FINDING A BALANCE

White Shark Conservation and Recreational Safety in the Inshore Waters of Cape Town, South Africa.

Deon C. Nel and Thomas P. Peschak (Editors)

A process initiated and funded by the City of Cape Town in partnership with WWF and DEAT

WWF South Africa Report Series - 2006/Marine/001

THIS CITY WORKS FOR YOU

Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa

Proceedings of a specialist workshop held 29 & 30 May 2006

WWF South Africa Report Series – 2006/Marine/001

Compiled and edited by

Deon C. Nel & Thomas P. Peschak

WWF Sanlam Marine Programme, WWF South Africa, Private Bag X2,
Die Boord, 7613, South Africa; email: dnel@wwf.org.za

AUGUST 2006

Foreword

The contents of these proceedings are the result of over a year's foresight and planning by the City of Cape Town, the Department of Environmental Affairs and Tourism (DEAT) and the World Wide Fund for Nature (WWF) South Africa. Following a number of shark attacks between 2001 and 2004, the City of Cape Town recognized that a proactive approach to addressing white shark management and recreational safety was needed. Central to this challenge was not only the apparent paradox between the objectives of recreational safety and white shark conservation, but also the lack of clarity about the roles and responsibilities of different government departments.

In June 2005, the City and its key partners, DEAT and WWF, started a process to assess the full range of possible causes and potential management responses so as to accurately inform the decision making process. WWF was approached to assist in facilitating a workshop of specialists in the fields of white shark conservation and recreational safety. A number of recognised experts were invited to contribute written papers on a broad range of topics. The workshop, held on 29 & 30 May 2006 in Cape Town, was characterized by very constructive debate and was successful in adopting a number of key conclusions and recommendations based on the information presented. Whilst these recommendations do not carry any legislative weight, they do constitute the collective opinion of the most highly regarded experts in these fields in South Africa and are backed up by fifteen scientific and background papers that were submitted to the workshop and reviewed by the editors. These recommendations have played a central role in informing the City's Draft White Shark and Coastal Recreational Safety Policy and Strategy.

I believe that the recommendations and contents of these proceedings present a rational and informed middle road on a very difficult and emotionally charged issue. It is my sincere wish that governmental policy makers as well as the public will have high regard for the contents of these proceedings, as I believe they lay a very solid foundation for moving forward on this important issue.

Dr Deon Nel
WWF Sanlam Marine Programme

CONTENTS

1. Introduction

The past four years has seen a higher than usual number of interactions between recreational water-users and great white sharks within False Bay and along the Atlantic seaboard of the Cape Peninsula. Although the number of shark attacks is still very low, incidents have been followed by highly emotive media and public response. The issue is further complicated by the following factors. The objectives of recreational safety (primarily the responsibility of the City of Cape Town), white shark conservation (primarily the responsibility of DEAT) and those of the Marine Protected Area surrounding the Cape Peninsula (primarily the responsibility of South African National Parks) have not been reconciled in a single strategy. There is a lack of clarity on the roles and responsibilities between local, provincial and national authorities, and a large number of unsubstantiated theories on the cause of shark incidents have found their way into the media and public domain.

This situation prompted the City of Cape Town, in partnership with the Department of Environmental Affairs and Tourism (DEAT) and the WWF Sanlam Marine Programme, to act proactively and convene a specialist workshop to guide the management of this issue. The objectives of the workshop were to:

1. Rationally and scientifically assess a range of key issues relating to shark attacks
2. To identify the key elements of a long-term strategy that will guide the management of this complex and emotive issue.

2. Workshop methodology

Specialists were invited to prepare papers on the following topics:

1. Conservation status of sharks and their role in healthy marine ecosystems
2. Shark Deterrents and Mitigation Options
3. Ecosystem Management:
   - *i. Seal Management*
   - *ii. Trek Net Fishing*
   - *iii. Cage Diving*
   - *iv. Estuary and River Management*
4. White Shark Population Dynamics
5. Current Shark Spotting Safety Programme
6. Recreational Trends
7. Review of Shark Attacks in Cape Town and South Africa
8. Emergency Response

9. Information, Communication and Awareness:
   - *i. Role of Government*
   - *ii. Role of NGO and CBO sector*
   - *iii. Role of the media*
10. Governance and Responsibilities
11. International Review of Management Approaches

A list of attendees and the complete versions of the papers submitted to the workshop are appended to this report (Annex 1).

At the workshop, papers were presented by the specialists and subject to interrogation by the participants. Each specialist was asked to present the main conclusions of their work and a set of recommendations for the long term strategy. These conclusions and recommendations were subject to discussion, refined and adopted by the workshop. For the purposes of clarity these conclusions and recommendations have been grouped into five themes: Governance, management and mitigation, safety and emergency response, education and awareness, research and biology of white sharks. The complete list of adopted conclusions can be found in Section 4.

Finally the workshop participants were asked to identify from the complete list of recommendations, some first tasks that could be tackled immediately in order to maintain the momentum of the workshop. These are described in Section 5.

3. Workshop outputs

Several important points need to be made about the nature of this workshop and its outputs.

Firstly, the recommendations adopted by the workshop merely constitute the agreed advice of the invited experts and do not constitute the long term strategy in itself. It is envisaged that the outputs of the workshop will be utilized to develop the long term strategy to be adopted by the Cape Town White Shark Working Group and the responsible authorities (i.e. City of Cape Town, Western Cape Provincial Government and DEAT).

Secondly, this workshop was not meant to be a public participatory process, but rather a specialist input process. It is envisaged that the outputs of this meeting and the long term strategy developed from the workshop be subjected to open and transparent public participatory processes.

Finally, opinions expressed in the specialist papers appended to this document are not necessarily the agreed opinion of the workshop. Readers are encouraged to cite specific

information from the specialist papers to the authors of that paper rather than the entire workshop report.

A summary of the agreed conclusions and recommendations of the workshop are contained in the following section.

4. Conclusions and recommendations adopted by the workshop

A) Governance

Conclusions:

1. The management of recreational safety as it pertains to white shark conservation in the vicinity of Cape Town is the responsibility of all spheres of government (i.e. local, provincial and national).
2. We need to ensure a co-operative and co-ordinated response to this problem.
3. We note that the first responses to this issue were community and NGO driven. Now is the time for a co-ordinated government response.
4. Government now has a window of opportunity to manage this issue proactively i.e. we should act in a co-ordinated and planned way before emotive and/or economic factors cloud rational and well planned decision making.
5. We acknowledge the key role that the Cape Town White Shark Working Group has played in co-ordination thus far. However, we recognize its limitations due to its informal status.

Recommendations:

1. All spheres of government need to recognize their responsibility towards the management of this issue and commit necessary resources as required.
2. An effective integrated white shark conservation and recreational safety strategy needs to be developed for Cape Town, which ascribes roles and responsibilities.
3. The current Cape Town White Shark Working Group should be given formal status.
    - The working group should be housed within local government structures, with strong participation by provincial and national government.
    - The working group should develop a formal Terms of Reference (TORs) that includes defined participation, responsibilities, authority and financial mechanisms.

B) Management and mitigation

Conclusions:

1. Although the incidence of shark attacks is still very low, there has been a gradual long term increase in the incidence of attacks in Cape Town and the Western Cape during the past 50 years.
2. An analysis of all documented shark attacks in the Cape Town region, revealed no obvious causative factors. However certain activities such as spearfishing and surfing do appear to carry higher risk.

CAGE DIVING

3. There is currently no evidence to link shark cage diving operations and risk to bathers from shark attacks in Cape Town.
4. Some degree of conditioning can occur between sharks and cage diving boats when operators do not comply with regulations and allow sharks to feed on the bait (i.e. sharks receive a reward). However, it appears that this conditioning occurs between the shark and the cage diving boats and cannot be linked to any conditioning with bathers as potential prey items.
5. Conversely, when shark diving operators abide by their regulations and sharks do not gain any reward, negative conditioning does occur (i.e. animals loose interest in boats quickly and move away).
6. However, it was recognized that even the perception of a link between cage diving operations and shark attacks is detrimental to shark conservation, tourism and the long term viability of the Cage Diving industry.
7. There is a problem of cage dive operators not complying with their permit regulations, which is largely driven by client expectations of the JAWS experience (i.e. aggressive sharks wrestling with the bait).

TREK NET (BEACH SEINE) FISHING

8. No significant relationship exists between trek net fishing catches or effort and the incidence of shark attacks.
9. Trek net catches of white sharks are very low.
10. Restrictions on nets are therefore unlikely to reduce the incidence of white shark attacks.

SEAL MANAGEMENT

11. The seal population in False Bay appears to have been stable in recent decades and therefore cannot be linked to the apparent increase in shark attacks.
12. No data or logical link exists between seal pup wash outs and shark attacks.

ESTUARINE MANAGEMENT

13. There appears to be no link between estuarine breaching and shark attacks.

14. It is unlikely that the City of Cape Town is able to change its estuarine breaching policy due to other socio-economic and environmental considerations.

Recommendations:

1. White Sharks should continue to enjoy full legal protection and be reserved for non-consumptive utilization.
2. A slight peak in shark attacks in September, before the seals pup, warrants further investigation.
3. A local shark attack investigator needs to be appointed, who can record details of incidents in a nationally standardized manner and provide the Natal Sharks Board with the information.

CAGE DIVING

4. Cage dive operators should have a limited daily bait allowance, to limit sharks gaining reward. This is reflected in the new draft policy.
5. An independent observer programme should be established to monitor compliance on all cage diving boats.
6. Greater awareness needs to be created amongst the tourists about cage diving regulations (i.e. we need to downplay their expectations).
   - Examples of ways of doing this could include regulations and code of conduct on display on operator's websites, boats, awareness brochures etc.
7. Create a mechanism for tourists to report non-compliance.
8. Not all white shark areas should be opened to cage diving. Some should remain closed for comparative reasons.

TREK NET FISHING

9. Muizenberg corner should be cleared as a precautionary measure, when trek netting for yellowtail occurs here (this apparently only happens about five times a year).
10. Research needs to be done on the numbers of smooth hound sharks and bronze whalers caught in nets, in order to assess possible impact on prey availability for white sharks.
11. The attachment of acoustic receivers to trek nets, to establish presence of tagged white sharks, should be attempted.

SEAL MANAGEMENT

12. Data about number of seal pups washing up should continue to be collected from the City's Cleansing Department.

ESTUARINE BREACHING

13. Research should rather focus on identifying hotspots of shark occurrence in False Bay rather than trying to link shark activity to estuarine breaching events.

SHARK DETERRENTS

14. Shark capture devices (e.g. shark nets or drum lines) are not recommended for False Bay for the following reasons:
    - White sharks appear to be transient in False Bay and such devices would therefore be less effective in ensuring local reductions in shark numbers.
    - Capture devices may lead to unsustainable catches at the regional and national scale due to:
        i. The transient nature of the sharks, and the fact that the population is open
        ii. Large and small White sharks may be caught, leading to higher impact
    - Shark nets will result in unacceptable levels of bycatch and entanglement of whales, dolphins, and possibly seals (increased inshore shark activity seems to occur in spring and summer which coincides with the occurrence of whales).
    - Globally there is a move away from capture devices due to their broader ecosystem impacts
15. The use of exclusion nets are an option at certain beaches, but certain constraints need to be considered, such as the effect on trek netting, damage by kelp, high costs and maintenance, and possible entanglements. It is recommended that a full Environmental Impact Assessment (EIA) is done before considering this option.
16. The use of physical barriers on surf beaches will be constrained by the high cost, aesthetics, and consequent affect on tourism and are therefore not recommended.
17. Investigate the development and use of electronic repellent barriers, and sonar and other acoustic shark detection devices for high recreational use areas.

SHARK SPOTTING PROGRAMME

18. The shark spotter programme should be formally recognized as an important part of the shark management and safety strategy, and should be funded by all three tiers of government.
19. DEAT needs to support the programme either through the Marine Living Resources Fund (MLRF) or through assisting to acquire Poverty Relief and other social programme support.
20. There is a need to continue to source private sector support and sponsors.
21. There is a need to assess the efficacy of the shark spotting programme. This information should determine the need for additional mitigation.
22. The limitations of the programme need to be clearly communicated to beach users.

C) Safety and Emergency Response

Conclusions:

1. During the past few decades there has been a large increase in numbers of water users in False Bay, especially sports in which the users venture further offshore (kayaking, surfing, kite surfing etc), and this increase is expected to continue.

2. Certain activities, such as spearfishing and surfing, do appear to carry a higher risk.
3. A white shark attack model was presented to the workshop. The workshop felt that the model held promise for explaining drivers for shark attack trends, but input parameters need to be refined.
4. Emergency response time and expert handling of patients following an attack can greatly improve survival statistics.

Recommendations:

1. We need to improve all our generic emergency response protocols rather than only place attention on shark attacks (which occur rarely).
2. Trauma kits need to be readily available at all beaches. These kits should be sealed and only opened for emergencies.
3. One standardized emergency number should be used. The NSRI number - Tel. 021 449 3500 – is suggested. This number needs to be displayed prominently at all beaches (e.g. print a sticker).
4. Emergency response and trauma medical aid courses should be offered to lifesavers, rescue workers, shark spotters as well as other water users (e.g. surf schools, clubs etc).
5. We need to agree on a generic shark attack response protocol. A draft has been created by the NSRI and Natal Sharks Board and SA Lifesaving need to agree to this.
6. A laminated card of this protocol needs to be produced and distributed.
7. We need to conduct emergency response simulation exercises.

D) Education and Awareness

Conclusions:

1. Large amounts of misconceptions and media hype around shark attack risk poses a significant communications challenge and continue to shape public perceptions.
2. There is currently no co-ordinated communication strategy or clarity on the roles of different institutions and levels of government.
3. Little funding is committed to proactive communications.

Recommendations:

1. Include communications in the formalized White Shark Working Group's TORs.
2. A communications task team should be established within the structures of the White Shark Working Group, with representation from all tiers of government and appropriate experts and stakeholders.
3. The communications task team should develop a proactive and positive communications and education strategy.
4. Hold media briefing and provide a media protocol and information pack, which could include:

- List of knowledgeable experts per topic
- Shark photo library

5. Need to develop a dedicated campaign within the above communications strategy that aims to break down entrenched misconceptions and myths.

E) Research and biology of White sharks

Conclusions:

1. White sharks occupy a key role in the ecosystem as an apex predator.
2. White sharks are declining in some parts of the world and consumptive impacts in False Bay may influence abundance elsewhere in southern Africa and worldwide, as we are dealing with an open population (records of animals traveling to Australia etc).
3. The abundance of white sharks in South Africa was declining prior to 1991 (before legal protection) and has been stable and possibly increasing very slightly (ca 1.6% per annum) since 1991[1].
   - However, it is highly unlikely that this could account for the recent occurrence of attacks.
4. Increase in numbers of sightings is largely accounted for by increased awareness; however, other contributions cannot be excluded such as localized changes in distribution.
5. False Bay is an important habitat for white sharks as it hosts a significant concentration of adult and near-adult white sharks. Historically it apparently was a pupping and nursery ground for white sharks, and still may be such.

Recommendations:

1. Need to better understand the white shark's role and position in the ecosystem.
   - Specifically the impact that changes in certain prey items (e.g. depletion and changes in ranges of smaller sharks) could have on the behaviour of white sharks.
2. Need to better understand possible contemporary changes in distribution (based on reliable anecdotal accounts) of white sharks.
   - Possibility to utilize long term recreational fishing data to understand historic occurrence of smaller white sharks.
3. Need to continue to monitor abundance trends through:
   - non-invasive and mark recapture monitoring techniques – specific attention needs to be given to utilizing Michael Scholl's photo-identification database.
   - Capture data from the Natal Sharks Board.
4. Need to better understand breeding grounds.
5. Need to better understand impacts of pollutants.

[1] This is based on CPUE data from Natal Sharks Board

5. Immediate follow up actions

1. Gregg Oelofse to investigate formal structures within the City of Cape Town for hosting the White Shark Working Group.

2. Jaques du Toit (Provincial government) provisionally volunteered his services as a local point person for documenting details of shark attacks. He will be in contact with Natal Sharks Board to be briefed on the standard reporting protocol.

