South Africa's White Shark cage-diving industry - is their cause for concern?

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Abstract

The following paper presents a review on recent research examining the white shark cage diving industry in South Africa. In particular we cover the controversial 'conditioning' debate and whether humans face an increased danger due to the industry's operation protocol.

Key findings of this review include:

- White sharks travel between cage diving sites at Mossel Bay, Gansbaai and False Bay. Therefore, concerns regarding the impacts cage diving may have on white shark/human interactions should be assessed at a 'South African', rather than 'region specific' level.

- Conditioning can only arise if white sharks gain significant and predictable food rewards. Thus, conditioning will only arise if operators intentionally and willfully

contravene current permit regulations prohibiting intentional feeding of sharks. On rare occasions, indications of positive conditioning have been observed at Mossel Bay (four sharks). Evidence exists that adherence to permit regulations and infrequent or no feeding of sharks does not promote conditioning, and may in fact cause sharks to temporally ignore chumming vessels.

- It is highly improbable that the 'conditioning of sharks' to a cage diving vessel would increase danger to human water users such as swimmers, surfers, scuba divers and kayakers. This is due to visual and olfactory dissimilarity of these humans to the conditioned neutral stimulus (i.e. the cage diving vessel and associated structures). However, even if the public perceive an 'increase in danger', this will have a negative effect on the (1) conservation status of white sharks in South Africa, (2) the perceived safety of beaches in the Western Cape, and (3) the long term viability of the cage diving industry.

- Conditioning controversy remains relevant due to some operators contravening permit conditions and intentionally feeding sharks. This state has arisen due to operators working in a consequent free environment where client expectation is high. The failure of DEAT to timely issue permits has exacerbated the non-compliant environment. Recent action by DEAT with regard to extreme contraventions of regulations (e.g. chumming adjacent to swimming beaches), must be extended to include all breaches of permit conditions, including the intentional feeding of sharks.

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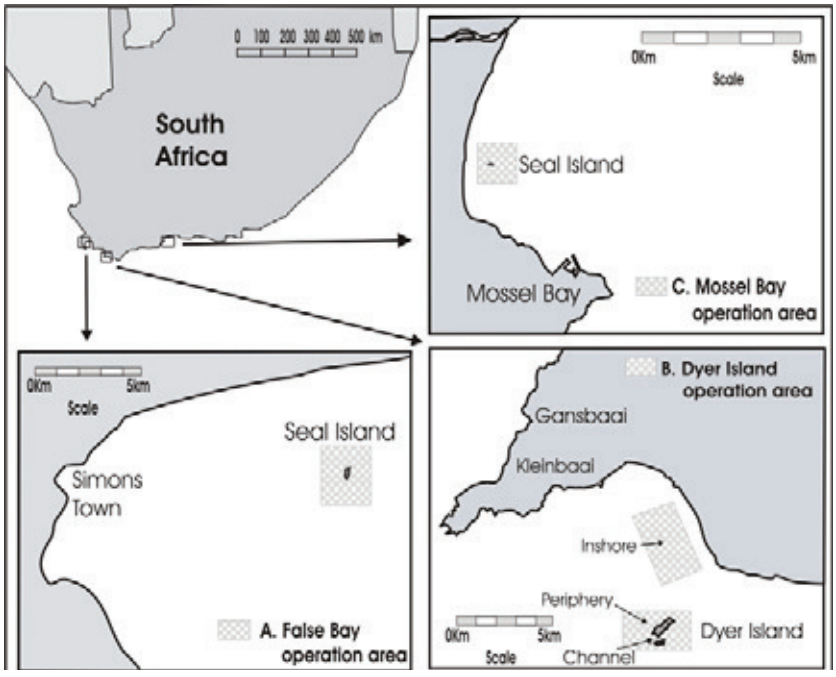
1. Introduction to Cage Diving in South Africa

The viewing of wild, often charismatic, animals by tourists is becoming increasingly popular throughout the world (Orams, 2000). Such tourism can be a conservation tool by enabling wildlife to generate income purely by its existence as a viewing spectacle. Wildlife tourism may also be of educational benefit as visitors are viewing animals in their natural habitats rather than contrived environments (e.g. zoo's). A controversial initiative in wildlife tourism is offering supplementary food (provisionisation) at viewing sites, which leads to wildlife congregating, thus ensuring greater observation predictability. This is particularly relevant to enigmatic, yet elusive predators that are difficult to view in the wild. A number of concerns have been raised in relation to such activities, including: (1) wild animals losing their innate caution towards humans, (2) increased intraspecific (within a species) aggression, (3) nutritional dependency on the source of food, and (4) a development of a conditioned response associating humans with food. Despite these concerns, provisionisation of wildlife for tourism continues due to the conservation, education and economic benefits it affords.

White shark cage diving tourism developed shortly after South Africa passed national legislation in 1991 protecting the white shark (*Carcharodon carcharias*) from all fishing exploitation (Compagno, 1991). White sharks are lured to cage diving boats by a chum (scent) slick that emanates from the boat (consisting of fish based products). A fish-based bait is tethered to the cage diving boat by a rope (circa 10-15m length), and is manoeuvred to entice sharks to swim close to a cage floating at the surface. Additional, non-chumming activities include the observation of natural predatory activity at Seal Island, False Bay where vessels patrol, searching for natural predations. Upon detection, boats move towards the attack to maximize viewing, photographic and video opportunities. At Seal Island, False

Figure 1. Cage diving sites in South Africa and approximate operational areas. Seal Island = 3 operators, Gansbaai = 8 operators, Mossel Bay = 1 operator.



Bay, and occasionally at other cage diving localities, seal resembling decoys are towed to induce a simulated breaching attack by white sharks.

