AN ASSESSMENT OF THE SHORE BAITFISHERY IN THE EASTERN CAPE

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ABSTRACT

The collection of bait organisms goes hand-in-hand with shore-angling in South Africa, hence the level of bait-collection can be used as an indicator of fishing effort and *vice versa*. This emphasises the importance of understanding the fisheries for bait organisms. In 1998 the South African fisheries policy was revised, culminating in the Marine Living Resources Act No. 18 (1998) which supported sustainable development, equitable access to resources and stability of the industry. The policy also dealt with the needs of subsistence fishers who had previously been all but ignored. This study looks to continue in this direction by investigating the opportunities for the establishment and management implications of small-scale commercial baitfisheries in the Eastern Cape.

Data were collected from eight clearly demarcated sampling areas using the roving survey method. A total of 97 survey trips were undertaken between September 2001 and April 2003 and 469 interviews were conducted on individual anglers. The data was analysed and discussed on the basis of three wider study regions and this allowed for a more accurate and focussed assessment of the fishery area and the potential for its formalisation.

Recreational fishers (91.5%) dominated in each of the three regions surveyed. The low number of subsistence fishers encountered in this study is not a standard pattern throughout South Africa. The dominance of local residents in the shore-fishery could have an important impact on the success of a formalised baitfishery in that the greater proportion of the potential market is accessible throughout the year. Most recreational shore-anglers were middle-aged (43.8 years± 12.9 years), and hence at the peak of their earning years and this may contribute towards the potential success of a small-scale commercial baitfishery.

Most anglers and baitfishers were of the opinion that all South Africans owned and were responsible for managing the living marine resources. The vast majority of recreational users paid for and were in possession of valid permits and approved of the baitfishery regulations. This implies that the greater majority of users recognise that the state is the rightful custodian of the resource and is responsible for management. No subsistence users were in possession of permits. Resource users in the Gamtoos to Tsitsikamma National Park region, where the inspection rate was highest, had the best knowledge of the regulations regarding both

baitfishing (67.2%± 38.8%) and angling (79.8± 21.4%). This substantiates the hypothesis that there is a direct correlation between knowledge of the regulations and the rate of inspection.

About 475 000 angler-days/year were fished in the study area, with the highest number of angler-days recorded in or near urban and peri-urban areas.

Bronze bream (65.9%) and dusky kob (61.1%) were the two most commonly targeted species, followed by white steenbras (31.7%), white musselcracker (31.4%) and blacktail (20.2%). A total of four purchased and 19 collected bait species was recorded during the study. Sardine, chokka and pink prawn were the most frequently encountered purchased bait. Red bait, sand prawn, mullet, siffie, sand mussel, bloodworm and saddleback were the most frequently encountered collected bait species. Sand prawn was identified as the preferred bait species for a wide range of angling species. The total quantity of bait organisms used per fishing trip was markedly less than the total amount collected per trip.

The ban of off-road vehicles (ORV's) from beaches (20 January 2002) resulted in spatial shifts in angler effort in certain areas, suggesting that total effort has reduced in areas where ORV's were commonly used. Subsequent to the ban, fishers were encountered, on average, much closer to access points.

The value of small-scale baitfisheries within the total study area was estimated at about R7 million per year. Across the entire study area red bait was identified as the most valuable bait in the rock-and-surf fishery in monetary terms, while sand prawn was also important.

The findings led to the conclusion that small-scale commercial baitfisheries in the study area are potentially viable. Scenarios for the establishment of baitfisheries are suggested and discussed.

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CHAPTER 1 - INTRODUCTION

The study by Brouwer *et al.* (1997) highlighted the magnitude of the shore-based linefishery in South Africa, including the Eastern Cape coast. While some information on bait use was provided by Brouwer's (1997) study, the majority of it was anecdotal and little information was available on the total offtake of bait and the size of the baitfishery. Brouwer *et al.* (1997) noted that sardine (*Sardinops sagax*), chokka (*Loligo reynaudi vulgaris*) and frozen pink prawns (*Haliporoides triarthus*) as well as estuarine and intertidal organisms were used as bait in the shore-based linefishery.

On the assumption that the collection of bait organisms goes hand-in-hand with shore-angling in South Africa, it may be possible that the level of bait collection can be used as an indicator of fishing effort and *vice versa*. However, bait collection is relatively unstudied, while linefisheries have been well studied in southern Africa (e.g. Smale and Buxton 1985, Clarke and Buxton 1989, Hecht and Tilney 1989, Attwood and Bennett 1995, Brouwer 1997, Brouwer *et al.* 1997, McGrath *et al.* 1997, Sauer *et al.* 1997, Attwood and Farquhar 1999, Griffiths 1999, Holtzhausen and Kirchner 1999, Kirchner and Beyer 1999, Penney *et al.* 1999, Van Der Elst and Schnetler 1999, Kirchner *et al.* 2000, Zeybrandt and Barnes 2001, Brouwer and Buxton 2002, Mann *et al.* 2002, Pradervand and Baird 2002, Mann *et al.* 2003). The fact that collection and angling go hand-in-hand emphasises the importance of understanding the fisheries for bait organisms. Moreover, many of the species used for bait are also harvested by recreational and subsistence fishers for food. Brouwer (1997) recommended the further study of bait use in the Eastern Cape.

While there is substantial knowledge of the biology and ecology of many of the bait species used by anglers, information on population dynamics of many of these species, except rock lobster and abalone, is limited. This is probably a consequence of the value of the fisheries. However, sand prawn (*Callianassa kraussi*) and mud prawn (*Upogebia africana*), both estuarine species, are relatively well studied, as is sand mussel (*Donax serra*), a sandy beach species.

Except for the study undertaken by the Centre for Marine Studies at the University of Cape Town (Anonymous 1999), limited information is available on bait species in the western half

of the Eastern Cape. The University of Cape Town desktop study summarised the available information on the distribution, abundance, exploitation, biology and stock status of several species. Further biological information was available in Day 1974a, Branch and Branch (1981) and Branch *et al.* (1994). The exploitation of intertidal bait and food species in the Transkei was dealt with by Bigalke (1973), Lasiak (1991), Robertson and Fielding (1997) and Majiza and Lasiak (2002), while an assessment of resource availability and suitability for subsistence collectors in South Africa as a whole was compiled by Cockcroft *et al.* (2002). The exploitation of intertidal organisms in South Africa, with a focus on historical trends, ecological impacts and implications for management was also dealt with by Griffiths and Branch (1997).

Other studies on intertidal marine and estuarine bait species include those by Muller (1984), who conducted a comprehensive study on siffie (*Haliotis spadicea*) in the Port Elizabeth area. Red bait (*Pyura stolonifera*) was studied by Van Driel (1978), Day (1974b) and Hanekom *et al.* (1999). Macroinvertebrates associated with red bait beds were studied by Fielding *et al.* (1994). The sand mussel (*Donax serra*) fishery has been well studied [e.g. Schoeman (1996) and Sims-Castley and Hosking (2003) (a cost-benefit analysis of a small-scale sand mussel fishery within Schoeman's (1996) study area)]. Studies on the biology of sand mussels on two Namibian sandy beaches were undertaken by Laudien *et al.* (2001). A study was conducted by Van Herwerden (1989) who looked at the disruption to mussel and coral worm beds during the collection of mussel worms. The exploitation of mussel species for food by both subsistence and recreational collectors is at a relatively low level within the study area (S. Kaehler, pers. comm.). Most of the research in South Africa has focussed on the exploitation of mussels (*Perna perna*) in the Transkei (e.g. Lasiak 1991, Dye and Dyantyi 2002) and KwaZulu-Natal (e.g. Tomalin and Kyle 1998) where exploitation levels are high.

There have been many studies conducted on estuarine species such as sand prawn (*Callianassa kraussi*) (*inter alia* Forbes 1973, Christie and Moldan 1977, Forbes 1977, Branch and Day 1984, Cockcroft and Tomalin 1987, Hodgson 1987, Wynberg and Branch 1991, Cowley *et al.* 2004) and mud prawn (*Upogebia africana*) (Christie and Moldan 1977, Hill 1977, Hodgson 1987, Hanekom and Erasmus 1988, Hanekom 1989, Hanekom and Baird 1992, Cretchley 1996, Cowley *et al.* 2004). Estimates of population and exploitation levels at some sites were included in these studies.

In 1998, the South African fisheries policy was revised and culminated in the Marine Living Resources Act No. 18 (1998). The policy supported sustainable development, equitable access to resources and stability of the industry. Most importantly for this study, the policy also dealt with the needs of subsistence fishers who had previously been ignored. The intention was to protect the needs of poor people who rely on marine resources for food or as a modest source of income, and to ensure sustainable use of these resources (Branch 2002).

Marine resources provide diverse opportunities to coastal human settlements (Harris *et al.* 2002a). However, Riechers *et al.* (1991) stated that "…fisheries managers are required to consider not only the biological and ecological aspects but also the human dimensions (social and economic) of a fishery." This statement is particularly relevant in the South African context. Many individuals, families and communities rely at least partly on income generated from the subsistence exploitation of coastal resources. Information on the nature of these fishers, their numbers and their socio-economic status is therefore important (Branch *et al.* 2002a). Similar information on the recreational users of the coastal resources is also important.

Since South Africa's first democratic election in 1994, emphasis has been placed on the upliftment of previously disadvantaged individuals and communities. Recent work by the Subsistence Fisheries Task Group has focussed on subsistence fishers and communities and their needs (e.g. Branch 2002, Branch *et al.* 2002a, Branch *et al.* 2002b, Clark *et al.* 2002, Harris *et al.* 2002a, Harris *et al.* 2002b, Hauck *et al.* 2002 and Kleinschmidt *et al.* 2003). The study presented here is intended to continue in this direction by investigating the opportunities available for the establishment and management implication of small-scale commercial baitfisheries in the Eastern Cape. These baitfisheries could provide opportunities for the socio-economic upliftment of coastal communities, but these opportunities need to be assessed before baitfisheries are considered.

Commercial baitfisheries for intertidal estuarine and marine species have been operating in Europe, Asia and North America for many years. In the United Kingdom baitfisheries target polychaete worms, crabs and molluscs, and are perceived to have a negative impact on natural heritage features (e.g. habitat damage and alteration, damage to non-target species, bird disturbance, prey depletion), fisheries (e.g. damage to intertidal cockle and mussel beds), recreational users (due to habitat damage and alteration), harbour operations (e.g. physical

damage to vessels), archaeological heritage (e.g. physical damage to structures) and other shoreline collectors (e.g. when over-exploitation of bait stocks takes place) (Fowler 1999). Olive (1993) mentioned similar impacts resulting from baitfisheries in the USA, Australia and Thailand. Effective management is therefore of paramount importance to the success and image of a commercial baitfishery, small-scale or otherwise. Furthermore, Majiza and Lasiak (2002) stated that determining the extent of disturbance to the environment requires knowledge of the number of people taking part in exploitative activities as well as the types and quantities of organisms taken. This was one of the purposes of this study.

The principal objectives of this study were:

1. To quantify bait use in the shore-based recreational and subsistence linefishery in the western half of the Eastern Cape from the eastern boundary of the Tsitsikamma National Park (TNP) to the Buffalo River in East London.
2. To assess the potential for the development of formalised baitfisheries in the region.

To achieve the objectives the following key questions were addressed. Explanations of each question are included in italics.

1. What bait organisms are used by fishers and what are their preferences? *Anglers generally target more than one species of fish and hence require a diversity of bait organisms. The preferred bait of anglers varies from one region to the next, even for the same angling species. Bait preference may also be dictated by habitat type.*
2. To what extent do anglers collect their own bait or purchase bait from other sources such as subsistence collectors or retail outlets? *Some anglers prefer to collect their own bait. Others prefer to buy bait from subsistence collectors because they lack the equipment to collect bait themselves or they prefer not to collect bait themselves. Others would rather buy bait from retail outlets as these retailers stock their preferred bait.*
3. Which bait species are collected and in what quantity? *This allows us to establish which species are the most favoured and thus most heavily exploited within the study area as a whole and within demarcated regions within the study area.*
4. What quantities of bait are used? *This allows us to establish which species are most popular and thus most heavily exploited within the study area as a whole and within demarcated regions within the study area.*

5. How many people are employed or active in the baitfishery, and what is the value of the fishery? *This allows us, in combination with work done on selected estuaries within the Eastern Cape, to obtain some idea of the value of the informal fishery and the potential for its formalisation.*
6. What are the demographic characteristics of the fishers within the baitfishery (race, sex, age, residence)? *The age, sex and racial composition of participants within recreational and subsistence sectors of the baitfishery varies. Patterns with regards to residence appear when data are analysed.*
7. Have fishers noticed change over time in the general abundance of individual bait species, the number of bait species or the size of individual bait organisms? *Anecdotal evidence can serve as an indicator to assess the status and health of the bait species populations.*
8. What are angler perceptions of current bait-collecting and angling regulations? *Anglers/collectors have varying opinions as to the best way to manage fish or bait stocks. An "us" (anglers) against "them" (managers/scientists) attitude is common. For this reason the opinion of anglers on present regulations and possible alternative options are important. This also allows the researcher to build a good relationship with many of the anglers as they feel they are not just being interrogated, but are making a contribution to the survival and development of their sport.*
9. What possibilities exist to formalise this sector and to create employment? *This is evaluated by taking all key question outputs into consideration and by undertaking an analysis of the value of the baitfisheries.*

The thesis is presented as follows: Firstly, the survey areas and study methods are presented, followed by an examination of the resource users. Angler effort and bait use is then assessed and opportunities for establishing small-scale commercial baitfisheries are identified. Finally, a general discussion is presented which deals with the current informal commercial baitfisheries in the Eastern Cape, formalising these baitfisheries, suggested scenarios for formalised baitfisheries and management of the formalised baitfisheries.

CHAPTER 2 - STUDY AREA AND SURVEY METHODS

2.1 Study area

The study area extended from the Groot River (the eastern boundary of the Tsitsikamma National Park) in the west to the Buffalo River (at East London) in the east. This area is extremely varied, not only in physical characteristics, but also in accessibility and proximity to urban, peri-urban and rural areas.

Based on methods used by Brouwer (1997), McGrath *et al.* (1997) and Kirchner *et al.* (2000), eight clearly demarcated sampling areas were selected from which to extrapolate information (Figure 2.1). The sampling areas were selected so as to include all possible physical characteristics (rocky shores, sandy beaches, rocky fishing substrata, sandy fishing substrata, proximity to estuaries, etc.) and variations in levels of accessibility and proximity to urban, peri-urban and rural areas. Urban angling and collecting areas were adjacent to the two major cities within the study area, Port Elizabeth and East London, as well as Jeffreys Bay. Peri-urban areas were defined as those areas on the outskirts of the major cities, such as Cape Recife, or those areas adjacent to smaller coastal towns and villages (e.g. Port Alfred, St. Francis Bay and Kidds Beach). Rural areas were not adjacent to built up areas, had few entry points and were thus usually difficult to access. Rural areas included stretches like Sundays River mouth east to The Krantz, or from the Great Fish River to Hamburg (Keiskamma River).

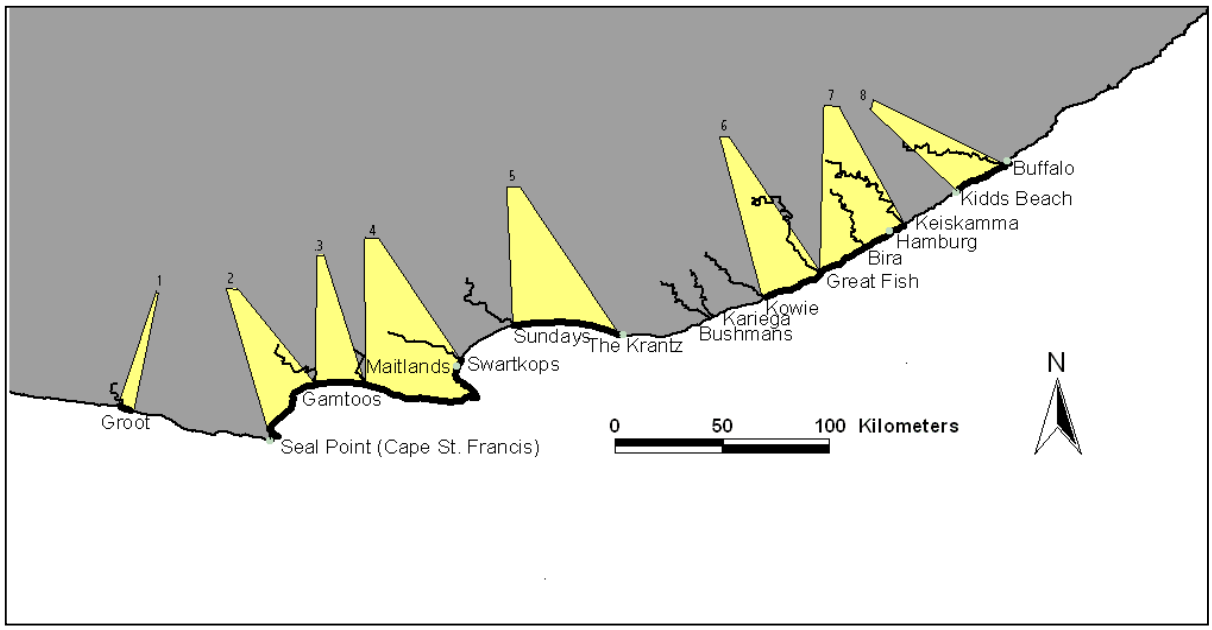


Figure 2.1: The eight survey areas along the Eastern Cape coast between the Groot River in the west and the Buffalo River in the east.

The eight survey areas are described below from west to east:

Area 1. A short stretch of coast (5 km) around the two resorts (Eersterivier and Skuitbaai) near the Eerste River mouth. This area was fairly inaccessible to anglers and was dominated by high rocks and gullies, interspersed with sandy beaches. This area was regarded as rural because there were no major urban areas or coastal towns close by and it was surrounded by farmland.

Area 2. A stretch of coast (39.5 km) between Seal Point (at Cape St. Francis) and the Gamtoos River. Angler accessibility was relatively easy for most of this stretch of coast due to a number of easily reached access points, parking areas and roads. However, the stretch from the Kabeljous River east to Gamtoos River could only be accessed from the Kabeljous River mouth. The stretch comprised rural (Kabeljous River to Gamtoos River), peri-urban (Seal Point to Aston Bay) and urban (coastline adjacent to Jeffreys Bay) areas. Rugged rocky points, calm sandy bays and stretches of sandy beach were all characteristics of this area.

Area 3. The 14.4 km stretch of coast from Gamtoos River to Maitlands River. This area was regarded as rural as there were no major settlements bordering this stretch of coast. It

comprised sandy beach entirely. Off-road vehicles have in the past been the preferred way of reaching angling spots in this area.

Area 4. The 68.3 km stretch of coast from Maitlands River to the Swartkops River. It was made up of urban (Cape Recife to Swartkops River) and peri-urban (Maitlands River to Cape Recife) areas and included stretches of rugged rocks, rocky points, stretches of beach and man-made foreshore (the "dolosse" to the east of Port Elizabeth harbour). Access to angling and bait-collecting areas in this stretch was relatively easy.

Area 5. The 46 km stretch of coast from Sundays River to The Krantz. This was an unbroken stretch of sandy beach where access to angling spots was difficult. The entire stretch was considered a rural area. ORV's have in the past been the most common way of accessing angling spots.

Area 6. The 25.7 km stretch of coast from the Kowie River to Great Fish Point. The area was dominated by low rocky points and sandy bays. It was made up of a short stretch of peri-urban coastline near the Kowie River mouth and rural areas (East Beach parking area to Great Fish Point). Most of the area was easily accessible on foot, although ORV's were in the past the preferred way of getting to angling spots.

Area 7. The Great Fish River to the Keiskamma River (33.5 km). It consisted mainly of low rocky points and long stretches of beach. Access to most of this stretch was difficult [except by off-road vehicles (ORV's) in the past] and the entire area was regarded as rural as there were no major coastal settlements nearby.

Area 8. The eighth sampling area extended from Kidds Beach to Hood Point (30.1 km) just west of the Buffalo River mouth in East London. It comprised rocky points and ledges, and sandy beaches. Accessibility to some areas was difficult. This area was made up of urban (Hood Point to Hickmans River), peri-urban (the area adjacent to Kidds Beach) and rural areas (Hickmans River to Kidds Beach).

2.2 Survey methods and questionnaires

Several survey methods have been developed to assess fisheries (Hayne 1991, Matlock 1991, Pollock *et al.* 1994, Malvestuto 1996). These include access point surveys (Jones *et al.* 1995, Brouwer *et al.* 1997, McGrath *et al.* 1997, Pollock *et al.* 1997, Sauer *et al.* 1997, Pradervand and Baird 2002 and Mann *et al.* 2003), roving surveys (Phippen and Bergersen 1991, Robson 1991, Weithman and Haverland 1991, Jones *et al.* 1995, Brouwer *et al.* 1997, Pollock *et al.* 1997, Zeybrandt and Barnes 2001), telephone surveys (Weithman and Haverland 1991, Cockcroft and Mackenzie 1997), mail surveys, door-to-door surveys and the study of logbooks, diaries and catch cards (Penney *et al.* 1999 and Zeybrandt and Barnes 2001). After studying the comparison of different survey methods by Pollock *et al.* (1994) and careful consideration of the different methods, it was decided to use the roving survey method. The roving survey is an on-site, intercept design survey method and is used extensively, particularly when catch, effort and socio-economic data are required. During a roving survey fishers are intercepted in the act of fishing. The access point survey is also of an on-site intercept design but fishers are intercepted immediately after they have completed their fishing trips. This method can also be used to obtain data on catch, effort, economic values and attitudes of anglers (Pollock *et al.* 1994). However, stretches of coast that have multiple access points (a feature of the Eastern Cape coast) cannot be surveyed effectively by a single person using an access point survey as fishers may exit beaches through unmanned access points. Furthermore, unused bait organisms are often discarded on the beach. Hence, data regarding bait collection and use thereof cannot be gathered effectively using an access point survey design.

The roving survey method has been used extensively in fisheries research, including when information is needed on catch and effort for specific areas. The main advantages are that the response rates are high and fishers are not required to recall catch information (Pollock *et al.* 1994). Fish and bait species are identified, counted and weighed by the clerk. This minimises bias associated with fisher recollection of effort and catches (Malvestuto 1983). Furthermore, roving surveys are used when access to a fishery occurs at too many points to accommodate an access point design (Pollock *et al.* 1994).

To obtain the maximum amount of information in as short a time as possible, questionnaires had to be carefully designed. The questions had to be brief and phrased clearly and unambiguously so that accurate and objective answers could be obtained (Pollock *et al.* 1994).

The questionnaires were designed to obtain the necessary data and information to address each of the key questions (see Chapter 1). The questionnaires were also designed in such a way that direct comparisons could be drawn between this study and the estuarine baitfisheries studied by Cowley *et al.* (2004). Further information on the development of the questionnaires was obtained from Pollock *et al.* (1994) and Brouwer (1997). Three questionnaires were developed: extensive (Appendix IA), medium (Appendix IB) and short (Appendix IC). The use of any one of the three questionnaires was determined by the number of fishers on a stretch of coast and allowed the survey clerk to interview as many fishers per survey trip as possible. A large majority (96%) of the interviews were conducted using the extensive questionnaire. The medium and short questionnaires were used 18 times during one survey trip (3 November 2001) on the coast between Kowie River and Great Fish Point. On this day a fishing competition was underway, hence there were many anglers present and the shorter questionnaires were used to interview as many of them as possible before the end of the competition.

2.3 Sampling strategy

During the design phase of a sampling strategy, emphasis must be placed on the feasibility and simplicity of the design while achieving the required precision for estimating harvest (Kirchner and Beyer 1999). This principle was applied during the design of the sampling strategy for this study.

Five areas were sampled on a monthly basis. Four of these were fixed monthly sample areas, namely Area 2 (Cape St. Francis to Gamtoos River mouth), Area 4 (Maitlands River mouth to Swartkops River mouth), Area 6 (Kowie River mouth to Great Fish Point) and Area 8 (Kidds Beach to Hood Point). The fifth monthly sample area was selected on a random basis from Areas 1, 3, 5 and 7.

One of three starting times (06:00, 11:00 and 15:00) was selected randomly and the sampling day began at these times (Brouwer 1997). Sampling days were also selected on a random basis (Clarke and Buxton 1989). Where multiple access or starting points were available, these were selected randomly, as was the direction of initial travel (east or west) (Brouwer 1997 and Clarke and Buxton 1989). A sampling day consisted of one full coverage of the selected stretch of coast (Pradervand and Baird 2002). For safety reasons no sampling was conducted at night.

The random selection of a fifth monthly survey area, starting times, sampling days, starting points and direction of initial travel was done by rolling dice.

Sandy areas and mixed rocky and sandy areas were surveyed using a 4 x 4 vehicle. Due to the dynamic nature of the sandy and mixed rocky and sandy coastline, some areas became temporarily inaccessible to 4 x 4 vehicles. These areas were then surveyed on foot. Rocky areas that were inaccessible to vehicles (such as the Eersterivier survey area) were surveyed on foot. Stretches of coast adjacent to built-up areas and with multiple access points (eg. the "dolosse" in Port Elizabeth, Marine Drive in Port Elizabeth and the Jeffreys Bay area) were surveyed on foot from each access point.

