TOWARDS A NEW APPROACH FOR COASTAL GOVERNANCE WITH AN ASSESSMENT OF THE PLETTENBERG BAY SHORE-BASED LINEFISHERY.

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By

Claire Margaret King

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Lastly, I would like to thank my mum for her support in every way and granting me the opportunity to obtain a tertiary education, Thanks mum!

ABSTRACT

The overall aim of this thesis, as required by the funders, was to provide research that would contribute towards the development of a bay management plan, specifically information on the local fisheries. The thesis therefore includes an assessment of the local shore-based linefishery in terms of catch and effort and socio-economics, and the development of indicators from this information with which to assess the sustainability of the fishery. Finally an implementation strategy for an integrated coastal management approach for local resource governance is proposed

The shore-based linefishery of Plettenberg Bay was assessed through a combination of roving creel and access point surveys which included questions aimed at the quantification of total effort, total catch and *cpue*, as well as the spatial trends in catch and effort. Angler demographics as well as opinions and knowledge of current fisheries regulations were obtained and the efficiency of the fishery inspectorate was assessed. The survey period extended from August 2003 to September 2004 during which 1189 angler interviews were conducted. Catch data obtained during this study was compared to catch data gathered during a research tagging program conducted in an area closed to fishing (Tsitsikamma National Park) and a semi-open area (Rebelsrus – Cape St. Francis), thereby highlighting differences in species composition, abundance and size distribution of certain species between areas of differing fishing pressures.

The fishery surveys revealed that the shore-based fishery is primarily recreational (99%) and dominated by white males. Most anglers agreed with the current fisheries regulations (60%) and admitted to abiding by them, however when tested on the regulations of their target species, their knowledge was poor. Effort in the fishery was highly seasonal with peaks coinciding with major school holidays. Total annual effort was estimated at 102 566 angler-hours, with distinct spatial patterns in effort. Total annual catch for the Plettenberg Bay shore-based linefishery was

estimated at 31 217 fish.year^{-1} with a total mass of 13.6 tons. Thirty-six fish species (26 teleost species and 10 elasmobranchs species) were identified during the survey period with Blacktail *Diplodus capensis*, Strepie *Sarpa salpa*, Red tjor-tjor *Pagellus natalensis*, Shad *Pomatomus saltatrix* and Sand steenbras *Lithognathus mormyrus* being the five most commonly caught species. Only 32% of interviewed anglers were successful in catching a fish with just 22% catching their primary target species. In addition, a large proportion of the anglers (69%) reported a decline in catch rate, with most blaming the commercial sector as a reason for the decline. The overall catch rate was (*cpue*) 0.374 fish.angler.hour^{-1} or 170 grams.angler.hour^{-1}, considerably lower than that obtained from the fishery exempt area (TNP = 1. 02 fish.angler.hour^{-1}) and the partially exploited area (Rebelsrus = 0.91 fish.angler.hour^{-1}).

In terms of species composition the most obvious difference between the three areas was the low proportion of non-migratory reef-associated species like red roman, poenskop, John brown, santer and bronze bream in Plettenberg Bay. Size comparisons revealed that the majority of species (particularly reef-associated species) were larger in the TNP than both the semi-exploited (Rebelsrus) and exploited area (Plettenberg Bay). Collectively theses findings suggest that certain species have been locally depleted, that recreational fishing has impacted heavily on the fish stocks and that even partial closure or limited access to an area can offer protection.

From the results key issues were identified and sustainability indicators proposed according to the three sustainability domains (ecological, institutional and social) proposed by Pajak (2000). Within the ecological domain the most pertinent issue was the low catch rate, particularly for reef-associated species. Indicators to track these issues included: percentage of successful trips (where fish were caught), percentage of anglers that reached their daily bag limits and the proportion of the overall catch that comprised larger, more desirable species. Institutionally the most pertinent issue was the apparent inability of management institutions to manage effectively

marine resources within Plettenberg Bay. Indicators within this domain included the proportion of anglers who were inspected, the existence of a localised management plan and an associated monitoring programme. Socially the fishery proved to be fairly sustainable. Indicators included in this domain were the proportion of subsistence anglers in the local fishing community, the percentage of correct answers pertaining to current fishery regulations, the level of non-compliance and the percentage of undersize fish retained.

Aggregation of all the indicators within a sustainability matrix revealed that the Plettenberg Bay shore-based linefishery was unsustainable and thus requires increased local management effort. Since there is no local management strategy in place, an integrated coastal management approach for the governance of the coastal resources in Plettenberg Bay has been proposed. The development of a Coastal Management Plan and a subsidiary Bay Management Plan provide the frameworks within which management strategies can be put into operation.

CHAPTER 1

GENERAL INTRODUCTION

Increasing attention is being given to coastal management around the world due to the growing demand and the ongoing overexploitation and degradation of coastal areas (Jentoft *et al* 1998). Analysis of historical data and recent fisheries assessments indicate that globally almost 70% of individual fish stocks are fully to overexploited (Garcia and Newton 1997) and within South Africa a number of important shore angling species are severely overexploited or in a process of decline. For example species such as white steenbras *Lithognathus lithognathus* and dusky kob *Argyrosomus japonicus* have been exploited down to levels of less than 20 and 10% of their pristine stock respectively (Bennett 1993, Griffiths 1997). Clearly the current management package is not ensuring optimal and sustainable exploitation (Attwood and Farquhar 1999, Griffiths and Lamberth 2002) and a paradigm shift in resource management is needed (Caddy 1999, Caddy & Cochrane 2001, Sinclair *et al*. 2002). The question has become one of not "Do we need a change in management philosophy?" but one of "What new approach to resource management is most appropriate?", as one cannot limit effort (the increasing number of anglers) without removing the general right to recreational marine exploitation (Attwood and Farquhar 1999).

For the current project which contributes to the development of a localised Bay Management Plan for Plettenberg Bay there needs to be an awareness of new or current management trends occurring on both a global and local scale. Presently there are no bay management plans in existence within South Africa and as a result no management structure or "blue print" exists for the present project to follow. This necessitated the initial development of a framework within which to work, a framework based on, and in accordance with, the various management concepts currently being incorporated into both fisheries and coastal management. For this reason a review of the various management concepts

which embody the principles of Ecosystems Based Management (EBM) (Appendix 1, Table 1), the way management is heading, are given in appendix 1. These include integrated coastal management (ICM), co-management and marine protected areas (MPA's). Legislation pertaining to coastal resource governance is also included within this appendix. From the various management concepts discussed within this appendix a few patterns and trends can be distinguished. Firstly management is moving away from the single species approach to looking at systems as a whole and managing on an ecosystem level. With this there is an increase in the involvement of people at the grass roots level (various stakeholders) through a more decentralized, participatory and integrated approach as opposed to the past traditional governmental command and control style. However, two major impediments have been identified in the development of a local Bay Management Plan. The first being the absence of a developmental framework and poor institutional capacity, the second being the lack of scientifically sound information on which to base management decisions. In lieu of this two interlinked projects were set up to: (i) gather scientifically sound information on the local fishery resources and their users and (ii) develop a set of indicators from this information that can be used within an assessment matrix relating to fishery management as a component of the overall Bay Management Plan. With an academic institution providing guidance, the projects were initiated and funded by the local Ocean Research Conservation Africa (ORCA) Foundation whose aim is "to create in partnership with the community, a conservation model in Plettenberg Bay to sustain marine and coastal resources through improved management, research and education" (ORCA 2003). The overall approach of developing a Bay Management Plan and how the current study contributes to this is shown in Figure 1.1. Due to the similarity in the overall aims of the two projects, with both contributing towards the management plan, chapter 5 (Towards a management plan) has been co-written with Kyle Smith and certain concepts have been shared between the two projects.

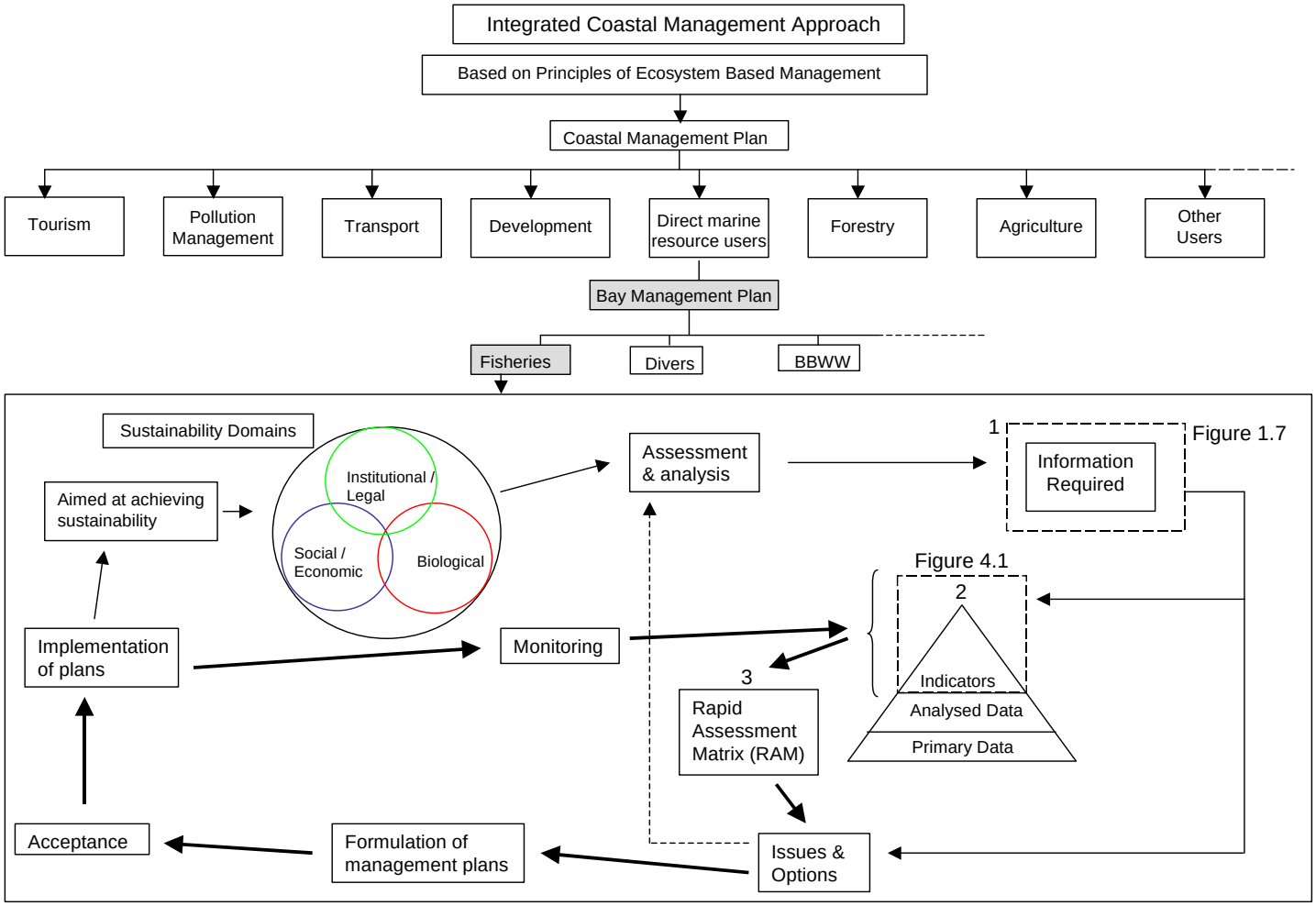


Figure 1.1. Flow diagram showing the manner in which data acquisition, indicators and rapid assessments relate within the fisheries sector, as one sector incorporated in a more ecologically and socially comprehensive ICM approach to local coastal governance in Plettenberg Bay
1: Assessment of the shore-based linefishery.
2: Indicator pyramid: indicators representing specific issues are identified from the analysed primary data (Chapter 4) (adapted from FAO 1998).
3: The indicators can be scored in a rapid assessment matrix to highlight areas of concern and management adapted accordingly.

1.1 Background on Plettenberg Bay

Plettenberg Bay is a popular coastal town situated along the Garden Route on the Southern Cape coast. The resident population is estimated at 72000 people, which increases considerably during Easter and December holiday periods when huge influxes of tourists flock to the area, increasing by 35000 and 65000 people respectively (Becke 2003). Marine related resource use varies from non-consumptive commercial and recreational activities such as whale and dolphin watching tours and yachting respectively to consumptive recreational and commercial fishing (Table 1.1).

Table 1.1. Activities directly linked to marine resource use in Plettenberg Bay include recreational and commercial ventures with both consumptive and non-consumptive facets.

	Consumptive	Non-consumptive
Recreational	Ski-boat fishing Spearing Rock & Surf fishing Estuarine fishing – boat & shore	Jet skiing Pleasure boating Yachting Surfing Kayaking Swimming
Commercial	Hake Deck Boats Hake Ski-boats Fishing Charters	Boat based whale watching Kayaking Scuba diving

Aided by the high biodiversity and natural scenic beauty of this region the town has grown into one South Africa's most popular up-market holiday destinations for both national and international tourists. Le Roux (2002) estimated that about 950 000 tourists visited Plettenberg Bay in 2002 with 65% of these visitors being domestic and 35% international. As a result of the towns popularity as a holiday destination the local economy has been shaped into one largely reliant on this tourism for its sustainability and it is estimated that tourism contributes R200 million per annum to the local economy (Becke 2003). This centering of the local economic activity around tourism and holiday related activities has inherently lead to an economy that has marked seasonal influxes or variations, coinciding with the regular tourist season peaks,

specifically around Easter and the Christmas holidays. Although other economic sectors such as construction and local fisheries exist it has been highlighted that the towns activities need to be further diversified to ensure employment between seasons with light manufacturing linked to tourism being mooted as a way to generate sustained economic activity (BDM consulting 1997). In the White Paper for Sustainable Coastal Development in South Africa (2000) it was stated that there is an urgent need for effective management of the natural resource base within the Garden Route, while at the same time creating jobs, dealing with urbanisation and developing the tourism potential.

Plettenberg Bay's reliance on tourism to sustain the local economy in turn depends heavily on the coastal goods and services that are responsible for the initial attraction of the tourists. The continued ability for the coastal environment to provide these goods and services ultimately depends on our ability to sustainably manage these assets to ensure the continued productivity of the area. In other words, not only do the benefits enjoyed by the coastal population, and those that temporarily visit, depend on the maintenance of a healthy productive coast but so do future opportunities for social and economic development. A recent report on public preference toward the provision of local coastal management services in Plettenberg Bay (Mollatt 2003) showed that:

1) The Bay has in the past been undervalued as a coastal asset.
2) The majority of respondents from the three sample population groups (local residents, domestic tourists and international tourists), were in favour of a Bay Management Plan and
3) Through a willingness to pay (WTP) questionnaire an additional value of between R 15 397 900 – R 20 330 500 was placed on the bay. This value could be obtained

through local surcharges levied at property rates and accommodation in order to provide funding for a Bay Management Plan.

The results of the study completed by Mollatt (2003) not only highlights the value of the Bay as a natural resource but more importantly showed the desire or willingness amongst residents and tourists for the implementation of a localised Bay Management Plan. With this initial interest it is therefore more likely that the local community will invest into the process and become an integral part in the development, monitoring and re-evaluation phases of the management plan. As previously mentioned, the management plan needs to be based on relevant information concerning the three domains of sustainability (Appendix 1). Within Plettenberg Bay there is a lack of this information and the project was designed to bridge part of this gap in relation to fisheries. ORCA commissioned two projects to research the local fisheries, one aimed at surveying the nearshore fisheries (commercial and recreational ski-boats, hake deck boats and recreational charters) and the other, this project, the onshore fisheries (rock-and-surf angling). The components dealt with in this project are highlighted on the flow diagram in Figure 1.2.

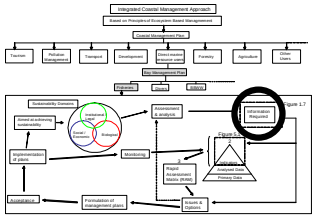
The aim of the current project was to therefore to gather baseline information on shore-based resource use from a biological and socio-economic perspective. The status of shore-based resources were assessed directly through fishery surveys and indirectly by spatial comparisons between closed, semi-open and open access areas. The fishery surveys included questions aimed at the identification and quantification of consumptive use within the Bay regarding total effort, total catch, *cpue* and the spatial dynamics of where this effort was occurring within the bay. At the same time information on the social demographics and current management issues was gathered (Figure 1.2 block A). The second aspect of the project involved utilizing catch information from research fishing in a closed and semi-open access area (Figure 1.2, block B) to

highlight differences in species composition, species abundance and size distribution of certain species to an open access area.

Once this initial data had been collected and analysed, key indicators were developed that could be used in a rapid assessment matrix (RAM) to indicate "levels" of sustainability. The results or values obtained from the chosen indicators were then scored via a set of reference points or pre-determined criteria on a scale of 0 to 4 representing a state from very poor to good. These scores were then placed within a RAM and the scores for each domain summed. Low domain totals represent non-sustainable practises and highlight the need for increased management effort within that particular domain (Figure 1.2, block C).

The specific objectives of the project were to:

- Quantify shore-based resource use in terms of:
  - Catch & effort
  - Angler demographics, attitudes towards and knowledge of current fisheries regulations
- Develop a suite of indicators with which to assess the sustainability of the shore-based linefishery using a Rapid Assessment Matrix.
- Develop a management protocol for Plettenberg Bay using an integrated coastal management approach.



Information Required

Sustainability Domains

Social / Economic

Institutions / Legal

Ecological

Who is using the bay?

Public preference & funding*

Current Management in Place

A

Non-consumptive

Diving

BBWW

Kayaking/Sailing

Consumptive

Nearshore

Onshore

Spearing

Recreational Fishing

Commercial Fishing

Recreational Fishing

Subsistence Fishing

Invertebrate Collecting

Bait

Food

Direct Methods

Fishery surveys

Total Effort

Total Catch

Total CPUE

Spatial dynamics

Patterns in Resource Use Identified

Social Demographics

Management Issues

Compliance

Knowledge

Inspections

B

Relative State of the Resources

Indirect Methods

Spatial comparison

Exploited vrs Protected

Spp Diversity

Spp abundance (*cpue*)

Size Frequency Distribution

Continued overleaf

Research Information Analyzed

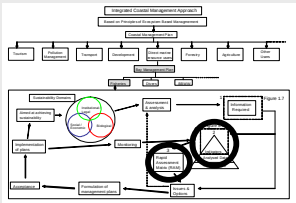
C

Indicators Developed

Figure 4.1

Criteria A	Value
Response / Result	A
Response / Result	B
Response / Result	C
Response / Result	**D**

Values are assigned to various responses or research results



Criteria values are compared to a set of reference points that indicate a performance ranging from Very poor to Good and given a corresponding score from 0 to 4

Indicators Scored

Criteria A Reference Points (values)	Indicator Performance	Score
	Good	4
	Fairly good	3
	Moderate	2
	Poor	**1**
	Very poor	0

Rapid Assessment Matrix

Domains	**Criteria A**	Criteria b	Criteria c	Total
Ecosystem Scores	**1**			
	Criteria A	Criteria b	Criteria c	Total
Social Scores				
	Criteria A	Criteria b	Criteria c	Total
Institutions Scores				

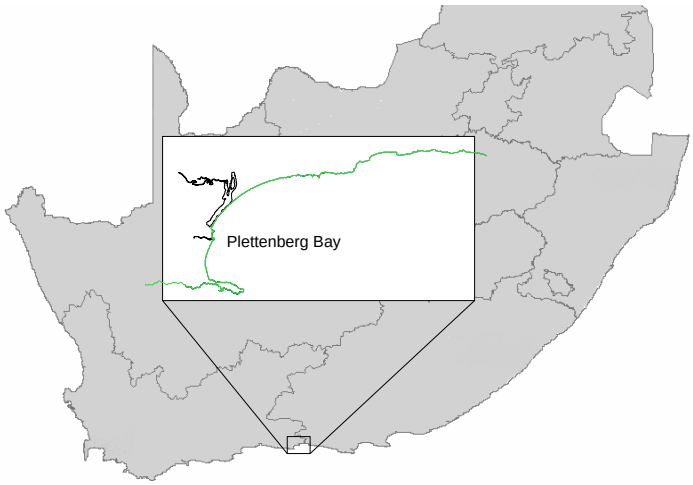
Criteria scores are entered into a rapid assessment matrix, low scoring domains indicating non-sustainability.

Figure 1.2. The components where research has been directed to gather information and develop indicators for inclusion into a rapid assessment matrix to highlight non-sustainability within the three environmental domains. BBWW = Boat Based Whale Watching. The insert shows the position this information fills within Figure 1.1. *Results from a separate Economic study (Mollatt 2003).

CHAPTER 2

STUDY SITE AND SURVEY METHODS

2.1 Study site



Plettenberg Bay is situated on a half-heart bay along the Southern Cape coast of Southern Africa. The study area has attempted to encompass the bay, which for the purposes of this project has been defined to extend from the Robberg Nature Reserve (RNR) in the west to the Tsitsikamma National Park (TNP) in the east. The area of interest is therefore bounded by two marine reserves, with TNP being the largest no-take marine reserve in the world (Anon. 2002a). The Plettenberg Bay coastline is approximately 40 km long consisting predominantly of sandy beaches interspersed by rocky outcrops, becoming more rugged toward the east with rocky beaches and steep cliffs. Estuaries that fall within the study site include the Keurbooms and Salt Rivers that are permanently open, and the Piesang and Majies Rivers that are intermittently open systems. The Keurbooms estuary is the dominant estuary in the region and plays a vital role in the life cycle of estuarine dependent fish species in the bay.

The major oceanographic feature along the southern Africa coast is the Agulhas Current (Beckley and van Ballegooyen 1992), which flows along the edge of the continental shelf. In the East London area it moves offshore and thus has minimal influence on the Cape south coast (Schumann *et al*. 1982). The average water temperature inshore of the Agulhas Current is about 17 ^{o}C (Greenwood and Clarke 1994), which decreases by 10 ^{o}C or more with wind-induced upwelling events (Schumann *et al*. 1988). Wind has a strong effect on the oceanography of the region which as a coastal area experiences wind throughout the year. In winter the prevailing wind direction is northwest which swings to southeast during summer (CSIR 1984) causing numerous upwelling events. The current patterns have not yet been established within the bay but further east towards Natures Valley the currents close inshore move mainly westwards as they are driven by waves coming from the south-east (Morant *et al*. 1983 *cited in* Anon. 2002a). Within the Tsitsikamma National Park Attwood *et al*. (2002) revealed that coastal–trapped waves were the dominant physical process influencing currents. In addition, they found that easterly winds caused upwelling in spring and summer producing onshore currents; while in winter regular longshore current oscillations were recorded (Attwood *et al*. 2002).

The climate is generally mild due to the influence of the sea, with an average maximum temperature of 26 ^{o}C in January and 19 ^{o}C in July and average minimum temperature of 15 ^{o}C in January and 7 ^{o}C in July (CSIR 1984). It rains throughout the year with spring months being the wettest. On average rain can be expected between 8 and 12 days a month. In the South African context, the area is cloudy with a daily sunshine duration of about 50% of the day.

2.2 Sampling areas

For the purposes of this study the coastline was divided into 5 coastal regions for ease of sampling (Figure 2.1), as there were only two survey clerks to cover the entire study area. The divisions were based on; the ability of survey clerks to cover an area efficiently for the greatest number of angler interceptions in one day, the locality of car parks and on natural boundaries such as rivers and rocky outcrops. The coastal zones are as follows:

- *Zone 1*: The Robberg Nature Reserve (RNR) with its already existing boundaries. Only shore fishing and not bait collecting is permitted in the reserve. There is only one access point through a controlled boom gate, which is manned by a Western Cape Nature Conservation official. The coastline in this zone is almost exclusively rock, with the exception of a tombola, which connects the island to the peninsula (Figure 2.2).
- *Zone 2*: This 7.91 km stretch of beach extends from the eastern border of the RNR to the western bank of the Keurbooms River mouth. It includes a long sandy beach (Robberg Beach), and two rocky outcrops that are easily accessible. Access to this zone is easy with numerous car parks and private footpaths from homes situated directly behind the fore dune (Figure 2.2)
- *Zone 3*: Extends from the eastern bank of the Keubooms River mouth to a rocky outcrop known as Bloubankies. This 7.95 km zone is exclusively sandy beach. The land adjacent to this stretch of coastline is mostly privately owned and thus there are only three public access sites to this area. Access through private land was however granted for the duration of the study. (Figure 2.2).
- *Zone 4*: Extends from Bloubankies eastwards for 6.66 km to a rocky outcrop known as Langbank, beyond which the coastline is impassable due to sheer cliffs. For this reason the area between Langbank and Salt River Point (2.78 km) was excluded from the study. All the

land adjacent to this area is privately owned and undeveloped. Zone 4 is the least accessible area of all the zones and walking this stretch is difficult but it has many good fishing spots with steep cliffs and short stretches of sandy beach. (Figure 2.2)

- *Zone 5*: The last zone falls within the bounds of de Vasselot Reserve (an extension of the TNP in which exploitation of marine resources is permitted) and extends from Salt River Point across the shallow Salt River mouth and Nature's Valley beach up to the Groot River, which is the eastern border of the Tsitsikamma National Park (Figure 2.2).

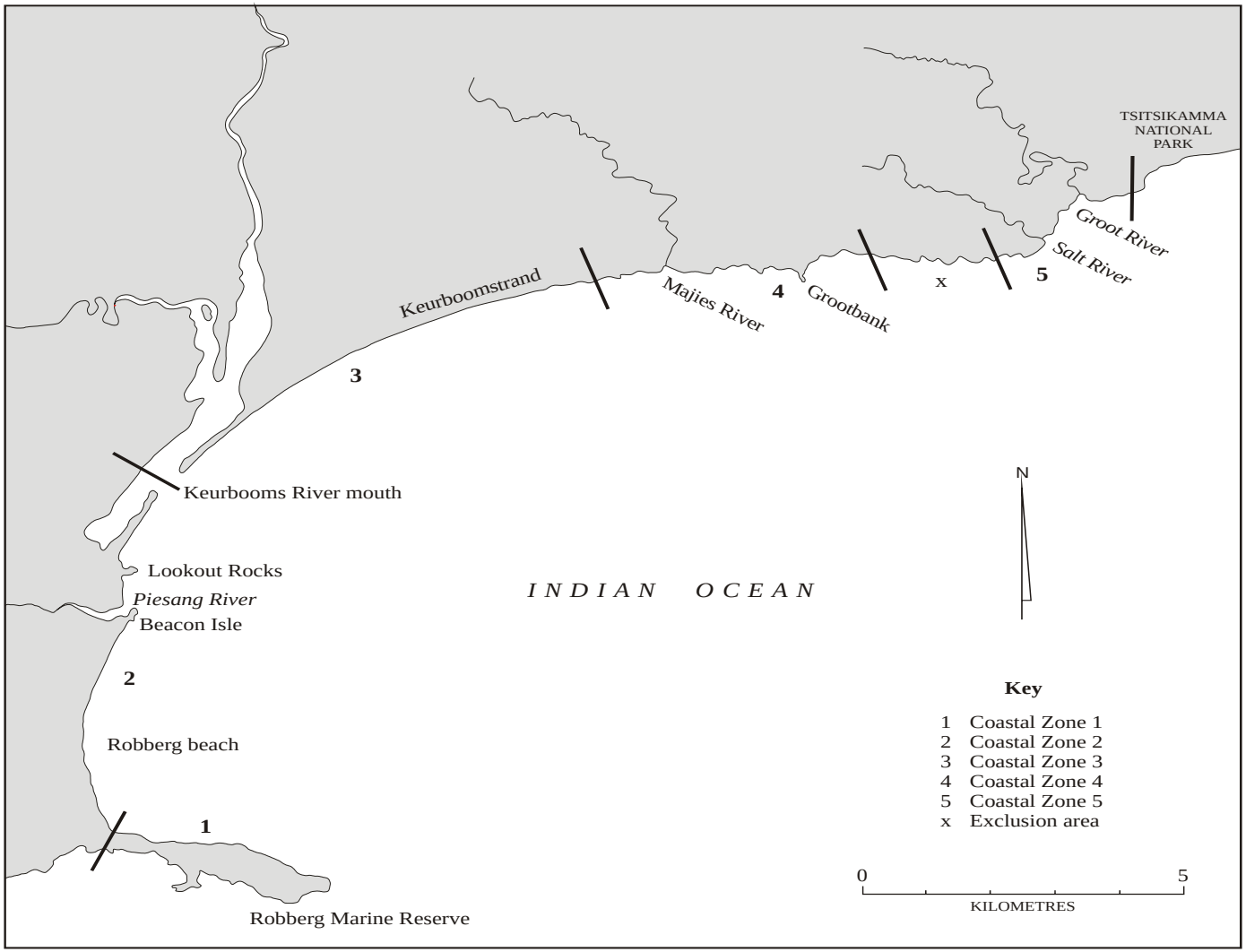
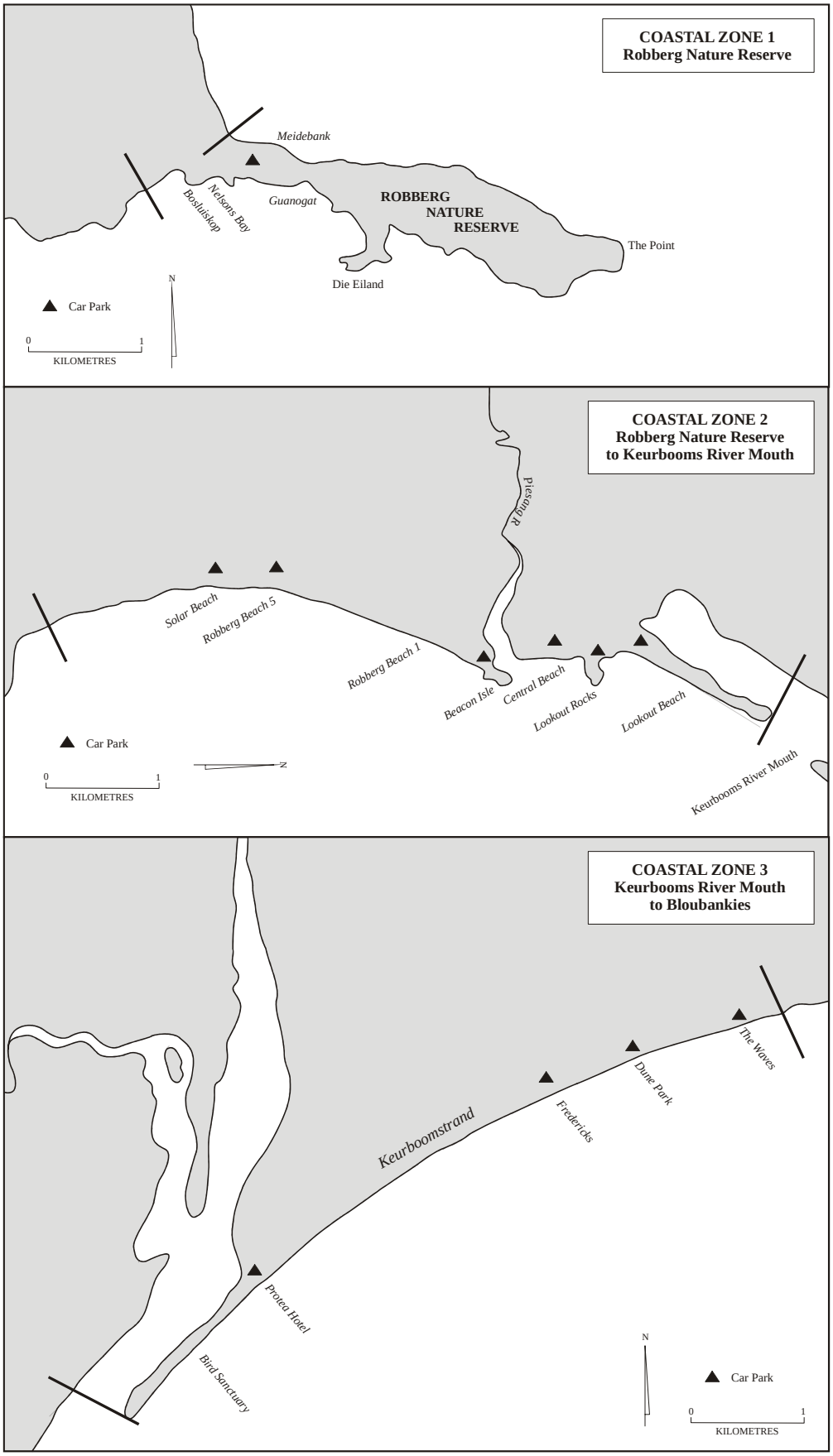


Figure 2.1. The Plettenberg Bay coastline showing the five sampling areas


COASTAL ZONE 1
Robberg Nature Reserve
Meidebank
Bosluiskop
Nelsons Bay
Guanogat
ROBBERG
NATURE
RESERVE
The Point
Die Eiland
N
Car Park
0
1
KILOMETRES
COASTAL ZONE 2
Robberg Nature Reserve
to Keurbooms River Mouth
Piesang R.
Solar Beach
Robberg Beach 5
Robberg Beach 1
Beacon Isle
Central Beach
Lookout Rocks
Lookout Beach
Keurbooms River Mouth
Car Park
N
0
1
KILOMETRES
COASTAL ZONE 3
Keurbooms River Mouth
to Bloubankies
The Waves
Dune Park
Fredericks
Keurboomstrand
Protea Hotel
Bird Sanctuary
N
Car Park
0
1
KILOMETRES

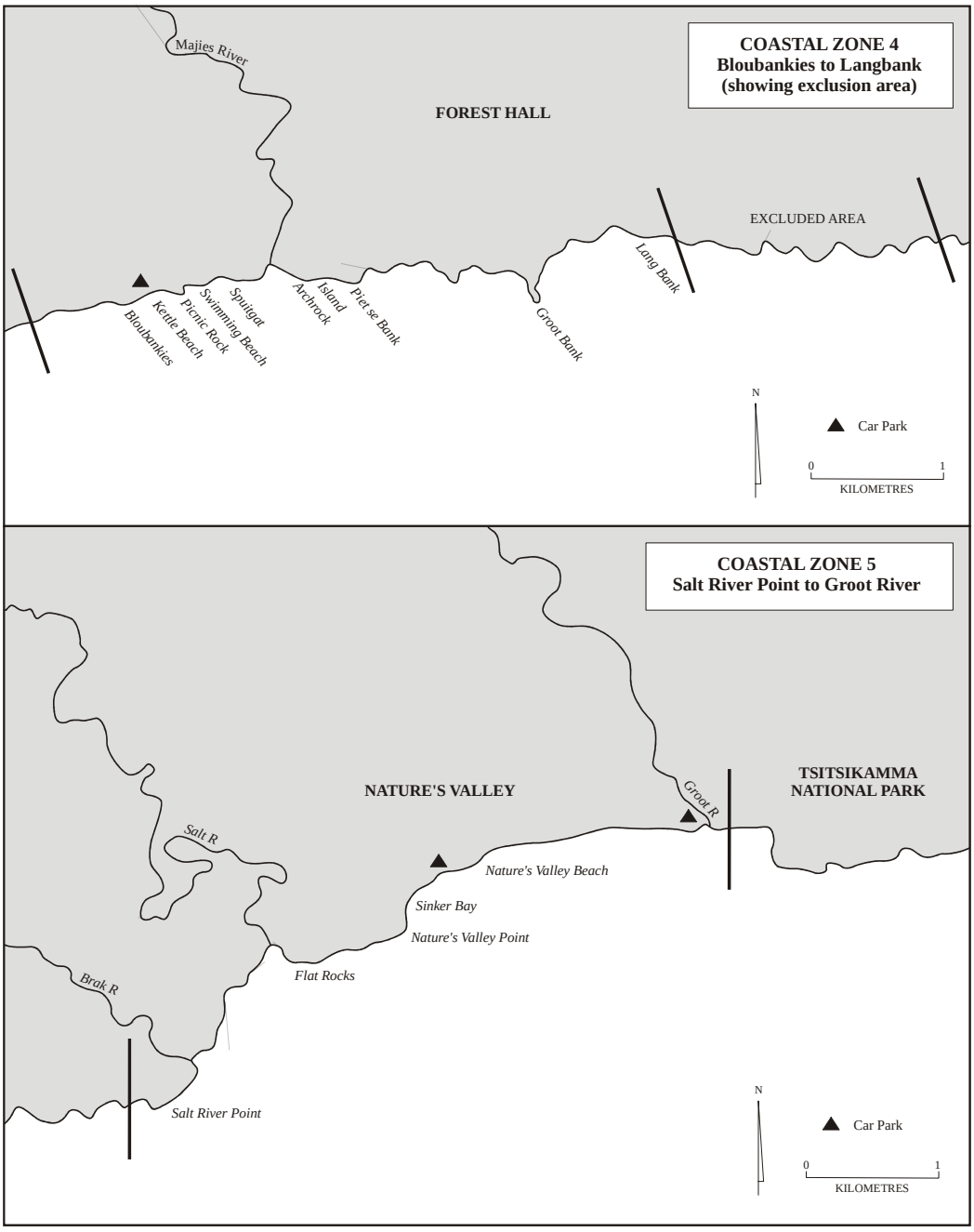


Figure 2.2. The five sampling zones in greater detail showing the most common fishing spots and access points to the fishery

2.3 Fishery survey methods

There are seven basic survey methods to estimate angler characteristics and activities: mail; telephone; door-to-door; fishing logbooks, diaries and catch cards; access point; roving; and aerial surveys (Pollock *et al*. 1994). The type of survey method used depends on which design will give the best quantitative estimates that are of interest and on the spatial and temporal characteristics of the environment in which the fishery operates. Fisheries surveys are classified as either off-site or on-site intercept methods. The two survey methods used in this study were both on-site intercept methods, namely the access point and roving creel survey. The advantages of on-site intercept methods are that they maximize response rates (percentage of the sample responding to the interview) because anglers are contacted in person during their fishing trips (Malvesto 1996). Memory recall biases are also minimized because questions pertain only to the trip in progress and trained survey clerks can identify fish species and obtain numbers, weights and lengths of fish by direct observation. Reliance on fishermen is thus avoided as they may misidentify fish and exaggerate measurements (prestige bias) (Pollock *et al*. 1994, Malvesto 1996).

