FISHING PATTERNS AROUND THE CAPE PENINSULA NATIONAL PARK: IMPLICATIONS FOR A FISHERIES MONITORING PROGRAM

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ABSTRACT

The Cape Peninsula supports a wide variety of fishing activities, both commercial and recreational and it has been proposed that the boundaries of the Cape Peninsula National Park include some of the adjacent marine areas where an extent of marine protection has been imposed. As part of the conservation strategy, a monitoring program needs to be designed that is capable of determining the amount of fishing effort and catch around the peninsula. Thus, the aims of this study were to 1) determine and compare fishing effort from different boat access points, 2) determine the extent of shore-based fishing occurring on particular areas of the Cape Peninsula and 3) use these data to design a monitoring program capable of detecting biologically significant shifts in resource abundance and providing data that are relevant to stock assessment models. Access point data was obtained from harbour or slipway records and shore-based fishing activities were recorded by means of a roving creel census. From these data, the required number of sampling days was calculated using desired levels of accuracy. Access point data showed that certain access points were more utilised than others, and there were annual fluctuations and seasonal trends in the number of boat-days at each access point. By examining frequency distributions of the number of boats launching per day it was determined that a number of factors, such as weather and crew well-being, affected the decision to launch each day. Effort on week days versus effort on weekends and public holidays was higher than might be expected for some of the access points if it is assumed that only commercial fishers operate during the week. The number of boats launching on either side of the peninsula on each day in 2002 showed that a finite pool of boats operates on the peninsula. There was a weak relationship between wind speed as measured at Cape Point lighthouse and the number of boats launching at each access point indicating that these wind speed data are not suitable for predicting fishing effort and when boats would not go out to sea because of bad weather. The number of sampling days needed at each access point was limited by the number of days to count and measure fish and count boats landed. It was determined that roman *Chrysoblephus laticeps* required the most sampling effort to obtain a minimum annual sample size. Roving creel surveys indicated that the number of surveys would be approximately 3244, 811 or 134 per year if 5, 10 or 20 percent precision is to be obtained, respectively. Therefore a fairly labour intensive monitoring program will be necessary if adequate data is to be collected for present and future management purposes.

INTRODUCTION

A large number of people in South Africa participate in commercial and recreational fishing activities for a variety of species. The commercial linefish sector operates from ski-boats which are maneuverable, have planing hulls and launch from slipways and larger, flat hulled, inboard motor powered deck boats that are moored in harbours. Recreational fishing includes shore-angling, boat angling, spearfishing, intertidal collecting and diving for invertebrates (primarily rock lobsters and abalone). Commercial and recreational fishers compete for many of the resources, such as abalone, rock lobster and several linefish species.

Each of the fishery sectors in South Africa has its own method of management. The abalone, rock lobster, demersal and pelagic fisheries are controlled by means of a total allowable catch (TAC) of which a few large companies hold the main percentage (Cochrane *et al.* 1997). These fisheries are relatively easy to monitor as there are few participants and only a few sites where the fish are landed and processed. In comparison, the squid fishery and commercial linefisheries are managed by way of effort limitation, with only a certain number and size of vessels allowed entry into the fishery (Augustyn and Smale, 1989, Penney *et al.* 1989). In contrast, recreational effort is not limited but gear restrictions, closed seasons, closed areas and bag and size limits are applied. In addition, recreational fishers are not allowed to sell their catch (van der Elst, 1989).

Whereas all commercial fisheries are monitored in one way or another, the rock lobster and abalone fisheries are the only type of recreational fisheries in the Western Cape that are monitored to some extent. There is a need to monitor all recreational fisheries to determine their impacts on fish stocks, but these fisheries are difficult to monitor and control for a number of reasons. Only a very small percentage of participants in the recreational fishery submit catch data and the reliability of such data is questionable (Penney, 1997). The large and virtually unlimited number of access points for shore-based fishers means that it is difficult to access a sizeable proportion of fishers for monitoring. The retrieval of catch data is expensive (Robertson, 2003) and consequently the recreational fishery suffers from a lack of data on which to base management decisions. For similar reasons enforcing recreational fishing is manpower intensive.

The sea around the Cape Peninsula supports rich and diverse fisheries. However, over a century of fishing has reduced many stocks to low levels (Cochrane *et al.* 1997) and there is concern about the sustainability of fishing in this region. There is a critical need to protect some of these species and to rebuild certain stocks. Marine Protected Areas (MPAs) are likely to play an important part of a conservation strategy, partly because they are relatively easy to enforce, in contrast to other recreational fishing controls because transgressors are easily spotted. MPAs are also able to protect many species over a long time period, especially territorial and sedentary slow growing species and provide insurance against stock collapse and maintenance of intraspecific genetic diversity (Attwood *et al.* 1997). In addition, there are studies that have shown evidence of improved catch rates as a result of MPAs (Alcala and Russ, 1990, Roberts *et al.* 2001, Gell and Roberts. 2002).

Around the shores of the Cape Peninsula, some existing fishery closures have had noticeable effects. A study undertaken by Lechanteur and Griffiths (2002) shows that, on the False Bay side, the Castle Rock Marine Protected Area has a greater density and diversity of fish species than the surrounding exploited area of False Bay. Likewise, on the Atlantic side, galjoen *Dichistius capensis* are more abundant in an area closed to fishing than in adjacent fishing grounds (Attwood, 2001). It is thus expected that expanding the network of MPAs around the peninsula will benefit fisheries by allowing stocks inside the protected areas to increase and perhaps supplement the surrounding fished areas.

The Cape Peninsula National Park (CPNP) was proclaimed in 1998. It currently extends from Signal Hill on the north side of the peninsula, to the Cape of Good Hope Nature Reserve in the south and will soon be expanded to include the sea that surrounds it (Clarke, 2002). The CPNP as proposed is situated near Cape Town (Figure 1), one of South Africa's largest metropolitan areas and fishing effort is expected to be very high. The new MPA will be zoned to accommodate several no-take areas while still allowing fishing by all sectors. The objectives of the new MPA will be to protect biodiversity and to sustain fisheries. Thus, monitoring will be a crucial component of the management of the MPA and it should be able to provide the data necessary to evaluate changes in the marine ecosystem as a result of the closing of some fishing grounds. Long term trends in fishing effort and fish catches, either number or size, will indicate the success of the closed area strategy and may indicate where further revision is required (Clark, 2002).

The aims of this study are to analyse the extent and distribution of boat and shore based fishing along the Cape Peninsula for the purpose of designing a comprehensive fisheries monitoring program. The focus of this study is the non-quota regulated fisheries, which have thus far eluded monitoring attempts. A fishery monitoring program should be able to detect biologically significant shifts in resource abundance in the MPA and to provide data that are relevant to stock assessment models. Personnel and cost implications of the monitoring program will be estimated.

MATERIALS AND METHODS

Study Area

Survey sites were located within the boundaries of the proposed marine component of the Cape Peninsula National Park (CPNP), which lies immediately south of the Cape metropolitan area. The tip of the Cape Peninsula (34°20`S; 18°24`E) marks the border between the eastern warm-temperate and western cool-temperate marine zones. The western shore of the peninsula is exposed to strong wave action, whereas the eastern shore ranges from low to moderate exposure. Sea surface temperature varies greatly across the peninsula, being influenced by cool upwelling water on the western side (temperature range 16-19°C) and the warmer False Bay water on the eastern side (temperature range 12-20°C). Igneous granite composed of silicate crystals, feldspar and quartz on a base of Malmsbury shale forms the coastline of the peninsula which is interspersed with small pocket beaches and boulder beaches (Kench, 1984). The inshore reefs support kelp beds that form extensive canopies from the low-tide mark to between the 15 and 20m isobaths (Branch and Branch, 1984).

Access point surveys occurred at Kalk Bay harbour, Millers Point slipway, Buffels Bay slipway (within the Cape of Good Hope Nature Reserve), Kommetjie slipway and Hout Bay harbour (Figure 1a). These are the only access points for boats within the CPNP. Roving creel surveys were done along several disjunct sections of coast known to be popular for fishing, namely Muizenberg, Black Rocks, Rooikrans, Pegrams Point, Gifkommetjie, Scarborough, Misty Cliffs and Soetwater to Kommetjie lighthouse (Figure 1b).