3. Janette du Toit to convene a meeting of stakeholders to discuss how DEAT can contribute to the sustainability of the shark spotter programme and to link this programme to the need for observers on shark cage diving operations.

4. Alison Kock will use her acoustic tagging data to assess the efficacy of the shark spotter programme.

5. Key sites for trauma kits to be identified by the White Shark Working Group.

6. Constitute a media task team under the White Shark Working Group with representation from City of Cape Town, DEAT and contributing NGOs.

7. Develop a media pack that includes:

   - A selection of appropriate images
   - Contact numbers of people responsible to speak on behalf of various organizations
   - Contact numbers of appropriate experts on shark biology and behaviour
   - Lists of websites; credible sources of information.

8. Hold a media briefing on the outcomes of the expert workshop. Media packs to be distributed at this briefing.

6. Attendance List

NAME	ORGANISATION	E-MAIL/PHONE
Lesley Rochat	AfriOceans Conservation Alliance	info@aoca.org.za
Sam Petersen	BirdLife South Africa	seabirds@birdlife.org.za
Austin Leader	City of Cape Town	Austin.leader@capetown.gov.za
Godfrey Mvuma	City of Cape Town	Godfrey.mvuma@capetown.gov.za
Gregg Oelofse	City of Cape Town	Gregg.oelofse@capetown.gov.za
Michelle Preen	City of Cape Town	Michelle.preen@capetown.gov.za
Ruth Richards	City of Cape Town	ruth.richards@capetown.gov.za
Tamryn Manzoni	City of Cape Town	Tamryn.manzoni@capetown.gov.za
Michael Meyer	Department of Environmental Affairs and Tourism	mmeyer@deat.gov.za
Herman Oosthuizen	Department of Environmental Affairs and Tourism	oosthuiz@deat.gov.za
Janette du Toit	Department of Environmental Affairs and Tourism	jdutoit@deat.gov.za
Steve Lamberth	Department of Environmental Affairs and Tourism	lamberth@deat.gov.za
Jacques du Toit	Department Environmental Affairs & Development Planning	jdtoit@pgwc.gov.za
Alison Kock	Iziko South African Museum	Alison@saveourseas.com
Len Compagno	Iziko South African Museum	lcompagno@iziko.org.za
Mike Anderson-Reade	Natal Sharks Board	malpha@shark.co.za
Geremy Cliff	Natal Sharks Board	cliff@shark.co.za
Sheldon Dudley	Natal Sharks Board	dudley@shark.co.za
Anne Hahn	National Sea Rescue Institute	annehahn@mweb.co.za
Craig Lambinon	National Sea Rescue Institute	lambinon@mweb.co.za
Ian Klopper	National Sea Rescue Institute	ian@emt.co.za
Yvonne Kamp	Nature Conservation Corporation	yvonne@natureconservation.co.za
Paul Sieben	SANPARKS	paul@sanparks.org
Winston Arends	SANPARKS	021-786 5656
Patrick Davids	Shark Spotter Programme	083 868 2121
Justin Jacobs	Shark Spotter Programme	083 963 1328
Monwabisi Sikweyiya	Shark Spotter Program me	073 923 1592
Cathy Vermeulen	Student	Cathy_ocean@mweb.co.za
Enrico Gennari	Student	enrshark@yahoo.it
Steve Kirkman	University of Cape Town	skirkman@botzoo.uct.ac.za
Ryan Johnson	University of Pretoria	Johnson@maxitec.co.za
Clive Wakeford	Western Province Lifesaving	083 745 9120
Michael Scholl	White Shark Trust	mscholl@whitesharktrust.org
Rob Little	World Wide Fund for Nature – South Africa	rlittle@wwf.org.za
Deon Nel	World Wide Fund for Nature – South Africa	dnel@wwf.org.za

Annexure 1:
Papers submitted to the workshop

Background

White Shark abundance: not a causative factor in numbers of shark bite incidents

Alison Kock[1,5] and Ryan Johnson[2]

Alison Kock: Shark Research Centre – Iziko Museums
Email: alison@saveourseas.com. Website: www.saveourseas.com

Ryan L. Johnson: University of Pretoria
Email: Johnson@maxitec.co.za, Cell: 0726296669

collaborators/co-authors (alphabetical order):
M. N. Bester[2], L. Compagno[1], G. Cliff[3], S. Dudley[3], E. Gennari[8], C. L. Griffiths[5], D. Kotze[6], K. Laroche[7], M. A. Meyer[6], W. H. Oosthuizen[6] & S. Swanson[6]

[1] Shark Research Centre, Iziko South African Museum,
[2] Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria,
[3] Natal Shark Board, KwaZulu Natal,
[4] Marine Biology Research Institute, University of Cape Town
[5] Department of Zoology, University of the Western Cape,
[6] Department of Environmental Affairs and Tourism, Marine and Coastal Management Branch,
[7] Behavioural Ecology Research Group, Department of Biological Sciences, Simon Fraser University,
[8] University of Rome

Abstract

Since the late 1990's the presence of white sharks in the False Bay region has become increasingly conspicuous. Not only has increased numbers of sightings been reported, but there has also been a localised spate of shark bite incidents on beaches along the Cape Peninsula. This paper reviews existing evidence regarding the status and behaviour of False Bay's white shark population.

Key findings of this review:

- The maximum rate of population growth is unique to every species and is termed 'intrinsic rate of population growth'. White sharks are K-selected species with life-history traits similar to those of mammals (large body size, slow growth, development of few young). Thus, their intrinsic rate of population growth is slow (4.0 – 11.9 % per annum). The maximum abundance of white sharks is ultimately limited by the

availability of resources, and is termed its 'carrying capacity'. Thus, white shark numbers in South Africa cannot increase either quickly or indefinitely.

- White shark abundance and population trends are scarce throughout their range. Evidence from global hotspots suggests low abundance, compared to sympatric shark species. Declines in numbers have been identified in the NW Atlantic, Australia and the USA. There are no global examples of an increase in abundance.

- In South Africa, the most reliable population trend information is provided by the Catch per Unit Effort (CPUE) from the protective gillnets in KwaZulu-Natal. Initially, the CPUE declined rapidly, but this decline has stabilised (1978 – 2003). Splitting CPUE data into 'pre 1991' and 'post 1991' (1991 being the year protective legislation was introduced) reveals that protection may have stabilized the population or even contributed to a slight rise in numbers. Prior to 1991, the number of sharks in the nets decreased by 1.3 % per annum, yet, following protection there appears to by a 1.6 % annual increase in capture rate. Yet, significant interannual variation means a degree of caution must be appreciated when interpreting these trends.

- Evidence illustrates that the actual recovery rate (population growth rate) of white sharks following protection appears slower than what the population is capable of (i.e. 4.0 - 11.9 % per annum). This apparent discrepancy may be caused by any one of a number of possibilities. Namely, (a) the presence of fewer than expected sexually mature females (b) human induced mortality being greater than we currently estimate or (c) South Africa's white shark population approaching its carrying capacity. There is currently not enough information available on this species' population status to either confirm or reject these possibilities.

- We need to appreciate the limitations and possibilities for region specific trends, but in the absence of any contradictory evidence, our most responsible approach is to accept that the long-term KZN trends can be used to infer regions specific trends, including False Bay.

- On a large spatial scale, white sharks move freely to and from False Bay, they undergo coastal migrations along South Africa's entire coast and are capable of transoceanic migrations. Thus, at present, the best evidence suggests that changes in the capture rate of white sharks in bather protection nets will probably be mirrored on localised scales. As such, it is improbable that an increase in white shark abundance within False Bay would not be reflected on a national scale (e.g. capture rate in the bather protection nets). No such increase has been observed.

- The white shark population within False Bay consists of the highest ratio of large white sharks (ca 350 – 500 cm total length) of those areas studied in South Africa

(incl: KZN beach netting, Mossel Bay and Gansbaai). Anecdotal evidence and eye-witness accounts suggest shark bites on humans are primarily instigated by 'large' white sharks, thus particular attention must be paid to mitigating shark bite incidents in False Bay. The importance of sharks in False Bay must also be acknowledged and appreciated, as False Bay may house a large percentage of South Africa's reproductive stock.

- White sharks are present at seal colonies along the Western Cape primarily during the winter months, whilst during the summer month's white sharks are observed near shore (e.g. adjacent to swimming beaches). This seasonal change in habitat use is not unique to False Bay, as this pattern is observed in Gansbaai, Mossel Bay and as far a field as California. It is highly unlikely that this behavioural pattern has only recently developed in white sharks residing in False Bay.

- Alternative possibilities to account for an increase in sightings in Muizenberg and Fish Hoek are that the distribution of white sharks within False Bay has changed (Chris Fallows, pers.com). Changes in distribution have been recorded for other shark species (e.g. bull sharks, blue sharks), but unfortunately no reliable historical data is available to compare present day white shark distribution to historical data. The current research program in False Bay indicates that white sharks use the entire bay, from Gordon's Bay all along the coast to Cape Point. Long term monitoring within False Bay will be a crucial step in determining the possibility of future changes in distribution.

  Furthermore, the reported increase in sightings may be caused by (a) the increasing profile of the white sharks along South Africa's Western Cape, (b) the increase in human vigilance towards spotting the presence of white sharks, and (c) change in the behaviour of human water users. Such an acute rise in sightings cannot be accounted for by the increase in the numbers of white sharks present.

- False Bay hosts a relatively high ratio of large white sharks that may potentially come into contact with human water users, particularly in summer months. However, based on the best evidence available, the population's status and composition has not changed markedly since protection in 1991. Thus, it is improbable that an increase in shark numbers is behind the recent spate of shark bite incidents.

Citation: Kock A. and R. Johnson 2006. White Shark abundance: not a causative factor in numbers of shark bite incidents. *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. Introduction

Since the late 1990's the presence of white sharks (*Carcharodon carcharias*) in the False Bay region has become increasingly conspicuous. Not only have kayakers, surfers and law enforcements officials on local beaches, reported increased numbers of sightings but there has also been a localised spate of shark bite incidents on beaches along the Cape Peninsula. Many people are under the impression that since the 1991 protective legislation, prohibiting the capture and killing of white sharks, the number of white sharks has grown considerably and that this is a causative factor behind the recent spate of shark bite incidents. A counter argument is that the substantial increase in the number of water users is the major contributing factor in the rise in shark bite incidents, and shark sightings have increased as a direct result of increased awareness and vigilance. The aim of this paper is to review the status of the white shark population in South Africa and even more locally, within False Bay, and assess the implications for water users. We will use the most recent information available to evaluate factors such as white shark population growth, local and global population trends, spatial and temporal patterns within False Bay.

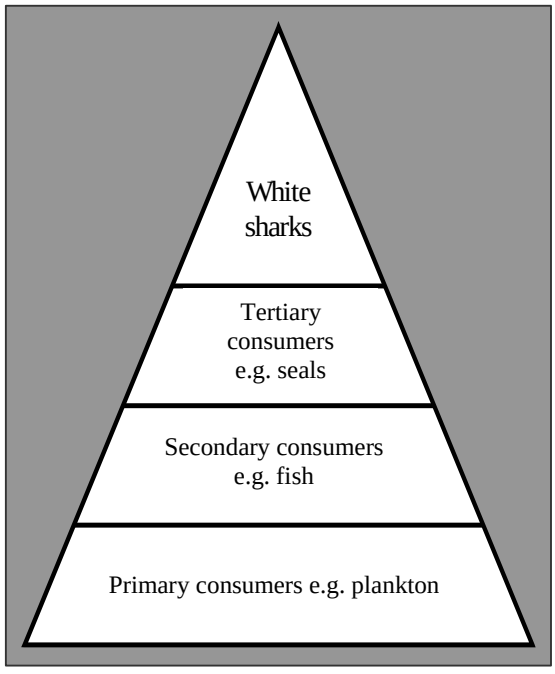


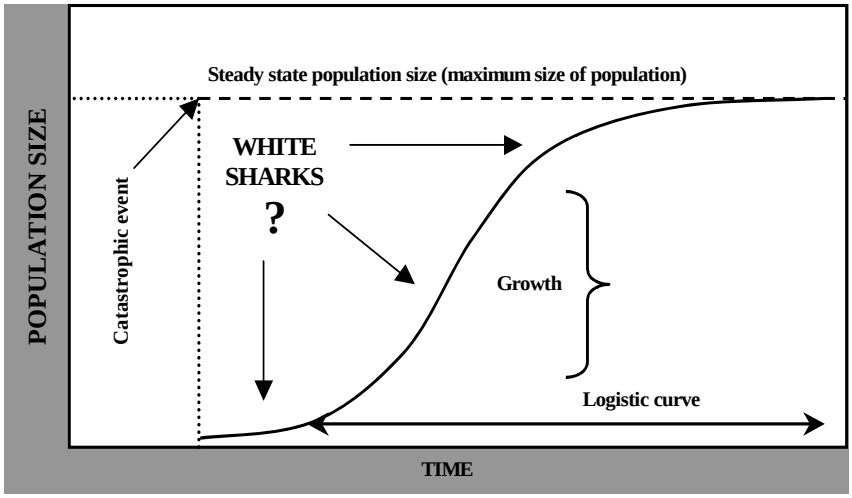
Figure 1. White sharks occupy the highest trophic levels (+ 4.5) in marine ecosystems and their populations are relatively small, compared to lower trophic level populations.

2. What governs the size of a population?

White sharks are apex predators, occupying the highest trophic levels in marine eco-systems (Fig. 1), thus their population density (relative to lower trophic levels) is consequently low (Cortes 1999). Many people presume that the white shark population can increase rapidly and indefinitely, however, this is not the case. No population can grow indefinitely, as resources (e.g. food, space) are limiting factors. Such an 'upper ceiling' for a given population is termed its 'carrying capacity'. In addition, different species have different rates of potential population increase. Let us explore a logistic model of population growth. This model starts with an undisturbed population inhabiting a constant environment for a long period of time (Fig. 2) (taken from Hoenig & Gruber 1990). The population has reached an equilibrium state, with the recruitment number (immigration and

births) equal to the number of individuals lost to the population (i.e. deaths and emigration), and thus the size of the population remains constant. However, what happens to this population when an outside force, such as exploitation (e.g. fishing), results in a significant reduction in the size of the population? In a healthy and uncrowded environment, with no resource limitations, population growth may approach an exponential curve, based on the species potential intrinsic growth rate, but as the population increases, resources become limiting and the population growth rate reduces and approaches zero (e.g. the populations carrying capacity).

Figure 2. Population growth as predicted by a logistic growth model. The fundamental problem is that we are unsure of where the South African white shark population is along this curve.



Each species also has its own intrinsic growth rate (innate ability to increase the size of their populations). However, it's very difficult to measure this rate of increase, especially on wild populations, but it's evident that species that grow fast, produce lots of young and that are short-lived are able to increase their populations relatively rapidly. Conversely, sharks have life-history traits, which are more comparable to mammals and the ability to increase the size of their populations is slow (Hoenig & Gruber 1990, Smith *et al*. 1998). These life-history traits include large body size, slow growth, late maturity, low natural mortality, the development of few well-developed young and long longevity (Table 1). Due to these life-history traits, white shark populations are poor at resisting population decimation from consumptive exploitation, and following decimation are slow to recover to their former abundance (Smith *et al*. 1998).

Table 1. Estimated life-history parameters for white sharks (Compagno 1997, Smith *et al*. 1998, Dudley & Simpfendorfer 2006).

Maximum size (cm)	640
Size at birth (cm)	109 – 165
Size at maturity (cm)	450 – 500 (female); 350 – 410 (male)
Age at maturity (years)	12 – 14 (females); 9 – 10 (males)
Longevity (years)	23 – 36 (even estimations of up to 60)
Gestation period	Uncertain (possibly 12 months or longer)
Reproductive periodicity	Uncertain (probably 2 or 3 years)
Litter size	2 – 10 pups / litter
Intrinsic annual rate of population increase	0.04 – 0.119

Although measures on the rate of population increase are difficult, they have been estimated for a few shark species, including white sharks. The maximum rate of population increase (r) for white sharks has been estimated to be in the range between 4 and 11.9% per annum. The most conservative of these estimates was Smith *et al*. (1998) who calculated r as between 4 – 5.6 % per annum, less conservative was Mollet & Cailliet (2002) with an estimate of 7.8 % per annum and lastly, Dudley & Simpfendorfer (2006) calculated the most optimistic growth rate at 11.9 % per annum. Within the context of these biological constraints, we can gain insight into temporal population trends in False Bay, South Africa and worldwide.