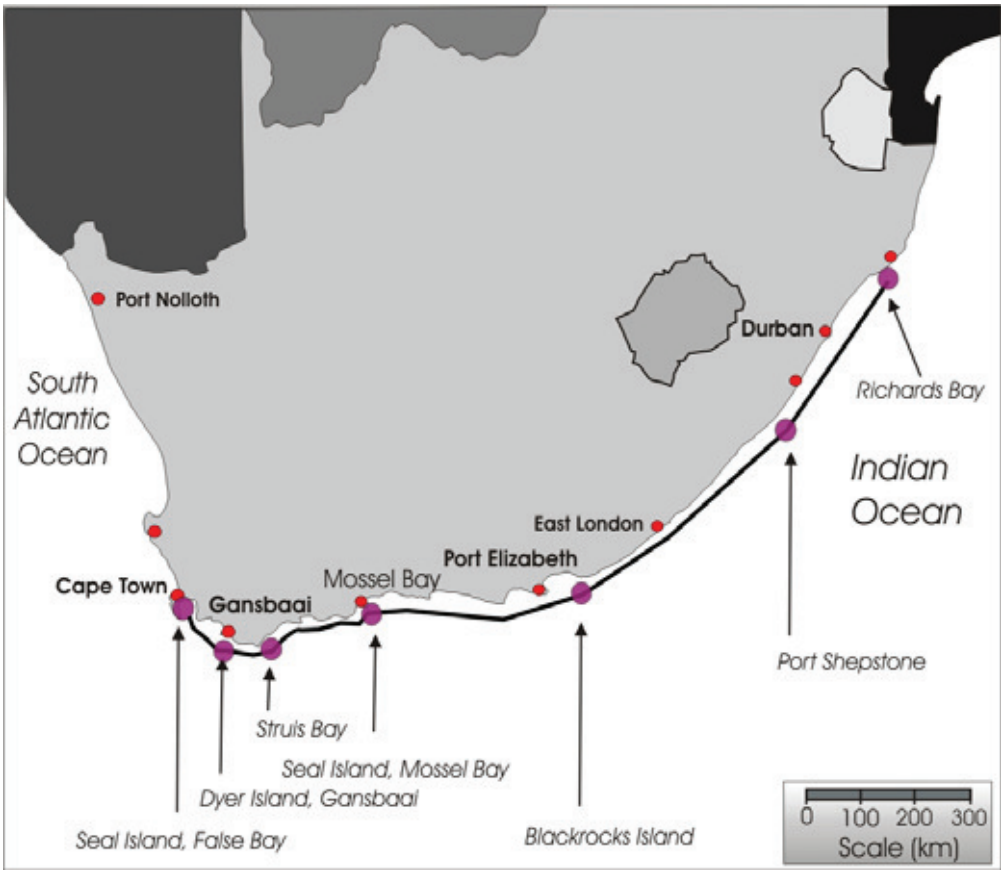
At present, white shark cage diving operations are permitted at three locations in South Africa, including Seal Island, False Bay (3 operations), Dyer Island, Gansbaai (8 operations); and Seal Island, Mossel Bay (1 operation). A further 1-3 vessels attract white sharks at these, and occasionally other locations (e.g. Struis Bay, Bird Island: Port Elizabeth, Grootbrak: Mossel Bay), for non-commercial scientific purposes (Fig. 1). Following a high profile spate of shark attacks in 1998 the white shark cage diving industry has suffered a continual stream of public accusations targeted at its operational procedure. Specifically, as to its impacts on the white sharks, the ecosystem as a whole, and whether it augments the danger white sharks represent to humans.

The aims of this paper are to present research detailing interactions between white sharks and chumming vessels in South Africa. Specifically, we wish to broach issues that South Africa's public have regularly voiced concerns over.

2. Movement patterns of white sharks between cage-diving sites

At Seal Island, False Bay three - four operators/research vessels chum and bait white sharks typically during a 6-month window over winter (typically mid April – mid October). A majority of concerns in the False Bay area have been directed towards these activities. However, should such concerns be limited to these specific operators, or should it be directed towards an industry as a whole? Between 2002 and 2005 permanent research programs at cage diving sites (False Bay, Gansbaai, Mossel Bay) and other localities (Port Elizabeth) have enabled movement of individual sharks between locations to be automatically tracked. Here we present preliminary evidence that white sharks travel between these areas on a regular basis (Fig 2). These estimates suggest that at least 5 to 13 percent of sharks travel between cage diving sites on a yearly basis (Fig. 2). At present, we are incapable of more accurately quantifying the frequency of movement of white sharks between cage diving localities within South Africa. Such quantification will only be possible once acoustic telemetry, photographic identification, and incidental observation datasets are combined and analysis completed. What is, however apparent, is that a number of white sharks do move between sites on a regular basis. As such, it is most appropriate to assess the operational procedure of all operators when addressing the possible negative impacts of cage diving, even when region specific concerns are raised.

Figure 2. Minimal estimates of movements of sharks between cage diving sites. Data attained only from acoustic tagged white sharks.



Sample size = *circa* 140 white sharks.
False Bay (FB), Gansbaai (GB), Mossel Bay (MB) and Port Elizabeth (PE) have permanent listening stations. Data from Struis Bay (SB), Port Shepstone (PS) and Richards Bay (RB) come from the incidental capture of tagged sharks.

	RB	PS	PE	MB	SB	GB
FB	0	0	0	**7**	0	**11**
GB	1	0	0	**19**	1	
SB	0	0	0	1		
MB	0	0	2			
PE	0	1				
PS	0					

3. Conditioning – what is it and how is it established

The possible association of humans with food (conditioning) has in cases, led to increased aggression towards humans by conditioned animals. Examples include tigers (McDougal, 1980), primates (Fa, 1992; Wrangham, 1974) cetaceans (Orams, 1995), reptiles (Walpole, 2001), and elasmobranchs (Shackley 1998). This fundamental criticism of the white shark cage diving has plagued the industry since its inception in 1992 (Bruce, 1995; Compagno, *et al*., 1997; Johnson, 2003). Although associative learning is a relative simple concept, the immediate assumption that 'cage diving' is causing an increase in attacks due to conditioning is an unfounded claim. To responsibly address this, we must establish (1) a clear understanding of conditioning in the 'cage diving' context; (2) document the actual cage diving operational procedure and interactions with sharks; and (3) assess the consequence to humans if sharks are, in fact, being conditioned.

