Frontier Mozambique Environmental Research

REPORT 4

Southern Islands Group - Mefunvo, Quisiva and Quipaco Islands.

Marine Biological and Resource Use Surveys of the Quirimba Archipelago.

Frontier Mozambique
1998

Frontier Mozambique Environmental Research

Report 4

Southern Islands Group - Mefunvo, Quisiva and Quipaco Islands.

Marine Biological and Resource Use Surveys of the Quirimba Archipelago.

Heasman, M., António, C.M., Myers, M., Stanwell-Smith, D. and Whittington, M.W. (eds)

Ministry for the co-ordination of Environmental Affairs, Mozambique

Darwin Initiative: Department for Environment and Rural Affairs, UK.

Frontier-Mozambique Society for Environmental Exploration

Mozambique
1998

Suggested Technical Paper citation:

Frontier Mozambique (1998) Heasman, M., António, C.M., Myers, M., Stanwell-Smith, D. and Whittington, M.W. (eds) Southern Islands Group - Mefunvo, Quisiva and Quipaco Islands. Marine Biological and Resource Use Surveys of the Quirimba Archipelago. Frontier Mozambique Environmental Research Report 4. Society for Environmental Exploration, London and Ministry for the Co-ordination of Environmental Affairs, Maputo.

ISSN 1479-1196*
***** This supersedes the ISSN number printed in the report**

Frontier-Mozambique
Frontier-Mozambique was initiated in January 1996 when a Memorandum of Understanding was signed between The Society for Environmental Exploration and the Ministry for the Co-ordination of Environmental Affairs (Ministério para a Coordenação de Acção Ambiental), Mozambique. The aim of Frontier-Mozambique was to undertake field research within the Quirimba Archipelago, an area of recognised biological interest and conservation value.

The Ministry for the Co-ordination of Environmental Affairs
The Ministry is a Mozambican government organisation which co-ordinates the sustainable development process, harmonising the activities of different public and private sectors with environmental principles and practises and developing appropriate policies and legislation towards this end. The Ministry also trains the necessary technicians through executive activities and demonstrate models of good practise.

The Society for Environmental Exploration (SEE)
The Society is a non-profit making company limited by guarantee and was formed in 1989. The Society's objectives are to advance field research into environmental issues and implement practical projects contributing to the conservation of natural resources. Projects organised by The Society are joint initiatives developed in collaboration with national research agencies in co-operating countries.

FOR MORE INFORMATION

Ministry for Co-ordination of Environmental Affairs
P.O. Box 2020
Acordo Lusaka Avenue 2115
Maputo,
Mozambique
Tel : 258-68843/51
Fax: 258-4658 49

Society for Environmental Exploration
50-52 Rivington Street, London, EC2A 3QP. U.K.
Tel: +44 20 76 13 24 22
Fax: +44 20 76 13 29 92
E-mail: info@frontier.ac.uk
Internet: www.frontier.ac.uk

Darwin Initiative
Department for Environment, Food and Rural Affairs, 4/CI Ashdown House, 123 Victoria Street, London, SW1E 6DE
Tel: +44 (0) 20 7944 6205
Fax: (0) 20 7944 6239
Email: darwin@defra.gsi.gov.uk

ACKNOWLEDGEMENTS

Field support for this work was provided by the Darwin/Frontier-Moçambique Marine Research Programme, a joint initiative of the Ministry for the Coordination of Environmental Affairs, Mozambique and the Society for Environmental Exploration, UK. Financial support for the Programme was provided by the Darwin Initiative, (Department of the Environment, UK) and the Society for Environmental Exploration. The authors would like to acknowledge the considerable efforts of all personnel involved in the running of the Programme, in particular Eibleis Fanning, Cath Muir, Jason Rubens, Mike Brewin, Shaun Russell, Leigh Stubblefield and William Darwall; and the many volunteer research assistants and their sponsors, without whose efforts this work would not have been possible.

Special thanks to our Diving Officer Peter Gaunt, for his technical support.

The following organisations are acknowledged for their contributions to the Programme: National Directorate of Forestry and Wildlife, Mozambique (Direcção Nacional de Florestas e Fauna Bravia); Institute for Fisheries Research, Mozambique (Instituto de Investigação Pesqueira); Institute for the Development of Small-Scale Fisheries (Instituto de Desenvolvimento da Pesca de Pequena Escala); University of Eduardo Mondlane, Maputo, Mozambique; Tropical Marine Research Unit (TMRU), York University; in particular the Frontier-Moçambique Project Advisory Committee (FPAC) representatives.

Thanks are due to the members of the Frontier Tropical Research Advisory Committee (TRAC) for their invaluable support.

The Society are grateful to the British Airways Assisting Conservation Programme and British Petroleum, Mozambique.

Finally, special thanks are due to Joachim and Lieglinde Gessner for the use of their land upon which the Programme has based its field operation and for their tireless support, help and encouragement for the Programme's work.

CONTENTS

EXECUTIVE SUMMARY

The following report details the findings of the Darwin/Frontier-Moçambique Quirimba Archipelago Marine Research Programme's surveys of the Southern Islands Group (S.I.G.) - namely the islands of Mefunvo; Quisiva; and Quipaco. The surveys were completed between April 1996 and December 1997 by the Programme's staff, research assistants, visiting scientists from the UK and Mozambican participants. This report is one of a series which describe the status and distribution of habitats, floral and faunal biodiversity and the scale and nature of resource use activity within the marine environment of the archipelago. A detailed introduction and background to the work of the Programme, together with a full explanation of the methods employed during the field-based survey work, are presented in "Technical Report 1: Introductions and Methods".

The S.I.G. covers an area of approximately 150 km^2 close to the coastline of Cabo Delgado Province, northern Mozambique. It includes a variety of habitat types: large stands of mangrove (Mefunvo and Quipaco island); seagrass beds (in extensive meadows between the islands and the adjacent mainland), and; fringing and patch reefs around most of the more exposed sections of shoreline (Mefunvo and Quisiva islands). In addition, the islands are situated close to the edge of the continental shelf and the deep, oceanic water of the Mozambique Channel.

This high concentration of differing habitat types was found to support a correspondingly rich and abundant flora and fauna. In turn, many of the fish, invertebrate and mangrove tree species were observed to be exploited by the local population who were heavily dependent on the natural resources of the islands. The abundance of natural resources also attracts increasing numbers of migrant fishermen from mainland Cabo Delgado Province, Nampula Province to the south and Tanzania to the north. The resulting increase in resource extraction poses a threat to the sustainability of many of the S.I.G. resources.

The results of the biological and resource use surveys are discussed in terms of the flora and fauna of the islands, potential threats to the habitats and considerations for management.

1.0 INTRODUCTION

This Report presents the findings of the Darwin/Frontier-Moçambique Marine Research Programme's survey work on three islands within the Quirimba Archipelago off the coast of Cabo Delgado Province in northern Mozambique. These three islands of Mefunvo, Quisiva and Quipaco, have been collectively grouped and named as the 'Southern Islands Group' and will be abbreviated to S.I.G. throughout this report (Fig. 1.1). These surveys represent a part of a larger study which aims to include a number of other islands within the southern part of the archipelago. The surveys were completed between April 1996 and December 1997.

The purpose of these surveys was to provide sufficient information to enable a framework for a coastal zone management plan to be developed which will ensure sustainable development and resource use within the Quirimba Archipelago. Prior to this study, little information on the distribution and composition of the marine habitats, or the pattern and scale of resource exploitation within the Archipelago was known.

The rationale and methodology for all surveys are summarised in Section 2.0.

Figure 1.1 A map illustrating the position of the Southern Islands Group study area within the Quirimba Archipelago, northern Mozambique.

2.0 METHODS

2.1 Introduction

The methods employed are explained here in brief as full details can be obtained from an earlier report entitled: *Technical Report No. 1: Introduction and Methods*. Any more recent modifications to methods or newly adopted techniques are noted below.

All geographic data relevant to the islands was taken from the nautical charts *Direcção Principal de Navegação e Oceanografia do Ministério da Defésa de URSS. No. 46605-M and No. 46604-M. 1:50 000*. A full listing of island dimensions and co-ordinates is presented in Appendix A1.

2.2 Intertidal Surveys

The Quirimba Archipelago is subject to a tidal range in excess of 4m which, combined with the shallow topography on the western side (continental side) of many of the islands, has led to the formation of extensive intertidal areas. These areas are commonly colonised by a high abundance and diversity of flora and fauna. The intertidal serves an important role in both stabilising and protecting the shoreline and in the provision of a food source for a number of fish species which graze the area on the high tides. Seagrasses and macroalgae play important roles in both substratum stabilisation and as a food source for feeding fish and crustaceans. The intertidal surveys conducted concentrated primarily on these flora.

The lack of coastal development within the S.I.G. has left the seagrasses and macroalgae relatively undisturbed. However, with the potential for coastal developments increasing it is important to identify the current distribution and diversity of algae and seagrass to allow development planning to minimise any subsequent impacts. Likely impacts from coastal development include siltation, dredging and pollution. Natural threats include physical disruption from hurricanes/storms (occurring mainly during the 'wet season', November-April), and salinity changes due to increased fresh water input or long dry spells.

The Programme's intertidal surveys therefore aimed to assess the diversity of seagrasses and macroalgae, their distribution, community types, associated fauna and status in terms of impacts by human activity.

2.2.1 Intertidal Flats

The first level of survey produced an overview of the distributions of flora and fauna for the intertidal area of the island as a whole. The intertidal area was then split into 'Areas' based on major differences in habitat structure and composition. Quadrats were then surveyed along transects within each area to identify species composition and any zonation of species assemblages. The tabulated data presented below in the results represents the median count per survey quadrat completed and the range of counts made.

2.2.2 Mangroves

Mangroves traditionally play an important role in the lives of people inhabiting the coastal areas of Mozambique and extensive use of mangroves of all species was observed during the course of the Programme's surveys. However, mangroves also play an important role in the stabilisation of the shoreline and in the provision of a food source and nursery area for many fish and invertebrates. The Programme's mangrove surveys aimed to identify the distribution, diversity and structure of stands and to also assess the scale and impact of mangrove cutting.

The surveys were conducted along transects and within 5m x 5m quadrats with the aim of producing a relatively detailed picture of the structure and composition of mangrove stands within the survey area. Data gathered from the individual transects was combined and extrapolated to give estimates for the whole stand.

For each tree, the basic structural attributes of 'diameter at breast height' (dbh) and height were recorded. The dbh value was then converted into a value for the basal area, which is the cross-sectional area of the tree stem at the point where dbh was measured.

The basal area (g) was calculated using the formula:

$$g = \pi.r^2$$

However, as r = dbh/2 then the equation, $g = \pi/4\ (dbh^2)$, was used. As it was most useful to express the basal area in terms of m^2/hectare(ha) then for dbh values measured in centimetres:

$$g(m^2) = \pi.(dbh^2)/4(10{,}000) = 0.00007854.(dbh^2)$$

Due to the relatively small number of trees normally found within a 5m x 5m quadrat, the basal area was calculated for all the trees of a particular species and was not split into dbh size categories for each species.

The individual basal areas were added together for each species and a basal area for the stand as a whole was estimated. Basal area is a good indication of the development of the stand and can be related to wood volume and biomass, however, as no sample felling was conducted it was therefore not possible to make estimates of stand biomass.

The relative density and dominance (contribution to the stand's basal area) of each species was estimated in the following way for each zone within a stand:

Relative Density = (number of individuals of a species / total number of individuals of all species) x 100

Relative Dominance = (total basal area of a species / basal area of all species) x 100

Finally, mean diameter of the stand for each species was estimated using the following formula:

$$dbh = \sqrt{((BA)(12732.39)/n)}$$

where; 'dbh' is the diameter of the tree of mean basal area, 'BA' is the total stand basal area for the species and '*n*' is the stand density for the species.

2.3 Subtidal Surveys

Coral reefs, seagrass beds, bare sand and rubble platforms, and mud channels, are all features of the area for which there is very little information with regard to species diversity, community composition and distribution. Subtidal habitats are often overlooked when assessing potential impacts as they are difficult to survey. However, even if not visible from the surface, these habitats provide some of the most productive and diverse communities on earth and, as such, their importance to man as a resource is enormous.

Surveys aimed to determine the distribution and extent of habitats and the diversity of flora and fauna within them. In addition to surveying the dominant structural biota, such as corals and seagrass, the following three groups of animals were examined: 'Invertebrates', which were included both for their importance in shaping reefs and as a resource to the local islanders; 'Reef Fish', which are a conspicuous and important component of the reef system fauna and are known to be good indicators of the general health of the reef; and 'Commercial Fish', (those species normally targeted by fishermen) which are an obviously important resource for the islanders.

2.3.1 Subtidal Habitat Surveys

Habitat surveys involved the census of species and an estimation of habitat compositions along swum transects running horizontally along the reef at a series of depths. For each of the islands within the S.I.G., an overview is presented summarising the main features of the subtidal habitat based on the sites surveyed. 'Site reports' detail the results of the surveys, which may be split into Upper and Lower Reef zones, based on a description of 'Reef Structure', 'Substratum Composition' and 'Biotic Cover'. The results for each site are also tabulated for each depth level surveyed, with a mode and range given for each data element.

Data elements are presented in the form of the "P6" abundance scale, listed below:

Scale	%
0	0
P	<1
1	2-5
2	6-25
3	26-50
4	51-75
5	76-90
6	91-100

2.3.2 Invertebrates and Impacts Surveys

The results of the surveys of the invertebrates and the natural/human impacts at each site are presented together, despite their obvious differences, for two reasons. Firstly, the levels of impact at all sites within the S.I.G. were very low and do not warrant a separate results section; and secondly, there are links between the two groups of data elements with the Crown of Thorns starfish (*Acanthaster plancii*) and the scar groups it produces during feeding activity.

An overview is presented summarising the main features of sites surveyed. Site reports detail the results of the surveys. The data show the mean count per 5 minutes (accurate to 1 d.p.) surveying completed and the range of counts made. A description outlining the main features of the data elements is also presented.

2.3.3 Reef Fish Census

An overview is presented summarising the main features of sites surveyed and includes a table of relative species richness indices (RSRi), (Note: these values are equivalent to the misnamed relative diversity indices of Technical Report 3), Shannon-Weaver diversity indices (SWi) and total species number for each site.

The Relative Species Richness indices (RSRi) were calculated for each site using the following formula:

$$RSRi = \frac{\text{No. of Reef Fish Species Observed}}{\text{Total No. of Reef Fish Species on Census List}}$$

A site report is given for each site surveyed, describing the major features of the reef fish population together with graphs summarising the diversity and abundance of reef fish at the family level. Due to the similarity between the family Acanthuridae (Surgeonfish) and Zanclidae, the Moorish Idol (*Zanclus cornutus*) was included in the former group. All the species included in the species survey list are given in Appendix A3 (adapted from Technical Report 1, Introduction and Methods). All species were used in the analysis except the Napoleon Wrasse (*Cheilinus undulatus*). This was the only fish of the

family Labridae surveyed and its inclusion in the surveys was due to its popularity in many dive resorts in the Tropics. Therefore, where it was observed, a note is made in the appropriate results section.

2.3.4 Commercial Fish Census

The commercial fish surveys were aimed at indirectly estimating levels of fishing pressure and fishing potential throughout the S.I.G. through an assessment of the commercial fish populations.

Although species-level identifications were made the results presented in this report concentrate on analysis at the family level e.g. Lethrinids; Lutjanids; Scarids; Siganids; Serranids; Haemulids and Carangids to avoid problems of mis-identification. A description is given of the commercial fish observed at each site and reference may be made to the presence and abundance of dominant species within a catch.

A few sites were dominated by a variety of seagrass species. Commercial fish (and the reef fish species normally censused during the reef fish survey) were found to be relatively scarce at these sites, the fish assemblages being dominated by species not normally surveyed by the Programme. Individual reports are made for these sites.

Abundance
Graphical presentations are given for the 'frequency of encounter' (numbers of sample intervals during which the species was seen: a measure of the species ubiquitousness over the site) and the composition of commercial fish families observed. These are presented for each site and where applicable for different depth ranges at a single site.

Size distributions
Due to the relatively small number of fish recorded for a particular species at any site, it was necessary to pool the data to attain a worthwhile sample size. Length distributions were combined for all species within each commercial fish family and for all the sites from each of the islands. Median estimated lengths and length ranges are presented for each commercial fish family for each island.

2.4 Resource Use Surveys

The islanders of the S.I.G., and the Quirimba Archipelago as a whole, are heavily dependent on the exploitation of natural resources for food, building materials and goods for trade. Additionally, the resources of the islands are exploited extensively by fishermen from both Nampula Province to the south and from Tanzania to the north during the 'dry season' (April-November). This exploitation can have a significant impact on the marine habitats and the Programme's surveys were targeted at assessing the type, scale and impact on the environment of these activities within the S.I.G.

The surveys were split into two broad areas, studying; first, the exploitation of finfish, and second, the exploitation of non finfish (primarily Mollusca and Holothuria). Assessment of mangrove cutting was carried out during the surveys of intertidal habitats.

2.4.1 Finfish Fisheries

The Programme's Finfish Resource Surveys aimed to determine the scales and patterns of the fishing methods for each of the islands of the S.I.G. With the exception of the Quirimba island (see Technical Report 5: The Seagrass Fishery of Quirimba Island), all the island summaries presented in this report were based on a short observation visit or a number of such visits and therefore only serve as a relatively limited 'snapshot' of the fishing activity and are not necessarily representative of the long-term patterns in fishing activity. To gain more information about the long-term situation informal interviews were conducted with local residents and local fishermen on all the islands studied. Results are presented as a simple description and a summary table where applicable.

2.4.2 Other Resource Collection

The results of surveys are split into three sections, based on: overall patterns of resource exploitation; resource exploitation within different intertidal zones; and resource exploitation in the subtidal areas. Within the first two sections, the results are analysed in terms of; gender, group activity and origin of collectors, collection methods and the catch composition. Appendix A5 gives an indication of the monetary value of each resource at the time of this study and Appendix A6 lists the common names of each of the resources exploited.

3.0 MEFUNVO ISLAND

3.1 Introduction

Mefunvo (12°33'00"S 40°36'00"E) is the largest island (4.3km by 3.1km) in the S.I.G. and lies to the south of the Montepuez Channel, separated from the mainland by a narrow waterway which can be crossed by foot at low water on Spring tides. The island supports a population of approximately 2000 people, the majority of which live in the large village at the north end of the island. There is no freshwater on the island.

Within the village is a fish freezing and processing plant (owned and operated by "Willaw" company) which represents the only active commercial fishing operation in the southern Quirimbas. During the time of the Programme's work (April 1996 - December 1997) the operation has changed from the commercial longlining for sharks (for the export of sharkfin to the Far East) to the purchasing of lobster and prawns from local gatherers (primarily for the South African market).

The majority of Mefunvo is covered in deciduous woodland interspersed with grassland and, in the more rocky areas, scrub bush. Along the western shore is a large stand of mangrove.

3.2 Intertidal Surveys

3.2.1 Overview

The extensive intertidal zone comprised an estimated 12.6km^2 of exposed flat. The sheltered western area supported a small mangrove stand with exposed flat. The outstanding feature of this intertidal was the predominance of macroalgae assemblages and seagrass beds at two distinct shore levels. Macroalgae dominated the midshore and seagrasses were conspicuous at the lower shore level. The exception was the western area which consisted predominantly of sand with a few patches of seagrasses. A total of 7 seagrass species (the highest site diversity within the S.I.G.), 104 species of macroalgae and 20 species of invertebrates were recorded for Mefunvo. The macroalgae included 1 Cyanophyta (Blue-green algae), 37 Chlorophyta (Green algae), 18 Phaeophyta (Brown algae) and 48 Rhodophyta (Red algae). This species richness makes Mefunvo the site of the highest algal diversity within the S.I.G. The flora was dominated by red algae representing 46% of the total number of species identified for Mefunvo. A full checklist for recorded taxa is presented in Appendix A2.

3.2.2 Area Reports

Four transects were surveyed and their locations are shown in Fig 3.1. A greater similarity in zonation pattern was found between areas from the same side of the island than for areas from different sides. This suggests that the island had two distinct intertidal zonation patterns. One covers the eastern shore and is dominated by

macroalgae assemblages (at midshore) together with dense seagrass beds (at lower shore), and the other covers the western shore and is made up of sand and scattered seagrass beds.

'North West Area'

A cross-sectional profile of a typical transect is shown in Figure 3.2. Three zones were identified on the basis of substratum composition (Table 3.1) and community structure (Tables 3.2, 3.3) of seagrass, macroalgae and invertebrates. Four seagrass species, 12 macroalgae species and 7 species of invertebrates were recorded.

Table 3.1 Percentage cover of substratum types along a typical transect within the 'North West Area' (P<1%). Median values and ranges (in brackets) are presented.

Substratum	Zone 2	Zone 3
Sand	0 (0-84)	100 (0-100)
Rock	100 (40-100)	20 (0-70)

Zone 1 was rocky beach without a conspicuous biota. Zone 2 was coral rag co-dominated by the seagrass *Thalassia hemprichii* with the macroalga *Laurencia papillosa.* Zone 3 was predominantly sand on which *Thalassia hemprichii* dominated with cover varying from 2 to 70%.

Table 3.2 Percentage cover of seagrass and macroalgae along a typical transect within the 'North West area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Taxonomic group	Zone 2	Zone 3
Seagrass		
Halodule wrightii	0	0 (0-1)
Halophila ovalis	0	0-P
Syringodium isoetifolium	0	0 (0-4)
Thalassia hemprichii	0 (0-34)	P (0-70)
Macroalgae		
Acanthophora muscoides	0-P	0-P
Cistoseira myrica	0 (0-1)	0
Cladophora mauritiana	0-P	0
Gelidiella acerosa	0	0 (0-40)
Hydroclathrus clathratus	0-P	0-P
Hypnea cornuta	0	0-P
Hypnea musciformis	0 (0-4)	0
Laurencia papillosa	3 (0-30)	0
Padina gymnospora	0	0-P
Turbinaria conoides	0	0-P
Ulva reticulata	0	0 (0-3)
Wurdemannia miniata	0	0 (0-2)

Table 3.3 Abundance (individuals/m^2, n=10) of invertebrate taxa along a typical transect within the 'North West Area'.

Taxonomic group	Zone 2	Zone 3
Gastropods		
Bulla sp.	0 (0-2)	0 (0-2)
Cypraea moneta	0 (0-1)	0
C. annulus	1.6	0 (0-1)
Morula granulata	0 (0-1)	0 (0-1)
Nassarius coronatus	0	0
Strombus gibberulus	0	0 (0-1)
Bivalve		
Pinna muricata	0	0 (0-16)

'North East Area'

Five distinct zones were identified (Fig. 3.3) within which 1 seagrass species, 39 species of macroalgae and 6 invertebrate species were recorded. The representation of substratum types within each zone are summarised in Table 3.4. The distribution of taxa across zones is presented in Tables 3.5 and 3.6.

Table 3.4 Percentage cover of substratum along a typical transect within the 'North East Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Substratum	Zone 1	Zone 2	Zone 3	Zone 5
Sand	0	0	6 (0-50)	1 (0-10)
Rubble	0	0	16 (0-100)	0
Rock	100	100	96 (0-100)	95 (0-100)

Zone 1, closest to the cliff, was rocky and dominated by the macroalgae *Ulva pulchra* (with 0-45% cover) while *Cypraea annulus* (with mean density of 4.8 individuals/m^2) was the most common invertebrate. At approximately 160 m from the cliff there was a very shallow lagoon (Zone 2) within which *Cystoseira myrica* and *Ulva pertusa* were relatively abundant. The most abundant invertebrate within this zone was the sea-urchin *Echinometra mathaei* (with mean density of 11.2 individuals/m^2). Zone 3 supported the highest algal diversity of all the zones but with low cover (less than 20% for a single species) and also had a low density of invertebrates. The most abundant macroalga was *Ulva reticulata* with cover varying from 0 to 76%. Zone 4, 463 m from the cliff, constituted a reef lagoon approximately 1.0 m deep and consequently was not sampled. However, a qualitative assessment revealed that in deep areas the lagoon was composed of bommies and soft corals whilst the shallower and exposed areas were luxuriantly colonised by the seagrass *Thalassodendron ciliatum*. Zone 5, the seaward and rubble zone, featured a consistently high cover of *Thalassodendron ciliatum* (0-90%).

Table 3.5 Percentage cover of seagrass and macroalgae along a typical transect within the 'North East Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Taxonomic group	Zone 1	Zone 2	Zone 3	Zone 5
Seagrass				
Thalassodendron ciliatum	0	0	0	57.5 (0-90)
Macroalgae				
Amphiroa sp.	0	0	0	0-P
Chamaedoris delphinii	0	0	0	0-P
Chondria dasyphylla	0	0	0-P	0
Cistoseira myrica	4 (0-8)	12 (0-30)	0 (0-16)	0
C. trinodis	0	0 (0-4)	0	0
Cladophora mauritiana	0	0-P	0	0
Dictyosphaeria cavernosa	0 (0-4)	4 (0-30)	0	0
Dictyota adnata	0	0	0	0-P
D. divaricata	0	0	0	0-P
Endosiphonia clavigera	0	0	0 (0-1)	0
Eucheuma dendiculatum	0	0	1 (0-8)	0
Galaxaura fasciculata	0	0	0 (0-2)	0
Gelidiella acerosa	1 (0-6)	0 (0-8)	0 (0-10)	0
Gracilaria fergusoni	0	0	0-P	0
Gracilaria sp.	0	0	0 (0-1)	0
Halimeda opuntia	0 (0-2)	1 (0-10)	1 (0-4)	0 (0-4)
Hydroclathrus clathratus	P (0-2)	0 (0-2)	1 (0-12)	0
Hypnea nidulans	0	0	3 (0-16)	0
H. pannosa	0	0	0	0-P
Jania adhaerens	2 (0-20)	0	0	0 (0-4)
Laurencia columellaris	0 (0-4)	0-P	0	0
L. complanata	0	0	0	0-P
L. papillosa	0	0-P	2 (0-8)	0
Lyngbya majuscula	4 (0-10)	0	0	0
Padina boryana	0	0	0 (0-2)	0
P. tetrastomatica?	0	0	0 (0-4)	0
Poritiera harvey	0	0	0	0-P
Sarconema filiformis	0	0	0-P	0
Sargassum aquifolium	0	1 (0-8)	0	0
S. binderi	0 (0-4)	0-P	0-P	0-P
S. duplicatum	0	0	0	0-P
S. swartz?	0	0-P	0	0
Turbinaria conoides	1 (0-8)	0 (0-1)	0	0
Udotea indica	0	0-P	0-P	0
Ulva pertusa	0	5 (0-20)	0 (0-20)	10 (0-30)
U. pulchra	1 (0-45)	0 (0-1)	0 (0-30)	0
U. reticulata	0	0 (0-35)	15 (0-76)	0-P
Valonia fastigiata	0	0 (0-4)	0	0
Vanvoorstia spectabilis	0	0	0-P	0

Table 3.6 Abundance (individuals/m^2, n=10) of invertebrate taxa along a typical transect within the 'North East Area'.

Taxonomic group	Zone 1	Zone 2	Zone 3	Zone 5
Gastropods				
Cypraea annulus	0 (0-5)	0 (0-6)	0	0
C. moneta	0	0 (0-1)	0	0
C. tigris	0	0 (0-1)	0	0
Strombus gibberulus	0	0 (0-1)	0 (0-1)	0
Thais savignyi	0	0 (0-1)	0	0
Echinoderms				
Echinometra mathaei	0	5 (0-25)	0	0

'South East Area'

Six distinct zones were identified (Fig. 3.4). The representation of substratum types in each zone are summarised in Table 3.7. Within these zones a total of 2 seagrass species, 30 species of macroalgae (Table 3.8) and 10 invertebrate species (Table 3.9) were recorded.

Table 3.7 Percentage cover of substratum along a typical transect within the 'South East Area'. (P<1%). Median values and ranges (in brackets) are presented.

Substratum	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Sand	2 (0-10)	1 (0-10)	11 (0-90)	11 (0-60)	18 (0-92)
Rubble	0	1 (0-10)	0	12.5 (0-90)	29 (0-100)
Rock	100 (0-100)	100 (80-100)	100 (2-100)	49 (0-100)	53 (0-90)

The reef platform sloped from the cliff towards the sea and included two shallow lagoons (at approximately 120m and 510m from the cliff). Zone 1, closest to the cliff, was a narrow bare sand beach. Zone 2 was rocky and colonised predominantly by *Ulva pulchra* (0-100% cover) and *Laurencia papillosa* (0-30% cover). Zone 3 included a lagoon where *L. papillosa* and *U. reticulata* dominated. The reef crest (Zone 4) was exposed and supported low algal diversity and cover (<10% cover).

The lower part of the reef crest bordered another lagoon (Zone 5) within which *Thalassodendron ciliatum* dominated (0-80%) especially in exposed areas. The lower shore (Zone 6) was also dominated by *T. ciliatum* and *Ulva reticulata.*

Table 3.8 Percentage cover of seagrass and macroalgae along a typical transect within the 'South East Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Taxonomic group	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Seagrass					
Thalassia hemprichii	0	0	0	1 (0-4)	2.0 (0-20)
Thalassodendron ciliatum	0	0	0	10 (0-80)	5 (0-30)
Macroalgae					
Chamaedoris delphinii	0	0	0	0	0-P
Cistoseira myrica	0 (0-2)	0 (0-1)	0	0	0
Dictyopteris delicatula	0	0	0	0	0 (0-2)
Dictyosphaeria cavernosa	4 (0-16)	0 (0-4)	1 (0-2)	0 (0-2)	0 (0-6)
Gelidiella acerosa	0	0-P	0	0-P	0
Halimeda opuntia	1 (0-10)	0-P	0-P	0	0 (0-2)
H. tuna	0	0	0	0	0-P
Hormophysa triquetra	0	0	0	0	0 (0-2)
Hydroclathrus clathratus	0	0	0 (0-1)	0-P	0
Hypnea hamulosa	0	0	0-P	0	0
Jania adhaerens	0	0(0-4)	0 (0-16)	0	0
Laurencia complanata	0	0	0	0	0-P
L. papillosa	8 (0-30)	4 (0-30)	2 (0-12)	0	0
L. sp.	0	0	0 (0-1)	0	0
Liagora ceranoides	0	0	0	0-P	0-P
Lyngbya majuscula	0	0	1.0	0	0
Padina boryana	0	0	0	0 (0-6)	0
P. tetrastomatica	0	0	0 (0-12)	0	0
Poritiera harvey	0	0	0	0	0-P
Sargassum aquifolium	0 (0-2)	2 (0-10)	0	0	0
S. asperifolium	0	0 (0-1)	0	0	0
S. duplicatum	0	0	0	0-P	3 (0-8)
Turbinaria conoides	0	0	0	0-P	0
T. ornata	0 (0-1)	0	0	0-P	0
Udotea indica	0	0-P	0-P	0	0
Ulva pertusa	3 (0-16)	0 (0-2)	2 (0-16)	0-P	0 (0-1)
U. pulchra	26 (0-100)	0	0	0	2 (0-20)
U. reticulata	0 (0-6)	2 (0-10)	1 (0-6)	8 (0-30)	13 (0-30)
Valonia fastigiata	0 (0-2)	0	0-P	0	0
Vanvoorstia spectabilis	0 (0-1)	0	0 (0-1)	0 (0-1)	0

Table 3.9 Abundance (individuals/m^2, n=10) of invertebrate taxa along a typical transect within the 'South East Area'.

Taxonomic group	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Gastropod					
Cerithium nodolosum	0 (0-7)	0 (0-3)	0 (0-8)	0	0
Conus sp.	0	0 (0-3)	0 (0-3)	0	0
Cypraea annulus	0	0 (0-7)	0	0	0
C. moneta	0	0	0 (0-1)	0	0
Cypraea sp.	0	0 (0-1)	0 (0-1)	0	0
Lambis chiragra	0	0	0	0	0 (0-1)
Mancinella alouina	0 (0-1)	0	0 (0-1)	0	0
Morula granulata	0	0	0 (0-1)	0	0
Strombus mutabilis	0	0	0 (0-1)	0	0
Thais savignyi	0	0	0 (0-20)	0	0
Bivalve					
Perna cf. *perna*	0	0 0 (0-3)	0 (0-20)	0	0
Echinoderm					
Echinometra mathaei	0	2.5 (0-7)	0 (0-1)	0	0 (0-4)

'South West Area'

A total of 2 seagrass species, 9 species of macroalgae and 4 invertebrate species were recorded from the four zones identified (Fig. 3.5) along the transect. Substratum types within each zone are summarised in Table 3.10. The distribution of taxa across zones is presented in Tables 3.11 and 3.12.

Table 3.10 Percentage cover of substratum along a typical transect within the South West area (P<1%). Median values and ranges (in brackets) are presented.

Substratum	Zone 2	Zone 3	Zone 4
Sand	40 (0-100)	5 (0-95)	100
Rock	100 (0-100)	100 (10-100)	0

Zone 1 was a bare sand beach. Zone 2 was predominantly rocky platform colonised mainly by the macroalgae *Valonia aegagrophila* (0-50% cover) and *Ulva reticulata* (0-30% cover). Zone 3 consisted of sand substratum on which the seagrass *Thalassia hemprichii* dominated (0-25% cover) together with the algae *Laurencia papillosa* (0-75%). The most abundant invertebrate within this zone was *Cypraea annulus* (18 individuals/m^2). Zone 4, bordering onto the MLWS, consisted of sand with small patches of *Thalassia hemprichii*.

Table 3.11 Percentage cover of seagrass and macroalgae along a typical transect within the 'South West Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Taxonomic group	Zone 2	Zone 3	Zone 4
Seagrass			
Cymodocea rotundata	0	0	3 (0-20)
Thalassia hemprichii	0	10 (0-25)	7 (0-30)
Macroalgae			
Cladophora mauritiana	0 (0-2)	4 (0-20)	0 (0-2)
Gelidiella myrioclada	2 (0-20)	0-P	0
Hydroclathrus clathratus	0-P	0	0
Laurencia papillosa	4.5 (0-25)	10 (0-75)	0
Turbinaria ornata	0-P	0	0
Ulva lactuca	0 (0-2)	0	0
U. reticulata	6 (0-30)	0	0
Valonia aegagrophila	10 (0-50)	0-P	0-P
Wurdemannia miniata	0	0 (0-4)	0

Table 3.12 Abundance (individuals/m^2, n=10) of invertebrate taxa along a typical transect within the 'South West Area'.

Taxonomic group	Zone 2	Zone 3	Zone 4
Gastropods			
Conus sp.	0	0.8	0
Cypraea annulus	0	18	0
C. tigris	0	0	0.4
Thais sp.	0.4	0	0
Bivalve			
Modiolus sp.	0	1.2	0
Pinna muricata	0	0	0.4

Figure 3.1 Location of intertidal transects on Mefunvo Island

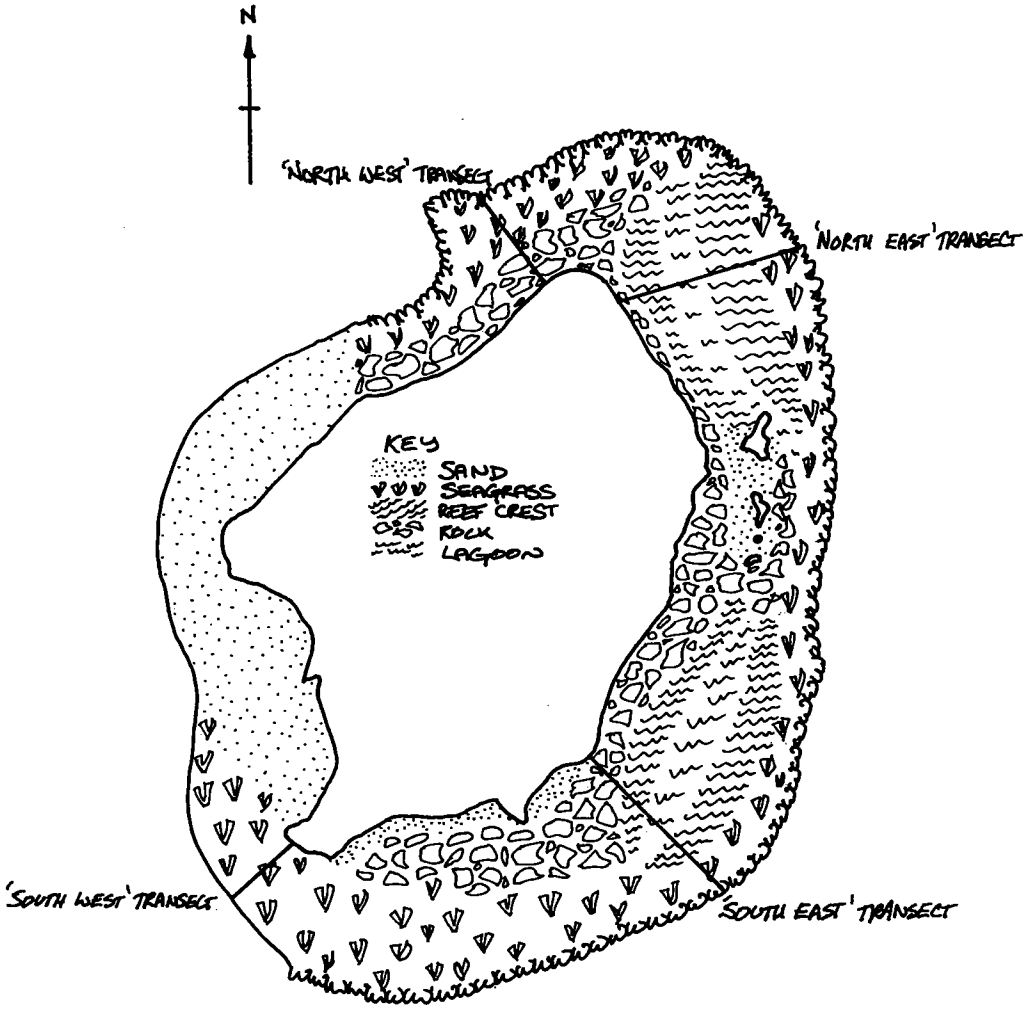


Figure 3.2 Intertidal transect: north-west Mefunvo Island

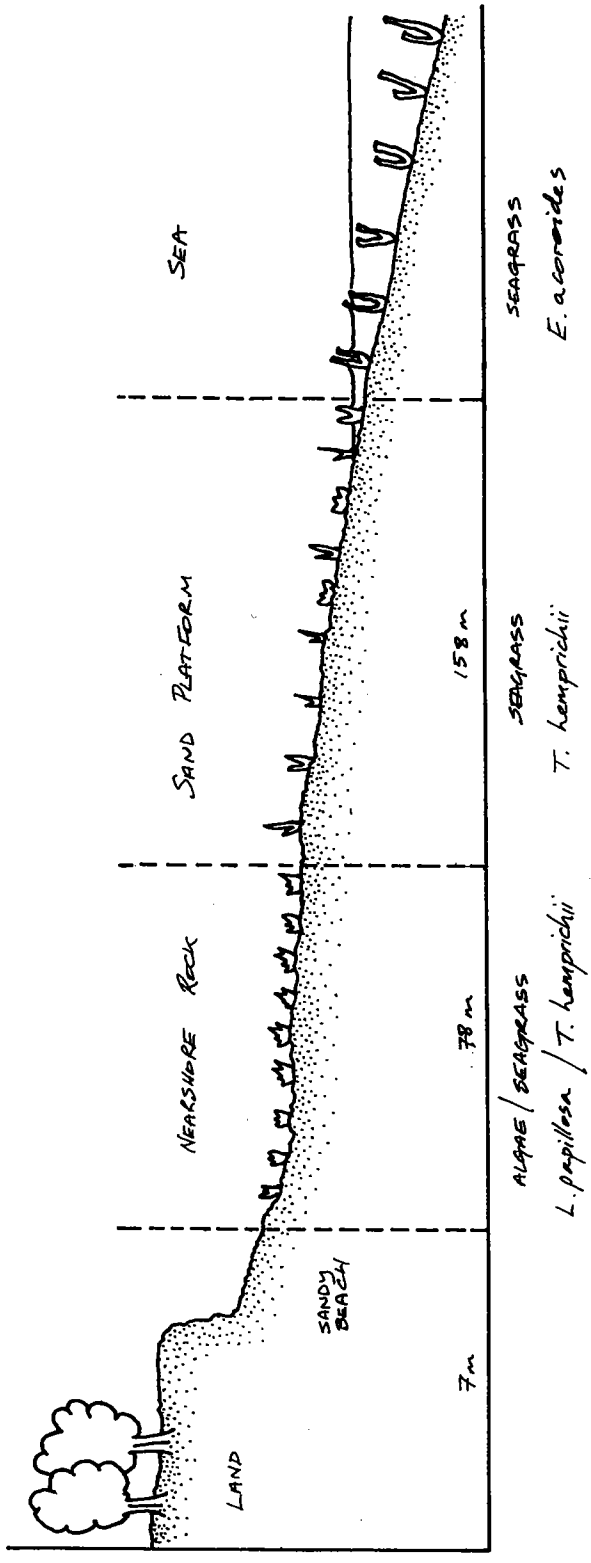


Figure 3.3 Intertidal transect: north-east Mefunvo Island

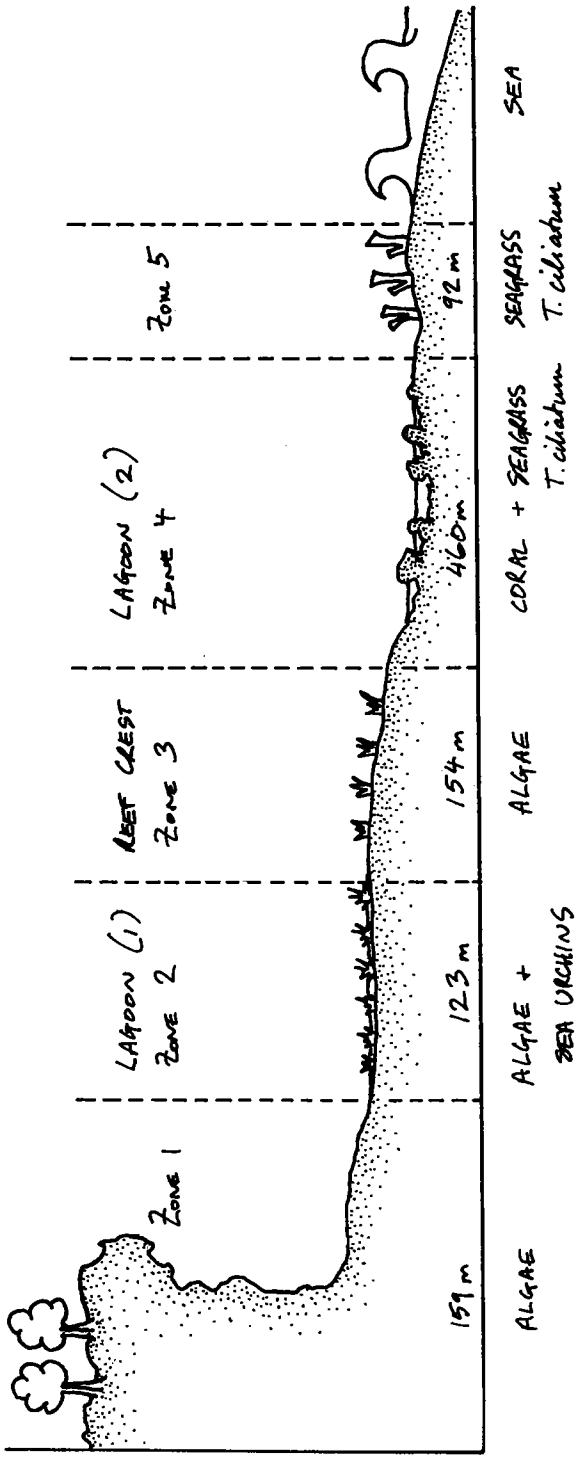


Figure 3.4 Intertidal transect: south-east Mefunvo Island

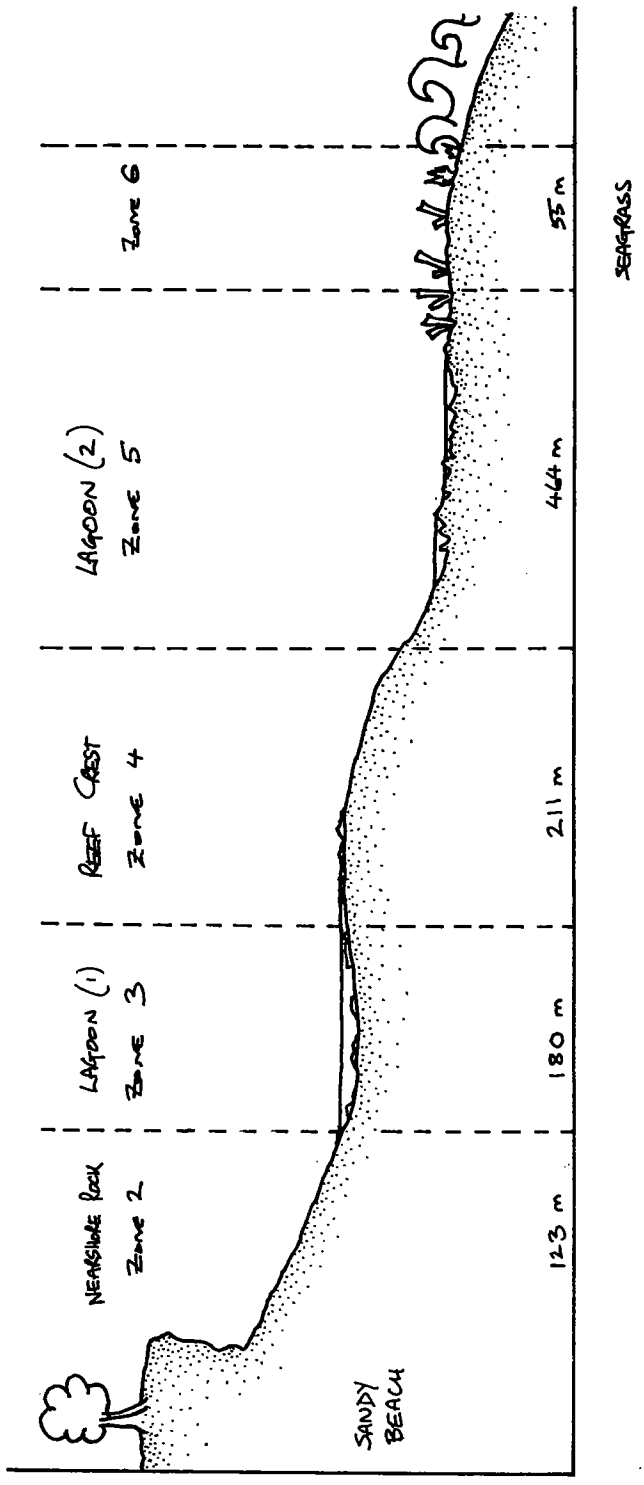
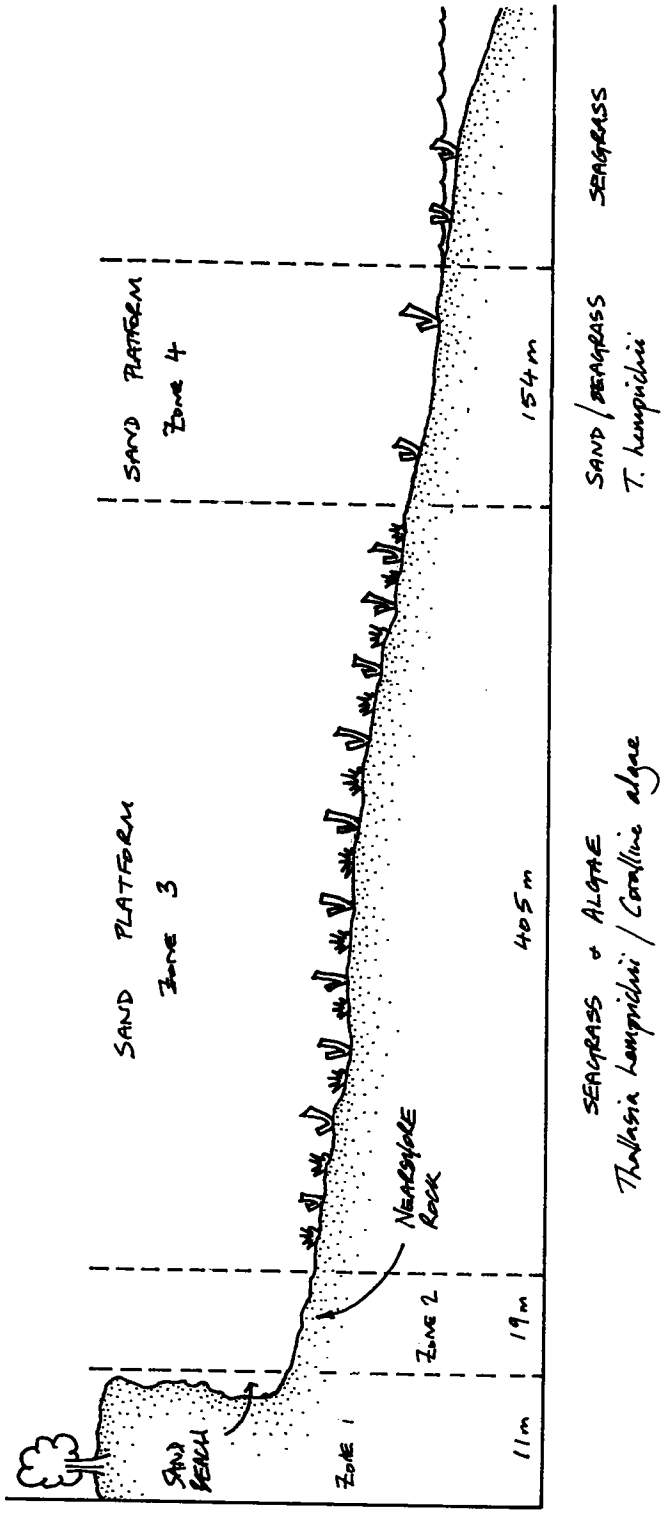


Figure 3.5 Intertidal transect: south-west Mefunvo Island



3.3 Mangrove Surveys

3.3.1 Overview

Mefunvo supports a single substantial stand of mangrove which stretches along the western shore of the island, becoming wider to towards its southern end (Figure 3.6). To the south the mangrove is drained via a series of creeks which run roughly perpendicular to the shoreline. Along the narrower band of mangrove to the north, rock outcrops intersect the stand. On the landward side of the stand a coral rag wall (<3m high) forms the boundary. Zonation of mangrove tree species was present although *Rhizophora mucronata* was common throughout the stand. Evidence of mangrove cutting was widespread.

