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ASSESSMENT OF THE RECREATIONAL LINEFISHERY IN SELECTED EASTERN CAPE ESTUARIES: TRENDS IN CATCHES AND EFFORT

P. PRADERVAND and D. BAIRD†*

Boat-based creel surveys were used to collect catch and effort data on the shore- and boat-based linefisheries of the Kromme, Gamtoos, Swartkops, Sundays, Bushmans, Kariega, Kowie and Great Fish estuaries in the Eastern Cape, South Africa, from January 1996 to April 1997. The surveys, which were performed primarily during routine fisheries law enforcement patrols by a regional conservation agency, recorded the catch and effort of 2 468 individual angler outings (12 840 angling hours) during 337 angler-count patrols. Although 26 species were recorded, a large proportion of the catch (85%) comprised only four species. Spotted grunter *Pomadasys commersonnii* (43%) was most commonly caught, followed by Cape stumpnose *Rhabdosargus holubi* (16%), dusky kob *Argyrosomus japonicus* (14%) and white seacatfish *Galeichthys feliceps* (12%). In terms of mass, the overall catch was dominated by *A. japonicus* (50%) and *P. commersonnii* (33%). Overall catch per unit effort (*cpue*) by number was highest during summer and lowest during winter, and vice versa for *cpue* according to mass. Angler counts showed the Sundays Estuary had the highest mean angling effort for both weekdays and weekends (10.1 and 22.9 anglers count^{-1} respectively). The Gamtoos Estuary had the lowest count for weekdays (5.5 anglers count^{-1}) and the Kariega Estuary the lowest for weekends (9.8 anglers count^{-1}). Shore-based was more popular than boat-based angling (59% compared to 41%), and all estuaries had substantially higher angling effort on weekends than on weekdays. Angling with bait (93.3%) was more popular than lure- or fly-angling (6.7% combined). Considerations for management of *A. japonicus* in the Eastern Cape estuarine linefishery are presented.

Key words: catches, Eastern Cape, effort, estuaries, recreational linefishery

Marine recreational linefishing is arguably the most popular form of marine resource usage along the South African coastline. Recent estimates placed the number of participants in the shore-fishery at 412 000 anglers (McGrath *et al*. 1997), and the number in the offshore boat-based fishery at 13 800 (Sauer *et al*. 1997). The extent of the catch in these fisheries also bears testimony to the popularity of marine linefishing, with an estimated recreational catch of 4.5 million fish (3 000 tons) during 1995 in the national shore-fishery alone (Brouwer *et al*. 1997). The reported economic contribution of recreational marine line-fishing (1.3% of the combined gross geographical product of South Africa's four coastal provinces) also provides an indication of the importance of the fishery (McGrath *et al*. 1997).

Despite the popularity of recreational marine line-fishing in South Africa, only limited aspects of the skiboat, shore- and spearfishery have been subjected to detailed investigation (Joubert 1981, Clarke and Buxton 1989, Coetzee *et al*. 1989, Hughes 1989, Bennett 1991, Bennett *et al*. 1994, Brouwer *et al*. 1997, Mann *et al*. 1997, McGrath *et al*. 1997, Sauer *et al*. 1997, Griffiths 1999a, Penney *et al*. 1999). Research on the South African estuarine linefishery is even more limited, with the only published analysis on this fishery being restricted to the work by Marais and Baird (1980a) and Baird *et al*. (1996) on the Swartkops and Sundays estuaries in the Eastern Cape, and an analysis of the Durban Bay linefishery in KwaZulu-Natal by Guastella (1994). Unpublished literature on the estu-arine linefishery includes an assessment of the St Lucia Lake system fishery in KwaZulu-Natal (Mann 1994), and by Daniel (1994) and Pradervand (1999a), both dealing with sectors of the Eastern Cape estuarine linefishery.

Recreational linefishing in Eastern Cape estuaries is either boat- or shore-based. Boat-angling is normally conducted from small boats that are usually powered by a single outboard motor, whereas shore-angling generally takes place from the most accessible areas along an estuary. There are distinct competitive and non-competitive components of the estuarine line-fishery, the former consisting of league and social competitions. The tackle employed in the fishery is relatively unsophisticated and light in nature, with a 4-kg breaking strain limit generally placed on lines used in competitions (J. Baptiste, KwaZulu-Natal Light Tackle Boat Angling Association, pers. comm.). Organized competition estuarine angling in the area

* Oceanographic Research Institute, P.O. Box 10712, Marine Parade 4056, South Africa. E-mail: seaworld@dbn.lia.net
† Department of Zoology, University of Port Elizabeth, P.O. Box 1600, Port Elizabeth 6000, South Africa. E-mail: zladdb@zoo.upe.ac.za

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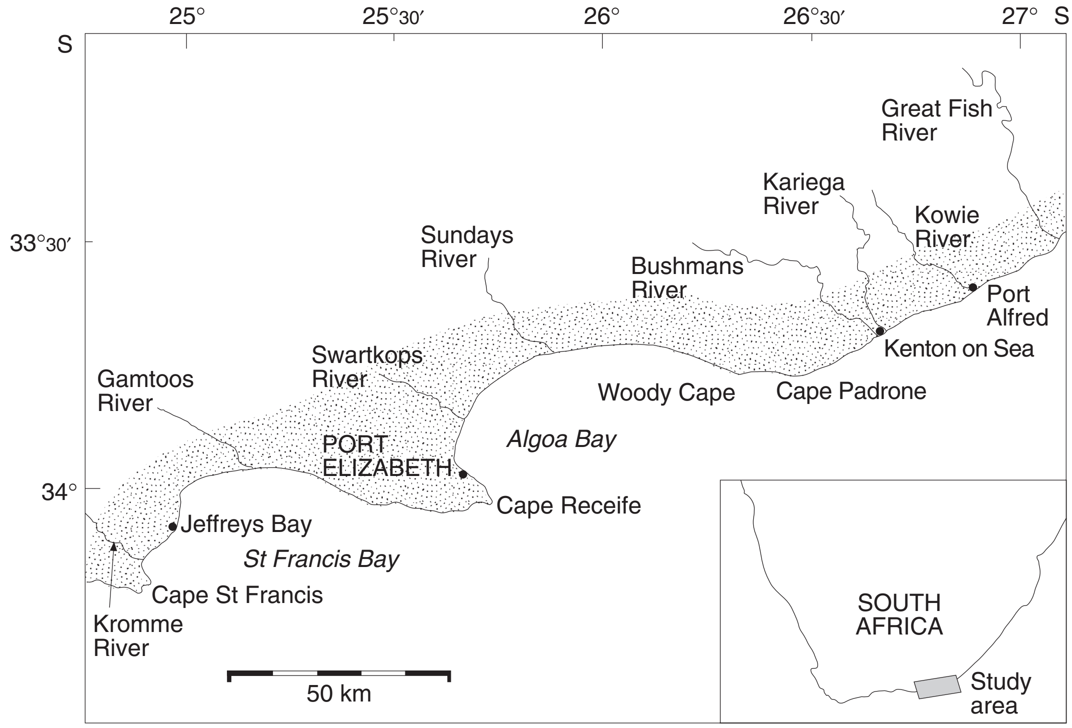

Fig. 1: Map of the study area showing location of the individual study estuaries

studied falls under the auspices of the Eastern Province Light Tackle Boat Angling Association (EPLTBAA) which, in 1997, had a minimum of 13 affiliated clubs and a total membership of 1 178 anglers (M. Roos, EPLTBAA, pers. comm.).