If a single angler was encountered he/she was interviewed and the number of rods in use was recorded. If a group of two or more anglers was encountered, a representative of the group was interviewed. The reason for this was that most angler groups used the same bait box and only one interview was necessary to quantify the amount of bait collected and used and the number of fish caught. If the group was using more than one bait box, the bait quantities were pooled. The number of anglers in each group and the number of rods in use were recorded.

The survey period commenced in September 2001 and ended in April 2003. On 20 January 2002 the use of recreational vehicles on beaches was banned [Section 44 of the National Environmental Act, 1998 (Act 107 of 1998)]. The presence and spatial distribution of all resource users (anglers and bait-collectors) were recorded using a Garmin GPS 12 Personal Navigator™ on each survey trip. These data were used to identify any changes in angler concentration as a consequence of the ban of vehicles on beaches.

2.4 Assumptions

The survey data were analysed based on the following assumptions:

1. The collected CPUE data was an unbiased indicator of overall CPUE. Malvestuto *et al.* (1978) and MacKenzie (1991) found no significant differences in the estimates for CPUE for completed and uncompleted trips.
2. Fishing success for short and long trips was identical. Heggenes (1987) and Phippen and Bergersen (1991) stated that fishing success was not dependent on trip length.
3. Interviewees answered the questions truthfully.

2.5 Sample size and survey duration

A total of 97 survey trips (437 hours of survey time) were undertaken during a 19-month period from September 2001 to April 2003. A total of 554 groups of fishers (986 individuals) were encountered and 469 interviews were conducted on individual anglers or a representative of a group of anglers. Of those groups not interviewed, 41 refused to be interviewed and 13 groups of anglers associated with suspected abalone poachers along Marine Drive west of Port Elizabeth were not interviewed for safety reasons. However, the number of anglers and the number of rods in use were recorded. The rest of the groups not interviewed (30) were leaving the beach at the end of their trip and were thus inaccessible. In such cases the number of anglers in each group was recorded.

2.6 Grouping of adjacent sampling areas

To simplify the interpretation of the findings, the similarities between adjacent survey sites were tested using contingency tables at $P = 0.05$ (Everit 1977, Everit 1993). Input variables included data on preferred bait species, preferred angling species and fishing substrata.

Independence was tested for the following combinations of adjacent survey areas:

1. East London, Birha and Port Alfred.
2. Sundays River, Port Elizabeth and Blue Horizon Bay.

3. St. Francis Bay and Eersterivier.

It was found that preferred bait species, preferred angling species and fishing substrata were independent of the survey areas in the above combinations of adjacent survey areas (Tables 2.1, 2.2 and 2.3). The data were therefore analysed and discussed based on the three wider study regions, namely:

1. Buffalo to Bushmans region (including East London, Birha and Port Alfred survey areas).
2. Bushmans to Gamtoos region (including Sundays River, Port Elizabeth and Blue Horizon Bay survey areas).
3. Gamtoos to TNP region (including St. Francis Bay and Eersterivier survey areas).

Table 2.1: Similarities in target angling species recorded between adjacent survey areas (P >0.05).

	X^2	Degrees of freedom	P
East London, Birha, Port Alfred	11	6	0.088
Sundays River, Port Elizabeth, Blue Horizon Bay	12	6	0.062
St. Francis Bay, Eersterivier	9	4	0.061

Table 2.2: Similarities in target bait species recorded between adjacent survey areas (P >0.05).

	X^2	Degrees of freedom	P
East London, Birha, Port Alfred	9	6	0.174
Sundays River, Port Elizabeth, Blue Horizon Bay	12	6	0.062
St. Francis Bay, Eersterivier	5	2	0.082

Table 2.3: Similarities in fishing substrata recorded between adjacent survey areas (P >0.05).

	X^2	Degrees of freedom	P
East London, Birha, Port Alfred	5	2	0.082
Sundays River, Port Elizabeth, Blue Horizon Bay	9	4	0.061
St. Francis Bay, Eersterivier	5	2	0.082

Discussing the results in terms of these three wider regions allowed for a more accurate and focussed assessment of each region and the potential for formalising its baitfishery.

CHAPTER 3 - RESOURCE USERS

3.1 Introduction

The resource users within the Eastern Cape are represented by the recreational and subsistence sub-sectors (Brouwer 1997). Recreational use of marine resources is widespread and accounts for a large proportion of the total harvest. It also contributes significantly to economic activity in coastal regions (Harris *et al.* 2002a). Brouwer (1997) estimated a total shore-fisher effort of 903 186 fisher-days/year for the area between Kei Mouth and Stil Bay. Research undertaken by Clark *et al.* (2002) on the distribution and numbers of subsistence fishers and their activities along the South African coast has shown that there are about 147 subsistence fishing communities, 28 338 subsistence fisher households and 29 233 people who could be considered subsistence fishers. Most of these fishers occur on the East Coast and live in both rural and urban settings. They harvest a variety of different species from the intertidal, shallow subtidal and nearshore environments. From the western boundary of the Tsitsikamma National Park to the Kei River (which includes the study area) Clarke *et al.* (2002) identified 26 subsistence fishing communities and 1452 subsistence fishers.

Studying the demographics provides an understanding of the diverse nature of the angling public (bait-collectors, recreational anglers, subsistence fishers, etc.). This is important when trying to establish if there is scope for the introduction of a small-scale commercial baitfishery, as the small-scale fishers would most likely be drawn from the subsistence sector, while the market will comprise mainly recreational anglers.

Identifying the resource users, their characteristics and their attitudes towards management is also important. Fisheries management involves the human dimension as well as the biological aspects of a fishery (Matlock *et al.* 1991). Fisher satisfaction with and attitudes to management regulations can be seen as an indication of the perceived effectiveness of management regulations (Spencer 1993, Brouwer 1997). Hence, if fishers are satisfied with regulations and regulatory bodies, innovations such as the introduction of small-scale commercial baitfisheries are more likely to be accepted by fishers, and thus succeed. Furthermore, compliance with regulations will improve if anglers and baitfishers understand the reasons for and agree to regulations before their introduction (Spencer 1993).

This chapter deals with the resource users encountered during the survey period and allowed for the identification of potential small-scale commercial fishers and their most likely market. The attitudes of resource users towards current baitfisheries and shore linefisheries management was also assessed.

3.2 Methods

The survey design was described in Chapter 2. Demographic data of the users included race, sex, age and place of residence. These were obtained using section A of the extensive, medium and short questionnaires (Appendix IA, IB and IC). Information regarding fisher attitudes was gathered using sections B and C of the extensive questionnaire (Appendix IA).

3.3 Results

3.3.1 Demographic profile of the resource users

The majority of the fishers interviewed were from the recreational sector (429 interviewees or 91.5%), while the rest were subsistence fishers (40 interviewees or 8.5%). A total of 11 subsistence fishers refused to be interviewed. However, the number of subsistence fishers in a group and their locality was recorded.

Most recreational fishers interviewed were white (95.3%), while 4.2% and 0.5% were coloured and black respectively (Table 3.1). The subsistence sector was dominated by black participants (90.0%) with coloureds and whites each comprising 5.0% (Table 3.1).

Table 3.1: The racial composition of the subsistence and recreational anglers and baitfishers interviewed during the study.

Race	Subsistence anglers and baitfishers (% of total)	Recreational anglers and baitfishers (% of total)
Black	36 (90.0)	2 (0.5)
Coloured	2 (5.0)	18 (4.2)
White	2 (5.0)	409 (95.3)
Asian	0 (0)	0 (0)
Total	40	429

All further data describing effort and catch trends in this study were analysed irrespective of race or colour.

All recreational fishers (429) and most of the subsistence fishers (33 or 82.5%) interviewed were male. The only female subsistence fishers were encountered in the Birha -Hamburg area. Of the 13 subsistence fishers interviewed in this area, seven (54%) were female.

The mean ages of the fishers in the recreational and subsistence sectors were similar (43.8 years and 42.8 years respectively). However, the age range in the recreational sector (19 to 80 years) was greater than the age range in the subsistence sector (23 to 68 years) (Table 3.2).

Table 3.2: Age distribution (mean ± SD) of fishers in the recreational and subsistence sectors.

Sector	Mean age (years)	Range
Recreational	43.8± 12.6	19-80
Subsistence	42.8± 12.0	23-68

Local anglers (those that lived in towns or settlements adjacent to the survey areas) dominated in each of the survey areas (Table 3.3). Most of the anglers interviewed (68.9%) were local residents. The Buffalo to Bushmans region had the highest proportion of visitors (41.4%) and the Gamtoos to TNP region the lowest (18.0%).

Table 3.3: The percentage of local and visiting anglers recorded in the survey regions.

Survey region	n	% locals	% visitors/tourists
Buffalo to Bushmans	207	58.7	41.3
Bushmans to Gamtoos	167	79.3	20.7
Gamtoos to TNP	95	82.0	18.0
Total study area	469	69.0	31.0

Most of the visiting fishers were encountered during the months December to February, which coincides with the Christmas Holiday period (Figure 3.1). The months March to May, which included the Easter holiday period, had the second highest number of visitors, while the winter months of June to August had the lowest number of visitors.

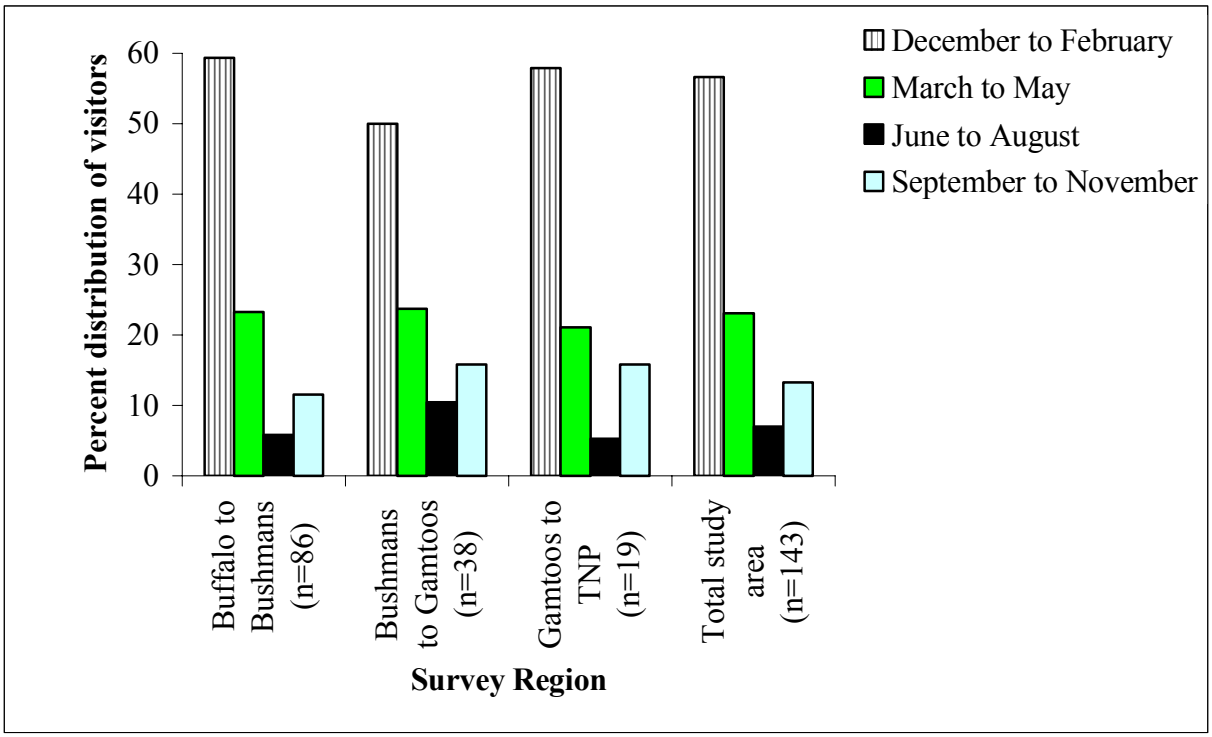


Figure 3.1: The percent distribution, according to season, of visitors interviewed.

3.3.2 Angler attitudes

Throughout the survey regions most anglers and collectors were of the opinion that the living marine resources were "owned" by all South Africans (Table 3.4) and that it was up to all South Africans to take responsibility for managing the resources (Table 3.5). Some of the users were of the opinion that national government (Marine and Coastal Management), local people of the area or local municipalities were the "owners" of the marine resources (Table 3.4). The national government (Marine and Coastal Management), local municipalities, the resource users and the local people of the area were suggested as other parties whose responsibility it was to manage the resources (Table 3.5).

Table 3.4: User opinion on "ownership" of living marine resources in each survey region.

Survey region	All South Africans (%)	National Government (MCM) (%)	Local people (%)	Municipalities (%)
Buffalo to Bushmans	92.7	1.7	3.4	2.2
Bushmans to Gamtoos	73.7	21.0	0	5.3
Gamtoos to TNP	74.0	16.6	9.4	0
Total study area	81.8	11.8	3.6	2.8

Table 3.5: User opinion on who should take responsibility for managing the living marine resources in each survey region.

Survey region	All South Africans (%)	National Government (MCM) (%)	Municipalities (%)	Resource users (%)	Local people (%)
Buffalo to Bushmans	77.6	7.8	3.9	7.3	3.4
Bushmans to Gamtoos	56.4	29.5	10.7	0	3.4
Gamtoos to TNP	76.0	21.9	0	0	2.1
Total study area	69.8	18.6	5.4	3.1	3.1

Figure 3.2 shows that most of the anglers and baitfishers were in possession of permits for each activity. However, more fishers were in possession of angling permits (87.7%) than bait-collecting permits (64.9%). Some 36.1% of users had their bait collection permits inspected and 46.0% of users had their angling permits inspected since the advent of the shore-angling permit system on 1 September 1998 (Marine Living Resources Act, 1998) (Figure 3.3). Table 3.6 shows that the mean permit inspection rate was low; inspections took place on only 1.1%± 2.4% and 1.2%± 2.4% of bait-collecting and angling trips respectively. The Gamtoos to TNP region had the highest bait (1.8%± 2.7%) and angling permit inspection rate (1.9%± 3.1%), while the Bushmans to Gamtoos region had the lowest bait (0.6%± 1.0%) and angling permit inspection rate (0.8%± 1.1%).

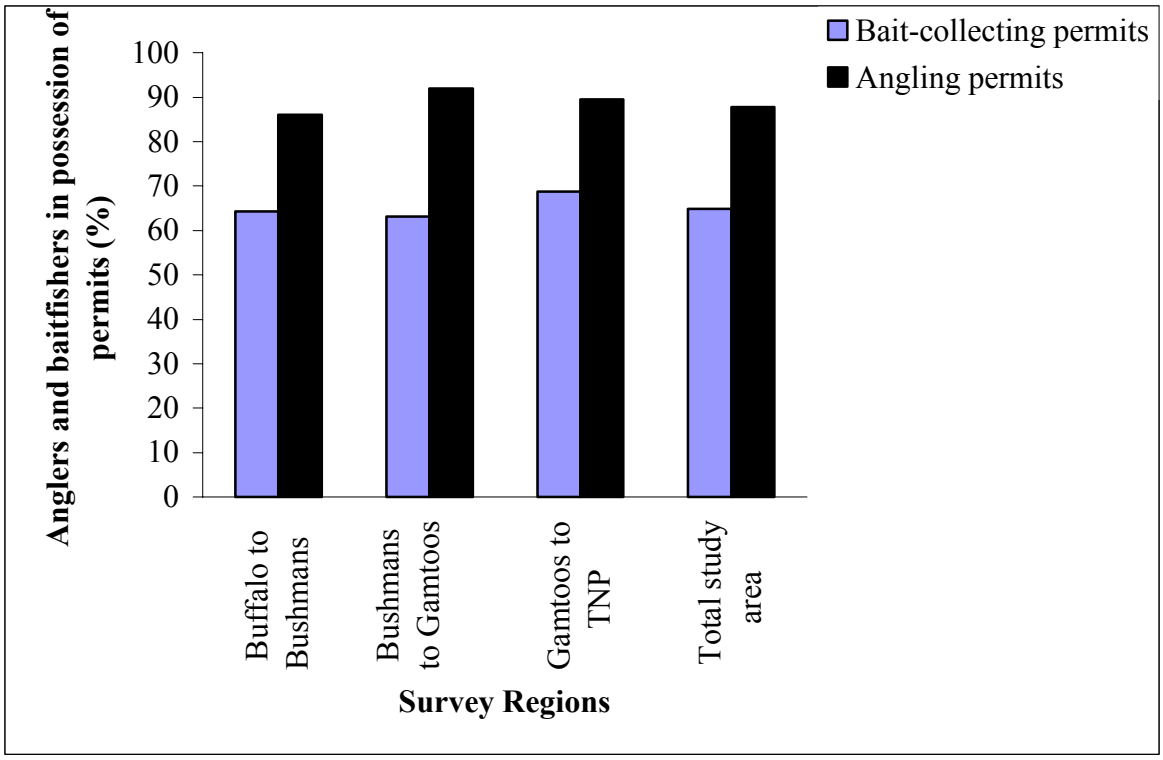


Figure 3.2: Percentage of anglers and baitfishers in each survey region who were in possession of valid permits.

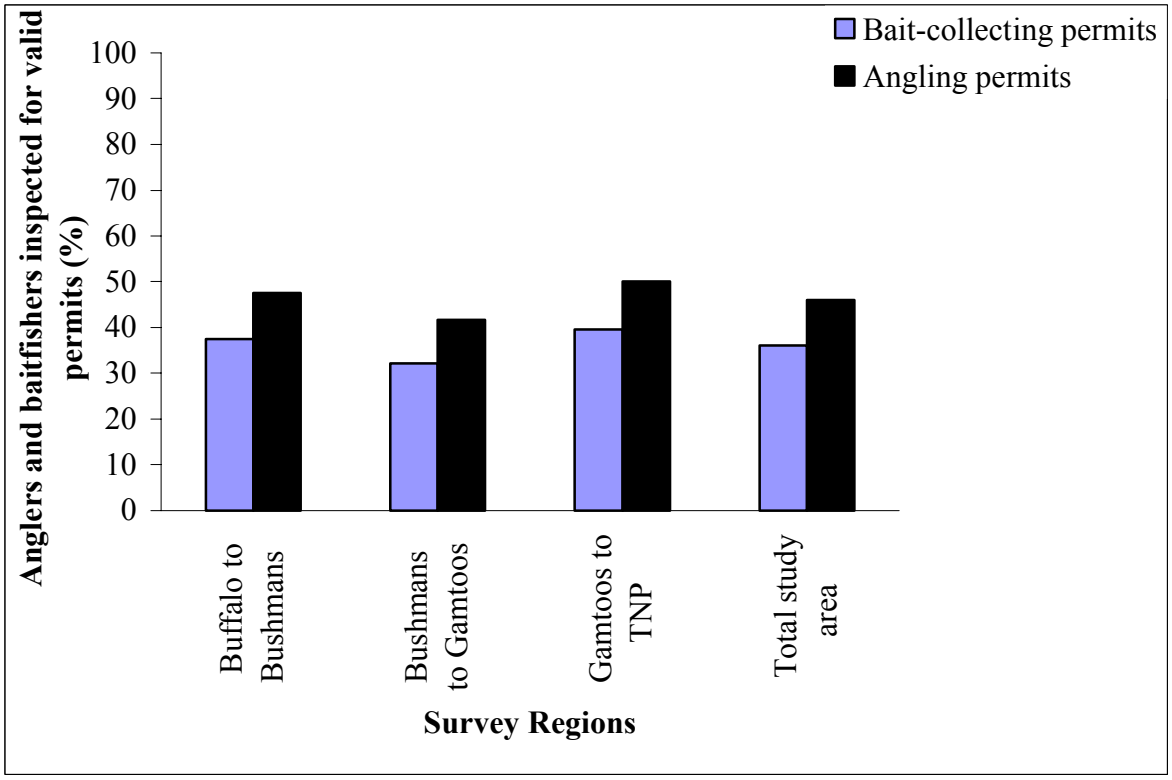


Figure 3.3: Percentage of anglers and baitfishers in each survey region who had their permits inspected since 1 September 1998.

Table 3.6: Percentage of bait-collecting and angling trips during which permits were inspected.

Survey region	Bait-collecting permit (% ± SD) inspected	Angling permit (% ± SD) inspected
Buffalo to Bushmans	1.2± 2.1	1.4± 2.0
Bushmans to Gamtoos	0.6± 1.0	0.8± 1.1
Gamtoos to TNP	1.8± 2.7	1.9± 3.1
Total study area	1.1± 2.4	1.2± 2.4

Only 31.8% and 34.3% of anglers and baitfishers respectively reported an inspection of bait catch and fish catch by fisheries officials in the study region (Figure 3.4). A greater proportion of interviewees in the Buffalo to Bushmans region had their bait catch (37.0%) inspected more often than their fish catch (31.0%). Table 3.7 shows that the inspection rate of the bait and fish catch across the study region was low. Inspections of bait catch took place on 1.0%± 2.3% of trips and of fish catch on 1.2%± 2.6% of trips. The inspection rate for bait and fish catch was highest in the Gamtoos to TNP region (1.3%± 2.5% and 2.0%± 3.5% respectively). The inspection rate was lowest in the Bushmans to Gamtoos region (0.4%± 1.0% for bait and 0.6%± 1.0% for fish).

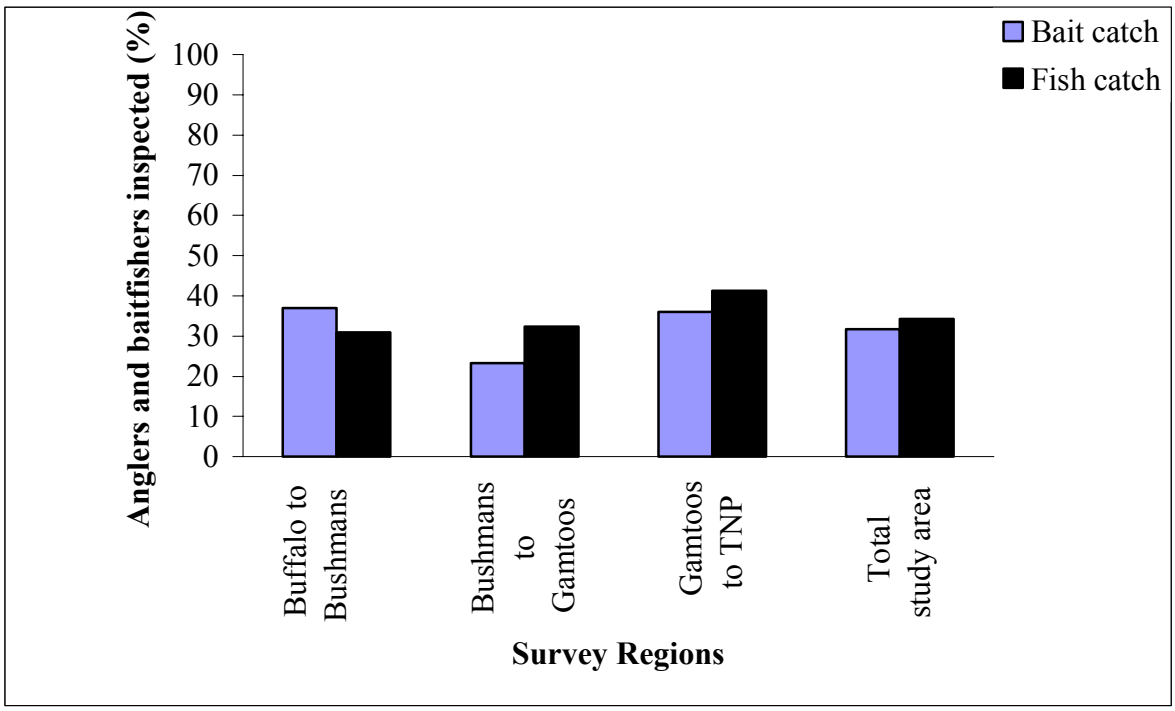


Figure 3.4: Percentage of anglers and baitfishers in each survey region who had their catches inspected since 1 September 1998.

Table 3.7: Percentage of angling and bait-collecting trips during which bait and fish catches were inspected.

Survey region	Bait catch (%± SD) inspected	Fish catch (%± SD) inspected
Buffalo to Bushmans	1.2± 2.3	1.4± 2.2
Bushmans to Gamtoos	0.4± 1.0	0.6± 1.0
Gamtoos to TNP	1.3± 2.5	2.0± 3.5
Total study area	1.0±2.3	1.2± 2.6

In general, 71.0% of the users agreed with and supported the current bait-collecting and angling permit system (Table 3.8), as long as the revenue was used for the monitoring and policing of angling and bait-collecting activities.

None of the subsistence baitfishers interviewed had bait-collecting permits. They were of the opinion that it was their right to use the resources along the coast and that they should not have to pay for this right. Another reason cited was that they could not afford the permits.

Table 3.8: Percentage of anglers and baitfishers in each survey region who agreed with the current bait-collecting and angling permit system.

Survey region	% anglers and baitfishers
Buffalo to Bushmans	76.5
Bushmans to Gamtoos	67.8
Gamtoos to TNP	65.6
Total study area	71.0

Knowledge of the bait-collecting regulations [Amended Regulations (R24 of 14 January 2000) in terms of the Marine Living Resources Act, 1998] was poor (Table 3.9). Examples of the types of information gathered to establish knowledge of the regulations were the angler's knowledge of bag limits, size limits and seasonal restrictions associated with the bait organisms in their possession.

