Stock Assessment of Exploited Invertebrate Subtidal Reef Species and Characterisation of Habitat Types along the Coast of the Cape Peninsula National Park
ZA 5027

<u>Final Report</u>

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For

THE TABLE MOUNTAIN FUND, WWF-SA

Centre for Marine Studies

University of Cape Town

September 2001

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SECTION I

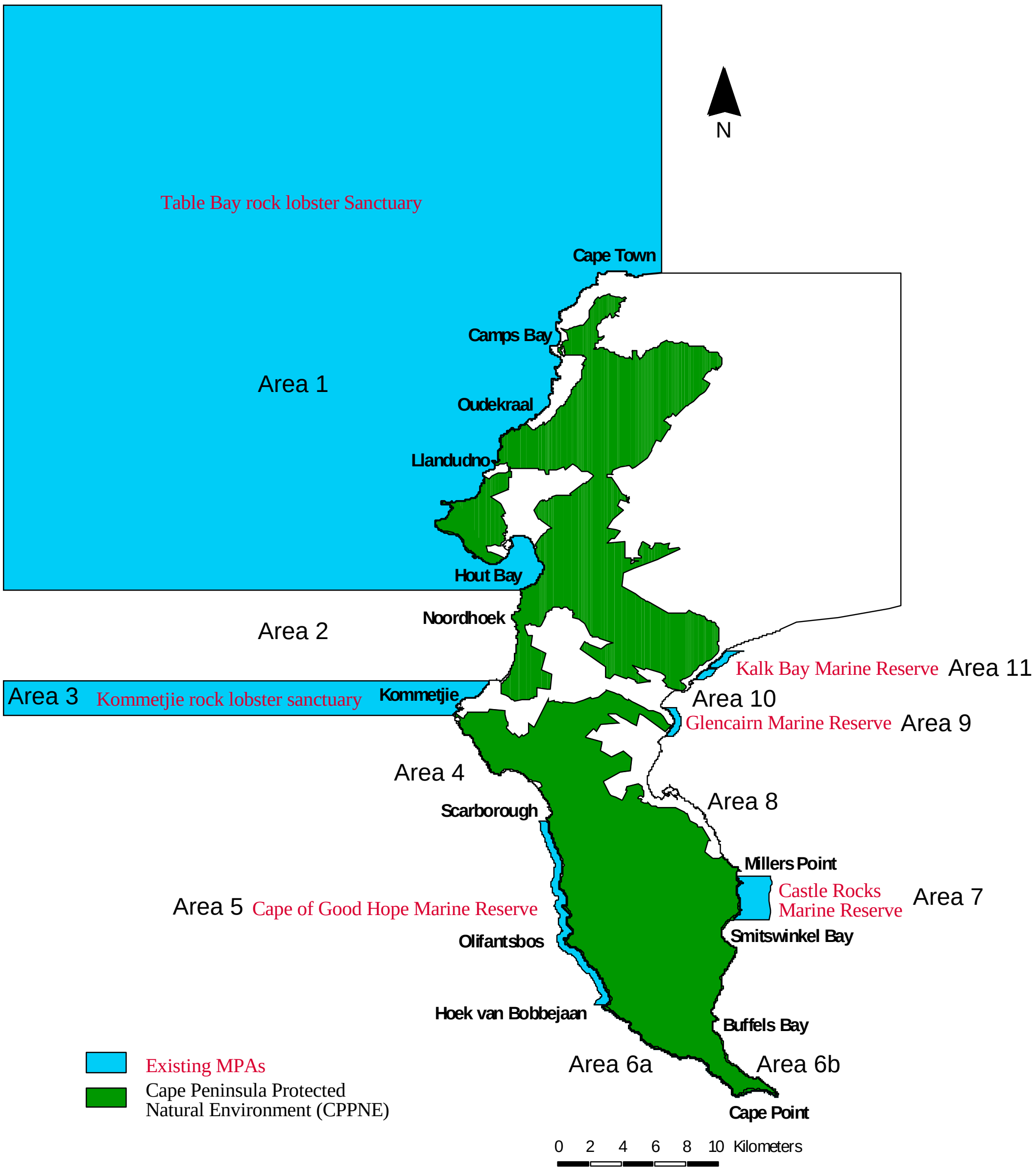
1. PROJECT OBJECTIVES

While most scientific literature has high praise for the establishment and the concept of MPAs, some authors (Attwood 1997b; Mayfield and Branch 2000b) have suggested that the current MPA network on the Cape Peninsula (Figure 1) is not as effective as it could potentially be. It is critical to acknowledge that many of the existing marine protected areas may have been poorly sited, due to a lack of information on the distribution and stocks of the exploited species, when they were proclaimed. Should this be the case, fisheries and biodiversity sustainability levels of the Peninsula risk unsustainable exploitation.

In an attempt to improve the efficacy of MPAs on the Cape Peninsula, the Cape Peninsula National Park is currently attempting to develop a marine component for the Park by incorporating a set of MPAs as its core component.

A fundamental requirement of this approach is to establish the efficacy of the existing network of MPAs and to suggest alternative proposals. This is the prime purpose of this report, which aims to assist with this process by mapping the distribution of principal exploited species and habitat types of the Peninsula. This data will be used as a basis for evaluating the existing MPA network before it is incorporated into the Park.

Figure 1 : Existing Marine Protected Areas of the Cape Peninsula.



2. BACKGROUND AND MOTIVATION

The Cape Peninsula coast is extremely rich in marine and coastal biodiversity with about 43% of all the South African marine species occurring in this region. It supports several important fisheries and contributes to the livelihood of many people (Attwood *et al.* 1997a).

The conservation status of many of the ecologically and economically important species on the Peninsula (and in South Africa as a whole) is very poor and most of the coastal fisheries are not properly managed. Many of these fisheries have deteriorated to such a point that spawner biomass estimates are below commonly accepted thresholds (Attwood *et al.* 1997b). This is because exploitation pressure continues to increase with growing numbers of fishers and technological improvements, while fishery regulations remain inadequate. As a result, many marine fish and shellfish species in South Africa are overexploited and some species are in a critical risk of being lost for future generations (Mayfield 1988). The widespread collapse of fisheries combined with the critical state of coastal biodiversity prompted a renewed interest in marine protection (Attwood *et al.* 1997b).

It is evident that most of the conventional fisheries management approaches, such as size limits and bag limits, have failed to conserve stocks of exploited species for sustainable use. Internationally, Marine Protected Areas (MPAs) are perceived as the leading tool for conservation. If properly managed, and with public support, MPAs worldwide provide substantial benefits for both fish and fishers. They have been shown to conserve natural ecosystems, act as effective reservoirs for biodiversity, aid to rebuilt depleted stocks, improve fishery yields and provide protection against stock collapse, amongst other benefits (Attwood *et al.* 1997a). MPAs also provide a good foundation for education and marine research.

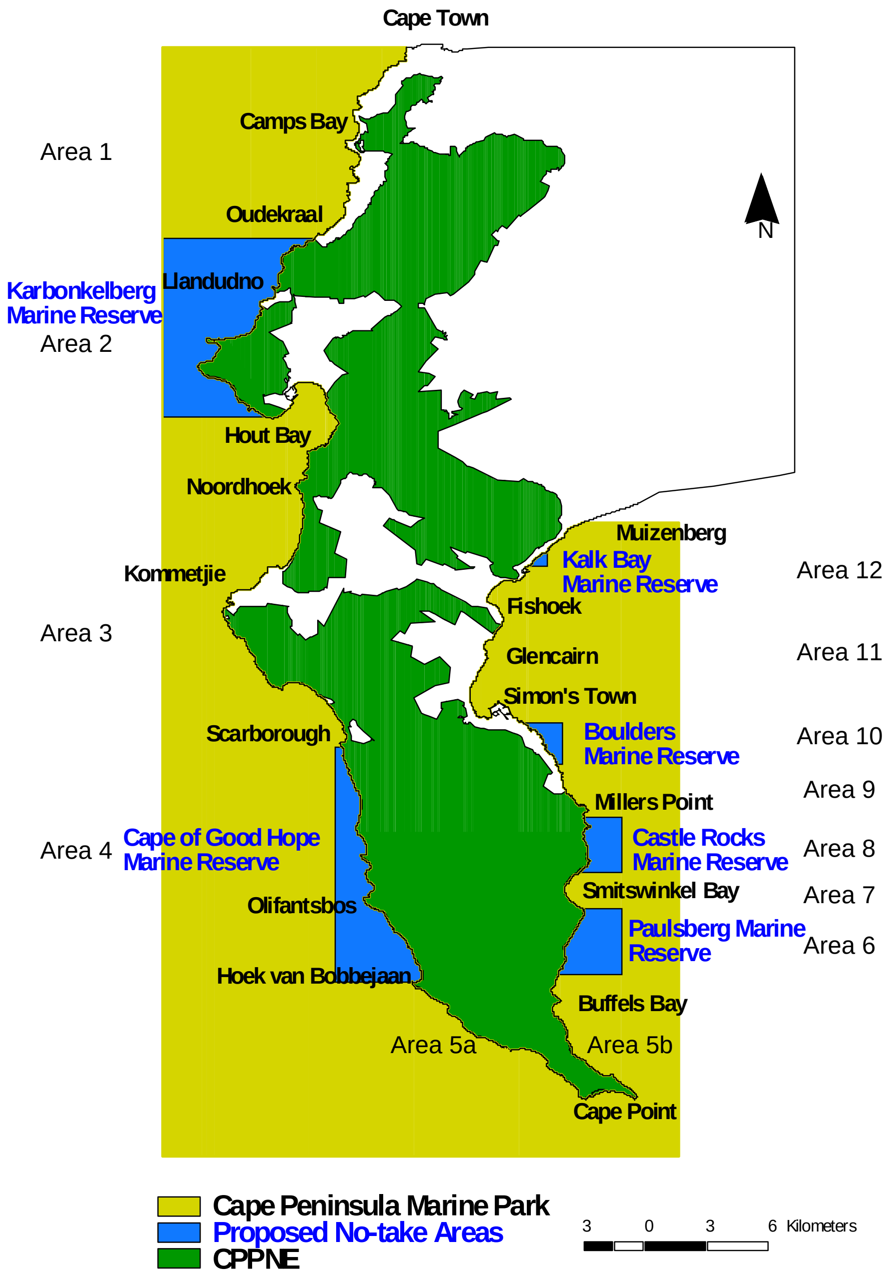
The Cape Peninsula at present has seven MPAs, the first of which was proclaimed in 1964. Most of these are ineffective, however, mainly due to their poor placement (Attwood *et al.* 1997b). At the time of proclamation, vital information on biogeographic and exploited species distribution patterns was not available. The existing MPA network is also plagued with legislative, socio-economic and administrative problems (Hockey and Buxton 1989). This has antagonised local fishers and has encouraged poaching. The revision and rationalisation of the existing MPA network on the Peninsula is an urgent priority and is recognised as such by Marine and Coastal Management, but up until now has been impossible owing to the lack of funds.

The newly proclaimed Cape Peninsula National Park (CPNP) is willing to take over the management of marine areas along its boundaries and has diverted a portion of the funds provided by the Global Environment Fund (GEF) for a feasibility study to evaluate this. This process has been constrained to a desktop study only as a result of limited funds. As a consequence, little is known of the distribution patterns of exploited species on the Peninsula. This is severely hampering efforts in this regard.

The aim of this project is to map the distribution of the remaining stocks of important exploited marine species and habitat types on the borders of the Park. This data will be used to guide the review process, and assist with the identification of possible new MPAs (Figure 2) and the formulation of appropriate boundaries, zonation and management plans for the Marine Component of the Park as a whole.

The data will also be extremely valuable as baseline information, against which future improvements can be evaluated and the benefits of the new MPA network demonstrated.

Figure 2 : Proposed Marine Protected Areas of the Cape Peninsula.



3. TERMS OF REFERENCE

The objectives of the exploited invertebrate reef species stock assessment is to provide micro-scale data on the distribution and abundance of these species necessary to:

1. Assess the status of the principal exploited invertebrate species on the Peninsula, particularly alikreukel, abalone and rock lobster;
2. Evaluate the effectiveness of the existing Marine Protected Area (MPA) network in terms of biodiversity conservation as well as the conservation and management of these species;
3. Provide essential baseline information against which future changes (improvements) can be evaluated and benefits of the MPA network demonstrated.

The objectives of the habitat type characterisation along the coast of the Park is to produce a detailed map of principal marine habitat types on the Peninsula which can be used to:

1. Assess the effectiveness of the existing MPA network with respect to biodiversity conservation;
2. Ensure that all these basic habitat types are incorporated within the revised MPA network;
3. To offer a means of extrapolating information on the distribution of other species along the coast of the Park.

SECTION II

1. MAPPING OF MARINE INTERTIDAL HABITATS

1.1 Generation of spatial data

ArcView (3.2) was used to compile a shapefile (Habitat_exposure.shp) containing all habitat and exposure data. A coastline produced by Terra Mare (CPPNE project) was buffered by 100m and then split into different intertidal habitat types and exposure ratings using onscreen digitising of 1:10000 digital orthophotographs. The resulting polygons were coded for each of the various habitat and exposure types. To facilitate the calculation of percentage habitat and exposure types along the Peninsula, a line cover (Habitat_exposure_line.shp) was generated. The data are in a Transverse Mercator projection (or Gausse Conic Conformal projection) centred on 19°, with a WGS84 spheroid. There are no offsets.

2. MAPPING OF HABITAT TYPES

The intertidal marine habitats abutting on the Cape Peninsula National Park were mapped using GIS techniques (Figures 3 – 5). Six different habitat types were identified, and were defined as follows:

- **Rock_solid**

This habitat type includes areas of shore, which are deemed to be composed of solid rocky material. In some cases these areas may be constructed of boulders, but the boulders are of such a large size that they are more likely to function ecologically as solid rock than as individual boulders. The geological material may be either Table Mountain Group Sandstone, Malmesbury Shale or granite.