3. Abundance and population trends

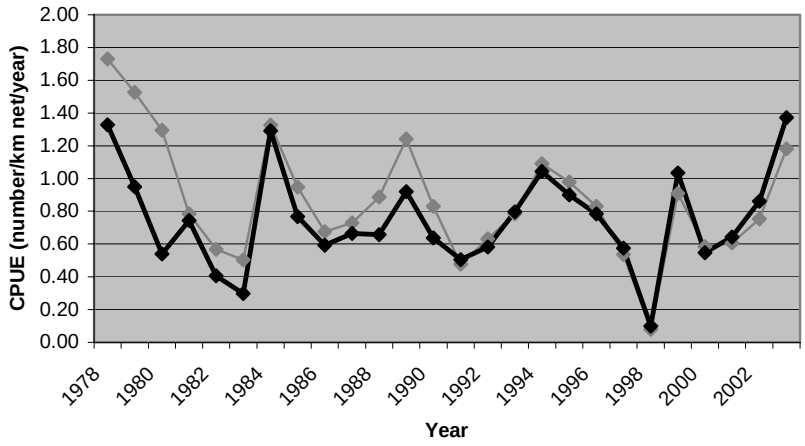
To date, there are no published estimates of global white shark abundance and very little abundance trends from areas where they regularly occur. This is due to the fact that white sharks are inherently rare and elusive, they migrate between and within continents, and sighting rates vary considerably between years. Complex ontogenic (changes with age) and sex biased behavioural patterns further complicate attempts to produce robust population estimates. Here we review the existing data on a local and global scale.

Globally, populations of white sharks have been severely reduced in most regions where they occur (Walker 1998). The most dramatic and rapid decline that has been reported comes from the NW Atlantic. In total 6087 white sharks were caught during a 14 year period in over 200 000 pelagic longlining sets, compared to 23 071 thresher sharks, 1 044 788 blue sharks and 60 402 hammerhead sharks. Porbeagle sharks (829 in 8 years) and oceanic white tips (8 526 in 14 years) were also rare. It's estimated that the population of white sharks may have decreased by up to 79 % since 1986, with no catches reported in some areas since the 1990's (Baum *et al*. 2003). A rapid decline was also observed for other large shark species, like hammerheads (89 %), tiger sharks (65 %), thresher sharks (80 %), blue (60 %) and oceanic white tip (70 %). Furthermore, the study predicts that these severe

declining trends may be reflective of a global phenomenon due to the intense fisheries taking place in all our oceans targeting many of the same species (Baum *et al*. 2003). Although Burgess *et al*. 2006 believes some of the results of this study to be exaggerated; they do acknowledge that there is more than likely a large decline. Australia has also experienced declines in white shark numbers over time as is evident by a decline in CPUE (catch per unit effort) by the protective gill netting programs (Reid & Krough 1992) and by game fishing catch statistics in SE Australia (Pepperell 1992). Declines have also been reported for eastern USA (Casey & Pratt 1985) and California (Pyle *et al*. 1996). Thus, available global evidence indicates that white sharks are relatively rare, as predicted by their life-history traits, and that their populations are declining, even in areas where they are protected.

In South Africa, white sharks were legislatively protected in 1991, the inaugural country to follow this route (Compagno 1991). This decision was a pre-emptive measure based on the fact that (a) white shark populations were declining in many regions internationally where they occur, (b) their life-history strategy predicts that they are vulnerable to over exploitation and (c) it was strongly suspected that the South African population was declining due to the high demand for white shark jaws as trophies locally and internationally (Compagno 1991). The aim of this legislation was to ensure that the white shark population was protected from over exploitation and it was hoped that it would re-cover over time. So what has happened since then? We looked at available sources of information to determine the current situation.

Figure 3. Annual CPUE of white sharks caught in the bather protection program along the KwaZulu Natal coast between 1878 and 2003 for all installations excluding Richard's Bay, Mzamba, and the months of June and July (black line). The effects of the sardine run in winter months are illustrated for the CPUE for all installations (except Richards Bay) in all months (grey line). (Source: Dudley and Simpfendorfer 2006).



As previously stated, there is very little information available on the status of white shark populations, however, the most reliable long-term data on white shark abundance in South Africa comes from sharks caught in the protective gillnets off the coast of Kwa-Zulu Natal. The CPUE offers information on temporal trends in South Africa's white shark population (Cliff *et al*. 1989). Cliff and Dudley 1992 reported substantial declines in the CPUE of white sharks between the mid 1960's and mid 1970's, but the decline has not persisted and catches of white sharks in the nets have stabilized from 1978 – 2003 (Fig. 3) (Dudley and Simpfendorfer 2006). Interestingly, splitting Dudley and Simpfendorfer's (2006) data into 'pre 1991' and 'post 1991' (1991 being the year protective legislation was introduced) does, however, reveal that protection may be having a positive effect on the number of white sharks. Prior to 1991, the number of sharks in the nets decreased by 1.3 % per annum, yet, following protection there appears to by a 1.6 % annual increase in capture rate. The interannual variation in this data does, however, lesson the robustness of these trends. Converse to the possibility of a slight increase is the discovery of the continual decline in the mean size of female white sharks caught in the nets since 1978, which may be indicative of a decline in this segment of the population (Dudley & Simpfendorfer 2006). Most importantly though is that there is no evidence of a 'leap' in white shark abundance.

White shark abundance in South Africa

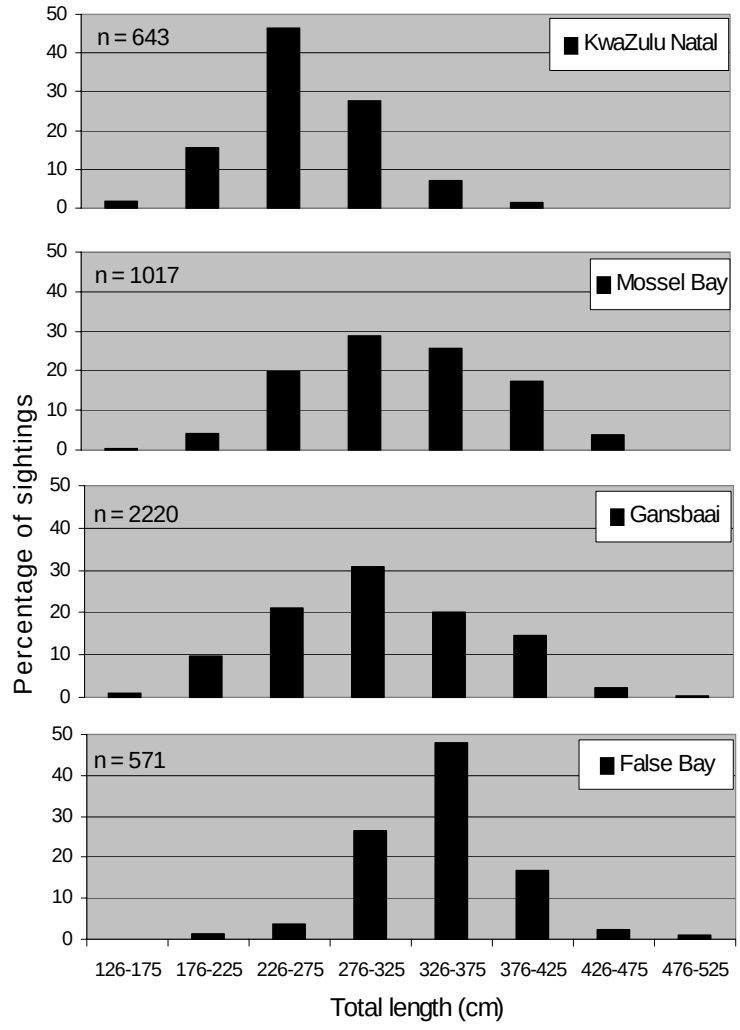
Research at three sites along the western Cape has so far gathered preliminary information on the minimum number of white sharks recorded in these areas. In Mossel Bay a minimum number of 198 individual white sharks sighted between 2001 and 2005. This number is established from successfully identifying 70.25 % of the 1104 white shark sightings made from the research vessel. In Gansbaai a researcher has identified over 1200 individual sharks between 1998 and 2005 (Michael Scholl pers. com.). In False Bay a minimum of 128 have been identified (2004 – 2005). To date, these estimates don't provide the answers we are looking for in explaining changes in shark bite rates and are still preliminary. However they do give us good baseline data to investigate future changes in distribution, abundance and behaviour for each area.

Marking individual white sharks (via tagging or photographic identification) can enable population estimates to be made based on the ratio of marked individuals in latter surveys (e.g. jolly-seber, Petersen techniques). This technique was used in 1996 by Cliff *et al*. 1996 on a small data set to estimate the white shark population between Richard's Bay (KwaZulu-Natal) to Struis Bay (western Cape) at circa 1279 individuals. There are currently two large-scale telemetry (acoustic tagging) projects operational in False Bay and Mossel Bay, which when completed will be able to provide more robust estimates on the white shark population. Additionally, a long-term identification project run in Gansbaai will similarly yield information on the abundance of the white sharks in South Africa.

4. False Bay's white shark population - can it act independently?

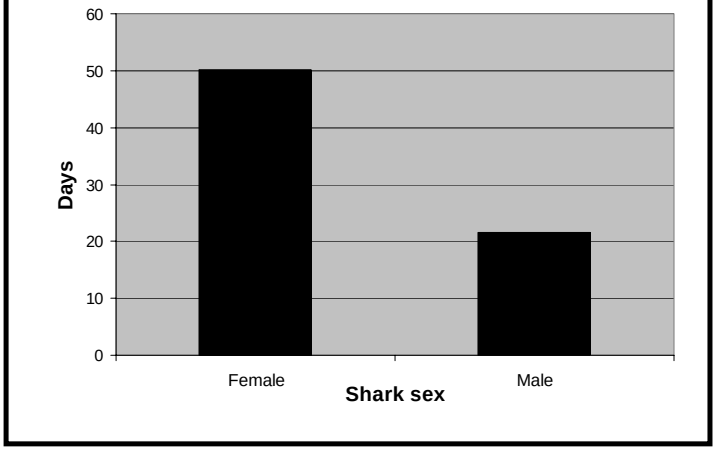
Based on our knowledge of movement of individual white sharks, can abundance trends in False Bay act independently from trends observed elsewhere in the country? Telemetry studies offer extensive evidence that white sharks within South Africa regularly move between areas (e.g. False Bay, Gansbaai, Mossel Bay, KZN), and thus do not represent an isolated population (Johnson *et al.* in review). Furthermore, genetic and satellite tracking results suggest that the 'South African' white shark population may form part of a 'global' white shark population, with linkages between South Africa, Australia and New Zealand (Pardini *et al.* 2001, Bonfil *et al*. 2005). Genetic evidence links South African male white sharks with Australia and New Zealand (Pardini *et al*. 2001), while satellite tracking data recently revealed that females of the species are capable of transoceanic return migrations between South Africa and Australia (Bonfil *et al.* 2005). In the broadest sense, this kind of information tells us that any change in the abundance of white sharks in South Africa will probably occur ubiquitously and be observed throughout the various areas where we scientifically observe white sharks.

Figure 4. Size ratio of white sharks at four areas along South Africa's coast. Dudley & Simpfendorfer (2006) source for KwaZulu Natal data, PCL to TL conversion (Mollet & Cailliet 1996).



What complicates this simple assumption is that males and females, small and large sharks may behave differently to one another. To illustrate this point we compared the size distribution of white sharks sighted in four areas. Namely, False Bay, Gansbaai, Mossel Bay, and sharks captured in the KZN bather protection nets (Fig. 4). It becomes obvious that False Bay, and to a lesser extent, Gansbaai, hosts the largest proportion of 'large' white sharks in the areas studied, conversely very few large sharks are sighted in the area of the KZN shark nets (no sexually mature female white sharks have ever been captured in the bather protection nets). The authors believe that the high proportion of large sharks in the False Bay region is due to the abundance and accessibility of Cape fur seals. Larger white sharks prey more frequently on marine mammals compared to smaller white sharks and this evidently affects their distribution throughout South Africa. A similar discrepancy in behaviour exists when comparing the residency patterns of male and female white sharks at the various study areas. At Mossel Bay, male white sharks display low site fidelity and often move in an out of the study area quickly. Alternatively, a number of females, particularly large females, display high site fidelity and remain resident in the study area for a number of months (Fig. 5).

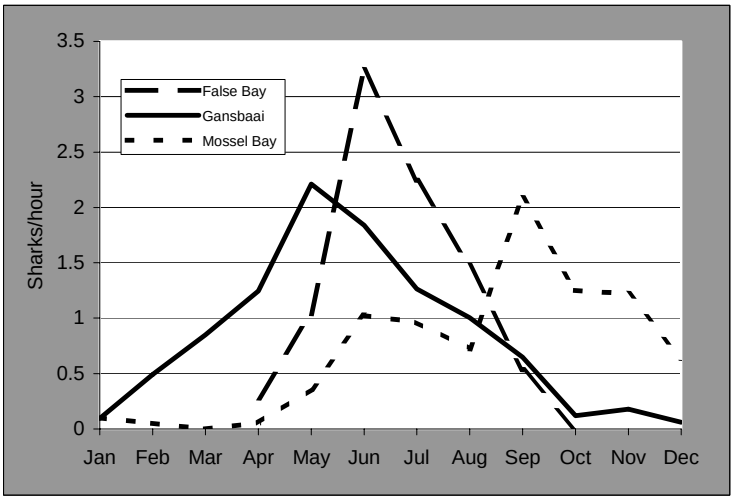
Figure 5. Mean number of days resident at Mossel Bay of 71 (58 female, 13 male) white sharks following attachment with RCODE acoustic transmitters



With this kind of information available, must we accept or reject the proposition that a 'geographically specific' change in abundance could occur in False Bay that would not be detected in other parts of South Africa, for example in the catch rates of the KZN sharks nets? The KZN sharks nets capture very few sharks over 350 cm TL (Dudley and Simpfendorfer 2006), even though they are capable of catching sharks as large as 450 cm (Geremy Cliff pers. com.), this may be because these large sharks occur primarily in the Western Cape in waters adjacent to seal islands, although alternative explanations, such as large sharks not frequenting nearshore KZN waters, are also possible. Subsequently, there is a slight possibility that there may be a localized (Western Cape region) increase in the number of large white sharks, and that this increase would not be reflected by catch rate data from KZN. Two points of caution must be made to contextualise this previous hypothesis. Firstly, white sharks' life history means that the recruitment into the population is strongly linked to the parental stock. That is, if the presence of large sexually mature white sharks in the Cape region were significantly increasing, this would be proportionally reflected in the annual recruitment of juvenile white sharks into the population, this in turn would be reflected in the catch rate of the bather protection nets. Such a trend has not been observed.

Secondly, the purpose of South Africa initiating protective legislation was the realization of the inherent vulnerability of white sharks to human exploitation. Female white sharks mature at between 12 and 15 years (ca 4.8 m total length), thus, in the presence of human induced mortality, very few will reach age of reproduction. The goal of protection is to ensure a sustainable population; this can only be met if a viable adult population exists. Our results highlight the importance of False Bay in housing such an adult population, and also cast doubt on the current existence of a healthy adult population. Thus, we need to appreciate the limitations and possibilities for region specific trends, but in the absence of any contradictory evidence, our most responsible approach is to accept that the long-term KZN trends can be used to infer region specific trends, including False Bay. Using the aforementioned evidence, it is unlikely that absolute numbers of white sharks have increased considerably in South Africa and as such False Bay.