2.3.1 Roving creel survey

The roving creel survey technique involves a survey clerk moving though the fishery on foot interviewing anglers while they are actively fishing (Pollock *et al.* 1994, Lockwood 2000, Cowx 2002). This survey method is used when there are too many access sites for survey clerks to intercept all anglers entering the fishery, as in the traditional access point survey. For this reason the roving survey method was best suited to zones 2 to 5. The progressive count method was used in conjunction with the roving survey, which entails counting the total number of anglers seen while completing a circuit of the fishery (Pollock *et al.* 1994). Roving surveys produce estimates of catch rate, fishing effort and information on social, attitudinal, or economic issues can also be obtained.

Catch rate (fish/hour) is derived from interviews, during which anglers are asked what time they started fishing and the number of fish caught up to the time of the interview. Effort (angler-hours) in a fishing area is based on counts of anglers multiplied by the average fishing time of all interviewed anglers. Total catch is not estimated directly, because interviews document only part of the catch, but rather it is calculated as the product of effort and catch rate (angler-hours x fish/hour) (Malvesto 1996). Roving surveys are also known to produce more interviews per unit staff time than access point surveys in low-use fisheries as the clerks actively seek out anglers (Pollock *et al*. 1994).

A number of disadvantages, however, are associated with roving creel surveys because interview data are taken from in-complete fishing trips (Cowx 2002). The first is that the probability of intercepting an angler is proportional to the duration of the fishing trip, meaning that anglers who fish for longer are more likely to be intercepted (Malvesto 1996). Sampling is thus subject to a 'length-of-stay' bias. There is also bias towards those anglers that fish more frequently (avidity bias) as survey clerks become more sociable with local anglers (Pollock *et al*. 1994).

2.3.2 Access point survey

This survey method differs to roving surveys in that survey clerks wait at specific access sites (car parks, launching sites or jetties) to the fishery for anglers to return from their fishing trips (Pollock *et al*. 1994, Malvesto 1996, Cowx 2002). A requisite for this survey method is that anglers use defined access sites to enter the fishery (Pollock *et al*. 1994). The nature of zone 1 with only one access point made this survey method the most appropriate for this area. A primary advantage of the access approach relative to the roving method is that estimates are based on complete fishing trips as opposed to incomplete fishing trips and thus trip length biases are avoided (Pollock *et al*. 1994, Malvesto 1996). The interpretation of completed trips requires fewer assumptions and catch and

effort can be calculated directly from completed trip data by summing daily values. Access point surveys can also be used to collect information on social, attitudinal, or economic issues.

There are a few key assumptions that need to be made when conducting roving creel and access point surveys in order to calculate catch per unit effort (*cpue*). According to Pollock *et al*. (1994) these are:

- Fishing success is not dependent on trip length
- *Cpue* remains unchanged for the entire fishing trip
- Interviewees answer the questions truthfully
- The catch rate of interviewed anglers is representative of that of all anglers

2.4 Boat – based angler surveys

Boat-based angler surveys were done as a means of auditing angler counts made by roving creel surveys. The survey procedure involved patrolling the entire study area close inshore by boat and with the aid of binoculars counting the number of anglers seen in each zone. The anglers' positions and the time taken to traverse each zone were recorded. The entire circuit took approximately an hour depending on sea conditions.

2.5 Research fishing

A second data set was used from two ongoing research tag and release programmes conducted within the boundaries of the fishery exempt Tsitsikamma National Park (TNP) and a partially exploited, privately owned area near Cape St Francis, Rebelsrus. Research fishing was carried out monthly during 4 - 5 day field trips by a group of 4 - 8 anglers. Fishing took place during daylight hours (mostly between 07:00 and 17:00), using a variety of baits and hook sizes. All fish caught were

recorded and measured to the nearest millimetre fork length (FL) and fish >250 mm FL were tagged (Cowley *et al*. 2002).

CHAPTER 3

PLETTENBERG BAY SHORE-BASED LINEFISHERY

3.1 INTRODUCTION

3.1.2 The South African Linefishery

The South African linefishery consists of commercial, recreational and subsistence sectors which collectively exploit over 200 fish species (Griffiths 1997, Griffiths and Lamberth 2002). The commercial sector is exclusively boat-based and operates offshore in depths ranging from 5m to 200m. The recreational sector is more diverse, including estuarine anglers that fish from either boats or the shore; rock and surf anglers fishing in the coastal inter-tidal environment; ski-boats operating in the same zone as the commercials; and marine spearfishers that operate either from boats or the shore (Griffiths 1997, Griffiths and Lamberth 2002). The subsistence sector, which has only recently been officially recognized, is limited to estuarine and coastal shore-based activities (Griffiths 1997). The focus of this study was primarily on coastal shore-based activities including the recreational and subsistence sectors that harvest linefish and bait organisms.

3.1.3 The South African shore-angling fishery

Recreational angling is an extremely popular growing activity in South Africa which has seen remarkable increases in the number of participants and advancements in fishing techniques and equipment in the past few decades (Brouwer 1997). Estimates suggest that approximately 412 000

participants were active on the South African coastline in 1995 which is increasing at a rate of 2% per annum (McGrath *et al*. 1997). The subsistence sector is proportionately smaller with an estimated 29 233 participants of which the majority are found on the East coast (Clarke *et al*. 2002). Subsistence fishers harvest a variety of different species from invertebrate bait and food organisms to a few linefish species (Britz *et al*. 2001, Clarke *et al*. 2002), which they rely on as a source of food or to sell to meet their basic needs of food security (Branch *et al*. 2002). The collective annual harvest by all sectors was estimated at 4.5 million fish weighing 3000 tonnes each year (Brouwer *et al*. 1997). In addition to its social benefits, the linefishery is economically important to local coastal economies. McGrath *et al*. (1997) estimated that the linefishery contributed 1.3 % of the combined gross geographic product for the four coastal provinces, of which shore angling contributed 76.3%. Maintaining the sustainability of the linefishery is therefore paramount to ensuring that these social and economic benefits are enjoyed by future generations.

Sustainability, however, is still an ideal to be realized (Ludwig *et al*. 1993, Wood *et al*. 2003) and the statement by Huxley (1884) that the fish of the sea are inexhaustible has ended. The FAO (1999) reported that approximately half of all major fish stocks are fully exploited and very close to their maximum sustainable limits, with another quarter overexploited or depleted. The effects of overfishing can only truly be shown by temporal comparisons of catch per unit effort (*cpue*) between early and modern-day catches or by spatial comparisons between protected and exploited populations (Attwood and Farquhar 1999). A drawback associated with making temporal comparisons is that recording of catch statistics only began in the 1980's (Bennett 1991) and thus long-term data series are few making it difficult to comprehend the original state of the unexploited stock (Rochet and Trenkel 2003). Examples of temporal studies include that of Bennett (1991a) who analysed South-

Western Cape angling club records from 1938 to 1985. The results revealed marked changes in catch rates with declines from 300-400g per angler-hour prior to 1960 to less than 100g in the mid 1980's. More rapid declines, however, are evident when examining catch statistics for individual species. For example, catches for white steenbras *Lithognathus lithognathus* in the South-Western Cape declined from around 4 fish.$100h^{-1}$ between 1997 and 1980 to less than 1 fish.$100h^{-1}$ after 1985 - a 75% decrease in only 5 years (Bennett 1991). Analysis of Border region (Eastern Cape) club data by Pradervand and Govender (2003) also revealed a significant decrease in overall annual *cpue* from 1982 to 1998.

Spatial comparisons between closed (fishery independent) and open (fished) areas provide a means of observing the effect that fishing can have on a population. Work done by Bennett and Attwood (1991) in the De Hoop Nature Reserve illustrates this very well; data collected for two years prior to fishery closure revealed that the average catch of two fish per angler per day rose to 14 fish per angler per day after closure. Similarly in the Tsitsikamma National Park (TNP) red steenbras *Petrus rupestris*, a heavily overexploited species, are twice as large and over ten times more abundant than in adjacent areas open to angling (Cowley and Hecht 1997). Cowley *et al*. (2002) also revealed that certain shore-angling species are between five and 21 times more abundant in the TNP than in open access areas along the Eastern Cape coast. Buxton and Smale (1989) found a similar trend for the Tsitsikamma National Park were the abundance and the average size of fish were greater in the reserve than an exploited area. In the Philippines, Russ and Alcala (1998) found that large predatory species with slow life histories declined in abundance under intense fishing pressure and recovered slowly when fishing ceased. A change in the catch composition, specifically a decline in the relative proportion of reef-associated teleosts (Hecht and Tilney 1989, Bennett *et al*. 1994, Brower *et al*.

1997) is a common trend of exploited stocks and has coined the term “serial overfishing” where fishers progressively target species lower down the food chain (Bonshack and Ault 1996), resulting in a population dominated by smaller individuals with faster life histories lower down on the trophic level (i.e. herbivores). Fishing can thus be seen to affect the entire ecosystem (Kaiser and Jennings 2002).

In an effort to ensure sustainable utilisation of South Africa’s linefish resources active management has been ongoing since the 1970s (Brouwer 1997). Current management measures include the use of size limits, bag limits, closed seasons and marine protected areas (Mann *et al*. 2003). Linefish catch regulations were first promulgated in 1973 under the Sea Fisheries Act No. 58 of 1973, which were modified in 1984 (Government gazette No. 9543 of 1984), replaced in 1988 (Sea Fisheries Act No. 12 of 1988) and further revised in 1992 (Government gazette No.14353 of 1992), and the most recent amendments being in April 2005 (Gazette Vol: 478 No. 27453). Despite a comprehensive set of management measures in place the continued decline in catches suggests that the current linefish management plan appears to be ineffective. Numerous reasons have been given for this, ranging from lack of institutional capacity to non-compliance by anglers (Bennett 1991, Griffiths and Lamberth 2002), but more pertinent to this project, there has been insufficient long-term monitoring and research conducted on catch and effort in the linefishery on which to base management decisions (Britz *et al*. 2001, Brouwer and Buxton 2002)

Work done on the linefishery has been directed mainly at specific species and studies focused on assessing catch and effort are few. Studies undertaken to assess catch and effort in the shore-fishery include those by Bennett (1991) and Bennett *et al*. (1994) who analysed angling club records in the

South-Western Cape. Coetzee and Baird (1981) used a similar approach with catches made off St Croix Island, Eastern Cape. Coetzee *et al*. (1989) studied catch and effort trends from angling club catches in the Eastern Cape and Hughes (1989) analysed catch and effort data in KwaZulu-Natal. Recently catch and effort data was published by Pradervand and Govender (2003) on Border region (Eastern Cape) angling club data for the period 1982-1998. Joubert (1981) and Clarke and Buxton (1989) conducted regional roving creel surveys to assess angler catch and effort and to determine club ratios and demographics of shore anglers in KwaZulu-Natal and near Port Elizabeth, respectively. Attwood and Farquhar (1999) assessed the state of the linefishery on the Cape south coast through roving creel surveys, which they compared to historic fishery records. In 1994 a nation wide survey was initiated to evaluate the participation in, and management of the South African linefishery (Britz *et al*. 2001, Mann *et al*. 2003). The national survey included assessments of the shore-angling fishery (Brouwer *et al*. 1997), the offshore boat-based fishery (Sauer *et al*. 1997), the spearfishery (Mann *et al*. 1997), the beach-seine and gill-net fisheries (Lamberth *et al*. 1997), and some economic aspects of these fisheries (McGrath *et al*. 1997). These surveys failed to cover the Transkei coast, as at the time of these studies this region fell outside the jurisdiction of the South African government, so in order to complete the national survey a study was initiated 1997 to evaluate the shore-based fishery on the Transkei Wildcoast (Mann *et al*. 2003). Prior to the national survey none of the previously mentioned studies took into account the human and economic dimensions of the fishery, which are essential components to consider when managing a fishery. For this reason and in order to make the current study comparable, a similar approach to data collection and analysis was used to that of Brouwer *et al*. (1997).

3. 2 METHODS

Fishery Surveys

3.2.1 Survey procedure

Random stratified sampling was used to obtain a more precise estimate of effort as weekend days and public holidays are known to receive higher levels of fishing effort than weekdays (Malvesto 1983, Pollock *et al*. 1994). Initially from September 2003 to December 2003 only two days were spent sampling each month in each zone (1 week day and 1 weekend/or public holiday), however it was later realized that insufficient coverage was being achieved and this was increased to three sampling a days a month in each zone (two weekdays and one weekend day or public holiday) according to the ratio 2:1 proposed by Cowley *et al*. (1994), except for September, November and March only 2 sampling days were done each month. Sampling dates were not randomly chosen due to survey clerks having to manage their time between two parallel projects, but instead were predetermined at the beginning of each month. Two survey clerks spent the day patrolling the coastline from 06:00 to 18:00 on each survey day (no night patrols were conducted for safety reasons). Several circuits of the zone were completed each day with the length of each circuit dependent on the distribution and intensity of angling effort, and thus were not standardized. The number of circuits completed in each zone varied according to the length of the zone and the number of access sites.

The roving survey method was initially used for all zones until December 2003 when the method was changed to an access point design for zone 1.The single access point to this zone made it better suited to an access point survey design and from January 2004 to August 2004 this method was used. For the access point survey, the same sampling technique was used in terms of sampling days and survey

procedure, except the sampling day was split so that only one survey clerk was present at the access point at one time.

No attempt was made to record environmental parameters (wind activity, air temperature and rainfall or sea conditions) as it has been shown that no correlation exists between environmental conditions and catch in the short-term (Coetzee and Baird 1981, Clarke and Buxton 1989). These relationships only become apparent with long-term data, hence it was felt that that a one-year sampling period was insufficient to make any meaningful correlations linked to fluctuations in weather.

3.2.2 Interview process

Only anglers actively involved in fishing, walking back from a fishing spot or packing up were interviewed. To avoid party bias only one member from each party was interviewed when anglers were standing within ear shot of each other, but if there was sufficient distance between them an attempt was made to interview all anglers from the party. If the intensity of angling effort exceeded the interview rate, interviewees were chosen in a systematic manner, for example every 3rd angler was interviewed (Brouwer 1997). If an individual angler was intercepted on a subsequent circuit of the fishery on the same day, the interview sheet was amended to include the corrected data on catch and effort.

The questionnaire design was adapted from surveys done by Brouwer (1997) in his assessment of the South African shore fishery and from Cowley *et al*. (1994) who assessed the fisheries of Eastern Cape estuaries (Appendix II). Information gathered from the interviews included: (i) user

demographics (name, age, sex, race, home town, education, occupation, household structure, fishing sector); (ii) fishing expenditures (daily expenditure, willingness to pay and value of angling equipment); (iii) anglers attitude and perception towards management (motivation for fishing, ownership of resources, possession of permit, fisheries regulation quiz, inspection rate, trends in catch and threats facing the linefishery); (iv) catch (species retained and released, size composition, to avoid misidentification of species and size exaggerations, all retained fish were inspected, identified and measured (FL and TL cm) by the survey clerk, while information on released fish were gleaned from the angler; (v) effort (time start, expected ending time, time of interview, number of anglers per party, fishing method and number of lines, frequency of day and night fishing in the survey area); (vi) bait dynamics (species, quantity, possession of permit, bait regulation quiz, bait trends, threats to bait fishery). All anglers were only interviewed once with this questionnaire. On subsequent interceptions a shorter questionnaire was used which recorded catch and effort, monies spent for that days fishing trip, target species and bait species and quantities (Appendix III).

For all the anglers which were not interviewed during the patrols information on the group sizes, number of lines, fishing method (bait, lure, fly) and angling platform (rock or beach), as well as sex and race were recorded (Pradervand and Baird 2002, Pradervand *et al*. 2003).

Since the survey clerks had no authority for the catch inspections and anglers were under no obligation to reveal their catches, there may have been under reporting of catches. No anglers under the age of 11 were interviewed because it was felt that they would not comprehend the questions (Mann *et al*. 2003).

3.2.3 Catch and effort calculations

Angler survey data is typically analysed to give daily catch estimates, however, due to the low number of interviews obtained on a number of survey days, data were analysed to give mean monthly estimates. The averaging procedure followed the "mean of the ratios" method (Pollock *et al*. 1997).

Effort

The unit of angling effort chosen was angler-hours. For roving creel survey data, total daily fishing effort was obtained by multiplying the average turnover time (time started to expected ending time) of interviewed anglers by the total number of anglers counted on that day (Pollock *et al*. 1994).

$$e = I_i \cdot T_i$$

Where:

e_i = fishing effort on day i

I_i = number of anglers counted on day I

T_i = average turnover time of each fishing trip (time started to expected ending time)

For access point survey data total daily fishing effort was obtained by summing the turnover times of all interviewed anglers.

To account for total daily effort, as it is likely that survey clerks miss nearby resident anglers who fish for short periods during the early morning or evening, an attempt was made to scale up the

estimated total effort. Past studies have adopted Brouwers' (1997) conversion factor of 2.48 (Attwood and Farquhar 1999; Mackenzie 2004) but since this value was deduced from a survey of larger proportions of the coastline it was felt that it was too high for the current project which covered a significantly smaller area and thus had better coverage. To obtain a value tailored to the current project the average distance patrolled during Brower's (1997) study and the average distance patrolled in the current study was compared. Due to the better coverage in the current study, this exercise unsurprisingly yielded a conversion factor of 0.99 (≈1.0). Effort estimates thus remained unchanged as essentially they were multiplied by one. The need to use a conversion factor was further assessed by a simple audit comparing angler counts (number of anglers per km/day) obtained from the roving creel surveys and a number of ad-hoc visual surveys conducted from a ski-boat that patrolled the coastline.

Boat-based visual surveys were done from October 2003 to September 2004 and covered zones 2 to 5. Sampling days were not randomly chosen but instead coincided with the sampling regime of the other ORCA project (Smith 2005), as the same boat was used for both projects. A number of the boat-based survey days coincided with days on which the survey clerks were performing roving creel surveys, enabling the audits to be done. The similarity in the data suggested that comprehensive coverage of the fishery was obtained.

To obtain an estimate of monthly fishing effort, the average effort of the two weekday surveys for each zone was multiplied by the number of weekdays in that month. Similarly, the effort on the weekend or public holiday survey was multiplied by the number of those days in that month.

$$E_{Total} = \overbrace{\left(e \,.\, x_1\right)}^{\text{Weekdays}} + \overbrace{\left(e \,.\, x_2\right)}^{\text{Weekends/ Pub. holidays}}$$

Where:

e = average daily fishing effort

x = number of days in that month (i.e. number of week days or weekend /public holidays in that month)

Total monthly effort (E) was calculated as the sum of the weekday and weekend effort estimates for each zone. Total annual effort for the entire study area was calculated as the sum of the monthly effort estimates.

A handheld GPS (global positioning system) was used to record the position of each angler or angler party to assess the distribution of effort along the coastline. GIS (global information systems) software, ESRI Arcview®, was used to visually display the distribution of effort in each zone. In order to generate these maps the most common fishing spots in each zone were given generic GPS points and all anglers fishing within the vicinity of each bearing were grouped.

Catch

The total catch for each month included both retained and released fish. For each angling party the catch of individual anglers was separated to avoid “party bias”.

Daily catch was estimated by multiplying the average number of fish caught that day by the total number of anglers counted that day, assuming that the catch of the interviewed anglers is representative of all anglers.

$$c_i = m_i \,.\, I_i$$

Where:

c_i = number of fish landed on the *i*th day
m_i = average number of fish caught per interviewed angler on the *i*th day
I_i = total number of anglers recorded on the *i*th day

The average daily estimates for the two weekday surveys were then multiplied by the number of weekdays in that month to obtain a monthly estimate for each zone. Similarly, the estimate on the weekend/public holiday was multiplied by the number of those days in the month to obtain a monthly estimate for that zone. The monthly week and weekend/public holiday estimates for each zone where then summed to get a total monthly estimate for that zone. Monthly catch was estimated by adding the estimates from each of the five zones. Annual catch estimates were obtained by summing the monthly totals.

The same method was used to obtain catch by weight for daily, monthly and annual estimates. Mass of fish captured was obtained by converting measured (or estimated) lengths of all fish using data provided by Anon (2000a). Where neither mass nor length was known, mean values for each species (pertaining to the month in which they were caught) were used to calculate catch and catch rate (Coetzee and Baird 1981, Clarke and Buxton 1989).

The species composition and dominant catch was calculated for each zone and for the entire sampling area from Robberg Nature Reserve to TNP. For the most commonly caught species (i.e. sparids) the following was calculated:

- The zone in which it was most commonly caught
- Size classes for all retained fish
- The dominant bait used to catch the species
- Seasonal (monthly) catch trends

Catch per unit effort (*cpue*)

To calculate daily *cpue* the total number/mass of retained and released fish (excluding elasmobranchs) caught on each survey day was divided by the total fishing effort (angler-hours) recorded on that day, expressed as fish.ang-hr^{-1}, or grams.ang-hr^{-1}.

$$cpue = \frac{\left(\sum_{i=1}^{n} C_i / E_i \right)}{n}$$

Where:

C_i = number or mass of fish caught (including those released) on the *i*th day
E_i = effort expended by interviewed anglers on the *i*th day
n = number of interviewed anglers on the *i*th day

To obtain monthly *cpue* estimates for each zone the values obtained for the week survey days were averaged and multiplied by the number of days in that month and similarly for the weekend/public holiday survey, which were then averaged again. A total monthly estimate (across all zones) was then

calculated by averaging the monthly estimates for each zone. The monthly variance of effort and *cpue* was estimated using the standard formula for sample variance (Zar 1984).

Annual *cpue* (by number and weight) was calculated by averaging the monthly totals (Pollock *et al*. 1994)

3.2.4 Spatial comparisons

To assess the possible effect fishing has on fish stocks in terms of catch composition and abundance (*cpue*), spatial comparisons were made with data collected from the TNP (a closed, no-take area adjacent to the sampling area) and from Rebelsrus (a moderately fished privately owned area approximately 132.5 km east of Plettenberg Bay). All three areas fall within the same bio-geographic zone (warm temperate) hence it was assumed that they had similar ichtyhofauna. The TNP data was obtained from a long-term tagging and monitoring programme that was initiated in 1995 (see Cowley *et al*. 2002). In 2004 the TNP tagging programme was extended to include the moderately exploited area at Rebelsrus. For comparisons, only data collected between February 2004 and December 2004 in both the TNP and Rebelsrus tagging programmes were used to avoid the possible influence seasonal changes may have on fish stocks. It is noteworthy that the *cpue* data from the TNP and Rebelsrus were collated from complete fishing trips, whereas *cpue* from Plettenberg Bay was calculated mostly from incomplete angler outings.

3.2.5 Angling success

To evaluate angling success the percentage of anglers who caught their primary and/or, secondary and/or tertiary target species, which was obtained from each questionnaire was calculated for each zone. This was also done for specific species and the percentage of anglers who targeted and caught that species was calculated.

3.3 RESULTS

From September 2003 to August 2004 a total of 156 days (1872 hours) were spent in the field with an average coverage of 31 days in each zone (Table 3.1). 2459 anglers were counted and 1189 interviews were conducted, of which 502 were re-surveys.

Table 3.1. The distribution of sampling effort in the different sampling areas.

Zone	Survey Days
1	32
2	30
3	32
4	30
5	32
Total	156

3.3.1 Angler demographics and attitudes

The shore-based linefishery of Plettenberg Bay was dominated by recreational anglers (99%) with only six individuals being identified as truly subsistence (Table 3.2). The low representation by the subsistence sector precluded independent analysis of the two sectors and all results pertain to the entire shore-based fishing population. Rock-based angling (60%) was more popular than surf fishing (40%).

Participation in the fishery was largely male-dominated (98%), and comprised mostly of white participants (65%), followed by coloureds (35%). In terms of age distribution, anglers ranged from 5 to 82 years old, but the most common age group was between 36 to 40 years old (Figure 3.1). Only 10% of the anglers interviewed belonged to angling clubs while 83 % of all anglers reported to be in possession of a fishing license. The majority of anglers were from South Africa (97%), of which 72% were from the Western Cape, 10% from Gauteng and 9% from the Eastern Cape. Within the local

Bitou Municipality most of the anglers came from New Horizons (28%), a coloured community on the outskirts of Plettenberg bay, followed by Plettenberg Bay itself (22%).

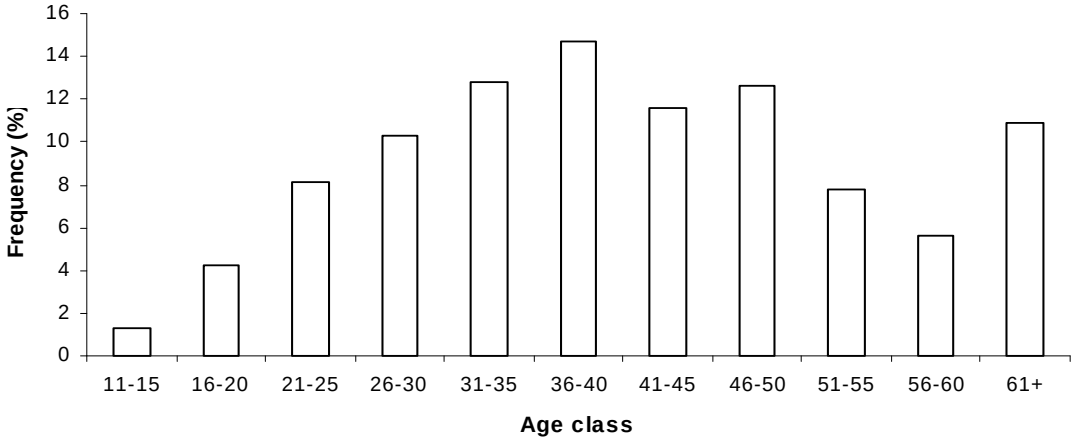


Figure 3. 1. The age distribution of shore-anglers in the Plettenberg Bay region.

Unsurprising, the chief motivation for shore fishing was recreation (82%), followed by food (9%), competition (2%) and livelihood (1%), (Figure 3.2). This was confirmed by the employment statistics of interviewed anglers, of which 79% were formally employed and thus do not rely on fishing to sustain themselves.

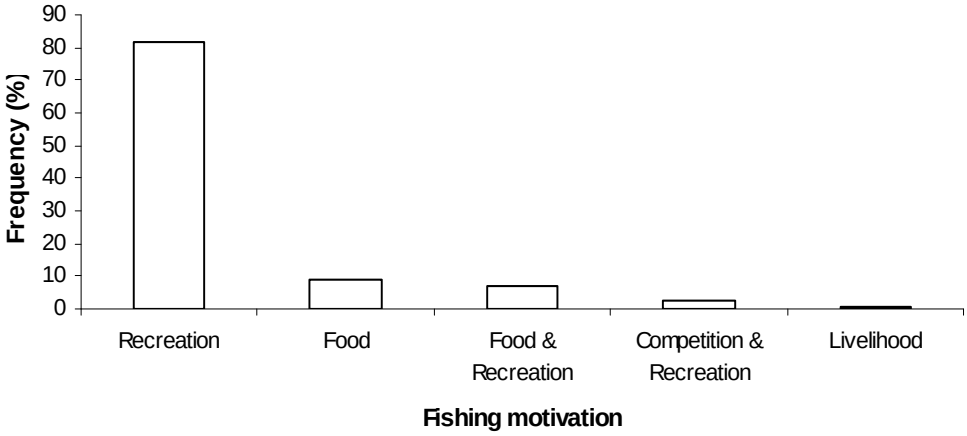


Figure 3.2. Motivation by interviewed anglers to participate in linefishing along the Plettenberg Bay coastline.

Most (60%) of the interviewees agreed with current linefish regulations. Marine reserves (68 %) were stated to be the most effective management measure for conserving linefish stocks, followed by closed seasons (58%) (Figure 3.3). As expected, the response of anglers to their compliance with the regulations was high; marine reserves (79%), bag limits and size limits (78%) and closed seasons (73%). Anglers' responses to whether the majority of local anglers abided by regulations, however, conflicted with these admitted compliance figures.

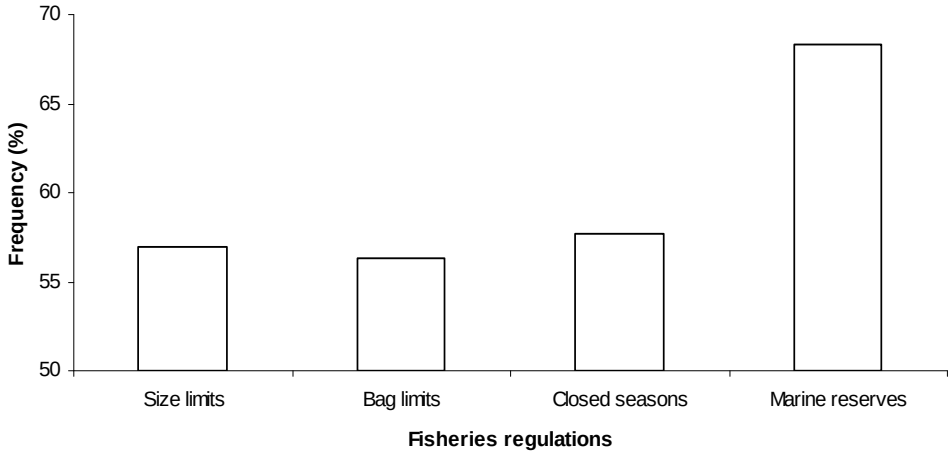


Figure 3.3. Frequency of respondents agreeing to the effectiveness of the current linefish regulations.

