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AN ASSESSMENT OF THE RECREATIONAL FISHERY IN THE ST LUCIA ESTUARINE SYSTEM, KWAZULU-NATAL, SOUTH AFRICA

B. Q. MANN, N. C. JAMES* and L. E. BECKLEY**

St Lucia is one of the largest estuarine systems in Africa, and attracts thousands of anglers each year. Catch card data from the National Marine Linefish System for the years 1986–1999 were analysed to determine catch composition, catch per unit effort (*cpue*) and seasonality of catches by recreational anglers. Because not all anglers completed catch cards, estimates of total catch were made using additional data on the number of private boat outings, the number of boat trailers at boat slipways and the number of boats recorded entering the campsite gates during 1992 and 1993. In all, 27 fish families, constituting 55 species, were recorded by recreational anglers. Dusky kob *Argyrosomus japonicus*, spotted grunter *Pomadasys commersonnii*, perch *Acanthopagrus berda*, Natal stumpnose *Rhabdosargus sarba*, springer *Elops machnata* and mini-kob *Johnius dorsalis* were the most prominent species caught in terms of numbers and mass. Catch rates expressed numerically (fish angler^{-1} h^{-1}) peaked during the summer and early winter. However, in terms of mass, catch rates peaked during late winter and spring, when there were increased landings of large dusky kob. Fluctuations in *cpue* were linked to salinity and estuary mouth conditions (i.e. mouth closure). Despite annual fluctuations in *cpue*, regression analysis revealed an overall downward trend for the dominant species (dusky kob and spotted grunter) and a gradual increase for stumpnose, perch and springer, but with the exception of stumpnose, these trends were not significant. Socio-economic aspects of the fishery were also investigated by conducting an independent boat-angler survey. The value of the recreational fishery, in terms of accommodation and direct angler expenditure, was estimated to be in the region of R9 million during 1992. Angler attitudes towards fishing regulations were positive and anglers generally had a good knowledge of the regulations for target species. Based on this assessment, a number of suggestions are made regarding the future management of the recreational fishery at St Lucia.

Key words: catch and effort, management, recreational angling, socio-economics, St Lucia estuarine system

St Lucia is one of the largest estuarine systems in Africa and forms part of the Greater St Lucia Wetland Park, which was proclaimed as a World Heritage Site in December 1999. It is a shallow, productive system that comprises 80% of the estuarine surface area in KwaZulu-Natal (Begg 1978). The estuary and adjoining lake contain a high diversity of marine, estuarine and freshwater fish species (Whitfield 1980) that, in turn, support large numbers of piscivorous birds and a large population of Nile crocodiles (Whitfield and Blaber 1978a, b, 1979a, b, c). In addition to the value of this ecosystem as a natural heritage site and an important nursery area for juvenile fish and invertebrates (Wallace 1975a, b, Wallace and van der Elst 1975), St Lucia also represents one of the most popular estuarine angling venues in southern Africa (Mann 1993). Thousands of anglers visit St Lucia each year, and the economy of the region relies to a large extent on income generated from fishing-associated activities (van der Elst 1980, Miltz *et al*. 1993).

KwaZulu-Natal Wildlife (previously Natal Parks Board) are the managers of the St Lucia estuarine system and provide accommodation and boat-launching facilities at four main sites around the system. Accommodation and hire-boats are also provided by the private sector in St Lucia village. Most angling takes place from small, motorized boats, although there is also some shore-angling along the lower reaches of the estuary. In addition to recreational angling, fish and prawns are also caught for subsistence and economic gain by inhabitants of rural areas adjacent to the lake (Mann 1995). These people use both gill- and seine-nets, and, although efforts have been made to legalize a small subsistence gillnet fishery (Mann 1996), much of the activity remains illegal.

This paper provides an assessment of recreational fishing in the St Lucia estuarine system from analysis of catch-and-effort data obtained from voluntary angler catch cards. In addition, a questionnaire survey of anglers was used to provide information on the socio-economic importance of recreational fishing at St Lucia. Based on this assessment, suggestions are made for future management of the recreational fishery at St Lucia.

* Oceanographic Research Institute, P.O. Box 10712, Marine Parade 4056, South Africa. E-mail: seaworld@dbn.lia.net

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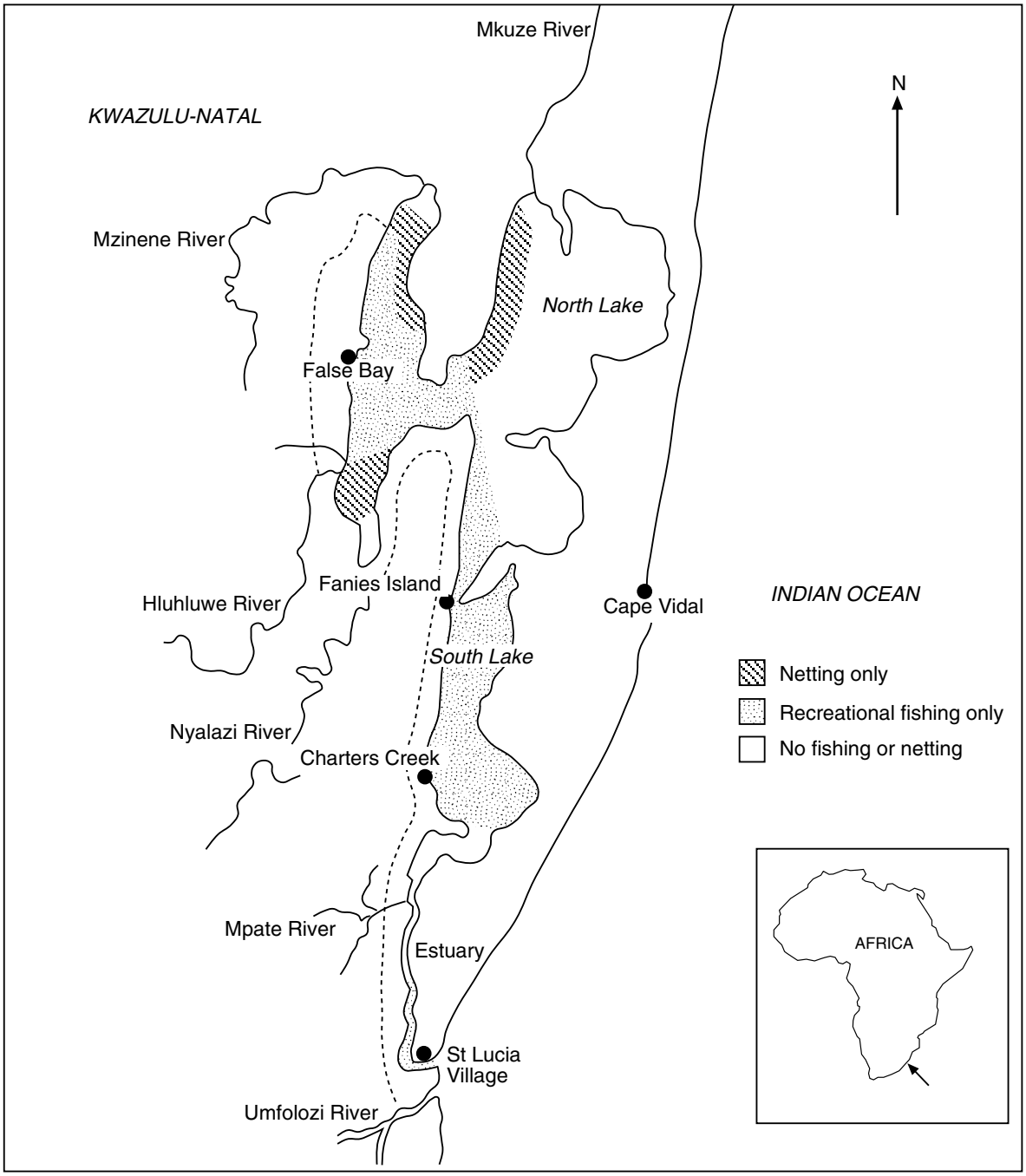

Fig. 1: Map of the St Lucia estuarine system showing areas mentioned in the text

MATERIAL AND METHODS

Study area

The St Lucia estuarine system is located on the northern KwaZulu-Natal coast and covers a surface area of approximately 300 km^2 (Fig. 1). The system has four main regions, False Bay, North Lake, South Lake and the estuary (Fig. 1). The estuary consists of a narrow 20-km channel linking South Lake to the sea and it is only this part of the estuarine system that experiences daily tidal fluctuation when the mouth is open. The average volume of the lake is approximately 295×10^6 m^3 and the average depth is <1m (Pitman 1980). Inflow of saltwater from the sea and evaporation results in the system being subjected to salinity fluctuations. Salinity of the system is therefore dependent on freshwater inflow such as rainfall, river inflow and ground water seepage. The most important rivers flowing into the lake are the Mkuze, Mzinene, Hluhluwe, Nyalazi and Mpate rivers (Fig. 1).