Across the entire study area users were aware of only 59.8%± 33.7% of the regulations pertaining to bait organisms in their possession. Fishers in the Bushmans to Gamtoos region had the lowest awareness of bait collection regulations (53.5%± 36.9%), while fishers in the Gamtoos to TNP region had the highest awareness of the regulations (67.2%± 38.8%). Awareness of the regulations pertaining to target angling species was also poor (Table 3.9). Once again, anglers in the Bushmans to Gamtoos region had the lowest awareness of the

regulations (54.8%± 27.6%), while those in the Gamtoos to TNP region had the highest awareness (79.8%± 21.4%). Across the entire study area, anglers only knew 63.0%± 27.9% of the angling regulations for the fish in their possession.

Table 3.9: **Percentage awareness of relevant bait collection and angling permits**.

Survey region	Mean % ± SD of bait-collecting regulations	Mean %± SD of angling regulations
Buffalo to Bushmans	61.3± 27.3	61.4± 31.5
Bushmans to Gamtoos	53.5± 36.9	54.8± 27.6
Gamtoos to TNP	67.2± 38.8	79.8± 21.4
Total study area	59.8± 33.7	63.0± 27.9

3.3.3 Fisher perceptions on population status and management

In presenting these findings, it must be borne in mind that these are qualitative opinions of the users.

Anglers viewed the state of bait organism populations as either unchanged or poorer than in previous years. Few indicated that any of the bait species had become more abundant.

In the Buffalo to Bushmans region, 44.9% of the users said there was less bait available for collection, while the same number (44.9%) had not noticed a difference (Table 3.10). The majority (71.0%) said there was no change in species diversity over the years (Table 3.11). Many (49.3%) fishers said the size of individual bait organisms had decreased over the years, while 45.4% said there had been no change in the size of individual bait organisms (Table 3.12).

The majority of fishers in the Bushmans to Gamtoos region (55.1%) were of the opinion that the overall abundance of bait had decreased over the years (Table 3.10), 45.5% said that the species diversity had decreased over the years and 46.1% said there had been no change over the years in species diversity (Table 3.11). Most fishers in this region (68.3%) thought that there had been no change in the size of bait organisms over the years (Table 3.12).

In the Gamtoos to TNP region most fishers (51.6%) stated that there was no overall change in the availability of bait over the years (Table 3.10) and 75.8% said there was no change in

the species diversity (Table 3.11). The majority of interviewees (68.4%) said there was no change in the size of bait organisms over the years (Table 3.12).

Table 3.10: Fisher opinions on changes in the overall availability of bait over time.

Survey region	Less bait (%)	More bait (%)	No difference (%)	Do not know (%)
Buffalo to Bushmans	44.9	5.8	44.9	4.4
Bushmans to Gamtoos	55.1	0	42.5	2.4
Gamtoos to TNP	36.8	7.4	51.6	4.2
Total study area	46.9	4.1	45.4	3.6

Table 3.11: Fisher opinions on changes in the number of available bait species (diversity) over time.

Survey region	Fewer species (%)	More species (%)	No difference (%)	Do not know (%)
Buffalo to Bushmans	19.3	5.8	71.0	3.9
Bushmans to Gamtoos	45.5	7.2	46.1	1.2
Gamtoos to TNP	21.1	1.1	75.7	2.1
Total study area	29.0	5.3	63.1	2.6

Table 3.12: Fisher opinions on changes in size of bait species over time.

Survey region	Smaller bait organisms (%)	Bigger bait organisms (%)	No difference organism size (%)	Do not know (%)
Buffalo to Bushmans	49.3	1.9	45.4	3.4
Bushmans to Gamtoos	29.3	0	68.3	2.4
Gamtoos to TNP	22.1	7.4	68.4	2.1
Total study area	36.6	2.4	58.2	2.8

The most commonly recorded reasons for the perceived changes in bait populations were increased subsistence fishing activity, commercial and recreational over-exploitation of bait resources and poaching (especially of abalone). The majority of the subsistence fishers did not give a reason for the decline in numbers and size, though a few blamed “general” collection (subsistence, recreational and commercial collection). Silting of estuaries and seaweed collectors were other reasons given by fishers for the perceived decline in size and numbers of some bait species.

3.4 Discussion

3.4.1 Demographic profile of the users

Recreational fishers (91.5%) dominated in each of the three regions surveyed during this study. Subsistence fishers comprised 8.5% of the fishers encountered across the total study area. Brouwer (1997) found that only 4% of the interviewees encountered between Kei Mouth and Stil Bay were subsistence fishers. However, the low number of subsistence fishers encountered is not a standard pattern throughout South Africa. Mann *et al.* (2003) found that 33% of anglers interviewed in the Transkei were subsistence anglers. The variation in the ratio of subsistence to recreational fishers from one stretch of coast to the next is probably a result of differences in accessibility, the socio-economic condition of communities and the level of traditional association of these communities with marine resource exploitation.

Local anglers and baitfishers dominated in all the survey regions and only 31.0% of the anglers and baitfishers interviewed were visitors. The dominance of local anglers could have an important impact on the success of a formalised baitfishery in that the greater proportion of the potential market is accessible throughout the year, with additional peaks in the market over holiday periods when a greater proportion of visitors enter the shore-fishery.

The majority of the recreational shore-anglers were middle-aged (43.8 years ± 12.6 years). A similar mean age was recorded for subsistence fishers (42.8 years ± 12.0 years). Brouwer (1997) calculated a mean age of 38 years for shore-fishers between Kei Mouth and Stil Bay. However, his study area was far larger than the area for this study. This may explain the difference in the mean age as age patterns may differ in areas included in Brouwer's (1997) study, but not in this study. Along the Transkei coast Mann *et al.* (2003) found that the 30-39 year age group was encountered most often, followed by the 40-49 year age group. Thus the average ages of fishers across the entire Eastern Cape fall within a similar broad range (between 30 and 49 years). However, Mann *et al.* (2003) made no distinction between recreational and subsistence fishers. Attwood and Farquhar (1999) also found that most shore anglers were middle-aged. Similarly, in Namibia the average age of shore-anglers was 45 years (Zeybrandt and Barnes 2001).

Middle-age is when recreational anglers and baitfishers are likely to be at the peak of their earning potential. They are also likely to have families, and angling and baitfishing may be part of family holiday and weekend activities. The dominance of middle-aged people in the recreational fishery may contribute towards the potential success of a small-scale commercial baitfishery. However, the increase in the mean age of shore-fishers since Brouwer's (1997) study may indicate a reduction in the number of new anglers entering the shore-fishery. This could have a negative effect on the success of a baitfishery in years to come on the one hand, and a positive effect on resource conservation on the other.

Only male recreational anglers were encountered. However, Clarke and Buxton (1989) found that 9.7% of recreational fishers interviewed in the Port Elizabeth area were female. In the Transkei shore-fishery 98.8% of the interviewees were male (Mann *et al.* 2003) and in the Namibian shore-fishery 94% of the anglers encountered were male (Zeybrandt and Barnes 2001). Female subsistence fishers were only encountered in the Birha -Hamburg area. On the whole, the subsistence sector was dominated by male fishers, a pattern also identified by Branch *et al.* (2002b). Fikizolo (1996) stated that Xhosa males, in the "Border" area (Great Fish River to Kei River) especially, preferred not to fish or collect bait organisms. This may help explain the relatively high proportion of female subsistence fishers in the Birha - Hamburg area. This state of affairs is rooted in traditional or customary beliefs, although this is changing with the influence of western trends (Fikizolo 1996).

3.4.2 Angler attitudes

The success of a formalised baitfishery may partly hinge on attitudes of anglers and baitfishers towards management issues.

Most anglers and baitfishers were of the opinion that all South Africans owned and were responsible for managing the living marine resources. Therefore, everyone should have fair and equitable access to these resources. The response that all South Africans have a management responsibility is interesting and implies that management should not be left entirely in the hands of national, regional and local authorities. This may indicate that users are now better educated/informed than in the past.

The vast majority of recreational users paid for and were in possession of valid permits and approved of the baitfishery regulations. This implies that the greater majority of users recognise the state as the rightful custodian of the resource and responsible for management. However, it is clear that the users demand the responsible organ of state (Marine and Coastal Management) to spend the revenue raised through permit fees on research, monitoring, enforcement and management. This trend is consistent with other studies carried out in South Africa. Brouwer *et al.* (1997) found that 63% of South African shore anglers "…agreed to the implementation of a marine recreational angling licence for shore-fishing, providing that funds were used to benefit the fishery…" and Mann *et al.* (2002) found that 85.3% of anglers in St. Lucia were prepared to pay for licences to provide funds for fisheries conservation, to keep the St. Lucia mouth open, to improve angling facilities and stock enhancement. Similarly, 78% of fishers in the Transkei were willing to pay for a fishing permit, as long as the money generated was used for the benefit and conservation of the shore-fishery (Mann *et al.* 2003). The message to Marine and Coastal Management is that resource users demand a greater degree of accountability and feedback on how their money is being used for management. The observations that anglers and baitfishers were of the opinion that all South African citizens owned and should manage the living marine resources provides opportunities for Marine and Coastal Management to factor in a greater degree of participation in surveillance by the general public.

The lack of permits among subsistence fishers in the study region mirrored the situation identified by Mann *et al.* (2003) in the Transkei. As in this study, subsistence fishers in the Transkei stated that they could not afford these permits and/or were of the opinion that it was their right to have free access to the resource (Mann *et al.* 2003). The latter opinion can only be changed through education.

Permit inspection rates for the western half of the Eastern Cape were low. While 36.1% of baitfishers and 44.0% of anglers have had their permits inspected since the introduction of the permit system, the frequency of permit inspections per angler outing was low (1.1%± 2.4% and 1.2%± 2.4% for baitfishing and angling permits respectively). The highest inspection rate was in the Gamtoos to TNP region; the lowest in the Bushmans to Gamtoos region. Inspection rates in the eastern half of the Eastern Cape were also low. Mann *et al.* (2003) found that only 12% of anglers in the Transkei had been inspected. The disproportionate ratio between the percentage of anglers who were in possession of valid

permits and the percent rate of inspection could be the reason why some anglers/users did not comply with the permitting system.

Brouwer (1997) suggests the existence of a link between knowledge of regulations and inspection rates. For example, he found that inspection rates in Kwazulu-Natal (11%) were higher than those in either the Western Cape (0.6%) or the Eastern Cape (0.8%) and that the level of fisher knowledge of regulations was greater in Kwazulu-Natal (62%) than in the Eastern and Western Cape (38% and 40%, respectively). A similar conclusion can be reached from this study. Resource users in the Gamtoos to TNP region, where the inspection rate was highest, had the best knowledge of the regulations regarding both baitfishing (67.2%± 38.8%) and angling (79.8± 21.4%). In comparison, anglers in the Bushmans to Gamtoos region, where inspection rate was lowest, had the least knowledge of the regulations for baitfishing (53.5%± 36.9%) and angling (54.8± 27.6%). In the Transkei only 15.5% of fishers knew the minimum size, 21.3% knew the bag limit and 30.2% knew whether there was a closed season for the angling species they were targeting (Mann *et al.* 2003). These observations substantiate Brouwer's (1997) hypothesis that there is a direct correlation between knowledge of the regulations and the rate of inspection. Therefore, by increasing the inspection rate (part of the "return" that anglers and baitfishers would like to see on their permit "investment"), knowledge and the possible resulting compliance with the regulations may be increased.

Most interviewees (69.9%) were of the opinion that the bag limits for most bait species were adequate and fair. However, anglers in the Jeffreys Bay to Eersterivier areas offered two reasons why the bag limit for bloodworm (collected mainly in the Kromme estuary) was too small. Firstly, they thought that the population size of bloodworm in the Kromme had increased and that the bag limit could therefore be increased. Secondly, they stated that the low bag limit reduced their fishing time because bloodworm is a "soft" bait organism that is easily removed from the hook. Such responses clearly point to the need for angler education highlighting the reasons why the restrictions pertaining to such species are important.

CHAPTER 4 - ANGLER EFFORT AND BAIT USE

4.1 Introduction

Several studies dealing with the recreational and commercial linefisheries have been conducted along the southern African coast (e.g. Smale and Buxton 1985, Clarke and Buxton 1989, Brouwer 1997, Brouwer *et al.* 1997, Penney *et al.* 1999, Kirchner and Beyer 1999, Attwood and Farquhar 1999, Pradervand and Baird 2002, Brouwer and Buxton 2002, Mann *et al.* 2003). However, only Clarke and Buxton (1989), Brouwer (1997) and Mann *et al.* 2003 touched on the issue of bait use by anglers in the shore-fishery, particularly on the Eastern Cape coast. Brouwer (1997) cursorily dealt with bait preferences of shore-fishers and skiboat anglers along the Eastern Cape coast, while Clarke and Buxton (1989) touched on bait-use in the Port Elizabeth region and Mann *et al.* (2003) mentioned bait preferences in the Transkei shore-based linefishery. Baitfisheries on estuaries have also been studied by, amongst others, Cowley *et al.* (2004), Nsubugu (2004) and Potts *et al.* (2005). These studies are relevant as estuarine anglers are also likely to make use of small-scale commercial baitfisheries to satisfy their bait needs.

This study focuses entirely on bait use patterns and catch and effort, and compliments studies undertaken on the shore-based linefishery in the Eastern Cape between East London and the Tsitsikamma National Park.

4.2 Methods

The survey design was described in Chapter 2. Information regarding angler effort and bait use was obtained using Sections A and B of the extensive, medium and short questionnaires, Section D of the extensive questionnaires and Section C of the medium and short questionnaires (see Appendices IA, IB and IC).

The unit of effort used in all calculations was an angler-day, which is the effort expended by one angler in one 24-hour cycle (Attwood and Bennett 1995). This unit of effort was recommended by Attwood and Bennett (1995) and used successfully by Brouwer (1997) and Attwood and Farquhar (1999). Attwood and Farquhar (1999) and Brouwer (1997) used a

scaling factor of 2.5 [calculated by Brouwer (1997)] to convert from an instantaneous shore-angler count to the total number of anglers who fished that particular stretch on that survey day.

Attwood and Farquhar (1999) described the calculation of angling effort as converting the number of anglers intercepted by the observer into a total daily count for the stretch being surveyed. Nearby resident anglers often make short visits to the shore in the morning or evening in addition to those that spend longer periods over midday. Consequently, the observer conducting a survey at a randomly chosen time may miss many anglers. For this reason the conversion factor of 2.5, calculated by Brouwer (1997), was used to convert the instantaneous shore-angler count to the total number of anglers within the survey area on that day (angler-days). Brouwer (1997) calculated this figure by relating an instantaneous count to total daily angler effort for data recorded from all parts of the South African coastline. The method for calculating this conversion factor was set out by C. Attwood in Brouwer (1997) and is included below. The estimates of daily total effort for each survey region were averaged and annual effort (angler-days/year) was calculated by multiplying this by 365.

Calculating a conversion factor for estimating daily effort from instantaneous shore-angler counts (C. Attwood cited in Brouwer (1997).

If an angler is on the beach on a particular day, the known starting time distribution and the mean duration of fishing is used to calculate the probability of encountering the angler on the beach at any given time.

To facilitate calculations and avoid integration, probability distributions are discrete. Time is rounded off to the nearest hour.

Symbols:

A_d :Number of anglers on the beach on day d.
O_{dt} :Number of observed anglers on day d at time t.
s_t :Probability of starting fishing at time t.
d_t :Mean duration of fishing trip starting at time t.
p_t :Probability of finding an angler on the beach at time t.
a_t :Step function.
N :Total number of surveyed anglers.
n_t :Number of surveyed anglers who started at time t.

Method

1. Calculate starting time distribution.

$$s_t = n_t / N \quad (1)$$

Note that

$$\sum_{t=0}^{23} s_t = 0.1 \quad (2)$$

2. Compute mean duration of fishing trip at time t. Add up the times of all fishing trips which started at time t (t=0,23) and divide by n_t.

3. Calculate probability of an angler being on the beach at time t.

$$p_t = \sum_{i=1}^{23} (s_i . a_i) \quad (3)$$

$$a_i = 1 \text{ if } 0 \leq (t-i) \leq d_i \quad (4)$$

$$a_i = 0 \text{ if } 0 \leq d_i \leq (t-i) \quad (5)$$

$$a_i = 1 \text{ if } 0 > (d_i-24) \geq (t-i) \quad (6)$$

$$a_i = 0 \text{ if } 0 > (t-i) > (d_i-24) \quad (7)$$

4. Calculate daily total from instantaneous count.

$$A_d = O_{dt} / p_t \quad (8)$$

Note that the scaling factor is simply p_t^{-1}

The study period coincided with the ban of off-road vehicles (ORV's) on South African beaches. This provided an ideal opportunity to undertake a preliminary assessment as to whether the ban would lead to a decrease in angler effort along the Eastern Cape coast. Global Positioning System technology was employed to record the location of all bait-collectors and anglers. All data were captured in Excel and MapSource databases and were used to calculate differences in effort between sampling areas before and after the ORV ban. On stretches of coast with a single or one principal access point, the mean number of angler groups encountered per kilometre per survey was plotted against the distance from the access point. The distance from the access point that angler groups were encountered before and after the ban and the change in overall effort with the advent of the ORV ban could then be identified. The distribution of anglers relative to a central point along beaches with multiple access points was also analysed as a control on the assumption that anglers were more evenly spread along these stretches of coast before and after the ORV ban than for stretches of coast accessed via a single access point. The percent decrease in angling effort between September 2001 and January 2002 (the months during the study period coinciding with the beaches being accessible to ORV's) and September 2002 and January 2003 (the corresponding months during which the beaches were closed) was calculated for the four monthly survey areas. Significance was tested using Chi-square analysis. This allowed for a further estimate of the decrease in angling effort with the advent of the ORV ban.

Temporal patterns of bait harvesting were analysed using circular statistical analysis (Bliss 1958, Batschelet 1981, Zar 1984, Upton and Fingleton 1989). This method was identified as the most appropriate tool for this purpose as bait collection patterns are generally governed by the state of the tides (a temporal pattern with no true zero point). A Rayleigh Test for randomness was used to establish whether there was any significant clustering around the mean time of collection relative to the daily tidal cycle and the spring/neap tide cycle at $p = 0.05$. Daily tidal and lunar (spring/neap) states were obtained from Anonymous (2001), Smith (2002) and Anonymous (2003).

The type and quantity of bait from bait boxes were recorded and the percent frequency encounter rate was calculated. Interviewees were also asked what their top three target angling species were and this was expressed as a percentage. Where possible, the three preferred bait species for the target angling species were then represented as a percentage.

Using the daily angler effort estimate for each study region and the average quantity of each bait species used by each angler, it was possible to calculate the quantity (numbers of individuals or weight) of the most important bait species purchased, collected and used per region per year. This was achieved by using the equation below:

$$Q = \frac{(B)}{n} \times E \times 365$$

where, Q is the total quantity of each bait species collected, purchased or used per year per survey region; B is the total amount (number of individuals/weight) of each bait species collected, purchased or used by the interviewed anglers during the entire survey period per survey region; n is the total number of anglers interviewed per survey region; E is the total daily effort for each survey region; and 365 is the number of days in a non leap year.

4.3 Results

4.3.1 Angling effort

Using the procedure outlined by Brouwer (1997) and Attwood and Farquhar (1999), total angler effort in all regions was estimated at about 475 000 angler-days/year (Table 4.1).

The Buffalo to Bushmans region had the highest effort in terms of angler-days/kilometre, followed by the Gamtoos to TNP region (Figure 4.1). However, most of the effort in the Gamtoos to TNP region was concentrated between Jeffreys Bay and Oyster Bay. Oyster Bay to TNP is relatively inaccessible, hence the lower fishing effort. Effort was 36.5% greater across the entire study area during the December holidays than during the rest of the year (Figure 4.2).

It can be argued that the calculated fishing effort is higher than expected. However, the results include data gathered during peak season periods. About 20% of the surveys also took place before the ORV ban when fishing effort was higher than it is currently (see later in Chapter 4).

Table 4.1: Calculated total angler-days/day and /year for each survey region.

Survey region	Angler-days/day	Angler-days/year
Buffalo to Bushmans	478	172 654
Bushmans to Gamtoos	489	176 663
Gamtoos to TNP	346	124 939
Total study area	1 313	474 256

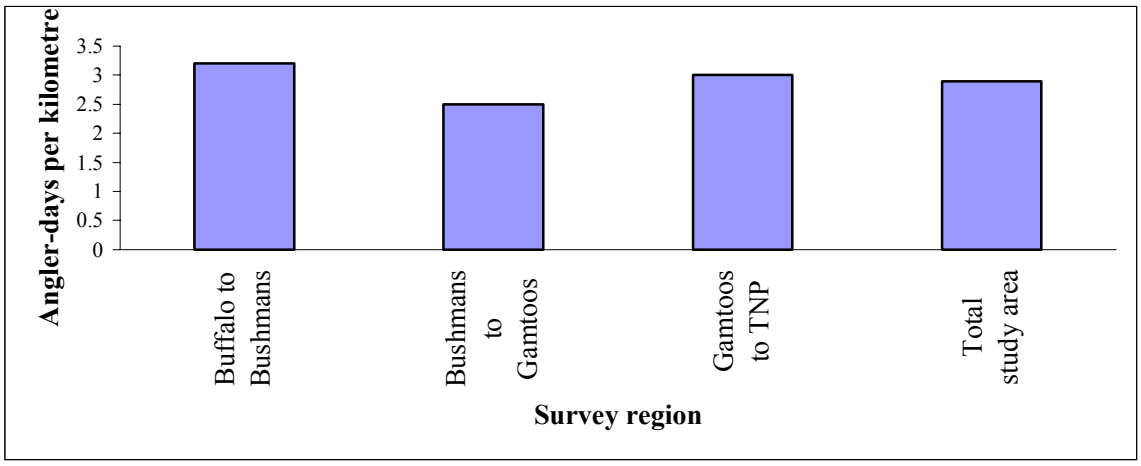


Figure 4.1: Estimated shore angler effort (angler-days/kilometre) for each survey region.

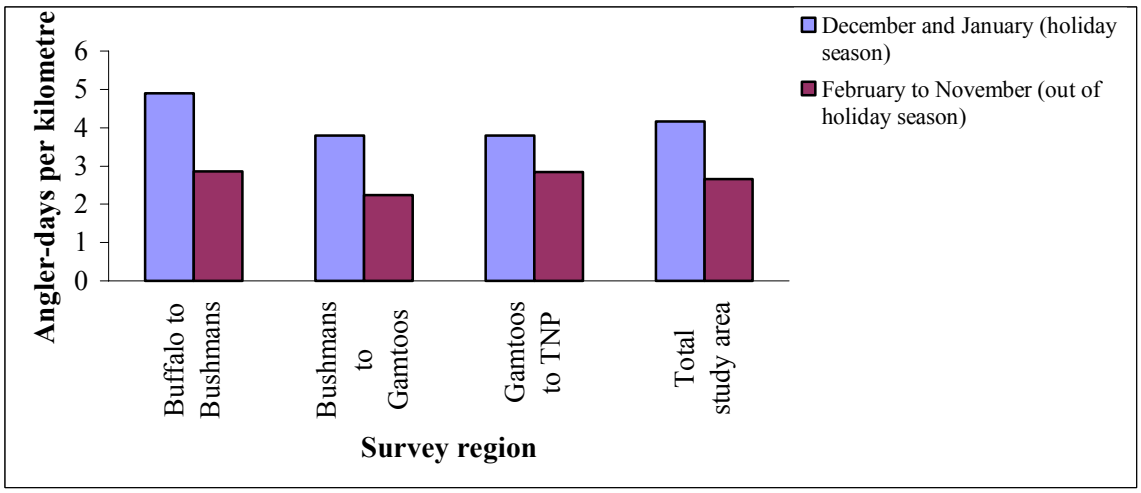


Figure 4.2: Estimated shore-angler effort (angler-days/kilometre) for each survey region during holiday season and out of holiday season.

Despite seasonal variations in estimated shore-angler effort (Figure 4.2), catch and value estimates for each bait species were based on the mean daily totals over the entire study period.

4.3.2 Bait collection and use

Shore-anglers used a wide variety of purchased and freshly collected bait organisms. Twenty-three bait species were recorded during this study (Table 4.2). Four of the species, chokka (*Loligo reynaudi vulgaris*), pink prawn (*Haliporoides triarthus*), sardine (*Sardinops sagax*) and red-eye herring (*Etrumeus whiteheadi*) were mainly purchased from shops (bait shops, fishing tackle shops, supermarkets and beach cafés). All other species were usually collected by the anglers. A number of bait species that are known to be used in the western half of the Eastern Cape were not encountered during the surveys (T. Hecht, Department of Ichthyology and Fisheries Science, Rhodes University, P. Cowley, South African Institute for Aquatic Biodiversity, W. Potts, Department of Ichthyology and Fisheries Science, Rhodes University and D. Kemp, pers. comm., pers. obs.). These are listed in Table 4.3.

Table 4.2: Bait species recorded during this study.

