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Short Communication

White shark and other chondrichthyan interactions with the beach-seine (treknet) fishery in False Bay, South Africa

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Public perception has been that an apparent increase in the nearshore occurrence of white sharks *Carcharodon carcharias* in False Bay, on the south coast of South Africa, can at least be partly attributed to beach-seine (treknet) operations attracting sharks into this coastal area. To assess the merit of these concerns, all available beach-seine catch-and-effort data from the False Bay fishery over a 32-year period were analysed. A total of 27 cartilaginous species from 15 families was recorded in around 11 400 hauls from 1974 to 2006. Most (98%) of these comprised small benthic invertebrate feeders such as smooth houndshark *Mustelus mustelus* and lesser guitarfish *Rhinobatos annulatus*. Large sharks such as *C. carcharias* and ragged-tooth shark *Carcharias taurus* were rare, occurring in <0.2% of hauls. The only medium to large sharks that occurred frequently (15% of hauls) in any appreciable numbers (0.3 per haul) were bronze whalers *Carcharhinus brachyurus*. The relatively high numbers of *C. brachyurus* compared with *C. carcharias*, their overlapping size distributions and the difficulty of identifying sharks from a distance, suggests that many of the sharks observed following beach-seine nets are the bronze whalers. Overall, the frequency of occurrence of *C. carcharias* in the nets is much lower than would be predicted from the high number of observations in the nearshore region. Furthermore, beach-seine fishing rights in False Bay have been reduced from around 170 in the 1970s to five at present. There has been no corresponding decrease in shark incidents. On the contrary, shark incidents have increased from two in the 1970s to six during the period 2000–2005. Overall, there appears to be no strong link between beach-seine activity and human incidents with white sharks in False Bay.

Keywords: beach-seine catch and effort, human incidents, white shark

Introduction

Shark, fishery and human interactions are an obvious and inevitable result of marine fisheries and aquatic recreation, as is the case with the beach-seine fishery in False Bay on the south coast of South Africa. Beach-seine nets were introduced into the Cape Province during the mid-1600s, but under strict control of the settlement commander (Thom 1952). Sector conflict between the beach-seine and other fisheries has existed since the 1700s, whereas concerns over the ecosystem effects of this fishery surfaced in the late 1800s (Gilchrist and Williams 1910, Lamberth 1994). Shark catches became an issue in the 1970s with the growing public perception that large catches of this collective group of 'keystone' predators were causing ecological imbalances in False Bay (Lamberth *et al*. 1994). In a subsequent study, these and other concerns surrounding the fishery were found to be mostly groundless (Lamberth 1994).

Since 1998, beach-seine and shark interactions, specifically white shark *Carcharodon carcharias*, have again become a public issue because human fatalities and injuries accredited to this species have increased in waters around the Cape (Cliff 2006). Among others, public perception is that beach-seine operations and/or the blood and stress response of catches are attracting *C. carcharias* into nearshore waters, bringing them into contact with bathers, surfers and other water users. This study tests the validity of these claims by reviewing beach-seine catch and effort in False Bay in relation to *C. carcharias* activity, over a 35-year period.

Material and Methods

Available catch data comprise records of around 11 400 beach-seine hauls in False Bay from 1974 to 2005 (Figure 1). These data vary in accuracy from the low-confidence commercial catch returns (Marine and Coastal Management, Netfish System — 8 500 hauls) to medium-confidence diarised hauls (J Petty, beach-seine right-holder — 2 001 hauls, C Fallows, Apex Images — 600 hauls) to high-confidence monitored catches (Lamberth *et al.* 1994 — 311 hauls). Incident records of *C. carcharias* over the same time period are from Cliff (2006).