Most of the eastern side of North Lake is a wilderness area where no public entrance is permitted, whereas portions of North Lake, South Lake and the estuary have been zoned for different types of harvesting (Fig. 1). Most recreational angling takes place from boats launched at slipways at St Lucia village, Charters Creek, Fanies Island and False Bay, although anglers also fish from the shore in the lower reaches of the estuary (Fig. 1).

Angling effort, catch composition and catch per unit effort (*cpue*)

Catch-and-effort data were obtained using a voluntary catch card system at four sites at St Lucia (i.e. St Lucia Estuary, Charters Creek, Fanies Island and False Bay) over the period 1986–1999. Catch cards were distributed and collected by KwaZulu-Natal Wildlife (KZNW) field rangers at boat slipways at Charters Creek and St Lucia Estuary. However, at Fanies Island and False Bay, catch cards were issued to visitors at the entrance gates to the campsite and anglers were requested to place completed cards in a marked postbox on departure. Information recorded on the catch cards included date, locality, number of anglers, hours fished, number of each species of fish caught and their estimated weights. The completed cards were sent to the Oceanographic Research Institute (ORI) in Durban where the data were captured onto the National Marine Linefish System (NMLS), a database maintained by Marine & Coastal Management, branch of the Department of Environmental Affairs and Tourism, in Cape Town.

Data collected from all sites between 1986 and 1999 were analysed to determine trends in catches, angling effort and *cpue*. Data were analysed from all sites combined as well as from each site separately. Data from False Bay and Fanies Island were combined (referred to as North Lake), because the collection of catch cards from these venues was poor and erratic. Because some anglers were unable to identify all fish accurately to species level, certain species were grouped at genus. There may also be a certain amount of misidentification of less common species by anglers.

There are a number of biases associated with voluntary catch-card data, including prestige bias, digit bias, unintentional misreporting, deliberate misreporting, apathy and non-response bias (Pollock *et al*. 1994). Mann-Lang (1996) and James *et al*. (2001) have discussed these biases in detail with regard to the collection of NMLS voluntary catch-card data in Kwa-Zulu-Natal estuaries.

Total catch and effort

Because not all boat-anglers completed catch cards, additional means were necessary to estimate the total number of boat outings per year. The total number of private boat outings at St Lucia Estuary and Charters Creek were estimated from daily counts of the number of boat trailers at boat slipways during 1992 and 1993. Cumulative counts were made during the course of the day by KZNW field staff on duty at the slipways, so turnover in the daily number of boat launches was largely accounted for. Mean number of boat outings for weekdays and weekend days were calculated. School holiday periods were made equivalent to weekend days. Private boat outings at Fanies Island and False Bay were estimated by counting the number of boats recorded entering the gates of these respective campsites (KZNW visitor statistics). These counts were then multiplied by the average number of boat outings per visit (x = 1.39), which was determined from recorded boat entry statistics and actual boat outings counted at Charters Creek. The number of hire-boat outings was determined from records kept by the four boat-hire companies in St Lucia village during 1992 and 1993 (hire-boats were not used at other sites on the lake). This figure was corrected for the 30% of boats hired for purposes other than angling, such as pleasure trips, bird-watching, etc. (St Lucia Wilds Boat Hire, pers. comm.).

Table I: Species reported in estuarine catches by recreational anglers in the St Lucia system from 1986 to 1999. Note that this species list is subject to misreporting by anglers, weights were often estimated by anglers and, in some cases, were not reported

Scientific name	Common name	Number caught	Total weight (kg)
Teleosts			
Belonidae			
Strongylura leiura	Yellowfin needlefish	9	3
Carangidae			
Caranx spp.	Kingfish	762	1 549
Caranx sexfasciatus	Bigeye kingfish	5	3
Caranx sem	Blacktip kingfish	85	54
Caranx ignobilis	Giant kingfish	5	6
Trachinotus botla	Largespot pompano	19	7
Scomberoides spp.	Queenfish	21	52
Trachinotus africanus	Southern pompano	98	82
Charidae			
Chanos chanos	Milkfish	2	7
Cichlidae			
Oreochromis mossambicus	Moçambique tilapia	70	17
Clariidae			
Clarius gariepinus	Sharptooth catfish	1 472	1 793
Elopidae			
Elops machnata	Springer	3 393	4 595
Gerreidae			
Gerres spp.	Pursemouth	1	
Haemulidae			
Pomadasys spp.	Grunter spp.	15 858	14 302
Pomadasys multimaculatum	Cock grunter	210	194
Pomadasys kaakan	Javelin grunter	274	188
Pomadasys olivaceum	Piggy	71	1
Pomadasys commersonnii	Spotted grunter	26 465	38 827
Lobotidae			
Lobotes surinamensis	Tripletail	10	42
Lutjanidae			
Lutjanus argentimaculatus	River snapper	246	271
Lutjanus russelli	Russel's snapper	3	1
Megalopidae			
Megalops cyprinoides	Oxeye tarpon	1	
Monodactylidae			
Monodactylus spp.	Moony	50	1
Mugilidae			
Mugil cephalus	Flathead mullet	1	
Liza spp.	Mullet	203	203
Liza tricuspidens	*S*triped mullet	1	2
Muraenesocidae			
Muraenesox bagio	Pike conger eel	294	513
Platycephalidae			
Platycephalus indicus	Bartail flathead	1 233	1 081
Pomatomidae			
Pomatomus saltatrix	Elf	2 083	1 196
Sciaenidae			
Argyrosomus japonicus	Dusky kob	42 247	156 239
Johnius dorsalis	Mini-kob	26 277	2 859
Otolithes ruber	Snapper kob	1 521	486
Argyrosomus thorpei	Squaretail kob	338	432
Serranidae			
Epinephelus lanceolatus	Brindle bass	3	138
Epinephelus spp.	Rockcod	448	637
Sillaginidae			
Sillago sihama	Silver sillago	92	2
Sparidae			
Diplodus sargus capensis	Blacktail	25	15
Rhabdosargus spp.	Stumpnose	4 787	2 924
Rhabdosargus holubi	Cape stumpnose	443	228
Rhabdosargus sarba	Natal stumpnose	6493	4376

(*Continued overleaf*)

Table I: *(continued)*

Scientific name	Common name	Number caught	Total weight (kg)
Sparidae			
Acanthopagrus berda	Perch	28 195	14 936
Lithognathus mormyrus	Sand steenbras	1	1
Diplodus cervinus	Zebra	2	1
Sphyraenidae			
Sphyraena spp.	Barracuda	52	101
Sphyraena jello	Pickhandle barracuda	49	71
Theraponidae			
Therapon jarbua	Thornfish	1 221	73
Trichiuridae			
Trichiurus lepturus	Cutlass fish	197	72
Elasmobranchs			
Carcharhinidae			
Carcharhinus limbatus	Blackfin shark	6	129
Carcharhinus leucas	Zambezi shark	26	569
Rhizoprionodon acutus	Milk shark	2	7
Dasyatidae			
Himantura gerrardi	Brown stingray	4	9
Gymnura natalensis	Diamond ray	7	70
Himantura uarnak	Honeycomb stingray	77	604
Odontaspididae			
Carcharias taurus	Ragged tooth shark	1	5
Sphyrnidae			
Sphyrna spp.	Hammerhead shark	3	11
Unidentified	Others	5 427	14 066

Angler survey

Socio-economic aspects of the St Lucia recreational fishery were investigated by conducting an independent boat-angler survey. During 1994, boat skippers were interviewed on the water during peak holiday periods (1–3 April, 12–15 May and 21–24 July). Most boat skippers were interviewed while fishing, but a few were interviewed on completion of their fishing outing. This survey was used to collect information on angler demographics, catch and effort, expenditure on fishing and attitudes and perceptions towards fishery management. The questionnaire used was similar to that used during a national linefishery survey conducted between 1994 and 1996 (Brouwer *et al*. 1997, McGrath *et al*. 1997, Sauer *et al*. 1997).