	Scientific name	**Common name**
Purchased species	*Etrumeus whiteheadi*	Red-eye herring
	Loligo reynaudi vulgaris	Chokka
	Haliporoides triarthus	Pink prawn
	Sardinops sagax	Sardine
Collected bait species		
Polychaeta	*Arenicola loveni*	Bloodworm
	Gunnarea capensis	Coral worm
	Pseudonereis variegata	Mussel worm
Crustacea	*Callianassa kraussi*	Sand prawn
	Ovalipes punctatus	White crab
	Panulirus homarus	Lobster
	Upogebia africana	Mud prawn
Mollusca	*Dinoplax gigas*	Saddleback/Armadillo
	Donax serra	Sand mussel
	Haliotis spadicae	Siffie/Venus ear
	Octopus vulgaris	Octopus
	Perna perna	Brown mussel
	Solen capensis	Pencil bait
	Patellidae spp.	Limpet
Tunicata	*Pyura stolonifera*	Red bait
Teleostei	*Mugilidae* species	Mullet
	Pomatomus saltatrix	Shad/Elf
	Sarpa salpa	Strepie
	Scomber japonicus	Mackerel

Table 4.3: Bait species that are used in the study region but not recorded during the study.

	Scientific name	**Common name**
Polychaeta	*Morphysa sanguinea*	Wonderworm
	Polybranchiorhynchus dayi	White tapeworm
Crustacea	*Ocypode* spp.	Ghost crab
	Plagusia chabrus	Cape rock crab
Mollusca	*Haliotis midae*	Abalone
	Oxystele spp.	Periwinkles
	Turbo sarmaticus	Ollycrock

It was found that anglers targeted 13 species of fish in the study region (Table 4.4). Bronze bream (65.9%) and dusky kob (61.1%) were the two most commonly targeted species, followed by white steenbras (31.7%), white musselcracker (31.4%) and blacktail (20.2%).

A range of preferred bait species was recorded for the targeted angling species (Table 4.4). Sand prawn was the preferred bait species for white steenbras, blacktail, spotted grunter, baardman, zebra and Cape stumpnose. Sand prawn was also a highly favoured bait species for bronze bream. White steenbras were also targeted with chokka and bloodworm and blacktail were also targeted using sardine and red bait. Mud prawn, coral worm and pink prawn were also favoured bait species for spotted grunter, especially along the “dolosse” in the Port Elizabeth area. Baardman were also targeted using bloodworm and chokka. Bloodworm and pink prawn were also popular when targeting zebra. Siffie, saddleback and red bait in descending order were the preferred bait species for white musselcracker. The two most preferred bait species for dusky kob were chokka and sardine, with octopus as the third favoured bait species. The favoured bait for Elasmobranchs was mackerel, which is often collected by anglers, followed by mullet and sardine. Shad, leervis and Cape stumpnose were only targeted with sardine, live mullet and sand prawn respectively. The most commonly used bait species for galjoen was red bait followed by pink prawn and mussel worm.

Table 4.4: The targeted angling species (in order of priority), the percentage of anglers targeting each species, the top three preferred bait species per angling species and the percent bait preference of anglers.

		Preferred bait species (percent frequency encountered)		
Targeted angling species	**% targeted**	**1**	**2**	**3**
Pachymetopon grande Bronze bream	65.9	Pink prawn 45.6	Sand prawn 30.9	Red bait 15.4
Argyrosomus japonicus Dusky kob	61.1	Chokka 49.6	Sardine 28.8	Octopus 11.5
Lithognathus lithognathus White steenbras	31.7	Sand prawn 37.5	Chokka 18.8	Bloodworm 12.5
Sparodon durbanensis White musselcracker	31.4	Siffie 28.0	Saddleback 24.5	Red bait 21.0
Diplodus capensis Blacktail	20.2	Sand prawn 38.0	Sardine 23.9	Red bait 22.8
Elasmobranch spp. Sharks and flatfish	7.5	Mackerel 70.6	Mullet 27.0	Sardine 2.4
Pomadasys commersonnii Spotted grunter	7.3	Sand prawn 33.3	Mud prawn 24.2	Coral worm/ Pink prawn 12.1
Pomatomus saltatrix Shad	6.8	Sardine 100	-	-
Lichia amia Leervis	6.4	Mullet (live) 100	-	-
Dichistius capensis Galjoen	4.6	Red bait 71.4	Pink prawn 28.6	Mussel worm 9.5
Umbrina spp. Baardman	3.1	Sand prawn 57.1	Bloodworm 21.4	Chokka 21.4
Diplodus hottentotus Zebra	2.2	Sand prawn 60.0	Bloodworm 20.0	Pink prawn 20.0
Rhabdosargus holubi Cape stumpnose	1.1	Sand prawn 100	-	-

In order of priority, sardine, chokka and pink prawn were the most frequently recorded purchased bait species (Figure 4.3), while red bait and sand prawn were the most commonly encountered species collected by anglers.

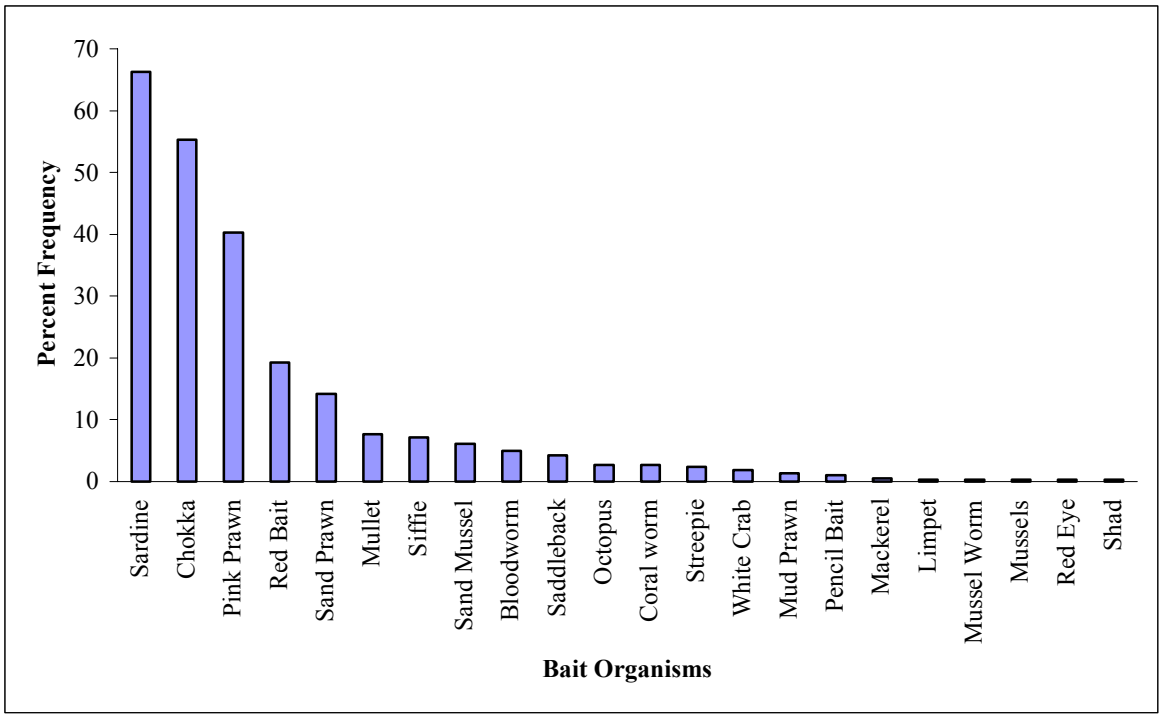


Figure 4.3: The percent frequency of bait species recorded in bait boxes throughout the sampling area.

Annual estimates of bait collected and bait used are shown in Tables 4.5, 4.6 and 4.7. Sixteen pods of red bait approximate 1kg [mean weight of a freshly cut red bait pod = 62.4g ± 9.8g (n = 25)], hence the weight of red bait collected and used could also be estimated. Red bait tends to lose moisture, hence weight, after collection. Therefore, the number of red bait pods collected was counted and the total weight was calculated by multiplying the number of pods by the mean weight of a freshly cut red bait pod.

In the Buffalo to Bushmans region six bait species were collected and used most often (Table 4.5). Sand prawn was the most heavily exploited species, followed by red bait. Siffie was exploited at a low level. However, the number of siffies removed on an annual basis was still high enough for it to potentially be an important component of a small-scale baitfishery.

In the Bushmans to Gamtoos region eight bait species were collected most often (Table 4.5). Sand mussel was the most heavily exploited species, followed by red bait and mullet. Siffie and saddleback were sufficiently popular to suggest that they could also be an important component of a small-scale baitfishery.

Only four bait species were generally used in the Gamtoos to TNP region (Table 4.5). Sand prawn was the most heavily exploited species in the region, followed by bloodworm and red bait. Siffie was also commonly used. Sand prawn and bloodworm were only used regularly between the Gamtoos River and Oyster Bay.

Table 4.5: Mean numbers of the most important bait organisms collected/angler/day, and the total estimates/year (± SD) per region.

Survey Region	Bait Species	Mean number/ angler/day	Total number/year
Buffalo to Bushmans	Sand Prawn	5.4± 29.6	932329± 5101914
	Red Bait	1.3± 5.2 (0.08kg)	231356± 901252 (14 460kg)
	Mullet	0.2± 0.7	38685± 125726
	Saddleback	0.1± 0.5	21986± 82285
	Sand Mussel	0.1± 0.7	10359± 122584
	Siffie	0.04± 0.2	6281± 38945
Bushmans to Gamtoos	Sand Mussel	3.0± 8.0	529880± 1418313
	Red Bait	1.6± 3.6 (0.1kg)	286135± 639389 (17 883kg)
	Mullet	1.5± 3.9	263499± 695180
	Mud Prawn	1.2± 6.4	213718± 1234621
	Coral Worm	1.0± 3.9	171328± 681779
	Sand Prawn	0.4± 3.5	74183± 61129
	Siffie	0.4± 1.0	71099± 169659
	Saddleback	0.2± 0.8	39421± 145018
Gamtoos to TNP	Sand Prawn	8.5± 16.3	1064789± 2033347
	Blood Worm	2.0± 4.1	254949± 511149
	Red Bait	1.2± 3.8 (0.08kg)	152470± 479905 (9 529kg)
	Siffie	0.2± 0.7	24262± 92861

In terms of the number of individual bait organisms collected per angler per day and the total number harvested per year throughout the survey area (Table 4.6), sand prawn was the most popular bait organism followed by red bait and sand mussel. Mullet, bloodworm, mud prawn, coral worm, siffie and saddleback were also collected in significant annual numbers and could therefore make an important contribution to small-scale baitfisheries.

The quantities of sardine, chokka, pink prawn and red-eye herring purchased per person are included in Table 4.7. In terms of weight, more sardine was purchased (0.5kg± 0.5kg) per angler per day than chokka (0.2kg± 0.2kg) or pink prawn (0.1kg± 0.1kg). Red-eye herring was seldom purchased, but this is probably a function of availability.

The quantity of bait organisms used by anglers (Table 4.8) was in many instances markedly less than the numbers collected. However, almost all of the sand prawns collected per day were used. The percent difference between the quantities collected and used for the other most favoured bait species is shown in Table 4.9.

Table 4.6: Mean number or weight of bait organisms collected/angler/day and the total estimate of bait harvest/year throughout the study area (± SD).

Collected Bait	Average number collected/angler/day	Total number harvested/year
Sand Prawn	4.4± 16.3	2071301± 7746389
Red Bait	1.4± 4.3 (0.09kg)	669961± 2020546 (41 873kg)
Sand Mussel	1.1± 3.2	540240± 1540897
Mullet	0.6± 1.7	302184± 820907
Bloodworm	0.5± 1.1	254949± 511149
Mud Prawn	0.5± 2.6	213718± 1234621
Coral Worm	0.4± 1.4	171328± 681779
Siffie	0.2± 0.6	101642± 301465
Saddleback	0.1± 0.5	61408± 227303
Strepie	0.1± 0.7	46974± 328818
Mackerel	0.1± 0.6	46963± 281844
White Crab	0.02± 0.1	9395± 46974
Pencil Bait	0.02± 0.2	9385± 93948
Octopus	0.01± 0.1	4697± 46974
Shad	0.003± 0.04	1409± 18790

Table 4.7: Mean quantity of purchased bait organisms/angler/day and the total estimate of bait purchased/year throughout the study area (± SD).

Purchased Bait	Average quantity (kg) purchased/angler/day	Total quantities (kg) purchased/year
Sardine	0.5± 0.5	234870± 234864
Chokka	0.2± 0.2	93944± 93948
Pink Prawn	0.1± 0.1	46974± 46953
Red-eye Herring	0.01± 0.3	4697±140922

Table 4.8: Mean quantities (numbers or weight) of bait organisms used/angler/day and the estimated total amount used/year in the total study area (± SD).

Collected Bait	**Average number of bait organisms used/angler/day**	**Total number used/year**
Sand Prawn	4.4± 20.8	2066859± 9864553
Sand Mussel	1.1± 5.0	516715± 2348703
Red Bait	0.9± 2.9 (0.06kg)	422767± 1362248 (26 423kg)
Bloodworm	0.3± 1.9	140899± 798559
Mullet	0.3± 0.6	140929± 986455
Mud Prawn	0.3± 3.1	140922± 1456196
Coral Worm	0.3± 2.0	140933± 939481
Siffie	0.1± 0.7	46971± 328818
Saddleback	0.1± 0.1	46974± 422767
Mackerel	0.04± 0.8	18790± 375792
Pencil Bait	0.02± 0.3	9395± 140922
Octopus	0.01± 0.1	4697± 46974
Purchased bait	**Average weight (kg) of frozen bait organisms used/angler/day**	**Total weight (kg) used/year**
Sardine	0.2± 0.5	93948± 234870
Chokka	0.1± 0.2	46974± 93948
Pink Prawn	0.02± 0.1	9395± 46974

Table 4.9: Percent difference between the quantities of bait collected and used for the most commonly used bait species.

Bait species	**Percent not used**
Sand Prawn	0.2
Sand Mussel	3.9
Coral Worm	17.7
Saddleback	23.5
Mud Prawn	34.1
Red Bait	36.9
Bloodworm	44.8
Mullet	53.4
Siffie	53.7

Of the collected species, sand prawn was used most often in terms of number of individuals. It was also the most successful bait species, along with red bait, in terms of the ratio of numbers of individuals used to numbers of fish caught. Sand mussel was overall the second most commonly used bait species in terms of numbers of individuals (Table 4.10).

Table 4.10: Average quantity of bait used/person/day in the study region, the percent of fish caught on each species and the ratio of fish caught (# individuals) to the amount of bait used (# individuals and/or weight in kg).

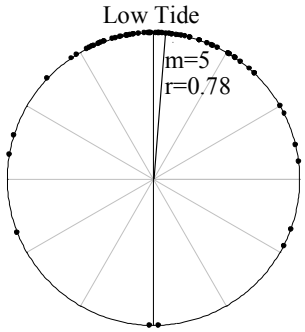
Bait species	Average amount used/person/day	% of fish caught	Ratio fish caught: bait used
Sand prawn	4.4 individuals	47.0	1:9
Sand mussel	1.1 individuals	8.2	1:11
Siffie	0.1 individuals	5.9	1:17
Red bait	0.06kg (0.9 individuals)	4.1	1:7 (0.4kg)

4.3.3 Temporal patterns of bait collection

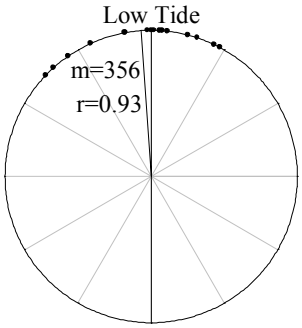
Results of the circular statistical analysis showed that the state of the daily and lunar tidal cycle in many instances had a significant effect on the time of collection of many bait species.

Rocky-shore intertidal organisms such as red bait, siffie and coral worm were collected almost exclusively at spring low tide (Figures 4.4 and 4.5). Although saddleback is also a rocky-shore intertidal organism that was collected at low tide (Figure 4.4), the lunar cycle was not significantly related to the time of collection (Figure 4.5). Sand mussel is an intertidal sandy beach organism and these were also usually gathered at low tide (Figure 4.4) irrespective of the lunar cycle (Figure 4.5). Mullet was collected at any tide (Figure 4.4) from either estuaries or the sea irrespective of the lunar cycle (Figure 4.5).

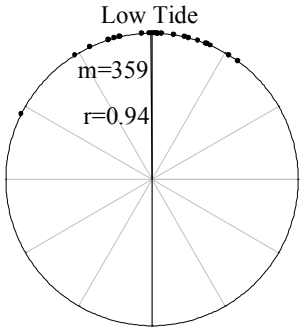
Sand prawn, mud prawn and bloodworm are estuarine organisms. According to the fishers interviewed mud prawns were collected at a range of tidal levels (Figure 4.4) and irrespective of the lunar cycle (Figure 4.5). However, this result is open to debate and personal observation suggests that mud prawns are usually collected at low tide. Sand prawns were usually collected at a time approaching low tide (Figure 4.4) and there was a significant clustering around the mean at a point approaching spring tide. However, sand prawn is often collected in closed estuaries which are unaffected by tides, hence the time of collection may be dictated more by preferred angling time relative to the tidal state. Bloodworm was collected exclusively around low tide (Figure 4.4), but the lunar cycle had no influence on collection (Figure 4.5).



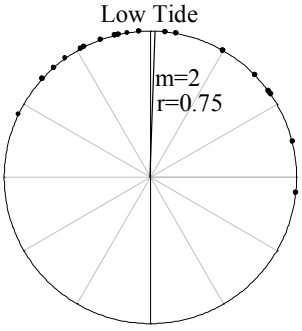
Red Bait (p<0.001, n=72)



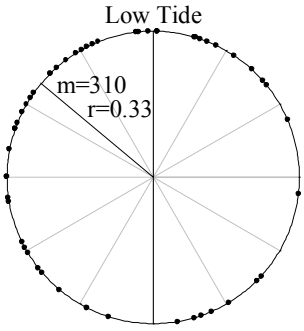
Saddleback (p<0.001, n=16)



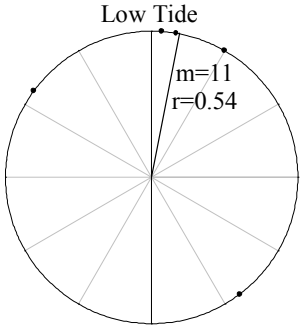
Siffie (p<0.001, n=27)



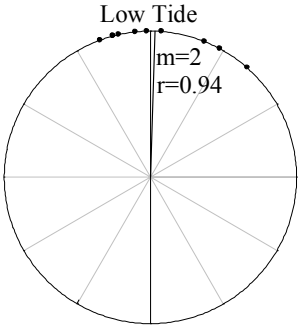
Sand Mussel (p<0.001, n=23)



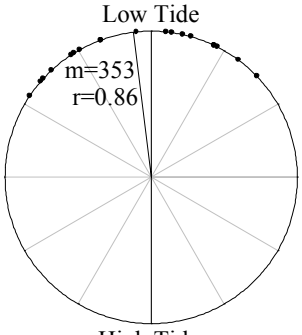
Sand Prawn (p=0.010, n=54)



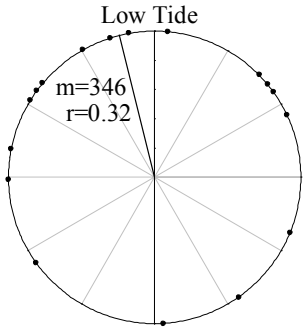
Mud Prawn (p=0.244, n=5)



Coral Worm (p<0.001, n=10)

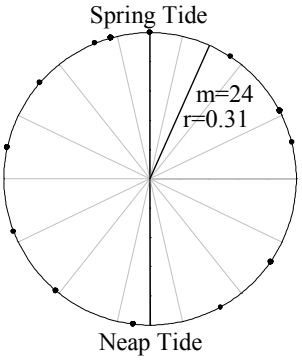


Bloodworm (p<0.001, n=19)

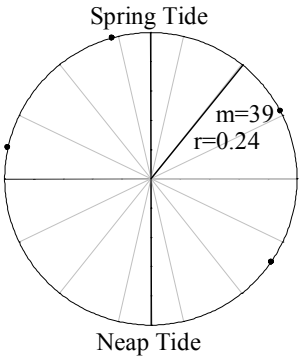


Mullet (p=0.177, n=17)

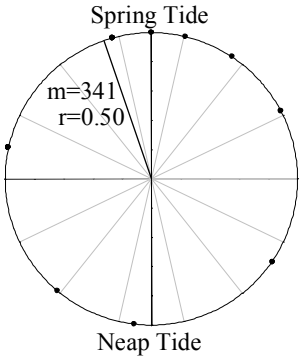
Figure 4.4: Time of collection of the nine most popular bait species during the daily tidal cycle, estimated using circular statistical analysis. Each dot represents an individual data point.



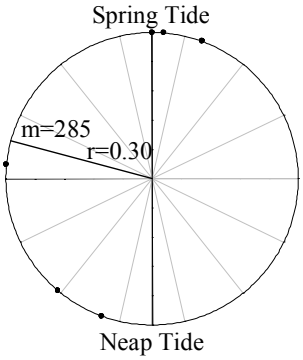
Red Bait (p<0.001, n=73)



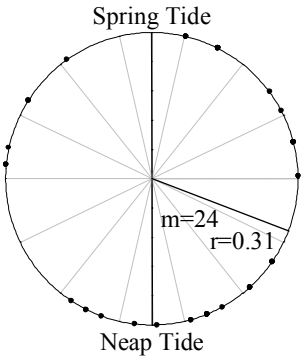
Saddleback (p=0.404, n=16)



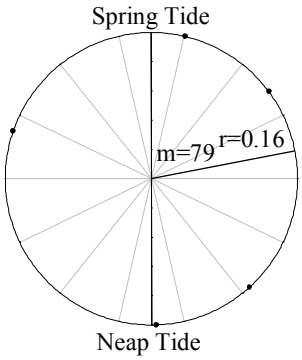
Siffie (p=0.001, n=25)



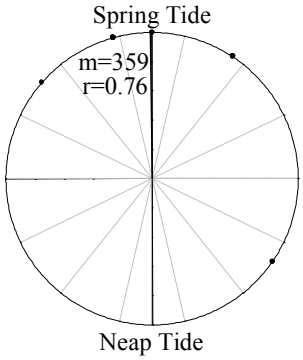
Sand Mussel (p=0.125, n=23)



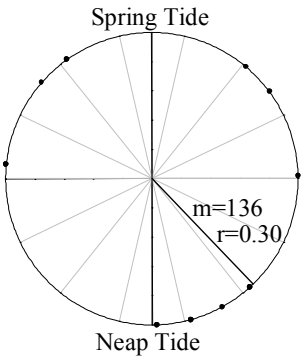
Sand Prawn (p=0.007, n=52)



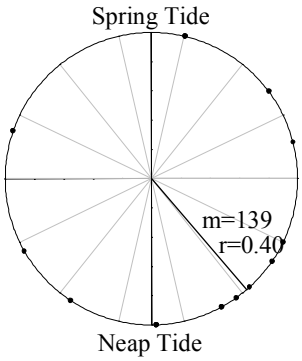
Mud Prawn (p=0.894, n=5)



Coral Worm (p=0.002, n=10)



Bloodworm (p=0.182, n=19)



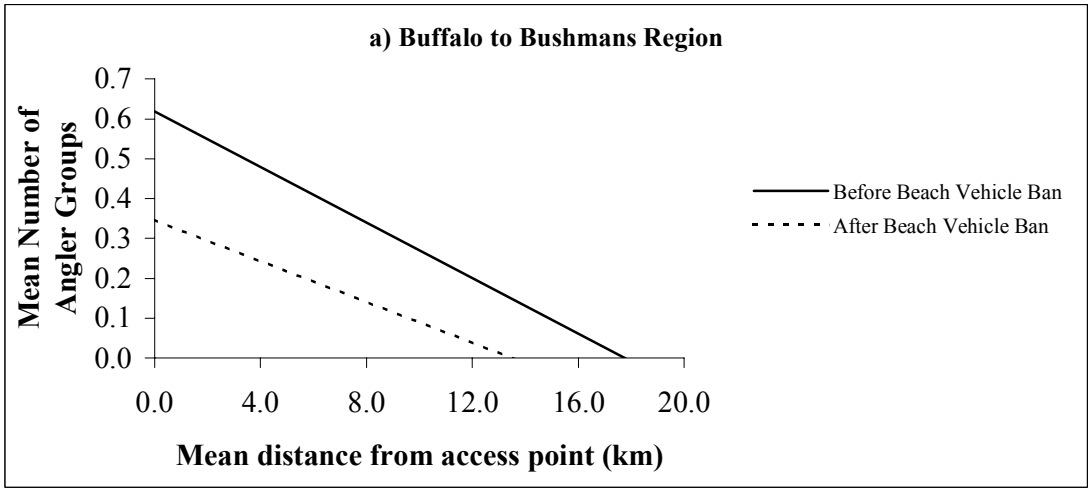
Mullet (p=0.089, n=15)

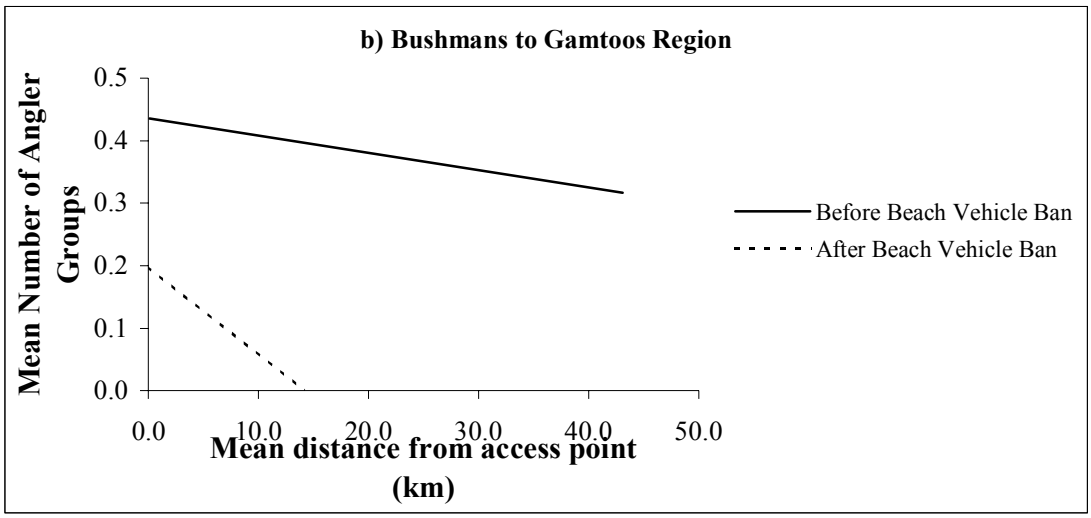
Figure 4.5: Collecting intensity of the most popular bait species in relation to the lunar spring tide cycle, estimated using circular statistical analysis. Each dot represents an individual data point.