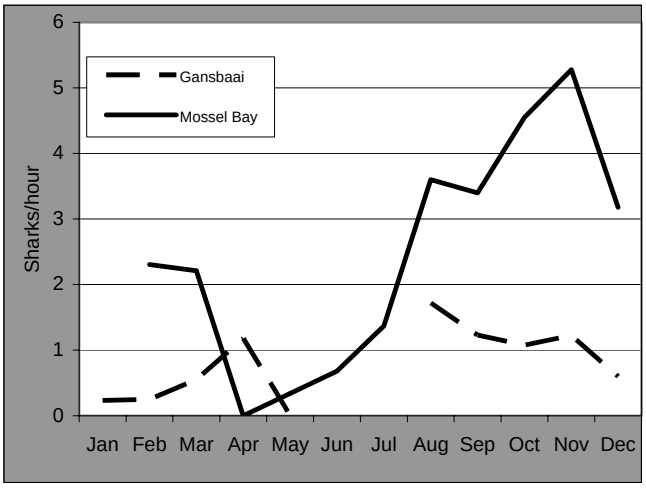
Figure 6. White sharks are seasonally (winter) abundant at seal colonies in the western Cape.



5. Behaviour of White sharks in False Bay

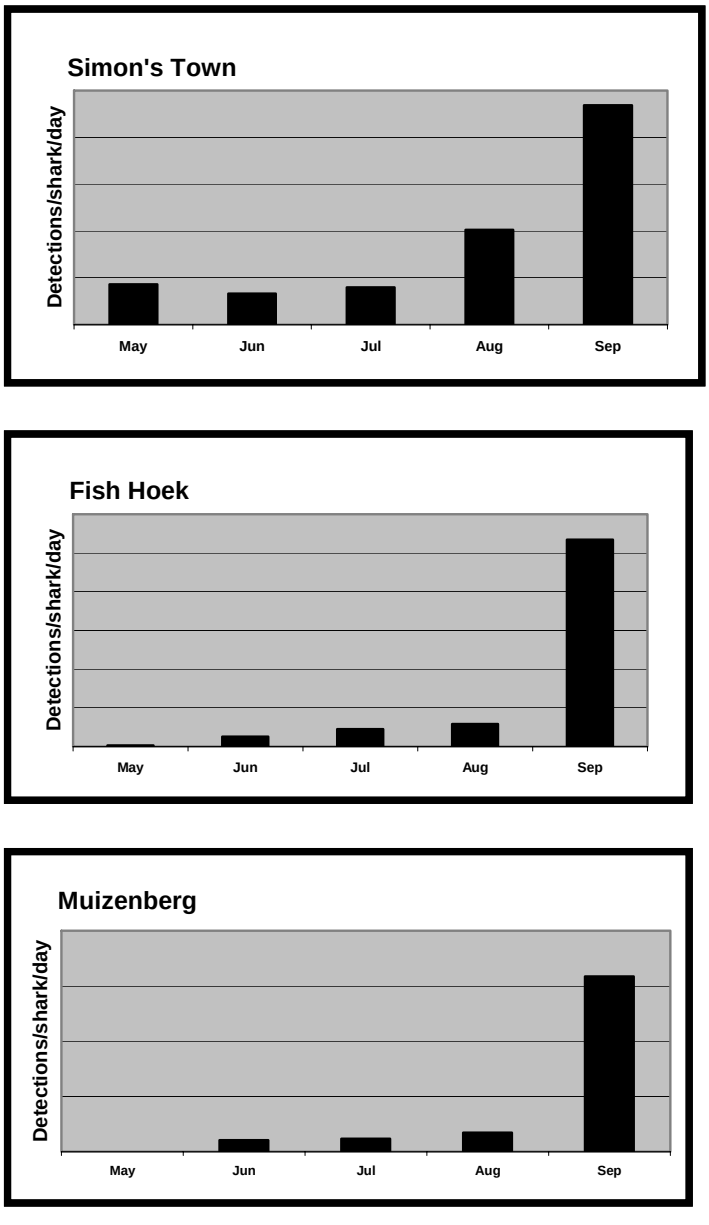
In the last *ca* two years, white shark sightings have been reported to be increasing in areas such as Muizenberg and Fish Hoek, with many statements by residents saying, “never before have they seen white sharks in these areas”, “white sharks occurring close to beaches is a unique situation”. Research has shown that white sharks are seasonally present at Seal Island, False Bay (Fig. 6). Sharks are most abundant from May – September, when they prey on young of the year Cape fur seals (Kock 2002). In general, towards the end of August the sharks are less abundant around the island and most sharks leave the island completely by October (Fig. 6).

Figure 7. White sharks are seasonally abundant (Spring-summer) near inshore areas at Gansbaai and Mossel Bay (Grootbrak).



Corresponding to this trend is an increase in the number of sharks recorded on monitors located close inshore in areas such as Muizenberg, Fish Hoek and Simon's Town (Fig. 8). What is important to note with regards to this seasonal change in habitat use is the history of it. Reports from military personal during aerial activities over False Bay in the 1960's and 1970's tell of large numbers of white sharks spotted just behind the breakers from Macassar to Muizenberg (Justin Menge pers. com.). Historically, when white sharks were hunted for trophies during big game fishing tournaments, most sharks caught in False Bay were caught near-shore in areas such as Strandfontein and Macassar (Johan Vosloo pers. com). Additionally, such a seasonal pattern and their occurrence near inshore areas have been observed in Gansbaai since 1998 (Fig. 6, 7) and have also been observed in Mossel Bay (Fig. 6, 7). Thus, claims that this behaviour (white sharks occurring inshore close to beaches) is unique to False Bay and only recent in their appearance are erroneous.

Figure 8. Preliminary data illustrating the seasonal change in behaviour at selected inshore areas in False Bay.



6. So where is the population and what is going to happen in the future?

The central questions of this paper are: "what has happened to the white shark population since protection? What is going to happen in the future? And what does this mean for human water users?" To answer this we have collated all-available theoretical and recorded data to produce estimates in the localized (False Bay) abundance of white sharks over time. Taken

into account are various measured and calculated parameters that contribute to population growth (Table 2). However, limitations in the data supplied to this estimate should be appreciated due to reasons outlined previously (e.g. limited data availability, localized changes in distribution etc.). As such, these results should be observed with caution, and be considered as indicators of what may have, and could happen within False Bay.

The most reliable data concerning relative trends in white shark numbers within South Africa stems from captures in bather protection nets. The most recent evidence, suggests that following protection the number of sharks has either remained stable or increased at a rate of 1.6 % per annum (Table 2). If these changes are in fact representative of the change in abundance within False Bay, then we would expect abundance to change by a factor of between 0.00 and 0.31 in the 15 years following protection. Between, 2004 - 2005 a minimum of 128 sharks was identified to occur within False Bay, all in the waters adjacent to Seal Island. The actual number may, however, (1) vary considerably throughout the year as sharks move in and out of the bay, and (2) be larger as a number of sharks were not successfully photographed during the ongoing study. Yet, conceptually, the estimated factors of increase (0.00 - 0.31) would suggest optimistically that since protection, white shark numbers in False Bay might have climbed by 26, from 102 to the current 128.

Table 2. Parameters utilized in localized population growth concept model. SA = South Africa, FB = False Bay, Var = variable, (model enables various entries).

Parameter	**Value**			**Source**
SA population estimate	1279 (1993)			Cliff *et al*. 1996
FB minimum population number	128 (2004 - 2005)			Kock (unpub. data)
Intrinsic growth rate	4.0 - 5.6% per annum			Smith *et al*. (1998)
	7.8% per annum			Mollet and Caillet 2002
	11.9% per annum			Dudley & Simpfendorfer 2006
Population carrying capacity	Var.			
	Pre 91	91 - 06	Post 06	
Observed population growth	-0.013	0.016	Na	Dudley & Simpfendorfer 2006
Mortality (nets)	ca 35.9	ca 30.9	Var.	Dudley & Simpfendorfer 2006
Mortality (fishing)	ca 50	ca 0	Var.	Cliff *et al.* 1996
Mortality (unaccounted for)	Var.	Var.	Var.	
False Bay shark bite number	8	12	Na	Cliff (S.A. Shark attack file), Levine 1996

Ultimately, can this information identify whether changes in the white shark population is the major driving force behind the rate of shark bite incidents in False Bay? To assess this we made the following assumptions. (1) The likelihood of a shark to bite a human that it encounters is constant over time, (2) that human water users are temporally constant and thus encounter likelihood is directly proportional to white shark numbers, (3) relative trends in KZN bather protection nets are indicative of changes in abundance in False Bay. Accepting these assumptions, we would then expect the relative shark bite rate in False Bay to roughly mirror the relative abundance of white sharks. Between 1970 and 1990 (pre - protection

period), shark bite rate in the False Bay / Cape Peninsula region averaged 0.38 shark bites per annum (1970 - 1990) (Cliff pers. com., Levine 1996). Following protection, shark bite rate has steadily increased and averaged 0.80 shark bites per annum (1991 - 2005) (Cliff et al. 2006, in review). Effectively, shark bite rate has increased by a factor of 2.13 since white sharks were protected in 1991. During the corresponding 15 - year period, our estimate optimally predicts that white shark abundance has changed by a factor of 0.31 from circa 102 sharks to circa 128 sharks. Thus, even appreciating the limitations of data and the cautious nature of our proposed estimate, the potential increase in shark abundance fails spectacularly to explain the recent rise in shark bite rate.

The major limitation to the above assessment is that it does not take into consideration changes in distribution of white sharks within South Africa. Thus, despite evidence that the population is relatively stable throughout South Africa, a greater percentage of the population may be occurring in False Bay waters. It is hoped that future analysis of photographic identification records and long term monitoring of movement patterns will offer some insight into the behavior and movement of individual sharks throughout South Africa.

A major cause of interest, however, is the discrepancy between the apparent rate of change measured by KZN sharks nets and the intrinsic rate of population increase that white sharks are capable of. Following protection white shark numbers should increase at near their intrinsic rate of population increase and move towards the population's theoretical carrying capacity. However, if there is significant difference between the expected population growth and the measured population growth than additional influence(s) must be limiting the recovery of white sharks. Such influences could be (a) resources becoming limited, (b) the rarity of mature sharks means a lower than expected ability to produce recruits, or (c) that human induced mortality is greater than we estimate. The fact that measured temporal trends in white sharks abundance are far below the expected trends suggests that South Africa’s white shark population remain depressed. As such, concerns raised in 1991 that lead to protective legislation being initiated remain valid, and the white shark population remains vulnerable to overexploitation, from practices such as, targeted culling or extension of bather protection nets to the Western Cape.

7. Alternative explanations

Although this papers’ scope does not include in-depth examination of alternative causes driving shark bite rate we feel that it is pertinent to at least introduce the subject. We have shown without a doubt that the shark bite rate cannot be explained by an increase in shark abundance. Similarly, neither can the acute rise in sightings, thus alternative factors have to be involved.

Increase in water users

Studies of human water use in the Cape region have concluded that the number of people using False Bay for swimming, surfing, kayaking and other beach/water activities increases substantially each year (Prochazka and Kruger 2001). Additionally it was found that the average density of people using 11 beaches around the Cape Peninsula more than doubled over the last circa 30 years. Studies have shown that an increase in beach usage closely mirrors adjacent population increase as well as increasing residential developments (Glassom & McLachlan 1989, De Ruyck *et al*. 1995; Prochazka & Kruger 2001). There is therefore no doubt that that since 1991 the number of people using False Bay for various water activities has increased dramatically and will continue to do so as the population continues growing. The authors believe this substantial increase in water users (particularly of activities in which humans become vulnerable to encountering white sharks, such as surfing and paddle skiing) needs to be examined more closely and, believe it will more than likely be realised as the driving force behind shark bite frequency. Expectantly, this will be explored further in the subsequent review on this topic.

Increased awareness

Since the spate of shark bite incidents in the Cape Peninsula region people have become increasingly aware of the presence of white sharks, largely due to the media. Furthermore people are more vigilant towards spotting for white sharks, especially in the Muizenberg and Fish Hoek region. Current research clearly shows that white sharks are distributed throughout False Bay (authors unpublished data). Preliminary information indicates that Simon's Town has relatively high levels of shark activity (higher than most sites at Muizenberg or Fish Hoek) (Fig. 10), and although they are spotted here occasionally, the sighting rate at Fish Hoek and Muizenberg is considerably higher. Sharks also regularly occur along the eastern shores of False Bay (Gordon's Bay and Koeël Bay), but sightings are rare in this area. Similarly the sighting rate at beaches, like at Mossel Bay and Gansbaai, where white sharks frequently swim within a few 100 meters of beach users, is low. The authors contribute these low sighting rates to a decrease in vigilance and unawareness in these areas, in addition to few high vantage points (unlike False Bay), which would facilitate spotting sharks, not a decrease in the number of sharks.

8. Conclusions

The original premise of this paper was set to describe temporal trends in the abundance and behaviour of white sharks in False Bay. Speculation exists claiming a dramatic rise in the sightings of white sharks, and that this in turn is a driving factor behind the recent spate of shark bites in the False Bay region. Although some evidence exists suggesting that False Bay is dominated by a restricted sector of South Africa's white shark population (namely a high ratio of large female sharks), most evidence suggests that the population should be

considered open. As such, increases and decreases in numbers would be reflected ubiquitously in all regions of South Africa. Despite limitations in available data, current indications suggest that since protection, South Africa's white shark population has remained stable or possibly increased slightly (circa 1.6 % per annum), and clearly is not increasing at its potential intrinsic rates of increase (i.e. 4.0 - 11.9 % per annum). This provides a strong argument that other factors are contributing to retarding the population's recovery. Such factors may include (a) a skewed population structure with fewer than expected sexually mature females, thereby hampering recruitment, (b) the population is already approaching its natural carrying capacity, or (c) human induced mortality (sharks nets and unaccounted fishing) is having a greater impact than we calculate. A secondary possibility to explain the reported sighting increase is that the behaviour of white sharks within the bay has altered, and sharks are spending progressively more time inshore where they can potentially encounter humans. We illustrate that white sharks naturally occur near shore, that this behaviour pattern is wide spread nationally and internationally, and that it has most likely occurred for numerous years. As such, the most plausible explanation for the apparent increase in sightings is the public's increase in awareness of white shark presence and subsequent increased vigilance.

Historical data confirms a conspicuous presence of white sharks in the False Bay region during years preceding protection, yet shark bite rate was markedly low. More recently, the recent spate of shark bite incidents (post 1997) cannot be explained by an increase in white shark numbers due to the population's inability to expand sufficiently quickly. Our most optimistic estimation for abundance increase since protection (factor of 0.28 - 0.31) dramatically fails to explain the jump in shark bite rate observed since protection (factor 2.13). As such, alternative explanations are required to explain the recent spate of shark bite incidents.

9. Recommendations

- Utilize mark-recapture models, using telemetry or photo-identification methodology, to determine absolute abundance of white sharks
- Continue monitoring white shark movement and behavioural patterns to (1) identify possible future changes in distribution within False Bay and possibly on a larger scale, (2) identify 'hotspot' areas and times of year of white shark presence within False Bay, (3) identify site-fidelity and residency patterns within False Bay, (4) identify factors driving behavioural patterns identified
- Recognise that False Bay provides an essential habitat for white sharks in South Africa and due to hosting a relatively large proportion of adult (sexually mature) white sharks, it may be particularly important for sustaining a healthy white shark population.
- Recognise that invasive management solutions for white sharks occurring in False Bay is likely to have negative ramifications for white shark numbers nationally and possibly internationally

- Support development and ratification of non-invasive management policies premised on co-existence of humans and white sharks in the False Bay region

10. Acknowledgements

The authors would like to acknowledge and thank the False Bay community and The City of Cape Town for their support of the current False Bay White Shark Ecology Project. This paper represents a review of a number of research projects and initiatives that have been conducted throughout South Africa by the authors, supervisors and a number of collaborators. Linda Stavrees, Dandy Reynolds from DEAT have contributed time and experience to projects. We would like to acknowledge the work of the Natal Sharks Board, and their scientists, whose long-term data we relied heavily on in generating this paper.

Such work would not have been possible without the support and assistance of many institutes and individuals. We would like to acknowledge the Save Our Seas Foundation (SOSF), the World Wide Fund for Nature - South Africa (WWF-SA) and International Fund for Animal Welfare (IFAW) for sponsorship and logistical support of the various research projects used in this review. The University of Pretoria (UP), University of Cape Town (UCT), National Research Foundation (NRF) and Marjay Trust have provided various postgraduate bursaries and funding to the contributing authors. The South African Navy (Simon's Town), The Institute for Maritime Technology and Shark Diving Unlimited, in particular Michael Rutzen and Morne' Hardenberg, provided invaluable logistic support. We would also like to thank the City of Cape Town, in particular, Mr. Gregg Oelofse, for their continued support.