- **Rock_boulder**

This habitat type is essentially composed of individual boulders of differing sizes, at least some of which are likely to be disturbed by wave action. The geological material may be either Table Mountain Group Sandstone, Malmesbury Shale or granite.

- **Rock_boulder_solid**

This habitat type comprises a mixture of solid rock and boulder substrata. The geological material may be either Table Mountain Group Sandstone, Malmesbury Shale or granite.

- **Sand**

This habitat type is composed of sand of differing particle sizes.

- **Mixed_rock_sand**

This habitat type may be predominantly either solid rock or sand, but contains elements of both. The presence of either is likely to have some ecological effect on the other. In some cases these areas may be constructed of boulders, but these are of such a large size that they are more likely to function ecologically as solid rock than as individual boulders. The geological material may be either Table Mountain Group Sandstone, Malmesbury Shale or granite.

- **Mixed_boulder_sand**

This habitat type may be composed predominantly of either individual boulders of differing sizes, at least some of which are likely to be disturbed by wave action, or sand, but contains elements of both. The presence of either is likely to have some ecological effect on the other. The geological material may be either Table Mountain Group Sandstone, Malmesbury Shale or granite.

A further category was mapped. This was:

- **Altered**

Altered habitats included areas where large, man-made constructions encroached on the intertidal zone. These included harbours, seawalls, and areas along the railway line in False Bay where the only material visible on the shore was imported material used as levelling for the construction of the railway line.

Figure 3 : Habitat types (Cape Town and the Northern Peninsula)

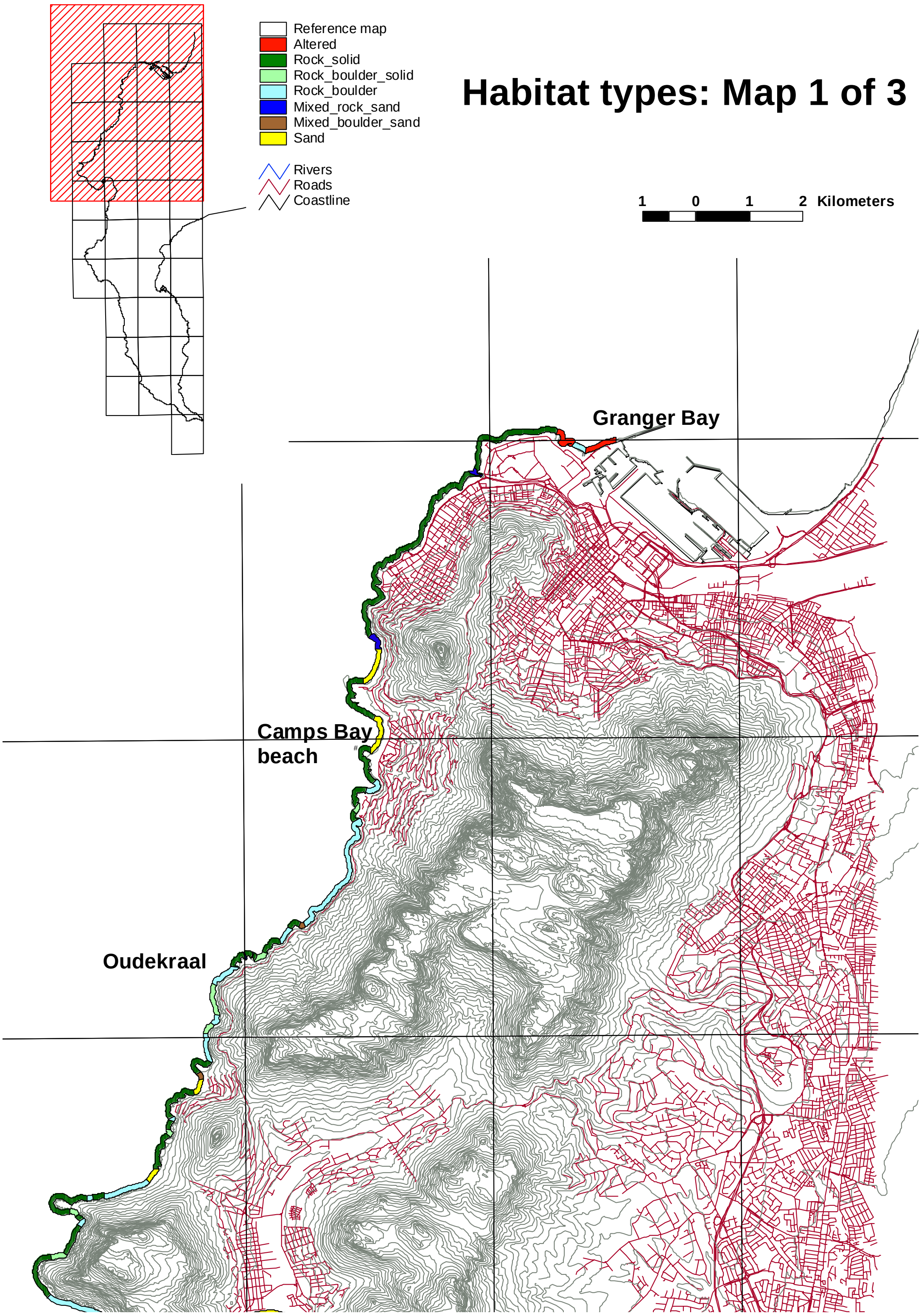


Figure 4 : Habitat types (Central Peninsula)

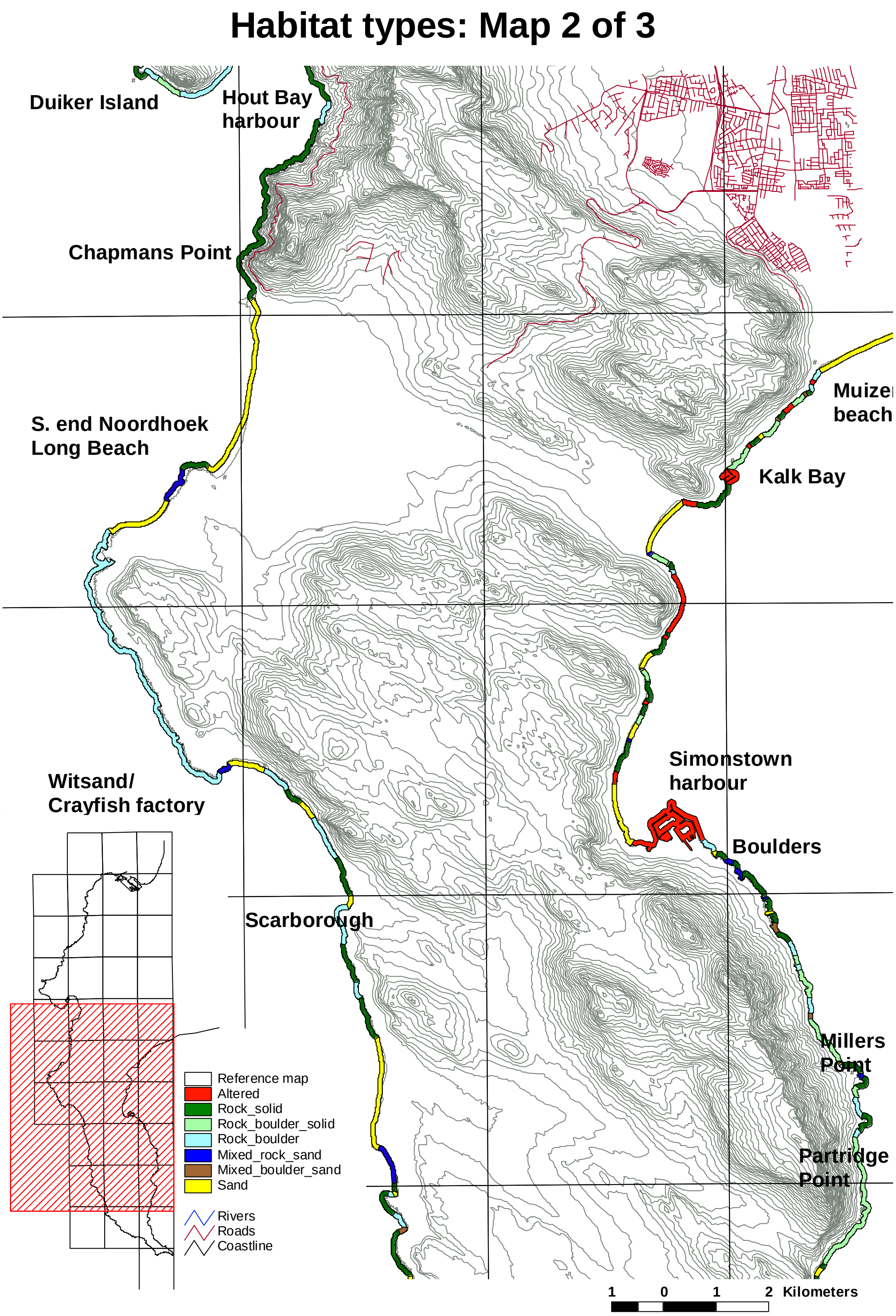
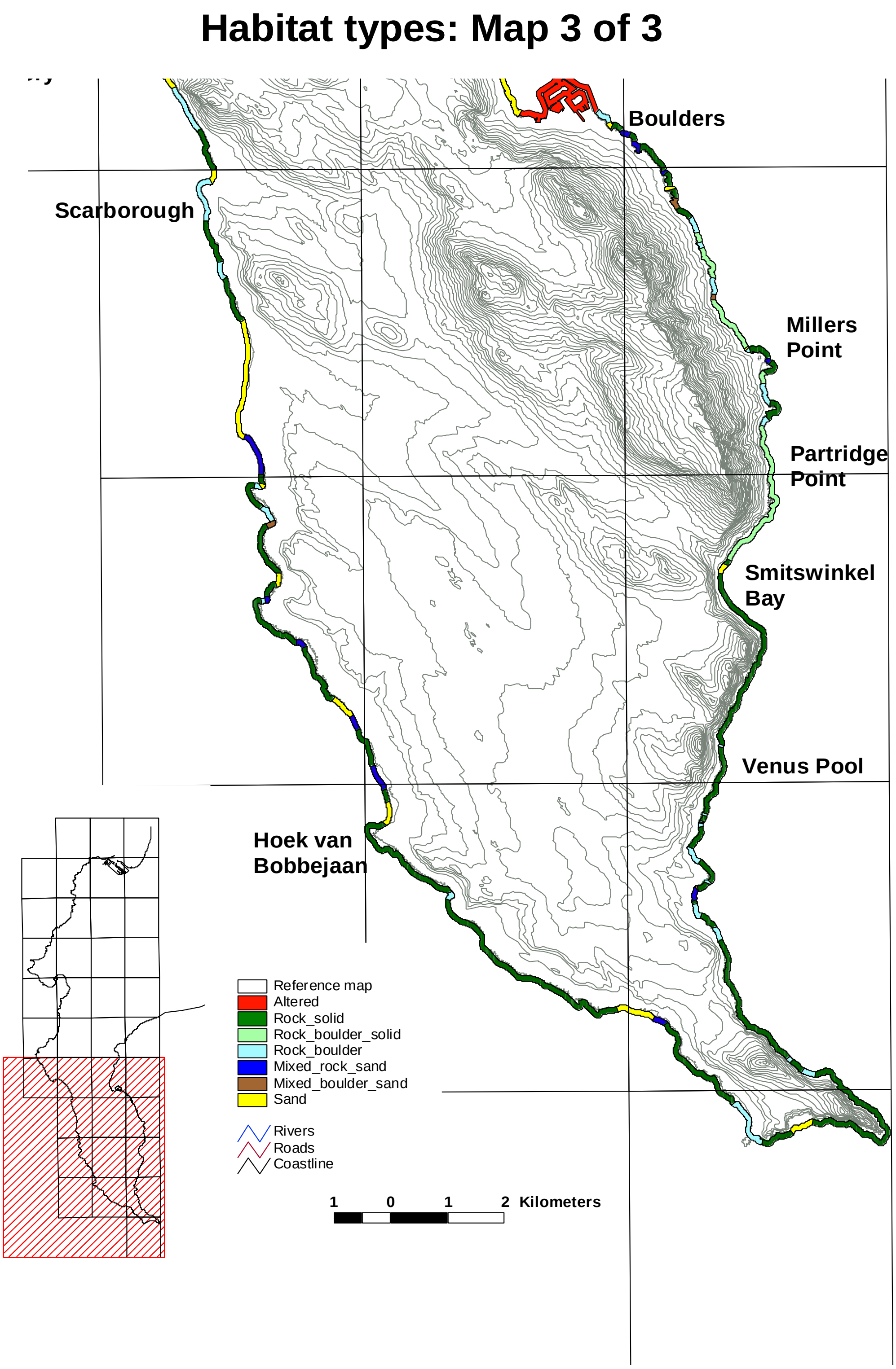


Figure 5 : Habitat types (Southern Peninsula)



3. MAPPING OF LEVEL OF EXPOSURE TO WAVE ACTION

An indication of the level of exposure of areas of coast to wave action was included in the mapping process (Figures 6 – 8). Assessing the level of exposure to wave action is difficult, and can differ markedly depending on the scale at which it is assessed. The physical complexity of the intertidal zone, and in particular areas of rocky substratum, results in the level of exposure to wave action differing considerably over only a few metres. Clearly it would not have been practical to map such a great level of detail. The assessment of level of exposure to wave action was thus performed subjectively for entire stretches of habitat type. The five levels that were considered were as follows:

- **Extremely_sheltered**
  Areas, which were deemed to receive only very minimal wave action, were classified as extremely sheltered. These areas usually receive no direct wave action. Instead, wave action is damped by some form of obstruction, and the area usually only receives dissipated, diffracted, or wind-generated surface waves. These areas are usually situated within deep embayments.

