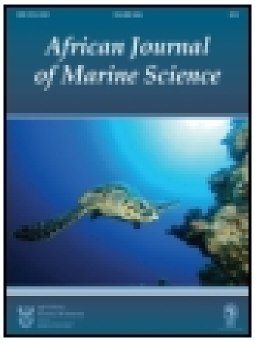

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Long-term catch and effort trends in Eastern Cape Angling Week competitions

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Catches from Angling Week competitions between 1999 and 2010 were analysed to examine changes in catch and effort. Over the course of the study period there was a marked drop in the number of competing anglers and a significant reduction in the total number of fish caught ($p = 0.026$). There was also a significant ($p < 0.01$) shift in the areas fished by anglers, from predominantly sandy to rocky reef areas. A total of 5 786 fish, representing 46 different species and 24 families, were positively identified from catches recorded on 2 710 catch cards. Due to the inability of anglers to correctly distinguish between *Mustelus mustelus* and *Triakis megalopterus* and between *Carcharhinus brachyurus* and *Carcharhinus obscurus*, these species were recorded together into two taxa. The most commonly caught species were *Argyrosomus japonicus* (20.3%), *Mustelus mustelus/Triakis megalopterus* (13.0%) and *Carcharias taurus* (11.8%). Mean CPUE for all fish caught, teleosts and elasmobranchs, as well as the top four teleost and elasmobranch species, increased over the course of the study period, with the exception of *Pachymetopon grande* and *C. brachyurus/C. obscurus,* which decreased. Only *C. brachyurus/C. obscurus* exhibited a significant ($p = 0.012$) decreasing trend in mean annual weight. Many of the species (43.6%) caught during Angling Week competitions were smaller than published estimates of weight-at-50% maturity. These results, from a unique long-term dataset, provide important information towards the sustainable management of the Eastern Cape shore-fishery.

Keywords: catch composition, catch per unit effort, shore fishery, South Africa

Introduction

Recreational shore-based angling is one of the most popular sport and outdoor activity pastimes in South Africa with an estimated 412 000 fishers (McGrath et al. 1997). It is a form of linefishing where fish are caught using a hook and line and comprises a social as well as a more formal organised competitive sector (van der Elst 1989).

Similar to other components of the linefishery, which include the subsistence as well as boat-based commercial sectors, excessive shore-fishing effort along the Eastern Cape has resulted not only in declining catches (Bennett 1991, Griffiths 1997, Brouwer and Buxton 2002, Pradervand and Govender 2003) but also changes in the species composition of catches (Bennett et al. 1994, Brouwer et al. 1997, Attwood and Farquhar 1999). Stock assessments indicate that many important linefish species are severely overexploited (Griffiths 1997, Hutchings 2000, Mann 2000) and that continued fishing pressure threatens endemic linefish populations. In 1996, shore-anglers alone were responsible for an annual catch of approximately 4.5 million fish, weighing around 3 000 tonnes (Brouwer et al. 1997).

Although the competitive sector comprises <3% of the total number of participants in the fishery (Pradervand and Govender 2003), the high frequency of competitions provide a useful long-term catch-and-effort dataset that can be used to assess the status of the fishery. Competition catch records have been used in several previous studies to monitor long-term trends in various regions of the South African marine shore-fishery. These have included assessments in KwaZulu-Natal (van der Elst and De Freitas 1988, Padervand et al. 2007), the Eastern Cape (Coetzee and Baird 1981, Coetzee et al. 1989, Pradervand and Govender 2003, Pradervand 2004) and the Southern and Western Cape (Bennett 1991, 1993, Bennett et al. 1994, Attwood and Bennett 1995).

The primary aim of this study was to analyse trends in the Eastern Cape competitive shore-fishery (between Port Alfred and Robberg) by quantifying catch-and-effort data during Angling Week competitions between 1999 and 2010. The format of Angling Week competitions, which are held once a year over a seven-day period, are distinctly different from other competitive shore-angling events that are typically fished over an eight-hour period on multiple days throughout the year. Unlike many other competitions, Angling Week catch records are not submitted to the National Marine Linefish System (NMLS). As a result, previous studies on it by Coetzee et al. (1989) and Brouwer and Buxton (2002) have been limited by data availability: five years (1978–1982) and two years (1995 and 1996) of data respectively. This study provides an opportunity to monitor a unique long-term dataset and provide information necessary for the sustainable management of the linefishery.

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Material and methods

Study area and competition format

Angling Week is an annual shore-angling competition that takes place between Port Alfred and Plettenberg Bay (Figure 1). The area encompasses approximately 182 km of sandy beaches and 128 km of rocky shores (Coetzee et al. 1989). The competition takes place over a pre-determined seven-day period during February or March. During this week, angling is permitted for any length of time, day or night. Teams consist of four anglers from clubs affiliated to the Eastern Province Shore Angling Association (EPSAA). Anglers are only allowed to use one rod and although there are no restrictions on the type of bait used (natural or artificial), the number of hooks is limited to two single hooks or one treble hook. Leaders, including traces, are restricted to a maximum length of 9 m and the main line diameter is limited to a maximum of 0.6 mm. Anglers fish with the intention of scoring the maximum number of points based on fish weight where one point is awarded for every kilogramme of 'edible' (teleost), or 'inedible' (elasmobranchs), fish caught. To be eligible, fish have to meet a minimum EPSAA weigh-in requirement of 1 kg for teleosts and 5 kg for elasmobranchs. Prior to 2007, eligible fish were individually weighed to one decimal point on a certified scale and the weight recorded on a weigh sheet that had to be witnessed by a member of an opposing team. To improve post-release survival rates, all catches are now only measured for length and then converted to weights using standard length/mass regressions given by Mann (2000). In addition to the species and size of fish caught, anglers also record the locality and date of captures.

Data analysis

Individual weigh sheets are submitted to EPSAA for prize-giving purposes and are captured onto a database and validated for transcription accuracy prior to analysis. The annual composition of catches, as well as annual species-specific catch per unit effort (CPUE) for commonly caught species, was determined. In the present study, we noted the inability of anglers to correctly distinguish between *Carcharhinus brachyurus* and *Carcharhinus obscurus* and between *Triakis megalopterus* and *Mustelus mustelus.* As a result, these species were recorded together into two taxa.

Angling week catch rate data (as with most recreational catch data) contained a high proportion of zero catches, which often results in it being overdispersed. Overdispersion can be accounted for by a negative binomial distribution rather than other discrete distributions within the exponential family (Hilborn 1985, Terceiro 2003). As a result, species-specific CPUE (fish angler^{-1} day^{-1}) for each Angling Week competition were estimated using a negative binomial generalised linear model with the different years as independent variables.