A working definition of classical conditioning is:

- *Classical (or Pavlovian) conditioning occurs when **repeated presentations** of a **neutral stimulus** (in this case boat/underwater cage/humans) are followed **each time** by a biologically important stimulus (in this case food), which elicits a response (e.g. attempted feeding). Eventually the **neutral stimulus** presented by itself produces a response (the conditioned response) similar to that originally evoked by the biologically important stimulus (Oxford dictionary, 2000).*

We would like to draw attention into a number of concepts (in bold) within this definition that require attention before a critical assessment can be conducted (Table 1). In the context of 'cage diving' we must first identify the 'neutral stimulus' that white sharks may potentially learn to associate with food. The white sharks sensory repertoire is diverse with specialised electrosensory and mechano-reception abilities, in addition to, the more recognized visual, tactile, auditory, olfactory sensory systems. On approaching a chumming vessel, white sharks locate proffered food using the most appropriate of these senses. To identify which sense are being used we observed sharks typical search patterns. During observations at Mossel Bay and Gansbaai a vast

Table 1. Terms within conditioning that require

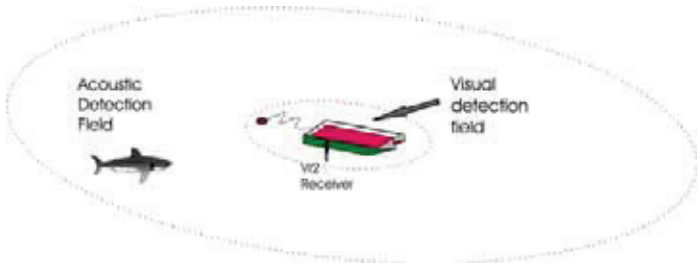
- ***"Repeated presentation":** Conditioning is a type of training, and as you cannot expect to run a marathon following one day of slogging it out on Table Mountain, you can not expect to condition an animal in one training session. Thus for conditioning to arise a large number of training sessions is required*
- ***"Each time":** By each time this definition highlights that a reward must be given predictably for conditioning to arise. If you only sporadically reward a dog after getting him to sit, it will take much longer, or be impossible to 'condition him to sit on command.*
- ***"Neutral stimulus":** The neutral stimulus is what will cause the stimulation of a conditioned response. If a dog is conditioned to respond to the whistling of its master, it will not respond similarly if its master claps his hands. Likewise, the type of sensory stimulus is important, an animal conditioned to a sound will not have the response stimulated by smell or vision.*

majority (ca 95%) of attempted feeding behaviours (e.g. gaping and mouthing at an object) were made towards either the tethered bait or towards the stern of a vessel where the chum bags were submerged. Non-induced (e.g. not lured by bait) mouthing towards the cage, divers, or other parts of the boat, does occur, but are rare. Thus, the fact that the sharks are directing there feeding attention towards inert baits implies that they are relying primarily on visual and olfactory senses when searching for food at a cage diving vessel. The utilisation on these senses presents a strong case that the 'neutral stimulus' that a shark could become conditioned to is the 'visual' and 'olfactory' appearance of the cage diving vessel.

4. Evidence for or against conditioning

What evidence exists to either confirm or deny that white sharks are been conditioned too visually and olfactory to associate a chumming cage diving vessel with food? To assess this, a scientific observer program at Mossel Bay (1 operator included) and Gansbaai (7 operators included) was conducted between June 2002 and January 2004. During which, observers accompanied boats on 601 chumming periods (n = 529 Gansbaai, n = 72 Mossel Bay) in which 2565 visits by white sharks were observed. During 2004-2005, research vessels at Mossel Bay and False Bay simulated the operational protocol of cage diving vessels to further assess the impact of chumming on white sharks. This latter research used acoustic telemetry, in addition to visual observation to investigate behaviour of sharks 'not observed' at the vessel, but swimming nearby (Fig. 3).

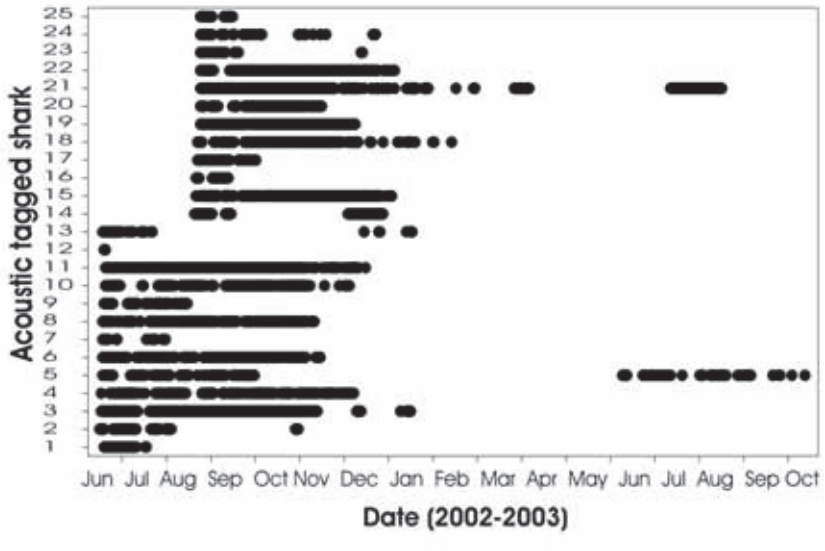
Figure 3. Experimental set up from research vessels. Presence of sharks tagged with acoustic transmitters was archived when swimming within circa 200m from research vessel.



The first requirement for a conditioned response to be established is long-term exposure of a shark to the cage diving vessels (i.e. sufficient number of training sessions). We examined visitation trends at Gansbaai (n = 19) and Mossel Bay (n = 9) in a number of easily recognizable sharks. Of noticeable interest was that a number of sharks at Mossel Bay displayed long sighting periods (28 – 68 days) in comparison to Gansbaai (4 - 30 days) suggesting a higher degree of residency in the Mossel Bay area. This trend was confirmed by acoustic monitors, which proved that many large female sharks spent upwards of six - seven months a year within Mossel Bay (Fig. 4). To date, no evidence of a similar residency pattern has been seen at Gansbaai (although this needs to be confirmed using telemetry), whilst, preliminary data collected at False Bay appears to indicate a moderate to high degree of residency (Fig. 5). The importance of this finding is that white sharks in areas of 'moderate

- high residency' may be sufficiently exposed to cage diving to enable a conditioned reflex to arise.

Figure 4. Residency patterns of 25 white sharks fitted with Acoustic pingers during the year 2002 at Mossel Bay.