- **Sheltered**
  These areas usually receive very little direct wave action. Instead, wave action is damped by some form of obstruction, and the area usually only receives dissipated, diffracted, or wind-generated surface waves. These areas are usually situated within shallow embayments, or towards the seaward edge of an embayment, and usually face away from the prevailing wave direction.

- **Moderate**
  Areas were deemed to receive moderate wave action if they fell between the Sheltered and Exposed categories. Such areas receive direct wave action, but this is either oblique, or the area is protected to a small degree by an obstruction.

- **Exposed**
  Areas were deemed to be exposed if they receive direct wave action, and are not protected

by obstructions to this wave action.

- **Extremely_exposed**

  Areas which receive direct wave action, and which face the prevailing wave direction, or headlands that protrude from the coastline, were classified as being extremely exposed.

Figure 6 : Level of Exposure (Cape Town and the Northern Peninsula)

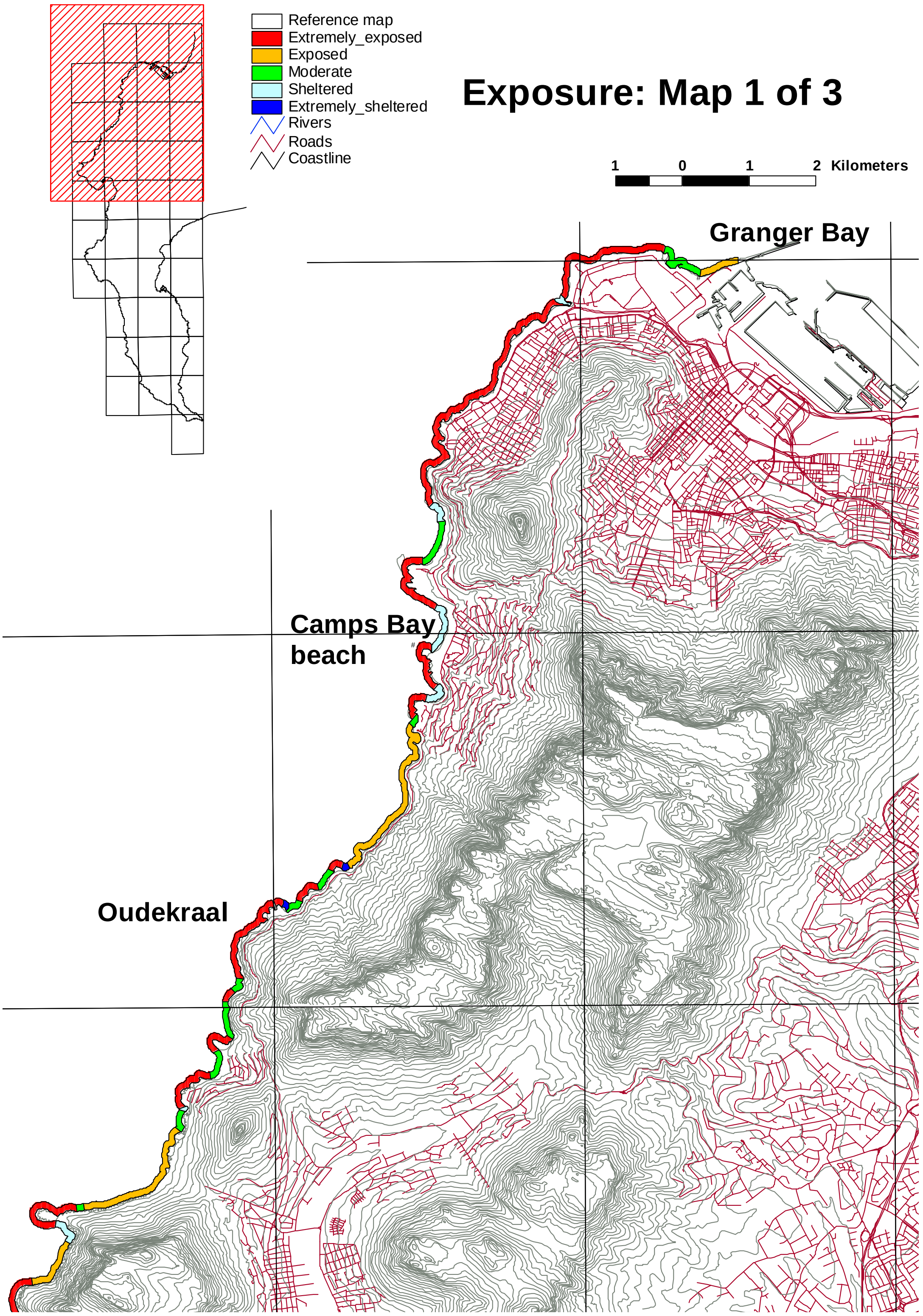


Figure 7 : Level of Exposure (Central Peninsula)

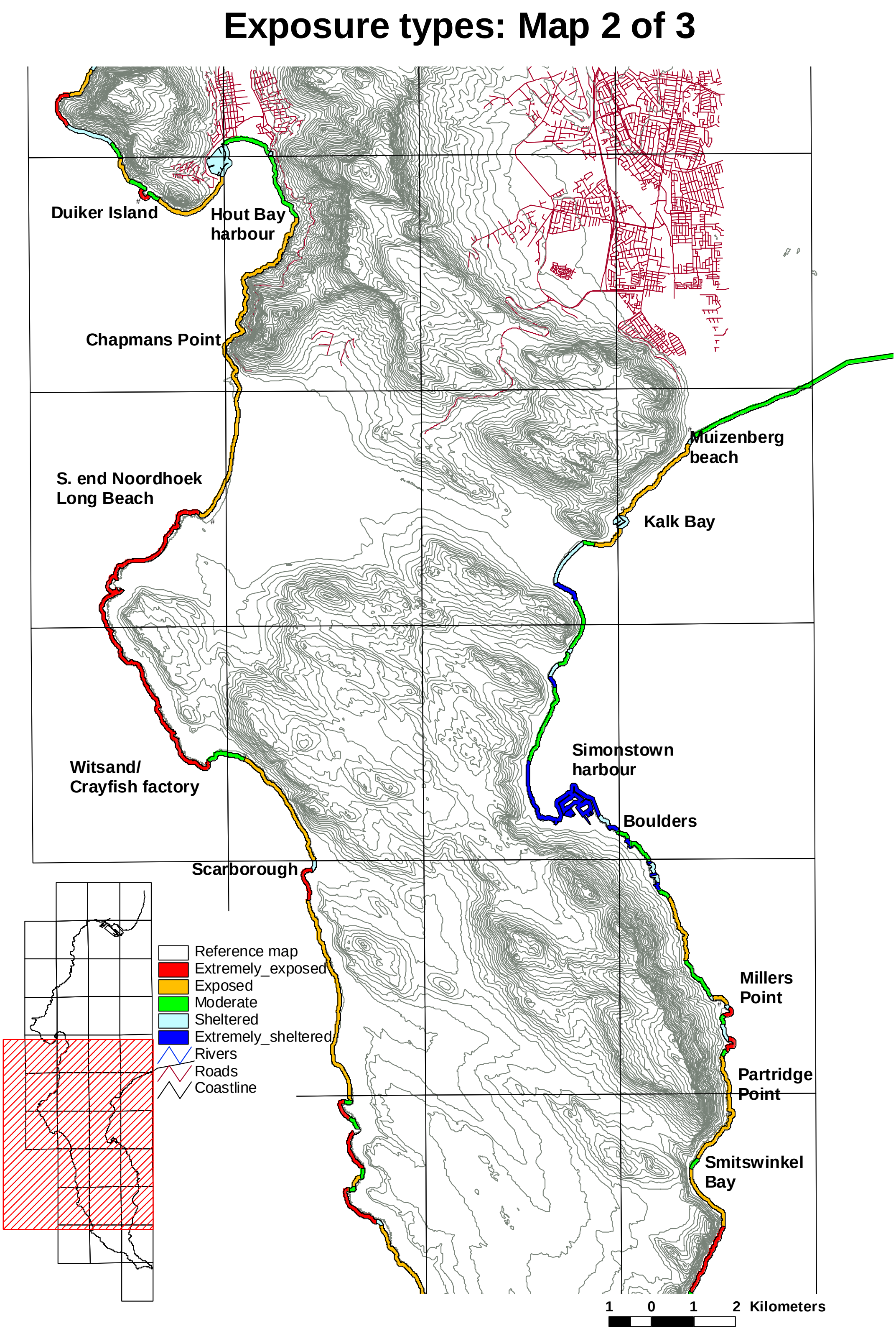
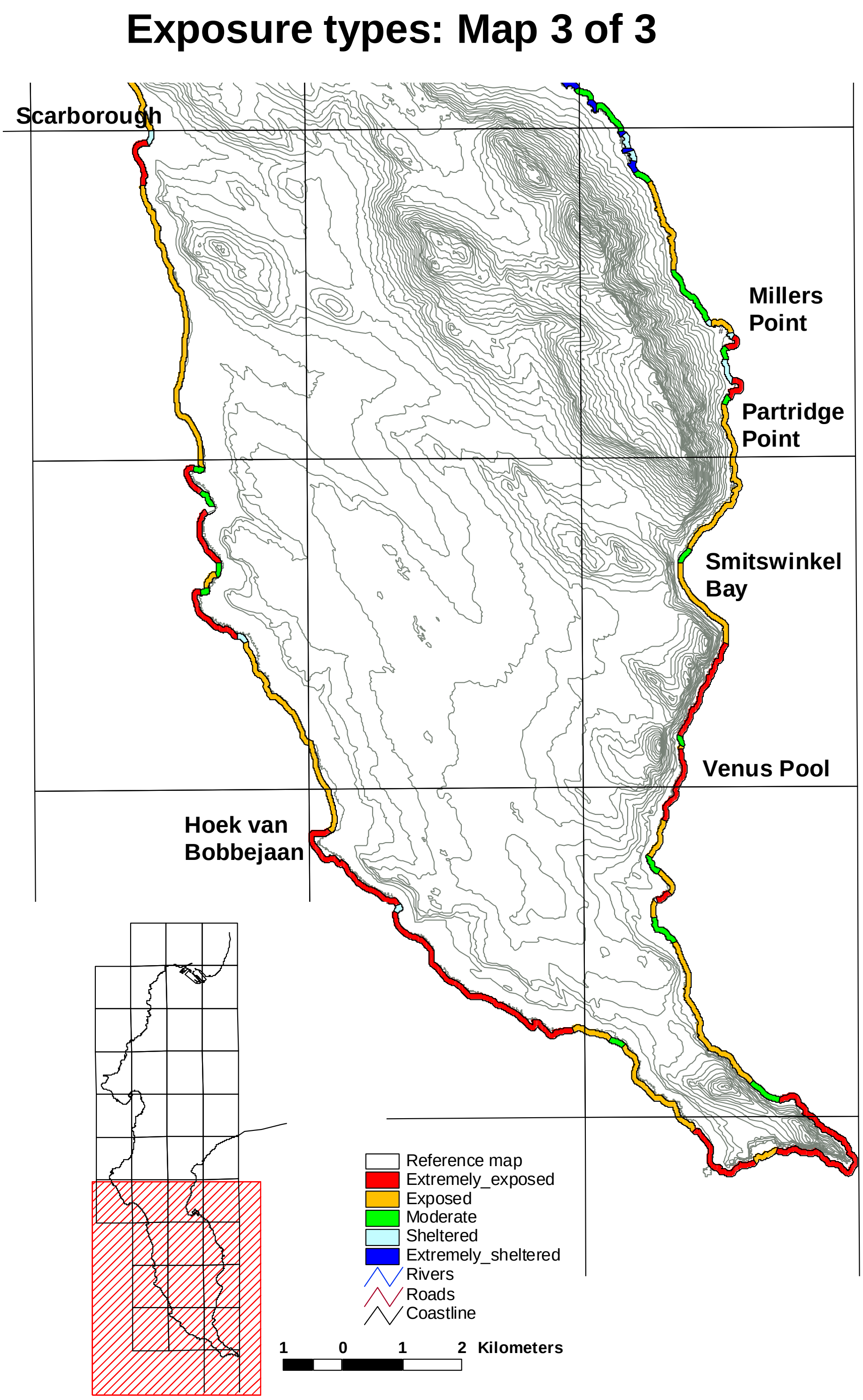


Figure 8 : Level of Exposure (Southern Peninsula)



4. RESULTS OF SPATIAL ANALYSES

4.1 Habitat Types

The length and percentage of shoreline composed of each habitat type are presented in Table 1. Of the entire coastline abutting the Cape Peninsula National Park, almost two thirds (66.3%) is composed of rocky substrata, 18.8% is sandy beach, and 4.2% is composed of mixed rocky and sandy substrata. Rocky habitats cover three quarters (74.3%) of the west coast, and only half (53.1%) of the False Bay coast. Sandy beaches contribute a larger percentage on the False Bay coast (23.9%) than on the west coast (15.8%). Ten percent (10.6%) of the total coastline is altered. The large percentage of altered coastline on the False Bay coast (19.7%) is largely due to Simon's Town Harbour and the railway line, which encroaches on the intertidal zone (Figures 3 – 5).

Table 1. *The length of shoreline abutting the Cape Peninsula National Park, which is, composed of the six habitat types. Totals for rock, sand, mixed substrata and "other" are presented in bold type.*

	Entire coast		**West coast**		**False Bay coast**	
Habitat type	Extent (km)	% of total shoreline	Extent (km)	% of total shoreline	Extent (km)	% of total shoreline
Rock	**66.3**		**74.3**		**53.1**	
Rock_solid	41.2		47.1		32.4	
Rock_boulder	16.4		24.0		7.2	
Rock_boulder_solid	8.8		3.1		13.5	
Sand	**18.8**		**15.8**		**23.9**	
Mixed	**4.2**		**4.8**		**3.2**	
Mixed_rock_sand	3.4		4.2		1.9	
Mixed_boulder_sand	0.8		0.6		1.2	
Other	**10.6**		**5.1**		**19.7**	
Altered	10.6		5.1		19.7	

4.2 Level of exposure to wave action

The length and percentage of shoreline, which receives different levels of exposure to wave action, are presented in Table 2. Almost two thirds of the total coastline abutting the Cape Peninsula National Park was rated as being exposed, with 19.8% being rated as moderate, and 16.7% as sheltered from wave action. In general, the west coast was more exposed (78.8% exposed) than the False Bay coast (32.4% exposed; Figures 6 – 8).

