EAST CAPE PARKS AND TOURISM AGENCY

Habitat Mapping and Rocky Shore Invertebrate Survey
Dwesa-Cwebe Marine Protected Area
Eastern Cape Province

FINAL REPORT

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PREFACE AND ACKNOWLEDGEMENTS

This report was commissioned as a result of a need to implement monitoring programmes in the Marine Protected Areas of the Eastern Cape Province. In order to manage the MPAs properly it is necessary to monitor naturally induced changes as well as those that result from management activities. This is particularly important in the light of potential biodiversity, habitat and ecosystem changes that might result from climate change. To measure change base line information is required.

Ezemvelo KwaZulu-Natal Wildlife in Durban provided much valuable input with regard to aligning the habitat mapping and intertidal surveys with those undertaken along the KwaZulu-Natal coastline. Dr Jean Harris Tamsyn Livingstone and Gillian Rhodes were particularly helpful and provided templates that formed the basis of the habitat mapping data collection process and the rocky shore survey. Mariana Tomalin from Durban also provided much useful input for the habitat mapping and was responsible for all habitat mapping data capture and GIS work. Mary Cole of the East London Museum helped to design the rocky shore survey, undertook much of the intertidal survey work and helped to analyse much of the data. Kevin Cole, also from the East London Museum was of great assistance during the course of the fieldwork at Cwebe and Dwesa. The mapping and intertidal surveys would not have been possible without the assistance of Mr Fanyana JuJu from Cwebe and Ms Tandiwe Buyeye from Dwesa. Special thanks are also due to the ECPT rangers from Dwesa and Cwebe who spent long days uncomplainingly walking and surveying the entire 19 km coastline in 100 m bites. Mandy Uys from Laughing Waters cc. provided great and intelligent assistance in the data analysis and presentation of the results.

The project was funded by East Cape Parks and Tourism.

EXECUTIVE SUMMARY

In order to assess both management effectiveness and environmental changes resulting from climate change it is necessary to have baseline data and to monitor indicators that reflect core management and environmental issues. A study was commissioned to obtain detailed baseline data relating to the habitat diversity of the immediate coastal habitat (Low tide to the coastal dunes) and to acquire baseline information of rocky shore communities in the Dwesa-Cwebe MPA that would provide benchmarks against which to measure change.

The coast between Humans Rocks in the south and the Suko estuary in the north (19 km of shoreline) was mapped with regard to habitat type across the width of the shore from the Forest Dune to the shallow subtidal (2 m depth) zone. Habitats were scored for presence/absence and type (indigenous or alien vegetation) of vegetation on the forest dune, scrub dune and fore dune, for reflective or dissipative sandy shores and for various rocky shore types such as high and low ledge platforms, broken rock, boulders etc. Habitats were assessed at 25 m intervals across successive GPS referenced, exactly measured, 100 m intervals.

Principal biotypes including mussel, seaweed and barnacle cover as well as the number and size of limpets were assessed in the high shore, mid shore and low shore zones at three rocky shore sites in Dwesa-Cwebe MPA and at Nqabara outside the the MPA. Sites were similar with regard to physical oceanography and topography but differed somewhat in biota particularly in the lower shore zones. High shore sites were dominated by bare rock. Mid-shore sites were similar in many respects with about 50% bare rock and similar proportions of polychaetes, seaweeds and barnacles. Low shore sites differed considerably with few mussels at Cwebe and dense mussels in the low shore at the Dwesa sites. Nqabara low shore is heavily targeted by subsistence shellfish collectors and had an impoverished fauna.

Using the data collected for this project, a monitoring programme to measure changes in both coastal habitats and rocky shore communities should be implemented.

1 INTRODUCTION

1.1 Background: Location and extent of the Dwesa-Cwebe Reserve and Marine Protected Area

The Dwesa-Cwebe Marine Protected Area (MPA) is located approximately 120 km north-east of East London on the east coast of South Africa. The MPA incorporates approximately 19 km of mainly rocky shore coastline and extends 6 nautical miles out to sea. The MPA is adjacent to the Dwesa-Cwebe Nature Reserve which extends between 2 and 4 km inland of the shore. The terrestrial nature reserve was the subject of a successful land claim by the communities of the area. Dwesa (11.5 km of shore) is separated from Cwebe (7.5 km of shore) by the Mbashe River but the two MPAs and Nature Reserves are managed as a unit. The boundaries of the Dwesa-Cebe MPA are marked by the western bank of the mouth of the Suku River in the north (approx. 32.205459S; 28.946712E) and Human's Rock (approx. 32.312779S; 28.827291E), just north of Nqabara Point in the south. The MPA also includes the tidal portion of the Mbashe River.

Figure 1. Map of Dwesa-Cwebe MPA showing locations referred to in the text.

The nature reserve is surrounded by seven communities that instituted the land claim. The Haven Hotel is situated near the mouth of the Mbashe River and is managed under license

to the East Cape Development Corporation and the community Land Trust which owns the land of the nature reserve. The Dwesa-Cwebe MPA experiences heavy illegal line fishing and intertidal invertebrate harvesting pressure from surrounding communities, and the Hotel is applying direct and indirect pressure on management authorities to allow line fishing for hotel guests.

1.2 Purpose of this Report

Dwesa-Cwebe MPA is managed by East Cape Parks and Tourism (ECPT) by way of a management contract with the national Department or Environment Affairs (DEA). In order to assess management effectiveness it is necessary to have baseline data and to monitor indicators that reflect core management issues. The purpose of this study was 1.) To obtain very detailed baseline data relating to the habitat diversity of the immediate coastal habitat (Low tide to the coastal dunes) and 2.) To acquire baseline information of rocky shore communities in the MPA that would provide benchmarks against which to measure change caused by anthropogenic and natural factors. The research would also provide useful information relating to the effect of the Dwesa-Cwebe MPA on the major intertidal species that are exploited along the rest of the coastline.

1.3 Assumptions and Limitations

The report is limited to some degree in that intertidal sampling is very dependent on sea conditions, and when operating far from home it is not always possible to select ideal sampling days and thus it is not always possible to do very detailed work in the low intertidal. Sampling at Nqabara was limited to assessing the major biotypes and limpet densities and sizes could not be measured.

2 METHODS

2.1 General

The methods employed in the habitat mapping and intertidal survey were designed to make all the data and results compatible with similar data collected by EKZN Wildlife for the entire KwaZulu-Natal coastline and the Pondoland coast from Mtamvuna to Port St Johns (J. Harris EKZN Wildlife) The principal researchers undertaking the Dwesa project had both been involved in the EKZN Wildlife surveys so coordination and compatibility of methods was likely to be good.

2.2 Habitat mapping

The coast between Humans Rocks in the south and the Suko estuary in the north (19 km of shoreline) was mapped with regard to habitat type across the width of the shore from the Forest Dune to the shallow subtidal (2 m depth) zone (Figure 1). It was not possible to map the area where cliffs intervened for about 3 km roughly 2 km north of the Khobole estuary. Habitats were scored for presence/absence and type (indigenous or alien vegetation) of vegetation on the forest dune, scrub dune and fore dune, for reflective or dissipative sandy shores and for various rocky shore types such as high and low ledge platforms, broken rock, boulders etc. Habitats were assessed at 25 m intervals across successive GPS referenced, exactly measured, 100 m intervals. At each 100 m interval GPS readings were taken at the spring high water mark and as near as possible to the spring low water mark in order that the shore line can be exactly demarcated on a suitable map. Because one of the objectives was to obtain detailed information of the intertidal zone, mapping was undertaken only for two hours either side of spring low tide.

Relevant information was coded and the codes recorded on the data sheet. An example of the data sheet used is given in Appendix 1, together with the type of information collected and the codes for each piece of information. Data were collected for the following zones on the shore

Forest dune: Indigenous forest or alien vegetation

Scrub dune: Scrub dune bush or grass

Foredune: Bare dune or vegetated dune, water in dune slack

High tide: 12 types or combinations of types of rocky shore ranging from solid rock to scattered rock and various kinds of rock ledge, 3 type of sandy shore – dissipative, reflective or intermediate

Mid tide: As for high tide

Low tide: As for high tide

Subtidal (2 m) Submerged or emergent rocks

The presence and approximate number of mussels on the low shore as well as any other salient features (cliffs, estuaries, houses, fences, light houses, roads etc) were also recorded. GPS referenced photographs were taken at some locations and these are submitted as a separate file with an image file and associated GPS locations. Printing the images will not provide sufficient detail to make them useful.

Habitat data were captured using an Access database of the same design as that used for the KZN-Wildlife mapping surveys. Shape files were generated using Arcview software and habitat maps of the shoreline from the forest dune to the subtidal zone were generated.

2.3 Intertidal rocky shore survey.

Initial planning included liaison with EKZN-Wildlife to obtain the details of the KZN rocky shore surveys. The KZN survey method was modified slightly in the light manpower available and experience with Eastern Cape rocky shores (M.Cole, EL Museum). The aim of the survey was to determine the abundance and distribution of key species on rock high ledge – essentially rocky platforms that do not get inundated by sand. Three sites were selected in the Dwesa MPA: 1) At Cwebe near the Mbanyane River 2) At Dwesa, approximately 200 m south of the Khobole River 3) At Dwesa about 1 km north of Humans Rocks (almost opposite the Walter Sisulu University Research station; see Figure 1). Site selection was governed by the type of habitat (rocky high ledge) and the practicality of getting a generator to the site. In the Dwesa-Cwebe MPA, 20 - 30 m lengths of shoreline were divided into low shore, mid shore and high shore zones. The position of each zone on the rocky shore was fixed by taking GPS readings, and drilling and seating brass screws into the rock platforms. All sampling was conducted within in the period of two hours on either side of spring low tide. Between twenty and thirty randomly placed 0.25 m^2 quadrats in each zone were assessed for the principal biotypes and biota either as percent cover or numbers depending on the type of organism. In general, molluscs excluding mussels and echinoderms were counted and other organisms assessed for cover. Percent cover was assessed using the point intercept method (121 points per quadrat). Limpets were measured in situ but limpets <20 mm were simply grouped as Limpets < 20 mm. Where mussels were present, a triplicate 15 cm x 15 cm sample of mussels was removed. The number of mussels in each sample was counted, individual lengths were measured and the sample weighed.

Within each zone at each site a fixed 1 x 1 m^2 quadrat was marked out, GPS referenced and the corners marked with brass screws drilled into the rocks. The quadrat was outlined with rope and photographs were taken of each quadrat as a biological reference point.

At Nqabara about 10 km south of Dwesa and outside the MPA, a high shore rock ledge site very similar to the Khobole and Mbayan sites was also assessed in a similar manner for the principal biotypes. At this site screws were not placed in the rock platforms because there was no possibility of getting a generator to the site and the in any case the division of the shore into low, medium and high shore was demarcated by ledges which made the divisions self-evident. It was not possible to measure limpets at Nqabara because of sea conditions and the principal biotypes were assessed as accurately as possible**.**

3 RESULTS

3.1 Habitat Mapping.

Except for 6 km of shore between the Suko and Mbanyane Rivers, the entire shore was mapped by the same team so the data collected with respect to defining habitat types are consistent. The results of the habitat mapping exercise have been delivered in a separate document. All data collected using the mapping format and codes shown in Appendix 1 were stored in an Access database. Arcview 3.3 was used to map the shoreline. A vegetation line as well as -2m depth contour was digitized off Google Earth. The waypoints collected at 100 m intervals generated the spring high tide and low tide levels using Arcview, and Arcview software was also used to generate polygons that captured coastal features at 25 m intervals. Data was exported from the Access database and attached to each polygon that was created. An attempt was made to check the accuracy of the habitat mapping using aerial images obtained from East Cape Parks and Tourism. However, the aerial images were in a different projection to the ArcView 3.3 shape files and the latter program couldn't project the existing polygons and lines to the same projection as the aerial photographs. Thus only Google Map images were used for mapping the vegetation line and the -2m contour depth line. All the shape files created were in WGS84 projection.

3.2 Intertidal sampling

Species recorded

Forty eight algal and invertebrate species were recorded in the intertidal survey in the Dwesa-Cwebe MPA (Table 1). Most of the invertebrate species were recorded by Dye 1988, 1992; Hockey 1988; Lasiak 1991; Fielding et al. 1994 in various research publications although there have been significant name changes in many of the invertebrates since then.

All three sites in the MPA and the Nqabara site were similar in aspect. They were all relatively flat, exposed, rock ledge platforms. Sketch maps of the four sampling sites together with relevant GPS points are shown in Appendix 2. However, despite their similarities with regard to physical oceanography and topography the sites differed somewhat in biota particularly in the lower shore zones and this resulted in slight differences in the way the low shores were assessed. Variability is a natural feature of rocky shores and there is also the possibility that anthropogenic impacts influence community structure despite the MPA status of all three Dwesa-Cwebe sites. There are undoubted anthropogenic impacts at Nqabara.

Table 1.Invertebrate species recorded at different tidal levels in the Dwesa-Cwebe MPA in the course of the Dwesa-Cwebe intertidal survey.

	Cwebe Mbanyana				Dwesa Khobole			Dwesa Cottages			
Species	**Upper**	**Mid**	**Low**	**Limpet**	**Upper**	**Mid**	**Low**	**Upper**	**Mid**	**Low limp.**	**Low muss.**
Porifera											
Orange sponge	X										
Polychaetes %											
Gunnarea capensis											
Pomatoleios krausii	X	X	X		X	X		X	X	X	
Arthropoda %											
Tetraclita serrata	X	X	X		X	X	X	X	X	X	
Octomeris angulosa	X	X	X	X		X	X		X	X	
C. dentatus	X	X									
Mollusca											
Perna perna	X	X	X	X	X	X	X		X	X	X
Striostrea margaritacea											
Acanthochitona garnoti		X				X			X		
Onithochiton literatus		X	X		X	X	X		X		X
Haliotis spadicea							X			X	X
Fissurella natalensis		X	X	X		X	X		X	X	
Fissurella spp.	X	X	X	X		X			X		X
Cymbula oculus			X		X		X	X	X	X	
Scutellastra longicosta		X	X	X		X	X		X	X	X
S. granularis	X	X			X	X			X		
S. argenvillei											
S. cochlear				X							X
S. barbara		X		X		X			X	X	
S. tabularis											
C. miniata miniata				X			X			X	
Helcion concolor	X				X						
Cellana capensis	X			X	X	X	X	X	X		
Limpets <20 mm	X	X	X	X	X	X		X	X	X	X
Oxystele sinensis				X							
O. tigrina											
O. tabularis	X	X	X	X	X	X		X	X	X	
O. variegata											
T. sarmaticus											
Nerita albicilla											
Nucella dubia	X										
N. squamosa											
Thais capensis		X				X					
Burnupena cincta											
B. lagenaria	X	X	X	X	X	X	X	X	X	X	X
Small whelks not identified			X		X	X			X		
C. cucullata	X	X			X	X					
Siphonaria spp.	X				X			X		X	
S. capensis											
Echinodermata											
Holothuria	X										
Parechinus angulosus											
Ascidea											
Pyura stolonifera				X			X				X
SEAWEEDS %											
Chlorophyta			X								
Ulva spp.	X	X			X	X			X		
Bryopsis flanaganii		X				X				X	
Codium spp.										X	
Caulerpa racemosa				X			X		X	X	X
C. filiformis											
Phaeophyta			X	X						X	
Ralfsia expansa	X	X				X	X	X	X		X
Sargassum	X	X		X		X	X			X	X
Leathesia difformis		X	X			X					
Iyengaria stellata		X			X	X			X		
Rhodophyta	X										
Short brown mat											
Plocamium spp.											
Gelidium spp.	X							X	X		
H. spicifera				X						X	X
Coralline branching	X	X			X	X	X	X	X		X
Coralline encrusting	X	X		X	X	X	X	X	X	X	X
Coralline hard encrust			X	X						X	
Encrusting black			X								
Mixture			X								

The data presented below indicate the main biotypes in the different zones at the various sampling site Dwesa-Cwebe and Nqabara. The data are presented as % cover of biotypes rather than % cover of individual species because at a primary level it is biotypes that determine shore function and it is at this level that monitoring is generally implemented (J. Harris and K. Sink pers. comm.). Thus algal cover is an important indicator of the shore type, as are mussel cover, barnacle cover, sponge or ascidian cover. Changes in these biotypes are practical to monitor. More detailed information relating to different aspects of the various biotypes is also presented with each Figure. For each sampling site and zone the size frequency distribution of the various limpet species is presented as well as the limpet densities (except Nqabara). For logical purposes the Figures have been numbered consecutively for each sampling site rather than in the order in which they are referred to in the text.

High shore sites were not unexpectedly dominated by bare rock, small amounts of foliose seaweeds (but higher proportions of encrusting seaweeds at Dwesa sites than Cwebe) and varying proportions of *T. serrata* barnacles (Figures 2, 14, 23). There was much denser cover of barnacles at Cwebe (17%) than at the other two sites (0.2 – 1.2% cover). *Cellana capensis* was the dominant high shore limpet, ranging from a low of $5.m^{-2}$ at Cwebe to $18.m^{-2}$ at Dwesa Cottages (Figures 4, 16, 25). The high shore at Nqabara consisted entirely of bare rock with very sparsely scattered *T. serrata* (Figure 35).

Mid-shore sites were similar in many respects with about 50% bare rock and similar proportions of Polychaetes ($\pm$10% cover mainly *Pomatoleios krausii),* seaweeds (14–17% cover) and barnacles (16-23% cover; Figures 5, 17, 26). However, the relative proportions of different kinds of seaweeds and barnacles varied between sites. Cwebe had roughly equal proportions of *T. serrata* and *Octomeris angulosa* while barnacles at Dwesa sites were largely composed of *T. serrata.* Algae were mainly foliose at Dwesa Cottages and Cwebe and almost entirely encrusting at Dwesa Khobole. Limpet densities were much lower at Cwebe ($1.m^{-2}$ *Scutallastra longicosta* and *S. granularis*) than at Dwesa (*C. capensis* dominant at densities of > $9.m^{-2}$ at Dwesa cottages and >$3.m^{-2}$ at Dwesa Khobole (Figures 6, 19, 28). The Nqabara site had a low proportion of bare rock and a relatively higher barnacle and polychaete cover. There were also very small numbers of small mussels in the mid-shore region (Figure 36).

Low shore sites showed the greatest differences between sites. The Cwebe site had very few mussels in the low intertidal (1.5% cover) and the area in which one would normally expect to find mussels was dominated by limpets (Figures 8, 11). Because the low shore

area appeared to have two distinct components they were assessed separately as Low shore and Limpet zone.

At Cwebe both the landward low shore edge and the seaward edge (the limpet zone) had high proportions of mainly foliose algae (40- 46%) with between 38% and 60% of bare rock, and *O. angulosa* provided most of the rest of the cover (Figures 8, 11). There was a much higher proportion of encrusting algae in the limpet zone than in the landward edge of the low shore, and there were very few barnacles in the limpet zone compared with the landward low shore (Figures 8, 11).

Although the density of the dominant low shore limpet at Cwebe (*S. longicosta*) was more than twice that of the same species in the limpet zone, the limpet zone contained considerably higher densities of a range of other limpet species (Figures 10, 13).