RESULTS

Catch cards

The number of boat outings reported on catch cards from the St Lucia system between 1986 and 1999 are depicted in Figure 2. An annual average of 4 885 catch cards was collected between 1986 and 1992, but since then the number of cards has declined steadily to a low of 1 764 in 1998. Most catch cards were collected from the estuary and Charters Creek, but the proportion of cards collected from Charters Creek has declined since 1995. Relatively few cards were collected from Fanies Island and False Bay, and the completion of catch cards from those two areas was very erratic. Care should therefore be taken in interpreting these results, because they will to a large extent reflect the amount of effort put into completing and collecting catch cards, rather than a decrease in angling effort.

The number of anglers per boat outing varied little throughout the study period, with a mean of 2.8 anglers per boat (*SD* = 0.20). Periods fished per outing ranged from 5.2 to 8.4 h, with a mean of 6.4 h per outing (*SD* = 0.96).

Catch composition

In all, 27 fish families, represented by 55 species, were recorded on catch cards from 1986 to 1999 (Table I). Teleosts accounted for 47 species and elasmobranchs the remaining eight. The composition of anglers' catches, in terms of number and mass, from all sites at St Lucia during the period 1986–1999 are shown in Figure 3a. Dusky kob *Argyrosomus japonicus*, grunter *Pomadasys* spp. (predominantly spotted grunter *P. commersonnii*, but also including cock grunter *P. multimaculatum*, javelin grunter *P. kakaan* and piggy

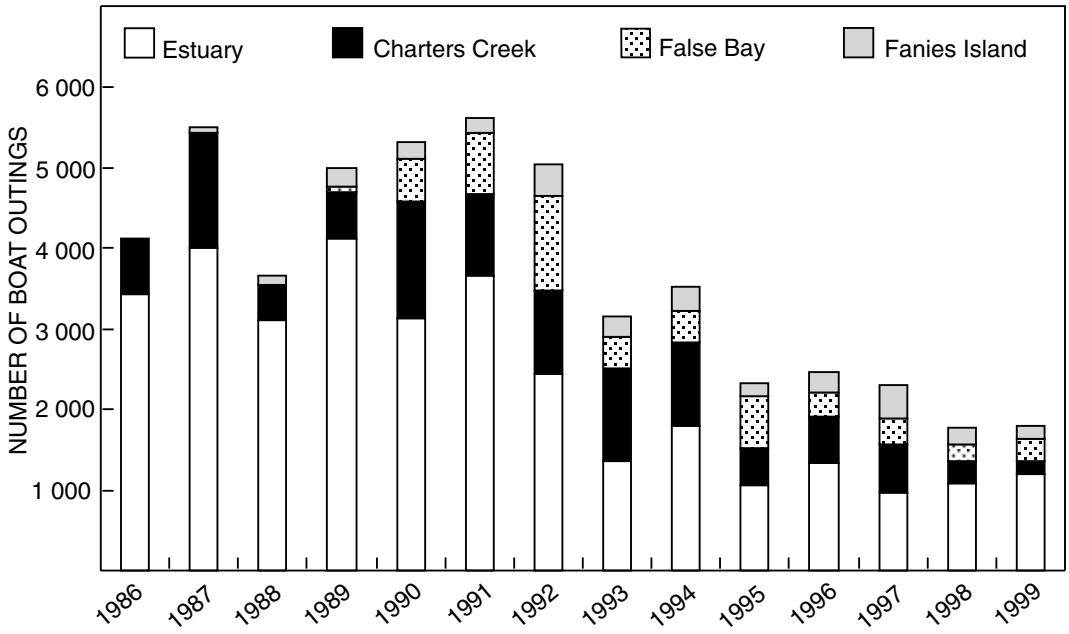

Fig. 2: Number of catch cards collected by KwaZulu-Natal Wildlife from the St Lucia estuarine system, 1986–1999

P. olivaceum), perch *Acanthopagrus berda*, stumpnose *Rhabdosargus* spp. (predominantly Natal stumpnose *R. sarba*, but also including Cape stumpnose *R. holubi*), springer *Elops machnata* and mini-kob *Johnius dorsalis* were the most prominent species caught. Dusky kob and grunter dominated the catch, together constituting 50% of the catch by number and 82% of the catch by mass.

Species composition was, however, not uniform throughout the whole system. Catches in the estuary (Fig. 3b) were dominated by grunter and perch, whereas in South Lake (Fig. 3c) and North Lake (Fig. 3d) dusky kob was the most prominent species caught in terms of both numbers and mass. Mini-kob also featured prominently in catches by number from North Lake.

Trends in *cpue*

The mean *cpue* for the whole system was 0.19 fish angler^{-1} h^{-1} (*SD* = 0.054) and 0.28 kg angler^{-1} h^{-1} (*SD* = 0.073). Regression analysis of *cpue* for the whole system revealed no significant trends in *cpue* with time (Fig. 4). Monthly *cpue* by number for the whole system between 1986 and 1999 did not show distinct seasonality (Fig. 5a). *Cpue* was generally lower during late winter and spring (July–October), but when expressed in terms of mass it was higher during that period (Fig. 5b).

Annual trends in total *cpue* (all species) for the lake part of the St Lucia system (Charters Creek, Fanies Island and False Bay) were correlated with salinity (Fig. 6). An increase in total *cpue* (by number) was recorded between 1987 and 1991 and again between 1996 and 1999, coinciding with periods of lower salinity.

Trends in *cpue* (by number) of the six most important angling species (dusky kob, grunter, stumpnose, perch, springer and mini-kob) caught in the St Lucia system (data from all sites combined) are depicted in Figure 7. Despite annual fluctuations in *cpue* for each species, the catch rate for dusky kob and grunter has shown a gradual downward trend, whereas the catch rate for perch, stumpnose and springer showed an overall upward trend. The catch rate for mini-kob showed no discernable trend. However, only the trend for stumpnose was significant ($r^2 = 0.47$, $F = 10.7$).

Although the weights recorded by anglers on catch cards must be viewed with caution because anglers estimate mass and are therefore subject to prestige and digit bias, the annual mean mass of individual dusky

