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ASSESSMENT OF THE IMPACT OF COMMERCIAL BEACH-SEINE NETTING ON JUVENILE TELEOST POPULATIONS IN THE SURF ZONE OF FALSE BAY, SOUTH AFRICA

B. M. CLARK, B. A. BENNETT* and S. J. LAMBERTH**

A total of 311 commercial beach-seine hauls monitored in False Bay between January 1991 and December 1992 yielded 38 930 juvenile teleosts from 31 species and 18 families. Eight teleost species important in anglers' catches in the South-Western Cape together provided nearly 60% of the total juvenile catch, of which *Rhabdosargus globiceps* (22,8%) and *Pomatomus saltatrix* (20,3%) were the most abundant. Mean juvenile catch per haul for all species was 125 individuals, mean annual catches of juvenile teleosts so amounting to approximately 74 000 individuals. Juvenile teleosts constitute <6% of the total beach-seine catch in False Bay, considerably smaller than the proportion of juveniles in other South African commercial and recreational fisheries. When compared to published estimates of natural mortality for juvenile teleosts frequenting nearshore sandy beach habitats, potential seine-net mortality was calculated to be insignificant for most of the species considered. However, estimated annual catches of juvenile *Lithognathus lithognathus* make up a significant proportion (>30%) of the total surf-zone standing stocks, and it is thought that juveniles of this species in False Bay may be under considerable threat because they are also caught in large numbers by shore-anglers.

Altesaam 311 kommersiële strandseëntrekke wat in Valsbaai tussen Januarie 1991 en Desember 1992 gemonitor is, het 38 930 jongbeenvis van 31 spesies en 18 families opgelewer. Agt beenvisspesies wat van belang in hengelaarsvangste in die Suidwes-Kaap is, het tesame amper 60% van die algehele jongvisvangs uitgemaak; van hulle was *Rhabdosargus globiceps* (22,8%) en *Pomatomus saltatrix* (20,3%) die volopste. Die gemiddelde jongvisvangs per trek vir alle spesies was 125 individue en die gemiddelde jaarvangs van jongbeenvis het aldus op sowat 74 000 individue te staan gekom. Jongbeenvis maak <6% van die totale strandseënvangs in Valsbaai uit. Dit is heelwat laer as die persentasie jongvis in ander Suid-Afrikaanse kommersiële en ontspanningsvisserye. Gemeet aan gepubliseerde ramings van natuurlike mortaliteit by jongbeenvisse wat in habitatte naby sandstrande hou, is die potensiële strandseënmortaliteit vir die meerderheid van die spesies onder oorweging na berekening maar onbeduidend. Die geraamde jaarlikse vangste van jong *Lithognathus lithognathus* maak egter 'n beduidende gedeelte (>30%) van die totale biomassa van die brandingsone uit, en daar word gemeen dat jongvis van hierdie spesie in Valsbaai aanmerklik bedreig mag wees aangesien groot getalle van hulle ook deur strandhengelaars gevang word.

Surf zones of sandy beaches are recognized as important nursery areas for juvenile fish throughout the world (Warfel and Merriman 1944, McFarland 1963, Gibson 1973, Lasiak 1981, Robertson and Lenanton 1984, Bennett 1989a, Wright 1989). Catches by commercial beach-seine fishermen operating in False Bay of juveniles of the so-called angling fish have been a source of considerable concern to recreational shore- and boat-anglers for a number of years (Clark and Bennett 1993). Concern has been stimulated by the marked reductions in anglers' catch rates in the area over recent decades, a situation attributed, at least in part, to mortalities of juvenile teleosts resulting from commercial beach-seining. Numerous restrictions have been imposed on the seine-netters by management authorities in response to these and other concerns (e.g. Theart *et al.* 1983). Many of these were subsequently revoked, however, because they were considered overly stringent and were not based on any scientific evidence showing that seine-netting was harmful (e.g. Walker 1993).

The results of several recent investigations now permit scientific evaluation of the alleged conflicts between recreational anglers and commercial netters. Penney (1991) documented the composition of and long-term fluctuations in catches made by purse-seine, beach-seine and commercial linefishermen in False Bay. Lamberth *et al.* (1994) briefly outline the history of the conflict surrounding the commercial beach-seine net fishery in False Bay and document the composition of the catches, whereas Clark *et al.* (1994) provide an assessment of the effects of beach-seining on the nursery function of estuaries for fish in False Bay. The current study documents the species composition and abundance of juvenile teleosts captured by beach-seine fishermen in False Bay. These data are compared with estimates of the total numbers of these juveniles in the surf zone, and hopefully will help to resolve the issue of whether or not commercial beach-seining is having a detrimental impact on juvenile teleost populations in the False Bay surf zone.

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Table I: Composition, abundance, frequency of occurrence and mean catch per haul (± *SE*) of juvenile teleost species recorded in 311 commercial beach-seine hauls made in False Bay between January 1991 and December 1992. Mean densities (± *SE*) and mean standing stocks (from Clark in prep.) of 15 species and the mean annual catches made by all beach-seine net operators in False Bay are also listed. Species important in anglers' catches off the South-Western Cape are marked with an asterisk