The Dwesa Khobole low shore was relatively uniform in that there was a distinct ledge that stepped down to the low shore, so there was effectively very little gradient. Only one low shore zone was assessed at this site. In strong contrast to Cwebe, the area was dominated by thick multi-layered clumps of mussels (51% mussel cover) that were densest at the seaward edge of the ledge where wave action was greatest. Mussels were generally large (mean size = 84.4 mm shell length SD 15.6). Only 15% of the shore was bare rock, there were almost no barnacles, and mainly foliose algae covered 33% of the shore (Figure 20). On shores like Dwesa Khobole care must be taken when evaluating habitat and ecosystem processes from % cover because of the effects of layering. Because mussel clumps consist of several layers, the importance of mussels as system drivers is much greater than the % cover data alone would suggest. Large foliose algae such as those that occur in the low shore at Dwesa Khobole can also be problematic because although they occupy considerable space when lying flat during low tide, they occupy much less surface area when the tide is high and the fronds are floating and supported. In addition, it is difficult to assess their spatial impact because the sweeping of their fronds physically impacts on a much larger space than that occupied by their holdfast. Limpet densities were low ($3.m^{-2}$) in the low shore (Figure 22), partly as a result of the dense mussel cover and partly as a result of the sweeping action of algal fronds referred to above.

The low shore of Dwesa Cottages was different from the other two low shore sites. The zone had a distinct limpet band at the inner edge of the low shore and an outer mussel zone at the seaward edge of the rocky shelf. Both areas had high coverage of foliose algae (>82% in the limpet zone and 41% in the mussel zone). However, the mussel zone had over 41% mussel cover compared to <2% in the limpet zone (Figures 29, 32). Again mussel clumps were multi-layered and mean size large (76.9 mm shell length SD 15.1), and the *caveats* noted above apply. It must be noted that the sampling at the Dwesa Cottages was difficult because of the

sea conditions, so limpet densities were probably under-estimated. Limpet densities were moderately high in the limpet zone (6.4m^{-2} - mainly *S. longicosta*) and very low in the mussel zone (Figures 31, 34) because mussel beds do not generally provide a good habitat for limpets. However they are very important in the limpet recruitment process because they provide surface area for newly recruited juveniles to settle on in habitat in which there is generally fierce competition for space.

At Nqabara there were virtually no mussels and few limpets on the low shore. Fine branching coralline algae (*Jania spp*.) dominated the zone and diversity was low (Figure 37).

CWEBE UPPER SHORE

Figure 2. Cwebe Upper shore biotypes

% Cover: Cwebe Upper shore	
Porifera	**0.07**
Polychaetes	4.2
Arthropoda	16.8
Seaweeds	1.72
Bare Rock	77.3
Mussels	0.10

% Composition of Cover	
Porifera	
Orange sponge	0.033
Purple sponge	0.033
Polychaetes	
Gunnarea capensis	0.00
Pomatoleios krausii	4.17
Arthropoda	
Tetraclita serrata	15.67
Octomeris angulosa	0.76
C. dentatus	0.36
SEAWEEDS	
Chlorophyta	0.03
Phaeophyta	1.29
Rhodophyta	0.40
Encrusting	0.30
BARE ROCK	77.3
Mollusca	
P. perna	0.10

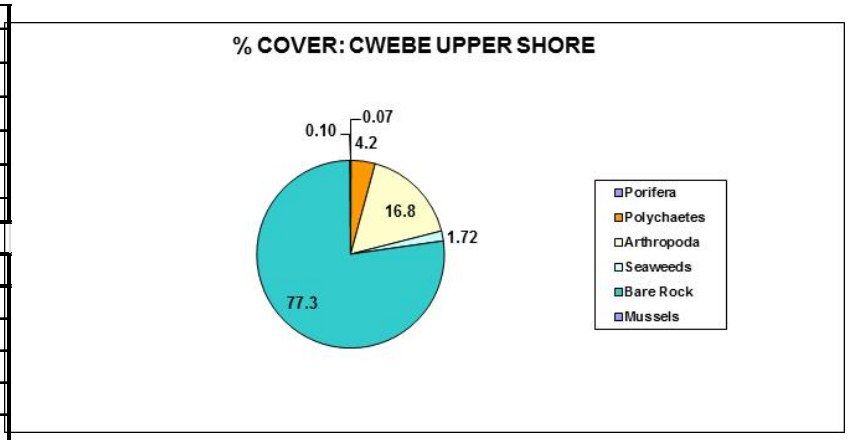
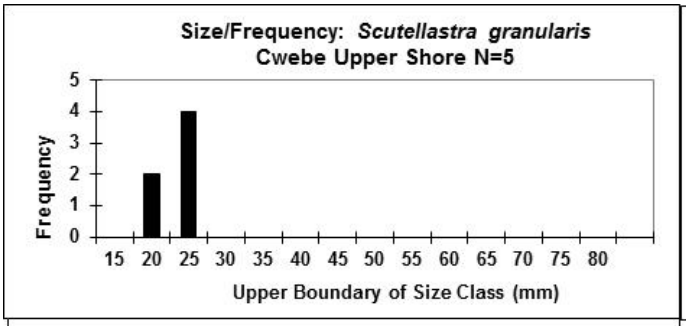
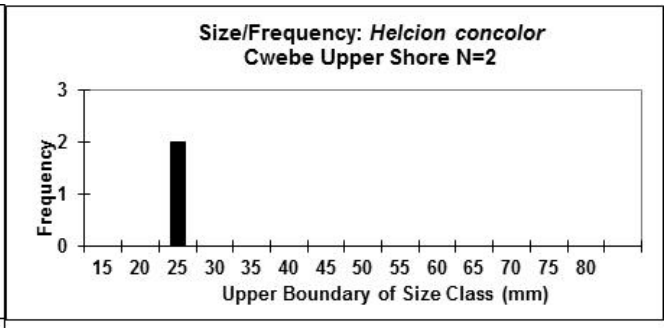


Figure 3. Cwebe Upper shore Limpet size frequencies





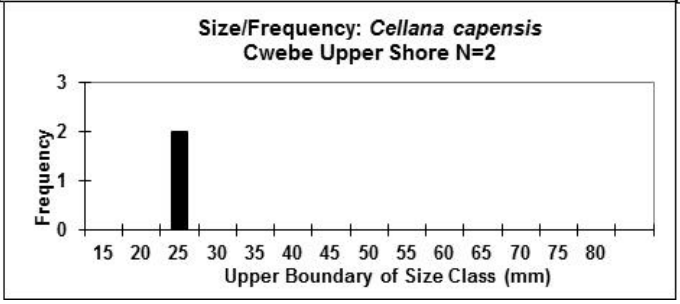
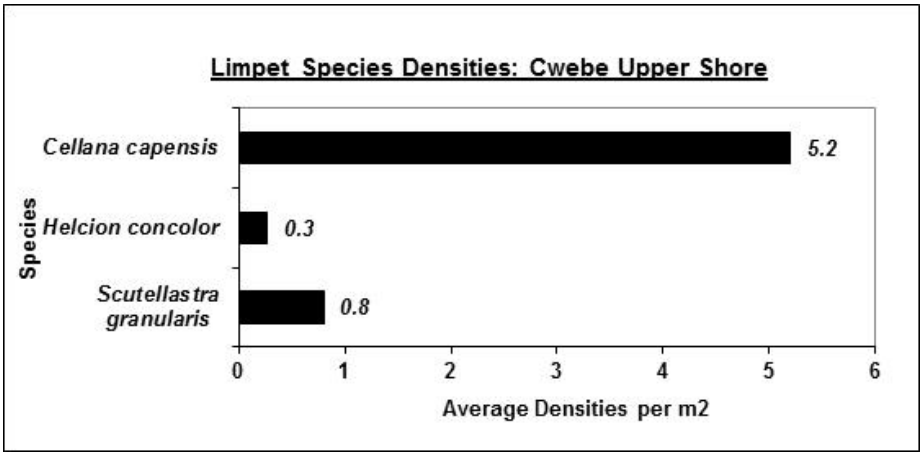


Figure 4. Cwebe Upper shore Limpet densities



CWEBE MIDDLE SHORE

Figure 5. Cwebe Middle shore biotypes

% Cover: Cwebe Midshore	
Polychaetes	11.9
Arthropoda	23.0
Seaweeds	15.1
Bare Rock	50.0
Mussels	0.79

% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	11.9
Arthropoda	
Tetraclita serrata	12.6
Octomeris angulosa	10.4
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	1.9
Phaeophyta	8.1
Rhodophyta	0.4
Encrusting	*3.3*
BARE ROCK	50.0
Mollusca	
P. perna	0.79

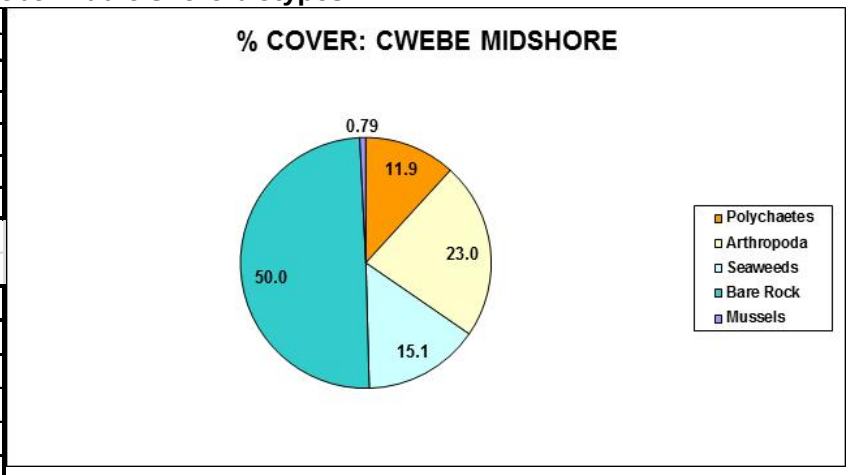


Figure 6. Cwebe Middle shore Limpet size frequencies

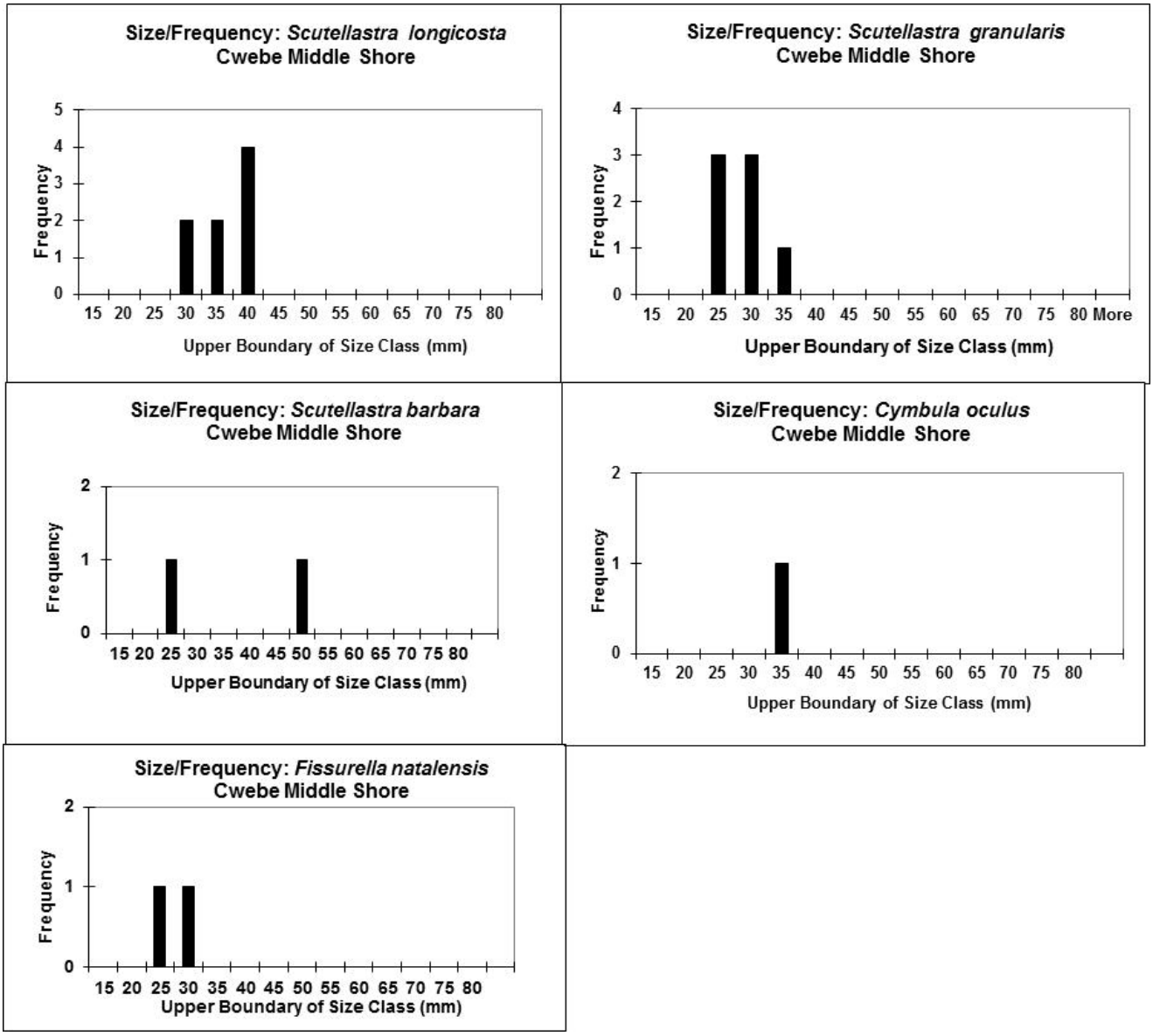
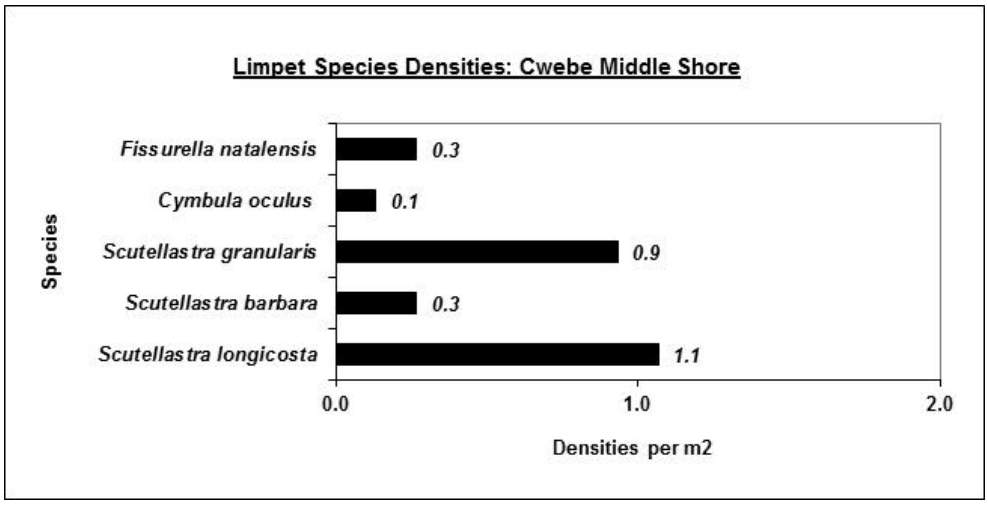


Figure 7. Cwebe Middle shore Limpet densities



CWEBE LOW SHORE

Figure 8. Cwebe Low shore biotypes

% cover: Cwebe Low Shore	
Porifera	0.0
Polychaetes	0.2
Arthropoda	14.3
Seaweeds	45.7
Bare Rock	38.3
Mussels	1.5

% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	0.2
Arthropoda	
Tetraclita serrata	0.6
Octomeris angulosa	13.7
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	2.0
Phaeophyta	11.6
Rhodophyta	32.1
% Encrusting	*2.8*
BARE ROCK	38.3
Mollusca	
P. perna	1.5