3.3.2 Transect Description

Two transects were surveyed through the stand, the locations of which are shown in Figure 3.6. A diagrammatic representation of a transect through the stand is illustrated in Figure 3.7 and described below.

Transect Description (seaward edge of stand to MHWS)

Zone 1 was primarily a mixture of *Sonneratia alba* and *Rhizophora mucronata* with a maximum canopy height of 4-5m. Evidence of the cutting of *S. alba* branches were noted. Substratum was rock-based in places.

Zone 2 was primarily a mixture of *R. mucronata* and *Brugiera gymnorrhiza* with a maximum canopy height of 8m.

Zone 3 was primarily a mixture of a few large *R. mucronata* and numerous small *Ceriops tagal* with a maximum canopy height of 10m. The substratum had a high mud content and was commonly waterlogged. *R. mucronata* and *C. tagal* saplings often formed dense stands within the zone (<10/m^2).

Quantitative Description

A quantitative analysis of the species composition and structure for each zone is presented in Table 3.13 below (only areas with significant mangrove colonisation have been analysed). The large variance in the data is almost certainly a reflection of the low numbers of quadrats surveyed rather than indicating a high degree of variability within the zones.

Table 3.13 Mangrove species composition and structure within the Mefunvo stand. Mean values and 95% confidence limits are given (all zones n=6).

Zone	Species	No. of trees/m^2	Relative Density	Basal Area (m^2/ha)	Relative Dominance	No. of saplings/m^2
1	*R. mucronata*	0.10±0.04	56	1.94±2.94	13	0.24-0.72
	S. alba	0.06±0.04	33	13.27±13.91	82	0.16-0.24
	C. tagal	0.02±0.04	11	1.00±1.95	5	0.00
2	*R. mucronata*	0.12±0.16	55	12.75±22.24	63	0.80-3.00
	C. tagal	0.02±0.04	9	2.06±4.04	10	0.00-0.32
	B. gymnorrhiza	0.08±0.08	36	5.44±4.67	27	0.16-0.52
3	*R. mucronata*	0.02±0.04	8	13.47±26.40	70	2.00
	C. tagal	0.20±0.16	84	3.81±5.36	20	0.00-4.00
	B. gymnorrhiza	0.02±0.04	8	1.95±3.82	10	0.00

Considered as a whole (Table 3.14) the Mefunvo mangrove was clearly dominated by *R. mucronata* both in terms of abundance and structural dominance. *C. tagal*, although present in large numbers had a low basal area for the stand that reflects its small size. This may be the result of cutting which has removed the larger specimens.

Table 3.14 Estimates for the size and composition of the Mefunvo Stand. All original figures were estimated to the nearest 100 and all basal area values have been calculated to the nearest $10m^2$. Mean values and 95% confidence limits are given (n=6).

Mangrove Species	Total number of trees	Mean Stand Diameter (cm)	Total Basal Area (m^2)
R. mucronata	6000±1700	10.40	60±15
*S. alba**	1700	16.78	40
C. tagal	4000±1600	6.53	10±2
B. gymnorrhiza	2200±1600	9.57	20±10

* *S. alba* occurred in a single quadrat only and therefore no measure of variance can be given.

Fauna of the Mefunvo mangrove

The number of crabs (unidentified spp.) increased markedly from the seaward edge of the mangrove in towards high water (Active crab burrows: *Zone 1* 6.1±1.9; *Zone 2* 9.7±2.5; *Zone 3* 17.5±3.5; mean and 95% confidence limits; n=20). This was perhaps a result of the change to a substratum with a gradually higher mud content along this transect. Oysters (*Saccostrea* sp.) and barnacles (unidentified spp.) were present as epifauna on the mangroves towards the outer edge of the stand and along the creeks.

Figure 3.6 Location of mangrove transects on Mefunvo Island

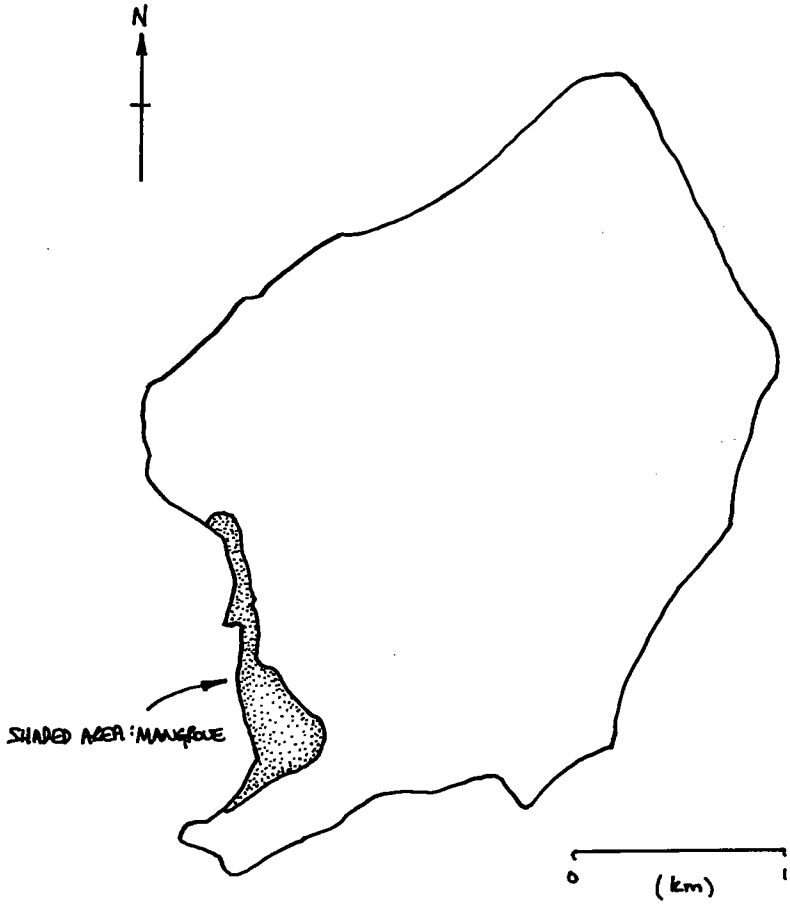
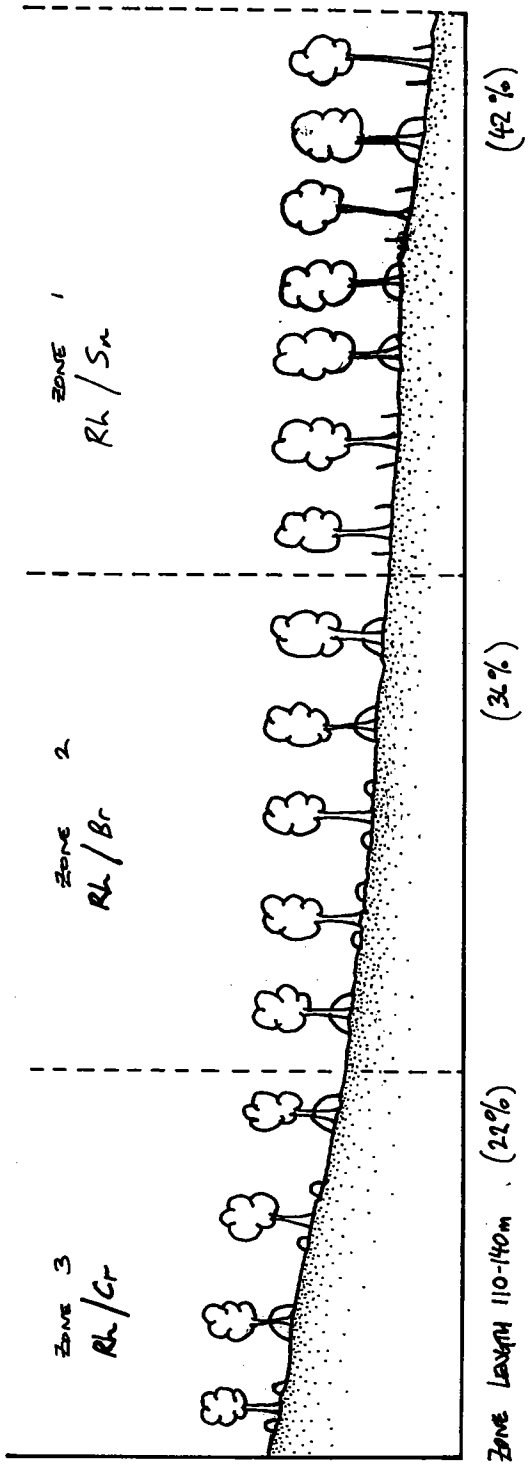


Figure 3.7 Transect diagram of Mefunvo mangrove



3.4 Subtidal Habitat Surveys

Subtidal surveys were undertaken at seven sites around the island, MF1 to MF7, as well as a further site (MF8) located on the reef north of the island which forms part of the southern bank of the Montepuez channel (Fig. 3.8). Data from three similar sites, MF4, MF5 and MF6, have been combined to describe the western side of the island.

3.4.1 Overview

Reef Structure and Composition
Exposed north-eastern sites exhibited areas of short vertical reef walls and horizontal platforms. Further south, reef morphologies differ with gently sloping reefs becoming more prevalent. South-eastern, southern and northern sites were shallow with limited reef development, although developed bommies were numerous. Western sites (MF4 - MF6) had no reef structures, while the site surveyed south of the Montepuez channel possessed a well developed steep sloping reef. Rugosity and substratum composition of sites followed a characteristic pattern, the most rugose sites being in north-eastern and Montepuez channel areas, where rock was dominant (MF1 and MF8). Undulating expanses of sand with low rugosity were indicative of western areas, while north, south and south-western areas exhibited highly rugose shallow reefs and bommies bordering the intertidal areas.

Benthic biota was highly variable between sites around the island. Western sites supported seagrass meadows while eastern reef sites exhibited hard and soft corals in equal proportions, with overall coral cover greater on upper reef sites. Small quantities of macroalgae and *Halimeda* spp. were present throughout these surveys. Site MF8 on the Montepuez channel followed a more common reef structure with soft corals dominating lower reef slopes. Most reef areas had a high diversity of coral forms with no obvious dominant form.

3.4.2 Site Reports

Site MF1:
The reef structure and community composition are described below and summarised in Table 3.15 and Figure 3.9.

Reef structure
The reef extended from the surf zone down to approximately 20m and consisted of three distinct sections. The deeper section, between 12-20m, had a shallow (10^0) slope and an underlying substratum of rock and rubble, colonised by a highly diverse array of corals. The seabed beyond the reef base at 20m was bare, predominantly sand with some rubble. The middle section, (8-12m), was a steep rock wall varying in angle ($50\text{-}90^0$). Many small caves and overhangs were seen in sections of the wall and a variety of coral types had colonised this area. The shallow plateau, from 8m to the surf zone, was on a slight slope ($0\text{-}10^0$) and again colonised with a diverse array of coral forms. A distinct 'spur and

groove' zone was evident perpendicular to the shore, with the narrow sandy grooves being approximately 15-20m apart.

Rugosity was relatively high, both at the base and above the wall, reflecting a well-developed hard coral community.

Substratum Composition

The shallow plateau and wall sections of the reef were formed primarily of rock, while the lower section was typically of rock and rubble. Although sand collected in the 'grooves' of the shallow 'spur and groove' zone, it was most abundant in the deeper portions of the reef and off reef.

Biotic cover

Hard and soft coral cover was greater in shallower areas, covering 50-75% of the reef surface above 8m. Below the 'wall' and greater than 12m depth, soft coral cover was generally between 25-50% while hard coral cover was patchy, often reaching 75-90% cover in some areas and separated by small patches of rubble. 'Branching, encrusting, fire' and both big and small 'massive' forms of coral achieved dominance in turn within these patches. Macroalgae and *Halimeda* spp. were present in small quantities throughout the reef with no evidence of zonation.

Table 3.15 A summary of the structure, composition and biotic cover at MF1(P<1% cover).

Reef Features		Upper Reef (n=11) Mode (0-6)	Upper Reef (n=11) Range (0-6)	Lower Reef (n=9) Mode (0-6)	Lower Reef (n=9) Range (0-6)
Morphology	Slope (°)	10	10-20	10	0-10
	Rugosity	3	3	4	3-4
Substratum	Rock	6	3-6	3	2-6
	Rubble	1	0-2	3	2-3
	Sand/Shell	1	P-3	1	P-2
	Mud	0	0	0	0
Biota	Hard Coral	4	3-4	2	2-5
	Soft Coral	4	2-4	3	2-3
	Seagrass	0	0	0	0
	Macroalgae	P	0-1	P	P
	Halimeda spp.	P	0-P	P	P-1
Coral State	Heterogeneity	0	0-1	0	0
	Dominance	Branching/Encrusting/ Small and Big Massive		Branching/Encrusting/ Fire/Big Massive	

Site MF2:

The reef structure and community composition are described below and summarised in Table 3.16 and Figure 3.10.

Reef Structure

The reef at this site was on a shallow slope (<10^0) above 14m. Low lying but diverse coral formations occurred between 14m and 7m while bommie and rocky outcrops on sand continued upto the surf zone. Some patches of seagrass were seen at the bottom of the reef (15m), but this rapidly changed to a bare sandy substratum beyond. Rugosity tended to be highest in shallower waters.

Substratum Composition

Rock, rubble and sand were present at all depths on the reef, while beyond 14m from the base of the reef sand became the dominant substratum type.

Biotic Cover

Hard and soft corals were similar in their cover over the reef area between 14m and 7m, although total cover was found to be slightly greater on the lower reef (14m). Hard coral cover was occasionally found to reach 75-90% in these deeper areas and was generally heterogeneous in form. Macroalgae and *Halimeda* spp. were present in small abundances at all depths, while seagrasses were present only in small patches below the coral, approximately between 14 and 16m.

Table 3.16 A summary of the structure, composition and biotic cover at MF2 (P<1 % cover).

Reef Features		Upper Reef (n=12) Mode (0-6)	Upper Reef (n=12) Range (0-6)	Lower Reef (n=17) Mode (0-6)	Lower Reef (n=17) Range (0-6)
Morphology	Slope (°)	0	0	0	0
	Rugosity	3	3-4	3	2-4
Substratum	Rock	3	3-4	4	2-5
	Rubble	3	2-3	2	1-3
	Sand/Shell	2	2	3	2-3
	Mud	0	0	0	0
Biota	Hard Coral	2	2	3	3-4
	Soft Coral	2	2-3	3	2-4
	Seagrass	0	0	0	0
	Macroalgae	P	P	P	0-P
	Halimeda spp.	P	P-1	P	P
Coral State	Heterogeneity	0	0	0	0
	Dominance	Branching/Encrusting/ Small Massive		Branching/ Small Massive	

Site MF3:

The reef structure and community composition are described below and summarised in Table 3.17 and Figure 3.11.

Reef Structure

A gentle slope (<10^0) extended from the edge of the intertidal area. A patchwork of low lying coral and bommies extended upwards from 7m to a damaged reef crest. Rugosities were low, especially on the deeper areas of the reef, reflecting the low coral development over much of the site.

Substratum Composition

The substratum composition in the upper reaches of the reef was generally of equal proportions of rock, rubble and sand. Towards the bottom of the reef sand became dominant.

Biotic Cover

Hard corals were the dominant biota at the top of the reef, although cover was always less than 25%. Soft corals tended to be relatively low in abundance, whilst seagrasses formed dense patches around bommies towards the bottom of the reef. Macroalgae and *Halimeda* spp. were uncommon.

Table 3.17 A summary of the structure, composition and biotic cover at MF3 (P<1 % cover).

Reef Features		Upper Reef (n=13) Mode (0-6)	Upper Reef (n=13) Range (0-6)	Lower Reef (n=6) Mode (0-6)	Lower Reef (n=6) Range (0-6)
Morphology	Slope (°)	0	0	0	0
	Rugosity	3	3	1	0-2
Substratum	Rock	3	3-5	2	0-2
	Rubble	2	2-4	3	P-4
	Sand/Shell	1	P-3	3	1-4
	Mud	0	0	P	0-2
Biota	Hard Coral	2	1-2	P	0-1
	Soft Coral	1	1-2	1	0-2
	Seagrass	0	0-P	4	P-5
	Macroalgae	P	P	0	0-P
	Halimeda spp.	0	0-P	0	0
Coral State	Heterogeneity	0	0	0	0
	Dominance	None dominant		Branching/ Small and Big Massive	

Sites MF4, MF5 and MF6 (western Mefunvo):
The area structure and community composition are described below and summarised in Table 3.18

Area Description
Sub-littoral areas between the west of Mefunvo and the continent were shallow, undulating, sandy plains with extensive seagrass beds. Depths were no greater than 10m. Towards the south-western tip of Mefunvo on the edge of the intertidal a few developed bommies were present with colonies of both hard and soft corals. Macroalgae and *Halimeda* spp. were also present in low numbers throughout the area.

Table 3.18 A summary of the structure, composition and biotic cover at Sites MF4, MF5 and MF6 (western Mefunvo) (P<1 % cover)

Reef Features		Inner Reef (n=16) Mode (0-6)	Range (0-6)
Morphology	Slope (°)	0	0
	Rugosity	3	3
Substratum	Rock	3	3-5
	Rubble	2	2-4
	Sand/Shell	1	P-3
	Mud	0	0
Biota	Hard Coral	2	1-2
	Soft Coral	1	1-2
	Seagrass	0	0-P
	Macroalgae	P	P
	Halimeda spp.	0	0-P
Coral State	Heterogeneity	0	0
	Dominance	None dominant	

Site MF7:

The reef structure and community composition are summarised in Table 3.19 and Figure 3.12 and are described below.

Reef Structure

The reef areas at this site border the intertidal areas to the north and south (see Figure 3.12) with extensive fields of coral bommies. A shallow (<5m) and flat sandy substratum lay between these two intertidal areas.

Substratum Composition

Sand was the dominant substratum between the two intertidal areas, with patches of rubble at the base of fringing rock/bommie fields.

Biotic Cover

Seagrass cover was not extensive, although occasionally dense patches were found. Macroalgae was always present, but not abundant, while *Halimeda* spp. was uncommon. Hard corals were found only in bommie areas and at the edges of the intertidal while soft corals were both in bommie areas and as individual colonies on the sandy substratum.

Table 3.19 A summary of the reef structure, composition and biotic cover (P<1 % cover).

Reef Features		Inner Reef (n=16) Mode (0-6)	Range (0-6)
Morphology	Slope (°)	0	0
	Rugosity	3	3
Substratum	Rock	3	3-5
	Rubble	2	2-4
	Sand/Shell	2	P-3
	Mud	0	0
Biota	Hard Coral	2	1-2
	Soft Coral	1	1-2
	Seagrass	0	0-P
	Macroalgae	P	P
	Halimeda spp.	0	0-P
Coral State	Heterogeneity	0	0
	Dominance	None dominant	

Site MF8:

The reef structure and community composition are summarised in Table 3.20 and Figure 3.13 and are described below.

Reef Structure

The reef was characterised by a generally steep slope (40-50^0) down to a depth of 20m. Beyond this a shallower gradient was evident down into the Montepuez channel. Rugosity was high at the top of the reef and reduced with depth. A profile of site MF8 has been presented in Fig. 3.14, as typical of corals in the channel to the north of Mefunvo island.

Substratum Composition

Rock was the dominant substratum in the upper reef areas. With depth, increasing amounts of rubble and sand were found, while off reef (>20m) the substratum appeared to be predominantly of sand.

Biotic Cover

In lower reef areas hard and soft corals were similar in proportion (25-50%) in contrast to the upper reef (<10m), where hard coral was dominant (75-90%). Macroalgae was only present on the lower reef while *Halimeda* spp. appeared to be present only in shallower waters.

Figure 3.8 Habitat sites at Mefunvo Island.

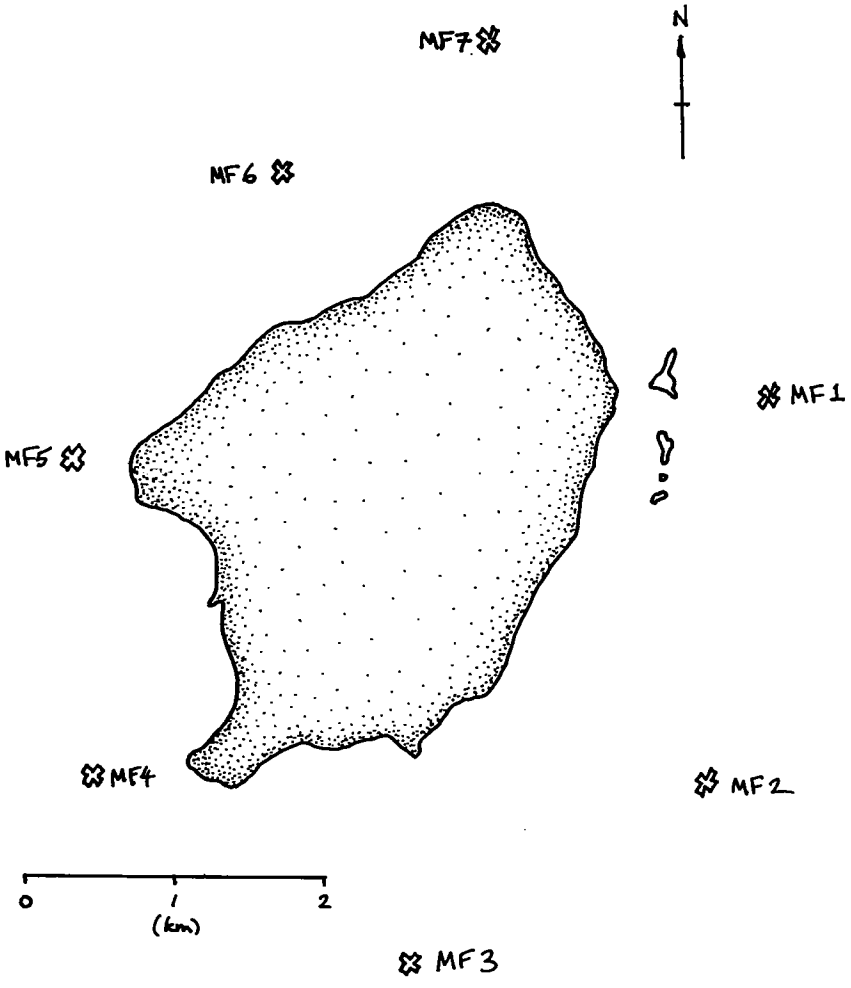


Figure 3.9 Diagram of the reef profile at MF1.

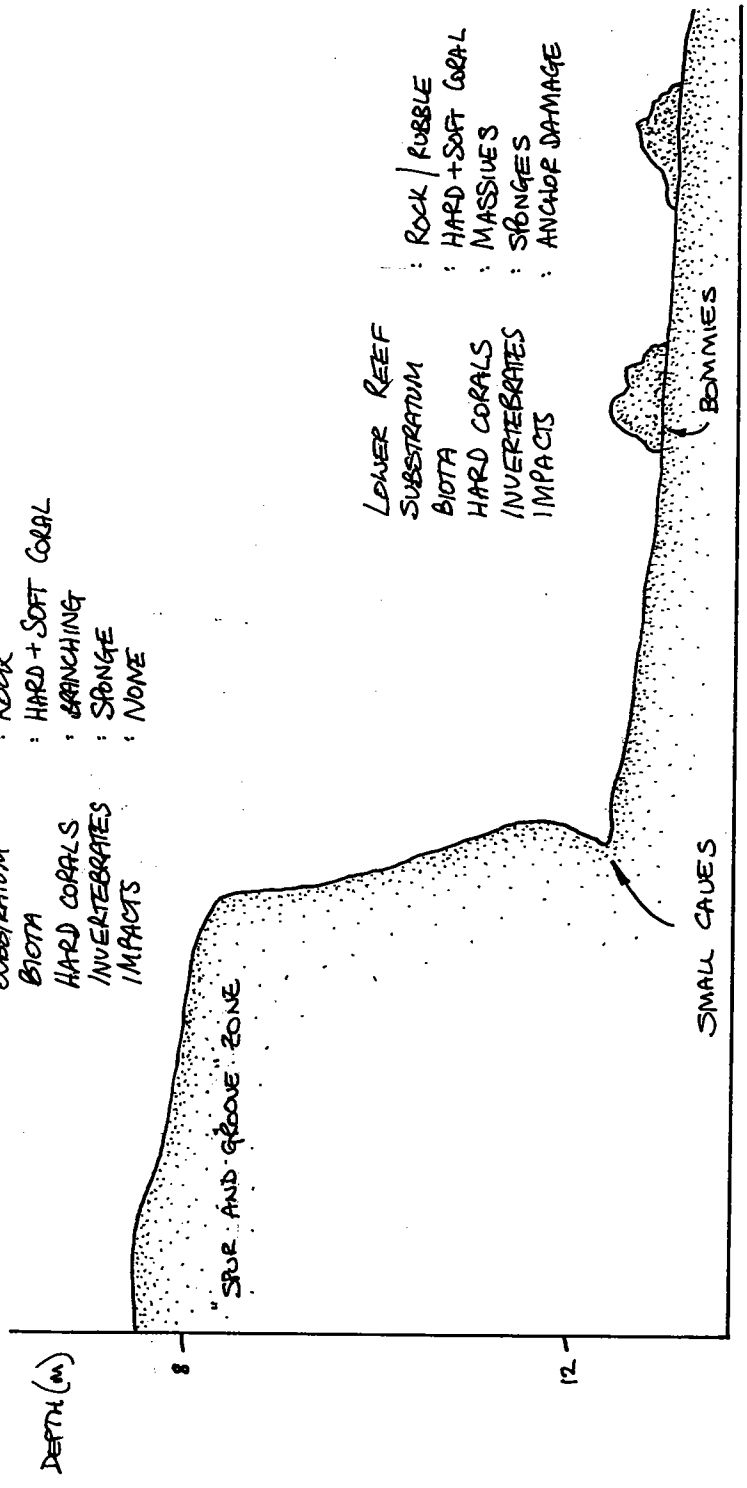


Figure 3.10 Diagram of the reef profile at MF2.

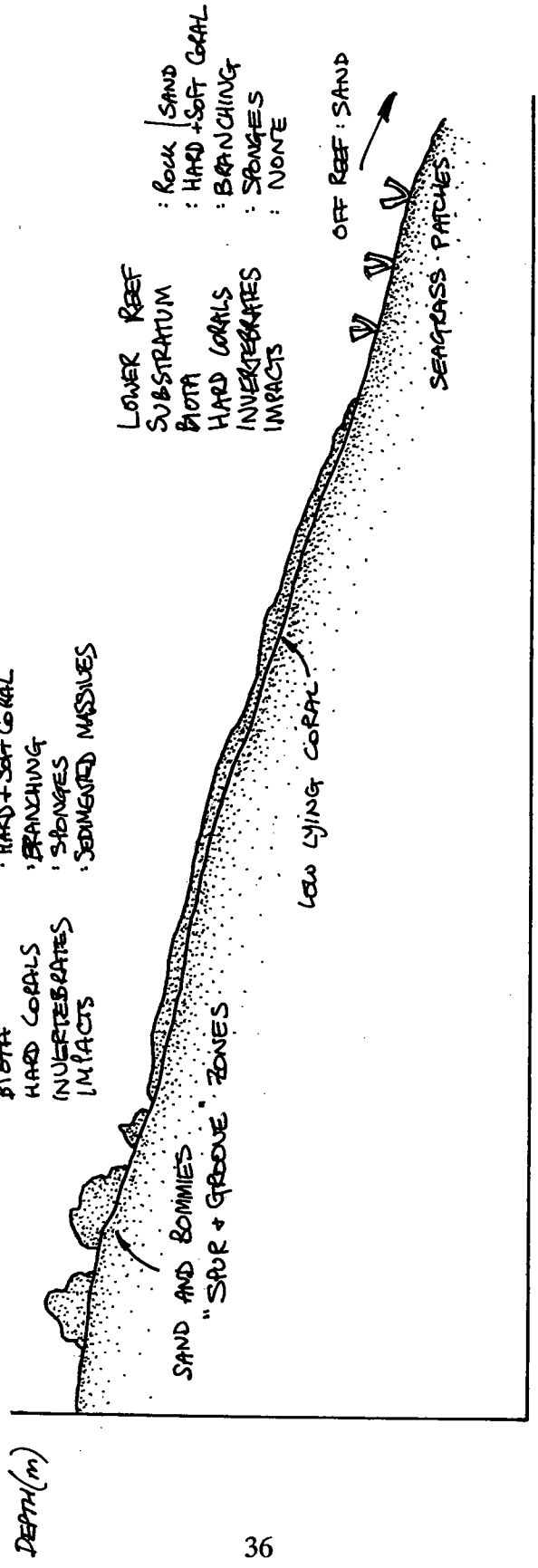


Figure 3.11 Diagram of the reef profile at MF3.

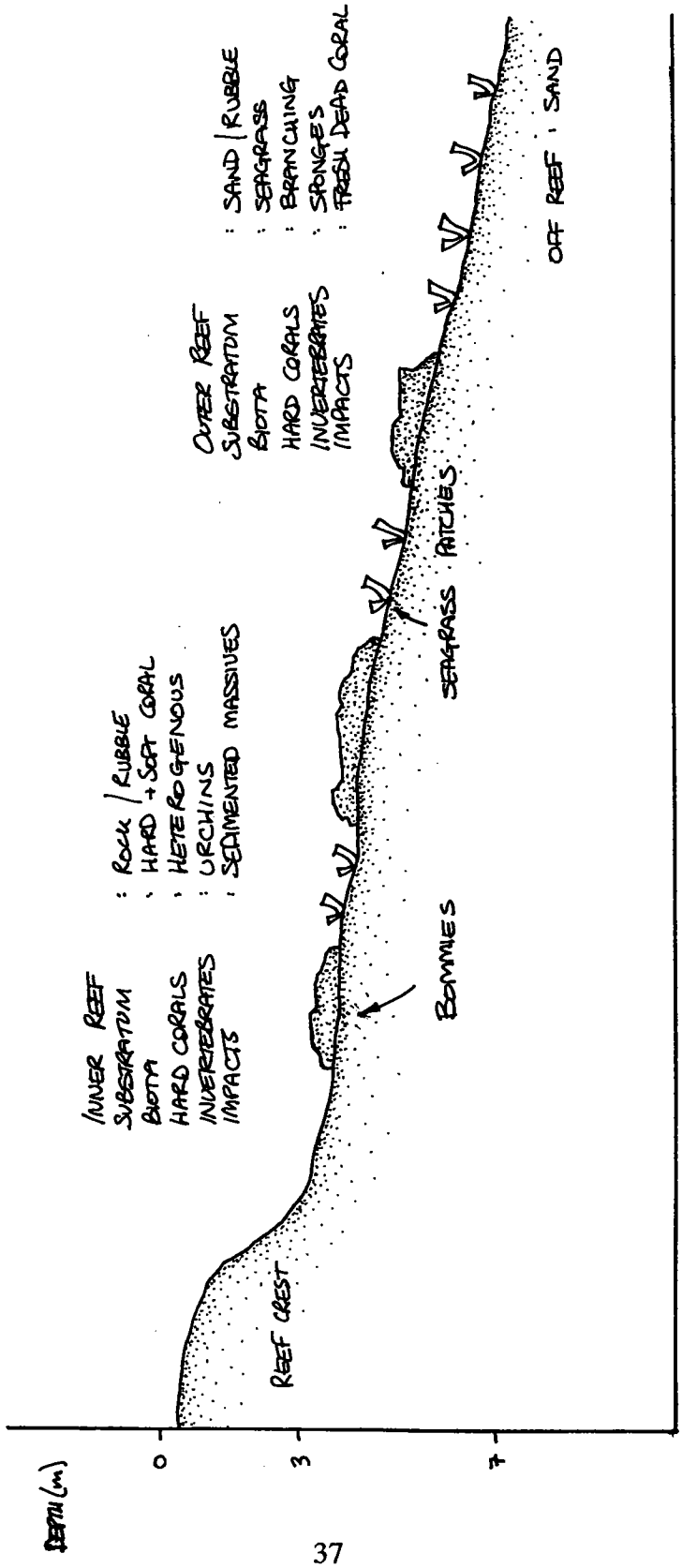


Figure 3.12 Diagram of the reef profile at MF7.

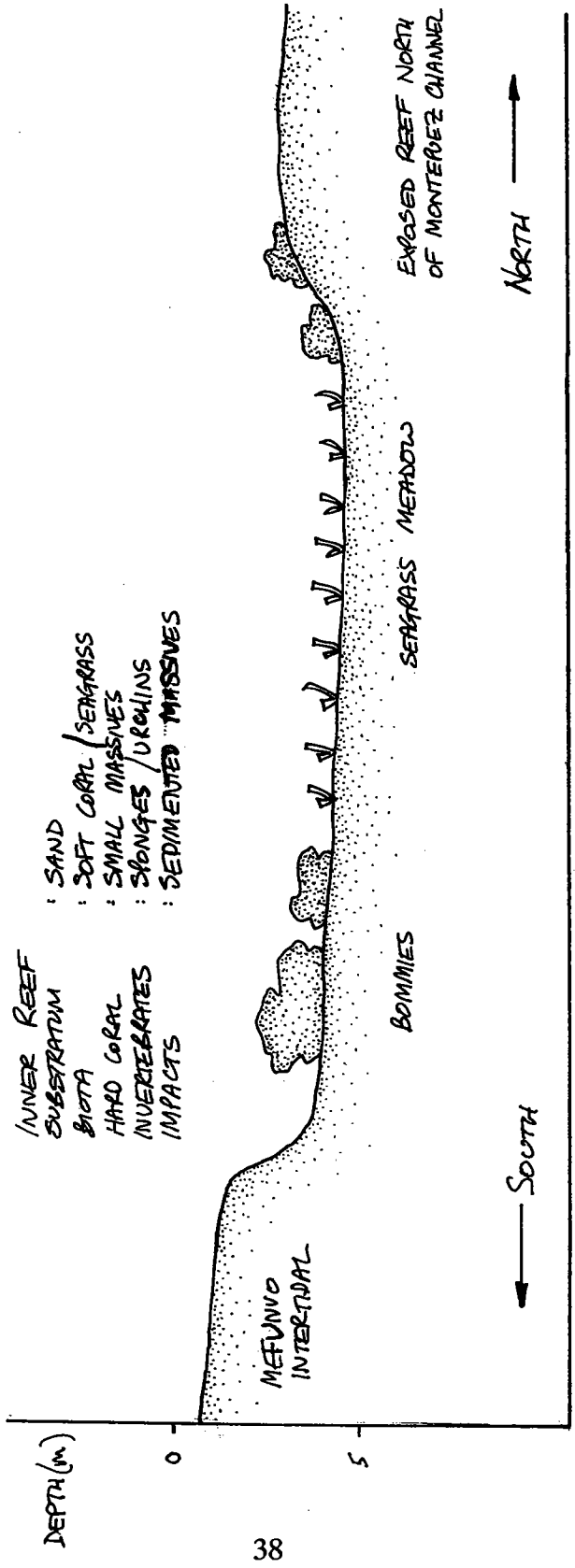


Figure 3.13 Diagram of the reef profile at MF8.

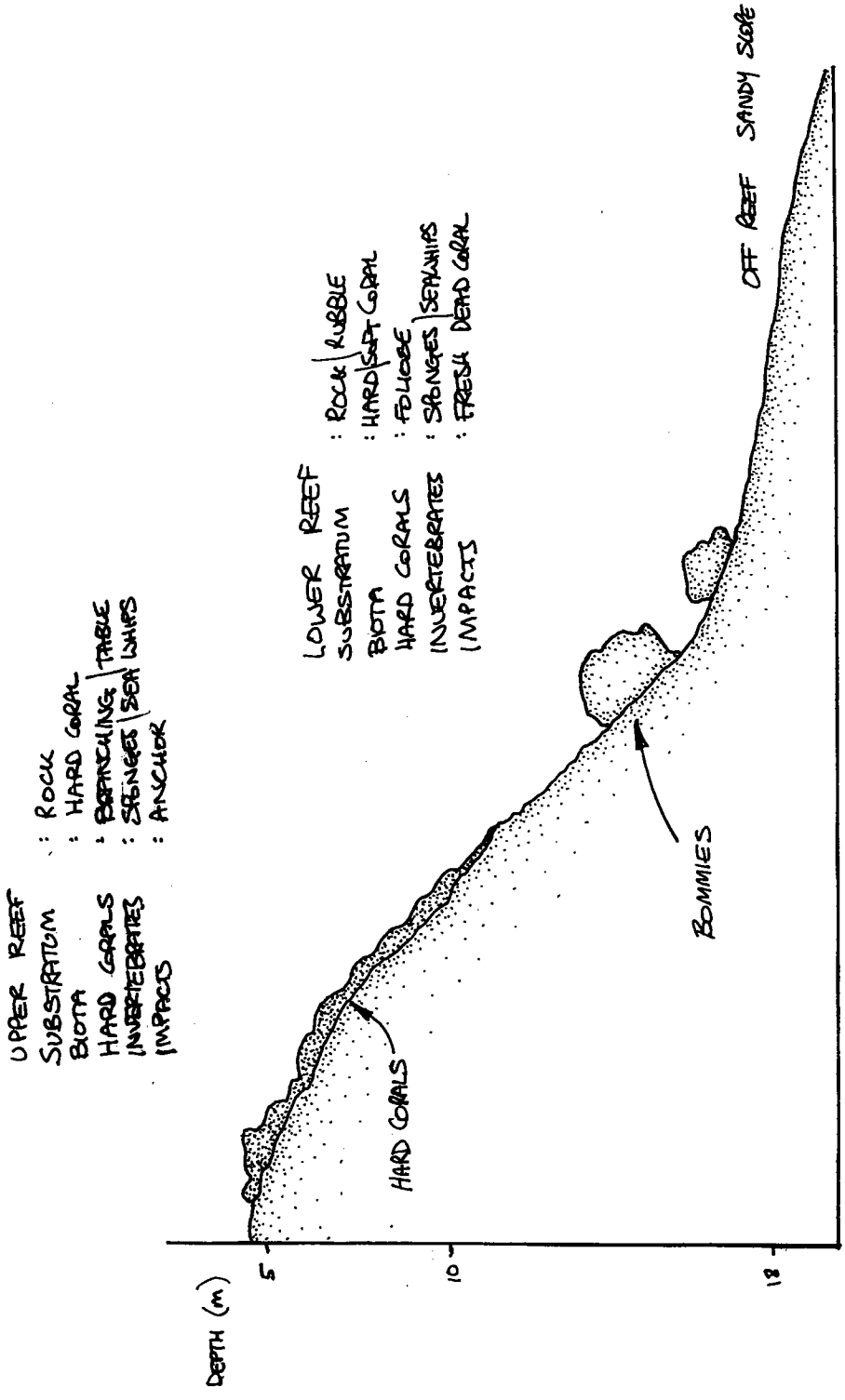


Figure 3.14 Diagram of coral profile at MF8.

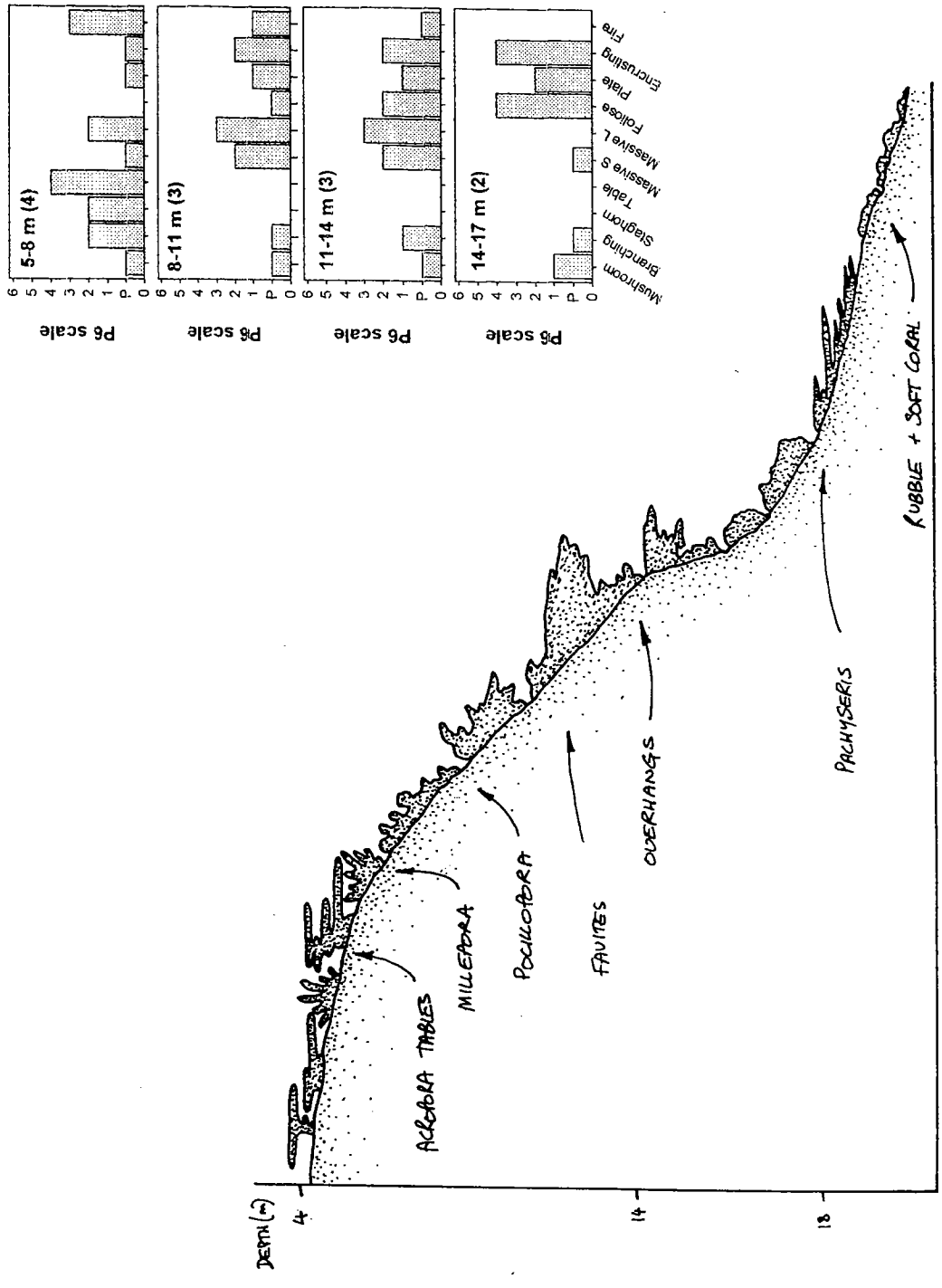


Table 3.20 A summary of the structure, composition and biotic cover at MF8 (P<1 % cover).

Reef Features		Upper Reef (n=16) Mode (0-6)	Upper Reef (n=16) Range (0-6)	Lower Reef (n=14) Mode (0-6)	Lower Reef (n=14) Range (0-6)
Morphology	Slope (°)	0	0-10	50	40-50
	Rugosity	3	1-4	3	2-4
Substratum	Rock	5	4-5	3	2-4
	Rubble	2	P-2	2	1-2
	Sand/Shell	1	P-2	2	1-4
	Mud	0	0	0	0
Biota	Hard Coral	5	4-5	3	1-4
	Soft Coral	3	3-4	3	1-3
	Seagrass	0	0	0	0
	Macroalgae	0	0	P	P
	Halimeda spp.	P	0	0	0
Coral State	Heterogeneity	0	0	0	0
	Dominance	Branching/Table		Foliose	

3.4.3 Subtidal Flora

A total of 9 seagrass species and 56 species of macroalgae (1 Cyanophyta, 27 Chlorophyta, 15 Phaeophyta and 13 Rhodophyta) were recorded, representing the highest subtidal species richness recorded within the S.I.G. In contrast to intertidal flora, which was dominated by red algae, the subtidal flora was dominated by green algae. A checklist of the seagrasses and macroalgae recorded is presented in Appendix A2.

Area Reports

Site MF1:

This site was dominated by seagrass, with few macroalgae present. A total of 5 seagrass species and 8 species of macroalgae were identified. The macroalgal flora included 2 species of Phaeophyta and 6 of Chlorophyta.

Site MF2:

In the upper sublitoral zone this site comprised a mixture of sand/rubble/seagrass and small scattered bommies while the lower zone was colonised by coral reefs. This site recorded the highest algal diversity (46 species) of all sites around Mefunvo Island and 6 seagrass species were also identified.

Site MF3:
This site consisted of areas of sand and seagrass with 6 species of seagrass and 3 of macroalgae recorded. This site together with MF2 supported the highest diversity of seagrass and had the lowest diversity of macroalgae compared to other sites surveyed.

Site MF5:
MF5 was a mixture of sand/seagrass, coral reef and small bommies. One seagrass species and 11 species of macroalgae were recorded. From 7.0-8.0 m the site consisted of sand with scattered bommies within which *Turbinaria ornata, Dictyota divaricata, Poritiera* spp. and *Halimeda melanesica* were the most common macroalgae. In deep waters the common macroalgae were *Halimeda* spp., *Dictyota* spp., and *Poritiera* spp (from 8-14m); from 14-17m was sand and rubble substratum colonised by soft corals, tiny unidentified algae, *Halimeda* spp. and *Udotea glauscens*. Patches of *Thalassodendron ciliatum* were also observed.

3.5 Subtidal Invertebrate and Impact Surveys

3.5.1 Overview

Macrosponges were high in density at most sites, while urchins were seen in dense aggregations in northern and southern areas only. Sea whips were often present on reef sites although high numbers occurred only in the Montepuez channel. Other invertebrates were observed only in small numbers. Some coral damage was attributed to boat anchors whilst most was of indeterminate cause.

3.5.2 Site Reports

Site MF1:
The distribution and density of invertebrates and incidences of reef damage are discussed below, and summarised in Table 3.21.

Apart from numerous macrosponges (up to 50 individuals/5 mins of survey) most other invertebrates were observed in small numbers. There was no obvious difference in the abundance of invertebrates between upper and lower reef, although the macrosponges were in greater numbers in shallower waters. Coral damage observed was limited to a few sedimented 'massive' forms and fresh dead coral.

Table 3.21 Invertebrates and Natural/Human Impacts at Site MF1 (values are for 5 minutes of survey)

		Upper Reef (n=10)		Lower Reef (n=23)	
Inverts/Impacts	**Type/Cause**	**Median**	**Range**	**Median**	**Range**
Macrosponges		25.0	20-50	5.5	0-10
Gorgonians	Sea Whips	0.1	0-1	0.8	0-4
	Sea Fans	0.2	0-2	-	-
Bivalves	Giant Clams	1.2	0-2	0.3	0-2
Gastropods	Murex	0.2	0-1	-	-
Urchins		1.4	0-4	0.6	0-3
Sea Cucumbers	Holothuria	0.2	0-1	0.2	0-1
	Others	0.6	0-1	0.1	0-1
Dead Corals	Sed. Massives	0.2	0-1	1.0	0-3
	Unknown	0.4	0-1	1.8	0-4
Human Effects	Anchor damage	-	-	1.0	0-3

Site MF2:

The distribution and density of invertebrates and incidences of reef damage are discussed below, and summarised in Table 3.22.