Table 2. *The length of shoreline abutting the Cape Peninsula National Park classified into five different levels of exposure to wave action. Totals for sheltered, moderate and exposed are presented in bold type.*

	Entire coast		**West coast**		**False Bay coast**	
Habitat type	Extent (km)	% of total shoreline	Extent (km)	% of total shoreline	Extent (km)	% of total shoreline
Sheltered	**16.7**		**8.9**		**29.8**	
Extremely_sheltered	7.7		0.2		20.2	
Sheltered	8.9		8.6		9.5	
Moderate	**19.8**		**12.2**		**32.4**	
Exposed	**63.5**		**78.8**		**32.4**	
Exposed	32.9		36.7		26.7	
Extremely_exposed	30.5		42.1		10.9	

SECTION III

1. IMPORTANCE OF MARINE RESERVES

The rapidly increasing density of humanity in coastal areas (Davis 1981) and the resultant increase in the intensity of human pressures on marine systems has increased the need for marine conservation (Allison *et al*. 1998). In recent years, the importance of marine reserves to the success of conservation efforts has become widely recognised and promoted (Roberts and Polunin 1993; Polunin and Roberts 1993; Agardy 1994; Childress 1997; Halpern in press). In particular, they are important for the management of exploited species because human harvesting often pushes targeted species below the level at which a natural predator would shift its focus to other prey (Davis 1981), and because other management methods have frequently failed (Bohnsack 1998). Reserve areas can play pivotal roles in the recovery of over-exploited stocks and sustain fishery yields (Polunin *et al*. 1983). They may also provide a source of recruitment to fished-out areas through long-shore migration of adults (Alcala and Russ 1990; Man *et al*. 1995). Furthermore, since reserves tend to contain individuals at both a higher density and of a larger mean size than adjacent exploited areas, recruitment elsewhere can be enhanced by the export of eggs or larvae (Bohnsack 1994; Man *et al*. 1995). An additional advantage of Marine Protected Areas (MPAs) is that they can be used to measure population parameters that cannot be obtained from exploited areas (Hockey and Branch 1994).

2. STATUS OF THE RESOURCES

Rock lobsters, abalone and alikreukel are all harvested around the Cape Peninsula. Sea urchins and kelp are currently not harvested on the Cape Peninsula, although Marine and Coastal Management have received requests for an experimental sea urchin fishery. Kelp is currently commercially harvested at only one location in the Cape Peninsula, in the Kommetjie region, by Kelp Products (PTY) Ltd. To the north and east of the Peninsula, Kelp is also harvested as feed for abalone on aquaculture farms. Given the current low levels of exploitation this resource does not appear to be under threat. There is a dearth of information regarding Kelp abundance, however, the Seaweed Research Unit at Marine and Coastal Management is currently assessing the abundance of kelp, using aerial photography (*pers* *comm. Anderson*). Due to their low commercial value and limited recreational use, data on the status of sea urchin and alikreukel resources in the Western Cape are limited. Quite the opposite is true for the rock lobster and abalone resources and these are dealt with in more detail below.

2.1 Status of the abalone resource

Per kilogram, abalone has one of the highest landed value of any of South Africa's marine resources. For the 1999/2000 season, the global total allowable catch (TAC) was 693 tons. Since then, improvements in stock assessment modelling have indicated both that the resource is currently at about 10% of its pristine (pre-exploited) level and that the current harvest level was unsustainable (estimates of sustainable yields were of the order of 300 tons). Consequently, the global TAC was reduced to 496 tons for the 2000/2001 season. Furthermore, Zone C, which lies between Hawston and Hermanus, was closed to all sectors (i.e. commercial, recreational and subsistence fishers). Of the 496 tons, 371 tons was allocated to the commercial industry, with 62.5 tons each being allocated to the recreational and subsistence sectors. This necessitated a reduction in the season length for recreational fishers to just 16 diving days and a reduced bag limit from 4 to 3 abalone per permit holder per day (*pers comm. Tarr*).

There are two principal threats to the survival of the abalone resource. Firstly, due to the high market value illegal harvesting (poaching) of abalone is rife. As an example of just how detrimental this illegal harvesting is, consider that between January and June 2000, 173 000 poached abalone (about 98 tons) was confiscated. For the first three months of 2001, just under 100 000 poached abalone have been confiscated (*pers comm. Mackenzie*). Estimates of the level of poaching range between 30% and 70% of the annual TAC, but could easily be much greater than the legal allocation. Secondly, a change in community structure starting in the early 1990's has led to a recruitment failure in the area between Cape Hangklip and Hermanus (Tarr *et al.* 1996). Juvenile (3-40mm shell length) abalone are dependent on sea urchins for their survival (Mayfield and Branch 2000a). These small abalone gain both protection from predation by living beneath the spiny canopy of the urchins and discarded algae as a direct consequence of the sea urchins messy eating habits. Since the early 1990's, the abundance of rock lobsters has dramatically increased in the area between Cape Hangklip and Hermanus, resulting in the decimation of the sea urchins, a favoured prey, (Mayfield and Branch 2000a) and consequent abalone recruitment failure.

2.2 Status of the rock-lobster resource

Current stock assessment methods suggest that the rock lobster resource is far below pristine levels. The most recent figures indicate that spawner biomass lies at about 6% and the fishable biomass (lobsters larger than 75mm carapace length) just 4% of pre-exploitation levels. Since 1988, for an as yet undetermined reason, rock lobsters have had a somatic growth rate about half that of the pre-1988 levels (Cockcroft and Goosen, 1995; Goosen and Cockcroft, 1995). As a direct consequence of this, the TAC has been annually reduced since the 1998/1999 season from about 4 000 tons then to just 2 018 tons for the 2000/2001 season. The well organised commercial fishery receives 80% of this TAC with the recreational and subsistence sectors receiving 9% and 11% respectively. This year, about 1700 subsistence permits have been issued. Poaching is a problem for this resource, and current estimates suggest it to be in the region of 400 tons per annum, though some believe this to be an underestimate.

At first glance, it would seem that rock lobsters are adequately protected – there are three dedicated rock lobster sanctuary areas on the West Coast (*viz*. The St Helena Bay, Saldanha Bay and Table Bay rock-lobster sanctuaries). However, research conducted over a two year period between 1998 and 2000 suggested that these sanctuary areas contain substantially fewer rock lobsters than surrounding, fished, areas (Mayfield and Branch 2000b). More recently, the survey on which this report is based suggested quite the opposite, and consequently in the forthcoming 12 months an attempt will be made to repeat the surveys.

3. DISTRIBUTION OF RESOURCES ON THE CAPE PENINSULA

3.1 Methodology

During December 2000 and January 2001, 163 sites between the Cape Town harbour and Muizenberg beach were surveyed (Figures 9 - 11). The distribution and abundance of exploited species abalone, rock lobster and alikreukel was assessed by diver counts along underwater transects (Figures 12 – 14). Random sites in rocky reef areas between 3m and 10m water depth were surveyed at roughly 500m intervals along the Peninsula coastline. Three separate 10m transect counts were surveyed at each site and the numbers of abalone, rock lobster and alikreukel recorded (Figures 12 – 14). These transects were carried out along a single line perpendicular to reef formations to avoid pseudo-replication. Details of reef characteristics (reef height, composition and mean cave size) at each site were recorded by the divers and compared with the habitat type characterisation described in Section II. The location of each site were accurately fixed using GPS and local markers to allow repeated sampling in the future (Appendix I & II).

Four commercially qualified divers including a commercial skipper, conducted the diver surveys from a boat, with the divers alternating dives. One diver was used per site.

At each site, a SCUBA diver descended to the sea floor at a depth of less than 10m and counted rock lobsters, abalone, alikreukel, kelp and sea urchins along three 10m transects, each transect being 1m wide (thus each transect covered $10m^2$). In order to minimise disturbance and counting errors, rock lobsters (and urchins) were counted on the outgoing survey of the three transects. Abalone and alikreukel were counted on the return survey along each transect and numbers were written onto an instruction sheet given to each diver at the start of each transect (Appendix I). In addition, an estimate was also made of the percentage of abalone and rock lobsters exceeding the legal size limit. This database will be extremely useful for comparison with future surveys when an analysis of the success of the proposed reserve network is evaluated. The survey information collected by each diver was recorded on a prepared dive slate, and this information transcribed onto a data sheet (Appendix II) once back on the boat.

As the three transects completed at each site were not independent samples, the mean of the three transects completed at each site and for each species was determined and the coast divided up into sensible units for statistical analysis. The abundance of the five species surveyed across the different sections of the coastline were compared using the non-parametric Kruskal-Wallis Analysis of Variance (ANOVA) by ranks (with the significance level (α) set at 0.05) due to the fact that for some sections of the coast few data points are available, and the data do not meet the criteria (normality and homogeneity of variance) to permit parametric statistics. For each species where the ANOVA demonstrated significant differences between sections of the coast, the data were further subjected to a Tukeys Honestly Significantly Different (HSD) test to elucidate which of the sections were significantly different from each other.

Figure 9 : Location of dive sites undertaken during this survey (Cape Town and the Northern Peninsula)

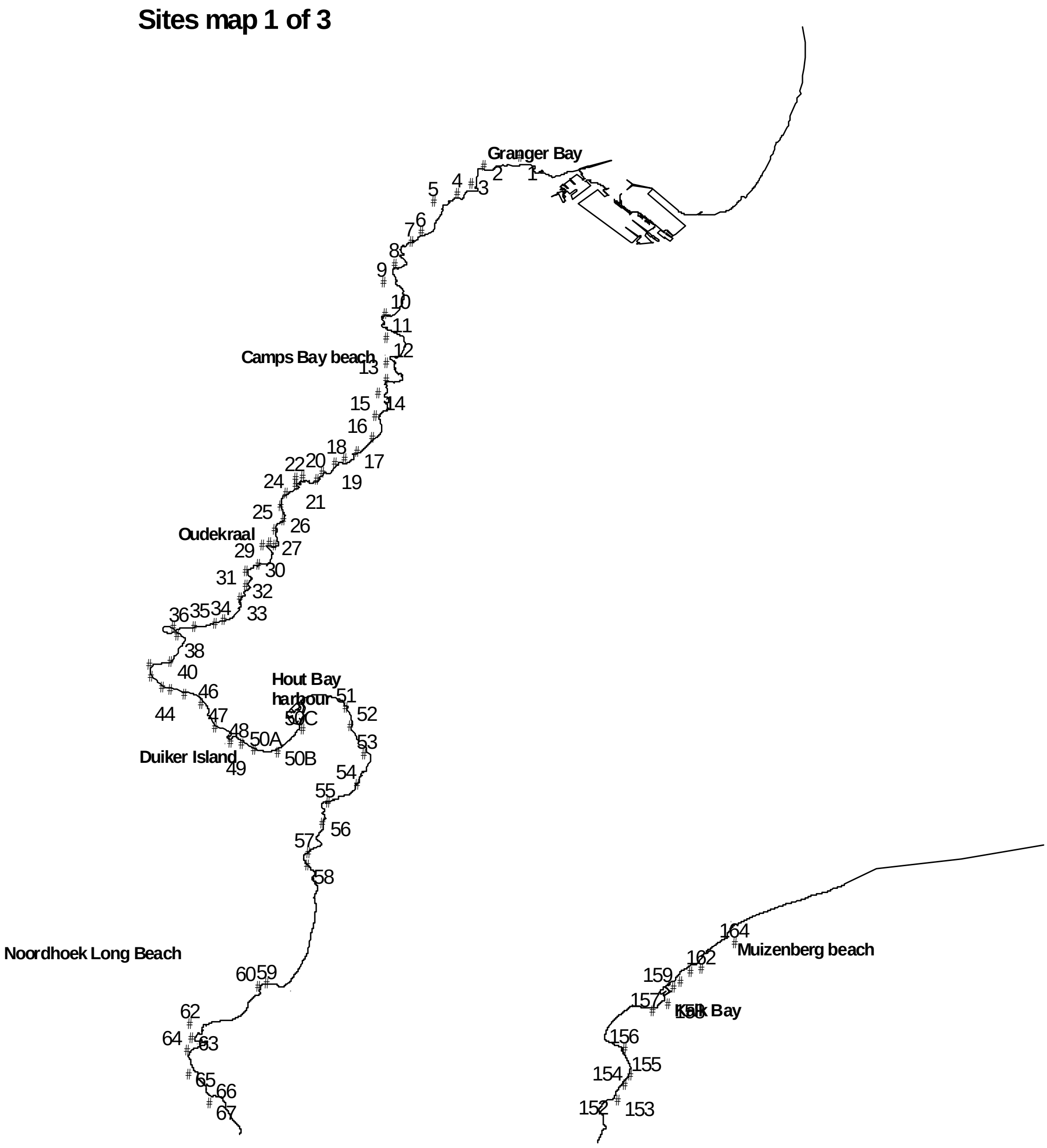


Figure 10 : Location of dive sites undertaken during this survey (Central Peninsula)