Scientific observers and assistants included; Tina Aydon, Dan Betts, Taffeta Bourke, Andy Brandy Casagrande, Julian Charivas, Ross Coventry, Neil Crooks, Marie Cuvier John Daniels, Ingrid, Lauren Ewing, Kathryn Ferguson, Lisa Haanke, Jennifer Hankock, Darren Hunniford, Amy Jewiss, Sanjay John, Nick Jones, Graham Horton, Jennifer Kiab, Sue Fen Kwa, Theodorus Koutroukides, Tamara Lodge, Mario, Andrea Marshall, Hannah Medd, Johann Mourier, Danny Muir, Pam Porteous, Ben Savage, Shane, Timo Seckler, Catharine Smith, Trey Snow, Peter Stratford, Catherine Vermeulen, Katja Walther, Lelani Weitz, Gregory Wright, Bethen Young. Cage diving operators: Shark Africa, Marine Dynamics, White Shark Diving Tours, White Shark Diving Company, White Shark Adventures, Ecoventures, Shark Lady Adventures, Shark Diving Unlimited allowed the use of their vessels for scientific observations throughout these studies.

11. References

Baum, J. K., Myers, R. A., Kehler, D. G., Worm, B., Harley, S. J. and Doherty, P. A. (2003). Collapse and conservation of shark populations in the northwest Atlantic. *Science* 299: 389 - 392

Bruce, B. D. (1992). Preliminary observations on the biology of the white shark (Carcharodon carcharias) in South Australian waters. *Australian Journal of Marine and Freshwater Research* 43: 1 - 11

Bonfil, R., Meyer, M., Scholl, M. C., Johnson, R., O'Brien, S., Oosthuizen, H., Swanson, S., Kotze, D. and Paterson, M. (2005). Transoceanic migration, spatial dynamics, and population linkages of white sharks. *Science* 310:100-103

Burgess, G.H., Beerkircher, L.R., Caillait, G., Carlson, J.K., Cortes, E., Goldman, K.J., Grubbs, R.D., Musick, J.A., Musyl, M.K., Simpfendorfer, C.A., (2006). Is the collapse of shark populations in the Northwest Atlantic Ocean and Gulf of Mexico real? Conservation perspective, Fisheries, 30 (10): 19 - 26

Casey, J.G. & Pratt, H.L. (1985). Distribution of the white shark (Carcharodon carcharias) in the western North Atlantic. *Memoirs of Southern California Academy of Science* 9: 2 - 14

Cliff, G. and Dudley, S. F. J. (1992). Protection against shark attack in South Africa, 1952 – 1990. In: 'Sharks: Biology and Fisheries'. (Ed. J. G. Pepperell). *Australian Journal of Marine and Freshwater Research* 43: 263 - 272

Cliff, G., Dudley, S. F. J. and Davis, B. (1989). Sharks caught in the protective nets off Natal, South Africa, 2. The great white shark Carcharodon carcharias (Linnaeus). *South African Journal of Marine Science* 8: 131 – 144

Cliff, G., Van der Elst, R.P., Govender, A., Witthuhn, T. & Bullen, E.M. (1996). First estimates of mortality and population size of white sharks on the South African Coast. The Biology of Carcharodon carcharias (eds.) A.P. Klimley & D.G. Ainley, pp. 393 - 400. Academic press, California

Compagno, L. J. V. (1991). Government protection for the great white shark (Carcharodon carcharias) in South Africa. *South African Journal of Science* 87: 284 - 285

Compagno, L. J. V., Marks, M.A. & Fergusson, I.K. (1997). Threatened fishes of the world: Carcharodon carcharias (Linnaeus, 1758) (Lamnidae). *Environmental Biology of Fishes* 50: 61 - 62

Cortes, E. (1999). Standardised diet compositions and trophic levels of sharks. *ICES Journal of Marine Science* 56: 707 – 717

De Ruyck, A. M. C., Soares, A. & McLachlan, A. (1995). Factors influencing human beach choice on three South African beaches: A multivariate analysis. Geojournal 36: 345 - 352

Dudley, S. F. J. and Simplefendorfer, C. A. (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

Glassom, D. & McLachlan, A. (1989). Recreation on Port Elizabeth beaches – December / January 1987 / 1988. Unpublished report of the Institute for Coastal Research. University of Port Elizabeth, Report Number 19

Hoenig, J. M. and Gruber, S. H. (1990). Life-history patterns in the elasmobranchs: Implications for fisheries management

Levine, M. (1996). Unprovoked attacks by white sharks off the South African coast. The Biology of Carcharodon carcharias (eds.) A.P. Klimley & D.G. Ainley, pp. 435-448. Academic press, California

Mollet, H. F. and Cailliet, G. M. (2002). Comparative population demography of elasmobranchs using life history tables, Leslie matrices and stage-based matrix models. *Marine and Freshwater Research* 53: 503 – 516

Pardini, A. T., Jones, C. S., Noble, L. R., Kreiser, B., Malcolm, H. Bruce, B. D., Stevens, J. D., Cliff, G., Scholl, M. C., Francis, M., Duffy, C. A. J. and Martin, A. P. (2001). Sex-biased dispersal of great white sharks. *Nature* 412: 139 – 140

Pepperell, J. G. (1992). Trends in distribution, species composition and size of sharks caught by gamefish anglers off south-eastern Australia. *Australian Journal of Marine and Freshwater Science*. 43: 213 - 225

Prochazka, K. & Kruger, L.M. (2001). Trends in beach utilisation on the Cape Peninsula, South Africa, during and after Apartheid. *Transactions of the Royal Society of South Africa* 56 (1): 25 - 40

Pyle, P., Anderson, S.D, Ainley, D.G. (1996). Trends in white shark predation at the South Farallon Islands, 1968-1993. The Biology of Carcharodon carcharias (eds.) A.P. Klimley & D.G. Ainley, pp. 375 - 379. Academic press, California

Reid, D. D. and Krough, M. (1992). Assessment of catches from protective shark meshing off New South Wales beaches between 1950 and 1990. *Australian Journal of Marine and Freshwater Research* 43: 283 – 296

Smith, S. E., Au, D. W. and Show, C. (1998). Intrinsic rebound potentials of 26 species of pacific sharks. *Marine and Freshwater Research* 49: 663 – 678

Walker, T. I. (1998). Can shark resources be harvested sustainably? A question revisited with a review of shark fisheries. *Marine and Freshwater Research* 49: 553 - 572

A review of shark attacks in False Bay and the Cape Peninsula between 1960 and 2005

Geremy Cliff

Natal Sharks Board, Private Bag 2, Umhlanga 4320 South Africa;
Email: cliff@shark.co.za

Abstract

According to the records of the South African Shark Attack File, which are kept by the Natal Sharks Board, there were 25 shark attacks in the waters of False Bay and the Cape Peninsula between 1960 and 2005. These statistics exclude provoked attacks, attacks on large craft and cases of posthumous scavenging but include cases in which surfboards were bitten without injury to the rider. Despite the low annual number and possible underreporting, the incidence of shark attack rose with each decade. Four of the attacks were fatal, three of which were in the last three years. Spearfishermen were involved in nine incidents and reasons for them being a high-risk group are discussed. The incidents occurred in every month of the year, with no peak during December and January when numbers of beach users are likely to be highest. Twenty incidents occurred in False Bay, of which four took place at both Muizenberg and Fish Hoek. Water clarity and depth and distance offshore did not appear to have an important impact. Great white sharks *Carcharodon carcharias* are thought to have been responsible for at least 22 incidents. The trend of an increase in the number of attacks with time is also evident in the Western Cape as a whole, the Eastern Cape, as well as many other parts of the world. This is attributed to the growing number of people participating in water sports such as wave riding and diving. Recommendations are put forward to reduce the incidence of shark attack and to prevent fatalities. In future, incidents must be more thoroughly investigated and ideally by a dedicated individual based in Cape Town.

Citation: Cliff G. 2006. A review of shark attacks in False Bay and the Cape Peninsula between 1960 and 2005. *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. Introduction

This paper reviews shark attacks in the waters of False Bay and the Cape Peninsula, referred to in this study as the waters of Cape Town, between 1960 and 2005. It provides a comparison with trends in shark attack elsewhere in South Africa and in other parts of the world.

2. Historical background and formation of the South African Shark Attack File

Shark attack in Cape Town is not a recent phenomenon. The second earliest record of a shark attack along the South African coast was in 1900 when a male prisoner of war had a leg severed at Seaforth; a second fatality occurred at Windmill Beach, Simonstown in 1901 (Davies 1964). In the first six decades of the 20th century there were nine incidents, of which four were fatal. Three of the incidents occurred at Melkbaai, Strand in December and January, one of which involved a "7ft blue pointer in clear water 60 yards from the shore". It is assumed that most of the victims were swimming at the time, although Davies (1964) states at least one was a diver.

These scant records were listed in a table of attacks for the Cape Province by Davies (1964), who was Director of the Oceanographic Research Institute in Durban at the time. He started the South African Shark Attack File (SASAF) in 1960 at a time of intense interest in the biology and behaviour of sharks, and in shark attack and its prevention in KwaZulu-Natal (KZN). Wallett (1983), who was employed as a researcher at the Natal Sharks Board from 1972-1976, added to the File. The File has been maintained by the Natal Sharks Board for over two decades. The details for many of the early Eastern and Western Cape incidents are very limited, while others may not be listed in the SASAF at all because they received little or no attention in the national press.

3. Recording of shark incidents

Cliff (1991) presented a list of incidents that occurred between 1960 and 1990 on the South African coast and an analysis of the associated trends. He defined an incident or attack as any physical contact between shark and victim or diving equipment worn on the body, or the victim's personal craft, even if the rider of the craft was uninjured. Provoked attacks and cases of posthumous scavenging were omitted, as were contacts with larger craft, such as yachts and fishing boats.

Non-fatal injuries were regarded as serious if they resulted in the loss of a limb, the removal of portions of muscle tissue, the puncturing of the peritoneum or the severing of major nerves and tendons. Bite patterns, descriptions of the sharks by victims or eye witnesses and the

occasional discovery of a tooth fragment were used to try and identify the species responsible.

4. Results

There were 25 shark attacks in the SASAF for the period 1960-2005 from Cape Town (Table 1). Despite the low numbers, including 26 years in which there were no incidents at all, and possible underreporting in the earlier years, the number of incidents per decade has increased steadily from one (0.1 per annum) in the 1960s through to eight (1.3 per annum) in the current decade.

Severity of injuries

There were only four fatalities, but it is noteworthy that three of these have occurred in the last three years. The other fatality was in 1997 when a spearfisherman disappeared at Pringle Bay. Of the non-fatal injuries eight were minor and eight serious. Five incidents resulted in no injuries to the victim, but diving or board-riding equipment was damaged.

Activity of the victims

The most outstanding feature of the 25 incidents was that nine (36%) involved spearfishermen (Figure 1). Although spearfishing is practised along the much of the South African coastline, it is a highly demanding, breath-hold activity (use of scuba is illegal) and is therefore far less popular than wave riding. Spearfishers are at greater risk than other recreational users of the sea in that they may venture far offshore, into water up to 30 m deep, spend several hours in the water, mostly at the surface, where they are highly conspicuous silhouettes and handle bleeding and struggling fish, which are highly attractive to sharks. As spearfishers often see sharks, they generally understand and accept the risk of an attack but they have also been known to shoot highly inquisitive or aggressive sharks with powerheads (an explosive device fitted to the end of the spear). Scuba divers are a low risk group, with only two incidents, none of which resulted in injury. Such diving generally takes place in large groups and generates a huge amount of noise, which may deter any sharks in the area. One of the two incidents occurred while divers were feeding fish with redbait.

Wave riding is possibly the most popular aquatic recreational activity in the region and four victims were surfers and two were bodyboarders. Of the four incidents involving swimmers, three were in 1970s. Swimmers generally spend far less time in the water and remain closer to the shore than the other users.

Table 1: List of shark attacks in False Bay and Cape Peninsula, 1960-2005

Name	Date	Locality	Activity	Injury	Region	Species	Time	Distance	Depth	Clarity
							(h)	(m)	(m)	(m)
AS	08-Feb-64	Muizenberg	body boarder	minor	right ankle	unknown	8	75	1	
ST	16-Feb-71	Fishhoek	swimmer	serious	right wrist	*C. carcharias*?	14	10	3	10
CL	31-Dec-72	Millers Point	swimmer	serious	left leg & foot	unknown		40		
GS	27-Nov-76	Clifton	swimmer	serious	Chest	*C. carcharias*?	16	250	5	30
RC	10-Jan-83	Muizenberg	sailboard	minor	Foot	unknown	18	200	3.5	
AL	20-Aug-83	Seal Island	spearfisher	minor	Thigh	*C. carcharias*	10		8	6
SD	15-Jun-84	Muizenberg	surfer	none	Surfboard	*C. carcharias*	17			
IJ	04-Jan-85	Buffels Bay	spearfisher	minor	Chest	*C. carcharias*	11	150	15	7
DS	11-Oct-87	Seal Island	spearfisher	minor	arm & leg	*C. carcharias?*	12		6	8
GvN	17-Sep-89	Smitswinkel	spearfisher	minor	Torso	*C. carcharias?*	14	250	8	6
NG	15-Sep-90	Oudekraal	spearfisher	minor	Hand	*C. carcharias*	13	150	10	8
EH	15-Feb-91	Miller's Pt	spearfisher	minor	Foot	*C. carcharias*	12	200	8	6
CM	13-May-91	Gordons Bay	scuba diver	none	dive cylinder	*C. carcharias*	13	1500	15	
CM	19-Oct-97	Gordon's Bay	scuba diver	none	dive gear	*C. carcharias*	10	100	11	3
IH	28-Dec-97	Pringle Bay	spearfisher	fatal	body not recovered	*C. carcharias?*	13	200	12	5
CL	01-Aug-98	Pringle Bay	spearfisher	serious	Foot	C. carcharias	13	5	3	5
SC	29-Jul-99	Kogelbaai	Surfer	serious	right thigh and upper leg	*C. carcharias*	15	20	2	3
PM	13-Sep-02	Fish Hoek	surf ski rider	none	ski rudder	*C carcharias*	15	100	3.5	7
CB	24-Dec-02	Scarborough	snorkel diver	serious	both hands and forearms	*C carcharias*	15	60	7	1.5
DB	12-Sep-03	Noordhoek	body boarder	fatal	left thigh and buttocks	*C carcharias*	15	70	3	1
JPA	05-Apr-04	Muizenberg	Surfer	serious	entire right leg amputated	*C carcharias*	14	30	2.5	1.5
TW	15-Nov-04	Fishhoek	swimmer	fatal	body not recovered	*C carcharias?*	8			
CS	28-Mar-05	Noordhoek	Surfer	serious	board; right lower leg & foot	*C carcharias*	9	60	3	
HM	04-Jun-05	Miller's Point	spearfisher	fatal	body not recovered	*C carcharias*	15	150	4	
TW	01-Oct-05	Fish Hoek	surf ski rider	none	ski front	*C carcharias*	15	80		1

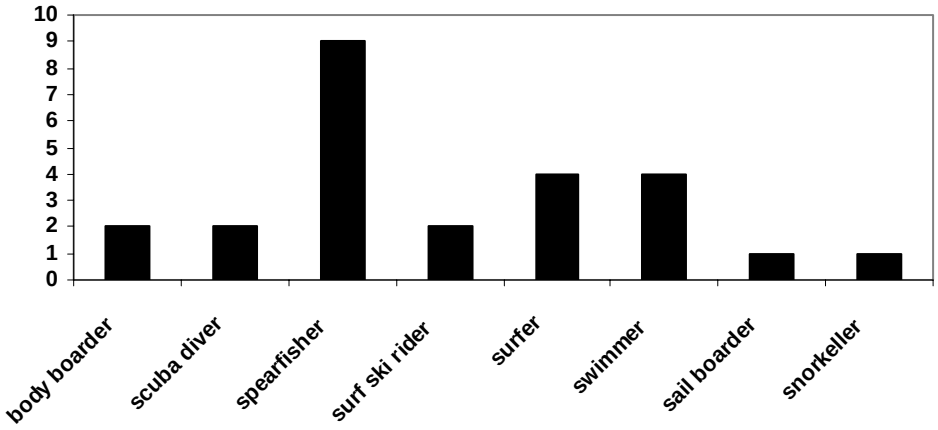


Figure 1: Activity of the 25 shark attack victims in Cape Town, 1960-2005.