Macrosponges, sea whips, urchins and three clams (*Tridacna* spp.) were the only invertebrates recorded at this site. Sponges were again more abundant on shallower slopes. Freshly dead coral and sedimented 'massive' form corals were regularly noted over the whole reef profile, while human impacts were limited to a few incidents of anchor damage and a single lost spear at the base of the reef.

Table 3.22 Invertebrates and Natural/Human Impacts at Site MF2 (values are for 5 minutes of survey).

		Upper Reef (n=10)		Lower Reef (n=23)	
Inverts/Impacts	**Types/Cause**	**Median**	**Range**	**Median**	**Range**
Macrosponges		7.8	1-20	5.3	0-17
Gorgonians	Sea Whips	0.4	0-2	0.1	0-3
Bivalves	Giant Clams	0.1	0-1	0.3	0-2
Urchins		-	-	0.1	0-1
Dead Corals	Sed. Massives	1.3	0-5	0.9	0-2
	Unknown	0.7	0-3	0.1	0-1
Human Effects	Anchor damage	0.3	0-1	0.1	0-1
	Spears	0.1	0-1	0.1	0-1

Site MF3:

The distribution and density of invertebrates and incidences of reef damage are discussed below, and summarised in Table 3.23.

Urchins and macrosponges were the most abundant invertebrates recorded. While sponges occurred in greater numbers towards the bottom of the reef, urchins were found in large numbers over the full reef profile. Sedimented 'massive' form corals were frequent and patches of freshly dead coral (cause unknown) were noted, especially on lower areas. Crown of Thorn starfish were present in small numbers (<2 individuals/5 min of survey), but no feeding scars were seen. No evidence of human impact was recorded

Table 3.23 Invertebrates and Natural/Human Impacts at Site MF3 (values are for 5 minutes of survey).

		Upper Reef (n=12)		Lower Reef (n=10)	
Inverts/Impacts	**Types/Cause**	**Median**	**Range**	**Median**	**Range**
Macrosponges		1.1	0-2	11.3	2-20
Gorgonians	Sea Fans	-	-	0.3	0-3
Bivalves	Giant Clams	1.1	0-2	0.2	0-1
Urchins		25	0-50	22	0-50
Sea Cucumbers	Holothuria	0.4	0-3	0.3	0-1
	Synapta spp.	-	-	0.1	0-1
	Other	0.2	0-1	-	-
C-O-T	Individuals	0.4	0-2	0.1	0-1
Dead Corals	Sed. Massives	0.9	0-3	0.9	0-3
	Unknown	0.2	0-1	1.5	0-7

Sites MF4, MF5 and MF6 (western Mefunvo)

The distribution and density of invertebrates and incidences of damage are discussed below, and summarised in Table 3.24.

Macrosponges were the most abundant invertebrates recorded on the sandy substratum of western Mefunvo. Urchins, sea cucumbers and clams were present in small numbers, as well as a single juvenile lobster. Small freshly dead 'branching' forms of coral were frequent and evidence of anchor dragging was found on four separate occasions.

Table 3.24 Invertebrates and Natural/Human Impacts at Sites MF4, MF5 and MF6 (western Mefunvo) (values are for 5 minutes of survey).

		Inner Reef (n=16)	
Inverts/Impacts	**Types/Cause**	**Median**	**Range**
Macrosponges		9.6	0-50
Bivalves	Giant Clams	0.3	0-2
Urchins		0.4	0-3
Sea Cucumbers	Others	0.1	0-1
Lobster		0.1	0-1
Dead Corals	Unknown	0.7	0-5
Human Effects	Anchor damage	0.2	0-1

Site MF7:

The distribution and density of invertebrates and incidences of damage are discussed below, and summarised in Table 3.25.

Macrosponges and urchins were the most abundant invertebrates recorded. Urchins were found to occur in small, but dense aggregations. No evidence of human impact was found.

Table 3.25 Invertebrates and Natural/Human Impacts at Site MF7 (values are for 5 minutes of survey).

		Upper Reef (n=12)	
Inverts/Impacts	**Types/Cause**	**Median**	**Range**
Macrosponges		21	7-32
Urchins		8	0-50
Sea Cucumbers	Others	0.4	0-2
Dead Corals	Sed. Massives	0.2	0-2

Site MF8:

The distribution and density of invertebrates and incidences of damage are discussed below, and summarised in Table 3.26.

Macrosponges and sea whips were abundant on both the upper and lower reef. Three large sea fans (the largest being 180cm in diameter) were found in the upper reaches of the reef. Clams, sea cucumbers and urchins were also present in low numbers. Freshly dead coral (cause unknown) was recorded on a number of occasions, while human impacts were noted by the presence of anchor damage and old fishing line.

Table 3.26 Invertebrates and Natural/Human Impacts at Site MF8 (values are for 5 minutes of survey).

		Upper Reef (n=17)		Lower Reef (n=19)	
Inverts/Impacts	**Types/Cause**	**Median**	**Range**	**Median**	**Range**
Macrosponges		17.5	1-20	12.6	2-20
Gorgonians	Sea Whips	5.4	0-20	4.6	2-6
	Sea Fans	0.2	0-1	-	-
Bivalves	Giant Clams	0.1	0-1	-	-
Urchins		0.2	0-2	1.4	0-3
Sea Cucumbers	Holothuria	0.6	0-6	0.6	0-2
	Others	0.1	0-1	1.6	0-3
Dead Corals	Unknown	0.4	0-3	1.0	0-2
Human Effects	Anchor damage	0.2	0-2	0.2	0-1
	Fishing Line	-	-	0.2	0-1

3.6 Reef fish census

3.6.1 Overview

Mefunvo was characterised by a long exposed outer fringing reef on the eastern side of the island, with a very sheltered sandy coast on the western side, facing the Mefunvo channel. Site MF8 was in the adjacent Mefunvo channel to the north of the island.

Table 3.27 The number of 5 minute replicates, total species count, relative species richness indices (RSRi) and Shannon Weaver diversity indices (SWi) calculated from the Mefunvo reef fish assemblage.

Site	Reps	Spp	RSRi	SWi
MF1 inner	25	42	0.58	3.11
MF1 outer	12	26	0.36	2.52
MF2	15	24	0.33	2.66
MF3 inner	11	12	0.16	2.06
MF3 outer	12	14	0.19	2.33
MF4-6	12	3	0.04	1.04
MF7	21	16	0.22	2.31
MF8	24	28	0.38	2.51

3.6.2 Site Reports

Site MF1:

This site was rich in reef fish species (42, of which 17 were butterflyfish). The site was subdivided into inner and outer reef sites, with higher diversity occurring on the inner reef area. Of the 989 fish seen (high abundance), no one species was dominant, although

the Dusky surgeonfish *Acanthurus nigrofuscus* occurred in all replicates. Figs. 3.15, 3.16 present the abundance and species richness of this site.

Site MF2:
This site yielded 24 species, of which 9 were butterfly fish and 5 were surgeon fish. However, the numerically dominant fish was the Redtooth trigger fish *Odonus niger* of which 34 were seen. The abundance and species richness are presented graphically in fig 3.17.

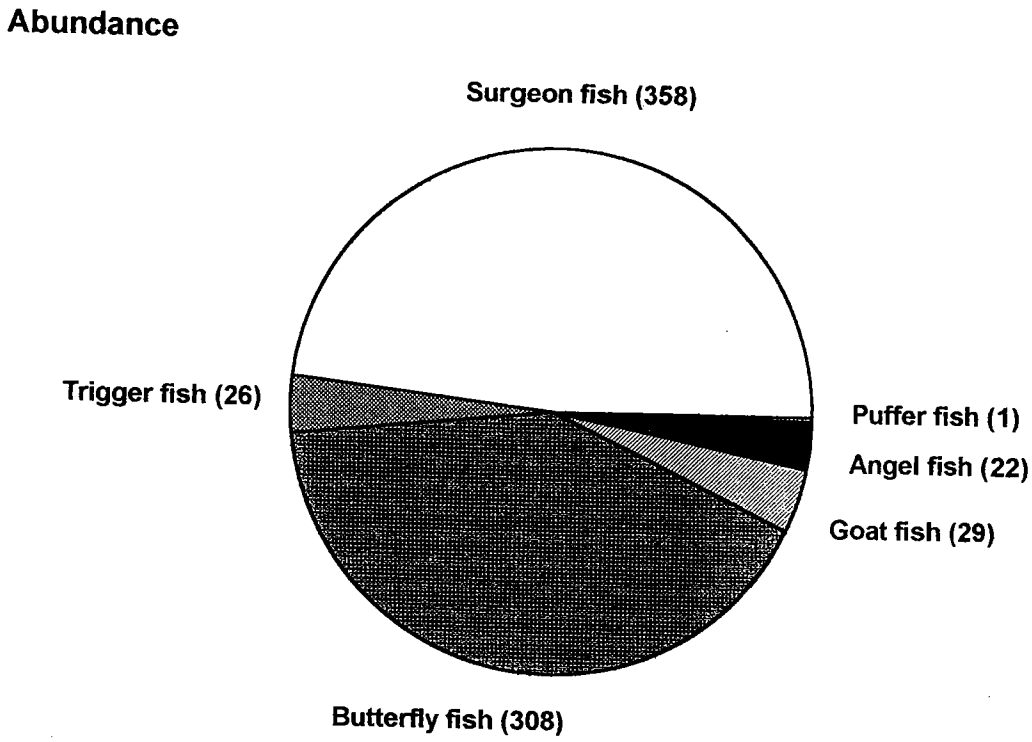
Site MF3:
This was subdivided into inner and outer reef areas, with slightly more species-richness and abundance on the outer site (14 to 12, and 93 to 70 respectively). The Twospot bristle-tooth *Ctenochaetus binotatus* and the Multispined angelfish *Centropyge multispinus* were numerically the most dominant. The abundance and species richness have been presented graphically in figs. 3.18, 3.19

Site MF4, 5, 6:
The three sites were combined as they were identical and almost devoid of reef fish. Only 4 fish from 3 species were seen. These results have been presented in fig. 3.20.

Site MF7:
A total of 16 species were observed at this site, of which 5 were surgeon fish. The Halfmoon trigger fish *Sufflamen chrysopterus* and the Dot-dash butterflyfish *Chaetodon kleinii* were numerically dominant (18 and 20 respectively of 115 fish). Reef fish abundance and species richness have been presented graphically in fig. 3.21.

Site MF8:
This site was a deep channel to the north of Mefunvo island, with a total of 28 species and 473 fish were seen. Surgeonfish made up 260 of these fish, including the 124 specimens of the Spotted unicornfish *Naso brevirostris*. Butterflyfish were represented by 11 species and 131 fish, mainly represented by the Dot-dash (*Chaetodon kleinii*) and Redfin (*Chaetodon trifasciatus*) butterflyfish. The abundance and species richness have been presented graphically in Fig. 3.22.

Figure 3.15 The abundance and species richness of reef fish at site MF1 (inner reef).



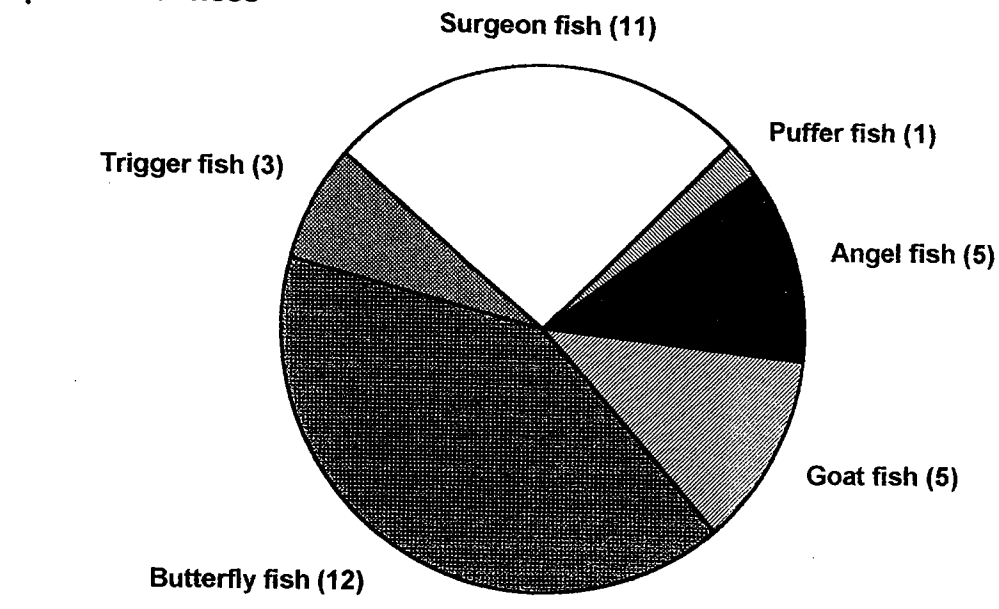


Figure 3.16 The abundance and species richness of reef fish at site MF1 (outer reef).

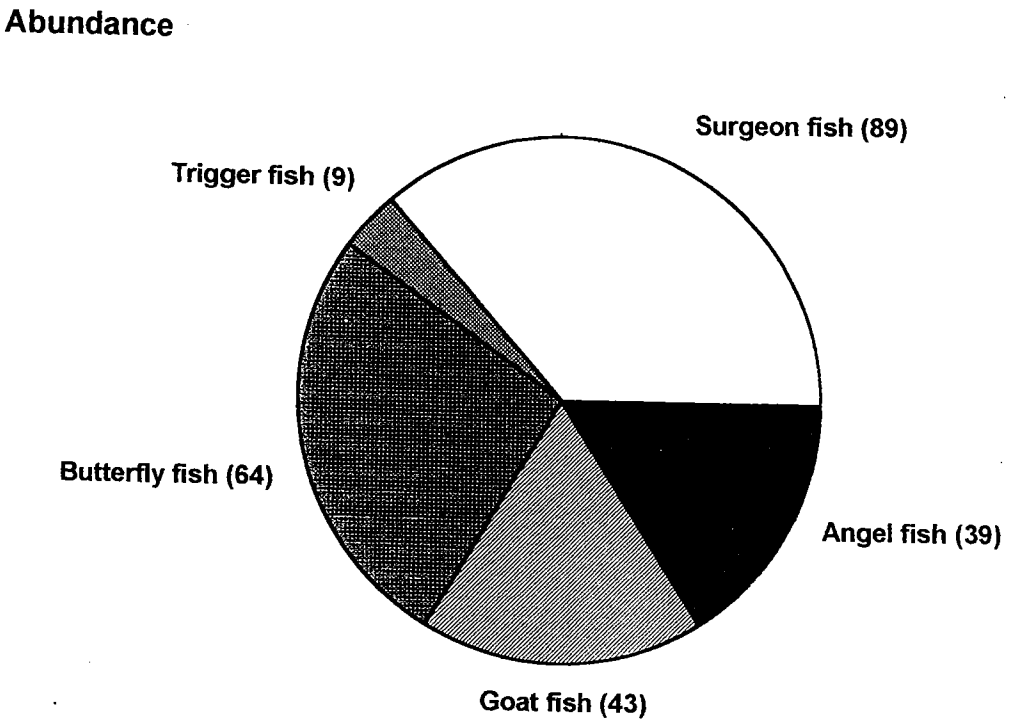
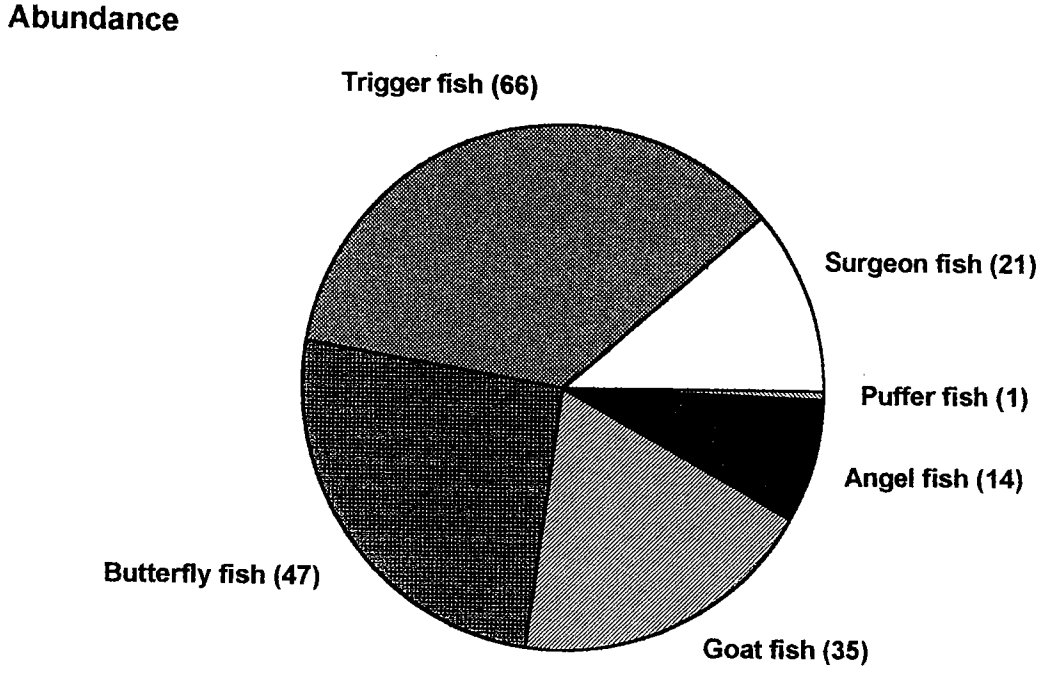


Figure 3.17 The abundance and species richness of reef fish at site MF2.



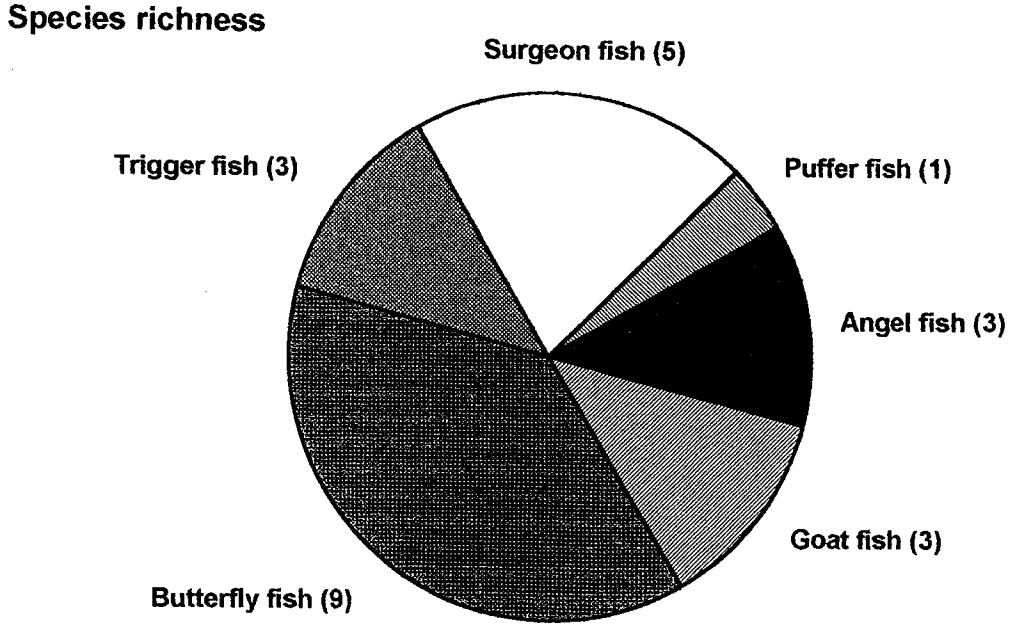


Figure 3.18 The abundance and species richness of reef fish at site MF3 (inner reef).

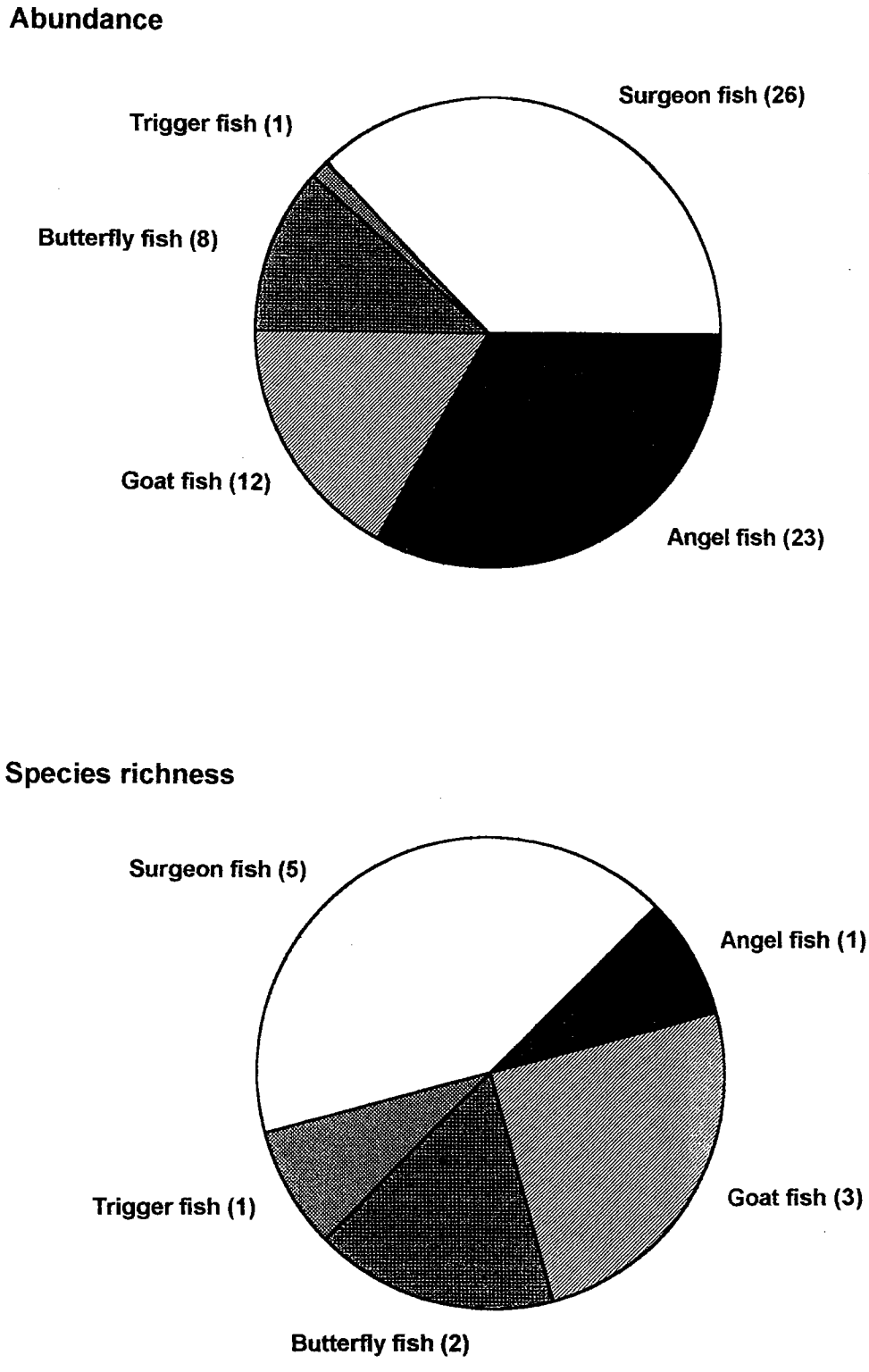


Figure 3.19 The abundance and species richness of reef fish at site MF3 (outer reef).

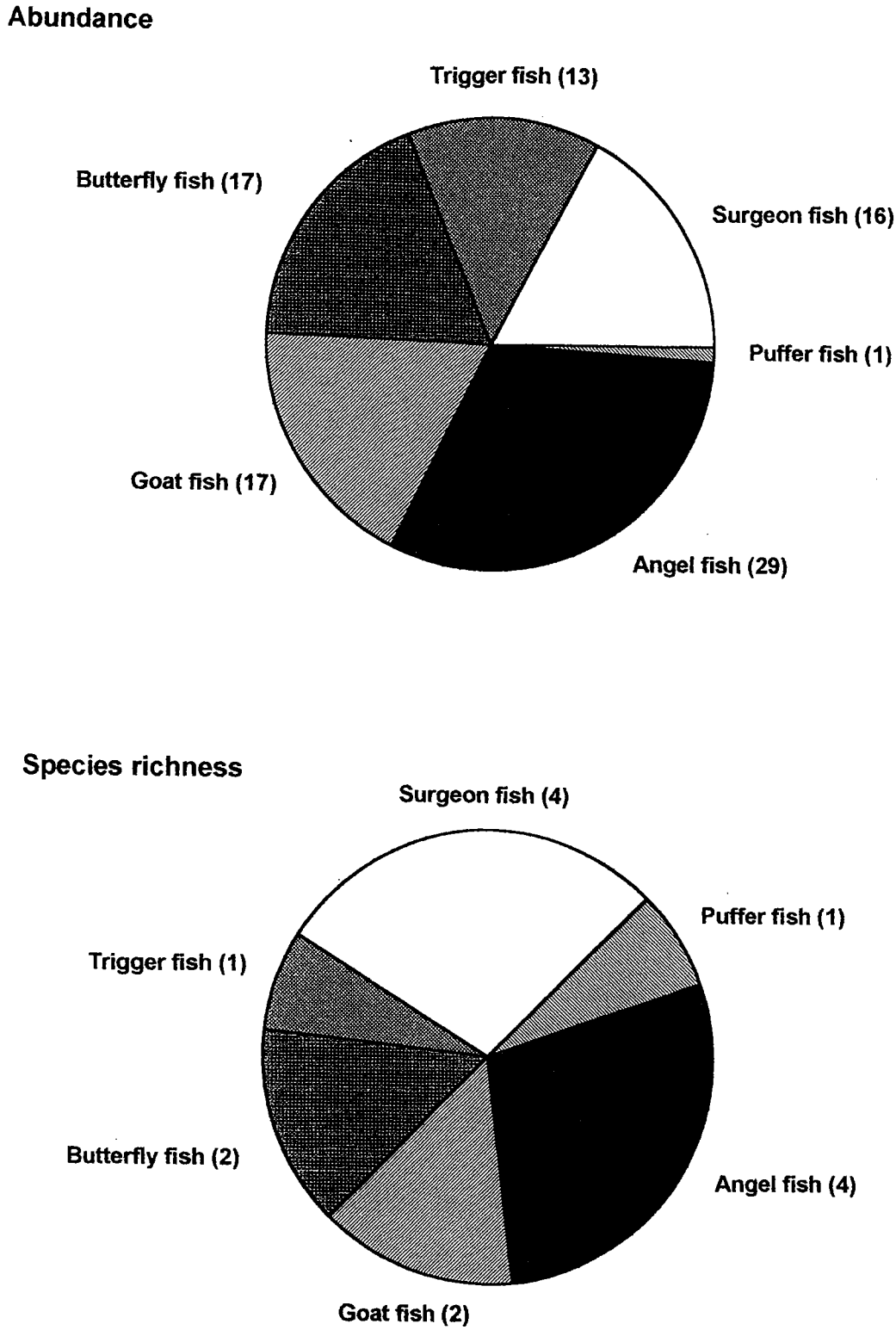


Figure 3.20 The abundance and species richness of reef fish at site MF4, 5 and 6.

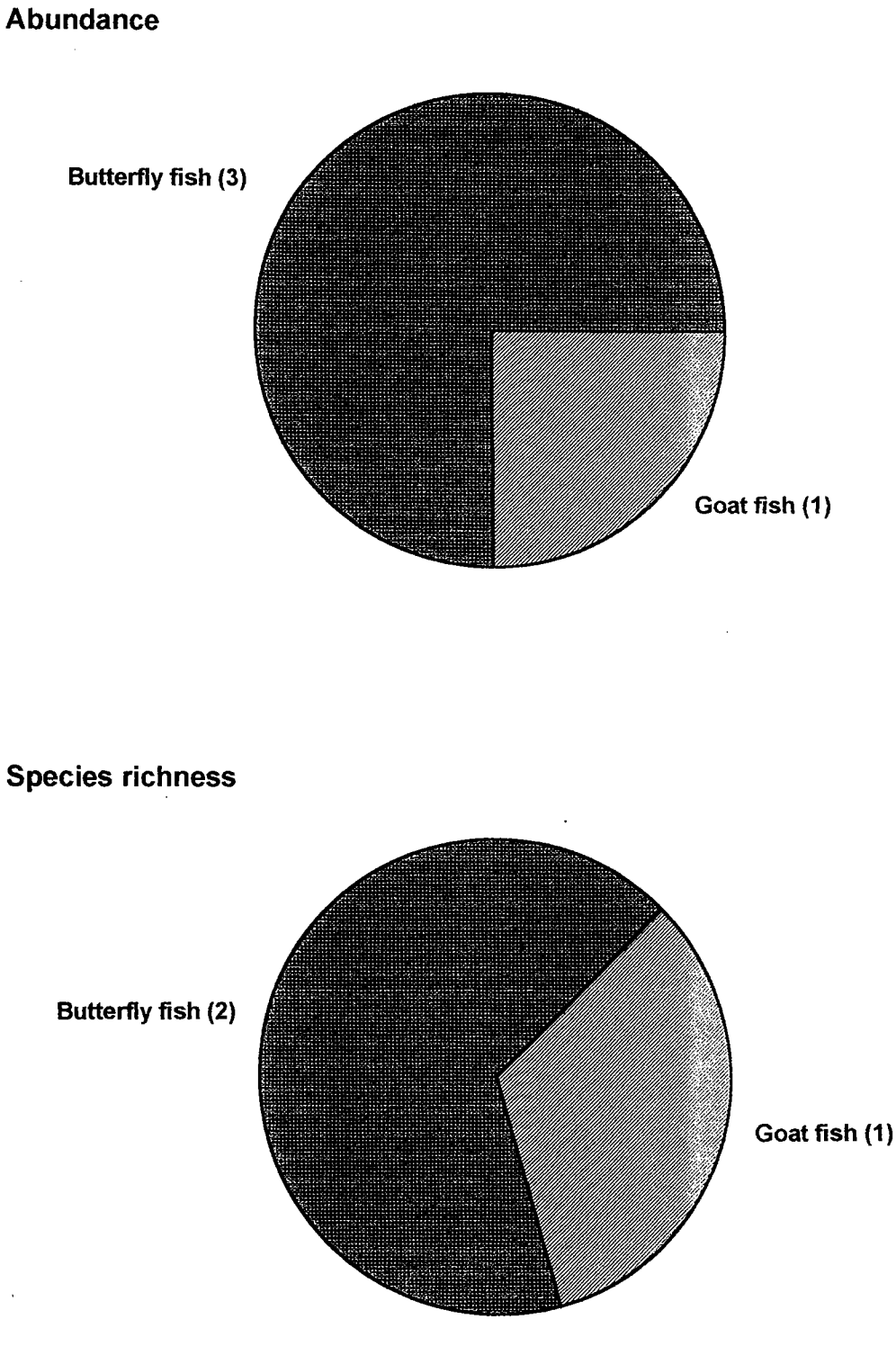


Figure 3.21 The abundance and species richness of reef fish at site MF7.

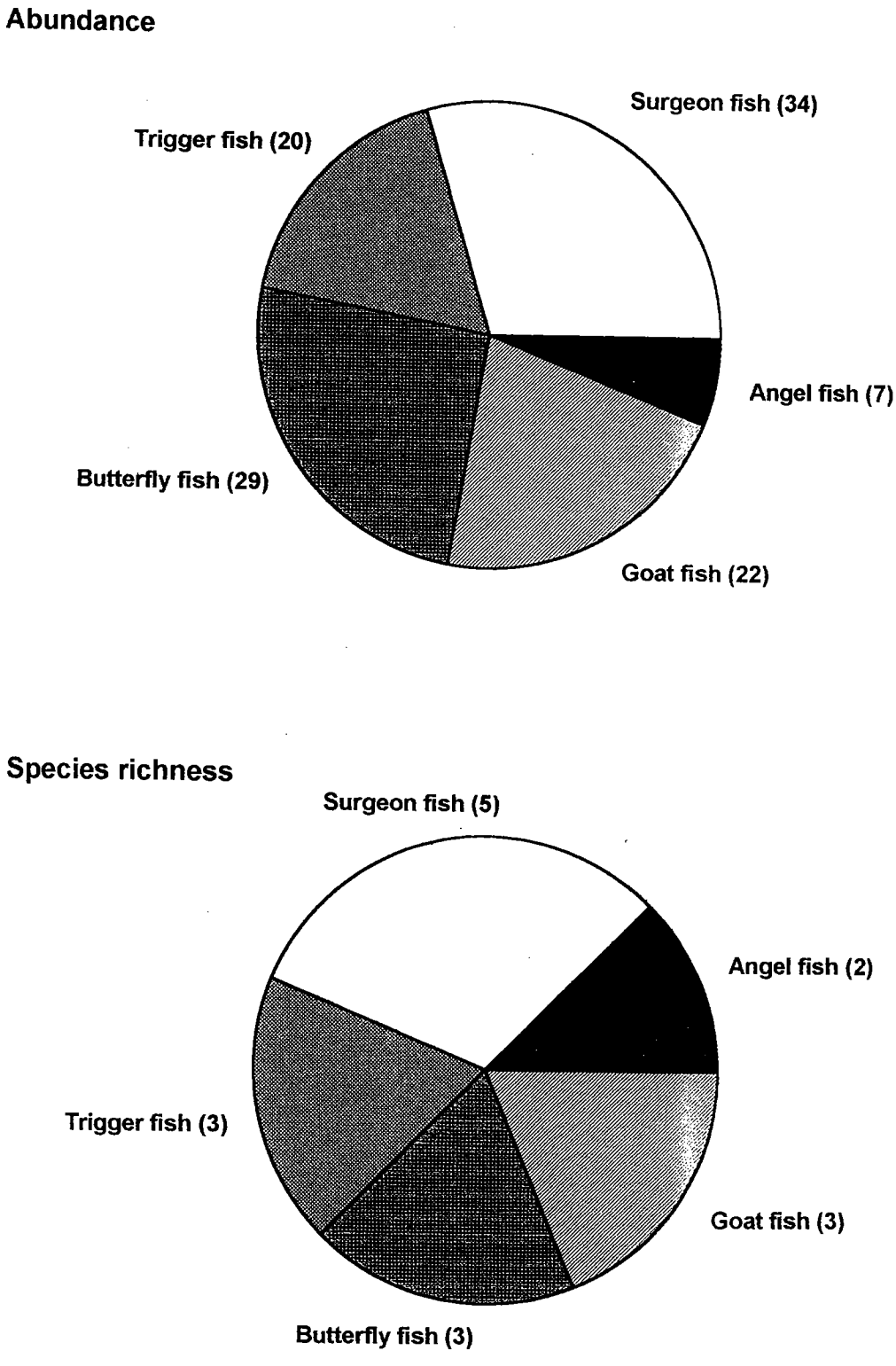
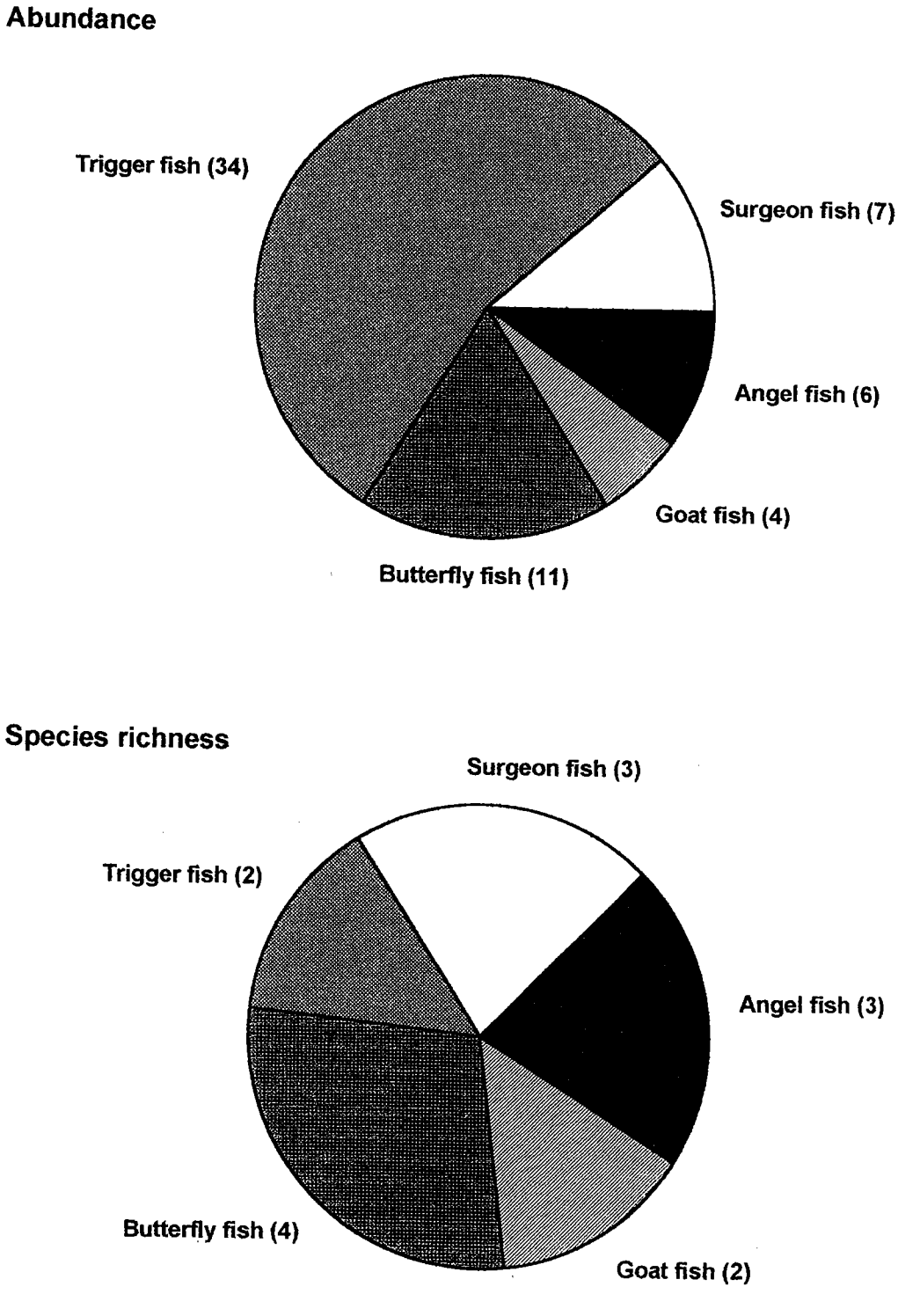


Figure 3.22 The abundance and species richness of reef fish at site MF8.



3.7 Commercial Fish Census

Commercial fish survey sites are the same as for subtidal habitat surveys (section 3.4).

3.7.1 Overview

The distribution of commercial fish was typical of many of the islands in the present survey, with higher numbers occurring on outer reef sites, and in the deep channel to the north of Mefunvo island. Sites MF4-7 have not been described as commercial fish were absent. As at Quisiva island, the numerically dominant family were the snappers (Lutjanidae).

3.7.2 Site Reports

Site MF1:
This site yielded 8 species but only 18 fish, of which 9 were the Bullethead parrotfish *Scarus sordidus*. Groupers (Serranids) of 4 species were also seen. The abundance and distribution of commercial fish at this site have been presented graphically in Fig. 3.23.

Site MF2:
There were 31 fish from 10 species seen at this site, of which many were groupers (Serranids). The most common was the Bluebarred parrotfish *Scarus ghobban*. The abundance and distribution of commercial fish at this site have been presented in Fig. 3.24.

Site MF3:
This site yielded 213 fish from 8 species, although two species dominated the results: 130 were the Onespot snapper *Lutjanus monostigma* and 66 were the Blackspotted sweetlips *Plectorhinchus gaterinus*. The abundance and distribution of commercial fish at this site have been presented graphically in Fig. 3.25.

Site MF8:
This site was the deep channel that ran to the north of Mefunvo island, and was the most diverse site for commercial fish. 176 fish from 15 species were seen. Of these, 94 were the Flametailed snapper *Lutjanus fulvus*. The abundance and distribution of commercial fish at this site have been presented graphically in Fig. 3.26.

Figure 3.23 The abundance and species richness of reef fish at site MF1.

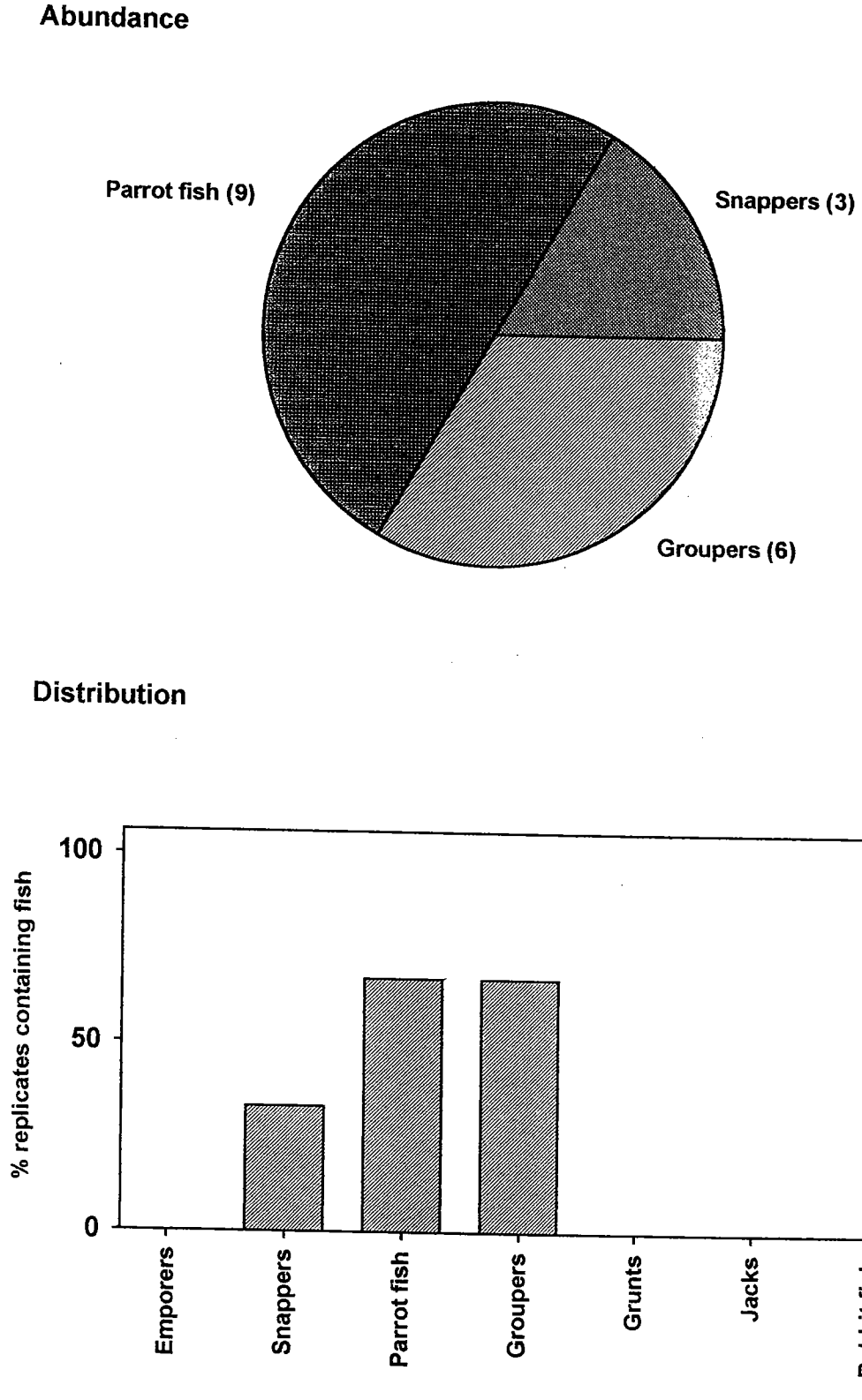
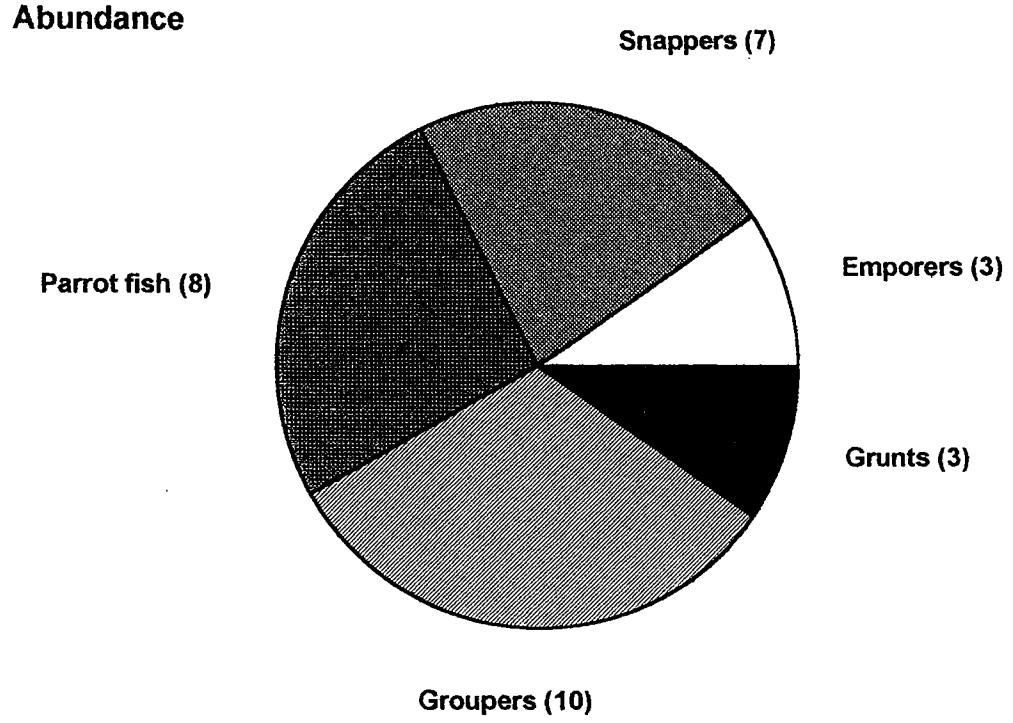


Figure 3.24 The abundance and species richness of reef fish at site MF2.



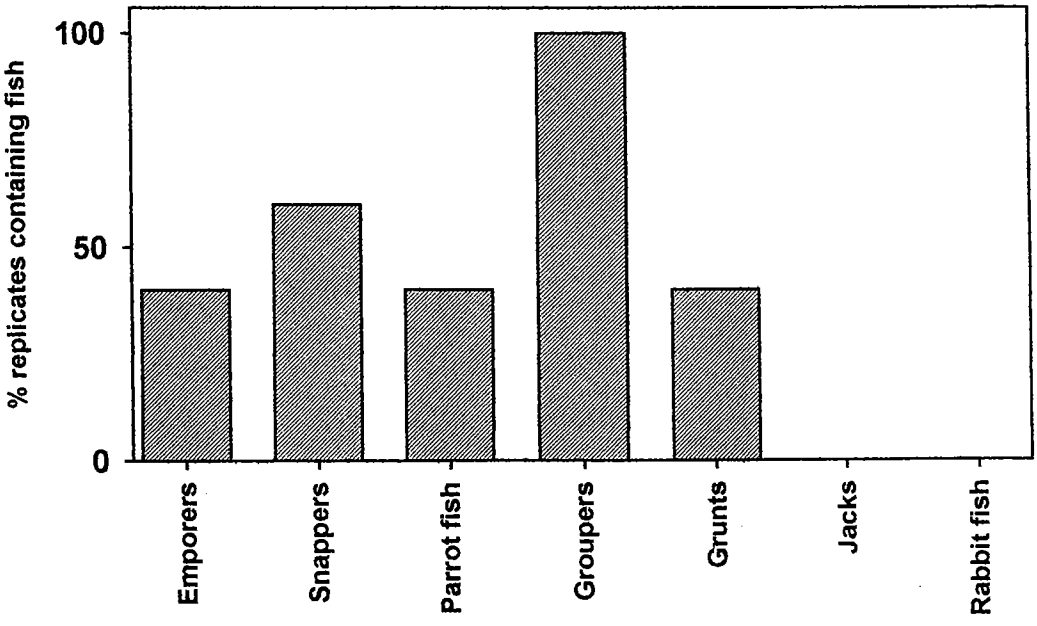
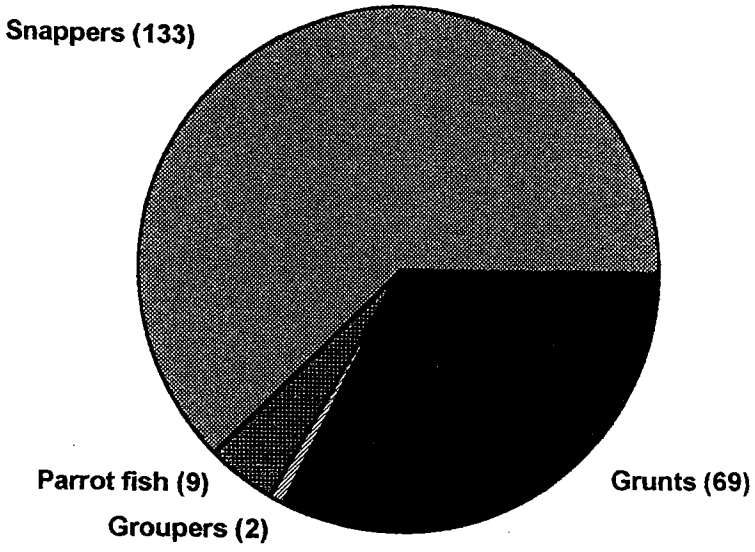


Figure 3.25 The abundance and species richness of reef fish at site MF3.