Family	Species	Seine-net catches					Standing stocks		Catch as a percentage of the standing stock per year
		Number caught	%*N*	%*F*	Catch per haul	Catch per year	Density (number·100m^{-2})	Mean stock	
Ariidae	*Galeichthys feliceps*	120	0,3	13,6	0,39 ± 0,10	228			
Carangidae	*Lichia amia*	47	0,1	3,6	0,15 ± 0,09	89	0,46 ± 0,01	6 843	1,3
	*Seriola lalandi**	764	2,0	3,2	2,47 ± 0,95	1 460			
	Trachurus trachurus capensis	2 503	6,4	8,1	8,10 ± 2,99	4 787			
Clinidae	*Clinis agilis*	6	<0,05	0,3	0,02 ± 0,02	11			
	Clinus superciliosus	1	<0,05	0,3	<0,01 ± 0,00	2	0,10 ± 0,2	1 437	0,1
Clupeidae	*Sardinops sagax*	3	<0,05	0,6	0,01 ± 0,00	6			
Dichistiidae	*Dichistius capensis**	18	<0,05	4,9	0,06 ± 0,01	34	0,18 ± 0,1	2 745	1,3
Monocanthidae	*Aluterus monoceros*	2	<0,05	0,6	0,01 ± 0,00	4			
	Cantherhines pardalis	1	<0,05	0,3	<0,01 ± 0,00	2			
Mugilidae	*Liza richardsonii*	12 562	32,3	85,9	40,39 ± 4,73	23 711	275,96 ± 4,48	4 139 399	0,6
Parascorpididae	*Parascorpis typus*	1	<0,05	0,3	<0,01 ± 0,00	2			
Pomatomidae	*Pomatomus saltatrix**	9 495	24,4	44,7	30,53 ± 5,63	18 161	11,38 ± 0,71	170 723	10,6
Sciaenidae	*Argyrosomus hololepidotus**	397	1,0	11,0	1,26 ± 0,35	754			
	Atractoscion aequidens	1	<0,05	0,3	<0,01 ± 0,00	2			
	*Umbrina canariensis**	50	0,1	4,5	0,16 ± 0,07	95	0,71 ± 0,02	10 603	0,9
Scombridae	*Scomber japonicus*	1	<0,05	0,6	<0,01 ± 0,00	2			
Sparidae	*Diplodus sargus capensis**	46	0,1	1,9	0,15 ± 0,01	35	7,68 ± 0,22	115 153	<0,1
	*Lithognathus lithognathus**	1 874	4,8	46,6	6,03 ± 1,87	3 499	0,70 ± 0,02	10 524	33,3
	Lithognathus mormyrus	7	<0,05	1,3	0,02 ± 0,01	13	0,18 ± 0,01	2 692	0,5
	Pterogymnus laniarius	1	<0,05	0,3	<0,01 ± 0,00	2			
	Rhabdosargus globiceps	10 643	27,3	66,0	34,22 ± 4,50	20 354	27,77 ± 0,49	416 615	4,9
	Rhabdosargus holubi	9	<0,05	0,3	0,03 ± 0,02	12	0,06 ± 0,00	938	1,8
	Sarpa salpa	82	0,2	1,9	0,26 ± 0,00	6	5,15 ± 0,31	77 294	<0,1
	Spondyliosoma emarginatum	115	0,3	2,6	0,37 ± 0,19	219			
Sphyraenidae	*Sphyraena acutipinnis*	2	<0,05	0,6	0,01 ± 0,00	4	0,01 ± 0,00	144	2,6
Stromateoidae	*Stromateus fiatola*	39	0,1	3,6	0,13 ± 0,06	71			
Syngnathidae	*Syngnathus acus*	1	<0,05	0,3	<0,01 ± 0,00	2	0,01 ± 0,00	212	0,9
Tetraodontidae	*Amblyrhynchotes honkenii*	14	<0,05	1,3	0,05 ± 0,01	24	1,92 ± 0,05	28 758	0,1
Triglidae	*Chelidonichthys capensis*	113	0,3	6,5	0,36 ± 0,14	219	0,30 ± 0,01	4 524	4,8
Zeidae	*Zeus capensis*	12	<0,05	1,3	0,04 ± 0,02	23			
All species		38 930			125,18 ± 21,77	73 980			

METHODS

Catches made by five of the seven commercial beach-seine net operators currently active on the False Bay coastline were surveyed over a two-year period, January 1991–December 1992. Nets used by these fishermen are 275 m long by 5 m deep, with stretched mesh sizes of 44–90 mm. During deployment, small boats are used to row these nets between 50 and 600 m offshore, where they are laid around shoals of fish or likely areas, and then hauled shorewards by 14–20 crew.

Total length (*TL*) of each fish was measured to the nearest 1 cm, except when hauls were very large, in which case a subsample of at least 120 fish was measured. The numbers of juvenile teleosts in each haul were estimated by calculating the numbers of individuals of each species smaller than the size at 50% maturity, as reported in the literature (Appendix). Owing to the limited time available following each haul, gonad analysis was restricted to those less common species for which published information was not available. The mean number of beach-seine hauls made per year in False Bay was calculated from personal records provided by the beach-seine fishermen and from catch returns submitted to the Sea Fisheries Research Institute between 1985 and 1992. Mean values are listed in the text as ± the standard error (*SE*) of the mean, where appropriate.

Estimates of the actual abundance of juvenile teleosts in the False Bay surf zone were obtained from a two-year experimental fine-mesh beach-seine netting programme consisting of 264 hauls at 11 sites in False Bay, as documented by Clark (in prep.). Mean densities of juvenile fish in the surf zone were calculated by dividing the total number of individuals of each species captured per haul by the area netted (estimated as the distance at which the net was laid offshore multiplied by the mean width of the haul). An estimate of the total surf-zone area (14,97 ± 1,35 km^2) was obtained by multiplying the mean width of the surf zone (137,3 ± 12,4 m) by the total length of sandy beach and mixed-shore coastline in False Bay (109 km — calculated from Hockey *et al.* 1983, Bally *et al.* 1984, Spargo 1991). Estimates of the total annual catches of juvenile teleost species made by anglers in False Bay were calculated by multiplying the proportion of juveniles in anglers' catches (Bennett and Attwood 1993) by angler catch per unit effort (*cpue*) for each species (Bennett *et al.* 1994) by total annual effort, estimated at 0,99 × 10^6 angler h·year^{-1} by Lamberth *et al.* (1994). Mean annual catches of each species of juvenile teleost recorded in the beach-seine catches were calculated by multiplying the mean annual effort (591 ± 23 hauls) by the mean catch per haul for each species (Table I).