Weigh sheets are only submitted for successful outings, therefore there is no information as to the number of days or the number of hours fished by individual anglers over the course of the seven-day competition. As a result, it was necessary to assume that if an angler had caught at least one fish on one day, then the angler had fished each day of the competition and that all competing anglers fished for the same length of time each day. This assumes that the effort expended throughout the week by successful anglers may be consistently overestimated, resulting in a negatively biased CPUE as anglers may, on average, fish a consistent fraction of the week across all years. Other than the vehicle ban on beaches in January 2002, the format of Angling Week competitions has remained fairly consistent throughout the study period.

Using published estimates of size-at-50% maturity, individual fish weights were used to determine the proportions of immature fish for each species caught. An inverse-variance weighted regression analysis was used to assess temporal trends in abundance and size structure of commonly caught species using the expected values from the negative binomial model and their associated standard errors. The weighted regression approach was considered suitable to

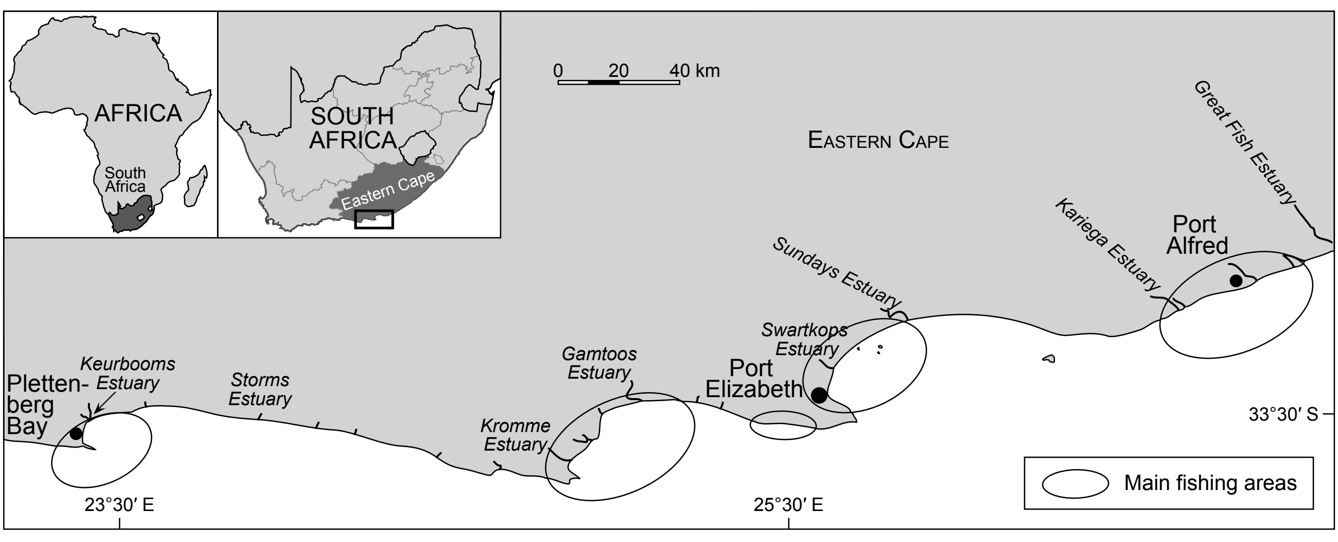

Figure 1: Map of South Africa showing the main locations fished during Angling Week competitions (Plettenberg Bay – Port Alfred) between 1999 and 2010

account for annual CPUE heteroscedasticity. Fishing localities recorded on weigh sheets were classified as either rocky or sandy beach areas and the annual percentage of trips to each type of area was calculated. Localities were categorised following key informant interviews with experienced anglers. A beta regression model (Ferrari and Cribari-Neto 2004, Cribari-Neto and Zeileis 2010) was fitted to test for any temporal trends in the type of area fished over the duration of the study period. A beta rather than an ordinary least squares regression model was chosen because it is specially designed to model continuous variates such as proportions as the dependent variable.

Results

Fishing effort

A total of 2 710 catch cards from Angling Week competitions was analysed between 1999 and 2010. There was a marked decrease in the number of competing anglers after the vehicle beach ban was implemented in January 2002 and a significant decline in the total number of fish caught ($p = 0.03$) (Figure 2). Over the course of the study period, there was a significant ($p < 0.01$) shift in the areas fished by anglers, from predominantly sandy to rocky areas (Figure 3).

Catch composition

A total of 5 786 fish, representing 46 different species (including grouped taxa) and 24 families, were positively identified in anglers' catches between 1999 and 2010 (Table 1). Numerically, the four most commonly caught teleost species over the course of the study period were *Argyrosomus japonicus* (20.3%), *Pachymetopon grande* (9.6%), *Sparodon durbanensis* (7.7%) and *Lithognathus lithognathus* (4.1%). The four most commonly caught elasmobranch species were *Mustelus mustelus/Triakis*

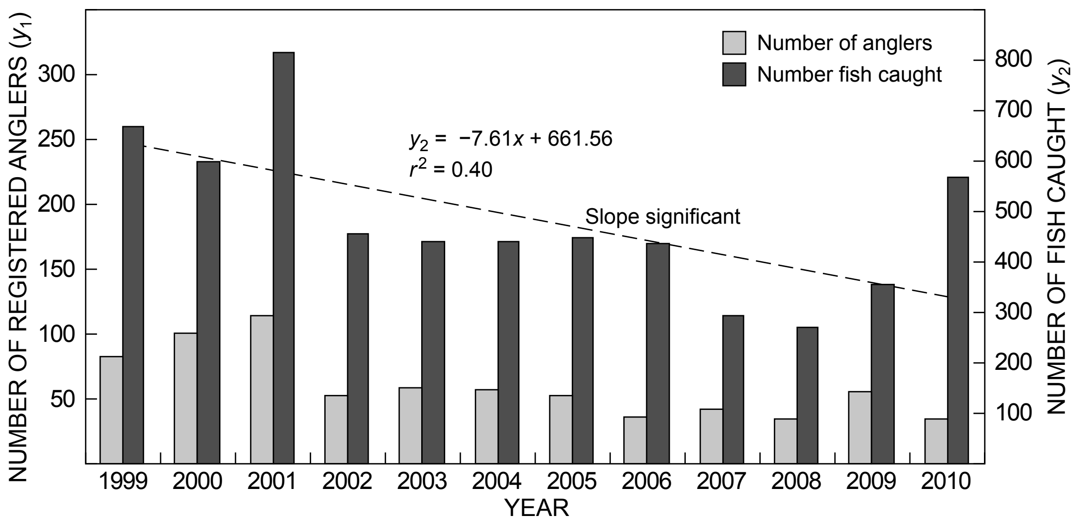

Figure 2: Number of anglers registered for Angling Week competitions and the total number of fish caught between 1999 and 2010