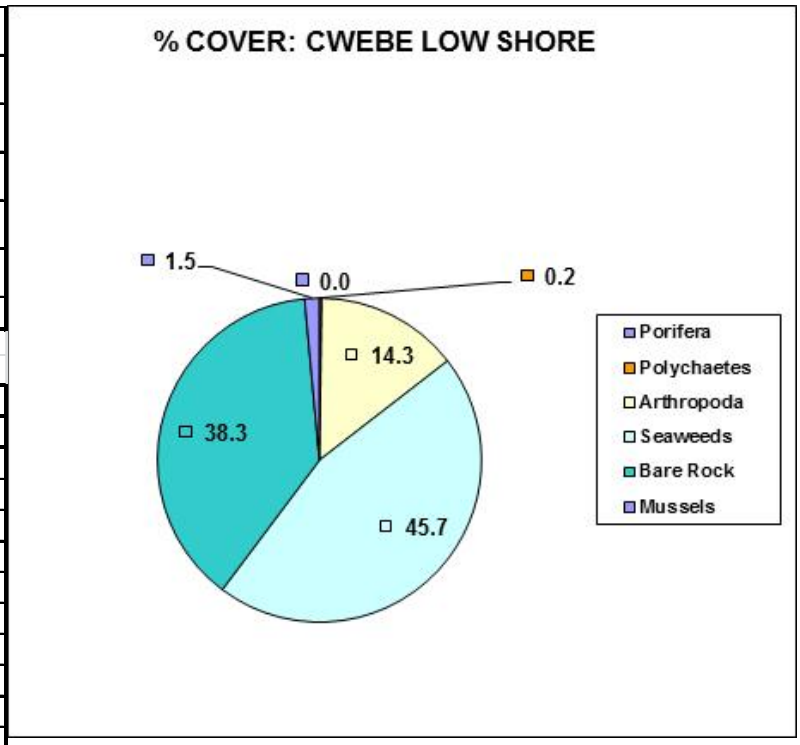


Figure 9. Cwebe Low shore Limpet size frequencies

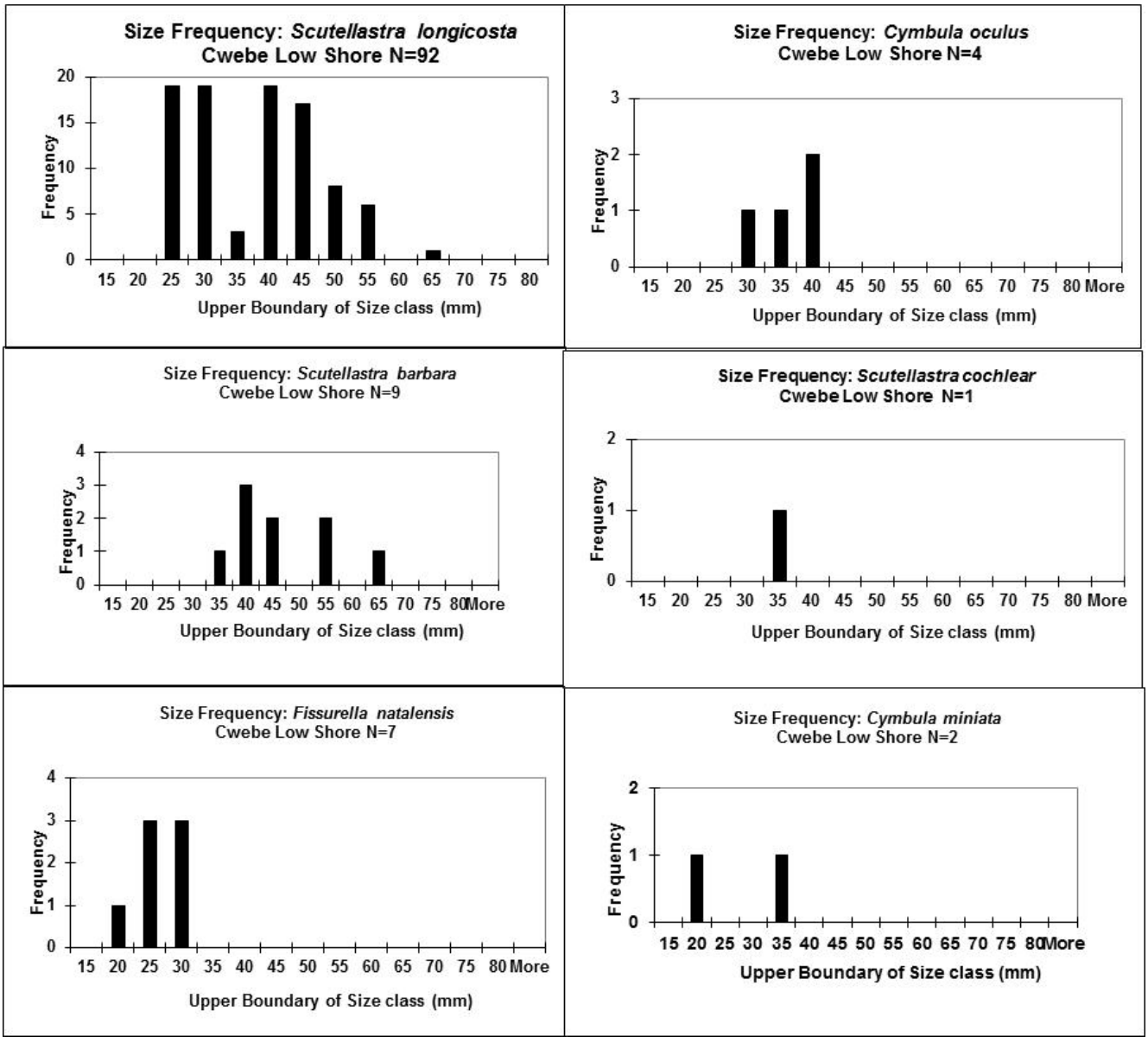
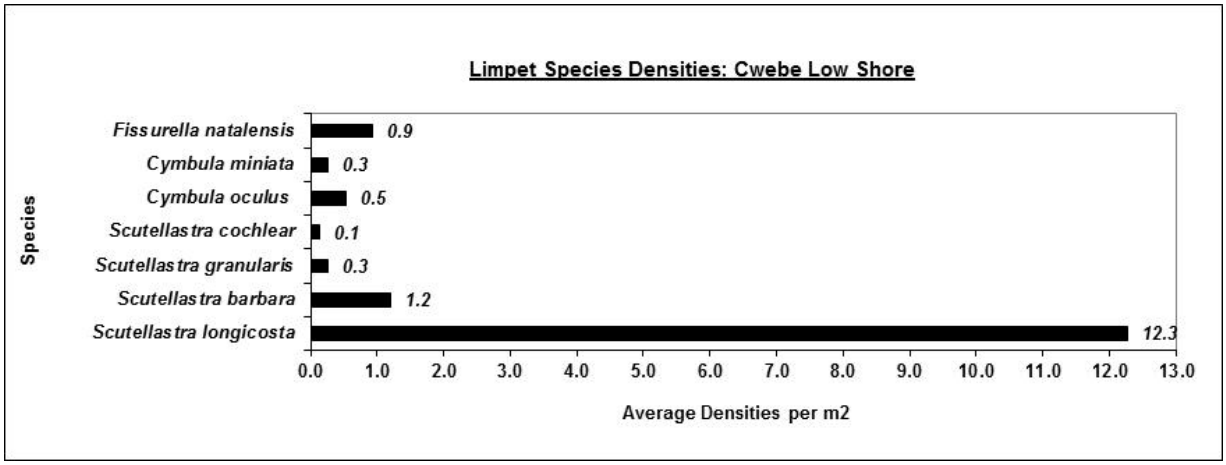


Figure 10. Cwebe Low shore Limpet densities



CWEBE LIMPET ZONE

Figure 11. Cwebe Limpet zone biotypes

% Cover: Cwebe Limpet Zone	
Porifera	**0.00**
Polychaetes	0.0
Arthropoda	0.4
Seaweeds	40.2
Bare Rock	59.2
Mollusca	0.2
% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	0.0
Arthropoda	
Tetraclita serrata	0.0
Octomeris angulosa	0.4
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	0.3
Phaeophyta	5.4
Rhodophyta	34.4
Encrusting	*10.1*
BARE ROCK	59.2
Mollusca	
P. perna	0.2

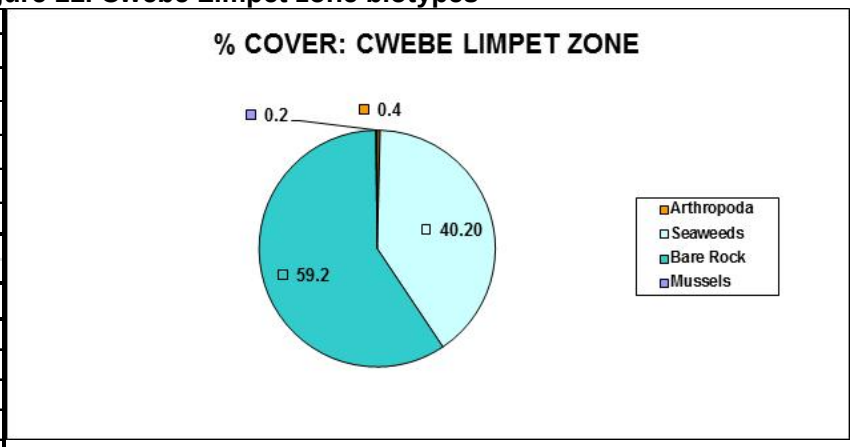


Figure 12. Cwebe Limpet zone Limpet size frequencies

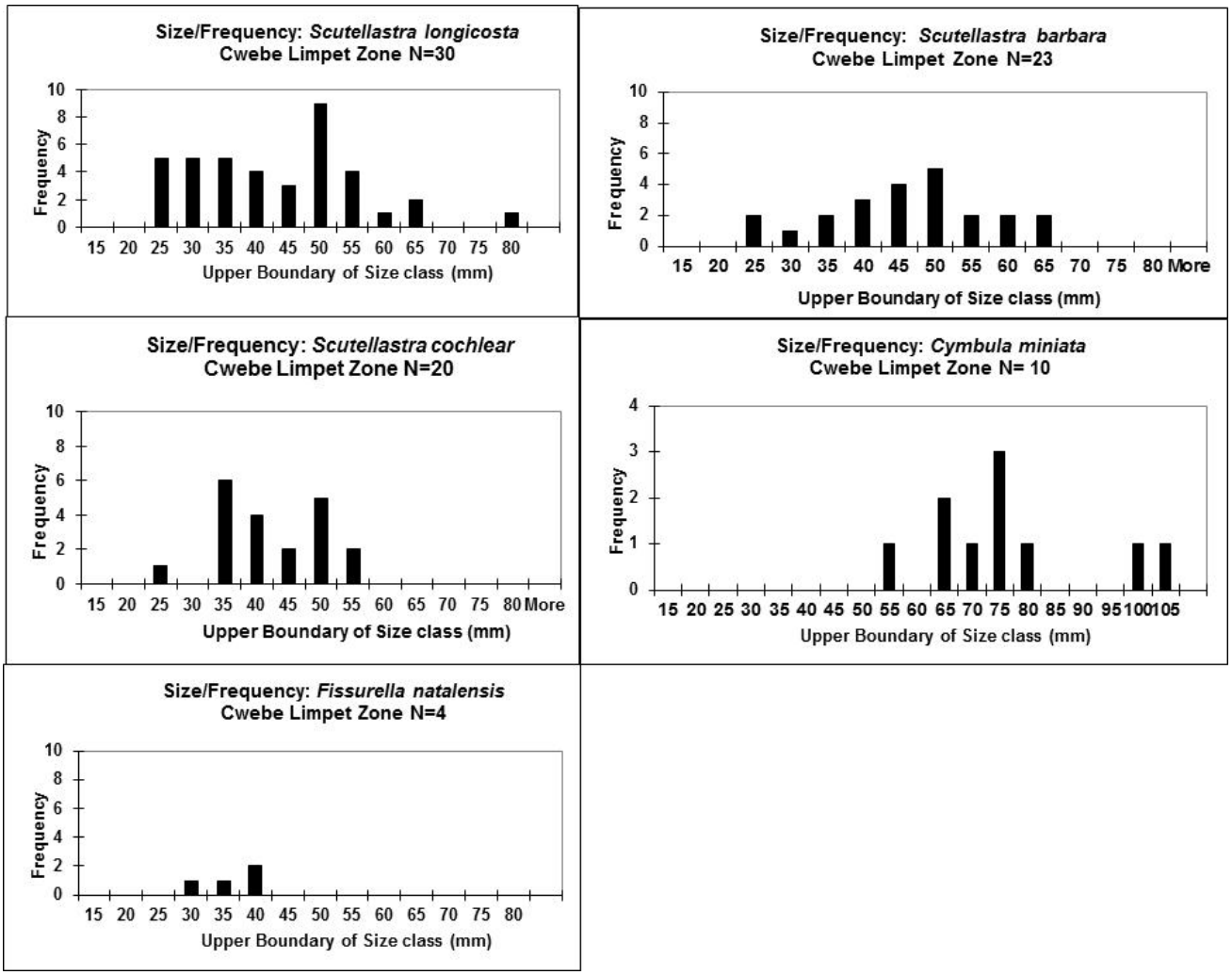
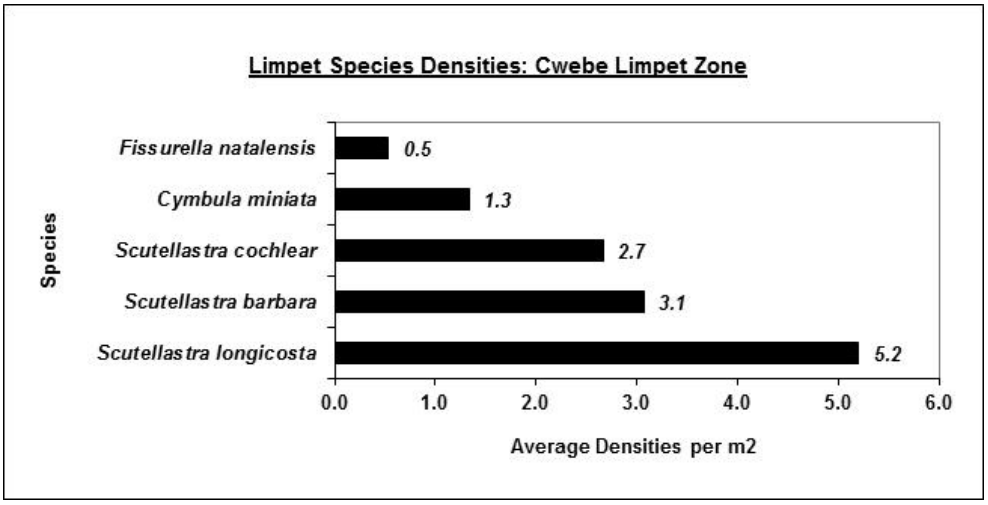


Figure 13. Cwebe Limpet zone Limpet densities



DWESA KHOBOLE UPPER SHORE

Figure 14. Dwesa Khobole Upper shore biotypes

% Cover: Dwesa Kobola UpperShore	
Porifera	**0.0**
Polychaetes	1.3
Arthropoda	1.2
Seaweeds	9.2
Bare Rock	88.3
Mollusca	0.1
% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	1.3
Arthropoda	
Tetraclita serrata	1.2
Octomeris angulosa	0.0
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	0.0
Phaeophyta	0.2
Rhodophyta	9.0
% Encrusting	*8.3*
BARE ROCK	88.3
Mollusca	
P.perna	0.10

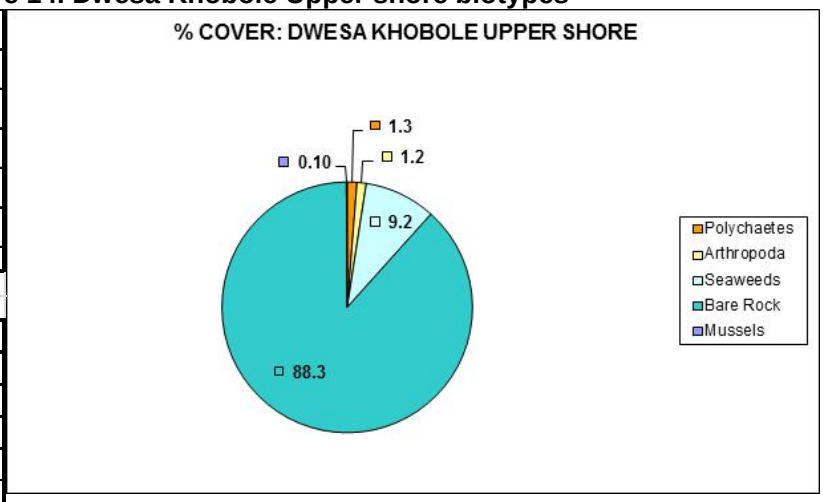


Figure 15. Dwesa Khobole Upper shore Limpet size frequencies

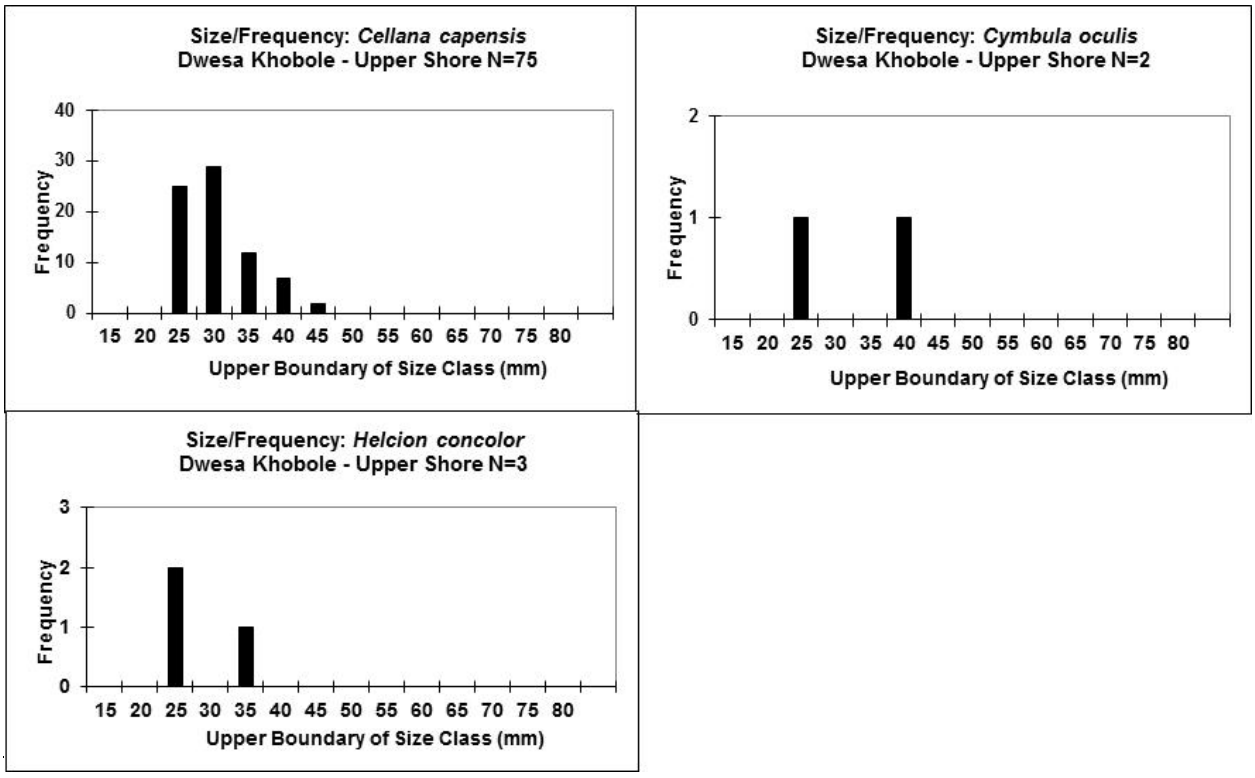
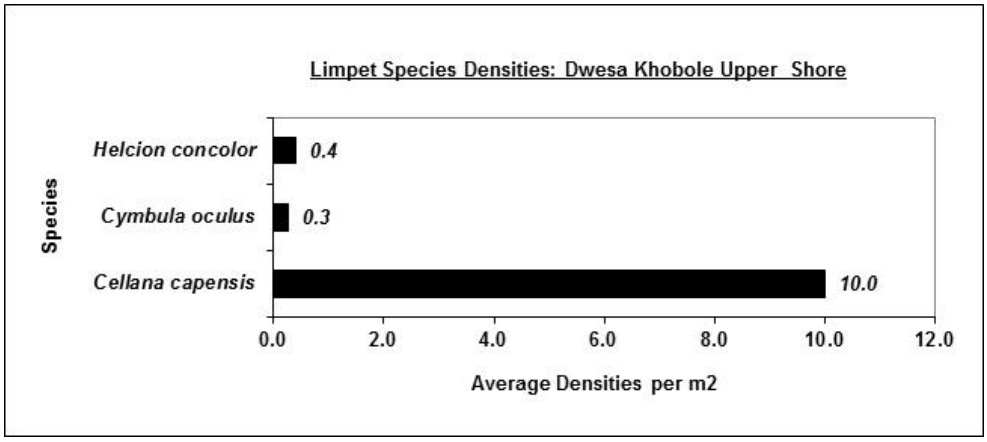


Figure 16. Dwesa Khobole Upper shore Limpet densities



DWESA KHOBOLE MIDDLE SHORE

Figure 17. Dwesa Khobole Middle shore biotypes

% Cover: Dwesa Khobole Mid Shore	
Porifera	**0.0**
Polychaetes	10.3
Arthropoda	15.8
Seaweeds	17.5
Bare Rock	54.6
Mollusca	**1.8**

% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	10.3
Arthropoda	
Tetraclita serrata	12.4
Octomeris angulosa	3.4
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	0.1
Phaeophyta	0.4
Rhodophyta	17.0
% Encrusting	*17.0*
BARE ROCK	FALSE
Mollusca	
P. perna	1.8