The test scores of anglers' knowledge regarding the current regulations were highest for closed seasons 62% (SD ± 61%) while the scores where both below 50% for size limits 25% (SD ± 27%) and bag limits 38% (SD ± 44%). A large majority of anglers (69%) reported a decline in catch rate over the years, however, only 16 % reported a decline in the average size of fish caught and only 10% were of the opinion that the composition of their catches had changed (Figure 3.4).

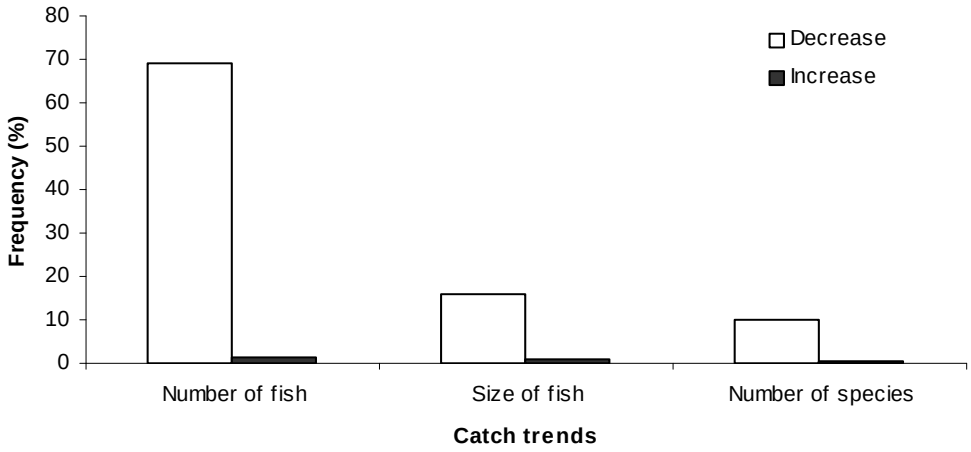


Figure 3.4. Response by anglers to changes in linefish catches over the years (n=682).

Several reasons were given for the assumed decline (Figure 3.5), with the majority saying that commercial fishing, particularly trawling, was to blame followed by general over-exploitation. The resident seal colony on the Robberg Peninsula, which has expanded from 8 individuals to approximately 2500 in the past few decades (Niewoudt 2003, WCNCB, pers comm.) is blamed by all fishing sectors for the decline of linefish stocks in the bay. Other reasons were dolphins, recreational ski-boat anglers, recreational shore anglers, pollution and the netting of white steenbras in False Bay, Cape Town.

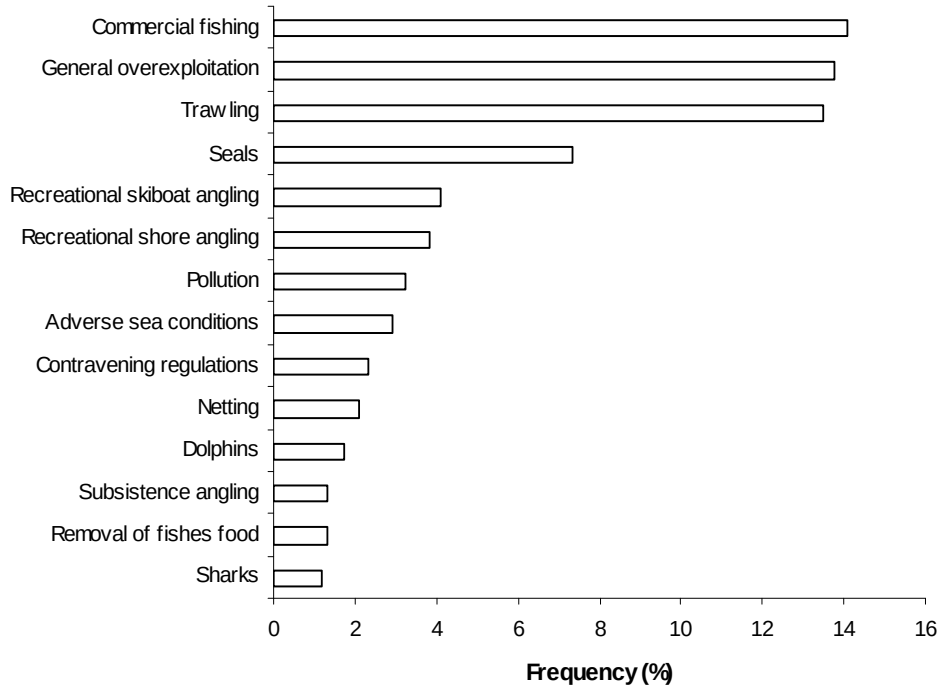


Figure 3. 5. Reasons given by anglers for the decline in linefish along the Plettenberg Bay coastline.

The frequency of angler inspections by MCM or CNC enforcement officers was low with only 42 % of the anglers ever being inspected.

3.3.2 Effort

The total estimated annual effort was 102 566 (SD ± 4862) angler-hours from September 2003 to August 2004. Peaks in effort were recorded during December, January, April and July, which coincide with the influx of holidaymakers to the area during the provincial school holidays. January receiving the greatest amount of effort (19 974 angler-hours) (Figure 3.6).

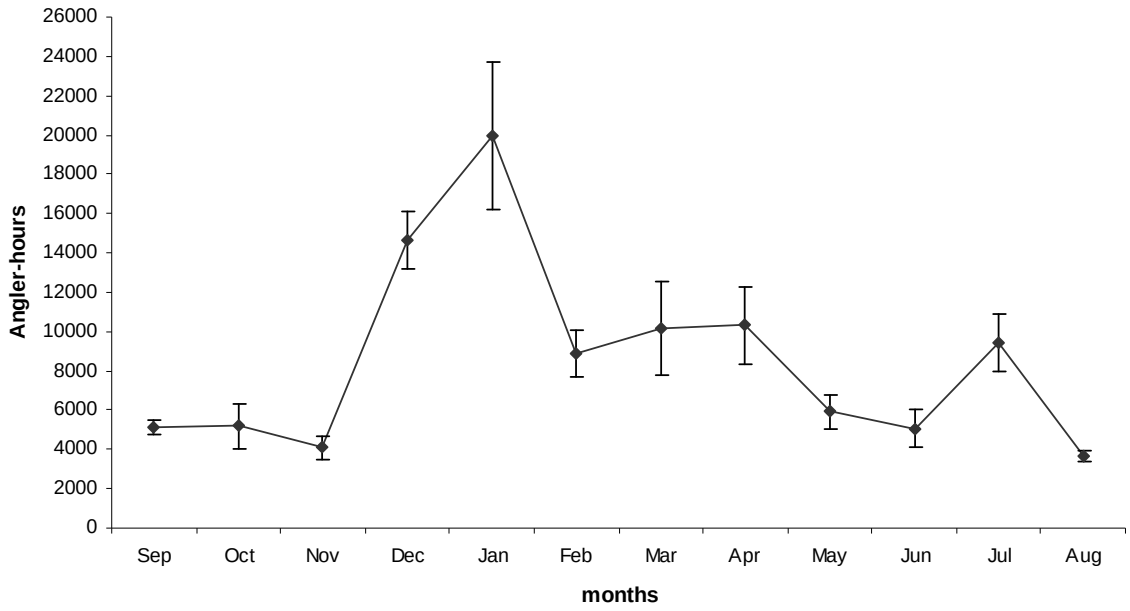


Figure 3.6. Estimated mean monthly effort expressed in angler-hours (mean ±SD) for the shore-based fishery in Plettenberg Bay from September 2003 to August 2004.

Distribution of fishing effort according to the different zones revealed that effort was greatest in zone 4 followed by zone 2, whilst zone 1 received the least amount of effort (Figure 3.7).

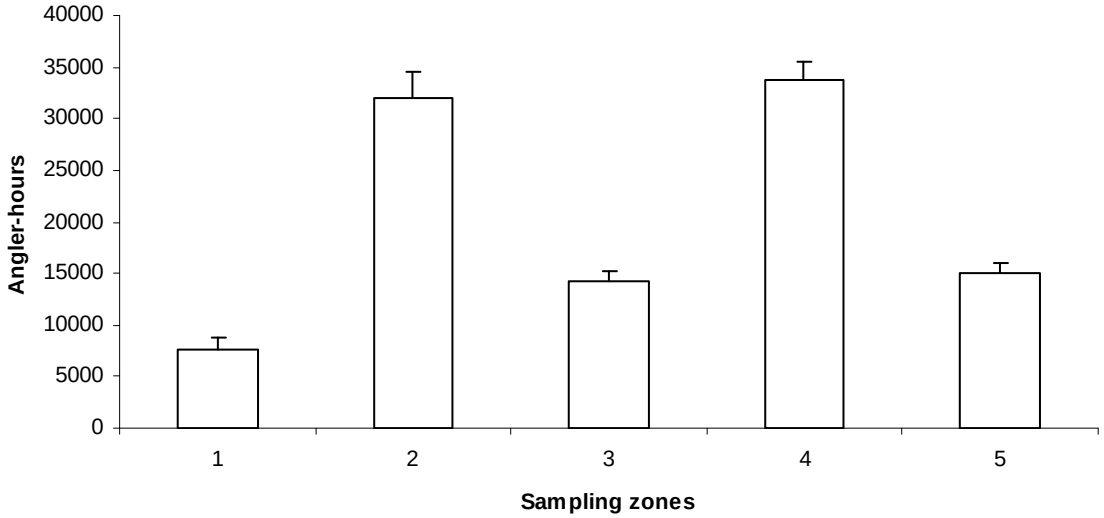


Figure 3.7. Estimated fishing effort in angler-hours (mean ±SD) in the five sampling areas in Plettenberg Bay.

3.3.3 Boat-based angler counts

The average shore angling effort for the entire sampling area deduced from boat-based angler counts was 0.72 ± 0.36 anglers.km^{-1}and 0.71 ± 0.39 anglers.km^{-1} from the roving survey counts (Table 3.2). The similarity ($p < 0.05$) in the effort estimates suggests that these methods are comparable and that the roving surveys were efficient in estimating total effort. The boat-based counts also validated that effort was greatest in zones 2 and 4.

Table 3.2. The number of anglers counted during roving creel and boat-based surveys and the average number of anglers per kilometer in four of the study areas from October 2003 to August 2004.

Survey method	Zone	Total distance patrolled (km)	Total no. of anglers counted	Anglers.km^{-1}
Roving creel survey	2	1305.15	820	0.63
	3	1311.75	409	0.31
	4	659.34	821	1.25
	5	694.32	459	0.66
	Total	3970.56	2509	0.71
Boat-based survey	2	261.03	203	0.78
	3	262.35	78	0.30
	4	219.78	254	1.16
	5	173.613	110	0.63
	Total	916.773	645	0.72

3.3.4 Spatial distribution of effort

Figure 3.8 illustrates the distribution of fishing effort along the Plettenberg Bay coastline, with the darker red areas indicating fishing spots that received the greatest amount of effort. Three “hot spots” were identified; central beach with its two rocky outcrops, Keurboomstrand and Natures Valley. Meidebank was the most commonly fished spot in zone 1 (Figure 3.9) as it is the most accessible spot from the car park. In zone 2 the rocky promontories namely, Beacon Isle rocks (161 anglers) and

Lookout rocks (228 anglers) received the highest amount of effort (Figure 3.10). In zone 3 the greatest amount of fishing effort was recoded near the public car park at The Waves and at a rocky outcrop, Bloubankies (Figure 3.11). Zone 4 had numerous fishing spots, but The Island received the greatest concentration of effort, followed by Piet se bank (Figure 3.12). In zone 5 popular areas included Natures Valley beach, Sinker bay and Salt River mouth (Figure 3.13).

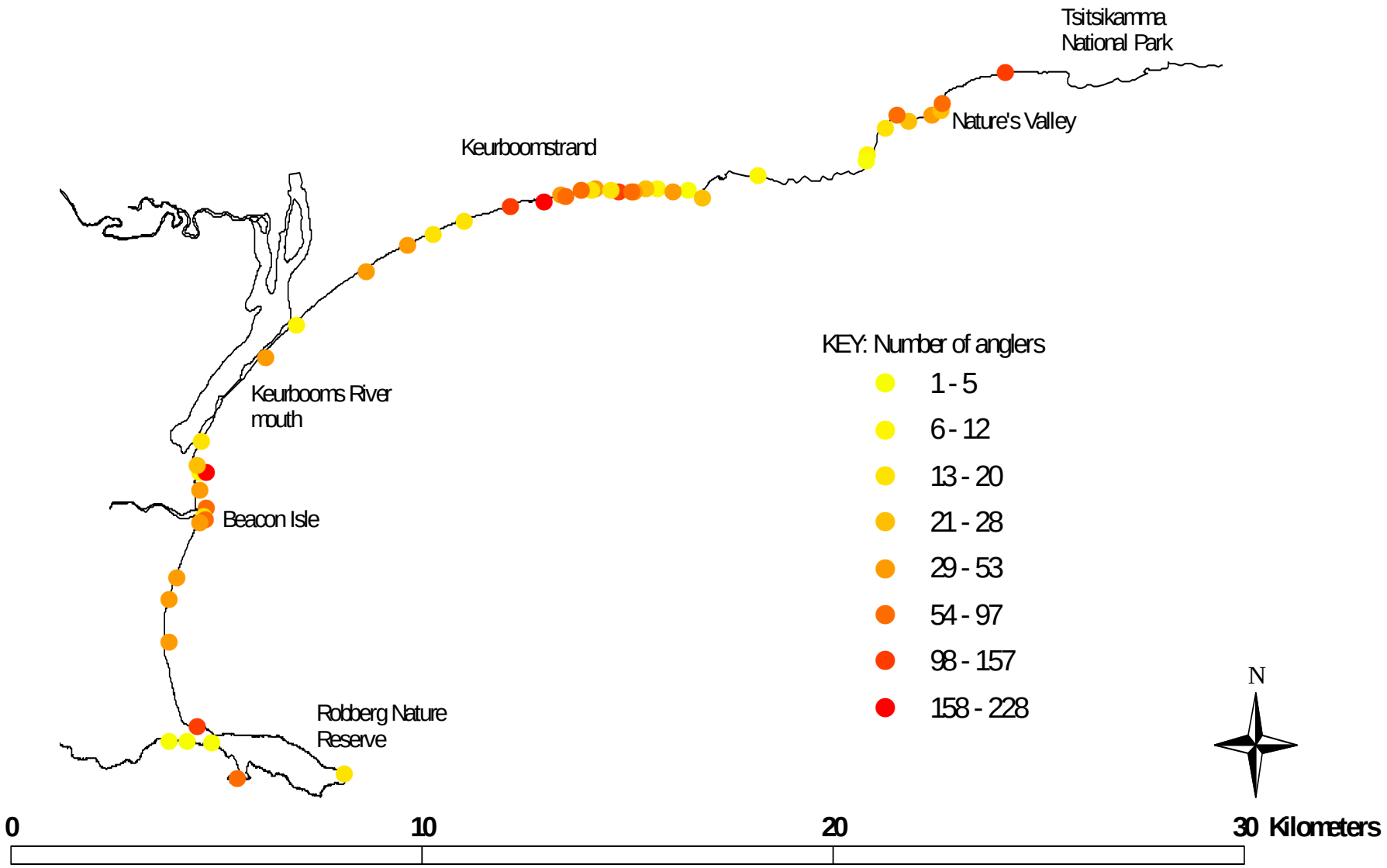


Figure 3.8. The distribution of fishing effort (expressed as no. of anglers) along the Plettenberg Bay coastline recorded during fishery surveys from September 2003 to August 2004.

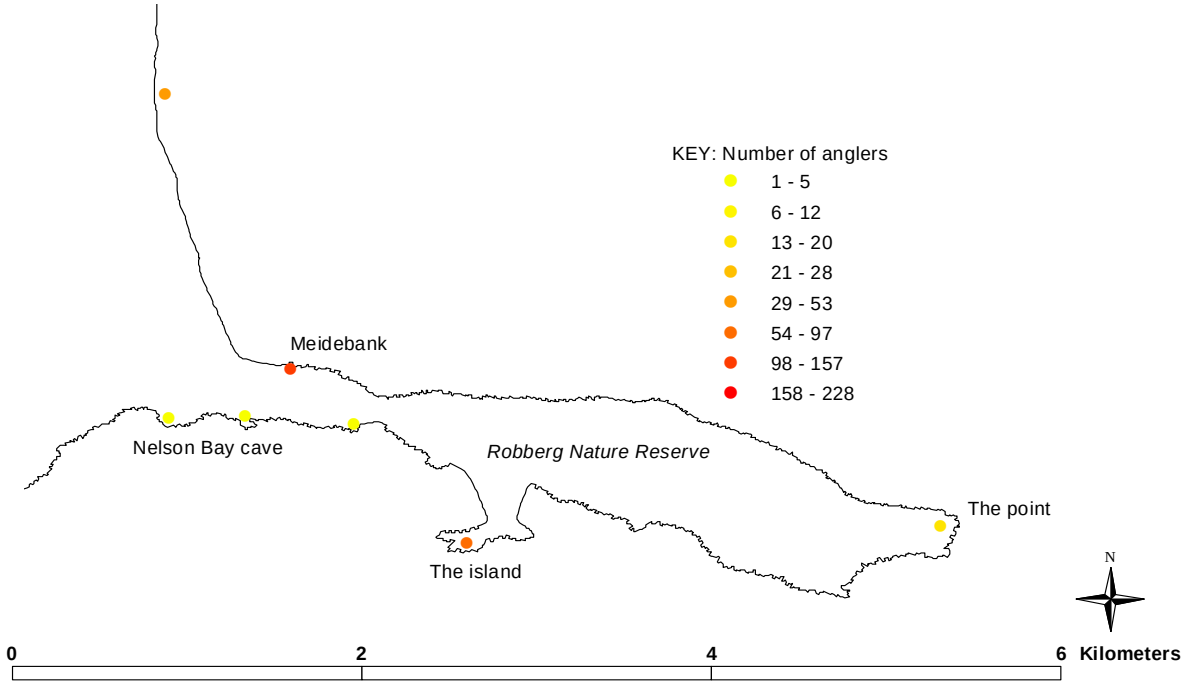


Figure 3.9. Distribution of fishing effort in zone 1, expressed as number of anglers recorded during the entire survey period (September 2003 – August 2004).

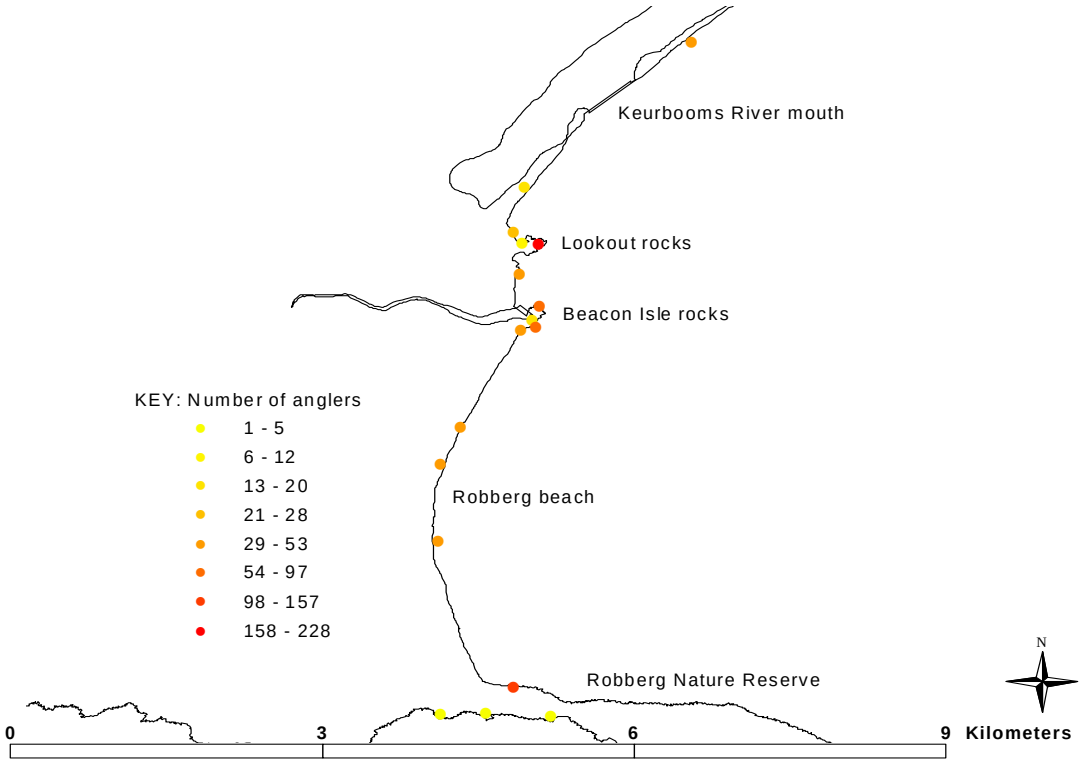


Figure 3.10. Distribution of fishing effort in zone 2, expressed as number of anglers recorded during the entire survey period (September 2003 – August 2004).

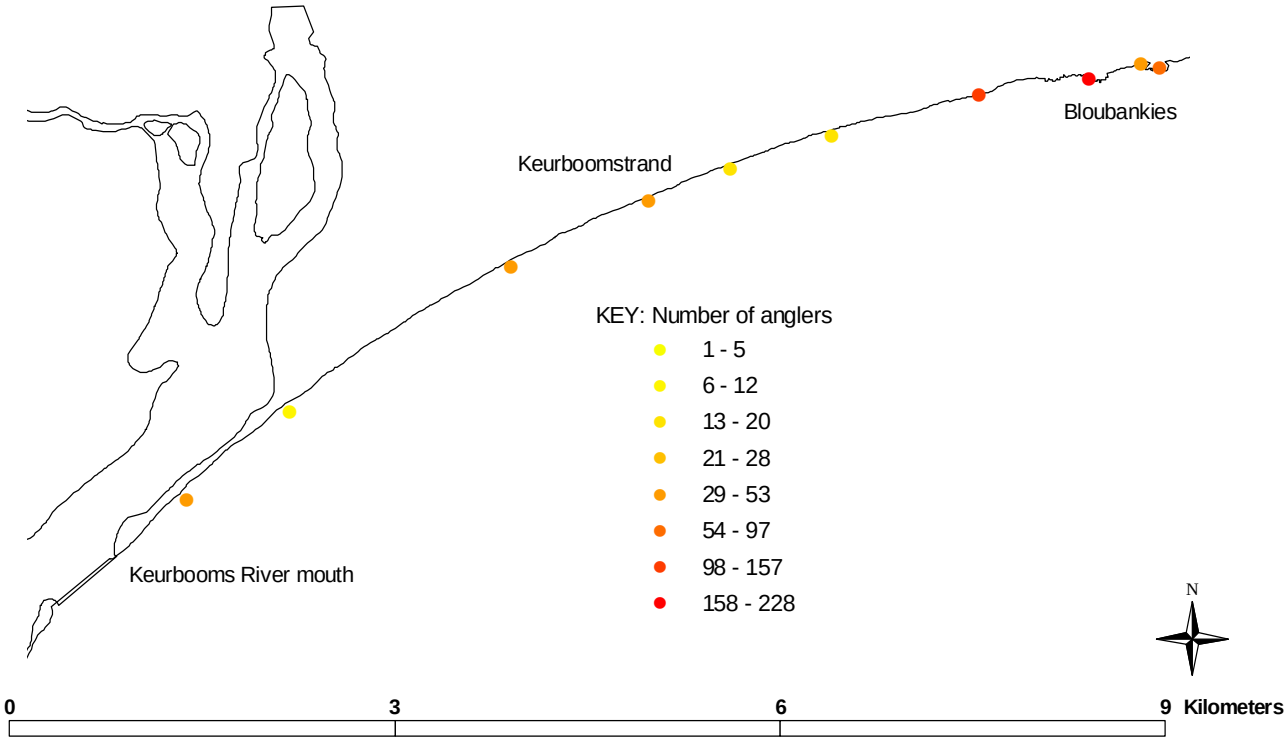


Figure 3.11. Distribution of fishing effort in zone 3, expressed as number of anglers recorded during the entire survey period (September 2003 – August 2004).

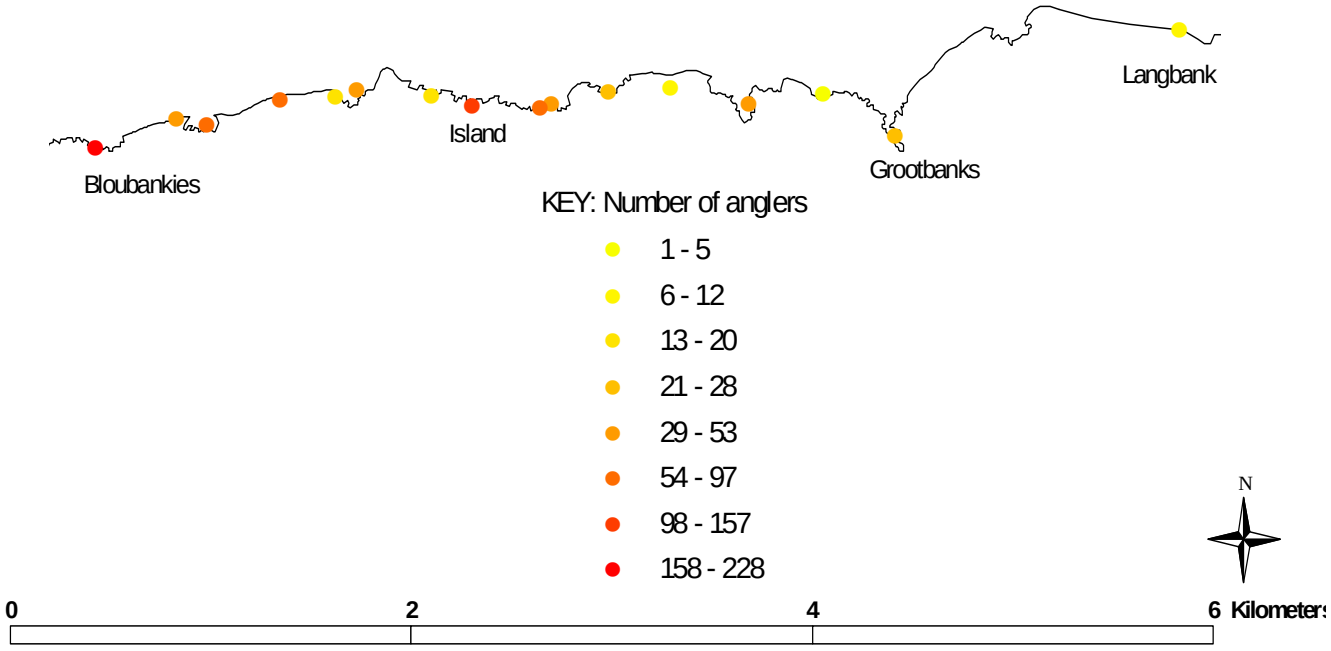


Figure 3. 12. Distribution of fishing effort in zone 4, expressed as number of anglers recorded during the entire survey period (September 2003 – August 2004).

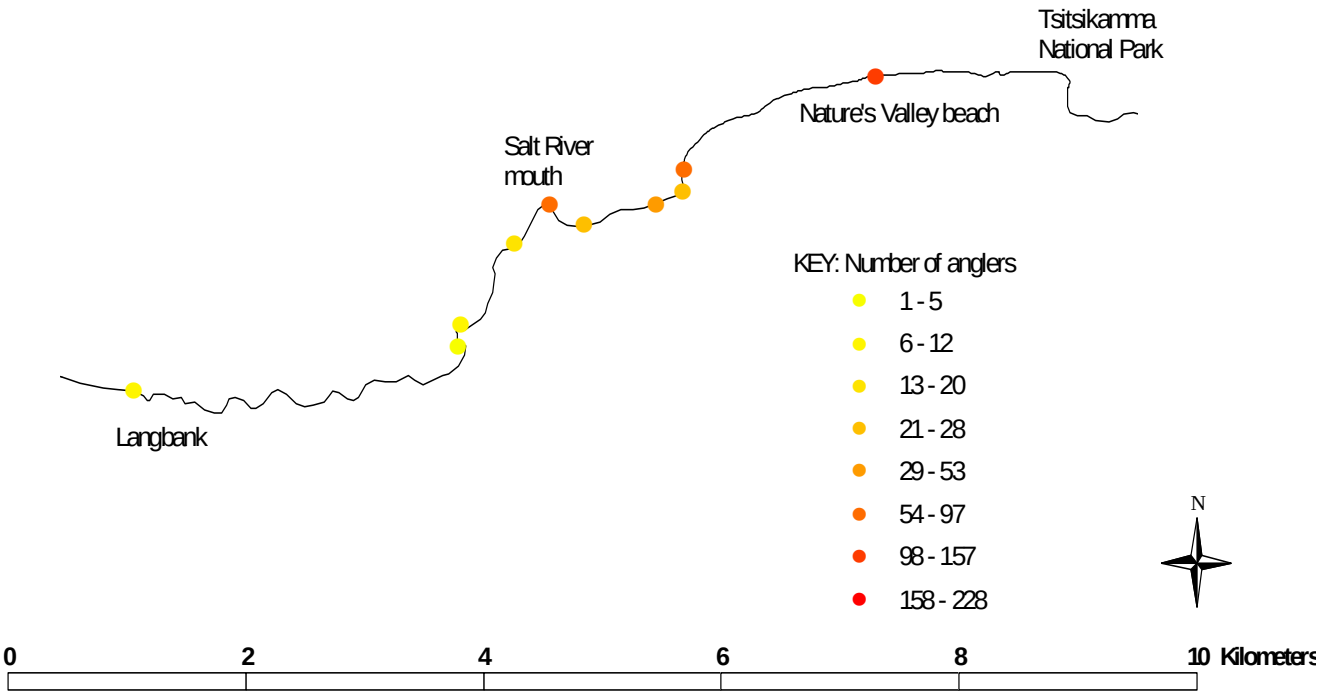


Figure 3.13. Distribution of fishing effort in zone 5, expressed as number of anglers recorded during the entire survey period (September 2003 – August 2004).

3.3.5 Catch composition

Thirty-six fish species (26 teleost species and 10 elasmobranchs species) representing 18 families were identified during the survey period (Table 3.3). The most commonly represented family amongst the teleosts was Sparidae (13 species). Blacktail *Diplodus sargus capensis* (20%) was the most commonly caught species by number, followed by strepie *Sarpa salpa* (15%), red tjor-tjor *Pagellus natalensis* (12%), shad *Pomatomus saltatrix* (12%) and sand steenbras *Lithognathus mormyrus* (10%). Since mass was not calculated for elasmobranchs, as the majority were released before survey clerks could measure them, the percentage catch composition by mass could only be calculated for teleosts. Blacktail not only dominated the teleost catch by number but also by mass

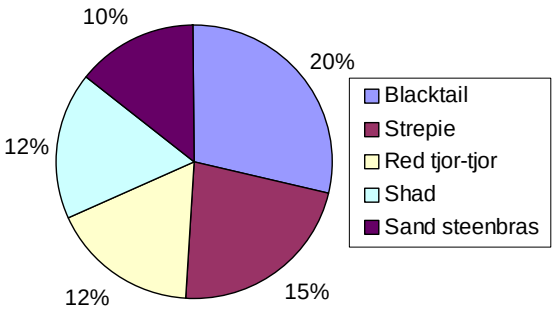
(68%), followed by white steenbras *Lithognathus lithognathus* (8%), shad (7%), musselcracker *Sparodon durbanensis* (4%) and dusky kob (3%) (Figure 3.14).

Table 3.3. Catch composition of all fish (retained and released) recorded from the Plettenberg Bay shore-based linefishery from September 2003 to August 2004.