RESULTS

Sampling of 311 commercial beach-seine net hauls made in False Bay between January 1991 and December 1992 yielded a total catch of 38 390 juvenile teleosts from 31 species and 18 families, as listed in Table I. In terms of numbers, three species, southern mullet (harder) *Liza richardsonii* (26,9%), white stumpnose *Rhabdosargus globiceps* (22,8%) and elf *Pomatomus saltatrix* (20,3%), dominated the catches. Four other species (horse mackerel *Trachurus trachurus capensis*, white steenbras *Lithognathus lithognathus*, yellowtail *Seriola lalandi* and kob *Argyrosomus hololepidotus*) each made up ≥1% of the total catch. Four species, *L. richardsonii*, *R. globiceps*, *P. saltatrix* and *Lithognathus lithognathus*, were present throughout the year, each occurring in >40% of the hauls. A further three species occurred in >5% of the hauls, whereas the remaining 24 species occurred only sporadically. Juveniles of eight teleost species targeted by anglers off the South-Western Cape were present in the catches (Table I). Together, these species constituted 59,8% of the total juvenile catch, or 23 287 individuals. *R. globiceps* and *P. saltatrix* were the most abundant angling species caught, but significant numbers (≥1% of the total catch) of *L. lithognathus*, *S. lalandi* and *A. hololepidotus* were also caught.

Mean catch per haul for all juveniles combined was 125,18, and the mean annual juvenile catch for all

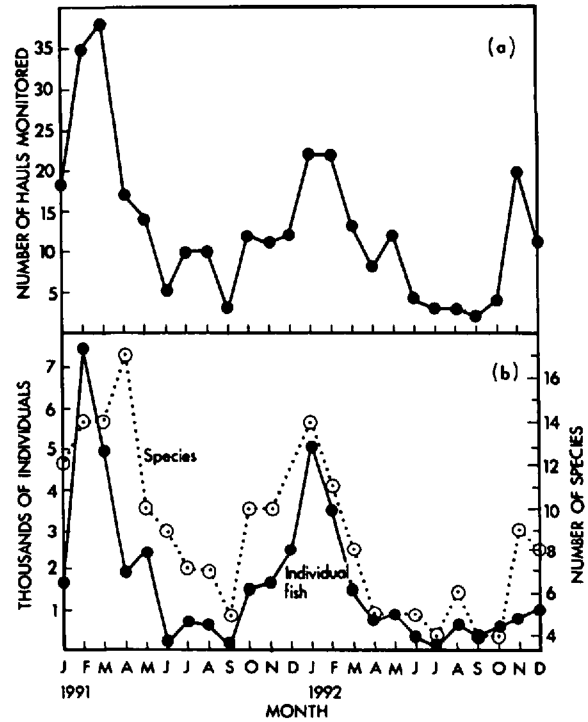

Fig. 1: Seasonal fluctuations in (a) commercial beach-seine net effort and (b) number of juvenile teleosts and juvenile teleost species in monitored commercial beach-seine hauls made in False Bay during 1991 and 1992

species was 73 980 individuals. Mean densities and total surf-zone standing stocks were calculated for 16 of the 31 juvenile teleost species recorded, for which reliable data were available (Table I). The proportion of the total standing stocks of these species captured annually by beach-seine fishermen in False Bay could thus be calculated (annual catch/standing stocks). Values were greatest for *L. lithognathus* (33,3%·year^{-1}), *P. saltatrix* (10,6%·year^{-1}) and *R. globiceps* (4,9%·year^{-1}). Only six of the other species each accounted for >1% of standing stocks per year.

Although the intensity of the monitoring programme varied little over the two-year sampling period, the number of hauls recorded per month (Fig. 1a) displayed a clear seasonal trend. The number of hauls recorded was greatest during summer (November–March) and smallest during winter (June–September). The number and the species composition of juvenile teleosts in the beach-seine hauls also showed strong seasonal variation (Fig. 1b). In terms of numbers, most (>60%) of the juvenile teleosts were caught between January and March, whereas few (<7%) were caught during winter. Similarly, the numbers of species recorded was highest between January and April (12–17) and lowest between June and September (4–9).

DISCUSSION

The total catch made by the commercial beach-seine fishermen monitored in False Bay consisted of 38 930 juvenile teleosts from 31 species. Catches displayed strong seasonal trends and were dominated by few species, five species providing >80% of the total number recorded. Although a substantial portion (>80%) of the juvenile catch was returned to the sea (Lamberth *et al.* 1994), estimates of fishing mortality given here are based on total catch, because post-release mortality was not assessed. The effects of beach-seine fishing given are therefore maximal ones and are almost certainly overestimated, perhaps by a considerable proportion. Estimates of surf-zone standing stocks of 16 of the juvenile teleost species recorded in the commercial catches, obtained from a fine-mesh beach-seine survey comprising 264 hauls conducted over a two-year period by Clark (in prep.), are considered to be reliable. With only one exception (*Trachurus trachurus capensis*, 5,3%*N*), experimental population estimates are available from False Bay for juveniles of all species providing ≥2% of juvenile teleosts recorded in the commercial catches.