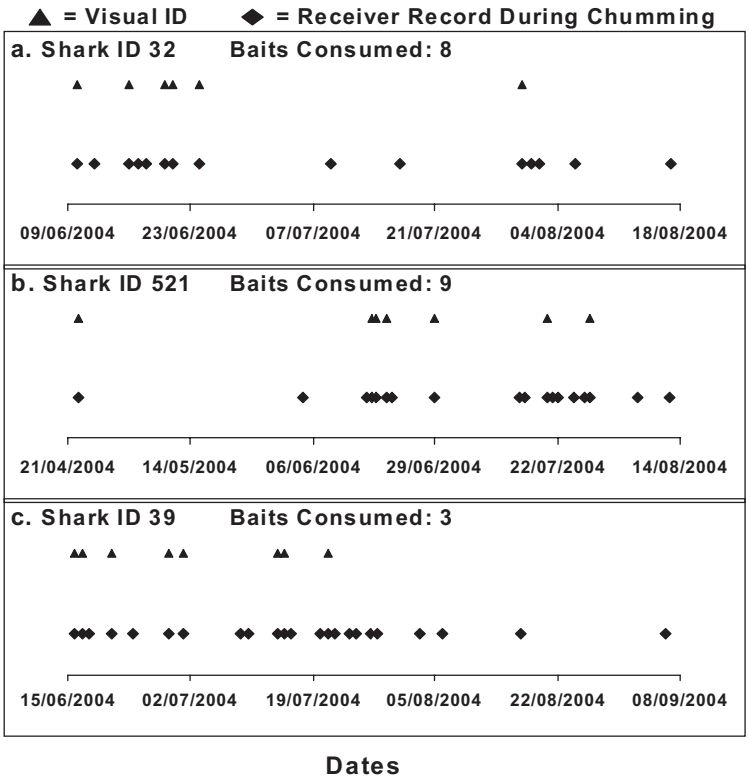


Figure 5. Temporal change in the response of acoustically tagged white sharks to our chumming vessels at False Bay.

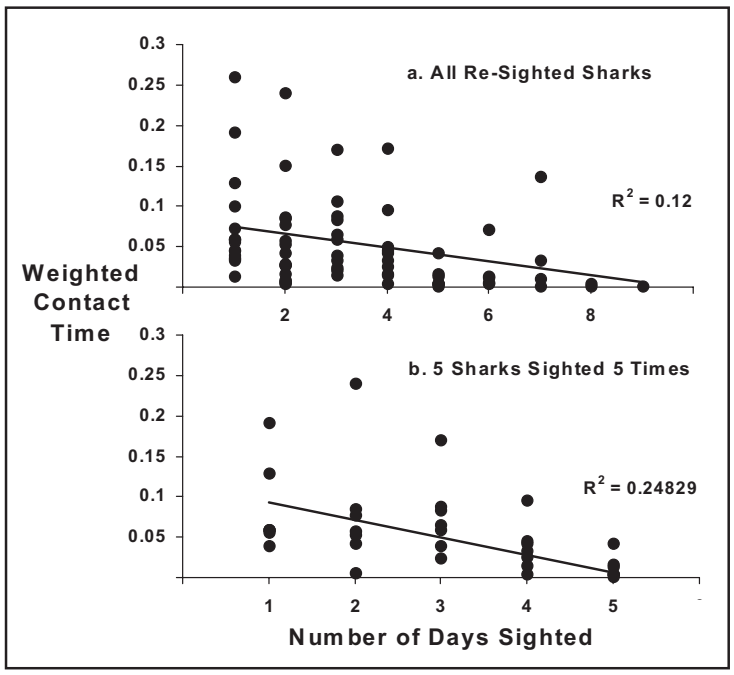


Figure 6. Weighted contact time of white sharks visiting a chumming vessel at False Bay

The next requirement for a conditioned response to be established is the repeated and predictable rewarding of sharks visiting a cage diving boat. During observations, a number of white sharks successfully mouthed bait during a visit at both Gansbaai (22.7%, n = 519) and Mossel Bay (30.1%, n = 85). However, as bait was often retrieved without any feeding occurring, the percentage of sharks that consumed bait dropped at both Gansbaai (15.2%, between 1 and 6 baits, n = 347) and Mossel Bay (25.7%, between 1 and 10 baits, n = 73). As the white sharks daily calorific requirement is unknown, the overall significance of such feeding remains unknown.

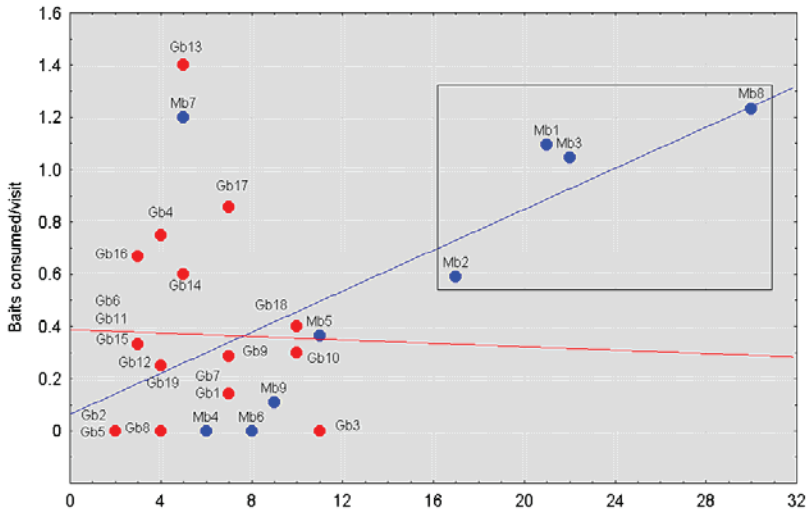
Within this context, can we observe changes in shark's behaviour that would indicate that they do positively associate chumming vessels as reliable food sources? Work from False Bay and Gansbaai offered us the first insight into this question when we measured the amount of time sharks spent at a boat (contact time) and how this changed over time. At both locations, a majority of the sharks spent progressively less time at the boat with increasing experience (Fig. 6). This finding is contradictory to what we would expect if sharks were being positively conditioned.

During 2004-2005, we deployed underwater listening hydrophones directly from our respective research vessels, and around the chumming area in Mossel Bay and False Bay. The purpose of this was to enable us to quantify the response of tagged sharks to a chumming/baiting vessel regardless of whether we could visually detect the shark or not. The findings of these experiments confirmed the above trends. At False Bay, following regular sightings, two sharks (Shark ID 32, Shark ID 39) ceased visiting our chumming vessel altogether despite being repeatedly detected in the near vicinity (Fig. 5). At Mossel Bay, white sharks in the near vicinity of the sole chumming vessel failed to be visually detected 49 percent of the time. Individually, six out of 21 sharks had a 'sighting frequency' of below 30 percent. This demonstrates a clear ability of white sharks to ignore chumming activities.