Species	Common name	Number caught	Percentage composition	Size range (mm FL)
CHONDRICHTHYES				
Callorhinchidae				
Callorhinchus capensis	Elephant fish	1	0.08	-
Carcharhinidae				
Carcharhinus brachyurus	Bronze whaler	12	1.01	-
Carcharhinus limbatus	Blacktip	3	0.25	-
Mustelus mustelus	Smoothhound	3	0.25	-
Triakis megalopterus	Spotted gullyshark	1	0.08	-
Rhinobatidae				
Rhinobatos annulatus	Lesser sandshark	68	5.73	-
Scyliorhinidae				
Haploblepharus edwardsii	Puffadder shyshark	2	0.17	-
Poroderma africanum	Striped catshark	3	0.25	-
Poroderma pantherium	Leopard catshark	1	0.08	-
Sphyrnidae				
Sphyrna zygaena	Smooth hammerhead	3	0.25	-
OSTEICHTHYES				
Ariidae				
Galeichthyes feliceps	White seacatfish	3	0.25	-
Carangidae				
Lichia amia	Leervis	1	0.08	-
Cheilodactylidae				
Chirodactylus brachydactylus	Twotone fingerfin	1	0.08	-
Clinidae				
Pavoclinus graminis	Grass kilpvis	2	0.17	-
Coracinidae				
Dichistius capensis	Galjoen	11	0.93	301-549
Haemulidae				
Pomadasys commersonii	Spotted grunter	22	1.85	361-665
Monodactylidae				
Monodactylus falciformis	Cape moony	27	2.28	170-345
Mugilidae				
Several species	Mullet spp	63	5.31	-
Pomatomidae				
Pomatomus saltatrix	Elf/Shad	140	11.80	290-493
Sciaenidae				
Argyrosomus japonicus	Dusky kob	28	2.36	319-905
Umbrina canariensis	Baardman	1	0.08	-
Kyphosidae				

Neoscorpis lithophilus	Stonebream	4	0.34	252-339
Serranidae				
Epinephelus marginatus	Yellowbelly rockcod	1	0.08	-
Sparidae				
Boopsoidea inornata	Fransmadam	9	0.76	134-200
Chrysoblephus laticeps	Red roman	3	0.25	291-343
Cymatoceps nasutus	Poenskop	1	0.08	-
Diplodus cervinus hottentotus	Zebra	10	0.84	193-449
Diplodus sargus capensis	Blacktail	233	19.65	180-415
Gymnocrotaphus curvidens	Janbruin	1	0.08	-
Lithognathus lithognathus	White steenbras	33	2.78	241-986
Lithognathus mormyrus	Sand steenbras	113	9.53	-
Pachymetopon grande	Bronze bream	1	0.08	-
Pagellus natalensis	Red tjor-tjor	146	12.31	-
Rhabdosargus holubi	Cape stumpnose	49	4.13	182-406
Sarpa salpa	Strepie	174	14.67	160-285
Sparodon durbanensis	Musselcracker	12	1.01	300-809
		1186		

a



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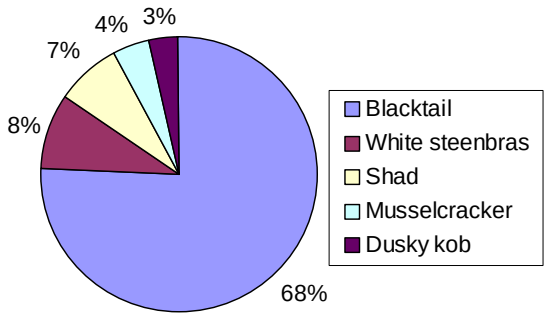

Figure 3.14. Percentage catch composition by number (a) and mass (b) for the top five teleost species caught from September 2003 – August 2004.

Figure 3.15 provides a breakdown of the top five species caught in each sampling zone and highlights that the majority of fish were caught in zone 4 (38%) followed by zone 2 (32%). For the purposes of this study sharks and rays were clumped into the category “elasmobranch” as anglers were rarely able to identify sharks to the species level and commonly released them before the survey clerks could correctly identify them. Lesser sandsharks *Rhinobatos annulatus*, were however, easily identifiable and were included in the analysis. This species formed a considerable proportion of the catch in zones 3 (34%) and 5 (22%), both of which have long sandy beaches which is the common habitat for this species (van der Elst, 1993). The catch in zone 1 was dominated by typical live bait species such as sand steenbras (25%), followed by strepie (25%) and mullet (22%), which were used to catch leervis - the most highly targeted species (34%) in zone 1 (Figure 3.20). Elasmobranchs were also commonly caught in zone 1 and featured in the top 5 species caught in this zone. In zone 2 sporadic catches of red tjor-tjor were recorded, which were associated with cold upwelling events and consequently were heavily targeted because of their prolific numbers. Blacktail was most abundant in zone 4 and featured in the top five species caught for all zones except zone 3, which is predominantly sandy beach.

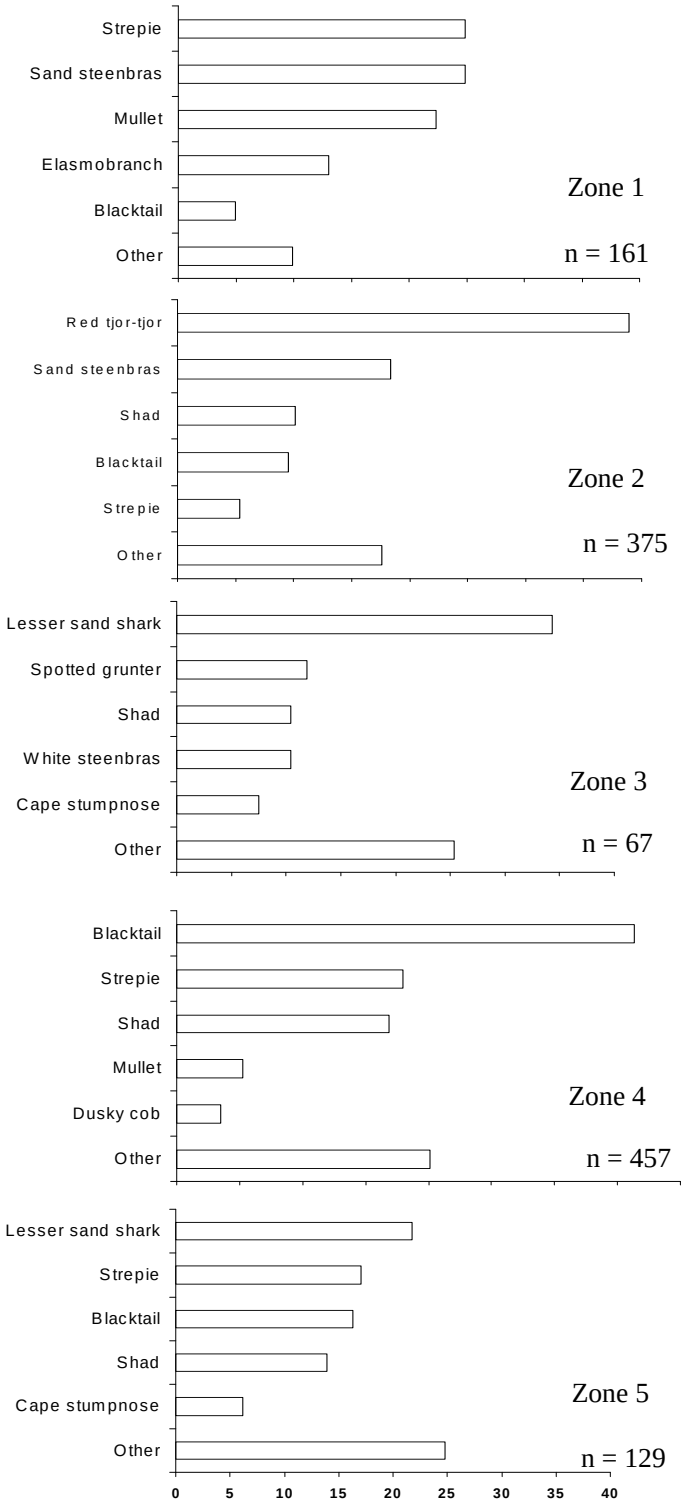

Figure 3.15. Top five species caught in the five sampling zones and their contribution (%) to the total catch (kept and released) in each zone from September 2003 – August 2004. n = number of fish recorded.

The retained (caught and kept) catch of many anglers contravened the minimal legal size limit (Table 3.4). White steenbras was the most commonly kept undersized fish (61%) followed by zebra (56%) and galjoen (44%). Anglers rarely reached their bag limits. Throughout the survey period, bag limits were only reached for shad (6%) and blacktail (3%). The majority of anglers abided by the closed seasons except for a minimal number of shad (1%) being caught in the closed season.

Table 3.4. Percentage of catch (retained) by anglers that contravened the regulations (Marine Living Resources Act, 1998 (Act No.18 of 1998)).

Species	Minimum size limit (mm)	% Undersized	Closed season	% Out of season	Bag limit	% Over bag limit
Galjoen	350	44	15 Oct - 28 Feb	0	5	-
Zebra	300	56	na	-	5	-
Musselcracker	600	35	na	-	5	-
Spotted grunter	400	29	na	-	5	-
Dusky cob	400	9	na	-	10	-
Shad	300	2	1 Sep - 30 Nov	1	5	6
White steenbras	600	61	na	-	5	-
Cape stumpnose	200	25	na	-	5	-
Blacktail	200	6	na	-	5	3

Monthly trends revealed that catches were greatest during January, with an estimated 16 334 fish caught weighing 4.1 tons. The average yield for the remainder of the year was 2 777 fish (2.7 tons) per month (Figure 3.16). The total annual catch for the Plettenberg Bay shore-based linefishery was estimated at 31 217 fish.year^{-1} with a total mass of 13.6 tons.

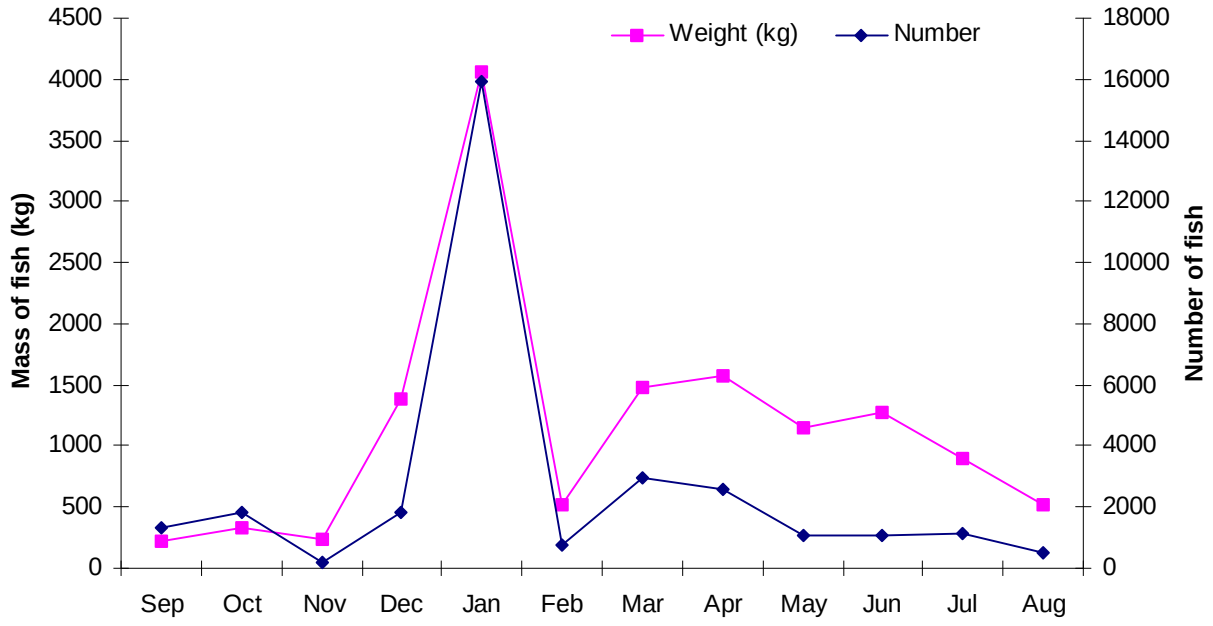

Figure 3.16. Estimated total monthly catch in terms of number of fish and weight of fish in the Plettenberg Bay shore-based linefishery between September 2003-August 2004.

3.3.6 Catch per unit effort

The mean annual *cpue* was estimated at 0.374 (± 0.325) fish.ang.hr^{-1} or 170 (± 162.1) grams.ang.hr^{-1}. Monthly trends in *cpue* (expressed numerically) exhibited peaks during January, February, April, June and September, all of which coincided with provincial school holiday periods (Figure 3.17). *Cpue* (expressed by weight) followed a similar trend except for May when a few large fish (musselcraker, white steenbras and dusky kob) were recorded causing the gravimetrical *cpue* to rise.

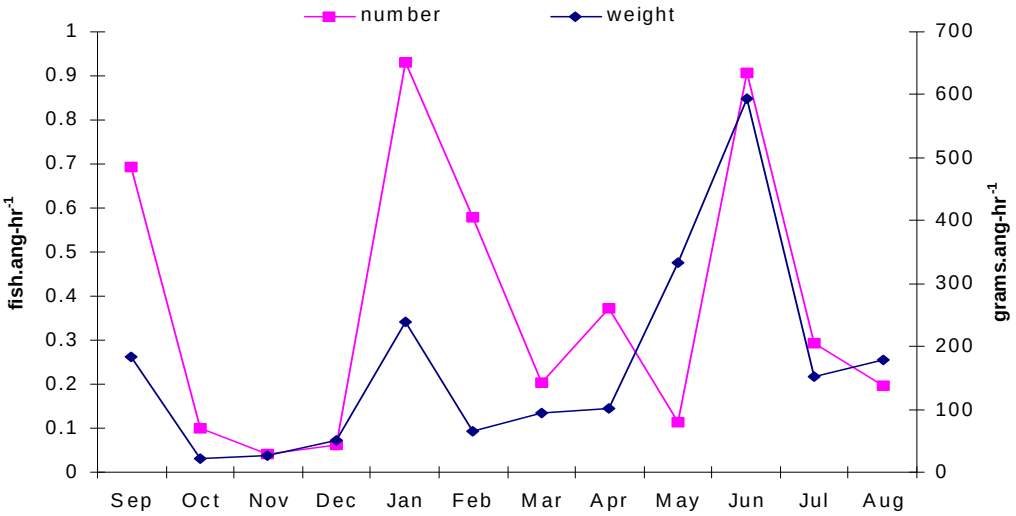

Figure 3.17. Mean monthly *cpue* by number (fish.ang-hr^{-1}) and weight (grams. ang-hr^{-1}) recorded on the Plettenberg Bay coastline from September 2003 to August 2004.

Analysis of *cpue* by zone revealed that *cpue* by number was greatest in zone 1, attributed to the high number of bait fish caught (sand steenbras, strepie and mullet). *Cpue* by mass was greatest in zone 5. The large difference in weight compared to number of fish caught in this zone was attributed to a few large musselcracker and white steenbras (Figure 3.18).

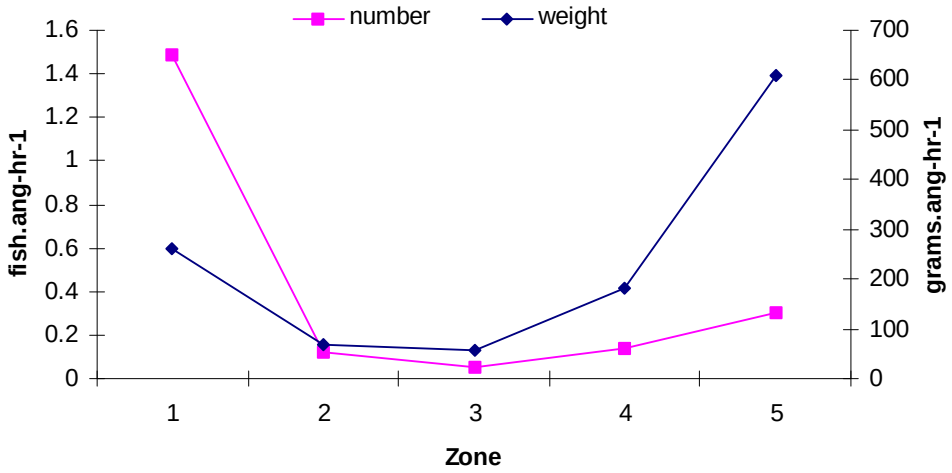

Figure 3.18. Average monthly *cpue* by number and weight for teleost species caught in the different zones from September 2003 to August 2004.

3.3.7 Targeted effort and success rate

White steenbras (22%) was the most commonly targeted species on the Plettenberg Bay coastline, followed by dusky kob (18%), shad (18%) and blacktail (14%) (Figure 3.19).

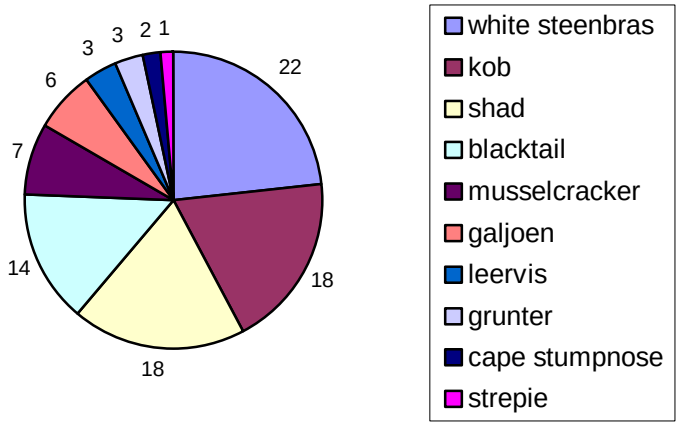

Figure 3.19. Percentage composition of the top 10 targeted species in the Plettenberg Bay shore-based linefishery between September 2003 and August 2004.

Target effort in each zone, however, revealed that leervis (34%) was the most commonly targeted species in zone 1, white steenbras in zones 2 and 3, dusky kob in zones 3 and 5, shad in zones 2 and 5, and blacktail in zone 4 (Figure 3.20).

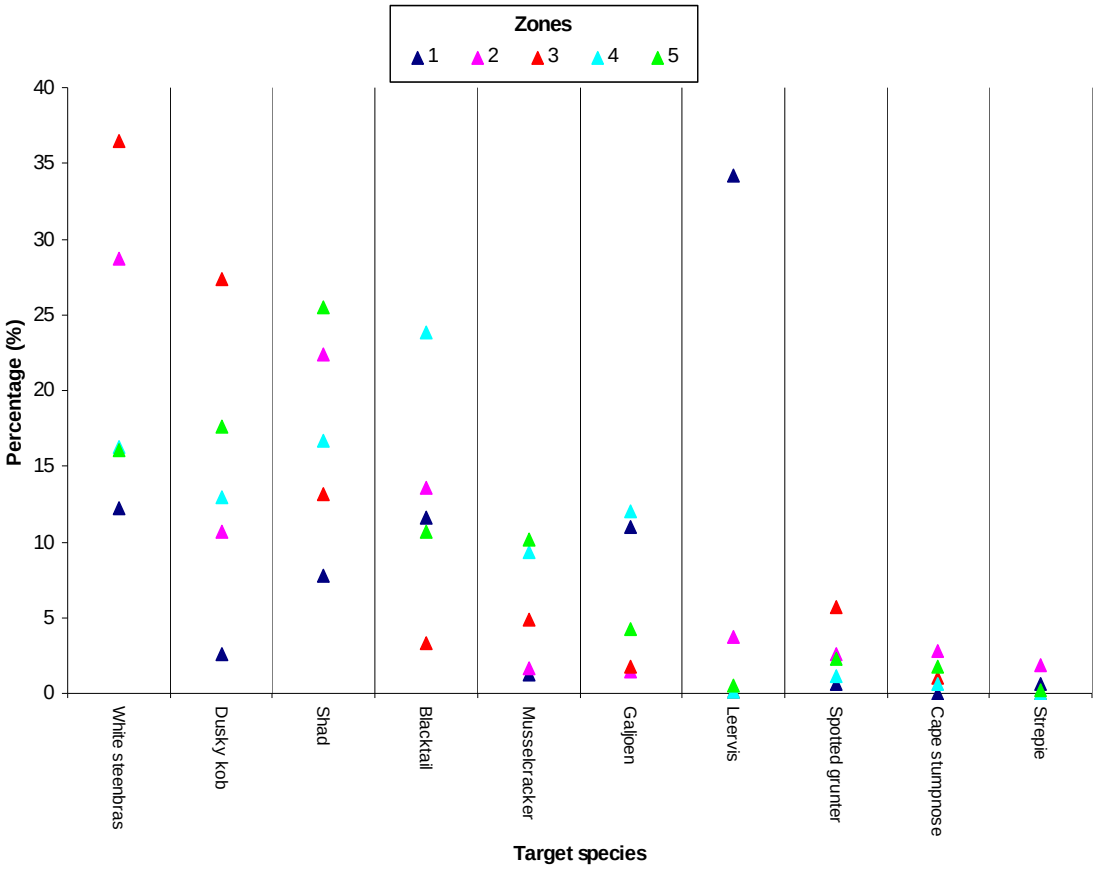

Figure 3.20. Top ten targeted species by all interviewed anglers in the different zones on the Plettenberg Bay coastline between September 2003 and August 2004.

Of all the interviewed anglers only 32% caught fish. An analysis of the percentage of anglers who caught their targeted species revealed that only 22% of the anglers caught their primary targeted species, 8% their secondary targeted species and only 2% their tertiary targeted species. No angler caught all three of their targeted species, with only 2.5 % of the anglers catching their primary and secondary targeted species and less than 1% caught either their secondary and tertiary targeted species or their primary and tertiary targeted species.

Targeting of specific species revealed that 36% of anglers who were targeting blacktail (as either their primary, secondary or tertiary targeted species) were successful, while 20% who were targeting shad were successful (Figure 3.20).

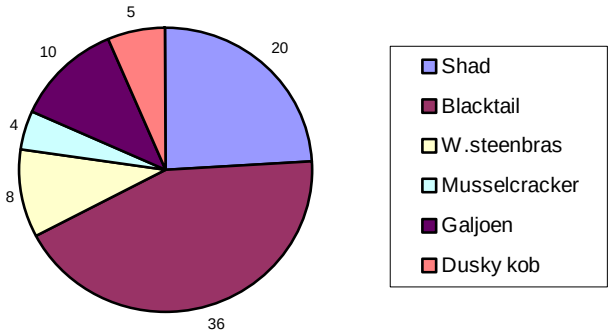

Figure 3. 20. Percentage of anglers interviewed who caught at least one of their three targeted species along the Plettenberg Bay coastline between September 2003 and August 2004.

3.3.8 Bait use

Shore anglers used a variety of purchased and collected bait organisms. Twenty-three different types of bait were recorded during this study (Table 3.8). The most frequently bought bait species were pilchard (63%) and chokka (32%), while red bait (25%), sand prawn (12%) and white mussel (11%) were the most commonly collected bait species (Figure 3.25).

Table 3.8. Bait species encountered during this study and the frequency of use.

	Scientific name	Common name	Frequency encountered
Exclusively purchased species	*Loligo vulgaris reynaudii*	Chokka	219
	Penaeid spp.	Pink prawn	26
	Sardinops sagax	Pilchard	431
Polychaeta	*Pseudonereis variegata*	Mussel worm	43
	Arenicola loveni	Bloodworm	19
	Marphysa sanguinea	Estuarine wonder-worm	4
Crustacea	*Callianassa kraussi*	Common sandprawn	83

	Upogebia africana	Estuarine mudprawn	35
	Ovalipes trimaculatus	Three-spot swimming crab	14
	Plagusia chabrus	Cape rock crab	4
Mollusca	*Donax serra*	White mussel	75
	Haliotis spadicae	Siffie/Venus ear	27
	Octopus vulgaris	Octopus	14
	Solen capensis	Pencil bait	9
	Perna perna	Brown mussel	1
	Turbo sarmaticus	Alikreukal	1
	Patellidae *spp.*	Limpet	1
Tunicata	*Pyura stolonifera*	Red bait	169
Teleostei	Mugilidae *spp.*	Mullet	11
	Sarpa salpa	Strepie	3
	Lithognathus mormyrus	Sand steenbras	3
	Scomber japonicus	Mackerel	3
	Pomatomus saltatrix	Shad	5

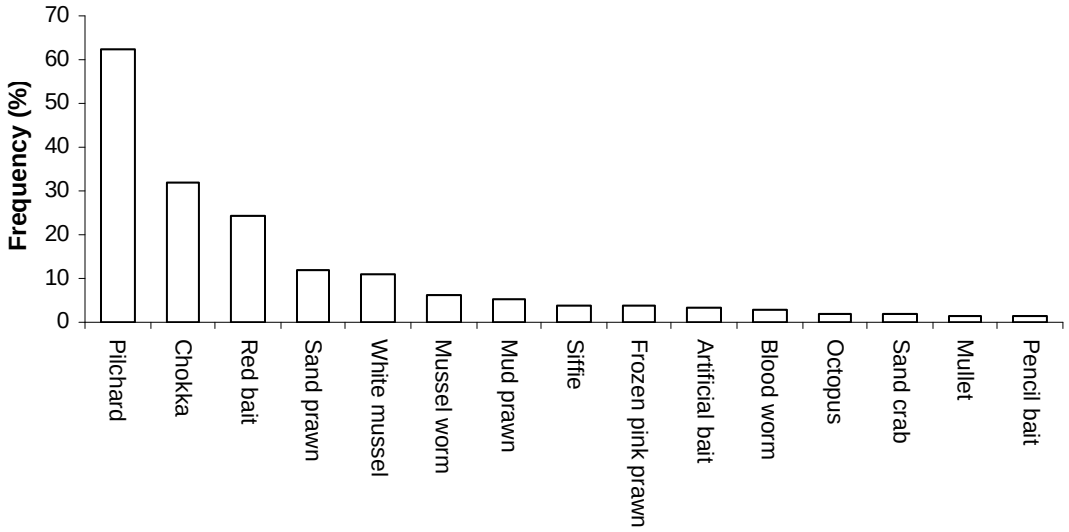

Figure 3. 21. The percent frequency of each type of bait used by anglers interviewed on the Plettenberg Bay coastline from September 2003 to August 2004.

Responses to the preferred bait organisms by anglers revealed similar trends to that encountered during fishery survey. The top five preferred bait organisms were red bait (22%), pilchard (15%), sand prawn (13%), white mussel (10%) and chokka (10%).

Trends in bait abundance showed that 36% percent of the anglers thought that there was no difference in bait abundance from when they first fished in the area (on average local anglers had 22 years fishing experience). Twenty-five percent, however, were of the opinion that there had been a decline in bait abundance, of which red bait was singled out as having declined the most (20%) followed by siffie/venus ear (16%) and in terms of estuarine bait resources anglers claimed common sand prawn (14%) and pencil bait (9%) have declined in abundance. In response to possible threats facing local bait resources, 28% of the anglers said there were none, while 21% blamed overexploitation to be the major cause for declines.

A quiz on bait regulations revealed that only 27% of all interviewees knew the regulations pertaining to bag limits of certain species. For the bait species most commonly targeted, 22% knew the regulations for red bait, 51% for sand prawn and 35% for white mussel. Of the anglers interviewed 54% claimed to be in possession of a bait-collecting permit.

3.3.9 A COMPARISON OF THE CATCH COMPOSITION, *CPUE* AND SIZES BETWEEN THE TNP, REBELSRUS AND PLETTENBERG BAY.

The TNP data set revealed the highest diversity of teleost species (n=32), followed by Plettenberg Bay (n=26) and Rebelsrus (n=24) (Table 3.9). Of the important linefish species not more than five of the following species (red roman, bronze bream, John brown and poenskop) were recorded in total during the survey period, whilst santer were not caught at all in Plettenberg Bay, while dusky kob and white steenbras, probably due to the lack of sandy habitats, were not captured in Rebelsrus (Table 3.11). Of interest is the large number of red tjor-tjor caught in Plettenberg Bay and lack of it in catches in the other two areas. The most noticeable difference in terms of elasmobranchs between the

areas was the lack of lesser guitarfish at Rebelsrus, the large number of bronze whalers captured in Plettenberg Bay and the lack of catsharks in Plettenberg Bay.

The overall teleost *cpue* was highest in the TNP followed by Rebelsrus and then Plettenberg Bay (Table 3.9), whereas for elasmobranchs the overall *cpue* was highest at Rebelsrus, followed by the TNP and then Plettenberg Bay (Table 3.10). Teleost *cpue* in Plettenberg Bay was less than one third that of other areas and for important linefish species and *cpue* for blacktail, galjoen and musselcracker was over five times higher in the TNP and Rebelsrus compared to Plettenberg Bay. The *cpue* of shad was slightly higher in the exploited area than in the TNP and Rebelsrus and the *cpue* of dusky kob was twice as high in the TNP when compared to the exploited area (Table 3.9).

Comparisons of the sizes of those fish that are fairly resident and thus benefit from the protection of marine reserves reveal that the majority of fish are larger in the TNP than both the semi-exploited and exploited area, with the exception of blacktail, dusky kob, shad, white steenbras which are larger in Plettenberg Bay and John brown in Rebelsrus, respectively (Table 3.11). Red roman were largest in the TNP with a 110mm difference in fork length between the TNP and Plettenberg Bay. Although the *cpue* for poenskop is similar between the TNP and Rebelsrus individuals were larger in terms of average weight and maximum size in the TNP, which shows that even moderate fishing pressure effects life history traits. Despite the significantly lower *cpue* for musselcracker in Plettenberg Bay compared to the TNP and Rebelsrus, individuals were on average twice as large in Plettenberg Bay than in the TNP, and four times larger than those in Rebelsrus.

Table 3.9. A comparison of the teleost catch composition and *cpue* between the Tsitsikamma National Park (TNP), Rebelsrus (REB) and Plettenberg Bay (PLETT) from February 2004 to December 2004.

Species	Common name	TNP No. captured	REB No. captured	PLETT No. captured	TNP *cpue*	REB *cpue*	PLETT *cpue*
Ariidae							
Galeichthyes feliceps	White seacatfish	21	1	3	0.02	<0.01	<0.01
Galeichthyes ater	Brown seacatfish	8	4	0	<0.01	0.02	0.00
Cheilodactylidae							
Chirodactylus brachydactylus	Twotone fingerfin	23	3	1	0.02	0.01	<0.01
Chirodactylus pixi	Barred fingerfin	3	0	0	<0.01	0.00	0.00
Clinidae							
	klipvius spp.	88	44	2	0.08	0.19	<0.01
Coracinidae							
Coracinus capensis	Galjoen	60	19	11	0.06	0.08	<0.01
Coracinus multifasciatus	Banded galjoen	1	0	0	<0.01	0.00	0.00
Haemulidae							
Pomadasys commersonii	Spotted grunter	0	0	22	0.00	0.00	<0.01
Monodactylidae							
Monodactylus falciformis	Cape moony	0	0	27	0.00	0.00	<0.01
Mugilidae							
	Mullet spp	0	0	63	0.00	0.00	0.01
Pomatomidae							
Pomatomus saltatrix	Elf/Shad	16	5	140	0.02	0.02	0.03
Sciaenidae							
Argyrosomus japonicus	Dusky kob	16	0	28	0.02	0.00	<0.01
Scorpididae							
Neoscorpis lithophilus	Stonebream	1	0	4	<0.01	0.00	<0.01
Serranidae							
Acanthistius sebastoides	Koester	24	4	0	0.02	0.02	0.00
Epinephelus marginatus	Yellowbelly rockcod	1	1	1	<0.01	<0.01	<0.01
Sparidae							
Boopsoidea inornata	Fransmadam	100	5	9	0.10	0.02	<0.01
Cheimerius nufar	Santer	18	0	0	0.02	0.00	0.00
Chrysoblephus laticeps	Red roman	69	1	3	0.07	<0.01	<0.01
Cymatoceps nasutus	Poenskop	107	20	1	0.10	0.09	<0.01
Diplodus cervinus hottentotus	Zebra	70	2	10	0.07	<0.01	<0.01
Diplodus sargus capensis	Blacktail	244	60	233	0.23	0.26	0.05
Gymnocrotaphus curvidens	John brown	35	13	1	0.03	0.06	<0.01
Lithognathus lithognathus	White steenbras	8	0	33	<0.01	0.00	<0.01
Lithognathus mormyrus	Sand steenbras	3	0	113	0.00	0.00	0.03
Pachymetopon blochii	Hottentot	1	0	0	<0.01	0.00	0.00
Pachymetopon grande	Bronze bream	49	4	1	0.05	0.02	<0.01
Pagellus natalensis	Red tjor-tjor	0	0	146	0.00	0.00	0.03
Rhabdosargus holubi	Cape stumpnose	20	1	49	0.02	<0.01	0.01
Sarpa salpa	Strepie	10	10	174	<0.01	0.04	0.04
Spondylisoma emarginatum	Steentjie	1	0	0	<0.01	0.00	0.00
Sparodon durbanensis	White musselcracker	63	9	12	0.06	0.04	<0.01
Tetraodontidae							

Amblyrhnchotes honckenii	Evileyed puffer	4	6	0	<0.01	0.03	0.00
Overall		**1064**	**212**	**1087**	**1.02**	**0.91**	**0.25**

Table 3.10. A comparison of the elasmobranch catch composition and *cpue* between the Tsitsikamma National Park (TNP), Rebelsrus (REB) and Plettenberg Bay (PLETT) from February 2004 to December 2004.

Species	Common name	TNP No. captured	REB No. captured	PLETT No. captured	TNP *cpue*	REB *cpue*	PLETT *cpue*
Callorhinchidae							
Callorhinchus capensis	Elephant fish	0	0	1	0	0	<0.01
Carcharhinidae							
Carcharhinus brachyurus	Bronze whaler	1	0	12	<0.01	0	<0.01
Carcharhinus limbatus	Blacktip	0	0	3	0	0	<0.01
Mustelus mustelus	Smoothhound	1	0	3	<0.01	0	<0.01
Triakis megalopterus	Spotted gullyshark	2	4	1	<0.01	0.02	<0.01
Rhinobatidae							
Rhinobatos annulatus	Lesser sandshark	13	1	68	0.01	<0.01	0.02
Scyliorhinidae							
Haploblepharus edwardsii	Puffadder shyshark	30	4	2	0.03	0.02	<0.01
Haploblepharus fuscus	Brown shyshark	2	12	0	<0.01	0.05	0
Poroderma africanum	Striped catshark	14	1	3	0.01	<0.01	<0.01
Poroderma pantherium	Leopard catshark	13	14	1	0.01	0.06	<0.01
Sphyrnidae							
Sphyrna zygaena	Smooth hammerhead	0	0	3	0	0.00	<0.01
Overall		**76**	**36**	**97**	**0.07**	**0.15**	**0.02**

Table 3. 11. A comparison of the size ranges (FL mm) and average mass (g) in brackets of teleost fish caught in the Tsitsikamma National Park (TNP), Rebelsrus (REB) and Plettenberg Bay (PLETT).

