South African Journal of Marine Science
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tams19

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Published online: 08 Apr 2010.

To cite this article: S. L. Brouwer , B. Q. Mann , S. J. Lamberth , W. H. H. Sauer & C. Erasmus (1997) A survey of the South African shore-angling fishery, South African Journal of Marine Science, 18:1, 165-177, DOI: 10.2989/025776197784161126

To link to this article: http://dx.doi.org/10.2989/025776197784161126

S. Afr. J. mar. Sci. 18: 165–177
1997

A SURVEY OF THE SOUTH AFRICAN SHORE-ANGLING FISHERY

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Roving creel surveys and aerial surveys of shore-angling were undertaken as part of a national investigation into linefishing in South Africa. Shore patrols utilized a random stratified sampling procedure to collect catch-and-effort data, and a questionnaire provided information on fishing effort, angler demographics, economics and attitudes towards current regulations. A total of 1 677 patrols, covering 19 616 km, was conducted between April 1994 and February 1996, during which period 9 523 anglers had their catches checked and 4 490 were interviewed. A further 16 497 km were covered by aerial surveys, when 22 609 anglers were counted. From the aerial surveys, angler densities were highest on the KwaZulu-Natal coast (4.65 anglers·km^{-1}), followed by the Southern Cape coast (2.29 anglers·km^{-1}), the Eastern Cape coast (0.36 anglers·km^{-1}) and the West Coast (0.12 anglers·km^{-1}). Catch rates varied from 1.5 kg·angler^{-1}·day^{-1} on the Southern Cape coast to 0.45 kg·angler^{-1}·day^{-1} on the KwaZulu-Natal coast. Total effort was estimated at 3.2×10^6 angler days·year^{-1} and the total catch was estimated at 4.5×10^6 fish·year^{-1} or 3 000 tons·year^{-1}. Targeted species varied regionally, with elf *Pomatomus saltatrix* (29%) being the most sought after species on the KwaZulu-Natal coast, kob *Argyrosomus japonicus* (18%) on the Eastern Cape coast and galjoen *Dichistius capensis* on the Southern Cape coast (30%) and along the West Coast (50%). The catch composition by mass was dominated by *P. saltatrix* on the KwaZulu-Natal coast (29%), the Eastern Cape coast (26%), and on the Southern Cape coast (56%) and by white stumpnose *Rhabdosargus globiceps* (40%) on the West Coast. Although anglers generally supported the regulations currently governing the linefishery, the questionnaire results showed that knowledge and compliance of them was poor. A low level of law enforcement was found, except for in KwaZulu-Natal. Management of the linefishery is discussed in relation to the findings of this study.

South African shore-angling is primarily recreational, and there has in recent years been an increase in effort and a corresponding marked decline in catches of some species (Van der Elst and de Freitas 1988, Bennett 1992). In an attempt to ensure sustainable utilization of linefish resources, active management of the shore-angling fishery has been ongoing since the 1970s. A comprehensive suite of national management regulations designed to limit catch and effort was introduced in 1985, and subsequently revised in 1992. However, this was done without detailed knowledge of angler attitudes towards such regulations.

Current management measures include the use of size limits, bag limits, closed seasons and closed areas. Regulations are enforced by the Sea Fisheries Inspectorate in the Cape coastal provinces and by the Natal Parks Board (NPB) in KwaZulu-Natal. The NPB conducts regular law enforcement shore patrols along the KwaZulu-Natal coast, during which anglers' catches are inspected and catch-and-effort data collected. The Sea Fisheries Inspectorate conducts infrequent shore patrols along the Cape coast, but catch-and-effort data are not recorded. Some voluntary catch-and-effort data are obtained from shore-anglers, primarily in KwaZulu-Natal, by means of catch cards issued at controlled access points along the coast (Van der Elst and Penney 1995). A National Marine Linefish System (NMLS) was established in the early 1980s to centralize all these data sources, standardize the recording procedures and produce comparable data (Penney 1994). These data are then captured onto the NMLS and analysed annually to provide feedback to managers. However, shore-angling data are sparse, except in KwaZulu-Natal.

Concern about declining catches has prompted research to focus on life history characteristics of the species (Van der Elst and Adkin 1991). The collection and analysis of shore-angling catch-and-effort data in South Africa has been limited. Bennett (1991) and Bennett *et al.* (1994) analysed angling club records in the South-Western Cape, Coetzee *et al.* (1989) studied catch-and-effort trends from angling club catches in the Eastern Cape and Hughes (1989) analysed catch-and-effort data in KwaZulu-Natal. Joubert (1981) and Clarke and Buxton (1989) conducted regional roving creel surveys in South Africa using non-uniform probability sampling to assess angler catch and effort, and to determine club ratios and demographics of shore-anglers in KwaZulu-Natal and near Port Elizabeth respectively. However, none of those studies documented anglers' attitudes towards the fishery regulations nor anglers' compliance with them. Bennett

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Manuscript received: January 1997