Seasonal and temporal trends

The 25 incidents were spread throughout the year, occurring in every month, with a maximum of four (16%) in September. There was no peak in the major holiday periods of December and January, when numbers of people in the water are likely to be the highest. The incidents occurred throughout the day between 08:00 and 19:00, with a peak of 6 (24%) between 15:00 and 16:00.

Geographical distribution

There were 20 incidents in False Bay (Figure 2), with five on the east coast (Gordons Bay to Pringle Bay), 10 on the north coast (Muizenberg to Fishhoek, including Seal Island) and five on the west coast (Millers Point to Buffelsbaai). Five incidents took place in the Atlantic Ocean on the western side of the Peninsula, of which two were at Noordhoek. The highest number of incidents was at Muizenberg and Fish Hoek (four each).

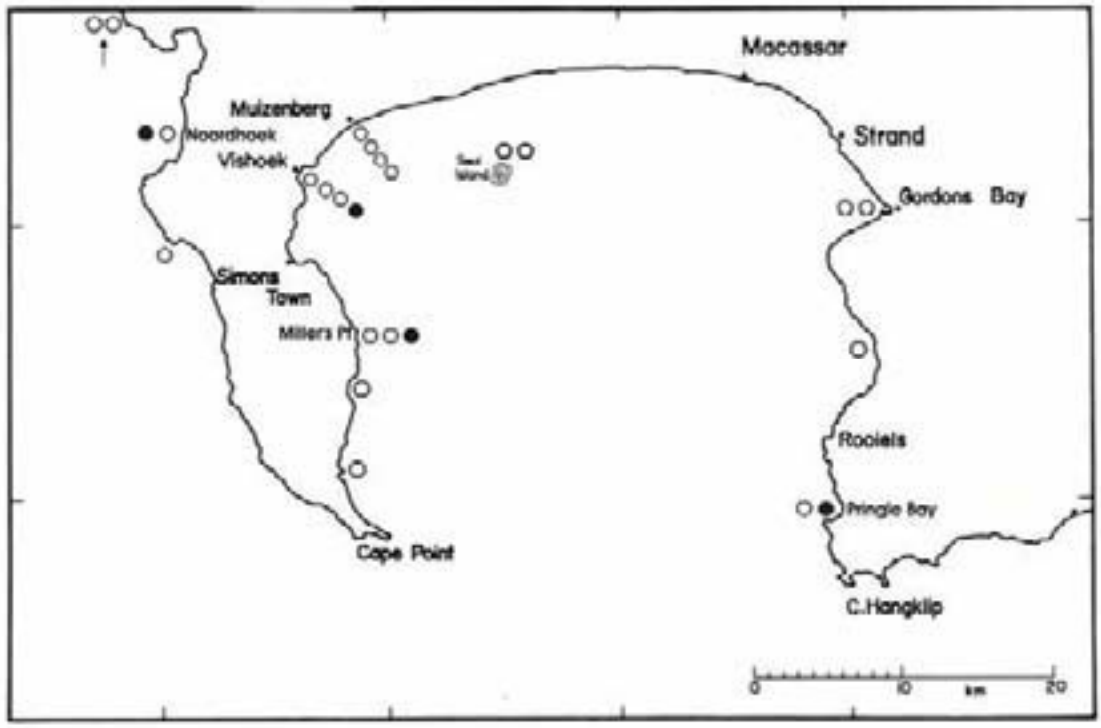


Figure 2: Locations of Cape Town shark attacks: 1960-2005. Solid circles represent fatalities, open circles represent no-fatalities. The two open circles at the top left of the map next to the up arrow represent incidents at Oudekraal and Clifton.

5. Environmental factors

Water turbidity did not play appear to play a role, with only four incidents (23% of the 17 incidents in which estimated water clarity was recorded) in turbid water (clarity of 1.5 m or less). The range in water clarity was 1-30 m with a median of 7 m. Only one of the 21 incidents in which water depth was estimated occurred in very shallow water - 1.5 m. The range was 1-15 m, with a median of 6 m. Distance offshore ranged from 5-1500 m (21 incidents), with a median of 100 m. Water temperature was noted in several attacks, but in almost all cases it was estimated. In several cases potentially valuable information such as the presence of seals, intense fish or fishing activity was not recorded.

6. Species responsible

In 22 incidents great white sharks *Carcharodon carcharias* were thought to be responsible; the species involved in the remaining three is not known. White sharks are common in the region, particularly False Bay. This species and the tiger *Galeocerdo cuvier* and the bull/Zambezi shark *Carcharhinus leucas* are responsible for most of the serious shark attacks in coastal waters

around the world, including South Africa (Cliff 1991). The other two species are tropical in their distribution and do not occur off Cape Town (Compagno 1984a). Other potentially dangerous shark species in the region are the raggedtooth *Carcharias taurus*, the copper or bronze whaler *Carcharhinus brachyurus*, the spotted sevengill cowshark *Notorynchus cepedianus* the smooth hammerhead *Sphyrna zygaena* and shortfin mako *Isurus oxyrinchus.* These species are far smaller and less aggressive than white sharks and are therefore wearier of approaching humans. All but the cowshark have dentition suited to seizing small prey such as fish and small sharks, rather than removing chunks from large prey (Compagno 1984a,b). While caution must be shown in assuming that white sharks are responsible for every shark attack off Cape Town, it is safe to conclude that it is only the great white shark that poses a major threat in these waters.

7. Motives for attack

There are at least three possible motives for an attack, namely:

- *Hunger* – where a human is mistaken for the shark's natural prey. The silhouette of a wetsuit-clad human at the surface could be mistaken for that of a seal (McCosker 1985);
- *Curiosity* – where the shark is making an investigatory bite out of curiosity. Many large sharks, particularly white sharks, will often mouth an inanimate object (Collier *et al* 1996);
- *Aggression* – where the shark is responding to the presence of an intruder, much like a dog will attack someone who encroaches its space.

In many attacks it is difficult to determine the shark's motive. A rapid strike, which is aborted before the bite has been completed, may be the result of a hungry shark encountering the unfamiliar taste of a fibreglass board or a neoprene-clad limb or it could be an aggressive shark merely wanting to chase away the intruder. White sharks larger than 2 m have little to fear other that larger white sharks and will often approach humans. The high incidence of scars on white sharks is probably a reflection of high levels of intraspecific aggression. Unfortunately human skin provides no protection against the attentions of even a curious white shark. It is very unusual for a shark to consume its victim, although the bodies of three of the four fatalities were apparently never recovered, despite intensive searches.

White sharks are renown for their aggressive nature and large individuals will even attack fishing boats. Wallett (1983) described several such incidents along the north coast of False Bay, particularly off Macassar. Between 1974 and 1977, Danie and Fanie Schoeman often actively fished for trophy-sized white sharks. Their boat was attacked on five occasions, but they hooked and boated 18 white sharks of 3-5 m. These catches and those of other trophy hunters prior to the declaration of the white sharks as a protected species in 1991 (Compagno 1991) may well

have lowered the incidence of shark attack in False Bay at the time and the several years thereafter.

8. Comparison with other areas

Historically the scarcity of incidents in colder waters, such as those of the Western Cape, lead Coppleson (1962) to conclude in his world study of shark attack that there is a close relationship between sea temperature and shark attack, with 70°F (21°C) being the critical temperature. Water temperature is now regarded as having a far greater impact on the recreational habits of humans in the sea than it has on shark behaviour. Cold tolerance in swimmers is rapidly lowered as water temperature drops below 21°C and time spent in the water is reduced accordingly. Since the 1970s there has been an increase in the number of shark attacks in colder waters of the Eastern and Western Cape (Figure 3) (Cliff 1991), as well as Australia (Coppleson and Goadby 1988). This has been attributed to the increasing popularity of water sports such as board riding and diving through the development of neoprene wetsuits, glassfibre surfboards and other personal watercraft and a variety of diving equipment.

Along the entire South African coast there were 201 incidents between 1960 and 2005, which is average of 4.4 per annum. In the last 16 years there were 95 incidents, with a mean of 5.9 per annum.

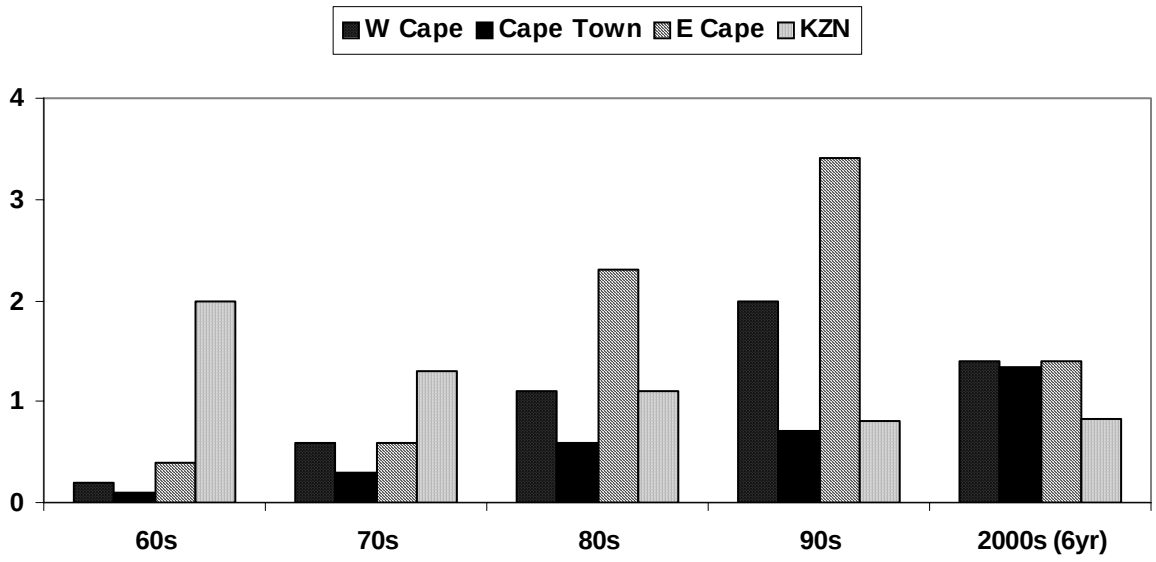


Figure 3: Number of attacks per decade in the three provinces, Western Cape, Eastern Cape and KwaZulu-Natal and the waters of Cape Town.

Western and Northern Cape

In the Western Cape as a whole there were 53 attacks between 1960 and 2005, of which just under a half (47%) have been off Cape Town (Table 2). Other attack localities were Mosselbaai (6) and Stilbaai and Buffelsbaai (3 each). The annual number of incidents increased over the first four decades, but, unlike Cape Town, has dropped in the current decade (Figure 3). There have been very few incidents in the Western Cape north of Table Bay and none along the entire Northern Cape coast. This is because few people use this extensive section of coast for in-water recreation. White sharks were implicated in 39 (73%) incidents. In the last 16 years there were 34 incidents (2.1 per annum), of which 15 were off Cape Town (0.9 per annum).

Table 2: Summary of attack statistics for Cape Town, Western Cape, Eastern Cape and KwaZulu-Natal.

	Cape Town	**Western Cape**	**Eastern Cape**	**KwaZulu-Natal**
Attacks per annum: 1960-2005	0.5	1.1	1.8	1.2
% Attacks by white sharks: 1960-2005	88	73	35	5
Attacks per annum: 1990-2005	0.9	2.1	3	0.9
% Fatal: 1990-2005	20	21	6	7

Eastern Cape

In the Eastern Cape there were 81 attacks in the same 46 year period (Table 2), with the highest number in the East London region (28), especially Nahoon Beach (21), followed by Port Elizabeth (8), Jeffreys Bay (7) and Cape St Francis (6). These locations are internationally renown surfing spots so it is not surprising that 65% of the victims were wave riders, mostly surfers. Like the Western Cape, the numbers of attacks per decade increased for the first four decades, but has fallen in the current decade (Figure 3). Many incidents involved raggedtooth sharks, resulting in very minor injuries, with the result that white sharks were only implicated in 35% of incidents. In the last 16 years there were 48 incidents (3 per annum).

KwaZulu-Natal

In KZN, where historically most shark attacks occurred, there were 57 incidents in the period 1960-2005 (Table 2), of which 35% were in the 1960s. The number of incidents was greatly reduced by the widespread introduction of shark nets in the mid 1960s (Figure 3). White sharks were implicated in only three (5%) incidents. In the last 16 years there were 14 incidents (0.9 per annum), of which three took place inside or very close to the shark nets.

9. Global perspective

The International Shark Attack File (*www.flmnh.ufl.edu/fish/Sharks/ISAF/ISAF.htm*) stated that worldwide, the 1990s had the highest total number of attacks of any decade and that this trend looks set to continue, with 58-78 shark attacks (3-11 fatalities) per annum in the current decade. While this is reflective of the ever-increasing amount of time spent in the sea by humans, fatality rates have dropped from 13% in 1990s to 8% in the present decade, due to advances in beach safety practices and medical treatment, and increased public awareness of avoiding potentially dangerous situations. Most of the attacks occurred in the USA, in particular Florida. In 2005 surfers and other boardriders made up 54% of the victims and swimmers 37%. Divers, including snorkelers, constituted only 5%.

There were 99 great white shark attacks worldwide in the last 16 years (6.2 per annum; ISAF website), of which 23 (23%) were fatal. Nearly half of these were in South Africa. Comparative figures for Cape Town over the same period were 15 white shark incidents (0.9 per annum), of which 27% were fatal.

10. Summary and Recommendations

In analysing the 25 shark attacks that have taken place off Cape Town over the last 46 years, no causative factors and few patterns emerge, although many of the incidents have not been exhaustively investigated. Great white sharks are the culprits in almost all cases, while spearfishermen represent the group that are at greatest risk. The number of attacks is low, but it has increased with each decade. This increase can be attributed to a regional and national rise in the number of people using the sea for recreation, particularly for activities such as surfing, paddling and diving. The fact that there have been three fatal attacks and another three resulting in serious injury in the last four years has resulted in considerable publicity. It is important to work with the media to minimise the sensationalism associated with these incidents.

There are a number of options to reduce the incidence of shark attack, which will be discussed elsewhere in this workshop. A better understanding of the movement patterns of white sharks, particularly in False Bay, is needed and will no doubt be achieved by various tagging and tracking projects. The use of spotters to warn swimmers of approaching sharks is certainly beneficial, but it could also scare beach users. There are other initiatives that would not prevent shark attack but could certainly save the lives of shark attack victims. These include:

- The availability of shark attack packs at all known or potential attack sites;
- Training of surfers and other sea users in first aid associated with a shark bite;
- A well organised emergency medical service.

It is imperative that all shark attacks are investigated and documented. This is best done by an individual/s based in Cape Town who can visit the scene, interview the victim and eye-witnesses, examine and photograph bitten surfboards and wetsuits, obtain photographs of the injuries and request that wounds or bitten equipment are X-rayed to check for tooth fragments. Prevailing environmental conditions and activities must be recorded. Press cuttings should be kept on each incident, although the information they contain should always be verified. The investigators will soon develop a working relationship with emergency and medical personnel to ensure that incidents which may be withheld from the media are still documented. The insensitive and indiscriminate distribution of digital images of the victim's wounds, such as occurred following the fatality at Noordhoek in 2003, must be avoided.

The standard questionnaire prepared by the Natal Sharks Board could be used. Incidents in which sharks merely investigate ("buzz") an individual should be documented, but not necessarily in the same detail as an attack. The NSB is willing to act as a depository for copies of all this information, to assist in determining the species of shark responsible and to be involved in the periodic analysis of this information. The NSB does receive press cuttings that appear in the major daily and weekend newspapers on shark attack through a service agency.