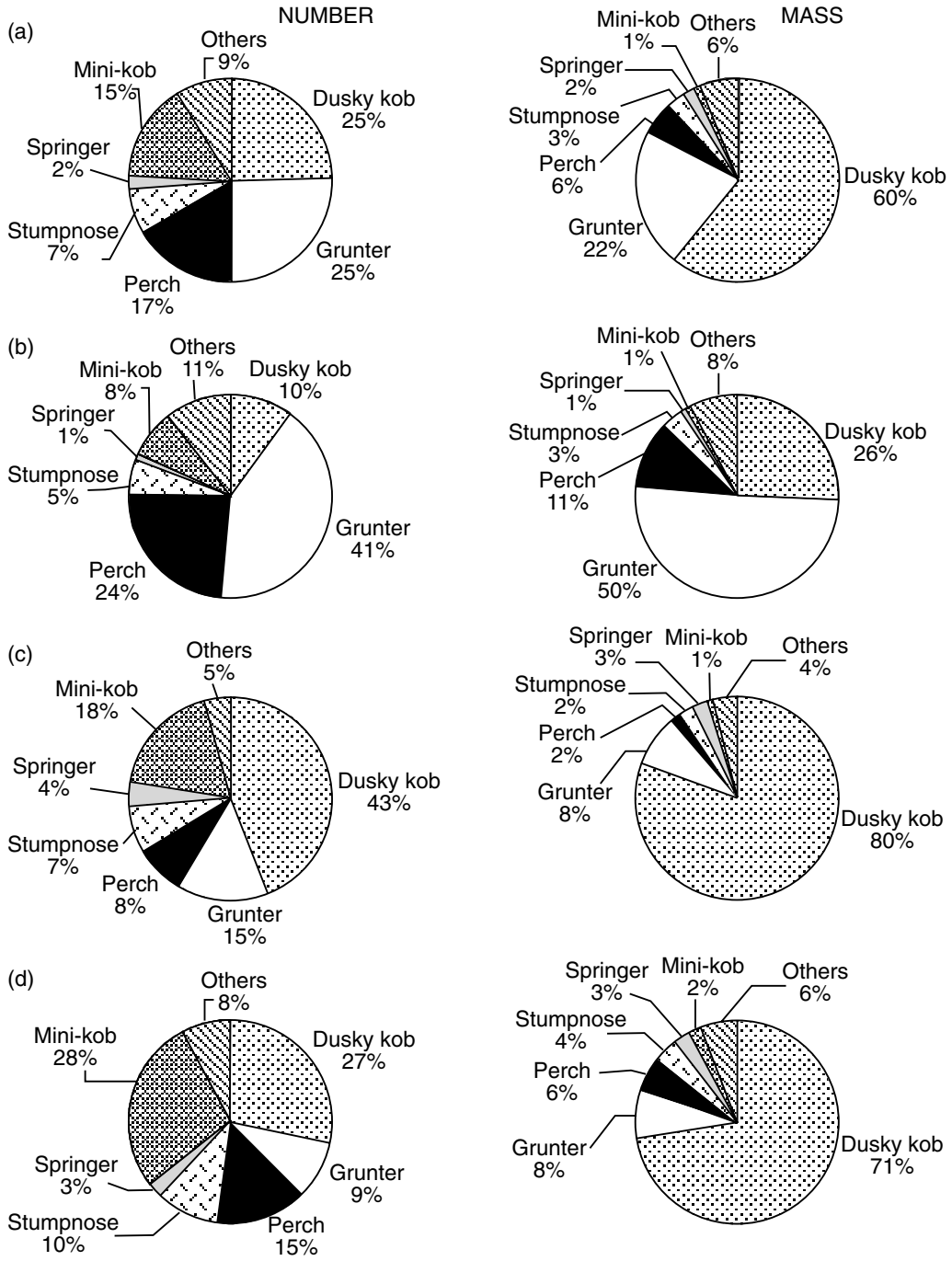

Fig. 3: Catch composition by number and mass of recreational angling species caught in (a) the whole St Lucia estuarine system, (b) the estuary, (c) South Lake (Charters Creek) and (d) North Lake (Fanies Island and False Bay), 1986–1999

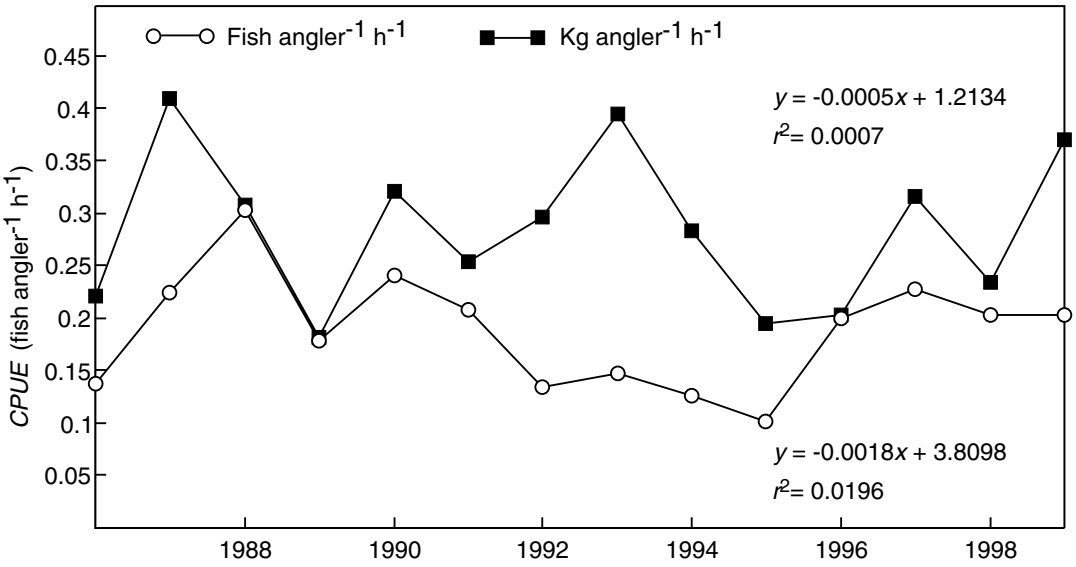

Fig. 4: Trends in mean annual *cpue* by number and mass for all angling species reported on catch cards from the whole St Lucia estuarine system, 1986–1999

kob and grunter are given (Fig. 8). The mean mass of grunter caught remained relatively stable at around 1.5 kg. In contrast, the mean mass of dusky kob in catches varied considerably over the study period. Many small dusky kob were caught in 1990 and 1996 (mean mass of 2.3 and 3.5 kg respectively), whereas in 1994 and 1999 the mean mass of dusky kob caught was 6.8 and 10.6 kg respectively. These values may reflect periods of good recruitment of dusky kob into St Lucia. Strong year-classes (cohorts) appear to remain in the system for a number of years, individual fish gradually increasing in size.

Total catch and effort (1992/1993)

A summary of the number of boat outings, total catch and average *cpue* recorded on catch cards in the St Lucia estuarine system during 1992 and 1993 is shown in Table II. The lower *cpue* in the estuary is largely a result of the smaller size of fish caught there relative to the main body of the lake, where larger fish such as dusky kob dominate catches.

The total number of private boat outings estimated from trailer counts at St Lucia Estuary and Charters Creek, and from corrected gate entry statistics at Fanies Island and False Bay, are shown in Table III. Also shown is the corrected number of hire-boat outings used only for fishing purposes in the estuary. Assuming that boat-fishing outings in which catch cards were not completed had a similar *cpue* to those that did, total catch from the St Lucia estuarine system was estimated at 62.7 and 64.5 tons for 1992 and 1993 respectively. Although the number of boat outings was less during 1993, the increase in the estimated total catch resulted from the good catches of relatively large dusky kob taken in both South Lake and North Lake. As no data were available for catches made by shore-anglers along the lower reaches of the estuary, this component was not included in the estimate of total catch.

Angler survey (1994)

A total of 102 boat-angler questionnaires was completed at the four sites around St Lucia during peak holiday periods. Most questionnaires were completed at St Lucia Estuary, as access to boats on the water was easier and more boat skippers could be interviewed. There was an average of 2.9 anglers per boat and 82% of these anglers were male. Most of the anglers were white (97.3%) and 20–40 years old (45%).