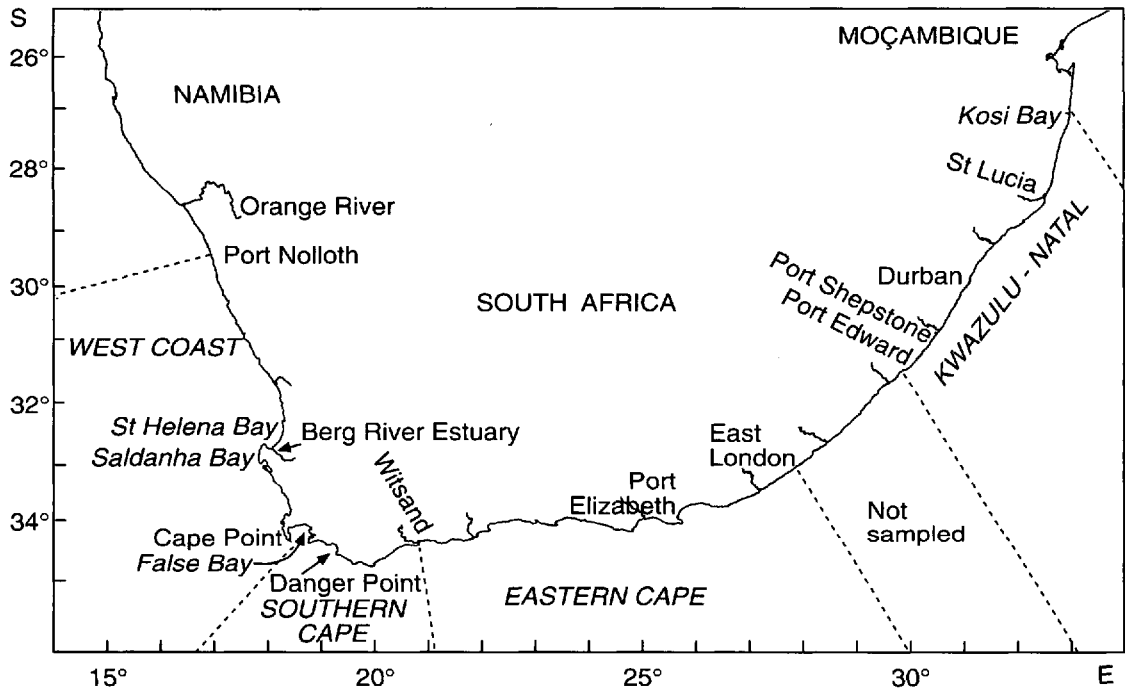

Fig. 1: Map of South Africa showing the four study regions and other places mentioned in the text

(1992) suggested that the measures introduced to conserve linefish stocks appear to have been largely unsuccessful, because they did not have the support of the majority of anglers. The central aim of the present study is, therefore, to evaluate participation in, and management of, the South African shore-angling fishery, providing an overview of the fishery. Detailed regional data will be described elsewhere. The study formed part of a larger programme investigating the South African linefishery, including the boat-based fishery (Sauer *et al.* 1997), the spearfishery (Mann *et al.* 1997), the beach-seine and gill-net fisheries (Lamberth *et al.* 1997) and some economic aspects of these fisheries (McGrath *et al.* 1997).

MATERIAL AND METHODS

Study area

For the purpose of this study, the South African coastline was subdivided into four regions (Fig. 1), the West Coast (Port Nolloth to Cape Point), the Southern Cape coast (Cape Point to Witsand at the Breede river mouth), the Eastern Cape coast (Witsand to East London) and the KwaZulu-Natal coast (Port Edward to Kosi Bay). The former Transkei and Ciskei regions were excluded, because these areas did not form part of South Africa at the inception of the study.

Survey techniques

Roving creel surveys appear to be the best method to assess catch and effort in fisheries where effort is dispersed over a large area (Essig and Holliday 1991). Such surveys, as well as aerial surveys to count anglers, were used to assess the fishery, based on methodologies developed in North America (Malvestuto *et al.* 1978, Malvestuto 1983, Essig and Holliday 1991) and in South Africa (Joubert 1981, Clarke and Buxton 1989).

Within each sampling site (an area that could be covered in one sampling period of four hours) the starting time (06:00, 10:00 or 14:00), starting point and direction of travel were chosen randomly. Each area was therefore likely to be visited over all daylight hours by the end of the sampling season (Jones

and Robson 1991). The roving creel surveys were conducted using a progressive count method. Sampling was not conducted at night.

Aerial surveys were used to cover the whole area during a single survey (instantaneous count) and to quantify the proportion of fishing effort omitted during the ground survey. These were conducted using a small, fixed-wing aircraft or a helicopter. Sampling time and direction of travel were chosen randomly, weather permitting. Ground-truthing of aerial surveys was carried out for part of the total sampling area.

Angling effort

The total annual angling effort was calculated from instantaneous counts (both aerial survey and shore-patrol data), using a modified version of the method developed by Pollock *et al* (1994):

$$E_{total} = E_{w1} + E_{w2} \quad , \tag{1}$$

where E_{w1} and E_{w2} are the weekday and weekend estimates respectively, which is given by:

$$E_{wj} = \left(\frac{\sum_{i=1}^{n} e_i}{(d/p)} \right) \times l \quad , \tag{2}$$

where j is weekdays or weekends, e_i is the number of anglers per kilometre on the ith day, d is the number of days sampled, p is the potential number of sampling days and l is the total length of the sample area. The total effort estimates employed anglers per kilometre rather than number of anglers in order to standardize the estimates for each area, because the regions differed in length.