In this paper, the results are presented of an initiative by the University of Port Elizabeth and the Western Districts Council (a regional conservation management agency) in making use of routine estuarine fisheries law enforcement patrols to collect catch and effort data to assess the estuarine linefishery.

MATERIAL AND METHODS

This study made use of fisheries law enforcement personnel from the Western Districts Council, who performed occasional boat patrols along the Kromme, Gamtoos, Sundays, Bushmans, Kariega, Kowie and Great Fish estuaries from January 1996 to April 1997 (Fig. 1). The patrols were performed in an opportunistic fashion, with no fixed sampling strategy. All patrols were carried out between 06:00 and 18:00, and therefore primarily covered the daytime fishery. The patrols covered a minimum of three-quarters of the length of the respective estuaries and were performed from the estuary mouth upstream, or from a point on the estuary to its mouth. Data were collected while travelling in one direction (i.e. not during the return trip to the launch site). The starting time and starting location of patrols was entirely at the discretion of the survey clerks. The patrols had an average duration of 100 minutes (ranging from 20 min. to 6 h) and consequently represent mostly progressive counts (Pollock *et al*. 1994).

During all patrols, anglers encountered along the patrol course were counted and information on the number of rods and handlines, group sizes, fishing method (bait, lure, fly) and angling platform (boat or shore), as well as on gender and race was collected. Bait-fishing is defined as the practice of baiting a hook with an organism, or part thereof, lure-fishing as the use of an artificial hooked-object that entices a fish to strike, and fly-fishing, the same as lure-fishing except that a weighted line is used to propel the fly. When logistics allowed, a subsample of the anglers was interviewed to obtain catch and effort information.

Table I: Breakdown of sampling effort on a per month basis for each estuary studied during 1996 and 1997. Data are presented in terms of the number of patrols that performed angler counts and the number of patrols that performed interviews, as well as the effort sampled during the interviews (individual angler outings and individual angling hours). Blanks indicate no sampling effort

Estuary	Sampling effort	1996												1997				Total
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Kromme	Number of patrols – counts	4	2	3		2	3	5	7	6	9	4	5	1				51
	Number of patrols – interviews					1		3	3		3	1	10	7		1	1	30
	Effort sampled (outings)					2		7	4		18	2	77	19		4	2	135
	Effort sampled (h)					24		13	7		27	4	184	51		6	4	320
Gamtoos	Number of patrols – counts	2	4	1		1	2	5	11	3	0	1	1					31
	Number of patrols – interviews			1	3	1		8	12	6	4	2	6	2		2	1	48
	Effort sampled (outings)			3	9	1		44	102	27	16	15	39	17		32	3	308
	Effort sampled (h)			18	113	4		384	795	130	80	81	181	92		181	1	2060
Swartkops	Number of patrols – counts*																	
	Number of patrols – interviews			4	13	16	4	2	3	4	3	4		5	8	13	10	89
	Effort sampled (outings)			24	36	139	37	4	52	52	44	70		39	18	98	15	628
	Effort sampled (h)			34	104	712	455	28	154	119	135	271		88	46	299	57	2502
Sundays	Number of patrols – counts	14	4	1	3			14	12	16	4	3	16	2				89
	Number of. patrols – interviews		1	5	6	4		19	8	3	1	5			3	3		58
	Effort sampled (outings)		5	69	65	69		82	39	68	8	6	42		12	20		485
	Effort sampled (h)		33	715	583	696		382	208	332	42	16	383		29	176		3595
Bushmans	Number of patrols – counts	1	3	1	1			2		2		1	4					15
	Number of patrols – interviews				4			4		1		2	2			1		14
	Effort sampled (outings)				15			13		3		3	4			4		42
	Effort sampled (h)				17			37		14		3	10			16		97
Kariega	Number of patrols – counts	1	3	1	2			2		1		4	11	3				28
	Number of patrols – interviews				5	3		4				1	7		6	2	2	30
	Effort sampled (outings)				28	8		18				3	19		19	4	3	102
	Effort sampled (h)				58	127		39				2	72		54	19	9	380
Kowie	Number of patrols – counts	5	5	6	10		2	9	8	12	4	6	11		5			83
	Number of patrols – interviews				14	10	11	14	4	9	5	6	6		1			80
	Effort sampled (outings)				208	24	43	51	15	34	20	20	16		3			434
	Effort sampled (h)				904	52	77	91	32	111	41	46	23		3			1380
Great Fish	Number of patrols – counts				7			4	9	10		1	9					40
	Number of patrols – interviews				13	3		4	8	10	1	2	5			1		47
	Effort sampled (outings)				201	7		18	44	38	1	3	19			3		334
	Effort sampled (h)				1542	70		76	356	328	4	7	96			27		2 506
Totals	Number of patrols – counts	26	21	13	23	3	7	41	47	50	17	20	57	6	5			337
	Number of patrols – interviews		1	10	58	38	15	58	38	33	17	23	36	14	18	23	14	396
	Effort sampled (outings)		5	96	562	250	80	237	256	222	107	122	216	75	52	165	23	2 468
	Effort sampled (h)		33	767	3321	1685	532	1050	1552	1034	329	430	949	231	132	724	71	12 840

* No angler count patrols were performed on the Swartkops Estuary

In order to supplement the catch and effort data collected during these patrols, opportunistic boat patrols were performed by clerks, independent of the estuarine management agency. These patrols were performed in an identical manner to the agency's patrols, but they were used only to interview anglers and not to make overall angler counts. Limited use of an angler-diary survey was also made to collect catch per unit effort (*cpue*) data. Thus, the data presented in this paper represent opportunistically collected information on angling catches and effort.

During angler interviews, information was collected on time spent actively angling, species caught, morphometrics of the catch (total length, cm), number of anglers in the party and the fishing methods employed (bait, lure, fly). All fish caught by the respondents, whether released or retained, were recorded. Where fish were retained, they were identified and measured by survey clerks, and when fish had been released, estimates of these were gleaned from the interviewees. Mass of fish was determined using standard length/mass regressions (van der Elst and Adkin 1991).

Units of *cpue* used in the study were mass of fish caught per angler per hour (kg angler^{-1} h^{-1}) and number of fish caught per angler per hour (fish angler^{-1} h^{-1}). All fish landed, whether released or retained, were included in *cpue* estimations. If a group of anglers was intercepted by survey clerks, *cpue* was estimated by dividing the total catch of the group by the number of anglers in the group. *Cpue* was also calculated for selected species, under the assumption that effort was directed equally at all species. Data from overlapping months were pooled.

It should be noted that, because the Swartkops Estuary was not under the jurisdiction of the Western Districts Council, it was not patrolled by the Council's fisheries law enforcement personnel during the course of the study. Instead, it was only patrolled by clerks independent of that Council. Those clerks exclusively collected catch and effort data, and did not perform any angler counts.

