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ASSESSMENT OF THE LINEFISHERY IN TWO URBAN ESTUARINE SYSTEMS IN KWAZULU-NATAL, SOUTH AFRICA

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The recreational linefisheries in Durban Harbour and the Mgeni Estuary were surveyed using roving creel and access-point surveys during the period January–December 2000. In total, 3 351 shore-anglers and 652 boat-anglers were checked for catch-and-effort information, and 432 shore-anglers were interviewed using a demographic and socio-economic questionnaire. Durban Harbour had much higher angling effort than the Mgeni Estuary. Angling activity was higher on weekends (121 and 23 anglers per count for the harbour and Mgeni Estuary respectively) than during the week (34 and 9 anglers per count respectively). Total effort expended in Durban Harbour and the Mgeni Estuary shore-fisheries during 2000 was estimated to be 54 024 and 11 977 angler-outings respectively. Annual effort for the Durban Harbour boat-fishery for the same period was estimated to be 9 991 angler-outings. The flathead mullet *Mugil cephalus* was the most commonly harvested species in both Durban Harbour and the Mgeni Estuary shore-fisheries (25.2 and 68.1% respectively), and spotted grunter *Pomadasys commersonnii* (41.5%) was the most commonly harvested species in the Durban Harbour boat-fishery. Because of their small size, a large proportion (>63%) of the total fish catch at both localities was released. Mean catch per unit effort for the Durban Harbour boat-based fishery (0.11 fish angler^{-1} h^{-1} or 0.15 kg angler^{-1} h^{-1}) was higher than that of the shore-based fishery (0.071 fish angler^{-1} h^{-1} or 0.034 kg angler^{-1} h^{-1}). The questionnaire survey indicated that anglers had high site fidelity, considerable years of fishing experience (mean of 17.2 years for the harbour, 13.6 years for Mgeni) and high compliance with possession of fishing permits (86% harbour, 84% Mgeni). Although anglers generally supported the regulations currently applicable to the linefishery (>71% harbour, >77% Mgeni), the questionnaire results showed that specific knowledge for target species was poor (45–70% harbour, 29–60% Mgeni). The level of fisheries law enforcement (6.4% of harbour outings inspected, 7% Mgeni outings inspected) was poorer than in the previously studied KwaZulu-Natal marine shore-fishery. Economic investment by participants in terms of angling equipment used in the shore-fisheries of the two systems was calculated to be >R10 million, and expenditure in terms of bait, travel and tackle costs was approximately R9 million per year.

Key words: catch and effort, catch composition, Durban Harbour, linefishery, Mgeni Estuary, socio-economics

On a global scale, marine recreational angling is an extremely popular pursuit (Hickley and Tompkins 1998). Along the South African coastline, angling is also widely practised, with an estimated 412 000 participants in the shore-fishery (McGrath *et al*. 1997) and 13 800 in the offshore boat-based fishery (Sauer *et al*. 1997).

The coastline of South Africa is exposed to rough seas and has few inlets and sheltered bays, resulting in estuaries being much sought-after for recreation, resource utilization and tourism, particularly as some South African estuaries are located in, or close to, cities. Similarly, in Australia, recreational marine linefishing is popular in estuaries, harbours and urban areas (Caputi 1976, Jones 1981, Jones and Retallick 1990, Pearn and Cappellutti 1999). Despite several South African estuaries being highly accessible, the various spatial and geographic features of the 250 estuaries along the coast make an appraisal of the national estuarine linefishery extremely difficult.

There is limited information on the linefishery for some of the larger estuarine systems in the Eastern Cape and KwaZulu-Natal (Marais and Baird 1980, Guastella 1994, Baird *et al*. 1996, James *et al*. 2001, Pradervand and Baird 2002, Mann *et al.* 2002). Those studies focussed primarily on the determination of catch, with little attention being given to the quantification of angling effort, socio-economics or anglers' attitudes towards fishery regulations. The aim of the present study was to evaluate participation in the linefishery in two urban estuaries (Durban Harbour and the Mgeni Estuary), so complementing the first national survey of the South African linefishery (Brouwer *et al*. 1997, Mann *et al*. 1997a, 2003, McGrath *et al*. 1997, Sauer *et al*. 1997, Fennessy *et al.* 2003), from which estuarine linefishing was excluded.

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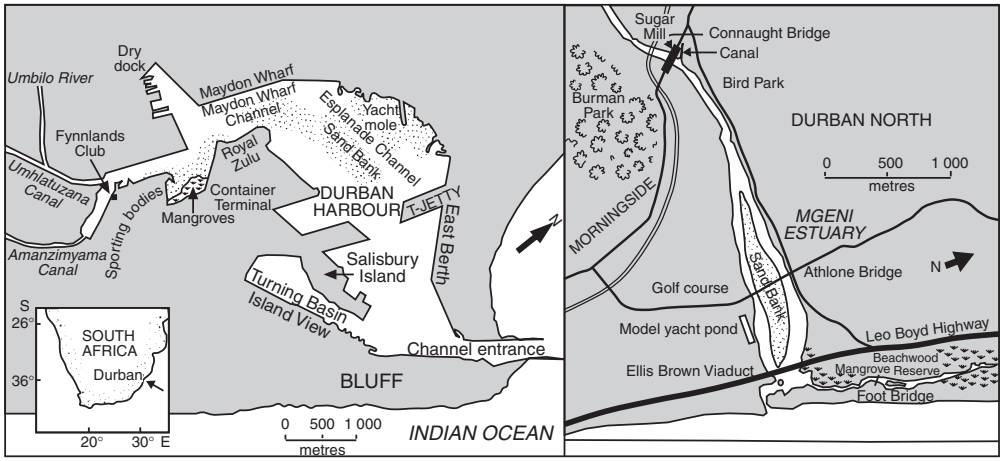

Fig. 1: Maps of Durban Harbour and the Mgeni Estuary

MATERIAL AND METHODS

Study areas

Durban Harbour and the Mgeni Estuary are two of 14 estuaries located within the Tongaat River to Umkomaas River boundaries of the Durban Unicity (Harrison *et al*. 2000). Durban Harbour (29°53´S, 31°00´E) is a large estuarine embayment located in immediate proximity to Durban city centre (Fig. 1). It has several canalized rivers entering it, a mean tidal range of 1.8 m, and a water surface area of 892 hectares at high tide (Begg 1978). The 21-km shoreline perimeter consists mainly of high wharves (>3 m), several low-level groynes and a series of extensive sandbanks that are exposed at low tide. Durban Harbour is a modern, well-equipped and highly industrialized port, and one of the busiest in Africa.

In contrast, the Mgeni Estuary (29°48´S, 30°02´E; Fig. 1) is situated about 5 km from the city centre in the north-eastern suburbs. Although extensive residential and industrial development has taken place at the head of the estuary, the 2.5-km long estuary retains a fairly natural ambience, with well-vegetated banks and open salt marshes (Begg 1978). The Beachwood mangrove reserve is located north of the mouth of the estuary.

Both shore- and boat-based angling are popular activities within the harbour. Although prohibited by the port authority since 1991 (Guastella 1994), shore-angling is still practised from the numerous wharves, groynes and extensive sandbanks in most areas of the harbour, with the exception of the container terminal, Salisbury Island and Island View areas (Fig. 1), from which anglers are strictly excluded. Boat-angling is permitted by the port authority and is normally conducted from small boats powered by outboard motors. There are distinct competitive and non-competitive components to the boat-fishery.

On the other hand, the Mgeni Estuary is open primarily to shore-based anglers, because motorized boats are not permitted on the estuary and it is generally too shallow to accommodate them. Shore-anglers fish from all areas along the estuary, barring those areas where private property prevents easy access to the water's edge. No major angling tournaments take place at this estuary.

Shore-angling roving creel survey

The Durban Harbour and Mgeni Estuary shore-based linefisheries were surveyed using a roving-creel survey (progressive count) in accordance with methods developed in North America (Malvestuto *et al*. 1978, Malvestuto 1983, Essig and Holliday 1991) and in South Africa (Brouwer *et al*. 1997). In the harbour, two researchers patrolled a 13 km predetermined route extending from the entrance channel along the east, north and west banks to the Royal Zulu site at the border of the container terminal (no public access) on

four days each month during the period January–December 2000. On the same days, the two researchers patrolled a 3.5 km predetermined route from the Mgeni Estuary mouth along the south bank to the Athlone Bridge, then along the north bank to the Connaught Bridge. A stratified random sampling strategy was selected with two weekdays and two weekend days per month selected *a priori* for the 12-month sampling period. Surveys were undertaken irrespective of weather conditions during daylight hours (07:00–17:00). Starting time was randomized according to morning or afternoon patrols and the direction of patrols was alternated each survey day. No night patrols were conducted because of personal security concerns. All anglers observed during the patrols were counted, their demographics noted, and accessible anglers were asked for information on time spent fishing, fish caught (both retained and released) and angling method (bait, lure, fly). All fish retained by anglers were identified and measured (total length) by the researchers. Mass estimates of retained fish were determined using standard length/mass regressions (Mann 2000).