Estimation of catch per unit effort

The catch per unit effort (*cpue*) in this study was calculated as follows:

$$cpue = \frac{\sum_{i=1}^{n} (C_i/E_i)}{n} \quad , \tag{3}$$

where C_i is the number or mass (kg) of fish retained by the ith angler, E_i is the effort expended by the ith angler and n is the number of anglers sampled.

Total catch was estimated by multiplying total effort by the *cpue*, as follows:

$$C_{total} = cpue \times E_{total} \quad . \tag{4}$$

As the above methods give instantaneous effort values, the values were modified to account for angler turnover during one day, as set out below. To facilitate calculations and to avoid integration, probability distributions are discrete. Time is rounded off to the nearest hour. The starting time distribution is given by

$$s_t = \frac{n_t}{N} \quad , \tag{5}$$

where s_t is the probability of starting fishing at time t, n_t is the number of surveyed anglers who started at time t and N is the total number of surveyed anglers. Note that

$$\sum_{t=0}^{23} s_t = 1.0 \quad . \tag{6}$$

The mean duration of fishing trip is computed, starting at time t. The times of all fishing trips which started at time t (t = 0.23) are summed and divided by n_t. The probability of an angler being on the beach at time t is given by

$$P_t = \sum_{i=0}^{23} (s_i a_i) \quad . \tag{7}$$

where P_t is the probability of finding an angler on the beach at time t and a_t is the step function.

$$a_i = 1 \text{ if } 0 \le (t-i) \le d_i \tag{8}$$

$$a_i = 1 \text{ if } 0 > (d_i-24) \ge (t-i) \tag{9}$$

$$a_i = 0 \text{ if } 0 > (t-i) > (d_i-24) \tag{10}$$

$$a_i = 0 \text{ if } 0 \le d_i \le (t-i) \quad , \tag{11}$$

where d_t is the mean duration of fishing trip starting time at time t.

The daily total was calculated from instantaneous count, using

$$A_d = \frac{O_{dt}}{P_t} \quad , \tag{12}$$

where A_d is the number of anglers on the shore on day d, O_{dt} is the number of observed anglers on day d at time t. Note that the scaling factor is simply P_t^{-1}.

Table I: Number of questionnaires conducted and catches inspected in the four study regions between April 1994 and February 1996

Area	Number of questionnaires	Number of inspections
West Coast	434	2 315
Southern Cape coast	1 162	1 761
Eastern Cape coast	1 556	3 273
KwaZulu-Natal coast	1 338	2 174
Total	4 490	9 523

Angler attitudes and preferences

Questionnaires were conducted as part of the roving creel survey between April 1994 and February 1996. Each respondent was interviewed once and on subsequent encounters only catch-and-effort data were collected. Questionnaires comprised separate sections addressing catch-and-effort data, angler information, economic information and attitudes towards fishery regulations (see Appendix). A test question determined knowledge of regulations by the anglers. Interviewees were asked to give the size limit, bag limit and the closed season for at least two species which they were targeting. All fish caught were identified, and total length (*TL*) of fish was taken to the nearest mm. Mass was determined using standard length/mass regressions (Van der Elst and Adkin 1991). Released fish were not included, because of the unreliability of angler reports, which can vary between 56 and 152% of the true catch (Claytor and O'Niel 1991).

RESULTS

A total of 1 677 shore patrols, covering 19 616 km, was conducted between April 1994 and February 1996. In all, 13 635 anglers were counted, of which 9 523 volunteered their catch-and-effort information and 4 490 were interviewed. A further 16 497 km were covered during the aerial surveys, when 22 609 anglers were counted. The regional results are given in Tables I and II.

Angling effort

The ground-truthing of aerial surveys in the Eastern Cape and Southern Cape coasts revealed that, for those regions, estimates of the total number of anglers were accurate (100% precision), whereas an error of 12% was recorded for the KwaZulu-Natal coast (generally the aerial counts slightly underestimated the total number of anglers). With the exception of the Southern Cape coast, the aerial survey estimates of angler density were less than those derived from shore patrols (Table III). This was because aerial surveys covered the whole coast, whereas shore patrols were restricted to areas where access was possible. The total effort for the South African shore fishery (excluding Transkei and Ciskei) was estimated at 3.2 million angler days·year^{-1} (Table IV).

Angler densities were highest around metropolitan areas, where large numbers of anglers reside and fishing areas are easily accessible. Angling effort was greater during the weekend; in the Eastern Cape, weekend angling accounted for 60% of the total shore-fishing effort. Angling effort also increased over the peak holiday seasons, accounting for approximately 34% of the annual effort. Of the anglers interviewed, 54% fished at night, but they assigned only 34% of their fishing time to night fishing.