RESULTS

Sampled effort

A total of 337 angler-count estuarine patrols was undertaken between January 1996 and April 1997 (Table I), and totals of 802 angling boats, 1 624 boat-anglers and 2 356 shore-anglers were counted. It should be noted that patrols were not conducted in a uniform manner, such that sampling effort was not equally distributed among the various estuaries; nor was sampling conducted on a regular monthly basis. Most of the patrols were performed on the Sundays (n = 89), Kowie (n = 83) and Kromme (n = 51) estuaries, primarily during the period July–December 1996. Some 62% of the patrols were carried out on weekdays and the remainder (38%) on weekends and public holidays. All estuaries, with the exception of the Great Fish, had >60% of patrols conducted during weekdays. Only 40% of patrols on the Great Fish Estuary were on weekdays.

In total, the catch and effort details of 1 305 angler outings were recorded, representing the catches of 2 468 individual anglers in 12 840 h of angling (Table I). The majority (67%) of the catch data were collected during the agency patrols, with the agency-independent patrols contributing 28% of data collected, and the diary-survey only 5%. Boat-based angling, non-competitive angling and angling with bait made up the majority (62, 78 and 94% respectively) of the fishing effort recorded, with only 38, 22 and 6% of the recorded data stemming from shore-based angling, competitive angling, and lure- and fly-angling respectively. Because of the lack of a stratified sampling strategy, the distribution of the total recorded angling effort was not uniform between study estuaries, or months of the year, and most data were obtained from the Sundays (28%), Great Fish (19%) and Swartkops (19%) estuaries during the periods March–May and July–September.

Angling effort

The Sundays Estuary had the highest mean total number of anglers for both weekdays and weekends (10.1 and 22.9 anglers count^{-1} respectively; Table II). The Gamtoos Estuary had the lowest recorded mean fishing effort for weekdays (5.5 anglers count^{-1}), and the Kariega Estuary the lowest for weekends (9.8 anglers count^{-1}). All estuaries had higher angling effort during weekends than during the week (15.9 v. 7.4 anglers count^{-1} respectively). The maximum number of anglers counted on a weekend day was 111 (Kowie), and the maximum number on a weekday was 60 (Kromme). Overall, shore-based angling was more popular than boat-based angling (59% compared to 41%; Table III). On a per estuary basis, however, boat-angling was more popular in the Kromme (57%), Gamtoos (64%) and Sundays (54%) estuaries, whereas shore-based angling was more popular on the Bushmans (51%), Kariega (88%), Kowie (82%) and Great Fish (59%) estuaries. Angling with bait was more popular than lure- or fly-fishing in all estuaries (Table III), and only in the Gamtoos estuary did lure-fishing feature prominently (43.4% of anglers). White anglers dominated the fishery, constituting an average of 73.5% of all anglers counted on each estuary (Table III).

Table II: Recorded angling effort for estuaries on which angler counts were performed

Estuary		Anglers count^{-1}							
		Weekends				Weekdays			
		Angling boats	Boat-anglers	Shore-anglers	Total anglers	Angling boats	Boat-anglers	Shore-anglers	Total anglers
Kromme	Mean	2.5	5.4	6.0	11.4	1.9	3.7	1.9	5.6
WE = 15	*SD*	2.7	6.7	7.5	13.8	5.6	10.5	2.6	11.5
W = 36	Max.	9	20	19	39	31	57	10	60
	Min.	0	0	0	0	0	0	0	0
Gamtoos	Mean	4.6	9.6	9.1	18.7	2.5	4.4	1.0	5.5
WE = 9	*SD*	2.6	5.3	8.8	12.1	1.6	3.0	1.9	3.4
W = 22	Max.	9	18	21	39	6	11	6	13
	Min.	0	0	0	0	0	0	0	0
Sundays	Mean	5.9	11.8	11.2	22.9	2.9	5.9	4.2	10.1
WE = 36	*SD*	6.5	13.1	12.0	22.2	3.1	6.6	5.9	11.3
W = 51	Max.	31	59	46	94	13	29	26	43
	Min.	0	0	0	0	0	0	0	0
Bushmans	Mean	5.3	12.7	7.0	19.7	0.6	0.9	5.0	5.9
WE = 6	*SD*	7.2	19.2	9.3	28.1	0.5	0.9	5.2	5.3
W = 9	Max.	19	50	22	72	1	2	14	15
	Min.	1	1	0	2	0	0	0	0
Kariega	Mean	0.7	1.5	8.3	9.8	0.3	0.7	6.2	7.0
WE = 6	*SD*	0.8	2.0	9.7	11.1	0.6	1.7	5.2	6.0
W = 21	Max.	2	5	24	29	2	6	22	22
	Min.	0	0	0	0	0	0	0	0
Kowie	Mean	1.3	2.7	15.1	17.8	1.1	2.2	7.8	10.0
WE = 35	*SD*	2.2	5.2	16.0	20.3	2.2	5.1	7.8	10.8
W = 54	Max.	12	29	82	111	12	31	30	55
	Min.	0	0	0	0	0	0	0	0
Great Fish	Mean	2.6	5.5	5.5	11.0	0.9	1.8	5.5	7.4
WE = 21	*SD*	3.4	7.3	4.9	9.9	1.4	2.8	4.7	5.0
W = 19	Max.	15	30	16	35	4	8	17	20
	Min.	0	0	0	1	0	0	0	0

WE = number of counts performed on weekends
W = number of counts performed on weekdays

Catch composition

A total of 26 species was recorded from all the estuaries sampled, but a large proportion of the catch (85%) comprised only four species (Tables IV, V). Spotted grunter *Pomadasys commersonnii* (43%) was most commonly caught, followed by Cape stumpnose *Rhabdosargus holubi* (16%), dusky kob *Argyrosomus*

Table III: Distribution of angling effort between shore- and boat-based angling; bait-, lure- and fly-angling; and racial composition of anglers for each estuary on which angler counts were performed. Data are presented as percentages of the total number of anglers counted on each estuary

Estuary	Frequency (%)											
	Shore-angling				Boat-angling				Racial composition			
	Bait	Lure	Fly	Total	Bait	Lure	Fly	Total	White	Black	Indian	Coloured
Kromme	43.0	0	0	43.0	55.0	2 0	0	57.0	87.1	5.2	0	7.7
Gamtoos	23.5	12.5	0	36.0	33.1	30.9	0	64.0	82.5	4.6	4.0	8.9
Sundays	45.7	0.3	0	46.0	46.9	7.1	0	54.0	77.7	6.0	2.7	13.6
Bushmans	51.0	0	0	51.0	49.0	0	0	49.0	75.4	7.1	0	17.5
Kariega	88.0	0	0	88.0	12.0	0	0	12.0	57.1	31.7	0	11.2
Kowie	81.4	0.6	0	82.0	16.7	1.3	0	18.0	60.4	22.0	0	17.6
Great Fish	59.0	0	0	59.0	39.0	2.0	0	41.0	66.7	28.7	0	4.6
Total	58.0	1.0	0	59.0	35.3	5.7	0	41.0	73.5	13.6	0.3	12.6