Boat-angling survey

In addition to surveying the shore-based fishery, information on the boat-based fishery in Durban Harbour was collected. Counts of fishing boats were performed during the course of the roving creel survey, because the area utilized by boat-anglers was adequately visible from the survey route. Catch-and-effort data of boat-anglers were obtained during an access-point survey after the one-day (6 h) angling competition hosted each month by the Fynnlands Angling Club in Durban Harbour.

Estimation of effort, catch per unit effort and total catch

SHORE-FISHERY

Total instantaneous effort on weekdays (E_{tw}) was calculated as:

$$E_{tw} = E_w \times W_d \quad , \qquad (1)$$

where E_w is the mean number of anglers recorded on weekday counts and W_d is the number of weekdays in the year 2000.

Total instantaneous effort on weekends (E_{twe}) was calculated as:

$$E_{twe} = E_{we} \times W_e \quad , \qquad (2)$$

where E_{we} is the mean number of anglers recorded on weekend day counts and W_e is the number of weekend days in the year 2000.

Total instantaneous effort ($E_{outings}$) in terms of individual angler outings is given by

$$E_{outings} = E_{tw} + E_{twe} \quad . \qquad (3)$$

As recommended by Pollock *et al*. (1994), instantaneous effort values were then expanded to represent total effort values in terms of individual angler-outings in a 24 h period ($E_{Toutings}$) by incorporating the turnover rate of 2.43 anglers 24 h^{-1} calculated for the national shore-fishery (Brouwer *et al*. 1997):

$$E_{Toutings} = E_{outings} \times 2.43 \quad . \qquad (4)$$

Total effort values in terms of angling hours (E_{Th}) was calculated as follows:

$$E_{Th} = E_{Toutings} \times a_i \quad , \qquad (5)$$

where a is the indicated average duration of angler outings (h) in locality i (see questionnaire survey).

Catch per unit effort (*cpue*) is given by:

$$Cpue = \frac{\sum_{i=1}^{n} \left(C_i / E_i \right)}{n} \quad , \qquad (6)$$

where C_i is the number or mass (kg) of fish retained by the ith angler, E_i the effort expended by the ith angler and n is the number of anglers sampled. Released fish were not included in *cpue* calculations, because of the unreliability of angler reports.

Total catch was estimated by multiplying total effort (E_{Th}) by *cpue*, i.e.:

$$C_{total} = cpue \times E_{Th} \quad . \qquad (7)$$

Total participation values in terms of the number of anglers that fished at each locality during 2000 (N_T) were calculated by apportioning indicated angler effort (in terms of the number of outings to the respective localities in the 12 months prior to the date of the interview) obtained from the questionnaire survey (see later) into distribution categories (i), i.e.:

0–20 outings $i = 1$
21–40 outings $i = 2$
41–60 outings $i = 3$, etc.,

and applying the equation

$$N_T = \sum \frac{\left(b_i / c \times 100 \right) \times E_{Toutings}}{d_i} \quad , \qquad (8)$$

where b is the number of interviewees in category i,

Table I: Summary of recreational fishing effort sampled during shore patrols in Durban Harbour and the Mgeni Estuary from January to December 2000. *Cpue* data for boat-fishing effort was sampled during an access-point survey at the Fynnlands boat ramp

Parameters	Shore-fishery		Boat-fishery
	Durban Harbour	Mgeni Estuary	Durban Harbour
Number of patrols	48	47	48
Number of anglers encountered	3 705	752	1 171
Number of anglers checked (*cpue* data)	2 742	609	652
Hours of fishing checked (*cpue* data)	4 563	962	3 912
Number of anglers interviewed (questionnaire)	344	88	–

c the total number of interviewees and d the average number of outings in category i (see Appendix I).

BOAT-FISHERY

The same procedure for the shore-fishery was applied to the boat-fishery, although a lower turnover of only 1.5 anglers 24 h^{-1} was utilized in Equation 4. A lower turnover for the boat-fishery was used, because observed boat-angling effort in Durban Harbour was always higher during mornings, with fewer launches in the afternoons and evenings. This was attributed to the higher wind speeds that generally prevail in the afternoons along the KwaZulu-Natal coast (Hunter 1989). Further, boat-angling competitions in the harbour were restricted to the period 06:00–12:00. Average duration of boat-outings (a) was taken as 6 h in Equation 5. This value was obtained from the access-point survey of boat-anglers (see later). The number of angling-boats was obtained by dividing the total estimated number of boat-anglers by the mean crew size per boat (obtained from the access-point survey).

Questionnaire survey

Anglers were also subjected to a socio-economic questionnaire (Appendix II) to collect information on demographics, fishing effort, knowledge of and compliance with fisheries regulations, and expenditure incurred in fishing. These interviewees were randomly intercepted, and not all anglers encountered were interviewed. If a group of anglers was intercepted, only one angler in the group was subjected to the questionnaire. Calculation of the expenditure associated with the estuarine fishery was restricted to direct costs related to estuarine angling, although the equipment could also be used for other types of angling (i.e. marine shore-angling). Travelling costs from the anglers' places of residence were calculated using the standard Automobile Association rate of R0.76 per km, and these were expressed on an individual angler basis.

RESULTS

Shore-angling roving creel survey

A total of 48 patrols was undertaken around Durban Harbour and 47 along the Mgeni Estuary from January 2000 to December 2000 (Table I, Fig. 2). In all, 3 705 and 752 shore-anglers were counted at the two localities respectively, with 74% of those in the harbour and 81% of those along the Mgeni Estuary volunteering *cpue* information.

The harbour was utilized far more extensively as an angling venue than the Mgeni Estuary, and weekend angling pressure was substantially higher than during the week (Table II, Fig. 2). Weekday shore patrols in the harbour had an average of 34 anglers per count and weekend patrols an average of 121 anglers, whereas patrols on the estuary averaged 9 anglers per count for

Table II: Recorded angling effort in terms of mean, minimum and maximum number of shore-anglers, boat-anglers and angling boats counted during shore patrols at each locality on weekdays and weekend days (January–December 2000)

Time	Mean	*SD*	Min	Max	*n*
Durban Harbour (shore-anglers)					
Weekday	33.8	19.0	12	80	24
Weekend	120.6	75.2	44	300	24
Durban Harbour (boat-anglers)					
Weekday	8.1	6.2	0	23	24
Weekend	40.7	29.4	0	108	24
Mgeni Estuary (shore-anglers)					
Weekday	9.1	9.7	0	33	24
Weekend	23.2	21.5	2	77	23
Durban Harbour (angling boats)					
Weekday	3.5	2.7	0	10	24
Weekend	17.7	12.8	0	47	24