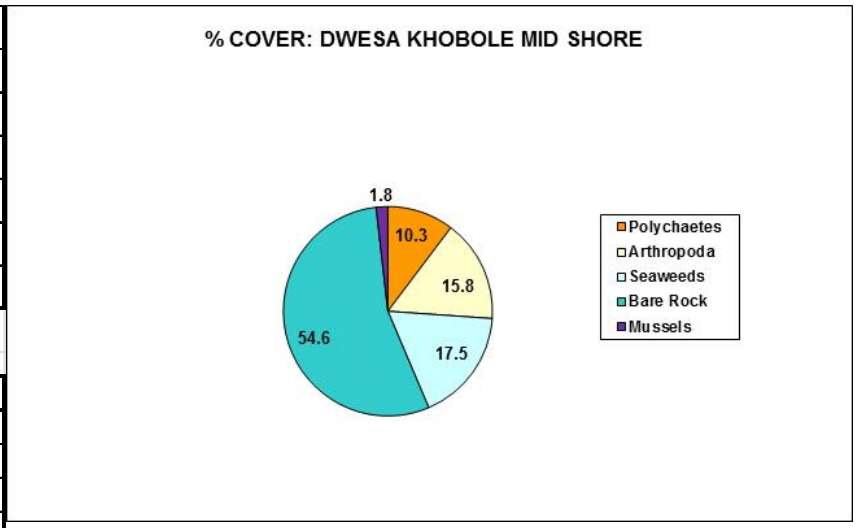


Figure 18. Dwesa Khobole Middle shore Limpet size frequencies

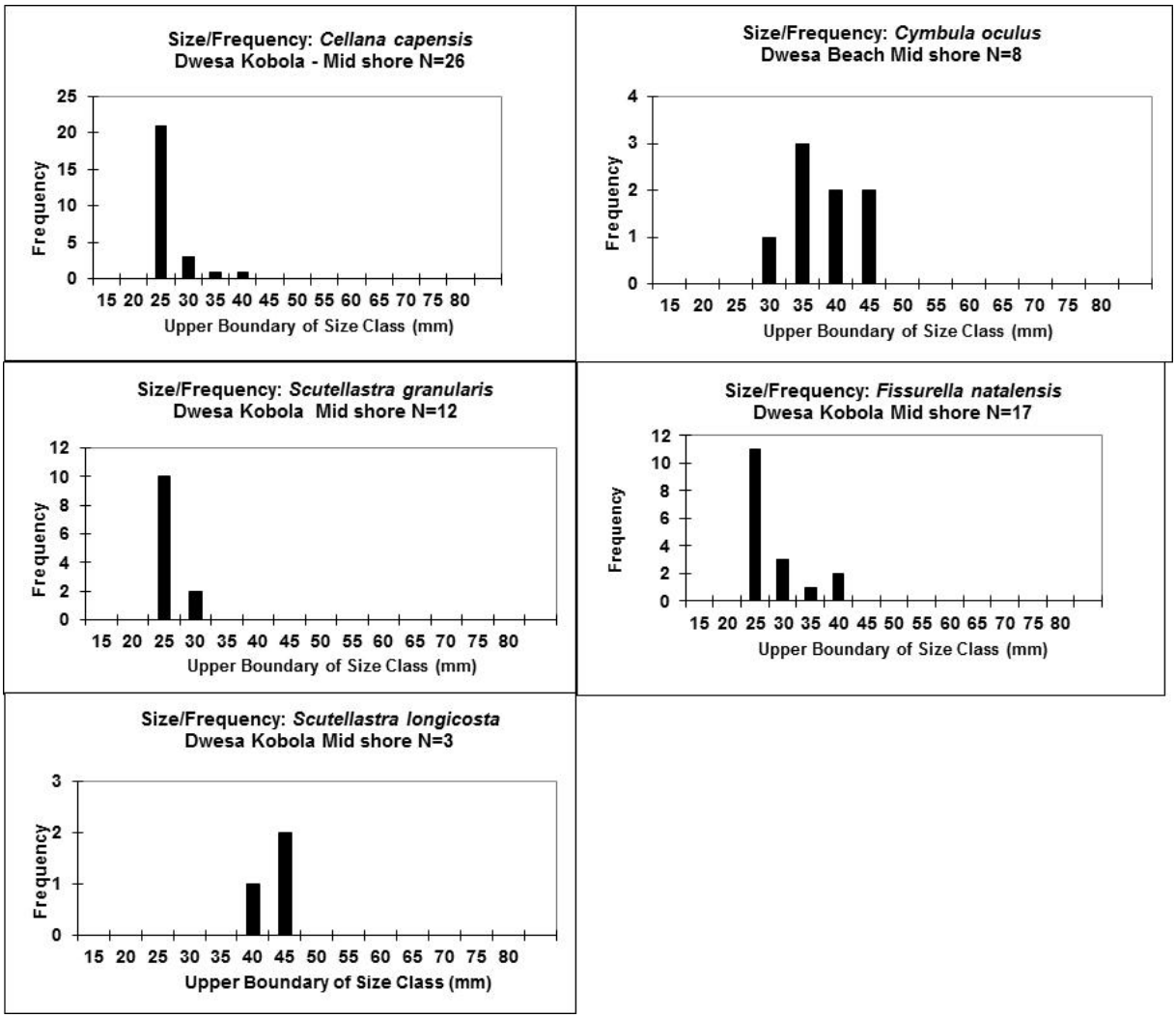
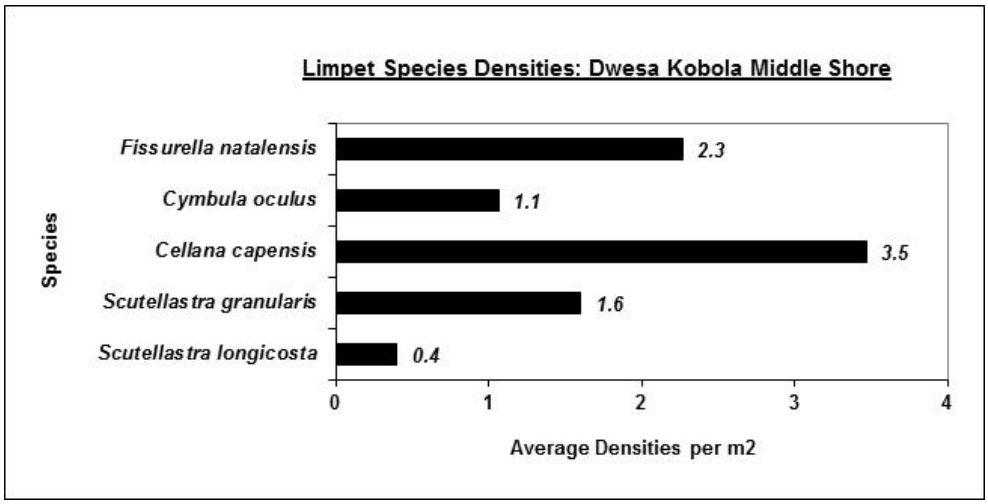


Figure 19. Khobole Middle shore Limpet densities



DWESA KHOBOLE LOW SHORE/MUSSEL ZONE

Figure 20. Dwesa Khobole Low shore biotypes

% Cover: Dwesa Khobole Mussel Zone	
Porifera	**0.00**
Polychaetes	0.0
Arthropoda	0.7
Seaweeds	33.02
Bare Rock	15.1
Mollusca	51.2
% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	0.0
Arthropoda	
Tetraclita serrata	0.3
Octomeris angulosa	0.4
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	0.7
Phaeophyta	3.8
Rhodophyta	28.4
Encrusting	*7.2*
BARE ROCK	15.1
Mollusca	
P. perna	51.2

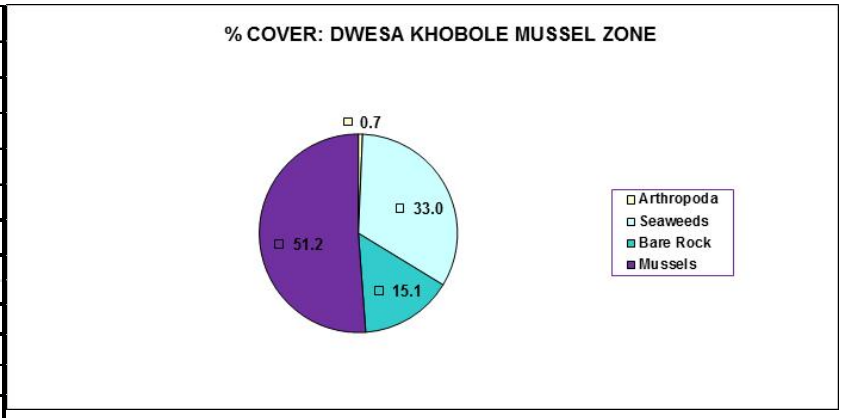


Figure 21. Dwesa Khobole Low shore Limpet size frequencies

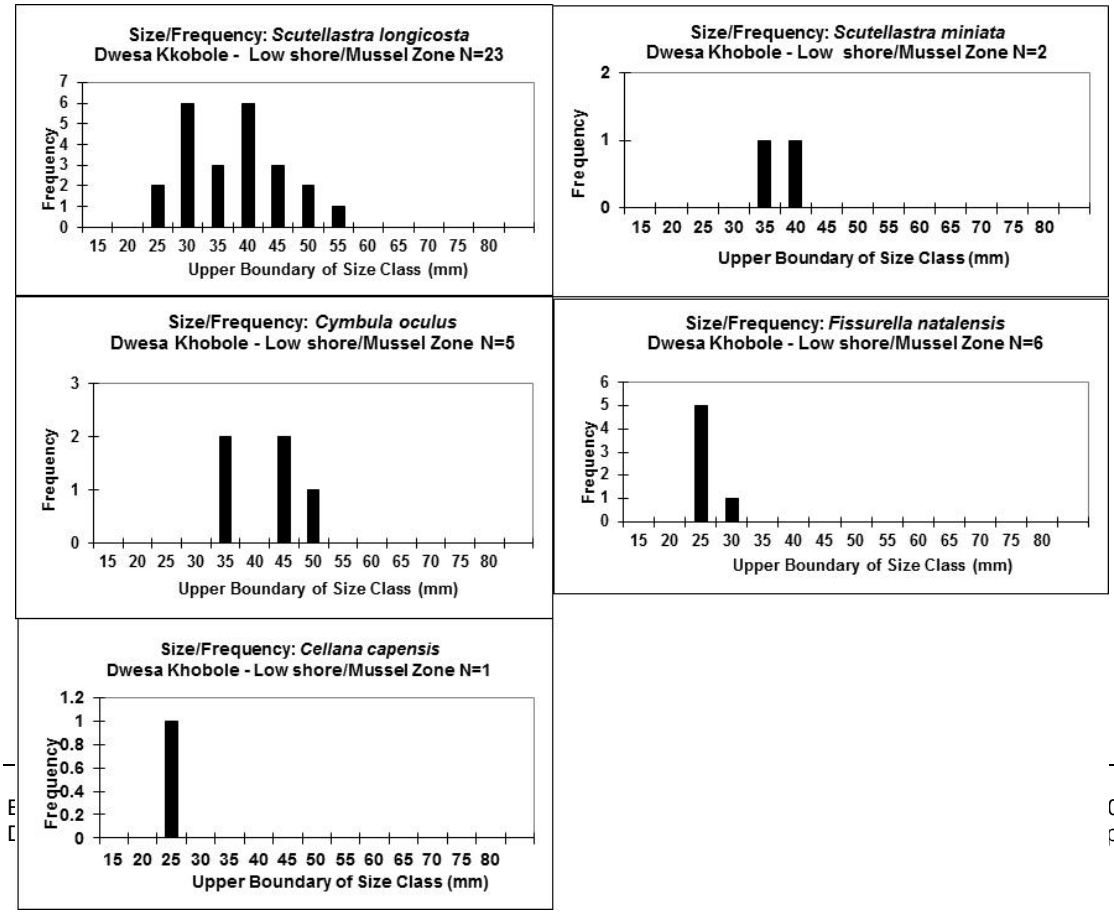
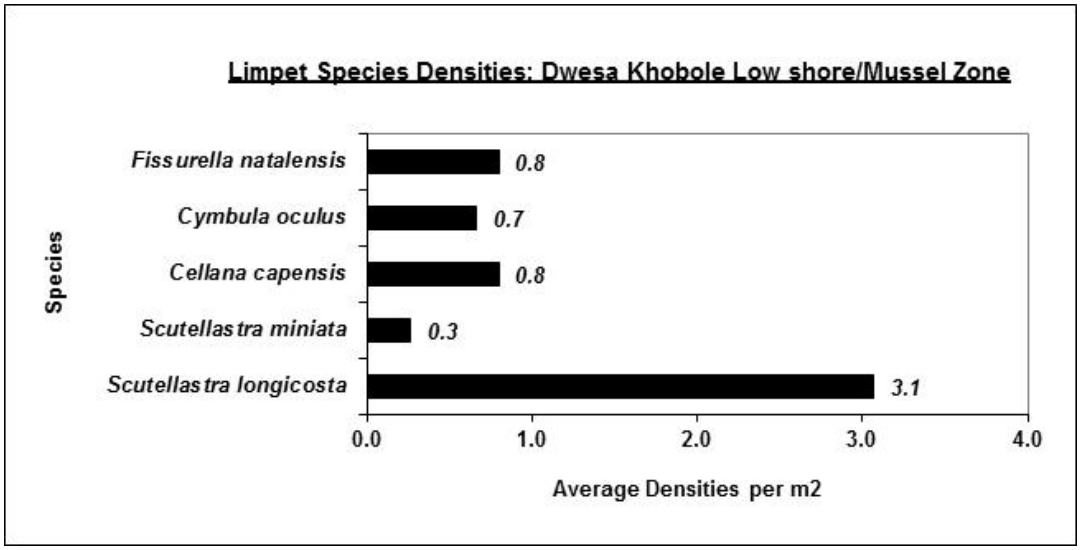


Figure 22. Khobole Low shore Limpet densities



DWESA COTTAGES UPPER SHORE

Figure 23. Dwesa Cottages Upper shore biotypes

% Cover: Dwesa Cottages Upper Shore	
Porifera	**0.00**
Polychaetes	0.2
Arthropoda	0.2
Seaweeds	6.25
Bare Rock	93.3
Mollusca	**0.0**

% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	0.2
Arthropoda	
Tetraclita serrata	0.2
Octomeris angulosa	0.0
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	0.0
Phaeophyta	0.3
Rhodophyta	6.0
Encrusting	*4.9*
BARE ROCK	93.3
Mollusca	
P. perna	0.0

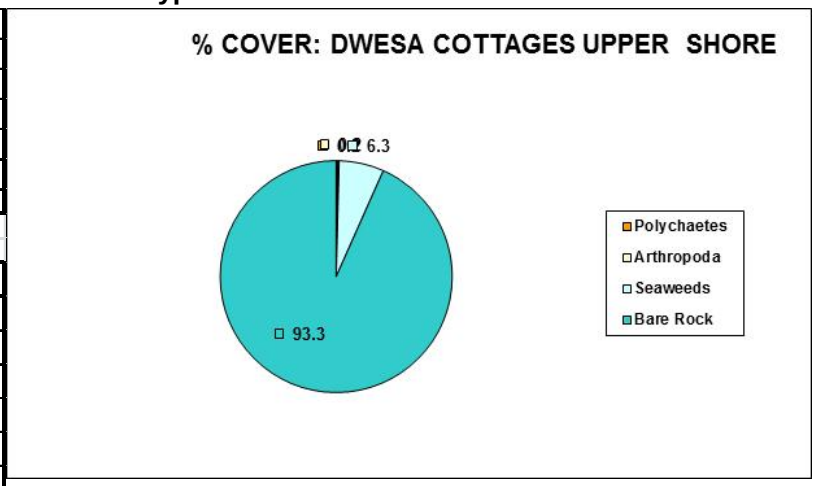


Figure 24. Dwesa Cottages Upper shore Limpet size frequencies

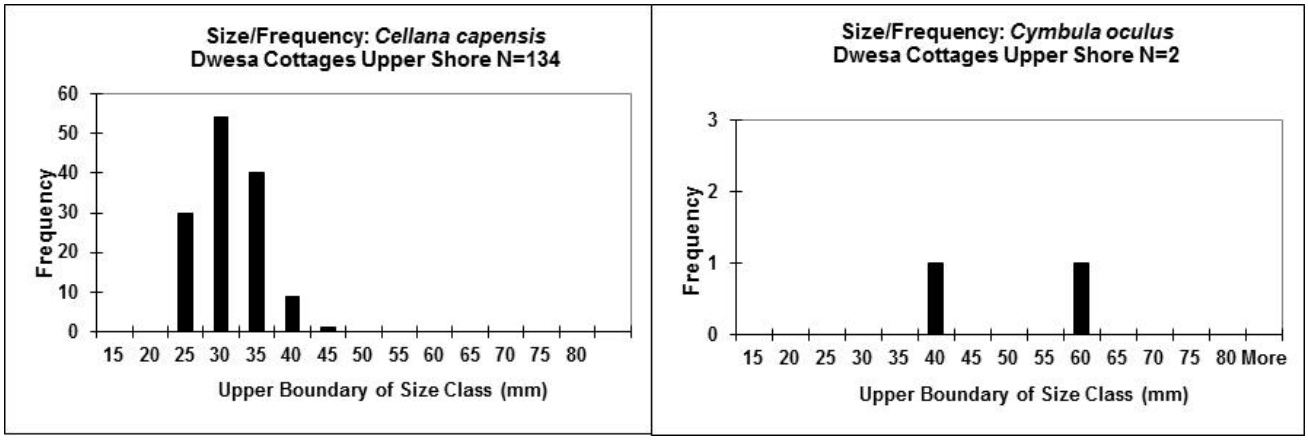
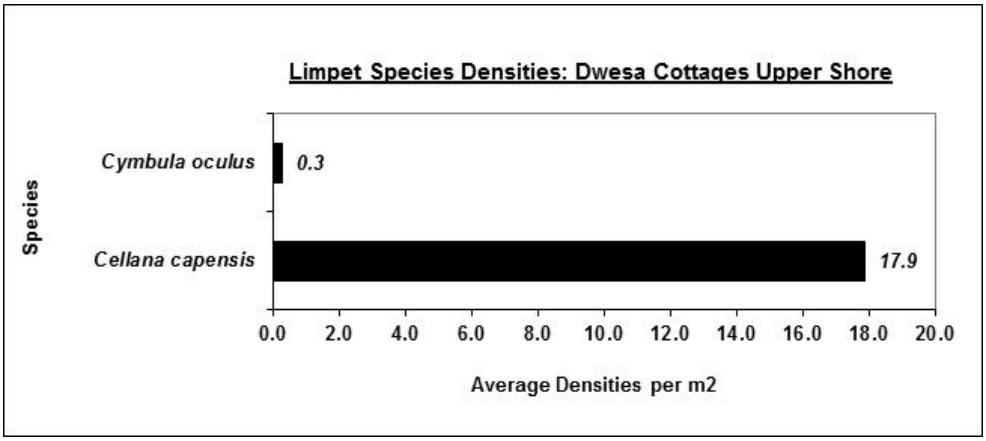


Figure 25. Dwesa Cottages Upper shore Limpet densities



DWESA COTTAGES MIDDLE SHORE

Figure 26. Dwesa Cottages Middle shore biotypes

% Cover: Dwesa Beach Mid shore	
Porifera	**0.00**
Polychaetes	8.2
Arthropoda	22.4
Seaweeds	13.95
Bare Rock	55.1
Mollusca	**0.3**

% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	8.2
Arthropoda	
Tetraclita serrata	21.0
Octomeris angulosa	1.5
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	0.5
Phaeophyta	1.5
Rhodophyta	12.0
Encrusting	*1.4*
BARE ROCK	55.1
Mollusca	
P. perna	0.3