Table IV: Total catch composition (retained and released fish) for eight Eastern Cape estuaries in terms of the number of fish caught. Species arranged in phylogenetic order according to Smith and Heemstra (1986)

Family	Species	Number caught (percentage contribution)								
		Kromme	Gamtoos	Swartkops	Sundays	Bushmans	Kariega	Kowie	Fish	Total
Chondrichthyes										
Callorhinchidae	*Callorhinchus capensis*			1 (0.2)						1 (<0.1)
Carcharinidae	*Mustelus mustelus*			2 (0.4)						2 (0.1)
Rhinobatidae	*Rhinobatos annulatus*				2 (0.3)		3 (2.4)			3 (0.1)
Dasyatidae		1 (0.6)		3 (0.6)	3 (0.4)		3 (2.4)	2 (1.4)	1 (0.2)	13 (0.5)
Scyliorhinidae	*Poroderma africanum*	1 (0.6)						1 (0.7)		2 (0.1)
Osteichthyes										
Elopidae	*Elops machnata*			19 (3.5)	4 (0.6)					23 (1.0)
Albulidae	*Albula vulpes*			1 (0.2)						1 (<0.1)
Muraenesocidae					2 (0.3)		2 (1.6)	1 (0.7)		5 (0.2)
Ariidae	*Galeichthys feliceps*	11 (6.5)	6 (3.4)	5 (0.9)	167 (24.6)	3 (7.5)		5 (3.4)	77 (16.0)	274 (11.6)
Platycephalidae	*Platycephalus indicus*			17 (3.1)	7 (1.0)	1 (2.5)	1 (0.8)	1 (0.7)		27 (1.1)
Serranidae								2 (1.4)		2 (0.1)
Monodactylidae	*Monodactylus falciformis*							1 (0.7)		1 (<0.1)
Carangidae	*Lichia amia*	2 (1.2)	8 (4.5)	47 (8.6)	8 (1.2)				5 (1.0)	70 (3.0)
Pomatomidae	*Pomatomus saltatrix*			9 (1.7)	5 (0.7)		1 (0.8)	6 (4.1)		21 (0.9)
Sciaenidae	*Argyrosomus japonicus*	5 (2.9)	75 (42.1)	10 (1.8)	138 (20.3)	3 (7.5)	16 (12.9)	15 (10.1)	60 (12.5)	322 (13.6)
Haemulidae	*Pomadasys commersonnii*	53 (31.2)	61 (34.3)	196 (35.9)	293 (43.1)	12 (30.0)	53 (42.7)	47 (31.8)	302 (62.8)	1 017 (43.0)
Sparidae	*Acanthopagrus berda*		1 (0.6)	5 (0.9)	5 (0.7)			2 (1.4)		13 (0.5)
	Diplodus cervinus hottentotus		1 (0.6)					2 (1.4)		3 (0.1)
	Diplodus sargus capensis	1 (0.6)		3 (0.6)	2 (0.3)		1 (0.9)	1 (0.7)		8 (0.3)
	Lithognathus lithognathus	16 (9.4)	11 (6.2)	11 (2.0)	5 (0.7)		2 (1.6)	7 (4.7)	27 (5.6)	79 (3.3)
	Rhabdosargus globiceps					2 (5.0)	20 (16.1)			22 (1.0)
	Rhabdosargus holubi	50 (29.4)	13 (7.3)	194 (35.5)	29 (4.3)	18 (45.0)	22 (17.7)	49 (33.1)	1 (0.2)	376 (15.9)
	Sarpa salpa	22 (12.9)	2 (1.1)	3 (0.6)		1 (2.5)		4 (2.7)		32 (1.4)
	Sparodon durbanensis								1 (0.2)	1 (0.1)
Mugilidae		2 (1.2)		20 (3.7)	9 (1.3)			2 (1.4)	3 (0.6)	36 (1.5)
Tetraodontidae		6 (3.5)								6 (0.3)
Cyprinidae	*Cyprinus carpio*				1 (0.2)				4 (0.8)	5 (0.2)
Total		170	178	546	680	40	124	148	481	2 367

Table V: Total catch composition (retained and released fish) for eight Eastern Cape estuaries in terms of the mass of fish caught. Species arranged in phylogenetic order according to Smith and Heemstra (1996)

Family	Species	Mass (kg) caught (percentage contribution)								
		Kromme	Gamtoos	Swartkops	Sundays	Bushmans	Kariega	Kowie	Fish	Total
Chondrichthyes										
Callorhinchidae	*Callorhinchus capensis*			3.0 (0.6)						3.0 (0.1)
Carcharinidae	*Mustelus mustelus*			36.0 (7.0)						36.0 (1.2)
Rhinobatidae	*Rhinobatos annulatus*				6.4 (0.5)		7.6 (7.3)			14.0 (0.5)
Dasyatidae		3.0 (5.1)		12.5 (2.4)	17.5 (1.3)		18.0 (17.3)	4.5 (3.3)	2.0 (0.5)	57.5 (1.9)
Scyliorhinidae	*Poroderma africanum*	1.8 (3.1)						2.0 (1.5)		3.8 (0.1)
Osteichthyes										
Elopidae	*Elops machnata*			89.4 (17.5)	10.8 (0.8)					100.2 (3.2)
Albulidae	*Albula vulpes*			2.5 (0.5)						2.5 (0.1)
Muraenesocidae					6.4 (0.5)		6.5 (6.3)	1.1 (0.8)		14.0 (0.5)
Ariidae	*Galeichthys feliceps*	0.3 (0.6)	0.2 (0.0)	5.0 (1.0)	21.1 (1.6)	1.6 (14.40)		3.5 (2.6)	17.1 (4.4)	48.8 (1.6)
Platycephalidae	*Platycephalus indicus*			16.3 (3.2)	7.7 (0.6)	1.3 (11.9)	0.2 (0.2)	1.1 (0.8)		26.6 (0.9)
Serranidae								0.1 (0.0)		0.1 (<0.1)
Monodactylidae	*Monodactylus falciformis*							0.9 (0.7)		0.9 (<0.1)
Carangidae	*Lichia amia*	5.9 (10.0)	6.6 (1.2)	22.0 (4.3)	4.4 (0.3)			17.5 (12.9)		56.4 (1.8)
Pomatomidae	*Pomatomus saltatrix*			5.9 (1.2)	4.5 (0.3)		1.5 (1.4)	10.6 (7.8)		22.5 (0.7)
Sciaenidae	*Argyrosomus japonicus*	6.4 (10.8)	445.8 (82.6)	13.4 (2.6)	931.9 (69.2)	0.8 (7.1)	27.1 (26.1)	38.6 (28.4)	96.9 (25.0)	1 560.9 (50.4)
Haemulidae	*Pomadasys commersonnii*	26.9 (45.6)	78.8 (14.6)	272.9 (53.4)	314.6 (23.4)	5.9 (53.8)	39.9 (38.4)	35.9 (26.4)	234.9 (60.5)	1 009.8 (32.6)
Sparidae	*Acanthopagrus berda*		3.0 (0.6)	0.9 (0.2)	4.8 (0.4)			0.4 (0.3)		9.1 (0.3)
	Diplodus cervinus hottentotus		0.2 (0.0)					0.4 (0.3)		0.6 (<0.1)
	Diplodus sargus capensis	1.3 (2.2)		0.8 (0.2)	0.7 (0.1)		0.8 (0.8)	0.1 (0.1)		3.7 (0.1)
	Lithognathus lithognathus	6.6 (11.2)	4.4 (0.8)	13.4 (2.6)	1.1 (0.1)		0.3 (0.3)	15.3 (11.2)	20.5 (5.3)	61.6 (2.0)
	Rhabdosargus globiceps	0.1 (0.2)					0.1 (0.0)	1.3 (1.0)		1.5 (<0.1)
	Rhabdosargus holubi	3.9 (6.7)	0.8 (0.2)	13.9 (2.7)	0.7 (0.1)	1.4 (12.7)	2.1 (1.9)	2.1 (1.5)	0.2 (0.0)	25.1 (0.8)
	Sarpa salpa	0.4 (0.7)	0.1 (0.0)	0.2 (0.1)		0.1 (0.2)		0.1 (0.1)		0.9 (<0.1)
	Sparodon durbanensis								2.1 (0.5)	2.1 (0.1)
Mugilidae		2.3 (3.8)		3.5 (0.7)	9.0 (0.7)			0.6 (0.5)	0.7 (0.2)	16.1 (0.5)
Tetraodontidae		0.1 (0.1)								0.1 (<0.1)
Cyprinidae	*Cyprinus carpio*				4.5 (0.3)				13.9 (3.6)	18.4 (0.6)
Total		59.0	539.9	511.6	1 346.1	11.1	104.1	136.1	388.3	3 096.2