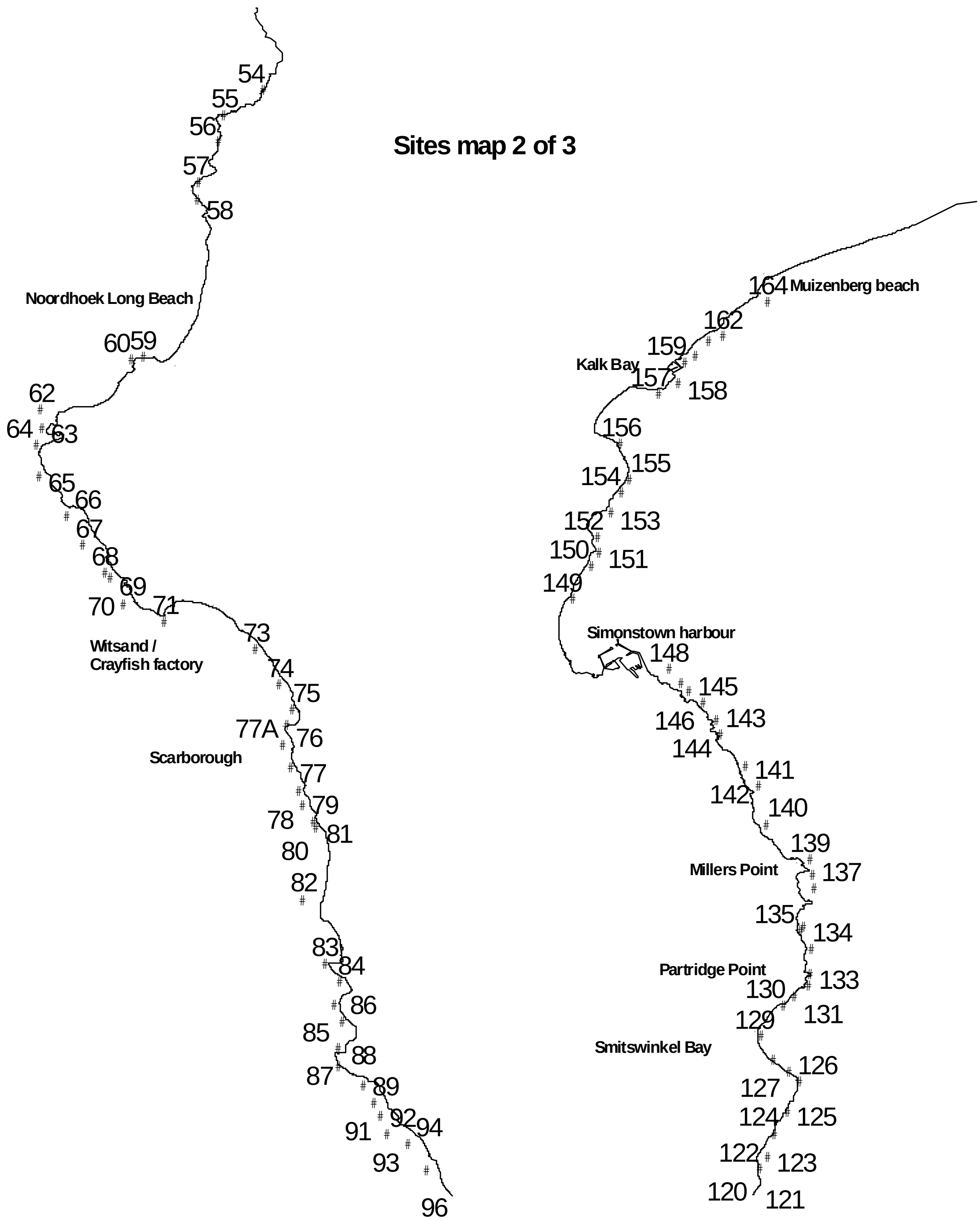


Figure 11 : Location of dive sites undertaken during this survey (Southern Peninsula)

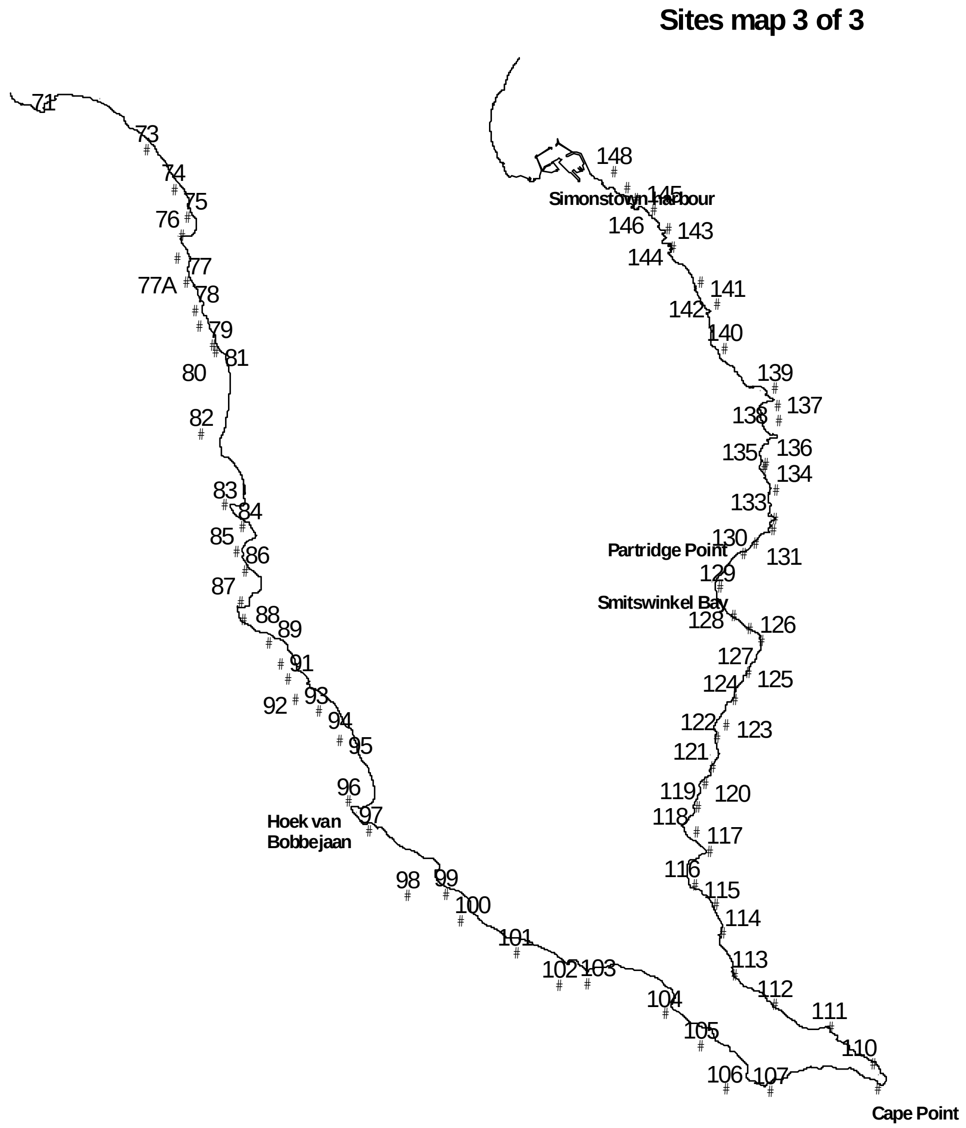


Figure 12 : Distribution and abundance of Abalone assessed from diver counts along underwater transects. Dots represent total count per site.

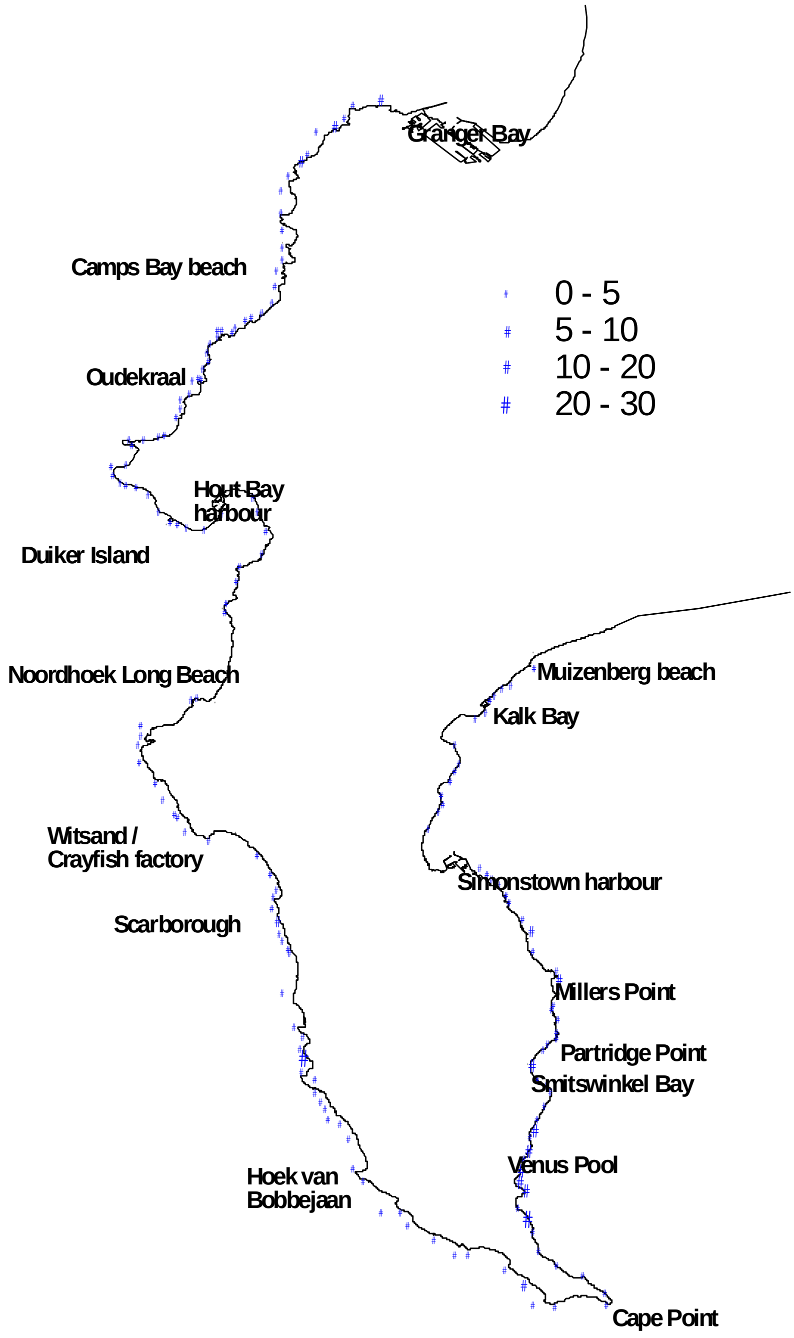


Figure 13 : Distribution and abundance of Rock Lobster assessed from diver counts along underwater transects. Dots represent total count per site.