Estimates of natural mortality for juvenile teleosts captured by the beach-seine fishermen were impossible to calculate during this study and are regrettably available for only one of the species under consideration, viz. *Rhabdosargus holubi*. Natural mortality of this species in the West Kleinmond Estuary in the South-Eastern Cape was estimated by Blaber (1973) to be some 30% of total standing stocks per month. Estimates of the rates of natural mortality of juvenile flatfish species of similar age-classes frequenting nearshore sandy beach habitats in the northern hemisphere are of a similar magnitude, ranging between 31 and 62% of existing standing stocks per month (Table II). These data suggest that the mortality rate of 30% used in this study is reasonable. Comparisons between mean annual beach-seine catches and standing stocks of juvenile teleosts in the False Bay surf zone therefore indicate that mortality attributable to this source is at most 10% of the natural mortality, and in most cases less than 0,5%, even if all the fish returned to the surf perished.

Although beach-seine fishermen capture a substantial proportion (10,6%) of the mean standing stocks of juvenile *Pomatomus saltatrix* in False Bay annually, juveniles of this species are abundant in South and West Coast estuaries (Van der Elst 1976, Winter 1979, Smale and Kok 1983, Whitfield and Kok 1992, Bennett 1994) and on inshore (5–50 m depth) sandy bottom areas along the South Coast (Smale 1984, Wallace *et al.* 1984). Beach-seine catches are therefore unlikely to inflict significant mortality on overall stocks of this migratory species. On the other hand, mortalities of juvenile *Lithognathus lithognathus*, which account for 33,3% of juvenile standing stocks per year, may be significant, because this species is already under heavy pressure as a result of human activities. Juveniles are entirely dependent on estuarine nursery areas in southern Africa during their first year of life and adult stocks are being overexploited by both anglers and beach-seine fishermen (Bennett 1993a, b). Data collected by Bennett (1993b) further suggest that juvenile *L. lithognathus* are resident in the surf zone of particular areas from 1 to 5 years of age, indicating that seining activities may result in significant local depletions of these age-classes in False Bay.

Table II: Natural mortalities (% standing stocks per month) of juvenile flatfish species frequenting nearshore sandy beach habitats in the northern hemisphere

Locality	Author	Mortality (%)
Firemore Bay, Scotland	Edwards and Steele (1968)	56
Firth of Forth, Scotland	Poxton and Nasir (1985)	53
Clyde Sea, Scotland	Poxton *et al.* (1982)	50
Port Erin Bay, Irish Sea	Riley and Corlett (1966)*	38
Red Wharf Bay, Irish Sea	Macer (1967)*	42
Filey Bay, North Sea	Bannister *et al.* (1974)*	53
Balgzand, Wadden Sea	Van der Veer (1986)	30
Balgzand, Wadden Sea	Zijlstra *et al.* (1982)	38

* Cited in Poxton *et al.* (1982)

A factor possibly introducing bias into stock assessment calculations made in this paper may be differences in the selectivity of the experimental and commercial nets employed during this study. A comparison between the size frequency distributions of commercial and experimental seine-net catches of the three species in the commercial catch which provided the greatest proportion of standing stocks (Fig. 2) indicates similar distributions for all except *Rhabdosargus globiceps*. This suggests that, although one would assume intuitively that catches made with the fine-mesh gear would tend to be skewed towards smaller fish for most species than are obtained with the coarse-mesh commercial gear, this is in fact not the case for the two species of greatest concern (*Lithognathus lithognathus* and *Pomatomus saltatrix*). Furthermore, Lamberth *et al.* (1994) noted that larger *R. globiceps* were only captured in commercial hauls made after sunset, which indicates that these individuals may only frequent the surf zone at night. All

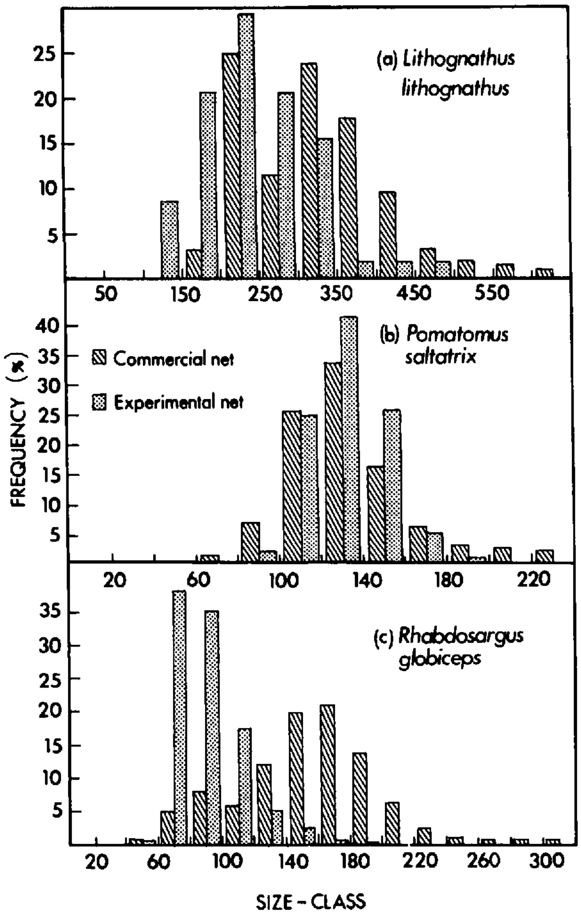

Fig. 2: Size frequency distributions of (a) *Lithognathus lithognathus*, (b) *Pomatomus saltatrix* and (c) *Rhabdosargus globiceps* in commercial (1991 and 1992) and experimental (1991–1993) beach-seine hauls made in False Bay

experimental seines were made during daylight only and therefore the paucity of larger specimens in these catches is hardly surprising.