Estimation of *cpue*

Catch composition varied regionally. In terms of the mass of fish caught, elf/shad *Pomatomus saltatrix* was the dominant species in KwaZulu-Natal (29%), the Eastern Cape (26%) and the Southern Cape (56%), whereas white stumpnose *Rhabdosargus globiceps* (40%) was the dominant species on the West Coast. Catches in KwaZulu-Natal (43%) and the Eastern

Table II: Number of shore patrols conducted between April 1994 and February 1996, distance patrolled, number of anglers counted and average number of anglers per kilometre in the four study regions

Area	Number of patrols	Distance patrolled (km)	Number of anglers counted	Anglers·km^{-1}
West Coast	653	6 784	2 714	0.40
Southern Cape coast	493	3 549	4 568	1.29
Eastern Cape coast	315	8 889	3 500	0.39
KwaZulu-Natal coast	216	394	2 853	7.23
Total	1 677	19 616	13 635	2.33

Table III: Distance flown (km) and number of anglers counted during aerial surveys in the four study regions

Area	Distance surveyed	Number of anglers	Anglers·km^{-1}
West Coast	8 127	983	0.12
Southern Cape coast	1 980	4 543	2.29
Eastern Cape coast	2 948	1 067	0.36
KwaZulu-Natal coast	3 443	16 016	4.65
Total	16 498	22 609	1.86

Cape (23%) were dominated numerically by strepie *Sarpa salpa*. The Southern Cape coast was dominated by *P. saltatrix* (59%) and the West Coast by *R. globiceps* (39%, Fig. 2). The highest number of fish caught per angler was recorded on the Eastern Cape coast (2.06 fish·angler^{-1}·day^{-1}) and the lowest on the West Coast (0.94 fish·angler^{-1}·day^{-1}, Table V). *Cpue*, in terms of mass, ranged from 1.548 kg·angler^{-1}·day^{-1} on the Southern Cape coast to 0.45 kg·angler^{-1}·day^{-1} on the KwaZulu-Natal coast. Total catch for the South African shore-angling fishery (excluding Transkei and Ciskei) was estimated at 4 519 914 fish·year^{-1}, or nearly 3 million kg·year^{-1}.

Angler attitudes and preferences

Primary target species were *P. saltatrix* in KwaZulu-Natal, dusky kob *Argyrosomus japonicus* in the Eastern Cape and galjoen *Dichistius capensis* in the Southern Cape and along the West Coast (Table V).

In general, anglers agreed with the current regulations, size limits receiving the strongest support (87%) and bag limits generally being the least acceptable (76%, Table VI). A large percentage of anglers admitted to disobeying linefish regulations (32%), except with regard to marine reserves (9%). KwaZulu-Natal had the greatest proportion of anglers claiming to obey the linefish regulations and the West Coast the lowest (Table VI). With the exception of anglers from KwaZulu-Natal, interviewees had a poor knowledge of the regulations regarding the species which they were targeting (Table VI).

A relatively high proportion of interviewees (63%) agreed to the implementation of a marine recreational angling licence for shore-fishing (63%), providing that funds accrued were used to benefit the fishery, i.e. improving angling facilities, for research and/or for law enforcement. The average acceptable fee that anglers were willing to pay varied regionally between R28 and R62 (Table VII).

Most interviewees reported a decline in shore-angling catches taken along the coast; 80% on the West Coast, 80 and 81% in the Southern and Eastern capes respectively and 87% in KwaZulu-Natal. The reasons offered varied widely (Fig. 3), major causes being industrial pollution (26%) in KwaZulu-Natal, trawling (25%) in the Eastern Cape, general overfishing and beach-seining in the Southern Cape (17%) and beach-seining and gill-netting on the West Coast (17%).

Table IV: Total angler effort and *cpue* in the shore fishery in the four study regions

Area	Total angler days·year^{-1}	Fish·angler^{-1}·day^{-1}	Kg·angler^{-1}·day^{-1}
West Coast	205 242	0.94	0.56
Southern Cape coast	658 862	1.40	1.55
Eastern Cape coast	903 186	2.06	1.15
KwaZulu-Natal coast	1 471 667	1.18	0.45
Total	3 238 921	5.58	3.71

Table V: Preferred species targeted by shore-anglers in the four study regions

West Coast	Southern Cape coast	Eastern Cape coast	KwaZulu-Natal coast
Dichistius capensis (50%)	*Dichistius capensis* (30%)	*Argyrosomus japonicus* (18%)	*Pomatomus saltatrix* (29%)
Rhabdosargus globiceps (19%)	*Argyrosomus inodorus* (22%)	*Pomatomus saltatrix* (14%)	*Argyrosomus* spp. (14%)
Pachymetopon blochii (12%)	*Lithognathus lithognathus* (17%)	*Lithognathus lithognathus* (11%)	*Pomadasys commersonni* (14%)
Argyrosomus spp. (5%)	*Pomatomus saltatrix* (12%)	*Pachymetopon grande* (9%)	*Diplodus sargus capensis* (13%)
Lithognathus lithognathus (4%)	*Diplodus sargus capensis* (4%)	*Sparodon durbanensis* (4%)	*Rhabdosargus sarba* (12%)