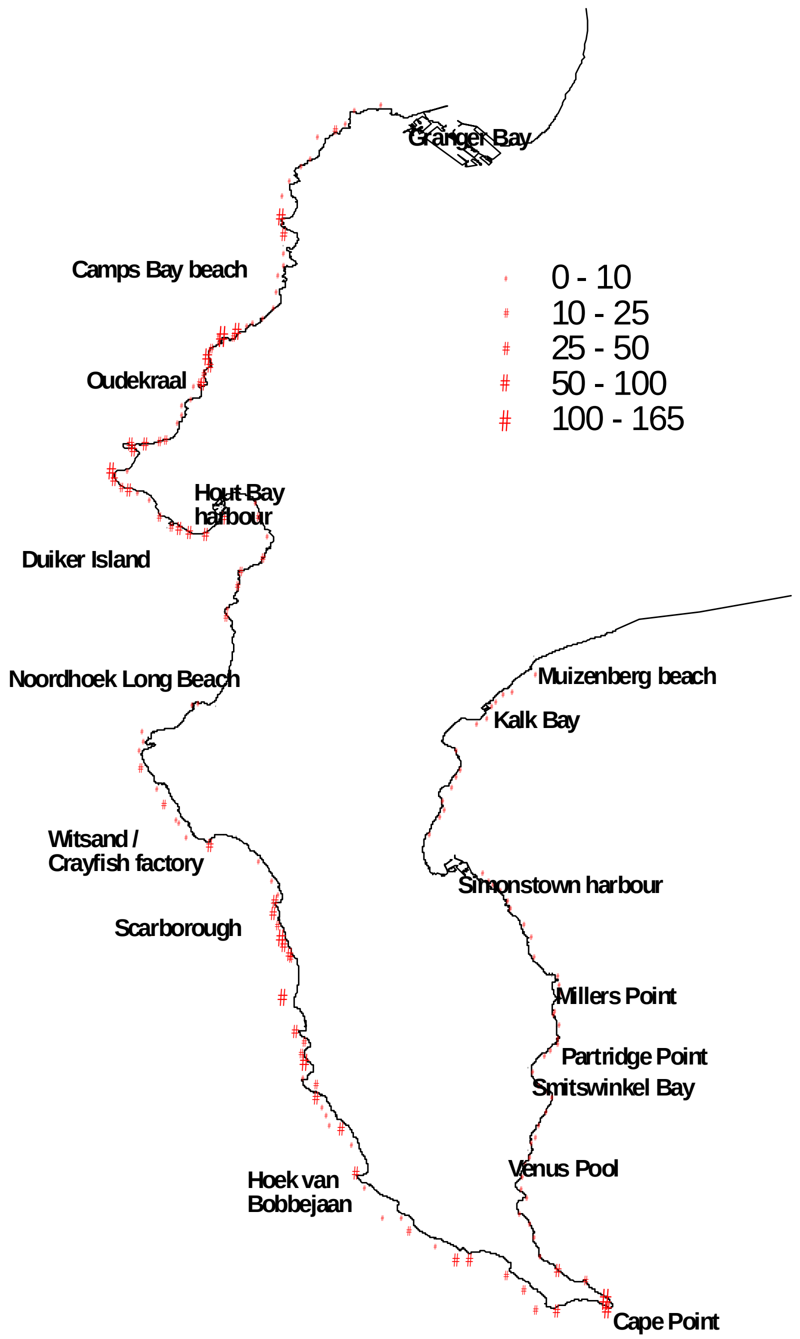
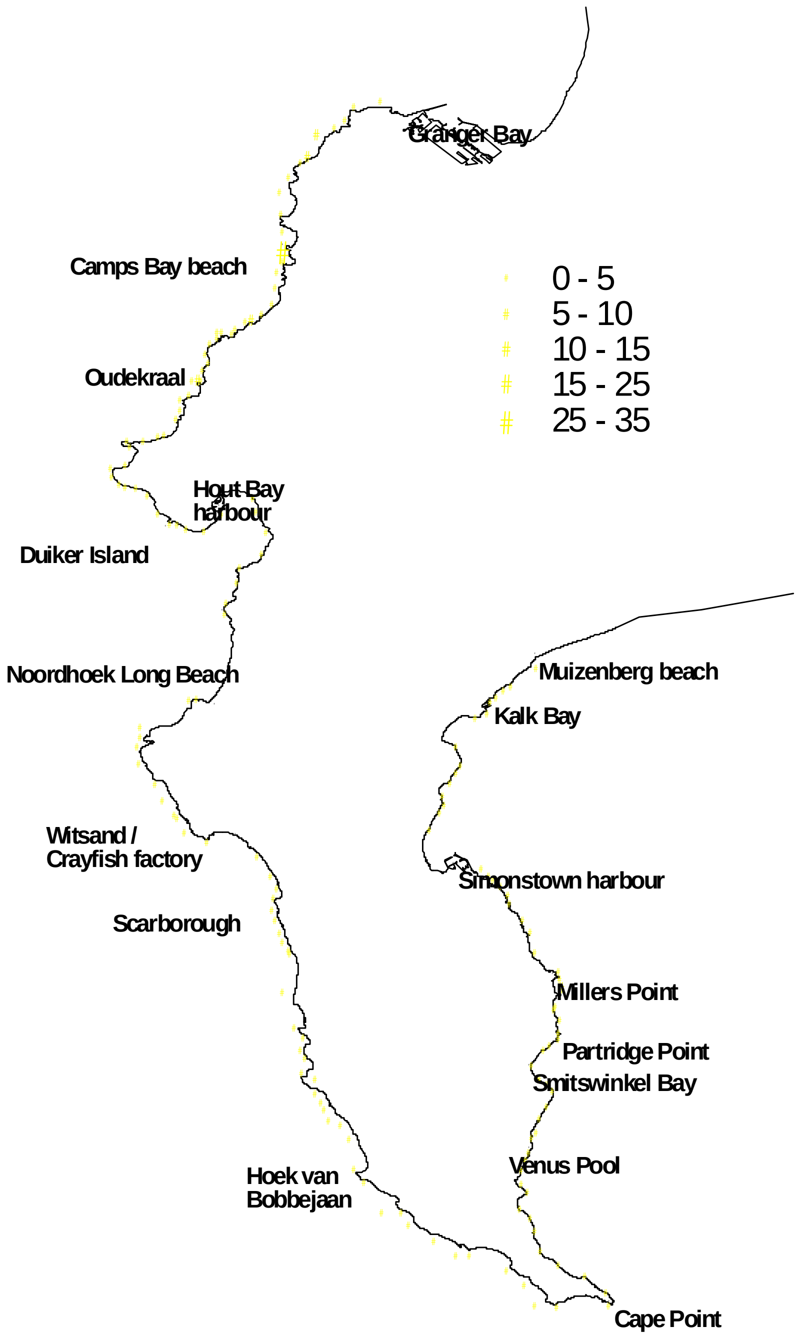


Figure 14 : Distribution and abundance of Alikreukel assessed from diver counts along underwater transects. Dots represent total count per site.



3.2 Results

Kelp was encountered in each of the sections of the coast (Figure 15; Graph 1), and there were no significant differences in kelp abundance between areas ($\chi^2 = 12.4$, df = 9, $P > 0.05$). Furthermore, there was no clear pattern of kelp being more or less abundant in areas from which it may not be harvested – most certainly this arises from the fact that kelp is not harvested by any user groups on the Cape Peninsula. Anecdotal reports (Seaweed Research Unit, Marine and Coastal Management) suggest that the abundance of kelp in the shallow waters around the Cape Peninsula increased over recent decades possibly due to increased nutrient levels.

Graph 1 : Abundance of kelp within existing MPAs and exploitable areas.

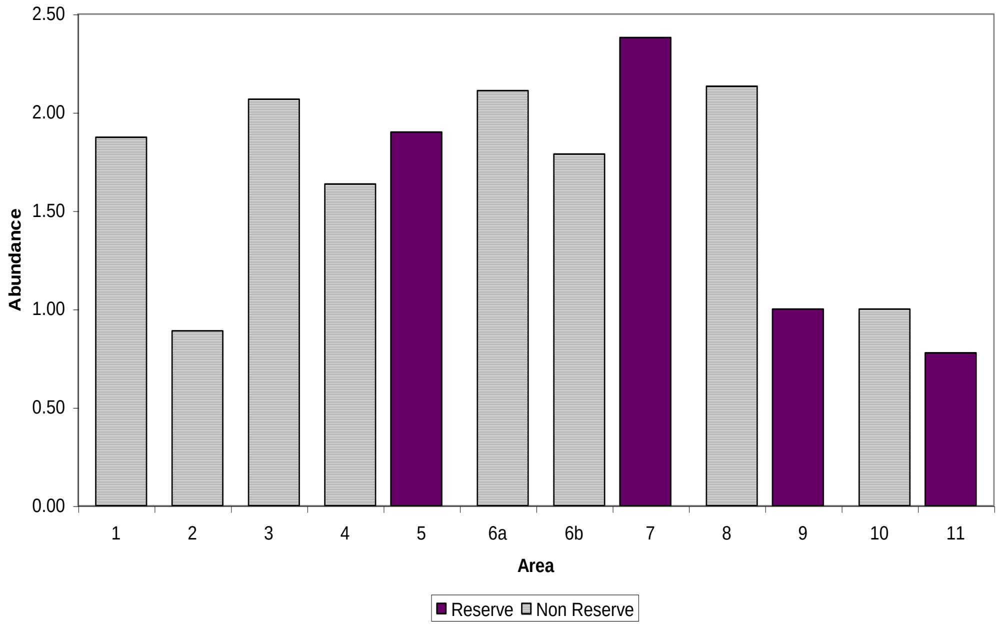


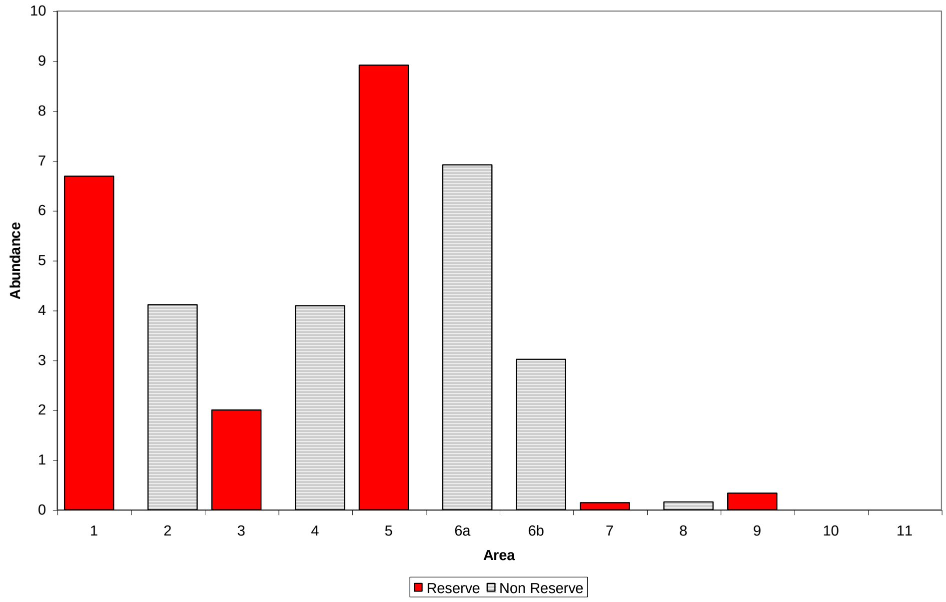
Table 3: Protection offered by existing and proposed MPAs

Existing reserves					
	rock lobster	sea urchin	abalone	kelp	alikreuk
in reserve	578.33	13.33	18.67	60.00	5.67
out reserve	209.00	98.00	79.00	239.33	45.33
total	787.33	111.33	97.67	299.33	51.00
% in reserve	**73.45**	**11.98**	**19.11**	**20.04**	**11.11**
Existing proposal					
	rock lobster	sea urchin	abalone	kelp	alikreuk
in reserve	473.33	45.00	49.33	152.67	11.67
out reserve	314.00	66.33	48.33	147.33	40.00
total	787.33	111.33	97.67	300.00	51.67
% in reserve	**60.12**	**40.42**	**50.51**	**50.89**	**22.58**
Increased protection by changing reserve siting	**0.82**	**3.38**	**2.64**	**2.54**	**2.03**
Alternative 1: Include 106-138 as reserve					
	rock lobster	sea urchin	abalone	kelp	alikreuk
in reserve	578.00	51.00	73.33	178.33	18.33
out reserve	209.33	60.33	24.33	121.67	33.33
total	787.33	111.33	97.67	300.00	51.67
% in reserve	**73.41**	**45.81**	**75.09**	**59.44**	**35.48**
Increased protection over existing reserves	**1.00**	**3.83**	**3.93**	**2.97**	**3.19**
Increased protection over existing proposal	**1.22**	**1.13**	**1.49**	**1.17**	**1.57**
Alternative 2: Include 106-138 as reserve and retain WCRL sanctuary					
	rock lobster	sea urchin	abalone	kelp	alikreuk
in reserve	677.00	51.00	73.33	178.33	18.33
out reserve	110.33	60.33	24.33	121.67	33.33
total	787.33	111.33	97.67	300.00	51.67
% in reserve	**85.99**	**45.81**	**75.09**	**59.44**	**35.48**
Increased protection over existing reserves	**1.17**	**3.83**	**3.93**	**2.97**	**3.19**
Increased protection over existing proposal	**1.43**	**1.13**	**1.49**	**1.17**	**1.57**
Increased protection over Alternative 1	**1.17**	**1.00**	**1.00**	**1.00**	**1.00**

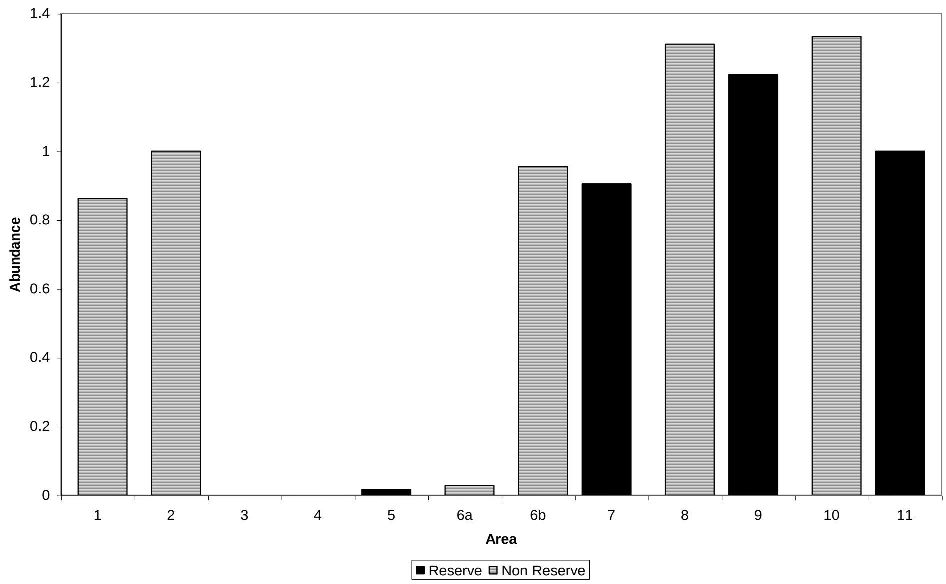
Although there were significant differences in abundance between the coastal areas for the other four species surveyed (rock lobsters (χ^2 = 50.43, df = 9, P < 0.05), sea urchins (χ^2 =

48.76, df = 9, $P < 0.05$), abalone ($\chi^2 = 30.09$, df = 9, $P < 0.05$) and alikreukel ($\chi^2 = 48.23$, df = 9, $P < 0.05$), there was no clear pattern of even the abundance of exploited species being greater inside the reserve areas (Figure 15; Graphs 2 - 5). This was particularly obvious for sea urchins.

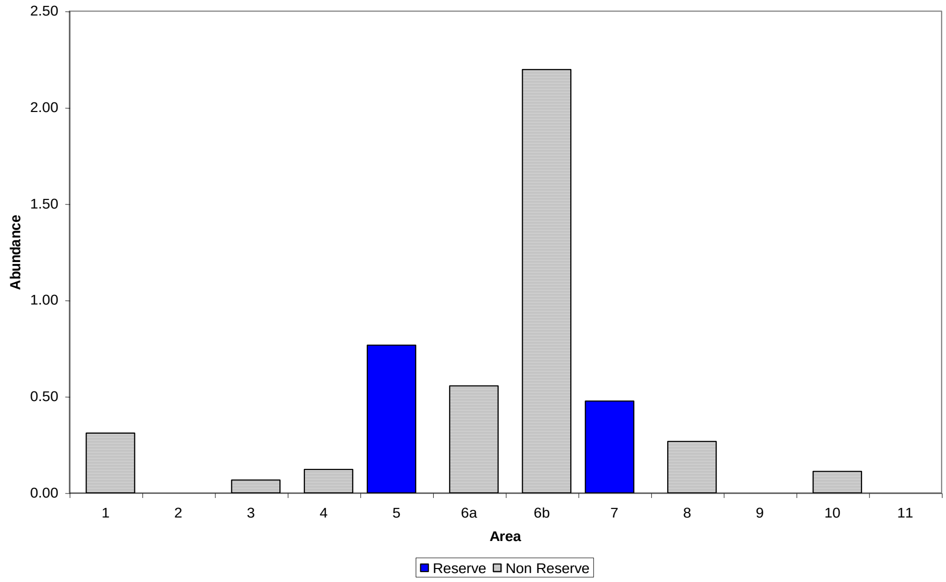
Graph 2 : Abundance of rock lobsters within existing MPAs and exploitable areas.