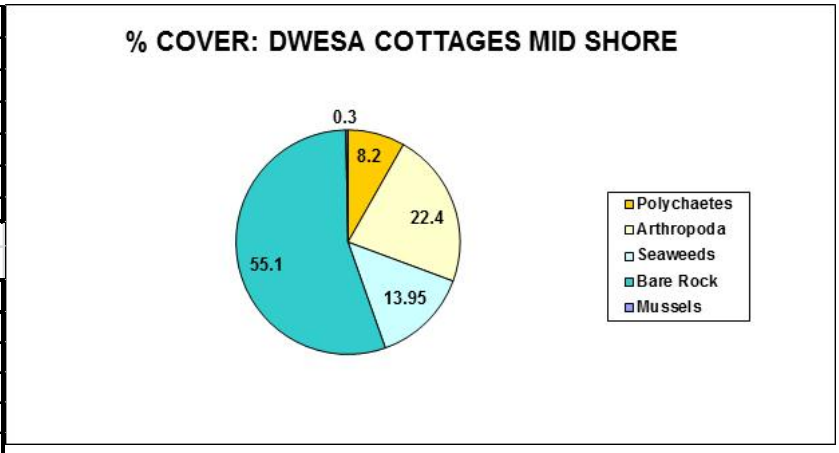


Figure 27. Dwesa Cottages Middle shore Limpet size frequencies

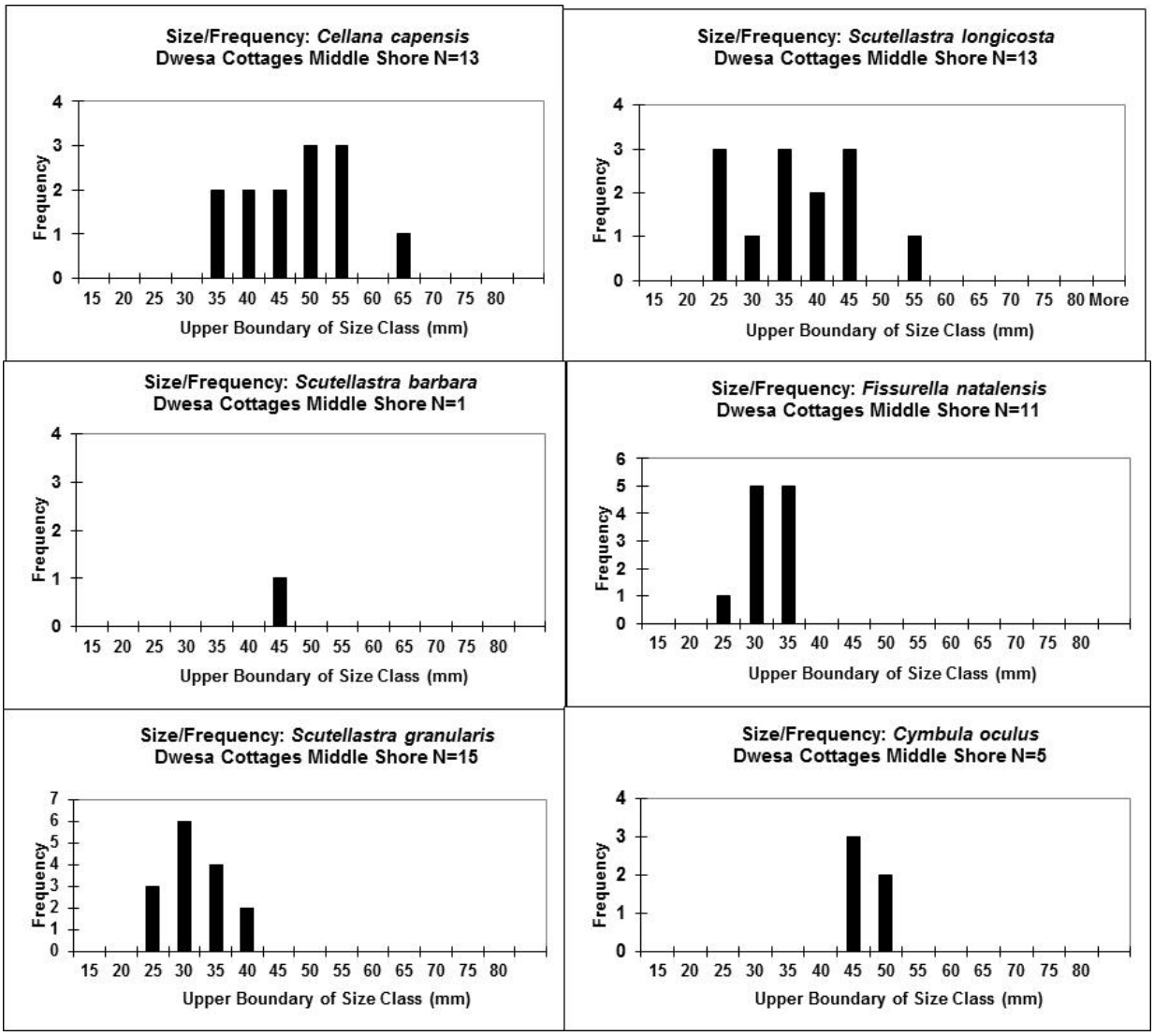
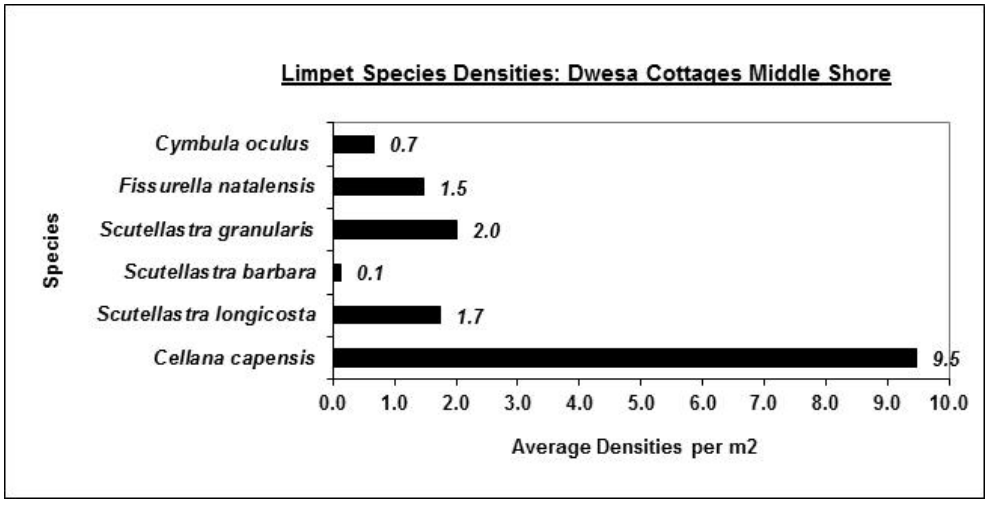


Figure 28. Dwesa Cottages Middle shore Limpet densities



DWESA COTTAGES LOW SHORE LIMPET ZONE

Figure 29. Dwesa Cottages Low shore Limpet zone biotypes

% Cover: Dwesa Cottages Limpet Zone	
Polychaetes	0.1
Arthropoda	0.5
Seaweeds	82.5
Bare Rock	15.5
Mollusca	1.38

% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	0.1
Arthropoda	
Tetraclita serrata	0.5
Octomeris angulosa	0.1
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	2.0
Phaeophyta	10.3
Rhodophyta	70.2
Encrusting	*6.3*
BARE ROCK	15.5
Mollusca	
P. perna	1.38

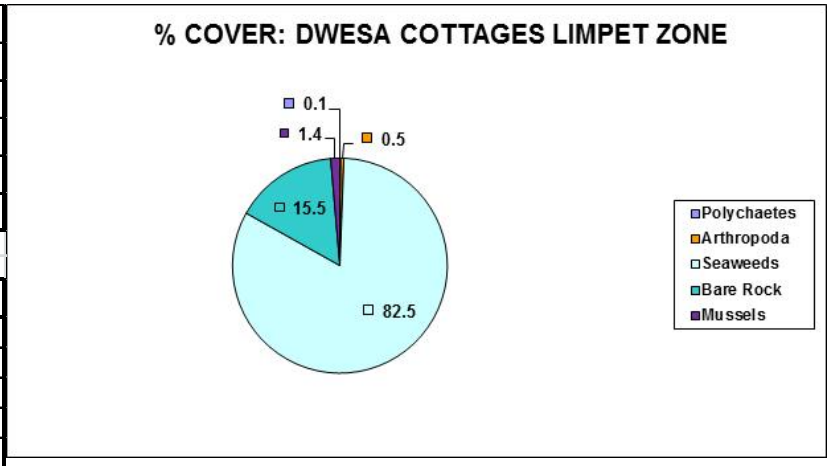


Figure 30. Dwesa Cottages Low shore Limpet zone Limpet size frequencies

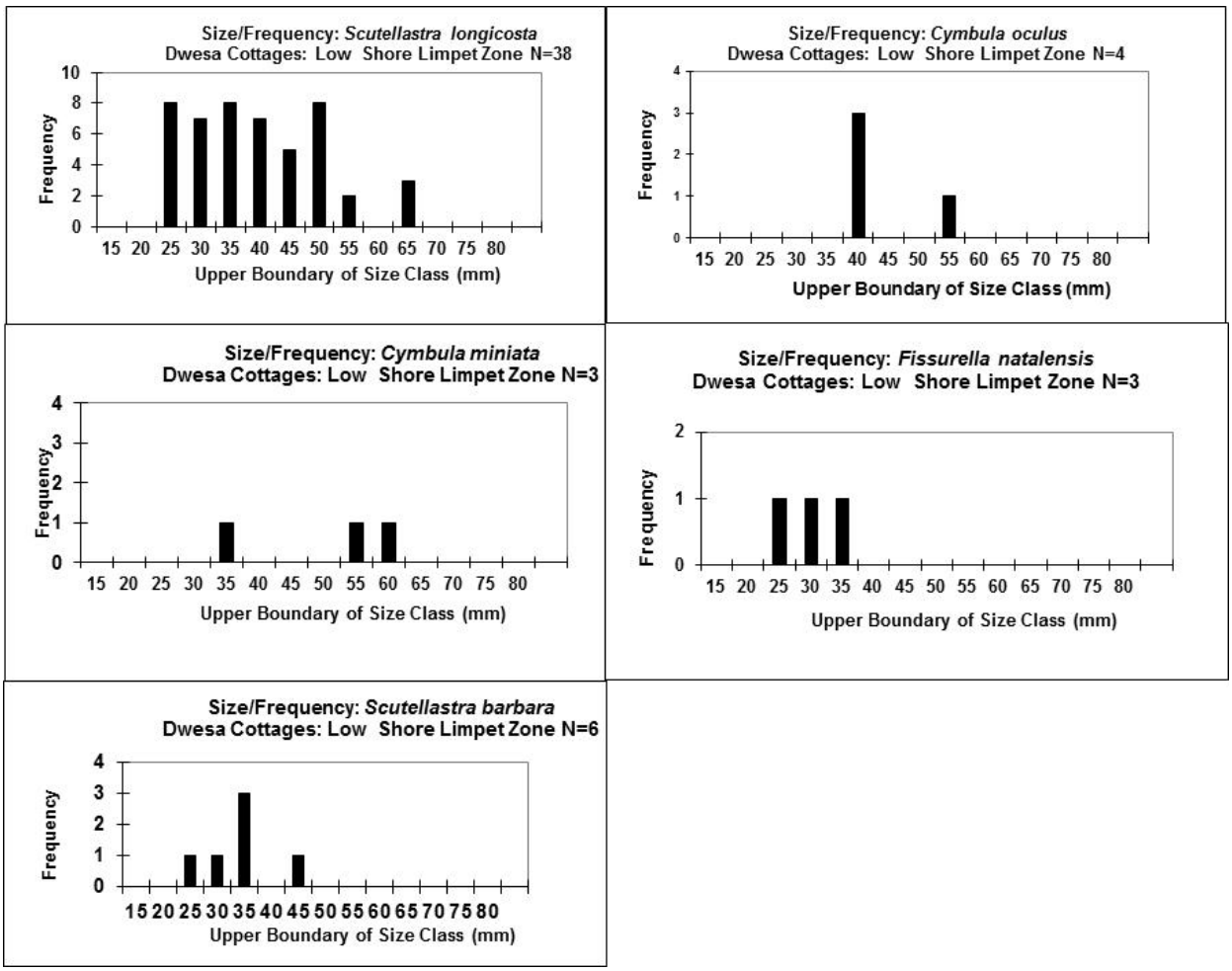
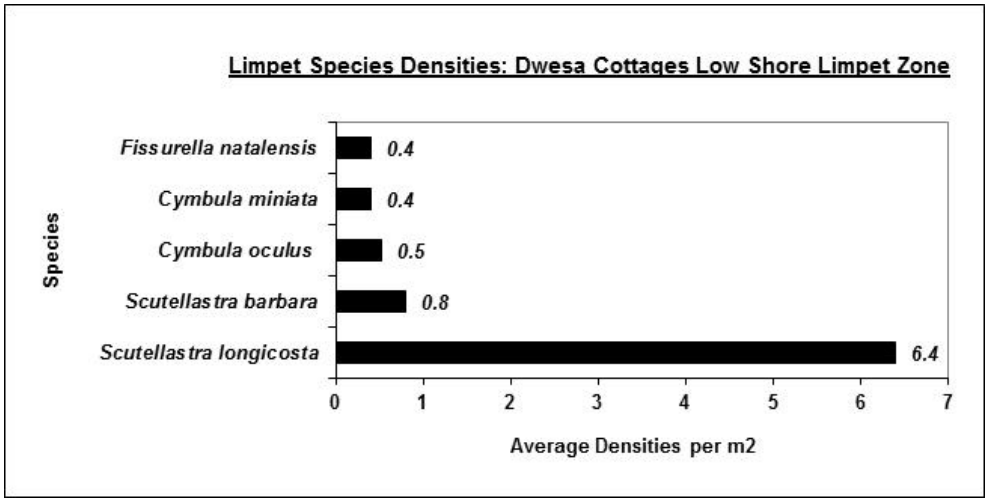


Figure 31. Dwesa Cottages Low shore Limpet zone Limpet densities



DWESA COTTAGES LOW SHORE MUSSEL ZONE

Figure 32. Dwesa Cottages Low shore Mussel zone biotypes

% Cover: Dwesa Beach Mussel Zone	
Porifera	**0.00**
Polychaetes	**0.0**
Arthropoda	**0.0**
Seaweeds	**58.80**
Bare Rock	**0.0**
Mollusca	**41.2**

% Composition of Cover	
Porifera	0.00
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	0.0
Arthropoda	
Tetraclita serrata	0.0
Octomeris angulosa	0.0
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	6.4
Phaeophyta	8.9
Rhodophyta	43.6
Encrusting	*8.0*
BARE ROCK	0.0
Mollusca	
P. perna	41.2

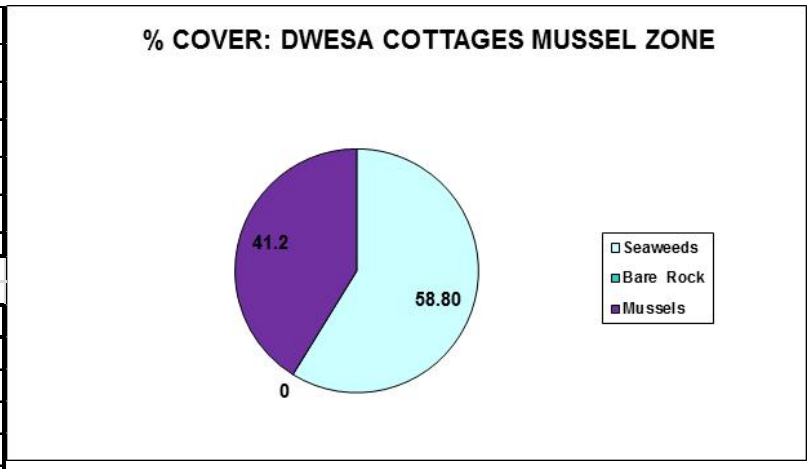


Figure 33. Dwesa Cottages Low shore Mussel zone Limpet size frequencies

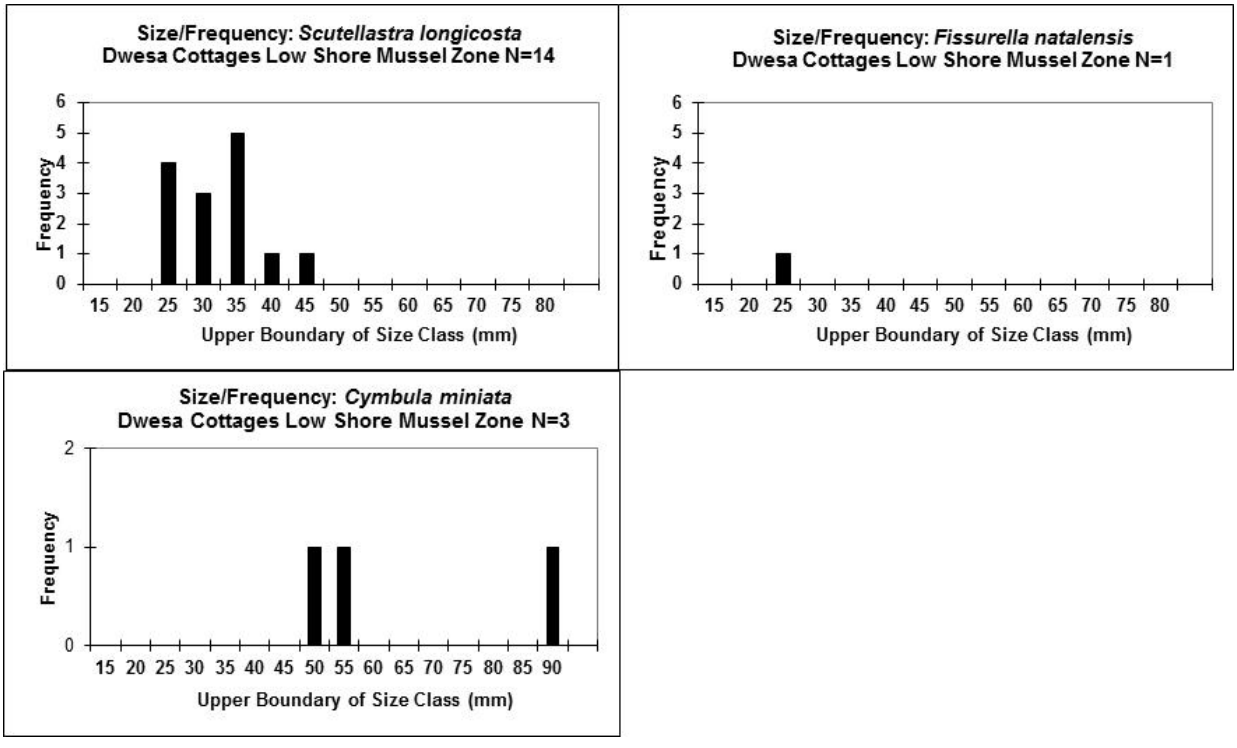
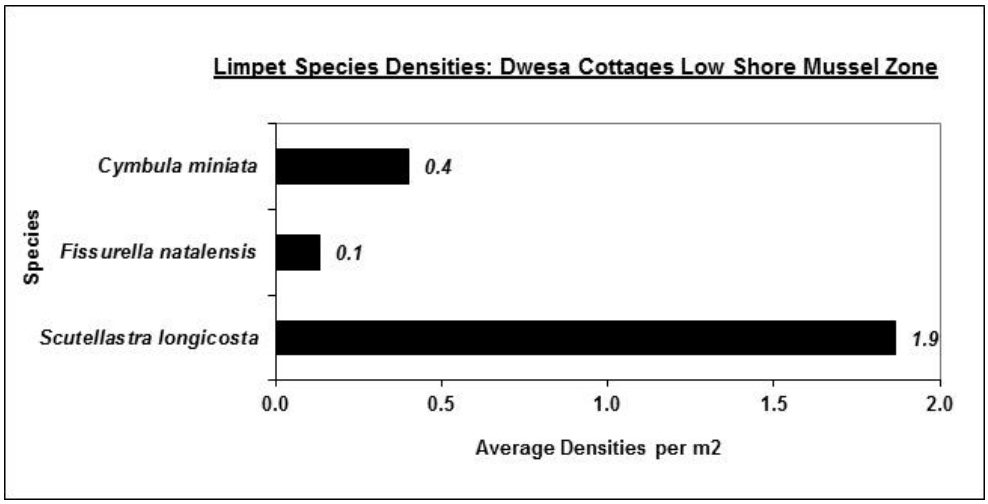