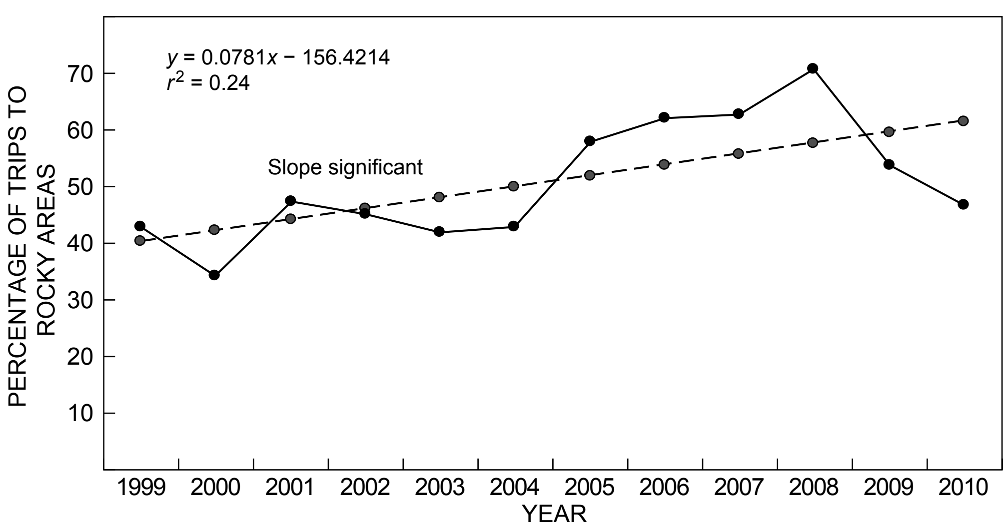

Figure 3: Temporal shift to rocky reef from sandy beach areas fished during Angling Week competitions between 1999 and 2010

Table 1: List of species caught during Angling Week competitions between 1999 and 2010. Percentage contribution is given in parentheses. Species are shown in phylogenetic order, according to Smith and Heemstra (1986)

Scientific name	Number	Weight (kg)	Mean weight (kg)	Weight range (kg)	% Mature
CHONDRICHTHYES					
Hexanchidae					
Notorhynchus cepedianus	7 (<0.1)	203.0 (0.3)	29.0	18.0–34.0	0.0
Carcharhinidae					
Carcharhinus brachyurus/Carcharhinus obscurus	610 (10.5)	8 327.3 (12.6)	13.6	3.4–13.0	<0.1
Carcharhinus limbatus	4 (0.1)	68.5 (0.1)	17.1	6.4–35.5	0.0
Carcharhinus brevipinna	2 (<0.1)	6.5 (<0.1)	6.5	6.5–6.5	0.0
Carcharhinus plumbeus	1 (<0.1)	42.0 (0.1)	42.0	NA	0.0
Triakidae					
Mustelus mustelus/Triakis megalopterus	751 (13.0)	10 399.7 (15.7)	14.2	1.8–36.0	80.4
Scyliorhinidae					
Poroderma africanum	7 (0.1)	39.3 (0.1)	5.6	5.0–6.4	100.0
Sphyraenidae					
Sphyrna zygaena	47 (0.8)	416.9 (0.6)	10.7	5.0–18.5	0.0
Odontaspididae					
Carcharias taurus	683 (11.8)	28 914.0 (43.7)	42.3	5.2–195.0	9.1
Torpeninidae					
Torpedo fuscomaculata	9 (0.2)	35.8 (0.1)	6.0	4.2–7.0	100.0
Rhinobatidae					
Rhinobatos annulatus	56 (1.0)	254.4 (0.4)	4.5	0.9–6.1	100.0
Rajidae					
Rostroraja alba	5 (0.1)	83.0 (0.1)	20.7	7.5–40.0	50.0
Dasyatidae					
Dasyatis chrysonota	188 (3.2)	1 681.6 (2.5)	8.9	3.0–30.0	90.0
Dasyatis brevicaudata	1 (<0.1)	95.0 (0.1)	95.0	NA	Unknown
Dasyatis thetidis	1 (<0.1)	45.0 (0.1)	45.0	NA	Unknown
Gymnuridae					
Gymnura natalensis	279 (4.8)	6 172.2 (9.3)	22.1	5.0–79.0	73.8
Myliobatidae					
Myliobatis aquila	57 (1.0)	571.4 (0.9)	10.0	4.0–21.0	100.0
Pteromylaeus bovinus	32 (0.6)	371.9 (0.6)	14.3	5.3–55.5	18.8
OSTEICHTHYES					
Elopidae					
Elops machnata	6 (0.1)	29.6 (<0.1)	4.9	4.0–6.0	Unknown
Plotosidae					
Plotosus nkunga	1 (<0.1)	1.2 (<0.1)	1.2	NA	Unknown
Triglidae					
Cheilodonichthys capensis	2 (<0.1)	1.5 (<0.1)	1.5	1.5–6.0	100.0
Serranidae					
Epinephelus marginatus	3 (0.1)	2.6 (<0.1)	1.3	1.1–1.5	0.0
Epinephelus andersoni	3 (0.1)	4.6 (<0.1)	1.5	1.0–2.0	67.0
Pomatomidae					
Pomatomus saltatrix	120 (2.1)	157.1 (0.2)	1.3	0.8–3.5	100.0
Haemulidae					
Pomadasys commersonnii	80 (1.4)	128.3 (0.2)	1.6	0.7–6.1	100.0
Sparidae					
Cheimerius nufar	6 (0.1)	12.4 (<0.1)	2.0	1.0–2.7	66.7
Diplodus capensis	155 (2.7)	179.9 (0.3)	1.1	0.4–4.4	100.0
Lithognathus lithognathus	237 (4.1)	864.1 (1.3)	3.6	0.7–14.3	38.8
Rhabdosargus holubi	11 (0.2)	11.7 (<0.1)	1.0	0.8–1.3	100.0
Diplodus hottentotus	35 (0.6)	38.2 (0.1)	1.1	0.6–2.1	100.0
Sarpa salpa	2 (<0.1)	1.8 (<0.1)	0.9	0.5–1.3	100.0
Sparodon durbanensis	446 (7.7)	2 256.8 (3.4)	5.0	1.0–15.5	100.0
Cymatoceps nasutus	78 (1.3)	212.3 (0.3)	2.7	1.0–8.2	16.7
Pachymetopon grande	555 (9.6)	814.8 (1.2)	1.4	0.8–5.5	99.6
Dichistiidae					
Dichistius capensis	10 (0.2)	15.0 (<0.1)	1.5	0.5–2.9	90.0
Scorpididae					
Neoscorpis lithophilus	5 (0.1)	6.2 (<0.1)	1.2	1.0–1.4	100.0
Monodactylidae					
Monodactylus argenteus	3 (0.1)	1.2 (<0.1)	1.2	1.2–1.2	100.0

Table 1: (cont.)