At the time of interview, skippers had fished for an average of 4.2 h, which represented a total effort of 1 227 angler-hours. During that time, a total of 175 fish was caught, representing a *cpue* of 0.14 fish angler h^{-1}. Bearing in mind that this estimate was primarily from incomplete fishing outings, the result was similar to the total *cpue* calculated from catch cards during 1993

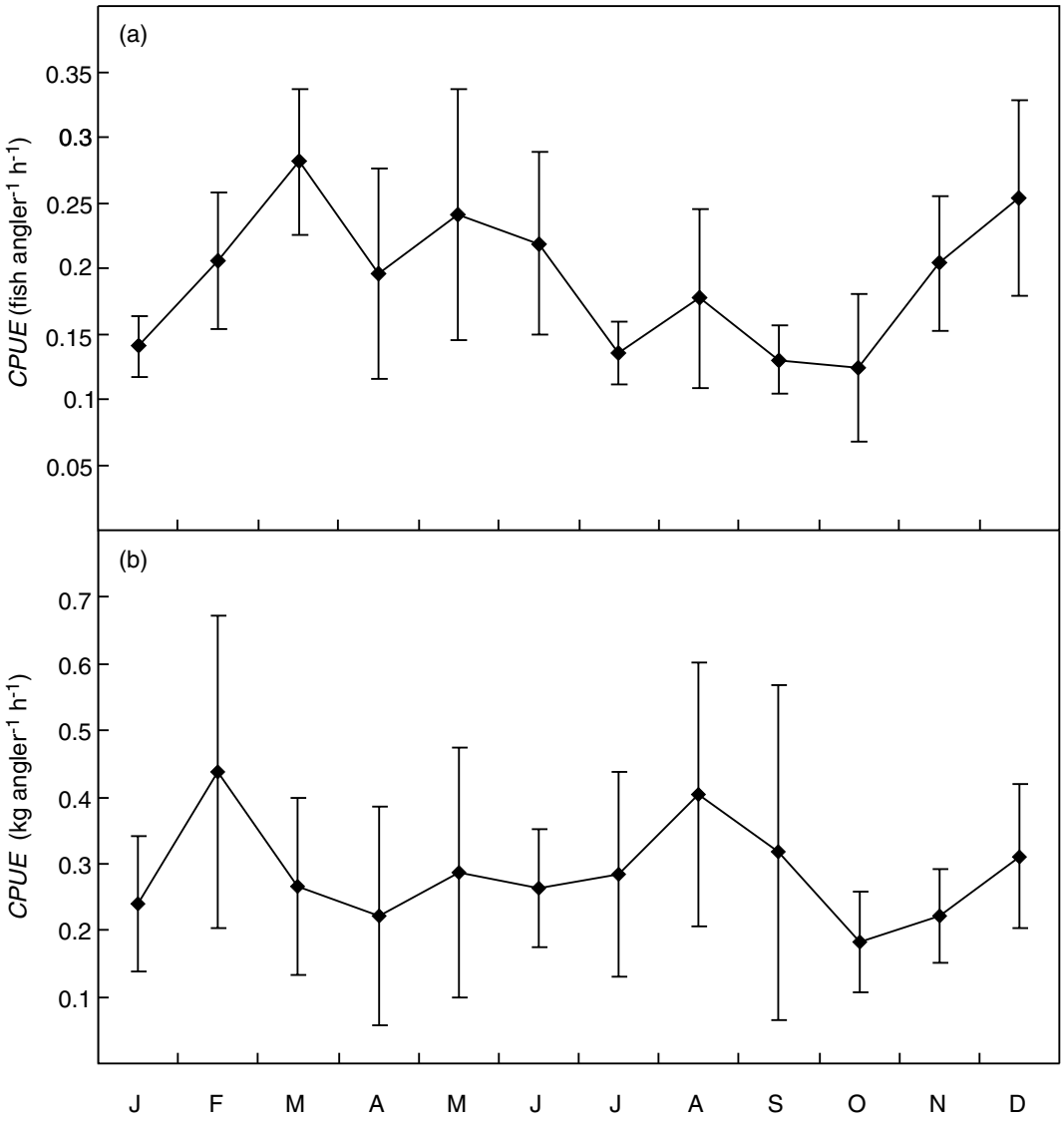

Fig. 5: Mean (±*SE*) monthly *cpue* by (a) number and (b) mass for all angling species reported on catch cards from the whole St Lucia estuarine system, 1986–1999

(i.e. 0.17 fish angler^{-1} h^{-1}). A total of 23 fish species was recorded, perch being the most important species caught (Table IV). This was because much of the survey was done during autumn and winter when large numbers of these fish congregate near the estuary mouth to spawn (Garratt 1993).

Dusky kob was the most sought-after angling species, half (52%) of the respondents indicating that they were targeting this species. Spotted grunter was the next most targeted fish, with most effort directed at this species in the estuary. Boat-anglers questioned had fished at St Lucia for an average of 17.3 days in the previous 12 months, with local anglers from Zululand (<100 km away) fishing more frequently (33.7 days per year) than visiting anglers from farther afield (14.9 days per year). Skippers interviewed had, on average, 19.5 years of angling experience and 29.4% of the boat skippers interviewed belonged to an an-

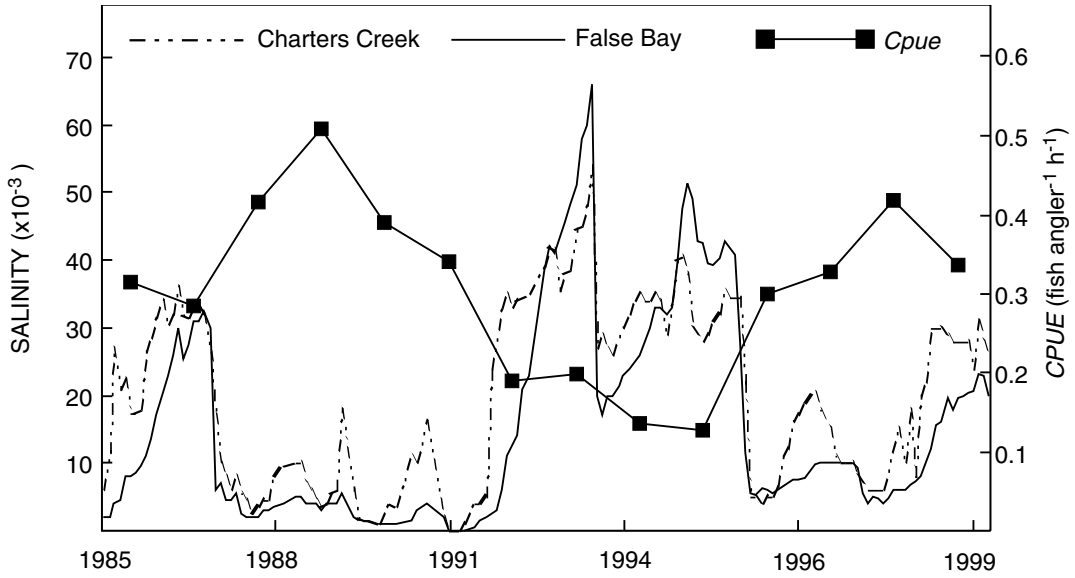

Fig. 6: Salinity measured at Charters Creek and False Bay, and total *cpue* by number of all angling species from the lake (South Lake and North Lake combined), 1986–1999

gling club.

Anglers' attitudes towards the current fishing regulations showed a surprisingly positive response, with 98% in favour of minimum size limits, 83% supporting bag limits, 96% agreeing with closed seasons and 94% recognizing the need for closed areas or marine reserves. A test of anglers' knowledge of the regulations pertaining to dusky kob and spotted grunter showed that, on average, 73% of anglers knew the size limit and bag limit for these species.

Most anglers (73%) had had their catches inspected by KZNW staff, with an average frequency of 4.1 times per year. Considering that, on average, anglers only fish at St Lucia for 17.3 days per year, this frequency of inspection represents exceptionally good enforcement of the regulations.