Species	Common name	TNP	REB	PLETT
Diplodus sargus capensis	Blacktail	175-343 (680)	212-313 (679)	133-390 (647)
Pachymetopon grande	Bronze bream	231-460 (1287)	302-380 (1112)	-
Dichistius capensis	Galjoen	281-521 (1711)	310-489 (1801)	270-512 (1095)
Gymnocrotaphus curvidens	John Brown	162-334 -	220-374 -	-
Sparodon durbanensis	White musselcracker	247-785 (2583)	197-577 (1301)	271-740 (5224)
Cymatoceps nasutus	Poenskop	138-490 (462)	210-310 (398)	-
Chrysoblephus laticeps	Red roman	181-420 (770)	-	271-310 (734)
Diplodus cervinus hottentotus	Zebra	142-420 (759)	270-280 (573)	170-382 (685)
Argyrosomus japonicus	Dusky kob	421-810 (2369)	- -	319-905 (1880)
Lithognathus lithognathus	White steenbras	305-437 (835)	- -	210-880 (4208)
Pomatomus saltatrix	Shad	330-402 (915)	390-423 (754)	255-472 (788)

3.4 DISCUSSION

3.4.1 Angler Demographics and attitudes

Understanding the human dimension of fisheries is crucial to successful fisheries management as it is not so much about managing the resource alone but more about managing the users themselves (Ludwig *et al*. 1993, Caddy & Cochrane 2001, Sinclair *et al*. 2002), as they are ultimately responsible for the trends in resource exploitation. A more integrated approach to management is therefore needed. Like many other shore-based fisheries in southern Africa, the Plettenberg Bay linefishery is primarily recreational and dominated by white anglers (Clarke and Buxton 1989, Brouwer *et al*.1997, Mann *et al*. 2003). This domination is attributed to Plettenberg Bay being a prime holiday destination for affluent white people from Cape Town (11%) and Gauteng (10%) with large numbers visiting the area during holiday seasons. Out of season, however, the fishery is dominated by coloured anglers who reside in communities on the outskirts of Plettenberg Bay. Coloured people have a long history of fishing in the area and fish primarily for food; consequently many small fish, which are easier to catch, dominate their catch. In terms of angler sex ratios the majority of anglers were men, a trend common to other shore fisheries on the South African coast (Clarke and Buxton 1989, Mann *et al*. 2003, Attwood and Farquhar 1999) with many of them being middle aged and within the upper earning income brackets in South Africa (Clarke and Buxton 1989, McGrath *et al*. 1997). The subsistence sector constituted a very small component of the shore fishery with only six individuals being identified as truly subsistence; of these two were full-time ghillies. The smaller number of subsistence anglers is a trend common to the rest of the South African linefishery with only 4.5 % of the anglers on the South African coast identified as subsistence (McGrath *et al*. 1997), except for the

Transkei were 33 % of the anglers interviewed were subsistence which is a consequence of a high unemployment rate in the area (Mann *et al*. 2003).

Incorporating angler attitudes and knowledge of current fisheries regulations is important in ensuring sustainable fisheries (Brouwer 1997). If anglers perceive the regulations to be ill conceived and only in place to limit their rights of harvesting a common resource, the resulting compliance will be poor (Bennett 1991). Locally, however, most anglers agreed with the existence of current fisheries regulations but had poor knowledge of these regulations when tested, thereby rendering the regulations to be ineffective. For example, 78% of the anglers proclaimed to comply with the size and bag limits but their knowledge on size and bag limits was only 25% and 38% respectively. A similar trend was found by Brouwer *et al.* (1997). This paradox may be attributed to either a lack of education or unwillingness of anglers to learn the regulations or alternatively it may be a function of the poor enforcement rate. Brouwer *et al.* (1997) established from the national linefish survey that the higher the inspection rate the greater the compliance, for example KwaZulu-Natal had the highest inspection rate of all the coastal provinces and as a result had the greatest proportion of anglers whicj were aware of the regulations, as well as claiming to obey the regulations. In the Plettenberg Bay area the inspection rates were very low and the survey clerks saw only two Western Cape Nature Conservation Board (WCNCB) officers and no MCM enforcement officers during the entire survey period. In terms of specific fishery regulations, marine reserves were chosen by anglers to be the most effective management tool available (68%) and also scored the highest in terms of angler compliance. These specifics are encouraging as MPA's have been suggested as being the best management tool available as they are easier to police and have numerous benefits in sustaining viable fish populations (Attwood and Bennett 1995, Cowley and Hecht 1997). After marine reserves,

closed seasons were considered the next most effective regulation but in terms of stated compliance recorded the lowest score of all the regulations. A possible reason for this was that many anglers perceived the regulation to be ineffective as catches of shad were lowest during the closed season. Bennett (1991) recorded a similar finding for galjoen in the South-Western Cape. Bag limits were thought to be the least effective management measure as anglers rarely caught their bag limit of 5 fish per day. Bag limits were only ever obtained for shad and blacktail, which suggests that this limit of 5 fish.angler^{-1} day^{-1} has little effect in limiting the total catch taken by shore anglers for other species. Attwood and Bennett (1995) reached a similar conclusion from a study on the shore fishery in the South-Western Cape and by Brouwer *et al*. (1997) in the national linefish survey. Despite anglers regarding bag limits as being the least effective regulation, admitted compliance by anglers towards this regulation was high. This, however, may be the result of there being insufficient fish to attain the daily bag limit. With a number of important linefish species being overexploited (e.g. shad) or collapsed (e.g. dusky kob, white steenbras, red roman, musselcracker and poenskop) (Griffiths and Lamberth 2002) this may well be possible. It however, must be acknowledged that these questionnaires were done prior to the amendments of regulations in 2005 (Gazette Vol: 478 No. 27453) which have drastically reduced bag limits and larger size limits for certain species. These amendments may have resulted in an entirely different response from anglers regarding their compliance and views on the effectiveness of the regulations.

Incorporating anglers in management (i.e. co-management) may also be beneficial in ensuring sustainable fisheries in the long-term as compliance is likely to improve if anglers are involved in decision making (Jentoft *et al*. 1998) and experienced anglers may have a wealth of non-scientific information to contribute towards management (Tobey and Volk 2002). For example a number of

anglers suggested increasing the size limits or introducing a maximum size limit to enhance recruitment into the fishery by retaining the larger, more fecund individuals in the fishery. In terms of enforcement a large proportion of anglers suggested that more law enforcement capacity was necessary to improve policing. Interviewees were also aware that the majority of anglers are ignorant of the regulations and suggested education schemes to improve compliance. This also suggests that they themselves may be willing to partake in educational programmes. With reference to MPA's, anglers suggested that closed areas should be cyclical in order to rebuild stocks from which they themselves and future anglers can benefit. However, Russ and Alcala (2003) showed that the rate at which fish biomass and density are lost subsequent to opening a closed area for the first time is much faster than the rate of recovery upon closure.

According to various authors a large majority of anglers believe that catches have declined over the years (van der Elst 1989, Bennett 1991, Bennett *et al*. 1994, Brouwer *et al*. 1997, Attwood and Farquhar 1999). Most shore anglers believe that the commercial sector is responsible for the decline and that their daily bag limits (5 fish per person for most species) cannot have the same impact as the commercial fishers who land tonnes of fish each day (Bennett 1991). Anglers fail to take into account that because of the large number of participants and unlimited access they may be having a greater impact on certain species than the commercial operators (Bennett 1991). Both Bennett (1991) and Gartside *et al*. 1999 believe that the recreational catch may equal or exceed the commercial catch for certain species. Shore anglers also fail to realize that the commercial sector is targeting a range of completely different species that do not even inhabit the inshore zone. Changing angler attitudes is therefore extremely important to ensure sustainability, as currently only 4% of the anglers interviewed perceived themselves to be a threat to local stock abundances. Similarly, on the Cape

south coast only 13% blamed shore anglers for catch declines (Attwood and Farquhar 1999). Implications of this attitude is that anglers will continue to disregard regulations until they comprehend the threat that they are placing on local populations, especially those that are highly resident with limited dispersal capabilities.

3.4.2 Fishing Effort

Fishing effort in Plettenberg Bay was highly seasonal with peaks that coincided with school holidays during December and January, April and July. The greatest amount of effort was expended during the Christmas (34%) and Easter (20%) holiday periods, respectively. Similar effort trends were observed for shore angling in a small open access area in the Tsitsikamma National Park between 1989 and 1995 (Hanekom *et al*.1997). Brouwer (1997) also showed that for the Port Elizabeth shore fishery effort was highest during the Easter holiday period. Similar trends have been reported from estuarine fisheries in the Eastern Cape (Cowley *et al*. 2004).

Temporal variability in effort can also explain the seasonal appearance of certain fish species (Attwood and Farquhar 1999). For example, peaks in effort in January, March and July corresponded with peaks in catches of blacktail and catches of shad in January and March. The high number of red tjor-tjor caught in January, on the other hand, were attributed to the summer-dominated upwelling events and the large number of local anglers that take advantage of their temporal abundance. Unfortunately, long-term trends in effort, cannot be established for the Plettenberg Bay area due to the lack of historic data with which to compare. It can only be assumed that effort has increased in Plettenberg Bay like the rest of the South African coast (McGrath *et al*. 1997), especially since

tourism is booming in the area attracting more and more people each year (Plettenberg Bay IDP, 2005).

The total annual fishing effort for the Plettenberg Bay coastline was estimated at 102 566 angler-hours or 0.66 anglers.km^{-1} from roving creel surveys, which is lower than the national average of 2.33 anglers.km^{-1} and considerably lower than that recorded for the KwaZulu-Natal coast of 7.23 anglers.km^{-1} (Brouwer *et al*. 1997). A possible reason for the low total annual effort compared to KwaZulu/Natal is that the latter region is highly populated with a higher proportion of coastal residents. The distribution of anglers on the Transkei coast (0.73 anglers.km^{-1}) was analogous to Plettenberg Bay with a relatively small resident fishing population and large influxes of people during holiday seasons (Mann *et al*. 2003). In terms of stratification of effort between weekdays and weekend/public holidays, more effort was expended on the weekends or public holidays than the weekdays. Brouwer (1997) reported a similar stratification in effort for the Eastern Cape shore fishery.

Spatial distribution of fishing effort on the Plettenberg Bay coastline revealed that shore angling was practiced throughout the region, but was lowest for the area between Langbank and Salt River point which is extremely difficult to traverse with its steep cliffs. Zone 4 accounted for 34% of the total effort, which is surprising as this zone is the most inaccessible of all the five sampling areas. In the past, according to anecdotal information provided by anglers, effort was concentrated in zones 1 and 2 but due to overexploitation in these areas catches declined and the effort has been redirected to zone 4. Attwood and Farquhar (1999) also found that catch rates in popular areas on the Cape south coast were once high but have declined as a result fishing pressure. Thirty-eight percent of the total

catch was landed in zone 4 and accounted for 80% of the galjoen, 60% of the zebra, 55% of the spotted grunter, 57% of the dusky kob, 71% of the blacktail and 55% of the shad landed over the survey period. The higher abundance of fish in this area is most likely the result of less historic fishing pressure. In addition, this zone is situated closest to the TNP boundary and hence may benefit from spillover from the marine reserve.

Fishing effort was second highest in zone 2, which is the most accessible of the all the sampling areas with its numerous car parks. Despite its long sandy beaches, rock fishing (Lookout rocks and Beacon Isle rocks) was the most popular in this zone. Large numbers of red tjor-tjor were caught off the rocks in this zone and hence accounted for 32% of the overall catch.

Robberg Nature Reserve (zone 1) was once famous for its catches of galjoen, poenskop, leervis and yellowtail (Anon 2000). However, in the current study, the lowest amount of effort and only 13 % of the catch was recorded in this zone. Although shoals of leervis still pass through the bay periodically none were recorded during the survey days. The reduced catches of leervis and yellowtail can also be ascribed to recreational and commercial boats fishing pressure on these migratory species (Attwood and Farquhar 1999). According to the Robberg Diaries catches of poenskop were common with at least one being landed on each fishing trip (Anon 2000). Clearly, the population of poenskop around the peninsula have been overexploited. The large number of poenskop still caught in the TNP highlights the value of restricted areas in protecting this species (Cowley 2002).

3.4.3 Catch

A number of indicators can be used to assess the catch status of a fishery. These include a change in species composition, changes in *cpue* and fluctuations in species-specific size composition over time (Clarke and Buxton 1989, Blaber *et al*. 2000, Pravervand and Govender 2003). Unfortunately no historic datasets exist for Plettenberg Bay, so temporal comparisons were not possible. However, spatial comparisons with a partially exploited (Rebelsrus) and a no-take marine reserve (TNP) were possible.

In terms of species composition, teleost catches in Plettenberg Bay were considerably different to both Rebelsrus and the TNP. The most obvious difference was the low proportion of non-migratory reef-associated species like red roman, poenskop, John brown, santer and bronze bream in Plettenberg Bay, which suggests that these species have been depleted. Comparing the species composition of the top five species caught in Plettenberg Bay and the TNP provides further evidence for this. Blacktail was dominant in both regions but the other four species varied considerably. Poenskop and zebra were amongst the top five species in the closed area (TNP) whereas strepie, red tjor-tjor and sand steenbras were in the top five species at Plettenberg Bay. Catches of these three species were minimal or absent in the TNP. The dominance by small-bodied fish with faster life histories is characteristic of exploited systems (Kaiser and Jennings 2002). The trend in any developing fishery is that the larger, highly valued species are removed first followed by the smaller, low valued species, resulting in a fishery dominated by smaller species. This process of fishing down the food chain is known as “serial overfishing” (Bohnsack and Ault 1996). The catch composition may not only be a reflection of abundance and catchabilty of these species but may also be a result of targeting efforts by anglers (Pradervand and Govender 2003). The majority of these small-bodied fish

were caught in zone 1, where anglers predominantly target leevis and thus strepie and sand steenbras were targeted and caught for live bait. The large number of red tjor-tjor (usually an offshore species) is also not a true reflection of the usual composition of the fishery as catches were only made during one month of the sampling period after upwelling events, which caused these fish to move into the shallows making them easy to catch. The composition of the targeted species can also be used to demonstrate a decline in stock abundance, as anglers switch from targeting the larger more desirable species to smaller more prolific species. For example, blacktail was historically not a prime target species (Attwood and Bennett 1995) and in this study it was the fourth highest target species, ahead of musselcracker and galjoen. Pradevand and Govender (2003) also reported that competition anglers switched from targeting large-sized species to small-size species due to overexploitation of the former. Similarly, Mann *et al*. (1997) found that anglers switched from targeting shad to strepie when catches of shad decreased to low levels in KwaZulu-Natal.

Cpue, however, is probably the best indication of stock decline as it is an index of abundance (Clarke and Buxton 1989, Pradervand and Govender 2003). Overall *cpue* was greatest in the TNP (1.02 fish-angler. hour^{-1}) followed by Rebelsrus (0.91 fish-angler. hour^{-1}) and then Plettenberg Bay (0.37 fish-angler. hour^{-1}). The low catch rate in Plettenberg Bay provides convincing evidence that local stocks have declined. Clarke and Buxton (1989) presented similar results through comparisons of catches between selected sites in the Port Elizabeth shore fishery and a nearby island, St Croix, which is relatively inaccessible. *Cpue* by mass was four times higher on the island because of its inaccessibility and consequently lower fishing pressure. These findings suggest that even partial closure or limited access to an area can offer protection. This is further highlighted by comparisons in *cpue* between Rebelsrus (partially-exploited area) and Plettenberg Bay, where *cpue* for blacktail,

galjoen, bronze bream, John brown and white musselcracker are far higher in the partially-exploited area. Even *cpue* for elasmobranchs was over six times greater in the TNP and Rebelsrus than Plettenberg Bay. Elasmobranchs are slow growing, mature at large sizes and have a low fecundity and are thus highly susceptible to overexploitation (Compagno and Smale 1989).

Further evidence to highlight the status of Plettenberg Bay linefish stocks is through changes in size distribution of targeted species over time (Pradervand and Govender 2003). Overall fish were larger in the TNP than both the semi-exploited and exploited areas, especially resident reef-associated species which benefit the most from area closure. Cowley *et al*. (2002) and Buxton and Smale (1989) also found that the mean individual sizes of certain species were significantly larger inside the TNP than outside.

The success rate of anglers can also be used as an indication of the health of the fishery. In Plettenberg Bay, only 32% of the anglers interviewed were successful and only 22% caught their primary target species. None of the interviewees caught all three of their targeted species. The highest success rates for targeted effort were for blacktail (36%) and shad (20%), which together with the fact that bag limits were only exceeded for these two species suggests that the status of these species is healthy on the Plettenberg Bay coastline. Blacktail and shad were also amongst the top five species caught in the Port Elizabeth (Clarke and Buxton 1989) and Transkei shore fisheries (Mann *et al*. 2003). Despite blacktail appearing to be so abundant (dominating by numbers and mass), Brouwer (1997) showed that the catch rate decreased by 43% in seven years in the Port Elizabeth region and the shad population is considered to be over-exploited (Griffiths and Lamberth 2002). Despite this,

shad were the dominant species by mass in KwaZulu-Natal (29%), the Eastern Cape (26%) and the Southern Cape (56%) (Brouwer *et al*. 1997).

White steenbras was the second most abundant species by mass (8%) in the Plettenberg Bay shore-based fishery. Most individuals were adolescents (<650 mm TL), while 61% were smaller than the minimum legal size of 600m TL. Pradervand and Govender (2003) also found that the majority (73%) of steenbras caught in the Border region of the Eastern Cape were immature. Seasonal trends revealed catches were greatest during winter, which coincides with their spawning migration (July to August) to the South-Eastern Cape and Transkei coasts (Bennett 1993). In terms of targeted effort, white steenbras was the most sought after species in the shore fishery (22%) despite their poor stock status (Bennett 1993). Local anglers reported that catches have declined substantially and although there are no historical datasets with which to compare locally, evidence is provided from the South-Western Cape. Bennett (1993) showed that the percentage contribution of white steenbras in angler catches, from the South-Western Cape declined from 30% in the 1960's to only 0.6% in 1996.

Galjoen was once the most commonly caught species on the Robberg peninsula (zone 1). According to angler diary entries, catches of up to ten fish per outing were recorded (Anon. 2000). In this survey, interviewees nominated galjoen as the species that had declined the most along the Plettenberg Bay coast. Therefore, it was not surprising that only one galjoen was recorded by the survey clerks in zone 1 over the entire study period. The *cpue* for galjoen was 24 times greater in the TNP and 32 times greater at Rebelsrus than the Plettenberg Bay shore fishery. Tagging studies have revealed a complex migration pattern with some individuals being resident while others migrate vast distances. One such study in the De Hoop Marine Reserve discovered that ten to twenty tonnes of

galjoen leave the reserve annually (Attwood and Bennett, 1994) thereby enhancing fisheries in adjacent areas. MPA's are therefore highly effective at conserving this species.

All the dusky kob recorded in this study were below 1 000 mm (TL) and thus considered juveniles while nine percent were below the minimum legal size of 400 mm TL. Pradervand and Govender (2003) found a similar occurrence in the Border region of the Eastern Cape with 99% of the dusky kob being immature. The minimum size limit (400 mm TL) in place during the study therefore offered little protection to the species as they only mature at 1000 mm TL (Griffiths 1997), however with the revised regulations this has been increased to 600 mm which should reduce the number of undersized fish being kept. In addition, the new of limit of 1 fish a day should also aid in greatly reducing effort. Long-term trends in *cpue* are unavailable for this species due to its confusion with another species (*A. inodorus)*, but it has been exploited to levels less than 10% of its pristine stock and is considered collapsed (Griffiths 1997). Even though this is a migratory species the *cpue* for this species was three times greater in the TNP than in Plettenberg Bay and only 5% of the anglers targeting dusky kob in Plettenberg Bay were successful. Its life history traits of late maturity and spawning aggregations together with its dependence on estuaries places this already collapsed stock under great pressure, especially since it is targeted by both estuarine and shore anglers and inshore ski-boats. Stock recovery is dependent on stringent management measures that address all life history stages (Griffiths 1996) as well as the maintenance of estuarine functioning for the juvenile phase.

The large number of white musselcracker caught in a very specific location near Salt River mouth was an anomaly, and supported by van der Elst (1993) who claimed that they appear to be resident for part of the year in specific locations. Possible reasons for the concentration of individuals at this site could be that it is bordered by the TNP on the one side and on the other by a relatively inaccessible and un-fished area, and thus may benefit from spillover from both sides. Musselcracker

were on average larger by mass in the Plettenberg Bay (5.2kg) than the TNP (2.5kg) but fish caught in the TNP attained a larger size and were 22 times more abundant. Like other sparids, musselcracker are highly vulnerable to overexploitation and trends in *cpue* from Port Elizabeth revealed a decrease from 30.3 grams. ang – hr^{-1} in 1985-86 (Clarke and Buxton 1989) to 6 grams. ang – hr^{-1} in 1996 (Brouwer 1997).

It must be acknowledged, however, that fishing mortality is not the only factor responsible for variations in catches. Environmental changes, natural variations in recruitment and changes in predator-prey populations are amongst a range of factors that can affect stock abundance (Attwood and Farquhar 1999). The degradation of estuaries may also affect the population sizes of estuarine dependent species such as white steenbras and dusky kob (Pradervand and Govender 2003). Comparisons between closed and open areas are also confounded by differences in habitat, past fishing pressure and larval supply between the two areas of comparison (Russ and Alcala 2003). Another possible cause for change in the populations of linefish species is the variations in abundance of pelagic forage fish such as sardine and anchovy, which are important in the diet of piscivorous species (Attwood and Farquhar 1999), such as shad and leervis which frequent the bay. Even though anglers are adamant that the local seal population is affecting local linefish stocks, a recent assessment by the WCNCB and The Centre for Dolphin Studies on the gut contents of the seals revealed that the seals feed mainly on hake, octopus, sardines and cartilaginous species (Niewoudt 2005, WCNCB, pers comm.). Consequently, despite a population increase, seals have probably had little effect on the shore fishery.

3.4.4 Bait use

The majority of anglers used purchased baits (e.g. pilchard and chokka) as they are easy to obtain and universal in terms of the species they catch. Surveys by Mackenzie (2004) and Brouwer (1997) on the Eastern Cape shore fishery revealed similar results. The popularity of pilchard and chokka can be attributed to their success in catching the three most commonly targeted species; white steenbras (45% combined), dusky kob (43% combined) and shad (77% pilchard only). Red bait was the top preferred bait organism of both purchased and collected baits and featured third in the frequency of bait usage. Many anglers also collected estuarine bait species, with sand and mud prawn being the most popular, followed by bloodworm. Mackenzie (2004) also found that these were the two most commonly used estuarine baits in the Eastern Cape shore fishery. The high frequency of sand prawn usage was because it was commonly used to catch white steenbras, the top targeted species in the Plettenberg Bay shore fishery.

Whether bait populations have declined locally as a result of overexploitation was not proved in this study but according to anecdotal information provided by anglers and from direct observations, certain bait species have declined in abundance. For example, the numbers and distribution of siffie and alikreukal (mainly used in targeting musselcracker) have declined and in certain areas e.g. Beacon Isle rocks they have disappeared all together. Whereas at Langbank and at Salt River Point (areas with low fishing effort) survey clerks noticed an abundance of these two species. The abundance of red bait also seemed to be reduced in areas that were easily accessible compared to areas in zone 4 that are relatively inaccessible. Anglers verified this decline by claiming that of all the collected bait species, red bait had declined the most. Chopping of mussel beds for mussel worm was

quite extensive in zone 4 and damage to the mussel beds was particularly evident after the December holiday season. Van Herwerden (1989) found that between 0.4 and 0.5 m^2 of mussel beds were destroyed in the collection of 20 mussel worms, which reveals just how damaging this extraction method can be. Mussel worm were used primarily when anglers were targeting galjoen and blacktail.

Anglers' perceptions on the status of bait stocks on the Plettenberg Bay coastline followed similar trends to that found by Mackenzie (2004). They thought that either the populations had stayed the same or remained unchanged, with similar numbers of anglers reporting for each. For those that believed stocks had declined the main reason given was general overexploitation and anglers collecting more than they need resulting in the surplus being discarded. Mackenzie (2004) found this to be true, in that the number of bait organisms actually used by anglers was markedly less than the numbers collected.

The fact that a large majority of anglers (73%) were unaware of the bait regulations in terms of bag limits, together with the low percentage claiming to have bait permits and low levels of enforcement threatens sustainability for the bait stocks on the Plettenberg Bay coastline. In terms of rebuilding bait populations, areas that are underutilized or relatively inaccessible should be closed off to bait collecting to seed adjacent areas through larval dispersal (Dye and Dyantyi 2002, Mackenzie 2004). The health of bait populations also needs to be monitored through regular surveys as well as the broader ecological damage caused by chopping (Mackenzie 2004).

3.4.5 Conclusion

The findings of this fishery survey have highlighted the poor status of the Plettenberg Bay shore-based linefishery. This was illustrated by social, biological and institutional aspects of the fishery, for example (i) poor angler knowledge regarding the regulations of their target species, (ii) low levels of compliance, (iii) low *cpue* and (iv) inadequate enforcement.

Clearly the sustainability of the fishery is questionable and the need for improved management is crucial. An assessment of sustainability using a suite of indicators and a proposed management protocol for the Plettenberg Bay fishery are described in chapters 4 and 5, respectively, of this thesis.

CHAPTER 4

SUSTAINABILITY AND INDICATORS

4.1 INTRODUCTION

The concept of sustainable development was first popularized by the Brundtland Report (World Commission on Environment and Development 1987) and subsequently by the United Nations Conference on Environment and Development (held in Rio de Janeiro in 1992) and is generally understood as a process balancing conservation and exploitation for long-term use, implying it to be a dynamic process evolving as the requirements of both the resource and society change (Dengbol and Jarre 2004). The concept of sustainability was incorporated into fishery management via the FAO Code of Conduct for Responsible Fisheries (FAO 1995). This code dictates the need to conserve multiple resources in their environment, to satisfy the social and economic needs of human beings and lastly for management to guide the required changes in institutions and technology (Garcia 2000). Consequently, the focus of fisheries management has changed from targeting single stock production to emphasizing the need to consider fisheries sustainability in relation to the entire ecosystem, including ecological, economic, social and institutional aspects (see chapter 1). This broader approach requires a significant increase in the information base and a profound change in governance. However, in view of the limited capacity and resources available in most management institutions, management systems are increasingly being based on ‘soft predictability’ utilizing indicators and qualitative predictions in place of complex predictive models (Dengbol and Jarre 2004). Pajak (2000) describes indicators as tools used to assess current conditions, simplify and communicate information and monitor progress towards ecological, social and institutional goals of sustainability. Indicators can also be viewed as a sign or signal, where each indicator reflects an important dimension of sustainability showing how far or close that dimension in the fishery is to sustainability. The indicators can therefore “signal” where managers should concentrate their efforts to achieve a sustainable fishery.

An ecosystem-based management (EBM) approach and its use of indicators are being increasingly researched and adopted so that a wide variety of indicators to track sustainability exist (FAO 1999, ICES 2000, 2001, 2002, Garcia and Staples 2000, Jamieson *et al*. 2001 and Sainsbury and Sumalia 2001). The challenge is to aggregate these indicators into a manageable set that will be useful in guiding daily decisions by resource managers and other decision-makers. The FAO guidelines (1999a) suggest the use of a sustainable development reference system (SDRS) as a way of organizing indicators within a general framework and also as a means to study, assess and report on the sustainability of a sector (Garcia *et al*. 2000, Garcia and Staples 2000, Pajak 2000, Dengbol and Jarre 2004). A number of these models have been developed including the Code of Conduct for Responsible Fisheries, the Ecologically Sustainable Development Framework, the Pressure-State-Response-Response framework with its derivatives and Pajak's (2000) model of sustainability based on the three management domains: environment, society and institutions. The structure and number of the sustainability domains within each model is what distinguishes them from each other. A full description of the various frameworks is beyond the scope of this thesis and a review may be seen in Garcia & Staples (2000). Although various papers present conceptual models (Pajak 2000, Garcia *et al*. 2000, Garcia and Staples 2000), and others propose possible indicators (Vandermeulen 1998, Ward 2000, Castro 2001, Rochet & Trenkel 2003), less has been documented on the assessment of proposed indicators (e.g. Degnbol & Jarre 2004, Adrianto *et al*. 2005) and the practical implementation of the models. Bowen & Riley (2003) identified the relative paucity of indicator-based approaches to management as a result of the complex linkages involved in and between the natural and societal systems and the difficulties in isolating cause - effect relationships. Furthermore due to the lack of information, expertise, institutional infrastructure and capacity frequently experienced at local levels of governance, the implementation of a "full house" SDRS is problematic.

Within a local fisheries context this project proposes a simple framework based on Pajaks' (2000) ecological, institutional and social sustainability domains, along with a select set of indicators that can be utilised to assess sustainability. The model should not be interpreted as an end product, rather as an iterative process beginning with the most urgent or critical issues identified at a local scale. This model should therefore provide the basis for a more complex, social, ecological and institutionally inclusive SDRS developed over time.

4.2 METHODS

With reference to Figure 1.1 (Chapter 1) a number of steps were involved in the selection of the indicators (Figure 4.1, A). Due to the lack of information regarding the local fisheries the first step incorporated a baseline assessment or status report of the local shore-based linefisheries (given in Chapter 3). The information gathered was then analysed in step two. Key sustainability issues were identified from these results (step three) and indicators that could be used to track these issues and meet a number of selection criteria were proposed (step four) (Figure 4.1 block D). Although it has been highlighted in the literature (Vandermeulen 1998, Garcia & Staples 2000, Linton and Warner 2003, Degnbol & Jarre 2004) that the selection of indicators should be directly linked to specific management objectives, the lack of local management objectives precluded the ability to do this. The setting up of such objectives in the correct manner with stakeholder involvement was again beyond the time scope of this project. In the absence of specific local objectives the generic fishery management objectives found in the FAO Code of Conduct for Responsible Fisheries (FAO 1995) and the Marine Living Resources Act (MLRA) (Act 18 of 1998) of South Africa were used as a guideline (Figure 4.1 block B, Table 4.1). Furthermore, key issues were identified in relation to these generic goals and the known impacts of fishing (Figure 4.1 block C, Table 4.2). Once the indicators had been identified they were classified according to the Driver – Pressure – State – Impact – Response Model (Bowen & Riley

2003)(Figure 4.1 block E) and the sustainability reference direction defined. The reference direction depends on whether the indicator will increase or decrease under exploitation (Rochet and Trenkel 2003). A brief rationale is then given for the selection of each indicator. Step seven involved, where possible, the setting of performance criteria for each indicator. The identification of performance criteria or reference values is one of the most controversial and problematic features of indicator development (Dahl 2000, Garcia and Staples 2000, Dengbol and Jarre 2004). Firstly due to the subjectivity of the scientist developing the indicators and secondly due to the limited availability of historic data in most fisheries with which to set reference points (Rochet and Trenkel 2003). Despite the large number of indicators in circulation few studies have aimed at developing sets of reference values or a scoring system. For this reason and to give the indicators more credibility a discussion by four fishery scientists was held to discuss the setting of performance criteria. Details of the participants are given in appendix IV. For certain biological indicators data from the Tsitsikamma National Park, which is considered pristine, was used as the top reference value. Performance of the indicators were scored according to a method proposed by Garcia *et al*. (2000) as either very poor to good and arbitrarily given a corresponding value of 0 to 4. Finally, methods are proposed for the data collection of the various indicators within an adopted monitoring program, however, no attempt has been made to elucidate a data collection time scale for the required monitoring program.