Scientific name	Number	Weight (kg)	Mean weight (kg)	Weight range (kg)	% Mature
Sciaenidae					
Argyrosomus japonicus	1 174 (20.3)	3 216.2 (4.9)	2.7	0.5–41.0	0.8
Atractoscion aequidens	1 (<0.1)	1.5 (<0.1)	1.5	NA	0.0
Umbrina robinsoni	50 (0.9)	115.7 (0.2)	2.3	1.0–7.9	62.0
Carangidae					
Carangoides gymnostethus	2 (<0.1)	3.0 (<0.1)	1.5	1.2–1.8	0.0
Lichia amia	55 (1.0)	290.2 (0.4)	5.3	1.3–15.0	29.1
Seriola lalandi	1 (<0.1)	3.2 (<0.1)	3.2	NA	0.0
Trachinotus africanus	5 (0.1)	41.9 (0.1)	8.3	2.0–11.6	Unknown
Total	5 786	66 138.8			

Note: % mature indicates the percentage of individuals sampled that were above weight-at-50% maturity. Unknown signifies that size-at-maturity data are unavailable for the specific species

NA = Not applicable

megalopterus (13.0%), *Carcharias taurus* (11.8%), *Carcharhinus brachyurus/Carcharhinus obscurus* (10.5%) and *Gymnura natalensis* (4.8%). These top eight taxa accounted for 81.8% of the total recorded catch by number. *Argyrosomus japonicus* dominated catches in all but three (2002, 2009 and 2010) of the 12 years investigated. All of the species showed considerable interannual variation in their respective contribution to total annual catch with no significant ($p > 0.05$) temporal trends. By number, teleosts were marginally more prevalent in catches (52.7%) than elasmobranchs. There were no significant temporal trends in the respective contributions of either group to total annual catch or species.

Catch per unit effort

The mean overall annual CPUE (fish angler^{-1} day^{-1}) for all species combined ($p < 0.01$), as well as for teleosts ($p < 0.01$) and elasmobranchs ($p = 0.26$), increased from 1999 to 2010 (Figure 4). All of the investigated top four teleost and elasmobranch species exhibited high interannual variation in mean annual CPUE (Figure 5). All of the species, with the exception of *Pachymetopon grande* and *C. brachyurus/ C. obscurus,* exhibited increasing trends in CPUE. Significant increases were evident for *Argyrosomus japonicus* ($p = 0.03$), *Sparodon durbanensis* ($p = 0.04$) and *Carcharias taurus* ($p = 0.03$).

Size composition

Regression analyses of the temporal trends in the mean annual weight of the top teleost and elasmobranch species are presented in Figure 6. *Sparodon durbanensis*, *L. lithognathus* and *C. brachyurus/C. obscurus* all showed a slight decrease in mean annual weight over the study period. The only significant decline ($p = 0.01$), however, was for *C. brachyurus/C. obscurus.* All other species exhibited slight, but non-significant, increases in mean annual weights over time.

Using published estimates of weight-at-50% maturity, many of the species (43.6%) caught during Angling Week competitions were considered to be juveniles rather than adults (Table 1). Of the top teleost and elasmobranch species caught, the majority of *A. japonicus*, *L. lithognathus*, *C. brachyurus/C. obscurus* and *C. taurus* were immature specimens (Table 1).

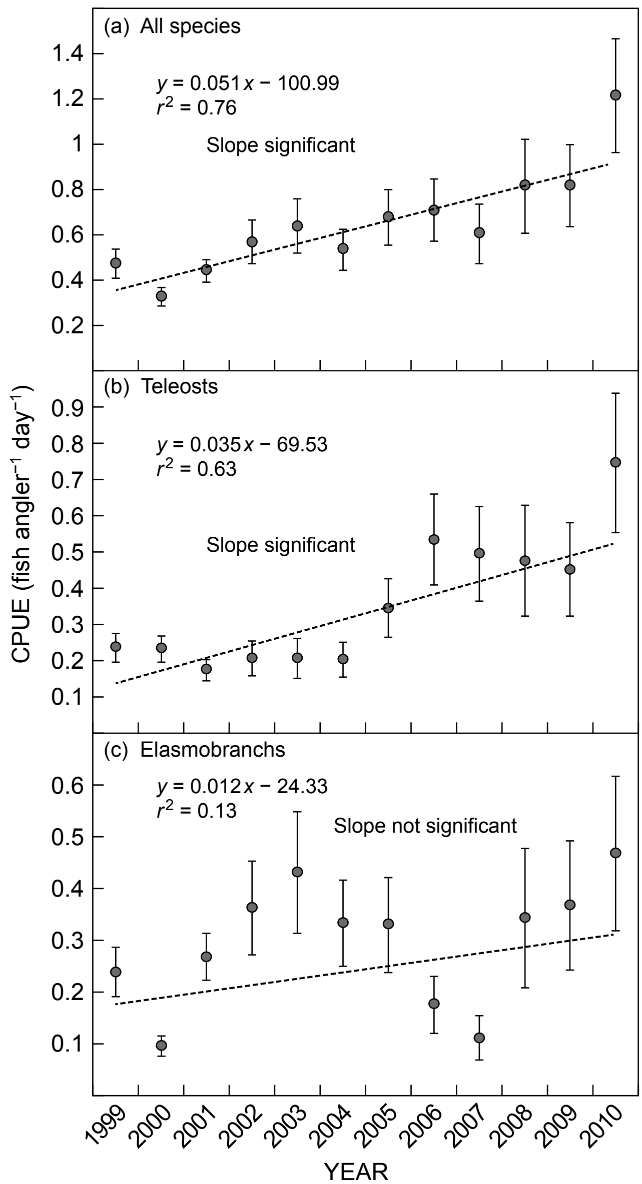

Figure 4: Temporal trends in CPUE for (a) all species combined, (b) teleosts and (c) elasmobranchs during Angling Week for the period 1999–2010