The implications of this discovery are critical to the management of cage diving. The fact that white sharks very often fail to respond to chumming stimulus may alternatively be indicative of possible 'negative' conditioning. White sharks who fail to gain rewards whilst investigating such chum slicks, may, over time, stop responding to what is effectively a false promise of food. Importantly, this provides evidence that if white sharks do not receive food rewards when visiting a cage diving vessel, then the possibility of positive conditioning is removed. At False Bay, it is also suspected that white sharks fail to respond to a chumming vessel, as the initial olfactory stimulation (or the chum slick) indicates a 'less attractive' scavenging opportunity in comparison to hunting and feeding on live prey. We thus concluded that the majority of sharks at Gansbaai and False Bay have such limited exposure to chumming vessels (either through limited residency or limited response) that they do not currently learn to associate cage diving boats with food.

Despite the majority of evidence suggesting minimal impact of cage diving on the behaviour of white sharks, some evidence of positive conditioning does exist. Following close inspection of the behaviour of individual sharks at Mossel Bay, we realised that four sharks were observed consistently at the cage diving vessel, and they gained more food during visits than other sharks (Spearman's rank, $(r_s)_{0.05(2),\ 124} = 0.290$, $p < 0.01$, Highly Significant) (Fig. 7). The experiences of these four sharks were unique, in that they fulfilled the requirements for conditioning by gaining 'predictable rewards' at 'regular intervals'.

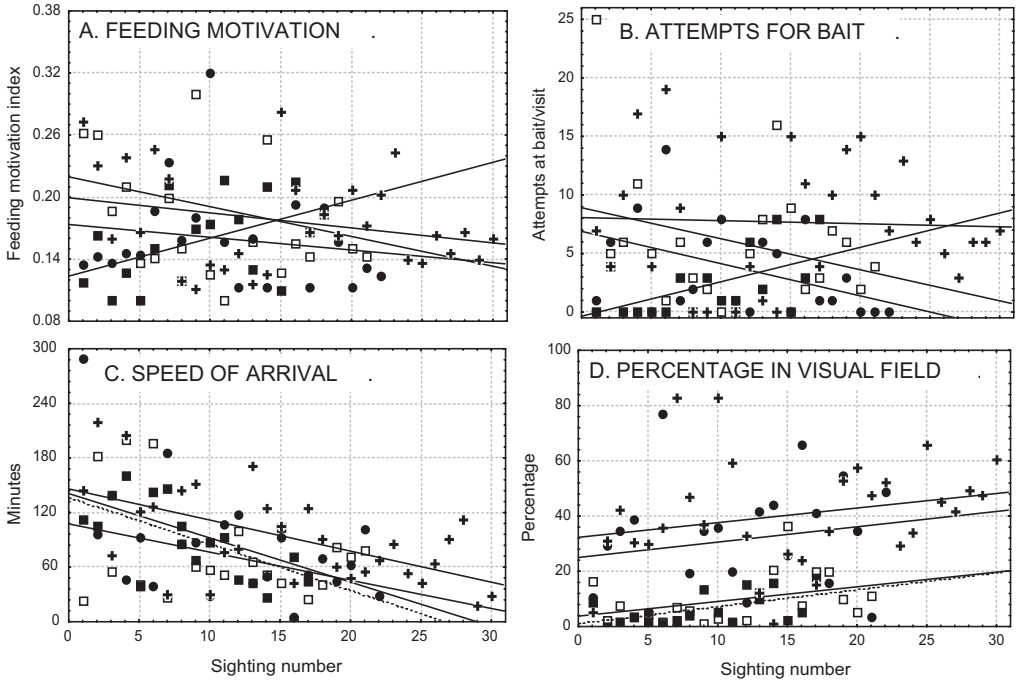
Figure 7. Relationship between 'reward predictability' and 'regular presentation' of easily recognisable sharks. Inserted boarder indicates four Mossel Bay sharks that had both high 'experience' and high 'feeding likelihood'.



Although these sharks did gain a noticeable amount of food rewards over many days, was there any indication that their behaviour was consequently altering? To assess this we tracked changes in 'speed of arrival' (minutes between start of chumming and arrival of shark), 'percentage in contact' (percentage of time between first and last sighting of a shark that it was visible at the boat), 'feeding motivation' (ratio of circles, passes and attempts at bait), and 'attempts at bait' (number of attempts to consume bait during a visit). These sharks did not appear to become more motivated to acquire the bait as would be indicated at

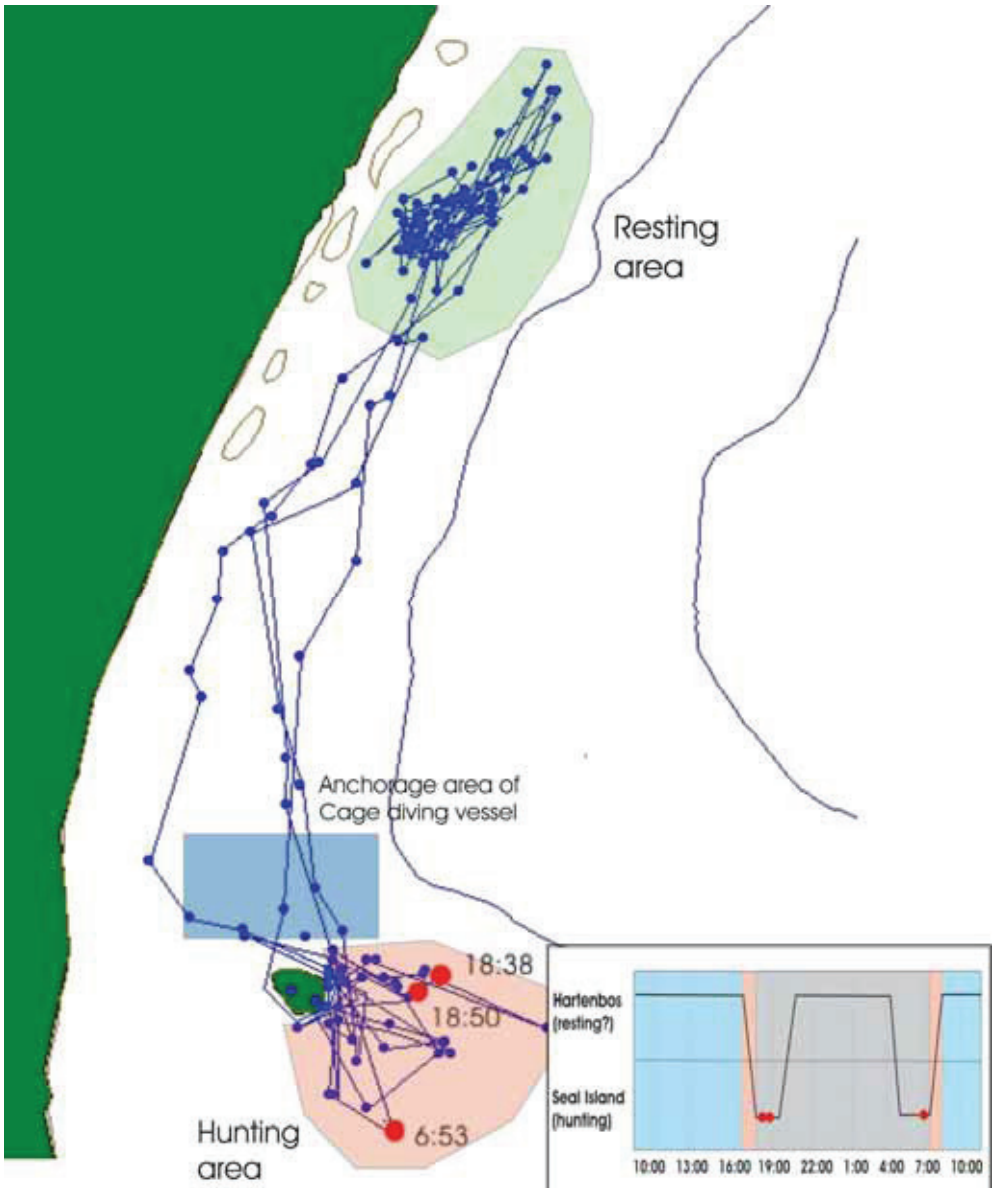
making a higher number and ratio of attempts for the bait (Figures 8A,B). There was a slight, non-significant, trend towards spending a greater proportion of a days visit in very near proximity to the boat (Fig. 8D). However, most obvious, was that all four sharks 'speed of arrival' to the boat significantly reduced with increasing experience, that is, they arrived progressively quicker to the boat following anchoring and the initiation of chumming (Figure 8C).