4.3.4 Effect of ORV ban on angler distribution and effort

Just less than five months of the 19 month survey period was conducted before the ORV ban, with the remainder conducted after the ban. After the ORV ban there was a decrease in the mean number of fisher groups encountered/survey trip/kilometre from the access point along those stretches of coast accessed by a single access point (Figure 4.6 a, b and c). There was also an overall decrease in both effort (number of angler groups per kilometre) and the mean distance from the access point that fisher groups were encountered (Table 4.11). The biggest decrease in distance from access point was observed in the Bushmans to Gamtoos region with a decrease of 4.5km. The smallest decrease in distance from access point was observed in the Gamtoos to TNP region (0.2km). For those areas accessed by multiple access points (Figure 4.7 a, b and c) there was also a decrease in the mean number of fisher groups encountered/survey trip/kilometre after the ORV ban. This was despite the fact that these areas were as accessible as before the ORV ban.

There was a significant decrease in the number of anglers encountered with the introduction of the ORV ban in the Port Alfred (42% decrease, Chi-square test $P < 0.001$) and St. Francis Bay (27% decrease, Chi-square test $P < 0.046$) survey areas (Table 4.12). However, in the other two areas, East London (Chi-square test $P > 0.83$) and Port Elizabeth (Chi-square test $P > 0.157$) there was no significant decrease.





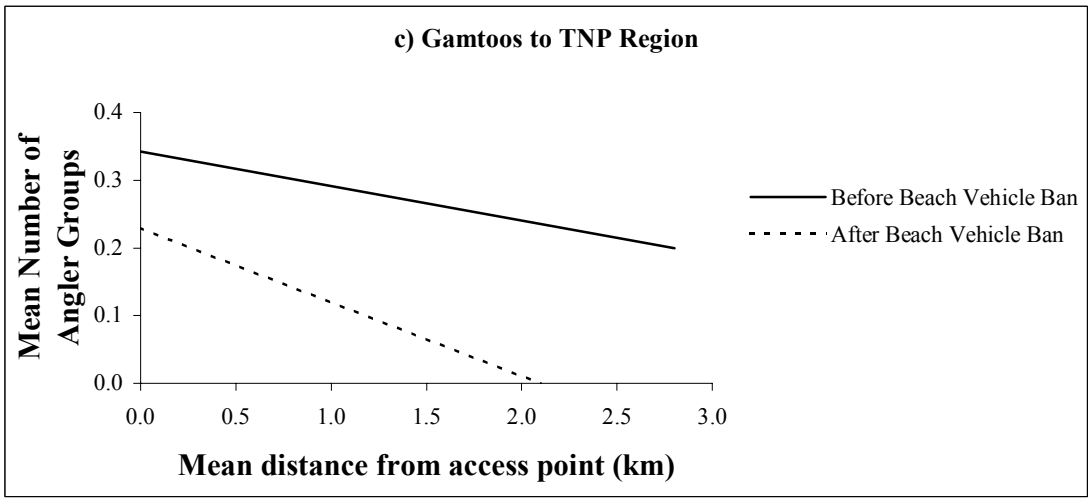
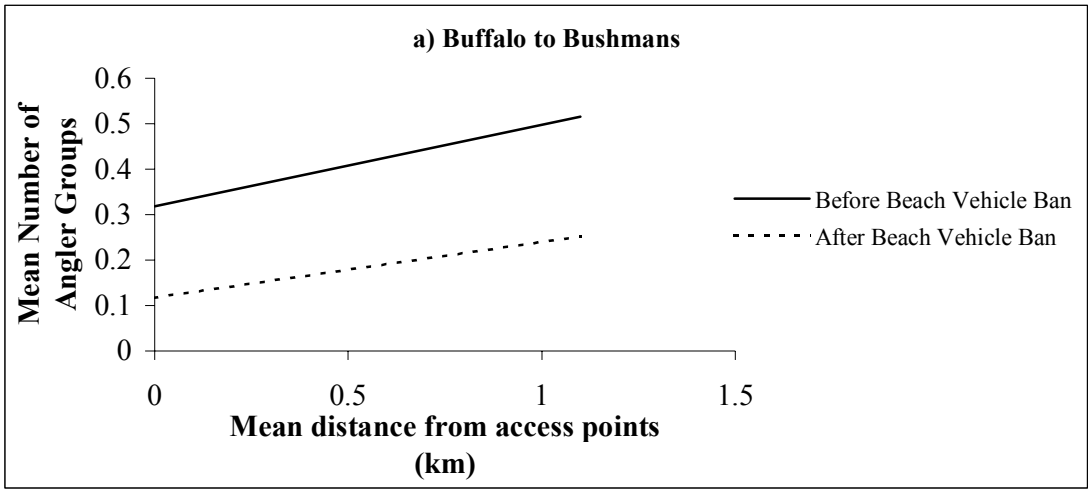
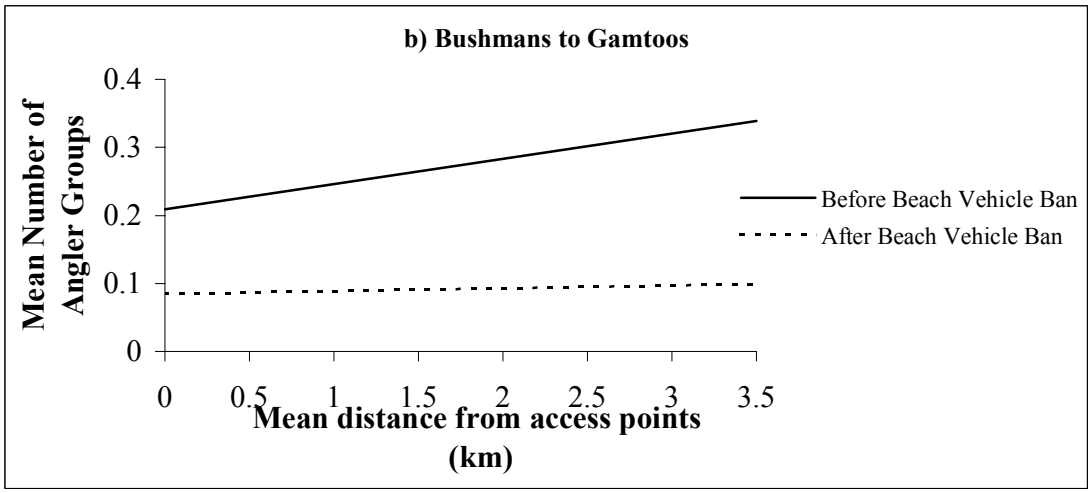


Figure 4.6: Angler distribution and abundance before and after the ORV ban along stretches of coast with single access points [(a) Buffalo to Bushmans region, (b) Bushmans to Gamtoos region and (c) Gamtoos to TNP region].





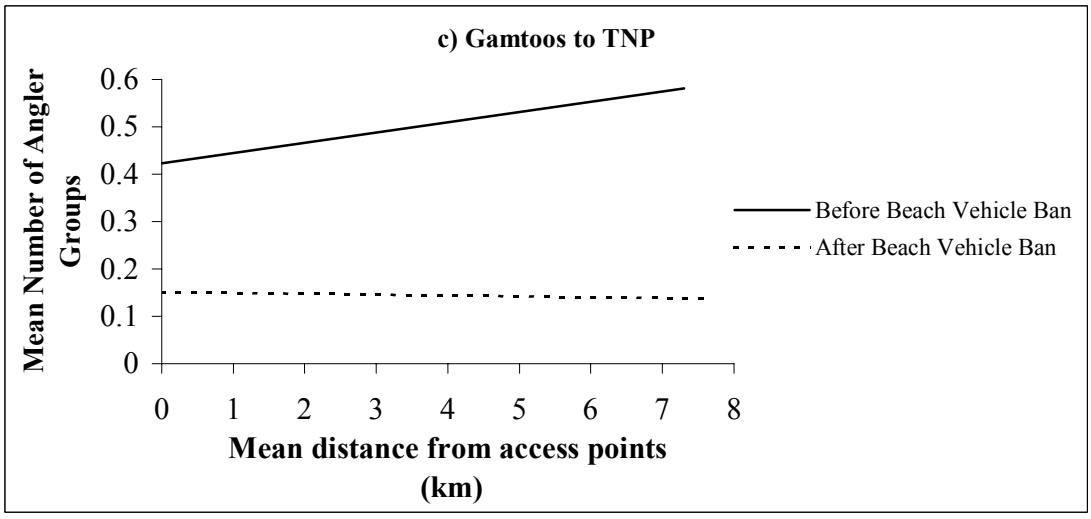


Figure 4.7: Angler distribution and abundance before and after the ORV ban along stretches of coast with multiple access points [(a) Buffalo to Bushmans region, (b) Bushmans to Gamtoos region and (c) Gamtoos to TNP region].

Table 4.11: Distance from the access point that fishers were encountered before (September 2001 to January 2002) and after (February 2002 to April 2003) the ORV ban in areas accessible by a single access point.

Survey Region	Before ORV ban (km)	After ORV ban (km)
Buffalo to Bushmans	2.7± 3.5	1.4± 1.8
Bushmans to Gamtoos	7.2± 11.6	2.7± 2.4
Gamtoos to TNP	0.9± 0.7	0.7± 0.3

Table 4.12: Percentage decrease in effort (angler-days) in the monthly survey areas following the introduction of the ORV ban.

Monthly survey areas	Decrease in effort (%)
East London	22
Port Alfred	42
Port Elizabeth	16
St. Francis Bay	27

The effect of the ORV ban is also illustrated by the pattern of angler distribution before and after the ORV ban in Figures 4.8 to 4.14.

Figure 4.8 (Area 8): Fishing spots around Leach Bay, Igoda Mouth, Gulu Mouth and Kidds Beach were easily accessed, hence fisher concentration was high. However, even before the ORV ban, fishers were seldom encountered along the less accessible stretches such as the area between Leach Bay and Gulu Mouth. Some stretches in this survey area were not open to ORV's prior to the national ban, therefore, angling with the use of vehicles was not as prevalent as in some of the other survey areas.

Figure 4.9 (Area 7): In the Birha survey area there are few beach access points. The diagram shows that before the ORV ban fishers were encountered fairly evenly across the area as ORV's were popular here. After the ORV ban, effort was concentrated around the settlements and access points, especially at Hamburg.

Figure 4.10 (Area 6): In the Port Alfred area ORV's were popular and fishers were evenly spread between the Great Fish and Kowie Rivers prior to the ORV ban. After the ORV ban fishers were encountered closer to the access points at East Beach (Port Alfred), Rufanes Beach, Riet Point (near Riet River), Kleinemond Point (near Kleinemond) and Great Fish Point.

Figure 4.11 (Area 5): Prior to the ban fishers were encountered up to 46 km from the Sundays River. After the ban fishers were only encountered at the Sundays River mouth. However, with the advent of the ban, access to this region was no longer possible. It is possible that fishers were accessing spots east of Sundays River mouth via private land. At this time the Blue Horizon Bay survey area (Area 3, Diagram 6), an area dominated by sandy beach and therefore similar to the Sundays River survey area, was introduced to the study.

Figure 4.12: In the Port Elizabeth survey area (from Maitlands Mouth to the Swartkops River mouth) (Area 4) there was no discernable difference in the distribution pattern of fishers before or after the ORV ban. Most of this region is easily accessible to anglers on foot. Within the Blue Horizon Bay region (Area 3) fishers were only encountered around Blue Horizon Bay settlement. This was expected as surveys were only conducted after the ORV ban and Blue Horizon Bay is the only free access point within this survey area. Van Stadens River and the campsite at Gamtoos River mouth are pay per access areas and were seldom used by shore-fishers.

Figure 4.13 (Area 2): In the St. Francis Bay area fishers were evenly spread before and after the ORV ban as most of this area is easily accessed on foot.

Figure 4.14 (Area 1): This coastline is inaccessible to vehicles and the few fishers encountered were always on foot. Before the ORV ban fishers were only encountered within a small area; after the ORV ban fishers were encountered at fishing spots further away. This was probably due to more survey trips being conducted after the ban than before, thus providing more opportunity for encountering anglers further away from the access point at Eersterivier.

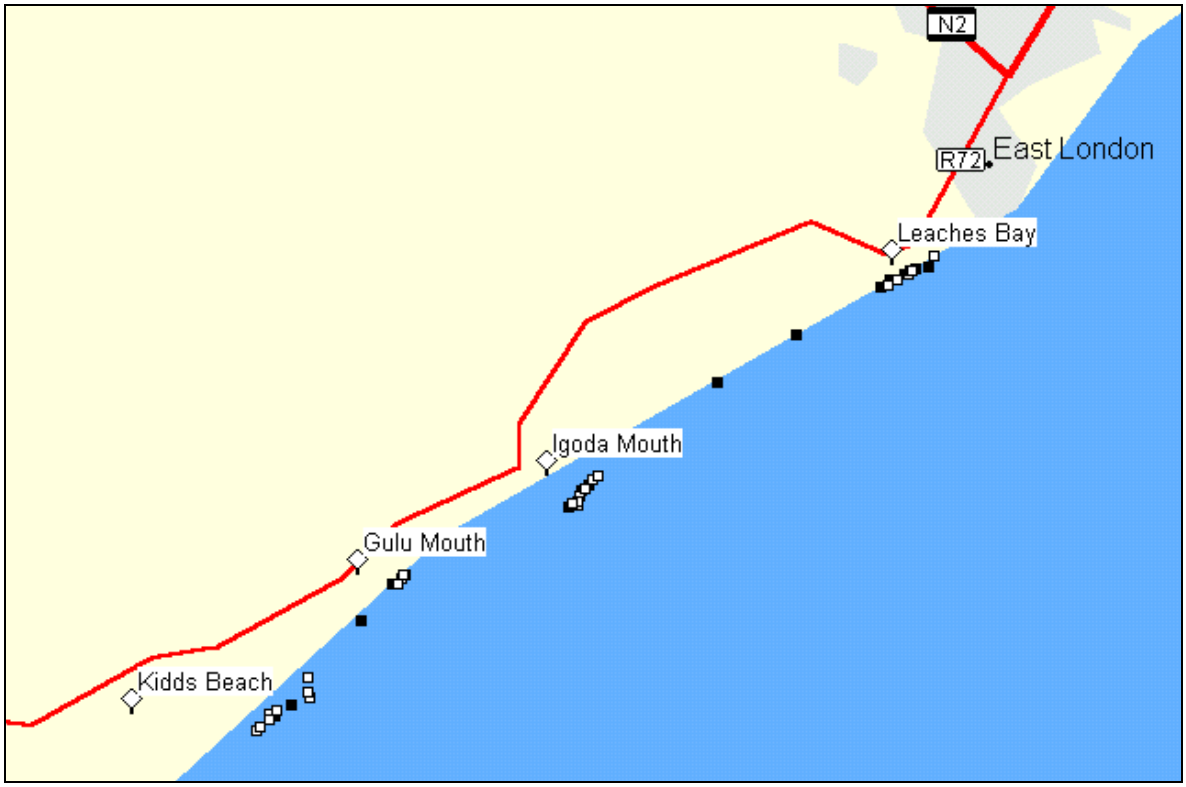


Figure 4.8: Angler concentration in the East London survey area before (black icons) and after (white icons) the ORV ban.

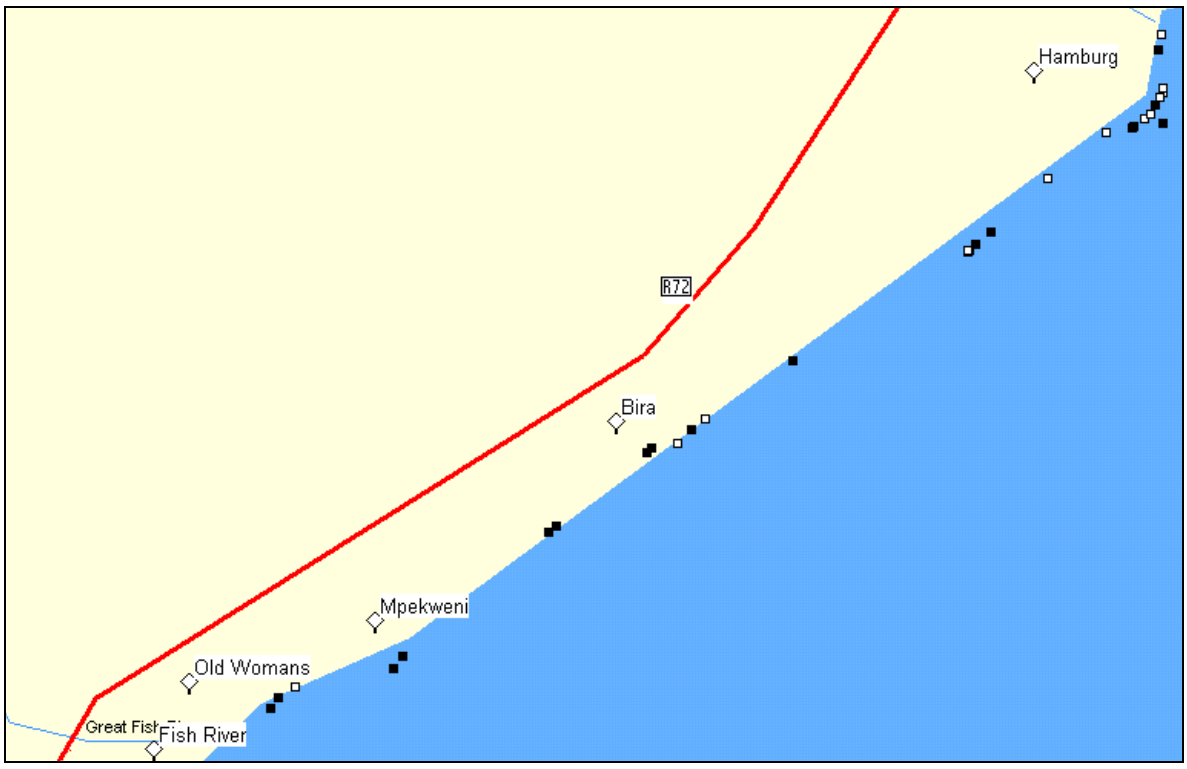


Figure 4.9: Angler concentration in the Birha survey area before (black icons) and after (white icons) the ORV ban.

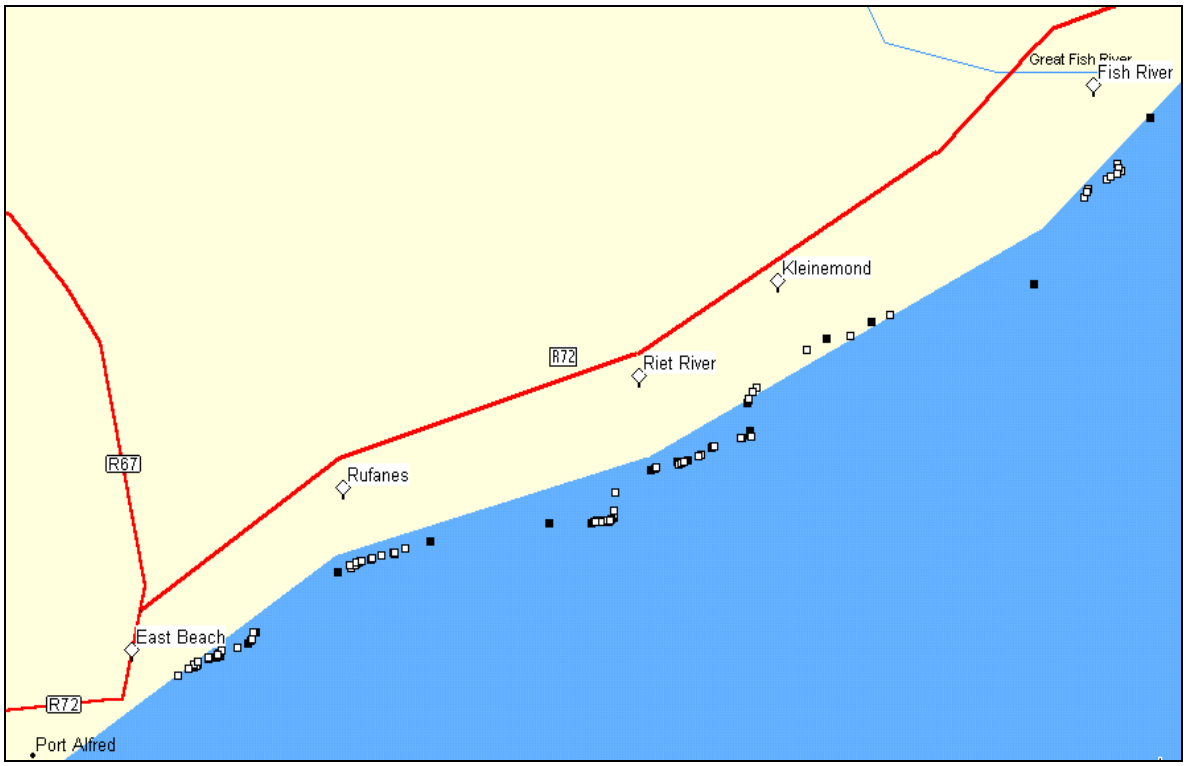


Figure 4.10: Angler concentration in the Port Alfred survey area before (black icons) and after (white icons) the ORV ban.

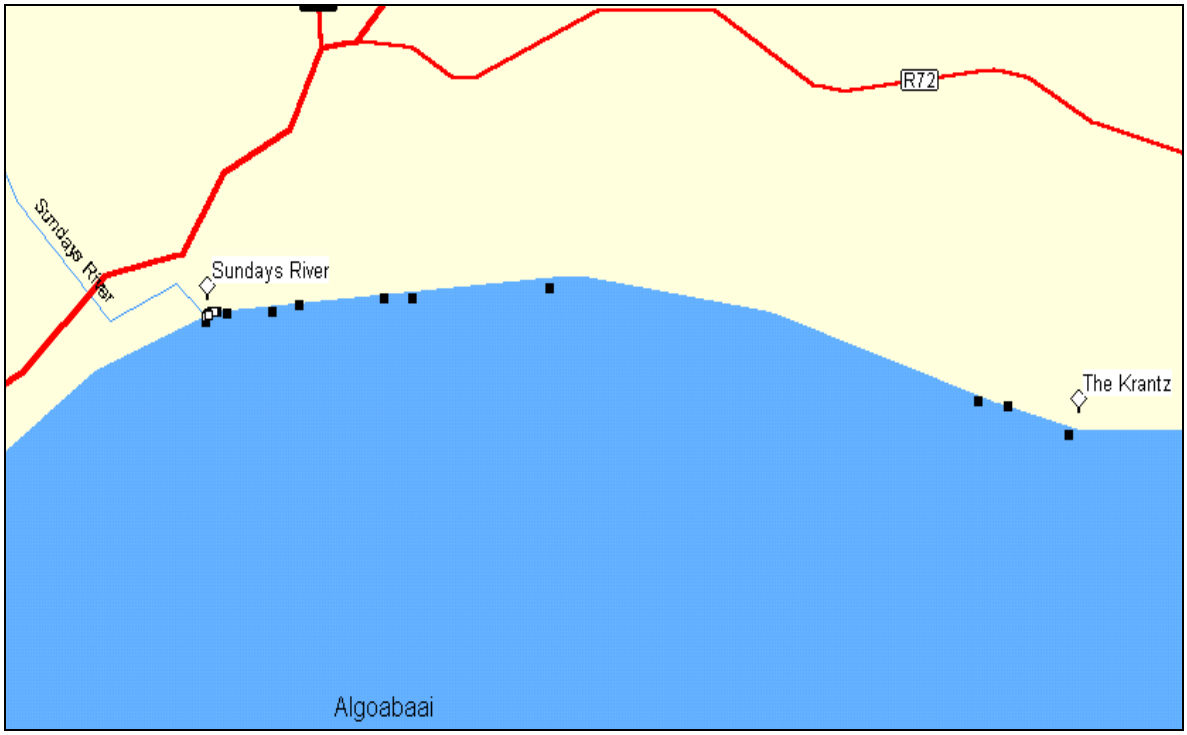


Figure 4.11: Angler concentration in the Sundays River survey area before (black icons) and after (white icons) the ORV ban.