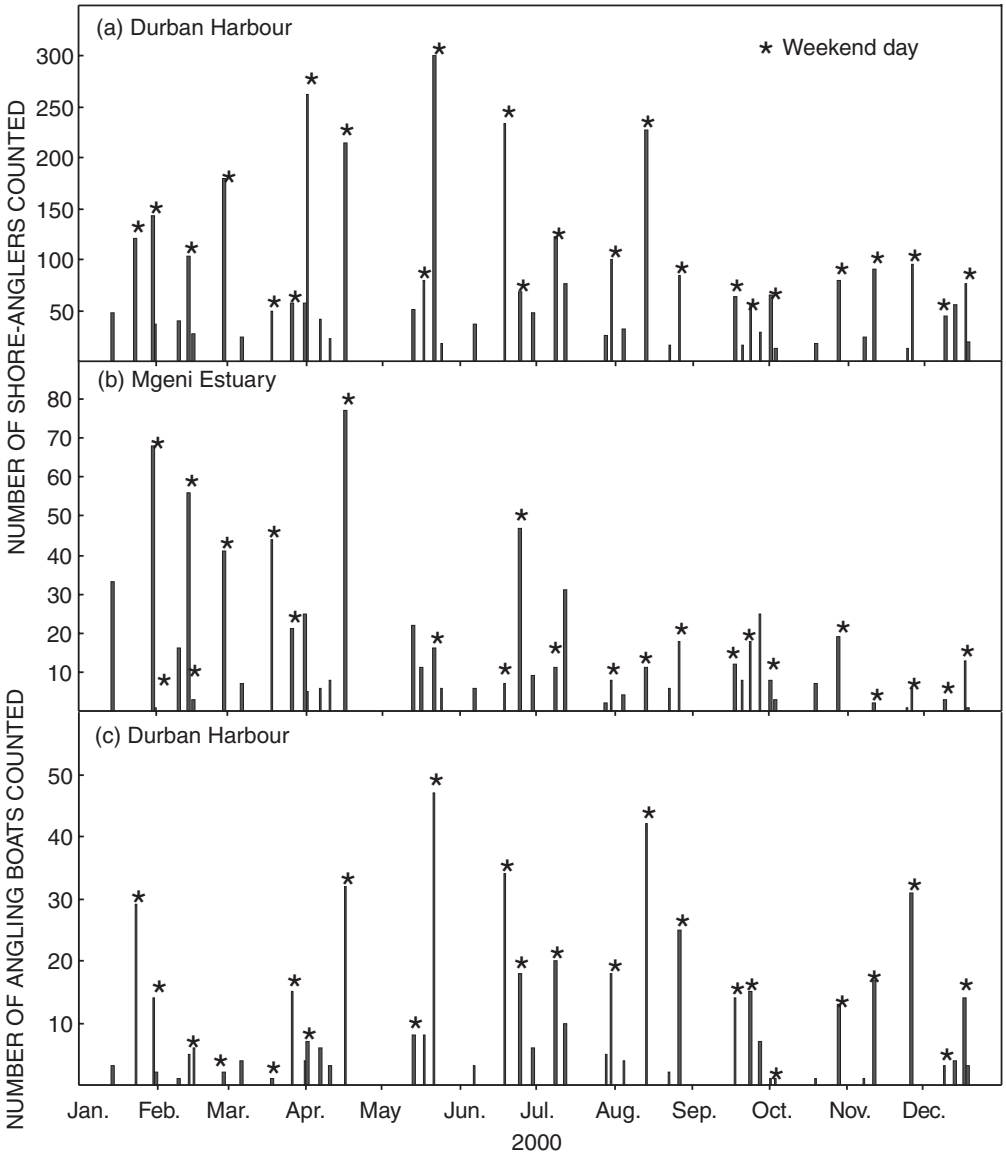

Fig. 2: Number of shore-anglers counted at (a) Durban Harbour and (b) the Mgeni Estuary, and (c) number of angling boats at Durban Harbour recorded during shore patrols in 2000

weekdays and 23 anglers for weekends. The number of shore-anglers recorded per count was generally lower during spring in both Durban Harbour and the Mgeni Estuary (Fig. 2).

The harbour shore-fishery was dominated by Indian males (67.6%), and the most popular method of fishing was with rods (95.6%), using baited hooks (96.9%, Table III). The Mgeni shore-fishery was also dominated

by Indian males (74.1%) fishing with rods (90.7%) and bait (98.3%). Handlines were used by 4.4% of anglers in the harbour and 9.3% of anglers in the estuary. Flyfishing and fishing with lures was poorly subscribed, with only 2.5 and 0.6% of anglers encountered respectively using these techniques in the harbour, and 1.5 and 0.2% of anglers respectively in the estuary. The majority of anglers at both sites were between the ages of 21 and 40 years.

In all, 36 fish species representing 25 families were positively identified in shore-anglers' catches in Durban Harbour (Table IV), with another 12 species being reported by the respondents themselves as fish they had released. No single species dominated the catches, flathead mullet *Mugil cephalus* (25.2%), white karanteen *Crenidens crenidens* (15.1%), spotted grunter *Pomadasys commersonnii* (10.5%) and river bream *Acanthopagrus berda* (5.9%) being the most commonly retained species. In terms of mass, *M. cephalus* (23.9%), *P. commersonnii* (19.3%), Natal stumpnose *Rhabdosargus sarba* (7.8%) and diamond mullet *Liza alata* (7.5%) made up the majority of the retained catch. In the Mgeni Estuary, 22 species from 11 families were identified by the researchers, with an additional eight species reported by anglers (Table IV). *M. cephalus* (68.1%) dominated the retained catch by number, followed by *P. commersonnii* (6.4%), *Acanthopagrus berda* (6.4%) and Leiognathidae (5.3%). In terms of mass, *M. cephalus* (41%), sharptooth catfish *Clarius gariepinus* (24.8%), *P. commersonnii* (8.4%) and slender giant moray *Thrysoidea macrura* (6.2%) constituted most of the retained catch. Length frequency distributions of the most commonly retained species are given in Figure 3. In the harbour shore-fishery, 31% of the retained catch of *P. commersonnii* and 50% of the retained catch of *A. berda* were less than the legal minimum size.

Boat-angling survey

In total, 24 weekday and 24 weekend day boat counts were carried out in Durban Harbour from January 2000 to December 2000, and a total of 509 angling boats with 1 171 anglers was counted (Table I). A total of 296 boat-angling outings, representing the catches by 652 anglers during 3 912 hours of fishing, was inspected after 12 boat-angling competitions (one per month). Boat-angling effort was substantially higher over the weekends than during the week (Table II), with a mean of 18 boats per weekend day count and a mean of four boats per weekday count. Unlike shore-angling, boat-angling had no clear seasonal trend in effort (Fig. 2).

A total of 38 fish species representing 21 families was positively identified in the catches retained by boat-anglers in Durban Harbour (Table IV). By number, the most commonly retained species were *P. commersonnii* (41.5%), largemouth queenfish *Scomberoides commersonnianus* (9.9%), *R. sarba* (6.7%) and torpedo scad *Megalaspis cordyla* (6.5%). By mass, the retained catch was composed mostly of *P. commersonnii* (40.3%), *S. commersonnianus* (18.4%), ladyfish *Elops machnata* (9.5%) and bigeye kingfish *Caranx sexfasciatus* (5.8%). Only a few of the retained fish were smaller than the legal minimum size limit (e.g. 7.6% of retained *P. commersonnii* were undersized, Fig. 3).

Effort, *cpue* and total catch

Using instantaneous effort values, the total effort expended in the Durban Harbour shore-fishery during 2000 was estimated at 22 232 angler-outings. Incorporating a turnover value of 2.43 increased this estimate to 54 024 angler-outings (equating to approximately 232 303 angling hours). Using the effort estimate of

Table III: Demographics of anglers counted during shore patrols at each locality in terms of race and gender. Values in parenthesis are percentage values of the total number of anglers checked at each locality

Locality	Race and gender													
	White			Black			Indian			Coloured			Total	
	M	F	T	M	F	T	M	F	T	M	F	T	M	F
Durban Harbour	817 (24.2)	52 (1.6)	869 (26.4)	73 (2.2)	1 (<0.1)	74 (2.3)	2 063 (61)	160 (4.7)	2 223 (67.6)	119 (3.5)	3 (0.1)	122 (3.7)	3 072 (93.4)	216 (6.6)
Mgeni Estuary	33 (4.4)	2 (0.3)	35 (4.7)	66 (8.9)	0 (0)	66 (8.9)	550 (74.1)	17 (2.4)	567 (76.4)	70 (9.4)	4 (0.5)	74 (10.1)	719 (96.9)	23 (3.1)