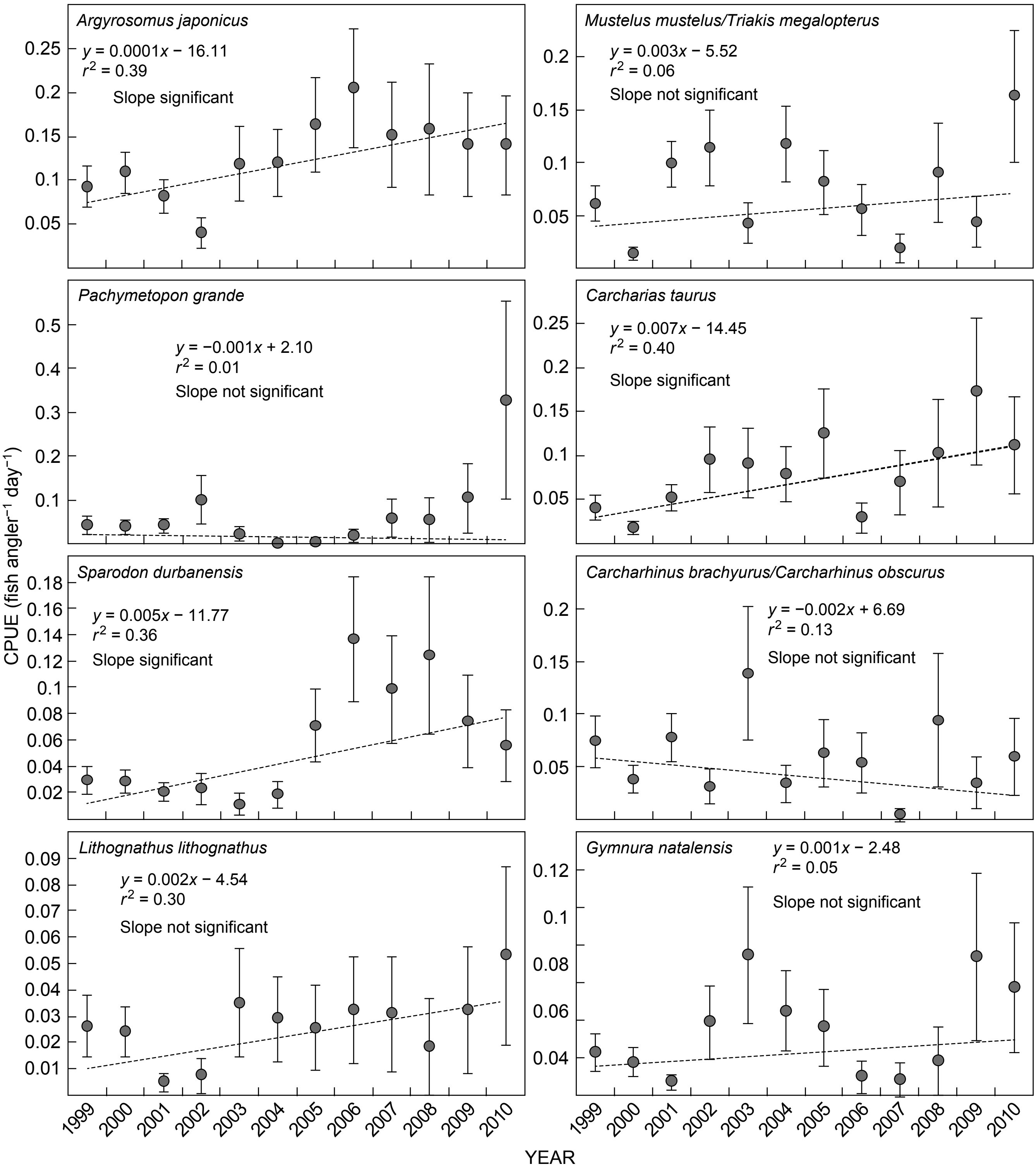

Figure 5: Temporal trends in CPUE by number for the four most commonly caught teleost and elasmobranch species during Angling Week for the period 1999–2010

Discussion

Fishing effort

The major change in the shore-angling fishery over the past two decades has been the implementation of the vehicle beach ban in 2002. As a result of this ban, there was a marked drop in the number of competing anglers registered for Angling Week and a significant reduction in the total number of fish caught. This trend reflects a 30% drop in the number of SASAA-registered club anglers in response to

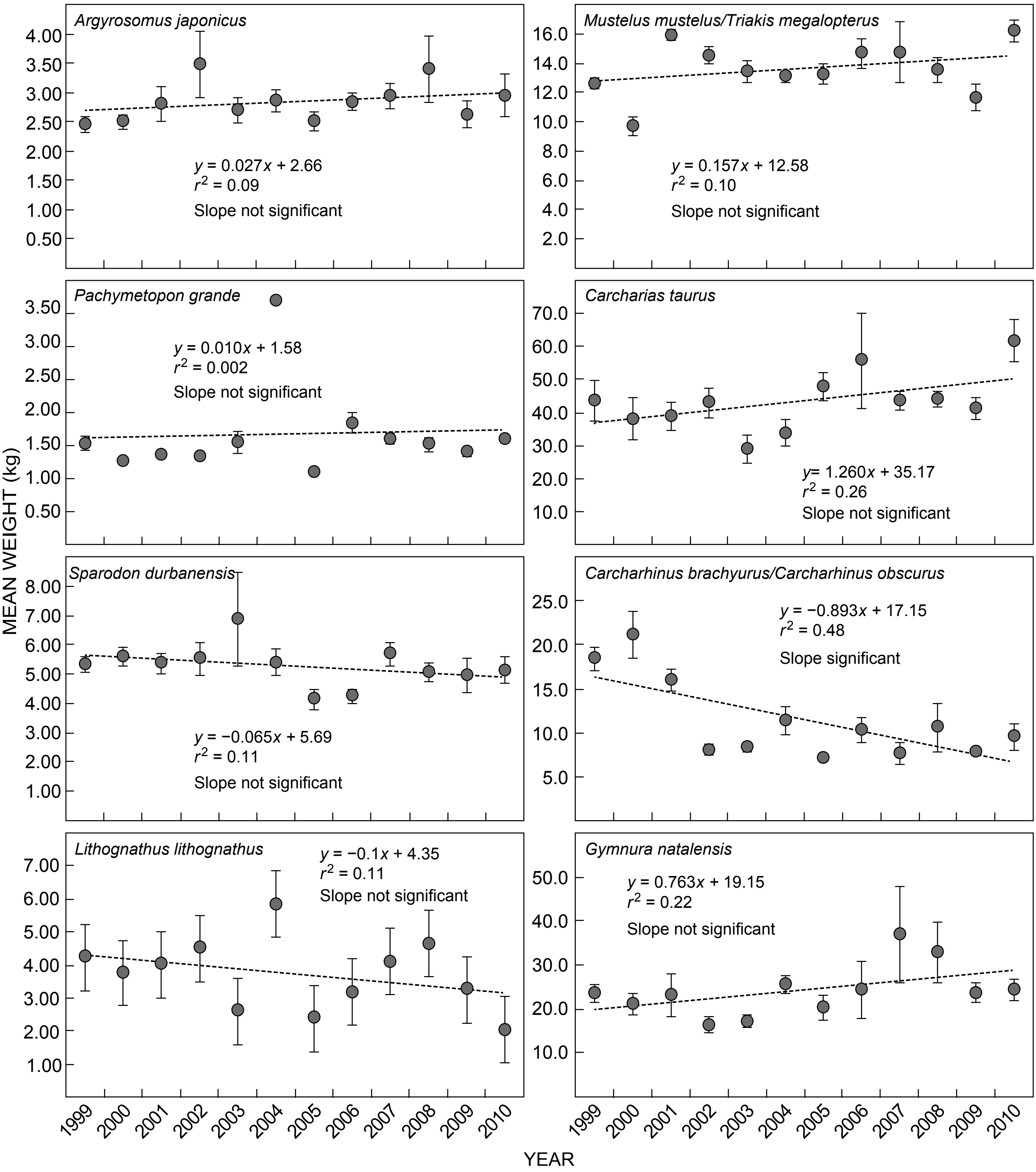

Figure 6: Temporal trends in mean weight for the four most commonly caught teleost and elasmobranch species during Angling Week for the period 1999–2010