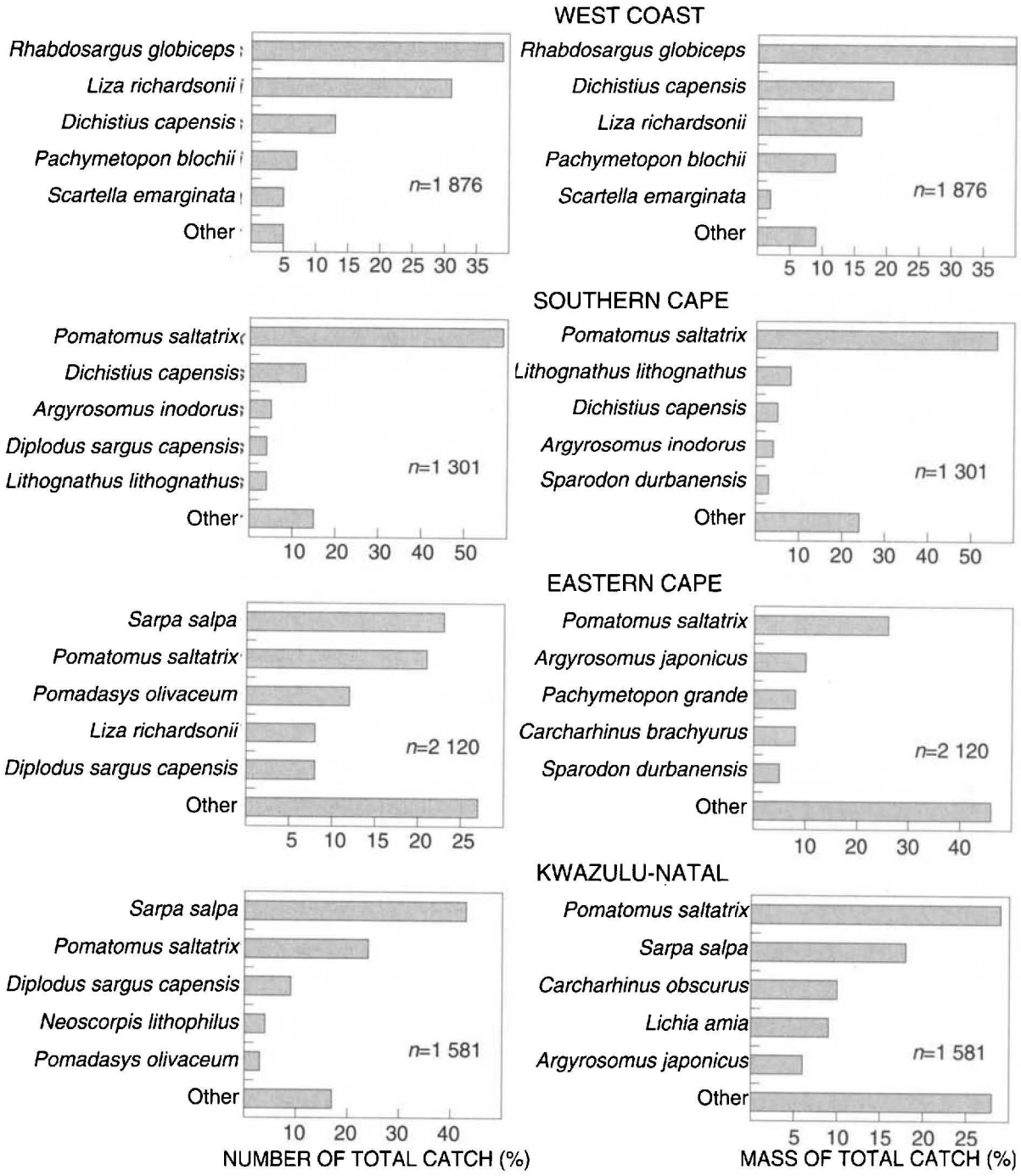

Fig. 2: Shore-angling catch composition, by number and by mass, for the four study regions, April 1994 – February 1996