Abundance



Distribution

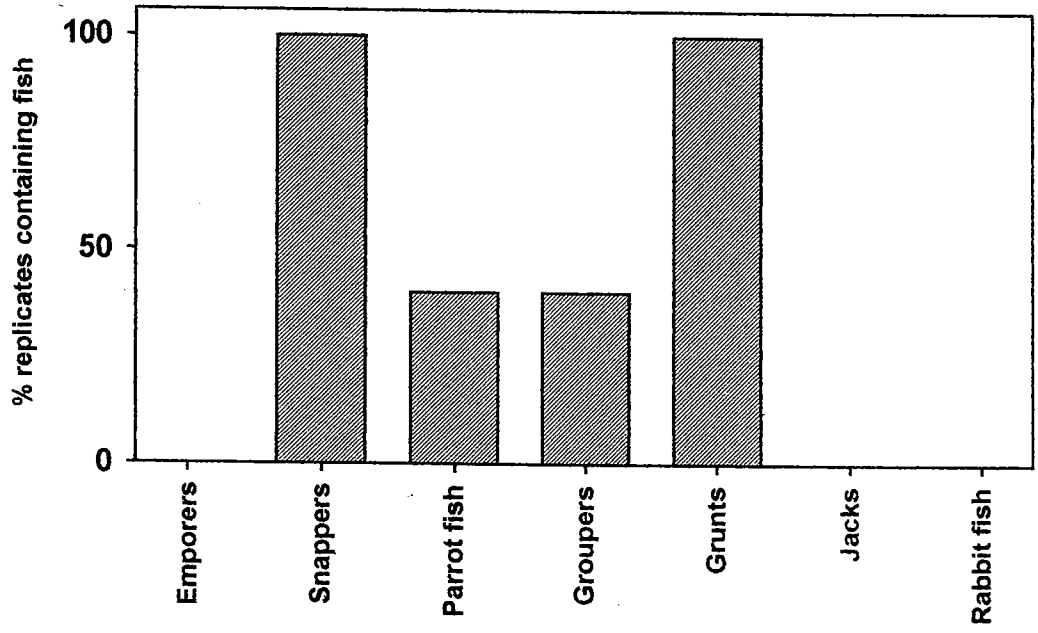
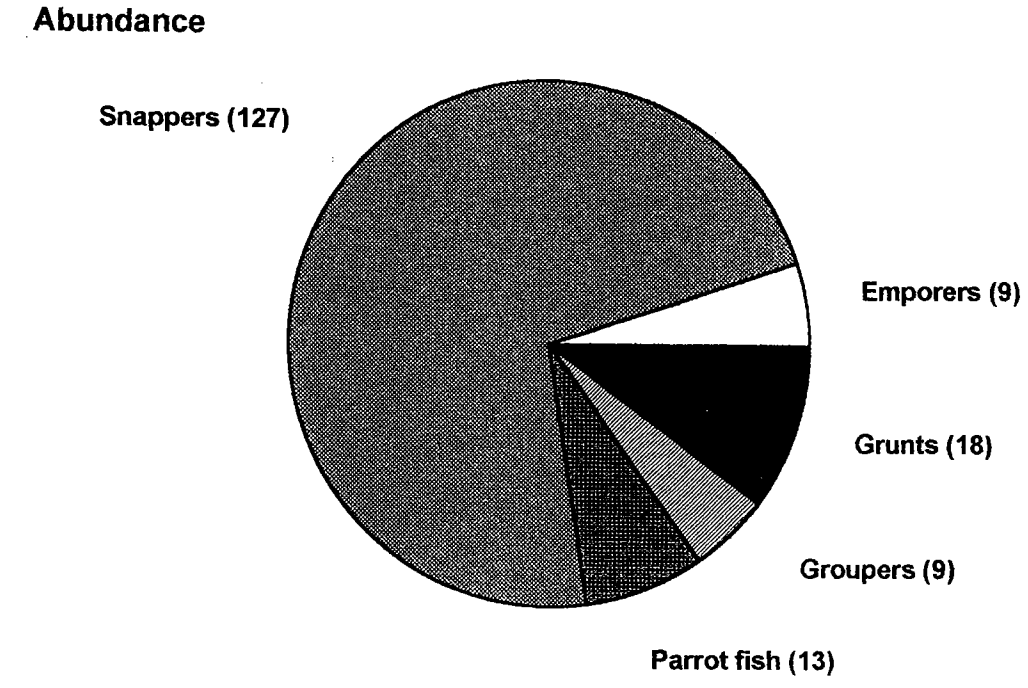
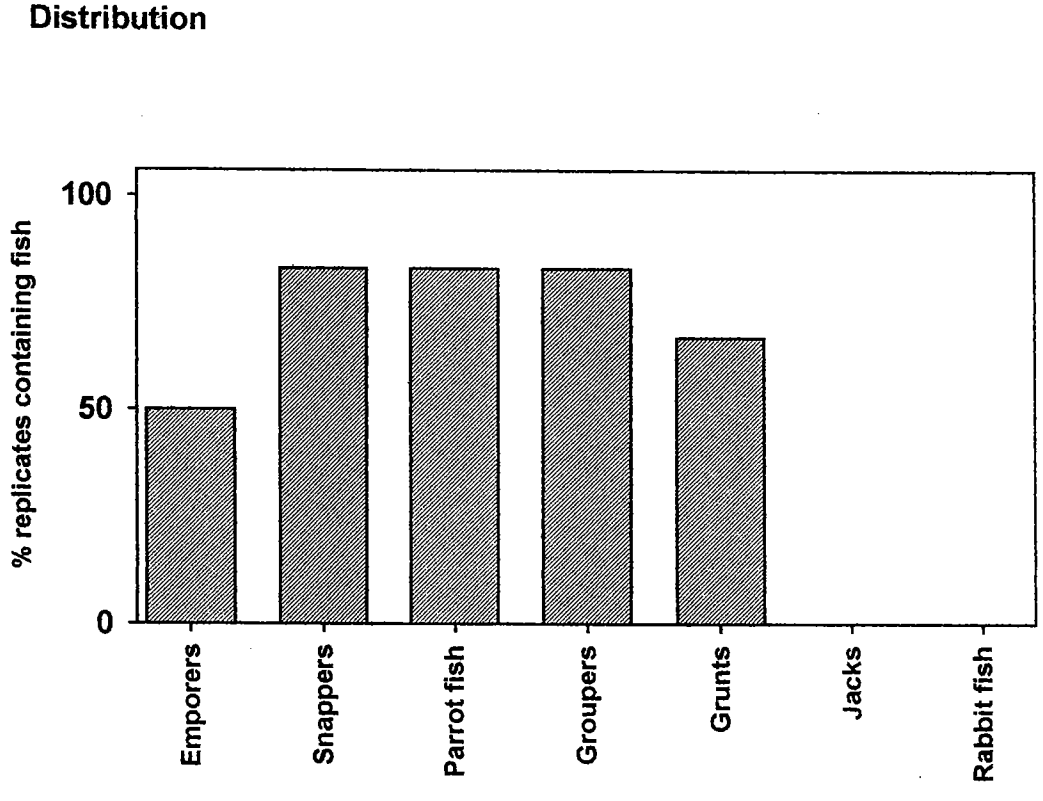


Figure 3.26 The abundance and species richness of reef fish at site MF8.





3.7.3 Size Distribution

The size distributions of the commercial fish recorded around Mefunvo island have been summarised in table 3.28. No Carangids (Tuna, Jacks) were observed in the study period. The snappers were clearly the most numerous family, with some fish quite large.

Table 3.28 Size distribution summary for the commercial fish of Mefunvo island (from 22 replicates).

'Commercial' Fish Family	Number	Estimated Median Length (cm)	Estimated Length Range (cm)
Lethrinidae	11	30	20-30
Lutjanidae	288	20	10-60
Scaridae	38	30	25-40
Serranidae	29	30	20-70
Siganids	85	20	15-40
Haemulidae	0	-	-
Carangidae	0	-	-

3.8 Finfish Fisheries

3.8.1 Overview

There is only one village on Mefunvo, situated on the north-west of the island. Access to boats is made easier for villagers as the large intertidal area, that surrounds the island, is relatively narrow and sandy at this point. Other small groups of houses and semi-permanent itinerant fishing camps also exist around the island, the two largest of these are on the south and south-western points. A lack of freshwater on the island necessitates frequent trips to the continent, which is close by (<2km). Due to the proximity of the continent and shallow depth of the waters west of the island, spring tides also make travelling to the mainland by foot a possibility.

At the time of the survey (August 1997) there were approximately 2000 residents, 500 of which are children, as well as a number of itinerant fishermen (approximately 80-100, according to the 'President' of the island) often staying for upto four months in the dry season. The involvement of the island's population with different fishing techniques is summarised in Table 3.29. Additionally, and perhaps because of the relatively good soil on the island, agriculture was said to involve upto 150 people. Although fresh water was a limiting factor, a number of types of crops were seen to grow there (these included bananas, maize, papaya, limes and sweet potatoes).

Table 3.29 A summary of the estimated population involvement with different fishing techniques.

Mefunvo Island	**Estimated No. (Aug. 97)**
Permanent Population	2000
Fishermen: resident	250
itinerant	80-100
Fishing Method	
Line	30
Seine net	156
Trap: Marema	40
Trap: Suri	5
Trap: Large Marema	0
Luwando	12 (2 traps)
Spear	40
Intertidal	0
Boats	
Sailing boats	8*
Canoes	40
Rowing Boats	0

* Refers to number of boats permanently based on the island.

The most common fishing method was seine netting, with most of the boats fishing in the seagrass areas of Montepuez Bay. Many of the fishermen using canoes utilised a combination of fishing methods with spear fishing and simple hook and line fishing being the most popular. Gill nets were also evident at both of the large itinerant camps where many of the canoes were based.

Catch composition of fish caught by sailing boats using seine nets in seagrass areas was predominantly of small fish, following the pattern of the Quirimba seagrass fishery (Central Island Group). The main species caught at the time of this study were the Variegated emperor (*Lethrinus variegatus*), the Seagrass parrotfish (*Leptoscarus vaigiensis*) and the African white spotted rabbitfish (*Siganus sutor*). See Technical Report 5, The Seagrass Fishery of Quirimba.

Spear and Line fishermen were generally catching larger fish than those working on the seagrass beds. One line fisherman indicated that between 5 and 10kg of fish was caught each day per person. These methods of fishing allowed closer access to bommie areas north and south of the island and, on occasion, west of the island on the outer reef. The main species caught included the Variegated Emperor (*Lethrinus variegatus*), the Pink-ear Emperor (*L. lentjan*), the Snubnose emperor (*L. barbonicus*), the Blackspotted sweetlips (*Plectorhinchus gaterinus*), the Oriental sweetlips (*P. orientalis*) and a variety of species of Scaridae, Serranidae and Mullidae.

Those fish not eaten by the fishermen or family members were either bartered or sold fresh or dried. The main market for fresh fish was at a collection/freezer point in the village run by a company called Willaw. Prices were between 5,000 and 10,000 Mt. per kg., depending on the size of fish. Most fish were sun dried by the fishermen and taken in bulk to the mainland, smaller fish were preferred for the ease of drying. Markets included Pemba, Arimba and Nacala and prices were said to be around 25,000 Mt. per kg., with approximately 3 kg. of fresh fish needed to give 1 kg. of dried fish.

Two large fence traps were also being built at the time of this survey, on the south and south-western intertidal areas of the island. The traps were owned by two families on the island, although three trap builders had been hired from the mainland.

3.9 Resource Collection

3.9.1 Overview

The distribution of intertidal habitats is given in Figure 3.1. The scale and patterns of collection were surveyed over 3 days in August 1997 and the results are summarised below. The areas where resources were targeted within the intertidal zone are illustrated in Fig. 3.27.

Scale and Intensity of Collection
A total of 69 people were observed collecting on the intertidal, giving an exploitation density of 5.5 people/km^2 for the entire intertidal area. The collection was higher in localised areas stretching from the south west around to the eastern shore.

Gender of Collectors
Adult women accounted for 56% of the collectors observed and the remainder included 24% men and 19% children (7 young females and 6 young males).

Group Structure
The majority (81%) of the collectors worked as individuals with the remainder working in groups.

Origin of Collectors
Of 63 collectors interviewed 57 had come from Mefunvo itself, 5 were from Quissanga and one person was from Pemba. Six people ran away from the researchers and consequently it was not possible to interview them.

Collection Methods
Eighty-six percent of collectors used iron rods and 14% collected by hand. Iron rods were used to collect octopi and fish in the rock pools and in shallow subtidal waters. Gastropods were collected by hand for food ('FO') and for the curio trade ('CT') and sea-cucumbers were also taken in the sand and coral rag/seagrass areas.

Catch composition

The main target resource were the octopi and during three days of the survey period 121 specimens were recorded from the catches (not a complete record of total catch). The other collected resources were *Chicoreus ramosus* (69 specimens), *Holothuria* spp. (60 specimens) and *Fasciolaria trapezium* (48 specimens) involving 6, 9 and 8 people respectively. The other targeted resources involved fewer people and included 2 specimens of 'CT' gastropods (1 collector), 10 specimens of FO gastropods (1 collector), 1 specimen of cuttle fish (1 collector), 50 bivalve specimens (2 collectors), 5 specimens of crustaceans (4 collectors), and diverse fish (4 collectors).

A trader near Mefunvo village was buying shells for the curio trade from local collectors. Prices were reported to range up to 15,000 Meticais per shell depending on size and species with the Trumpet shell *Charonia tritonis* being the most sought after. Other important species were the Bull-mouth helmet (*Cypraecassis rufa*), Horned helmet (*Cassis cornuta*), Spider conch (*Lambis lambis*) and Tiger cowry (*Cypraea tigris*). Five hundred large shells were reportedly taken to Nacala every 4 months.

3.9.2 Distribution of effort across intertidal zones

All collection was observed to take place on the sand and coral rag/seagrass beds where collector density reached 11.5 people/km^2. No-one was seen working on either the lagoon, reef crest or nearshore rocks.

3.9.3 Subtidal Collection

During the study period no subtidal collection of molluscs, holothuria or crustaceans was observed.

3.9.4 Discussion

The collection intensity for Mefunvo Island was variable from area to area. The highest pressure was observed on the south western and eastern shores. The lowest collection intensity was observed on the northern shore, where density was <1 person/km^2. The concentration of collection pressure in localised areas indicates that the distribution of resources was not uniform throughout the intertidal zone.

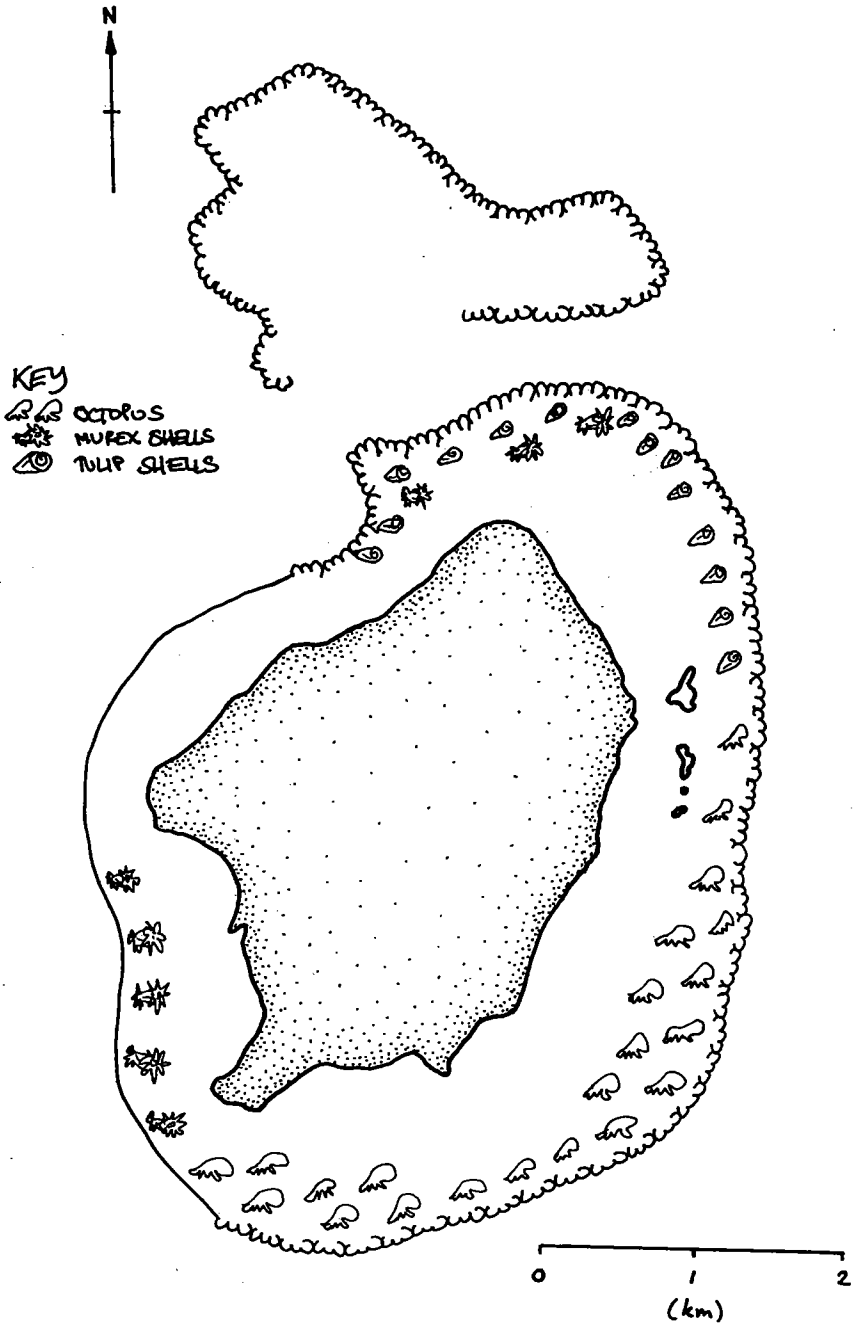
In Mefunvo the collection of intertidal resources was undertaken mostly by adult women, unlike both Quisiva (equal gender split) and Quipaco (mostly adult males). The
distinct patterns among the islands can be explained by the variability in the number of itinerant fishermen present - this group generally contributes greatly to the total number of collectors observed in some islands.

Children were only observed in the sand/seagrass zones close to the village, due probably to the difficulty of travel among sites. Typically both men and women

collected in all areas irrespective of distance from home. Catch composition among adult males and females was similar.

Octopi were the main target of collection and were the most abundant resource constituting an important source of food and income for the islanders. The second most collected resources were holothuria and 'CT' gastropods to be sold in Tanzania and to dealers in Pemba and Nacala.

Figure 3.27 Target areas for intertidal resources on Mefunvo Island.



4.0 QUISIVA ISLAND

4.1 Introduction

Quisiva (12°35'42"S 40°37'00"E) is a small island (1.2km by 2.8km) situated to the north of the Arimba peninsular (Fig. 1.1). Historically it was the site of a Portuguese convent in the seventeenth century, but in more recent times the island has only been permanently inhabited for the past thirty years. At the time of the survey work (August 1996) there were approximately twenty houses on the island. There is a small well in the village supplying limited freshwater (quantities and quality varies seasonally with the rainfall patterns). The alternative source of freshwater is from Arimba (about one hours journey by sailing boat) where there is also a small market for the purchase of goods. Close to the village are a few small 'shambas' for vegetable cultivation. The island is also home to a well-known witch doctor ('curandeiro') who serves many of the islands and nearby coastal villages.

At the island's westernmost point lies a long sandbar which forms a sheltered anchorage for local boats. To the north and south lie large expanses of sand and seagrass beds. To the east of the island a fringing reef exists which forms large underwater cliffs at its northern section.

4.2 Intertidal Surveys

4.2.1 Overview

In Quisiva Island macroalgae dominated the eastern outer reef intertidal area while seagrasses dominated the sheltered north western shore. A total of 4 seagrass, 87 macroalgae (including 1 Cyanophyta, 32 Chlorophyta, 12 Phaeophyta and 42 Rhodophyta) and 16 invertebrate species were recorded. The algal flora was dominated by members from Rhodophyta, which contributed 48% of the total diversity recorded for this island. Checklists for the recorded taxa in S.I.G. are presented in Appendix A2.

4.2.2 Area Reports

Three transects were surveyed as are shown in Figure 4.1.

'North East Area'

The 'North East Area' was a reef platform which sloped gently to low water for a distance of 1.3km and at mid-shore level included a shallow seagrass lagoon. Three zones were identified (Figure 4.2) and 2 seagrass species, 26 taxa of macroalgae and 7 taxa of invertebrates were recorded within these zones. Substratum types within each zone are summarised in Table 4.1. The distribution of taxa across zones is presented in Tables 4.2 and 4.3.

Table 4.1 Percentage cover of substratum along a typical transect within the 'North East Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Substratum	Zone 1	Zone 2	Zone 3
Sand	0	10 (0-40)	2 (0-10)
Rubble	0	80 (60-100)	0
Rock	100	0	95 (90-100)

Closest to the cliff, Zone 1 was a rock platform sparsely colonised by algae of low diversity. The most abundant invertebrate was *Morula granulata* (with mean density of 20+ individuals/m^2). Zone 2 comprised a shallow seagrass lagoon with *Thalasso-dendron ciliatum* the dominant species (30 - 95% cover). The reef crest (Zone 3) was very exposed and consequently supported low macroalgal diversity and cover. In this zone no target invertebrate species were recorded.

Table 4.2 Percentage cover of seagrasses and macroalgae along a typical transect within the 'North East Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Taxonomic group	Zone 1	Zone 2	Zone 3
Seagrass			
Thalassia hemprichii	0	0-P	0
Thalassodendron ciliatum	0	50 (30-95)	0
Macroalgae			
Acanthophora muscoides	0	0-P	0
Chaetomorpha crassa	2 (0-10)	0	0
Cladophora mauritiana	5 (0-30)	0	0
Dictyosphaeria cavernosa	0-P	0	0
D. verluysii	0	0	0-P
Gelidiella acerosa	0	0	0-P
Gracilaria fergusoni	0	0	0-P
Halimeda opuntia	0-P	5 (0-30)	0-P
H. tuna	0	0-P	0
Hydroclathrus clatrathus	0-P	0-P	0 (0-20)
Hypnea hamulosa	0	0-P	0
Hypnea sp.	0-P	0-P	0
Jania adhaerens	0	0-P	0
Laurencia papillosa	0 (0-1)	0	0
Liagora ceranoides	0	0	0-P
Lyngbya majuscula	0	0	0-P
Neomeris van bosseae	0	0	0-P
Padina gymnospora	0	0 (0-36)	0
Poritiera pulvinata	0	0	0-P
Sargassum aquifolium	0	0	0-P
S. duplicatum	0	0	0 (0-1)
Turbinaria ornata	0	0	0-P
Ulva lactuca	0-P	1 (0-8)	0
U. pertusa	0	0	0 (0-1)
U. pulchra	0	2 (0-15)	10 (0-45)
U. reticulata	0-P	0	0

Table 4.3 Abundance (individuals/m^2, n=10) of invertebrate taxa along a typical transect within the 'North East Area'.

Taxonomic group	Zone 1	Zone 2	Zone 3
Gastropods			
Conus ebraeus	0 (0-1)	0	0
Cypraea annulus	0	0 (0-7)	0
Marginella sp.	0	0 (0-1)	0
Morula granulata	52.5 (0-60)	0 (0-4)	0
Rhinoclavis sinensis	0	0 (0-1)	0
Strombus mutabilis	0	0 (0-1)	0
Echinoderms			
Stomopneustes sp.	0	5 (0-10)	0

'North West Area'

Three zones were identified (Fig. 4.3) and 3 seagrass, 13 macroalgae and 11 invertebrate species were recorded. The substratum types within each zone are summarised in Table 4.4. The distribution of taxa across zones is presented in Tables 4.5 and 4.6.

Table 4.4 Percentage cover of substratum along a typical transect within the 'North West Area' (P<1% of cover). Median values and ranges (in brackets) are presented.

Substratum	Zone 1	Zone 2	Zone 3
Sand	0	33 (0-100)	100
Rock	100	67 (0-100)	0

Zone 1 had low algal diversity and cover but supported a relatively high diversity and density of invertebrates of which *Morula granulata* (with mean 65.6 individuals/m^2) dominated. *Nerita textilis* and *Patella* sp. were also common. Zone 2 was a rock platform with a good cover of sand and thus few rock-dwelling macroalgae colonised this zone. Zone 3 was a sand flat with a patchy cover of the seagrass *Thalassia hemprichii*. The most abundant invertebrate was *Rhinoclavis* sp.

Table 4.5 Percentage cover of seagrass and macroalgae along a typical transect within the 'North West Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Taxonomic group	Zone 1	Zone 2	Zone 3
Seagrass			
Halophila ovalis	0	0	0-P
Thalassia hemprichii	0	0	24 (0-80)
Thalassodendron ciliatum	0	0	1 (0-10)
Macroalgae			
Boergesenia forbesii	0	0-P	0
Chaetomorpha crassa	0	4 (0-20)	0
Cystoseira myrica	0	0-P	0
Dictyosphaeria cavernosa	0-P	1 (0-5)	0
Gracilaria sp.	0	0-P	0
Halimeda opuntia	0	0	0-P
Hydroclathrus clathratus	0-P	0-P	0
Jania adhaerens	0	0	0 (0-15)
Spongocladia vaucheriaerformis	0	0	0-P
Ulva lactuca	5 (0-50)	0 (0-2)	0
U. pulchra	0	0-P	0
U. reticulata	0-P	0	0
Valonia aegagrophila	0-P	0	0

Table 4.6 Abundance (individuals/m^2, n=10) of invertebrate taxa along a typical transect within the 'North West Area'.

Taxonomic group	Zone 1	Zone 2	Zone 3
Gastropods			
Cypraea annulus	0 (0-1)	0	0 (0-4)
Marginella sp.	0	0	0 (0-1)
Morula granulata	1.5 (0-50)	0	0
Nerita textilis	0 (0-6)	0	0
Patella sp.	5 (0-18)	0	0
Rhinoclavis sp.	0	0	12.5 (0-100)
Thais savignyi	0 (0-1)	0	0
Trochus sp.	0	0	0 (0-2)
Bivalves			
Pinctada sp.	0	0	0 (0-1)
Pinna muricata	0	0	2 (0-5)
Chitons			
Acanthopleura sp.	0 (0-1)	0	0

'South Area'

Within the three zones identified (Fig. 4.4), 2 seagrass species, 15 species of macroalgae and 5 invertebrate species were recorded. The substratum types in each zone are summarised in Table 4.7. The distribution of taxa across zones are presented in Tables 4.8 and 4.9.

Table 4.7 Percentage cover of substratum along a typical transect within the 'South Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Substratum	Zone 1	Zone 2	Zone 3
Sand	100	20 (0-100)	100
Rock	0	80 (0-100)	0

Zone 1 was a narrow sand beach devoid of conspicuous biota. Zone 2 was predominantly rock colonised by relatively diverse algae with *Morula granulata* and *Echinometra mathaei* being the most common invertebrates. Zone 3 was mostly sand with a very low cover of seagrasses and macroalgae.

Table 4.8 Percentage cover of seagrass and macroalgae along a typical transect within the 'South Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Taxonomic group	Zone 1	Zone 2	Zone 3
Seagrass			
Halophila ovalis	0	0	0-P
Thalassia hemprichii	0	0	0 (0-4)
Macroalgae			
Centroceras clavulatum	0	0-P	0
Cistoseira myrica	0	0 (0-2)	0
C. trinodis	0	0 (0-10)	0
Cladophora sp.	0	0-P	0-P
Dictyosphaeria cavernosa	0	0-P	0
Gelidiella acerosa	0	0-P	0
Halimeda cilindracea	0	0	0-P
H. opuntia	0	0-P	0 (0-1)
Hydroclathrus clatrathus	0	2 (1-6)	0 (0-1)
Hypnea nidifica	0	0-P	0
Laurencia obtusa	0	0 (0-15)	0
L. papillosa	0	1 (0-9)	0 (0-1)
Sargassum asperifolium	0	0-P	0
Ulva pulchra	0	0-P	0
Vanvoorstia spectabilis	0	0 (0-9)	0

Table 4.9 Abundance (individuals/m^2, n=10) of invertebrate taxa along a typical transect within the 'South Area'

Taxonomic group	Zone 1	Zone 2	Zone 3
Gastropods			
Cypraea annulus	0	0 (0-1)	0
Morula granulata	0	5.5 (0-46)	0
Nerita textilis	0	0 (0-2)	0
Strombus mutabilis	0	0 (0-1)	0
Echinoderm			
Echinometra mathaei	0	2 (0-10)	0

Figure 4.1 Intertidal transect locations on Quisiva Island.

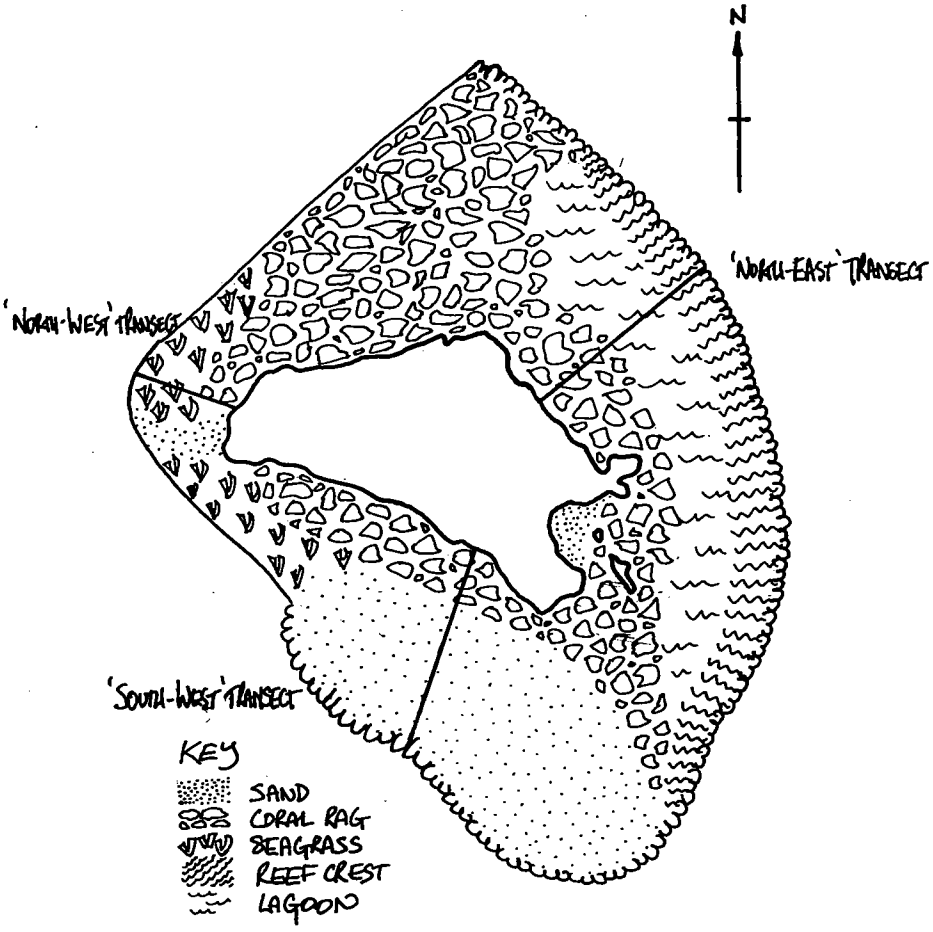


Figure 4.2 Intertidal transect: north-east Quisiva Island.

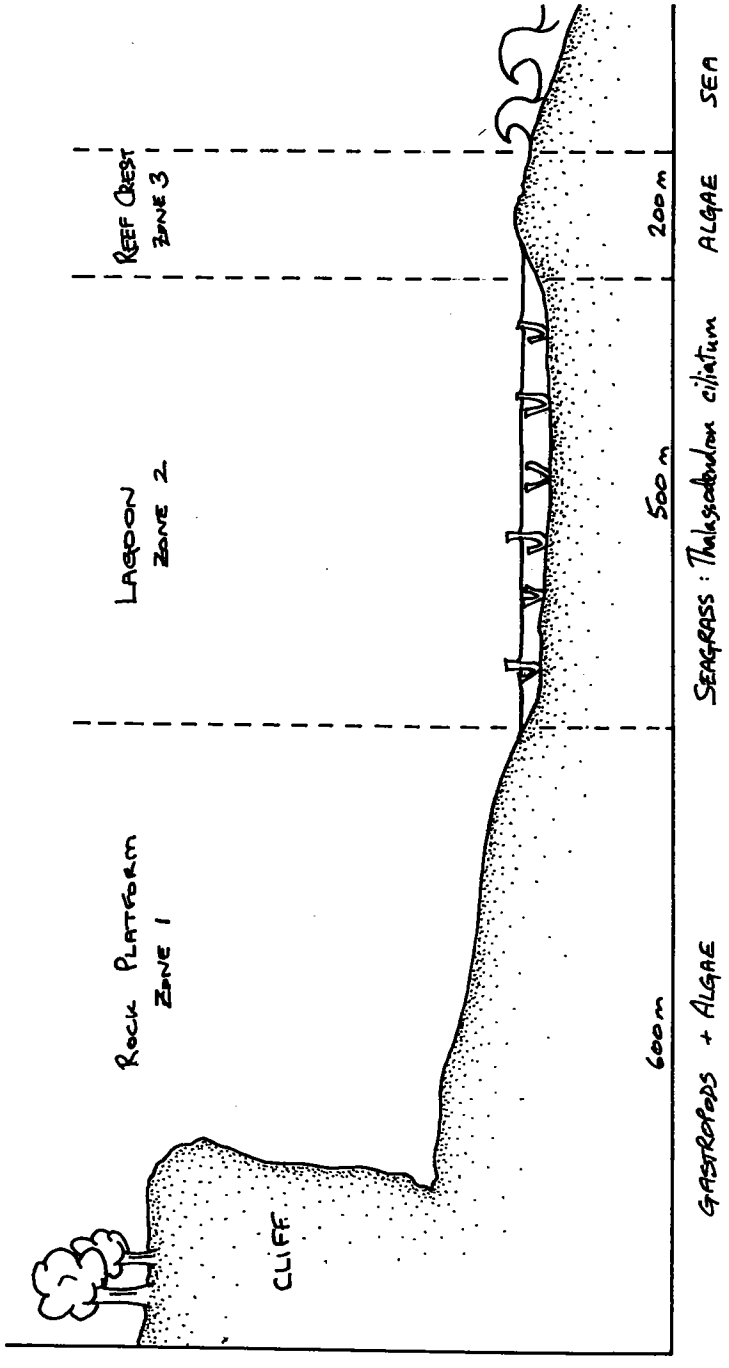


Figure 4.3 Intertidal transect: north-west Quisiva Island.

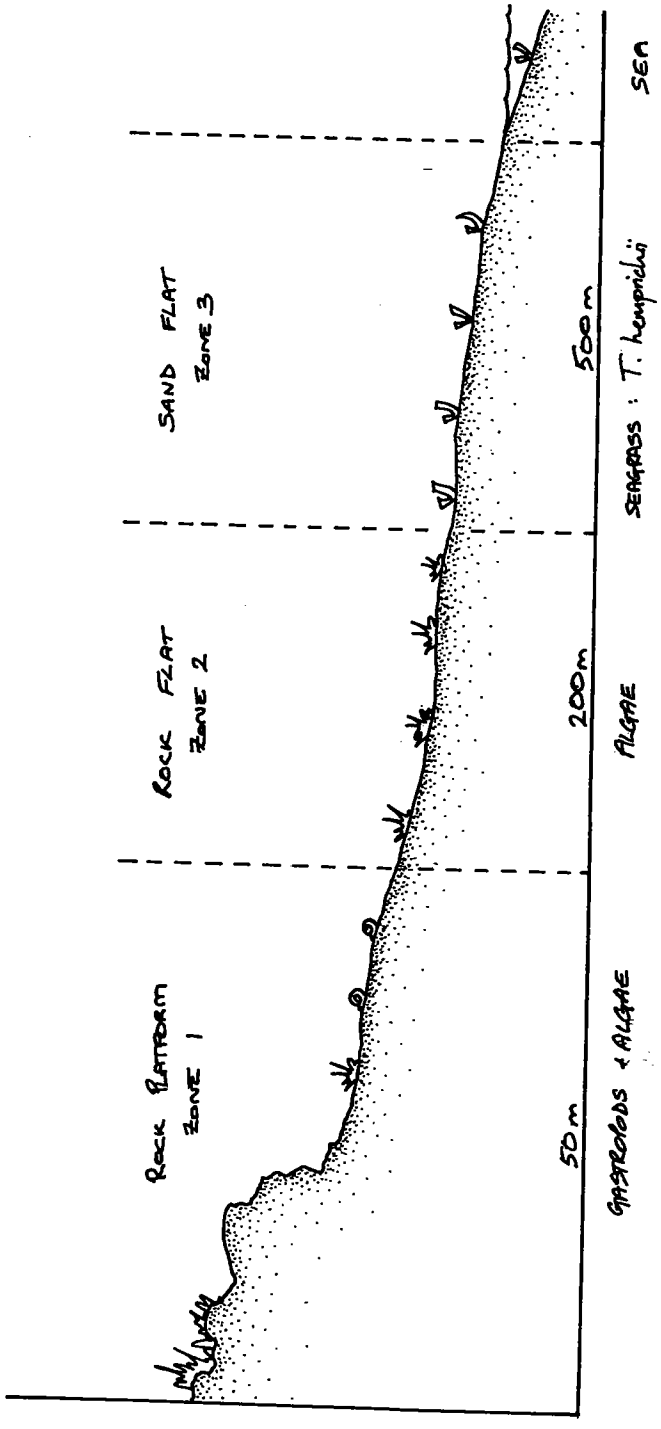
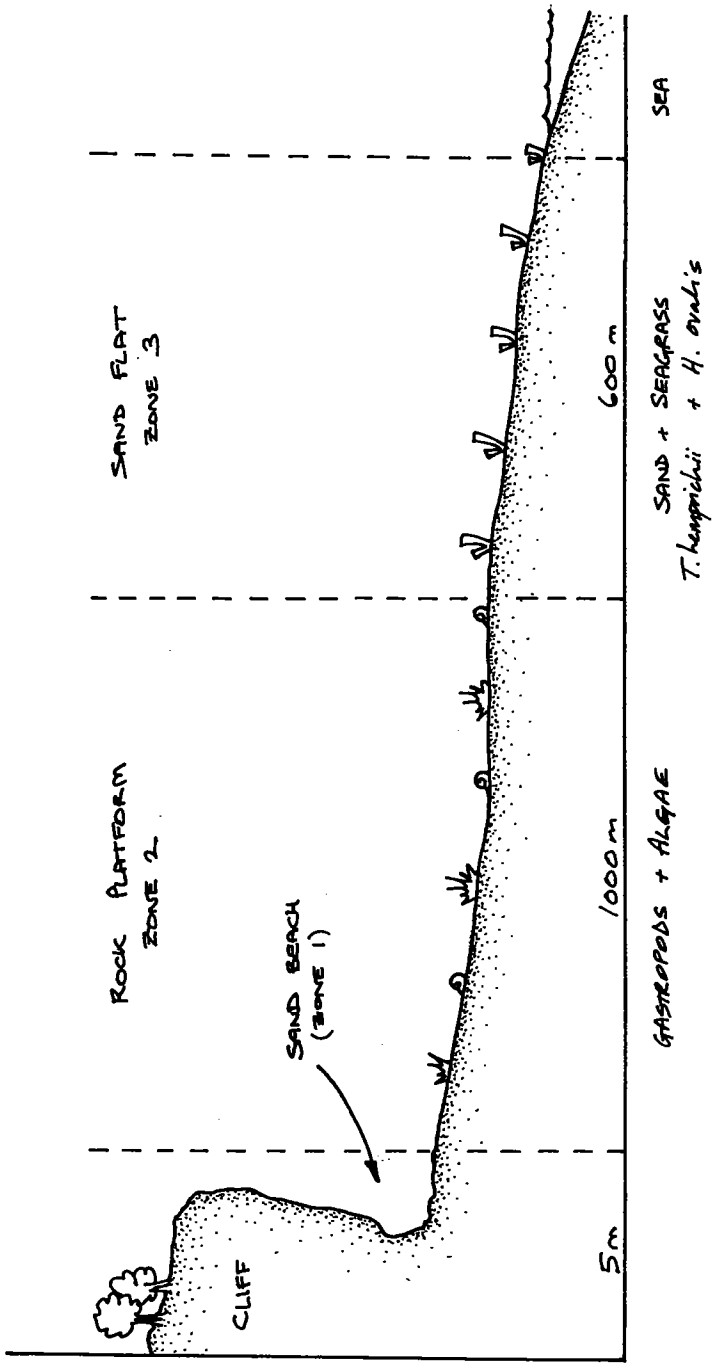


Figure 4.4 Intertidal transect: south-west Quisiva Island.



4.3 Mangrove Surveys

4.3.1 Overview

No mangrove trees were observed during the survey of Quisiva island. Isolated trees may have existed behind rock outcrops close to high water that were not recorded, but no mangrove stand was present.

4.4 Subtidal Habitat Surveys

Subtidal surveys were conducted around all sides of the island, although more concentrated on the eastern shores where the main areas of coral reef were found. The surveys were grouped into five areas as marked on Figure 4.5.

4.4.1 Overview

Reef Structure and Composition
There were marked differences in the reef slopes, with the exposed outer reef being composed of both vertical walls and near-horizontal platforms and the more sheltered reefs possessing a gently sloping reef over the entire profile (site QS5 was flat sand). Rugosity was similarly varied, with a completely flat surface at site QS5 to a rugose, fully-developed reef in parts at site QS2. The composition of the substratum was similarly varied; ranging from areas where rock was dominant (sites QS2 and QS3), to areas of mixed substratum (sites QS1 and QS4) to non-reef areas composed entirely of sand.

At sites QS1-QS4 hard corals were the dominant biota, with abundances greatest at QS2 (all corals were absent from QS5). Soft corals were common at most sites, particularly on the shallower parts of the reefs. Seagrasses, macroalgae and *Halimeda* spp. were present at most sites but abundances were low. Hard corals were heterogeneous in form at all reef sites.

4.4.2 Site Reports

Site QS1:
The reef structure and community composition are summarised in Table 4.10 and Figure 4.6 and are described below.

Reef Structure
The reef at this site was well-developed, being extensive both vertically and horizontally and possessing well-defined morphological/biological zones. A near vertical rock wall extended from 12-18 m and in places was undercut to form small caves. Below the wall at 18-20 m there was a sand/rubble slope (30°) which became less steep with depth. Above the wall was a 'spur and groove' zone, with a minimal slope that extended to the intertidal zone. Rugosity was similar at all depths, although tending to be lower at the base of the reef.

Substratum Composition

The vertical wall, where it existed at this site, was constructed entirely from rock but elsewhere there was a mix of substrata with rock tending to be dominant.

Biotic Cover

Hard and soft corals comprised the majority of the biotic cover present, being abundant over much of the reef. Very little macroalgae or *Halimeda* spp. were recorded. The hard corals were entirely heterogeneous in form, with no dominant forms present.

Table 4.10 A summary of the structure, composition and biotic cover at QS1 (P<1 % cover).

Reef Features		Upper Reef (n=12) Mode (0-6)	Upper Reef (n=12) Range (0-6)	Lower Reef (n=12) Mode (0-6)	Lower Reef (n=12) Range (0-6)
Morphology	Slope (°)	70	60-70	30	30-50
	Rugosity	3	2-3	2	1-3
Substratum	Rock	2	2-3	3	1-3
	Rubble	3	P-4	2	1-2
	Sand/Shell	3	2-4	3	1-3
	Mud	0	0	0	0
Biota	Hard Coral	3	3-4	2	1-2
	Soft Coral	2	2	2	P-3
	Seagrass	0	0	0	0
	Macroalgae	2	1-2	P	0-P
	Halimeda spp.	P	P	0	0
Coral State	Heterogeneity	0	0	0	0
	Dominance	None		None	

Site QS2:

The reef structure and community composition are summarised in Table 4.11 and Figure 4.7 and are described below.

Reef Structure

The reef at this site shared many of the characteristics of site QS1, with a shallow, flat, plateau dropping down a steep or vertical rock wall, and ending with a shallow slope to the base of the reef (approximately 20m depth). Rugosity tended to be highest towards the base of the reef. A profile of this site has been presented graphically, with a breakdown of the various coral forms (Fig. 4.8).

Substratum Composition

The reef was mainly comprised of rock, especially in the steeper sections. Sand was abundant in places on the plateau above the wall. Rubble occurred in very small quantities only.

Biotic Cover

Hard corals were the dominant biota on the reef, being most abundant at 20m and least abundant at 10m. Soft corals covered approximately 25% of the lower reef, but were less abundant shallower. Macroalgae and *Halimeda* spp. were present in low abundances at all depths, whilst seagrasses were only present at the top of the reef. Hard corals were generally heterogeneous in form, with only 'foliose' form corals dominant at the base of the reef.

Table 4.11 A summary of the structure, composition and biotic cover at QS2 (P<1 % cover)

Reef Features		Upper Reef (n=12) Mode (0-6)	Upper Reef (n=12) Range (0-6)	Lower Reef (n=12) Mode (0-6)	Lower Reef (n=12) Range (0-6)
Morphology	Slope (°)	0	0	80	75-90
	Rugosity	2	2-3	3	3-5
Substratum	Rock	2	1-3	6	6
	Rubble	P	P	0	0
	Sand/Shell	5	4-5	1	0-1
	Mud	1	1	0	0
Biota	Hard Coral	2	2-3	4	4-5
	Soft Coral	1	P-1	2	2-3
	Seagrass	P	P	0	0
	Macroalgae	1	P-1	P	0-P
	Halimeda spp.	1	P-1	P	0-P
Coral State	Heterogeneity	0	0	0	0
	Dominance	None		Foliose	

Site QS3:

The reef structure and community composition are summarised in Table 4.12 and described below.

Reef Structure

The reef structure at this site differed considerably with sites QS1 and QS2, having a relatively gentle slope over the entire reef profile. Rugosities were also relatively low, reflecting the lower coral development over much of the site. A profile of this site has been presented graphically, with a breakdown of the various coral forms (Fig. 4.9).

Substratum Composition

The composition of the substratum varied little with depth, there being a generally equal proportion of rock, rubble and sand. Towards the bottom of the reef rock became dominant.

Biotic Cover

Hard corals were the most abundant biota at all depths, although least developed towards the top of the reef. Soft corals tended to be present in relatively low abundances, whilst seagrasses, macroalgae and *Halimeda* spp. were uncommon. Hard corals were heterogeneous in form, although 'table' and 'encrusting' forms were abundant in some areas.

Table 4.12 A summary of the structure, composition and biotic cover at QS3 (P<1 % cover)

Reef Features		Upper Reef (n=12) Mode (0-6)	Upper Reef (n=12) Range (0-6)	Lower Reef (n=12) Mode (0-6)	Lower Reef (n=12) Range (0-6)
Morphology	Slope (°)	5	0-10	0	0-5
	Rugosity	1	0-2	3	2-4
Substratum	Rock	3	2-3	6	5-6
	Rubble	3	2-3	2	1-3
	Sand/Shell	2	2-3	1	P-2
	Mud	0	0	0	0
Biota	Hard Coral	2	2-3	3	3-4
	Soft Coral	1	0-1	2	1-2
	Seagrass	0	0	P	0-1
	Macroalgae	2	0-2	1	P-2
	Halimeda spp.	P	0-P	P	0-P
Coral State	Heterogeneity	0	0	0	0
	Dominance	None		None	

Site QS4:

The reef structure and community composition are summarised in Table 4.13 and described below.

Reef Structure

This site had a relatively sheltered aspect and the reef formed a wide platform, with little or no slope. The morphology was typified by widely spaced and alternating flat sand/rubble areas which were dotted with coral bommies and elongated coral 'spurs' (<4m high, 10m wide and 100m long). Rugosities were moderate over all the reef.

Substratum Composition

Generally rubble was the most dominant component of the reef substrata, although rock and sand were also widespread.