the beach vehicle ban (E Holmes, SASAA, pers. comm.). Although the reduction in effort will reduce incidences of fishing mortality, there was a significant increase in fishing effort directed at rocky rather than sandy habitats over the course of the study period. A similar trend, in response to the beach vehicle ban, was observed by Dicken et al. (2006) in which anglers stated that the ban made it almost impossible to access the more remote sandy beach locations. Unable to carry the heavy tackle necessary to catch sharks for long distances and because of issues of vehicle security, many anglers had switched from targeting sharks to smaller teleost species. These species generally require lighter fishing tackle and can be fished from more readily accessible areas, close to vehicle parking areas, which are invariably rocky-shore areas with associated subtidal reef. Similar changes in the distribution of fishing effort in response to the vehicle beach ban have been recorded along the KwaZulu-Natal (KZN) coast (Mann et al. 2008). This shift in target and habitat preference could potentially place additional pressure on many of South Africa's reef fish species, which are already considered to be under pressure (Griffiths 2000, Mann 2000, Griffiths and Lamberth 2002).

Catch composition

Although a total of 46 species was recorded during Angling Week over the study period, four taxa, *A. japonicus*, *P. grande*, *C. taurus* and *M. mustelus/T. megalopterus*, comprised more than 50% of the total catch by number. The dominance by a few species in the catch of a multispecies linefishery is likely to reflect the abundance and catchability of species and is evident in all sectors of the South African linefishery (Brouwer et al. 1997, Mann et al. 2003, Pradervand et al. 2007). Although the number of species recorded was greater than in the Border (Great Fish River–Kei River) competitive shore-fishery (34 species; Pradervand and Govender 2003), it was less than that recorded in either the KZN (117 species; Pradervand et al. 2007) or the former Transkei (71 species; Pradervand 2004) regions. In part, this reflects the increased ichthyofaunal diversity displayed with decreasing latitude along the east coast of South Africa (Turpie et al. 2000). Another contributing factor, however, is that the minimum size requirements for both teleost and elasmobranch species in the KZN and Transkei fisheries is only 0.5 kg. This is markedly lower than the legal size requirements for Angling Week, which precluded the catches of smaller species. It is also important to note that Angling Week catches are recorded from a single week during the summer. The seasonality of the competition is likely to affect the catch composition, for instance the low catches of galjoen *Dichistius capensis,* which are typically caught during the winter. In contrast, the studies by Pradervand and Govender (2003), Pradervand (2004) and Pradervand et al. (2007) assessed catches throughout the year.

Catch composition in the present study was similar to that recorded for Angling Week competitions between 1978 and 1982 (Coetzee et al. 1989). One major difference, however, between the two studies was the marked decrease in the contribution of teleosts (particularly *Pomatomus saltatrix*) in favour of elasmobranch species. This shift was also noted by Brouwer and Buxton (2002) from an analysis of Angling Week catches in 1995 and 1996. Such changes in catch composition over time could be interpreted as a sign of decreasing abundance of traditionally targeted linefish species (Bennett et al. 1994, Attwood and Farquhar 1999). Declining catches of *P. saltatrix* since the 1980s in the Eastern Cape were also noted by Baird et al. (1996) and Pradervand and Baird (2002).

The catch composition recorded in the present study differed considerably from some previous studies that have assessed shore-angling catches along the Eastern Cape coast. Catches recorded by Brouwer et al. (1997) and Clarke and Buxton (1989) were dominated by small species such as *P. saltatrix*, *Sarpa salpa*, *Pomadasys olivaceum* and *Diplodus capensis.* These studies, however, surveyed primarily non-competitive anglers who tend to target teleost rather than elasmobranch species and are not limited by minimum competition size requirements. However, there were similarities in some aspects to catches recorded in the Border competitive shore-fishery, which also comprised of larger-sized species such as *A. japonicus*, *P. grande*, *C. taurus* and the Triakidae (Pradervand and Govender 2003).

Analysis of temporal trends in overall catch composition indicated that the contribution of teleosts and elasmobranchs remained relatively constant over the study period. This is similar to findings from the Border competitive shore-fishery (Pradervand and Govender 2003). There were, however, considerable fluctuations in the annual numerical contributions of the commonly caught species. This is likely the combined result of weather patterns and short-term changes in targeting and fishing techniques used by anglers. Similar trends were evident in the KZN (Pradervand et al. 2007), Transkei (Pradervand 2004) and Border (Pradervand and Govender 2003) shore-fisheries. In contrast to these other fisheries, however, there were no significant or identifiable trends in changing fishing patterns related to the size, or type of species caught in the present study. Changes in catch composition may be indicative of once dominant species decreasing in abundance, and correspondingly being replaced by other species.

Catch per unit effort

Comparisons of the CPUE data collected from Angling Week competitions with those reported for other studies are complicated due to differences in the methods of data collection, competition regulations (i.e. minimum size limits and tackle configurations), the seasonality of data collection, species targeted and the methods used to standardise CPUE. All of these factors influence the relative abundance and catch rates of the different species.

In contrast to other long-term studies, which have assessed shore-angling catches (Coetzee et al. 1989, Bennett 1991, Pradervand and Govender 2003), the overall CPUE in this study increased over time. This was similar to trends in both the KZN (Pradervand et al. 2007) and Transkei competitive shore-fisheries (Pradervand 2004). In these two fisheries, however, increases were primarily the result of anglers targeting smaller, traditionally non-targeted species, in response to decreased levels of the once commonly caught larger species. This was in marked contrast to the present study in which CPUE trends for three of the most commonly caught species (i.e. *A. japonicus*, *C. taurus* and *S. durbanensis*) showed significant increases. The decline in CPUE of *C. brachyurus*/*C. obscurus* is of concern. *Carcharhinus obscurus*, in particular, is one of the most K-selected of all elasmobranchs (Simpfendorfer et al. 2002). Off South Africa, there is a well-developed commercial linefishery for small *C. obscurus* and concern has been expressed over the high level of mortality and decreases in CPUE (Pradervand et al. 2007). It is also the most commonly caught species in the protective gillnets off the KZN coast with a mean annual catch of 232 between 1978 and 2003 (Dudley and Simpfendorfer 2006). The potential effect of the nets and other fishing activities on *C. obscurus* is considered high due to very low intrinsic rates of population increase (Smith et al. 1998) and could have contributed to the declining trends observed in our study.