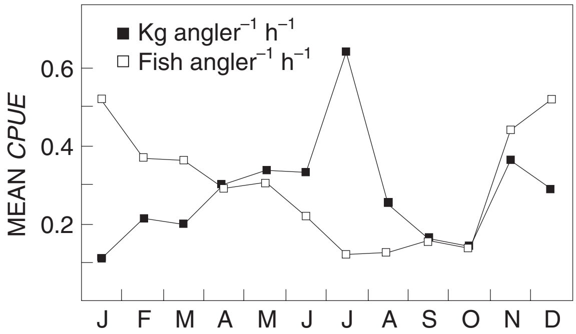

Fig. 2: Total mean monthly *cpue* by number and mass for the recreational linefishery in eight Eastern Cape estuaries, January 1996–April 1997

japonicus (14%) and white seacatfish *Galeichthys feliceps* (12%). In terms of mass, the overall catch was dominated by *A. japonicus* (50%) and *P. commersonnii* (33%).

On a per estuary basis (Table IV), *P. commersonnii* was the most commonly caught species in the Kromme (31.2%), Swartkops (35.9%), Sundays (43.1%), Kariega (42.7%) and Great Fish (62.8%) estuaries. *R. holubi* dominated catches in the Bushmans (45%) and Kowie (33.1%) estuaries, and it made up a substantial proportion of catches in the Swartkops (35.5%) and Kromme (29.4%) estuaries. In terms of mass (Table V), *P. commersonnii* dominated catches in the Kromme (45.6%), Swartkops (53.4%), Bushmans (53.8%), Kariega (38.4%) and Great Fish (60.5%) estuaries, and it constituted a substantial part of the catch on the Kowie Estuary (26.4%). *A. japonicus* dominated the catch in the Gamtoos (82.6%), Sundays (69.2%) and Kowie (28.4%) estuaries.

Overall, *P. commersonnii* were present in catches during all months of the year, and were the dominant component by number and by mass during most months. Although *A. japonicus* were recorded in anglers' catches during all months, they only dominated catches during July (by number) and July, August, September and October (by mass). Although less important in terms of mass, *G. feliceps* and *R. holubi* consistently constituted a notable proportion of catches by number throughout the year.

A large proportion of the recorded catch was relatively small specimens. With the exception of elf *Pomatomus saltatrix* and *A. japonicus*, the majority of recorded specimens were below the minimum legal size limit (Table VI). *P. saltatrix* and *A. japonicus* had >70% of the recorded specimens above the minimum legal size limit.

Table VI: Mean sizes and *SD* of six commonly targeted species for which five or more measurements were available. The data are for all specimens for which measurements, or estimates thereof, were obtained (both released and retained fish). For species subject to a minimum size limit, the percentage of the total sampled catch smaller than the limit is presented. The minimum size limits of those species is presented in parenthesis. Please note that because lengths of some recorded specimens were not available, the total number of fish for some estuaries may not equal those given in Table IV

Species		Total length (cm)											
		Kromme	Gamtoos	Swartkops	Sundays	Bushmans	Kariega	Kowie	Fish	Total	Min.	Max.	Undersized (%)
A. japonicus	Mean	*	74.2	44.0	63.2	*	52.8	53.5	42.9	59.9	13.0	177.4	31
(40 cm *TL*)	*SD*	*	28.9	19.2	44.8	*	12.0	25.3	19.9	19.1			
	n	4	75	10	138	3	16	15	59	320			
P. commersonnii	Mean	35.0	45.0	44.0	41.0	32.0	36.0	35.0	39.1	41.0	12.0	81.0	48
(40 cm *TL*)	*SD*	12.7	11.9	10.0	11.7	7.8	12.1	12.4	11.9	12.6			
	n	25	61	196	293	12	53	47	234	921			
L. lithognathus	Mean	32.2	28.6	36.0	22.8	*	*	50.6	29.4	31.9	9.0	87.4	92
(60 cm *TL*)	*SD*	12.3	9.8	21.1	8.2	*	*	17.1	19.3	73.3			
	n	9	10	11	5	0	2	7	27	71			
L. amia	Mean	*	39.1	29.6	32.0	*	*	*	*	34.6	17.0	82.3	96
(70 cm *TL*)	*SD*	*	8.4	11.0	11.2	*	*	*	*	12.9			
	n	2	8	47	8	0	0	0	2	67			
E. machnata	Mean	*	*	73.2	67.3	*	*	*	*	72.5	45.0	97.0	n.a.
(No limit)	*SD*	*	*	9.1	15.7	*	*	*	*	11.3			
	n	0	0	19	4	0	0	0	0	23			
P. saltatrix	Mean	*	*	29.7	29.1	*	*	40.8	*	33.0	17.5	45.0	20
(30 cm *TL*)	*SD*	*	*	6.8	7.1	*	*	2.0	*	8.1			
	n	0	0	9	5	0	1	6	0	21			

* Values omitted because sample size was deemed too small

Table VII: Mean *cpue* per estuary for the four most commonly caught species

Species	*Cpue* (fish angler^{-1} h^{-1})							
	Kromme	Gamtoos	Swartkops	Sundays	Kariega	Kowie	Fish	Total
P. commersonnii	0.19	0.03	0.09	0.09	0.14	0.04	0.12	0.08
A. japonicus	0.02	0.04	0	0.04	0.03	0.02	0.02	0.03
R. holubi	0.18	0.01	0.09	0.01	0.06	0.04	0	0.03
G. feliceps	0.04	0	0	0.05	0	0	0.03	0.02

Catch per unit effort

Overall, the estuarine fishery was characterized by a distinct peak in mean monthly *cpue* by number during summer (November–January), decreasing to lowest levels from midwinter to early spring (July–October). By mass, mean *cpue* peaked from autumn to midwinter (April–July), and again in November (Fig. 2).