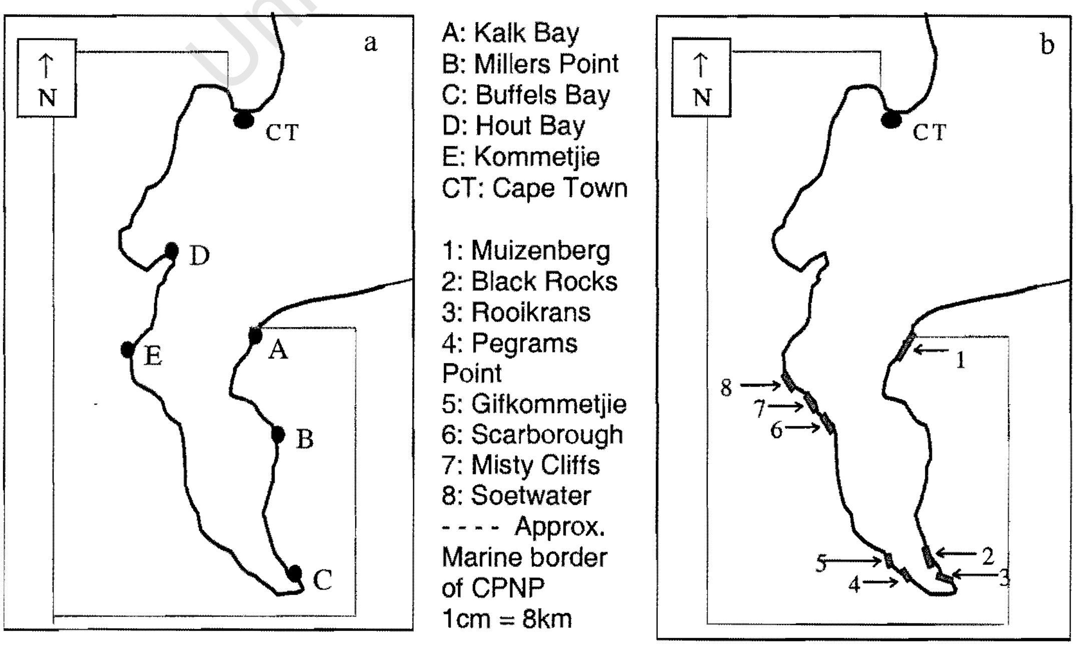

Fig 1: Outline of Cape Peninsula showing proposed marine boundaries of CPNP and (a) harbour and slipway access points and, (b) roving creel patrol sites

Access Point Survey

Catch and effort records for the boat-based fisheries were collected by government officials charged with the management of the respective sites. However, data collection procedures differed between sites.

Kalk Bay harbour: Staff of Marine and Coastal Management (the national fishery management agency) completed log-books on a daily basis in which the total number of vessels and total catch of each species were recorded. Catch quantities were estimated (not weighed) in kilograms. Data were available for the years from 1996 to 2002.

Millers Point slipway: The use of the slipway is leased to the Cape Boat and Ski-boat Club who attend the site and record the number of vessels that launch daily. There was no distinction between commercial and recreational vessels but the slipway is only used by fishing vessels. The club used these data for auditing purposes as vessels are charged a launching fee. Data were available from January to December 2002.

Buffels Bay slipway: Access is controlled by the South African National Parks, who own the land. The number of vessels launching here was recorded on a daily basis by this authority. Only fishing vessels use this slipway. Data were available from January to December 2002.

Hout Bay harbour: Staff of Marine and Coastal Management recorded the number of boats launching each day. Only fishing vessels use the slipway. These data were entered into a log-book on a daily basis. Catch quantities and species composition were estimated infrequently and were not reliable. Data were available for the years 1998 to 2002.

Kommetjie slipway: Staff of Marine and Coastal Management completed log-books on a daily basis in which the number of vessels and the number of rock lobster landed per fishing vessel was recorded on a daily basis. Data were available for the recreational rock lobster fishing seasons from 1995 to 2002, excluding the 1998-1999 and the 2000-2001 seasons.

Roving-creel survey

Roving-creel surveys were conducted by observers who patrolled stretches of coastline (shown in Figure 1b) and conducted interviews when encountering fishers (anglers, divers, spearfishers and collectors). Interview questions aimed to find out whether the fisher had a permit, to determine how long the fisher had been fishing on that day and to determine what species, if any, had been caught and the number and size of the specimens (Appendix I). Roving creel surveys were conducted randomly on weekdays, weekends and public holidays. Surveys were only conducted during the day and not at night. However, surveys were conducted at different times of day and the direction was not the same every time. Data were logged on a handheld computer with a GPS attachment that tracked the path of the observer and geo-referenced each interview.

Fishing Effort Analysis

ACCESS POINT SURVEY:

The number of boats launching was compared among sites and over time (seasonally and annually). The following aspects were considered:

i. The total number of boat-days per year for each harbour/slipway for the years for which data were available

ii. Frequency distributions of the number of boats per day for each harbour in 2002. Binomial probabilities were used to calculate the probabilities of a) bad weather and b) other factors preventing boats from launching. Least squares fits were used to compare observed data to expected data thereby calculating these probabilities.

iii. The amount of effort on weekdays (Mondays to Fridays) versus the amount of effort on weekends (Saturdays and Sundays) and public holidays. Differences were tested (α = 0.05) using chi-square analysis whereby the expected ratio was the number of available weekdays versus the number of available weekend and public holidays for each access point, and where the observed ratio was the number of boat weekdays versus the number of boat weekend and public holiday days.

iv. Number of boats entering the sea on the east side of the Cape Peninsula (Millers Point) was compared with the number of boats entering the sea on the west side of the peninsula (Hout Bay)

v. The number of boats launching at different wind speeds. Wind speed records for 2002 were obtained from Cape Point lighthouse. The wind speed record for 5:00am on each day was chosen to be correlated with the number of boats launching at each harbour as it was assumed that most fishers would make the decision whether or not to go to sea at this time of day. Wind speed was converted to the speed of the southerly component as the majority of winds affecting the Cape Peninsula are of a southerly nature (Shannon, 1989).

ROVING CREEL SURVEY:

The observer intercepted the fisher before the fishing trip was complete. Effort expended and catch up to that moment was recorded on interview. These estimates were doubled to account for a complete trip as it was assumed that each fisher was intercepted half way through a fishing trip. Effort was expressed as number of fishers encountered per kilometer per day. Fishers were classed as either anglers, divers, collectors or spearfishers depending on the activity which they were undertaking and equipment they were using at the time they were intercepted and interviewed.

Data were not gathered for a complete year (sampling is ongoing). Hence the survey presented here is regarded as a pilot study only.

NATIONAL MARINE LINEFISH SYSTEM (NMLS) DATA:

These data represent compulsory catch submissions by commercial fishers. The system was interrogated for the years 2001-2002 in the areas between Seal Island and Cape Point (east side of the Peninsula) and Cape Point to Mouille Point (west side of the peninsula), to give estimates of catch per unit effort (in this case, catch per boat per day) by species.

Estimating monitoring requirements

The basis for estimating monitoring requirements is the need to achieve a certain degree of accuracy in estimates of effort and fishing mortality rates. These two parameters are used extensively in linefish assessment, in the first instance to assess direct fishing pressure and in the second instance to measure its effect on the fish stock. Length measures are used to calculate an age distribution which in turn is used to calculate fishing mortality rate (F). This rate is used in spawner biomass per-recruit (SB/R) models which provide information that is used to help assess the state of the stock (Griffiths, 1997a).