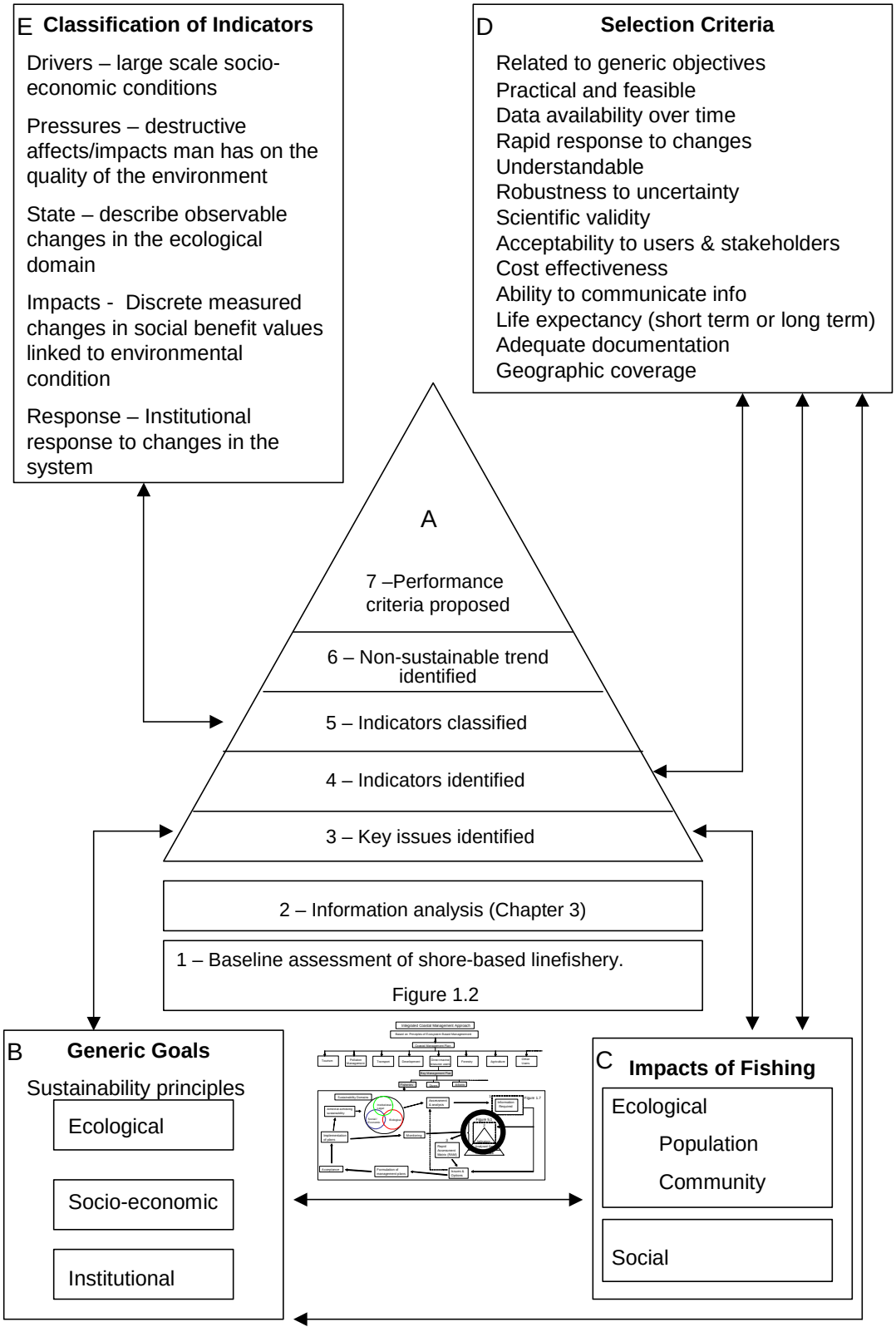

Figure 4.1. The seven steps involved in the selection of indicators. The diagram highlights how the selection of indicators is dependent on the management objectives, the known impacts of fishing and other criteria. The insert shows where this diagram fits in with Figure 1.1. in Chapter 1.

Table 4.1. Generic goals or principles of sustainable development related to the FAO Code of Conduct for Responsible Fisheries (FAO 1995) and South African Marine Living Resources Act (Act 18 of 1998) that were adopted for this study.

Socio-Economic Domain	
Principle S1: 'The human needs (in terms of sustainable access to high quality and safe food, employment, income and recreation), and societal / ethical values should be satisfied.'	
S1.1	Enhancing education, skills and professional qualifications of fishers
S1.2	Facilitating effective participation in decision-making
Institutional Domain	
Principle I1: 'An effective management system should be in place to guide the institutional and technological change required.'	
I1.1	Consultation and participation in laws and regulations.
I1.2	Research in all relevant disciplines and dissemination of results.
I1.3	Taking fisheries into account in multi-use of the coastal zone.
I1.4	Promoting awareness about conservation and management among fishers.
I1.5	Monitoring management performance and reviewing management strategies.
Ecological Domain	
Principle E1: 'The target resource characteristics should be maintained at levels capable of ensuring its natural renewal and continuous exploitation under ecologically acceptable conditions.'	
E1.1	The maintenance of quality, diversity and availability of resources.
E1.2	Prevention of over fishing and overcapacity.
Principle E2: 'The environment conditions should be protected, maintained and enhanced (where appropriate) to ensure the maintenance of resource productivity.'	
E2.1	Maintenance of biodiversity, population structure and ecosystems.
E2.2	Monitoring of the coastal environment and assessment of environmental impact.

Table 4.2. Impacts of fishing on the environment. The environment has been split into an ecological domain where fishing impacts at both the population and community level and the socio-economic domain dealing with impacts on humans.

Ecological Domain	
Populations: Removal of older and larger fish	*Communities*: Targeting of certain species
Decrease in population size	Change in overall species composition
Change in size frequency distribution	Change in species diversity
Change in life history traits	Change in trophic structuring due to the removal of fish in upper trophic levels
Socio-Economic Domain	
Source of recreation	
Source of food	
Source of employment and income	

Once quantitative values were determined for each indicator and scored via the performance criteria the values were aggregated across the various sustainability domains to give indices of

sustainability (Figure 1.2, block C). This was achieved by using a rapid assessment matrix (RAM), which is a simple method allowing the quick identification of the most limiting components of sustainability within each domain (Wood *et al*. 2003). The total score for each domain was converted to a percent of the total possible score to allow domains with different numbers of indicators to be compared. Low domain totals represent non-sustainable practises and highlight the need for increased management effort within that particular domain.

4.2.1 Evaluation and assignment of indicators

Domain: Socio-Economic

A - *Generic Principle:* 'Human needs (in terms of sustainable access to high quality and safe food, employment, income and recreation), and societal / ethical values should be satisfied.'

A1 - *Issue:* Poor regulatory knowledge.

Indicator: Percentage of correct regulatory questionnaire answers.

Rationale: This issue is not necessarily an educational problem as the fishery is primarily recreational with high education levels (69% matric, 40% tertiary qualification), but rather an ethical problem of anglers purposefully not willing to learn and thus abide by the linefish regulations. The following indicator was deduced from a test taken by anglers to determine their knowledge on the regulations pertaining to their target species.

Type of Indicator: Driver.

Sustainability reference direction: An increase in the percentage of fishers who give correct answers in relation to the regulations signifies sustainable fishing practises.

Data collection method: Fishery surveys.

Action: Educational drive.

Performance Criteria:

Proportion of fishers who knew the current linefish regulations	Indicator Performance	Score
80 - 100%	Good	4
60 – 80%	Fairly good	3
40 – 60%	Moderate	2
20 – 40%	Poor	1
0 – 20%	Very poor	0

A2 - *Issue:* Admitted non-compliance.

Indicator: Percentage of fishers who admit to breaking the linefish regulations.

Rationale: As mentioned in the previous chapter angler acceptance and adherence to the linefish regulations is essential for these laws to be effective. The percentage of anglers who admit to breaking the regulations are those directly contributing to the non-sustainability of the fishery. The following two indicators deal with the issue of non-compliance in terms of their admittance to contravening the regulations and by the number of undersize (illegal) fish retained.

Type of Indicator: Driver.

Sustainability reference direction: A decrease in the percentage of fishers who admit to breaking the regulations signifies sustainable fishing practises.

Data collection method: Fishery surveys.

Action: Increase awareness and law enforcement.

Performance Criteria:

Proportion of fishers who admit to breaking the current linefish regulations	Indicator Performance	Score
0 – 20%	Good	4
20 – 40%	Fairly good	3
40 – 60%	Moderate	2
60 – 80%	Poor	1
80 – 100%	Very poor	0

A3 - *Issue:* Non-compliance.

Indicator: Percentage of undersized fish kept.

Type of Indicator: Pressure.

Sustainability reference direction: A decrease in the percentage of undersized fish kept signifies sustainable fishing practises.

Data collection method: Fishery surveys.

Action: Increase awareness and law enforcement.

Performance Criteria: The nine most commonly caught species that have legal size limits were used collectively to calculate the performance criteria. These species were galjoen, zebra, musselcracker, spotted grunter, dusky kob, shad, white steenbras, cape stumpnose and blacktail.

Proportion of undersized fish kept	Indicator Performance	Score
< 20%	Good	4
20 – 30%	Fairly good	3
30 – 40%	Moderate	2
40 - 50%	Poor	1
> 50%	Very poor	0

A4 - *Issue:* Dependency on fishery resources for food.

Indicator: Proportion of subsistence anglers in the shore fishery.

Rationale: The greater the number of anglers dependent on fishery resources for survival the greater the pressure on those resources. Consequently, a reduction in the number of subsistence anglers will alleviate that pressure which in turn signifies a higher employment rate and thus a reduced dependency on the resources.

Type of Indicator: State.

Sustainability reference direction: A decrease in the percentage of subsistence anglers signifies social integrity within the community.

Data collection method: Fishery surveys.

Action: Job creation through industry expansion and diversification.

Performance Criteria: For the purposes of this study a subsistence angler was defined as a poor person that is unemployed and fishes for food, lives locally and uses low technology gear such as a handline (Branch *et al*. 2002).

Proportion of subsistence anglers	Indicator Performance	Score
0 - 20%	Good	4
20 – 40%	Fairly good	3
40 – 60%	Moderate	2
60 - 80%	Poor	1
80 – 100%	Very poor	0

Domain: Institutional

B - *Generic Principle:* 'An effective management system should be in place to guide the institutional and technological changes required'.

B1 - Issue: Effective and implemented bay management plan.

Indicator: Existence of a management plan for Plettenberg Bay.

Rationale: A management plan is the main instrument that specifies how management is to be conducted and by whom and details the objectives for the plan (FAO 1997).

Type of Indicator: Response.

Sustainability reference direction: The existence of a management plan is seen as contributing towards sustainable practises.

Data collection method: Local municipal policies and national legislation.

Performance Criteria:

Nature of bay management plan	Indicator Performance	Score
Fully integrated at National level with full implementation and measurable indicators	Good	4
Fully integrated at National level with limited implementation	Fairly good	3
Integration at National Level	Moderate	2
Limited areas managed, but no management plan	Poor	1
No management plan in place	Very poor	0

B2 - Issue: Management needs to be adaptable.

Indicator: Existence of a monitoring programme to gather data to upgrade management strategies.

Rationale: No fishery is constant. There are continual changes in the needs of the users, the policies governing them and in the resource itself. For management to be effective it has to be adaptable as new information becomes available. The implementation and administration of a monitoring program to track changes within the sustainability environments and gauge the success of the management plan in meeting its objectives is therefore an essential component in ensuring the overall success of the management initiative.

Type of Indicator: Response.

Sustainability reference direction: The existence of such a monitoring program is seen as contributing towards sustainable practises.

Data collection method: Local municipal policies and national legislation.

Performance Criteria:

Nature of monitoring program	Indicator Performance	Score
Incorporation of collected data into management plan	Good	4
Regular, long-term fishery surveys and other programs in place to collect required data	Fairly good	3
Regular surveys collecting limited information	Moderate	2
Some sporadic surveys conducted	Poor	1
No monitoring program in place	Very poor	0

B3 - *Issue:* Effective enforcement of current regulations.

Indicator: Inspection rate by fisheries officers.

Rationale: Brouwer (1997) showed a direct correlation between the number of fishery inspections and angler compliance. The regular presence of a fishery inspector and the subsequent increased possibility of individual inspection should increase voluntary compliance. For this indicator only the inspection rate of Plettenberg Bay residents that had been fishing for more than five years in the area was used.

Type of Indicator: Response.

Sustainability reference direction: A greater enforcement presence contributes towards sustainable practises.

Data collection method: Fishery surveys.

Action: Increase number of random inspections.

Performance Criteria: Based on the inspection rate of Plettenberg Bay resident anglers who had been fishing in the area for more than five years.

Proportion of anglers who have been inspected	Indicator Performance	Score
80 - 100%	Good	4
60 – 80%	Fairly good	3
40 – 60%	Moderate	2
20 – 40%	Poor	1
0 – 20%	Very poor	0

Domain: Ecological

C - *Generic Principle:* 'The target resource characteristics should be maintained at levels capable of ensuring its natural renewal and continuous exploitation under ecologically acceptable conditions.'

C1 - *Issue:* Success rate.

Indicator: Percent trips where fish are caught.

Rationale: Fishing impacts fish communities in a number of ways but the most obvious is the removal of individuals (Polunin 2002, Heino and Godø 2002). By monitoring the success rate of anglers' indirect assumptions regarding the abundance of fish can be made.

Type of Indicator: State.

Sustainability reference direction: An increase in the success rate signifies a sustainable trend in the fish population.

Data collection method: Fishery surveys.

Action: Decrease bag limits, increase size limits, closed areas.

Performance Criteria:

Percentage of successful trips	Indicator Performance	Score
80 - 100%	Good	4
60 – 80%	Fairly good	3
40 – 60%	Moderate	2
20 – 40%	Poor	1
0 – 20%	Very poor	0

C2 - *Issue:* Success rate.

Indicator: Percent of anglers reaching their bag limits per trip, as specified by the Marine Living Resources Act (Act No. 18 of 1998).

Rationale: This indicator is linked to the one above and follows the same reasoning.

Type of Indicator: State.

Sustainability reference direction: An increase in the success rate signifies a sustainable trend in the fish population.

Data collection method: Fishery surveys.

Action: Decrease bag limits, increase size limits, closed areas.

Performance Criteria:

Percentage of anglers reaching bag limits	Indicator Performance	Score
80 - 100%	Good	4
60 – 80%	Fairly good	3
40 – 60%	Moderate	2
20 – 40%	Poor	1
0 – 20%	Very poor	0

C3 - *Issue:* Species diversity.

Indicator: The proportion that large, desirable species make to the overall catch

Rationale: An ecosystem effect of fishing is that the larger more desirable individuals are fished out first, resulting in the system being dominated by smaller-bodied individuals (Kaiser and Jennings 2002). These species tend to be resident reef fish which are particularly susceptible to overfishing because of their slow growth rate and late age-at-sexual maturity (Bennett 1991, Mann and Buxton 1997, Griffiths and Lamberth 2002).

Type of Indicator: State.

Sustainability reference direction: An increase in the proportion of these species to overall catch signifies a sustainable trend.

Data collection method: Fishery surveys.

Action: Decrease bag limits, increase size limits, closed areas.

Performance Criteria: The following resident, reef fish were chosen for the purposes of this indicator; red roman, poenskop, galjoen, bronze bream, musslecracker and zebra. The collective proportion these species make in the catch of the TNP shore-based linefishery is 40%, which is used as the top benchmark.

Proportion (%) these large species make to the overall catch	Indicator Performance	Score
80 - 100%	Good	4
60 – 80%	Fairly good	3
40 – 60%	Moderate	2
20 – 40%	Poor	1
0 – 20%	Very poor	0

4.3 RESULTS

Assessment of proposed indicators (sustainability matrix)

The performance scores of indicators within the three sustainability domains are tabled in the sustainability matrix shown in Table 4.2. The shore-based linefishery proved to be non-sustainable with an overall sustainability index of 33%. Institutionally the management of local fisheries resources was extremely low with a sustainability index of 17%. The lack of a municipal coastal management plan or associated monitoring programme for fisheries contributes to this low score. Ecologically the local shore-based linefishery is in a poor state. Fish abundance (reflected by the poor success rate) is low and certain target species (especially larger more desirable species) are absent in the fishery. The socio-economic domain on the other hand was satisfactory, scoring a 12 out of a possible 16 to yield a sustainability index of 75%. The most limiting criteria within this domain were the poor degree of angler knowledge regarding the linefish regulations and the large number of undersize fish that were kept illegally.

Table 4. 2: Sustainability matrix showing the three domains of sustainability and their related indicators with reference criteria and the current value for the Plettenberg Bay shore-based linefishery together with scores of overall sustainability.

	Indicator	Reference criteria					Current value	Score
		Very poor (0)	Poor (1)	Moderate (2)	Fairly good (3)	Good (4)		
Social	*% Correct regulatory answers*	0 -20%	20 – 40%	40 – 60%	60 - 80%	80 – 100%	42 %	2
	% Admitted non-compliance	80 - 100%	60 – 80%	40 – 60%	20 – 40%	0 – 20%	23 %	3
	% Catch undersized	>50 %	40 – 50 %	30 – 40 %	20 - 30 %	< 20%	30 %	3
	% Subsistence anglers	80 - 100%	60 – 80%	40 – 60%	20 – 40%	0 – 20%	1%	4
	Total							**12 (75%)**
Institutional	*Existence of management plan*	No management plan	Limited areas managed, but no management plan	Integration at National level	Fully integrated at National level with limited implementation	Fully integrated at National level with full implementation and measurable indicators	No management plan	0
	Monitoring program in place	No monitoring program in place	Some sporadic surveys conducted	Regular surveys collecting limited information	Regular, long term fishery surveys and other programs in place to collect required data	Incorporation of collected data into management plan	No monitoring program in place	0
	Proportion of anglers who have been inspected	0 -20%	20 – 40%	40 – 60%	60 - 80%	80 – 100%	57 %	2
	Total							**2 (17%)**
Ecological	*% Trips fish are caught*	0 -20%	20 – 40%	40 – 60%	60 - 80%	80 – 100%	32%	1
	% Anglers reaching bag limits	0 -20%	20 – 40%	40 – 60%	60 - 80%	80 – 100%	9%	0
	% Large species make to the overall catch	0 -20%	20 – 40%	40 – 60%	60 - 80%	80 – 100%	3%	0
	Total							**1 (8%)**
Overall sustainability								**33%**

4.4 DISCUSSION

Presently most fisheries are in a non-sustainable state as is illustrated by the progressive decline of the world's marine resources since the 1950s (Grainger and Garcia 1996 *cited in* Garcia and Staples 2000). The Plettenberg Bay shore-based fishery is no different as highlighted by the sustainability matrix (Figure 4.2), with an overall sustainability index of 33%.

The socio-economic domain proved to be the most sustainable (75%) of the three domains, however an index of 100% is required for a fully sustainable condition (Pajak 2000). This high value was expected as the fishery is primarily recreational and a large proportion of the anglers are employed (79%), which suggests that people are not dependent on the resource for their livelihood. This was validated by the low percentage (1%) of subsistence anglers currently active in the fishery, which equates to a high score of four (good) in the sustainability matrix indicating that majority of human needs (food, income and employment) are satisfied according to the generic principles proposed by the FAO Code of Conduct for Responsible fisheries (FAO 1995). There are however potential political and social problems associated with the use of this indicator, firstly by deciding on a reference of 0 – 20% as the desired condition implies that subsistence angling is non-sustainable as it involves maximizing catch for either sale or consumption and should be reduced to a minimum. Politically this indicator opposes the MLRA, which has identified subsistence as a formal fishery sector and thus promotes the continuity and growth of this sector (Branch *et al*. 2002). For social sustainability, an objective would be to have the least number of people below the poverty line as possible, but this opposes the age-old tradition of people living off the sea (Clarke *et al*. 2002) and tradition should not be lost. In relation to the generic principle of "satisfying ethical values" indicator A1, which addressed the issue of poor regulatory knowledge was decided to be an ethical issue rather than a recreational one as most of the anglers were well educated and thus have the capability of learning the regulations. A possible

solution to this ethical issue would be to educate anglers about the underlying principles of why the regulations are in place and that by compliance they are only safe-guarding the future of their own fishing. Education is therefore the key to enhancing compliance. The African naturalist Baba Dioum in his quote "We protect what we love, we love what we understand and we understand what we are taught" confirms this (*cited in* Pajak 2000). Two other indicators, namely A2 and A3, also addressed the issue of non-compliance and scored highly (3, fairly good) in the sustainability matrix indicating that most anglers are compliant. These results however, may be contentious as anglers are unlikely to admit to contravening the regulations or to keeping undersize fish for fear of the survey clerks reporting them to the authorities, and thus the interpretation of these indicators should be made with caution. Greater compliance can be achieved through two synergistic factors 1) increasing voluntary compliance through education and stakeholder buy-in into the management strategies and 2) by increasing the possibility and level of punishment so that it exceeds the potential reward of breaking the law (Britz *et al* 2001).

A major issue that dominates projects at any scale when trying to achieve sustainability is inadequate administrative and legislative frameworks (Burbridge 1997, Caddy & Cochrane 2001, Sinclair *et al*. 2002, Griffiths and Lambeth 2002). The current study revealed a similar trend for the institutional authorities in charge of local fisheries management, as a sustainability index of only 17% was reached (Figure 4.2). The fact that there is no reference towards coastal management in the Integrated Development Plan (IDP) document or a coastal management plan in place to guide daily decisions signifies that the sustainable utilization of local marine resources and its associated benefits are not a priority of the Bitou Municipality. It however, must be acknowledged that fisheries are not a municipal responsibility but that of national governments and due to the inadequacy of national government to carry out this responsibility and the requirement of the devolution of power to lower levels of government (Glavovic 2000a),

municipalities need to become more involved in managing local fisheries. This may require increasing their awareness of the social and economic value of the marine environment in an attempt to improve their political will in planning for and implementing an Integrated Coastal Management (ICM) approach to management (Burbridge 1997). In relation to indicator B2, monitoring the fishery in terms of the users needs and the status of the resource is essential in ensuring that the management strategy is continually effective. In Plettenberg Bay however, there is no such monitoring programme in place, consequently one should be established to collect catch and effort data, as the current study only provided information on one year which may not be a true reflection of the fishery as inter-annual fluctuations exist in every fishery (Coetzee *et al*. 1989, Gartside *et al*. 1999). Despite evidence of overexploitation already, the value of future monitoring will allow for iterative management and hopefully the implementation of new management strategies.

A key requirement in the pursuit of institutional sustainability is also the ability to manage and enforce resource-use regulations (Charles 2001). However, there are only two MCM officers that patrol the Plettenberg Bay coastline and their area of jurisdiction extends from Bloukrantz River in the TNP to Klein Brak near Mossel Bay (Niewoudt 2003, WCNCB, pers comm.), an area that is far too extensive to be covered effectively by two people. In addition, their efforts are mainly directed at controlling the large-scale commercial fisheries with less attention being paid to the inshore coastal resources (Griffiths and Lamberth 2002). A recent agreement between WCNCB and MCM for WCNCB to take on the responsibility of marine resource management in the area together with MCM, however should increase inspection rates and hopefully the level of compliance (Niewoudt 2005, WCNCB, pers comm.). The participation of anglers in management, one of the sub-principles of the FAO Code of Conduct for Responsible Fisheries (FAO 1995), which was not covered in the current study should also be incorporated into further monitoring

programmes by including a question related to the degree of stakeholder participation in the management of local resources. This is important as the greater the participation of stakeholders in the management process the more likely the programme is to succeed (Tobey and Volk 2002). Furthermore, it is suggested that unless the institutional problems discussed above are addressed, policy goals will be undermined and the benefits that flow from sustainable utilization of these resources will not be realized (Britz *et al*. 2001).

According to Pajak (2000), ecological integrity is the degree to which "ecosystem elements – species, habitats and natural processes – are intact and functioning in ways that ensure sustainability and long-term adaptation to changing conditions and human uses…". The current study revealed that this is not the case for the Plettenberg Bay shore-based linefishery, which according to the sustainability matrix is non-sustainable at present levels of exploitation (Table 4.2). Fishing has substantially reduced the local abundance of fish, which is evident by the poor success rate of anglers (indicators C1 and C2) and changes in species composition (indicator C3), specifically resident reef-associated species when compared to the TNP, an adjacent marine protected area. Caution needs to be taken with regards to indicator C2, which uses bag limits as an indication of the success rate. Recent amendments to the linefish regulations rendered this indicator to be ineffective, as at the time of the study the regulations permitted anglers to retain five fish per day per species which because they were hardly ever achieved for most species (Bennett *et al*. 1994, Attwood and Bennett 1995, Cowley *et al*. 2002) enabled the performance criteria to be set. The new regulations (Gazette Vol: 478 No. 27453 of April 2005) permit anglers to keep only one fish per species per day (for most species). Attaining this bag limit is more likely to be reached and thus may result in a higher score in the matrix, indicating that the fishery is sustainable, which is not a true reflection of the fishery. Cognizance of regulation amendments therefore needs to be taken into account. Finally, given the continued decline in fisheries and the ineffectiveness of current management methods as highlighted above, together with increasing

effort and poor angler knowledge, the future sustainability of our fisheries is questionable. It is only through the development of sound management objectives and implementation of clearly defined operational management procedures (OMP) (Griffiths *et al*. 1999) that future catches can be sustained. Within the sphere of OMP's, MPA's have been identified as a reliable management option to rebuild the stocks of overexploited species. Finally, considering the benefits of MPA's as highlighted in this study and by numerous others (Buxton and Smale 1989, Dugan and Davis 1991, Rowley 1994, Attwood and Bennett 1995, Cowley *et al*. 2002), the implementation of this management option in Plettenberg Bay may be the best option available to ensure future catches. The size and placing of such 'closed areas' in Plettenberg Bay, however, requires further research attention, as does the value of the adjacent marine protected area, the TNP, to the Plettenberg Bay fisheries with respect to larval transport and overspill of adults, as it has not been entirely proven that export of larvae into adjacent areas occurs (Rowley 1994).

In conclusion, the study has shown the Plettenberg Bay shore-based linefishery to be non-sustainable at present levels of exploitation due to the poor status of the fishery and poor institutional capacity by the organizations responsible for fisheries management. Therefore, in order to ensure that the needs of the present generation do not compromise the ability of future generations to meet their own needs, a management solution is needed to ensure the continued benefits of the coastal zone. Since there is no management plan at present to guide the utilization of coastal resources the final chapter proposes an approach for the local municipality to plan for and implement such a strategy.

CHAPTER 5

TOWARDS A MANAGEMENT PLAN

With the promulgation of new policies and legislation within South Africa over the last ten years, management within both the fisheries and coastal sectors is becoming more holistic, integrated, co-operative and participative (see Chapter 1). Of key significance is the White Paper for Sustainable Coastal Development in South Africa (2000), which lays out a plan of action for achieving a broad set of goals and objectives for coastal management. Importantly, the White Paper called for the drafting of a National Environmental Management: Coastal Zone Bill which in turn required that each coastal province compile a Coastal Management Programme (see Appendix 1, Figure 5). The ICM approach advocated in these documents should be seen as a process which co-ordinates and integrates the various coastal management sectors in deciding the strategies and actions that will be used in managing the coastal area. The White Paper (2000) and the Provincial Coastal Management Plans provide the structural framework and direction within which to implement the ICM approach. In other words, the ICM concept and general approach to resource management should be incorporated into a CMP. Although the development of local CMP is not a statutory function of coastal municipalities, as mentioned in the previous chapter, it is strongly recommended due to the importance of adapting management to suite local conditions and requirements consistent with the area of management and directly linked to the local management objectives. Furthermore municipalities need to become more involved in managing local fisheries, as they are the “closest” and most affected by the ecological and economic health and productivity of the coastal zone (Anon. 1996). In order to address local needs, it is advocated that a local BMP becomes part of the CMP (see Figure 1.1). The coastal and marine resources within the Bitou Municipalities’ (Plettenberg Bay) jurisdiction must be seen as important components in the alleviation of poverty and in providing opportunities for local economic development (LED). The adoption of an ICM approach to the local coastal governance should

therefore assist the local municipality to achieve the strategic objectives set out in their IDP; including 1) the need to ensure social, economic and ecological sustainability, 2) create effective, participative and transparent local governance and 3) promote local economic and social development for the People of Bitou within a safe and healthy environment (Plettenberg Bay IDP 2005). Although the White Paper (2000) and the WCCMP (2003) provide policy frameworks to guide CZM efforts, a lack of appropriate administrative structures, expertise and a defined protocol to implement these policies will hinder the development of local ICM plans or approaches.

By synthesising available literature dealing with ICM initiatives, methods and lessons learned, this chapter identifies a set of criteria and steps that should be fulfilled when implementing an ICM initiative. The objectives being to firstly outline a process to aid the development and implementation of a local ICM approach within the Bitou Municipality and secondly to identify the stakeholders along with their roles and responsibilities within this process. It is imperative that it be understood at this point that the guidelines by themselves will not achieve sustainable development but require the commitment, participation and understanding of all the stakeholders as to the need for an ICM approach to the planning and use of the coastal area.

The literature review emphasised a number of conditions or criteria that need to be addressed for ICM initiatives to be successful. Furthermore a number of steps within a structured approach to the management strategy (referred to as the policy cycle) were highlighted (Table 5.1). Details of the literature reviewed are given in Appendix V. From the criteria and steps highlighted within Table 5.1 an implementation protocol for local ICM initiatives is proposed in Figure 5.1. Some of the criteria listed in the table cannot be defined as finite steps but are rather principles that need to be met continuously throughout an ICM process. Consequently, they were not included in the

implementation protocol but should rather be achieved throughout the long-term iterative management process.

5.1 Necessary criteria for implementing an ICM initiative

The success of an ICM initiative is partly dependent on strong and effective leadership (Hewawasam 2000). Not only does the leadership need to be dedicated and consistent but needs to provide a high level of ongoing administrative and political support. In this regard, the first step in developing an ICM strategy for the management of Plettenberg Bay coastal resources is to ensure that the local municipality agree on the need for an ICM approach and accept responsibility for overseeing and implementing the proposed strategy (Figure 5.1, Section B.1) (Vallega 2001). Enhancing the managers' political will to adopt such an approach may require an awareness campaign that highlights the socio-economic value of the coastline as well as the need for an integrated approach due to the complex multi-use nature of the coastal zone (Burbridge 1997). Importantly, the management approach needs to be formally incorporated and aligned within the local Integrated Development Plan (IDP), the Local Economic Development Plan (LED) and the Spatial Development Plan (SDP) thereby providing the legal backing and "weight" behind the program.

Table 5.1. Main criteria and steps regarded as being important to achieve successful ICM. Reference codes for specific papers advocating the steps and criteria are given on the right. Literature citation are given in Appendix V.

		Literature advocating criteria or step requirements.
Criteria that need to be addressed for successful ICM initiatives	Develop the need for ICM / Public education	1, 3, 8, 9, 11, 20, 23, 24, 30, 31, 32, 33, 34
	Appoint Leadership / Champion / Management unit	1, 9, 15, 22, 26, 28, 30, 33, 34
	Define geographical boundaries	3, 6, 21
	Stakeholder involvement / Participatory	1, 4, 7, 8, 9, 10, 13, 14, 15,17, 18, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 32, 34
	Formation of Sub-committees	6, 15, 17, 21, 23, 27
	Phased / Iterative approach	3, 4, 8, 12, 13, 14, 17, 20, 22, 23, 24, 32, 33, 34
	Importance of research / information	1, 3, 6, 7, 8, 9, 10, 11, 13, 17, 18, 20, 22, 23, 24, 28, 33, 34
	Sharing Information / Knowledge	7, 11, 20, 26, 30, 31, 34
	Continuous training / Capacity building	7, 9, 15, 20, 23, 24, 28, 30, 32, 33, 34
	Limited no. management issues tackled	12, 13, 20, 24, 26, 32
	Establish baselines	8, 14, 33
	Objective based measurable outcomes	14, 18, 21, 22, 24, 26, 34
	Define socioeconomic & environmental goals	3, 14, 33
	Form vision	5, 15, 21
	Co-ordinated with all government levels	1, 7, 15, 20, 22, 23, 24, 32, 33, 34
	Be flexible & adaptable	7, 20, 22, 28, 32
	Schedule implementation	18, 21, 23
	Indicator system developed	2, 9, 14, 17, 18, 21
	Securing access rights	15
	Adequate enforcement	15, 31
Important steps highlighted in the ICM policy cycle	Assess current situation	3, 7, 11, 18,
	Identify Objectives	3, 4, 5, 6, 11, 18, 32
	Identify Issues	8, 11, 12, 13, 16, 19, 23, 25, 31, 32, 33
	Prioritize	16, 26
	Data Collection / Research	3, 4, 17, 19, 22, 29
	Analysis	11, 16, 17, 19, 23, 25, 29, 32, 33
	Develop options / Strategy formulation	1, 3, 4, 11, 16, 17, 31
	Program preparations / Plans formulation	6, 7, 8, 12, 13, 17, 18, 19, 25, 29, 31, 32, 33
	Agreement of actions	5, 11
	Revision of plan	1, 2, 4, 5, 6, 8, 18, 19, 33
	Formal adoption & funding	6, 7, 8, 12, 13, 15, 19, 21, 23, 25, 26, 28, 29, 31, 32, 33
	Implementation	2, 3, 5, 6, 7, 8, 11, 12, 13, 17, 18, 19, 23, 25, 29, 31, 32, 33
	Monitoring effectiveness / Evaluation	2, 3, 5, 6, 9, 11, 12, 13, 14, 15, 17, 18, 23, 25, 27, 28, 29, 31, 32, 33

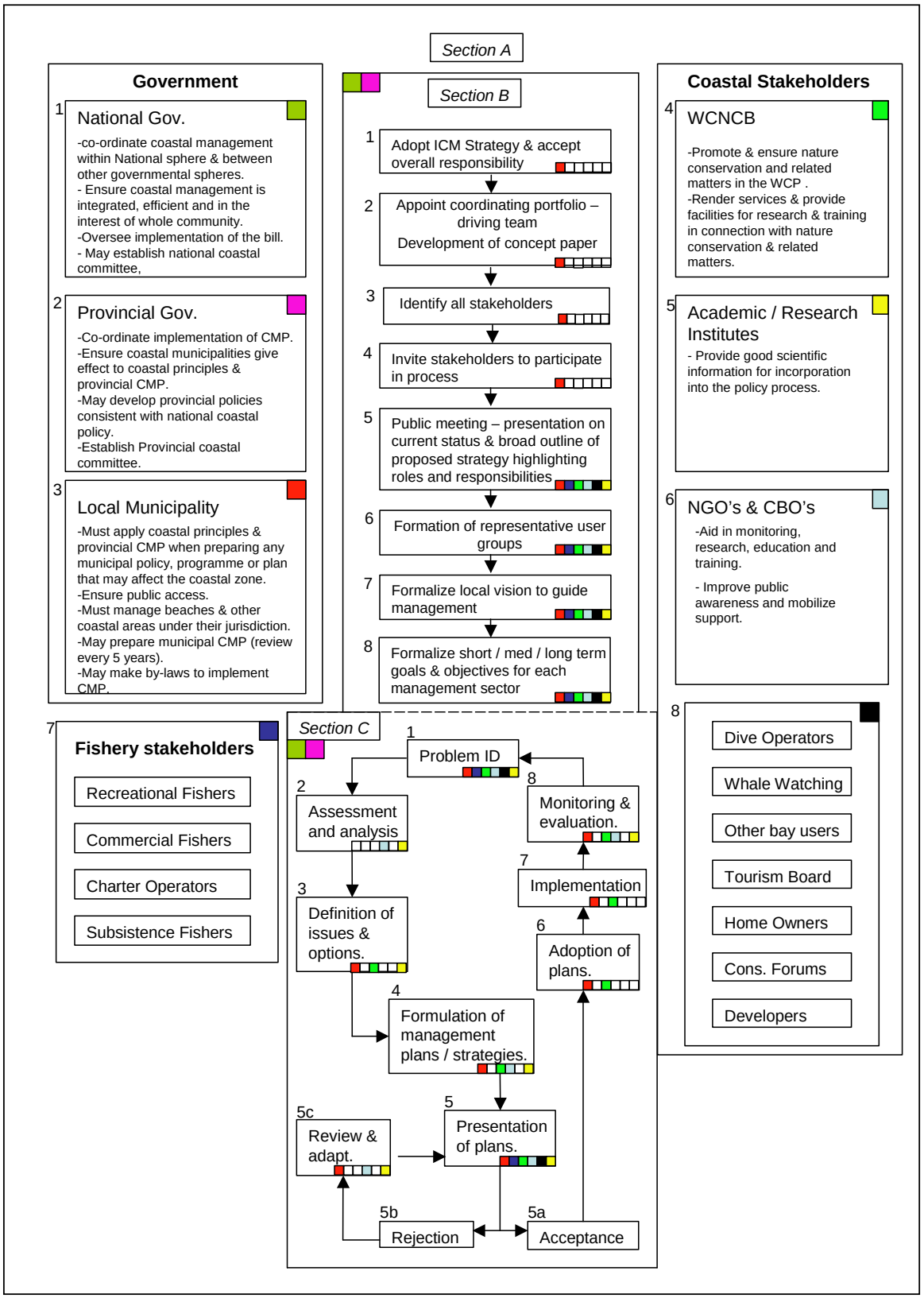

Figure 5.1. Proposed local ICM implementation protocol. The diagram is broken into three parts. Section A lists the various stakeholders involved (1 to 8), section B deals with specifics of initial implementation whilst section C deals with the ongoing policy cycle of how issues should be dealt with. The stakeholders involved in each step or phase are indicated by the colour-coded blocks.