Figure 8. Change in behaviour of four sharks over time. A: Sharks motivation to acquire proffered bait, B: the number of attempts at the bait per visit, C: how soon the sharks arrived at boat following initiation of chumming, and D: The percentage of a visit that a shark was visible to observers.



Research into the fine scale movement patterns of white sharks at Mossel Bay, gave us insight into how the frequent feeding of these sharks may have begun to alter their behaviour, and possibly offer evidence that they were associating the cage diving vessel as a reliable source of food. During 2005, we manually tracked the movements of three white sharks in Mossel Bay. A typical movement pattern is given in Figure 9. In words, white sharks would rest for much of the day and night opposite Hartenbos beach (Fig. 9: Resting area), then in the early morning and late evening make forays down to Seal Island and patrol the seaward side of the island hunting for traversing seals (Fig. 9: Hunting area). The sole cage diving operators chum slick would intercept sharks traversing between these areas, particularly when they moved during daylight hours. The quickening of arrival time by the four aforementioned sharks may have resulted from these sharks more frequently moving towards the Seal Island in anticipation of the cage diving vessel's presence.

Figure 9. Typical behaviour of white sharks at Mossel Bay between resting area and hunting area over 24 hour period (red dots indicate successful attacks on seals. Cage diving vessel may intercept white sharks travelling between two areas. Hunting occurs around sunrise and sunset (see insert).



These four cases were unique throughout our research. They do however indicate that conditioning may be possible if white sharks experience extensive reward based experiences when visiting chumming boats. Although feeding was relatively sparse throughout the study, it is interesting to note that a research vessel, using the same methodology as cage diving vessels, succeeded in restricting feeding to under 7% of visits (compared to 15% and 26% at Gansbaai and Mossel bay) demonstrating that bait loss can indeed be minimized. In addition, reliable, but anecdotal, reports suggest an increase in feeding at operator's vessels since observers stopped accompanying trips. Such claims cannot be disregarded, as it is impossible to quantify or restrict the frequency of feeding by any operator in South Africa at present. Management options to limit feeding are available and are presented in Table 2.

Table 2. Management recommendations

- *Place limits on amount of bait (e.g. three pieces) and amount of chum operators are allowed to take to sea daily*
- *Attachment of bait by tougher rope to reduce likelihood of sharks ingesting bait*
- *Improve operator compliance with non-feeding stipulations in code of conduct. (more detail in management section 8)*
- *Increase research into investigating reliable 'non-food' replacements (e.g. scented decoys, sound attraction)*

5. Does conditioning increase danger to humans

We feel that sufficient evidence exists to confirm that white sharks can be conditioned by the practice of chumming and baiting. It must be stressed, however, that this is not inherent to the practice of cage diving, and feeding is not necessary for operators to successfully conduct their business. Regardless, logic would appear to dictate that such 'conditioned' white sharks would pose a greater threat to human water users. Why is this the case?

To answer this question we re-examined in detail the concept of animals learning through association in the cage diving context. What immediately struck us was a fundamental question. "Would a 'white shark' conditioned to associate a '40ft chumming boat and cage' have this conditioned reflex stimulated by the detection of a '6ft swimmer or board rider'"? Fortunately, much study into this field has been completed, and the general concept has been termed "Rearrangement gradients" (Chirlanda and Enquist, 2003). A rearrangement gradient predicts that progressively larger deviations away from the conditioned stimuli (e.g. cage diving boat) would retard the stimulation of a conditioned response (attempted feeding). In other words, the 'feeding anticipation' response of a white shark would less likely be evoked by a 'floating shoe' than it would by a 'cage diving boat' as the 'floating shoe' holds little resemblance to the cage diving boat.