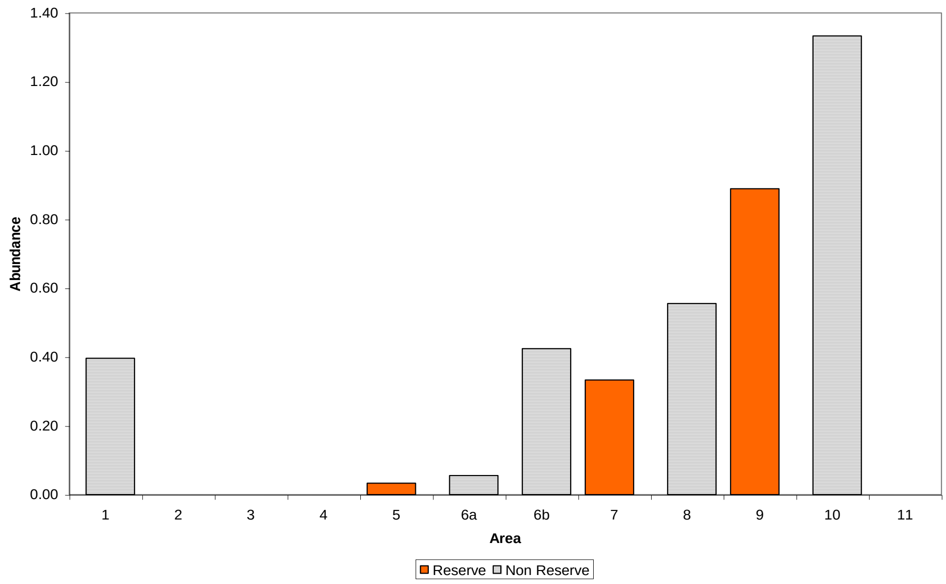
Graph 3 : Abundance of sea urchins within existing MPAs and exploitable areas.



Graph 4 : Abundance of abalone within existing MPAs and exploitable areas.



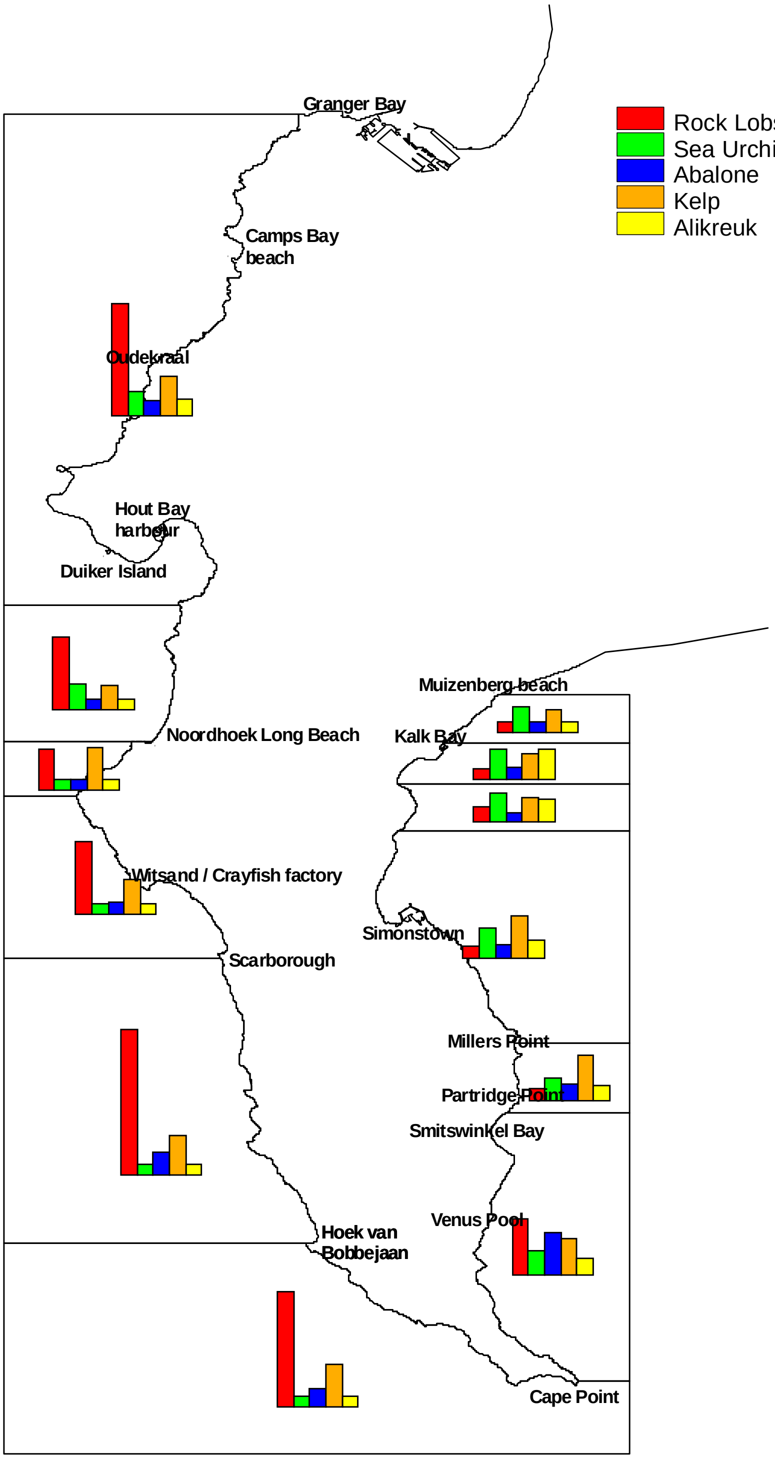
Graph 5 : Abundance of alikreukel within existing MPAs and exploitable areas.



The greatest abundance of rock lobsters was found in Area 5 (Figures 1 and 15; Graph 2), the Cape of Good Hope Marine Reserve, though the next most abundant was found in Area 6a, the area just West of Cape Point. Rock lobsters were scarce in False Bay (Areas 7 – 11). The high abundance of rock lobsters in Area 1, the Table Bay rock lobster sanctuary is surprising given previous research (Mayfield and Branch 2000b), though their low abundance in False Bay anticipated because this area is typically several degrees warmer than the areas on the West Coast.

With the exception of the Areas 3 – 6a, sea urchins were common (Figures 1 and 15; Graph 3). The lack of sea urchins between Kommetjie and Cape Point is probably explained by the abundance of rock lobsters in these areas – rock lobsters are voracious predators, well capable of controlling the abundance of their prey. Abalone were at least twice as abundant in Area 6b when compared to other sections of the coast (Figures 1 and 15; Graph 4). This is most likely due to a combination between the difficulty in accessing this stretch of the coastline from the landward side, and the low frequency with which prevailing sea conditions permit diving in this area. Extremely few alikreukel were encountered on the West Coast (Areas 1 – 6a, Figures 1 and 15; Graph 5), though abundance did increase markedly with increasing distances north of Cape Point and inside False Bay. This species occurs in greatest densities on the South Coast of South Africa; thus their near absence on the West Coast is in line with their established distribution pattern.

Figure 15 : Abundance of Rock Lobster, Sea Urchin, Abalone, Kelp and Alikreukel communities in relation to existing MPA network



4. EVALUATION OF THE EXISTING MARINE PROTECTED AREA NETWORK

The current network of protected areas on the Cape Peninsula includes rock-lobster sanctuaries (within which just rock lobsters are protected) and marine reserves (within which most species, including rock lobsters, are protected). In order to assess the success of the current reserve network at a basic level, the total of each species found in areas where it receives protection was compared to the total for each species in areas where exploitation is permitted. Of all the rock lobsters encountered through the entire survey, 73.5% were counted in areas within which they currently receive protection (Figures 1 and 15). This is an extremely high value, but it must be remembered that this is a resource under immense pressure, especially given the current slow growth rate.

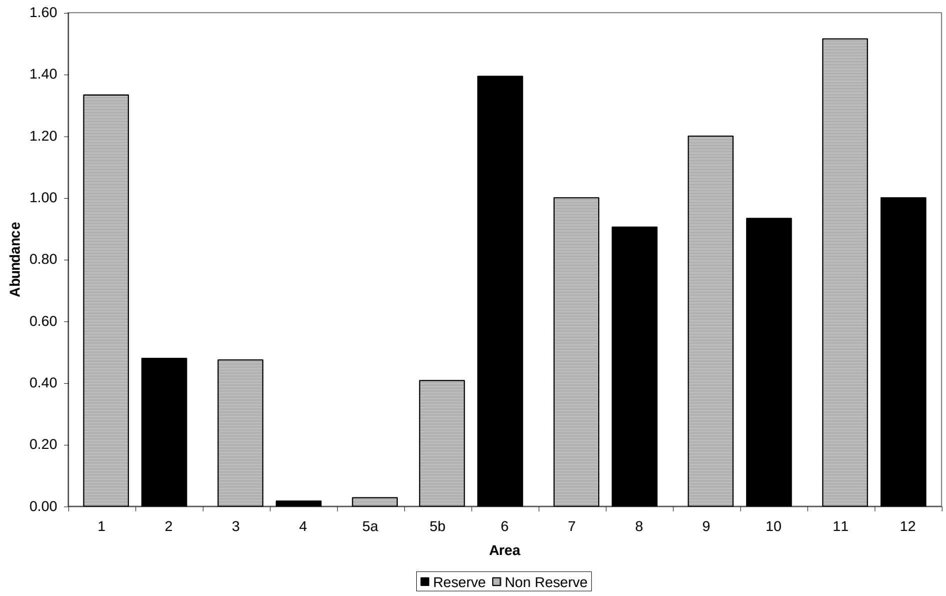
The figures are substantially smaller for the other four species, with estimates of the proportions receiving protection ranging between 11 and 20%. Current levels of exploitation of kelp are very low and abundance appears to be increasing (*pers comm. Anderson*). These figures are most worrying for abalone – a resource under tremendous pressure in other parts of the Western Cape, for sea urchins – due to the high dependence placed on them by juvenile abalone (Mayfield and Branch 2000a) and for alikreukel – a resource becoming increasingly desired by recreational divers.

Given that the future of fishing in South Africa is likely to include more fishers demanding greater access to dwindling resources, careful planning is required to ensure sustainable management of these, and other, resources for future generations.

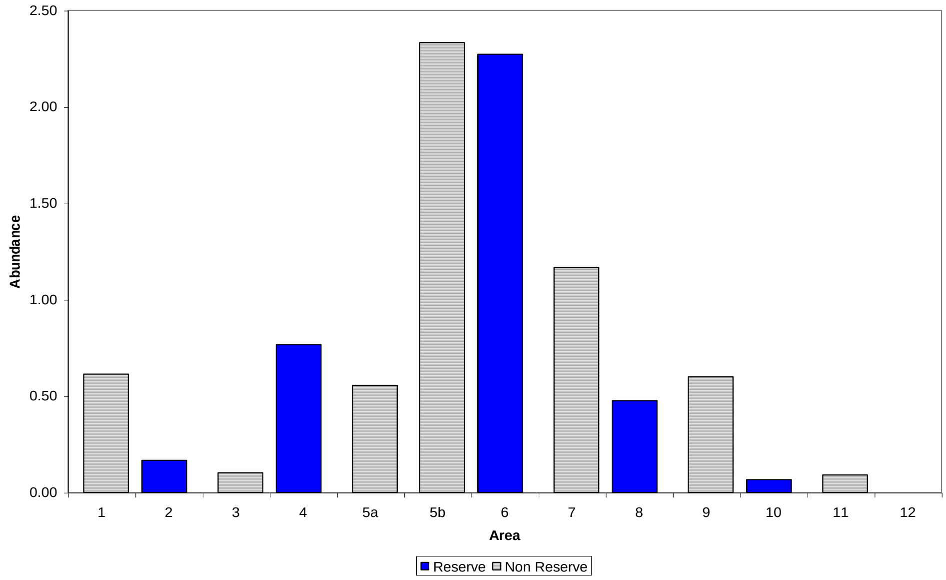
5. EVALUATION OF THE PROPOSED MARINE PROTECTED AREA NETWORK

The proposed Marine Protected Area network will significantly improve the conservation status of sea urchins (χ^2 = 50.14, df = 9, P < 0.05; Figure 16; Graph 6), abalone (χ^2 = 32.59, df = 9, P < 0.05; Figure 16; Graph 7), kelp (χ^2 = 13.96, df = 9, P < 0.05; Figure 16; Graph 8), and alikreukel (χ^2 = 39.76, df = 9, P < 0.05; Figure 16; Graph 9). The minimum increase for any of these species is a two-fold increase, though the increase is substantially greater than two for sea urchins and abalone (Table 3). However, of concern is that the proposed network will result in a 20% decrease in the protection level afforded to rock lobsters (Figure 16; Graph 10). Although at first glance it may appear that species are adequately protected (50% or so of current biomass protected for abalone and rock lobster), it must be recognised that especially for abalone and rock lobster, where overall biomass levels are only about 5 – 15% of pristine levels, conserving 20% of what is left is inadequate. Realistically one should aim to protect about 10% of the pristine stock.

