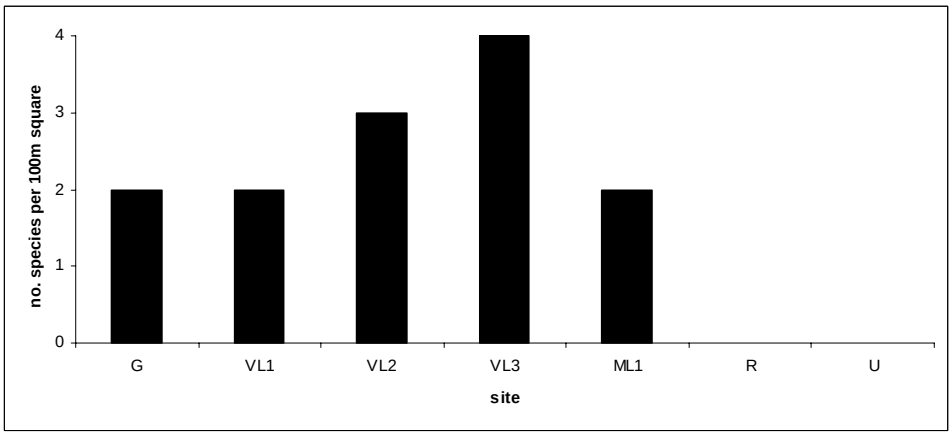

Figure 4: Total number of giant clam species at each site surveyed in the TORBA Province during the Marine Resources Stock Assessment Survey (1998-2000).

Appendix 4

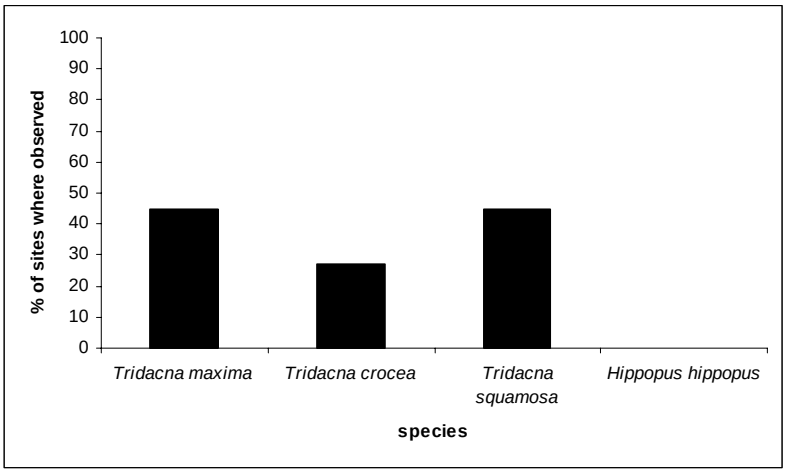

Figure 1: Percentage of sites occupied by each giant clam species in the TAFEA Province; surveyed during the Marine Resources Stock Assessment Survey (1998-2000).

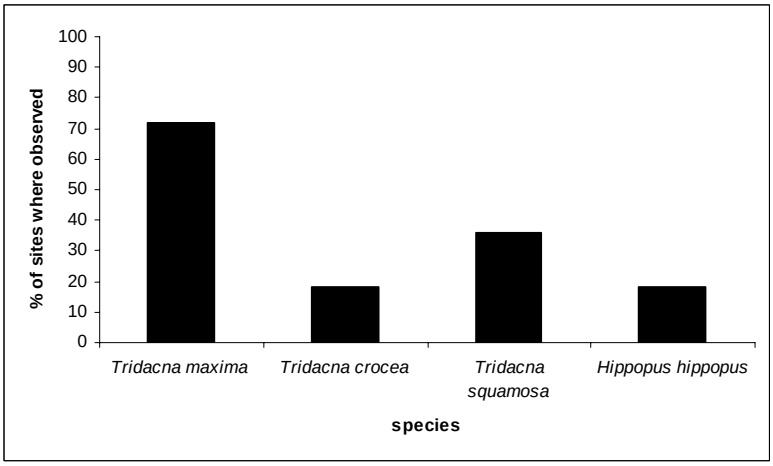

Figure 2: Percentage of sites occupied by each giant clam species in the Shepherd Islands; surveyed during the Marine Resources Stock Assessment Survey (1998-2000).