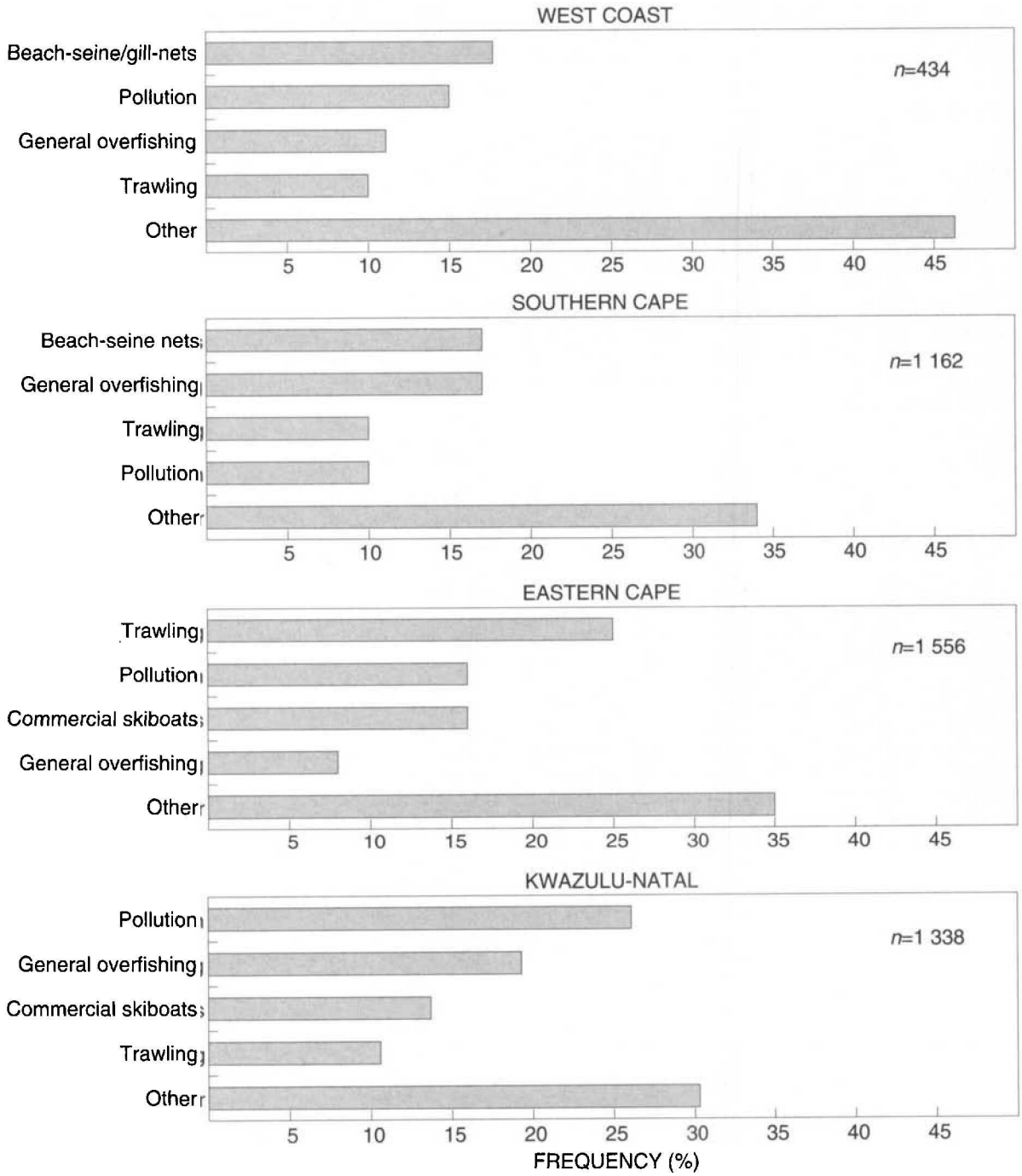

Fig. 3: Primary reasons given by interviewees for the decline in catches in the South African shore fishery for the four study regions

Table VI: Questionnaire data for the four study regions, showing the percentage of shore-anglers that agree, disobey and have knowledge of the linefish regulations in South African waters

Parameter	Frequency (%)											
	West Coast			Southern Cape coast			Eastern Cape coast			KwaZulu-Natal coast		
	Agree	Disobey	Knowledge	Agree	Disobey	Knowledge	Agree	Disobey	Knowledge	Agree	Disobey	Knowledge
Size limit	81	39	35	84	22	43	91	50	35	93	31	54
Bag limit	76	44	43	75	29	45	80	30	36	76	25	61
Closed season	82	40	36	76	29	33	84	25	45	72	21	72
Marine reserve	86	12	–	83	13	–	86	9	–	83	3	–

The frequency of inspections by fisheries inspectors was generally low (<2%) on the West Coast and in the Southern and Eastern Cape, whereas 10.9% of the interviewees were inspected on the KwaZulu-Natal coast (Table VIII).

DISCUSSION

Survey techniques

Roving creel surveys have been conducted for various reasons, ranging from catch-and-effort analysis (Malvestuto 1983), through angler catch preferences (Miranda and Frese 1991) and economic surveys (Storey and Allen 1991) to assessment of public opinion on off-road vehicle use (Els and McLachlan 1990). Although the methodology used here was developed in accordance with accepted North American studies (Malvestuto 1983), modifications were necessary for the South African coastline. The main difficulties were the extensive area of the coast (approximately 2 500 km), combined with a limited research staff and financial restraints. The stratified sampling technique used in the present survey was preferable to using uniform probability sampling, because roving creel surveys become ineffective when equal effort is spent sampling areas of high and low fishing intensity (Stanovick and Nielsen 1991). Unfortunately, postal surveys, which can survey large numbers of anglers in a large area, were not appropriate because of the low levels of literacy in South African coastal communities (Shindler 1994).

Angler effort

The notable differences found between the shore and aerial surveys in KwaZulu-Natal (Tables II and III) were likely a result of shore patrols being conducted primarily on foot, and only in areas where beach access was relatively easy, whereas the aerial surveys covered the entire coastline. However, estimates of shore-angling effort from the KwaZulu-Natal aerial surveys were similar to those from shore patrols conducted by the Natal Parks Board (NPB) during 1995. Those patrols used more manpower and covered a larger area (42 268 km) than those conducted during the current study. Consequently, a combination of aerial survey data and NPB shore patrol data was used to calculate total angling effort for the KwaZulu-Natal coast. Similarly, along the West Coast, aerial survey estimates of effort were half those of the shore patrols, because the aerial surveys covered large, uninhabited sections of the coast. The Eastern Cape shore patrol and aerial survey estimates were similar, but only limited aerial surveys were conducted in that region. The Southern Cape aerial survey estimates of angler

Table VII: Percentage of shore-anglers willing to pay an annual licence fee (and the average acceptable fee) for the four study regions

Area	Percentage agreement	Average fee (Rand)
West Coast	70.5	28
Southern Cape coast	61.0	53
Eastern Cape coast	54.0	62
KwaZulu-Natal coast	67.1	31

Table VIII: Percentage of inspections by law enforcement officials in the four study regions

Area	Inspections (%)
West Coast	1.39
Southern Cape coast	0.63
Eastern Cape coast	0.75
KwaZulu-Natal coast	10.90
n	4 490

density were higher than the shore patrol data, because all aerial surveys there were conducted only on weekends, when angler densities were generally higher. These differences in estimates of effort highlight the importance of using a random sampling procedure and the benefits of adopting more than one sampling method for a large survey.