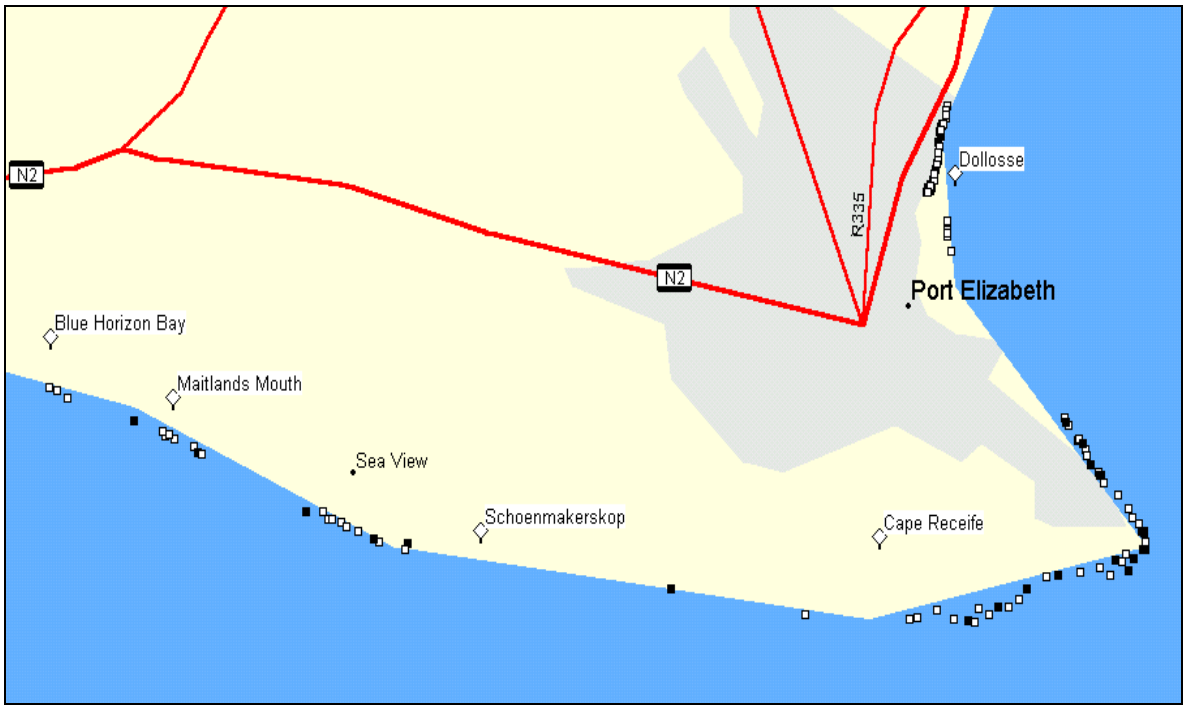


Figure 4.12: Angler concentration in the Port Elizabeth survey area before (black icons) and after (white icons) the ORV ban.

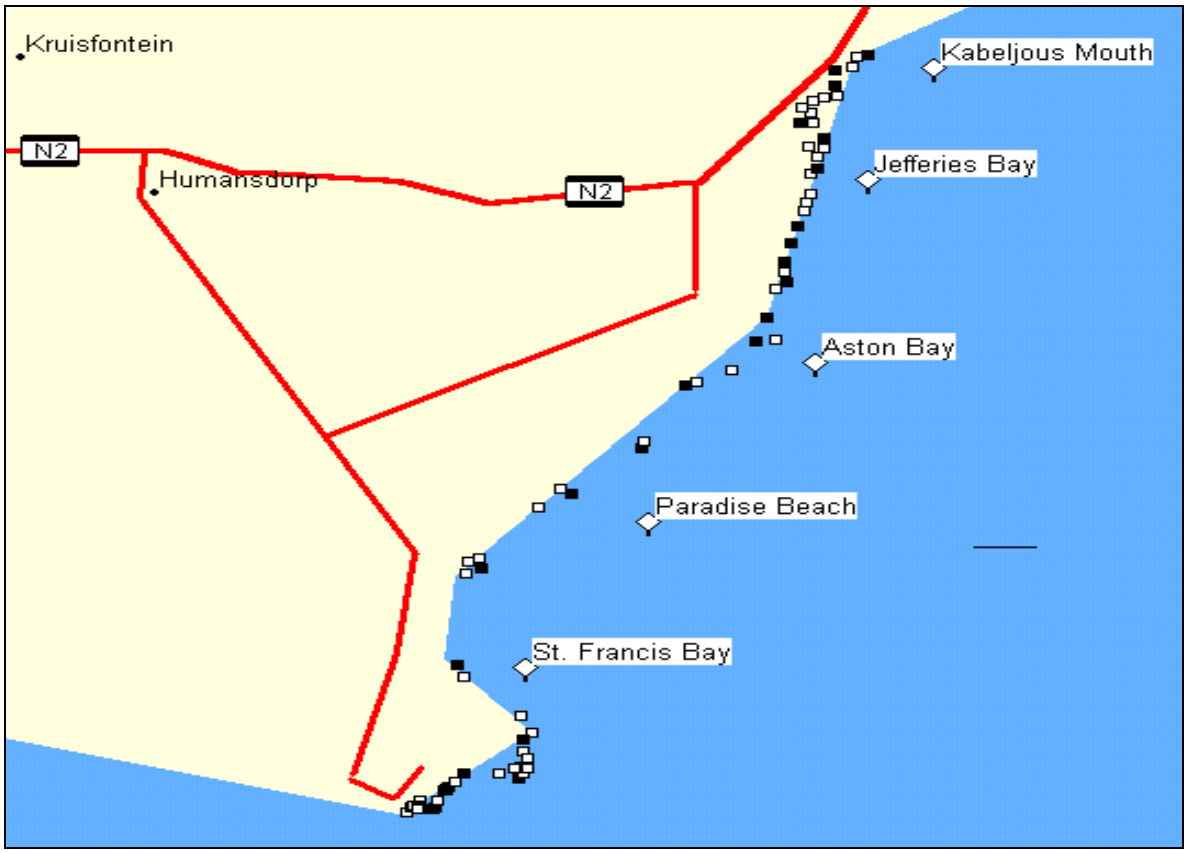


Figure 4.13: Angler concentration in the St. Francis Bay survey area before (black icons) and after (white icons) the ORV ban.

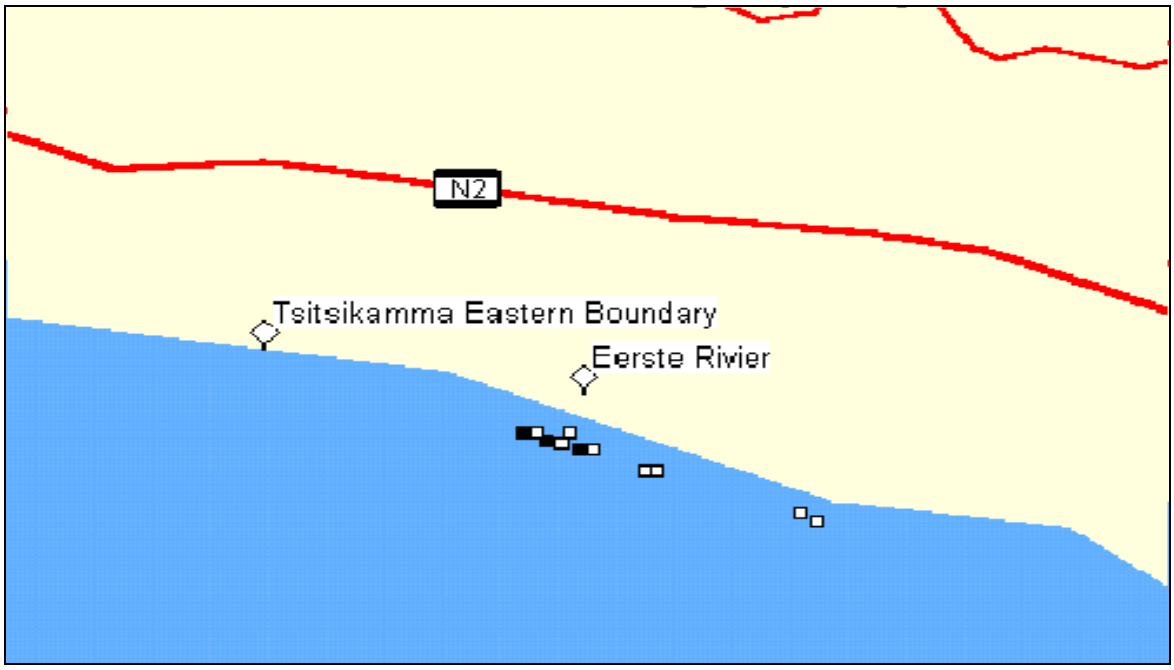


Figure 4.14: Angler concentration in the Eersterivier survey area before (black icons) and after (white icons) the ORV ban.

4.4 Discussion

4.4.1 Angling Effort

About 475 000 angler-days/year were fished in the study area, with the highest effort recorded in or near urban and peri-urban areas such as Port Elizabeth and Port Alfred. Brouwer (1997) calculated an estimated 900 000 angler-days/year fished by shore-anglers between Kei Mouth and Stil Bay, an area approximately twice the extent of the region covered in this study. In Attwood and Farquhar (1999) shore angling effort for each survey stretch varied from almost 0 to 11 angler-days/kilometre, with an average of 1.42 angler-days/kilometre across the entire study area. This is about half the average daily angling effort estimated in this study (2.9 angler-days/kilometre).

The Bushmans to Gamtoos region had the highest effort in terms of angler-days per year, despite this region having the lowest angler-days/kilometre. This is probably due to long stretches of inaccessible sandy beaches that dominate many parts of this region. The Buffalo to Bushmans region had the highest angler-days/kilometre and the second highest angler-days fished per year. The Gamtoos to TNP region had the lowest fishing effort at 125 000

angler-days, with the bulk of this effort concentrated between the Gamtoos River and Oyster Bay.

4.4.2 Angling species, bait collection and bait use

Anglers targeted 13 fish species within the study region (Table 4.4). Bronze bream (65.9%) and dusky kob (61.1%) were the two most commonly targeted species, followed by white steenbras (31.7%), white musselcracker (31.4%) and blacktail (20.2%). These results differ from Brouwer (1997) who concluded that, in descending order, kob, shad, white steenbras and bronze bream had the highest relative proportion of directed effort between Kei Mouth and Stil Bay.

Below is a brief description of the five most popular angling species. Bronze bream are found on rocky shores and may remain in one area for many years. They are popular angling species, but their slow growth rate makes them vulnerable to overfishing (Heemstra and Heemstra 2004). Dusky kob are found in estuaries, the surf zone and over rocky reefs. They are coastal migrants and popular angling species, although catches have declined significantly over recent years (Heemstra and Heemstra 2004). White steenbras are also coastal migrants. They are usually encountered in the surf zone or in estuaries, the juveniles being estuarine dependent. Heavy fishing pressure and estuarine degradation have resulted in a crash in the white steenbras population (Heemstra and Heemstra 2004). White musselcracker are usually found over rocky reefs. Adults undertake spawning migrations, but are usually restricted to one locality (Heemstra and Heemstra 2004). Blacktail are usually found over rocky areas, although juveniles do enter estuaries and the surf zone (Heemstra and Heemstra 2004). Although blacktail is a fairly small species, they remain a popular angling species.

The decrease in angling effort along the coastline may have lead to an increase in angling effort in estuaries. Potts *et al.* (2005) undertook a study on the Great Fish River and found that fishing effort on the estuary had doubled since the advent of the ORV ban. Dusky kob has become less important as a shore-angling species since Brouwer's (1997) study. This may be due to the fact that kob have become scarcer since the ORV ban, as they are easily caught in estuaries. The increase in fishing effort in estuaries such as the Great Fish may have placed extra pressure on dusky kob stocks, decreasing the numbers available to shore-

anglers and resulting in shore-anglers targeting other species such as bronze bream. Bronze bream have become more important as an angling species since Brouwer's (1997) study. Such trends need to be investigated further.

Furthermore, bronze bream and white musselcracker are largely resident marine species, making them easier for shore-anglers to target than coastal migrants or estuarine dependent species. Shore-anglers may now cluster around areas such as reefs close to access points that they know hold fish. Consequently, resident reef fish such as bronze bream and white musselcracker may therefore be targeted more often. Therefore, they have become more important in the shore-linefishery since Brouwer's (1997) study and the advent of the ORV ban. This may result in local depletion of resident reef fish stocks. However, the ORV ban has resulted in a marked decrease in fishing effort in areas some distance from access points, allowing reef fish stocks in these areas to recover. These trends should also be investigated further and could be an important component of the next National Marine Linefish Survey.

Estuarine and shore zone angling effort should in future be surveyed and monitored simultaneously, and should incorporate a bait use aspect. These various sectors of the South African fishery are clearly linked and should be addressed together.

A wide range of purchased and collected bait species was recorded during the study. Sardine, chokka and pink prawn (shop purchased) were encountered most often, followed by red bait, sand prawn, mullet, siffie, sand mussel, bloodworm and saddleback (the most commonly encountered collected species). The findings substantiate Brouwer's (1997) and Clarke and Buxton's (1989) observations. Brouwer (1997) found that more anglers used purchased bait than collected bait organisms. He also found that sardine and chokka were the most commonly used purchased species but that many shore-anglers used red bait, sand prawn and sand mussels. Clarke and Buxton (1989) also found that sardine was the most popular purchased bait in the Port Elizabeth area and that saddleback, siffie, sand mussel and sand prawn were the most popular collected species. Mann *et al.* (2003) found that sardine (used by 28.2% of anglers), red bait (16.9%), pink prawn (14.6%) and chokka (10%) were the most often used bait organisms in the Transkei. The extent to which sardine and pink prawn were used in the Transkei was lower than in this study. This may be as a result of the higher proportion of subsistence anglers encountered along that coast. Mann *et al.* (2003) found that local anglers (mainly subsistence) used red bait, sand prawn, crabs and mussel worm as bait,

while visitors used sardines, chokka and pink prawns and some bait collected from the local environment. The level of red bait use in the Transkei is similar to that estimated in this study, while sand prawn use was half of that estimated in this study.

Sand prawn was identified as the preferred bait species for a wide range of angling species. Bronze bream and white steenbras are two of the most commonly targeted angling species and sand prawn (a favoured bait for both species) is thus one of the most important of the collected bait species. Clarke and Buxton (1989) also found that sand prawn, along with sand mussel, was an important bait species for bronze bream in the Port Elizabeth area, while Brouwer (1997) recorded red bait and annelid worms as being important bait organisms for this species. In this study, of the other preferred collected species, siffie followed by saddleback, was the favourite bait organism when targeting white musselcracker, a trend also identified by Brouwer (1997) and Clarke and Buxton (1989). Red bait was the preferred bait species for galjoen. Sand prawn and red bait are the most important collected bait species in the fishery because they are fairly easy to collect and are commonly used. Bloodworm is also popular for many angling species but is only collected in the Kromme River and is, hence, seldom used elsewhere in the Eastern Cape.

In all cases the quantity of bait organisms used per fishing trip was less than the total amount collected for that trip. This suggests that bait left over at the end of a fishing trip is discarded. Some collected bait species (bloodworm, saddleback, siffie, sand mussel and mullet) can be frozen and used at a later stage. Those interviewed during this survey generally adhered to daily bag limits, however anglers usually discard left-over bait (especially red bait, sand prawn and mud prawn) at the end of a fishing trip, hence they are not using their daily legal limit per day. This may be justification for decreasing the daily bag limits for some species and should be investigated further.

Despite the fact that red bait was encountered more often than any other collected bait species, more sand prawns were collected per person (in terms of numbers). Furthermore, more fish were caught on sand prawn than on any of the other collected bait species. The popularity of red bait is due to its widespread distribution and the fact that it is encountered on many rocky shores (Lindsay *et al.* 1999b). Sand prawn, on the other hand, requires specialised equipment for collecting (prawn pump) and can usually only be collected at low tide in open estuaries (see Figure 4.4). The low percent of fish caught on sand mussel is

probably a result of the scarcity of sand mussels in many areas. The low number of siffies used per person per day and the low ratio of fish caught to siffies used was probably due to this species only being used for targeting white musselcracker, a relatively scarce and difficult fish to catch.

4.4.3 Temporal patterns of bait collection

Monitoring any fishery is important, not only for ecological reasons but also to ensure the economically sustainable exploitation of resources. The circular statistical analysis results could be important for the future monitoring of baitfisheries in the Eastern Cape

The results suggest that monitoring of marine intertidal bait-collecting activities can be limited to the spring low tide period in the case of red bait, siffie and coral worm. However, the collection of saddleback and sand mussel will have to be monitored at low tide, irrespective of the spring/neap tide cycle.

Collecting activities for estuarine species is less affected by the lunar cycle. Sand prawn is generally collected on an outgoing tide, therefore monitoring should take place over this period. Mud prawn and mullet were collected at all tidal states, irrespective of the spring tide cycle. These activities can therefore be monitored at randomly selected intervals at any tidal state. Bloodworm was collected at low tide and irrespective of the spring/neap tide cycle, hence monitoring activity can be limited to low tide periods.

4.4.4 Effect of ORV ban on angler distribution and effort

The results have shown that there have been spatial shifts in angler effort in certain areas and tentatively indicate that total effort has been reduced in those areas where ORV's were commonly used. Fishers often collected bait organisms in areas close to their chosen fishing spots. Prior to the ORV ban bait was collected at sites that are now difficult to access (i.e. points that were some distance away from principal access points). After the ban fishers were encountered, on average, much closer to principal access points. Van der Merwe (1988) stated that ORV's transported anglers to fishing spots that would otherwise have been out of reach of anglers on foot. It was therefore hypothesised that, with the ORV ban, the average distance that angler groups were encountered would decrease and this was confirmed in this

study. There has been a strong push by anglers for the relaxing of the ORV ban in some cases. In a statement issued by the Office of Marthinus van Schalkwyk, Minister of Environmental Affairs and Tourism on 3 December 2004, anglers taking part in organised fishing competitions may now apply for permits to use ORV's during these competitions. However, a large section of the public is currently in favour of the ORV ban. Moffet and de Ruyck (1995) found that less than 0.5% of respondents to a national questionnaire survey felt that the use of off-road vehicles on the beach contributed to an overall "ideal" beach experience. The subject of ORV's is clearly a sensitive one and should be dealt with as such.

According to a desktop study undertaken by Van der Merwe (1988) the use of ORV's may have had a negative impact on coastal ecosystems as a whole. Prior to the ban ORV's had been used in coastal areas for a long time, particularly near settlements close to coastal dunes and beaches (Van der Merwe 1988). Van der Merwe found that beach erosion was far more evident on beaches used by ORV's than beaches free of ORV's. Vehicles were also found to crush plants, break plant rhizomes and crush and kill macrofaunal species such as ghost crabs that either hunt or live on the beach (especially at night when many macrofaunal species are active) (Van der Merwe 1988). Bird species are also affected by vehicles as their nests are destroyed or abandoned by adults as a result of disturbance by vehicles. When precocial young hatch they may run and hide in vehicle tracks when a car approaches, making them especially vulnerable as drivers often follow the tracks left by other vehicles. The sandy beaches of the Eastern Cape are host to many plant and animal species and there is little doubt that ORV's have an impact on the biology and populations of these species.

The decrease in the distance from access points that fishers were found since the introduction of the ORV ban may, as explained earlier, result in local depletion of angling species as well as bait species around access points. However, residential angling species and intertidal bait species at sites some distance from access points are likely to recover. This should off-set any localised depletion of fish and bait stocks and should be investigated in future.

CHAPTER 5 – OPPORTUNITIES FOR AND ESTIMATED VALUE OF SMALL-SCALE COMMERCIAL BAITFISHERIES IN THE EASTERN CAPE

5.1 Introduction

With the promulgation of the Marine Living Resources Act (Act 18 of 1998) subsistence fishers in South Africa were legally recognised for the first time. Prior to this fishers harvesting marine resources for purposes other than recreational or commercial fishing were regulated through law enforcement and were considered poachers or were not managed at all (Hauck *et al.* 2002). This is despite strong historical evidence for the use of shellfish as a source of food and medicine in southern Africa. For example, coastal communities in the Transkei are known to have exploited shellfish species including crayfish, red bait and mussels for centuries (Bigalke 1973).

Steps are now being taken to recognise some of the subsistence fishers as small-scale commercial fishers and to give them fishing or harvesting rights in accordance with small-scale commercial fisheries definitions. Illegal small-scale commercial baitfisheries are known to exist within the study region. For example, Meyer and McDonald (1999b) stated that between 35 and 45 bait-collectors on the Swartkops River estuary rely on selling bait as their only source of income. Robertson and Fielding (1997) reported that coastal people in the Transkei have been earning money by gathering and selling invertebrate species such as oysters, mussels, rock lobsters, octopus etc. to visitors, hoteliers and fish factory operators. However, the sale of bait organisms to anglers brought little income (estimated at R27 000 per annum) because of the low unit price and small sales volumes.

The transformation of subsistence fisheries into small-scale commercial fisheries could result in an increased income for fisheries households and communities. However, the establishment of a successful small-scale fishery would depend on the presence of a suitable market. Therefore, the potential size of the market in monetary terms (Rand) has to be assessed before considering the formalisation of the currently illegal baitfisheries.

It is also important to assess the possible effects that small-scale baitfisheries would have on local communities. For example, formalising a fishery may result in some of the current "illegal" participants losing their income from the activity. This could have wider implications in terms of household food security. Clark *et al.* (2002) identified 147 communities who were involved in subsistence or informal fishing on the coast of South Africa. In total these communities consisted of 28 338 households and 29 233 fishers. Most of these communities had been involved in fishing activities for more than 50 years and were highly dependent on the resources harvested (Harris *et al.* 2002a). Between the TNP and the Kei River (a region that includes the study area) 26 subsistence communities were identified by Clark *et al.* (2002).

However, one should be cautious when legalising a previously illegal activity. For example, Mann (2003) found that, after the introduction of an experimental gillnet fishery in the St. Lucia estuary, there was an almost total lack of compliance with permit conditions. Any commercial fishery should therefore be managed in such as way as to ensure the sustainable utilisation of the exploited resource (Cowley *et al.* 2004), which in turn could ensure the long-term economic success of the fishery. Intertidal and shallow water resources are especially susceptible to overfishing. These are also the resources targeted most often by current subsistence collectors (Branch *et al.* 2002a) and possibly by future small-scale commercial bait-collectors. Sustainable exploitation requires the development of a sound resource management plan for subsistence fisheries (Cockcroft *et al.* 2002).

This chapter considers opportunities for the establishment and development of small-scale commercial baitfisheries in the western half of the Eastern Cape and provides an estimate of the potential value of such a fishery.

5.2 Methods

The survey design was described in Chapter 2. Data used to estimate the value of the baitfishery were obtained from answers to Section B of the extensive, medium and short questionnaires (see Appendices IA, IB and IC).

The mean amount in Rand that anglers spent or were prepared to spend on bait per trip was calculated by summing the total amount that interviewees stated they spent or were prepared to spend on bait per trip per region, then dividing it by the number of fishers interviewed in that region. The total amount that anglers spent or were prepared to spend on bait per region per year was then calculated by multiplying the mean amounts per trip by the total annual effort (in angler-days per year) calculated for each survey region in Chapter 4.

The amount that some bait species may contribute to the total value of baitfisheries was also estimated. Through information gathered from interviewees, personal observation and discussions with W. Potts and S. Burton (Knysna Oyster Company) the current value of four bait species used within the shore linefishery was estimated. In the study area subsistence collectors sold mud prawn and sand prawn for an average price of R10 for 50 prawns and coral worm at R10 for 20 worms (as non-value added products). The Knysna Oyster Company harvests red bait from their oyster lines in Algoa Bay and sells 250 g packets of red bait (a value added product) to retailers for about R2.38 (R9.50/kg). Retailers sell this red bait at about R10/250g bag or R40/kg. Based on these figures and the total numbers of bait organisms collected and used by shore-anglers, the potential maximum and minimum value of these four bait species fisheries was calculated.

5.3 Results

The estimates presented below do not account for the rate of inflation during the period September 2001 to April 2003. Over and above the expense of collecting bait (e.g. fuel, food and drink) it was calculated that anglers spent just over R21.01/person/day or R9.97 million per annum on sardine, pink prawn and chokka within the study area (Table 5.1). However, based on the answers from the questionnaires, anglers were on average prepared to spend R35.60/person/day, or R16.88 million per annum on bait (Table 5.1), if it were readily and legally available. By subtraction, this suggests that the value of a small-scale baitfishery for the study area, for those species that are currently collected, could potentially be worth approximately R7 million per year. For the Buffalo to Bushmans, Bushmans to Gamtoos and Gamtoos to TNP regions the potential baitfishery values per year equated to about R3.6 million, R3 million and R270 000 respectively.

Table 5.1: The amount (Rand) spent on bait and the amount (Rand) anglers were prepared to spend on bait.