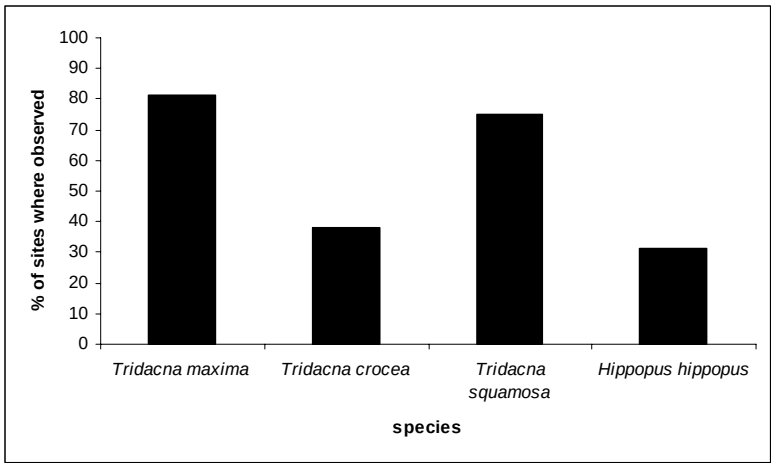

Figure 3: Percentage of sites occupied by each giant clam species in Malekula, MALAMPA Province; surveyed during the Marine Resources Stock Assessment Survey (1998-2000).

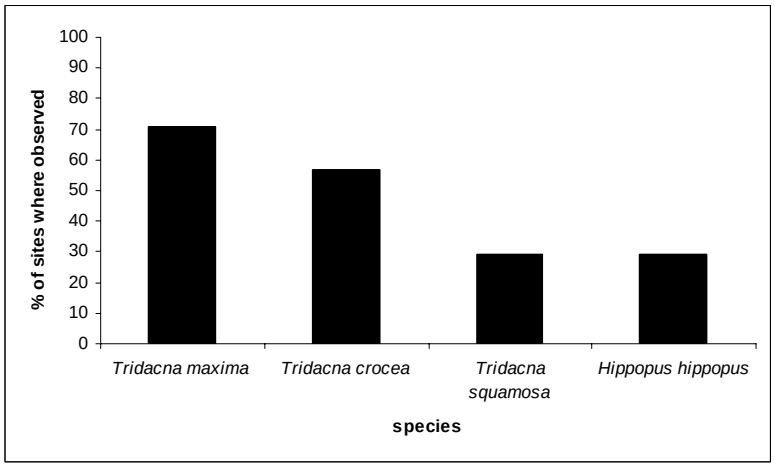

Figure 4: Percentage of sites occupied by each giant clam species in the TORBA Province; surveyed during the Marine Resources Stock Assessment Survey (1998-2000).

Appendix 5

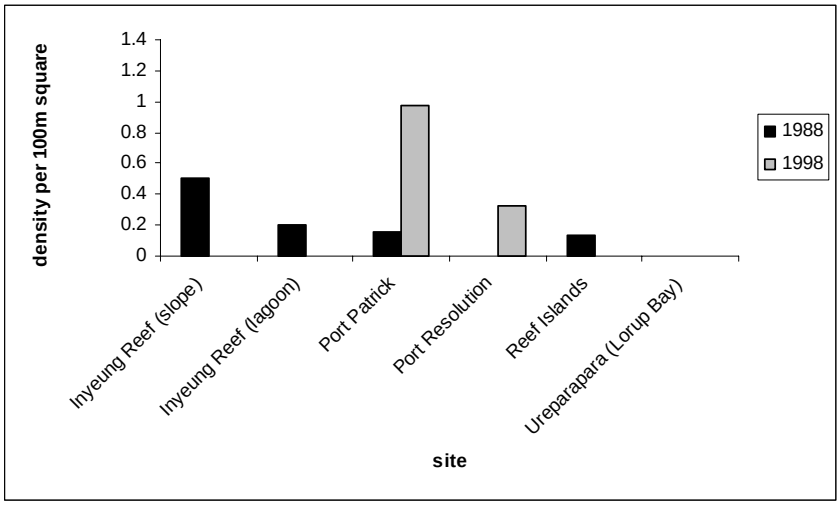

Figure 1: Total density per 100m^2 of *Tridacna maxima* during the Vanuatu Marine Resources Survey (AIMS, 1988) and the Marine Resources Stock Assessment Survey (1998-2000).