Taylor (1993) reported that up to 80% of fish caught in competitions are taken by only a few top anglers, and similar findings were recorded by Dicken et al. (2006). With the implementation of the vehicle beach ban, it is probable that only the most avid and dedicated fishers now compete in Angling Week competitions. A more skilled set of anglers, combined with continued technological improvements in fishing tackle, fishing techniques, bait types, as well as a shift in fishing effort to more rocky reef areas, could all be contributing factors to increased CPUEs, particularly those of teleost species.

The mean overall CPUE for all fish caught and teleosts in this study was less than half of that recorded from Angling Week competitions between 1978 and 1982 (Coetzee et al. 1989) and about one-third less for elasmobranchs. Similar reductions in CPUEs over this longer time period were also observed for all four of the most commonly caught teleost species, with the exception of *S. durbanensis,* which surprisingly had increased. *Sparodon durbanensis* is a slow-growing, long-lived species considered to be highly vulnerable to overfishing (Buxton and Clarke 1991). It is thus likely that the observed increase was as a result of directed targeting for this species in rocky areas. By comparison to the Coetzee et al. (1989) study, the CPUE trends for all four of the most commonly caught elasmobranch species had increased by more than double. Changes in the catch composition and CPUE are often used as an index of stock abundance (Gulland 1983, Punt 1993). The changes evident in Angling Week catches between the present study and those recorded by Coetzee et al. (1989) — almost two decades earlier — are perhaps indications of declining teleost populations and shifting fishing patterns, primarily as a result of overexploitation.

Size composition

Concomitant with CPUE trends, changes in the mean mass of a fish species can provide an indication of exploitation levels, with mean size of fish caught tending to decrease with increasing exploitation (Ricker 1975, Butterworth et al. 1989). Analysis of temporal changes in mean mass showed that the only taxa to experience a significant change were *C. brachyurus/C. obscurus,* which declined over the study period. This result, in conjunction with declining CPUE trends for this taxa, provides further support for the hypothesis of overexploitation. Other studies of competitive shore-fisheries in the Eastern Cape (Coetzee et al. 1989) and Southern Cape (Bennett et al. 1994) reported no significant changes in mean annual size of fish landed. Trends in fish sizes, however, may have been masked by the time frames of these studies. When the mean size of *A. japonicus* and *P. grande* in the present study are compared to those from Angling Week catches more than two decades ago, they have decreased by 8% and 34% respectively.

Despite the minimum catch size requirements of Angling Week competitions, an analysis of size compositions showed that many of the species caught were immature specimens. Of the most commonly caught species, almost all of *A. japonicus*, *L. lithognathus*, *C. brachyurus/C. obscurus* and *C. taurus* were below mass-at-50% maturity. This suggests that the inshore region of the Eastern Cape is being used as a nursery area for these species, as was noted by Griffiths (1996) for *A. japonicus*, Bennett (1993) for *L. lithognathus*, Bass et al. (1973), Hussey et al. (2009) and Dicken (2011) for *C. brachyurus/C. obscurus* and Smale (2002) and Dicken et al. (2006, 2007) for *C. taurus.* The prevalence of immature fish in competitive shore-angling competitions has also been noted in the Border (Pradervand and Govender 2003), Transkei (Pradervand 2004) and KZN fisheries (Pradervand et al. 2007). The prevalence of juveniles, however, could also be attributed to the overfishing and subsequent decline of adult specimens. Although fishing competitions now employ a strict catch-and-release policy, the large numbers of immature fish being handled is likely to result in some post-release mortality. This could have serious consequences for species such as *A. japonicus* whose stock has been decimated primarily by overfishing of juveniles in estuarine and inshore environments (Griffiths 1997).

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References

Attwood CG, Bennett BA. 1995. A procedure for setting daily bag limit on the recreational shore-fishery of the south-western Cape, South Africa. *South African Journal of Marine Science* 15: 241–25.

Attwood CG, Farquhar M. 1999. Collapse of linefish stocks between Cape Hangklip and Walker Bay, South Africa. *South African Journal of Marine Science* 21: 415–432.

Baird D, Marais JFK, Daniel C. 1996. Exploitation and conservation of angling fish species in selected South African estuaries. *Aquatic Conservation Marine and Freshwater Ecosystems* 6: 319–330.

Bass AJ, D'Aubrey JD, Kistnasamy N. 1973. Sharks of the east coast of southern Africa. 1. The genus *Carcharhinus* (Carcharhinidae). Investigational Report No. 33. Durban: South African Association for Marine Biological Research, Oceanographic Research Institute.

Bennett BA. 1991. Long-term trends in the catches by shore anglers in False Bay. *Transactions of the Royal Society of South Africa* 47: 683–690.

Bennett BA. 1993. The fishery for white steenbras *Lithognathus lithognathus* off the Cape coast, South Africa, with some considerations for its management. *South African Journal of Marine Science* 13: 1–14.

Bennett BA, Attwood CG, Mantel JD. 1994. Teleost catches by three shore-angling clubs in the south-western Cape, with an assessment of the effect of restrictions applied in 1985. *South African Journal of Marine Science* 14: 11–18.

Brouwer SL, Buxton CD. 2002. Catch and effort of the shore and skiboat linefisheries along the South African Eastern Cape coast. *South African Journal of Marine Science* 24: 341–354.

Brouwer SL, Mann BQ, Lamberth SJ, Sauer WHH, Erasmus C. 1997. A survey of the South African shore-angling fishery. *South African Journal of Marine Science* 18: 165–177.

Buxton CD, Clarke JR. 1991. The biology of the white mussel cracker *Sparodon durbanensis* (Pisces: Sparidae) on the Eastern Cape coast. *South African Journal of Marine Science* 10: 285–296.

Butterworth DS, Punt AE, Borchers DL, Pugh JG, Hughes GS. 1989. *A manual of mathematical techniques for linefish assessment. South African National Scientific Programmes Report* 160: 1–89.

Cribari-Neto F, Zeileis A. 2010. Beta regression in R. *Journal of Statistical Software* 34: 1–24.

Clarke JR, Buxton CD. 1989. A survey of the recreational rock-angling fishery at Port Elizabeth, on the south-east coast of South Africa. *South African Journal of Marine Science* 8: 183–194.