M = Male
F = Female
T = Total

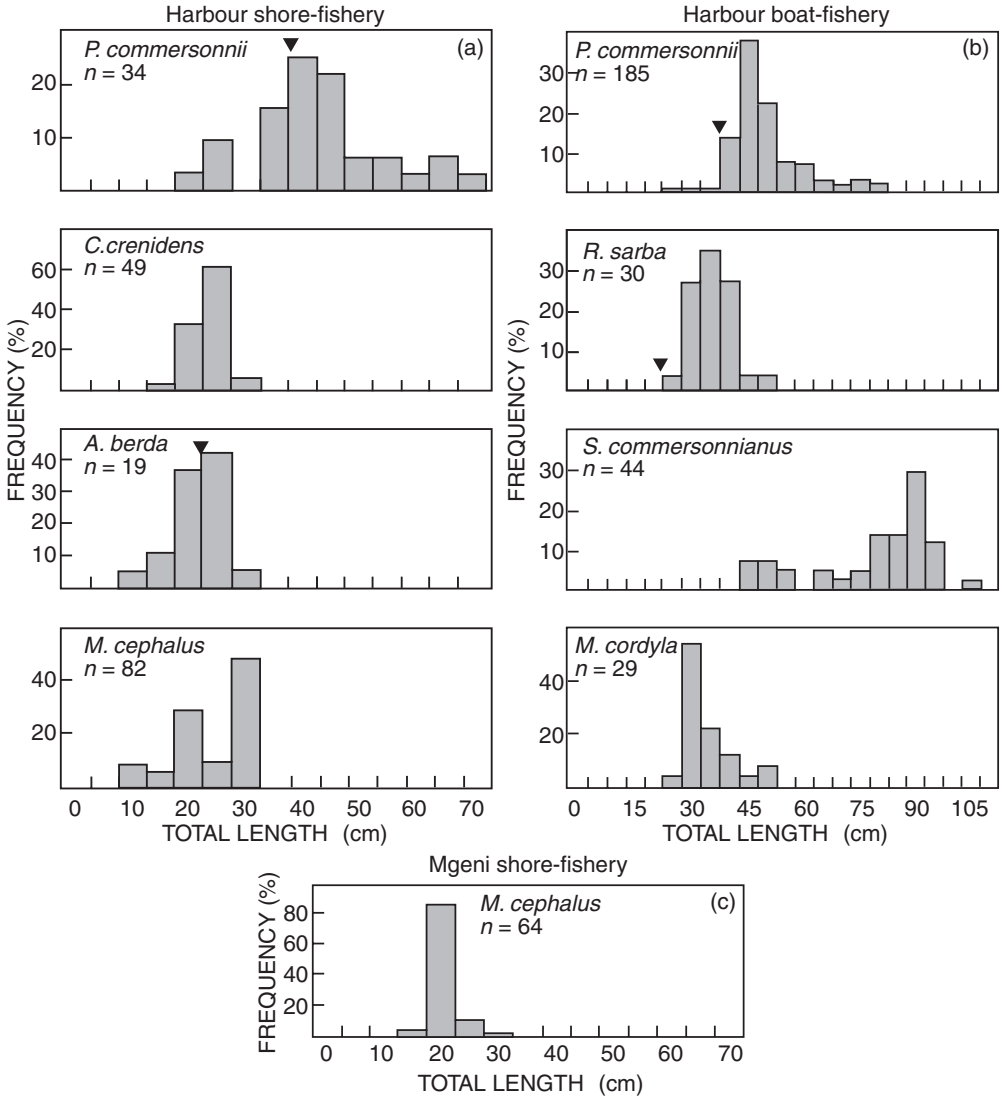

Fig. 3: Length frequency distributions of the most commonly caught species in (a) the Durban Harbour shore-fishery, (b) the Durban Harbour boat-fishery and (c) the Mgeni Estuary shore-fishery during 2000. Arrows indicate minimum size limits where applicable

54 024 angler-outings, the number of participants in the shore-fishery during 2000 was estimated at 4 881 anglers (Appendix I). Total effort expended in the boat-fishery based on instantaneous effort values was 6 661 angler outings. Incorporating a turnover value of 1.5 resulted in a total effort estimate of 9 991 angler-outings, or 4 344 boat-outings, representing 59 946 hours of fishing. Using the effort estimate of 9 991 an-

Table IV: Species composition of recorded catches by shore- and boat-anglers in Durban Harbour and shore-anglers in the Mgeni Estuary from January to December 2000. Results are presented in terms of total number of fish recorded (Total no.), total number of fish retained (No. kept), and total mass of fish retained (Mass). Percentage of total retained catch is given in parenthesis. Species are arranged according to Smith and Heemstra (1986)

Family	Species	Common name	Harbour shore-anglers			Harbour boat-anglers			Mgeni shore-anglers		
			Total no.	No. kept	Mass (kg)	Total no.	No. kept	Mass (kg)	Total no.	No. kept	Mass (kg)
Rhinobatidae	*Rhinobatos annulatus*	Lesser sandshark				1 (0.1)	0	–	7 (2.1)	2 (2.1)	1.0 (3.1)
Dasyatidae	*Himantura gerrardi*	Brown stingray				1 (0.1)	1 (0.2)	1.5 (0.3)			
Elopidae	*Elops machnata*	Ladyfish	4 (0.4)	2 (0.6)	6.5 (4.3)	15 (0.9)	15 (3.4)	55.0 (9.5)			
Albulidae	*Albula vulpes*	Bonefish	2 (0.2)	2 (0.6)	0.4 (0.3)						
Muraenidae	*Thyrsoidea macrura*	Slender giant moray	6 (0.7)	1 (0.3)	2.0 (1.3)	7 (0.4)	1 (0.2)	2.0 (0.4)	2 (0.6)	1 (1.1)	2.0 (6.2)
Clupeidae	*Hilsa kelee*	Kelee shad	10 (1.1)	9 (2.8)	2.5 (1.6)						
Synodontidae	*Synodus indicus*	Indian lizardfish	1 (0.1)	0	–	2 (0.1)	0	–	1 (0.3)	0	–
Belonidae	Unidentified	Needlefish	1 (0.1)	0	–						
Platycephalidae	*Platycephalus indicus*	Bartail flathead	48 (5.3)	0	–	40 (2.5)	17 (3.8)	16.5 (2.9)	2 (0.6)	1 (1.1)	0.3 (0.9)
Ambassidae	*Ambassis* spp.	Glassy	2 (0.2)	0	–				6 (1.8)	0	–
Kuhliidae	*Kuhlia mugil*	Barred flagtail				1 (0.1)	0	–			
Serranidae	*Epinephelus andersoni*	Catface rockcod	2 (0.2)	0	–	15 (0.9)	3 (0.7)	3.4 (0.6)			
	Epinephelus coioides	Orangespotted rockcod	1 (0.1)	0	–	9 (0.6)	5 (1.8)	2.9 (1.5)			
	Epinephelus marginatus	Yellowbelly rockcod	1 (0.1)	0	–						
	Epinephelus spp.	Unspecified rockcod				54 (3.3)	0	–	1 (0.3)	0	–
Teraponidae	*Terapon jarbua*	Thornfish	2 (0.2)	0	–	3 (0.2)	0	–	26 (7.6)	0	–
Pomatomidae	*Pomatomus saltatrix*	Elf	7 (0.8)	7 (2.2)	3.4 (2.2)	11 (0.7)	1 (0.2)	0.6 (0.1)	1 (0.3)	1 (1.1)	0.6 (1.9)
Haemulidae	*Pomadasys commersonnii*	Spotted grunter	134 (14.8)	34 (10.5)	29.5 (19.3)	551 (34.0)	185 (41.5)	233.6 (40.3)	34 (9.9)	6 (6.4)	2.7 (8.4)
	Pomadasys kaakan	Javelin grunter	11 (1.2)	9 (2.8)	0.9 (0.6)	96 (5.9)	7 (1.6)	3.9 (0.7)			
	Pomadasys maculatum	Saddle grunter	5 (0.6)	2 (0.6)	0.7 (0.5)	155 (9.6)	0	–			
	Pomadasys multimaculatum	Cock grunter	6 (0.7)	2 (0.6)	3.3 (2.2)	151 (9.3)	6 (1.4)	8.2 (1.4)			
	Pomadasys olivaceum	Piggy	23 (2.5)	4 (1.2)	0.1 (0.1)						
	Pomadasys spp.	Unspecified grunter	17 (1.9)	0	–				7 (2.1)	0	–
Lutjanidae	*Lutjanus* spp.	Unspecified snapper	2 (0.2)	0	–						
Sparidae	*Acanthopagrus berda*	River bream	41 (4.5)	19 (5.9)	3.6 (2.4)	9 (0.6)	2 (0.5)	0.8 (0.1)	39 (11.4)	6 (6.4)	1.3 (4.0)
	Crenidens crenidens	White karanteen	73 (8.0)	49 (15.1)	8.9 (5.8)	2 (0.1)	2 (0.5)	0.1 (<0.1)			
	Diplodus sargus capensis	Blacktail	34 (3.7)	5 (1.5)	1.1 (0.7)	5 (0.3)	1 (0.2)	0.8 (0.1)			
	Diplodus cervinus hottentotus	Zebra	8 (0.9)	0	–	2 (0.1)	0	–	6 (1.8)	0	–
	Rhabdosargus holubi	Cape stumpnose	2 (0.2)	0	–				2 (0.6)	1 (1.1)	0.1 (0.3)
	Rhabdosargus sarba	Natal stumpnose	21 (2.3)	12 (3.7)	12 (7.8)	38 (2.4)	30 (6.7)	24.6 (4.3)	1 (0.3)	1 (1.1)	0.3 (0.9)
	Rhabdosargus spp.	Unspecified stumpnose	8 (0.9)	0	–						
	Sarpa salpa	Karanteen	2 (0.2)	0	–	1 (0.1)	0	–	1 (0.3)	0	–
Monodactylidae	*Monodactylus falciformis*	Cape moony	26 (2.9)	3 (0.9)	0.4 (0.3)				1 (0.3)	0	–
Gerreidae	*Gerres* spp.	Pursemouth	16 (1.8)	14 (4.3)	3.6 (2.4)						
Ephippidae	*Platax pinnatus*	Dusky batfish				1 (0.1)	0	–			
Drepanidae	*Drepane longimanus*	Concertina fish				16 (1.0)	12 (2.7)	5.6 (1.0)			
Sillaginidae	*Sillago sihama*	Silver sillago	15 (1.7)	13 (4.0)	2.3 (1.5)	38 (2.4)	3 (0.7)	0.9 (0.2)			