Economic assessment

Most anglers came from Gauteng (49%) and KwaZulu-Natal (49%), and most were employed. The average duration of a boat-anglers' holiday at St Lucia was 8.2 days. Of the anglers interviewed, 82 (80.4%) paid for accommodation during their stay at St Lucia (others were day visitors or had private accommodation). The average price paid for accommodation was R734 per boat interviewed (i.e. R31 per person per day). The average expenditure per boat outing was calculated as follows: bait R19, tackle R11, boat fuel R25, refreshments R19. On average, total expenditure was therefore R72 per boat outing (excluding hire-boats, which cost approximately R100 per day to hire). Extrapolating from the number of private and hire-

Table II: Total catch, effort and *cpue* recorded on catch cards at the four sites at St Lucia during 1992 and 1993

Region	1992			1993		
	Number of boat outings	Catch (kg)	*Cpue* (kg boat outing^{-1})	Number of boat outings	Catch (kg)	*Cpue* (kg boat outing^{-1})
St Lucia Estuary	2 448	2 838	1.16	1 365	2 648	1.94
Charters Creek	1 022	11 445	11.20	1 132	16 809	14.85
Fanies Island	393	5 449	13.90	247	4 507	18.25
False Bay	1 165	9 546	8.20	406	4 255	10.48
Total	5 028	29 278		3 150	28 219	

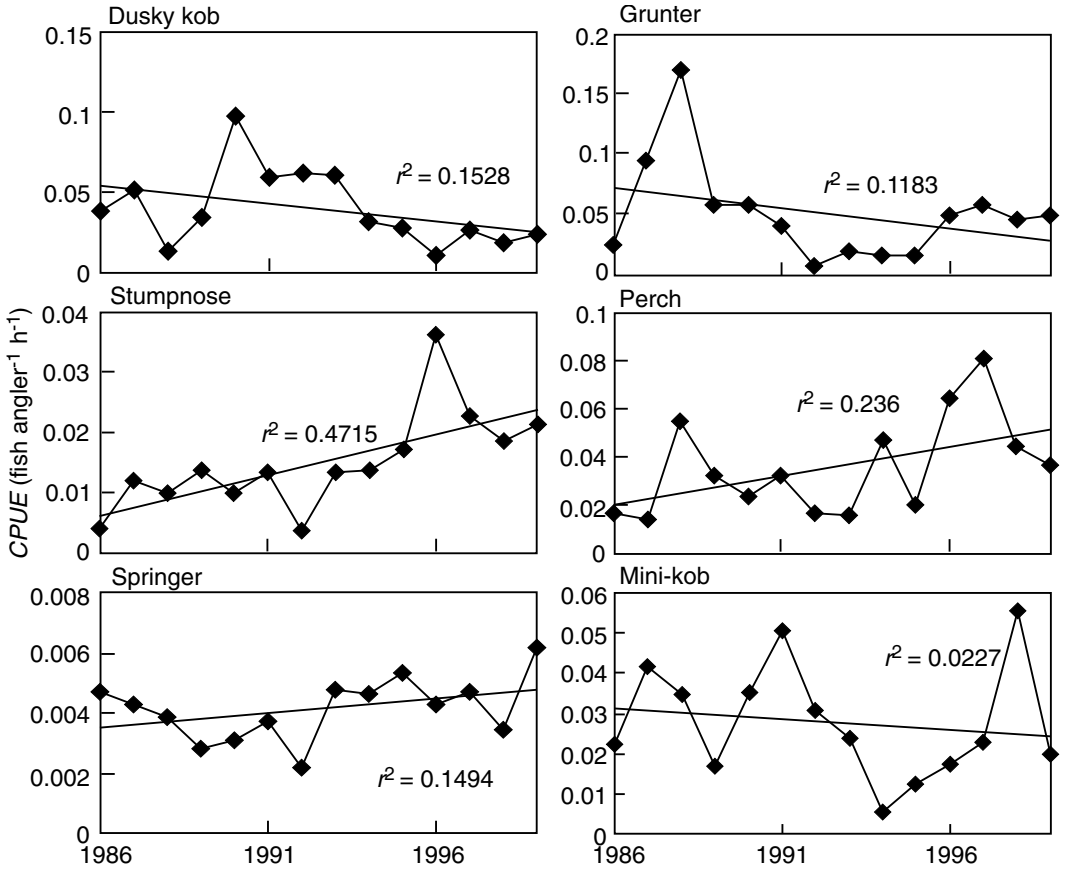

Fig. 7: Annual *cpue* trends in the number of dusky kob, grunter, stumpnose, perch, springer and mini-kob from the whole St Lucia estuarine system, 1986–1999

boat outings recorded during 1993 (i.e. 7 136 and 1 698 outings respectively), this would amount to approximately R763 398 direct expenditure by estuarine boat-anglers at St Lucia annually. The average value of privately owned boat rigs (boat and trailer inclusive) was R22 863 per rig, whereas the average value of boat-angling tackle (rods, reels, etc.) was R2 296 per angler.

Angler attitudes

Of the anglers interviewed, 88% ate the edible fish that they caught, 100% fished primarily for recreation, 28% fished competitively (similar to the 29% who were club anglers) and 9% indicated that they had, on occasions, sold their fish. In all, 82.4% felt that fishing at St Lucia had deteriorated. The main reasons given were closing of the St Lucia mouth (37.3%), overfishing (31.4%) and trawling (10.8%).

A total of 87 anglers (85.3%) indicated that they would be prepared to pay for a license to provide funds for fisheries conservation. However, most stipulated certain conditions, such as ensuring that funds were

Table III: Total number of private and hire-boat outings recorded at St Lucia during 1992 and 1993

Region	Estimated total number of boat outings	
	1992	1993
St Lucia Estuary (private boats)	4 053	3 153
St Lucia Estuary (hire-boats for fishing)	2 274	1 698
Charters Creek	2 528	2 091
Fanies Island	694	537
False Bay	2 124	1 355
Total	11 673	8 834

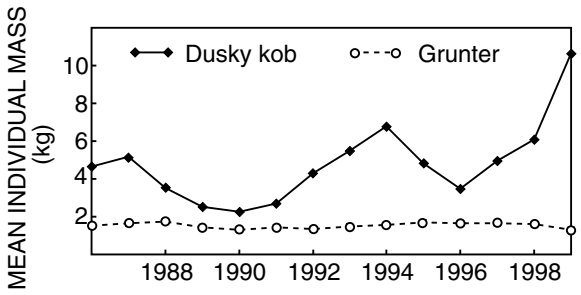

Fig. 8: Annual trends in the mean reported mass of dusky kob and grunter from the whole St Lucia estuarine system, 1986–1999

Table IV: The 10 most abundant fish species recorded in a boat-angling survey conducted in St Lucia estuarine system during 1994

Species	Common name	Number	%
Acanthopagrus berda	Perch	88	50.3
Pomadasys commersonnii	Spotted grunter	13	7.4
Rhabdosargus sarba	Natal stumpnose	12	6.9
Johnius dorsalis	Mini-kob	11	6.3
Thrysoidea macrura	Slender giant moray	8	4.6
Argyrosomus japonicus	Dusky kob	7	4.0
Elops machnata	Springer	5	2.9
Caranx spp.	Kingfish spp.	5	2.9
Pomadasys kakaan	Javelin grunter	3	1.7
Pomatomus saltatrix	Shad	3	1.7
Otolithes ruber	Snapper kob	3	1.7

used for fisheries conservation (not just another form of taxation), use of funds to keep the St Lucia mouth open, improvement of angling facilities and stock enhancement. The average price that anglers were willing to pay for a marine angling licence was R23 per year.

DISCUSSION

Angling effort

The decreasing trend in the number of catch cards collected at St Lucia between 1986 and 1999 (Fig. 2) is not linked to an actual trend in angling effort and simply reflects decreasing effort in submission and collection of angling data. Trends in angling effort within the St Lucia estuarine system tend to fluctuate from year to year, depending on the availability of fish. For example, the well known "grunter run" between August and November each year attracts thousands of anglers to St Lucia Estuary. This run consists of post-spawned spotted grunter, which re-enter the estuary after spawning at sea (Wallace 1975b). During years when the mouth is closed and grunter cannot re-enter the estuary, numbers of anglers visiting St Lucia tend to drop (BQM, pers. obs.). Similarly, dusky kob catches tend to improve during winter (May–August) and when good catches are made word quickly gets out and large numbers of anglers visit St Lucia.

Overall, angling effort at St Lucia is probably increasing at approximately 2% per annum, similar to that estimated for the recreational shore-fishery (McGrath *et al*. 1997). Although recreational angling is an open-access fishery, a continued increase in angling effort in St Lucia will ultimately result in overfishing and stock collapse. In addition to permit regulation (e.g. angling permits and boat launching fees, which have already been introduced), the number and physical size (parking space) of boat launching facilities are probably the key to controlling expansion of boat-fishing effort at St Lucia. Careful consideration should therefore be given before new launch sites are created or parking facilities expanded, because it would be unwise to allow angling effort to escalate much beyond current levels.