Following the municipalities adoption of the principles of an ICM approach the establishment of a coastal management unit that is responsible for coordinating between government departments, NGO's, local communities and the private sector is essential (Figure 5.1, Section B.2) (ECCMP 2004). Coordination of effort and effective inter-organizational linkages among the actors involved is key to the success of the programme (Tobey and Volk 2002). Improved coordination will facilitate a clearer definition of the roles and responsibilities of the various departments that have a shared or overlapping responsibility for coastal resources and will also improve the flow of information between organizations to ultimately boost capacity for management (ECCMP 2004). A coordinating body (task team) should be constituted under the auspices of the municipality. This task team body should be multidisciplinary and include experts in coastal management, regional planning, resource economics, environmental management and ecology (Anon. 1996). The team must be responsible for developing a 'concept paper' or 'discussion document' which lays out in simple terms the need for the new programme, what it intends to accomplish, indicates how the programme will be developed and by whom. In addition, it must reveal how much time and money is required (Anon. 1996). Important information such as current legislation and resource status should also be included in this concept paper (Die 2002). The task team must identify all the stakeholders that need to be involved in the process and formally invite these stakeholders to participate in the ICM approach and assist with the development of a resource management plan (Figure 5.1, Section 3 & 4). The earlier stakeholders are involved in the process the greater their sense of ownership over the programme which in turn leads to better compliance with the management measures (Die 2002) and ensures that existing local knowledge and experience is integrated into the plan (Tobey and Volk 2002).

To ensure the success of the ICM initiative the general public have to be made fully aware of the ICM programme as well as its goals and policies (Anon. 1996). To achieve this, public meetings that are open, facilitative, inclusive, transparent and informative need to be held, that allow for

detailed discussions and questions relating to the concept paper (Die 2002). This process also allows the public to express their views and contribute towards the contents of the plan (ECCMP 2004) (Figure 5.1, Section B.5). Initial investment in the consultation process will save a great deal of resources later and will help the plan to have the highest possible initial acceptance when it is implemented (Die 2002). Following the public announcement of the ICM initiative a forum of user groups, from all sectors of the community need to be established to provide users with a formalized means to voice their needs and views (Figure 5.1, Section B.6). An example of this is already present in Plettenberg Bay with the recent formation of the Central Beach Launch Site Forum. It is comprised of fifteen sectors including National Sea Rescue, municipal representative, Rate Payers Association, New Horizons, Kwanakotula, the Ski-boat club, commercial fishing sector, charter fishing sector, inflatables and Personal Water Craft (PWC), hobie cats, charter diving, research and tourism. This forum, requested by central government as part of Plettenberg Bay's application for a launch site, is primarily a communication forum between government and the launch site users aimed at increasing public participation.

A key component in the formulation of an ICM approach is the development of a local vision to guide management (Figure 5.1, Section B.7) (Rodgers & Biggs 1999, Hauk & Sowman 2001, McMcleave *et al.* 2003). All stakeholders should be involved in this process to ensure that consensus is reached as to the long-term plans for Plettenberg Bay. The vision statement creates the foundation of the management programme by providing a reference against which all management decisions can be evaluated and informs the principles on which the objectives of the programme are based (ECCMP 2004). A range of short, medium and long-term goals and objectives for each management sector also need to be formalized by the stakeholders to guide daily and long-term management decisions (Figure 5.1, Section B.8). The developmental vision for Plettenberg Bay currently reads as follows: "To be the best together" expressing the need to be united in diversity, united in action and have continual improvement on past performances. The

spatial vision reads as: “Bitou, a place for all” expressing the belief that South Africa and Bitou belongs to all who live in it, a home for all and a home that ensures economic, social and ecological sustainability (IDP 2005). These visions were formulated at a strategic planning session in 2003 and spatial development framework forum meeting in 2004 respectively thereby guiding both the developmental and spatial components of the local IDP document.

Other aspects that contribute towards successful ICM initiatives include the co-ordination of all levels of government in terms of (i) legislative and policy support and (ii) in ensuring that the management objectives of the lower tiers of government are in accordance with the upper tiers. The sharing of information along with continuous training and capacity building for those involved in ICM programs is especially important since ICM should be seen as a flexible, adaptive strategy that continuously evolves as new information becomes available or as the system changes. Importantly ICM should follow a phased, iterative approach beginning on a small scale with a limited number of management issues being tackled and growing as capacity and knowledge increase and measurable objective based outcomes are met. An ICM policy cycle describing a phased approach is explained below.

5.2 Policy cycle

Experience locally and internationally demonstrates that coastal management is not a ‘once off’ activity, it needs to be understood as a cyclical process of continual improvement, in which the role players learn from and build upon their practical experience, thereby steadily increasing the effectiveness of the management strategy (ECCMP 2004). Consequently, several cycles of the management strategy may need to be performed before the programme is sufficiently refined to address the specific objectives of the plan. There are many variations in the policy cycle, which

vary according to political structures and available resources, but the central idea of a multiple step cycle of planning-commitment-implementation-evaluation remains constant (Tobey and Volk 2002). The cycle proposed in Figure 5.1 Section C has been developed from the various papers highlighted in Table 5.1.

Stage 1: Problem issue identification

The initial cycle requires reviewing and synthesizing available information pertaining to the coastal environment to identify major issues contributing to non-sustainability. Subsequent cycles of the policy may also raise further issues through the evaluation phase.

Stage 2: Assessment and analysis

In many instances there is a lack of data pertaining to the status of the resource in question as well as the socio-economic forces acting on the resource users (Britz et al. 2001). Since an effective ICM programme must be based on adequate information, surveys may need to be performed to obtain this information or existing information must be collaborated (Anon. 1996).

Stage 3: Definition of issues and options

Issues identified from the analysis of information in stage two need to be defined and reduced to a manageable number (Olsen 2003, Clarke 1997). The various management options related to alleviating these issues also need to identified and defined.

Stage 4: Formulating the ICM plan

The management options identified in the previous stage need to be incorporated into a workable framework that managers can use to address the issues identified during the analysis. The formulation of a single management strategy is complex. The best approach therefore may be to

generate and test several strategies through pilot-scale implementation to arrive at the most appropriate management strategy that is suited to local conditions (GESAMP 1996).

Stage 5: Presentation of plans

Once the plans have been formulated they need to be presented to all the stakeholders for acceptance (5a) before the process can continue, or alternatively be rejected (5b), in which case the plans will have to be reviewed and adapted (5c) accordingly and once again presented to the stakeholders for approval.

Stage 6: Adoption of plans

The formal adoption of the programme will require a high-level administrative decision, in this case by the municipality. It will also include consideration and agreement of a budget for each phase of the programme (Anon. 1996, GESAMP 1996).

Stage 7: Implementation

At this stage in the ICM process the management plan becomes operational and the actions aimed at implementing the plan begin (Vallega 2001). New management mechanisms are enforced. Enforcement is an essential element of programme implementation and without it the credibility of the management unit could be damaged (FAO 1997).

Stage 8: Monitoring and Evaluation

The outputs of the ICM programme must be evaluated (Vallega 2001). The monitoring process establishes what has been achieved and the evaluation procedure determines whether the completed actions have contributed to the desired outcomes and goals of sustainable development (ECCMP 2004). It is therefore important for the goals to be achieved through the ICM approach and CMP to be specified as clearly and quantitatively as possible, otherwise assessments as to

how well they are being achieved are difficult (Anon. 1996). The evaluation phase, which is often omitted by a number of management initiatives, is the stage where the greatest amount of learning occurs and also provides evidence that the changes in the managed environment are attributed to the ICM programme (GESAMP 1996). Documenting the achievements attained through the new management approach is essential in demonstrating to all stakeholders the success of the ICM in achieving sustainable development and thereby ensuring continued support (Burbridge 1997, Tobey and Volk 2002, GESAMP 1996, Bower and Turner 1998).

Although the protocol outlined above follows a linear stepwise implementation, it is not always practical or feasible to stick solely to the model. It may become necessary to begin a later step before the previous is completed or even begun. Furthermore, where data is lacking and urgent management might be required the precautionary approach should be followed with actions being taken to alleviate the stress before the research results are gathered. In anticipating and predicting the likely causes of environmental degradation, rather than reacting to their outcome should mean that the intervention prevents the costs involved in rectifying the damages (Stojanovic *et al.* 2004).

5.3 Collective roles and responsibilities of all stakeholders

The various stakeholders that should be a part of the initial and ongoing process are specified in Section A (Figure 5.1). A summary of their main roles and responsibilities and the specific stages of involvement in the ICM process is described below.

National government

Marine and Coastal Management Chief-Directorate of the Department of Environmental Affairs and Tourism (DEAT) is the lead agent responsible for the management of South Africa's coastal

resources (Glavovic 2000a). Responsibilities include policy formulation and implementation, coordination of management activities within and between governmental spheres, biological diversity protection, offshore resource management, research, and environmental education (WCCMP 2003). In practice, the national office plays an advisory role and has limited capacity, delegating national coastal committees with management responsibilities. Their role is also to ensure that coastal management is integrated, effective, and efficient and in the interests of the whole community (Figure 5.1, Section A.1).

Provincial government

The role of provincial government is to coordinate the implementation of the provincial coastal management plan (PCMP) and ensure that coastal municipalities give effect to coastal principles and the PCMP. Responsibilities include monitoring the state of the environment in the coastal zone and coastal management in the province to ensure that it is undertaken in an integrated, effective, and efficient manner. Other responsibilities include development and reviewing of provincial legislation and monitoring the state of the coast within the province. In addition, they establish a provincial coastal committee (PCC), which facilitates communication between the different governance spheres (Figure 5.1, Section A.2).

Although both the national and provincial government levels have not been shown to be specifically involved in any particular step, a better option is for both of these government levels to oversee the entire process ensuring that local management remains within the boundaries set by the provincial and national coastal management plans.

Local government

The primary functions of municipalities in relation to coastal management are to firstly manage beaches and other coastal areas under their jurisdiction in an integrated, effective, and efficient

manner that is in accordance with the coastal management principles of the Coastal Zone Bill and secondly ensure public access to coastal public property. Furthermore local municipalities may (i) prepare and implement municipal coastal management programmes as either part of an integrated development plan or separately, (ii) vary boundaries of the coastal buffer zone and (iii) establish coastal set-back lines in zoning / land use schemes (WCCMP 2003). Once a CMP has been developed, the municipalities have the power to create by-laws to assist with implementing their CMP's (Figure 5.1, Section A.3). It is envisaged that the local municipality would be a lead agent to implement the ICM approach and develop the CMP and as such would be involved in all the steps given in Section B and most steps in Section C (Figure 5.1). Currently an exception would be in the research and analysis step (C.2) which would be outsourced to a research facility.

Western Cape Nature Conservation Board (WCNCB)

The objects of the WCNCB are to promote and ensure nature conservation and related matters in the Western Cape Province; to render services and provide facilities for research and training in connection with nature conservation and related matters (WCCMP 2003) (Figure 5.1, Section A.4). Specific involvement of the WCNCB would be in the definition of issue and options (C.3) resulting from previous assessment, the formulation of management strategies (C.4), the adoption and implementation of the strategies (C.6 & C.7) and in the monitoring and evaluation (C.8) of the strategy.

Research institutions

The role of universities and research institutions is to assist with the policy process by collecting and analysing data concerning coastal resources. One of the fundamental requirements for a successful ICM approach is that decision-making is based on scientifically sound data (Anon. 1996, Tobey and Volk 2002) (Figure 5.1, Section A.5). As such research institutions would be specifically involved in the assessment and analysis step (C.2), the definition of issues and

options (C.3), the formulation of proposed management strategies (C.4) and the monitoring and evaluation of those strategies (C.8) should they be accepted.

Non-governmental and Community-based organisations

They have a valuable role to play in improving public awareness of and mobilising support for the coastal policy and its implementation and also in management activities such as monitoring, research, education and training (Glavovic 2000a) (Figure 5.1, Section A.6). NGO's and CBO's could assist or replace research institutes in the assessment and analysis of potential problems (C.2), the formulation of management strategies (C.4) and the ongoing monitoring and evaluation of those strategies (C.8) should the be accepted.

Additional stakeholders include those of the fishery sector (recreational, subsistence, commercial sectors and charter operators), and other tourism and development related role players (Figure 5.1, Section A. 7 & 8). The involvement of these stakeholders needs to go beyond simply informing and post implementation consultation to one where they have the ability to be a part of the process with adequate representation and possibility for input. However, to aid this process it is recommended that the various stakeholder groups form representative bodies that can be used as paths of communication and help in conflict resolution. It is not possible for all stakeholders to be involved in every step, rather certain steps need to be carried out by specific groups with regular feedback to all other stakeholders and provisions for their comments on the reports. As such all stakeholders should be involved from Section B.5 through to B.8 and importantly in steps C.1 &C.5 of the policy cycle. In particular, step C.5 should be seen as an opportunity for information exchange and stakeholder input.

Although the stakeholders have been identified and an implementation protocol outlined for a localised ICM approach in Plettenberg Bay, the incorporation of the program into the municipal

management strategy requires departmental restructuring, which is currently under review (Windvogel 2005, pers comm.). What has been proposed is that within this restructuring there needs to be a department or leader who will be responsible for driving the process, ensuring that other relevant departments are involved in the process and communicating between all stakeholders and the different levels of government. Of equal importance to the supervision of the project is the ability of local government to fund the ICM initiative.

5.4 Funding

Once the municipality has identified the budget requirements in implementing an ICM approach it is crucial that sufficient funding is secured. Unreliable funding can create significant obstacles and ultimately jeopardize the overall success the management programme (Hauck and Sowman 2001). Of equal importance is the long-term availability of funds due to the iterative and expanding nature of ICM (Christie *in press*). There are too many cases where once donor funding and technical assistance are removed the initiative fails (Hauck and Sowman 2001, Olsen 2002, Christie *in press*). Fund raising is a challenge that must also be addressed. Three means of obtaining financial support for the programme are outlined below.

Surcharge levies:

The first is through a local environmental surcharge levied on local residents through property rates and on tourists through rates imposed on accommodation facilities visited (Mollatt 2003). Through a willingness-to-pay survey, which was aimed at quantifying public's preference for the provision of coastal management services in Plettenberg Bay, Mollatt (2003) deduced that on average residents were willing to pay approximately R175 per annum (R15 per month) toward a Bay Management Plan while domestic and foreign tourists were willing to pay a daily levy of approximately R6 and R22, respectively. Aggregated across their respective populations this

yielded a passive use value (or quantitative public preference) of between R15 397 900 – R20 330 500 per annum (Mollatt 2003).

Public-Private-Partnerships (PPP's):

The second avenue is through the establishment of PPP's where certain activities can be outsourced from the municipality to various other organisations who would have the capacity and funding to fulfil their obligations. For example, the ORCA Foundation has already funded a number of research projects to gather scientific data for input into a BMP and organised sponsorship to fund the 'ORCA' education centre and operate an education vessel. Part of the success of ORCA has been the links and partnerships that have been created between ORCA and various local businesses that have an ongoing role to play to fund the education centre and research projects.

National government funding:

The third avenue is through central governmental funding. Local municipalities may, upon entering into a memorandum of understanding between themselves and the governmental agency (Marine and Coastal Management), be paid a fee to carry out certain obligations that the governmental agency due to limited manpower and capacity is unable to. The money generated form the local municipal councils and the Marine Living Resources Fund (MLRF) would be placed into a trust that would then be used to fund activities set out in the memorandum of understanding (Griffiths & Lamberth 2002). From a coastal and fishery perspective this could include marine compliance inspections and monitoring along with public education and awareness programs. Although it is not a statutory function of the municipality to exercise these aspects they are important features to be incorporated into both the BMP and the CMP.

CHAPTER 6

CONCLUSION

In terms of achieving the specific objectives of this study the fishery assessment (chapter 3) provided sound baseline information regarding the status of the shore-based resources and dynamics of the resource users. Previously, no studies had attempted to gather the information required for management decisions in Plettenberg Bay, a problem plaguing the management of many coastal fisheries in South Africa (Wood *et al*. 2003). The sustainability of the shore-based linefisheries of Plettenberg Bay was assessed using a suite of functional indicators (chapter 4), which when aggregated within a sustainability matrix revealed that the fishery was not sustainable. Catch comparisons with the TNP and Rebelsrus further highlighted the poor status of the fishery, with a low *cpue* and reduced species composition. Collectively these findings suggest that recreational fishing has impacted heavily on resident fish stocks and that current management measures have failed. Clearly, an alternative management strategy to ensure sustainability within this fishery must is needed.

Mollatts' (2003) study substantiated the need for coastal management services in Plettenberg Bay, which revealed public preference for and gave an economic justification for a localised Bay Management Plan. This study has provided the protocol to achieve this (chapter 5). An integrated coastal management approach to the governance of the coastal resources in Plettenberg Bay was proposed with the development of a CMP and a subsidiary BMP providing the frameworks within which the management strategies can be put into operation. An implementation and ongoing management protocol that would form a core part of these plans are presented in Chapter 5, and certain steps in achieving this have already been addressed (see Appendix vi). The simple protocol provides the opportunity for the local municipality to initiate a more integrated approach to coastal management. The importance of an integrated management approach for coastal

resources was discussed in chapters 1 and 5. In short, to realise and sustain the flow of goods and services, the diversity, health and productivity of coastal ecosystems the coast must be managed on a co-ordinated and integrated basis due to the multi-use nature of the coastline and the complex governing structure where many different government agencies interact – if coastal development is to be sustainable (Glavovic 2000a). Not only is this approach sanctioned by national government (White Paper for Sustainable Coastal Development 2000) but is increasingly being adopted worldwide due to its effectiveness (Glavovic 2000a).

As previously mentioned there are no Bay Management Plans in existence in South Africa and therefore no 'blue print' for the project to follow. Therefore, the approach taken here in developing an implementation protocol must be seen as the first step in developing a workable Bay Management Plan for the region and will require further iterations. The suite of proposed indicators will also need to be validated by analyzing their performance across a number of case studies under varying conditions before they can be accurately used to determine whether a system is sustainable or not (Charles 2000), since there are few cases where indicators have been used for actual management (Dengbol and Jarre 2004).

Although this management protocol along with the proposed indicators have been developed for Plettenberg Bay, it is envisaged that other municipalities within the warm temperate south coast bioregion can adopt it. What remains is for the local municipality to 'buy into' the process and for a lead agent or champion to promote, encourage and support the development of a local coastal management plan thereby taking the concepts and ideas proposed here and making them a reality. After all recommendations are only as good as the actions they cause and the results they create.

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APPENDIX 1

Unpublished Report

Co-written by Kyle Smith and Claire King

An overview of Ecosystem Based Management approaches

The search for improved management frameworks has led to a global shift towards the introduction and implementation of more holistic Ecosystem Based Management approaches (EBM) (Table 1). This broad terminology generally implies an approach that within ecologically meaningful boundaries simultaneously addresses and balances the diverse societal needs and desires, with those of the environment to ensure sustainability (Griffis and Kimball1996, Heissenbuttel 1996, Pajak 2000) (Figure 1). Although EBM is being accepted as the way forward, application is still in its infancy with the international community still seeking precedents for how these ecosystem approaches should be implemented (Caddy & Cochrane 2001). This is largely due to the lack of clearly defined objectives (del la Mare *in press*) and the limits of our knowledge regarding complex ecological interactions (Reichman & Pulliam 1996). Various adaptive management approaches that embody the principles of EBM for both conservation and fishery management, (Figure 1 & 2), are being explored and include:

- the concepts of Large Marine Ecosystem management (LME),
- Integrated Coastal Management (ICM),
- Co-management,
- and Ecosystems Approach to Fisheries (EAF).
- the use of Marine Protected Areas (MPA's),

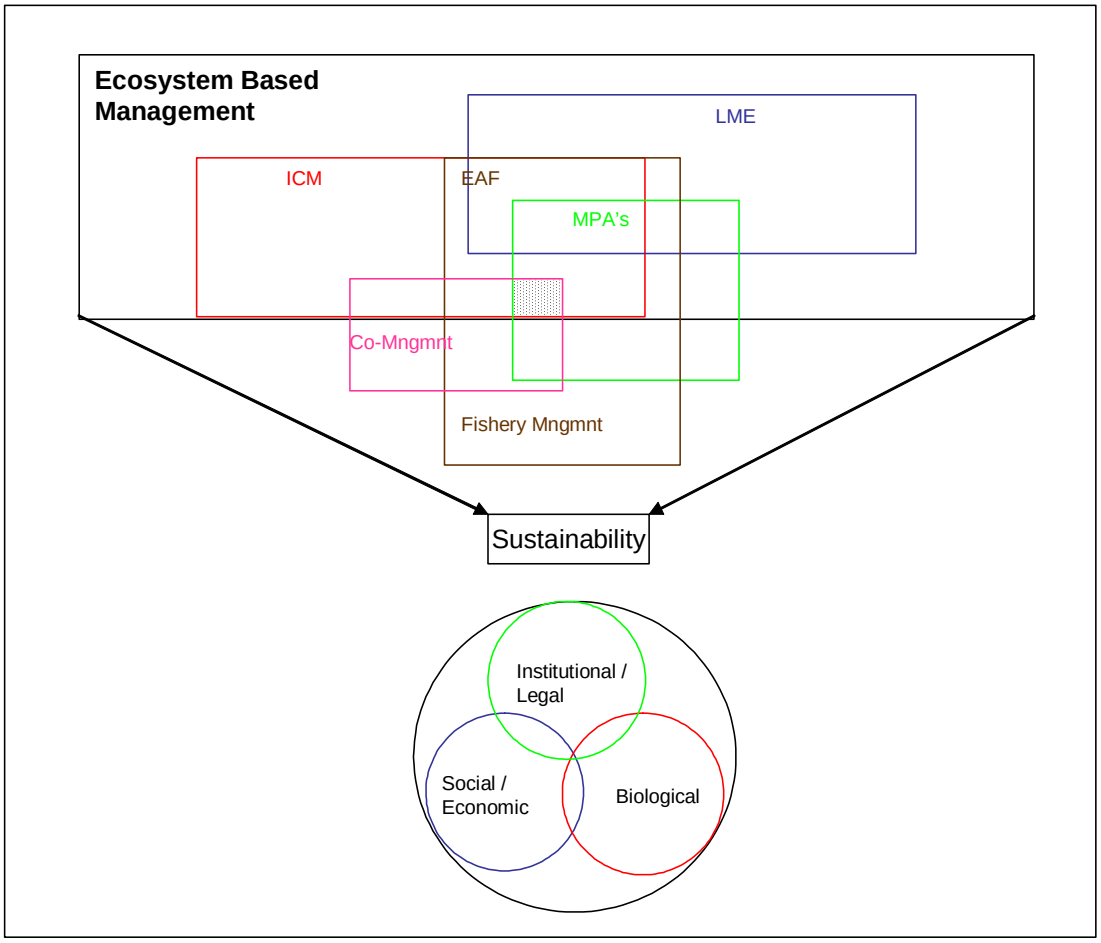

Figure 1. Diagram showing the various management options incorporating EBM principles aimed at achieving sustainability by addressing three domains: Institutions, Biological and Socio/Economic. (Adapted from Caddy 1999 and Pajak 2000). The management options that have bearing on the current project dealing with localized coastal fisheries are indicated by the shading. ICM = Integrated Coastal Management, LME = Large Marine Ecosystem management, EAF = Ecosystem Approach to Fisheries, MPA = Marine Protected Area

Table 1. Principles pertaining to Ecosystem based management and the Ecosystems Approach to Fisheries.

Principles of the Ecosystem Approach (Convention on Biological Diversity 1993)
1: Objectives of Management are a matter of societal choice. 2: Management should be decentralized to the lowest appropriate level. 3: Ecosystem managers should consider the effects of their activities on adjacent and other ecosystems. 4: Recognising potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management program should: a) Reduce those market distortions that adversely affect biological diversity b) Align incentives to promote biodiversity conservation and sustainable use c) Internalise costs and benefits in the given ecosystem to the extent feasible 5: Prioritise conservation of ecosystem structure and functioning to maintain ecosystem services. 6: Managed within limit of functioning. 7: Undertaken at the appropriate spatial and temporal scales. 8: Objectives set for long term, varying temporal scales and lag-effects recognised. 9: Recognise change is inevitable. 10: Seek the appropriate balance between, and integration of, conservation and use of biological diversity. 11: Should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices. 12: Should involve all relevant sectors of society and scientific disciplines.
Principles of the EAF (FAO 2003)
1: Natural resources should not be allowed to decrease below their level of maximum productivity. 2: Fisheries should be managed to minimize their impact on the ecosystem. 3: Ecological relationships between harvested, dependent and associated species should be maintained. 4: Management measures should be compatible across the entire distribution of the resource (across jurisdictions and management plans). 5: Because the knowledge on ecosystems is incomplete, the precautionary approach should be taken. 6: Governance should ensure both human and ecosystem well-being and equity.

Large Marine Ecosystems and Integrated Coastal Management

Although both LME management and ICM embody the principals of EBM there are some fundamental differences. LME's are more science driven with a focus on understanding how large-scale discrete ecosystems function from an ecological perspective whereas ICM efforts

are primarily issue-driven with a focus on governance processes and people management (Griffis & Kimball 1996). This is largely a result of the coastal zone area being more complex in terms of activities, institutions and numbers of role players that need to be involved in the management process.

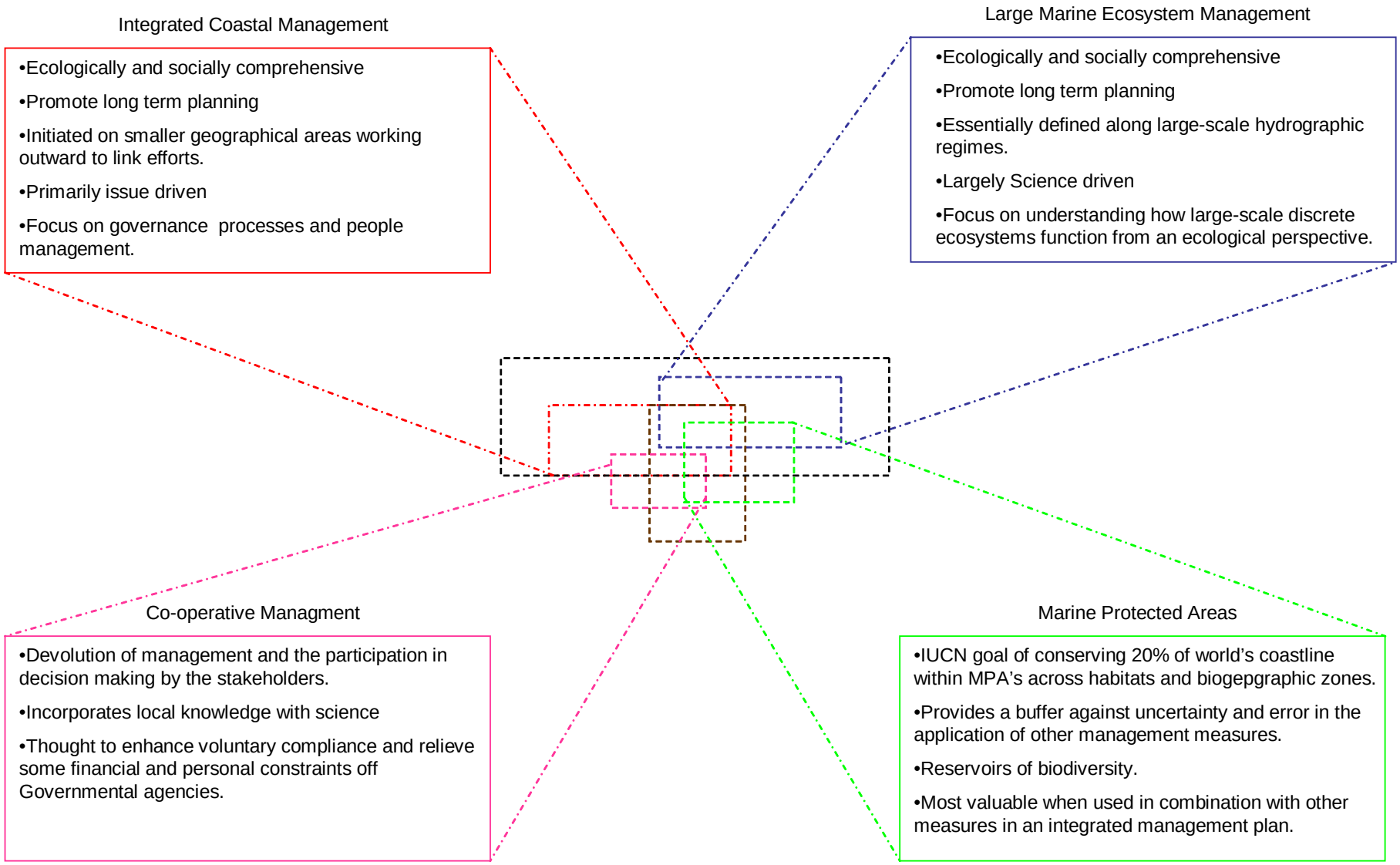

Figure 2. Key components of the various management approaches that can be used to achieve EBM.

The ICM process provides the mechanism for negotiating acceptable levels of use amongst the various stakeholders, facilitating changes from resource-use maximisation in one dimension to resource-use optimisation and balancing between several dimensions. In other words, the balancing of interests through wise, informed choices and tradeoffs. It is a system which brings together the multiple resource users and factors their effects on each other and also the combined effect on the environment in order to optimise social and economic benefits whilst maintaining the environment and its processes by reducing the impacts (Masalu 2000, Olsen 2003). This requires greater knowledge, understanding and involvement of the social and political forces shaping the behaviour of the resource users. It is by now well known and accepted that management is not only about managing the resource base but rather the ability to manage and influence the resource users (Caddy & Cochrane 2001, Sinclair *et al*. 2002, Wood *et al*. 2004). One method to achieve this which is gaining recognition as potentially more effective than the traditional centralised top-down, authoritarian command and control style of management is cooperative or co-management (Pomeroy 1999).

Co-management

Co-management refers to a more devolved, holistic, ecosystems approach to resource management that includes the participation of the various resource users or stakeholders in the overall decision-making and management of those resources (Jentoft *et al* 1998, Hauk & Sowman 2001, Caddy & Cochrane 2001, Wittmer & Birner 2001). Motivation for this shift in resource management comes from three fundamental motivating factors: firstly by incorporating knowledge gained from social and biological sciences with traditional and

local knowledge gained over time, more effective and relevant solutions to management issues may be reached. Secondly, stakeholder involvement in the regulatory decision making process may enhance acceptance and compliance (Jentoft *et al*. 1998) and thirdly governmental agencies often face limited financial, personal and equipment facilities to adequately monitor and enforce standing regulations (FAO 1982).

It may be argued that due to changes in fisheries technology, increased human populations and the erosion of particular cultural practises and values required for the long term sustainability of co-management initiatives, it may not be possible to re-instate traditional systems of self-management. Sowman (1993) and Hutton & Pitcher (1998) identified the imbalance of capacity between potential partners and the lack of organization amongst user groups as a limitation in the implementation of co-management initiatives in South Africa.