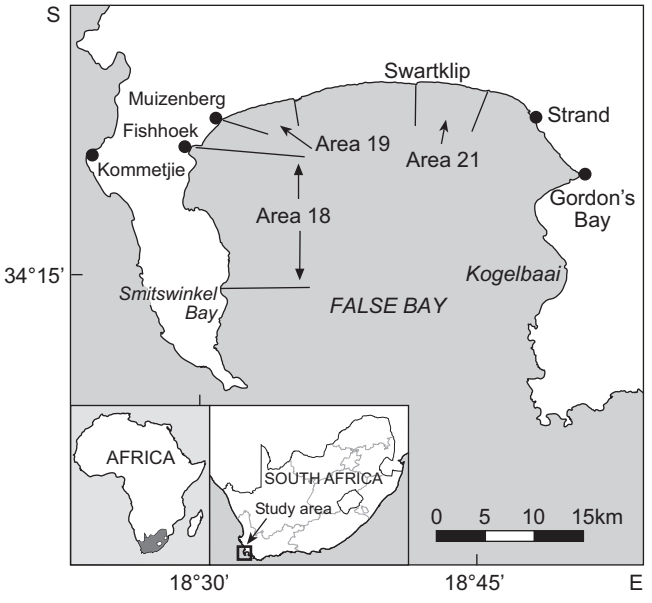

Figure 1: Map of False Bay, South Africa, showing present-day beach-seine fishing Areas 18, 19 and 21. Area 20 has been closed to beach-seining since 2003

Results and Discussion

A total of 27 cartilaginous species from 15 families has been recorded from beach-seine hauls taken in False Bay over the past 35 years (Table 1). Numerically, none of these species comprised more than 1% of the total catch. The chondrichthyan haul was dominated by lesser guitarfish *Rhinobatos annulatus*, St Joseph shark *Callorhinchus capensis*, smooth houndshark *Mustelus mustelus*, eagle ray *Myliobatis aquila* and blue stingray *Dasytatis chrysonota*, which together made up 98% of the chondrichthyan catch.

The only medium to large sharks (>2m) that occurred in any appreciable numbers (0.3 per haul) were bronze whalers *Carcharhinus brachyurus*, of which in excess of 3 000 were caught (Table 1). In marked contrast, only 20 (about one in every 500 hauls) *C. carcharias* were caught in the nets. Other medium to large sharks present in low to very low numbers were dusky shark *Carcharhinus obscurus*, sandbar shark *Carcharhinus plumbeus*, sevengill cowshark *Notorhynchus cepedianu*s, mako *Isurus oxyrinchus*, ragged-tooth *Carcharias taurus* and hammerhead *Sphyrna zygaen*a. The size frequency distributions of all of these species overlap with that of juvenile *C. carcharias,* which suggests that they may often be confused with each other. Indeed, beachgoers often believe that medium-sized *M. mustelus* and gullysharks *Triakis megalopterus* caught in the nets are juveniles of either *C. carcharias* or *C. taurus*. Further, most members of the public and anglers find it difficult to distinguish between different species of sharks when they are observed in silhouette and are of similar size (Figure 2). Identification becomes even more difficult when the silhouettes are viewed through water, obliquely and at a distance, from the beach or mountainside vantage point.

The frequency of occurrence of *C. brachyurus* in beach-seines (15% of hauls) is several orders of magnitude greater than that of *C. carcharias* (0.1–0.2% of hauls, Table 1). This, supported by overlapping size frequencies, suggests that the high frequency of 'white sharks' observed by the public and spotters may often be bronze whalers. Such sharks are frequently observed following beach-seine nets into the shallows and may even beach themselves while chasing fish. Shark anglers often take advantage of this behaviour by casting their baits behind the seine nets. To date, there is no record of a white shark been caught in this manner. On the other hand, beach-seine fishers often observe *C. carcharias* prior to a haul, but the sharks seem to disappear once the net is set and they are seldom caught. Overall, the frequency of occurrence of *C. carcharias* in the seine nets is much lower than would be predicted from the relatively high number of observations made from various vantage points. Mistaken identity aside, this suggests that *C. carcharias* may be actually avoiding the nets.