Published data on the size composition of teleost species caught by recreational and other commercial fishermen in South Africa allow a simple comparison to be drawn between the proportions of juvenile teleosts taken by beach-seining and other fisheries (Table III). Of the total of 726 447 fish of all types recorded in the commercial beach-seine hauls monitored during this study (Lamberth *et al.* 1994), only 5,4% (38 930 fish) were juvenile teleosts. By contrast, juvenile fish make up between 73 and 97% of the five major species targeted by the purse-seine fishery in South Africa

Table III: Proportions of immature fish of various species in the catches of important South African commercial and recreational fisheries

Species	% Immature	Reference
	Purse-seine	
Scomber japonicus	88,8	Crawford *et al.* (1978)
Trachurus trachurus capensis	76,2	Crawford *et al.* (1978)
Sardinops sagax	96,5	Crawford *et al.* (1978)
Etrumeus whiteheadi	93,1	Crawford *et al.* (1978)
Engraulis capensis	72,6	Crawford *et al.* (1978)
	Linefish	
Petrus rupestris	70,8	Smale (1986)
Ephinephelus guaza	71,0	Smale (1986)
Polysteganus praeorbitalis	42,0	Smale (1986)
Cheimerius nufar	12,0	Smale (1986)
Cheimerius nufar	25,0	Garratt (1985)
Chrysoblephus puniceus	50,0	Garratt (1985)
Seriola lalandi (offshore)	14,0	Penney (1990)
Seriola lalandi (inshore)	50,5	Penney (1990)
Argyrozona argyrozona	28,4	Nepgen (1977)
Pachymetopon blochii	29,0	Nepgen (1977)
	Angling	
Various spp.	17,3	Bennett and Attwood (1993)
Various spp.	12,0	Coetzee (1978)
	Beach-seine	
Various spp.	5,4	This study

(Crawford *et al.* 1978), between 12 and 71% of catches of important commercial linefish species (Nepgen 1977, Garratt 1985, Smale 1986, Penney 1990), and between 12 and 17% of anglers' catches (Coetzee 1978, Bennett and Attwood 1993). The proportion of juvenile teleosts in beach-seine catches is therefore well below that of several other South African fisheries. Further, the proportions of immature fish in line catches presented here are probably underestimates, because they do not include mortalities of undersized fish resulting from handling or barotrauma. These fish are discarded before the catch is landed.

Considerable overlap exists between species targeted by anglers and commercial beach-seine fishermen in False Bay, and anglers often accuse beach-seine fishermen of being responsible for the documented declines in catch rates (Bennett 1991, Penney 1991, Lamberth *et al.* 1994). The analysis by Bennett *et al.* (1994) of the composition of anglers' catches in the South-Western Cape revealed that six species (*L. lithognathus, Dichistius capensis, Diplodus sargus capensis, Argyrosomus hololepidotus, Umbrina canariensis* and *Rhabdosargus globiceps*) provided numerically the bulk (>85%) of the catches. Juveniles of these six species, together with another two moderately important species (*P. saltatrix*

Table IV: Proportions of immature fish and estimated total annual juvenile catch of a number of teleost species by beach-seine fishermen and anglers in False Bay (calculated from Bennett and Attwood 1993, Bennett *et al.* 1994)

Species	% Immature		Annual juvenile catch	
	Beach-seine	Anglers	Beach-seine	Anglers
Pomatomus saltatrix	55	<1	18 161	–
Diplodus sargus capensis	1	1	35	280
Lithognathus lithognathus	44	77	3 499	6 300
Dichistius capensis	45	29	34	4 900
Argyrosomus hololepidotus	11	<1	754	–
Umbrina canariensis	4	3	95	50

and *Seriola lalandi*), jointly constituted almost 60% of the total juvenile teleost catch in beach-seine hauls monitored during the current survey, indicating considerable scope for conflict between the two fisheries. Examination of the proportions of immature fish from a number of these species in beach-seine catches (Table I) and anglers' catches (from Bennett and Attwood 1993), however, allows their impact on juvenile stocks to be compared (Table IV). Proportions of immature *Diplodus sargus capensis*, *Dichistius capensis* and *U. canariensis* were the same (the first) or slightly higher (the last two) in beach-seine catches, whereas immature *P. saltatrix* and *A. hololepidotus* are rarely caught by anglers. However, the proportion of *L. lithognathus* in anglers' catches is considerably higher than for the beach-seine fishery. More important, however, is the total annual catch of juveniles of these six species made by beach-seine fishermen and anglers in False Bay, also shown in Table IV. Total annual beach-seine catches of immature *P. saltatrix*, *A. hololepidotus* and *U. canariensis* exceed anglers' catches, although total catches remain small for all except *P. saltatrix*. The reverse is true for the other three species, anglers' catches of *L. lithognathus* and *Dichistius capensis* being very much greater than those of the seine-net fishery.