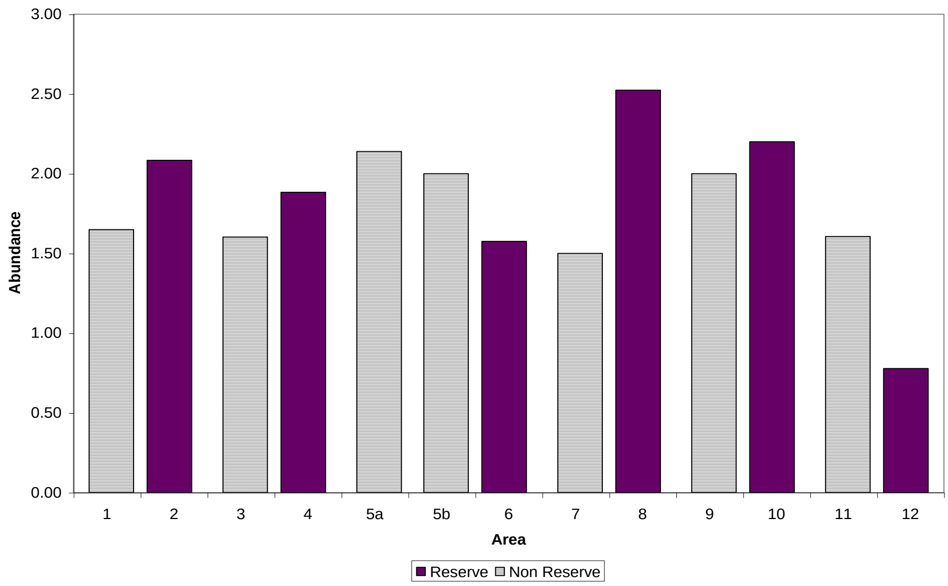
Graph 6 : Abundance of sea urchins in the proposed MPAs



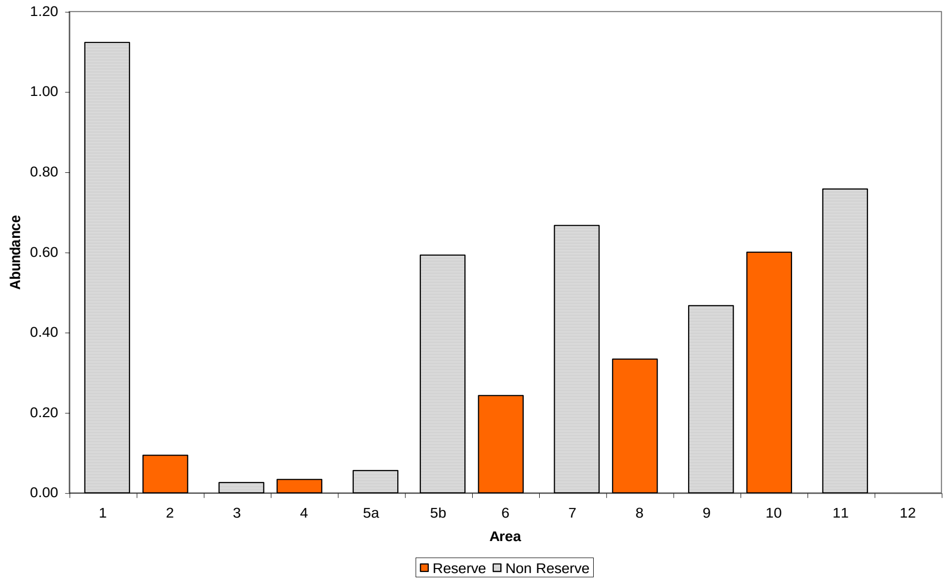
Graph 7 : Abundance of abalone in the proposed MPAs



Graph 8 : Abundance of kelp in the proposed MPAs



Graph 9 : Abundance of alikreukel in the proposed MPAs



Graph 10 : Abundance of rock lobster in the proposed MPAs

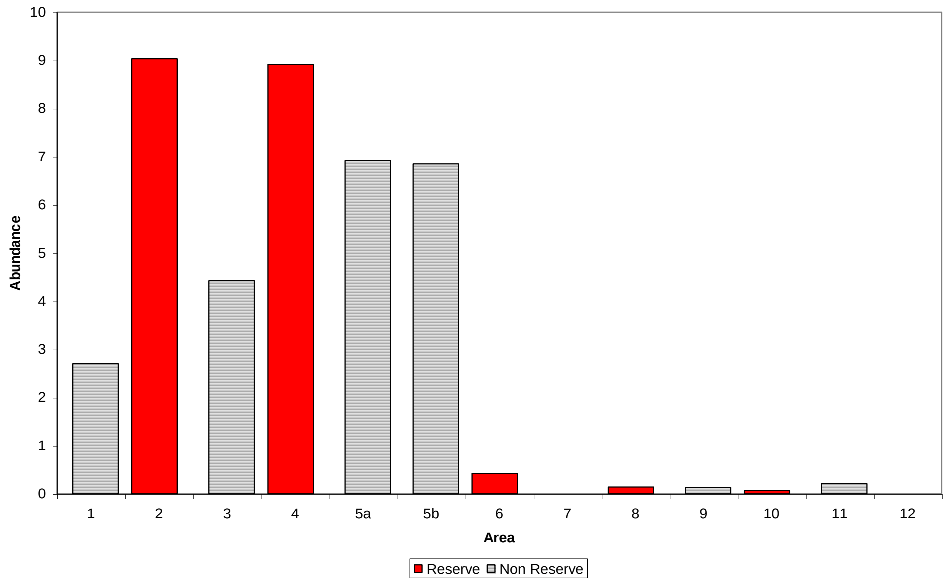
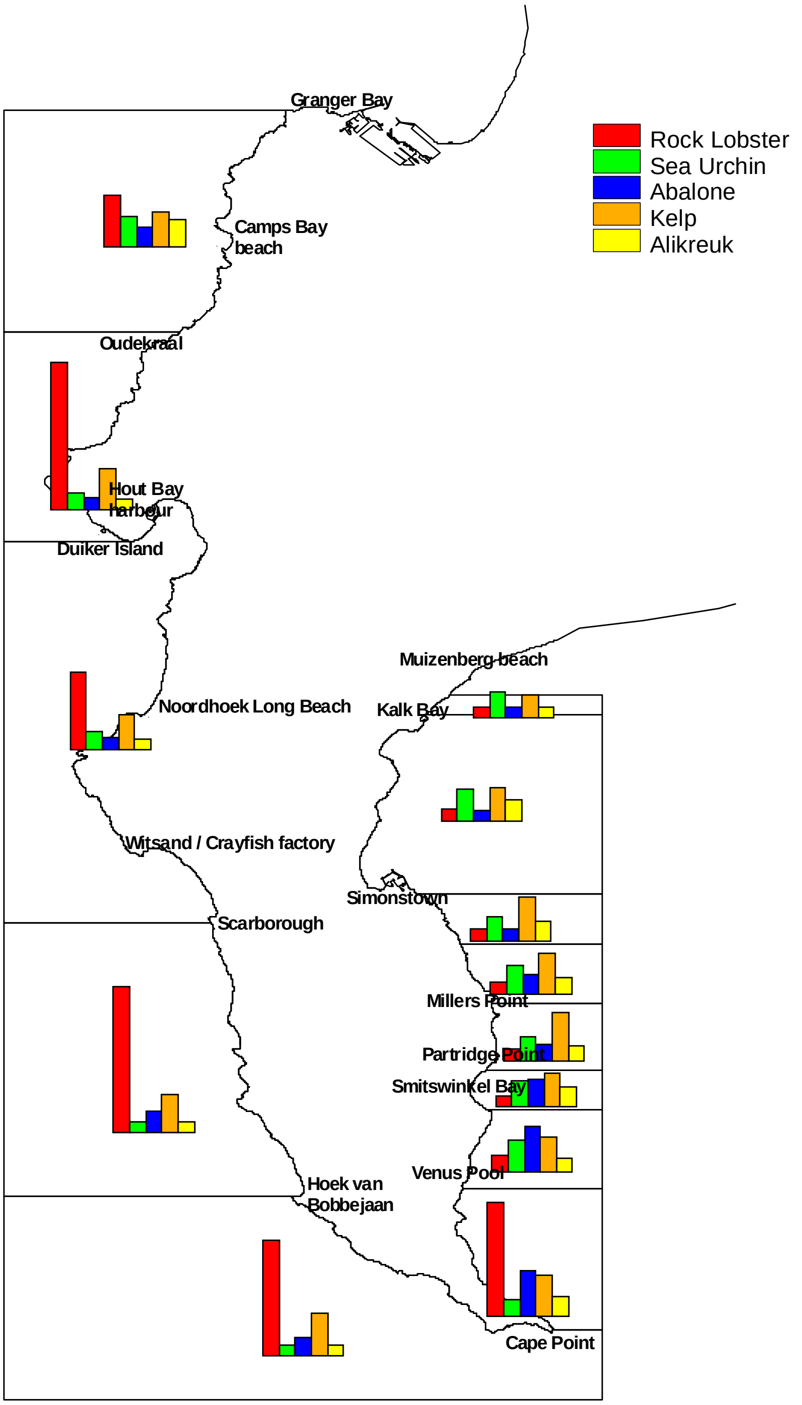


Figure 16 : Abundance of Rock Lobster, Sea Urchin, Abalone, Kelp and Alikreukel communities in relation to proposed MPA network



5.1 Alternative proposals

In order to establish where each species was most abundant, the average abundance at each site was calculated and the sites ranked in descending order. Thereafter, logical groupings were determined such that a contiguous stretch of coastline contained large numbers of these resources. On analysis, it was apparent that the most obvious place to establish a marine reserve would be to have it extend from Maclear Beach to Millers Point (Figure 2 - Alternative 1). This would substantially improve the conservation status of the species surveyed. By adding this area into the existing proposal, a 50% increase in the protection of both abalone and alikreukel and a 20% increase in the protection of rock lobsters is achieved (Table 3 – Figure 16). Furthermore, this area incorporates Cape Point – one of South Africa's premier tourist destinations.

For species found on the Cape Peninsula, rock lobsters are probably second only to abalone in their need for conservation (Mayfield and Branch 2000b). With the resource estimated to be at 4% of pristine and with the current somatic growth rate greatly depressed by historical standards, rock lobsters need all the protection that they can be afforded. Furthermore, because scientific opinion on the value of the Table Bay rock-lobster sanctuary is divided (Mayfield and Branch 2000b), it makes sense to continue assessing the role this sanctuary plays in the management of the rock-lobster resource prior to any motivation for it to be deregulated. According to the data presented here, retaining this rock-lobster sanctuary in addition to Alternative 1 (Alternative 2) will give 43% more protection to rock lobsters (over the existing proposal), and 17% over Alternative 1.

Although the proposed Boulders Beach marine reserve protects very few of the exploited species assessed here (Figures 2 and 15; with the single exception being alikreukel), it is an extremely popular tourist destination. It is therefore suggested by the author (S. Mayfield) that a marine reserve be established in this area. The area contains a wide diversity of substrata (Figure 4; sand, rock and mixed areas) making it potentially an extremely useful marine reserve for the conservation of biodiversity.

It is further suggested (S. Mayfield) that the Glencairn and Kalk Bay marine reserves (Figure 1) be de-proclaimed should the proposed fish survey also demonstrate them to be having limited conservation importance. These invertebrate data suggest that these reserves afford protection to extremely few exploited invertebrates and if there is a maximum limit to the number or size of the proposed Marine Protected Areas, it is suggested that these areas be sacrificed in exchange for another, more productive area. Furthermore, they are not considered prime tourist areas.

SECTION IV

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APPENDIX I : Diver Survey Instruction Sheet.

Transects

- 3-10 m depth
- 3 x 10m transects per site in a line, 1 m width
- 1 site per 500 m on rocky reef
- Record GPS position of each site
- Transects to run across reef

Depth

- Record on way out
- Record depth at start of each 10 m section

Rock Lobsters

- Record on way out
- Record no. of lobsters in each 10 m section
- Estimate proportion undersize (<80 mm carapace length) in each 10 m section

Urchins

- Record on way out
- Score 0-3 for each 10 m section
- Score 0 = 0 m^{-2}
  1 = 1-9 m^{-2}
  2 = 10-50 m^{-2}
  3 = >50 m^{-2}

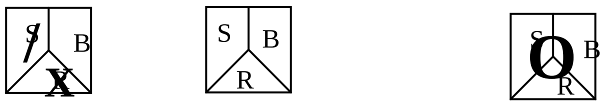
Kelp

- Record on way out
- Score 0-3 for each 10 m section
- Score 0 = 0 m^{-2}
  1 = 1-2 m^{-2}
  2 = 3-5 m^{-2}
  3 = >5 m^{-2}

Reef-type

- Record on way out
- Indicate presence of Sand/Boulder/Rock
- E.g.

Rock   Rock + Boulder   Rock + Boulder + Sand



Caves

- Record on way out
- For each 10 m transect score average cave size on scale of 0-3
- Score 0 = none

    1 = fist sized

    2 = head size

    3 = body size

Reef height

- Record on way out
- Height difference between highest & lowest point on each 10 m section

Abalone

- Record on way back
- Estimate no. abalone in each 10 m section
- Estimate proportion undersize (<114 mm) in each 10 m section

Alikreukel

- Record on way back
- Estimate no. alikreukel in each 10 m section
- Estimate proportion undersize (<114 mm) in each 10 m section

APPENDIX II: Diver Survey Site Data Sheet

The survey information collected by each diver was recorded on a prepared dive slate, and this information transcribed onto a data sheet (below) once back on the boat.

Diver name:		Date:	
Site number:		GPS Coordinates	
Transect no.	1	2	3
Depth (m)			
Rock Lobster (no.)			
% Undersize			
Urchin (0-3)			
Kelp (0-3)			
Reef type (R/B/S)			
Caves (0-3)			
Reef height (m)			
Abalone (no.)			
% Undersize			
Alikreukel (no.)			