Catch composition and *cpue*

Anglers recorded a total of 55 species within the St Lucia system throughout the study period. Most were marine species, which are either estuarine-associated or estuarine-dependent to various degrees (Whitfield 1998). Only two freshwater species were recorded in catches, sharptooth catfish *Clarius gariepinus* (barbel) and Moçambique tilapia *Oreochromis mossambicus*. Barbel are only caught in False Bay and North Lake when the salinity is $<5 \times 10^{-3}$ (BQM, pers. obs.). A large variety of piscivorous fish, most important of which are dusky kob and springer, were recorded in anglers' catches. These piscivorous fish feed primarily on small plankton feeders such as estuarine round-herring *Gilchristella aestuaria* and orange-mouth glass-nose *Thryssa vitrirostris*, which are abundant in the system (Whitfield and Blaber 1978a). Historically, fishers congregated at the St Lucia mouth to catch several shark species that enter the estuary to feed on shoals of mullet (primarily *Mugil cephalus*). The Zambezi shark *Carcharhinus leucas*, which was the most frequently caught shark in catches, feeds and pups in the estuary and the young move into the lakes (Bass 1976). However, at present very few sharks are caught in the estuary or lake (Table I). Similarly, sawfish *Pristis pectinata* used to be relatively common in St Lucia (R. van der Elst, ORI,

pers. comm.) but are now extremely rare.

Dusky kob, spotted grunter, perch, Natal stumpnose, mini-kob and springer dominate catches at St Lucia. Dusky kob and grunter each contributed 25% of the total catch (by numbers). The dusky kob is a sensory-feeder that prefers the turbid water of Lake St Lucia to that of clear-water systems such as Kosi Bay (van der Elst 1977). Kingfish species *Caranx* spp., which are visual predators, feature prominently in catches at Kosi Bay (James *et al.* 2001) but were less frequent in catches at St Lucia (Table I).

The catch composition was slightly different in the lake (North and South Lake) from that in the estuary. Catches in the estuary were dominated by grunter and perch, whereas dusky kob were the most prominent species caught in terms of both number and mass in the lake.

The catch composition from St Lucia Estuary during the present study period was similar to that recorded during Natal Coastal Angling Union (NCAU) competitions held at St Lucia mouth between 1956 and 1976 (van der Elst 1977), when again dusky kob, grunter, stumpnose, springer and perch were the most important euryhaline species taken. However, NCAU competitions then were fished by shore-anglers, both in the surf and in the first kilometre of the estuary, and are therefore not directly comparable with light-tackle boat catch data reported on catch cards. Nevertheless, this broad comparison suggests that, other than a decline in sharks, there has been relatively little change in species composition of the main species caught at St Lucia during the past 20 years.

The fish fauna at St Lucia is variable and to a large extent determined by salinity (van der Elst 1976). In the present study, increases in *cpue* in the lake were correlated with decreases in lake salinity, and *vice versa*. Similarly, Wallace (1975a) and van der Elst (1976) found that high salinities in North Lake were often associated with a reduction in species diversity. The salinity in the lower reaches of the estuary remains fairly stable, so *cpue* in the estuary was likely not affected by salinity. However, the state of the estuary mouth can affect catches. For example, floods in September 1987 resulted in scouring of the estuary mouth, with associated reduction in salinity and increased turbidity, and it is likely that good recruitment followed this event (Harris and Cyrus 1996). Surprisingly, *cpue* in the estuary increased slightly in 1993, when the mouth closed for 10 months. Wallace (1975b) attributed increases in fish abundance in the estuary during periods of mouth closure to seaward movement of fish from the lake. Formation of a sandbar across the mouth blocks the movement of fish to and from the sea (Whitfield 1998). Because angling species abundance is obviously related to mouth condition and prevailing salinities, maintaining adequate freshwater inflow and ensuring that the entire system continues to function as an estuary are considered to be of prime importance in the management of St Lucia's fish resources.

Regression analysis revealed no discernable trends in *cpue* for the whole system. *Cpue* for individual target species fluctuated widely, probably related to the state of the estuary mouth and salinity of the lake. Despite annual fluctuations, *cpue* for perch, stumpnose and springer showed an overall upward trend. This is surprising because van der Elst (1977) reported a decline in *cpue* for perch in the estuary between 1956 and 1976. *Cpue* for perch also declined in Kosi Bay, which, in comparison to St Lucia, has suffered relatively little estuarine degradation (James *et al*. 2001).

Catch rates of dusky kob and grunter showed an overall downward trend, although it was not significant. Dusky kob is a heavily overexploited species, with recent assessments showing that the stock has collapsed to 2.3% of pristine spawner biomass levels (Griffiths 1997). The species is caught along the entire South African east coast, and as such, strict management measures are required to rebuild stocks (Griffiths 2000). *Cpue* of spotted grunter in St Lucia Estuary showed no clear trend between 1956 and 1976 (van der Elst 1977). Similarly, there was no clear trend in *cpue* for spotted grunter found in Kosi Bay (James *et al.* 2001). However, gillnet catches in the Swartkops and Sundays estuaries, where spotted grunter is the main species caught, revealed a decrease in abundance between 1980 and 1992 (Baird *et al*. 1996). A recent per-recruit stock assessment of spotted grunter off KwaZulu-Natal has revealed that grunter stocks are probably optimally exploited (S. T. Fennessy, ORI, unpublished data). The *cpue* of mini-kob showed no discernable trend. Although this species forms an important component of catches in the recreational fishery in St Lucia, it is not targeted to any great extent and is often regarded as a pest by anglers (Fennessy 2000).

Total catch and effort

Estimates of total catch and effort for the St Lucia system were clearly subject to a number of assumptions and biases. With regard to total effort estimation (Table III), it was not possible to count boat trailers at St Lucia and Charters Creek every day of the year for the full two years. For this reason, average weekday and weekend counts were used to scale up counts made. The number of boat outings estimated for Fanies Island and False Bay is probably less accurate, because it is based on the number of boats recorded entering the respective camping site gates multiplied by

the average number of boat outings recorded for boats that entered Charters Creek camping site. Charters Creek only provides hutted accommodation and does not have a camping site, whereas Fanies Island and False Bay have camping sites. The result is that anglers tend to spend less time at Charters Creek (as it is more expensive) than at the other two venues. The number of boat outings estimated for Fanies Island and False Bay are therefore probably underestimates of the actual number.

Undoubtedly the greatest bias in the estimation of total catch can be attributable to the non-reporting of catches (non-response bias). Many anglers do not take the trouble to complete a catch card if no fish were caught. This results in an overestimation of catch rates because only successful fishing outings tend to be reported. Ways in which to overcome these assumptions and biases to ensure improved monitoring of recreational fishing at St Lucia would be to implement a launch register at each boat slipway. In this way each boat outing would then be recorded, and it could have the added use of being a safety check. The completion of catch return cards should also be made compulsory. A staff member of the conservation authority should be delegated the responsibility to oversee the collection of accurate catch-and-effort data at each launch site. This would ensure that a trained individual undertakes completion of catch cards and that it becomes an inspection rather than a voluntary submission of data. This will eradicate many of the biases associated with voluntarily submitted data (Mann-Lang 1996) and assist in ensuring better compliance with the fishing regulations. This is in line with the observer programme recommended for the boat-based linefishery (Sauer *et al.* 1997).

Socio-economics of the recreational fishery

Recreational angling is one of the most important drawcards for visitors to the St Lucia region, and maintenance of healthy fish stocks is therefore of paramount importance for tourism. This was clearly seen during drought years around 1952 and again between 1969 and 1972 when the lake became hypersaline and fishing deteriorated dramatically. The result of this was that anglers stayed away and St Lucia village became a virtual ghost town (van Zyl 1973). This impact on the economy of the region is also apparent to a lesser extent when the St Lucia mouth closes for extended periods. Anglers perceive that fishing in the estuary deteriorates when the mouth is closed and this is frequently associated with a reduction in numbers of visitors to St Lucia (L. Walters, St Lucia Publicity Association, pers. comm.). With diversification of available activities and the recent proclamation of the Greater St Lucia Wetland Park as a World Heritage Site, visitor profile to the area is likely to change, with a greater number of international tourists whose interests will probably be in viewing the landscapes and biodiversity of the area rather than angling *per se*. Nevertheless, many South Africans will continue to visit St Lucia for the purpose of angling.