In conclusion, therefore, it appears that, although beach-seine fishermen in False Bay capture a considerable number of juvenile teleosts each year, these form only a small proportion of the total beach-seine catch, a proportion which is considerably less than that for several other South African commercial and recreational fisheries. Natural mortalities of juvenile teleost species frequenting surf-zone habitats are high, probably exceeding 30% per month, and mortality attributable to beach-seining is therefore likely to be relatively insignificant for most of the affected juveniles. Historically, this may not always have been the case, however, and therefore the general reduction in commercial beach-seining effort in the late 1970s and early 1980s was probably entirely justified. Annual beach-seine catches of juvenile *Lithognathus lithognathus* still, however, make up a considerable portion (>30%) of total surf-zone standing stocks of the species in False Bay. Beach-seine catches of juveniles of this species, together with that of anglers, calculated to be almost double that of the beach-seine catch, may collectively pose a significant threat to juvenile stocks of this endemic species. On the basis of the above, therefore, any sanctioned increase in beach-seine effort in the foreseeable future would appear to be ill-advised.

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LITERATURE CITED

BAIRD, D. 1977 — Age, growth and aspects of reproduction of the mackerel, *Scomber japonicus*, in South African waters (Pisces: Scombridae). *Zoologica Afr.* **12**(2): 347–362.

BALLY, R., McQUAID, C. D. and A. C. BROWN 1984 — Shores of mixed sand and rock: an unexplored marine ecosystem. *S. Afr. J. Sci.* **80**(11): 500–503.

BENNETT, B. A. 1989a — The fish community of a moderately exposed beach on the Southwestern Cape coast of South Africa and an assessment of this habitat as a nursery for juvenile fish. *Estuar. coast. Shelf Sci.* **28**(3): 293–305.

BENNETT, B. A. 1989b — A comparison of the fish communities in nearby permanently open, seasonally open and normally closed estuaries in the South-Western Cape, South Africa. *S. Afr. J. mar. Sci.* **8**: 43–55.

BENNETT, B. A. 1991 — Long-term trends in the catches by shore anglers in False Bay. *Trans. R. Soc. Afr.* **47**(4 & 5): 683–690.

BENNETT, B. A. 1993a — The fishery for white steenbras *Lithognathus lithognathus* off the Cape coast, South Africa, with some considerations for its management. *S. Afr. J. mar. Sci.* **13**: 1–14.

BENNETT, B. A. 1993b — Aspects of the biology and life history of white steenbras *Lithognathus lithognathus* in southern Africa. *S. Afr. J. mar. Sci.* **13**: 83–96.

BENNETT, B. A. 1994 — The fish community of the Berg River estuary and an assessment of the likely effects of reduced freshwater inflows. *S. Afr. J. Zool.* **29**(2): 118–125.

BENNETT, B. A. and C. G. ATTWOOD 1993 — Shore-angling catches in the De Hoop Nature Reserve, South Africa, and further evidence for the protective value of marine reserves. *S. Afr. J. mar. Sci.* **13**: 213–222.

BENNETT, B. A., ATTWOOD, C. G. and J. D. MANTEL 1994 — Teleost catches by three shore-angling clubs in the South-Western Cape, with an assessment of the effect of restrictions applied in 1985. *S. Afr. J. mar. Sci.* **14**: 11–18.

BENNETT, B. A. and C. L. GRIFFITHS 1986 — Aspects of the biology of galjoen *Coracinus capensis* (Cuvier) off the South-Western Cape, South Africa. *S. Afr. J. mar. Sci.* **4**: 153–162.

BLABER, S. J. M. 1973 — Population size and mortality of juveniles of the marine teleost *Rhabdosargus holubi* (Pisces: Sparidae) in a closed estuary. *Mar. Biol.* **21**(3): 219–225.

CLARK, B. M. (in preparation) — The surf-zone ichthyofaunal assemblage of sandy and mixed shore habitats in False Bay, South Africa, with notes on the composition of southern African surf-zone ichthyofaunas.

CLARK, B. [M.] and B. A. BENNETT 1993 — Are juvenile fish an issue in the trek net controversy? In *Fish, Fishers and Fisheries. Proceedings of the Second South African Marine Linefish Symposium, Durban, October 1992*. Beckley, L. E. and R. P. Van der Elst (Eds). *Spec. Publ. oceanogr. Res. Inst. S. Afr.* **2**: 157–159.

CLARK, B. M., BENNETT, B. A. and S. J. LAMBERTH 1994 — A comparison of the ichthyofauna of two estuaries and their adjacent surf zones, with an assessment of the effects of beach-seining on the nursery function of estuaries for fish. *S. Afr. J. mar. Sci.* **14**: 121–131.

COETZEE, P. S. 1978 — Aspects of the composition of anglers catches off St Croix Island, with special reference to the biology of *Cheimerius nufar*, Ehrenberg, 1820 (Teleostei, Sparidae). M.Sc. thesis, University of Port Elizabeth: 215 pp.

CRAWFORD, R. J. M., CENTURIER-HARRIS, O. M., WINGATE, G. H. L. and B. D. KRIEDEMANN 1978 — Revision of species and age composition of landings in the South African purse-seine fishery, 1950 to 1976. *Fish. Bull. S. Afr.* **10**: 69–88.

DAVIES, D. H. 1956 — The South African pilchard (*Sardinops ocellata*). Sexual maturity and reproduction 1950–54. *Investl Rep. Div. Fish. S. Afr.* **22**: 155 pp.

DAY, J. H., BLABER, S. J. M. and J. H. WALLACE 1981 — Estuarine fishes. In *Estuarine Ecology with Particular Reference to Southern Africa*. Day, J. H. (Ed.). Cape Town; Balkema: 197–221.

DE VILLIERS, G. 1987 — Harvesting harders *Liza richardsoni* in the Benguela upwelling region. In *The Benguela and Comparable Ecosystems*. Payne, A. I. L., Gulland, J. A. and K. H. Brink (Eds). *S. Afr. J. mar. Sci.* **5**: 851–862.