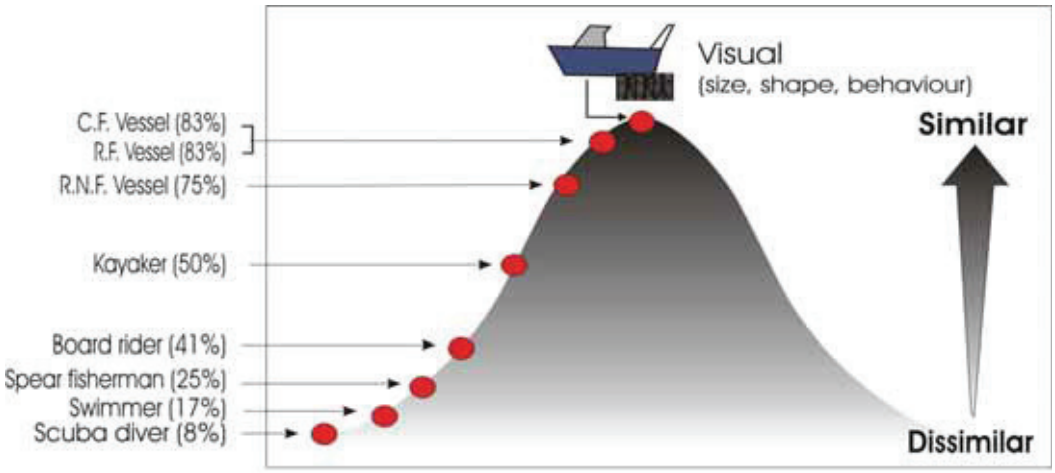
The sensory stimulus that entices the white shark to the 'cage diving vessel' are initially 'smell' and later, when specifically identifying the locality of potential food, it is 'vision' and 'smell' (previously discussed). Thus similarity in 'olfactory' and 'visual' stimulation is required for a conditioned shark to associate a new object with a cage diving vessel and have its anticipated feeding response evoked. We have examined the various human activities (commercial and recreational fishing vessels, recreational non fishing vessels, kayaking, board riding, swimming, scuba diving, spear fishing) and calculated the likelihood that they will elicit such a 'conditioned response'. Visual similarity was rated (from 0 = dissimilar, up to 4 = identical) in terms of size, shape, and behaviour (e.g. bottom vs. surface, anchor vs. floating), olfactory was rated similarly in terms of odour similarity and strength (Fig. 10). Resulting scores were used to score (0-19% = highly improbable, 20-39% = improbable; 40-59% = possible, 60-79% = probable, 80-99% highly probable) then rank the various activities (Fig. 10). It must, however, be stressed, that whilst we used other animal studies to approximate perceived similarity, these ratings represent educated guesses only. From this investigation, it appears highly improbable that a sharks 'conditioned reflex' would be stimulated if it fortuitously encountered either swimmers, surfers, kayakers, scuba divers, or spear fishermen due to visual and olfactory dissimilarity from a cage diving vessel (Fig. 10). Therefore, it is highly unlikely that cage diving is related to attacks on humans. It is however, probable that commercial and recreational fishing vessels could be mistaken as cage diving vessels and a conditioned response may be evoked (Fig. 10). However, it must be remembered that these vessels are essentially simulating chumming vessels in many ways.

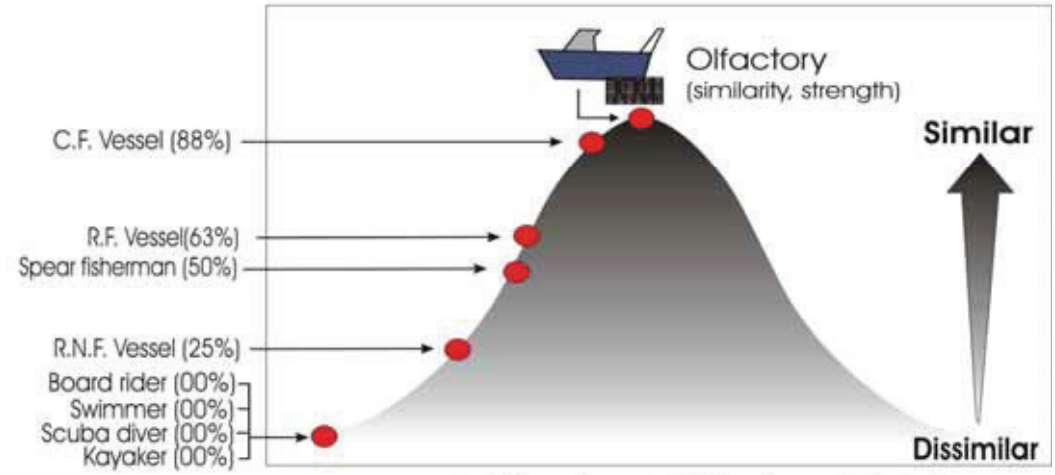
6. Management of the cage diving industry

The Department of Environmental Affairs and Tourism (DEAT) is tasked with the management of the cage diving industry in South Africa. As such, total allowable effort, the operational procedure, and the industries compliance all fall under DEAT's mandate. As such it is worthwhile assessing this aspect of the cage-diving industry in relation to ensuring no sharks become conditioned.

The Marine Living Resources Act (MLRA) was ratified in 1998 (Act No. 18, 1998) seven years after vessels in South Africa began to attract white sharks for tourism and viewing purposes. When applying the act to the existing industry several considerations had to be assessed. These included the development of international tourism, socio-economic considerations, the optimal sustainable utilisation of South Africa's marine resources, and the precautionary principle. As such, it was decided that the existing industry fulfilled the MLRA's mandate with regards to the non-consumptive exploitation of the protected white shark. Critics of the industry, however, rightly point out that in addition to 'optimal utilisation' the MLRA also stipulates the need to apply a precautionary approach in respect of the management and development of marine living resources.

Figure 10. Similarity in perception of a white shark conditioned to a 'cage diving vessel' with other human water users. (C.F. Vessel = Commercial fishing vessel chumming; R.F. Vessel = Recreational fishing vessel not chumming; R.N.F. Vessel = Recreational non-fishing vessel)





	Visual	Olfactory	Total
C.F. Vessel	Highly probable	Highly probable	Highly probable (85%)
R.F. Vessel	Highly probable	Probable	Probable(73%)
R.N.F. Vessel	Probable	Improbable	Possible(50%)
Spear fisherman	Improbable	Possible	Improbable (37%)
Kayak	Possible	Highly improbable	Improbable (25%)
Board rider	Improbable	Highly improbable	Improbable (21%)
Swimmer	Highly improbable	Highly improbable	Highly improbable (8%)
Scuba diver	Highly improbable	Highly improbable	Highly improbable (4%)

Following the 1998 spate of shark attacks in the eastern and western Cape, significant public concerns arose regarding the impact of cage diving, and research projects were initiated to address these. As a response, DEAT, in conjunction with the industry, researchers and other interested parties held a number of meetings to form a workable Code of Conduct based on a precautionary approach (Oosthuizen *pers. comm*.). The most crucial of these operational stipulations (in regard to links between cage diving and attacks) were concerned with limiting the total allowable effort, confinement activities to seal islands where natural chumming occurs, and forbidding of any intentional feeding of sharks. Within these and other regulatory confines, DEAT is satisfied they have fulfilled their role in applying the MLR's act in a responsible, informed and cautious manner with regard to the industries management.