(continued)

(Table IV: continued)

Family	Species	Common name	Harbour shore-anglers			Harbour boat-anglers			Mgeni shore-anglers		
			Total no.	No. kept	Mass (kg)	Total no.	No. kept	Mass (kg)	Total no.	No. kept	Mass (kg)
Sciaenidae	*Argyrosomus japonicus*	Dusky kob	18 (2.0)	8 (2.5)	1.8 (1.2)	9 (0.6)	5 (1.1)	10.9 (1.9)			
	Argyrosomus thorpei	Squaretail kob	5 (0.6)	3 (0.9)	1.5 (1.0)	32 (2.0)	8 (1.8)	4.4 (0.8)			
	Johnius dussumieri	Small kob				2 (0.1)	0	–			
	Otolithes ruber	Snapper kob	26 (2.9)	5 (1.5)	2.6 (1.7)	47 (2.9)	25 (5.6)	14.2 (2.5)	11 (3.2)	2 (2.1)	0.6 (1.9)
	Unidentified	Unspecified kob	2 (0.2)	0	–	8 (0.5)	0	–			
Leiognathidae	*Leiognathus equula*	Slimy	145 (16.0)	6 (1.9)	1.1 (0.7)	39 (2.4)	0	–	37 (10.8)	5 (5.3)	0.9 (2.8)
Carangidae	*Alectis indicus*	Indian mirrorfish				4 (0.3)	4 (0.9)	5.6 (1.0)			
	Caranx ignobilis	Giant kingfish	4 (0.4)	4 (1.2)	3.2 (2.1)				1 (0.3)	0	–
	Caranx sem	Blacktip kingfish	3 (0.3)	3 (0.9)	3.2 (2.1)	3 (0.2)	2 (0.5)	2.8 (0.5)			
	Caranx sexfasciatus	Bigeye kingfish	3 (0.3)	3 (0.9)	7.3 (4.8)	8 (0.5)	8 (1.8)	33.6 (5.8)			
	Caranx spp.	Unspecified kingfish	2 (0.2)	0	–	13 (0.8)	7 (1.6)	6.6 (1.1)			
	Trachinotus botla	Largespot pompano							3 (0.9)	0	–
	Megalaspis cordyla	Torpedo scad	3 (0.3)	1 (0.3)	0.9 (0.6)	81 (4.9)	29 (6.5)	20.9 (3.6)			
	Scomberoides tol	Needlescaled queenfish	4 (0.4)	1 (0.3)	0.3 (0.2)	4 (0.3)	0	–			
	Scomberoides commersonnianus	Largemouth queenfish				49 (3.0)	44 (9.9)	106.8 (18.4)			
Pomacentridae	*Abudefduf* spp.	Damsel	2 (0.2)	2 (0.6)	0.6 (0.4)						
Labridae	Unidentified	Wrasse				2 (0.1)	0	–			
Mugilidae	*Mugil cephalus*	Flathead mullet	2 (9.0)	82 (25.2)	36.6 (23.9)	7 (0.4)	5 (1.1)	2.4 (0.4)	64 (18.7)	64 (68.1)	13.2 (41.0)
	Liza alata	Diamond mullet	13 (1.4)	13 (4.0)	11.5 (7.5)				1 (0.3)	1 (1.1)	1.0 (3.1)
	Liza tricuspidens	Striped mullet	4 (0.4)	4 (1.2)	1.2 (0.8)				7 (2.1)	0	–
	Unidentified	Unspecified mullet	56 (6.2)	0	–				23 (6.7)	0	–
Acanthuridae	*Acanthurus* sp.	Surgeon	1 (0.1)	1 (0.3)	0.3 (0.2)						
Trichiuridae	*Trichiurus lepturus*	Cutlassfish	3 (0.3)	2 (0.6)	0.8 (0.5)	36 (2.2)	4 (0.9)	1.2 (0.2)	1 (0.3)	0	–
Soleidae	Unidentified	Unspecified sole	1 (0.1)	0	–	27 (1.7)	10 (2.2)	2.9 (0.5)	1 (0.3)	0	–
Tetraodontidae	Unidentified	Toby				8 (0.5)	1 (0.2)	0.7 (0.1)	16 (4.7)	0	–
Cichlidae	*Oreochromis mossambicus*	Moçambique tilapia							1 (0.3)	1 (1.1)	0.2 (0.6)
Claridae	*Clarius gariepinus*	Sharptooth catfish							3 (0.9)	2 (2.1)	8.0 (24.8)
Other	Unidentified	Unidentified fish				4 (0.3)	0	–	36 (10.5)	0	–
Total			908	325	153.0	1 619	446	579.0	342	94	32.2

Table V: Fishing experience and frequency of shore-angling by interviewees in Durban Harbour and the Mgeni Estuary

Parameter	Durban Harbour (*SD*)	Mgeni Estuary (*SD*)
Years fished in estuaries	17.2 (13.1)	13.6 (13.5)
Years fished at locality	15.1 (13.3)	10.9 (13.5)
Proportion (%) of career fished at locality	87.4 (28.3)	83.7 (33.1)
Number of outings to locality (previous month)	4.1 (5.0)	3.4 (3.2)
Number of outings to locality (previous year)	36.2 (48.3)	30.4 (38.3)
Percentage of anglers fishing at night	49.6	34.1
Number of nights fished in last year	22.0 (36.9)	15.5 (18.5)
Proportion (%) of night-fishing in total effort	49 (30)	51 (32.6)

gler-outings, the number of anglers that fished from boats in the harbour during 2000 was calculated to be 1 561 anglers, and the number of boats used for angling during that year 678 (Appendix I). The total effort expended in the Mgeni Estuary shore-fishery during 2000 was estimated at 4 929 angler-outings using instantaneous effort values and 11 977 angler-outings by applying a turnover value of 2.43. The effort estimate of 11 977 angler-outings equates to approximately 43 716 angling hours and 1 295 participants (Appendix I).

Average *cpue* estimates for the shore-fishery at both localities were similar: 0.071 fish angler^{-1} h^{-1}, or 0.034 kg angler^{-1} h^{-1}, for Durban Harbour and 0.098 fish angler^{-1} h^{-1}, or 0.033 kg angler^{-1} h^{-1}, for the Mgeni Estuary. However, the average *cpue* values for the harbour boat-fishery were somewhat higher (0.11 fish angler^{-1} h^{-1}, or 0.15 kg angler^{-1} h^{-1}) than the shore-fishery.

The total annual harvest attributable to the shore-based linefishery in Durban Harbour was estimated to be 16 494 fish (7 898 kg), and for the boat-linefishery at 6 594 fish (8 992 kg). The annual linefishing harvest in the Mgeni Estuary was estimated at 4 284 fish (1 443 kg).

Questionnaire survey

In total, 344 (9%) of the 3 705 anglers encountered in the harbour, and 88 (12%) of the 752 anglers encountered at the estuary, were interviewed using the socio-economic questionnaire (Appendix II). Although most respondents indicated extensive fishing experience at the study sites (Table V), some anglers (14% in the harbour and 29% in the Mgeni) had fishing experience of less than one year. Furthermore, a very high proportion of respondents had fished only in the study localities throughout their entire estuarine fishing careers. Respondents in the harbour indicated that they had undertaken an average of four outings to the locality in the previous month and 36 outings in the previous year, whereas interviewees at the estuary indicated a mean of three outings there in the previous month and 30 outings in the previous year. Interviewees in the harbour indicated a mean trip duration of 4.3 h (± 2.4 *SD*) and anglers in the Mgeni Estuary a mean trip duration of 3.7 h (± 1.9 *SD*).

Fishing at night was practised by 50% of harbour respondents and 34% of Mgeni respondents (Table V). The former had undertaken an average of 22 night-fishing outings in the previous year, accounting for 50% of their total effort (in terms of outings) in the harbour. Respondents from the Mgeni Estuary who fished at night indicated an average night-fishing effort of 16 outings in the previous year, 34% of their total effort there.

The majority of respondents in the harbour (77%) and at the Mgeni Estuary (71%) fished exclusively at these respective localities and did not participate in any other angling disciplines. For anglers that did participate in other types of angling, marine shore-angling (rock and surf) was the most popular. Some 9% of harbour respondents indicated that they also fished in the Mgeni Estuary, and 24% of respondents from the estuary indicated that they also fished in Durban Harbour.

In general, anglers regarded current linefish regulations as being effective for their intended purposes, with marine reserves receiving the most support (84%) in this regard (Table VI). A notable proportion of respondents admitted to disobeying linefish regulations, and the most frequently disobeyed regulations were size limits. In general, anglers' knowledge of linefish regulations for the species that they were targeting was poor.