Figure 34. Dwesa Cottages Low shore Mussel zone Limpet densities

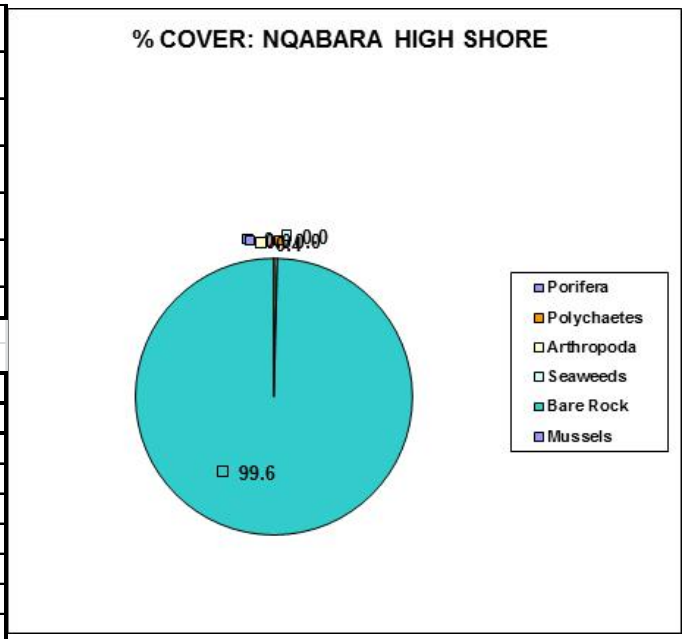


NQABARA HIGH SHORE

Figure 35. Nqabara High shore biotypes

% cover: Nqabara High Shore	
Porifera	**0.0**
Polychaetes	**0.0**
Arthropoda	**0.4**
Seaweeds	**0.0**
Bare Rock	**99.6**
Mussels	0.0

% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	0.0
Arthropoda	
Tetraclita serrata	0.4
Octomeris angulosa	0.0
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	0.0
Phaeophyta	0.0
Rhodophyta	0.0
% Encrusting	*2.8*
BARE ROCK	99.6
Mollusca	
P. perna	0.0

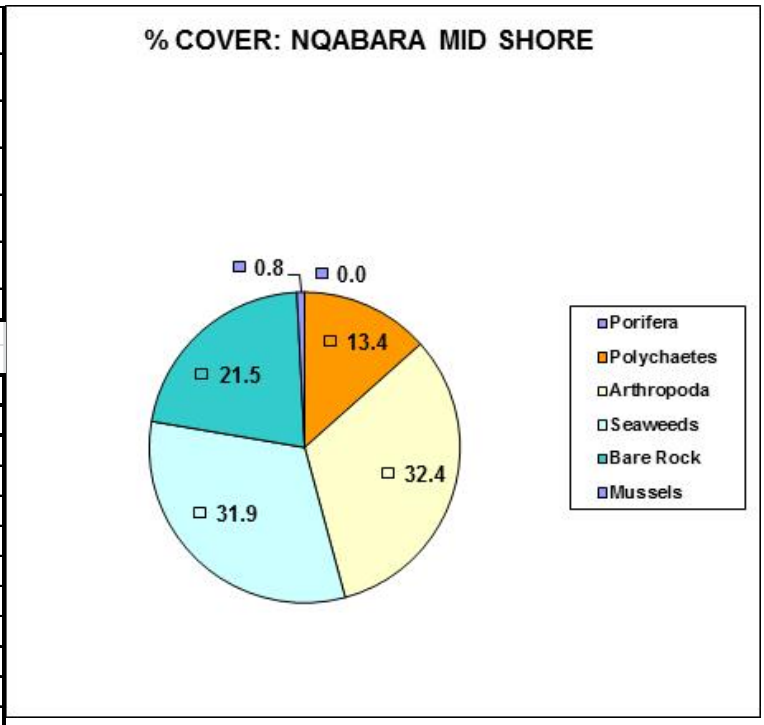


NQABARA MIDDLE SHORE

Figure 36. Nqabara High shore biotypes

% cover: Nqabara Mid Shore	
Porifera	**0.0**
Polychaetes	**13.4**
Arthropoda	**32.4**
Seaweeds	**31.9**
Bare Rock	**21.5**
Mussels	0.8

% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	13.4
Arthropoda	
Tetraclita serrata	23.2
Octomeris angulosa	9.2
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	2.7
Phaeophyta	4.0
Rhodophyta	25.2
% Encrusting	*2.8*
BARE ROCK	21.5
Mollusca	
P. perna	0.8

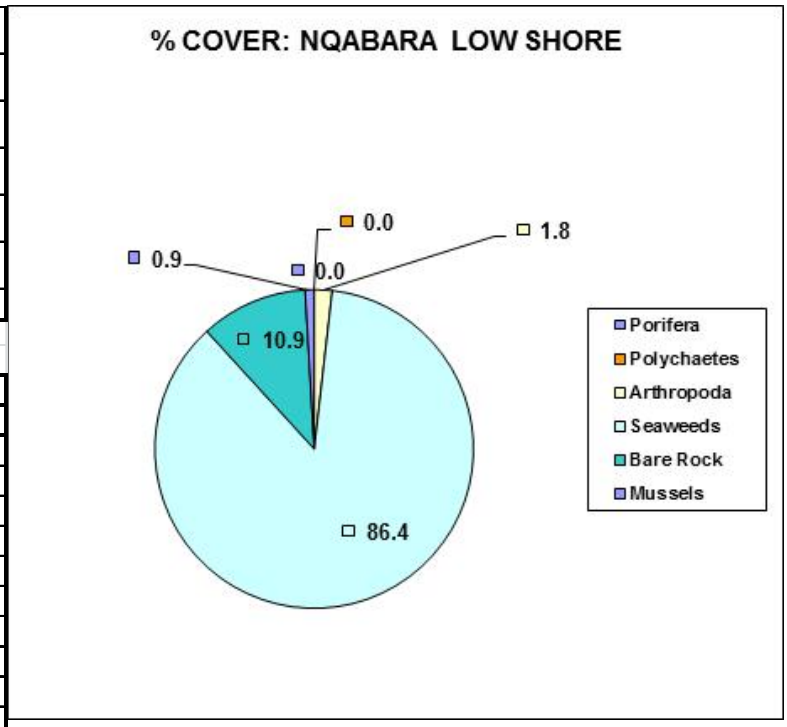


NQABARA LOW SHORE

Figure 37. Nqabara High shore biotypes

% cover: Nqabara Low Shore	
Porifera	**0.0**
Polychaetes	**0.0**
Arthropoda	**1.8**
Seaweeds	**86.4**
Bare Rock	**10.9**
Mussels	0.9

% Composition of Cover	
Porifera	
Orange sponge	0.0
Purple sponge	0.0
Polychaetes	
Gunnarea capensis	0.0
Pomatoleios krausii	0.0
Arthropoda	
Tetraclita serrata	0.0
Octomeris angulosa	1.8
C. dentatus	0.0
SEAWEEDS	
Chlorophyta	6.5
Phaeophyta	9.8
Rhodophyta	70.1
% Encrusting	*2.8*
BARE ROCK	10.9
Mollusca	
P. perna	0.9



4 DISCUSSION

4.1 General

Historically, human activities have had mainly negative impacts on terrestrial and marine environments generally as a result of exploitation, pollution, disturbance, and habitat modification. The results are loss of biodiversity, and unsustainable resource use, and sometimes ecosystem changes. One of the most effective counters to human environmental impacts is the proclamation and implementation of Protected Areas and the difference in the Nqabara site and those inside the MPA underline the valuable role that MPAs play in conserving biodiversity and breeding stocks of harvested organisms. Several other studies undertaken by Theresa Lasiak and Arthur Dye in the 1980s and 1990s document the extent of intertidal harvesting activities around Dwesa-Cwebe, and the differences in rocky shore community structure between protected and harvested areas (Lasiak and Dye 1989; Dye 1992; Dye and Lasiak 1994; Dye et al 1994; Dye et al 1997).

A great deal of research that provides invaluable detail of the biota and processes of the Dwesa-Cwebe MPA was undertaken by Arthur Dye and Theresa Lasiak, both individually and in conjunction with other scientists. Publications include assessments of intertidal shellfish stocks, evaluation of the population dynamics, reproductive and recruitment processes of a wide arrange of molluscs, studies aimed at understanding primary production, succession and re-colonisation processes, and natural changes in rocky shore community structure. These publications should be sourced by management authorities to provide further benchmark data for Dwesa-Cwebe. The Dwesa-Cwebe MPA plays a major role in strengthening our understanding of benchmark communities in the Agulhas and Natal bioregions

The intertidal rocky shore data presented above provide baseline data for the Dwesa-Cwebe MPA. The three sites vary considerably in their structure but temporal and spatial variability is a feature of rocky shores in this area (Dye 1988; 1990; 1992) and in almost all other rocky shores. Differences in rocky shore community structure can be naturally engendered e.g recruitment variability or storm events, or they may be anthropogenically engineered by subsistence or recreational collecting or other tourism activities such as trampling. It is of interest that the Cwebe site, which is far from any compliance centres, shows signs of illegal subsistence collecting (no mussels and low limpet densities) while the Dwesa sites, which are very close to the ECPT offices, show high mussel coverage and limpet densities. The site at Nqabara which is outside the MPA and heavily targeted by subsistence collectors has an impoverished intertidal biota.

4.2 Monitoring

The provision of benchmark areas and populations against which change can be measured is a critical management feature both where resource use is a feature of the environment, and in a world facing potentially large environmental changes brought about by climate change. Changes in habitat types and features on a large scale and changes in the the relative composition of the various biotypes within individual habitats can be relatively easily assessed and provide a means of monitoring changes in a region that forms the transition zone between the Agulhas and Natal bioregions. Such monitoring in turn provides an indication of both management requirements and management effectiveness in terms of controlling anthropogenic impacts and managing for climate change.

It is important to design a suitable monitoring programme that will detect changes in habitats and benchmark communities, preferably in time for management interventions to reverse negative trends where this is possible. One of the major drivers behind this current habitat mapping and biodiversity assessment was to provide information against which change can be measured. Changes in overall habitat types along the Dwesa-Cwebe coast can really only be monitored by repeating the mapping exercise. For practical and cost reasons this should be done at intervals of not less than 5-10 years. The main value of the detailed coastal mapping provided in this project is in providing a high resolution baseline for the entire coastline which provides a very powerful management tool. Critical and sensitive habitats can be identified for special interventions such as increased compliance or monitoring, or surveys for the presence of rare species. In addition, if management perceives that change might be occurring in any particular area (e.g. significant sanding), habitat mapping of a small section of coast can be undertaken to assess the level of change.

Ideally a rocky shore intertidal survey similar to the one carried out for this project should be undertaken at the same sites every five years. It is for this reason that the various shore levels at each site have been geo-referenced and marked with brass screws. However, rocky shore community structures are time consuming to evaluate and a high level of expertise is required. The ECPT have indicated that photography of quadrats within the various intertidal zones is a preferred option, since sampling is greatly simplified. Local staff can take the photographs when sea conditions are really good and the photographs can be analysed at leisure off site. This method has been used before to examine long term changes in middle shore communities at Dwesa (Dye 1998a,b). Dye (1998) photographed fixed quadrats over a 15 year time period and changes were assessed at an individual quadrat basis in the middle shore. Experimental photography in the low shore has shown that it is possible to assess the main space occupiers fairly successfully. Problems arise when large algal species overly other species, and identification of mussels and encrusting algae might become difficult. The

identification of limpet species is also difficult, particularly when they have a varied algal biota growing on the shell. The clarity and resolution of the photographs is clearly critical to the process and a photographer would need some training in angles, light and focus. Considerable skill in interpreting photographs would need to be developed. Initially photographs would need to be taken, interpreted and validated on the spot

To implement a monitoring programme on the rocky shore, between 25 and 30 randomly placed quadrats within each of the zones identified above should be photographed annually (assuming practice has enabled sufficient detail for interpretation). The photographer would need to assess the size quadrat that provides sufficient detail for interpretation. A 1 m^{-2} quadrat might require the photograph to be taken from too far away to identify the necessary biotypes and a 0.5 m^{-2} or 0.25 m^{-2} quadrat might be required. The author would suggest a 0.25 m^2 quadrat is the best option. Percent cover of the relevant biotypes would then be determined off site.

A monitoring programme should also incorporate some examination of limpet densities, size frequencies and species composition since these are useful indicator organisms. It is difficult to obtain these data by photography and a limpet reference collection should be built up to assist monitors.

In the course of the intertidal survey, a 1 m^{-2} square was marked out and photographed in the centre of each zone at each site. The usefulness of this single quadrat in each zone is limited to providing an indication of change within the 1 m^{-2} quadrat. Because of the natural variability of rocky shores it cannot be used to describe change at the level of the zone in which it is located, but it can potentially provide a long term data that provides some indication of the changes that occur in rocky shore community structure.

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APPENDICES

Appendix 1:

Habitat mapping data sheet

Dwesa-Cwebe Habitat Mapping Data													Mapsheet No.			**N**	
Date:													Mapper				
Coastal Region:																	
Zone:									Windspeed:								
Series start landmark:									Swell height:								
Series end landmark:									Tide conditions:								
		If start **Landmark**				**Forest dune FD**	**Scrub dune SD**	**Fore dune F**	**Top shore T**	**High shore H**	**Mid shore M**	**Low shore L**	**Subtidal S**	**Mussels**	**Landmarks**	Notes	Notes
		GPS Fix		25 m													
100 m				25 m													
				25 m													
		GPS fix		25 m													
				25 m													
100 m				25 m													
				25 m													
		GPS fix		25 m													
				25 m													
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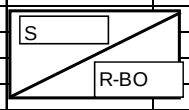
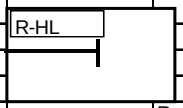
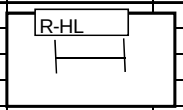
		GPS fix		25 m													
				25 m													
100 m				25 m													
				25 m													
		GPS fix		25 m													
						FD	**SD**	**F**	**T**	**H**	**M**	**L**	**S**	**Mussels**	**LM**	**Notes**	**Notes**

Codes used for habitat mapping are shown on the following page.

Development/Feature			Special features	
Final Code	**Common Name**			
AR	Access Road			
AR-T	Tarr Road			
CF-DL	Drainage line			
CF-ER	Erosion area			
CF-GULLEY	Gulley			Sand at top of zone Rocks at bottom
CF-STREAM	Stream			
DE-BRAAI	Braai area			
DE-GA	Garden			
DE-GABION	Gabion			
DE-GOLFC	Golf Course			
DE-GR	Grass area			
DE-H	House			Sand and Rock high ledge mixed
DE-HUT	Lifesavers Hut			
DE-P	Parking			
DE-PIPE	Pipe			
DE-RUBBLE	Rubble			
DE-PLAT	Viewing Platform			
DE-ST	Stairway			
DE-WALL	Concrete wall			
				Rocks in half of zone
Coast General				
CF-MCLIFF	Mega Cliff			
CF-CH	Channel			
CF-CLIFF	Cliff			
CF-EST-A	Estuary			
Forest Dune	Combinations + Dev./Features			
VEG-IN-FOREST-A	Indigenous coastal forest + Dev/Feature			Rocks in Middle third of zone
VEG-AL-A	Alien Vegetation + Dev/Feature			
Scrub Dune	Combinations + Dev./Features			
VEG-IN-BU	Dune scrub bushes			
VEG-IN-GR	Grass			
Fore Dune	Combinations + Dev./Features			
DH-BA-A	Bare dune hummock			
DH-VE-A	Vegetated dune hummock			
WATER	Water			
NP	Zone not present			
Intertidal/Subtidal	**Common Name**			
R-C	Mixture of Emergent and Submerged rocks			
RBO-A	Rock boulders			
RBO-ARTF	Artificial rock boulders			
RBR-A	Broken rocks			
RE-A	Emergent rocks			
RL-TA	High rock ledge			
RL-TB	Low rock ledge			
RL-TC	Mixture of High and Low rock ledge			
RLBR-TA	Rock Broken Ledge High (>20cm)			
RLBR-TB	Rock Broken Ledge Low			
RLBR-TC	Mixture of High and Low Broken ledge			
RS-A	Sumberged rocks			
RSC-A	Scattered rocks			
RSO-A	Solid Continuous Rocks			
S-A	Sand			
Sandy Shores	**Common Name**			
S-D	Sandy shore dissapative			
S-R	Sandy shore reflective			
S-I	Sandy shore intermediate			
S-E	Sandy shore within 500m of an estuary			
Mussels	**Common Name**			
MUSS +	Scattered mussels			
MUSS ++	Fair mussels			
MUS +++	Dense mussels			

Appendix 2:

Sketch maps of the three sampling sites at Dwesa-Cwebe and one at Nqabara.

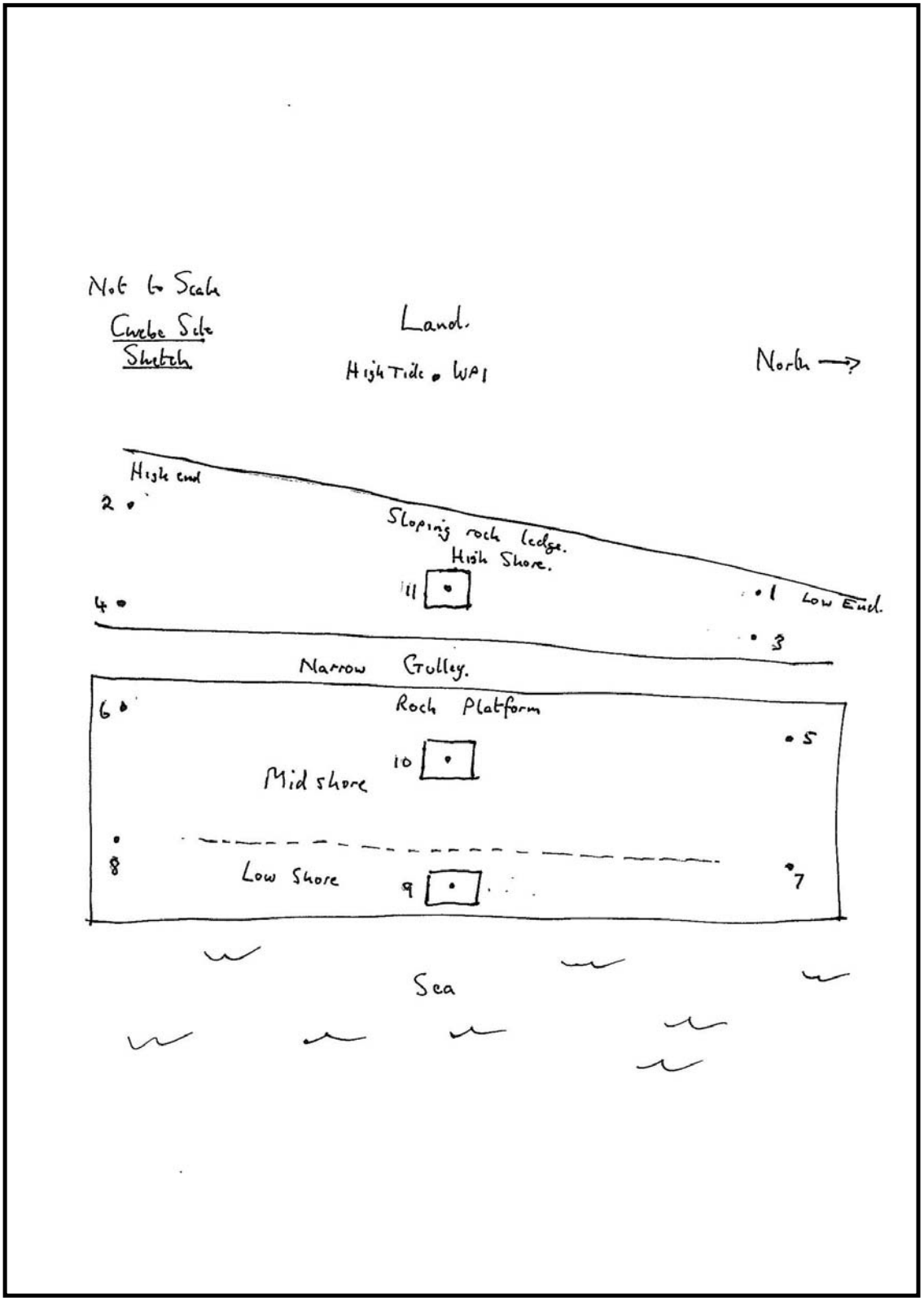
1. **Cwebe Site – near Mbanyana River.**