Estimation of *cpue*

Most *cpue* data from previous studies, e.g. Coetzee *et al.* (1989), Bennett (1991), are not comparable to this study, because they used only angling club competition data. Clarke and Buxton (1989) used a random stratified sampling design similar to the present study, but confined their study to the Port Elizabeth area. Although the species composition has remained relatively unchanged in that region since the earlier study, the *cpue* has declined substantially, particularly for sparids such as bronze bream *Pachymetopon grande*, musselcracker *Sparodon durbanensis* and blacktail *Diplodus sargus capensis*. The present species composition and *cpue* of the major species caught on the KwaZulu-Natal coast are similar to those reported by Jourbert (1981) for that coast, although catches of *S. salpa* were numerically more important than *P. saltatrix* during the present study, and catches of piggy *Pomadasys olivaceum* appear to have declined since the previous study.

The *cpue* by mass was highest in the Southern Cape, where the catch consisted mostly of larger species, such as *P. saltatrix* and *D. capensis*. Although the *cpue* by mass was low in KwaZulu-Natal and the Eastern Cape, the number of fish caught in those regions was relatively high, the Eastern Cape having the largest catches. Catches in those areas consisted mostly of small fish such as *S. salpa*. As expected, target species were not necessarily the most regularly caught, the targeting of prime species probably contributing to the decline of those fish. This phenomenon has also been noted in offshore species such as seventy-four *Polysteganus undulosus* (Van der Elst and de Freitas 1988).

Angler attitudes and preferences

In contrast to the opinion of Bennett (1992), the current regulations seem to have the support of the majority of anglers. In spite of this, many of the interviewees had little knowledge of or abided by the regulations, which is cause for concern. Therefore, an angler education programme should be implemented, not simply aimed at informing participants of current regulations, but also the rationale behind them. There was a correlation between compliance with regulations and the frequency of inspection. This was demonstrated in KwaZulu-Natal, which had the highest inspection rate and the least percentage of interviewees admitting to disobeying the regulations, and they had the best knowledge of the regulations. It is therefore suggested that efforts should be made to improve law enforcement along the rest of the coast, and to attempt to move towards the system of shore patrols conducted by the NPB (Coetzee 1993).

The introduction of an angling licence has been shown to reduce angling effort in the USA (O'Malley and Crawford 1995), and the present study shows that the majority of South African shore-anglers would agree with such an undertaking, provided the funds generated were used to improve the fishery. However, McGrath *et al.* (1997) noted that, for South Africa, the introduction of an angling licence would probably not reduce current fishing effort. The major advantages of the licencing system lies in the accurate determination of the number of anglers and its potential for funding fisheries research and development.

A total of 4.7% of interviewees fished for their livelihood (subsistence anglers), either relying on fish for food and/or to exchange for other goods (McGrath *et al.* 1997). Although subsistence fishing is therefore a small component of South African angling effort, it represents approximately 20 000 households that are below the breadline and dependent on shore-fishing to contribute to their daily needs (McGrath *et al.* 1997). It is interesting to note that, as subsistence anglers primarily catch *S. salpa* and other small fish species which are easy to catch, there is probably little competition between subsistence and recreational anglers in terms of species targeted.

This study has shown that the current fisheries regulations are being ignored by many shore-based anglers, thereby rendering them ineffective. For example, the current bag limits were designed primarily to reduce fishing mortality on heavily fished species. In many fisheries worldwide, this restriction has been proved to be politically more acceptable than other regulations, with few recreational anglers being able to justify the need to keep large numbers of fish (Porch and Fox 1991). However, at the time of their implementation in South Africa, there was no clear scientific basis to assign a bag limit correctly to a particular species (Attwood and Bennett 1995). As a result, many of the bag limits are too large to offer any protection to the species they aim to protect. This results in few anglers reaching the bag limit and no fish being released, a problem noted by Bennett

(1993) and Attwood and Bennett (1995). Furthermore, the present regulation of a minimum size limit allows the retention of the largest individuals, which are often the most fecund (Brousseau and Armstrong 1987). Certainly, a maximum size limit may be preferable for some species, although enforcement may prove to be a difficult task.