The highest overall *cpue* by number (0.08 fish angler^{-1} h^{-1}) was of *P. commersonnii*, followed by *A. japonicus* (0.03 fish angler^{-1} h^{-1}), *R. holubi* (0.03 fish angler^{-1} h^{-1}) and *G. feliceps* (0.02 fish angler^{-1} h^{-1}; Table VII). All other recorded species had *cpue* values of ≤ 0.01 fish angler^{-1} h^{-1}. On a per estuary basis, *P. commersonnii cpue* was highest in the Kromme and Kariega estuaries (0.19 and 0.14 fish angler^{-1} h^{-1}, respectively) and *A. japonicus cpue* highest in the Gamtoos and Sundays estuaries (both 0.04 fish angler^{-1} h^{-1}). *R. holubi cpue* was highest in the Kromme and Swartkops estuaries (0.18 and 0.09 fish angler^{-1} h^{-1}, respectively) and *G. feliceps cpue* the highest in the Sundays and Kromme estuaries (0.05 and 0.04 fish angler^{-1} h^{-1} respectively).

For purposes of expressing *cpue* according to angling method (Table VIII), the lure and fly categories were combined to increase sample size. Predatory species such as *A. japonicus*, garrick *Lichia amia*, skipjack *Elops machnata* and *P. saltatrix*, all had notably higher *cpue* values for lure-/fly-angling compared to bait angling. This is also reflected in the differences in the mean and maximum mass of *A. japonicus* caught by these two sectors (Table IX). No substantial difference was apparent between the average mass of lure/fly- and bait-caught specimens of other highly piscivorous species such as *L. amia* and *E. machnata*.

Table VIII: Mean *cpue* of bait-angling and lure/fly-angling for selected species. Numbers of fish are shown in parenthesis

Species	*Cpue* (fish angler^{-1} h^{-1})	
	Bait	Lure/fly
P. commersonnii	0.08 (1 010)	0.01 (7)
A. japonicus	0.02 (258)	0.08 (64)
R. holubi	0.03 (376)	0 (0.0)
G. feliceps	0.02 (274)	0 (0.0)
L. amia	<0.01 (6)	0.08 (64)
E. machnata	<0.01 (5)	0.03 (18)
P. saltatrix	0.02 (10)	0.03 (11)

DISCUSSION

Survey techniques

A similar initiative of utilizing fisheries law enforcement personnel to collect catch and effort data was carried out in KwaZulu-Natal in the early 1980s, when the Oceanographic Research Institute (ORI) started making use of Natal Parks Board coastal staff on routine fisheries law enforcement patrols (Penney 1994). This initiative was instrumental in the formation of the National Marine Linefish System (NMLS), which at present includes the results of the most extensive marine recreational fisheries monitoring programme in South Africa (Pradervand and Govender 1999). The use of law enforcement patrols for the collection of catch and effort data, as opposed to dedicated data-collecting creel surveys, however, introduces certain biases into the data. As the primary objective of these patrols was law enforcement, patrolling staff are sometimes obliged to focus their efforts on periods and/or areas of high angling effort (Pradervand *et al*. 1999). This results in improper sampling selection and avidity biases (Pollock *et al*. 1994). In the present study, this is reflected in the

Table IX: Mass of bait- and lure-caught specimens of three highly piscivorous species

Species	Mass (kg)					
	Bait-angling			Lure-angling		
	n	Mean	Maximum	*n*	Mean	Maximum
A. japonicus	258	1.7	28.0	64	17.1	51.0
L. amia	6	0.9	2.6	64	0.8	7.0
E. machnata	5	3.3	6.0	18	3.2	4.3

lack of uniformity in the temporal and spatial distribution of sampling effort, and consequently the survey data are unavoidably biased.

Although Andersen and Thompson (1991) stated that angler-diary surveys could produce estimates of catch as accurate as could be gained from creel surveys, Essig and Holliday (1991) regarded such methods to be prone to prestige bias, misidentification of species and misreporting of lengths and mass. As the diary-survey data constituted only 5% of the total data collected here, these potential biases are ignored.

The inclusion of fish released by respondents in calculations is possible cause for bias, given the unreliability of angler reports, which can vary between 56 and 152% of the true catch (Claytor and O'Niel 1991). Those authors deemed the inclusion of released fish necessary, given the nursery function of estuaries, as well as the expected large proportions of legally non-retainable fish (i.e. fish smaller than minimum legal size) in the catch and the increased popularity of catch-and-release fishing.

As was the case in all the other studies that documented catch and effort in the various sectors of the South African marine linefishery, the present study did not document the night-time fishery. This is an important omission because the catch rate of certain species such as *A. japonicus* and *G. feliceps* is known to be substantially higher at night (McDonald *et al.* in prep.).

Angling effort

The Sundays Estuary was utilized more extensively as an angling facility than any of the other estuaries on which angler counts were performed, having a mean total of 10.1 and 22.9 anglers (shore- and boat-based) for weekdays and weekend counts respectively. The mean weekday count was similar to the 7 anglers count^{-1} reported by Baird *et al.* (1996) for the Sundays Estuary during the period 1992–1993, but the mean weekend count was almost half that reported in the previous study (22.9 v. 43 anglers count^{-1}). Baird *et al.* (1996) also reported substantially higher angling pressure on the Swartkops Estuary during that period (46 anglers weekday count^{-1}, 148 anglers weekend count^{-1}), which indicates that the Swartkops estuary is undoubtably the most utilized estuary (for angling) in the present study area (Kromme Estuary to Great Fish Estuary). Proximity to large urban areas undoubtably plays a major role in the popularity of an angling venue, and estuaries that situated closer to such areas generally experience higher levels of angling effort (Baird *et al.* 1996, Brouwer *et al.* 1997).

As noted previously, angling effort was much higher over weekends than during the week (Joubert 1981, Clark and Buxton 1989, Baird *et al.* 1996, Brouwer *et al.* 1997). Shore-based angling was more popular (59% of all anglers counted) than boat-based angling in all the estuaries studied, with the exception of the Kromme (43%), Gamtoos (36%) and Sundays estuaries (46%). Baird *et al.* (1996), found shore-based angling to be the most popular method of angling in both the Swartkops and Sundays estuaries. Angling with bait was by far the most popular method of fishing, with the exception of the Gamtoos Estuary, where 43.4% of anglers counted were fishing with lures. The high proportion of lure anglers in this estuary is attributable to increased lure-fishing effort during the inshore migration of *A. japonicus* in late winter/early spring (see estimation of *cpue*).

White anglers dominated the fishery, constituting 73.5% of all anglers counted. The overall dominance of white anglers in other sectors of the South African marine linefishery has been established previously (McGrath *et al.* 1997), but it may vary from area to area (Joubert 1981, McDonald *et al.* in prep.).