EDWARDS, R. and J. H. STEELE 1968 — The ecology of 0-group plaice and common dabs at Loch Ewe. 1. Population and food. *J expl mar. Biol. Ecol.* **2**: 215–238.

GARRATT, P. A. 1985 — The offshore linefishery of Natal. 1. Exploited population structures of the sparids *Chrysoblephus puniceus* and *Cheimerius nufar*. *Investl Rep. oceanogr. Res. Inst. S. Afr.* **62**: 18 pp.

GELDENHUYS, N. D. 1973 — Growth of the South African maasbanker *Trachurus trachurus* Linnaeus and age composition of the catches, 1950–1971. *Investl Rep. Sea Fish. Brch S. Afr.* **101**: 24 pp.

GIBSON, R.N. 1973 — The intertidal movements and distribution of young fish on a sandy beach with special reference to the plaice (*Pleuronectes platessa* L.). *J. expl mar. Biol. Ecol.* **12**: 79–102.

GRIFFITHS, M. H. and T. HECHT 1993 — Two South African *Argyrosomus hololepidotus* species: implications for management. In *Fish, Fishers and Fisheries. Proceedings of the Second South African Marine Linefish Symposium, Durban, October 1992*. Beckley, L. E and R. P. Van der Elst (Eds). *Spec. Publ. oceanogr. Res. Inst. S. Afr.* **2**: 19–22.

HECHT, T. 1976 — The general biology of six major trawl fish species of the Eastern Cape coast of South Africa, with notes on the demersal fishery, 1967–1975. Ph.D. thesis, University of Port Elizabeth: [vii] + 353 pp.

HECHT, T. 1977 — Contributions to the biology of the Cape gurnard, *Trigla capensis* (Pisces: Triglidae): age, growth and reproduction. *Zoologica Afr.* **12**(2): 373–382.

HOCKEY, P. A. R., SIEGRIED, W. R., CROWE, A. A. and J. COOPER 1983 — Ecological structure and energy requirements of the sandy beach avifauna of southern Africa. In *Sandy Beaches as Ecosystems*. McLachlan, A. and T. Erasmus (Eds). The Hague; W. Junk: 507–521 (Developments in Hydrobiology **19**).

JOUBERT, C. S. W. 1981 — Aspects of the biology of five species of inshore reef fishes on the Natal coast, South Africa. *Investl Rep. oceanogr. Res. Inst. S. Afr.* **51**: 16 pp.

LAMBERTH, S. J., BENNETT, B. A. and B. M. CLARK 1994 — Catch composition of the commercial beach-seine fishery in False Bay, South Africa. *S. Afr. J. mar. Sci.* **14**: 69–78.

LASIAK, T. A. 1981 — Nursery grounds of juvenile teleosts: evidence from the surf zone of King's Beach, Port Elizabeth. *S. Afr. J. Sci.* **77**(9): 388–390.

LASIAK, T. A. 1982 — Structural and functional aspects of the surf-zone fish community in the Eastern Cape. Ph.D. thesis, University of Port Elizabeth: 459 pp.

McFARLAND, W. N. 1963 — Seasonal change in the number and biomass of fishes from the surf at Mustang Island, Texas. *Publs Inst. mar. Sci. Univ. Texas* **9**: 91–105.

NEPGEN, C. S. DE V. 1977 — The biology of the hottentot *Pachymetopon blochii* (Val.) and the silverfish *Argyrozona argyrozona* (Val.) along the Cape south-west coast. *Investl Rep. Sea Fish. Brch S. Afr.* **105**: 35 pp.

PENNEY, A. J. 1990 — Yellowtail migration patterns and their management implications. *Rep. S. Afr. natn. scient. Progms* **167**: 63–69.

PENNEY, A. J. 1991 — The interaction and impact of net and line-fisheries in False Bay, South Africa. *Trans. R. Soc. S. Afr.* **47**(4 & 5): 663–681.

PENNEY, A. J., BUXTON, C. D., GARRATT, P. A. and M. J. SMALE 1989 — The commercial marine linefishery. In *Oceans of Life off Southern Africa*. Payne, A. I. L. and R. J. M. Crawford (Eds). Cape Town; Vlaeberg: 214–229.

POXTON, M. G., ELEFTHERIOU, A. and A. D. McINTYRE 1982 — The population dynamics of 0-group flatfish on nursery grounds in the Clyde Sea area. *Estuar. coast. Shelf Sci.* **14**: 265–282.

POXTON, M. G. and N. A. NASIR 1985 — The distribution and population dynamics of 0-group plaice (*Pleuronectes platessa* L.) on nursery grounds in the Firth of Forth. *Estuar. coast. Shelf Sci.* **21**: 843–857.

ROBERTSON, A. I. and R. C. J. LENANTON 1984 — Fish community structure and food chain dynamics in the surf-zone of sandy beaches: the role of detached macrophyte detritus. *J. expl mar. Biol. Ecol.* **84**: 265–283.

SMALE, M. J. 1984 — Inshore small-mesh trawling survey of the Cape south coast. 3. The occurrence and feeding of *Argyrosomus hololepidotus, Pomatomus saltatrix* and *Merluccius capensis*. *S. Afr. J. Zool.* **19**(3): 170–179.

SMALE, M. J. 1986 — The feeding biology of four predatory reef fishes off the south-eastern Cape coast, South Africa. *S. Afr. J. Zool.* **21**(2): 111–130.

SMALE, M. J. and H. M. KOK 1983 — The occurrence and feeding of *Pomatomus saltatrix* (elf) and *Lichia amia* (leervis) juveniles in two Cape south coast estuaries. *S. Afr. J. Zool.* **18**(4): 337–342.