Because many of the current regulations appear to be less effective than envisaged, alternative restrictions are necessary. Marine Protected Areas (MPAs), where no fishing is allowed, is one such alternative. Ongoing MPA research in South Africa has shown that protected areas are particularly effective in protecting long-lived, slow-growing, resident teleosts (Buxton 1993) and in seeding adjacent areas by emigration of adult fish (Attwood and Bennett 1994). Another important function of MPAs is that they provide protection for the whole ecosystem, following the World Conservation Union (IUCN) principles of habitat protection rather than single species protection (Buxton 1987). The present study shows that existing marine reserves are widely accepted (84.5%) by South African shore-anglers. Comparisons with research fishing in the Tsitsikamma National Park demonstrates that the *cpue* in that MPA is higher (5.6 kg·angler^{-1}·day^{-1}, P. Cowley, Rhodes University, unpublished data) than the average *cpue* found in this study (0.926 kg·angler^{-1}·day^{-1}). Marine reserves are easy to police and few anglers admitted to poaching in reserves (9.3%). The response to closing new areas, however, was not tested and may prove contentious.

CONCLUSION

The present study and work by McGrath *et al.* (1997) have shown the magnitude and importance of the recreational shore-fishing sector in South Africa, and have highlighted the poor understanding of this fishery. Long-term catch-and-effort data are scarce, anglers' knowledge and compliance with the regulations is limited and policing (except in KwaZulu-Natal) is poor. It is suggested that a long-term monitoring programme, similar to the one presented here, be undertaken every 4–5 years in order to provide catch-and-effort data. The survey could also be used to assess the effectiveness of an angler education programme and of law enforcement along the coast. That many shore-anglers are willing to pay a licence fee is encouraging, and such fees could be channelled to funding many of the costs of research and management of the shore- and other fisheries.

ACKNOWLEDGEMENTS

We thank the numerous individuals who assisted with the fieldwork especially Mr B. van der Walt in KwaZulu-Natal, and all the anglers who cooperated so willingly during this survey. The pilots of the aircraft and helicopter, especially Capt. D. Hilland of Court Helicopters, and Messrs D. Gerneke, P. Buschel, W. Waldeck andE. Le Roux are acknowledged for their assistance with the aerial surveys. We also thank all those people who accommodated us during the survey, especially Cape Nature Conservation and the Natal Parks Board. We thank Dr M. H. Griffiths and Mr C. G. Attwood (both of the Sea Fisheries Research Institute) for reviewing previous drafts of this manuscript and Mr Attwood for statistical advice. We also thank Ms S. Abraham of Rhodes University for the art work. Funding for this research wasadministered by the Sea Fisheries Research Institute.

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APPENDIX

Shore-angling questionnaire

SECTION A: (Catch and effort data)

Questionnaire number:_____

Locality:_____ Date:_____ Time:_____ Number of rods:_____ Beach vehicle:_____

Bait: Sardine_____ Squid_____ Prawn_____ Red bait_____ Other_____

What time did you start fishing?_____

What are the three main species you try to catch?_____

SECTION B: (Angler information)

Angler age: _____ Sex:_____ Code:_____ Club affiliation:_____

How many days have you been fishing in the last week,_____ month_____, year_____

Do you fish at night?_____ If YES, how often in the last 12 months?_____

How many years have you been fishing for?_____

Which stretch of coast do you normally fish?_____

SECTION C: (Economic information)

What is your occupation (write in detail):_____

Where do you live (postal code)?_____

Are you on an overnight, weekend or longer trip/holiday? YES / NO

If YES, where are you staying (Postal code)?_____

What method of transport did you use to come on this trip?_____

How many people came with you? _____ How many of them will fish?_____

How many days will you spend away from home on this trip?_____ How many days will you fish?_____

What is the estimated cost of your trip (for all members, excluding your transport costs)?_____

How far did you come fishing today (kilometres one way)?_____

What method of transport did you use (describe vehicle type, model etc.)?_____

If NOT OWN vehicle what were your transport costs?_____

If OWN vehicle how many people came with you? _____ How many of them will fish?_____

How much did you spend this outing on: Bait?_____ Refreshments?_____ Other?_____

How much have you spent on tackle in the last month? _____

How much have you spent on rods and reels in the last 12 months? _____

What is the estimated value of all your shore angling equipment (ie what would they sell for)?
Beach vehicle?_____ Rods?_____ Reels?_____ Tackle?_____
Is your beach vehicle used exclusively for fishing?_____
Why do you fish? Food_____Recreation_____Competition_____Livelihood_____Other (specify)_____

SECTION D: (Angler attitudes)

Which of the following regulations, in your opinion, are effective ways of managing our fish stocks?
Minimum size limits?_____ Bag limits?_____ Closed seasons_____ Marine reserves?_____
Do you obey these regulations? (Ask each regulation specifically eg. Have you ever kept an undersized fish?)
Minimum size limits?_____ Bag limits?_____ Closed seasons_____ Marine reserves?_____
Have you ever sold your catch?_____
There are other possibly ways to manage a fishery, would you support a:
Limited access system?_____ Maximum size limit?____ Licensing system?_____ if YES, how much?_____
Has the fishing deteriorated over the years? YES \ NO. If YES, What has cased this decline?
Pollution_____Gill netting____ Trawling____Commercial linefishing ____ Ski-boats (recreational)_____
Shore angling_____ Other (specify)_____
Do you do any other type of angling (specify)?_____ Is angling you major sport?_____
Have you ever tagged a fish? _____ Have you ever caught a tagged fish before?_____
What did you do with the tag?_____
Test questions:

Species			
Minimum size			
Bag limit			
Closed season			

When was the last time your catch was inspected by a fisheries officer?_____