Although the majority of anglers (86% harbour, 84% Mgeni) indicated that they were in possession of a valid fishing permit, 62% of harbour anglers and 63% of Mgeni anglers stated that they were willing to pay for this permit. Excessive cost, the belief that linefish should be a free resource and the lack of visible bene-

Table VI: Percentage of shore-angling respondents who agreed, disobeyed and knew the appropriate national linefish regulations for their target species

Parameter	Durban Harbour (n = 344)			Mgeni Estuary (n = 88)		
	Agree (%)	Disobey (%)	Knowledge (%)	Agree (%)	Disobey (%)	Knowledge (%)
Size limits	82	24	30	83	18	40
Bag limits	71	18	33	77	9	54
Closed seasons	77	7	55	79	5	71
Marine reserves	83	4	–	85	7	–

fits to permit holders from funds accrued from the permit system were the most common reasons mentioned for dissatisfaction with the current fishing permit requirement.

Some 52% of interviewees at the harbour and 49% of those at the Mgeni Estuary did not know what happened to the funds accumulated through the fishing-permit system. Most of the remainder mentioned that the money went to support marine conservation, but stressed that they had not seen any visible benefits (e.g. increased number of fisheries inspectors, increased control of pollution).

The frequency of catch inspections by fisheries inspectors was generally low, with 66% of respondents fishing in the harbour and 63% of anglers fishing at the Mgeni Estuary not having had their catches inspected in the previous year. The proportion of outings during which respondents indicated that their catches had been inspected compared to the total outings conducted by the anglers to the respective localities was also low (6.4% for Durban Harbour and 7% for the Mgeni Estuary). Some 71% of anglers in the harbour and 39% in the Mgeni Estuary indicated that fishing had deteriorated in the respective localities over the years. The reasons offered varied widely, respondents from the Durban Harbour indicating causes to be pollution (76%), overfishing (16%) and poaching (16%), and Mgeni Estuary respondents indicating pollution (47%) and siltation (20%).

Although the majority of interviewees at both localities (77% harbour, 68% Mgeni) were employed, a notably larger proportion of respondents at the Mgeni Estuary (25 v. 12%) were unemployed (Table VII). Most of the anglers interviewed resided within the Durban Unicity (96 and 93% for the harbour and Mgeni respectively), with only a few anglers residing in areas outside KwaZulu-Natal. A small proportion of respondents (2.6% in the harbour and 3.4% in the Mgeni) were on holiday, with the vast majority of anglers being on day-trips from their homes. The mean distance travelled (one-way) for respondents fishing in the harbour was 18.7 km (± 15.8 *SD*) and 14.6 km (± 10.6 *SD*) for respondents fishing in the Mgeni Estuary.

Respondents in Durban Harbour indicated somewhat higher expenditure on estuarine angling than interviewees in the Mgeni Estuary (Table VIII). Harbour anglers had a mean total investment (resale value) in estuarine angling equipment of R1 976 (US$1 = R8 in 2000), more than twice that of Mgeni Estuary anglers (R782). Using calculated participation estimates, total value in terms of capital equipment (rods, reels, etc.) invested in the fishery was calculated at R9.6 million for the harbour and R1 million for the Mgeni Estuary. Annual expenditure in terms of bait, tackle, equipment and travelling costs was calculated at R7.9 million for the harbour and R840 000 for the Mgeni Estuary fishery. (Note that bait and travelling costs were calculated on the total estimated number of angler-outings, but tackle and equipment were costed on the estimated number of participants).

Although fishing for recreational purposes was the primary motivation for most respondents in both Durban Harbour (93%) and the Mgeni Estuary (97%), the opportunity of catching fish to eat was also an im-

Table VII: Employment status of respondents at each locality

Locality	Employment status			
	Employed (%)	Unemployed (%)	Pensioner (%)	Student (%)
Durban Harbour (n = 343)	76.7	11.7	8.6	3.0
Mgeni Estuary (n = 88)	68.2	25	4.5	2.3

Table VIII: Summary of expenditure per respondent associated with shore-fishing in estuaries. Values are in Rands. Tackle purchased refers to expendable items such as sinkers, hooks and nylon purchased in the month prior to date of interview, and equipment purchased refers to capital items such as rods and reels purchased in the year prior to date of interview. Total value of equipment is estimated resale value

Parameter	Bait cost (per outing)	Travel cost (per outing)	Tackle purchased (per month)	Equipment purchased (per year)	Total resale value
			Durban Harbour		
Mean	15.80	15.80	63.20	518.40	1 976.30
SD	15.70	13.80	162.60	2 028.70	3 679.20
Minimum	0	0	0	0	0
Maximum	150.00	72.70	1 500.00	30 000.00	35 000.00
			Mgeni Estuary		
Mean	10.70	12.50	23.70	147.30	782.00
SD	8.80	13.10	42.90	219.30	1 427.40
Minimum	0	0	0	0	0
Maximum	40.00	84.70	200.00	1 200.00	7 900.00

portant consideration (13% and 17% in Durban Harbour and the Mgeni Estuary respectively). Only five interviewees out of a total of 432 from both localities indicated that they fished for subsistence or livelihood.

DISCUSSION

Angling effort

Durban Harbour is used far more extensively as an angling venue than the Mgeni Estuary. Incorporating angler turnover, the total (shore and boat) annual angling effort in the harbour was estimated to be 64 015 angler-outings, substantially more than the estimated 11 977 angler-outings for the Mgeni Estuary. Using counts obtained from shore patrols conducted by KwaZulu-Natal Wildlife staff in Durban Harbour, Guastella (1994) estimated an instantaneous shore-angling effort of 34 170 angler-outings per year, higher than the instantaneous effort of 22 232 shore-angler outings determined in this survey. Further, the present effort estimate of 9 991 angler-outings (incorporating angler turnover) for the boat-fishery is lower than the 16 000 angler-outings per year approximated by Environmental Advisory Services (1991). Although there were differences in sampling strategies, the discrepancies in total instantaneous effort estimates between the two studies may indicate that both shore- and boat-angling effort in the harbour is declining. However, this apparent decline for shore-angling effort is countered by the present estimate of 4 881 participants in the harbour shore-fishery, higher than the annual average of 3 700 shore-angling licences issued by the port authority for Durban Harbour in the period 1986–1991 (Guastella 1994).

Compared to other estuarine systems in KwaZulu-Natal, boat-angling effort in Durban Harbour (4 344 boat-outings in the year 2000) was considerably less than the 11 673 boat-outings per year calculated for the St Lucia system (Mann *et al*. 2002), but more than the 2 300 boat-outings calculated for the Kosi Bay system (James *et al*. 2001). The total annual effort estimate (shore and boat) for Durban Harbour (292 249 angling hours) was similar to the total effort estimate of 360 000 angling hours for the Swartkops Estuary (Pradervand 1999), one of the most popular urban estuarine angling destinations in the Eastern Cape.

Considering the extent of shore-angling in Durban Harbour (54 024 angler-outings for 2000), the 1991 prohibition of shore-angling in the harbour by the port authority (Guastella 1994) has clearly being unsuccessful. Consequently, it is recommended that the port authority should recognize the existence and extent of shore-angling in the harbour, and should manage the fishery accordingly. Suggestion of management options for the linefishery in the harbour is beyond the scope of this paper, but it is envisaged that zoning of areas appropriate to usage will be an important management option for the shore-fishery.

Fishing in both Durban Harbour and the Mgeni Estuary are essentially weekend activities. Some 62% of shore-based angling effort and 70% of boat-based angling effort in the harbour was over weekends, as was 54% of the total shore-fishing effort in the Mgeni Estuary. The importance of weekends as high-effort

angling periods has also been shown for other sectors of the South African linefishery, including both the marine shore-fishery (Joubert 1981, Brouwer *et al*. 1997) and the recreational skiboat-fishery (Smale and Buxton 1985). The majority (80%) of angling effort in the harbour and all the effort in the Mgeni Estuary stemmed from shore-based anglers. The importance of shore-based anglers in the estuarine linefishery has previously been unrecognized, with the exception of Pradervand and Baird (2002), who showed shore-anglers accounted for up to 59% of angling effort in some Eastern Cape estuaries. Accessibility to the estuary shoreline, as well as factors such as local regulations and the economic status of participants, appear to be important criteria determining the shore-angler to boat-angler ratio in an estuarine fishery.