GPS points (see sketch map for locations)

Location	**South**	**East**
1	32.23029	28.92801
2	32.23041	28.92799
3	32.23030	28.92805
4	32.23042	28.92804
5	32.23032	28.92815
6	32.23049	28.92817
7	32.23032	28.92822
8	32.23049	28.92823
9	32.23043	28.92825
10	32.23044	28.92819
11	32.23034	28.92803

The seaward boundary of the low shore zone is the edge of the rock shelf

Sketch Map of Cebe Mbanyana Site



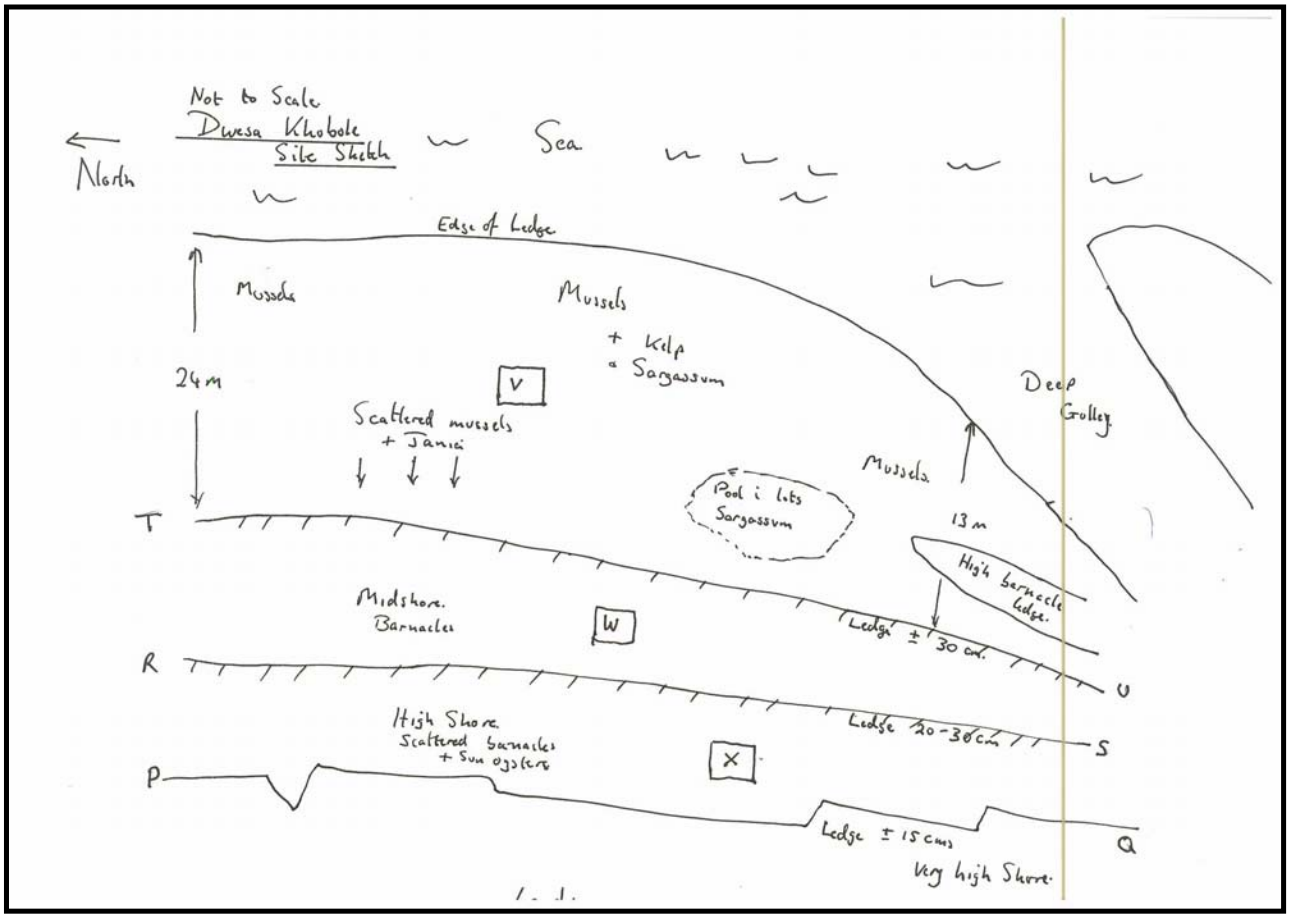
Dwesa Khobole Site

GPS points (see sketch map for locations)

Location	South	East
P	32.30346	28.83769
Q	32.30354	28.83742
R	32.30349	28.83772
S	32.30359	28.83748
T	32.30353	28.83773
U	32.30359	28.83750
V	32.30357	28.83775
W	32.30355	28.83753
X	32.30353	28.83750

The seaward boundary of the low shore zone is the edge of the rock shelf

Sketch map of Dwesa Khobole Site



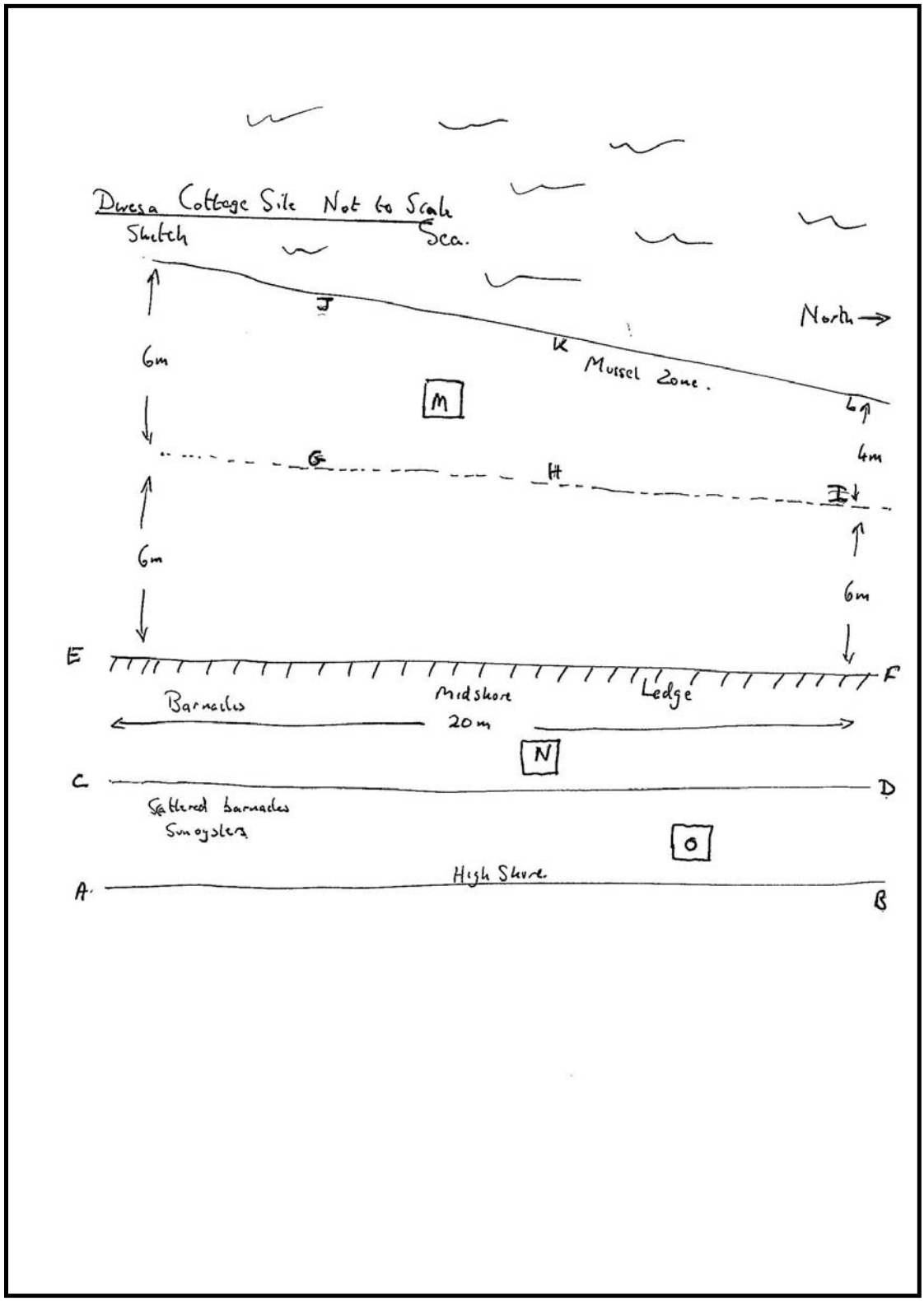
Dwesa Cottages Site.

GPS points (see sketch map for locations)

Location	South	East
A	32.30801	28.83050
B	32.30782	28.83066
C	32.30812	28.83082
D	32.30797	28.83094
E	32.30818	28.83093
F	32.30808	28.83109
G	32.30813	28.83113
H	32.30818	28.83105
I	32.30821	28.83103
J	32.30814	28.83112
K	32.30821	28.83108
L	32.30824	28.83105
M	32.30820	28.83103
N	32.30816	28.83090
O	32.30802	28.83076

GPS points G – L are almost on the seaward edge of the rock shelf. The edge of the shelf marks the seaward boundary of the low shore/mussel zone. Wave action made getting GPS points right on the edge difficult.

Sketch Map of Dwesa Cottages Site



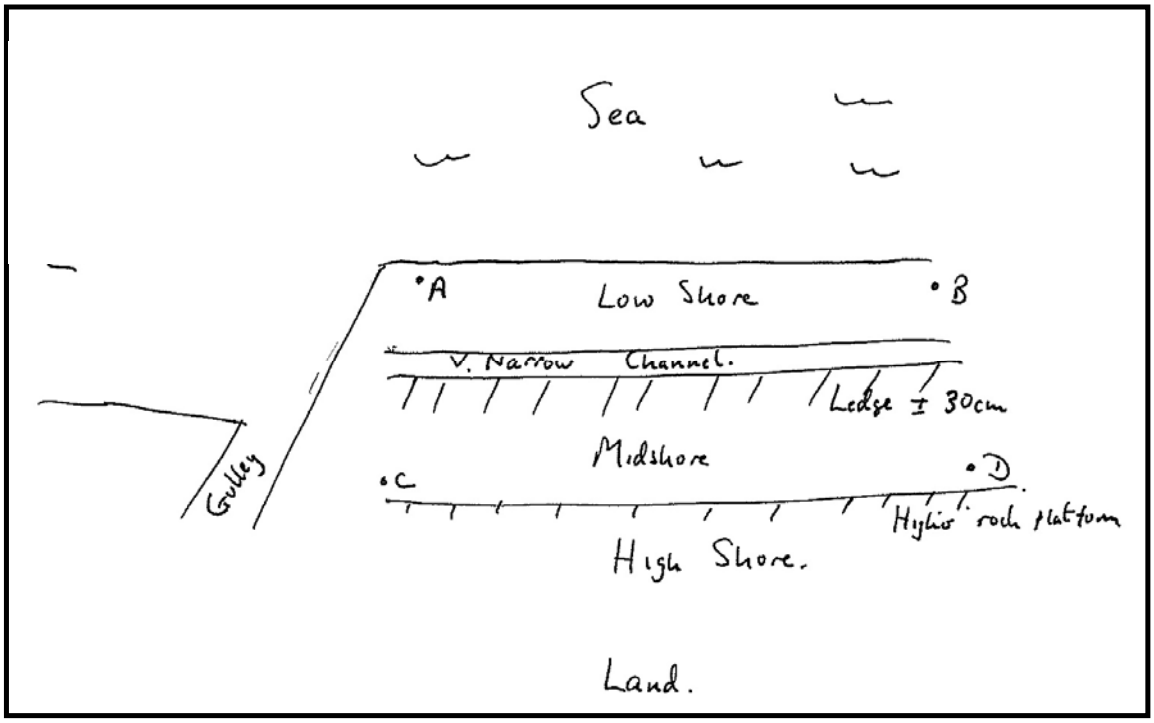
Nqabara Site.

GPS points (see sketch map for locations)

Location	South	East
A	32.34109	28.79282
B	32.34122	28.79282
C	32.34109	28.79248
D	32.34122	28.79248

The GPS points only outline the mid and low shore area. The seaward boundary of the low shore zone is the edge of the rock shelf

Sketch Map of Nqabara Site



Appendix 3:

1 m^2 Quadrats in each intertidal zone at each site.
GPS reading is for the centre of each quadrat.
Brass screws mark the corners of each quadrat.
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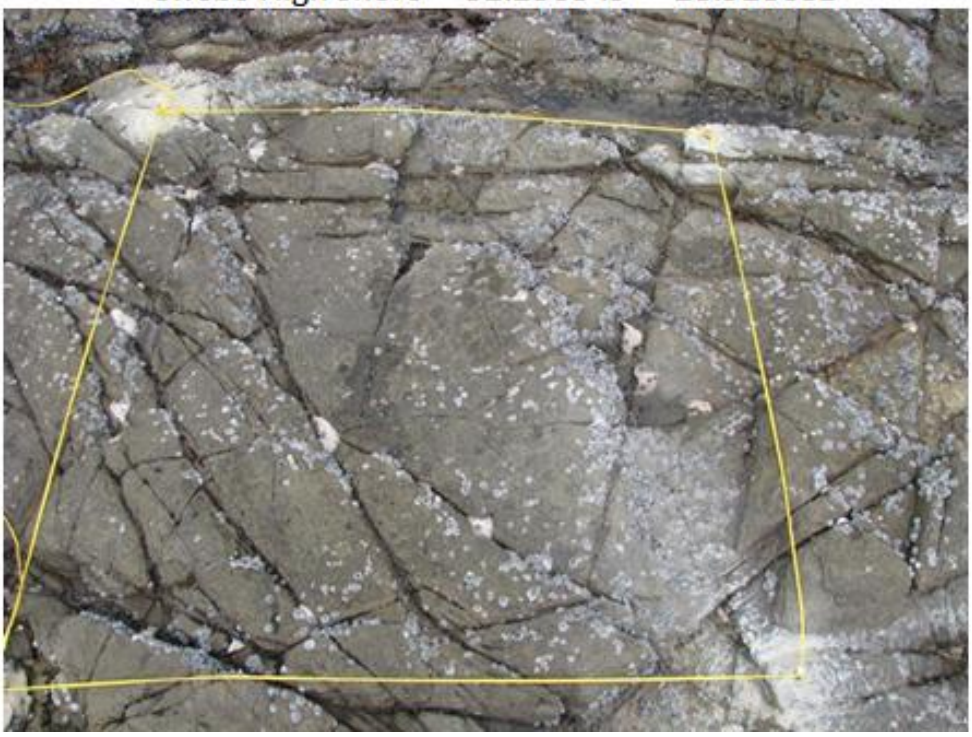
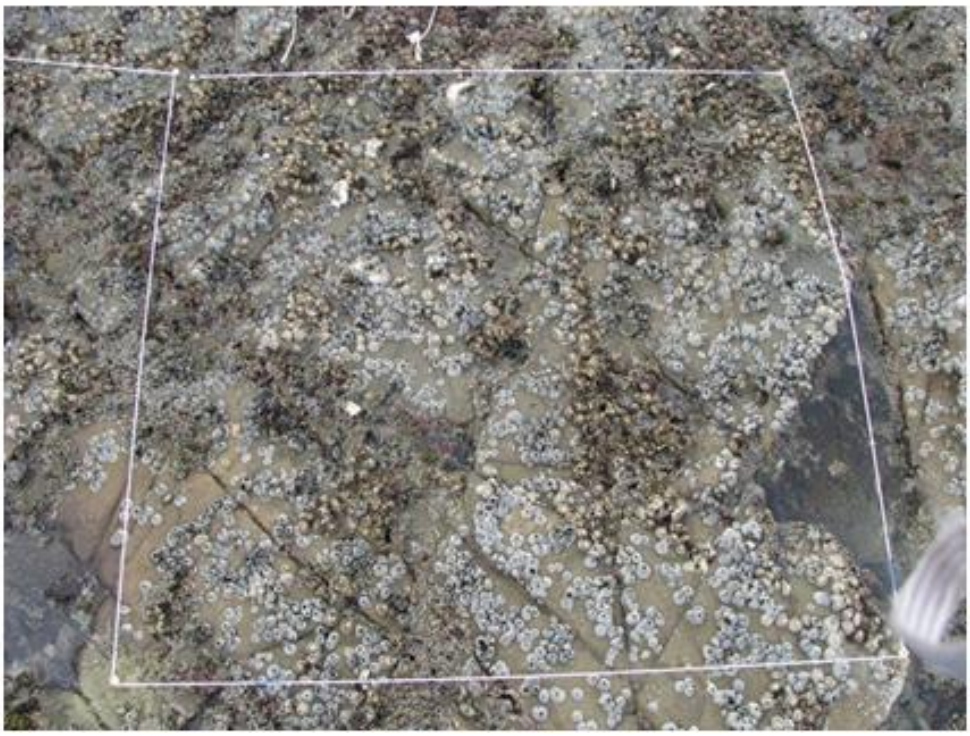
Site	S GPS	E
Cwebe High	32.23034	28.92803
Cwebe Mid	32.23044	28.92819
Cwebe Low	32.32043	28.92825
D-Khobole High	32.30353	28.83750
D-Khobole Mid	32.30355	28.83753
D-Khobole Low	32.30357	28.83775
D-Cottages High	32.30802	28.83076
D-Cottages Mid	32.30816	28.83090
D-Cottages Low	32.30820	28.83103