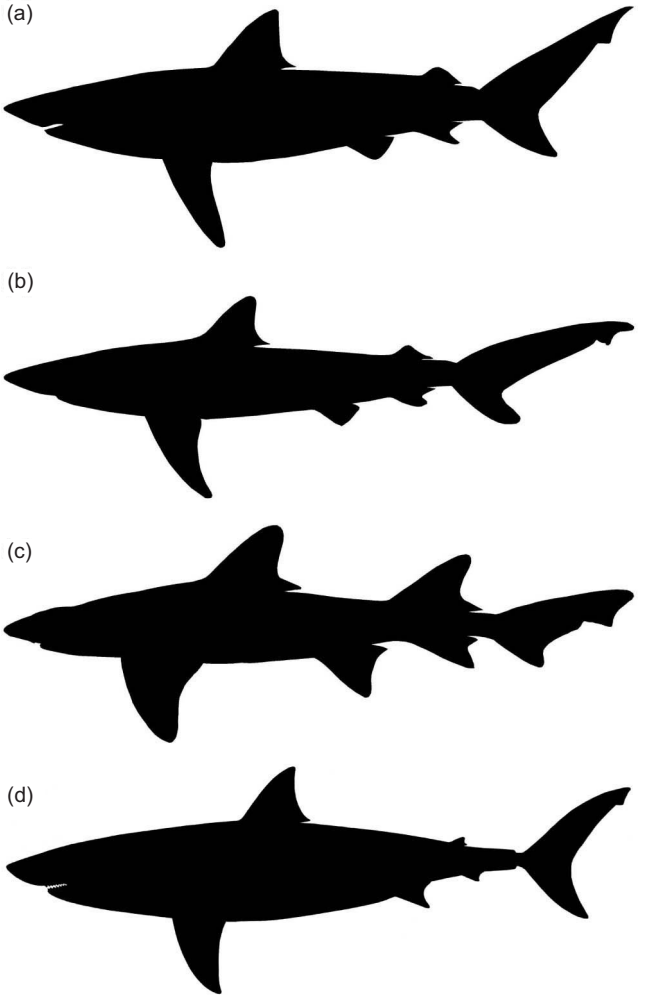

Figure 2: Shark silhouettes: (a) bronze whaler *Carcharhinus brachyurus*, (b) dusky shark *Carcharhinus obscurus*, (c) gullyshark *Triakis megalopterus* and (d) white shark *Carcharodon carcharias*. Adapted from Compagno *et al*. (1989). The size frequencies of the three former species all overlap with *C. carcharias* in the 180–200cm size range

Table 1: Summary of information of all sharks, skates, rays and chimaerids recorded caught by the False Bay beach-seine fishery in 2 001 diarised hauls 1974–1987 (J Petty), 311 monitored hauls 1991–1993 (Lamberth 1994), 8 500 hauls reported in catch returns 1983–2006 (Marine and Coastal Management, Netfish System) and 600 observed hauls 1993–2006 (C Fallows, Apex Images). Lengths-at-maturity after Compagno *et al.* (2005), Heemstra and Heemstra (2004) and Wallace (1967). Skates and rays measured in dorsal width