The numbers of anglers recorded per count were generally lower during spring at both study sites. This can possibly be attributable to the windy conditions along the KwaZulu-Natal coast then (Hunter 1989). However, boat-based effort in the harbour did not show the same trends, and the regular occurrence of organized angling club competitions is probably the reason for this. These boat-based competitions, which are held throughout the year on weekends, effectively oblige entrants to fish regardless of weather conditions. Because shore-anglers, on the other hand, constitute mainly non-club anglers fishing socially, they are less likely to fish in bad weather, and consequently their effort may decrease during windy months. It should be noted that there was a series of severe fish kills in the Mgeni Estuary during November 2000 (A. Connell, CSIR, pers. comm.), and these undoubtedly contributed to the curtailed angling effort in the estuary during the last two months of that year.

Surprisingly, shore- and boat-based angling effort did not increase markedly during holiday periods at either study site. This is in contrast to the national shore-fishery, where peak holiday periods accounted for 34% of the annual effort (Brouwer *et al*. 1997). This lack of increased effort during holiday periods, and the fact that only 2.6% of respondents were on holiday away from their normal places of residence, strongly suggests that the harbour is not an angling destination for tourists.

The shore-based fishery at both study sites was dominated by Indian males, similar to the KwaZulu-Natal shore-fishery (Joubert 1981, Mann *et al*. 1997b). This trend differs considerably from that of the Eastern Cape estuarine linefishery, in which whites constituted >70% of anglers and Indians <0.3% (Baird *et al*. 1996, Pradervand and Baird 2002). The majority of shore-based anglers used rods, and they fished mostly with bait. This is similar to the Eastern Cape estuarine linefishery, where rod-fishing with bait is also the most popular form of shore-based fishing (Baird *et al*. 1996, Pradervand and Baird 2002).

Catch composition

Most species caught by anglers at the study sites were marine species, either estuarine-associated or estuarine-dependent to some degree (Whitfield 1998), and were representative of typical KwaZulu-Natal estuarine linefishing catches (van der Elst 1977, James *et al*. 2001, Mann *et al*. 2002). None of the 36 species identified in shore-anglers' catches in the harbour had a particularly high individual contribution to the total shore-based catch, and the most commonly retained species were *M. cephalus, C. crenidens, P. commersonnii* and *A. berda*. This was similar to the catch composition previously reported by Guastella (1994) for shore-anglers in Durban Harbour, the only exception being *C. crenidens*, which made up a much larger proportion of the catch in the present study. This is possibly because of misidentification of this species by KwaZulu-Natal Wildlife staff during routine shore patrols, one of the primary data sources used in the study by Guastella (1994). Although less diverse (22 species), the overall catch by shore-anglers in the Mgeni Estuary was similar to catches by shore-anglers in Durban Harbour, with the exception of two species, Moçambique tilapia *Oreochromis mossambicus* and *C. gariepinus,* which are euryhaline freshwater species. Also, the catch from the Mgeni Estuary was dominated by a single species, *M. cephalus*, which made up 68% of the catch by number. No comparable historical catch composition data are available for the Mgeni Estuary.

Although similar in diversity to retained shore-based catches, retained boat-based catches in the harbour consisted mostly of one species, *P. commersonnii,* which constituted 42 and 40% of the catch by number and mass respectively. The remainder numerically was mostly *S. commersonnianus* (9.9%), *R. sarba* (6.7%) and *M. cordyla* (6.5%). Catch composition was similar to that reported by Guastella (1994).

Cpue

Estimates for the shore-fisheries at both localities were similar (0.034 kg angler^{-1} h^{-1} and 0.033 kg angler^{-1} h^{-1} for Durban Harbour and the Mgeni Estuary respectively), but were substantially less than those reported by Pradervand (1999) for the shore-fishery

in Eastern Cape estuaries (0.22 kg angler^{-1} h^{-1}). The present *cpue* estimates were also lower than catch rate values given by Mann *et al*. (1997b) for the KwaZulu-Natal marine shore-fishery (rock and surf: 0.25 fish angler^{-1} h^{-1}, or 0.096 kg angler^{-1} h^{-1}).

Cpue estimates for the harbour boat-fishery (0.11 fish angler^{-1} h^{-1}, or 0.15 kg angler^{-1} h^{-1}) were substantially higher than those for the shore-fishery. A similar mean of 0.1 kg angler^{-1} h^{-1} for boat-based angling was estimated for the period 1987–1991, but was considerably lower than the mean of 0.34 kg angler^{-1} h^{-1} estimated for the period 1976–1980 by Guastella (1994). *Cpue* values for the Durban Harbour boat-fishery were also similar to those calculated from voluntarily completed catch cards from the boat fisheries in the St Lucia (0.19 fish angler^{-1} h^{-1}, or 0.15 kg angler^{-1} h^{-1}; Mann *et al.* 2002) and the Kosi Bay estuarine systems (0.16 fish angler^{-1} h^{-1}, or 0.25 kg angler^{-1} h^{-1}; James *et al*. 2001). The harbour *cpue* was less than the creel-surveyed *cpue* estimates for the boat-fishery at selected Eastern Cape estuaries (0.44 kg angler^{-1} h^{-1}; Pradervand 1999). However, the boat-fishery *cpue* estimates of the present study were derived from competition anglers, who are generally more successful than social anglers (Clarke and Buxton 1989, Brouwer and Buxton 2002). The greater success of boat-angling compared to shore-angling in terms of *cpue* has previously been demonstrated for Eastern Cape estuaries (Pradervand 1999) and needs to be considered in management scenarios.

Size of catches

Most of the fish caught at the study sites were small, highlighting the nursery function of estuaries (Wallace 1975, Wallace and van der Elst 1975). Fortunately, the majority of all fish caught (64 and 73% of the shore-based catch in the harbour and Mgeni Estuary respectively; 72% of the boat-based catch in the harbour) were released. Some anglers, however, still retained fish smaller than the legal minimum size. This non-compliance with national fisheries regulations was most prevalent in the shore-fishery.

Estimation of total catch

Using calculated total effort (incorporating angler turnover) and *cpue* estimates, the total annual catch for Durban Harbour (boat and shore) was estimated at 23 088 fish (16 890 kg), lower than the 37 732 fish estimated by Guastella (1994). Although Guastella (1994) did not provide an estimate of total mass caught by the shore-fishery, her estimate of the total mass caught by the boat-fishery (11 114 kg) was also higher than that for the boat-fishery in the present study (8 992 kg).

In Durban Harbour, despite 71% of the total estimated retained catch by number being attributed to the shore-fishery, 53% of the total estimated catch by mass stemmed from the boat-fishery. In terms of the annual linefishery harvest from the harbour, the shore-fishery is responsible for a large number of small-sized fish, whereas the boat-fishery accounts for fewer large-sized fish. As expected, the total estimated harvest attributable to the Mgeni Estuary shore-fishery (4 284 fish, or 1 443 kg) was considerably less than that of the harbour shore-fishery.

Questionnaire survey

In general, shore-anglers operating in the two study locations regarded the current linefish regulations as effective for their purpose. However, angler knowledge of the various regulations was limited, notably less than that of shore-anglers along the coast of KwaZulu-Natal (Mann *et al*. 1997b). Of all the regulations, anglers had the least knowledge of size limits. This, combined with the fact that size limits were the most frequently disobeyed regulation, suggests a link between anglers' knowledge of regulations and their lack of compliance. This low compliance with the minimum size regulations is cause for concern, given the nursery function of the study sites (Wallace 1975, Wallace and van der Elst 1975) and the resultant large proportion of undersized fish that are available to anglers. Considering the low frequency of catch inspections by KwaZulu-Natal Wildlife personnel at the two sites, which was less than that for marine shore-anglers (rock and surf) in KwaZulu-Natal (Mann *et al*. 1997b), and the number of undersized fish that were retained by anglers, it is suggested that more rigorous law enforcement efforts, combined with angler education programmes, be undertaken by KwaZulu-Natal Wildlife.

Over the years, logistical reasons have prevented night-time fishing activity from being included in surveys that have investigated various aspects of the South African marine linefishery. This is unfortunate, given that there is substantial night fishing effort in the shore and estuarine sectors of the linefishery, and that nocturnal linefish catches may well differ considerably from those made during the day. The questionnaire survey indicated that up to half the interviewees fished at night; on average 50 and 34% of outings were at night in the harbour and Mgeni Estuary respec-

tively. Effort therefore needs to be channelled into including night-time fishing effort in future studies that assess sectors of the South African linefishery, because motivations and expectations of the anglers, catch composition and *cpue* may differ considerably from that of daytime anglers. Furthermore, night studies would provide better validation of angler turnover rates.

Durban Harbour and the Mgeni Estuary appear to provide extremely important recreational outlets. Most interviewees fished exclusively in one of these localities, and only a small number fished in other estuarine systems or participated in other angling disciplines (e.g. marine shore-angling, skiboat-angling).