Survey region	Actually spent/person/ day (Rand)	Prepared to spend/person/ day (Rand)	Total actually spent/ year (Rand)	Total prepared to spend/ year (Rand)
Buffalo to Bushmans	13.05 ± 20.01	34.03 ± 34.84	2253130 ± 3454799	5875402 ± 6015251
Bushmans to Gamtoos	23.35 ± 23.96	40.48 ± 55.01	4123313 ± 4231077	7149548 ± 9716461
Gamtoos to TNP	28.72 ± 24.88	30.88 ± 16.18	3589500 ± 3109734	3859368 ± 2021514
Total study area	21.01 ± 23.08	35.60 ± 40.42	9965943 ± 10944956	16884318 ± 19170114

The potential maximum and minimum value of fisheries for red bait, sand prawn, mud prawn and coral worm within the shore linefishery is shown in Table 5.2. Based on the price at which red bait is sold, it was estimated that almost R1.7 million worth of red bait was collected and over R1 million worth was used per annum. Red bait could therefore be the most valuable of the potential baitfisheries. The annual value of collected and used sand prawn was almost equal and estimated at about R414 000. The coral worm and mud prawn fisheries were valued at R85 664 collected (R70 467 used) and R42 744 collected (R28 184 used) respectively. The estimates for coral worm and mud prawn were far lower than the values for red bait and sand prawn, although the data suggest that their use by shore-anglers is largely restricted to the Port Elizabeth region.

Table 5.2: The estimated maximum and minimum value (Rand) of four bait species used between the Buffalo River and the TNP.

Bait species	Retail price	Amount collected/ annum	Amount used/ annum	Maximum value (amount collected)	Minimum value (amount used)
Red bait	R40/kg	41 873 kg	26 423 kg	R1 674 920	R1 056 920
Sand prawn	R10/50	2 071 301 individuals	2 066859 individuals	R414 260	R413 372
Coral worm	R10/20	171 328 individuals	140 933 individuals	R85 664	R70 467
Mud prawn	R10/50	213 718 individuals	140 922 individuals	R42 744	R28 184

In each of the survey regions, barring the Port Elizabeth area, all anglers interviewed claimed not to buy bait from collectors. In the Port Elizabeth region 3.6% (4 out of 112) of anglers

interviewed said they had bought mud prawn from local cafés or directly from subsistence collectors. The same percent of anglers acknowledged buying coral worm from subsistence collectors in the Port Elizabeth area.

Although the number of anglers who acknowledged buying bait organisms from subsistence collectors was low, it is well known that illegal commercial baitfisheries for mud prawn and sand prawn exist on many estuaries in the Eastern Cape (Meyer and McDonald 1999b). This includes the Keiskamma, Great Fish, Kowie, Bushmans, Kariega, Sundays, Swartkops and Kromme estuaries (P. Cowley, W. Potts, pers. comm., pers obs.). Approximately 70% of the interviewees said they would buy bait if this activity were legalised. Hence, the total amount that anglers are prepared to spend on bait would be lower than the estimates in Table 5.1. If 70% of shore-anglers were to regularly buy their bait this would equate to a total value of around R4.8 million/annum.

5.4 Discussion

To estimate the potential size of the market in monetary terms anglers were asked how much they actually spent on bait and how much they were prepared to spend on bait. It was calculated that the value of small-scale baitfisheries targeting shore-anglers within the study area could potentially reach about R7 million per year. The Buffalo to Bushmans region may contribute as much as R3.6 million per year to this total, making it the most important region in terms of potential value to small-scale baitfisheries. The Bushmans to Gamtoos region would also contribute a substantial amount (R3 million) to the potential total value of a baitfishery. While the contribution of Gamtoos to TNP region to the total potential value is far less than the other regions, most of this market would be concentrated in a relatively small area (Jeffreys Bay/St. Francis Bay).

Given that only 70% of the recreational anglers interviewed said they would support a formal small-scale baitfishery, the potential value of the fishery might only be about R4.8 million. However, with the acceptance of a baitfishery and its convenience to anglers, the number of anglers prepared to buy bait from collectors would probably increase.

Across the entire study area red bait was identified as the most valuable bait in the rock-and-surf fishery in monetary terms, while sand prawn was also important. Mud prawn and coral worm were only collected and used by shore-anglers in the Port Elizabeth area, hence their value with regards to the entire survey area was far lower than for red bait and sand prawn. However, within the relatively small area in which they are regularly used, they may still form an important component in a local baitfishery. Red bait values were based on value-added product prices; as a result the estimated value for red bait may be inflated. No prices for raw or non-value added red bait could be established, but it could be sold as a value added product in a small-scale baitfishery. Therefore, the value estimated above is relevant.

Due to the unwillingness of many subsistence collectors to be interviewed, estimating the number of people employed informally in this sector was not possible. While few anglers admitted to buying bait organisms from subsistence fishers, it is well known that a number of informal baitfisheries have been operating in the study area. Mud prawn and sand prawn are collected in many estuaries and sold by subsistence collectors (pers. obs. and Cowley *et al.* 2004). These estuaries include the Keiskamma, Great Fish, Kowie, Bushmans, Kariega, Sundays, Swartkops and Kromme (P. Cowley, W. Potts, pers. comm., pers obs.). For example, Meyer and McDonald (1999b) estimated that between 35 and 45 bait-collectors in the Swartkops estuary rely on the selling of bait as their only source of income. There is also an informal coral worm baitfishery (N. Strydom, South African Institute for Aquatic Biodiversity, pers. comm., pers. obs.) and a red bait fishery (T. Hecht, pers. comm.) in the Cape Recife area.

A potential market not assessed in this study is the recreational estuarine fishery. Based on the prices for sand prawn and mud prawn presented in this chapter, and the numbers of prawns harvested in the Great Fish River between October 2003 and September 2004 (Potts *et al.* 2005) and in the Kowie River between June 2000 and July 2001 (Cowley *et al.* 2004), estimated values for these estuarine baitfisheries could also be calculated.

The combined estimated value of the recreational and subsistence mud prawn harvest in the Great Fish River was R47 729. However, 66% of the mud prawn harvest was collected by subsistence fishers who sold some to recreational anglers, but used most themselves. Hence, the value of the prawns collected by recreational anglers is likely to be less than half the amount calculated above. Similarly, the value of sand prawns collected was R6 297. Once

again, most of these (60%) were collected by subsistence collectors; therefore, the recreational market will be worth much less than this. In the Kowie River (between June 2000 and July 2001) mud prawn with an estimated value of R52 130 were harvested. Once again, most of these (64%) were harvested by subsistence anglers and collectors. Therefore, recreational use is probably less than half the calculated amount. However, the results for Cowley *et al.*'s (2004) study are relatively old. The number of mud prawns collected may have changed since the advent of the ORV ban, especially if fishing effort on the Kowie River has increased similarly to the fishing effort on the Great Fish River. If similar calculations are done for all estuaries in the study area, a substantial contribution to the total sand prawn and mud prawn market from the estuarine angling sector would be identified. There is little doubt that estuarine anglers would make use of small-scale commercial baitfisheries, increasing the potential for their success.

From the evidence presented above, there are clearly opportunities for the establishment of small-scale commercial baitfisheries in the western half of the Eastern Cape. However, the establishment of small-scale baitfisheries is likely to have a greater effect on the subsistence community than the recreational community. The livelihoods of individuals or families within the subsistence community could be affected positively if they are actively involved in the formalised fishery, or negatively if they are excluded from the formalised fishery or no longer collect and sell bait informally.

Most harvesters have limited opportunity for maintaining their livelihoods and the use of marine resources for direct consumption or by offering their catch for sale is important to their well-being (Harris *et al.* 2002a). Branch *et al.* (2002a) and Hauck *et al.* (2002) noted that during the Subsistence Fisheries Task Group roadshows many resource users stated that they would rather be small-scale commercial fishers than subsistence fishers. They felt that this would improve their livelihood by allowing them to sell their catch rather than just consuming it. Further suggestions made by fishers reported in Hauck *et al.* (2002) included the need for assistance with the storing and marketing of their catches, business development and the diversification of catches to include more than one species. These perceptions and desires of subsistence fishers are ideally suited to the development of a formal small-scale commercial baitfishery in the Eastern Cape. They also show that subsistence collectors are willing to make use of opportunities provided to them for the improvement of their current

socio-economic situations. This ensures a greater potential for success of small-scale commercial baitfisheries.

Cockcroft *et al.* (2002) suggested that one of the major challenges of the Marine Living Resources Act was to balance the requirements for sustainable utilisation of resources with that of equity and stability in all fishing sectors recognised by the act. Cockcroft *et al.* (2002) also suggested that factors such as depressed economic conditions (resulting in high unemployment) and unrealistic expectations of nearshore marine resources as the key to poverty alleviation in coastal communities were important challenges to overcome in the successful management of subsistence fisheries. These factors are undoubtedly also applicable when considering small-scale baitfisheries and their management. However, if the requirements for the sustainable utilisation of bait resources and the equity and stability in all fishing sectors is successfully balanced, there is little reason to doubt that the establishment of small-scale commercial baitfisheries in the Eastern Cape would be viable. The opportunities in the form of total value (this Chapter), available market (Chapter 3 and Chapter 4) and levels of bait use (Chapter 4) are certainly present.

CHAPTER 6 – GENERAL DISCUSSION

This chapter collates the findings of the study and elucidates the extent of the baitfishery along the western half of the Eastern Cape coast. It focuses on scenarios of how baitfisheries could be formalised and managed.

The results presented in Chapters 3, 4 and 5 provide an overview of the resource users, angler effort, bait use, the opportunities for the establishment of small-scale commercial baitfisheries and their estimated potential value. These findings led to the conclusion that baitfisheries in the study area are potentially viable.

6.1 The Eastern Cape baitfishery

Except for the study by Sims-Castley and Hosking (2003) on the commercial exploitation of sand mussels in the Maitlands to van Stadens River area, the possibilities for establishing small-scale commercial baitfisheries in the Eastern Cape have not been examined. In the past some tackle shops in the Eastern Cape sold bait (Hanekom and Baird 1992, T Hecht, P. Cowley, pers. comm., pers. obs.) and it is still sold illegally along the Wild Coast (Robertson and Fielding 1997) and throughout the study area (e.g. Keiskamma River, Great Fish River, Kowie River, Swartkops River, Cape Recife, Jeffreys Bay and St. Francis Bay). These activities are unregulated, generally not monitored and law enforcement is ineffective. Formal baitfisheries have been operated and managed successfully in other countries (Fowler 1999). It is therefore important to examine how the management of these fisheries may inform the development of similar fisheries in the Eastern Cape.

Olive (1993) identified three types of bait-collectors:

1. Bait collection by anglers for their own use.
2. Bait collection by semi-professional bait-diggers supplying local retail outlets.
3. Bait collection by professional bait-diggers contracted to wholesalers.

Each of these types of bait-collecting activities has different characteristics, with a different pattern of interaction with management. For example, Type 3 collectors will likely be

restricted to places where there are substantial natural stocks. They are also likely to be responsive to management plans that optimise yield. For effective management Olive (1993) also emphasised the need for information on:

1. The impact of collection on associated fauna.
2. The effects of bait digging on populations of bait species and their ability to sustain the predation pressure.
3. The dynamics of recovery from excessive bait collection.
4. The potential for management that would permit satisfaction of demands for bait, while protecting other aspects of the environment (e.g. tourism and conservation).

These are all points relevant to South African baitfisheries, including potential small-scale commercial baitfisheries. However, quantitative information on the effects of bait collection on intertidal community structures in South Africa is scarce (see Chapter 1). Further information required for effective management, but not mentioned by Olive (1993) above, is information on the economic viability of a fishery.

Substantial bait industries have developed in areas other than Europe. In the USA populations of the blood worms *Glycera dibranchiata* and *Nereis virens* support major baitfishing industries in Maine (Creaser *et al.* 1983 in: Olive 1993). While no value was provided for this baitfishery, Olive (1993) described it as… "very significant in commercial terms, being the fifth largest marine resource grouped by organism type." This fishery supports Type 3 collectors mentioned above (those supplying wholesalers). However, it is unlikely that commercial baitfisheries in the Eastern Cape could operate at this level and Type 2 commercial bait-collectors are the most likely participants.

In the north-central region of the USA (Illinois, Michigan, Minnesota, Ohio, South Dakota and Wisconsin) bait species (fish and nonfish) are cultured or harvested from the wild (Meronek *et al.* 1997). Dealers reported that 54% of non-fish bait was harvested from the wild (Meronek *et al.* 1997). In this region estimates of the value of the baitfish and non-fish bait industry were $161 841 356 and $91 950 191 respectively (Meronek *et al.* 1997).

The two USA examples given above emphasise the size and importance of the baitfishery industries in this region. Meronek *et al.* (1997) estimated that the bait industry in the USA as a whole was worth approximately $1 billion annually.

Other baitfisheries include the collection of bait worms in Queensland (Australia) (Forbes 1984 in: Olive 1993), China and Korea (Choi 1985 in: Olive 1993) and Thailand (Hylleborg *et al.* 1986 in: Olive 1993). However, few details are given by Olive (1993) on these fisheries.

The South African situation is different in that the commercial collection and selling of certain bait species is illegal. Despite this, informal (illegal) small-scale commercial baitfisheries have been operating in the Eastern Cape for many years. For example, Robertson and Fielding (1997) found that in the Transkei local people earned about R833 000 per annum by selling bait and food to visitors and hotels. Bait-collectors, as mentioned earlier, have been active in the Transkei area for a number of years. The Transkei baitfishery is an unregulated and informal fishery that offers opportunities for expansion and regulation. Robertson and Fielding (1997) argued that subsistence utilisation and sale to visitors should be encouraged in the Transkei.

6.2 Formalising the baitfishery

The activities of subsistence fishers range from those who consume most of their harvest to those who sell most of their catch (Harris *et al.* 2002a). Branch *et al.* (2002a) and Hauck *et al.* (2002) noted that many subsistence resource users would rather be small-scale commercial fishers to improve their livelihoods. In particular, those fishers harvesting a resource to which a value is attached (e.g. abalone) were especially keen to legalise and commercialise their activities. Therefore, if a legal value is attached to bait organisms for which there is a known market, there is little reason to doubt that small-scale baitfisheries could be successful.

The Subsistence Fisheries Task Group developed a suite of principles regarding the implementation of subsistence fisheries in South Africa (Harris *et al.* 2002b). These included:

1. Subsistence fisheries must be implemented to protect the rights of those fishers who have historically made use of marine resources and who depend on these resources.
2. The sustainability of resource use and fisheries is imperative because of the high dependency of fishers on the resource to provide basic food security.
3. Existing subsistence fisheries should be formalised and no new subsistence fisheries should be created, nor should new subsistence fishers who were previously not involved in the fishery be admitted.
4. Alternative resource use and livelihood strategies should be explored to reduce harvesting pressure.

These principles have important implications for the establishment of baitfisheries in the Eastern Cape and should be adhered to. However, point 3 may limit future value-added opportunities, e.g. the establishment of fisheries for live strepies or mackerel if economically viable.

The dominance of males in the subsistence sector throughout the study area suggests they would dominate any potential small-scale baitfishery. However, in the Birha/Hamburg area more than 50% of the baitfishers encountered were female. By implication any formalised baitfishery in this area should include a representative complement of women. Attaching a monetary value to a bait species in this area must not result in formerly uninvolved males "hijacking" the fishery.

In all regions there was a decrease in the number of angler groups/kilometre after the ORV ban. It was initially hypothesized that bait-collecting and angling effort would increase in the near proximity to access points as a consequence of the ban. Clearly, this was not the case. The implication of this might be that any added bait-collecting effort resulting from a small-scale baitfishery would be off-set by the decrease in recreational activity since the ORV ban. The observed trends in angler density and distribution after the ORV ban also suggest that there has been a decrease in shore-angling effort. However, this perception would need to be substantiated with future studies. Nevertheless, given that 80% of the survey trips were

undertaken after the ban and that most of the economic data was therefore also collected *post factum*, the market for bait remains significant.

User perceptions on the state of bait organism populations being either unchanged or poorer than in previous years could play a role in their acceptance or non-acceptance of a small-scale commercial baitfishery. Their perceptions could be interpreted as preliminary objections to the establishment of such fisheries. However, if bait organisms became legally available, shore-anglers may likely reduce the amount of bait that they collect themselves, hence keeping the level of exploitation the same as it is at present. Nonetheless, it is possible that demand for bait organisms will increase if the estuarine, deep sea and long-line sectors make use of small-scale commercial baitfisheries. Therefore, it is imperative that the level of effort in each linefishery sector be monitored as it could be a direct measure of the extent of bait use. However, the level of bait exploitation and population levels should also be monitored.

Furthermore, anglers are temporally restricted when it comes to bait harvesting (see Chapter 4). If small-scale commercial baitfisheries are introduced this temporal restriction will no longer apply. Certain bait species will be available irrespective of the tidal state, which in turn might increase angler efficiency (i.e. catch rates) for certain species. For example, an angler targeting white musselcracker will not have to wait for a suitable tide to collect siffie. Formalising the fishery and the provision of quality value-added products (e.g. live siffie) might result in additional pressure on targeted fisheries resources.

Of the 19 recorded bait species collected by anglers, nine have the potential to contribute to a successful small-scale baitfishery. These are red bait, sand prawn, sand mussel, live mullet, bloodworm, mud prawn, coral worm, siffie and saddleback. However, the collection of live mullet may not be viable due to the difficulty in and equipment required for keeping them alive. There seems to be little demand for frozen mullet within the shore-based linefishery in the Eastern Cape.

Strepie, mackerel, white crab, pencil bait, octopus and shad were rarely collected. Therefore, these bait species are not likely to be part of a small-scale baitfishery. Pencil bait could be an important component of a baitfishery aimed at estuarine anglers in the Port Elizabeth to Cape St. Francis area, but this falls outside the scope of this study.

6.3 Scenarios and opportunities for baitfisheries

Baitfisheries in urban/peri-urban and rural areas would have different characteristics. The infrastructure for marketing and monitoring is likely to be easily accessible in urban/peri-urban areas, while such infrastructure may not be available to fisheries operating in rural areas. Furthermore, urban/peri-urban areas are likely to have a substantial market all year round, while rural areas will more likely experience market peaks over weekends and holiday periods, with little potential for business at other times. Therefore, the development of separate scenarios for rural and urban/peri-urban areas would be necessary. Below are two suggested scenarios for the establishment of small-scale commercial baitfisheries in urban/peri-urban and rural areas.

Urban/peri-urban area scenario

In urban and peri-urban areas licensed bait-selling kiosks should preferably be established in close proximity to Marine and Coastal Management, Municipal Nature Conservation or other local, provincial or national law enforcement offices. This will simplify control and assist with monitoring. In the two main urban areas (Port Elizabeth and East London) where there are large potential markets, several kiosks could be licensed to sell bait. The owners of the kiosks could contract collectors (with a territorial user right) to supply the kiosks. Collectors could sell their catch for their own account or alternatively could enter into a co-operative agreement with kiosk owners. Kiosk owners could invest in live fish tanks, pumps, fridges and freezers to keep bait in good condition and provide the angling public with a high quality product on days when the sea or tides are unsuitable for bait collection.

Rural area scenario

In rural areas the demand for bait is likely to be lower than in the urban and peri-urban areas. Individual or small groups of collectors could be allocated a territorial user right for an estuary or a particular stretch of coast. Such legal collectors could sell directly to the angling public and not necessarily through a recognized bait kiosk.

A requirement for both scenarios would involve training collectors and monitoring their catches. Licensed collectors and sellers would require training to keep records of their catches and sales, providing Marine and Coastal Management with monthly or quarterly returns. This could be monitored by Marine and Coastal Management and Nature Conservation officers who could also provide assistance in compiling these returns. Formal small-scale baitfishers should initially be recruited from current subsistence and informal fishers.

Anglers buying bait from bait sellers should still have to be in possession of a permit for those bait organisms. Daily bag limits (or purchase limits in the case of a small-scale commercial baitfishery) should still apply.

Below are suggested scenarios for each study region.

Buffalo to Bushmans region

Most of the anglers interviewed resided in the study area and this provides a year-round market for bait, although there is a significant increase in angler effort during holiday periods as 41.4% of anglers are seasonal visitors. This region is the most heavily fished in terms of angler-days/kilometre, which provides a substantial potential market.

Taking into account the preferred bait for the most commonly targeted angling species and the quantities of each species collected by anglers, six potential commercially viable bait species were identified. These were sand prawn (also popular with estuarine anglers), redbait, mullet (also popular with estuarine anglers), saddleback, siffie and sand mussel. Each of these organisms, except sand mussel, is readily available within this area. Sand mussels do, however, occur in small quantities on some beaches between Great Fish Point and the coastline east of Hamburg.

It was calculated that anglers spent R2 253 130 per year on bait in this area. However, if bait was legally for sale it was calculated that they would be prepared to spend R5 875 402 per year. Therefore the market is potentially worth approximately R3.6 million per annum. The region between the Buffalo River and Kidds Beach only provides a low 11% of the market (approximately R400 000 per annum). Much of the accessible urban area within this region is

avoided by day-trippers as it is in a potentially dangerous area frequented by prostitutes and associated members of society. This situation may change as the area is being developed as an Industrial Development Zone. Other resorts and access points west of East London are easily reached and safer, therefore more popular than the urban region.

Several possible market nodes (holiday resorts, favoured beach access points and popular angling and bait collection sites) were identified as potential positions for bait kiosks and selling points. In the Buffalo to Bushmans region the sites identified were East London harbour (urban), Kidds Beach cafés (rural), Hamburg trading store (rural), Great Fish River Diner (rural), Port Alfred (peri-urban) and Kenton-on-Sea (peri-urban).

Bushmans to Gamtoos region

Most of the anglers interviewed resided in the study area (79.3%). This also provides a year-round market for bait-sellers. Although this region had the lowest recreational angling effort (2.5 angler-days/km) it still equated to 176 663 angler-days/year, which provides a substantial potential market.

Eight potential commercially viable bait species were identified in the region. These were sand prawn, mud prawn, redbait, saddleback, siffie, sand mussel, coral worm and mullet. Each of these organisms is readily available within the area.

Within this region it was calculated that anglers spent R4 123 313 per year on bait. In addition it was calculated that they were prepared to spend R7 149 548 per year on bait. The market in the region is therefore potentially worth around R3 000 000 per annum. It was estimated that about 26% of this market (R750 000 per annum) is concentrated within the urban area of Port Elizabeth, between Swartkops River and Cape Recife.

A small proportion of recreational anglers acknowledged buying bait from collectors in the Port Elizabeth area, specifically at the Swartkops estuary and Cape Recife. No subsistence collectors were encountered on sandy beaches east of Sundays River or between Maitlands River mouth and Gamtoos River mouth. Schoeman (1996), in a study on the exploitation of sand mussels between the Maitlands and Gamtoos River, also failed to encounter subsistence collectors. Recreational users in the Maitlands to Gamtoos River area were overwhelmingly

opposed to any form of commercial harvesting of sand mussels (Schoeman 1996). This may prove to be a problem in the allocation of sand mussel harvesting rights.

Central and easily accessible areas were identified as potential sites for bait kiosks and selling points. These included Sundays River/Colchester (rural/peri-urban), the Swartkops River area of Port Elizabeth (urban), Port Elizabeth Harbour (urban) and the Shark Rock area on the Port Elizabeth beachfront (urban). These sites would serve both local users and holidaymakers as they are located close to or within permanently occupied areas, holiday resorts, access points and bait collection sites.

Gamtoos to TNP region

Most of the anglers interviewed in this area were local residents (82.0%) and this would provide a year-round market for bait sellers. This region had the second highest recreational angler effort (3.0 angler-days/km). This equates to 124 939 angler-days/year, which provides a substantial potential market. Most of this effort was concentrated between Jeffreys Bay and Oyster Bay.

Four potential commercially viable bait species were identified in this area, *viz.* sand prawn, redbait, siffie and bloodworm. Red bait and siffie are readily available in this area. Sand prawn is readily available in the Kromme, Kabeljous and Gamtoos estuaries, while bloodworm is only available in the Kromme estuary.

It was calculated that anglers spent R3 589 500 per year on bait in this area. However, if the sale of collected bait were legal it was calculated that they were prepared to spend R3 859 368 per year on bait. Therefore the market is potentially worth far less than the other regions (about R270 000). However, in the early 1960s, bloodworm was collected in the Kromme River and provided to residents. Very few resident St. Francis Bay anglers collected their own bloodworm (T. Hecht, pers. comm.). As most of the angling effort is concentrated in the Jeffreys Bay to Oyster Bay area, the potential baitfishery value of R270 000 is high enough to justify the establishment of small-scale commercial baitfisheries.

No recreational anglers acknowledged buying bait from collectors and few subsistence fishers seemed to be active in this area. Potential sites for bait kiosks and selling points

include Jeffreys Bay (urban), St. Francis Bay (peri-urban) and Cape St. Francis (peri-urban). Each of these sites would serve as convenient points for the majority of anglers in this region, locals or otherwise. The coastline west of Cape St. Francis to the TNP is difficult to access and angler numbers are low, therefore it is unlikely to be economically feasible to establish bait outlets in this region.