Biotic Cover

Although hard corals were the most abundant biota present, their abundances were not high (typically <15% cover). The other biota recorded were less abundant, each covering approximately 1% of the reef area. The 'branching' form was the only hard coral form that was dominant over parts of the site.

Table 4.13 A summary of the structure, composition and biotic cover at QS4 (P<1 % cover).

Reef Features		Upper Reef (n=12) Mode (0-6)	Upper Reef (n=12) Range (0-6)	Lower Reef (n=12) Mode (0-6)	Lower Reef (n=12) Range (0-6)
Morphology	Slope (°)	0	0	5	0-5
	Rugosity	2	2-3	2	2-3
Substratum	Rock	2	2-3	3	3-4
	Rubble	3	2-3	3	2-3
	Sand/Shell	2	2	2	2-3
	Mud	0	0	0	0
Biota	Hard Coral	2	2	2	2-3
	Soft Coral	2	2	1	0-1
	Seagrass	P	0-1	P	0-P
	Macroalgae	1	P-1	P	0-P
	Halimeda spp.	1	P-1	P	0-P
Coral State	Heterogeneity	0	0	0	0
	Dominance	None		Branching	

Site QS5:

The reef structure and community composition are summarised in Table 4.14 and described below.

Site Description:

This site was essentially a bare, flat, sand plain, with only seagrass present in limited abundances.

Table 4.14 A summary of the structure, composition and biotic cover at QS5 (P<1 % cover).

Reef Features		Upper Reef (n=6) Mode (0-6)	Upper Reef (n=6) Range (0-6)
Morphology	Slope (°)	0	0
	Rugosity	0	0
Substratum	Rock	0	0
	Rubble	0	0
	Sand/Shell	6	6
	Mud	0	0
Biota	Hard Coral	0	0
	Soft Coral	0	0
	Seagrass	P	0-P
	Macroalgae	0	0
	Halimeda spp.	0	0
Coral State	Heterogeneity	0	0
	Dominance	None	

4.4.3 Subtidal Algae

Seagrasses were not observed at the outer reef sites surveyed (QS1 and QS4). A total of 14 species of macroalgae including 5 Chlorophyta, 3 Phaeophyta and 6 Rhodophyta were recorded. A species list for the S.I.G. is shown in Appendix A2.

Site reports

Site QS1:

This site comprised a steep reef wall (27m) with sand and rubble substratum at the base. The algal diversity and abundance were very low here, only 4 species were recorded.

Site QS4:

A total of 11 species of macroalgae were recorded and the upper sublitoral zone was commonly colonised by *Halimeda* spp. and *Dictyota* spp. while the lower was characterised by the conspicuous occurrence of *Poritiera harvey* and *Thysanocladia dentata.*

Figure 4.5 Subtidal habitat sites: Quisiva Island.

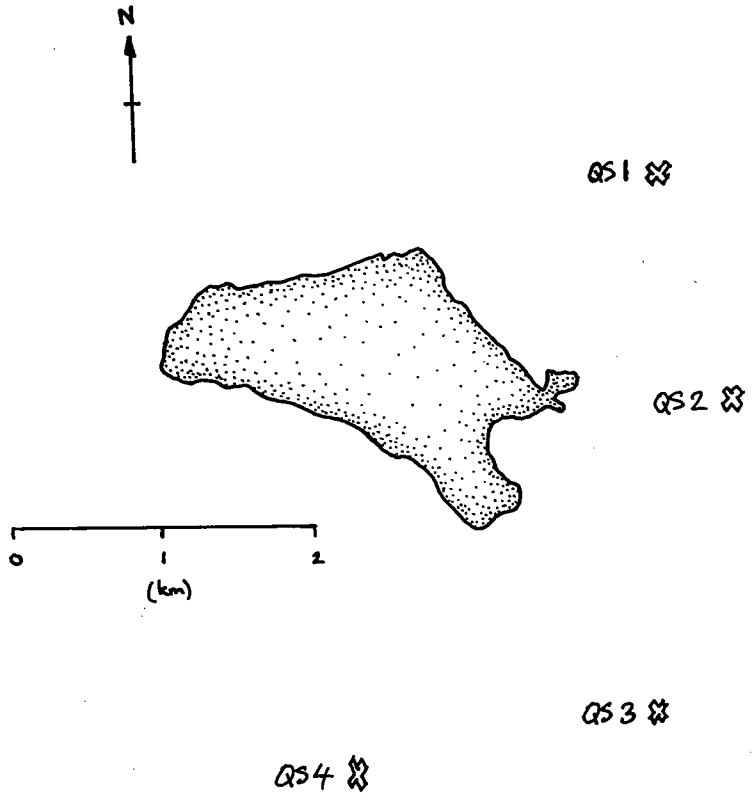


Figure 4.6 Diagram of the reef profile at QS1.

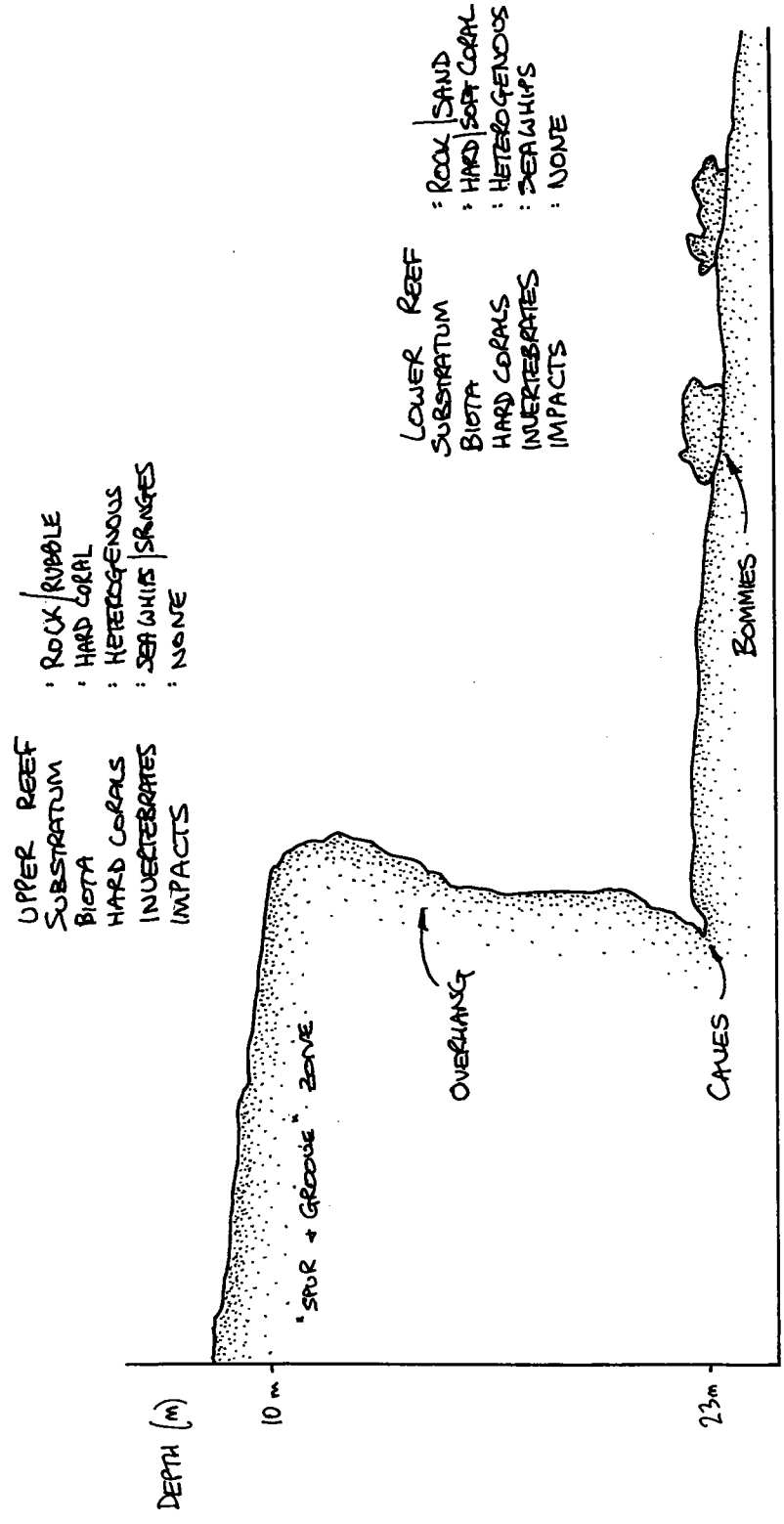


Figure 4.7 Diagram of the reef profile at QS2.

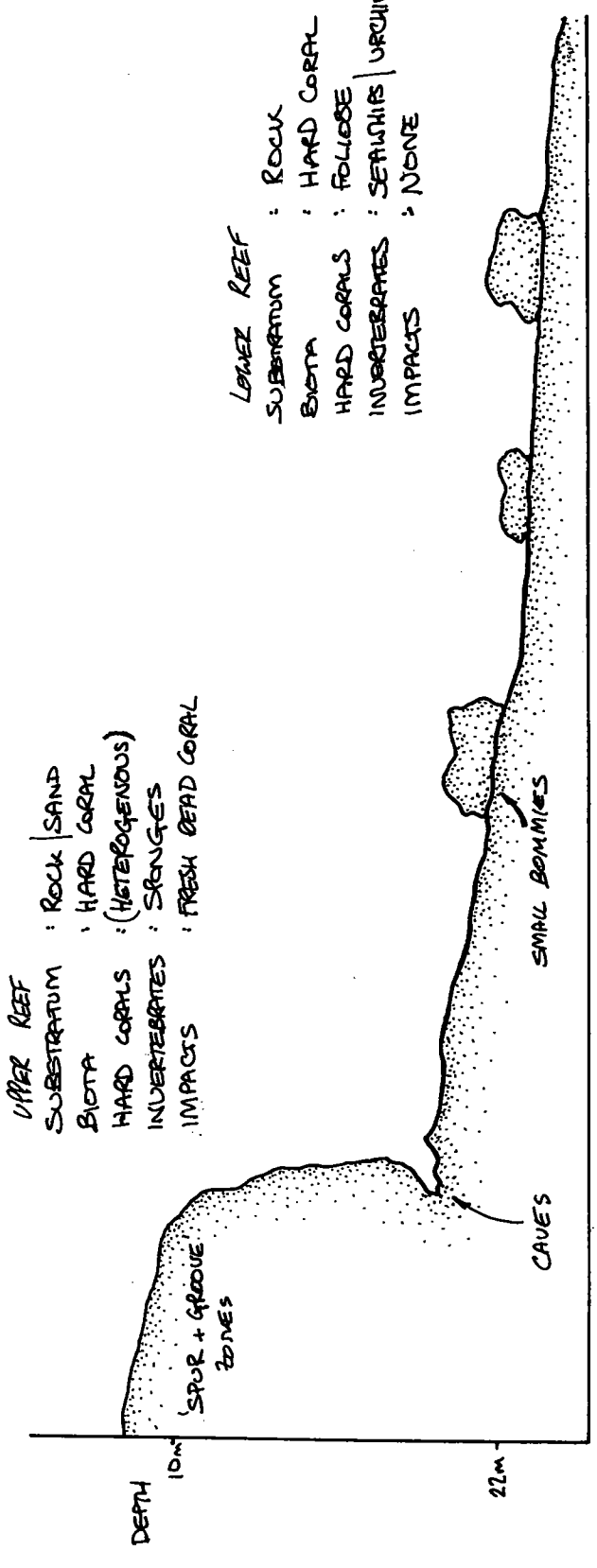


Figure 4.8 Diagram of coral profile at QS2.

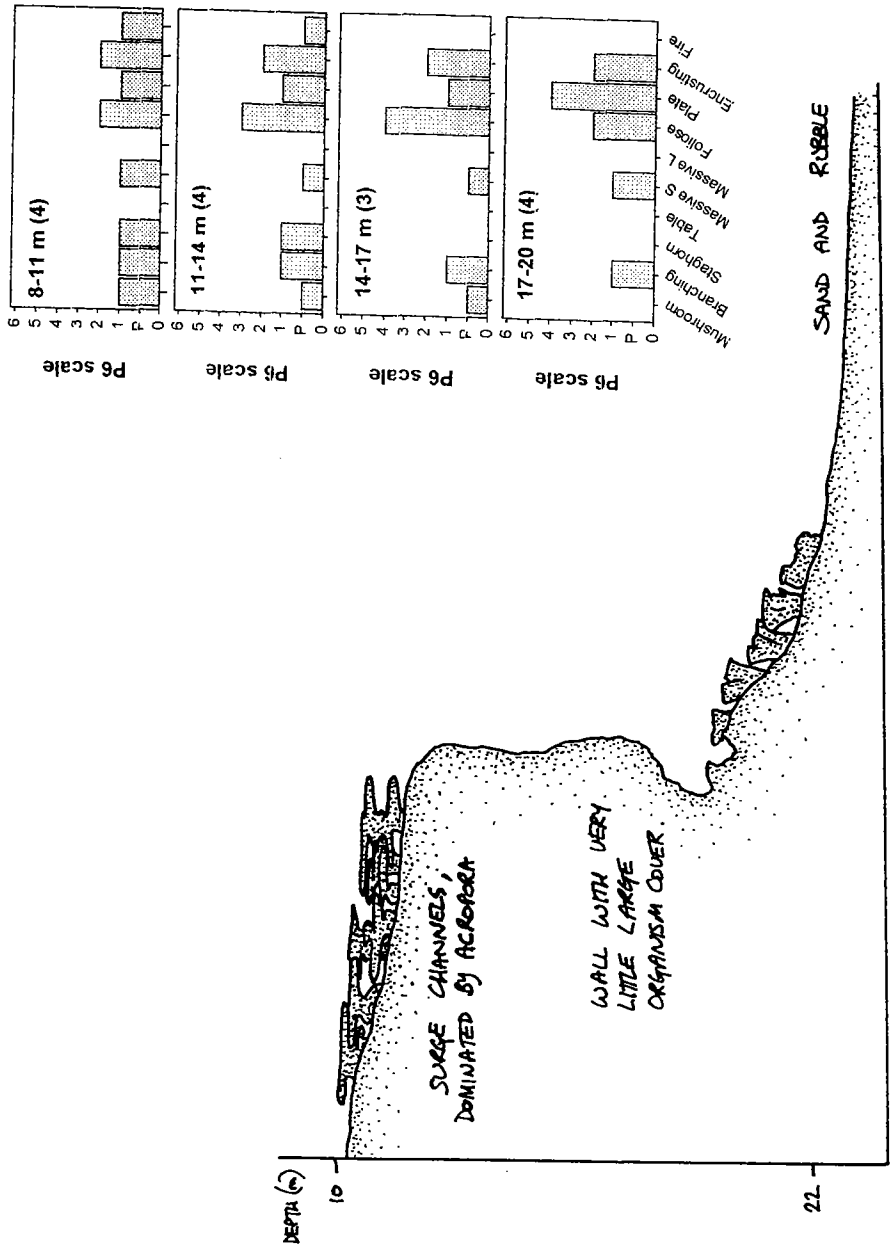
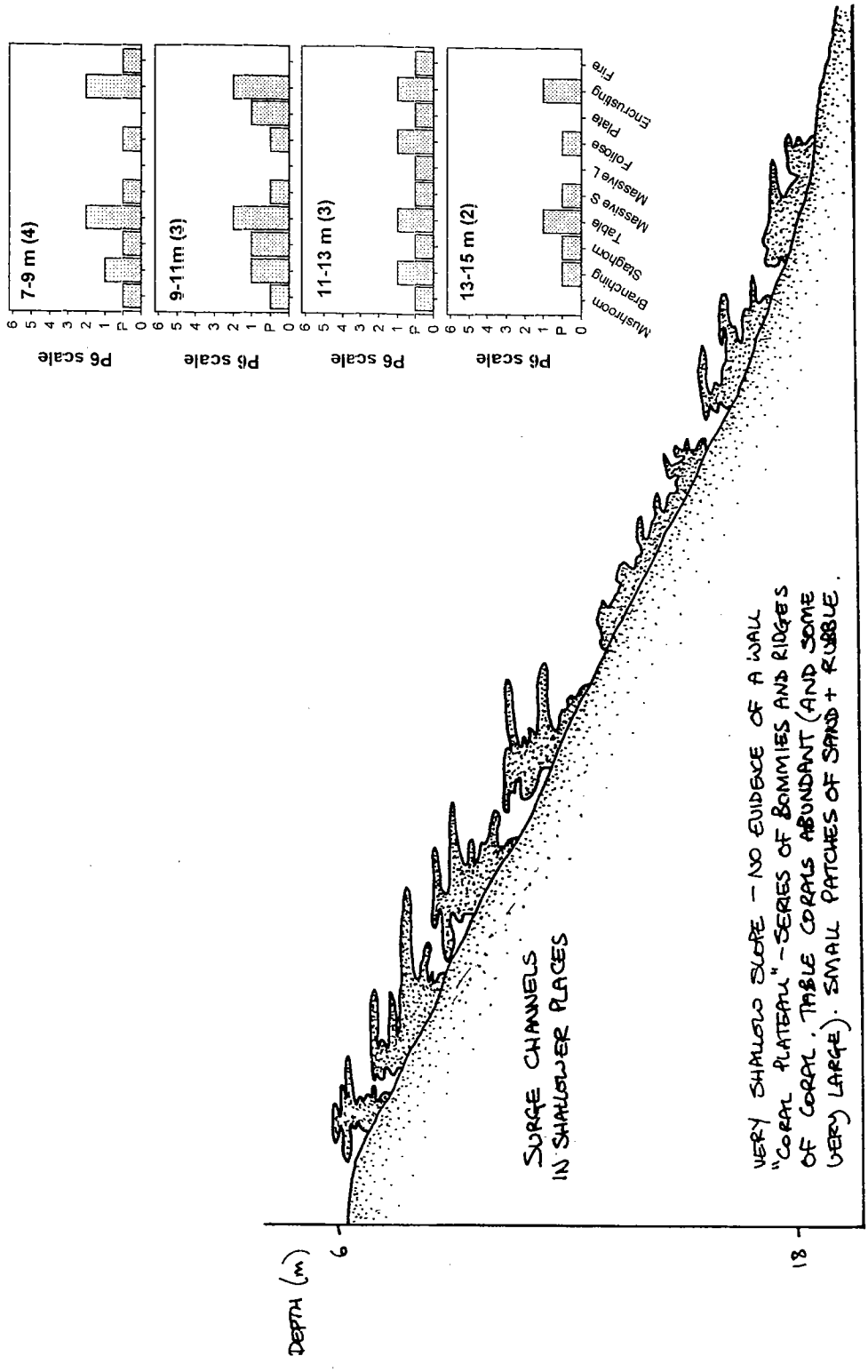


Figure 4.9 Diagram of coral profile at QS3.



4.5 Subtidal Invertebrate and Impact Surveys

4.5.1 Overview

The number of data elements recorded for many of the sites surveyed around Quisiva island, particularly the fringing outer reef area, were relatively low in comparison with other islands within the Programme's study area. Macrosponges and sea whips (Leptogorgonia) were commonly the dominant invertebrates, the former on the upper reef sections and the latter on the lower reef sections.

4.5.2 Site Reports

Site QS1:
The distribution and density of invertebrates, and incidences of reef damage are summarised in Table 4.15 and are discussed below.

Sea Whips were the most dominant invertebrates, both on the upper and lower reef. Macrosponges and urchins were particularly common on the upper reef, with urchins forming dense aggregations. Coral damage was recorded to be greater on the upper reef with sedimented 'massive' form corals, freshly dead coral (cause unknown) and one area of white band disease.

Table 4.15 Invertebrates and Natural/Human Impacts at Site QS1 (values are for 5 minutes of survey).

		Upper Reef (n=11)		Lower Reef (n=11)	
Inverts/Impacts	**Types/Cause**	**Median**	**Range**	**Median**	**Range**
Macrosponges		4	1-15	0.5	0-2
Gorgonians	Sea Whips	5	3-22	10	0-20
	Sea Fans	0	0-1	0	0
Bivalves	Giant Clams	0	0-1	0	0-1
Urchins		2	0-55	0	0
Sea Cucumbers	Holothuria	0	0-1	0	0-2
	Synapta spp.	0	0-1	0	0
	Others	0	0-1	1	1-5
Dead Corals	Sed. Massives	0	0-4	0	0-1
	Unknown	0	0-4	0	0
White Band Dis.		0	4	0	0

Site QS2:
The distribution and density of invertebrates, and incidences of reef damage are summarised in Table 4.16 and are discussed below.

Sea whips were recorded in large numbers over the lower half of the reef. Unusually, urchins were observed to occur in greater numbers on the lower half of the reef; the pattern of urchin distribution observed on other islands in the archipelago is for the greatest urchin densities to occur at <10 m depth. Macrosponges were common over the entire reef profile. Fresh dead coral (cause unknown) and human impact damage which was attributed to boats' anchors was noted on the upper reef.

Table 4.16 Invertebrates and Natural/Human Impacts at Site QS2 (values are for 5 minutes of survey)

		Upper Reef (n=12)		Lower Reef (n=12)	
Inverts/Impacts	**Types/Cause**	**Median**	**Range**	**Median**	**Range**
Macrosponges		1	0-9	4	3-6
Gorgonians	Sea Whips	0	0	20	20-50
	Sea Fans	0	0-1	1	1-2
Urchins		0	0-1	7	1-20
Sea Cucumbers	Others	0	0	1	1-2
Dead Corals	Unknown	1	0-2	0	0
Human Effects	Anchor Damage	0	0-1	0	0

Site QS3:

The distribution and density of invertebrates, and incidences of reef damage are summarised in Table 4.17 and are discussed below.

Very few invertebrate data elements were recorded at this site and additionally, abundances were generally low, with only macrosponges common over the whole reef profile. Fresh dead coral (cause unknown) and human impact damage, which was attributed to boats' anchors, was noted on the upper reef.

Table 4.17 Invertebrates and Natural/Human Impacts at Site QS3 (values are for 5 minutes of survey)

		Upper Reef (n=12)		Lower Reef (n=12)	
Inverts/Impacts	**Types/Cause**	**Median**	**Range**	**Median**	**Range**
Macrosponges		5	4-11	3	1-9
Gorgonians	Sea Fans	0	0	0	0-1
Bivalves	Giant Clams	0	0-1	0	0
Sea Cucumbers	Others	0	0	0	0-2
Dead Corals	Unknown	0	0	1	0-3
Human Effects	Anchor Damage	0	0	1	0-2

Site QS4:

The distribution and density of invertebrates, and incidences of reef damage are summarised in Table 4.18 and are discussed below.

In a similar pattern to the results of the survey of Site QS3, there were few invertebrates recorded, and of these macrosponges were the most common. Impacts on the reef were again limited to fresh dead coral (cause unknown) and human impact damage which was attributed to boats' anchors.

Table 4.18 Invertebrates and Natural/Human Impacts at Site QS4 (values are for 5 minutes of survey).

		Upper Reef (n=12)		Lower Reef (n=12)	
Inverts/Impacts	**Types/Cause**	**Median**	**Range**	**Median**	**Range**
Macrosponges		5	4-9	2	0-10
Gorgonians	Sea Fans	0	0	0	0-1
Bivalves	Giant Clams	0	0-1	0	0-1
Gastropods	Murex	0	0	0	0-1
Urchins		0	0	0	0-5
Sea Cucumbers	Others	0	0	0	0-1
Dead Corals	Unknown	0	0	0.5	0-2
Human Effects	Anchor Damage	0	0	0	0-1

Site QS5:

No invertebrates were found at this site.

4.6 Reef Fish Census

4.6.1 Overview

Quisiva has areas of both exposed, fringing outer reef and relatively sheltered inner reef, differing considerably in development and structure. Unlike many of the other islands studied, the pattern of reef fish diversity and abundance observed during surveys around the island did not correspond to these variations. However, in general, the more exposed sites surveyed supported the highest diversities and abundances of reef fish. The diversity of reef fish at each site is given in Table 4.19 below. For a complete list of the censused species present at each site, refer to Appendix A3.

Table 4.19 The relative species richness indices (R.S.R.i.), Shannon-Weaver diversity indices (SWi) and total number of reef fish species observed. Numbers are for those fish observed from the 73 fish species censused.

Site	Reps	Spp	RSRi	SWi
QS1 upper	12	6	0.36	1.91
QS1 lower	22	5	0.48	2.90
QS2	11	24	0.33	2.38
QS3	6	6	0.19	1.90
QS4	16	25	0.34	2.65

4.6.2 Site Reports:

Site QS1:
This site had the highest diversity of reef fish (35 species), with over half the species belonging to the butterflyfish family (Chaetodontidae). This family together with the Surgeonfish (Acanthurids) were the most abundant families, the most common species of which were; Thompson's surgeonfish (*Acanthurus thompsoni*, <20-50 fish/5 mins.), the Brown Tang (*Zebrasoma scopas*, <8 fish/5 mins.) and the Pennant butterflyfish (*Heniochus acuminatus*, <8 fish/5 mins.). Napoleon wrasse (*Cheilinus undulatus*) were observed at this site. The relative abundance and diversity of reef fish recorded are shown in Figures 4.10, 4.11.

Site QS2:
There was a general low abundance of reef fish at this site, with only; Thompson's surgeonfish (*Acanthurus thompsoni*, <13 fish/5 mins.) occurring in significant numbers. Diversity was similarly, relatively low for most families, although 4 species of angelfish (Pomacanthidae), were identified which was the highest (equal with QS1) recorded for Quisiva.. The relative abundance and diversity of reef fish recorded are shown in Figure 4.12.

Site QS3:
The diversity and abundance of reef fish was the poorest of the reef sites surveyed around Quisiva island (13 species identified). Two species dominated in terms of numbers; Thompson's surgeonfish (*Acanthurus thompsoni*, <20-50 fish/5 mins.) and the Dusky surgeonfish (*Acanthurus nigrofuscus*, <15 fish/5 mins.), whilst butterflyfish (Chaetodontids) accounted for over half the species identified. The relative abundance and diversity of reef fish recorded are shown in Figure 4.13.

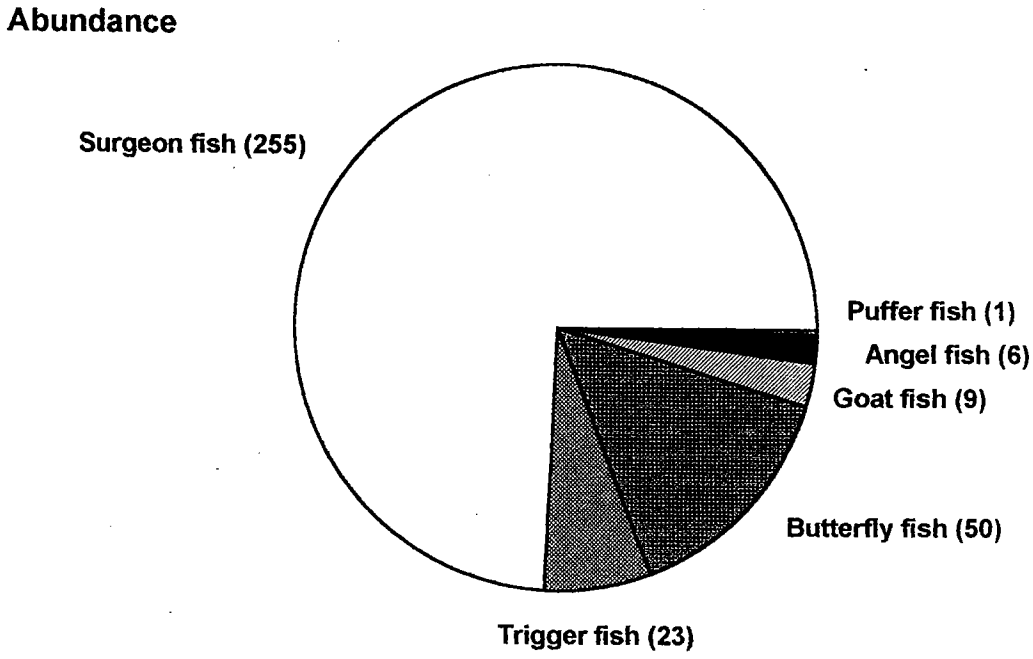
Site QS4:

There was little variation in reef fish abundance or diversity with depth at this site (19-21 species). Surgeonfish (Acanthurids) accounted for approximately half the reef fish observed (included; *Acanthurus thompsoni*, <20-50 fish/5 mins.) whilst butterflyfish (Chaetodontids) accounted for approximately half the reef fish species identified (10 species). The relative abundance and diversity of reef fish recorded are shown in Figure 4.14.

Site QS5:

There were no reef fish observed at this site. This was probably the result of the fact that this site consisted of an extensive area of bare sand.

Figure 4.10 Abundance and species richness of reef fish at the site QS1 (upper reef).



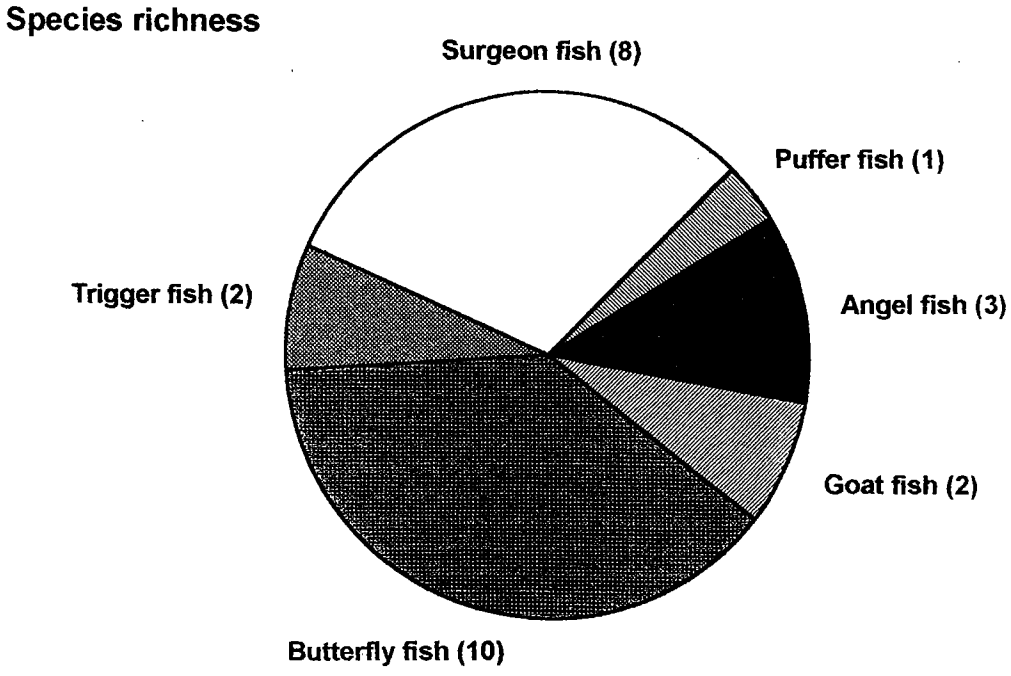
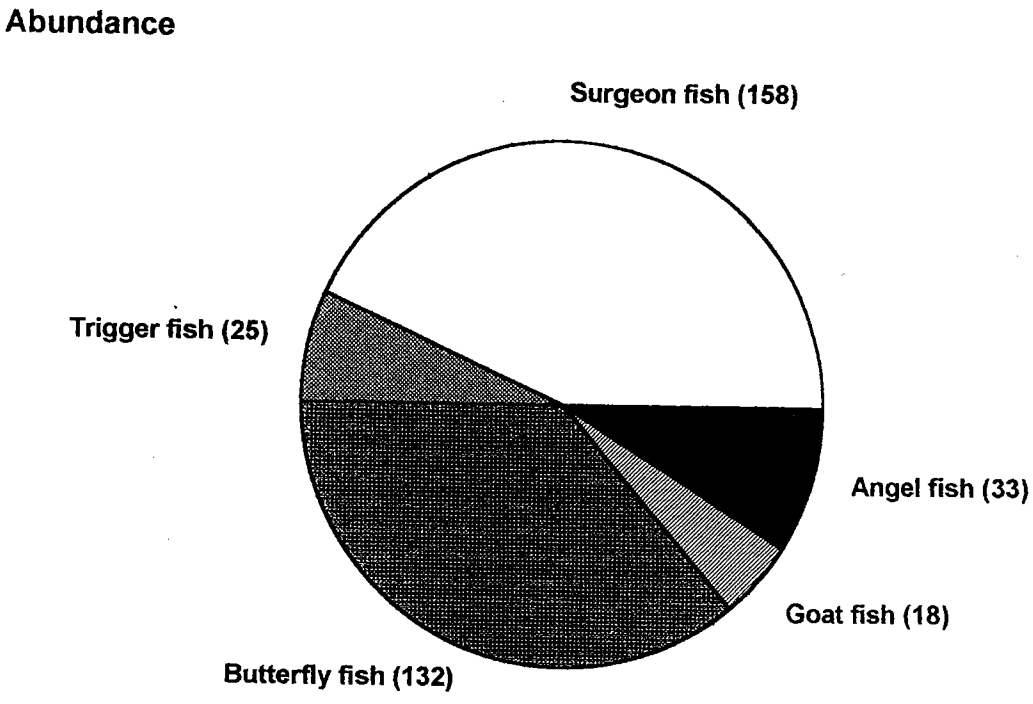


Figure 4.11 Abundance and species richness of reef fish at the site QS1 (lower reef).



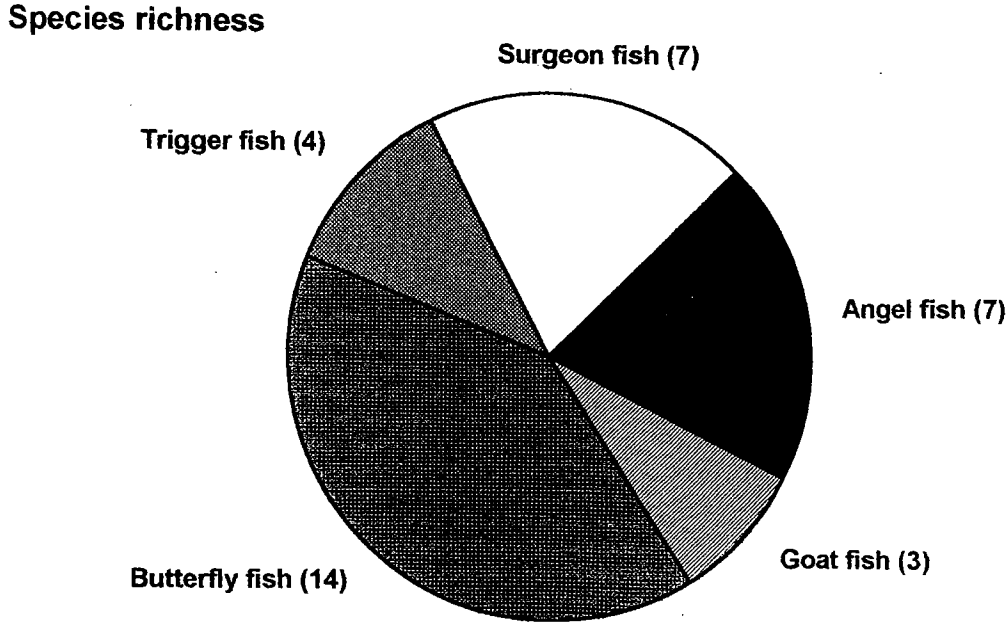
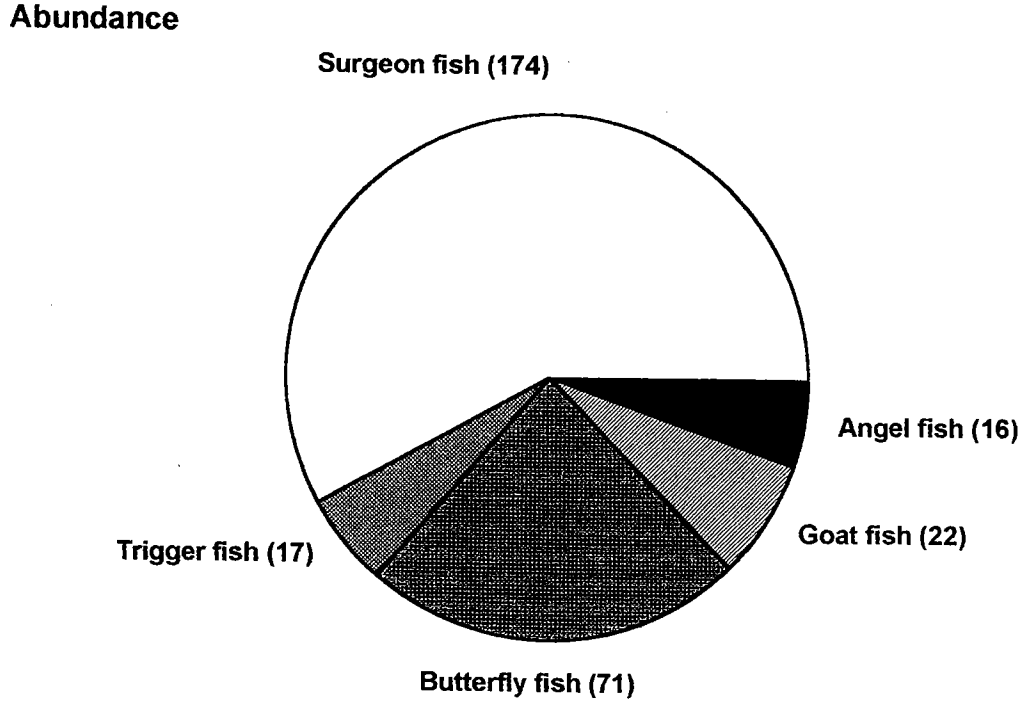


Figure 4.12 Abundance and species richness of reef fish at the site QS2.



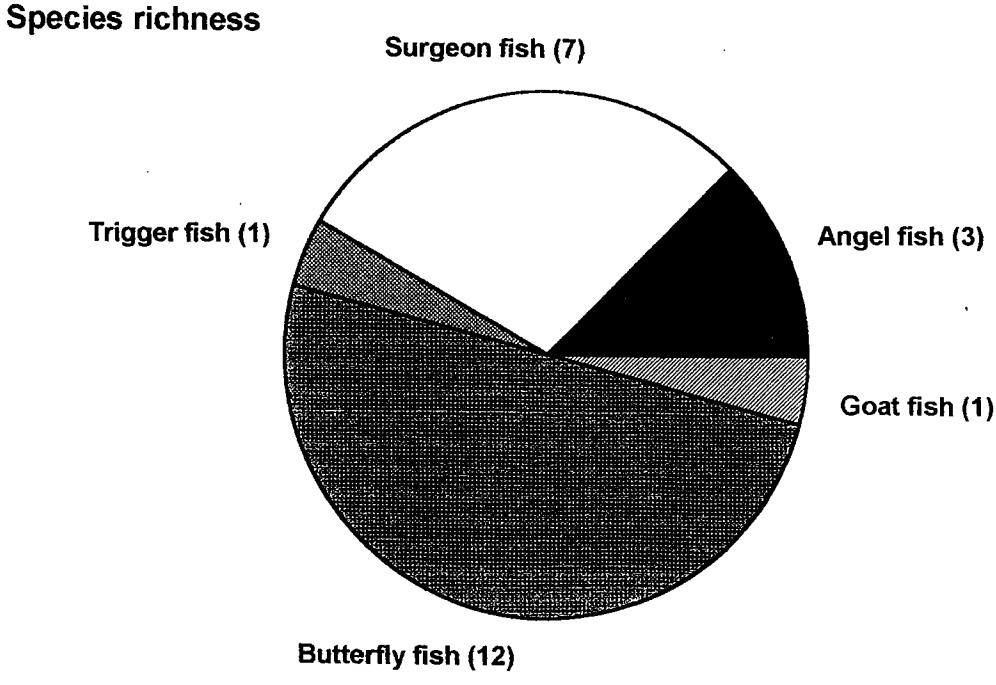
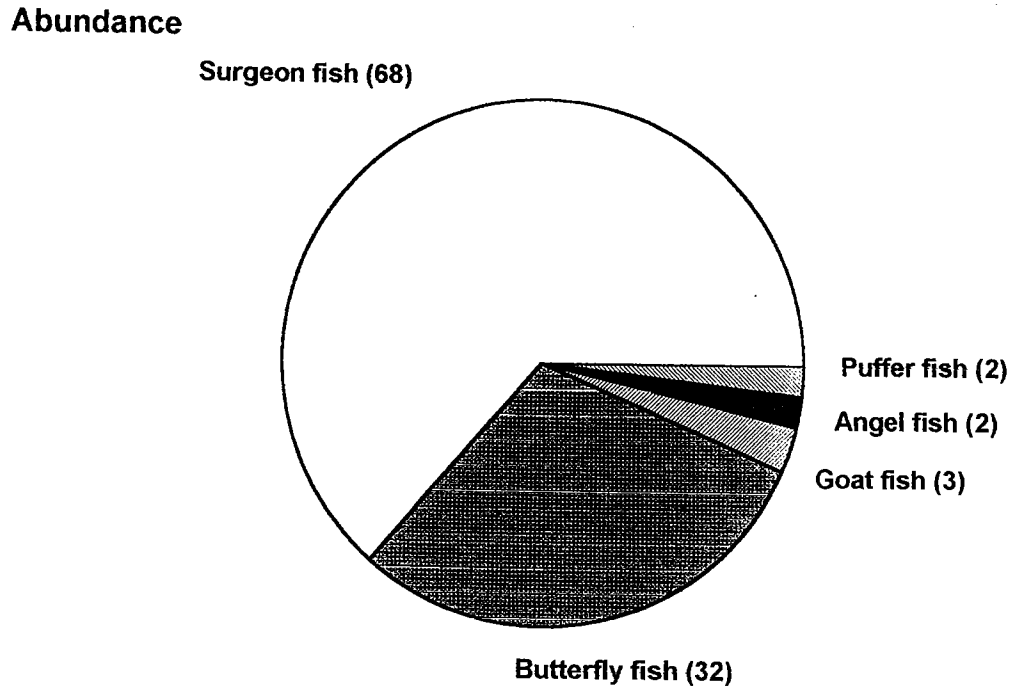


Figure 4.13 Abundance and species richness of reef fish at the site QS3.



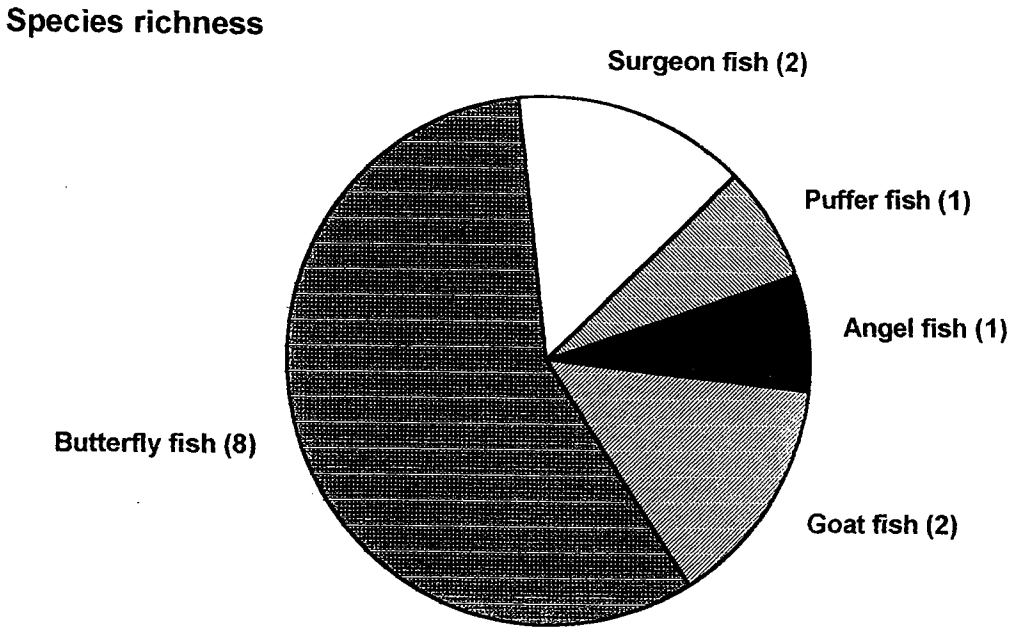
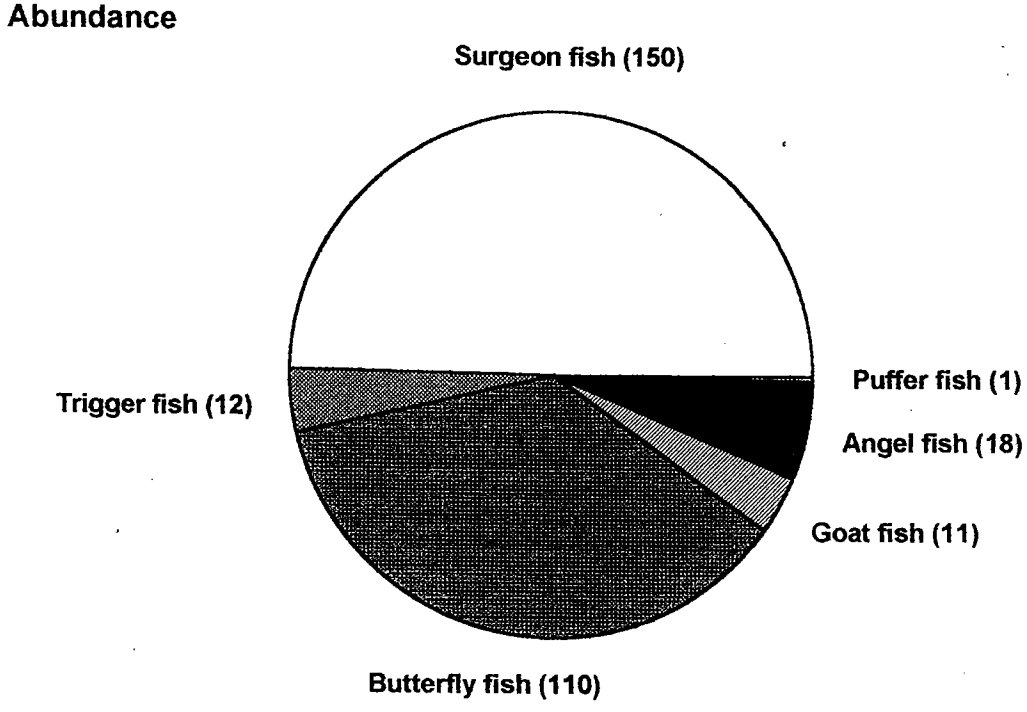
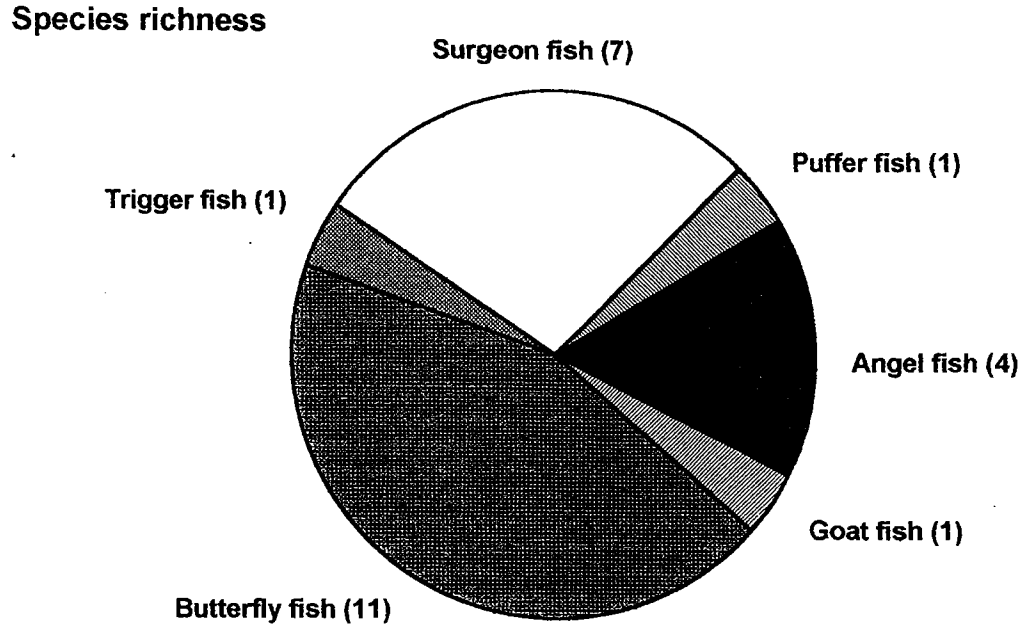


Figure 4.14 Abundance and species richness of reef fish at the site QS4.





4.7 Commercial Fish Census

Survey sites are as for the subtidal habitat surveys reported above (Fig. 4.5)

4.7.1 Overview

The populations of commercial fish were seen to vary in relation to the reef structure at each site. Sites QS1 and QS2 were exposed outer reef supporting a relatively high abundance of fish, in particular snappers (Lutjanids). The reef became less developed and more sheltered from sites QS3-QS4 and a corresponding decrease in commercial fish abundance was noted. The diversity of commercial fish species decreased in a similar pattern with site position. No evidence of the impact of fishing activity could be ascertained from the surveys findings.