MONITORING AT SLIPWAYS:

The CPUE data were used to determine the number of days per month that it was necessary to be able to sample a certain number of fish in a year to determine changes in fish sizes.

i. The percentage of each fish species (snoek *Thyrsites atun*, geelbek *Atractoscion aequidens*, kob *Argyrosomus japonicus*, yellowtail *Seriola lalandi*, roman *Chrysoblephus laticeps* and hottentot *Pachymetopon blochii*) landed at each access point was determined by calculating the percentage of fish landed on the entire peninsula respectively for the east and west sides. It was assumed that fish caught on the west side of the peninsula were only landed and counted at Hout Bay harbour. The percentage of fish caught on the east side of the peninsula was broken into three smaller percentages for Kalk Bay, Millers Point and Buffels Bay. These percentages were determined according to the number of boats at each site.

ii. The number of boat days (NB) at each site was determined from the access point data.

iii. The CPUE (catch per boat) was calculated from NMLS catch (C) and effort (E) data where the catch volume (kg) of each species was divided by the number of boats recorded for each month:

$$CPUE_{sp} = \frac{C_{sp}\,(kg)}{E\,(boats)} \qquad \text{.......................................(1)}$$

iv. The number of fish (NL) landed at each access point per day per month was then calculated by dividing NB by 30 and then multiplying by the CPUE and then dividing by the mean weight (W) of the fish species:

$$NL_{sp} = \frac{NB(boats)}{30\,days} \times \frac{CPUE_{sp}\,(kg.\,boat^{-1})}{W_{sp}\,(kg)} \qquad \text{.....................(2)}$$

Where W_{sp} is the mean weight of each fish species

v. The minimum number of each fish species per month (NF_{sp}) that it would be necessary to count to achieve a desired sample size (S) (set by M. Griffiths, pers. comm.) was calculated as follows:

$$NF_{sp}\,(month^{-1}) = \frac{S(fish) \times P_{sp}}{M_{sp}} \qquad \text{...........................(3)}$$

Where P_{sp} is the proportion of catch of that species that is landed at each access point and M_{sp} is divided by the number of months per year in which that species is caught.

vi. The number of sampling days (N_{sp}) needed per month for each fish species at each site was calculated by dividing NF_{sp} by NL_{sp} and rounding up so that decimals were counted as complete days:

$$N_{sp} = \frac{NF_{sp}}{NL_{sp}} \qquad \text{...(4)}$$

MONITORING OF SHORE-BASED FISHING:

The mean ($\bar{x}$) and standard deviation (s) of effort counts are used to calculate the number of samples (n) needed to achieve a desired precision in the estimate of effort. Various 95% confidence intervals about the mean were calculated for different levels of precision (d) ranging from d = 0.05$\bar{x}$ to d = 0.25$\bar{x}$.

The equation that estimates sample size (n) with the desired precision of the mean is as follows (Krebs, 1999):

$$n = \left[\frac{t_{\alpha} s}{d'}\right]^2 \qquad \text{.......................................(5)}$$

Where t_{α} = Students's t-value for n - 1 degrees of freedom for the 1 - α level of confidence.

The standard deviation was estimated using results of the roving creel survey for each site. In practice t_{α}-values for 95% confidence limits are almost always around 2 (Krebs, 1999, Zar, 1999). Thus equation 5 becomes:

$$n = \left(\frac{2\,s}{d}\right)^2 \qquad \text{.......................................(6)}$$

RESULTS

Access Point Data

A comparison of the total number of boats using each slipway shows consistent differences between sites but no clear temporal trends (Figure 2). Despite Kommetjie being used exclusively by rock lobster fishers during a short season, this was the most heavily utilized site. Millers Point (not illustrated because data only available for 2002) had 6010 boat-days suggesting that it is the second most utilized site. Hout Bay had approximately half that quantity making it the third most utilized site. Buffels Bay (data only available for 2002) with 1066 boat-days was used least frequently. Kalk Bay harbour has a finite number (maximum = 48) of vessels permanently moored there.

The number of days for the recreational rock lobster fishing season has been decreased by MCM regulations from 247 days in 1995 to 167 days in 1997 and finally to 90 days from 2000 up until the present. Hence, the decrease in boat days at Kommetjie is concurrent with the shortening of the rock lobster fishing season.

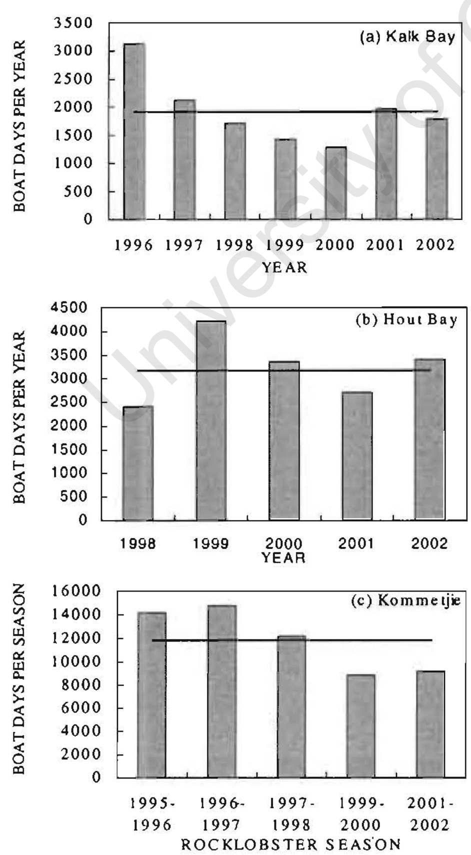

Fig 2: Comparison of number of boat days for each year/season showing mean for (a) Kalk Bay, (b) Hout Bay and (c) Kommetjie. The line across each graph indicates the mean.

Boat trips are not equally distributed throughout the year. Figure 3 shows mean monthly effort from 1996 to 2002 for Kalk Bay and mean monthly effort from 1998 to 2002 for Hout Bay. Only 2002 data were available for Millers Point and Buffels Bay. Kommetjie is not included in the comparison as data are only available for the rock lobster fishing season i.e. only part of the year. Some of this seasonal variation can be explained by the rock lobster fishing season which covered summer months although the exact dates and days of the season varied from one year to the next. In the case of Kommetjie, the site is only used during the rock lobster season for rock lobster, as line-fishers prefer using other sites where line-fish dealers purchase directly from boats. The Kalk Bay data do not include rock lobster fishing because these boats are permitted to catch linefish only, yet there is a tendency for less boats to go out to sea during winter. The seasonal effect is therefore not entirely due to the rock lobster season, indicating that either fishing success or weather conditions (or both) are better in the summer than in the winter (Figure 3).

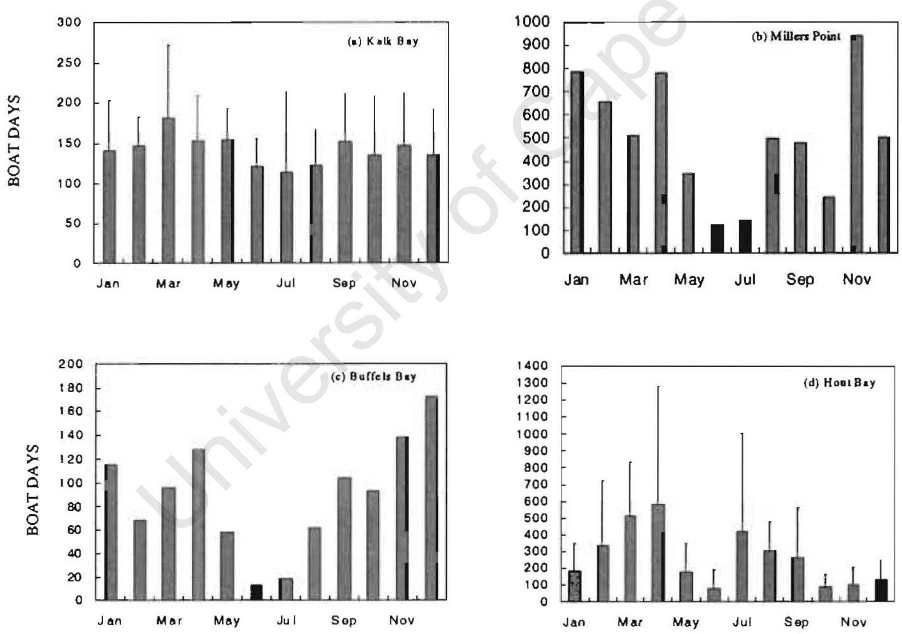

Fig 3: Monthly effort (boat days) for (a) Kalk Bay (1996-2002), (b) Millers Point (2002), (c) Buffels Bay (2002) and (d) Hout Bay (1998-2002) Mean (±sd) were estimated where data allowed.