6.4 Management

Several studies have shown the effects of exploitation on changes in population structure of bait species. These studies emphasise the importance of managing a baitfishery not only from an economically sustainable point of view, but also from an environmental point of view. Uncontrolled exploitation of brown mussels (*Perna perna*) has resulted in the reduction in density and size of these mussels in many intertidal areas of the Transkei (Van Erkom Schurink and Griffiths 1990) and central KwaZulu-Natal (Tomalin and Kyle 1998). Eekhout *et al.* (1992) studied the exploitation of intertidal limpet stocks on the West Coast of South Africa between the Kleinsee River and the Olifants River. They found that 15 months after the partial removal of *Patella granatina* from the study sites there was almost no recovery in the density of limpets. In the case of *Patella argenvillei* it was found that density only returned to normal after 14 months. The slow rate of recovery displayed by these limpet species suggests that these could not be harvested on a sustainable basis. While Eekhout *et al.* (1992) conducted their studies on the West Coast, the lessons learnt here and from the studies by Van Erkom Schurink and Griffiths (1990) and Tomalin and Kyle (1998) can be applied to the Eastern Cape intertidal species as well. Moreover, it emphasises the need for intertidal community structure studies with particular reference to commonly used bait species.

Estuarine bait organisms are also vulnerable to over-exploitation. Wynberg and Branch (1991) identified a clear difference in sand prawn densities between physically similar bait-collecting areas and conserved areas in the Langebaan Lagoon in the Western Cape. They concluded that the reduction in sand prawn densities was a result of bait-collecting activities in the non-conserved area. However, Forbes (1977) suggested that the rapid turnover of generations and strong recruitment from a small proportion of mature females indicates that

sand prawn populations could recover quickly from exploitation. This suggests that sand prawn may be well suited to small-scale commercial baitfisheries.

The most direct effects of exploitation are changes in size and density of the exploited species. In addition, the method of exploitation of one species may affect others and produce a ripple effect throughout the community (Griffiths and Branch 1997). Harvesting methods should therefore be chosen or developed in such a way that the effects on associated organisms are minimised (Griffiths and Branch 1997). Wynberg and Branch (1991) also clearly showed that other non-target macrofaunal organisms were disturbed during sand prawn collection in the Langebaan Lagoon in the Western Cape. Similarly, the collection of mussel worm for bait can also be extremely destructive to other organisms. Van Herwerden (1989) found that between 0.4 and 0.5 m^2 of mussel beds and 0.7 m^2 of coral worm reef was destroyed in the collection of 20 mussel worm. Van Herwerden (1989) also stated that the objective of conservation (i.e. the regulation or management of a fishery in this case) is to maximise sustainable utilisation while retaining biological diversity. Hence, potentially broader ecological damage as a result of bait collection should be monitored along with the health of the bait species populations.

Eekhout *et al.* (1992) suggested that the management of living marine resources required a holistic approach, combining measurement of population parameters in undisturbed and experimentally harvested populations, an assessment of the effects of exploitation on the community and the development of quantitative population and economic models. These are sound management principles that could be applied to the management of a small-scale commercial baitfishery. Moreover, Stephenson and Lane (1995) and Caddy (1999) suggested that managers should focus on appropriately combining biological factors with the operational, social and economic considerations of the fishery. In other words, management should focus on integrated fisheries rather than solely on fish/bait populations. While these holistic approaches to management are of course correct, they require substantial human and financial resources. They may therefore not be practical for the management of small-scale commercial baitfisheries in the Eastern Cape. The Marine Living Resources Act advocates that experimental fisheries should be established and monitored prior to the allocation of medium to long term rights. It is therefore recommended that a pilot experimental baitfishery be established at a suitable site and monitored for an appropriate period of time prior to establishing formal small-scale commercial baitfisheries along the Eastern Cape coast.

A wide range of baitfishery management strategies are used internationally and these can be generally summarised into two categories (Fowler 1999):

1. Voluntary management which offers flexibility and simplicity with a risk that management guidelines will be ignored.
2. Regulations and prohibitions with legally enforceable controls which may create enforcement problems for statutory bodies.

Fowler (1999) noted four kinds of bait-collectors and suggested that their characteristics be taken into account when developing management options and strategies:

1. Experienced commercial collectors who use and manage the same area.
2. Inexperienced, inefficient commercial collectors who take up bait-collecting for a short period only and show no concern for local bait stocks.
3. Experienced recreational collectors who collect for personal use and are aware of the impact of their activities.
4. Inexperienced recreational collectors who are inefficient and lack concern for local bait stocks.

Bait-collectors in the Eastern Cape fall into categories 2, 3 and 4 above, although results presented in Chapter 3 suggest that not all experienced recreational collectors (point 3) in the Eastern Cape are aware of the impact of their activities, especially when collecting bloodworm. If a formalised baitfishery is established, it is inevitable that all four groups will eventually be present. Due to the presence of the two inexperienced groups mentioned above, the implementation of a voluntary code of conduct alone would be difficult to achieve. Some of these bait-collectors will simply not be concerned with local environmental issues. Hence, the continuation of current bag and size limits and enforcement of regulations for recreational collectors is strongly suggested. Regulations governing commercial collection will also have to be established. Adherence to these regulations can be enforced through the establishment of territorial user rights. In the past, open access in fisheries has resulted in over-investment and over-exploitation. This can be limited with the introduction of small-scale limited access commercial baitfisheries through the implementation of property rights (Christy 1996). All three regional scenarios provided above (in 6.3) could involve the implementation of

property rights in the form of a territorial user right fishery (TURF) (Britz *et al.* 2002, Hara 2003, Hauck and Sowman 2003).

Equitable utilization and distribution of access rights must be established, not only to the satisfaction of the fishers, but also to allow effective management of the baitfishery. One suggestion is the establishment of a species-specific TURF (Britz *et al.* 2002, Hara 2003, Hauck and Sowman 2003). Theoretically, the allocation of a TURF allows the right holders and the state to co-manage a resource based on the incentives provided by the long-term biological and financial sustainability of the system (Britz *et al.* 2002). Efficient management of any fishery is also extremely important for other reasons, as any activity may have negative effects on other fisheries or seaside activities and structures. Management should involve measures to protect and enhance stock productivity, and institute measures to control effort and output to improve economic efficiency (Ahmed *et al.* 1997). In the Eastern Cape a co-management system in the form of territorial user rights is likely to be the most effective way of managing small-scale baitfisheries. It would provide a mechanism to overcome the immense implementation and enforcement difficulties for the regulatory authorities. In practice, co-management (in this case TURFs) refers to a power-sharing partnership between government agencies and citizens with a stake in the common pool resource (Ahmed *et al.* 1997). Should small-scale baitfisheries be considered, it is proposed that these be TURFs, an internationally accepted co-management system (Britz *et al.* 2002). This would involve a shift from open-access rights to more exclusive access associated with property rights and a degree of "ownership" over the resource (Stephenson and Lane 1995).

A summary of the suitability for commercial harvesting of the most commonly used bait species is provided below. Given that few stock assessments have been carried out for many of the species, their suitability for harvesting is based on an analysis of what is known about their biology, ecology, a preliminary assessment of the health of populations and by applying the precautionary approach (Garcia 1994).

Red bait (*Pyura stolonifera*)

Red bait is exploited at low levels in the western half of the Eastern Cape and is used mainly as bait by subsistence and recreational anglers, although Fielding *et al.* (1994) found that in areas along the KwaZulu-Natal coast red bait was heavily exploited for food.

Red bait populations may be classified as "healthy" within the study region (Lindsay *et al.* 1999b). They further noted that red bait could support a subsistence fishery as extensive subtidal stocks make it difficult to over-exploit. Harris *et al.* (2002b) also recognise the suitability of red bait to small-scale commercial use. Cockcroft *et al.* (2002) recommended a small-scale commercial fishery for red bait. A red bait fishery could be based on beach-cast material and live harvest. Furthermore, Cockcroft *et al.* (2002) suggested that the harvesting of red bait within the study area should be governed by effort control, closed areas, bag limits and harvesting restrictions. Harvesting restrictions would include the removal of the flesh only, leaving the test attached to the substratum. Although the empty pods decay fairly quickly (2-4 weeks), it allows mobile organisms, which make up 70% of the fauna associated with red bait, to relocate (Fielding *et al.* 1994). Hanekom *et al.* (1999) found that the recolonisation by red bait of areas cleared of red bait was slow in many cases. This should be borne in mind when considering the potential of red bait as a viable small-scale commercial species.

Sand prawn (*Callianassa kraussi*)

Sand prawn is found in many southern African estuaries (Forbes 1977) from Lamberts Bay to San Martinho in Mozambique (Cockcroft and Tomalin 1987). It is the dominant macrobenthic species in many South African closed estuaries and is common in many sheltered sandy areas in estuary mouths (Forbes 1977).

Sand prawn is collected in all estuaries in the western half of the Eastern Cape. Between 94% and 100% is collected by anglers, while the remainder is collected by subsistence baitfishers who illegally sell the prawns to anglers (Meyer and McDonald 1999a).

Sand prawn populations may be regarded as under-exploited within the study region (Meyer and McDonald 1999a). However, the destructive nature of sand prawn harvesting (using prawn pumps) may have an impact on the associated benthic meio- and macrofauna (Meyer and McDonald 1999a). Wynberg and Branch (1991) estimated that approximately 1 000 to 1 500 organisms are disturbed for every 50 prawns (the daily legal limit per person) that are pumped in Langebaan Lagoon, resulting in heavy predation by birds on the disturbed animals. On the strength of this Meyer and McDonald (1999a) suggested that additional pressure on the resource was not justified. On the other hand, Cockcroft *et al.* (2002)

suggested that small-scale commercial harvesting could be undertaken in some estuaries within the study region. Moreover, Cockcroft *et al.* (2002) suggested separate zones for small-scale commercial, recreational and subsistence collectors. However, separate zonation is only likely to work in large open estuaries where there is plenty of space to establish such zones. Many estuaries within the study region, especially permanently or temporarily closed estuaries, are too small for this to be a practical option and could result in unnecessary user conflict.

Mud prawn (*Upogebia africana*)

Mud prawns are found in open estuaries along most of the South African coast and into Mozambique and occur in muddy intertidal sand banks (Branch *et al.* 1994). They are collected in all open estuaries in the Eastern Cape (Hanekom and Baird 1992). In the Swartkops estuary 35-45 subsistence baitfishers rely on the sale of mud prawns as their only source of income (Meyer and McDonald 1999b). Mud prawns are also sold in other estuaries in the study area (e.g. Kowie, Keiskamma and Great Fish estuaries).

Mud prawn stocks are regarded as under-exploited within the study region as a whole (Meyer and McDonald 1999b), however, this may not be true for all estuaries as mud prawns seem to be heavily exploited by both recreational and subsistence collectors in the Swartkops and Great Fish estuaries. Additionally, harvesting mud prawns is a destructive activity which may impact benthic meio- and macrofauna (Wynberg and Branch 1994). Consequently, Meyer and McDonald (1999b) suggested that additional pressure on the resource was not warranted. On the other hand, Cockcroft *et al.* (2002) and Harris *et al.* (2002b) suggested that small-scale commercial collection could be undertaken in some estuaries. Cockcroft *et al.* (2002) also suggested separate zones for small-scale commercial, recreational and subsistence collection. However, as mentioned previously, this could lead to user conflict.

Coral worm (*Gunnerea capensis*)

Coral worms are found along much of the southern African coast. They are gregarious and form large intertidal structures composed of sandy tubes (Branch *et al.* 1994). Coral worm is abundant in the Eastern Cape and colonise areas formally occupied by other intertidal reef organisms (Lindsay *et al.* 1999a).

Coral worm is seldom used as bait in the Eastern Cape (Lindsay *et al.* 1999a), except in the Port Elizabeth area where it is collected and sold illegally by subsistence baitfishers. Little is known about the health of the population but it is regarded as under-exploited in most areas (Lindsay *et al.* 1999a). Coral worm reef systems are often destroyed by anglers and baitfishers searching for mussel worm (Lindsay *et al.* 1999a). Lindsay *et al.* (1999a) suggested that no commercial harvesting of coral worm be allowed due to the destructive nature of the collection methods.

Bloodworm (*Arenicola loveni*)

Bloodworm are large polychaete worms found in U-shaped burrows in estuaries, lagoons and sandy beaches (Branch *et al.* 1994). Bloodworm is only collected and used as bait in the Jeffreys Bay, St. Francis Bay and Cape St. Francis area (Gamtoos to TNP region). It is extremely popular and heavily exploited in the Kromme River (Robertson *et al.* 1999). Although Robertson *et al.* (1999) did not indicate how heavily bloodworm was exploited in the Kromme River, they did give an estimated annual harvest by recreational shore-anglers of 3.8×10^6 on the Cape south coast and 52241 on the Cape east coast.

No recent stock assessments have been undertaken in South Africa. However, Gaigher (1979) in: Robertson *et al.* (1999) estimated a population density of $0.75m^{-2}$ in the Breede River Estuary and $1.2m^{-2}$ at Leisure Island (Knysna). No stock assessments were located for the Eastern Cape, but it is possibly depleted in many of the provinces estuaries (Robertson *et al.* 1999), although they did not specify in which estuaries. Bloodworm is a poor candidate for small-scale commercial collection as it is easily over-exploited (although this was not tested experimentally). Harvesting may be destructive to the broader environment (Robertson *et al.* 1999) through disturbance of the substratum. A prawn pump is usually used to collect bloodworm and the negative effects of this collection technique on other estuarine intertidal species has been described by Wynberg and Branch (1991, 1994).

Sand mussel (*Donax serra*)

Sand mussels are abundant on some wave-exposed beaches in the Southern and Eastern Cape and up the West Coast into Namibia (Branch *et al.* 1994). Sand mussel is collected as bait and for human consumption, particularly between Bushmans River and Sundays River, and

the stretch of coast between Maitlands River and Gamtoos River. Sand mussel is regarded as under-exploited within the study region as a whole (Meyer 1999), especially between Cape Padrone and Sundays River, and between Maitlands River and Gamtoos River.

In the past there has been intense interest in starting commercial harvesting operations, but the public have not been supportive (Schoeman 1996). As the resource is under-exploited in some areas (especially between the Maitlands and Gamtoos River mouths and Sundays River east to Cape Padrone), it may be suitable for small-scale commercial collection, especially in areas where there is low recreational pressure (Meyer 1999). As in the case of sand and mud prawns, Meyer (1999) and Cockcroft *et al.* (2002) suggested separate zones for small-scale commercial, recreational and subsistence harvesting of sand mussels. However, this could lead to conflict between recreational, subsistence and commercial harvesters. As applicable to rock lobster and abalone (prior to the recreational ban on abalone), it is proposed here that zoning of coastal areas for various types of harvesting forms not be considered as an option. Baitfishers and recreational users should have equal access to collecting areas. If zoning is to be considered, it should only be for the complete closure of an area to all users.

Siffie/venus ear (*Haliotis spadicae*)

Siffies are common along the South African coast between False Bay and Tongaat on the KwaZulu-Natal North Coast (Godfrey and Cowley 1999). Siffies are usually found on the seaward side of reefs close to spring low water. They occupy rocky crevices or the spaces between other large, sessile organisms such as red bait (Muller 1984, Branch *et al.* 1994).

Siffies are subjected to fairly low levels of exploitation by bait anglers in most parts of the study area. However, in the Bushmans to Gamtoos region it is quite heavily exploited (about 17 099 individuals removed per year). Siffies are currently seldom targeted as food (S. Kaehler, pers. comm.).

Not enough information is available to suggest a stock-status, as the rigour of work that has been undertaken to date is not suitable (Godfrey and Cowley 1999). According to Godfrey and Cowley (1999) there is a lack of research into growth, mortality, production and recruitment of siffies. This is vital information when estimating the status of a population and its suitability for recreational, subsistence and commercial harvesting. However, the presence

of subtidal adults is enough to suggest that siffie can be harvested as intertidal populations may be replenished by spawning subtidal adults.

Saddleback/armadillo (*Dinoplax gigas*)

According to Branch *et al.* (1994) saddlebacks are attached to rocks and buried in sand or under boulders on flat rocky reefs from the Cape Peninsula to northern Transkei/southern KwaZulu-Natal. The rate of exploitation of saddleback appears to be increasing along the old Ciskei coastline (Lindsay and Cowley 1999). It is used as a food source by some subsistence fishers (S. Kaehler, pers. comm.) and as bait by anglers (Chapter 4).

Not enough information is available to suggest a stock status (Lindsay and Cowley 1999). According to Lindsay and Cowley (1999) further research, especially on growth, recruitment and standing stock, is required before a decision on the suitability of saddleback for commercial harvesting can be made. Subtidal (hence inaccessible) adult saddlebacks could act as broodstock reserves for intertidal populations (Lindsay and Cowley 1999). This is enough to suggest that saddleback could be harvested to a limited extent.

To ensure the sustainability of small-scale commercial baitfisheries, studies on stock status and the effect of exploitation on species populations should be undertaken.

In conclusion, before establishing small-scale commercial baitfisheries in the Eastern Cape, the following factors should be addressed:

1. The bait species to be collected and sold should be identified.
2. The sustainability of the stocks to be harvested and the suitability of the harvesting methods (in terms of ecosystem impacts) should be assessed.
3. Suitable situations (points of sale) should be identified.
4. Suitable storage facilities (e.g. freezers, tanks, etc.) should be considered.
5. The reliability and seasonality of the market should be assessed.
6. The number of people involved, the overall effect on the fisher community, the potential individual income and the impact of small-scale commercial baitfisheries on other harvesters and resource users should be considered.

Once the above factors have been taken into consideration a pilot/experimental baitfishery should be established and monitored. If results from the experimental baitfishery suggest that a commercial baitfishery could be established, monitored and managed successfully then a small-scale commercial baitfishery could be introduced in the Eastern Cape.

APPENDICES

APPENDIX IA

LONG QUESTIONNAIRE

Questionnaire number_____ Interviewer_____

Time_____ Date_____ Day of the week_____

Location_____

Interviewee status and number of participants: *1.Angler*_____ *2.Bait-collector*_____ *3.Both*_____

Section A: Fisher information

1. Race group (circle): *1.African 2.White 3.Coloured 4.Asian 5.Other*
2. Sex (circle): *1.Male 2.Female*
3. Age_____
4. Place of residence_____
5. Fishing Substrate_____
6. What time did you start fishing?_____
7. What time will you stop fishing?_____

Section B: General bait information

1. Why do you collect bait organisms? (circle): *1.Angling 2.Food 3.Sell 4.Other (explain)*_____
2. What bait do you have with you? Where did you collect it or purchase it? How much did you collect or purchase? How much did you pay for the purchased bait? What time did you start and stop collecting bait? How many of you collected the bait in your possession?

Bait organism	Amount obtained	Place obtained	Time collected	Number of collectors	Cost
			-		
			-		
			-		
			-		

3. How many days per month do you go fishing and collect bait? *1.Fishing*_____ *2.Collect bait*_____ *3.Both*_____
4. Did you buy any bait from subsistence collectors? (circle) *1.Yes 2.No*
5. If yes, then from how many?_____
6. Would you buy bait from collectors if this were legal? (circle) *1.Yes 2.No*

7. What is the maximum you are prepared to spend on bait for a day's fishing?_____
8. Has there been a change in bait abundance, species diversity and bait organism size over the years? (circle)

   1.More bait 2.Less bait 3.No difference 4.Do not know

   1.More species 2.Fewer species 3.No difference 4.Do not know

   1.Bigger bait 2.Smaller bait 3.No difference 4.Do not know
9. Which species have become noticeably scarcer/more common and smaller/bigger over the years? (list the bait species and tick the appropriate cells)

Organism	Scarcer	More common	Smaller	Bigger

10. What are the main threats to the bait organisms that you collect? (circle) *1.Agricultural pollution 2.Industrial pollution 3.Speed boating 4.Silting of estuaries 5.Commercial collection 6.Subsistence collection 7.Recreational collection 8.General collection 9.Other (explain)*_____

Section C: Ownership of, access to and management of marine resources and target bait and angling species

1. Who owns the living marine resources on our coast and in our estuaries? (circle) *1.All SA citizens 2.National government (MCM) 3.Provincial government 4.Local people of the area 5.Local municipality 6.Anglers 7.Bait-collectors 8.Anglers and bait-collectors 9.Other (explain)*

   _____
2. Who should be responsible for managing the living marine resources on our coast and in our estuaries? (circle) *1.All SA citizens 2.National government (MCM) 3.Provincial government 4.Local people of the area 5.Local municipality 6.Anglers 7.Bait-collectors 8.Anglers and bait-collectors 9.Other (explain)*_____
3. Do you have a valid bait-collecting permit? (circle) *1.Yes 2.No*
4. Has your bait-collecting permit ever been inspected by a fisheries inspector? (circle) *1.Yes 2.No*
5. If yes, how often? (circle) *1. 1 in 10 outings 2. 1 in 50 outings 3. 1 in 100 outings*
6. Do you have a valid angling permit? (circle) *1.Yes 2.No*

7. Has your angling permit ever been inspected by a fisheries inspector? (circle) *1.Yes 2.No*
8. If yes, how often? (circle) *1. 1 in 10 outings 2. 1 in 50 outings 3. 1 in 100 outings*
9. Are you happy with the current permit system? (circle) *1.Yes 2.No*
10. If no, why not?_____
11. Should fishers be required to purchase permits for angling and bait collection along our coast and in our estuaries? (circle) *1.Yes 2.No*
12. What do you think happens to the money spent on permits? _____

    _____
13. What are your major target bait species, in order of preference, and what are their minimum legal size limits and daily bag limits?

Bait organism	Minimum legal size	Daily bag limit

14. Has your bait catch ever been inspected by a fisheries inspector? (circle) *1.Yes 2.No*
15. If yes, how often? (circle) *1. 1 in 10 outings 2. 1 in 50 outings 3. 1 in 100 outings*
16. What are your three major target angling species, in order of preference, and what are their minimum legal size limits and daily bag limits? Is there a closed season for your target angling species? What are your top three preferred bait species in order of preference for your preferred angling species?

Angling species	Minimum legal size	Daily bag limit	Closed season	Preferred bait

17. Has your fish catch ever been inspected by a fisheries inspector? (circle) *1.Yes 2.No*
18. If yes, how often? (circle) *1. 1 in 10 outings 2. 1 in 50 outings 3. 1 in 100 outings*
19. For which bait species are the legal limits insufficient for your needs? Why?

Bait organism	Reason

Section D: Fish and bait catch

1. May I check your bait and fish catch?

Bait organism	Amount (numbers/weight)	% of trips used

Angling species	Bait used

To be completed by clerk after the interview

Bait organism	Amount used (numbers/weight)	Angling species caught	Number and total weight of fish caught

APPENDIX IB

MEDIUM QUESTIONNAIRE

Questionnaire number_____ Interviewer_____

Time_____ Date_____ Day of the week_____

Location_____

Interviewee status and number of participants: *1.Angler*_____ *2.Bait-collector*_____ *3.Both*_____

Section A: Fisher information

1. Race group (circle): *1.African 2.White 3.Coloured 4.Asian 5.Other*
2. Sex (circle): *1.Male 2.Female*
3. Age_____
4. Place of residence_____
5. Fishing substrate_____
6. What time did you start fishing?_____
7. What time will you stop fishing?_____

Section B: General bait information

1. Why do you collect bait organisms? (circle): *1.Angling 2.Food 3.Sell 4.Other (explain)*_____
2. What bait do you have with you? Where did you collect it or purchase it? How much did you collect or purchase? How much did you pay for the purchased bait? What time did you start and stop collecting bait? How many of you collected the bait in your possession?

Bait organism	Amount obtained	Place obtained	Time collected	Number of collectors	Cost
			-		
			-		
			-		
			-		
			-		

3. How many days per month do you go fishing and collect bait? *1.Fishing*_____ *2.Collect bait*_____ *3.Both*_____
4. Did you buy any bait from subsistence collectors? (circle) *1.Yes 2.No*
5. If yes, then from how many?_____
6. Would you buy bait from collectors if this were legal? (circle) *1.Yes 2.No*
7. What is the maximum you are prepared to spend on bait for a days fishing?_____

Section C: Fish and bait catch

1. May I check your bait and fish catch?

Bait organism	Amount (numbers/weight)	% of trips used

Angling species	Fork length	Weight	Bait used

To be completed by clerk after the interview

Bait organism	Amount used (numbers/weight)	Angling species caught	Number and total weight of fish caught

APPENDIX IC

SHORT QUESTIONNAIRE

Questionnaire number_____ Interviewer_____

Time_____ Date_____ Day of the week_____

Location_____

Interviewee status and number of participants: *1.Angler*_____ *2.Bait-collector*_____ *3.Both*_____

Section A: Fisher information

1. Race group (circle): *1.African 2.White 3.Coloured 4.Asian 5.Other*
2. Sex (circle): *1.Male 2.Female*
3. Age_____
4. Place of residence_____
5. Fishing substrate_____
6. What time did you start fishing?_____
7. What time will you stop fishing?_____

Section B: General bait information

1. What bait do you have with you? Where did you collect it or purchase it? How much did you collect or purchase? How much did you pay for the purchased bait? What time did you start and stop collecting bait? How many of you collected the bait in your possession?

Bait organism	Amount obtained	Place obtained	Time collected	Number of collectors	Cost
			-		
			-		
			-		
			-		
			-		

Section C: Fish and bait catch

1. May I check your bait and fish catch?

Bait organism	Amount (numbers/weight)	% of trips used

Angling species	Fork length	Weight	Bait used

To be completed by clerk after the interview

Bait organism	Amount used (numbers/weight)	Angling species caught	Number and total weight of fish caught

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