Coetzee PS, Baird D. 1981. Catch composition and catch per unit effort of anglers' catches off St Croix Island, Algoa Bay. *South African Journal of Wildlife Research* 11: 14–20.

Coetzee PS, Baird D, Tregoning C. 1989. Catch statistics and trends in the shore-angling fishery of the east coast, South Africa, for the period 1959–1982. *South African Journal of Marine Science* 8: 155–171.

Dicken ML. 2011. Population size of neonate and juvenile dusky sharks (*Carcharhinus obscurus*) in the Port of Ngqura, South Africa. *African Journal of Marine Science* 33: 255–261.

Dicken ML, Booth AJ, Smale MJ, Cliff G. 2007. Spatial and seasonal distribution patterns of juvenile and adult raggedtooth sharks (*Carcharias taurus*) tagged off the east coast of South Africa. *Marine and Freshwater Research* 58: 127–134.

Dicken ML, Smale MJ, Booth AJ. 2006. Shark fishing effort and catch of the raggedtooth shark (*Carcharias taurus*) in the South African competitive shore angling fishery. *African Journal of Marine Science* 28: 589–601.

Dudley SFJ, Simpfendorfer CA. 2006. Population status of 14 shark species caught in the protective gillnets off KwaZulu-Natal beaches, South Africa, 1978–2003. *Marine and Freshwater Research* 57: 225–240.

Ferrari SLP, Cribari-Neto F. 2004. Beta regression for modelling rates and proportions. *Journal of Applied Statistics* 31: 799–815.

Griffiths MH. 1996. Life history of *Argyrosomus japonicus* off the east coast of South Africa. *South African Journal of Marine Science* 17: 135–154.

Griffiths MH. 1997. The management of South African dusky kob *Argyrosomus japonicus* based on per-recruit models. *South African Journal of Marine Science* 18: 213–228.

Griffiths MH. 2000. Long-term trends in catch and effort for the Cape commercial linefishery: snapshots of the 20th century. *South African Journal of Marine Science* 22: 81–110.

Griffiths MH, Lamberth SJ. 2002. Evaluating the marine recreational fishery in South Africa. In: Pitcher TJ, Hollingworth C (eds), *Recreational fisheries: ecological, economic, and social evaluation*. Oxford: Blackwell Science. pp 227–251.

Gulland JA. 1983. *Fish stock assessment: a manual of basic methods.* New York: John Wiley & Sons.

Hilborn R. 1985. Fleet dynamics and individual variation: why some people catch more fish than others. *Canadian Journal of Fish and Aquatic Sciences* 42: 2–13.

Hussey NE, McCarthy ID, Dudley SFJ, Mann BQ. 2009. Nursery grounds, movement patterns and growth rates of dusky sharks, *Carcharhinus obscurus*: a long-term tag and release study in South African waters. *Marine and Freshwater Research* 60: 571–583.

Hutchings JA. 2000. Collapse and recovery of marine fisheries. *Nature* 406: 882–885.

Mann BQ (ed). 2000. *Southern African marine linefish status reports. Special Publication* No. 7. Durban: Oceanographic Research Institute.

Mann BQ, McDonald AM, Sauer WHH, Hecht T. 2003. Evaluation of participation in and management of the former Transkei shore linefishery. *African Journal of Marine Science* 25: 79–97.

Mann BQ, Nanni G, Pradervand P. 2008. A monthly aerial survey of the KwaZulu-Natal marine shore fishery. ORI Unpublished Report No. 264. Oceanographic Research Institute, Durban.

McGrath MD, Horner CCM, Brouwer SL, Lamberth SJ, Mann BQ, Sauer WHH, Erasmus C. 1997. An economic valuation of the South African linefishery. *South African Journal of Marine Science* 18: 203–221.

Pradervand P. 2004. Long-term trends in the shore fishery of the former Transkei coast, South Africa. *African Zoology* 39: 247–261.

Pradervand P, Baird D. 2002. Assessment of the recreational linefishery in selected Eastern Cape estuaries: trends in catches and effort. *South African Journal of Marine Science* 24: 111–130.

Pradervand P, Govender RG. 2003. Assessment of catches in shore angling competitions from the border region of the Eastern Cape, South Africa. *African Zoology* 38: 1–14.

Pradervand P, Mann BQ, Bellis MF. 2007. Long-term trends in the competitive shore fishery along the KwaZulu-Natal coast, South Africa. *African Zoology* 42: 216–236.

Punt AE. 1993. A simple effort-based stock assessment technique. In: Beckley LE, van der Elst RP (eds), *Fish, fishers and fisheries. Proceedings of the second South African marine linefish symposium, Durban*, *23–24 October 1992. Special Publication* No. 2. Durban: Oceanographic Research Institute. pp 73–79.

Ricker WE. 1975. Computation and interpretation of biological statistics of fish populations. *Bulletin of the Fisheries Research Board of Canada* 191: 1–382.

Simpfendorfer CA, McAuley RB, Chidlow J, Unsworth P. 2002. Validated age and growth of the dusky shark, *Carcharhinus obscurus*, from Western Australian waters. *Marine and Freshwater Research* 53: 567–573.

Smale MJ. 2002. Occurrence of *Carcharias taurus* in nursery areas of the Eastern and Western Cape, South Africa. *Marine and Freshwater Research* 53: 551–556.

Smith MM, Heemstra PC (eds). 1986. *Smiths' sea fishes*. Johannesburg: Macmillan Publishers.

Smith SE, Au DW, Show C. 1998. Intrinsic rebound potentials of 26 species of Pacific sharks. *Marine and Freshwater Research* 49: 663–678.

Taylor V. 1993. The effect of recreational rock and surf angling on fish resources along the Cape Coast. In: Beckley LE, van der Elst RP (eds), *Fish, fishers and fisheries. Proceedings of the second South African marine linefish symposium, Durban*, *23–24 October 1992. Special Publication* No. 2. Durban: Oceanographic Research Institute. pp 186–190.

Terceiro M. 2003. The statistical properties of recreational catch rate data for some fish stocks off the northeast US coast. *Fisheries Bulletin* 101: 653–672.

Turpie JK, Beckley LE, Katua SM. 2000. Biogeography and the selection of priority areas for conservation of South African coastal fishes. *Biological Conservation* 92: 59–72.

van der Elst RP. 1989. Marine recreational angling in South Africa. In: Payne AIL, Crawford RJM (eds), *Oceans of life off southern Africa.* Cape Town: Vlaeberg Publishers. pp 164–176.

van der Elst RP, De Freitas AJ. 1988. Long-term trends in Natal marine fisheries. In: Macdonald IAW, Crawford RJM (eds), *Long-term data series relating to southern Africa's renewable natural resources. South African National Scientific Programmes Report* 157: 76–83.

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