The patterns of usage differed at each site. At Kommetjie the number of boats launching each day was fairly consistent and described by a unimodal distribution (Figure 4). Typical values are around 100 launches per day, infrequently dropping below 50 or rising above 160.

The bimodal distribution at Kalk Bay (Figure 4a) suggests a process in which poor weather accounts for a relatively large proportion (29.6%) of "zero activity" days. Ignoring this initial peak, the mode is in the range of 11 to 15 boats per day. The maximum number that launched at Kalk Bay was 21. Assuming that these vessels could go to sea on 70% of the days of the year, the probability of going to sea versus not going to sea was computed by fitting the data shown in Figure 4a to a binomial frequency distribution, after accounting for bad weather days. This analysis suggests that the probability of a vessel going to sea on any day when weather is permitting is 2.7%.

Modal frequency at Millers Point is between one and ten (Figure 4b) but the number of launches at this site is highly variable. At Buffels Bay and Hout Bay for almost half the year no boats launch. Modal frequencies are in the range 0 to 10 (Figures 4 c and d) and decrease exponentially thereafter.

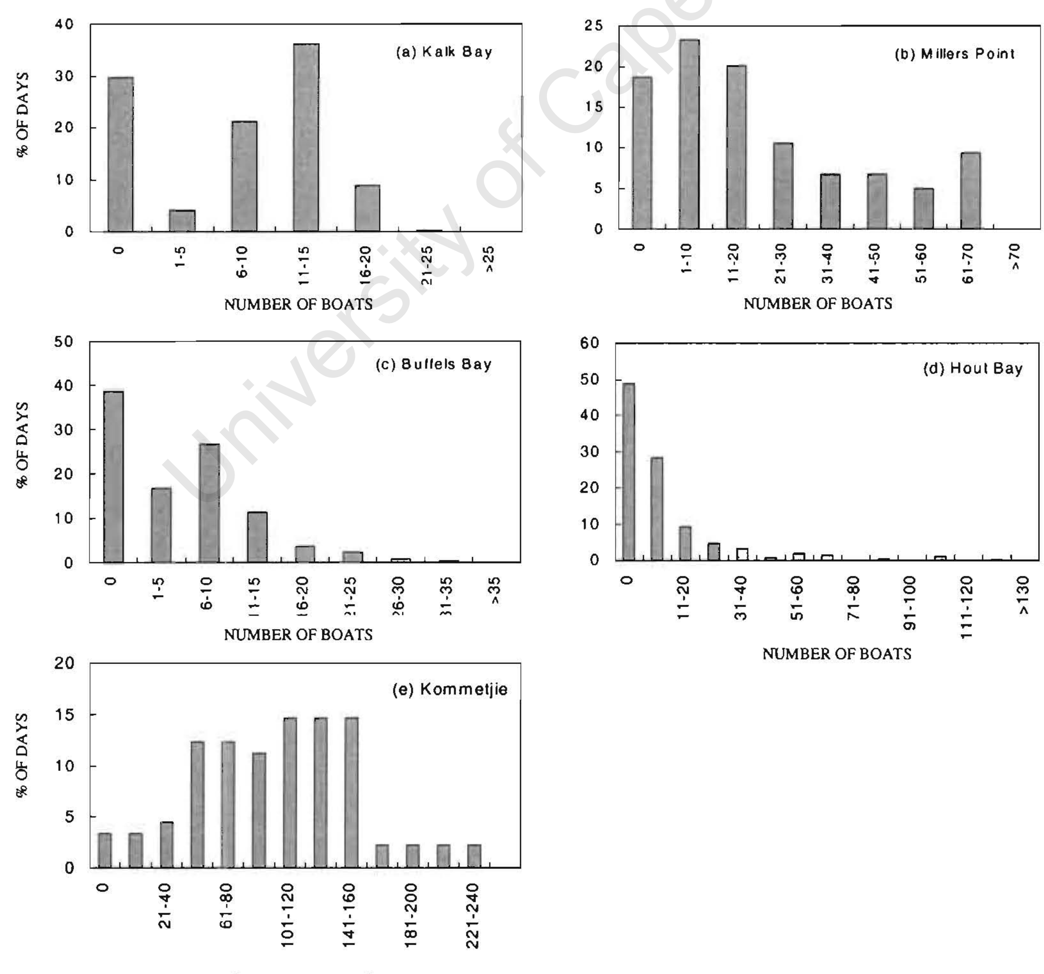

Fig. 4: Frequency distribution of the number of boats launching per day in 2002 for (a) Kalk Bay, (b) Millers Point, (c) Buffels Bay, (d) Hout Bay and (e) Kommetjie

The number of boats fishing on weekends (and public holidays) was significantly different to the number of boats fishing on weekdays at all of the harbours, except for Kalk Bay (Table I). Hout Bay showed a higher ratio of fishing effort during the week than was expected possibly because the opportunities for catching snoek occurred mainly during the week.

Table I: Chi-square test results for week versus weekend and public holiday effort at each of the boat access points

	Kalk Bay	Millers Point	Buffels Bay	Hout Bay	Kommetjie
n (boat days)	1782	6010	1066	3179	59105
n (sample days)	365	352	365	365	71
wk:wkend days	2.23	2.35	2.23	2.23	2.09
wk:wkend boats	2.18	1.47	0.66	2.97	1.99
α	0.05	0.05	0.05	0.05	0.05
Crit. value of χ^2	3.84	3.84	3.84	3.84	3.84
Calculated χ^2	0.21	322.30	398.15	41.84	3.93

A scatter-plot of the number of ski-boats at Millers Point versus the number at Hout Bay (Figure 5) shows that when a large number of vessels were launching at one site there were few launching at the other. The maximum number of vessels that launched on any one day at both sites was 140, but usually many fewer. It often happened that there were no launches at either site This indicates that there is a finite pool of fishing vessels that can launch on either side of the peninsula as conditions dictate.

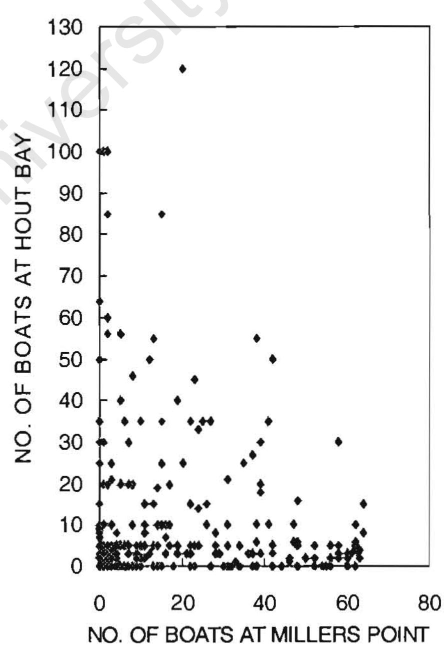

Fig. 5: Scatter plot of the number of boats launching at Millers Point and number of boats launching at Hout Bay for each day of 2002.

It was assumed that the mean number of boats launching per day for each wind speed range would decrease with an increase in the wind speed. However, the mean number of boats launching shows only a weak relationship with wind speed. Hout Bay shows the strongest relationship with few boats launching in wind speeds over 15 $m.s^{-1}$ and no boats launching in wind speeds over $20 m.s^{-1}$. Kalk Bay showed a generally decreasing trend in the mean number of boats although the difference between the number of boats launching at low wind speeds ($0\text{-}10 m.s^{-1}$) versus the number launching at high wind speeds ($20\text{-}30 m.s^{-1}$) was not as large as might be expected. Buffels Bay and Millers Point both show an initial decrease but then an anomalous increase in the mean number of boats launching at high wind speeds. There was no pattern at Kommetjie, which is not shown. Wind data collected at Cape Point lighthouse might not be completely relevant to conditions at each of the access points. Hence, conditions for launching might have been more suitable at each of the access points than was predicted by data from the wind meter at Cape Point.