			Mean number per haul	% of shark and ray catch	% of total catch	% occurrence	Size range (cm)	Length-at-maturity (cm)	% immature
Alopiidae	*Alopias vulpinus*	Thresher shark	<0.001	<0.001	<0.001	<0.01		300–400	
Callorhinchidae	*Callorhinchus capensis*	St Joseph	5.273	15.800	0.226	40.2	12–101	44–58	34
Carcharhinidae	*Carcharhinus brachyurus*	Bronze whaler	0.322	0.963	0.014	15.1	48–305	200–240	95
	Carcharhinus obscurus	Dusky shark		0.000	<0.001			280–300	
	Carcharhinus plumbeus	Sandbar shark	<0.001	<0.001	<0.001	<0.01		140–180	
Dasyatidae	*Dasyatis brevicaudata*	Short-tail stingray	0.010	0.029	<0.001	1	46–200		
	Dasyatis chrysonota	Blue stingray	3.450	10.337	0.148	29.6	15–80	41–50	92
	Gymnura natalensis	Diamond ray	0.058	0.173	0.002	4.5	106–180	100–110	0
Hexanchidae	*Notorynchus cepedianus*	Sevengill cowshark	<0.001	<0.001	<0.001	0.1		130–200	
Lamnidae	*Carcharodon carcharias*	Great white shark	0.002	0.010	<0.001	0.2	180–195	350–500	100
	Isurus oxyrinchus	Shortfin mako	<0.001	<0.001	<0.001	0.1		200–290	
Myliobatidae	*Myliobatis aquila*	Eagle ray	4.900	14.682	0.21	35	14–116	54–60	92
	Pteromylaeus bovinus	Duckbill ray	0.013	0.039	0.001	1.3	50–114	95–120	100
Narkidae	*Narke capensis*	Onefin electric ray	0.019	0.058	0.001	1.9	6–17		
Odontaspididae	*Carcharias taurus*	Spotted ragged tooth	0.006	0.019	<0.001	0.3	176–197	190–230	100
Rajidae	*Raja alba*	Spearnose skate	0.058	0.173	0.002	2.6	20–45	90	100
	Raja miraletus	Twineye skate	0.003	0.010	<0.001	0.3	28.5	45	100
	Raja straeleni	Biscuit skate	0.180	0.540	0.008	7.1	8–70	40–80	100
Rhinobatidae	*Rhinobatos annulatus*	Lesser guitarfish	14.814	44.384	0.634	73.3	15–95	58–65	89
Scyliorhinidae	*Halaelurus natalensis*	Tiger catshark	0.003	0.010	<0.001	0.3	46	35–50	0
	Haploblepharus edwardsii	Puffadder shyshark	0.029	0.087	0.001	1	30–58	37–69	33
	Poroderma africanum	Pyjama shark	0.010	0.029	<0.001	0.6	48–80	58–72	66
Sphyrnidae	*Sphyrna zygaena*	Smooth hammerhead	0.002	0.006	<0.001	0.1		210–240	
Torpedinidae	*Torpedo fuscmaculata*	Electric ray	0.003	0.010	<0.001	0.3	40	39–45	
Triakidae	*Galeorhinus galeus*	Soupfin shark/vaalhaai	0.029	0.088	<0.001	0.3		120–185	
	Mustelus mustelus	Houndshark	4.177	12.515	0.179	36.3	21–160	70–80	49
	Triakis megalopterus	Spotted gully shark	0.013	0.039	0.001	1	140–180	130–150	0

Beach-seine chondrichthyan catches are strongly seasonal, with 11–14 species occurring in summer (November–March) compared with 3–5 species in winter (June–August) (Table 2). Most *C. carcharias* recorded in the nets have been juveniles (180–200cm) and all were caught in February/March when catches of other sharks and rays are peaking. This may be on account of these individuals being netted while foraging for smaller shark and ray (Cliff *et al*. 1989). In support of this hypothesis is the high number (6–10 per haul) of *M. mustelus* caught in the nets during that period. However, a multitude of factors are likely to play a role. For example, summer upwelling could be a contributing factor towards increased catches, with cold upwelled water driving many fish, including sharks, into the warmer shallows (Lamberth *et al.* 1994).

The number of beach-seine operators in False Bay has declined from around 170 in the early 1970s to five at present (Table 3). On the other hand, white shark incidents have increased from two in the 1970s to six for the period 2000–2005 (Cliff 2006). Therefore, contrary to popular opinion, there is a negative trend between beach-seine activity in False Bay and incidents involving *C. carcharias*. However, the correlation is statistically insignificant ($p > 0.05$). In turn, there is a weak and insignificant positive correlation between days fished and *C. carcharias* incidents (Table 3). Overall, there appears to be no significant relationship between beach-seine activity and white shark attacks in False Bay.

Teleost fish such as mullet *Liza richardsonii,* white steenbras *Lithognathus lithognathus,* yellowtail *Seriola lalandii*

Table 2: Seasonality of shark, skate, ray and chimaerid catches in 311 monitored beach-seine hauls during the period 1991–1993. Total per haul, mean number of species per haul and total number of species refer to catches of Osteichthyes and Chondrichthyes (after Lamberth *et al*. 1994)