Cwebe High Shore 32.23034S 28.92803E

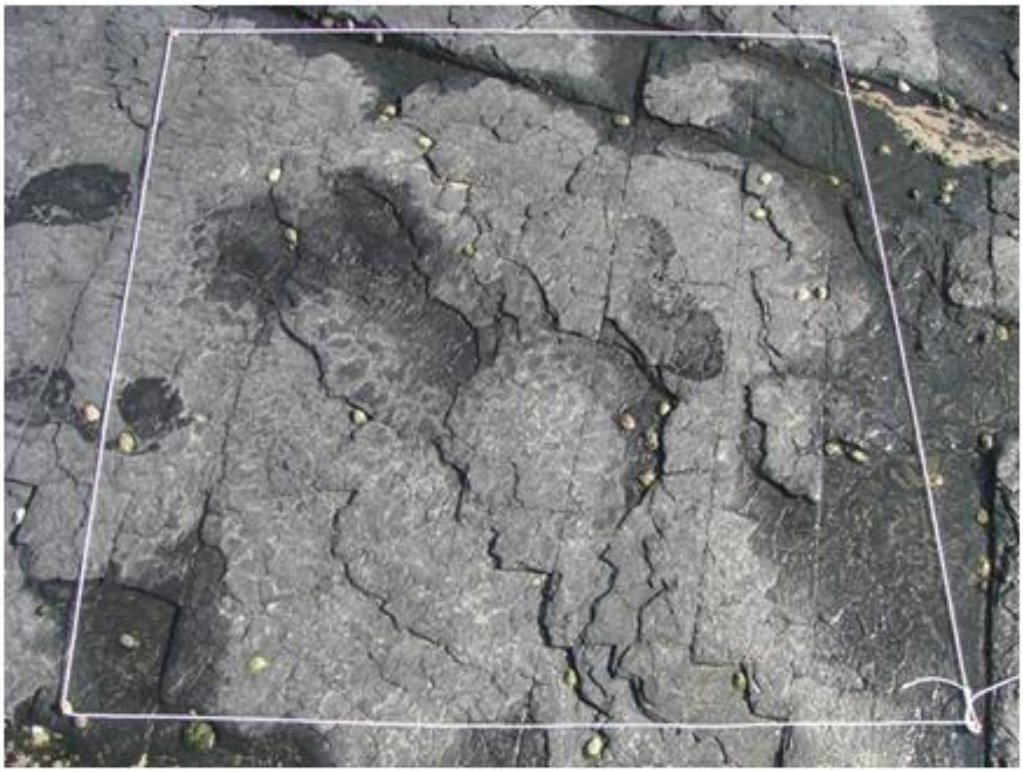


Cwebe Mid Shore 32.23044S 28.92819E

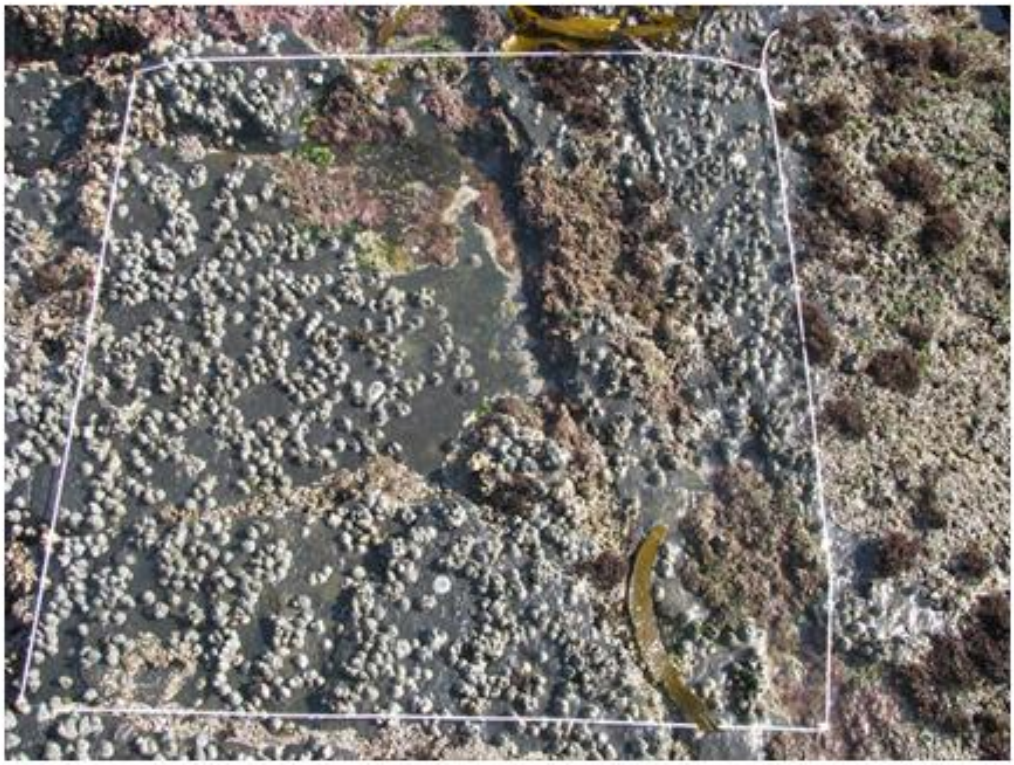


Cwebe Low Shore 32.32043S 28.92825E

Dwesa-Khobole High Shore 32.30353S 28.83750E



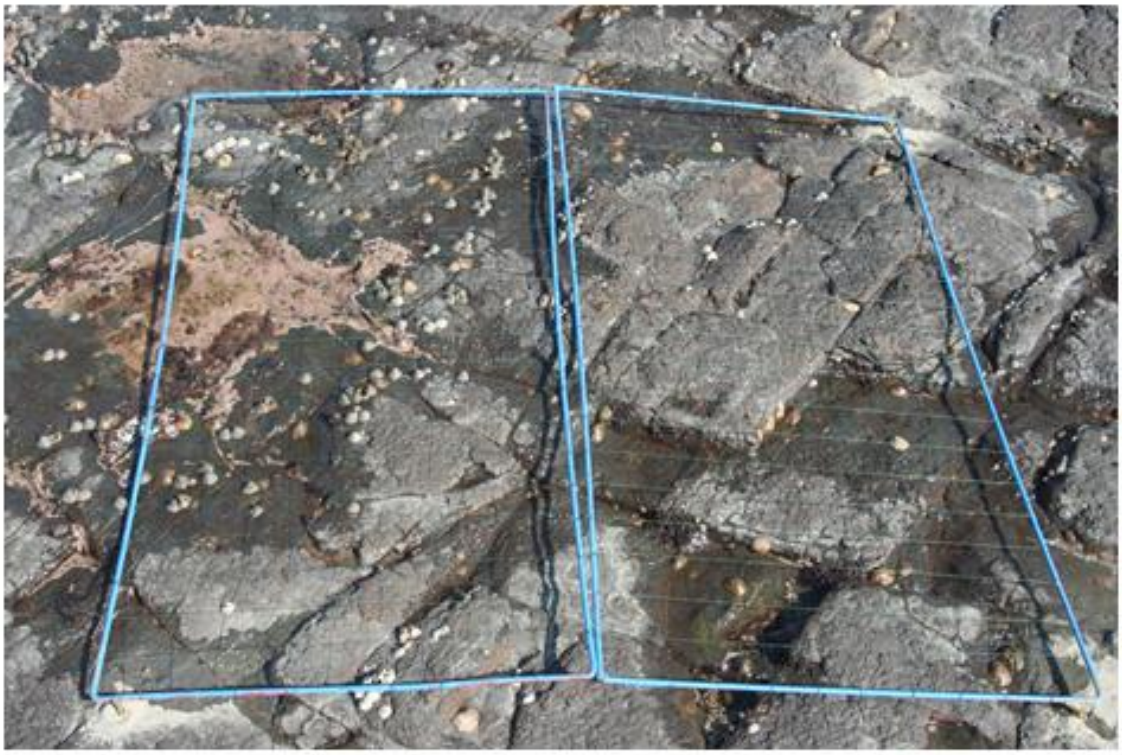
Dwesa-Khobole Mid Shore 32.30355S 28.83753E



Dwesa-Khobole Low Shore 32.30357S 28.83775E

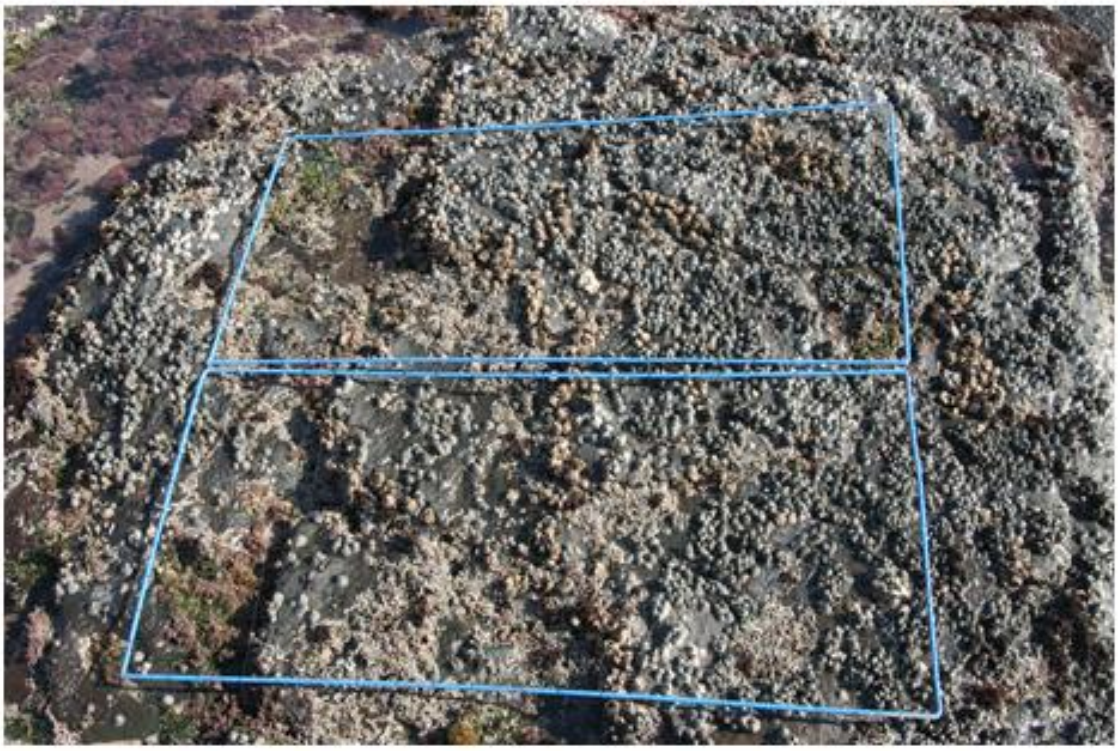
Dwesa-Cottages High Shore 32.30802S 28.83076E

Dwesa-Cottages High Shore 32.30802S 28.83076E



Dwesa-Cottages Mid Shore 32.30816S 28.83090E

Dwesa-Cottages Mid Shore 32.30816S 28.83090E



Dwesa-Cottages Low Shore 32.30820S 28.83103E

Appendix 4

Additional Geo-referenced images from habitat mapping exercise. GPS is taken at the point at which the photograph was taken. Sometimes more than one photograph was taken from one point. Additional images are included to demonstrate the rocky shore detail that can be achieved for monitoring purposes .

Image No	S GPS	E
2992	32.28609	28.87150
2994	32.28064	28.88413
2995	32.28064	28.88413
2996	32.27933	28.88407
2997	32.27934	28.88277
2998	32.27337	28.88277
2999	32.27337	28.88277
3000	32.27337	28.88277
3001	32.29368	28.85727
3002	32.29362	28.85723
3003	32.29362	28.85723
3005	32.29353	28.85722
3007	32.29415	28.85762
3010	32.29415	28.85762
3011	32.29438	28.85759

Image No.2992 32.286095 28.87150E

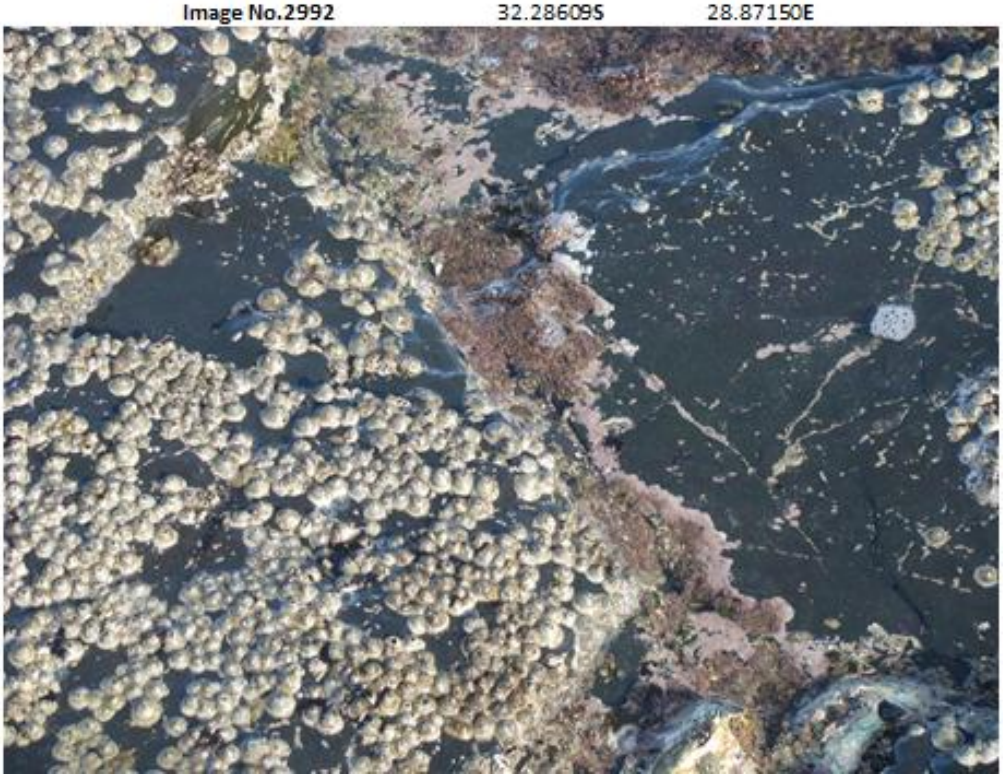


Image No.2994 32.28064S 28.88413E

Image No.2995 32.28064S 28.88413E

Image No.2996 32.27933S 28.88407E

Image No.2997 32.27943S 28.88277E

Image No.2998 32.27337S 28.88277E

Image No.2999 32.27337S 28.88277E

Image No.3000 32.27337S 28.88277E

Image No.3001 32.29368S 28.85727E

Image No.3002 32.29362S 28.85723E

Image No.3003 32.29362S 28.85723E

Image No.3005 32.29353S 28.85722E

Image No.3007 32.29415S 28.85762E

Image No.3010 32.29415S 28.85762E

Image No.3011 32.29438S 28.85759E

Rocky shore monitoring

- The following five photographs have been added to indicate the kind of detail that can be achieved by photographing quadrats on the rocky shore for the purposes of monitoring changes on the main space occupiers. Resolution could probably be improved with a skilful photographer.
- It would be necessary to develop some interpretation skill and ground truth the initial exercises
- The metre square images provide further detail

Image No.3043 32.30357S 28.83763E

Image No.3049 32.30360S 28.83762

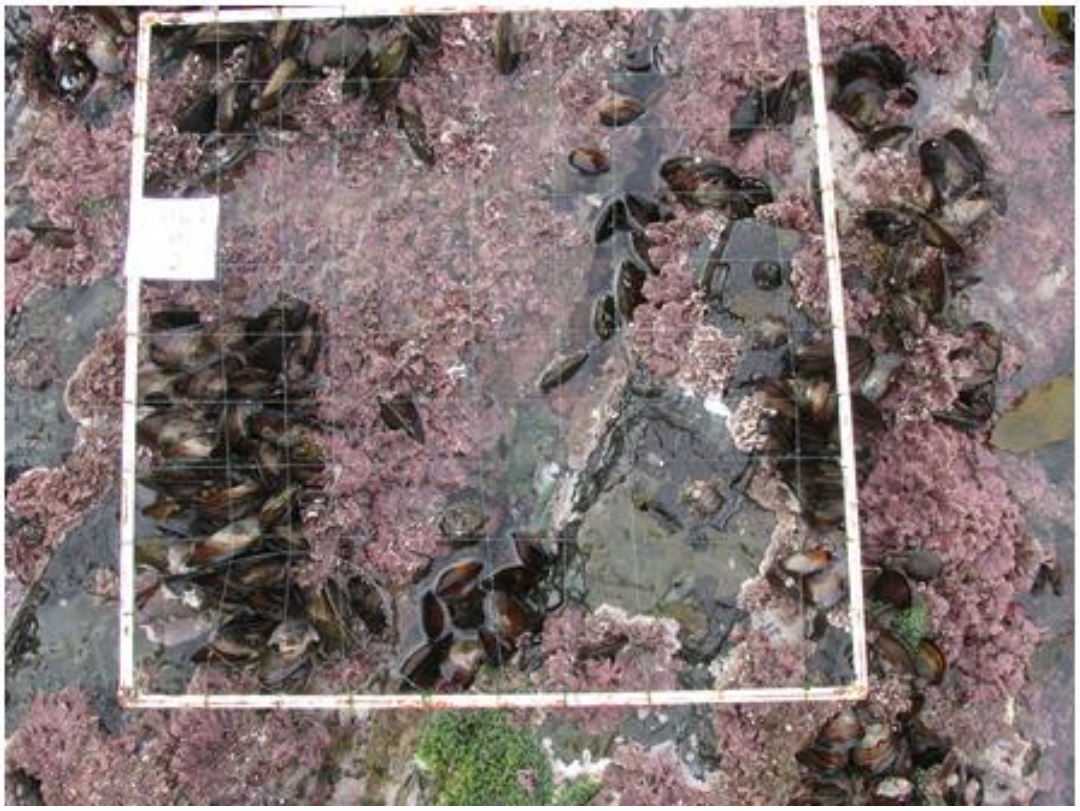


Image No.3051 32.30357S 28.83773E

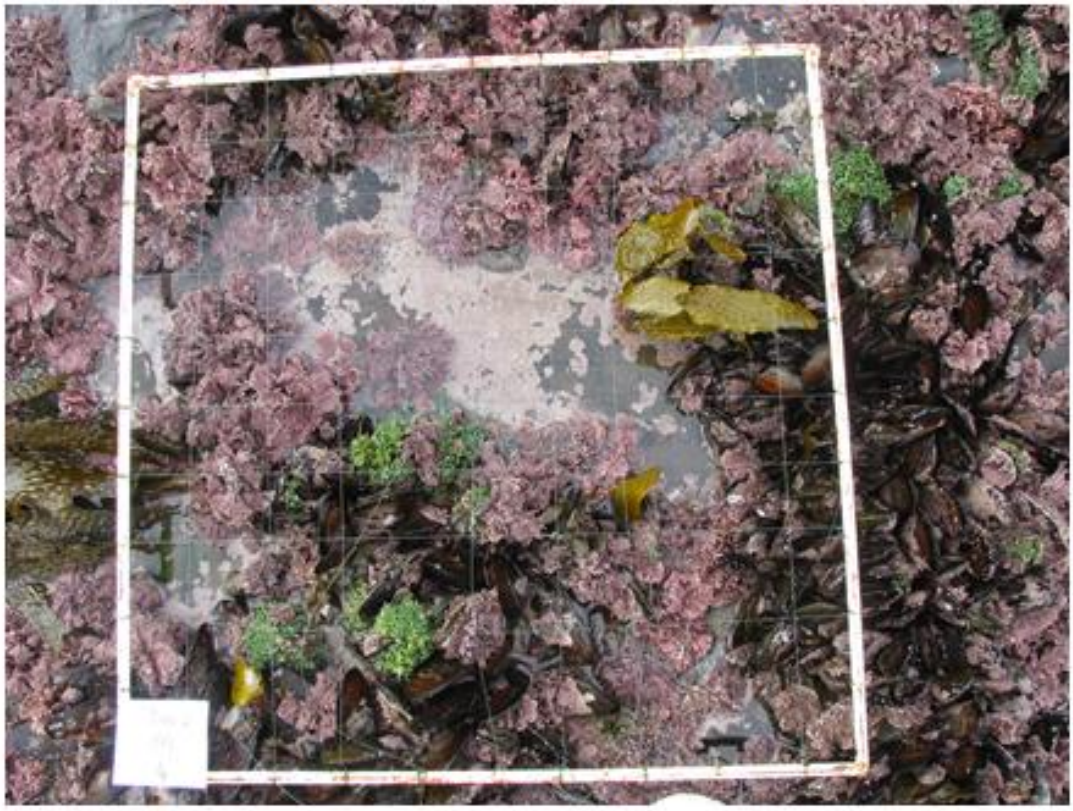


Image No.3096 32.34114S 28.79264E

Image No.3045 32.30352S 28.83772E