4.7.2 Site Reports

Site QS1:
Large shoals of the Blue-lined snapper (Lutjanid), *Lutjanus kasmira* and the Yellowspot emperor (Lethrinid), *Gnathodentex aurolineatus* (estimated length < 30 cm) dominated the commercial fish at this site. The Blackspotted sweetlips (Haemulid), *Plectorhinchus gaterinus* was also common. A few groupers (Serranids: estimated length < 50 cm) and a solitary jack (Carangid), *Caranx* sp., of estimated length 120 cm were recorded. The Yellowtop fusilier (Caesionid) *Caesio xanthonota* was also seen in large numbers.

Site QS2:
The Blue-lined snapper (Lutjanid) *Lutjanus kasmira* formed large shoals (100+ individuals) at this site. In addition a number of grouper (Serranids) species were identified, including; Peacock grouper *Cephalopholis argus,* Coral hind *C. miniata,* Potato grouper *Epinephelus tukula* and Malabar grouper *E. malabaricus*. A single Slatey sweetlips (Haemulid), *Diagramma pictum* was also recorded. Results are presented in Fig. 4.15.

Site QS3:
In general a low diversity and abundance of commercial fish was observed at this site, mainly comprising a mixture of small parrotfish (Scarids) and groupers (Serranids). Of note, was the presence of the Green jobfish, *Aprion virescens* (Lutjanidae) and the Indian Ocean steephead parrotfish, *Scarus strongylocephalus* (Scaridae). Results are presented in Fig. 4.16.

Site QS4:

In the shallow water (<6 m) only 3 species of commercial fish were seen; the parrotfish (Scarids), Bullethead parrotfish *Scarus sordidus* and Bluebarred parrotfish *S. ghobban*, and the Blackspotted sweetlips (Haemulid) *Plectorhinchus gaterinus*. The abundance and diversity of fish increased slightly with depth, the most common species being the parrotfish (Scarids), including; Bridled parrotfish *Scarus frenatus, S. ghobban* and *S. sordidus*, and the Paddletailed snapper (Lutjanid) *Lutjanus gibbus*. Results are presented in Fig. 4.17.

Site QS5:

The absence of reef or other biotic cover (bare sand only) here probably accounted for the absence of any commercial fish during the surveys at this site.

Figure 4.15 The abundance and distribution of commercial fish at site QS2.

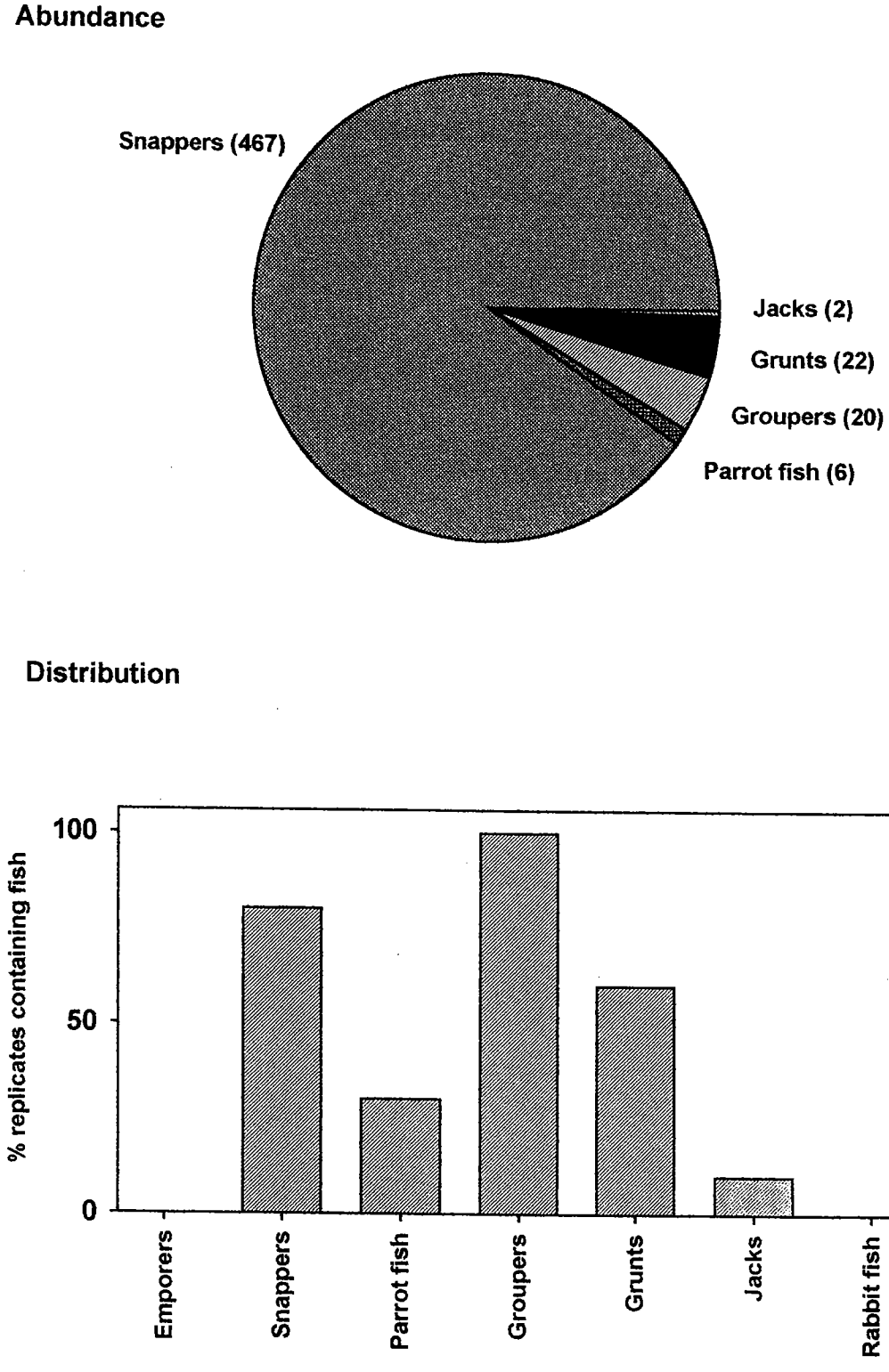


Figure 4.16 The abundance and distribution of commercial fish at site QS3.

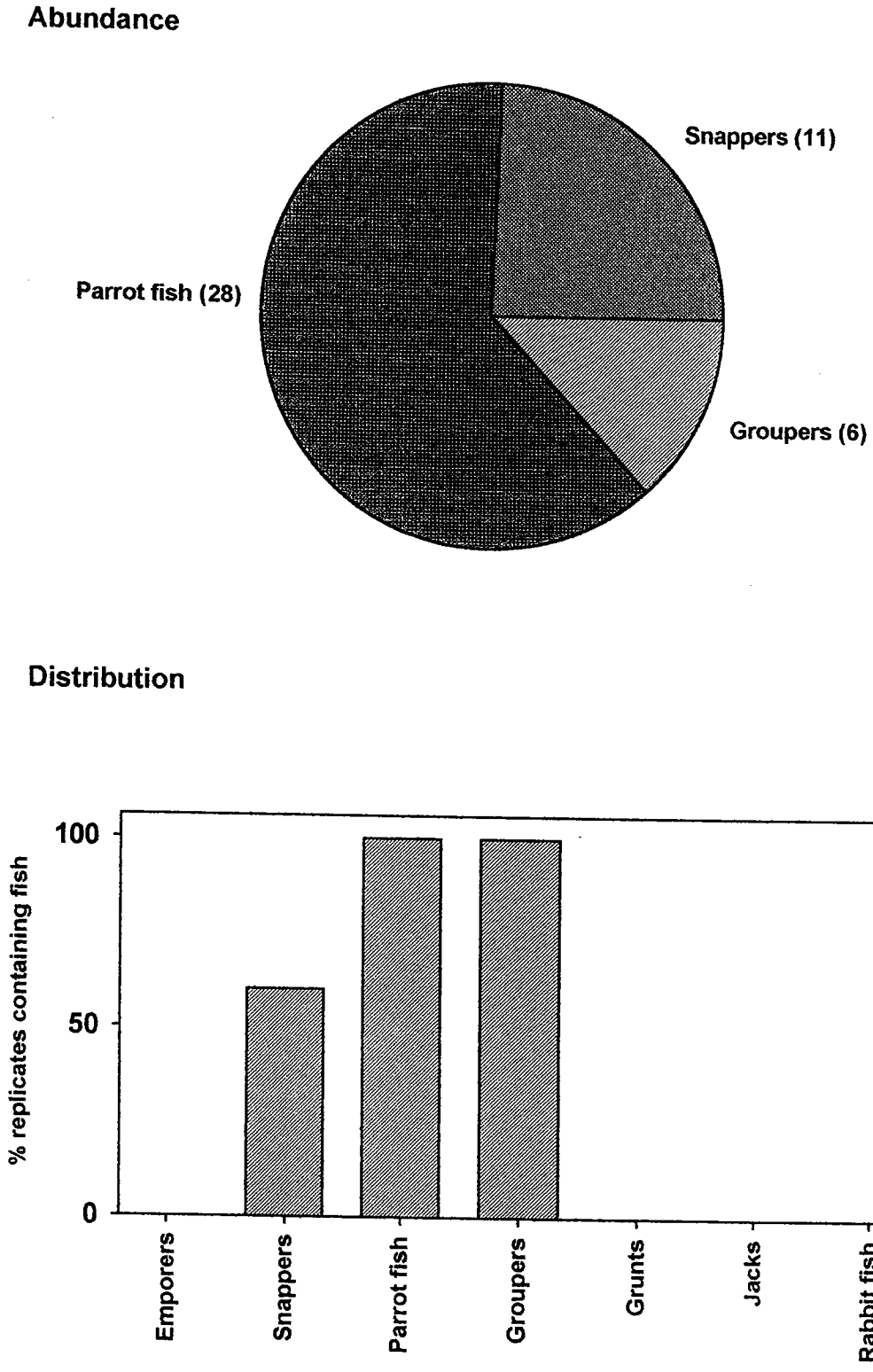
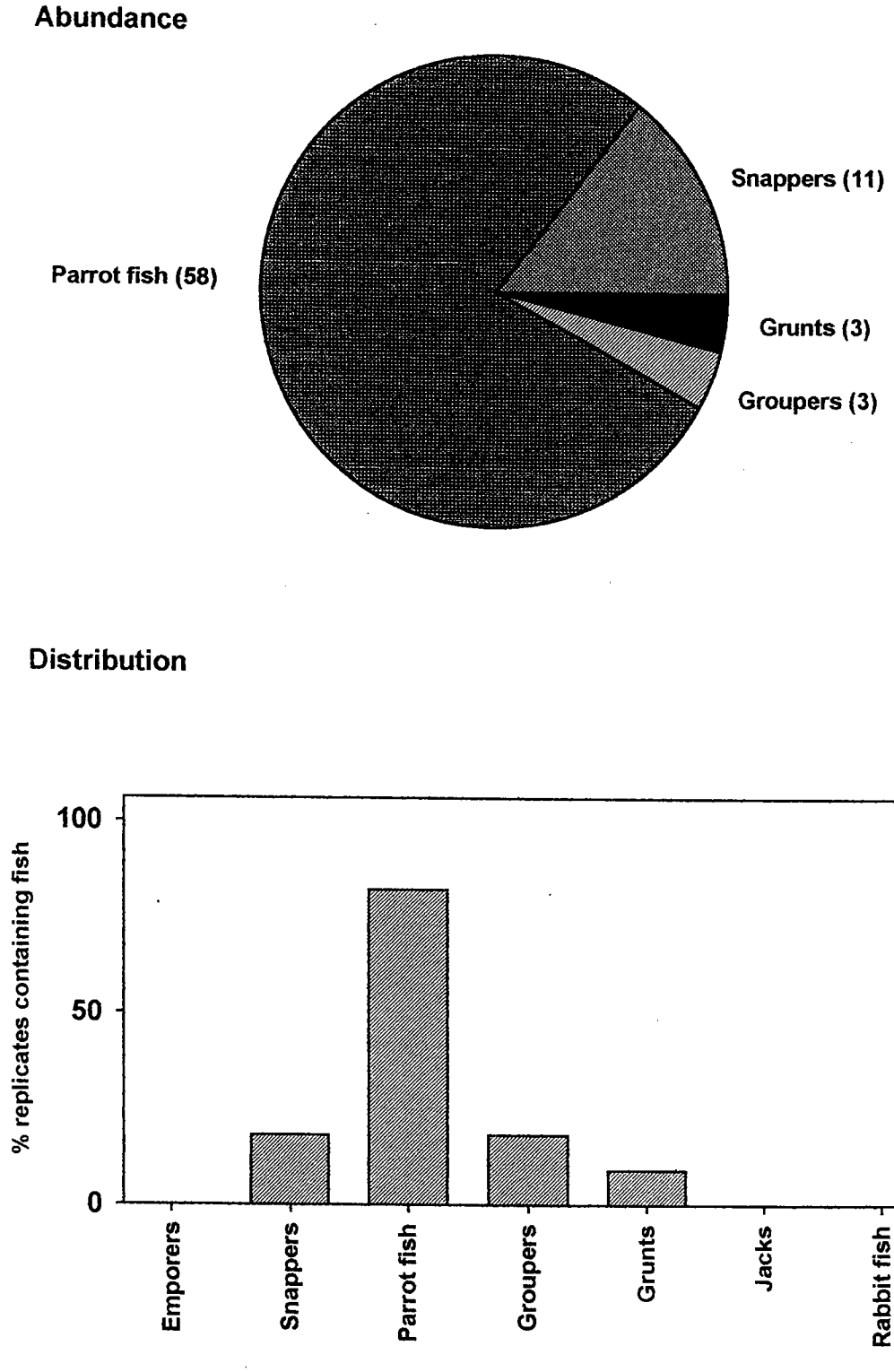


Figure 4.17 The abundance and distribution of commercial fish at site QS4.



4.7.3 Size Distributions

The size distributions of the commercial fish recorded are summarised for all the sites in Table 4.20 below. The length ranges of the commercial fish recorded are relatively small in comparison to many of the other islands surveyed although the reason for this was not apparent.

Table 4.20 Size distribution summary for the commercial fish of Quisiva island (from 26 replicates).

'Commercial' Fish Family	Number	Estimated Median Length (cm)	Estimated Length Range (cm)
Lethrinidae	0	-	-
Lutjanidae	489	20	20-40
Scaridae	92	40	30-40
Serranidae	29	45	40-50
Siganids	0	-	-
Haemulidae	25	40	30-40
Carangidae*	2	120	120

* based on less than 5 fish

4.8 Finfish Fisheries

4.8.1 Overview

The study of the finfish fishery on Quisiva took the form of a fleet survey, sampling of catches from the range of fishing methods and interviews with islanders and itinerant fishermen (Table 4.21). There was no discernible agriculture on the island, and thus the population are particularly reliant on fish and other seafood as a source of food and income.

Table 4.21 A summary of the estimated population involvement with different fishing techniques.

Quisiva Island	Number
Permanent population	50
Fishermen: resident	18
itinerant	70*
Fishing Method	
Line	15
Seine net	55
Trap: Large Marema	0
Trap: Marema	12
Trap: Suri	0
Luwando	0
Spear	5
Sailing boats	5
Canoes	22

* number present in August 1996 when survey took place.

During the dry season a significant component of the island's population is made up of itinerant fishermen from the Nacala area (Nampula Province). During interviews they indicated that they usually stayed within the Quirimbas for three months during the dry season before returning to the mainland. Some of them planned to return before the wet season at the end of October. Although the numbers of itinerant fishermen visiting the island had increased markedly in the last few years, some of the fishermen indicated that they had been coming to Quisiva from Nacala for up to eight years.

The permanent fishermen on the island most commonly used canoes to fish alongside the reefs and over seagrass areas using longlines or box traps. There was also one local fishing canoe used for spearfishing trips. The fish caught were either eaten by the fishermen's family or sold locally fresh for between 3,500 and 5,000 Mt. per kilo or dried and sold on the mainland in Pemba or Nacala for between 17,000 and 20,000 Mt. per kilo. The fishermen purchase their canoes and fishing equipment on the mainland. (Canoes were 150,000 Mt. (approximately $15; fishing lines 7,000 Mt. for six metres and fishing hooks 1,500 Mt. each). A single sailing boat belonging to an island resident was used solely for the transportation of dried fish to the mainland and to bring supplies back to Quisiva.

The Nacalese fishermen had one large sailing dhow owned by a company called LusoAfrica used for shell collecting, two fishing boats that used shark nets and a smaller fishing boat that fished only at night. A number of speargunners also operated from these boats. The spearfishing was primarily for the immediate food needs of the fishermen whilst staying on the island and for providing fish to dry to take back to their families in

Nacala. one of the Nacalese fisherman interviewed estimated that each boat took between 3 and 5 sacks of dried fish and four sacks of dried octopus back to Nacala when they left.

The spearfishers appeared to target a variety of reef fish and no one species or family dominated the catch, although groupers (Serranidae), parrotfishes (Scaridae) and wrasses (Labridae) feature prominently. The fish caught were generally fairly large, ranging in size from 15 to 40 cm.

4.9 Resource Collection

4.9.1 Overview

The collection of resources on the intertidal zone of Quisiva was surveyed over 3 days in July 1996. The distribution of intertidal habitats is given in Figure 4.1 and the scale and patterns of collection are summarised below. The areas where resources were targeted within the intertidal zone are illustrated in Figure 4.18.

Scale and Intensity of Collection
A total of 48 intertidal collectors were interviewed. This number of collectors gave an exploitation density of 9.0 people/ km^2 for the entire intertidal flat.

Gender of Collectors
There was an almost equal representation of adult men (13) and adult women (15) with 20 children. Of the children 16 were boys and 4 were girls.

Group Structure
Of the people observed, 58% were collecting in groups and 42% collected as individuals.

Origin of Collectors
Of 48 collectors interviewed 42 were from Quisiva itself, and 6 had come from Nacala in Nampula province.

Collection Methods
The majority (56%) of people collected by hand, 33% used iron rods as well and small numbers of men used other methods. There were 3 seine netters, 1 snorkelling hand collector and 1 snorkelling speargun user.

Catch Composition

Most people (71%) were involved in the collection of 'FO' gastropods (270 *Fasciolaria trapezium* specimens and 331 specimens of *Chicoreus ramosus*). The collection of 84 octopi by 20 people made this the second most collected resource. Also collected were 'CT' gastropods (*Cypraea tigris, Cypraecassis rufa, Lambis lambis* and *Conus* spp.) and holothuria (4 species) by 14 individuals each, bivalves (*Barbatia* and *Tridacna* species) by 11 people, and fish (9 species) by 7 people.

4.9.2 Distribution of Effort across Intertidal Zones

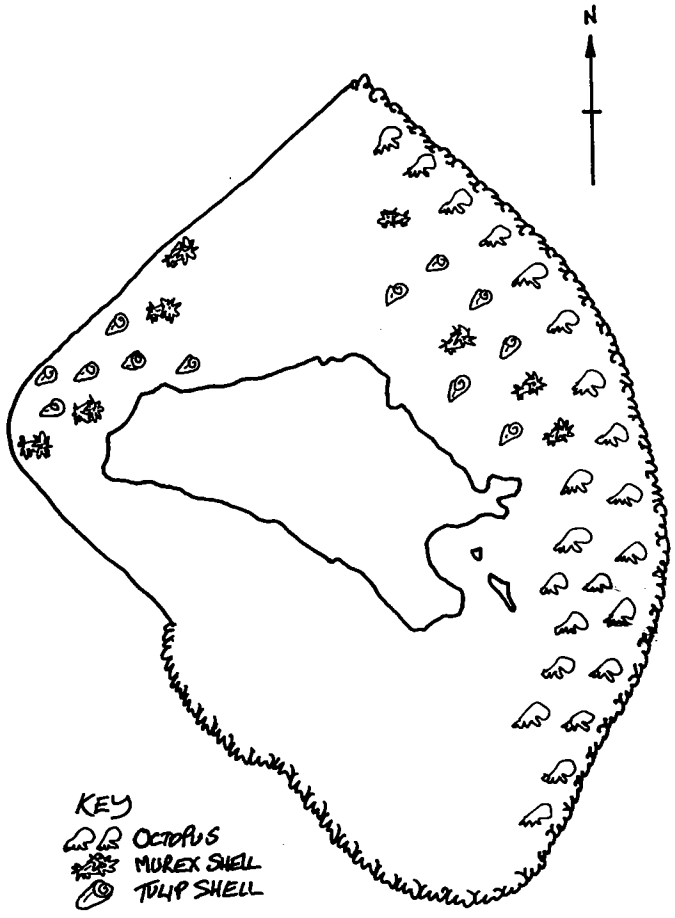
Of the 48 interviewed collectors 30 were working in the lagoon / crest, whilst of the remainder 9 were found in the sand / seagrass zone and 9 on the nearshore rock platform giving densities of 20, 5 and 7 people/ km^2, respectively.

4.9.3 Subtidal Collection

Two methods for the subtidal exploitation of molluscs and holothuria by adult males who snorkelled in the shallow (up to 6 metres) outer reef areas were observed. One method involved the use of one or two man 'casquinhas'. Generally 6 'casquinhas' operated daily, and brought in a mixture of fish, molluscs and holothuria. Some exploiters targeted fish, with the incidental catch of 2 to 3 specimens of *Lambis lambis*. Other exploiters appeared to target the molluscs and one individual collected 20 *L. lambis* and 45 *Fasciolaria trapezium* specimens. another individual collected 13 *L. lambis*, 15 *F. trapezium*, 2 *Tridacna* sp., 2 'Kufulie' holothuria and 2 *Octopus vulgaris*.

The second method relied on large (12m length) traditional boats called 'lanchas'. During the study period there was one of these operating from Quisiva itself, which was reportedly owned by the 'LusoAfrica' curio trade exporter in Nacala. This boat had been loaned to 17 men from that town who worked from on board, staying in the Quirimba islands in the dry season (May-November) and returning monthly to sell the 'CT' gastropods to LusoAfrica. They were staying on Quisiva for three months, and during the study period were collecting on a daily basis. Two of these daily catches, from the shallow reef zones between Quisiva and Mefunvo Islands, were analysed. The main target species was *L. lambis* (numbers caught were 60 and 165 specimens on each day), with less than 10 specimens of the following: *Phalium glaucum, Cypraecassis rufa, Cassis cornuta, Cypraea tigris, Tridacna* sp., *Pinna* sp., *Fasciolaria trapezium* and holothuria. Reef-fish were taken incidentally in low numbers (less than 20 per day).

Figure 4.18 Target areas for intertidal resources on Quisiva Island.



5.0 QUIPACO ISLAND

5.1 Introduction

Quipaco island (12°41'00"S 40°36'42"E) is a small (1.0 km by 0.9km), oval island situated close to the southern point of Arimba and forms the southerly most island in the Quirimba Archipelago and of the Programme's study area (Fig. 1.1). The island has no permanent population but commonly has small, temporary camps of fishermen and mangrove cutters. There is no freshwater on the island.

The centre of the island is occupied by a large mangrove-filled lagoon with a narrow entrance which opens on the western shore, thus forming a surrounding 'horseshoe' of raised coral rag. The vegetation on the island is a mixture of woodland, dry scrub and grassland.

5.2 Intertidal Surveys

5.2.1 Overview

Quipaco is the smallest island within the S.I.G. with an estimated intertidal flat of 1.1km^2. In contrast to the other islands of the S.I.G., on Quipaco neither seagrass nor macroalgae dominated the more sheltered western and northern areas. The low abundance of macroalgae and absence of seagrass on the east coast of Quipaco is possibly linked to the highly exposed aspect of the intertidal reef flat and the high number of herbivorous sea urchins present. The absence of seagrass is directly linked to the absence of suitable soft or rubble substratum.

A total of 5 seagrass species, 91 species of macroalgae (1 Cyanophyta, 34 Chlorophyta, 12 Phaeophyta and 44 Rhodophyta) and 14 species of associated invertebrates were recorded. A checklist for seagrass and macroalgae taxa is presented in Appendix A2. Like other southern islands the macroalgal flora of Quipaco was dominated by species from the Class Rhodophyta, which represented almost half of the species recorded. The patterns of zonation were determined based on three transects, the locations of which are shown in Figure 5.1.

5.2.2 Area Reports

'Western Area'

The 'Western Area' is the least exposed area of intertidal flat. The typical patterns of zonation are presented in Figure 5.2. The west and north-west transects appeared to have great similarity in floral zonation (macroalgae and seagrass beds), but with differences in species composition, abundance and diversity of flora and fauna.

Three zones were identified within which 2 seagrass species, 31 taxa of macroalgae and 3 taxa of invertebrates were recorded. The proportions of substratum types are

summarised in Table 5.1. The distributions of the various taxa across zones are presented in Tables 5.2 and 5.3.

Table 5.1 Percentage cover of substratum along a typical transect within the western area (P<1%). Median values and ranges (in brackets) are presented.

Substratum	Zone 2	Zone 3
Sand	10 (0-68)	33 (0-100)
Rock	90 (32-100)	67 (0-100)

Zone 1 was predominantly bare rock devoid of conspicuous biota. Zone 2 constituted a rock platform dominated by macroalgae notably *Laurencia papillosa* (with 0-24% cover) and *Gelidiella acerosa* (with 0-30% cover). The most common invertebrates were *Cypraea annulus* (in Zone 2); *Cypraea annulus* and *Echinometra mathaei* (in Zone 3).

Table 5.2 Percentage cover of seagrass and macroalgae along a typical transect within the 'Western Area' (P<1% of cover). Median values and ranges (in brackets) are presented.

Taxonomic group	Zone 2	Zone 3
Seagrass		
Thalassia hemprichii	2 (0-20)	40 (20-90)
Thalassodendron ciliatum	0	0 (0-10)
Macroalgae		
Amphiroa sp.	0 (0-10)	0
Avrainvillea erecta	0	0-P
Boergesenia forbesii	0-P	0
Caulerpa sertularioides	0	0-P
Caulerpa sp.	0	0-P
Chaetomorpha crassa	12 (0-30)	0
Champia sp.	0 (0-2)	0-P
Chondria sp.	0 (0-1)	0
Cistoseira myrica	0 (0-2)	0
Cladophora sp.	0-P	0
Dictyosphaeria cavernosa	0 (0-5)	0
Dictyota adnata	0	0-P
D. divaricata	0	0 (0-1)
Gelidiella acerosa	5 (0-30)	0
Gracilaria crassa	0 (0-20)	0
G. folifera	0 (0-6)	0
Halimeda opuntia	0	0 (0-10)
Hydroclathrus clathratus	0-P	0
Hypnea cornuta	0 (0-1)	0
Hypnea sp.	0	0 (0-5)
Jania adhaerens	0	(0-P)
Laurencia distichophyla	0	0-P
L. papillosa	5 (0-24)	0
Lyngbya majuscula	0	0-P
Padina gymnospora	0	0 (0-4)
Sarconema filiformis	0-P	0
Turbinaria ornata	0-P	0
Ulva reticulata	0-P	0
Valonia fastigiata	0 (0-5)	0
V. macrophysa	0-P	0 (0-8)
Vanvoorstia spectabilis	0 (0-2)	0-P

Table 5.3 Abundance (individuals/m^2, n=10) of invertebrate taxa along a typical transect within the 'Western Area'.

Taxonomic group	Zone 2	Zone 3
Gastropods		
Cypraea annulus	0 (0-6)	4 (0-11)
Cypraea tigris	0	0 (0-4)
Echinoderms		
Echinometra mathaei	0	1 (0-8)

North West Area

A total of 1 seagrass species, 13 taxa of macroalgae and 6 invertebrate species were identified within the 2 zones. A diagram of the north-west transect is in Figure 5.3. The substratum types within each zone are summarised in Table 5.4. The distribution of these taxa across zones are presented in Tables 5.5 and 5.6.

Table 5.4 Percentage cover of substratum along a typical transect within the 'North West Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Substratum	Zone 1	Zone 2
Sand	0 (0-50)	95 (50-100)
Rock	90 (50-100)	5 (0-50)

Zone 1 was a rock platform dominated by *Laurencia papillosa* and *Dictyosphaeria cavernosa.* Zone 2 was largely sandy substratum with abundant *Thalassia hemprichii* (0-85% cover).

Table 5.5 Percentage cover of seagrass and macroalgae along a typical transect within the 'North West Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Taxonomic group	Zone 1	Zone 2
Seagrass		
Thalassia hemprichii	0	60 (30-85)
Macroalgae		
Amphiroa sp.	0	0-P
Boergesenia forbesii	0 (0-2)	0 (0-2)
Chaetomorpha crassa	0	0 (0-3)
Dictyosphaeria cavernosa	10 (0-50)	0-P
Dictyota pardalis	0	0 (0-2)
Enteromorpha sp.	0-P	0
Gelidiella acerosa	0 (0-8)	0
Laurencia papillosa	1 (0-12)	0
U. pertusa	0-P	0
Udotea orientalis	0	0-P
Ulva reticulata	0 (0-2)	0
Valonia macrophysa	0 (0-2)	0 (0-5)
Wurdemannia miniata	0	0-P

Table 5.6 Abundance (individuals/m^2, n=10) of invertebrate taxa along a typical transect within the 'North West Area'.

Taxonomic group	Zone 1	Zone 2
Gastropods		
Cypraea annulus	0 (0-2)	0 (0-1)
Morula granulata	1 (0-4)	0
Thais savignyi	A (0-A+)	0
Echinoderm		
Echinometra mathaei	0	0 (0-2)
Synapta maculata	0	0 (0-5)
Bivalve		
Pinna muricata	0	0 (0-2)

North East Area

The north-eastern intertidal was approximately 330m wide, representing the widest intertidal area around Quipaco. Three zones were identified and a total of 2 seagrass species, 29 taxa of macroalgae and 11 taxa of invertebrates were recorded. A diagram of the north-east transect is in Figure 5.4. The substratum types within each zone are summarised in Table 5.7. Their distribution across zones is illustrated in Tables 5.8 and 5.9.

Table 5.7 Percentage cover of substratum along a typical transect within the 'North East Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Substratum	Zone 1	Zone 2	Zone 3
Mud	0	0	2 (0-8)
Sand	0 (0-40)	2 (0-12)	10 (0-56)
Rubble	0	0	25 (0-98)
Rock	95 (60-100)	95 (88-100)	60 (0-100)

Zone 1, closest to the cliff, was a rock platform on which *Laurencia papillosa* (with 0-90% cover) dominated the algal vegetation with the seagrass *Thalassia hemprichii* occurring commonly in the depressions. Zone 2 had a rocky substratum and rock pools in its lower area. The exposed areas were devoid of macroalgae and supported a relatively high diversity and density of invertebrates. The most common macroalgae was: *Jania adhaerens*,. Zone 3, the seaward zone, had a rock substratum with substantial rubble. This zone supported high algal diversity but the cover was generally low (<5% cover).

Table 5.8 Percentage cover of seagrass and macroalgae along a typical transect within the 'North East Area'. (P<1% of cover). Median values and ranges (in brackets) are presented.

Taxonomic group	Zone 1	Zone 2	Zone 3
Seagrass			
Thalassia hemprichii	1 (0-16)	0 (0-16)	0 (0-23)
Thalassodendron ciliatum	0	0	0 (0-1)
Macroalgae			
Acanthophora muscoides	0	0	1 (0-4)
Boergesenia forbesii	0	0	0-P
Caulerpa sertularioides	0	0	0-P
Centroceras clavulatum	0 (0-1)	0	0
Chamaedoris delphinii	0	0	0 (0-12)
Champia sp.	0-P	0	0 (0-4)
Chondria armata	0	0	0 (0-3)
Cystoseira myrica	0 (0-2)	0 (0-2)	0
Dictyosphaeria cavernosa	0-P	0 (0-4)	0 (0-4)
Dictyota divaricata	0	0	0-P
Digenia simplex	0	0	0-P
Enteromorpha sp.	0 (0-1)	0 (0-1)	0
Eucheuma dendiculatum	0	0	0 (0-4)
Gelidiella acerosa	0-P	0-P	0 (0-4)
Gracilaria fergusoni	0	0 (0-2)	0 (0-P)
Gracilaria sp.	0	1 (0-10)	0 (0-3)
Halimeda opuntia	0	0	0-P
Hydroclathrus clathratus	0 (0-4)	0	0
Hypnea musciformis	0	0 (0-1)	0
Jania adhaerens	0	0 (0-30)	0
Laurencia papillosa	10 (0-90)	0	0 (0-7)
Laurencia sp.	0	0	0-P
Lyngbya majuscula	0 (0-6)	0	0
Padina boryana	0	0-P	1 (0-4)
Sargassum aquifolium	0	0 (0-2)	0-P
Turbinaria ornata	0	0	0-P
Ulva reticulata	0 (0-12)	0 (0-1)	0 (0-3)
U. pertusa	0 (0-4)	0 (0-4)	1 (0-3)
Valonia fastigiata	0	.0 (0-12)	0
Valonia macrophysa	0	0	0-P

Table 5.9 Abundance (individuals/m^2, n=10) of invertebrate taxa along a typical transect within the 'North East Area'.

Taxonomic group	Zone 1	Zone 2	Zone 3
Gastropods			
Cypraea annulus	0	1 (0-12)	0
Mancinella alouina	0	0 (0-1)	0
Morula granulata	0 (0-4)	0	0
Nerita albicilla	0	2 (0-12)	0
Rhinoclavis sinensis	0 (0-4)	0 (0-1)	0
Thais savignyi	2 (1-8)	0 (0-2)	0
Limpets			
Patella sp.	0	2 (0-10)	0
Bivalves			
Perna cf. perna	5 (2-20)	0	0
Echinoderms			
Echinometra mathaei	0	0	0 (0-12)
Chitons			
Acanthopleura sp.	0 (0-1)	0 (0-8)	0
Barnacles			
Chthalamus sp.	0	4 (0-17)	0

Figure 5.1 Intertidal transect locations on Quipaco Island.

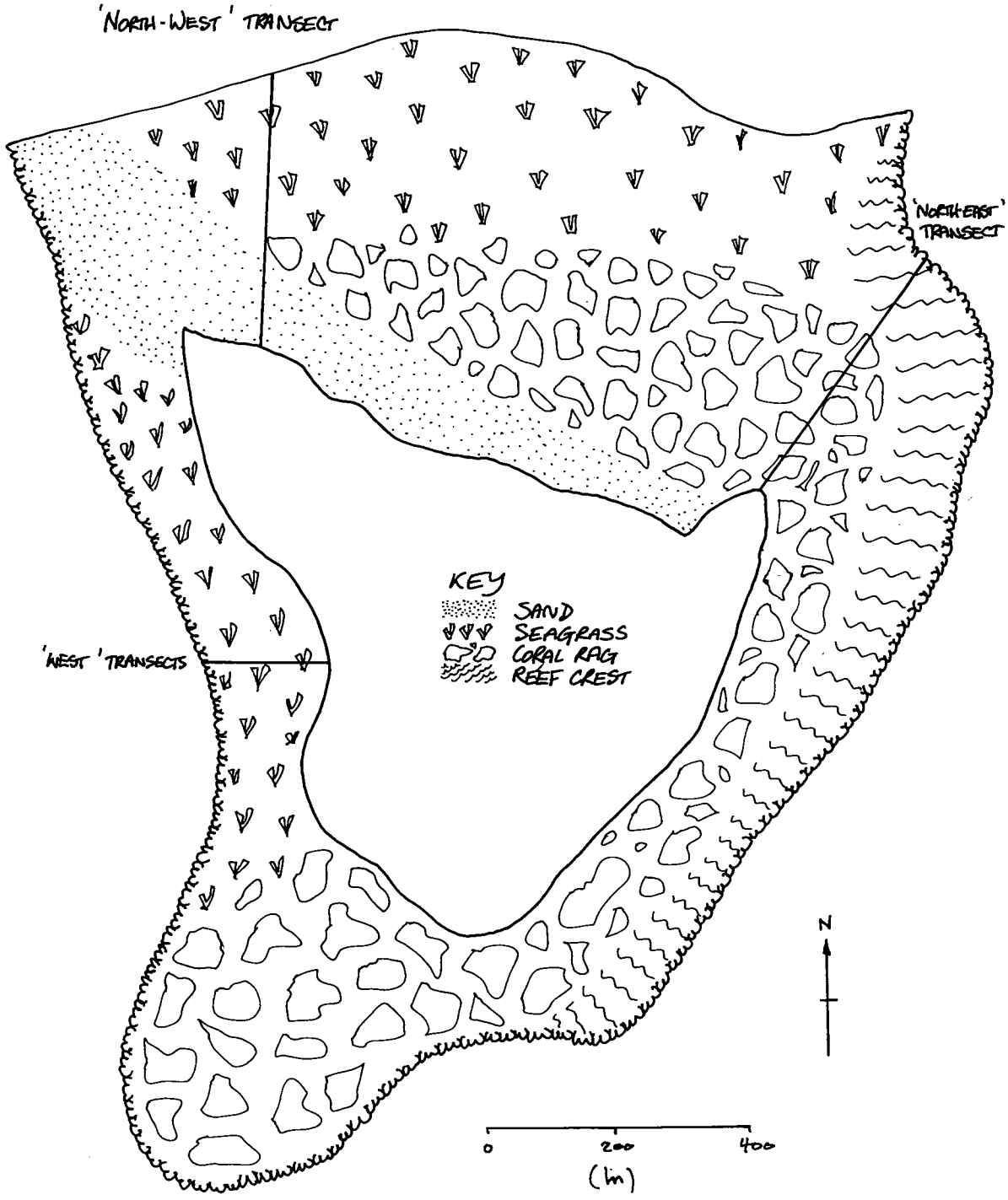


Figure 5.2 Intertidal transect: west Quipaco Island.

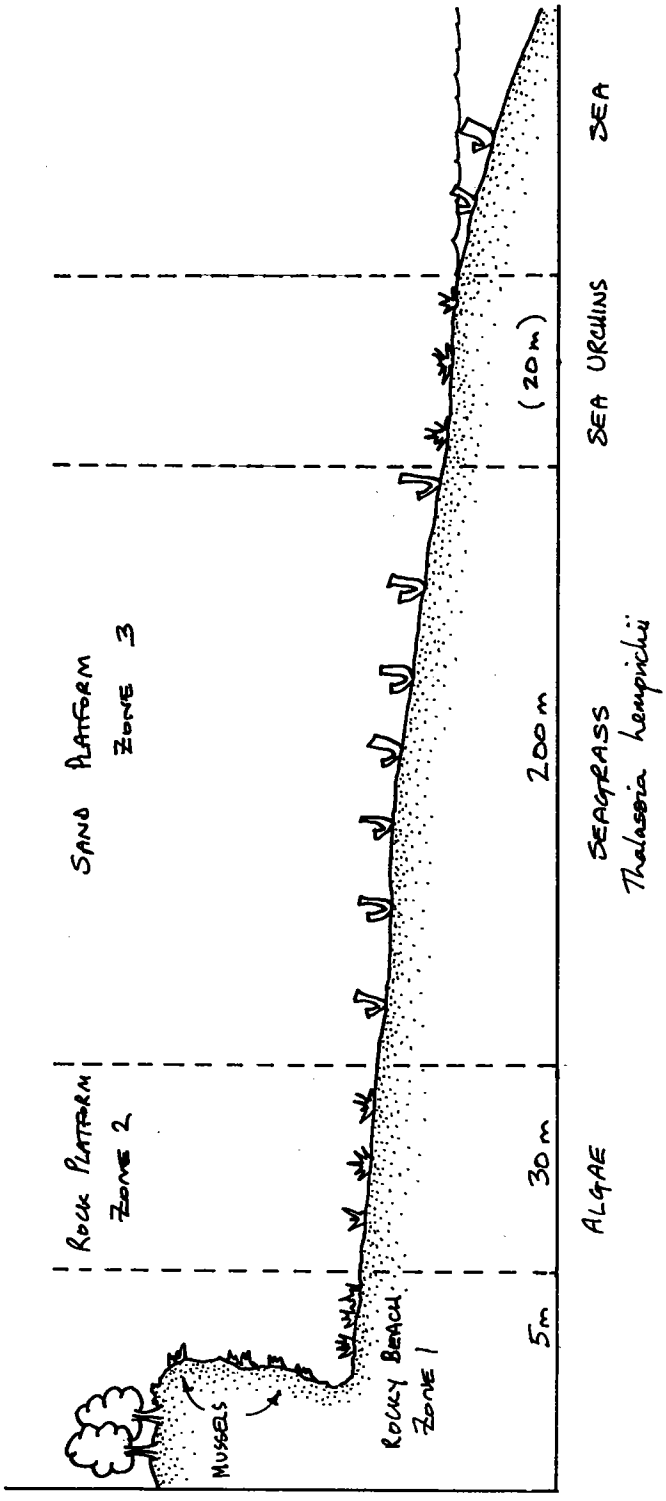


Figure 5.3 Intertidal transect: north-west Quipaco Island.

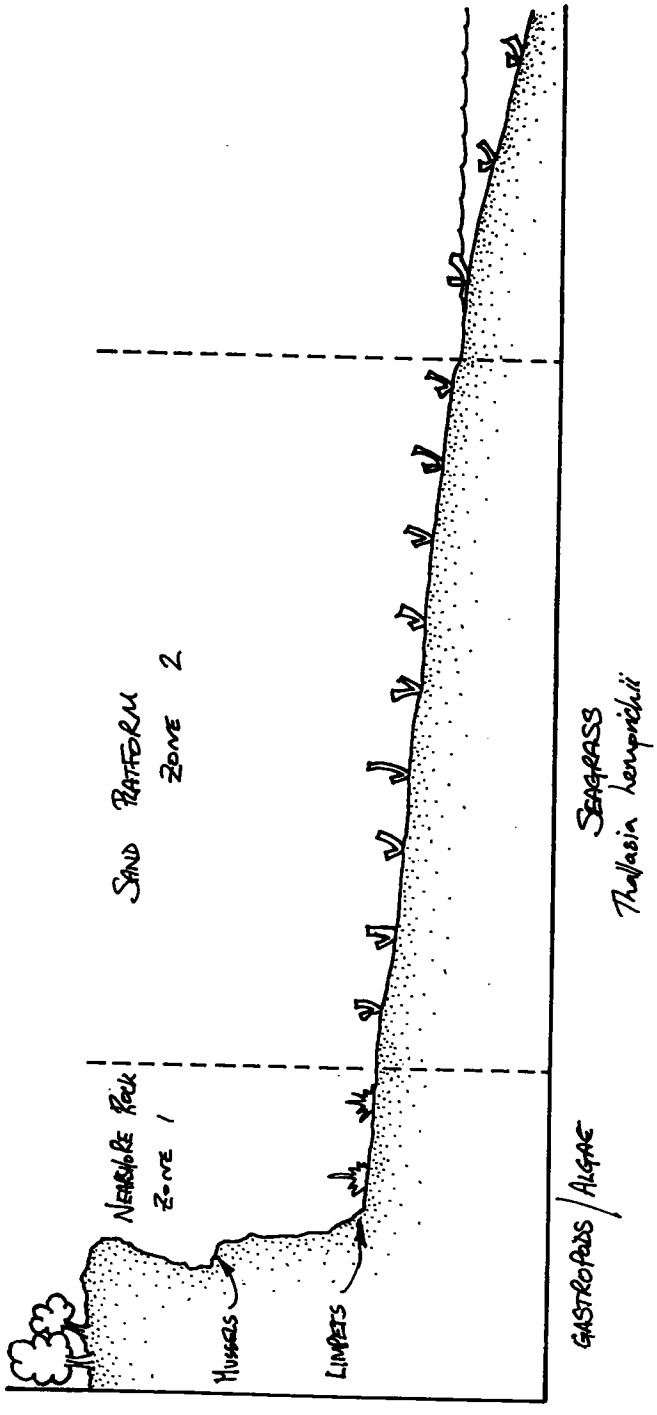
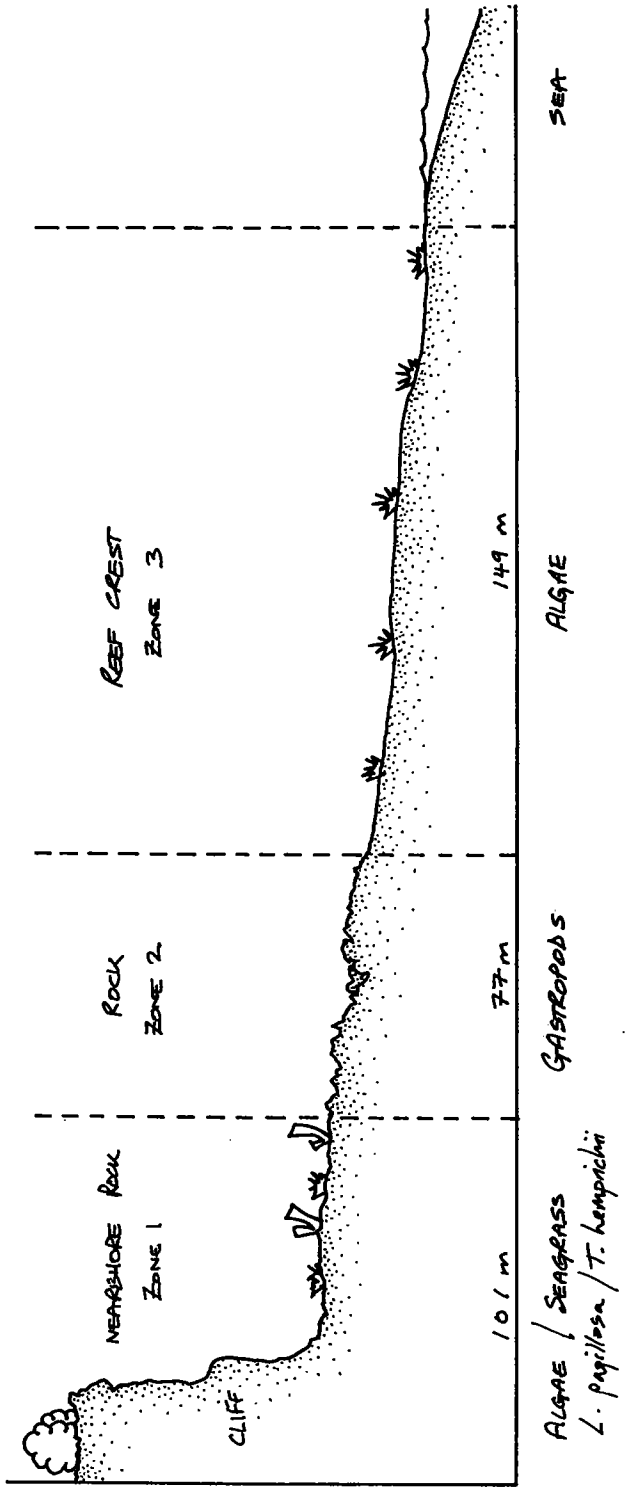


Figure 5.4 Intertidal transect: north-east Quipaco Island.



5.3 Mangrove Surveys

5.3.1 Overview

The unusual topography of Quipaco island has allowed a mangrove stand to develop in a large lagoon area in the central part of the island, in a similar fashion to Sencar and Matemo islands (see Technical Report 3: Central Islands Group and 4: Northern Island Group respectively). A coral rag wall (<4m high) encloses the lagoon which opens to the sea through a narrow entrance on the western shore of the island (Figure 5.5). The stand did not exhibit marked zonation in tree species. *Brugiera gymnorrhiza* dominated much of the stand and was subject to a relatively high degree of cutting. Although the stand was intersected by numerous creeks, rock boulders and outcrops, it can be considered as a single unit and has been analysed in this fashion.

5.3.2 Transect Reports

Three transects were surveyed through the stand, the locations of which are shown in Figure 5.5. Although the stand did not exhibit the zonation of species composition typical of the more common fringing stands, different community types could be distinguished:

Community 1 was dominated by *B. gymnorrhiza* and was most common in the eastern portion of the stand. Evidence of extensive cutting, particularly in the more easily accessible areas. Canopy height up to 12m.
Community 2 was dominated by *C. tagal* and covered approximately 25% of the stand. Mainly restricted to the drier areas of the lagoon close to the rock outcrops and surrounding wall. Canopy height was typically 10m high. Evidence of cutting was often widespread in this community type.
Community 3 was dominated by *R. mucronata* and covered a relatively small portion of the stand close to the creek edges and in the wetter, mud substratum areas. Canopy height was up to 15m.
Community 4 contained a mixture of tree species and covered over 50% of the stand. The canopy height was up to 15m and the mixture of species led to small open patches in canopy. Areas of clear felling and extensive cutting were noted. In places these led to dense areas of saplings (30+/m^2), particularly *C. tagal.*

Quantitative Description
The species composition and structure of mangroves within each community type are presented in Table 5.10 below.