SPARGO, P. E. 1991 — False Bay, South Africa - an historic and scientific overview. *Trans. R. Soc. S. Afr.* **47**(4 & 5): 363–375.

TALBOT, F. H. 1955 — Notes on the biology of the white stumpnose, *Rhabdosargus globiceps* (Cuvier), and on the fish fauna of the Klein River estuary. *Trans. R. Soc. S. Afr.* **34**(3):

387–407.

THEART, J. D, THEART, F. G. A. and H. B. CROUS 1983 — Verslag van die takkomitee na die uitreiking en benutting van net permitte. Unpublished Report, Chief Directorate, Marine Development, Cape Town: 135 pp.

TILNEY, R. L. 1990 — Aspects of the biology, ecology and population dynamics of *Galeichthys feliceps* (Valenciennes) and *G. ater* (Castelnau) (Pisces: Ariidae) off the south east coast of South Africa. Ph.D. thesis, Rhodes University: 278 pp.

VAN DER ELST, R. P. 1976 — Game fish of the east coast of southern Africa. 1. The biology of the elf, *Pomatomus saltatrix* (Linnaeus), in the coastal waters of Natal. *Investl Rep. oceanogr. Res. Inst. S. Afr.* **44**: 59 pp.

VAN DER ELST, R. [P.] 1988 — *A Guide to the Common Sea Fishes of Southern Africa*, 2nd ed. Cape Town; Struik: 398 pp.

VAN DER ELST, R. P. and F. ADKIN (Eds) 1991 — Marine linefish. Priority species and research objectives in southern Africa. *Spec. Publ. oceanogr. Res. Inst. S. Afr.* **1**: 132 pp.

VAN DER VEER, H. W. 1986 — Immigration, settlement, and density-dependent mortality of a larval and early postlarval 0-group plaice (*Pleuronectes platessa*) population in the western Wadden Sea. *Mar. Ecol. Prog. Ser.* **29**: 223–236.

WALKER, T. 1993 — Great trek debate. *S. Afr. comml Mar.* **2**(4): 28–29.

WALLACE, J. H., KOK, H. M., BUXTON, C. D. and B. [A.] BENNETT 1984 — Inshore small-mesh trawling survey of the Cape south coast. 1. Introduction, methods, stations and catches. *S. Afr. J. Zool.* **19**(3): 154–164.

WARFEL, H. E. and D. MERRIMAN 1944 — Studies on the marine resources of southern New England. 1. An analysis of the fish population of the shore zone. *Bull. Bingham Oceanogr. Colln* **9**(2): 1–91.

WHITFIELD, A. K. and H. M. KOK 1992 — Recruitment of juvenile marine fishes into permanently open and seasonally open estuarine systems on the southern coast of South Africa. *Ichthyol. Bull. J. L. B. Smith Inst. Ichthyol.* **57**: 1–39.

WINTER, P. E. D. 1979 — Studies on the distribution, seasonal abundance and diversity of the Swartkops Estuary ichthyofauna. M.Sc. thesis, University of Port Elizabeth: 150 pp.

WRIGHT, J. M. 1989 — Detached chlorophytes as nursery areas for fish in Sulaibikhat Bay, Kuwait. *Estuar. coast. Shelf Sci.* **28**(2): 185–193.

ZIJLSTRA, J. J., DAPPER, R. and J. IJ. WITTE 1982 — Settlement, growth and mortality of post-larval plaice (*Pleuronectes platessa*) in the western Wadden Sea. *Neth. J. Sea Res.* **15**(2) 250–272.

APPENDIX

Sizes at 50% maturity (*TL*) of teleost fish caught in commercial beach-seine nets in False Bay, as reported in the literature

Family	Species	Length at 50% maturity (mm)	Reference
Ariidae	*Galeichthys feliceps*	315	Tilney (1990)
Carangidae	*Lichia amia*	600	Van der Elst (1988)
	Seriola lalandi	700	Penney *et al.* (1989)
	Trachurus trachurus capensis	200	Geldenhuys (1973)
Clinidae	*Clinis agilis*	45	Lamberth *et al.* (1994)
	Clinus superciliosus	65	Day *et al.* (1981)
Clupeidae	*Sardinops sagax*	210*	Davies (1956)
Coracinidae	*Dichistius capensis*	310	Bennett and Griffiths (1986)
Mugilidae	*Liza richardsonii*	230†	De Villiers (1987)
Pomatomidae	*Pomatomus saltatrix*	240	Van der Elst (1976)
Sciaenidae	*Argyrosomus hololepidotus*	340	Griffiths and Hecht (1993)
	Atractoscion aequidens	590	Van der Elst and Adkin (1991)
	Umbrina canariensis	300	Lamberth *et al.* (1994)
Scombridae	*Scomber japonicus*	470*	Baird (1977)
Sparidae	*Diplodus sargus capensis*	180	Joubert (1981)
	Lithognathus lithognathus	650	Bennett (1993b)
	Lithognathus mormyrus	190*	Lasiak (1982)
	Pterogymnus laniarius	280	Hecht (1976)
	Rhabdosargus globiceps	310*	Talbot (1955)
	Rhabdosargus holubi	180	Day *et al.* (1981)
	Sarpa salpa	180	Joubert (1981)
	Spondyliosoma emarginatum	220	Van der Elst (1988)
Syngnathidae	*Syngnathus acus*	125	Bennett (1989b)
Tetraodontidae	*Amblyrhynchotes honckenii*	80	Day *et al.* (1981)
Triglidae	*Chelidonichthys capensis*	305	Hecht (1977)

* Corrected from standard length *SL* to *TL*
† Corrected from fork length *FL* to *TL*