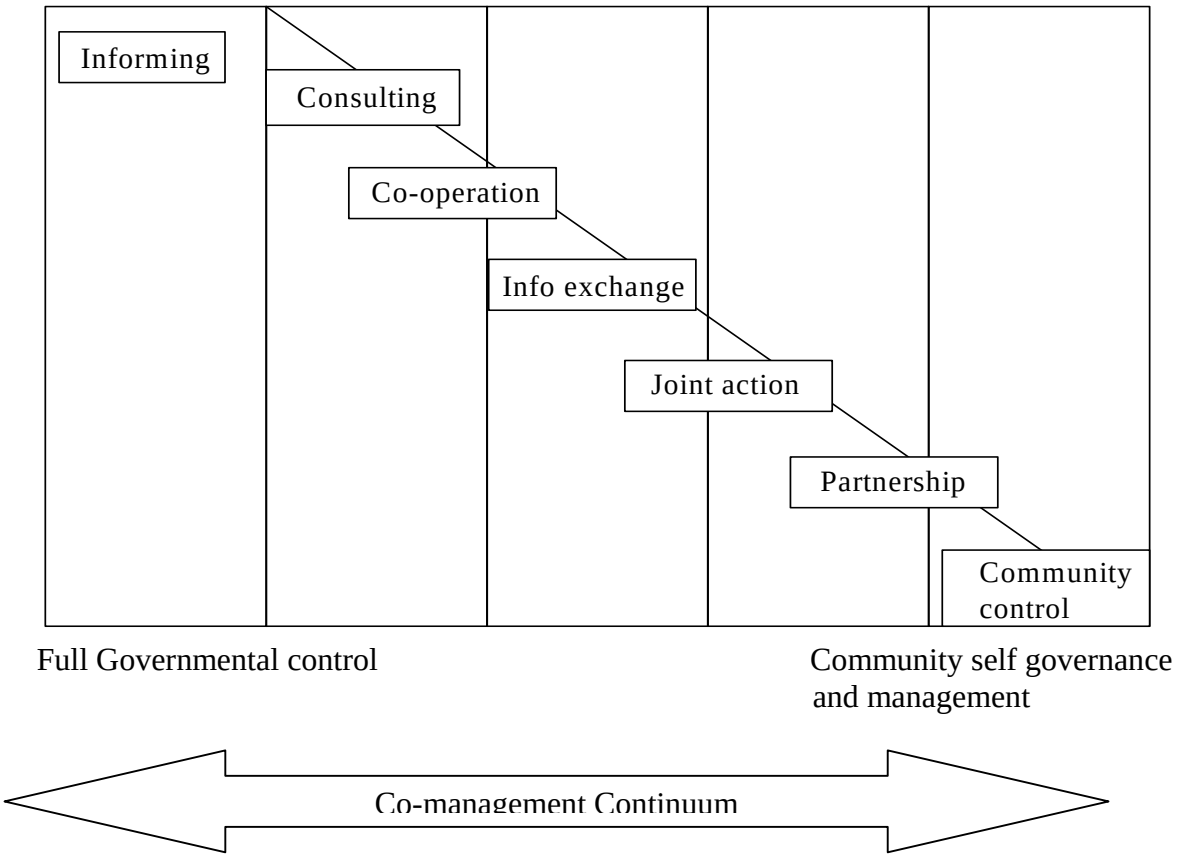

Figure 3. The Co-management continuum where management structures vary from users being merely consulted with regard to regulation formation to users becoming actively involved in the design, implementation and enforcement of regulations (adapted from Pomeroy and Berkes 1997).

However as shown in Figure 3 co-management does not necessarily mean total control of resource management by communities. Instead depending on the characteristics of the various stakeholders involved and the physical and technical attributes of the resource being managed, co-management initiatives may fall along a continuum between pure state control at one end and pure stakeholder based control at the other (Pomeroy 1999, Pomeroy and Berkes 1997, Wittmer & Birner 2001). By firstly building coastal partnerships between the stakeholders, various spheres of government, coastal communities and the general public and secondly by devolving management to include local stakeholders in decision making, ICM

can be seen to fit in with the co-management continuum. The extent to how far along the continuum it falls will again depend on the cultural, economic and political environment of the program and the length of time a local ICM initiative has been running and the success it has been showing (McCleave *et al* 2003).

Co-management in South Africa is still in its infancy, as is evident in Table 2 with most co-management projects being initiated and implemented in the last five years (Hauck and Sowman 2003). Although this makes it difficult to evaluate under what conditions co-management is likely to succeed, a set of conditions central to achieving the success of co-management arrangements in South Africa have been identified (Hauck and Sowman 2001, Hutton and Pitcher 1998). Given the history of inequality in South Africa where a large number of South Africans were denied access to and ownership of coastal resources, a fundamental first step is the allocation and security of access rights to resources. Not only does this address the issue of equitable access within the White Paper for Sustainable Coastal Development (2000), hereafter referred to as the White Paper, but also gives the resource users a sense of ownership over the resources which in turn provides incentive for users to manage the resources sustainably (Jentoft 2003). Secondly there is a need for long-term government support and commitment to co-management efforts. There is an apparent unwillingness on the part of government agencies to devolve power to local levels because of their scepticism that other levels of governance can accept responsibility and be accountable for management of local resources (Hutton and Pitcher 1998, Jentoft 2003). Establishing local organisations with legitimate representation that government agencies will recognise will therefore be a significant

challenge in facilitating meaningful partnerships (Hutton and Pitcher 1998). Consequently empowerment and capacity building of communities will be an essential step to ensuring greater and more meaningful participation in the decision-making process.

Table 2. An overview of co-management initiatives in South Africa (from Hauck and Sowman 2001)

Project	**Co-mgmt sector**	**Stage of co-mgmt**	**Type of co-mgmt**	**Scale**	**Resources involved**	**Timeframe**
Amadiba Tourism	Tourism	Planning	Supportive	Local	Cultural & scenic; (intertidal)	2 years
Industry-Government	Fisheries (commercial)	Implemented	Consultative	National	Hake fishery	20-25 years
KEN Tourism	Tourism	Collapsed		Local	Cultural & senic; (fish)	5 years
Kleinmond Inshore fishery	Fisheries (Artisanal)	Terminated	Consultative	Local	Inshore fish	1 year
Kosi bay Gillnetting	Fisheries (subs)	Implementation	Co-operative	Local	Fish	7 years
Olifants River Gillnetting	Fisheries (subsistence)	Implementation	Co-operative while operating	Local	Fish	6 years
Pondoland Forestry	Coastal forestry	Pre-Planning		Local	Medicinal plants, trees, grasses	3 months
St. Helena Seaweed	Mariculture	Planning	Advisory	Local	Seaweed	2 years
St. Lucia Gillnetting	Fisheries (subsistence/artisanal)	Terminated	Consultative	Local	Fish	6 years
Sokhulu Mussel	Fisheries (subsistence)	Implementation	Co-operative	Local	Inshore mussels	5 years

One of the themes within the White Paper is not only the need for integration amongst coastal management efforts and a corresponding increase in the capacity building of all

spheres of government (Glavovic 2000a), but is also one aimed at creating proactive and meaningful partnerships between government, civil society, NGO's and the private sector (Public Private Partnerships – PPP's). Roman & Azucena (2003) state that one of the key elements of success in environmental governance aimed at sustaining economic, social and ecological development, especially at the local government level, is the creation of such partnerships thereby combining the strengths of government, the private sector and civil society groups. The private sector's interest in maintaining the integrity of coastal systems and in co-operating with other stakeholders in the endeavour to promote sustainable coastal development is central to the continuous flow of goods and services that sustain this sector (Glavovic 2000a). Both Sowman (1993) and Hutton & Pitcher (1998) conclude that although co-management initiatives may have initial costs and require long-term government commitment, greater user participation in management will play a key role in future coastal and fisheries management. In summary, increased emphasis is being placed on promoting sustainable use, decreasing unemployment whilst increasing equity, economic efficiency, stability and user participation in management (Hutton *et al*. 1997).

In an overview of the status of coastal zone management (CZM) in South Africa in 1993, Sowman highlighted the absence of a policy framework to guide CZM efforts and the lack of supporting legislation and appropriate administrative structures for its implementation, had impeded the implementation of comprehensive CZM systems in South Africa till that point. However, we are seeing from the outcome of various international conventions and through the socio-political environment in South Africa with its dispensation towards participatory democracy, a greater provision and call for more holistic management with some form of

user participation. The ability to embrace concepts like co-management within a coastal and fisheries context is now being provided.

Marine protected areas (MPA's)

A number of conventions, to which South Africa is party, call for the designation of MPA's. The World Conservation Union (IUCN) in 1992 proposed a goal of conserving 20% of the world's coastline through a network of MPA's covering a range of biogeographical zones. This is being regarded as a central component of precautionary fishery management (Clark 1996). MPA's have been widely advocated as a tool for conservation and fisheries managers to maintain or restore regional biodiversity and ecosystem processes (Done & Reichelt 1998). Numerous studies have shown the benefit of MPA's for the protection of targeted fish species (Bennett & Attwood 1991, Buxton 1993, Cowley *et al*. 2002) and the subsequent ability to sustain bounding fisheries through the net exportation of larvae, juveniles and adults (Attwood *et al*. 1997, Ward and Hegerl 2003). It has however been cautioned that MPA's alone may not guarantee the long-term persistence of targeted species and that they should be used in combination with other management measures as part of an adaptive management scheme (Sumaila *et al*. 2000).

Legislation pertaining to coastal resource management

Over the last two decades there have been progressive and substantial changes in international agreements, mandates and treaties with regards to fisheries and environmental management (Table 3). Under the influence of these international agreements and the

political transition in South Africa, from an authoritarian system of government to a multiparty participatory democracy, a number of national policies and legislative documents have been formulated to regulate and guide the management and use of natural resources in South Africa, including fisheries and the coastal sectors (Hutton & Pitcher 1998, Mayekiso *et al*. 2001, Hauck & Sowman 2001, van Stittert 2003) (Table 4). Figure 4 shows the progression and relationships between these international agreements and the cascading effect they have had to help shape the suite of environmental legislation that exists in South Africa.

Table 3: Key International Conventions that helped shape South Africa's Marine Environmental Legislation. Overall emphasis has moved from a priority on single species or targeted species protection to a broadening of conservation objectives to include a more holistic ecosystems approach with habitat and biodiversity protection being highlighted.

Key International Conventions / Mandates & Treaties	Description
1982 Law of the Sea Convention UNCLOS	Provided for the first time, a universal legal framework for the rational management of marine resources and their conservation for future generations and included the provision for a 200 mile exclusive economic zone (EEZ)
1992 United Nations Conference on Environment and Development (UNCED): Rio Declaration	A set of 27 principles on the environment and development, designed to promote international cooperation for sustainable development.
1992 United Nations Conference on Environment and Development (UNCED): Agenda 21	Of importance to fisheries management is Chapter 17, which identifies the importance of the marine environment, describing it as "an essential component of the global life-support system and a positive asset that presents opportunities for sustainable development." It outlines certain programme areas that include integrated management and sustainable development of coastal areas, including EEZs, sustainable use and conservation of marine living resources of the high seas and strengthening international, including regional, co-operation and coordination.

1992 CANCUN Declaration	Although not the first forum to discuss the notion of responsible fishing, it was the first to do so at the global level. One of the main aspects of the Declaration was that it called upon the FAO to draft, in consultation with relevant international organizations, an international Code of Conduct for Responsible Fishing, taking into account the Declaration.
1993 United Nations Convention on Biological Diversity	The convention recognized the importance of biological diversity, acknowledging that "conservation and sustainable use of biological diversity is of critical importance for meeting the food, health and other needs of the growing world population".
1995 Jakarta Mandate	Outlined an action program for implementation of the Convention on Biological Diversity with respect to marine and coastal biodiversity.
1995 FAO Code of Conduct	The Code of Conduct consists of a collection of principles, goals and elements of action. It represents a global consensus or agreement on a wide range of fisheries and aquaculture issues
2001 Reykjavik Conference	Addressed steps on how to introduce ecosystem-based approaches in to the mainstream of fisheries management thereby acting on the Jakarta Mandate and the FAO Code of Conduct
1995 United Nations Fish Stocks Agreement	Primarily address the management of straddling and highly migratory stocks. It calls for the greater protection of the marine environment in general through the use of the precautionary principle, the protection of habitats of special concern and the use of selective fishing gear to minimise by-catch.
Key Regional Conventions	Description
1981 Convention on the Protection, Management and development of the Marine and Coastal environment of the West and Central African region (Abidjan Convention)	Broad objectives included the development, protection and standardized management of the coastal and marine environment in the West and Central African region.
1985 Convention on the Protection, Management and development of the Marine and Coastal environment of the East African region (Nairobi Convention)	Broad objectives included the development, protection and standardized management of the coastal and marine environment in the East African region.

Table 4: National Key Legislation Relevant to Coastal Management.

Key Legislation	Description
The Constitution Act 108 of 1996	Is the supreme law of the land. It emphasises cooperative governance and provides the legal basis for allocating powers to different spheres of government. The Environmental Right provides that: "Everyone has the right: a) to an environment that is not harmful to their health or well-being; and b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that – i. prevent pollution and ecological degradation; ii. promote conservation; and iii. secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."
Sea Shore Act 21 of 1935	States that the State President has custodianship over the sea and seashore. Thereby the control of development, pollution and waste management is the responsibility of the State.
Marine Living Resources Act 18 of 1998	Aims a increasing the socio-economic benefits to coastal communities through the guiding principles of equity, sustainability and stability. It highlights the need to protect whole systems thereby conserving biodiversity and maintaining the populations of all species at levels consistent with their respective roles in the ecosystem. Advocates the precautionary approach in cases where little information is available.
National Environmental Management Act 107 of 1998	Establishes principles for decision making on matters affecting the environment, institutions that will promote cooperative governance, and procedures for coordinating environmental functions by organs of state.
White Paper For Sustainable Coastal Development for SA 2000	Promotes a people-centred approach to coastal development maximising opportunities for economic and social development through the maintenance of an ecologically sound ecosystem. The white paper sets out a vision, a number of principles and goals for coastal management.
Biodiversity Bill of 2003	Provides for: the management and conservation of the biological diversity of South Africa, the sustainable use of our biological resources and, the fair and equitable sharing of benefits arising out from the use and application of genetic resources and material.
Protected Areas Act of 2004	Provides for the declaration and management of different types of protected areas in South Africa.

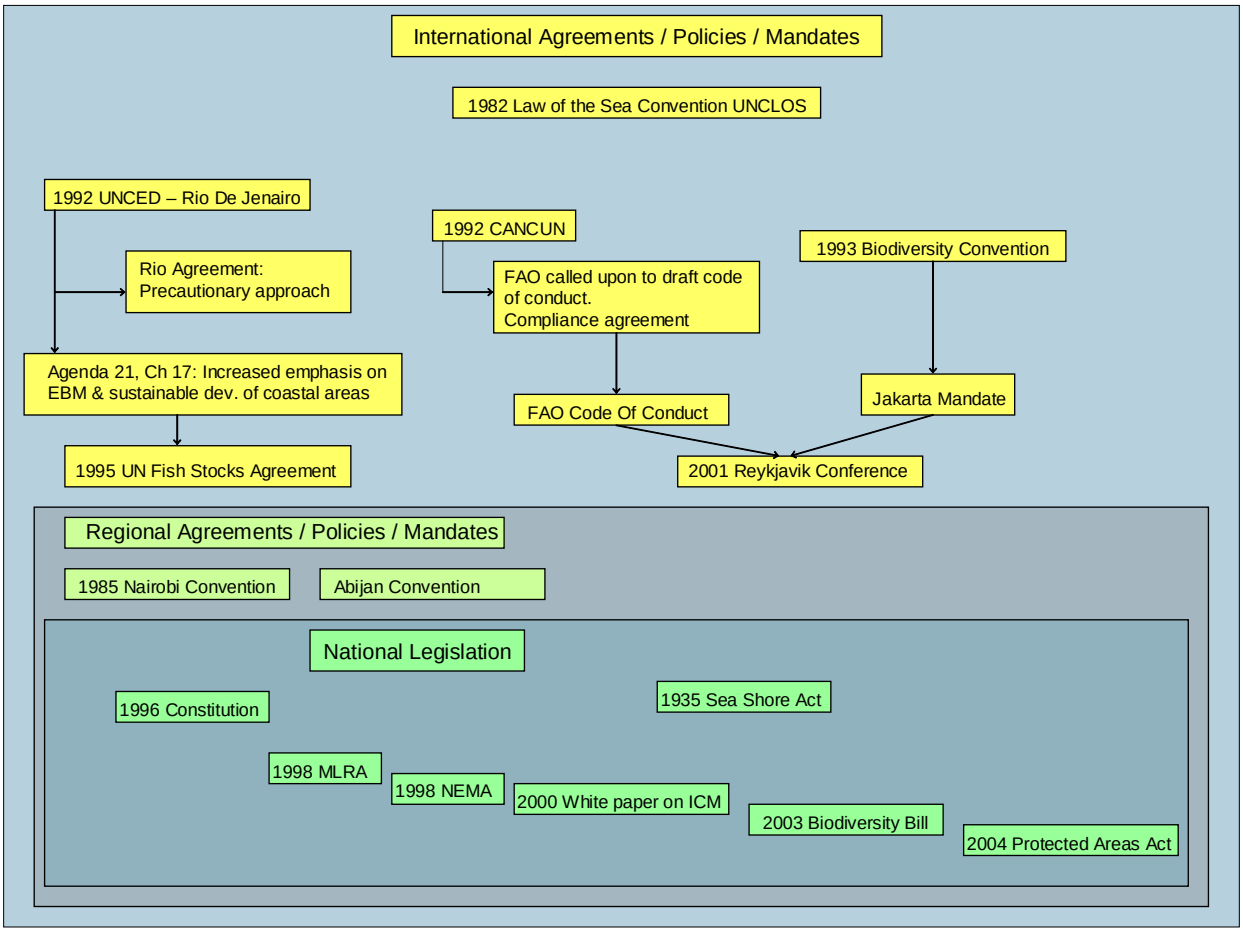

Figure 4. The suite of Key International, Regional Policies / Mandates and Agreements that have shaped the suite of environmental laws South Africa has today.

South African management has in the past been dominated by a centralised, top-down command and control style with central government, through the Department of Environmental Affairs and Tourism (DEAT), playing a major role in assuming responsibility for management of marine resources (Glavovic 2000a). South African fisheries have been managed through two broad forms of control: (i) the management of catch through limits such as daily bag limits, size restriction, catch quota and gear restriction, and (ii) management of effort through limited entry, closed areas and closed seasons (Griffiths and Lamberth 2002). Although government has in the past established scientific working groups

to determine the scientific bases for management decisions, and formally recognised various industrial and interest groups, which facilitated consultation and the exchange of information, the direct inclusion of other types of user groups such as fishing communities in resource management was until recently never attempted (Hutton & Pitcher 1998). Although a framework for creating sustainable coastal development protocols at the local level is being provided, these regional and local ICM programs must respond to and provide benefit to their own stakeholders. In other words, under the guidance of the overarching national policies ICM programs should be adapted and modified to best suit the local conditions and requirements of the social, economic and ecological coastal domains. It must be context specific.

At a provincial level, specifically for the Western Cape, the Department of Environmental Affairs and Development Planning of the Western Cape (DEA&DP) deals primarily with the planning, management and use of coastal natural resources (WCCMP 2003). With the Western Cape Nature Conservation Board (WCNCB) assisting by promoting and ensuring nature conservation and related matters in the province. Each province is also required by the new Coastal Zone Bill to produce a Provincial Coastal Management Plan (PCMP), as indicated in the WCCMP (2003) (Table 5). The PCMP aims to present a strategy for both the public and private sectors to create opportunities to not only sustain, but also to enhance livelihoods and to build institutional capacity and raise awareness of the value of the coast. Key benefits of the application of coastal management programmes will be improved planning and allocation of coastal resources and better targeted investment from government and non-government organizations to support sustainable coastal development (WCCMP 2003).

Local authorities in South Africa are, according to the Local Government Municipals Systems Act (Act No. 32 of 2000), legally bound to compile Integrated Development Plans (IDP) for their areas of jurisdiction (Table 5). The responsibilities of local government, where capacity exists, are building regulations, local tourism, municipal planning and beaches (Glavovic 2000a). However, most of the smaller local municipalities in rural areas lack the resources and capacity to implement these responsibilities. In an attempt to boost their capacity, some local authorities cooperate with nature conservation agencies and are involved in co-management initiatives with community-based organisations and non-governmental organisations. These organisations play a valuable role in a range of coastal management activities including monitoring, research, education and training. Figure 5 highlights how local municipal coastal management plans should be formulated under the overarching provincial and national directives with input from various stakeholders through public private partnerships.

Table 5: Provincial and local Policies Relevant to Coastal Management.

Policies	Description
Provincial	
Coastal Management Plan (CMP)	Used as a practical guide to conduct well co-ordinated and integrated coastal zone management. More specific and takes into account distinctive qualities of each province.
Local	
Integrated Development Plan (IDP)	Local plan and policy guideline to guide the implementation of the National and Provincial policies and objectives.

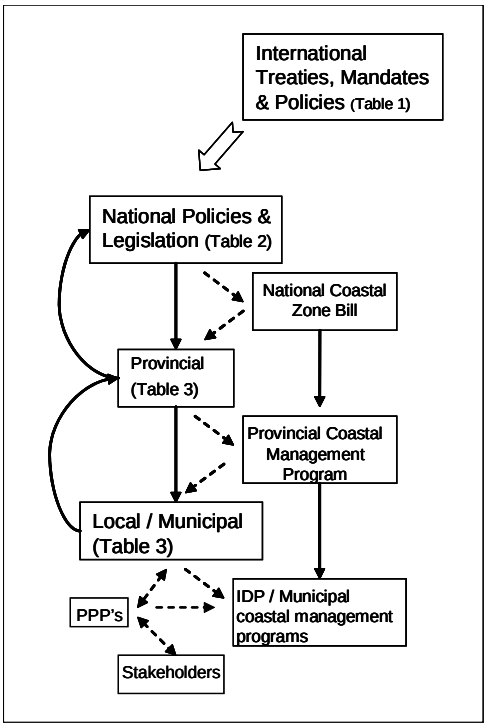

Figure 5. The hierarchical cascade governing environmental management in South Africa with the relevant legislation and management programs guiding coastal management at each level.

APPENDIX II

ROCK AND SURF ANGLING QUESTIONNAIRE

Questionnaire number: _____ Interviewer: _____
Date:_____ Time:_____ GPS co-ordinate:_____
Locality:_____
Weather: _____
Fishing from: Rock _____ Shore _____ Other _____
Sector: Subsistence: _____ Recreational: _____
Number of anglers in party _____

(*Introduce yourself and explain what you doing*)

SECTION A: SOCIO-ECONOMIC INFORMATION

1. **Name:** _____
2. **Age**: 0-5 6-10 11-15 16-20 21-25 26-30 31-35
   36-40 41-45 46-50 51-55 56-60 61+
3. **Sex**: M F
4. **Race**: Black _____ White ____ Asian ____ Coloured _____ Other _____
5. **Home language**: English _____ Afrikaans _____ Xhosa _____ Other_____
6. **Place of residence** (*Province, Country*): _____
7. **Highest educational qualification**: _____
8. **Occupation of angler**: _____
9. **Income bracket**: 1 2 3 4 (*see flash card for key, Rand per week*) **Pension**?
10. **Club affiliation?** _____
11. **Why do you fish?** Food ___ Recreation ___ Competition ___ Livelihood __Other
12. **What do you do with your catch?** (*PROMPT HIM e.g. What about small fish? Ever sold a fish?*)

	All	Some	Minimal	None
Eat it				
Sell it				
Give it away				
Return to the sea				

13. **How many people are in your household?** _____ (*permanent residents*)
14. **How many of them fish?** _____
15. **What are the other sources of income in your household?** (*Explain e.g. who?*)
    Fixed employment _____ Pension grant _____
    Casual labour _____ Other _____
16. **How important is your fish catch in your households diet?**
    Crucial _____ Fairly important _____ Not important _____
17. **How many times a week do you (your household) eat meat? _____**

18. **How much have you spent on**:
    bait? _____
    food and drink on this trip? _____
    accommodation on this trip? _____
    fuel on this trip? _____
    other on this trip? _____
19. **What is the maximum amount of money you would be prepared to pay to go on a fishing trip (like this outing) ? _____**
20. **What is the estimated value of all your rock-and-surf angling equipment** (*e.g. what would they sell for?*)
    Rods? _____ Reels? _____ Tackle? _____
    Other? _____

SECTION B: OWNERSHIP AND ACCESS TO THE LIVING RESOURCES OF THE COASTLINE

1. **Who owns the living resources (fish and bait) along this stretch of coastline?**
    All SA citizens __ The government __ People of Plett __ God __
    The Plett municipality ___The anglers ____ Our ancestors __ Other _____
2. **How did you obtain the right to fish along this stretch of coastline?**
    By inheritance ____ Local/ Traditional chief ____ Ancestors _____
    Local Council/ Municipality ____ From the Government _____ Other _____
3. **Do you have a recreational fishing permit?** Y N

SECTION C: MANAGMENT AND ANGLER ATTITUDES

1. **Who do you think is responsible for managing the living resources of this coastline?**
    Government Provincial government Local Council/Municipality
    Anglers People living near the coastline Other: _____
2. **Which fishing regulation (s) do you think is the most effective way to manage our fish stocks?** (*Ask each regulation specifically*)
    Minimum size limits_____ Bag limits_____
    Closed seasons_____ Marine reserves_____
    Other _____
3. **Do you have any suggestions on how our fish stocks should be managed?**
    None _____
4. **Do you obey these regulations?** (*Ask each regulation specifically e.g. Have you ever kept an undersized fish?*)
    Minimum size limits_____ Bag limits_____
    Closed seasons_____ Marine reserves_____
5. **Has your catch ever been inspected by a fisheries inspector?** Y N

6. **What are your 5 major target species on this stretch of coastline?**
Test the minimum size limit, bag limit and closed season for each one.

Species	Minimum legal size	Bag limit	Closed season

7. **How many years have you been fishing for? _____**
8. **In which ways is your current catch different from that in the past?**
   More fish Fewer fish More species Fewer species
   Bigger fish Smaller fish No difference Don't know
9. **Which species are noticeably scarcer than before? _____**
10. **In your opinion what are the threats facing the resources along this stretch of coastline?**
    Pollution Recreational shore - angling Recreational skiboat- angling
    Commercial fishing Subsistence angling Trawling Overexploitation
    Other _____

SECTION D: CATCH AND EFFORT DATA

1. **What time did you start fishing today? _____**
2. **What time do you expect to stop fishing today? _____**
3. **Type of fishing gear being used? _____**
4. **Number of lines in use**: _____
5. **What have you caught today** (*including discards*)? **Do you mind if I inspect your catch?**

Fish species	Length	Weight	Bait used for each fish	Kept/ Released

SECTION E: BAIT DYNAMICS

1. **What bait do you have with you, how much, how and where was it obtained?**

Bait organism	Quantity	How obtained	Where obtained

2. **If collected, how long did it take to collect this bait? _____**
3. **If collected, do you have a bait-collecting permit?** Y N
4. **If applicable, do you have a cast/throw net permit?** Y N
5. **What are your 3 preferred bait organisms for rock & surf angling?**
   Test the minimum size, max. no. per person/day and accepted collection method

Species	Minimum size	Max. no. per day	Collection method

6. **In what way does the bait you collect differ from the past?**
   More bait Less bait More species Fewer species
   Bigger bait Smaller bait No difference Don't know
7. **What do you think is threatening the bait resources that you target?**
   _____

SECTION F: GENERAL

1. **How often do you fish this stretch of coastline?**
   _____ days/week _____ days/month _____ days/year
2. **On average how many hours do you fish a day? _____**
3. **Do you fish at night?** Y N **If YES, how many…**
   _____ days/week _____ days/month _____ days/year
4. **Do you fish…**
   More on week-days More on week-ends When there is a fish run
   Public holidays Other: _____

Thank-you for your time.

APPENDIX III

RE-SURVEY QUESTIONNAIRE

Questionnaire number: _____ Interviewer: _____
Date:_____ Time:_____ GPS co-ordinate:_____
Locality:_____
__
Weather: _____
Sector: Recreational _____ Subsistence ____ Shore ____ Rock ____
Number of anglers in party _____

1. **Name:** _____
2. **Sex**: M F
3. **Race**: White Black Coloured Other
4. **Place of residence**(*Province, country*): _____
5. **How much have you spent on**:
   bait? _____ food and drink? _____ accommodation? _____
   fuel? _____other? _____
6. **Start fishing today?**_____ **Stop fishing today?** _____
7. **Type of fishing gear being used:** _____
8. **Number of lines in use**: _____
9. **What species are you targeting?** _____
10. **What have you caught today** (*including discards*)? **Do you mind if I inspect your catch?**

Fish species	Length	Weight	Fishing method (bait, lure, fly)	Bait used for each fish	Kept/ Released

11. **What bait do you have with you, how much, how and where was it obtained?**

Bait organism	Quantity	How obtained	Where obtained (*refer to map*)

12. **If collected, how long did it take to collect?** _____

Thank you for your time.

APPENDIX IV

Details of Indicator discussion group participants. Held at Rhodes University, Grahamstown.

Name	Title	Affiliation
Cowley, Paul	Dr.	South African Institute of Aquatic Biodiversity, Grahamstown
Sauer, Warwick	Prof.	Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown
King, Claire	Miss.	Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown
Smith, Martin	Mr.	Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown

APPENDIX V

List of references used in the synthesis of ICM practices.
ICM = Integrated Coastal Management
SAM = Strategic Adaptive Management
FMP = Fisheries Management Plans

Paper No.	Author	Field of management
1	Sowman, M. 1993	ICM
2	Ehler, C. N. 2003	ICM
3	Stanford, J. A. & G. C. Poole 1996	EBM
4	Cochrane *et al*. 2004	EAF
5	Rodgers, K. & H. Biggs 1999	SAM
6	Vallega, A. 2001	ICM
7	Toby, J. & R. Volk 2002	ICM
8	GESAMP 1996	ICM
9	ECCMP 2004	ICM
10	Wittmer, H. & R. Birner 2001	ICM
11	Doody, J. P. 2003	ICM
12	Treby, E. J. & M. J. Clark 2004	ICM
13	Olsen, S. B. 2003	ICM
14	Olsen. S. B. 2002	ICM
15	Belfiore, S. 2003	ICM
16	Hauk, M. & M. Sowman 2001	ICM
17	Fletcher *et al*. 2005	ICM
18	FAO guidelines 1998	ICM
19	Die, D. 2002	FMP
20	Bower, B.T & R. K. Turner 1998	ICM
21	Clark, J. R. 1997	ICM
22	McMcleave *et al*. 2003	ICM
23	WCCMP 2003	ICM
24	Torell *et al*. 2000	ICM
25	USAID	ICM
26	Gupta, M. & S. Fletcher 2001	ICM
27	Hewawasam, I. 2000	ICM
28	Okemwa *et al*. 1997	ICM
29	Stojanovic *et al*. 2004	ICM
30	Thia-Eng, C. 1993	ICM
31	Torell *et al*. 2004	ICM
32	White *et al*. in press	ICM
33	Olsen *et al*. 1997	ICM
34	Burbridge, P. R. 1997	ICM
35	Glavovic, B. 2000b	ICM

APPENDIX VI

As highlighted in the table below certain steps of the proposed policy cycle (Chapter 5) have already been addressed, for example local coastal stakeholders have already raised concern over the status of local coastal resources, especially fish stocks (Section C.1.) and that further degradation may have implications on the tourism potential of the bay. In response to this concern a locally based NGO initiated two research projects to study and assess the existing fisheries (Section C.2.). A number of important issues were identified from the analyses (Section C.3.), together with a suite of fisheries indicators to be used in a monitoring capacity to rapidly evaluate and assess the sustainability of the fishery in future surveys. Should the local municipality accept the protocol the next step would be to formulate specific management plans for presentation to all stakeholders (Section C. 4.). If accepted (Section C.6c.) these plans would then need to be formally adopted and implemented (Section C.8). Ongoing monitoring of the proposed indicators (Section C. 9.), would then allow the previously identified issues to be reassessed and the implemented strategies to be evaluated. Two monitoring programs have been proposed. The first, run by the local municipality would be done on a continuous basis and only collect data required for monitoring the indicators of sustainability. The second monitoring program would be run every five years and include an in-depth assessment of the fishery and local resources. This second monitoring program may be outsourced to local research or academic institutes.

Activities and actions that have already been accomplished in the implementation of the proposed policy cycle.

Steps within the Policy Cycle	**Activities or actions taken**		
Step C.1. Problem identification	Initial concern expressed by local stakeholder as to state of bay resources. Specifically fish stocks.		
Step C.2. Assessment and analysis	Projects initiated		
	Fishery surveys completed		
	Analysis of results		
Step C.3. Definition of issues and options	Domain	Issue	Options
	Socio/Economic	Low angler knowledge Poor Compliance	Awareness programs Increased signage and available information
	Institutional	Low inspection rate Lack of municipal CMP Lack of monitoring programs	Develop and implement a CMP and monitoring program Increase inspections
	Ecological	Low CPUE Size reductions Lack of certain species	Closed areas Restrict effort Closed seasons
Step C.4. Formulation of management plans			
Step C.5. Presentation of plans			
Step C.6. Outcome of presentation: acceptance or rejection			
Step C.7. Adoption of plans			
Step C.8. Implementation			
Step C.9. Monitoring and evaluation	Use of indicators developed through the research projects in an ongoing monitoring program.		