11. Acknowledgments

I would like to thank those individuals in Cape Town who have assisted with the documentation of the shark attacks and various Natal Sharks Board staff who have assisted in the compilation of the reports on each shark attack.

12. References

Cliff, G. 1991. Shark attacks on the South African coast between 1960 and 1990. *South African Journal of Science* **87**(10): 513-518.

Collier, R.S., M. Marks and R.W. Warner 1996. White shark attacks on inanimate objects along the Pacific coast of North America

Compagno, L. J. V. 1984a. F.A.O. species catalogue. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. (1) Hexanchiformes to Lamniformes. *F.A.O. Fish Synop.* **125**: 1-249.

Compagno, L. J. V. 1984b. F.A.O. species catalogue. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. (2) Carcharhiniformes. *F.A.O. Fish Synop.* **125**: 251-655.

Compagno, L.J.V. 1991. Government protection for the great white shark (*Carcharodon carcharias*) in South Africa. *South African Journal of Science* **87**(7): 284-285.

Coppleson, V.M. 1962. *Shark Attack.* Angus and Robertson, Sydney 269 pp.

Coppleson, V.M. and P. Goadby. 1988. *Shark Attack. How, Why, When and Where Sharks Attack Humans.* Angus and Robertson, Sydney: 262 pp.

Davies, D.H. 1964. *About Sharks and Shark Attack.* Shuter and Shooter, Pietermaritzburg: 237 pp.

McCosker, J.E. 1985. White shark attack behavior: observations of and speculations about predator and prey strategies. *Southern California Academy of Sciences,* Memoirs **9**: 123-135.

Wallett, T. 1983. Shark Attack in Southern African Waters and Treatment of Victims. Struik, Cape Town: 184 pp.

Governance

Governance and Responsibilities: White shark management and recreational safety in the Cape Metropole

Gregg Oelofse

44 Wale Street, City of Cape Town;
Email: Gregg.oelofse@capetown.gov.za

Abstract

The issue of governance and responsibility for safety of recreational water users from the threat of attack by White Sharks is unclear and complex. White Shark management resides with the Department of Environmental Affairs and Tourism, however, the impacts and consequences of shark attacks impacts all three government spheres and associated parastatals. These complexities of responsibility are aggravated by the decidedly grey area of governmental jurisdiction and delegation relating to the coastal zone and the interface between the marine and terrestrial environments. An effective recreational safety strategy, coordinated through formalised cooperative governance between all spheres of government, must be considered a key element in any holistic conservation strategy for White Sharks. Currently the opportunity exists for proactive, informed, considered and well designed approaches to be implemented that are in the interests of both people and White Sharks. Optimising this opportunity is likely to ensure that reactive and economically driven short term and potentially undesirable measures are avoided.

Citation: Oelofse G. 2006. Governance and Responsibilities: White shark management and recreational safety in the Cape Metropole. *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. Introduction

The issues of governance and responsibility regarding White Shark management and recreational safety in South Africa, especially in the Cape Metropole, are complex and not clearly defined and described. The conservation and management of White Sharks, including declaring it a protected species, the permitting of non-consumptive activities such as cage diving, research and monitoring of populations and enforcement of relevant regulations clearly fall within the delegated authority of the Department of Environmental Affairs and Tourism (DEAT). However, the implementation of these management objectives when viewed holistically, are far more complex.

South Africa is governed through a three-tiered system of governance, namely National, Provincial and Local Government. Each of these spheres of governance have prescribed and legislated areas of competence as set out in the South African Constitution. Within the Cape Metropole there are a further two government parastatals that have areas of coastal and marine responsibility and jurisdiction, namely the South African National Parks and CapeNature. South African National Parks (Table Mountain National Park) manages the Marine Protected Area and CapeNature is the delegated authority for the area between the high and low water mark.

This paper does not attempt to assign responsibility regarding white shark safety for people, but more importantly, discusses and highlights the complexities that exist and proposes a number of recommendations around an institutional arrangement that best serve not only the government institutions involved, but both the public and white sharks.

2. Legislation Reviewed

In writing this paper the following legislation was reviewed to provide input to the discussions:

- South African Constitution (1996)
- National Environmental Management Act 107 (1998)
- Municipal Systems Act 32 (2000)
- Marine Living Resources Act 18 (1998)
- Seas Shores Act 21 (1935)
- White Paper on Coastal Development (2000)

3. Description of Complexities

Given that it is a clearly defined and legislated responsibility that DEAT is the responsible governing body regarding white shark management, conservation, compliance, the permitting of non-consumptive activities such as cage diving, research and monitoring of populations, the question arises as to what are the complexities?

The logical progression would follow that DEAT would therefore also be responsible for the safety of other users within the same environment. Surely management delegations, practises and policies are guided by a range of principles including managing conflict between species, safety and mitigating the impact of human activities on the ecology and behaviour of white sharks?

This is in fact not necessarily the case and is where the complexities begin.

The confusion arises through the very nature not only of sharks and shark attacks but through the decidedly grey area of coastal management. A large proportion of shark attacks, and the greatest focal area for shark safety, occurs within the inshore area which is most easily accessible to recreational users. This inshore area (as opposed to the deep sea) is, or lies adjacent too, the interface between the marine and terrestrial environment, commonly known as the coastal zone. It is here that delegated responsibilities for governance are defined not by ecological process and human activities and a recognition that these integrate across marine and terrestrial environments, but rather by the high and low tide mark. In other words, quite literally in terms of governance and responsibility, a line has been drawn in the sand.

Secondly, shark attacks by their nature impact on a range of government competencies. An attack on a bather at a beach not only becomes an issue of safety for the individual, but impacts directly on broader issues such as tourism, business and economy at the micro and local level, while a single attack may even impact on business, economic growth and tourism at the metropolitan, provincial and national level.

Further complexities arise if it is assumed that one government agency, in this case DEAT, is responsible for management of white sharks, while a separate government sphere, in this case the City of Cape Town, is responsible for the safety of recreational users. In this example management principles being applied by DEAT that are beyond the control of the sphere of government responsible for safety, could arguably be enhancing risk factors. Conversely, in this example, safety mechanisms and practises initiated by the sphere of government responsible for safety may jeopardise the management goals of DEAT, and may in fact even be in direct conflict with those management goals, policies and principles.

The precedent that management practises must take place within a framework of safety, and that reasonable responsibility does sit with the managing authority, is supported by a question tabled in Parliament in February 2005 where the Democratic Alliance requested that the Minister of Environmental Affairs and Tourism to respond directly to the suggestion that cage diving increased the incidence of shark attacks in coastal areas.

4. Current Defined Roles and Responsibilities

The South African Constitution provides the framework for roles and responsibilities at the broadest level, while the Seashore Act and Marine Living resources Act provide greater detail and powers of delegation for the Minister of Environmental Affairs and Tourism. Within the Constitution, responsibility for the environment is placed with National and Provincial Government (Schedule 4, Part A). This includes all legislated competencies relating to environmental management and ensuring that current and future generations have access to a safe and healthy environment. The Marine Living Resources Act provides for the delegation of the management of Marine Protected Areas to statutory bodies, and in the case of Cape Town, to the TMNP. Local Government is delegated responsibility by the Constitution for Beaches and Amusement Facilities (Schedule 5, Part B), as well as local tourism.

As expected none of the current set of legislation makes any specific reference to responsibility for mitigating or managing shark attacks.

The only possible argument for responsibility may be inferred through the competencies of Beaches and Amusement Facilities. The argument being that by providing an amenity on, or formal access point to, a beach, the delegated authority has the associated responsibilities of providing safety and security. However, the question would still remain if this responsibility extends beyond the delegated area of jurisdiction and into the marine environment. Further questions remain relating to responsibility of naturally occurring wild animals.

If it is argued from the delegations and roles within the Constitution that responsibility of safety rests with the organisation that either provides or manages an amenity, then both the City and the TMNP would have this responsibility within the Cape Metropole. If this is the case, the complexities are increased as under the Constitution both have the right to exercise any power concerning a matter reasonably necessary for, or incidental to, the effective performance of its functions (156(5)). This situation may potentially lead to a conflict between local government (no powers to manage white shark populations or activities) and DEAT which does have the power to manage white sharks. This situation from a local government perspective would allow them to claim that they are unable to perform their designated function of providing safety and therefore cannot be held responsible, thus deferring responsibility back to DEAT. As discussed later in the paper, this situation must be avoided in the interests of both people and white sharks.

5. Legal Responsibility for Safety and Possible Liability

The legal extent to which any government sphere may be held responsible or liable for a shark attack is not sufficiently clear to make an absolute statement in this paper. The research undertaken for this paper could not establish a single case globally where any

government has been held liable for a shark attack on an individual. In South Africa no example exists. Further no one set of rules or situation would apply as a range of factors and circumstances would inform a legal outcome around each specific shark attack. Each case would be different due to the nature of shark attacks and the victims' location and activity at the time of the attack. It is therefore likely that legal responsibility would only emerge through a litigation process in which a victim or family of a victim took legal action against one of more of the spheres of government. In other words liability would be determined in a test case that could possibly set the future legal precedent around this issue. However for the purpose of this discussion it is worth noting and considering the following:

a) Broadly speaking both legally and socially it is globally recognised that using the ocean (in all forms) holds inherent risks and that the concept of "use at own" risk applies.
b) Sharks are universally accepted as naturally occurring wildlife and predators within the worlds' oceans.
c) Rights of access to the beach/coast for all South Africans are legally established. Given that people may therefore access the ocean across more than 2500km of coastline, legally it may be argued that it is not reasonable to ensure that any sphere of government can provide safety to this extent.
d) Certain activities are higher risk than others. Examples such as spear fishing, SCUBA diving, open ocean swimming, surfing and kayaking expose the individual to various safety risks by their own choice

However, it should also be noted, that liability and responsibility may be more strongly argued under the following situations:

a) Any government body found to have acted in such a way that the public was intentionally misinformed or uninformed about known dangers and risks (an example here would be if government intentionally kept information from the public that large numbers of white sharks were present in the inshore area)
b) Any policies actively implemented that are shown to have resulted in an attack. (An example here would be if it was proved that cage diving – either the practise or the location of the activity – led directly to an attack on an unrelated victim and the government had acted irresponsibly/unreasonably in allowing the activity to take place or had been negligent in its duties in assessing all options).
c) Any government body found to be promoting an activity that was shown to have resulted in an attack on an unrelated individual.
d) If government was shown to have not taken "reasonable" measures to inform or warn the public of potential dangers or reasonable measures to minimise the risk of known danger
e) If a government body charged the public an entrance fee specifically to the beach and swimming area and promoted it as a safe recreational amenity.

In summary, liability is not clear and will only be tested if a case is brought against a government body. In such an instance, the case may be determined on the actions that government did or did not undertake that in a court of law would be deemed either, reasonable and fair or negligent, reckless and intentional.

6. Related and Impacted Responsibilities

As stated upfront in this paper, the issue of shark attacks and related responsibilities is complex and not clearly defined. Shark attacks impact negatively on local business (business in close proximity to the location of the attack), local tourism and may impact on tourism at a regional and even a national scale. South Africa as a developing and emerging country has prioritised social and economic development as a national goal to be driven and prioritised at all levels of governance, local and regional. Shark attacks, or negative perceptions as a result of shark attacks that impact on these social and economic priorities, are therefore arguably a sphere of interest and responsibility at all levels of governance.

In addition, all levels of governance are constitutionally bound to provide safe and healthy living environments for the communities of South Africa.

7. What is the current situation?

In Cape Town, sharks and shark attacks have received significant media coverage over the last three to four years. Within this situation, no sphere of government has publicly or officially taken responsibility for implementing formal programmes or actions to lower the incidence of attacks. There are a range of reasons for this response, namely:

- Actual and delegated responsibilities, as described in this paper, are not clear
- Taking responsibility has financial implications. In other words, there will be a significant financial and resource cost involved to any government body that does acknowledge or take responsibility
- A perception by authorities that acknowledgement of responsibility will put the authority at risk of liability
- Shark attacks as described, occur across delegated boundaries (the Seashore Act and Marine Living resources Act)
- Finally, and arguably, shark attack preventative measures themselves are controversial, complicated and difficult to manage.

This lack of acknowledgement and delegation of responsibility by authorities has certainly slowed and impacted on the delivery of safety programmes and actions. In fact, in Cape Town, this resulted in communities taking responsibility themselves, with two community driven and funded safety programmes effectively providing a measure of safety at two of Cape Town's beaches.

8. Cape Town Shark Working Group

In response to the current situation a Shark Working Group representing officials from a range of government spheres, academic institutions, NGO's and emergency services was established in 2004. The Working Group was initially and informal structure which over time has become more formalised, but which to date still does not have any recognised powers of authority or responsibility. It is argued in this paper that this working group was a successful and appropriate response to the situation in Cape Town at the time, and has successfully developed working relationships between various role-players resulting in a greater coordination of activities and approaches. Questions however, remain as to the sustainability of the Working Group in its current form in the long term and in its ability to effect positive change across government sectors.

9. Brief Case Study of a Successful Approach

In KwaZulu-Natal the beaches are protected by a statutory body, the Natal Sharks Board. Originally the Durban City Council erected the first form of shark barriers in 1907. However it was in 1962 that the Natal Provincial Administration created the Natal Sharks Board with the duty of approving, controlling and initiating measures for safeguarding bathers against shark attacks. The Natal Sharks Board currently acts as a service provider to a number of local authorities in the area. (Reference; Natal Sharks Board Web Site) The benefits of this approach are:

- A single organisation responsible for recommending, controlling and initiating measures for safeguarding bathers against shark attacks
- A single organisation whose core function and resources are dedicated to a single objective
- Authority to take effective action and make decisions
- Highly successful safety measures in place (in the interests of this paper, debate on shark nets and the resulting marine life mortality including sharks is avoided) that have lowered the incidence of shark attacks

This approach has been extremely successful in achieving what was originally required, that of lowering the incident of shark attacks. It is unlikely that the same success would have been achieved if a single organisation with powers and authority had not been established.

10. Concluding Discussion

There can be no doubt that shark safety in the broadest terms is not only the responsibility, but also in the interests, of National, Provincial and Local Government in the Western Cape, specifically in the City of Cape Town. Further that this interest and responsibility extends to include the TMNP, the delegated managing authority for the Marine Protected Area. It is also argued that it is not in the interests of the public, or White Sharks, for the various

authorities to avoid taking responsibility or actively "passing the buck" between and amongst each other.

If it were not for two community driven programmes, although only speculation at this point, it is highly likely that in the last 18 months there could have been more injuries and fatalities in Cape Town and governance may well have found themselves in a very different situation.

The conservation of White Sharks is a priority, both nationally and internationally and although often incorrectly considered mutually exclusive, shark safety measures or the lowering of the incidence of shark attack must be viewed as a key conservation strategy in the long term. Currently a window of opportunity exists in which all government agencies can work together to ensure that a reactive situation does not develop and that proactive, informed and considered actions are taken that are sustainable over the long term. If we allow a situation to develop in which economic considerations are the determining factor, conservation principles will be compromised. Therefore the following recommendations are made:

- That all spheres of governance openly acknowledge their responsibility and role with respect to shark safety
- That an effective white shark safety programme be recognised and acknowledged as a key element in a holistic and integrated White Shark conservation programme.
- That all spheres of governance and key stakeholders recognise and acknowledge the opportunity for proactive responses currently exists. Making use of this opportunity and being proactive will avoid possible severe and undesirable reactive responses at a later stage that may compromise conservation goals
- That at this time it is not considered necessary to establish a Cape Metropole controlling body similar to that of the Natal Sharks Board. However, it is recommended that the current Working Group be given formal status by all tiers of government as a form of co-operative governance
- That this recognised Working Group have a formally accepted Terms of Reference agreed by all parties that includes clearly defined participation, responsibility, delegation, authority and financial mechanisms.
- The establishment of this Working Group be endorsed by the Specialist Review process and is submitted to the relevant authorities for support and approval.