It is difficult to compare the present fishing effort data with those of other estuarine fisheries in South Africa because such data are limited. The only comparable values available are preliminary estimates from Durban Harbour and the Mgeni Estuary, KwaZulu-Natal (Pradervand *et al.* in prep.). In the latter study, a mean weekday effort of 45 anglers count^{-1} and mean weekend effort of 174 anglers count^{-1} was recorded in the Durban Harbour from January to October 2000. Mean effort of 11 anglers count^{-1} during the week and 27 anglers count^{-1} at weekends was recorded in the Mgeni Estuary for the same period. These values, especially that of Durban Harbour, are higher than those recorded in the present study, and give an indication, when considering that South Africa has at least 250 functional estuaries (Whitfield 1995), many of which are well known angling venues (van der Elst 1989), of the total effort that is expended in the national estuarine linefishery.

Guastella (1994) provides an indication of the extent of participation in estuarine linefishing. She reported participation in the "Catch a Million" angling competition, held annually for one day in December in Durban Harbour from 1990 to 1992, and which averaged 8 000 anglers each year. Although that competition is not held now, other competitions held currently, such as the "St Lucia Bonanza", the "Richards Bay Bonanza" and the "Meerensee 21 Species", with their large prize monies on offer, attract up to 1 000 estuarine anglers on an annual basis and bear testimony to the extent of estuarine linefishing in South Africa.

Catch composition

A number of the fish species caught in South African estuaries are regarded as extremely important angling species, especially *P. commersonnii* (Kyle 1988, Marais and Winter 1988), *A. japonicus* (Smale and Buxton 1985), white steenbras *Lithognathus lithognathus*, *L. amia* and *P. saltatrix* (van der Elst 1989, van der Elst and Adkin 1991). Although 26 species were recorded in the present study, four (*P. commersonnii*, *A. japonicus*, *R. holubi* and *G. feliceps*) made up the majority (85%) of the catch by number, and two (*A. japonicus* and *P. commersonni*) dominated the catch by mass (83%). Although having a much higher diversity, anglers' catches in KwaZulu-Natal estuaries are also dominated by a limited number of species. Guastella (1994) reported 88 species in anglers' catches from Durban Harbour, of which *Pomadasys* spp. and members of the Mugilidae made up more than 50% of the catch by number. Unpublished long-term data from the NMLS have indicated in excess of 50 species in anglers' catches from the St Lucia and Kosi Bay estuarine systems, and that the catch in these systems is consistently dominated by a combination of haemulid, sciaenid and sparid species (NMLS, unpublished data).

Comparing the catch composition in the present study with that of previous studies on the Eastern Cape estuarine linefishery (Marais and Baird 1980a, Baird *et al*. 1996) revealed the catch composition in the Swartkops and Sundays estuaries to be similar in diversity, but different in the contribution of certain species. The earlier studies recorded *P. commersonnii* as dominant, making up at least 62% of the catch in each estuary, whereas the present study recorded it constituting only 36 and 43% of the catch in the Swartkops and Sundays estuaries respectively. *R. holubi* and *G. feliceps* were scarce (<2.7%) in the catches reported in the previous studies, but formed notable proportions of catches in the Swartkops (*R. holubi*: 35.5%) and Sundays (*G. feliceps*: 24.6%) estuaries during the present study. In contrast, Marais and Baird (1980a) recorded *L. lithognathus* as being the second most commonly caught fish in the Swartkops Estuary during the period 1978–1980, whereas the present study showed it to contribute only 2% of the total catch in that estuary. The discrepancy between the earlier studies and the present study in terms of the importance of certain species in anglers' catches may indicate a change in abundance of the respective species in these estuaries, or it may be an artifact of the different sampling strategies employed in the respective studies. The earlier studies primarily utilized competition data solicited from angling clubs, whereas the present study utilized mainly creel-survey data. Because of the targeting of larger species during competitions (Clarke and Buxton 1989) and the imposition of minimum size limits for weigh-ins (Coetzee *et al*. 1989), competition records have different biases from creel surveys, and consequently may prohibit direct comparison. However, considering that the reported abundance of *P. commersonnii* in gillnet catches in the Swartkops and Sundays estuaries has declined somewhat over the years (Marais and Baird 1980b, Marais 1981, Baird *et al*. 1996), and that *L. lithognathus* is regarded as having collapsed, with a current spawning biomass per recruit of 6% (Lamberth 2000), the recorded decrease in the importance of these two species in anglers' catches is more than likely a result of an overall decrease in their abundance, rather than differences in sampling strategies. Consequently, the increased importance of the smaller *R. holubi* and *G. feliceps* in anglers' catches may well be as a result of a decrease in the occurrence of the larger species. Alternatively, the discrepancy in the datasets may reflect the all-inclusive nature of the present data (both retained and released fish), whereas the previous studies utilized only fish retained.

The proportion of *A. japonicus* in anglers' catches remained relatively constant over time. Marais and Baird (1980a) and Baird *et al*. (1996) recorded *A. japonicus* as contributing from 1.9 to 2.4% of anglers' catches in the Swartkops Estuary in the periods 1972–1978 and 1988–1993, and 27.9% of the catch in the Sundays Estuary during the period 1988–1993. The present study recorded *A. japonicus* as making up 1.8% of the catch in the Swartkops Estuary and 20.3% of the catch in the Sundays Estuary.

In contrast, *P. saltatrix* has not been an important component of linefish catches in the study area during the last two decades, because both Marais and Baird (1980a) and Baird *et al.* (1996), as well as the present study, reported low catches of the species. Historically, however, *P. saltarix* appear to have formed an important component of the estuarine catch; Gilchrist (1918) reported the species as being three times more abundant than spotted grunter *P. commersonnii* in gillnet catches made in the Swartkops Estuary in the early 1900s.

Catch per unit effort

The recreational linefishery in the eight estuaries studied revealed distinct seasonal trends in *cpue*. Expressed numerically, *cpue* revealed a distinct summer peak (November–December), and in terms of mass, it increased notably from autumn to midwinter (April–July) and again in late spring (November). These peaks are

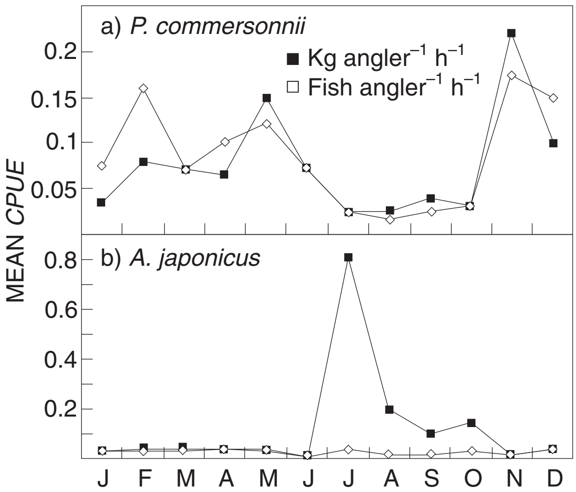

Fig. 3: Mean monthly *cpue* by number and mass for (a) *P. commersonnii* and (b) *A. japonicus* for all eight estuaries combined, January 1996–April 1997

the result of increased catches of individual species during those months, and consequently may be the result of an increased abundance of those species during the periods listed (i.e. seasonality). Increased *cpue* during autumn (April, May) and during November was the result of larger catches of *P. commersonnii*, and increased *cpue* during July, the result of bigger catches of *A. japonicus*, as shown by the higher mean monthly *cpue* for those species during the respective periods (Fig. 3). The high overall *cpue* by number during January and December was primarily the result of increased catches of *R. holubi.*