Table 5.10 Mangrove species composition and structure within the Quipaco stand. Mean values and 95% confidence limits are given (Community 1: n=4; Community 2: n=4; Community 3: n=1; Community 4: n=13; 'n/a' is not available).

Zone	Species	No. of trees/m^2	Relative Density	Basal Area (m^2/ha)	Relative Dominance	No. of saplings/m^2
C. 1	*R. mucronata*	0.11•0.06	74	34.6•31.9	43	0.32•0.16
	B. gymnorrhiza	0.41•0.13	19	44.5•12.2	55	1.76•0.76
	C. tagal	0.04•0.02	7	2.2•1.1	3	0.0
C. 2	*R. mucronata*	0.04•0.02	13	23.5•11.5	42	0.02•0.04
	B. gymnorrhiza	0.04•0.02	13	1.4•1.1	2	0.05•0.02
	C. tagal	0.22•0.05	73	31.6•14.8	56	2.77•1.61
C. 3*	*R. mucronata*	0.20	83	6.6	17	n/a
	B. gymnorrhiza	0.04	17	31.8	83	n/a
C. 4	*R. mucronata*	0.18•0.07	26	22.5•11.6	49	1.31•0.63
	B. gymnorrhiza	0.23•0.08	34	10.6•4.4	23	0.01•0.02
	C. tagal	0.23•0.08	34	11.9•3.8	26	7.57•3.45
	A. marina	0.04•0.01	6	1.3•0.2	3	0.0

*A single quadrat was surveyed in C. 3 and therefore no measure of variance is possible.

The lack of strong zonation patterns and the numerous creeks and rock outcrops within the stand made it difficult to extrapolate results to estimate the overall composition and development of the stand. As a result, two methods of estimation were employed. The first was produced from an extrapolation of the data obtained from the community analysis, where the stand as a whole was split into the different community areas and the data subsequently summed (Table 5.11). The second relied solely on data obtained from all quadrats surveyed and was extrapolated without reference to possible community zoning patterns (Table 5.12). Consequently, the latter represents a truer arithmetic estimate of the stand composition whereas the former is biased but probably represents a truer reflection of the stand. Of note: the discernment of the different communities were based on the authors' assessment of the data and therefore a measure of variance is not possible.

Table 5.11 Estimates for the size and composition of the Quipaco stand based on the analysis of communities. All original figures were estimated to the nearest 100 and all basal area values have been calculated to the nearest $10m^2$ (n=21).

Mangrove Species	Total number of trees	Mean Stand Diameter (cm)	Total Basal Area (m^2)
R. mucronata	11,100	15.1	200
B. gymnorrhiza	19,700	9.8	150
C. tagal	15,400	9.5	110
A. marina	200	8.5	<1

Table 5.12 Estimates for the size and composition of the Quipaco Stand based on analysis of stand as a whole. All original figures were estimated to the nearest 100 and all basal area values have been calculated to the nearest $10m^2$. Mean values and 95% confidence limits are given (n=21).

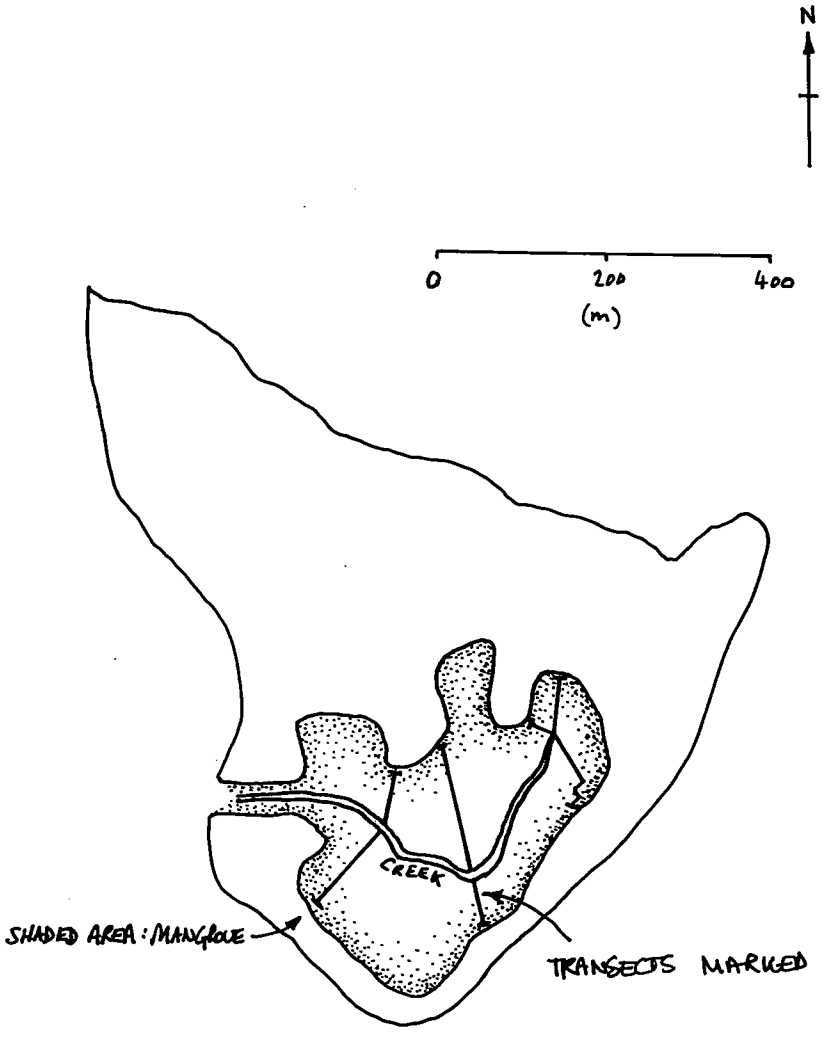
Mangrove Species	Total number of trees	Mean Stand Diameter (cm)	Total Basal Area (m^2)
R. mucronata	11,600•8,600	13.8	170•140
B. gymnorrhiza	16,900 •18,800	12.3	200•180
C. tagal	11,900 •12,500	11.1	120•180
*A. marina**	80	<1	<1

* *A. marina* occurred in a single quadrat only and therefore no measure of variance is possible.

Fauna of the Quipaco mangrove

There was no observed difference between the fauna of the different communities of mangrove trees. Crabs (unidentified spp.) were common throughout. In the muddier areas, the gastropod snails *Cerithidea decollata* and *Terebralia palustris* were noted. A large (20-25 cm long) pale brown, 'rat-like' mammal was also noted amongst the rocks of the surrounding coral rag wall.

Figure 5.5 Location of mangrove transects on Quipaco Island.



5.4 Subtidal Habitat Surveys

Subtidal surveys were conducted in four separate areas around the island (QP1-QP4). Sites QP2 and QP3 have been described together due to their similarity. The location of the sites are shown in Figure 5.6.

5.4.1 Overview

Reef Structure and Composition
The reef morphology did not differ considerably between sites with sub-littoral slopes around the island being no greater than 10°. Sandy substrata predominated around the island with extensive seagrass meadows. Rock and bommie fields existed only at sites QP1 and QP4, either side of the northern intertidal area which connects the island with the mainland at low water.

Big and small 'massive' forms of coral were the dominant biota on bommies, while areas of Fire coral often formed the dividing line between seagrass beds and the intertidal. Macroalgae and *Halimeda* spp. were both found in low abundances.

5.4.2 Site Reports

Site QP1:
The reef structure and community composition are discussed below and summarised in Table 5.13.

Reef Structure
A low gradient sandy slope (<10°) continued away from the island with areas of small bommie fields becoming less frequent with distance from the shore. Rugosity was generally low on the sandy substratum, although some of the larger bommies were covered with well developed corals and rugosity was high.

Substratum Composition
Substratum composition varied little at this site with sand predominant both on inner and outer surveys. Bommie areas became less frequent away from the shore.

Biotic Cover
Seagrasses were the dominant biotic cover, while hard and soft corals were generally restricted to bommie areas. Some areas of soft corals were evident in the sandy substratum and amongst the seagrass on the outer survey site.

Table 5.13 A summary of the structure, composition and biotic cover at QP1 (P<1 % cover).

Reef Features		Upper Reef (n=12) Mode (0-6)	Upper Reef (n=12) Range (0-6)	Lower Reef (n=12) Mode (0-6)	Lower Reef (n=12) Range (0-6)
Morphology	Slope (°)	0	0-10	0	0
	Rugosity	2	1-3	0	0-2
Substratum	Rock	2	P-4	P	P-5
	Rubble	0	0-2	P	0-2
	Sand/Shell	4	2-6	6	3-6
	Mud	-	-	-	-
Biota	Hard Coral	0	0-2	0	0-3
	Soft Coral	0	0-1	1	0-2
	Seagrass	2	1-4	6	3-6
	Macroalgae	P	P-1	P	0-1
	Halimeda spp.	P	P-2	P	0-1
Coral State	Heterogeneity	0	0	0	0
	Dominance	Branching/ Big and Small Massives		Branching/ Big and Small Massives	

Sites QP2 and QP3:

The reef structure and community composition of the two sites are discussed below and summarised in Table 5.14.

A shallow sandy area (<10°) sloped continued away from the island with a dense covering of seagrass. An occasional outcrop of hard coral was reported (predominantly 'branching' and small 'massive' forms), as were small colonies of soft corals amongst the seagrass. Macroalgae and *Halimeda* spp. were only present in low numbers.

Table 5.14 A summary of the structure, composition and biotic cover at QP2 and QP3 (P<1 % cover).

Reef Features		Upper Reef (n=18) Mode (0-6)	Upper Reef (n=18) Range (0-6)	Lower Reef (n=12) Mode (0-6)	Lower Reef (n=12) Range (0-6)
Morphology	Slope (°)	0	0	0	0
	Rugosity	1	1	0	0-1
Substratum	Rock	P	0-2	0	0-P
	Rubble	0	0-1	0	0-P
	Sand/Shell	6	5-6	6	6
	Mud	-	-	-	-
Biota	Hard Coral	0	0-1	0	0-P
	Soft Coral	0	0-P	0	0-P
	Seagrass	5	4-5	5	5-6
	Macroalgae	P	0-1	2	1-2
	Halimeda spp.	P	0-P	1	P-2
Coral State	Heterogeneity	0	0	0	0
	Dominance	Branching/ Small Massive		Branching/ Small Massive	

Site QP4:

The reef structure and community composition are discussed below and summarised in Table 5.15 and Figure 5.7.

Reef Structure

A gentle slope ran down from the edge of the intertidal zone (<10°) towards to centre of the bay, west of the island. Depths within the bay and between the island and the mainland reached no more than 10m. On the edge of the intertidal a homogeneous bank of dense fire coral was found. Large bommie fields were also recorded at a depth of 4-8m.

Substratum Composition

Sand was the dominant substratum type (Range: 90-100%) at this site, with a few patches of rubble present. Bommie/rock outcrops were few, typically 5m in diameter.

Biotic Cover

Hard and soft corals were present only on bommies and at the edge of the intertidal. 'Fire' coral dominated the coral forms close to the intertidal while 'encrusting' and 'massive' forms of coral dominated the bommie areas. Macroalgae and *Halimeda* spp. were present only in low numbers, while seagrasses dominated the biotic cover throughout the area.

Table 5.15 A summary of the structure, composition and biotic cover at QP4 (P<1 % cover).

Reef Features		Upper Reef (n=22) Mode (0-6)	Range (0-6)
Morphology	Slope (°)	0	0
	Rugosity	2	0-3
Substratum	Rock	2	0-3
	Rubble	1	0-2
	Sand/Shell	6	2-6
	Mud	-	-
Biota	Hard Coral	1	0-3
	Soft Coral	1	0-4
	Seagrass	4	0-4
	Macroalgae	P	0-1
	Halimeda spp.	0	0-P
Coral State	Heterogeneity	0	0-1
	Dominance	Fire/Encrusting/ Big Massive	

5.4.3 Subtidal Flora

Unlike other islands of S.I.G. the subtidal area of Quipaco was mainly colonised by seagrasses with sand and scattered bommies. The diversity of algae was highest on the outer reef and seagrass dominated the western subtidal habitats. A total of 6 seagrass species and 35 taxa of macroalgae were recorded from sites QP1, QP3 and QP4. A checklist of all seagrass and macroalgae taxa in the S.I.G. is presented in Appendix A2.

Area reports

Site QP1:

This site was predominantly sand and seagrass with bommies and a large variety of sponges. One seagrass species and 27 taxa of macroalgae (1 Cyanophyta, 13 Chlorophyta, 5 Phaeophyta and 8 Rhodophyta) were recorded in this site.

Site QP3:

This site consisted of rubble and sand substrata on which the seagrass *Thalassodendron ciliatum* dominated. At this site 1 seagrass species and 8 taxa of macroalgae were recorded. Of the 8 macroalgae 4 were Chlorophyta, 2 Phaeophyta and 2 Rhodophyta.

Site QP4:

QP4 comprised sand and seagrass with a few scattered bommies; 5 seagrass species and 5 macroalgae taxa were recorded. The algal flora consisted of 2 Chlorophyta and 3 Phaeophyta.

Figure 5.6 Subtidal habitat sites, Quipaco Island.

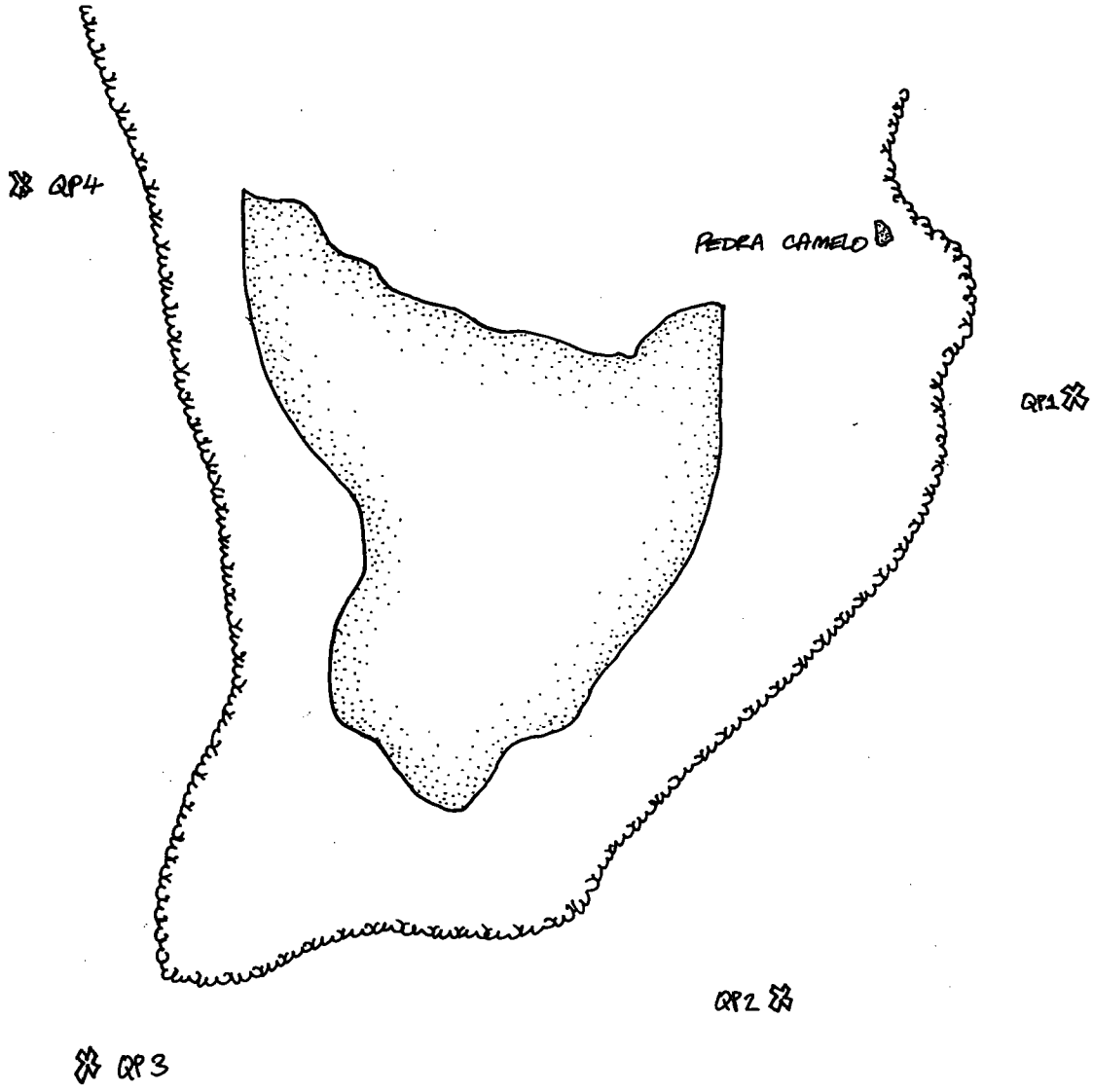
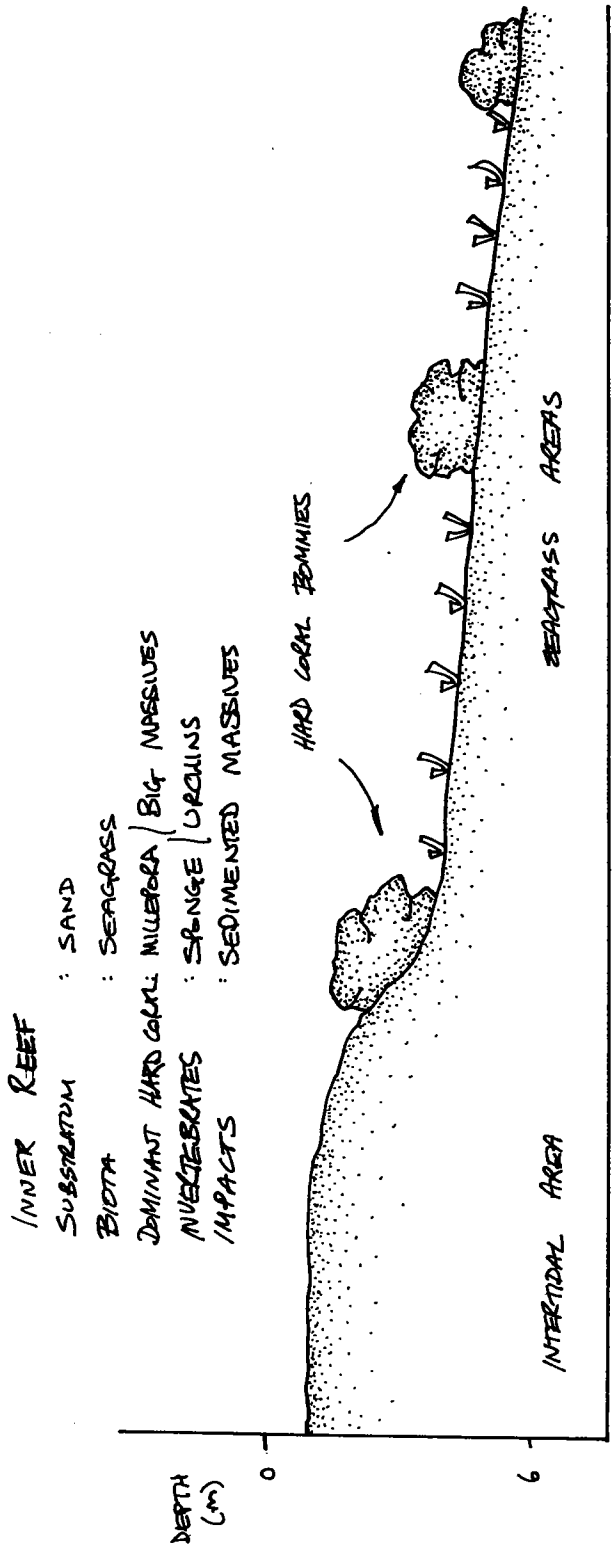


Figure 5.7 Diagram of the reef structure at QP4.



5.5 Subtidal Invertebrate and Impact Surveys

Survey sites are as for the subtidal habitat surveys reported above (Figure 5.13).

5.5.1 Overview

Macrosponges were the dominant invertebrates on all sites around the island, while urchins and sea whips (*Leptogorgonia* spp.) were common at site QP4. In most cases the other invertebrates surveyed occurred in relatively low numbers. Examples of coral damage were uncommon and largely limited to occasional sedimented 'massive' form corals and freshly dead coral (cause unknown). Examples of human impact were found, these included anchor damage, fishing line and an old fish trap at QP4.

5.5.2 Site Reports

Site QP1:
The distribution and densities of invertebrates and incidences of reef damage are described below, and summarised in Table 5.16.

Most notable was the high density of macrosponges recorded. There was no marked gradation in numbers with depth. Urchins formed small aggregations at the outer site, while sea cucumbers were present only in low numbers. Four giant clams (*Tridacna* spp.) were also reported at the outer site. Coral damage was limited to a few sedimented 'massive' form corals and fresh dead corals. Human impact was noted by the presence of three old fishing lines at the outer site..

Table 5.16 Invertebrates and Natural/Human Impacts at Site QP1 (values are for 5 minutes of survey).

		Upper Reef (n=12)		Lower Reef (n=12)	
Inverts/Impacts	**Types/Cause**	**Median**	**Range**	**Median**	**Range**
Macrosponges		3	1-A+	10.5	0-A
Bivalves	Giant Clams	-	-	0	0-1
Urchins		-	-	7.5	0-A
Sea Cucumbers	Holothuria	0	0-1	0	-
	Synapta spp.	-	-	0	0-1
	Others	1	0-1	-	-
Dead Corals	Unknown	1.5	0-2	1.5	0-3
	Sed. Massives	-	-	0	0-4
Human Effects	Fishing Line	-	-	0	0-1

Sites QP2 and QP3:
The distributions and densities of invertebrates and incidences of reef damage are summarised in Table 5.17 and described below.

Apart from a large number of macrosponges on the deeper areas of these two sites, the only other noted invertebrates were a few sea cucumbers and five adult lobsters, seen together at QP3 outer. A few colonies of freshly dead coral were present but there was no evidence of any human impact.

Table 5.17 Invertebrates and Natural/Human Impacts at Sites QP2 and QP3 (values are for 5 minutes of survey).

		Inner Reef (n=6)		**Outer Reef** (n=7)	
Inverts/Impacts	**Type/Cause**	**Median**	**Range**	**Median**	**Range**
Macrosponges		1	0-3	A	2-A
Sea Cucumbers	Holothuria	0	0-2	-	-
Lobsters		-	-	0	0-5
Dead Corals	Unknown	0	0-1	-	-

Site QP4:

The distributions and densities of invertebrates and incidences of reef damage are summarised in Table 5.18 and described below.

Macrosponges and urchins were recorded in large numbers, with sponges again being the dominant invertebrate. A few sea whips, sea cucumbers and lobsters were also seen. Coral damage was noted with many sedimented 'massive' coral forms (up to 9 per 5 min survey) and some fresh dead coral (cause unknown). Human impacts included one incidence of anchor damage and a single old fish trap.

Table 5.18 Invertebrates and Natural/Human Impacts at Site QP4 (values are for 5 minutes of survey).

		Upper Reef (n=16)	
Inverts/Impacts	**Types/Cause**	**Median**	**Range**
Macrosponges		3	0-A+
Gorgonians	Sea Whips	0	0-8
Bivalves	Giant Clams	0	0-1
Urchins		12.5	0-A+
Lobsters		0	0-2
Sea Cucumbers	Others	0	0-2
Dead Corals	Unknown	0	0-1
	Sed. Massives	1	0-9
Human Effects	Anchor damage	0	0-1
	Old Fish Traps	0	0-1

5.6 Reef Fish Census

5.6.1 Overview

The shallow sub littoral surrounding Quipaco was mainly sandy, with a few bommie fields to the north of the island. The reef fish assemblage was sparse, most fish observed were associated with the bommies. A summary of the species richness is presented in Table 5.19. A complete list of censused species at Quipaco has been included in Appendix A3.

Table 5.19 The number of 5 minute replicates, total species count, relative species richness indices (RSRi) and Shannon Weaver diversity indices (SWi) calculated from the Quipaco reef fish assemblage.

Site	Reps	Spp	RSRi	SWi
QP1 inner	18	10	0.14	1.98
QP1 outer	23	16	0.22	2.08
QP2	18	2	0.03	0.64
QP3 inner	6	1	0.01	0.00
QP3 outer	8	0	0	0
QP4 inner	8	13	0.18	2.03
QP4 outer	12	20	0.27	2.40

5.6.2 Site Reports

Site QP1:
This site was one of two at Quipaco that had a reasonable species richness of reef fish (20 species), with eight species each of butterflyfish (Chaetodontids) and surgeonfish (Acanthurids). Of these, the most common species were the Threadfin butterflyfish (*Chaetodon auriga*, 0.8 fish/5 min) and the Twospot bristletooth (*Ctenochaetus binotatus*, 3.2 fish/5 min) respectively. The site at QP1 was subdivided to two sampling stations, on the outer and inner reef areas. The outer area had more species (16) and numbers (206) of reef fish than the inner area (10 species, 72 fish). The Twospot bristletooth also made up 33% (93 of 278) of the total fish observed. The abundance and species richness of reef fish observed on both inner and outer areas are presented graphically in Figs. 5.8, 5.9.

Site QP2:
This was a site of sand, with little habitat suitable for reef fish. Only two species were observed, and only three fish. Of these, two were the Black-striped goatfish (*Upeneus tragula*). The abundance and species richness of reef fish observed are presented graphically in Fig. 5.10.

Site QP3:

This broad and sandy site was subdivided and surveyed on both inner and outer areas. No fish were observed on the outer area, and only two fish were seen on the inner area, both of which were the Black-striped goatfish (*Upeneus tragula*).

Site QP4:

This site was nominally the most diverse at Quipaco, with a total of 22 species observed at the inner and outer subdivided areas. As with site QP1, more species were observed at the outer area (20) than the inner area (13). Of the total species count, nine were surgeonfish (Acanthurids) and eight were butterflyfish (Chaetodontids). The Brown tang (*Zebrosoma scopas*) and Redfin butterflyfish (*Chaetodon trifasciatus*) were the most abundant of the two families respectively. The abundance and species richness of reef fish observed on both inner and outer areas are presented graphically in Figs. 5.11, 5.12.

Figure 5.8 The abundance and species richness of reef fish at site QP1 (inner reef).

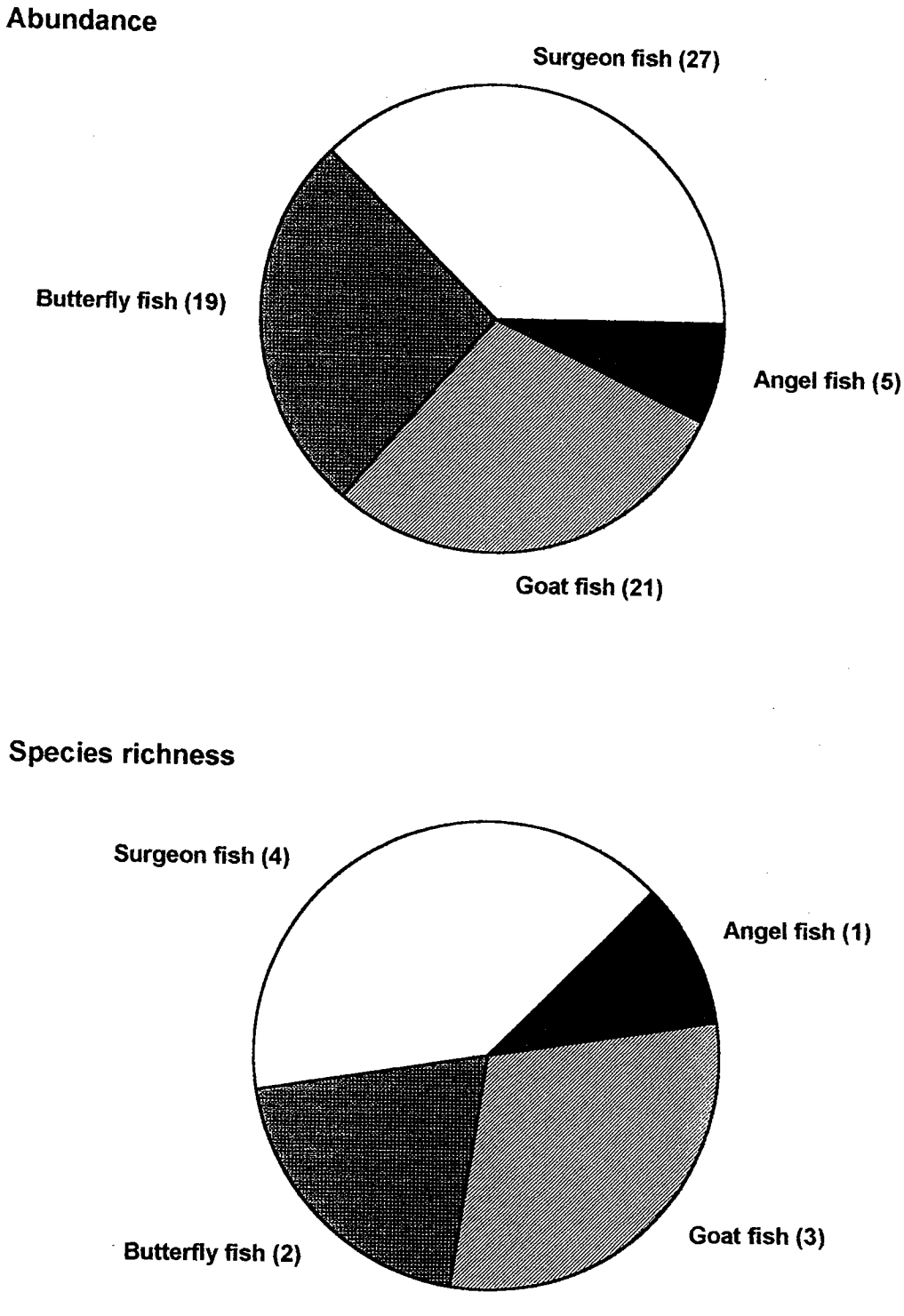


Figure 5.9. The abundance and species richness of reef fish at site QP1 (outer reef).

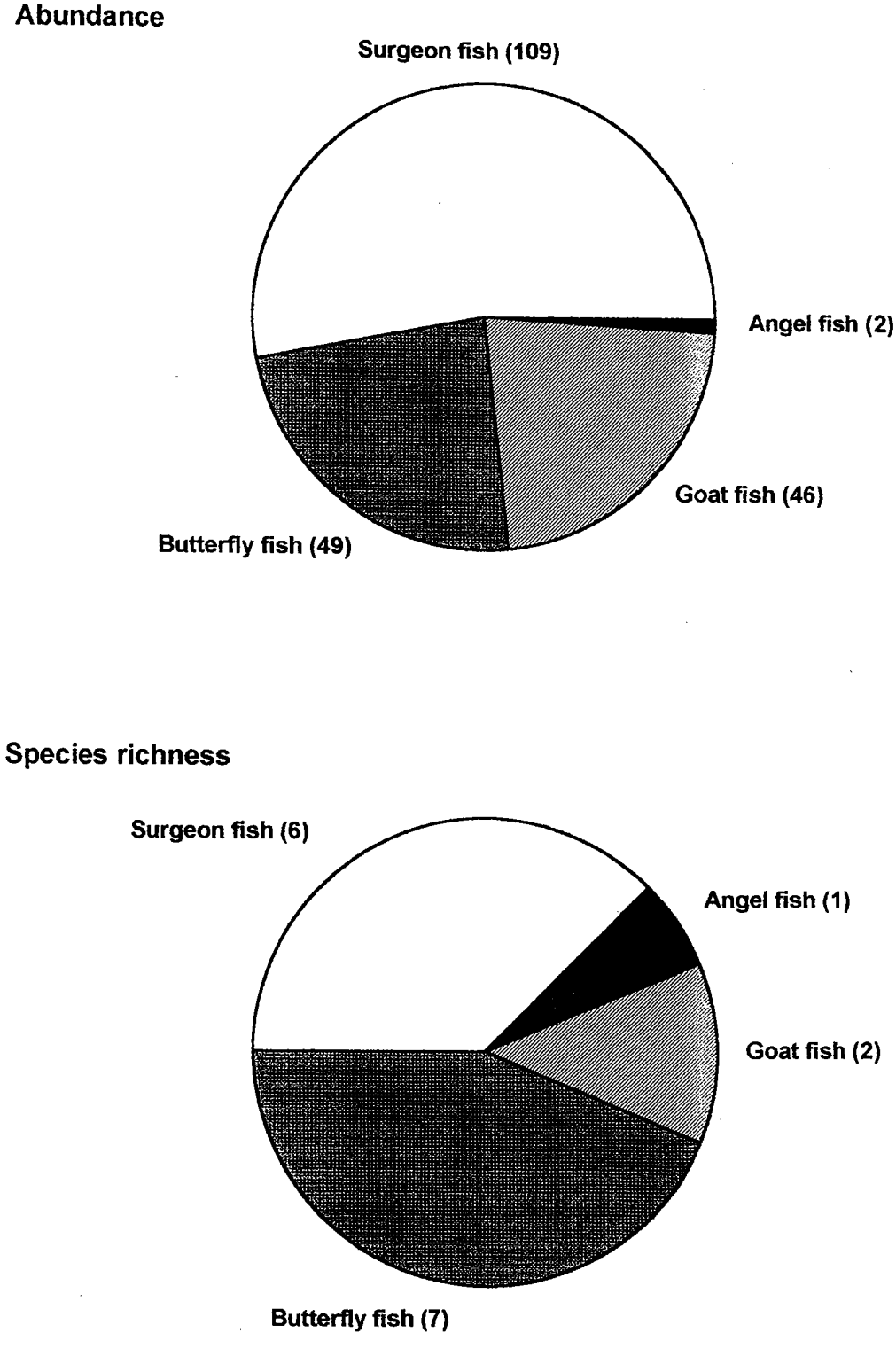


Figure 5.10. The abundance and species richness of reef fish at site QP2.

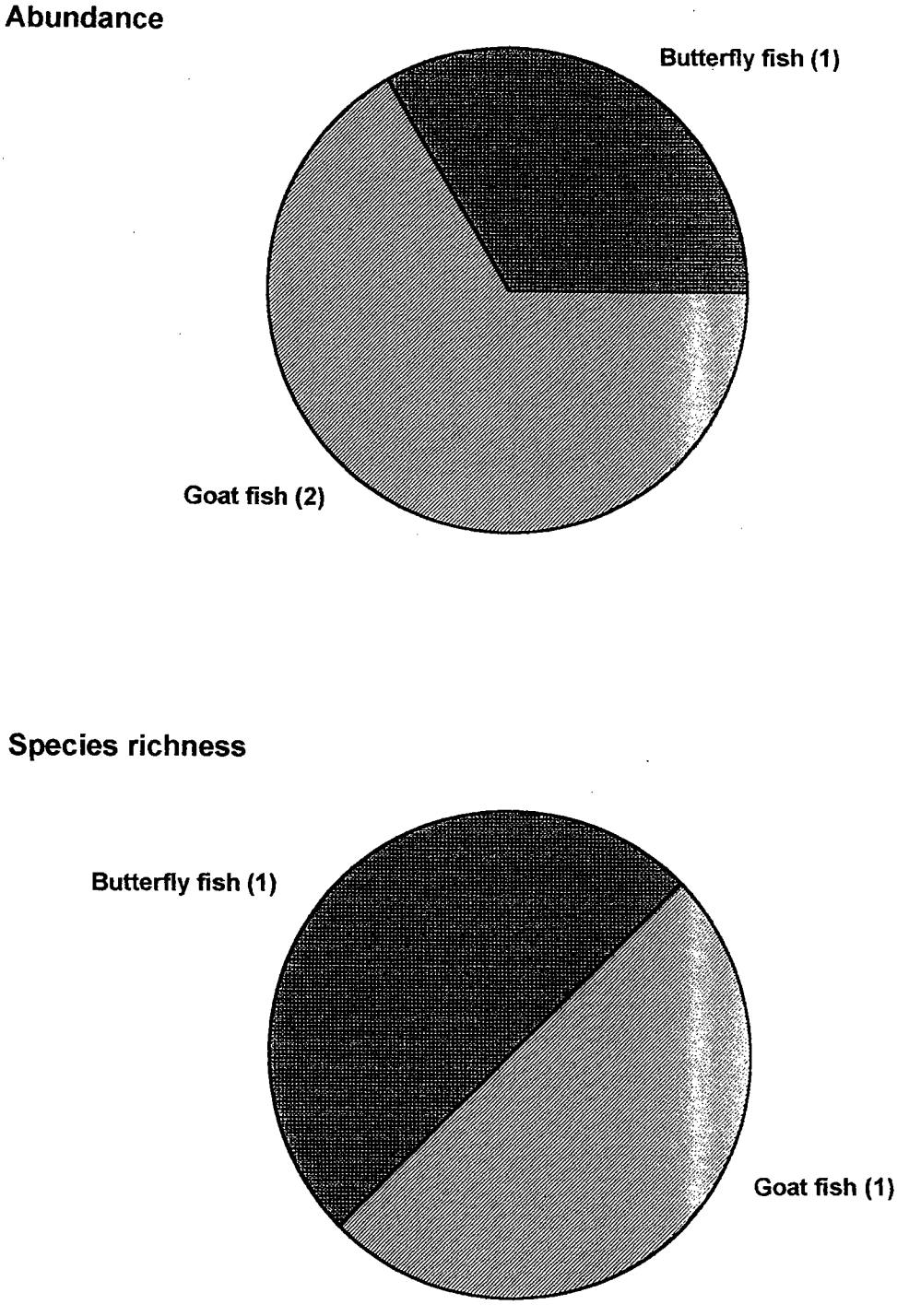


Figure 5.11 The abundance and species richness of reef fish at site QP4 (inner reef).

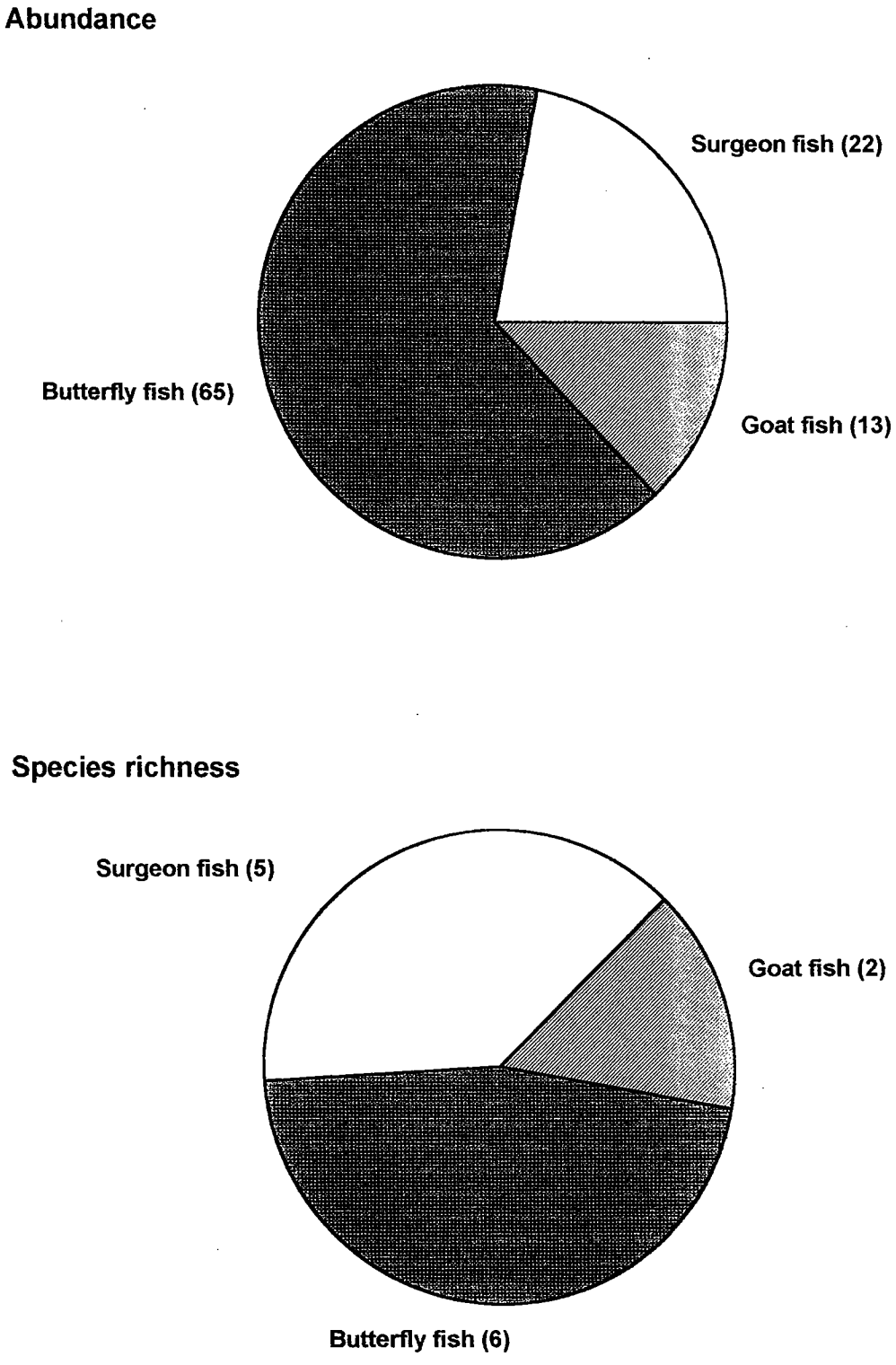
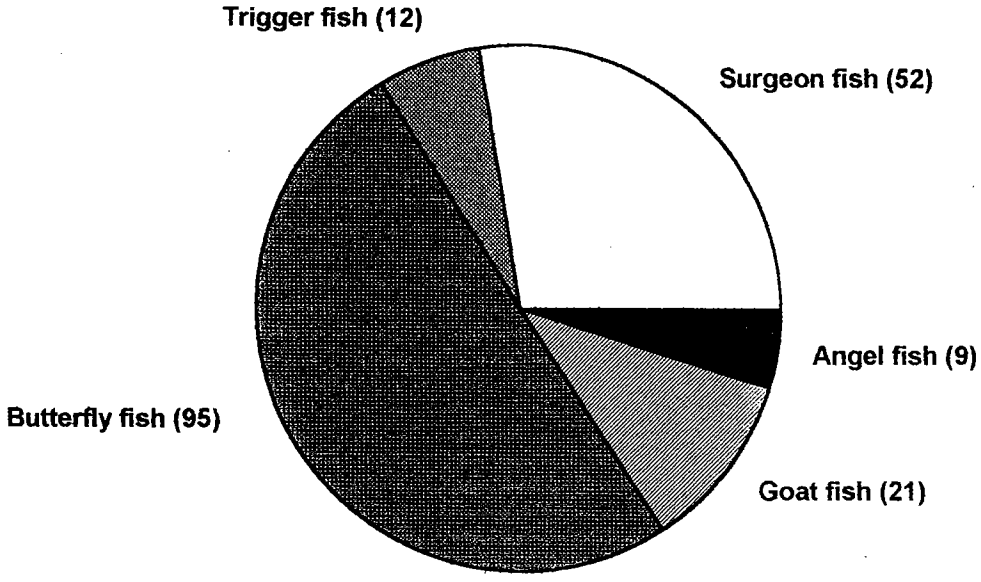
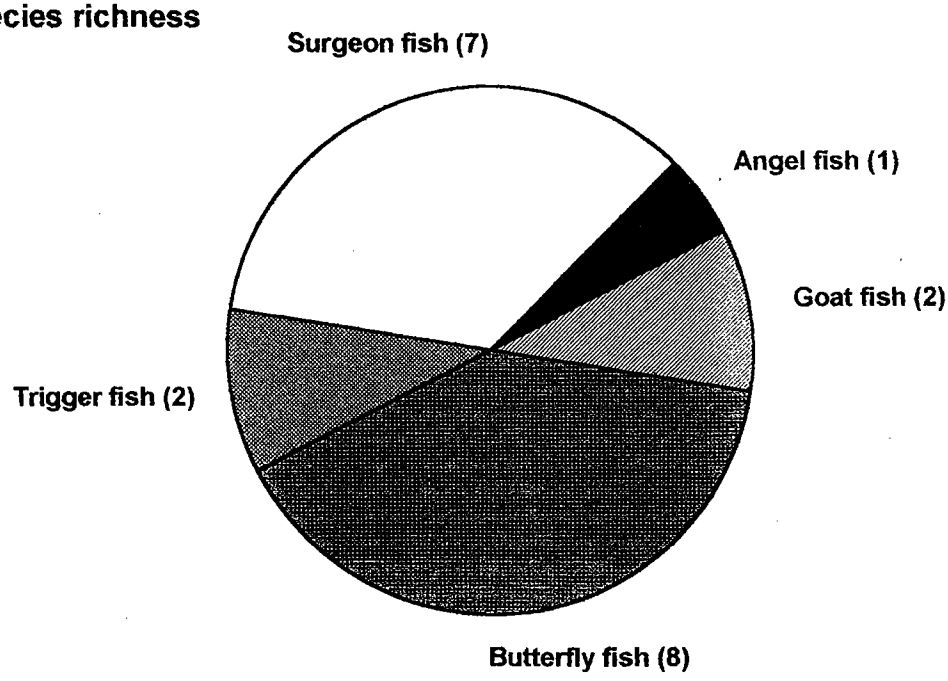


Figure 5.12 The abundance and species richness of reef fish at site QP4 (outer reef).

Abundance



Species richness



5.7 Commercial fish census

5.7.1 Overview

Commercial fish populations were censused at three of the four sites at Quipaco. Overall, the abundance and species richness of commercial fish was low, with the sub littoral habitats mainly sandy. Of the fish seen, the higher numbers of emperors (Lethrinids) are consistent with seagrass habitats. There was little fishery activity at Quipaco, as discussed in Section 5.8.

5.7.2 Site Reports

Site QP1:
Very few commercial fish were seen at this site, with only Tail-barred parrotfish *Scarus caudofasciatus* observed.

Site QP3:
Low diversity of commercial fish were seen, with two species observed. The majority of these (49 of 51) were emperors (Lethrinid), mostly the Thumbprint emperor *Lethrinus harak*. The presence of emperors is indicative of seagrass dominated habitats, consistent with the site's characteristics. The remainder were groupers (Serranids). The abundance and distribution of commercial fish at this site are presented graphically in Fig. 5.13.

Site QP4:
A similar commercial fish assemblage to site QP3 was observed at this site. Most of the fish (24 of 31) were the Thumbprint emperor *Lethrinus harak*, with the remainder made up of groupers (Serranids). The abundance and distribution of commercial fish at this site are presented graphically in Fig. 5.14.

5.7.3 Size Distributions

A summary of the size distribution of commercial fish observed at Quipaco is presented in Table 5.20. The fish observed were small relative to islands in the C.I.G. and at low abundance levels. A lack of hard corals and suitable benthic substratum may be the major factor in such a reduced fish assemblage.

Table 5.20 Size distribution summary for the commercial fish of Quipaco Island

Family	Number	Median (cm)	Range (cm)
Lethrinidae	73	15	10-15
Lutjanidae	0	0	0
Scaridae	8	35	25-35
Serranidae	9	25	15-35
Haemulidae	0	0	0
Carangidae	0	0	0
Siganidae	0	0	0

Figure 5.13 The abundance and distribution of commercial fish at site QP3.