Table 3. Incidences of disregarding regulations in television productions/daily operations.

- *Regular and repeated intentional feeding of sharks,*
- *Use of illegal chums and baits (incl. seals and whales),*
- *Taking of visitors (usually media related) outside of the cages safety to 'free dive' with white sharks,*
- *The intentional pulling of sharks towards the vessels and cages, frequently causing collisions,*
- *Towing of 'human/surfboard' type decoys to elicit white shark breaches,*
- *Illegally landing on seal Island's for filming,*
- *Permitting visitors to carry out irresponsible activities (e.g. climbing upon a whale carcass whilst sharks feed on it, throwing gumballs into a sharks mouth etc.).*

Why then does controversy still surround the cage-diving industry? The authors feel that it is primarily due to the fact that, despite regulations existing, some (not all) operators disregard regulations. The failure to comply by some of the operators is witnessed by South Africans in the numerous 'white shark television features' that have used the cage-diving operators as their production bases (examples presented in Table 3). It must be asked; why 'compliance' is such a tough issue in a relatively confined industry (12 permitted operators working from three localities). We briefly have identified three areas that we feel have contributed to the failure of the industry to uniformly adhere to existing regulations.

- **Client and operator expectation:** When assessing the readiness of some operators to disregard regulations, particularly with respect to feeding, we must understand the expectation of clients arriving at a cage diving vessel (incl. tourists, journalists, production companies). For the previous 30 years the white shark has been portrayed as the ultimate hunter of humans, and it is undeniably this 'JAWS reputation' that has been the catalyst for the cage diving industries' success. Such a marketing opportunity has being capitalized on by many of the operators (i.e. the adrenaline adventure rather than the ecotourism experience) further enhancing visitor expectation of teeth gnashing excitement. Thus significant pressure exists for operators disregard certain operational regulations (particular feeding and wrestling sharks) to produce a 'good show'.

- **Regulatory reliance of 'voluntarily buy in' by operators and failure of self-regulation:** By 'reliance of voluntarily buy in' we are referring to the numerous existing stipulations within the permit conditions that rely heavily on the 'responsible nature' of a given operator to ensure compliance. This is specifically evident in the 'handling of sharks' section of the permit conditions. Stipulation 6.4 states: ***"The permit holder shall ensure that the white shark is not encouraged to ingest the bait and that no white shark is fed".*** Yet stipulation 6.5 reads ***"The permit holder shall ensure that the crewmember handling the bait line shall drop the bait line as soon as the shark took the bait in its mouth".*** Such contradictions and ambiguities make these stipulations effectively unenforceable. Any operator can justly defend himself, by claiming that any feeding was accidental (the "I was blinded by the glare" syndrome).

- **Delay by DEAT to issue operational permits:** DEAT first issued one-year operational permits to existing cage-diving operations during 2000-2001. Following expiration of these permits, operators were issued with temporary 'exemptions' (carring similar compliance requirements) that enabled them to continue operations. DEAT's explanation to delays was given as (a) legal flaws in the application process, (b) difficulties in transforming the sector, and (c) a heavy workload (Marahaj *et al.* 2003). The delay by DEAT to issue permits has understandably caused the industries to question the capacity/capabilities of DEAT to manage the industry. Further, such questioning has created the impression that operators can carry out their work in a 'consequent free environment' in which even fragrant disregard of permit conditions will not result in any form of censor. Marahaj *et al.* (2003) also highlighted a degree of unhappiness, and distrust, of the industry towards DEAT due to not issuing permits. The industry sighted 'investor caution' and delays in their company's 'development' as the main consequence of the delay in permit issuing.

The combination of these three factors has created an environment where there is significant pressure on operators to disregard certain regulations whilst operating in, what is effectively, a 'consequent free environment'. Occasional action by DEAT has resulted in some success with respect to the extreme regulation breaches (e.g. chumming adjacent to swimming beaches). However, if effective management of the industry is to be achieved, compliance enforcement must be extended to the numerous examples of less extreme regulation breaches that occur on a daily basis (Table 4 for management regulations).

Table 4. Management recommendations

- *Introduce 'compliance information sheet' that must be displayed by operators on vessels and advertisements (e.g. websites, brochures)*
- *Create easy and effective channels for tourists to lodge complaints against operators in regard to such a 'compliance sheet'.*
- *Prioritize the issuing of operational permits to the industry.*
- *Re-investigate the effectiveness of 'industry self-regulation' (e.g. the white shark protection foundation) as a means of ensuring compliance.*
- *Initiate an ongoing observer program throughout the industry.*
- *Readdress "unenforceable" stipulations in current code of conduct and permit conditions.*

7. The way forward

In summary, it is apparent that cage-diving management must be dynamic and respond to continual developments in research and understanding. Whilst the authors are confident that cage diving activities are not contributing to the recent rise in attack rate, we recognize that even a perceived link may have dramatic consequences on the white sharks national conservation status, and the stability of an economically viable non-consumptive industry. Recent research that has focused on addressing some of these voiced concerns has been presented here, with the intention of informing those concerned on the scientific justification behind management decisions.

Cage diving is a non-consumptive utilisation of white sharks, which despite protection are vulnerable to consumptive exploitation from humans. These operations are consistent with the MLR's act stipulation for optimal and sustainable resource utilisation. To minimize ecological and behavioural impacts 'Permit Conditions' and a 'Code of Conduct' have been established. If followed, cage diving can be a beneficial industry that in no way augments the small risks that white sharks represent to humans. At present, however, the disregard of permit conditions, by some operators, has understandably established a negative public perception towards the industry. This perception has been exacerbated by the recent spate of attacks in the False Bay region. DEAT's recent action against offending operators has successfully halted extreme cases of non-compliance (e.g. chumming off swimming beaches). However, such enforcement must be extended to include the numerous 'less dramatic' breaches of operational protocol that occur on an almost daily basis (i.e. intentional feeding of sharks). It must be appreciated that dissatisfaction over DEAT's failure to timely issue permits has, in part, led to the disrespecting of regulations as recognized by Maharaj *et al*. (2003). Ultimately the issuing of permits, and increased compliance enforcement will benefit the industry, the white sharks conservation status, and most importantly satisfy the

publics demand of being able to use the water without fear that cage-diving is placing them in undue danger.

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