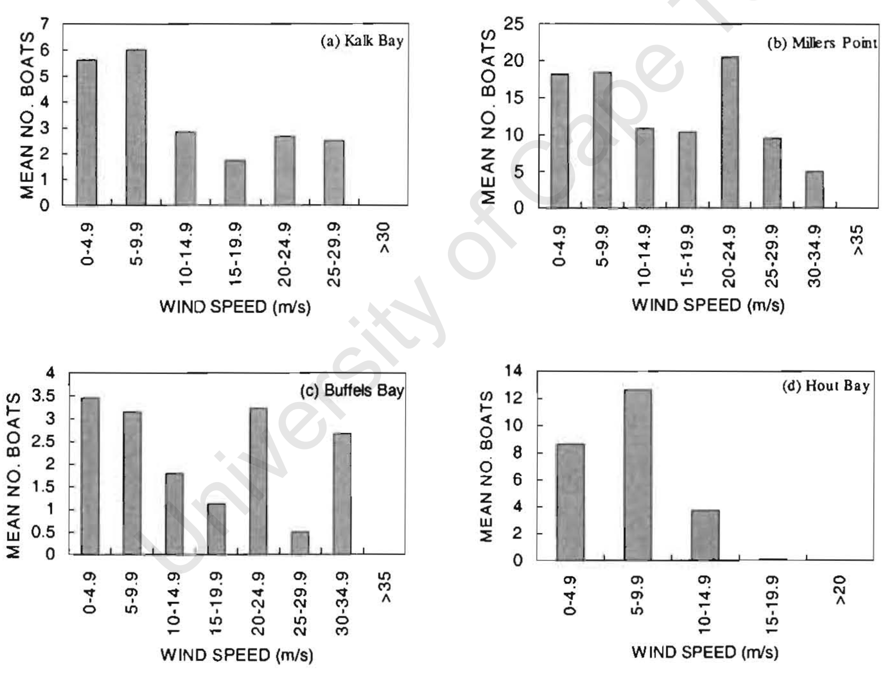

Fig. 6: Relationship between the mean number of boats launching per day and the southerly component of wind speed for launching sites at (a) Kalk Bay, (b) Millers Point, (c) Buffels bay and (d) Hout Bay

The percentage of the total fish catch landed on the peninsula was larger on the eastern side of the peninsula than on the western side. However, there was more fishing effort on the False Bay (eastern) side (NMLS data used 2234 boat-days on eastern side versus 797 boat-days on western side of peninsula to determine effort). Very small or no catches of geelbek, kob and yellowtail are landed at Hout Bay, where the dominant species caught is snoek (Table II).

Snoek, yellowtail, roman and hottentot are caught throughout the year but almost all of the kob and geelbek were landed from November to April, hence these two species can only be effectively sampled over 6 months (Table III). Millers Point requires the greatest number of samples for all fish species and Hout Bay the smallest except for snoek because it was the dominant species landed at Hout Bay (Table III).

The number of days that each slipway needs to be monitored will be determined by the species that requires the most person sampling days. The number of person days per month needed for measuring fish was the highest for roman at 51 person days per month for all sites (Table IV). This indicates that a minimum of two people will need to be employed to be able to measure the required number of fish per year.

Table II: Percentage of the total fish catch of each species for the Cape Peninsula landed at each access point

Area	Snoek	Geelbek	Kob	Yellowtail	Roman	Hottentot
Kalk Bay	13.6	19.3	19.5	19.3	18.7	14.4
Millers Pt.	47.9	67.7	68.3	67.7	65.5	50.3
Buffels Bay	8.4	12	12.1	12	11.6	8.9
Hout Bay	30	1	0	1	4.2	26.4
TOTAL	100	100	100	100	100	100

Table III: Required minimum number of fish to be measured per month at each access point to obtain annual sample of fish lengths. Number of each fish per site is multiplied by the number of months in which each fish is available to sample.

Area	Snoek	Geelbek	Kob	Yellowtail	Roman	Hottentot
Kalk Bay	113	32	163	80	16	12
Millers Pt.	399	113	569	282	55	42
Buffels Bay	70	20	101	50	10	7
Hout Bay	250	2	0	4	4	22
Min annual sample	10000	1000	5000	5000	1000	1000
No.months to sample	12	6	6	12	12	12

Table IV: Number of sampling days needed per month at each site to obtain the annual sample for each species

Area	Snoek	Geelbek	Kob	Yellowtail	Roman	Hottentot
Kalk Bay	2	7	13	7	12	2
Millers Pt.	2	7	10	10	10	2
Buffels Bay	3	6	13	13	15	2
Hout Bay	2	NA	NA	2	15	1
TOTAL	8	19	36	31	51	5

Pilot roving creel survey data:

Surveys were done from June 2002 to January 2003 (Appendix II). An index to determine the relative importance of each site was calculated by determining the mean number of fishers per kilometre per site (Table V). This number is an indication of the intensity of fishing that occurs at each site and is not necessarily an absolute density. For example, Rooikrans does not have a kilometer of coastline from which to fish, but if it did it would have an average Of 15 fishermen fishing at this site at any time during the day. The mean number of organisms caught per fisher for each site was also determined (Appendix III).

Table V: Roving creel results for each site, giving the estimated distance covered per site per trip, the mean number of fishers encountered per trip and per kilometer (±sd).

Site	Estimated distance(km)/trip	Fishers/trip		Fishers/km	
		Mean	stdev	Mean	stdev
Muizenberg	1.52	1.74	3.36	1.14	2.21
Black Rocks	1.41	1.00	1.29	0.71	0.92
Buffels Bay	1.64	2.31	6.55	1.41	3.99
Rooikrans	0.2	3.00	3.00	15.00	15.00
Pegrams	1.24	0.41	0.80	0.33	0.64
Gifkommetjie	1.01	0.50	0.55	0.50	0.54
Scarborough	1.15	1.30	2.36	1.13	2.05
Misty Cliffs	2.36	1.06	2.46	0.45	1.04
Soetwater	2.07	2.19	2.51	1.06	1.21

The percentage of fishers who owned permits varied depending on the type of fishing that they were involved in (Figure 9). Divers had the highest percentage (86%) and anglers were second highest (83%). In contrast, only 64% of collectors had permits and only one spearfisher was interviewed; he did not have a permit.

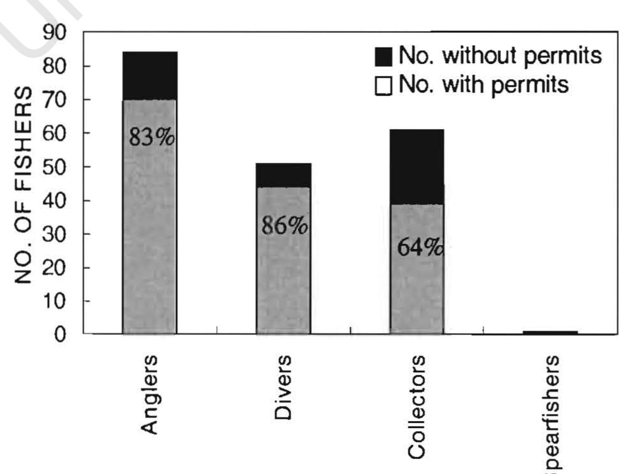

Fig. 9: Compliance with permit requirement by fishers interviewed during roving creel survey of Cape Peninsula (June 2002 – January 2003)

The number of surveys of each site needed to obtain estimates at different precision levels of shore-based fishing effort on the peninsula was determined. The data were limited in that there were not enough captured organisms to obtain an adequate estimate of catch per unit effort. The total number of trips needed to determine effort for the entire peninsula is much lower than the number of trips needed for individual sites (Table VI). The number of roving creel surveys necessary to obtain accuracy to within 10 percent is 811 days per year. This equates to three persons having to each complete an average of six surveys per week assuming that leave-time is given to each employee (312 working days + 53 leave days per person per year). Four times more effort (i.e. 12 persons) would be required to obtain accuracy to within 5 percent.