		Number per haul											
Family	Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Callorhinchidae	*Callorhinchus capensis*	1.3	11.49	4.1	3.33	7.58	1.44	2.85	1.15	0.2	1.44	10.19	1.75
Carcharhinidae	*Carcharhinus brachyurus*	0.1	0.53	0.76	0.25	0.08		0.08				0.26	0.42
Dasyatidae	*Dasyatis brevicaudata*		0.04	0.02									
	Dasyatis chrysonota	3.5	5.58	9.22	0.21	3.85					0.5	0.71	0.42
	Gymnura natalensis	0.03	0.16	0.14									0.04
Lamnidae	*Carcharodon carcharias*		0.02										
Myliobatidae	*Myliobatis aquila*	3.83	9.84	9.71	2.79	5.04		0.22	0.23	0.4	1.5	0.81	2.54
	Pteromylaeus bovinus	0.03	0.02	0.02								0.03	
Narkidae	*Narke capensis*		0.02	0.04	0.04				0.08				0.04
Odontaspididae	*Carcharias taurus*											0.06	
Rajidae	*Raja alba*	0.1		0.2	0.04	0.04							0.08
	Raja miraletus					0.04							
	Raja straeleni	0.18	0.09	0.24	0.54	0.42						0.16	0.13
Rhinobatidae	*Rhinobatos annulatus*	46.65	5.02	2.55	5.33	0.42	4.56	18.92	11.92	2.8	13.31	14.23	30.29
Scyliorhinidae	*Halaelurus natalensis*												0.03
	Haploblepharus edwardsii			0.02								0.26	
	Poroderma africanum	0.03										0.06	
Torpedinidae	*Torpedo fuscmaculata*			0.02									
Triakidae	*Mustelus mustelus*	2.68	6.02	10.31	1.58	4.46			0.15		0.25	1.94	4.29
	Triakis megalopterus	0.05	0.02			0.04							
Mean number of fish per haul		2 867	2 209	1 446	2 485	4 541	1 848	1 576	2 779	2 938	5 001	844	1 322
Mean number of species per haul		9	9	10	7	6	7	6	9	6	9	9	9
Total number of species		35	46	40	35	31	18	15	22	14	22	38	36
Total number of shark and ray species		12	13	14	9	10	3	3	5	3	5	11	11
Mean number of sharks and rays per haul		58	39	37	14	22	6	22	14	3	17	29	40

Table 3: Summary of the number of beach-seine operators, effort, catches of the main target species and *C. carcharias* incidents (Cliff 2006) in False Bay from 1970 to 2005. Correlations, trends and significance levels are given. Data represents over 11 000 hauls

	1970–1974	1975–1979	1980–1984	1985–1989	1990–1994	1995–1999	2000–2005	r^2	Trend	Significance
Beach-seine operators[1]	170	60	15	9	7	7	5	0.657	–	$p > 0.05$
Net-days per annum	605	1 259	551	1 336	1 179	991	1 297	0.0004	+	$p > 0.05$
L. richardsonii (ton year^{-1})	136	192	155	235	177	149	235	0.032	+	$p > 0.05$
L. lithognathus (ton year^{-1})	41	58	37	16	33	18	4	0.764	–	$p > 0.05$
S. lalandii (ton year^{-1})	2	2	28	72	128	87	90	0.431	+	$p > 0.05$
P. saltatrix (ton year^{-1})	4	6	6	5	7	4	9	0.186	+	$p > 0.05$
C. carcharias incidents	2	0	3	2	2	4	6			

[1] Due to the differences in reporting amongst fishers and observers, the number of operators is likely to be a more accurate reflection of effort than net-days

and elf *Pomatomus saltatrix* account for over 85% of the False Bay beach-seine catch (Lamberth *et al*. 1994). Assuming that catch per year reflects abundance, there is no significant relationship between catches of these species and *C. carcharias* incidents (Table 3). The relatively strong but insignificant negative relationship to *L. lithognathus* is a good example of a false correlation, as the decline in catches is due to stock collapse and subsequent management decision to decommercialise this species.

In conclusion, *C. carcharias* incidents in False Bay appear to have no strong link to beach-seine activity there. This also seems to be the case elsewhere where — with the exception of directed recreational angling and illicit commercial targeting, spearfishing, tuna cages, the abalone diving industry and some longline fisheries — *C. carcharias* incidents and 'bycatch' are rare compared with other shark species (Wallet 1983, Penn 2002, Baum *et al.* 2003, Shivji *et al.* 2005, Dudley and Simpfendorfer 2006, Maguire *et al.* 2006).

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