Increased anglers' catches of *P. commersonnii* during autumn and spring has previously been recorded in the Swartkops Estuary by Marais and Baird (1980a), and it appears to be the result of a greater abundance of the species during those periods. This is supported by Marais and Baird (1980b), who reported the seasonal abundance of *P. commersonnii* in gillnet catches from the Swartkops Estuary to be highest during spring and autumn. Increased abundance of that species during spring appears to be the result of a post-spawning migration from offshore into estuaries along the east coast of southern Africa (Wallace 1975a, b). Large catches of *P. commersonnii* in both the inshore and estuarine environments along the KwaZulu-Natal coast are known to occur during these periods (Wallace and van der Elst 1975).

The higher catch rate of *A. japonicus* during winter and spring (July–October, Fig. 3) appears to be related to an inshore migration of large *A. japonicus* during that period. Such a migration, however, was not documented in previous studies that assessed the ichthyofaunal component of Eastern Cape estuaries by gill-netting (Marais 1981, 1982, 1983a, b, Marais and Baird 1980b) or the analysis of anglers' catches (Marais and Baird 1980a, Baird *et al*. 1996). This behaviour was, however, suggested by Coetzee *et al*. (1989) for *A. japonicus* in their study of the shore (rock and surf) fishery along the same stretch of coastline as the present study. This inshore migration is well known to the estuarine angling community, and to local estuary managers (D. Langman, Western District Council, pers. comm.) and serves to stimulate considerable angling effort towards the species during those months. This inshore migration appeared to be more pronounced in the Sundays and Gamtoos estuaries (PP, pers. obs.), and consequently the mean *cpue* for *A. japonicus* was highest in these systems. The mean size of *A. japonicus* sampled in the two systems was significantly (multiple range test; $p < 0.05$) larger than the mean size of *A. japonicus* in the other estuaries studied. The mean size of specimens recorded during the period July–October was also significantly larger than during other periods of the year (multiple range test, $p < 0.05$). The most popular method of targeting these large *A. japonicus* in the Sundays and Gamtoos estuaries during this inshore migration was by trolling lures from a boat (PP, pers. obs.).

The composition of anglers' catches appeared to be influenced by the angling method employed (bait, lure or fly). Some species were more prone to lure- and fly-angling than to bait-angling, as was evidenced by certain species being caught more by a single angling method, even though that angling method was not the most commonly utilized method in the fishery. Predatory species such as *A. japonicus*, *L. amia* and *E. machnata* had higher *cpue*s for lure or fly-angling than for bait-angling. However, non-piscivores, such as *P. commersonnii*, had a much higher *cpue* for bait-angling than for lure- or fly-angling. The angling method may also determine the mean size of fish caught. For example, *A. japonicus* caught by lure/fly were on average much larger than those caught with bait. This effect is probably species-specific, because no substantial difference was apparent between mass of *L. amia* and *E. machnata* caught by these two methods.

A large component of each catch in the estuaries studied was of fish that were below minimum legal size. This can be expected, given the fact that estuaries function as nursery areas for the juveniles of at least 81 fish species (Day 1981, Wallace *et al*. 1984, Whitfield 1998). Of the recorded species subject to such a limit, only *A. japonicus* and *P. saltatrix* had resulted in >60% of the fish caught being above the size limit. This situation indicates that present minimum size limits have the potential to reduce fishing mortality to a greater or lesser extent, particularly in estuaries, and depending on the species concerned.

Management considerations for *A. japonicus*

A most disconcerting factor to arise from the present study was that, whereas the majority (69%) of the *A. japonicus* caught were larger than the present minimum legal size of 400 mm *TL*, a large proportion (60%) of the legally retainable catch was below the size at which 50% of the population reaches sexual maturity (1 070 mm *TL* for females, Griffiths 1997). Therefore, the majority of *A. japonicus* of legal size caught in the estuaries studied were, in fact, juveniles. This, combined with the proven ineffectiveness of the current daily bag limit of 5 fish angler^{-1} day^{-1} in successfully reducing fishing mortality in *A. japonicus* (Griffiths 1997), has undoubtably contributed towards the stock collapse of this species (Griffiths 2000). A substantial increase in the minimum size limit of *A. japonicus* (from the current 400 mm *TL* to at least 600 mm *TL*), coupled with a severe drop in the daily bag limit (from 5 to 1 fish angler^{-1} day^{-1}) has therefore recently been proposed to try to ensure effective stock rebuilding (Griffiths 1999b).

The late winter/early spring inshore migration of large *A. japonicus* warrants further investigation. Many anglers exploit this behaviour by switching from bait-fishing to lure-fishing, and actively target the species during these periods. The facts that lure-angling proved much more efficient than bait-angling, and produced larger specimens than bait angling, need to be taken into consideration by managers. Although Griffiths (1997) regarded recruitment overfishing in estuaries and the nearshore environment as the main cause of depletion of *A. japonicus* stocks, harvesting of the more fecund large fish can only serve to contribute towards the depleted status of *A. japonicus* stocks. Managers would therefore do well to consider the possibility of supplementing present regulations with non-traditional management approaches. For example, in Eastern Cape estuaries, steps such as seasonal prohibition on certain angling methods, seasonal banning of angling in certain estuaries, implementing maximum size limits, and periods of obligatory catch-and-release fishing could be considered. The suitability and potential effectiveness of such regulations, however, should be thoroughly established before implementation. Failure to do so could result in ineffective regulations being implemented, as seems to have been the case with the national linefish regulations established in 1984. The daily bag limits assigned in those regulations were not based on sound scientific data (Attwood and Bennett 1995), and consequently many of the bag limits were too large to offer any protection to the species they were intended to protect (Bennett 1993, Attwood and Bennett 1995, Pradervand 1999b).

Furthermore, given the wide distribution of *A. japonicus* in South African waters (Griffiths and Hecht 1995, Griffiths 1996), their susceptibility to all sectors of the national linefishery (Griffiths 1997) and their migratory habits (Griffiths 1996), a holistic approach addressing all phases of the species life history, as emphasized by Griffiths (1996, 1997), should be incorporated in any management strategy aimed at rebuilding the *A. japonicus* stock.

CONCLUSION

The exclusion of the estuarine linefishery from the recently completed national survey of South Africa's marine linefishery (Brouwer *et al.* 1997, Mann *et al.* 1997, McGrath *et al.* 1997, Sauer *et al*. 1997), together with the limited quantity of published data available for the estuarine linefisheries, suggests that more research focus should be placed on these fisheries in future. Effort should be made towards ensuring that managers realize the extent of linefishing in estuaries and the effects that fishery has on the status of estuarine-dependent linefish species.

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