Table VI: Number of roving creel surveys needed per site and for the entire peninsula in order to accurately estimate shore-based fishing effort. Survey numbers are related to a desired level of precision (d) for the mean effort, such that the 95% confidence intervals are represented by d.

Site	No. of fishers per trip		25%		10%		5%	
	Mean	stdev	d (25%)	n (25%)	d (10%)	n (10%)	d (5%)	n (5%)
Muizenberg	1.74	3.36	0.43	240	0.17	1500	0.09	6002
Black Rocks	1.00	1.29	0.25	107	0.10	667	0.05	2667
Buffels Bay	2.31	6.55	0.58	513	0.23	3209	0.12	12834
Rooikrans	3.00	3.00	0.75	64	0.30	400	0.15	1600
Pegrams	0.41	0.80	0.10	239	0.04	1492	0.02	5967
Gifkommetjie	0.50	0.55	0.13	77	0.05	480	0.03	1920
Scarborough	1.30	2.36	0.33	211	0.13	1318	0.07	5270
Misty Cliffs	1.06	2.46	0.27	344	0.11	2148	0.05	8592
Soetwater	2.19	2.51	0.55	84	0.22	526	0.11	2105
TOTAL				1878		11739		46958
Entire Peninsula	8.43	12.01	2.11	130	0.84	811	0.42	3244

DISCUSSION

Scope of fishing

There are many kinds of fishing targeting many different species on the Cape Peninsula. Commercial fishers are boat-based and target several species of linefish, as well as rock lobster and abalone. Recreational fishers are shore- and boat-based and also target several species of linefish, rock lobster, abalone as well as bait organisms such as polychaetes and mussels. Shore-based fishers include anglers, divers, spearfishers and collectors. The collectors consist of a large number of fishers who collect organisms such as limpets and giant periwinkles from the intertidal zone for subsistence purposes as well as anglers who collect bait organisms. There is no clear domination by any of these groups of fishers and monitoring needs to take all types of fishers and organisms into consideration.

Dynamics of fishery

BOAT-BASED FISHING

There are more boats targeting linefish launching on the east side of the peninsula than on the west side. This is probably because False Bay supports a larger variety and number of fish than the sea on the west side of the peninsula, which has a reduced abundance and variety of fish. This is shown by the National Marine Linefish System data for fish landed on the Cape Peninsula. The access points to False Bay are also usually more sheltered than Hout Bay. Hout Bay has a high variability in the number of boats launching as it is almost entirely dependent on a single fish species, namely snoek. The number of boats launching on the west side of the peninsula greatly increases during the recreational rock lobster season because of the addition of the large number of boats launching at Kommetjie.

At all the access points there are more commercial and recreational boats launching in the summer than in the winter. This is most likely due to the increased availability of migratory predatory fish such as kob and geelbek. In addition, weather conditions are generally more suitable for fishing in the summer than in the winter. Kalk Bay showed less of a decline in the number of boat-days in winter than the other sites, probably because Kalk Bay is used only by commercial fishers who need to fish throughout the year. Wind measured at Cape Point was a poor indicator of the number of boats launching each day, possibly because wind speed at Cape Point is generally higher than at the harbours because of increased velocity above sea level and the effects of cliffs which create gusting and local circular movements. Thus, it could not be used for predictive purposes.

There was a significant difference between the number of boats launching during the week compared with the number launching on weekends at all sites except Kalk Bay. The difference was not as large as might be expected for Hout Bay and Millers Point, if recreational fishers were only fishing on weekends and public holidays, and at Kommetjie there were more boats fishing during the week than on weekends. The results show that many recreational fishing licence holders are fishing whenever possible on all days of the week indicating that they have no other form of employment and are fishing for a commercial purpose, providing a legal versus *de facto* situation. If recreational fishers held a form of employment other than fishing, most of them would only be able to fish on weekends and public holidays, thereby increasing the number of fishers on these days to higher than the number on weekdays.

SHORE-BASED FISHING

Fishers were located at several sites around the peninsula, some sites being more popular than others, depending on the time of year. For example the sites along the west side of the peninsula are more popular for angling during the winter months when galjoen are allowed to be caught. Some sites were used for targeting specific species, for example, Rooikrans is used by anglers targeting yellowtail. Other sites, such as Muizenberg and Soetwater, are popular fishing sites for anglers and collectors because they are easy to access and fishers do not have to travel far to reach them.

Shore-based fishers were seen on weekdays, weekends and public holidays. Most of the shore-based fishers claimed to be fishing for recreational purposes and for food and not for commercial purposes. Some of the shore-based anglers did not have permits (Figure 9). Divers and anglers had the highest percentage of permit holders possibly because diving and angling are fairly costly types of recreational fishing and persons who can afford to buy the required gear can also afford to buy a permit. It has been determined that less than 5% of rock and surf anglers in South Africa are members of a household that is in poverty (McGrath *et al.* 1997). In addition, there is a risk for divers and anglers being checked and fined for not having a permit as they are likely to be seen with the large amount of gear they have to have with them. The largest percentage of non-permit holders was in the collector category indicating that many collectors are subsistence fishers, who claimed they were collecting organisms for food and who cannot afford to buy a permit or who are unaware that they are supposed to have one for collecting certain organisms. Some of the collectors were anglers collecting bait who had angling permits but did not have bait collecting permits.. Spearfishing is the smallest sector of the South African linefishery (Mann *et al.* 1997) and only one spearfisher was interviewed who did not have a permit.

Monitoring Strategies

No single monitoring strategy will suffice. There is a need for a combination of access point and roving creel surveys and compulsory returns (voluntary returns are not reliable, not comprehensive and unrepresentative) to collect data. Access point and roving creel surveys have been used to determine fishing effort for the entire South African coastline (Brouwer *et al.* 1997, Sauer *et al.* 1997). Other monitoring methods were considered but would not be suitable for collecting data on the Cape Peninsula. Cockcroft and Mackenzie (1997) were successful in obtaining information on the west coast rock lobster fishery from telephone survey. However, telephone surveys would not be reliable because only permit holders would be able to be interviewed and, as can be seen from the interview results (Figure 9), a considerable proportion of fishers do not own permits.

Aerial surveys have advantages in that they are quick and it is easy to count fishers in places that are difficult to access by foot or motor vehicle. However, they have many disadvantages because although rods are easy to count, divers, collectors and captured organisms cannot be counted or measured. This means that the amount of fishing effort for abalone, limpets and bait organisms cannot be determined. In addition, aerial surveys have been found to underestimate the number of anglers along stretches of coastline (Brouwer *et al.*, 1997).

Monitoring requirements

Data from the proposed monitoring program will be used for different management and monitoring strategies in a manner that depends on each type of fishery.

LINEFISHERY

The boat-based linefishery requires effort data that differentiates between the number of commercial and recreational fisher. The extent and proportion of commercial and recreational fishing needs to be determined and so that economic evaluations, such as that done by McGrath (1997) can be made.

The management of the South African linefishery is based on spawner biomass per recruit (SB/R) models which require length measurements. SB/R models represent the most appropriate stock assessment methods available because there is no long time series of catch data available and the spawner biomass per recruit information is available (Griffiths, 1997a). Data requirements for SB/R models include a growth-curve (some of which can be determined from suitable length measurements), the length/weight relationship, age at maturity and natural mortality. Fishing mortality (F), which is needed to determine SB/R, can be estimated using a catch curve, which requires information on the length composition of the catch and an age/length key (Griffiths, 1997a). However, the catch curve method only provides a useful estimation of F after several years of sampling a specific number of fish (Griffiths, 1997a).

The current status of species exploited in the Cape Peninsula is shown in Table VII. There are still many gaps in the data for some of the species.