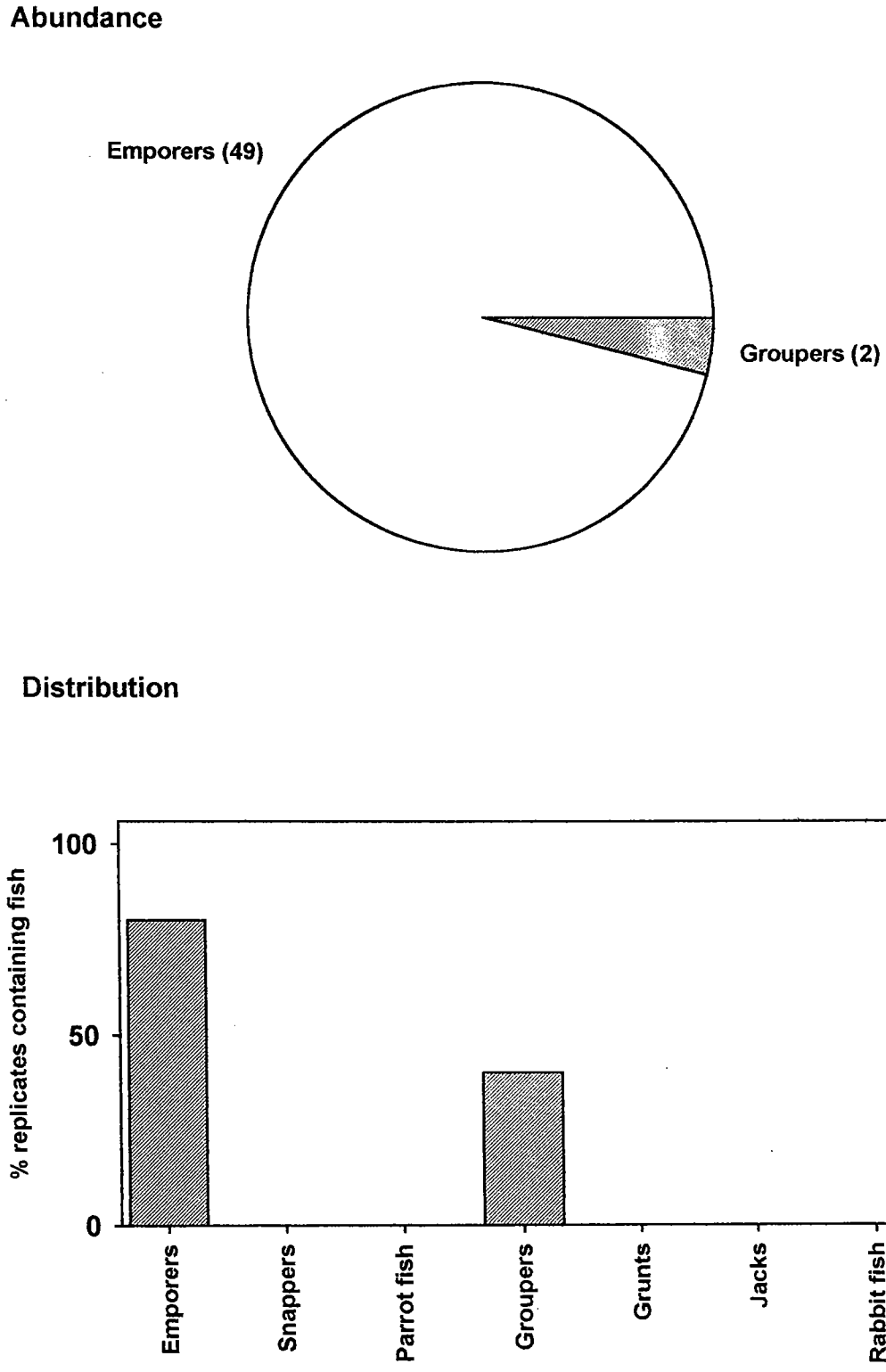
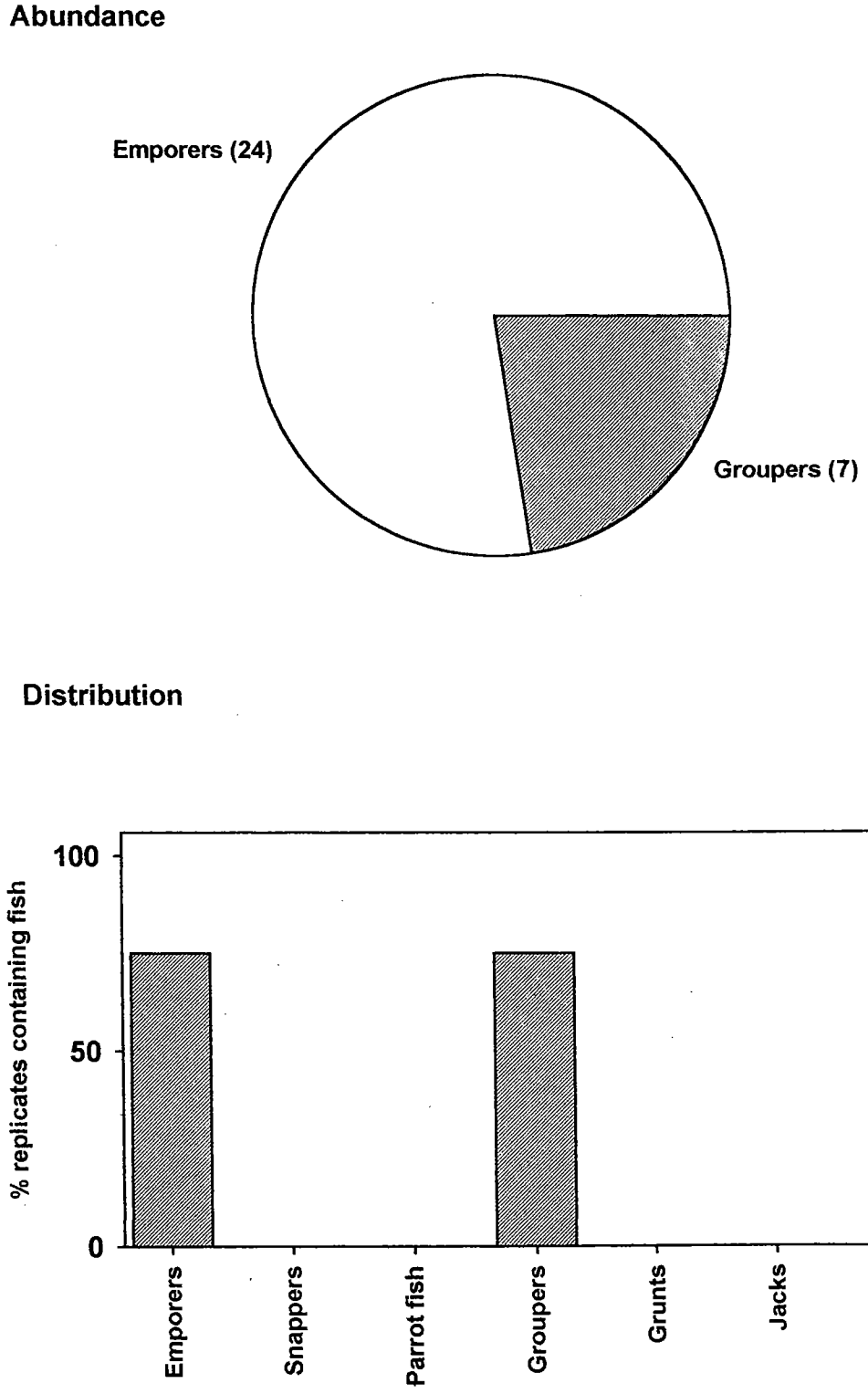


Figure 5.14 The abundance and distribution of commercial fish at site QP4.



5.8 Finfish Fisheries

5.8.1 Overview

Quipaco had no permanent population and was purely a base for itinerant fishermen from the mainland, as well as being used as a source of good mangrove wood. No fresh water was available (the nearest being in Arimba) and no suitable areas for growing crops were seen. Two small fishing camps were observed on the island, one to the north, and one to the south-west of the island on a beach in the mangrove area. The latter camp was also used as a base for the mangrove cutting operation. The numbers of fishermen using different techniques is summarised in Table 5.21.

Table 5.21 A summary of the estimated population and different fishing techniques used on Quipaco.

Quipaco Island	**Number**
Permanent population	0
Fishermen: resident	0
itinerant	17*
Fishing Method	
Line	3
Seine net	2
Trap: Large Marema	0
Trap: Marema	3
Trap: Suri	0
Luwando	0
Spear	8
Boats	
Sailing boats	0
Canoes	11

* number present in July 1997 during survey.

Spear fishing was the most popular method at both camps. Small groupers (Serranidae), surgeonfish (Acanthuridae) and barracudas (Sphyraenidae) were commonly caught, as well as large numbers of lobster (*Panulirus ornatus*). Catches were relatively large, typically 10kg of fish per canoe per day. Most fish was dried and sold on the mainland, however the market for the lobster could not be established.

The only sail boat observed on Quipaco was used for the transport of water and foodstuffs to the fishermen. This boat was based on the mainland near Arimba and usually used for net fishing.

5.9 Resource Collection

5.9.1 Overview

The main intertidal habitats are shown in Fig. 5.1. In total 27 collectors were interviewed between 2nd and 5th August 1997. The areas of the intertidal zone where the resources were collected are illustrated in Fig. 5.15. The scale and patterns of resource collection found within this period are described below.

Scale and Intensity of collection
A total of 27 people were observed collecting on the intertidal during the three days survey, giving an exploitation density of 25 people/km^2 for the entire intertidal area. However, the most exploited areas were located on the north western and north eastern shores.

Gender of collectors
Adult males were the main collectors (22), with 3 children (young females) and 2 adult women

Group Structure
Many of the collectors operated as individuals (note the high proportion of adult males collecting on this island).

Origin of Collectors
All 27 collectors interviewed were from outside Quipaco as the island did not have a permanent population. Seventeen collectors were from Pemba, 8 had come from Arimba and 2 were from Mecúfi District.

Collection Methods
Intertidal resources were mostly collected by hand (81%) and some collected with the aid of iron rods (19 %).

Catch Composition
The main target resource groups were 'FO' gastropods and octopi with 44% and 41% of collectors involved, respectively. The 'FO' gastropods species collected comprised *Fasciolaria trapezium* (58 specimens) and *Chicoreus ramosus* (37 specimens). The edible resources collected included *Octopus vulgaris* (22 specimens), *Mancinella alouina* (1 specimen) and about 4 kg of mussels (unidentified sp.). Five people were collecting sea cucumbers (14 specimens), 4 people 'CT' gastropods (3 specimens) and 1 person had collected a small quantity of fish.

5.9.2 Distribution of Effort across Intertidal Zones

All the collectors were working in the seagrass beds and their density reached 56/km^2. However, as the intertidal area is narrow, the people collecting in the seagrass also made outings to the reef crest.

5.9.3 Subtidal Collection

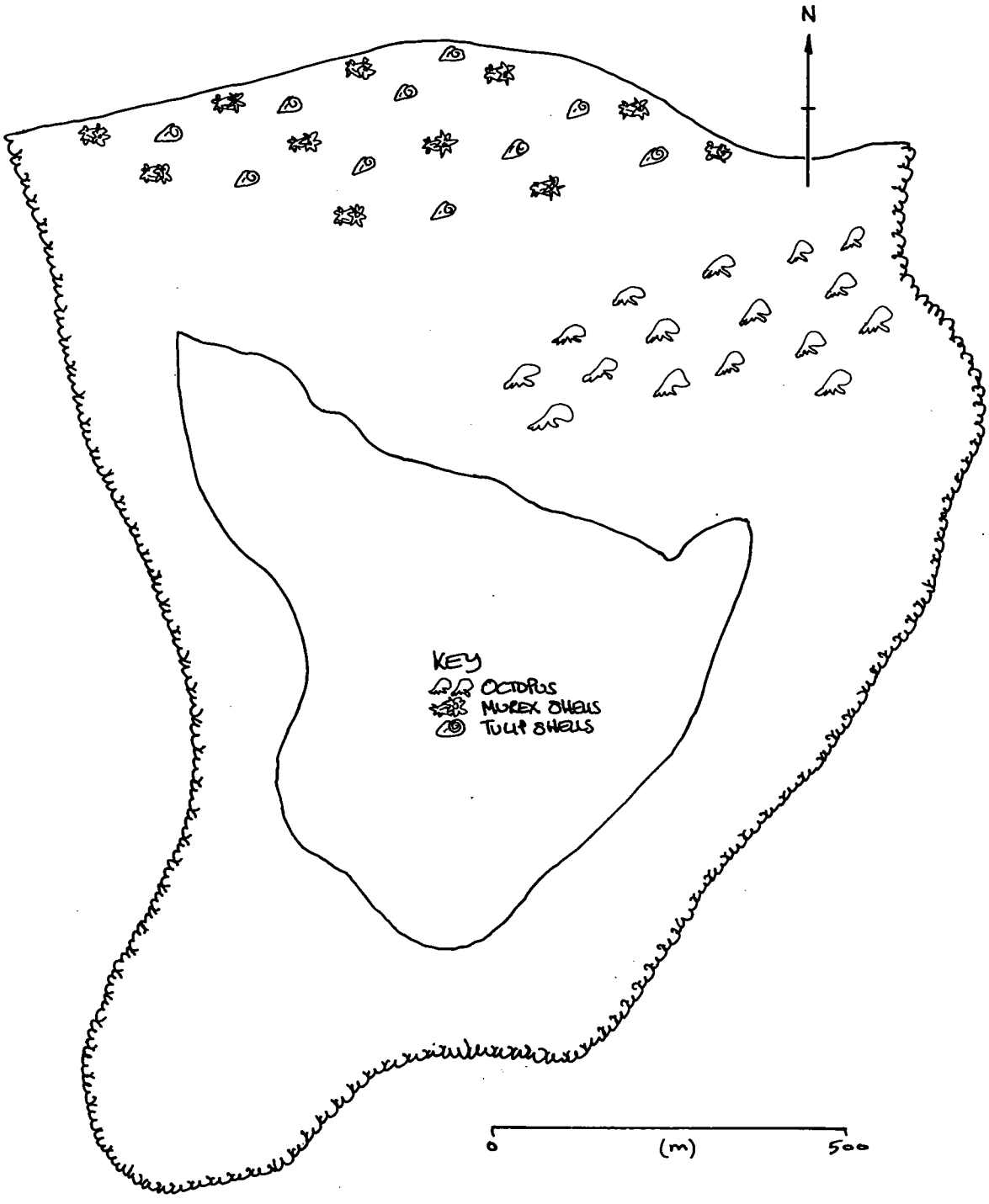
A few itinerant fishermen were interested in capturing finfish and in some cases people from Sito (a village on the mainland) and Arimba were undertaking subtidal collection of lobster to sell to a commercial operator on Mefunvo Island with refrigeration facilities. No subtidal collection of gastropods or sea cucumbers was observed during the survey period.

5.9.4 Discussion

Whilst other islands of the S.I.G. were inhabited, Quipaco had no permanent residents and the island's resources were exploited by itinerant fisherman who set up camp for several weeks in the dry season (May to November). During the survey period the number of these fishermen varied. In addition, several people from the adjacent mainland, Arimba, were daily visitors to the island in search of subtidal marine resources. A higher collection pressure was observed along the north coast of the island. Two women and 3 children from the adjacent mainland village Arimba were noted.

According to interviews with some fishermen Quipaco was an important site for the subtidal collection of lobster and holothuria for sale on Mefunvo or to a joint Mozambican and Tanzanian operation in Arimba. It appears that lobster exploitation here was at a low level.

Figure 5.15 Target areas for intertidal resources on Quipaco Island.



6.0 DISCUSSION

The findings reported indicate that the S.I.G. contained highly diverse habitat types, flora and fauna. The remote location of the islands, the topography of the region, the recent political instability and its associated prevention of coastal development have all combined to preserve the islands (and the Quirimba Archipelago as a whole) as an area of national importance for marine habitats. The following sections discuss the various habitats and resource use activities studied by the Programme within the S.I.G. in terms of threats to their status and/or sustainability, requirements for management and further study.

6.1 The Mangrove Habitat

Of the three S.I.G. islands, Mefunvo and Quipaco islands both supported significant stands of healthy mangrove. Quisiva possessed no mangrove. The total area of mangrove was however, significantly less than the extensive stands of mangrove found within the Central Islands Group (C.I.G.) (see Technical Report 3: Central Islands Group). A total of six species of mangrove tree were identified, with *Ceriops tagal*, *Brugiera gymnorrhiza* and *Rhizophora mucronata* the most common.

Most of the mangrove areas surveyed exhibited evidence of cutting, particularly in the more accessible areas close to creeks and footpaths. The scale of cutting was greatest on Quipaco where a temporary camp was set up as a base for cutting activities. The reasons for travelling to the island for mangrove cutting rather than utilising the easily accessible mangrove stands along the coast were not immediately obvious. However, on analysis of the survey results, the proportion of the stand on Quipaco that was *B. gymnorrhiza*, a favoured tree for use as a building material, was particularly high. It is probable that the relative ease of extraction and the large numbers of this species present compensated for the logistical difficulties in cutting on the island.

The overall threats to the mangroves of the S.I.G. were thought to be relatively low in the short term, with none of the clear felling or intensive wood extraction seen elsewhere in the archipelago (e.g. Quiwandala stand, Quirimba Island, Technical Report 3: Central Islands Group). However, the scale of cutting on Quipaco island will require management in the mid- to long-term for this resource use activity to be sustainable.

6.2 The Intertidal Flats

Macroalgae

The species richness of macroalgae within the S.I.G. was high with a total of 153 taxa (135 identified to species level and a further 18 specimens identified to genus level). This was a similar number to those found in both the C.I.G. (195 taxa) and the N.I.G. (158 taxa) (see Technical Report: 3 and 4). This level of species richness compares favourably with those areas studied further south in Mozambique (C.M. António, pers. obs.).

No species of macroalgae were observed to be utilised by the islands' population and the obvious human impacts were limited to trampling by invertebrate collectors and by the dragging of nets in the lower zones of the intertidal. Consequently, the threats to macroalgae richness and diversity were considered low.

Invertebrates

Assessment of the intertidal invertebrate populations resulted from a combination of the findings from the biological surveys of the intertidal zone and investigations into the activities of collectors targeting intertidal invertebrates. Given the wide variety of invertebrates inhabiting the intertidal areas, the limits on the taxonomic expertise available and logistical and time constraints, a full study of intertidal invertebrate fauna was not possible.

The collection of invertebrates from the intertidal areas was a common activity although the scale and nature of the exploitation varied considerably between the islands and was dependent on: the overall size and characteristics of the intertidal area; the size of the island's population, and; the scale of other resource use activities based on the island. The majority of invertebrates were collected on a subsistence basis for consumption at home, or for barter on the islands for other staple food items. However, there is an increasing numbers of migrant fishermen within the islands, particularly Quisiva island, operating on a more commercial basis which may threaten the sustainability of this resource.

There is currently no management of the collection of intertidal invertebrates within the archipelago. Given the importance of this resource activity to many of the islanders, there is a real need for management initiatives to both safeguard the sustainability of the resource and to maintain the status of invertebrate populations.

6.3 Seagrass Meadows

Ten seagrass species (from seven genera) were identified within the S.I.G. from the 11 species so far recorded in northern Mozambique (S. Bandeira pers. comm.). Significant areas of seagrass meadow were noted to the north west of Mefunvo island and around much of Quipaco, including the exposed eastern subtidal areas.

Fishing activity was witnessed in seagrass meadow areas but was limited in scale, with most fishermen in the S.I.G. targeting reef areas. Handlining and trap fishing were the most common methods employed. This is markedly different from the C.I.G. (Technical Report 3: Central Islands Group) where the majority of fishing activity was carried out using seine nets in seagrass meadow areas.

6.4 Reef Habitat

Reef structure

Coral reef was found in a variety of forms around all of the S.I.G. islands with the exception of some of the sites to the west of islands and some to the east of Quipaco, where the generally sheltered waters supported seagrass meadows and areas of sand. Three major forms of reef structure were identified: the steep reef wall which was often found off the north east of Quisiva island and was typified by site QS2 (Fig. 4.8); the shallow slope, coral garden of the outer fringing reef which was typified by site QS3 (Fig. 4.9) and the edge of channel profile found at site MF8 (Fig 3.13). In other areas where reef development was poor, coral was usually limited to bommies.

Natural threats to the coral, e.g. Crown of thorns starfish (*Acanthaster planci*) and White band disease, were rarely recorded during the surveys. Human impacts were also limited, although all but the most exposed reef areas, showed evidence of anchor damage. Sedimented 'massive' form hard corals were widespread in the turbid waters of the bay to the west of Quipaco island. The reefs of the N.I.G. can consequently be considered to be, at most sites, close to their 'natural state'. Management controls to protect the reefs are therefore not an urgent requirement but should be included as an important component to any overall management plan for the islands.

Reef invertebrates

Few of the commercially exploited invertebrates listed on the survey sheets were observed. An exception to this was at a single site to the west of Quipaco where lobsters were commonly observed. However, the site was being exploited by local collectors and therefore numbers may rapidly decrease. The presence of a commercial buying operation for lobsters on Mefunvo means that they were a lucrative resource for local fishermen to exploit.

Commercial buyers of curio trade gastropods operated on both Mefunvo and Quisiva islands and sold the shells onto the 'LusoAfrica' company based in Nacala, Nampula Province. A number of boats on Quisiva island targeted the collection of these gastropods together with holothuria (sea cucumbers). Holothuria collection was noted to occur throughout the S.I.G. Some of the islanders collecting on the intertidal zone purposefully targeted sea cucumbers or collected them incidentally to their main catch. However, the greatest numbers of holothuria were taken by teams operating from boats

using SCUBA and snorkelling equipment. Many of these teams of collectors were comprised of Tanzanian fishermen operating illegally within Mozambican waters.

Logistical constraints and available taxonomic expertise, limited the extent to which further detailed assessments of reef invertebrates could be made.

Reef-associated fish

The majority of reef sites surveyed showed a consistency in the relative levels of 'reef fish' diversity and in the abundance and diversity of 'commercial fish' populations. The exceptions were sites surveyed around Quipaco island which supported low populations of all fish. Of the 73 species of 'reef fish' on the census list devised for the fish survey, a total of 71 were observed (confirming the suitability of the Programme's fish census sheet). The fish tended to be more diverse at those sites with greatest hard coral development, in particular site MF1 which supported the highest species richness of the S.I.G. survey sites.

The 'commercial' fish were noted to concentrate on the steeper reef areas with the greatest numbers being recorded at site QS2 (this site also supported large numbers of large fish e.g. Potato grouper *Epinephelus tukula* and the Napoleon wrasse *Cheilinus undulatus* which are popular with diving tourists). The most common 'commercial' fish family was the snappers (Lutjanids) which formed shoals of up several hundred individuals.

The reef based fishery within the S.I.G. was mainly limited to the more sheltered areas (e.g. to the south and north of Quisiva and Mefunvo islands). A variety of methods were employed, the most common being boat-based seine netting, handlining and spearing. Fishing on outer reef areas was limited by exposure to the large waves of the open ocean, preventing the safe use of canoes and traditional sailing vessels close to reef edge.

Given the existing fishing pressure on much of the reef areas, the status of 'commercial' fish populations were judged to be currently under little threat. However, improvements in available fishing technology and fishing vessels, or an increase in fishing pressure, could quickly alter this situation.

6.5 Key sites for flora and fauna within the S.I.G.

The outer reef of Mefunvo and Quisiva islands

The outer reef of Mefunvo and Quisiva supported large areas of well-developed coral reef, including coral gardens and vertical walls with a high diversity and abundance of fish life. Human impacts on the reefs were low. These sites would be attractive to diving tourists.

6.6 Key threats within the S.I.G.

S.I.G.: curio shells and holothuria populations

The status of the populations of molluscs collected for the curio trade and the holothuria of the islands was unknown. However, the intensity of collection and the low numbers observed during the surveys threatened the abundance and diversity of these resources, particularly in the more accessible areas. Localised areas of over-exploitation may already exist. Urgent management controls are required to safeguard the conservation of these resources.

Mangrove cutting on Quipaco

Although substantial areas of healthy mangrove were found on Quipaco, the scale and intensity of wood extraction and the overall small size of the stand, combine to pose a threat to the continued sustainability of this resource use activity. Monitoring of the status of this stand is recommended.

6.7 Recommendations for future studies within the S.I.G.

1) An assessment of the effects of various management strategies that could be employed to safeguard the flora and fauna of the islands and ensure the sustainability of the resource use activities in the S.I.G. is required. However, the formulation and implementation of an integrated management plan for the Quirimba Archipelago as a whole, should be the ultimate aim of work in this field.

2) A series of ecological studies on the inter-dependency and roles of the different habitat types with concern to the factors maintaining the biodiversity of the area.

3) The communities of the S.I.G. are heavily reliant on the natural resources of the islands for their food, building materials and income. More detailed socio-economic studies are required to evaluate this dependency and to assess the effects of the introduction of resource management schemes to the islands. Further to this, environmental education initiatives are required to create a better understanding by the islands' community and administration of the processes that affect the resources they exploit and the marine environment in general.

APPENDICES

A1 Geographic data for the Southern Islands Group

i) Grid References for the islands of the S.I.G.

Island	Latitude	Longitude
Mefunvo*	12°33'00"S	40°36'00"E
Quisiva*	12°35'42"S	40°37'00"E
Quipaco*	12°41'00"S	40°36'42"E

ii) Dimensions of the islands of the S.I.G. (Units are kilometres and are based on the maximum dimensions).

Island	North-South	East-West
Mefunvo*	4.2	3.1
Quisiva*	1.2	2.8
Quipaco*	0.9	0.8

iii) Positional data for the S.I.G. subtidal survey sites

Mefunvo

Site	Latitude	Longitude
MF1*	12°32'24"S	40°37'01"E
MF2	12°33'39.7"S	40°37'03.6"E
MF3*	12°34'30"S	40°36'18"E
MF4	12°34'04.1"S	40°34'39.1"E
MF5*	12°32'51"S	40°34'36"E
MF6*	12°31'45"S	40°35'21"E
MF7	12°31'17.0"S	40°35'52.4"E
MF8	12°30'35.0"S	40°35'53.3"E

Quisiva

Site	Latitude	Longitude
QS1*	12°35'21"S	40°37'57"E
QS2*	12°35'57"S	40°38'09"E
QS3*	12°36'48"S	40°38'06"E
QS4*	12°37'48"S	40°36'54"E
QS5*	12°36'12"S	40°35'42"E

Quipaco

Site	Latitude	Longitude
QP1	12°40'31.7"S	40°37'32.1"E
QP2	12°41'17.1"S	40°36'49.0"E
QP3	12°41'20.2"S	40°36'12.4"E
QP4	12°40'30.9"S	40°36'08.3"E

*Grid references, dimensions and survey site positions taken from the nautical chart 'Direcção Principal de Navegação e Oceanografia do Ministério da Defésa de URSS. No 46605-M and 46604-M. 1.ª Ediçao II-X-1986. 1:50 000. Additional survey site data recorded on a Global Positioning System (GPS, Garmin 45XL).

A2 Seagrass and Macroalgae

Seagrass and macroalgae taxa recorded during the intertidal surveys of the S.I.G.

i) Intertidal Flora

Seagrass

Cymodocea rotundata
Enhalus acoroides
Halodule wrightii
Halophila ovalis
Syringodium isoetifolium
Thalassia hemprichii
Thalassodendron ciliatum

Macroalgae

Cyanophyta

Lyngbya majuscula

Chlorophyta

Anadyomene wrightii
Avrainvillea erecta
A. obscura
Boergesenia forbesii
Boodlea composita
Bornetella oligospora
Caulerpa racemosa var. *clavifera*
C. racemosa var. *turbinata*
C. racemosa var. *uvifera*
C.sertularioides
Caulerpa sp.
Chaetomorpha crassa
Chamaedoris delphinii
Chlorodesmis sp.
Cladophora fascicularis
C. mauritiana
C. cf. *saviniana*
C. sibogae
Cladophora sp.
Codium dwarkense
Dictyosphaeria cavernosa
D. verluysii
Enteromorpha kylinii
Halimeda cilindracea
H. discoidea
H. macrolaba
H. opuntia
H. tuna
Microdictyon montagnei
Neomeris van bosseae
Spongocladia vaucheriaerformis
Ulva fasciata
U. lactuca
U. palmetta
U. pertusa

Chlorophyta (continued)

Udotea orientalis
U. pulchra
U. reticulata
U. rigida
Valonia aegagrophila
V. fastigiata
V. macrophysa
Valoniopsis pachynema

Phaeophyta

Cistoseira myrica
C. trinodis
Dictyopteris delicatula
Dictyota adnata
D. bartayresii
D. cervicornis
D. ceylanica
D. divaricata
D. friabilis
D. pardalis
Hormophysa triquetra
Hydroclathrus clatrathus
Padina boryana
P. gymnospora
Padina sp.
Sargassum aquifolium
S. asperifolium
S. binderi
S. duplicatum
S. *swartz*
Sargassum sp.
Spatoglossum asperum
Turbinaria conoides
T. ornata var. *ornata*

Rhodophyta

Acanthophora dendroides
A. muscoides
A. specifera
Acrocistis nana
Actinotrichia fragilis
Amansia dietrichiana
A. glomerata
Amphiroa anceps
A. beauvoise
A. fragilissima
Bostrychia binderi
B. tenella
Caulacanthus ustulatus

Rhodophyta (continued)

Centroceras clavulatum
Ceramium sp.
Champia cf. *indica*
C. cf. *globulifera*
Champia sp.
Chondria cf. *armata*
C. dasyphylla
C. sedifolia
Chondria sp.
Dasyopsis cf. *pilosa*
Digenia simplex
Endosiphonia clavigera
Eucheuma dendiculatum
Gelidiella acerosa
G. myrioclada
G. crassa
G. edulis
G. fasciculata
G. fergusoni
G. folifera
G. millardeti
G. salicornia
Gracilaria sp.
Kappaphycus striatum
Kappaphycus sp.
Halymenia venusta
Hypnea cornuta
H. hamulosa
H. musciformis
H. cf. *nidifica*
H. cf. *nidulans*
H. pannosa
Jania adhaerens
Laurencia columellaris
L. complanata
L. distichophyla
L. obtusa
L. papillosa
L. poiti
Laurencia sp.
Liagora ceranoides
Poritiera harvey
P. pulvinata
Pterocladia parva
Sarconema filiformis
Soliera robusta
Vanvoorstia spectabilis
Wurdemannia miniata

A2 Seagrass and Macroalgae (Continued)

ii) Subtidal Flora

Seagrass

Cymodocea rotundata
Cymodocea serrulata
Enhalus acoroides
Halodule uninervis
Halodule wrightii
Halophila ovalis
Syringodium isoetifolium
Thalassodendron ciliatum
Halophila stipulacea

Macroalgae

Cyanophyta

Lyngbya majuscula

Chlorophyta

Acetabularia sp.
Anadyomene wrightii
Avrainvillea erecta
A. obscura
Bornetella oligospora
Bryopsis sp.
Caulerpa sp.
C. cupressoides var. *flabellata*
C. lanuginosa
C. peltata
C. scapelliformis
C. serrulata
C.sertularioides
C. taxifolia
Chaetomorpha crassa
Chamaedoris delphinii
Chlorodesmis sp.
Codium dwarkense
C. geppi
Codium. sp.
Dictyosphaeria cavernosa
D. verluysii
Halimeda cilindracea
H. discoidea
H. gigas
H. macrolaba
H. milanesica
H. renschii
Halimeda sp.

Chlorophyta (continued)

Neomeris van bosseae
Udotea flabellum f. *flabellum*
U. flabellum f. *longifolia*
U. glauscens
U. orientalis
Ventricaria ventricosa

Phaeophyta

Chonospora implexa
Cladosiphon occidentale
Dictyopteris delicatula
Dictyota adnata
D. ciliolata
D. divaricata
D. pardalis
Hydroclathrus clatrathus
Padina boryana
P. gymnospora
Pocockiella variegata
Rosenvingea intricata
Sargassum aquifolium
S. duplicatum
S. latifolium
S. *swartz*
Sargassum sp.
Spatoglossum asperum
Turbinaria decurrens
T. ornata var. *ornata*

Rhodophyta

Actinotrichia fragilis
Amphiroa anceps
A. fragilissima
Chondrococcus harvey
Galaxaura breviarticulata
G. oblongata
G. tenera
Haliptylon subulata
Halymenia sp.
Halymenia venusta
Hypnea cornuta
Jania adhaerens
Laurencia columellaris
Liagora tenera
Liagora sp.

Rhodophyta (continued)

Poritiera harvey
P. pulvinata
Thysanocladia dentata
Trichogloea sp.
Wurdemannia miniata

A3 Reef Fish Surveys

Summary data for the reef fish surveys of the S.I.G. ('**% rate**' is the number of replicates in which the species was seen; '**total**' is the total Nº of the species seen in all surveys. Nº of replicates: Mefunvo 93; Quisiva 67; Quipaco 132). Total Nº of species recorded was 63, of the 73 reef fish on the reef fish survey list. **P/A** refers to presence / absence of that species.

Scientific name	Common name	Mefunvo		Quisiva		Quipaco		
		%rate	total	%rate	total	%rate	total	P/A
Acanthuridae	**Surgeonfish**							
Acanthurus leucosternon	Powderblue	0	0	6	9	9	7	+
Acanthurus lineatus	Lined	0	0	0	0	0	0	
Acanthurus tennenti	Lieutenant (Tennents)	6	7	1	1	5	8	+
Acanthurus nigricauda	Blackstreak	6	9	4	4	9	16	+
Acanthurus nigrofuscus	Dusky	12	25	63	252	53	178	+
Acanthurus thompsoni	Thompson's	2	3	60	351	18	150	+
Acanthurus triostegus	Convict	1	1	0	0	1	2	+
Ctenochaetus binotatus	Twospot Bristletooth	26	101	0	0	28	73	+
Ctenochaetus stigosus	Goldring Bristletooth	0	0	10	24	15	54	+
Ctenochaetus striatus	Striped Bristletooth	3	4	9	9	3	4	+
Naso brevirostris	Spotted Unicornfish	4	6	3	4	91	27	+
Naso hexacanthus	Sleek Unicornfish	0	0	0	0	0	0	
Naso lituatus	Orangespine Unicornfish	1	1	7	10	5	6	+
Paracanthus hepatus	Palette Surgeonfish	0	0	0	0	0	0	
Zebrasoma desjardinii	Sailfin Tang (Desjardin's)	4	12	6	6	1	1	+
Zebrasoma scopas	Brown Tang (Brushtail)	13	21	43	58	40	153	+
Zanclus cornutus	Moorish Idol	13	20	43	77	16	25	+
Balistidae	**Triggerfish**							
Balistapus undulatus	Orangestriped	0	0	6	4	14	15	+
Balistoides conspicillum	Clown	0	0	0	0	0	0	
Balistoides viridescens	Titan (Moustached)	0	0	0	0	1	1	+
Melichthys vidua	Black	0	0	3	4	3	8	+
Odonus niger	Red-Tooth	0	0	0	0	9	35	+
Pseudobalistes fuscus	Blue & Gold	0	0	0	0	0	0	
Rhinecanthus aculeatus	Wedge Picasso	2	2	0	0	0	0	
Rhinecanthus rectangulus	Picasso	0	0	0	0	0	0	
Sufflamen chrysopterus	Half-moon	6	10	21	36	51	96	+
Sufflamen bursa	Scythe	0	0	30	33	16	19	+
Chaetodontidae	**Butterflyfish**							
Chaetodon auriga	Threadfin	40	102	34	53	37	60	+
Chaetodon bennetti	Bennett's	0	0	1	2	1	2	+
Chaetodon blackburnii	Blackburn's	1	1	0	0	0	0	+
Chaetodon dolosus	African	0	0	0	0	0	0	
Chaetodon facula	Double-Saddled	6	6	15	16	10	20	+
Chaetodon guttatissimus	Spotted	2	3	12	12	24	51	+
Chaetodon kleinii	Dot-Dash (Klein's)	11	19	33	44	68	135	+
Chaetodon leucopleura	Somali	0	0	6	6	0	0	+
Chaetodon lineatus	Lined	0	0	3	4	4	5	+
Chaetodon lunula	Racoon	5	5	18	20	12	24	+
C. madagascariensis	Madagascan	2	4	0	0	10	18	+
Chaetodon melannotus	Black-Backed	5	5	13	13	14	31	+
Chaetodon meyeri	Meyer's	0	0	18	14	10	16	+
Chaetodon trifiscialis	Chevron	0	0	19	24	5	8	+
Chaetodon trifasciatus	Redfin	25	74	48	91	37	120	+
Chaetodon unimaculatus	Teardrop	0	0	0	0	12	31	+
Chaetodon vagabundus	Vagabond	0	0	7	10	1	1	+
Chaetodon xanthocephalus	Fried-Egg	8	8	1	1	2	3	+
Chaetodon zanzibariensis	Zanzibar	0	0	1	2	1	1	+
Forcipiger longirostris	Big-Long-Nose	0	0	9	8	4	5	+
Hemitaurichthys zoster	Black Pyramid	0	0	10	13	11	27	+
Heniochus acuminatus	Pennant Bannerfish	2	2	30	45	22	41	+
Heniochus monoceros	Masked Bannerfish	0	0	10	17	5	8	+

A3 Reef Fish Surveys (Continued)

Scientific name	Common name	Mefunvo		Quisiva		Quipaco		
		%rate	total	%rate	total	%rate	total	P/A
Mullidae	**Goatfish**							
Mulloidichthys flavolineatus	Yellow Stripe	0	0	0	0	3	3	+
Parupeneus barberinus	Dash-Dot	39	78	40	56	39	101	+
Parupeneus bifasciatus	Double Barred	0	0	0	0	8	8	+
Parupeneus cyclostomus	Yellow Saddled	1	2	1	1	4	5	+
Parupeneus macronema	Long Barbel	14	21	6	4	30	52	+
Upeneus tragula	Black Striped	4	4	1	1	2	2	+
Parupeneus pleurostigma	Sidespot	0	0	1	1	6	11	+
Pomacanthidae	**Angelfish**							
Apolemichthys trimaculatus	Yellow	0	0	6	5	3	3	+
Centropyge acanthops	African Pygmy	0	0	0	0	2	12	+
Centropyge bispinosus	Two-Spined	0	0	3	3	9	13	+
Centropyge flavicauda	White-Tail	0	0	7	18	0	0	+
Centropyge multispinus	Multi-Spined	10	16	22	26	44	111	+
Pomacanthus chrysurus	Earspot	0	0	0	0	2	2	+
Pomacanthus imperator	Emperor	0	0	9	6	8	9	+
Pomacanthus maculosus	Yellow-Bar	0	0	0	0	0	0	
Pomacanthus rhomboides	Old Woman	0	0	0	0	0	0	
Pomacanthus semicirculatus	Semi-Circle	0	0	9	10	0	0	+
Pygloplites diacanthus	Royal	0	0	9	7	5	7	+
Tetradontidae	**Pufferfish**							
Arothron hispidus	White-Spotted	0	0	1	1	0	0	+
Arothron immaculatus	Immaculate	0	0	1	2	0	0	+
Arothron meleagris	Guineafowl	0	0	1	1	2	2	+
Arothron nigropunctatus	Black-Spotted	0	0	0	0	2	2	+
Arothron stellatus	Star	0	0	0	0	0	0	

A4 Commercial Fish Surveys

Summary data for the commercial fish surveys of the S.I.G. Figures are the total number of individuals observed (numbers of replicate observations: Mefunvo 22; Quisiva 26; Quipaco 13)

Species	Mefunvo	Quisiva	Quipaco
Lethrinidae			
Lethrinus harak	0	0	46
Lethrinus mahsenoides	0	0	0
Lethrinus obsoletus	0	0	0
Lethrinus xanthochilus	0	0	0
Monotaxis grandoculis	12	0	0
Gnathodentex aurolineatus	0	0	0
Other emperors	0	0	27
Lutjanidae			
Aprion virescens	7	11	0
Macolor niger	0	0	0
Lutjanus bohar	0	0	0
Lutjanus ehrenbergii	0	0	0
Lutjanus fulviflamma	0	0	0
Lutjanus fulvus	94	0	0
Lutjanus gibbus	13	11	0
Lutjanus kasmiri	24	467	0
Lutjanus monostigma	131	0	0
Other snappers	1	0	0
Scaridae			
Cetoscarus bicolor	0	0	0
Hipposcarus harid	0	0	0
Leptoscarus vaigiensis	0	0	0
Scarus capistratoides	0	0	0
Scarus caudofasciatus	6	0	8
Scarus frenatus	0	18	0
Scarus ghobban	14	16	0
Scarus japanensis	0	0	0
Scarus niger	0	0	0
Scarus psittacus	0	0	0
Scarus rubroviolaceus	0	0	0
Scarus scaber	0	0	0
Scarus sordidus	19	55	0
Scarus strongylocephalus	0	3	0
Scarus tricolor	0	0	0
Scarus viridifucatus	0	0	0
Other parrotfishes	0	0	0

A4 Commercial Fish Surveys (Continued)

Species	Mefunvo	Quisiva	Quipaco
Serranidae			
Aethaloperca rogaa	0	0	0
Cephalophilis argus	0	4	0
Cephalophilis miniata	19	18	0
Cephalophilis nigripinnis	0	0	0
Cephalophilis sexmaculata	0	0	0
Cephalophilis sonnerati	0	0	0
Cephalophilis spiloparea	0	0	0
Epinephelus caeruleopunctatus	0	0	0
Epinephelus fasciatus	0	0	0
Epinephelus hexagonatus	0	1	0
Epinephelus malabricus	0	2	0
Epinephelus ongus	0	0	0
Epinephelus polyphekadion	3	0	0
Epinephelus tukula	0	1	0
Plectropomus laevis	0	0	0
Plectropomus punctatus	1	0	0
Variola louti	1	3	0
Variola albimarginata	3	0	0
Other groupers	0	0	9
Haemulidae			
Diagramma pictum	0	22	0
Plectorhinchus flavomaculatus	9	0	0
Plectorhinchus gaterinus	81	3	0
Plectorhinchus gibbosus	0	0	0
Plectorhinchus orientalis	0	0	0
Plectorhinchus plagiodesmus	0	0	0
Plectorhinchus playfairi	0	0	0
Other grunts	0	0	0
Carangidae			
Carangoides ferdau	0	0	0
Caranx ignobilis	0	0	0
Caranx melampygus	0	0	0
Other jacks	0	2	0
Siganidae			
Siganus stellatus	0	0	0

A5 Biological Resources

Local and Regional Use and Cost of the Islands' Biological Resources. (prices in Meticais)

Latin name	Use	Quirimba Cost/unit	Quirimba Cost/kilo	Pemba Cost/unit	Pemba Cost/kilo
Bivalvia					
Arcinella sp.	Food			1,000 (Nacala)	
Barbatia sp.	Food		1,000/handful		
Gafrarium sp.	Food		1,000/cup		
	Curio trade			1,000	
Mytilidae sp.	Food	Not sold	Not sold	Not sold	Not sold
Pinctada sp.	Food	1,000/string dried; 2,000/cup	5,000 *[4] 10,000		
Pinna sp.	Food; Bait		2,000 *[7]		
Atrinia sp.	Food		1,000		
Saccostrea sp.	Food	Not sold	Not sold	Not sold	Not sold
Striostrea sp.	Food	Not sold	Not sold	1,000	
Telina sp.	Curio trade			10,000	
	Food	Not sold	Not sold	Not sold	Not sold
Trachycardium sp.	Food	Not sold	Not sold	Not sold	Not sold
Tridacna sp.	Curio trade	3,000 large			
		1,000 small			
	Food	3,000 large			
Gastropoda					
Chicoreus ramosus	Operculum	250			75,000 (Tanzania)
	Food				
Fasciolaria trapezium	Food				75,000 (Tanzania)
	Operculum	250			
Haliotis sp.	Food	Not sold	Not sold	Not sold	Not sold
Mancinella alouina	Food	Not sold	Not sold	750	
Marginella sp.	Food	Not sold	Not sold	Not sold	Not sold
	Operculum	100*[1]			
Morulla granulata	Food	Not sold	Not sold	Not sold	Not sold
Natica gualteriana	Food	Not eaten	Not eaten	1,000/ 10	
Nerita sp.	Food	Not sold	Not sold	Not sold	Not sold
Terebralia palustris	Food/ bait				
Strombus mutabilis	Food	Not sold	Not sold	Not sold	Not sold
Turbo coronatus	Food	Not sold	1,000	Not sold	Not sold

A5 Biological Resources (Continued.)

Latin name	Use	Quirimba Cost/unit	Quirimba Cost/kilo	Pemba Cost/unit	Pemba Cost/kilo
Gastropoda					
Cassis cornuta	Curio trade	5-15,000 *3			
Charonia tritonis	Curio trade			120,000	
Chicoreus chicoreus	Curio trade	2,500		10,000	
Conus spp.		1000	1000 *8		
Cypraea tigris	Curio trade	1000			10,000
Cypraecassis rufa	Curio trade	Class Price 1st 15,000 2nd 7,000 3rd 3750	30, 000		30,000 *5
Harpa spp.	Curio trade			5,000	
Lambis chiragra	Curio trade				
Lambis lambis	Curio trade	250 (small) 1,000-1,500 (large)	50,000	10-15,000*7	
Littorina spp.	Curio trade			250	
Marginella sp.	Curio trade			5,000/100	
Mitra spp.	Curio trade	Not sold	Not sold	2,000/5	
Mitra sp.	Curio trade			8,000	
Monodonta australis[*1]	Curio trade	1,000			
Murex pecten	Curio trade	1,000			
Nassarius coronatus	Curio trade			250/10	
Patella spp.	Curio trade Food			250/10	
Peristernia forskalii	Curio trade			8,000	
Phalium glaucum	Curio trade			1,000 (N) *7	6,500 (N) *7
Strombus sp. (bottom spike)	Curio trade			15,000	
Strombus sp. (top spike)	Curio trade			2,000	
Terebra spp.	Curio trade	Not sold	Not sold	10,000	
Tonna spp.	Curio trade			5,000	
Trochus spp.	Curio trade			2,000	
	Food	Not sold	Not sold	Not sold	Not sold

A5 Biological Resources (Continued)

Latin name	Use	Quirimba Cost/unit	Quirimba Cost/kilo	Pemba Cost/unit	Pemba Cost/kilo
Octopus vulgaris	Food		3,000 fresh; 10-13,000 dry; *8		
Holothuria					
General	Food			Tanzania	50,000 *2
B. marmorata (Namunya)	Food	250			
S. variegatus (Bosi)	Food	1,000			
A. miliaris (Namwali)	Food	500-1,000	10,000		
Ningi	Food	1,000	15,000		
H. nobilis (Grife)	Food	100			
Pwazi	Food	100			
Crustacea					
Scylla serrata	Food		5,000 *6		
Panulirus ornatus	Food	5-10,000 *6			

NOTES:

Prices were given by Saidi Kashim, a shell collector and vendor in the Quirimbas and Pemba, in 9/96. Prices of holothuria were given by various exploiters. The currency exchange rate was at 12,000 meticais/ US Dollar.

*1 given by intertidal exploiter on 15/9/96.
*2 given by intertidal exploiter on 16/8/96.
*3 given by Quiwandala fisherman on 2/8/96.
*4 given by intertidal exploiter on 17/8/96.
*5 given by intertidal exploiter on 15/8/96.
*6 is the usual price that is paid on camp.
*7 given by intertidal exploiter on 28/8/96, on Quisiva.
*8 given by intertidal exploiter on 23/9/96 on Quilaluia.
*9 given by intertidal exploiter on 15/8/96.
*10 given by ITR user on 15/8/96.

A6 Names of Biological Resources

Scientific, common English and local names of the biological resources utilised by the people of the Southern Island Group.

Bivalves (Bivalvia)

Scientific Name	Common Name	Kimwani Name	Makua Name
Atrina vexillum	Giant Pen	Nyeta	Nyeta
Barbatia fusca	Almond Ark	Ombe	Ikope
Gafrarium sp.	Venus clam	Namesa/Kauri	Kamesa
Malleidae sp.	Oyster	Ulumbe/Soka	Uwala
Mytilidae spp.	Mussel	Jojobwe	Jojobwe
Pecten spp.	Scallop	Ulumbe/Ombe lume	Uwala
Pinctada nigra	Pearl oyster	Saja	Mbare
Pinna muricata	Pinna	Kaza	Ipazo
Saccostrea sp..	Rock oyster	Ulombe/ Enlumbe	Uwala
Striostrea sp.	Rock oyster	Kipambama maulu	
Telina sp.	Tellin	Kauri lume	Komrobwe
Trachycardium sp.	Cockle	Ombe lume	Ikope
Tridacna squamosa	Fluted giant clam	Nyeta	Nyeta

Gastropods (Gastropoda)

Scientific Name	Common Name	Kimwani Name	Makua Name
Cassis cornuta	Horned Helmet		
Charonia tritonis	Trumpet Triton		Nimbululu
Chicoreus ramosus	Ramose Murex	Kome muka	
Conus spp.	Cones	Nkindo	Epata
Cypraea spp.	Cowries	Pwazi	Ucana
Cypraecassis rufa	Bullmouth Helmet	Mbana	Nafundo
Fasciolaria trapezium	Tulip whelk	Kome lume	Ninkome
Haliotis spp.	Abalone		Nanrododo
Harpa major	Harp		
Lambis chiragra	Arthritic spider	Spulapondo	Shidikamondo
Lambis lambis	Common spider	Spulapondo	Shidikamondo
Littorina spp.	Periwinkle		
Mancinella alouina	Salmon-lipped whelk	Nadoda	Namalukumi
Marginella spp.	Marginella	Ofu	Ofu
Mitra mitra	Mitre		
Monodonta australis	Toothed Top	Singinya	
Morulla granulata	Mulberry shell	Nadoda	Natota
Murex pecten	Venus comb Murex	Nikome	
Nassarius coronatus	Shielded Dogwhelk		Nsoro
Natica gualteriana	Comma necklace		Mweri
Nerita spp.	Nerite		Nankusero
Patella spp	Limpet		Anakikombe
Peristernia forskalii	Forskals whelk		
Phalium glaucum	Grey bonnet	Sebulalu	
Polinices tumidus	Pear moon		
Strombus mutabilis	Humpback conch	Sololandimo	Nansolola
Terebra spp.	Auger		
Terebralia palustris	Mangrove whelk	Nonde	Kolote
Tonna spp.	Ton		
Trochus spp.	Top	Ukindo	Irauwe
Turbo coronatus	Turban	Opolo	Singine