Porter and Haynes (1993) estimated that there were around 583 270 occupied bed-nights provided by KZNW and private enterprise at St Lucia village during 1991 (excluding Cape Vidal and the eastern shores). Assuming that 45.4% of these bed-nights were made up by anglers who fished in the estuarine system (determined from a visitor survey conducted by Mann 1994), and that they spent an average of 17.3 days per year at St Lucia (determined from the boat-angler survey), this would amount to 15 307 estuarine anglers fishing in the St Lucia system annually. Although there is little statistical confidence in this estimate, it provides an indication of the popularity of St Lucia as an angling venue and can be used as a preliminary estimate of angler participation.

Angler attitudes towards the current fishing regulations were surprisingly positive, and their knowledge of the regulations for the two most targeted species was also good. This can be attributed largely to the effective education of anglers by explaining the regulations (e.g. in angler brochures and signage made available around the estuarine system) and by the presence of conservation officials at boat launching sites. The frequency of catch inspections was probably overemphasized in the survey because the presence of a conservation official when returning from a fishing outing and the act of completing a catch card was probably considered by some anglers as equivalent to having their catch inspected. The importance of enforcement of regulations towards improving angler compliance has been shown for the KwaZulu-Natal coast, which is relatively better patrolled than other areas of the South African coast (Brouwer *et al.* 1997).

Recreational fishing at St Lucia clearly generates a substantial amount of revenue. Porter and Haynes (1993) calculated that approximately R1.5 million was generated by accommodation facilities provided by KZNW at sites around St Lucia during 1991. The actual income earned by the private sector in providing accommodation for visitors to St Lucia village is not known. However, if 100% bed occupancy were to be achieved, then the estimated income to the private sector would be approximately R16.9 million (Porter and Haynes 1993). Assuming that anglers fishing in the St Lucia estuarine system make up 45.4% of all visitors (Mann 1994), then at least R8.3 million annually could be ascribed to revenue earned from

accommodation provided for anglers alone. This estimate is similar to the results of the boat-angler survey, where the average price paid for accommodation was R31 per person per day. Multiplying up by the estimated number of anglers (15 307) and the average number of days spent at St Lucia (17.3), this would give an estimate of R8.2 million spent on angler accommodation annually. In addition to accommodation, direct estuarine boat-angler expenditure was estimated to be R760 000 per year but this did not take travel costs, boat maintenance, equipment replacement, etc. into account.

Studies conducted elsewhere have shown that recreational fisheries can be considerably more valuable than commercial fisheries targeting the same species (Bell 1981). This is primarily a result of the large number of participants involved in recreational fisheries and the associated subsidiary industries (e.g. bait, tackle, boats, motors, trailers, navigation and fish finding equipment, accommodation). In addition, recreational fishing provides an extremely important form of relaxation and is one of the most popular pastimes of many South Africans. For this reason, expenditure by recreational anglers is largely irrespective of the amount of fish they catch (McGrath *et al*. 1997). Lamberth and Turpie (2001) attributed a value to the South African estuarine recreational fishery of R414 per kg of fish caught. In a situation where fish resources are becoming increasingly overexploited, recreational interests will ultimately take precedence over commercial interests (Winstanley 1985).

The majority of anglers interviewed at St Lucia (85%) believed that fishing had deteriorated and that closing of the estuary mouth, overfishing and trawling were the main reasons for this decline. Even in the absence of comparable long-term data, it is clearly evident that catches at St Lucia have declined considerably since the halcyon days when extremely large catches of sharks, dusky kob and spotted grunter were made (Mara 1985). There is little doubt that fishing has played a major role in depleting a large variety of estuary-dependent marine linefish species (Mann 2000). However, reduction of freshwater inflow into St Lucia as a result of drainage of the Umfolozi floodplain and other wetlands, breaching of a separate mouth for the Umfolozi River, the construction of dams, irrigation and a forest station, have probably had the greatest overall impact on the St Lucia system itself (Taylor 1993). The mouth of St Lucia is largely controlled by "mega-floods" such as that recorded in 1984 after cyclone Demoina. The KZNW response to management is therefore a "hands-off" approach where possible, to try and allow the system to function as naturally as possible. However, regular dredging near the mouth is necessary to try and maintain the estuarine functioning of the system. A careful dredging protocol has therefore been established (Taylor *et al*. 1995).

Little is known about the impact of offshore trawling on St Lucia's fish stocks. Studies by Fennessy (1994) and Fennessy *et al*. (1994) on the bycatch of prawn trawlers operating on the Tugela Bank showed that squaretail kob *Argyrosomus thorpei* was the only linefish species that constituted a significant proportion of the trawl bycatch. More recently, prawn trawling has been taking place close inshore off the St Lucia mouth, but the bycatch in this area is not known. If species such as spotted grunter and Natal stumpnose, which are known to spawn off the St Lucia mouth (Wallace 1975b), are being caught in substantial numbers by the trawlers, this will undoubtedly have a severe impact on fish stocks in St Lucia. Furthermore, the effects of prawn trawling on the benthic habitat and associated ecosystem are poorly understood. As a precautionary measure it is strongly believed that prawn trawling should not be allowed in the vicinity of the St Lucia mouth because of the immense importance of this system, both as nursery area and wildlife heritage, as well as its importance for recreational fishing (Wallace 1975a, b).

Other management considerations

With the recent failure of an attempt to implement a subsistence gillnet fishery in St Lucia for the benefit of neighbouring rural communities (Mann in press), it has been suggested that management authorities should consider establishing a commercial gillnet fishery. The establishment of such a fishery in St Lucia is likely to have disastrous consequences for the estuary and scientific argument is strongly opposed to such a step. Apart from the likely biological impacts of such a fishery on the fish resources, the employment gained and the money generated through sale of fish would probably be considerably less than that currently generated by the recreational fishery (Lamberth and Turpie 2001). With the recent World Heritage Site status and the promise of tourism development in the area, many viable alternatives to commercial gillnetting could be found, and it is to be hoped that these alternatives are investigated and implemented. For example, possibilities exist for microenterprise developments such as the sale of bait and tackle and the hiring of boats. Furthermore, the possibility of implementing a recreational fishing levy as a trust fund to help start ecotourism business enterprises in adjacent rural communities could be explored.

The current zoning of the St Lucia estuarine system

into fishing areas and no-take wilderness areas should be maintained (Fig. 1). Apart from providing direct protection to a proportion of the less mobile juvenile fish stocks in the system, wilderness areas are considered to be an important addition to the suite of single-species management regulations (Attwood *et al*. 1997). In this regard, such areas provide an undisturbed refuge where the whole ecosystem is protected. This can be considered a holistic approach towards ecosystem management; the no-take wilderness areas in St Lucia represent some of the only protected estuarine habitats in South Africa where no fishing (or any human disturbance) is permitted.

In the past there has been considerable criticism focused on certain anglers at St Lucia for exploiting the fish resources for commercial gain. This activity was primarily confined to anglers making large catches of dusky kob during winter. With the current "collapsed" status of dusky kob stocks in South African waters (Griffiths 1997), stringent new regulatory measures have been proposed to rebuild the stocks (Griffiths and Lamberth in press). These measures include an increase in the minimum size limit from 40 to 60 cm total length and a reduction in the bag limit from five to one fish angler^{-1} day^{-1}. With effective enforcement, these measures will largely preclude the "commercial" exploitation of dusky kob in St Lucia. There has also been much debate over the years regarding the policy to allow fishing competitions in a protected nature reserve such as Lake St Lucia (A. Forbes, University of Natal, pers. comm.). Clearly, the economic gain from such fishing competitions needs to be carefully weighed up against their impact on the fish resources. Competitions that offer prizes for threatened or vulnerable fish species and which encourage large catches to be made should clearly be avoided. However, the practice of catch-and-release competitions offers good potential and, if correctly managed, could be promoted.

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