Table VII: Current status of the main exploited linefish species on the Cape Peninsula (Southern African marine linefish status reports, Mann, 2000)

Species	SB/R	F (per year)	M (per year)
Snoek	unknown	unknown	unknown
Geelbek	5% of SA stock	0.62	0.5
Kob	2.3% of pristine	0.63 (juveniles), 0.06 (adults)	0.1
Yellowtail	unknown	0.4	0.3
Roman	31%	0.29	0.288
Hottentot	unknown	unknown	0.138

Catch per unit effort (CPUE) would provide additional information on stock condition, catch composition and the division of catch between sectors. However, CPUE does not take natural mortality (M) into account and total fishing mortality (F) cannot be determined from CPUE. In addition, the additional manpower required for accurately determining CPUE for boat-based fishing is very high and cost considerations would need to be taken into account (Griffiths, 1997a).

Although the SB/R method is used for the commercial linefishery, its use in the recreational fishery is debatable because reliable mortality estimates are difficult to obtain and the SB/R statistic is only meaningful if recruitment is constant (Sparre and Venema, 1998). Advantages of using CPUE data for assessing recreational shore-based fishing include:

- The CPUE-based method is less biased than the per-recruit methods
- CPUE data could be cheaper to collect than catch-at-age data as less monitoring time is required to collect CPUE data
- CPUE is less susceptible to systematic sampling error than catch-at-size monitoring and is capable of sampling high- and low-density areas with similar amounts of monitoring effort

(Attwood, 2002)

The CPUE method is preferable for fish stocks that are in long-term decline, such as galjoen (Attwood, 2002) and many other species targeted by shore-based fishers.

Current data collection by harbour masters or other relevant authority currently consists entirely of counting the number of boats going out to sea at each harbour/slipway each day. Data collection could be improved if a distinction was made between recreational and commercial boats and if accurate fish counts (species and number) were done. Harbour records showed temporal gaps in data collection and inconsistency in the units used to count the number of landed fish and this needs to be avoided.

ROCK LOBSTER AND ABALONE

Rock lobster and abalone commercial fisheries are managed on the basis of a TAC but the recreational catch of these organisms is largely unknown (Cockcroft and Mackenzie, 1997). Only certain sites have reasonably accurate records e.g. the number of boats being launched and rock lobsters being landed at Kommetjie. Many of these rock lobsters and abalone are caught for commercial purposes by recreational fishers. Although officials could record whether boats are licenced commercials or not, the proportion of true recreational to commercial catch is difficult to determine as it is difficult to determine how many fishers are illegally selling their catch

OTHER INVERTEBRATES

This group includes limpets and bait organisms which are collected by subsistence fishers for food and by other fishers for bait. There is currently no management plan for these fisheries and no assessment procedures. Although there are regulations regarding the collection of these organisms, there is no information regarding the extent of their exploitation. Therefore, in this exploratory stage any effort information will be useful for determining exploitation on the Cape Peninsula.

The proposed monitoring program

The monitoring program needs to be capable of detecting biologically significant shifts in resource abundance and providing data that are relevant to stock assessment models. A compromise needs to be made between the desired and the achievable level of precision. The amount of effort required increases exponentially as the desired level of precision increases. Ideally, sampling should be as precise as possible, but as the results showed, precision to within 5% of the mean requires a high number of sampling days and personnel. Precision could also be improved by stratifying sampling into weekdays and weekends. There are also limiting factors, such as the accessibility to some shore-fishing areas, the mobility of personnel to get from one site to the next and time constraints on slipways when attempting to count fish because boats have to make way after landing as quickly as possible.

The minimum annual sample sizes of the main linefish species targeted on the peninsula were chosen by first looking at data from the NMLS for the east and west sides of the peninsula, thereby obtaining an approximate idea of the number of fish landed on the peninsula each year. Other research was then considered, for example Griffiths (1997b) sampled almost 9000 kob in the South-Western Cape from 1990 to 1994 (approximately 2250 sampled per year). Pulfrich and Griffiths (1988) were able to construct a size distribution after sampling a number of access points. Samples included 470 hottentot at Hout Bay and approximately 4200 fish at Kalk Bay over the course of two years. Other current research has shown that the number of snoek needing to be measured per year is at least ten thousand and the number of yellowtail and geelbek is in the region of at least five thousand per year (Griffiths, pers. comm). Sample sizes need to be within a certain percentage of the total catch for each species and thus is higher for snoek than for other species. This information provided an indication of the number of samples needed for each species and the NMLS data and the number of boat-days at each access point gave an indication of whether the required number of samples was going to be possible or not. For example, monthly and annual catches of geelbek show much variation and considering it is only caught for half of the year, five thousand measurements may not be possible. Thus a compromise was reached between the desired number of samples and the number that it will be possible to achieve. It would possibly be more efficient to use roving creel survey of shore fishers only on weekends when fishing effort is highest and to ensure that data collected by government is improved and is supplemented by recorded catch inspections with appropriate length measurements.

Costs of monitoring have been estimated on the basis of running costs i.e. staff and travel costs (Table VII). Staff costs were based on the current labour wage at MCM of R40/hour (R320 per day) and travel costs were based on the current AA rate of R2.40 per kilometer. The estimate of kilometers to be covered was based on personal experience during roving-creel and access point survey: 120km per day for roving creel surveys and 70km per day for access point surveys. The number of roving creel surveys was based on 10 percent precision.

Table VII: Estimates of staff and funding (in Rand) requirements for fisheries monitoring in the Cape Peninsula National Park

Type of survey	No. staff	No.days/person	km /month	Total Cost/month	Total cost/ year
Access Point	2	15	2100	14850	178200
Roving creel	3	16	5760	29760	357120
TOTAL	5	31	7860	44610	535320

CONCLUSION

Implementation of a fishing monitoring program is a necessary part of the future management of the marine component of the Cape Peninsula National Park. Both shore- and boat-based fishing effort is likely to increase as the population of Cape Town continues to grow and determining the effectiveness of the surrounding marine protected areas in protecting certain marine organisms will be an essential part of ensuring that overexploitation does not occur. The collection of data will ensure that future management decisions will be based on a greater and more accurate amount of information than is currently possible.

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Appendix I: Roving creel survey Interview questions

1) What category does the fisher fall under?
   a) angler
   b) diver
   c) collector
   d) spearfisher

2) Does the fisher have the appropriate permit?
   a) yes
   b) no

3) At what time the did the fisher commence fishing?

4) Has the fisher captured any organism(s)?
   a) Yes
   b) no

5) If yes, identify the organism(s)
   a) linefish species
   b) abalone
   c) rock lobster
   d) periwinkle
   e) polychaete
   f) sand prawn
   g) limpet
   h) red bait
   i) white mussel
   j) black mussel

6) If the organism is a linefish, measure it.

Appendix II: Results of roving creel surveys showing fishers and captured organisms encountered. A zero figure for distance indicates a problem with the cyber tracker device not recording distance covered and therefore where distance was estimated for calculations.

Date	Distance (m)	Area	Angler	Diver	Collector	Spearfisher	Galjoen	Abalone	R.lobster	Periwinkle	Polychaete	S. prawn	Limpets	Red bait	W.mussel	B.mussel
6-Jun-02	1787	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Jun-02	897	Scarborough	1	0	0	0	1	0	0	0	0	0	0	0	0	0
6-Jun-02	11	Gifkommetjie	1	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Jun-02	991	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Jun-02	1865	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Jul-02	298	Scarborough	4	0	0	0	1	0	0	0	0	0	0	0	0	0
17-Jul-02	152	Misty Cliffs	1	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Jul-02	48	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Jul-02	1082	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Jul-02	670	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Jul-02	318	Muizenberg	1	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jul-02	1319	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jul-02	527	Black Rocks	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jul-02	1760	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Sep-02	1004	Buffels Bay	1	0	1	0	0	0	0	0	0	0	0	0	0	0
7-Sep-02	325	Black Rocks	0	0	2	0	0	0	0	0	8	32	0	0	0	0
7-Sep-02	1380	Pegrams	0	0	1	0	0	0	0	0	0	0	0	0	0	0
7-Sep-02	772	Gifkommetjie	1	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Sep-02	194	Soetwater	1	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Sep-02	2341	Soetwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Sep-02	3254	Misty Cliffs	0	1	0	0	0	4	0	0	0	0	0	0	0	0
19-Sep-02	1887	Pegrams	0	0	2	0	0	0	0	0	0	0	0	0	80	0
19-Sep-02	1244	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Sep-02	404	Black Rocks	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Sep-02	290	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Sep-02	0	Soetwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct-02	1966	Scarborough	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct-02	0	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct-02	1255	Gifkommetjie	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct-02	3769	Black Rocks	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct-02	297	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct-02	221	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct-02	2495	Soetwater	2	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix II (continued)