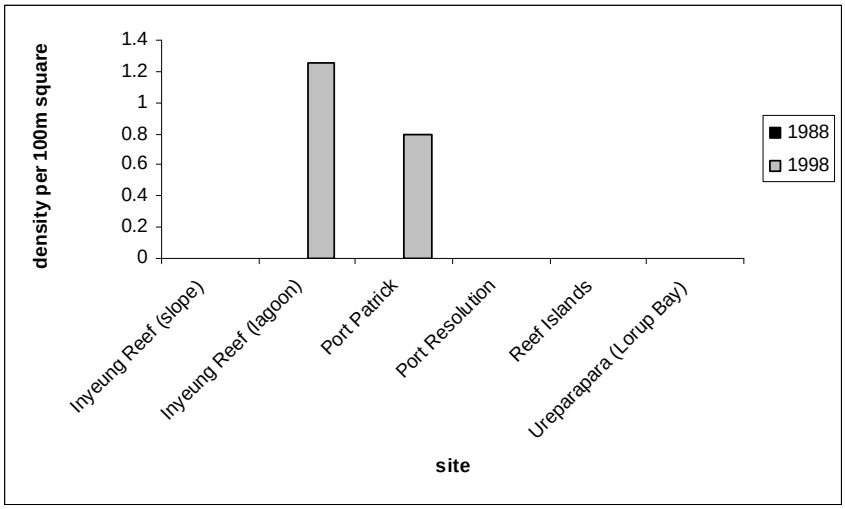

Figure 2: Total density per 100m^2 of *Tridacna squamosa* during the Vanuatu Marine Resources Survey (AIMS, 1988) and the Marine Resources Stock Assessment Survey (1998-2000).

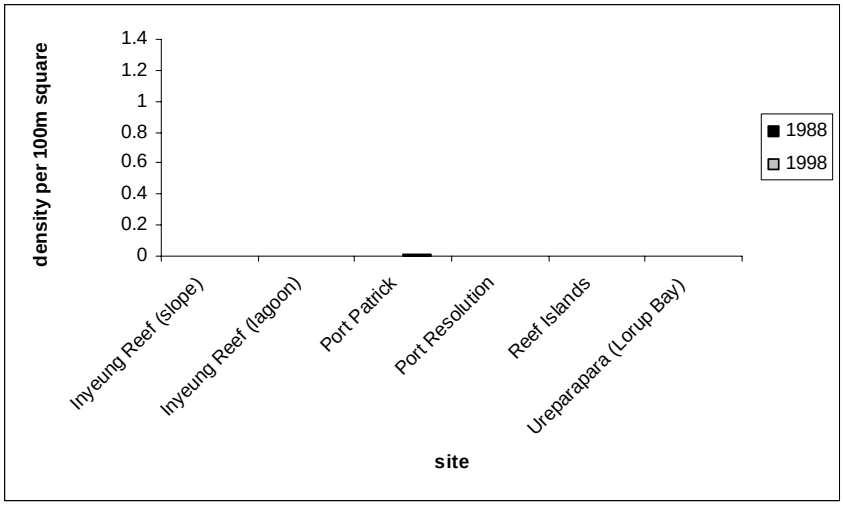

Figure 3: Total density per 100m² of *Tridacna crocea* during the Vanuatu Marine Resources Survey (AIMS, 1988) and the Marine Resources Stock Assessment Survey (1998-2000).

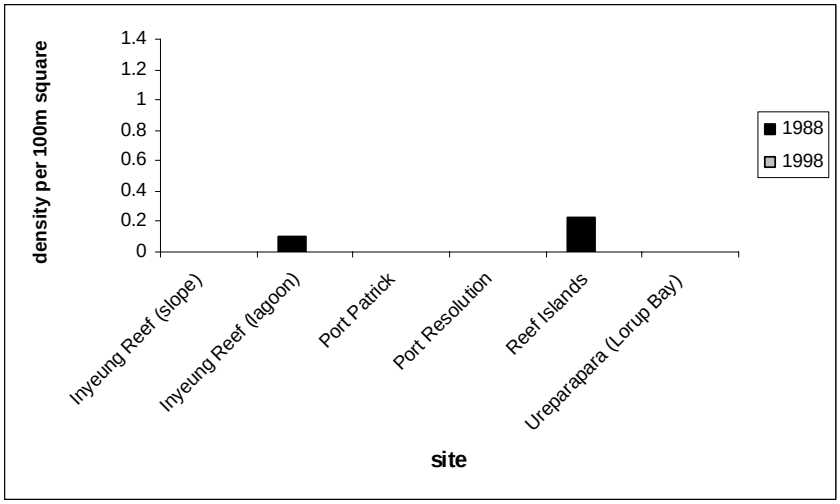

Figure 4: Total density per 100m² of *Hippopus hippopus* during the Vanuatu Marine Resources Survey (AIMS, 1988) and the Marine Resources Stock Assessment Survey (1998-2000).