The total economic investment in Durban Harbour and the Mgeni Estuary shore-fisheries is substantial. In terms of estuary fishing equipment (fixed assets) possessed by anglers, the total investment was calculated at R9.6 million for the harbour shore-fishery, with a total annual expenditure of R7.9 million. The Mgeni Estuary linefishery, which supports a larger proportion of otherwise unemployed anglers, had considerably less investment in angling equipment than the harbour shore-fishery. The value of equipment invested in that shore-fishery was calculated at R1 million, with an annual expenditure of around R840 000. The difference between the two sites in terms of costs is to be expected, given the larger size of the harbour and its greater popularity as a fishing venue.

Compared to total economic investment in the KwaZulu-Natal marine shore- and skiboat-fisheries (McGrath *et al*. 1997), the investment in the shore-fisheries of Durban Harbour and the Mgeni Estuary is small. However, including the value of estuarine angling boats and associated boat-angling equipment, plus the addition of the numerous other estuarine angling locations in KwaZulu-Natal, the total cumulative economic contribution of the estuarine linefishery on a provincial level would compare favourably with both the marine shore- and skiboat fisheries.

Considering the low returns in terms of catches, and the fact that <1% of interviewees at both localities admitted to fishing for subsistence purposes, the Durban Harbour and Mgeni Estuary shore-fisheries are primarily of a recreational nature. However, considering the lower investment (per angler) for the Mgeni Estuary fishery, and the fact that this fishery services a larger proportion of unemployed anglers, that fishery may be of more importance to *bona fide* subsistence fishers, as defined by Branch *et al*. (2002), than that of Durban Harbour.

The present study has revealed the magnitude and economic importance of linefishing in two urban estuaries in KwaZulu-Natal. The importance of shore-angling in the two estuarine systems has also been highlighted and, although downplayed in the past, it is probably more extensive in terms of participants and expended effort nationally than estuarine and marine boat-based recreational fishing. The observed propensity for shore-based anglers to retain undersized fish is cause for concern, especially because several linefish species are estuarine-dependent during their juvenile phase. However, if an ethic of catch and release can be inculcated, urban estuaries could continue to function as valuable recreational resources to city dwellers.

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APPENDIX I

Details of the method used to calculate the number of recreational anglers participating in the Durban Harbour and Mgeni Estuary linefisheries

Interviewees' outings per year	Mean outings per year	Number of interviewees in sample	Percentage of sample	Estimated total number of outings by anglers included in category	Calculated total number of anglers
		Durban Harbour shore-fishery			
261–280	270.0	1	0.28	153.5	0.6
241–260	250.0	1	0.28	153.5	0.6
221–240	240.0	3	0.85	460.4	1.9
201–220	210.0	2	0.57	307.0	1.5
181–200	200.0	1	0.28	153.5	0.8
161–180	180.0	4	1.14	613.9	3.4
141–160	152.5	4	1.14	613.9	4.0
121–140	132.0	2	0.57	307.0	2.3
101–120	120.0	9	2.56	1 381.3	11.5
81–100	95.6	18	5.11	2 762.6	28.9
61–80	71.8	8	2.27	1 227.8	17.1
41–60	51.3	55	15.63	8 441.3	164.6
21–40	30.7	48	13.64	7 366.9	240.2
0–20	6.8	196	55.68	30 081.5	4 403.3
Total		352	100	54 024.0	4 880.8
		Mgeni Estuary shore-fishery			
160–180	180.0	1	1.27	151.6	0.8
141–160	149.0	2	2.53	303.2	2.0
121–140					
101–120	120.0	3	3.80	454.8	3.8
81–100					
61–80	72.0	2	2.53	303.2	4.2
41–60	52.0	9	11.39	1 364.5	26.2
21–40	29.2	10	12.66	1 516.1	51.9
0–20	6.5	52	65.82	7 883.6	1 205.7
Total		79	100	11 977.0	1 294.8
		Durban Harbour boat-fishery			
81–100	90.0	2	1.77	176.0	2.0
41–60	51.7	9	7.96	793.7	15.4
21–40	25.0	1	0.88	88.4	3.5
0–20	5.8	101	89.4	8 932.9	1 540.2
Total		113	100	9 991.0	1 561.1

* The method is based on the total calculated 54 024 outings per year for the Durban Harbour shore-fishery, 11 977 per year for the Mgeni Estuary shore-fishery and 9 524 per year for the Durban Harbour boat-based fishery

APPENDIX II

Shore-angling questionnaire

SECTION A

Locality _____ Date ____/____/ 2000 Time _____ Method: Bait/ Lure / Fly

Bait: Sardine/Squid/Cracker/Other _____ Obtained from where ? _____

(Interviewee) Number of rods? _____ Number of handlines? _____ 1 2 3 4 5

(Whole group) Number of rods? _____ Number of handlines? _____ Group Size: _____ M F

Ages of group: < 10 11–20 21–30 31–55 > 55

SECTION B

Age: _____ Code: _____ Time start fishing? _____ Time stop? _____ Active time? _____

What type of fish were you targeting today? _____

How many days have you spent estuary fishing in the last week? _____, month? _____, 12 months? _____

Do you ever fish in estuaries at night? Y / N If YES, how often in the past 12 months? _____

Which estuaries do you normally fish? _____

Which estuary fishing club do you belong to? (full name) _____

How many years have you been estuary fishing? _____ How many years in harbour/Umgeni? _____

SECTION C

Which of the following regulations, in your opinion, are effective in managing our fish stocks?

Minimum size limits? Y / N Bag limits? Y / N Closed seasons? Y / N Closed areas/MPAs? Y/N

Have you ever: (while fishing in estuaries)

Kept undersize fish? Y/N Kept over bag limit? Y/N Kept in closed season? Y/N Fished in closed areas? Y/N

Have you ever sold your estuarine catch? Y / N If YES, how many times in the last 12 months? _____

What estuary-caught species do/have you normally sell/sold? _____

Knowledge of regulations	target 1	target 2
What is the minimum size for:		
What is the bag limit for:		
What is the closed season for:		

Do you possess a marine angling licence (R35) YES / NO

Are you happy paying for the R35 marine angling licence? YES / NO

If NO, why not? (Give reasons) _____

What do you think happens to the money that is collected from the angling licences? _____

_____

While fishing in H/U, # times has your licence been inspected in the past month? _____ 12 months? _____

While fishing in estuaries, have you ever reached your bag limit? YES / NO. How many times in the last year? _____

If YES, specify for which species _____

Why do you choose to fish in the H/U? _____

Is it legal or illegal to fish from the shore in the harbour? Y / N

Do you think shore-fishing should be allowed? Y / N Do you think boat-fishing should be allowed? Y / N

If so, where should shore-anglers be allowed to fish in the harbour? _____

Have you ever been asked to move from your fishing spot by Port authorities? Y / N How often in past 12 months?

_____

What steps would you like to see Portnet take to improve the harbour as an angling venue? _____

_____

Do you ever fish from a boat in the harbour Y/N. If YES, how many times in past 12 months? _____

SECTION D

What is your occupation? (Write in detail) _____

If unemployed / retired, last occupation? _____ Where do you live? (City / Suburb) _____

Are you on an overnight, weekend, or longer trip / holiday? (i.e. staying away from home) YES / NO

If YES (i.e trippers / holidaymakers), where are you staying? (hotel, friends?) _____
What transport did you use to come on this trip? (describe vehicle type, model, cc) _____
How many people came with you on this trip? _____ How many of this group will be estuary fishing? _____
How many days will you spend away from home on this trip / holiday? _____
How many days of this trip / holiday will you spend estuary fishing? _____
What is the estimated cost of your trip / holiday? (all members excluding transport) _____

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

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

(If own vehicle) Specify number of passengers: _____ How many of this group are fishing? _____

(If not own vehicle) What were transport costs? (i.e. taxi) _____

Rands spent on bait this outing? _____ Rands spent on estuarine angling terminal tackle in the past month? _____

Expenditure on estuarine angling equipment i.e. rods, reels, knives, etc. in past 12 months? _____

What is the estimated value of your estuarine fishing equipment? (What would they sell for?)

Rods: _____ Reels: _____ Other: _____

Why do you fish? Food _____ Recreation _____ Competition _____ Livelihood _____ Other (specify) _____

SECTION E

Have you ever caught a tagged fish while fishing? Y / N. If Y, what happened to the tag? _____

Has fishing in this location deteriorated over the years? YES / NO If YES, what is the cause of the decline?

_____

Pollution Siltation Seine- netting Gillnetting Trawling Overfishing (commercials) Overfishing (recreationals) Overfishing (all) Other _____

Do you participate in any other form of fishing? _____

(Only for the interviewee's catch)

Species	Number kept	Total lengths	Number released