Date	Distance (m)	Area	Angler	Diver	Collector	Spearfisher	Galjoen	Abalone	R.lobster	Periwinkle	Polychaete	S. prawn	Limpets	Red bait	W.mussel	B.mussel
26-Oct-02	1949	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct-02	2340	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct-02	922	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct-02	1761	Muizenberg	3	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct-02	1309	Soetwater	6	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct-02	750	Misty Cliffs	1	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct-02	322	Soetwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct-02	1215	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct-02	2255	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct-02	1326	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct-02	1220	Soetwater	1	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov-02	0	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov-02	1023	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov-02	2001	Gifkommetjie	1	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov-02	741	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov-02	1238	Soetwater	5	0	2	0	0	0	0	0	0	0	0	0	0	0
9-Nov-02	0	Soetwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov-02	0	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov-02	21	Scarborough	0	0	0	1	0	0	0	0	0	0	0	0	0	0
3-Dec-02	2125	Muizenberg	1	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Dec-02	3817	Buffels Bay	6	0	4	0	0	0	0	0	0	0	0	1	0	115
24-Dec-02	2125	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Dec-02	450	Rooikrans	6	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Dec-02	1887	Pegrams	0	0	2	0	0	0	1	0	0	0	0	0	0	0
24-Dec-02	3800	Buffels Bay	2	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Dec-02	1966	Scarborough	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Dec-02	3631	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Dec-02	2479	Soetwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix II (continued)

Date	Distance (m)	Area	Angler	Diver	Collector	Spearfisher	Galjoen	Abalone	R.lobster	Periwinkle	Polychaete	S. prawn	Limpets	Red bait	W.mussel	B.mussel
26-Dec-02	3631	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Dec-02	1966	Scarborough	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Dec-02	3800	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Dec-02	2000	Gifkommetjie	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Dec-02	1887	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Dec-02	450	Rooikrans	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Dec-02	2125	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Jan-03	3631	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Jan-03	1966	Scarborough	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Jan-03	1887	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Jan-03	3800	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Jan-03	2125	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Jan-03	1603	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Jan-03	1827	Scarborough	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Jan-03	447	Misty Cliffs	0	0	2	0	0	0	0	0	0	0	30	0	0	0
8-Jan-03	0	Soetwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Jan-03	2006	Muizenberg	0	2	8	0	0	0	2	0	0	0	50	0	0	0
8-Jan-03	1493	Muizenberg	2	0	1	0	0	0	0	0	50	0	0	0	0	0
10-Jan-03	1106	Black Rocks	3	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Jan-03	321	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Jan-03	137	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Jan-03	2165	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Jan-03	1675	Soetwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Jan-03	1013	Soetwater	0	0	2	0	0	0	0	0	0	0	0	0	0	0
11-Jan-03	2479	Soetwater	1	3	3	0	0	4	22	0	0	0	0	0	0	0
11-Jan-03	0	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Jan-03	1120	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Jan-03	1172	Buffels Bay	0	12	13	0	0	8	38	0	0	0	0	0	0	0
11-Jan-03	1822	Muizenberg	0	8	0	0	0	19	1	3	0	0	0	0	0	0
11-Jan-03	1080	Soetwater	2	0	1	0	0	0	0	0	0	0	3	0	0	0
14-Jan-03	3631	Misty Cliffs	2	1	2	0	0	0	0	10	0	0	0	0	0	0
14-Jan-03	1428	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Jan-03	1877	Black Rocks	0	0	2	0	0	0	0	0	0	0	0	0	0	0
14-Jan-03	258	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Jan-03	14	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Jan-03	1244	Scarborough	5	0	2	0	0	0	0	0	0	0	0	0	0	0

Appendix II (continued)

Date	Distance (m)	Area	Angler	Diver	Collector	Spearfisher	Galjoen	Abalone	R.lobster	Periwinkle	Polychaete	S. prawn	Limpets	Red bait	W.mussel	B.mussel
17-Jan-03	0	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Jan-03	1265	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Jan-03	1848	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Jan-03	919	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Jan-03	1122	Pegrams	2	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Jan-03	1538	Pegrams	2	17	10	0	0	39	50	0	0	0	37	0	0	0
18-Jan-03	267	Misty Cliffs	9	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Jan-03	1280	Soetwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Jan-03	2125	Muizenberg	0	2	1	0	0	0	0	0	0	0	0	0	0	0
18-Jan-03	1120	Soetwater	4	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jan-03	519	Soetwater	0	0	1	0	0	0	0	0	0	0	0	0	0	0
22-Jan-03	2379	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jan-03	1557	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jan-03	2283	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jan-03	0	Black Rocks	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jan-03	433	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jan-03	1133	Soetwater	0	0	1	0	0	0	0	0	0	0	11	0	0	0
28-Jan-03	1718	Misty Cliffs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Jan-03	131	Scarborough	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Jan-03	335	Buffels Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Jan-03	786	Pegrams	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Jan-03	1824	Muizenberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Jan-03	841	Muizenberg	2	0	0	0	0	0	0	0	0	0	0	0	0	0
		TOTAL	79	46	63	1	2	74	114	13	58	32	131	1	80	115

Appendix III: Mean number of captured organisms encountered per site. A blank value indicates that the organism was not targeted by fishers at that site, whereas a zero value indicates that the organism was targeted but was not caught.

Area	Organism	Mean number
Black Rocks	Galjoen	0.00
	Abalone	
	Rock lobster	
	Giant periwinkle	
	Polychaete	4.00
	Sand prawn	16.00
	Limpets	0.00
	Red bait	0.00
	White mussel	0.00
	Black mussel	0.00
Buffels Bay	Galjoen	0.00
	Abalone	0.67
	Rock lobster	3.17
	Giant periwinkle	0.00
	Polychaete	0.00
	Sand prawn	0.00
	Limpets	0.00
	Red bait	0.17
	White mussel	0.00
	Black mussel	19.17
Gifkommetjie	Galjoen	0.00
	Abalone	
	Rock lobster	
	Giant periwinkle	
	Polychaete	
	Sand prawn	
	Limpets	
	Red bait	
	White mussel	
	Black mussel	
Misty Cliffs	Galjoen	0.00
	Abalone	2.00
	Rock lobster	0.00
	Giant periwinkle	10.00
	Polychaete	0.00
	Sand prawn	0.00
	Limpets	15.00
	Red bait	0.00
	White mussel	0.00
	Black mussel	0.00

Area	Organism	Mean number
Muizenberg	Galjoen	0.00
	Abalone	0.79
	Rock lobster	0.38
	Giant periwinkle	0.25
	Polychaete	33.33
	Sand prawn	0.00
	Limpets	4.17
	Red bait	0.00
	White mussel	0.00
	Black mussel	0.00
Pegrams	Galjoen	0.00
	Abalone	2.29
	Rock lobster	2.94
	Giant periwinkle	0.00
	Polychaete	0.00
	Sand prawn	0.00
	Limpets	2.47
	Red bait	0.00
	White mussel	26.67
	Black mussel	0.00
Scarborough	Galjoen	0.83
	Abalone	
	Rock lobster	
	Giant periwinkle	
	Polychaete	0.00
	Sand prawn	0.00
	Limpets	0.00
	Red bait	0.00
	White mussel	0.00
	Black mussel	0.00
Soetwater	Galjoen	0.00
	Abalone	1.33
	Rock lobster	7.33
	Giant periwinkle	0.00
	Polychaete	0.00
	Sand prawn	0.00
	Limpets	4.67
	Red bait	0.00
	White mussel	0.00
	Black mussel	0.00