Management

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

Ryan Johnson[1] and Alison Kock[2, 4]

Ryan L. Johnson: University of Pretoria.
Email: Johnson@maxitec.co.za, Cell: 0726296669

Alison Kock: Shark Research Centre – Iziko Museums
Email: alison@saveourseas.com. Website: www.saveourseas.com

collaborators/co-authors (alphabetical order):
M.N.Bester[1], L.Compagno[2], S. Dudley[3], C.L. Griffiths[4], T.Keswick[5], P.G.H. Kotze[6], K. Laroche[7], M.A.Meyër[6], W.H.Oosthuizen[6], S. Swanson[6] & L Jacobs[8]

[1] Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria,
[2] Shark Research Centre, Iziko South African Museum,
[3] Natal Shark Board, KwaZulu Natal,
[4] Marine Biology Research Institute, University of Cape Town
[5] Department of Zoology, University of the Western Cape,
[6] Department of Environmental Affairs and Tourism, Marine and Coastal Management Branch,
[7] Behavioural Ecology Research Group, Department of Biological Sciences, Simon Fraser University,
[8] Cape Peninsula University of Technology

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.

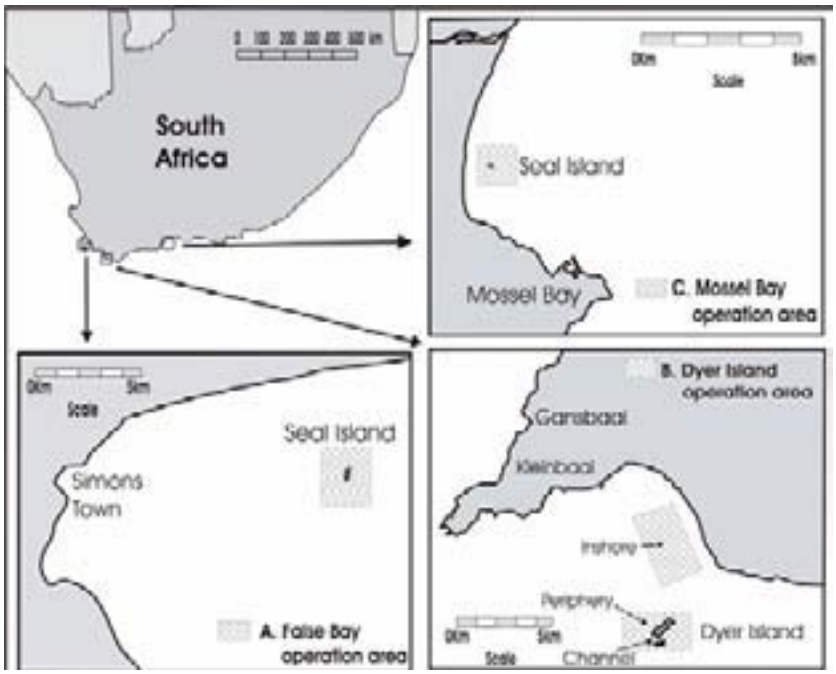
Citation: Johnson R and A Kock. 2006. South Africa's White Shark cage-diving industry - is their cause for concern? *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

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.

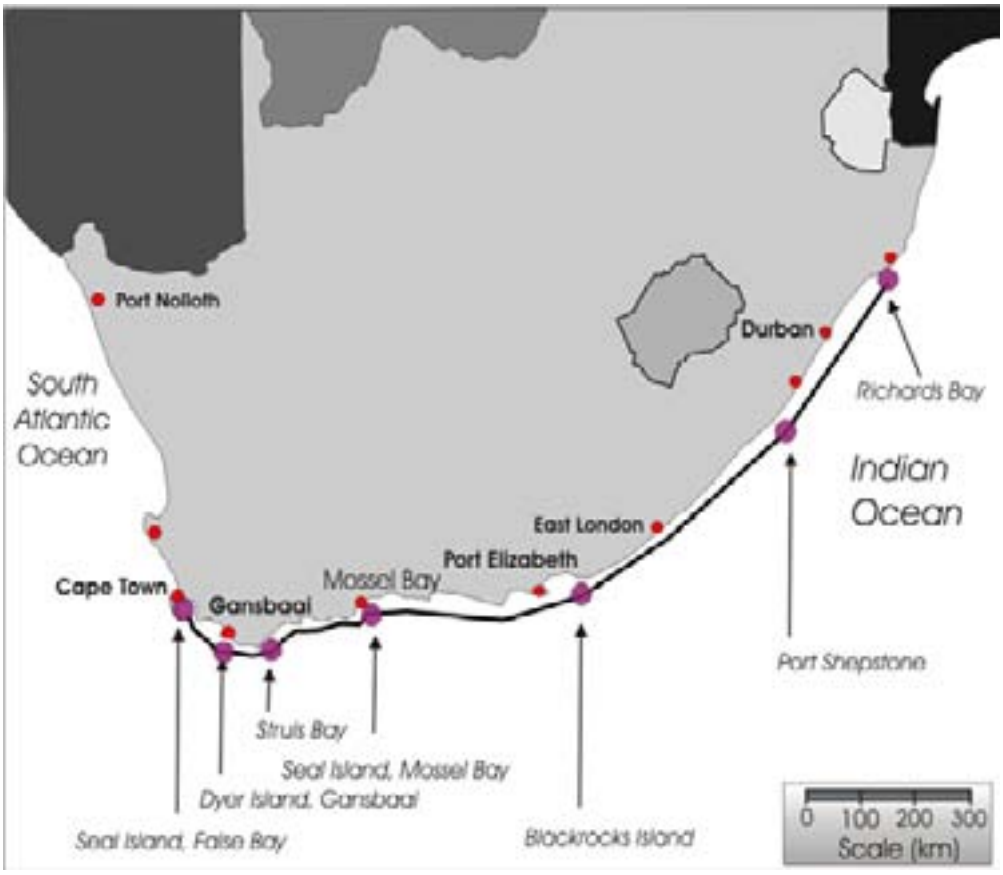
At present, white shark cage diving operations are permitted at three locations in South Africa, including Seal Island, False Bay (3 operations), Dyer Island, Gansbaai (8 operations); and Seal Island, Mossel Bay (1 operation). A further 1-3 vessels attract white sharks at these, and occasionally other 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

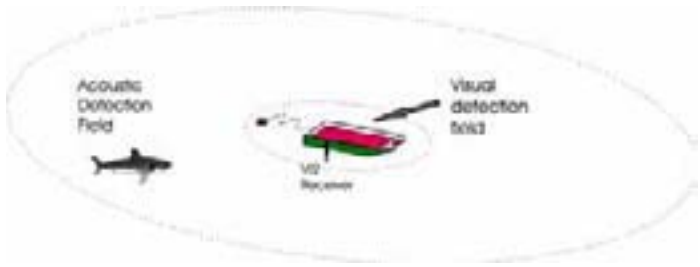
- ***"Repeated presentation":** Conditioning is a type of training, and as you cannot expect to run a marathon following one day of slogging it out on Table Mountain, you can not expect to condition an animal in one training session. Thus for conditioning to arise a large number of training sessions 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).

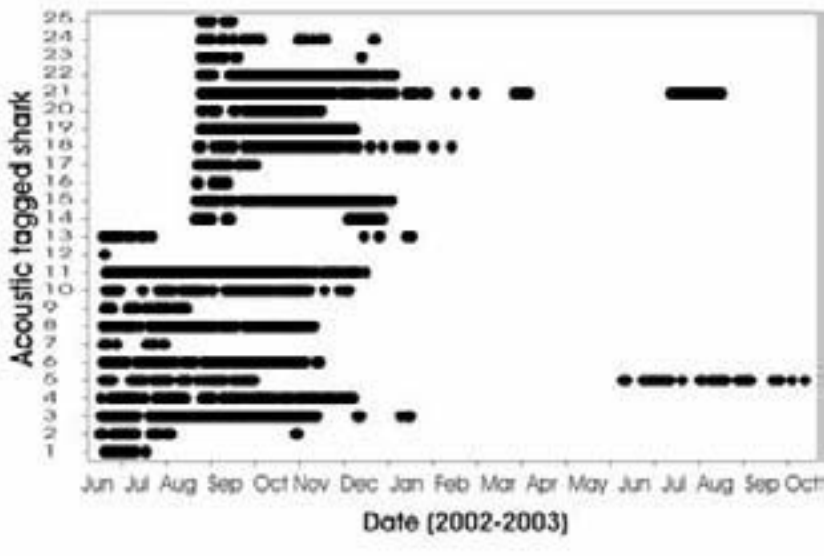
Figure 3. Experimental set up from research vessels. Presence of sharks tagged with acoustic transmitters was archived when swimming within circa 200m from research vessel.



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.



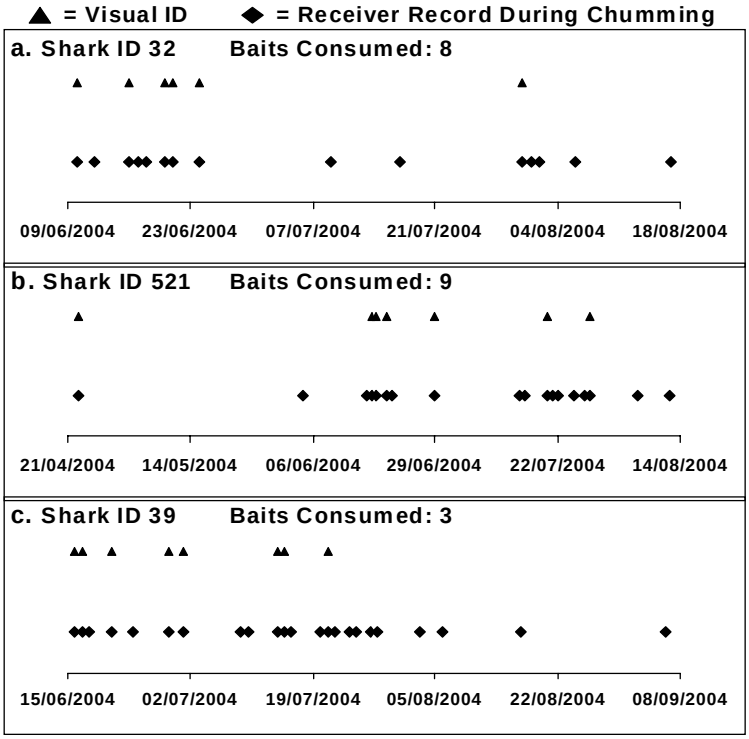


Figure 5. Temporal change in the response of acoustically tagged white sharks to our chumming vessels at False Bay.

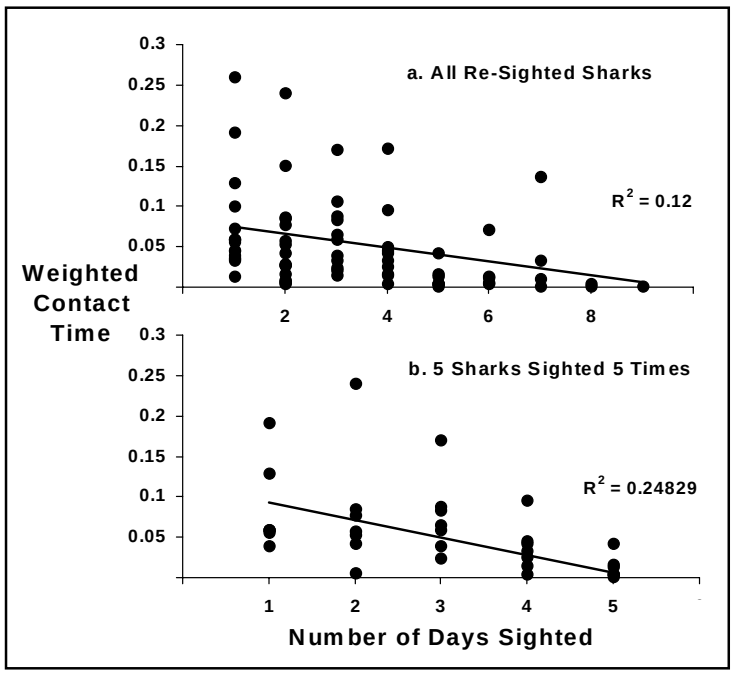


Figure 6. Weighted contact time of white sharks visiting a chumming vessel at False Bay

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.

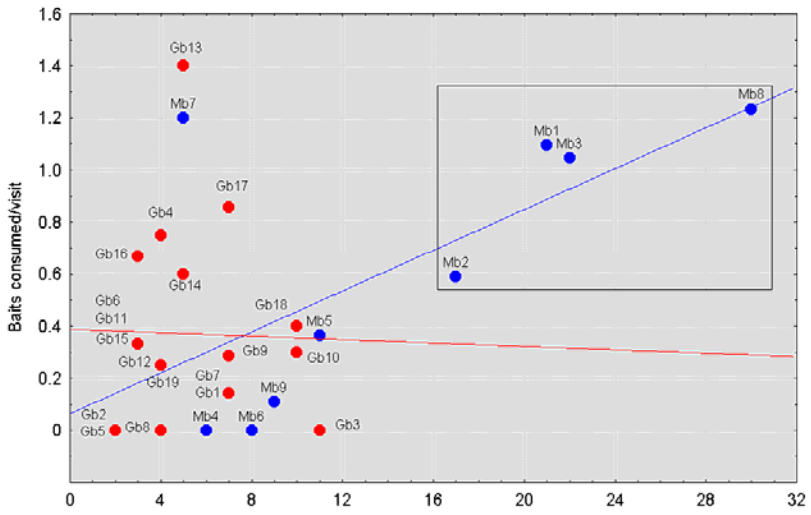
Within this context, can we observe changes in shark's behaviour that would indicate that they do positively associate chumming vessels as reliable food sources? Work from False Bay and Gansbaai offered us the first insight into this question when we measured the amount of time sharks spent at a boat (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'.

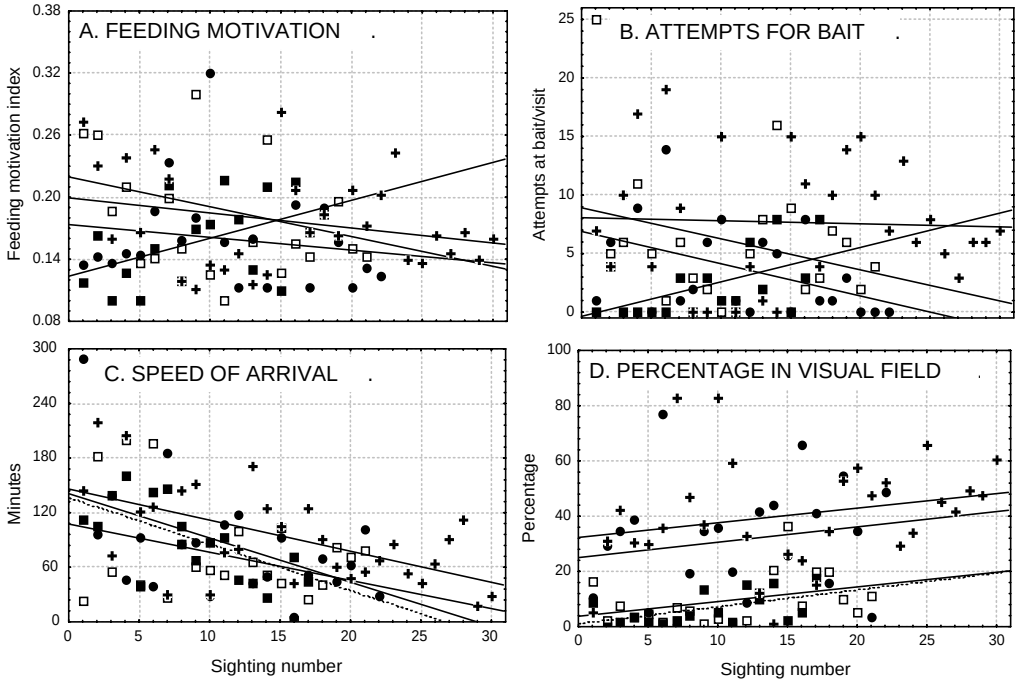
Figure 7. Relationship between 'reward predictability' and 'regular presentation' of easily recognisable sharks. Inserted boarder indicates four Mossel Bay sharks that had both high 'experience' and high 'feeding likelihood'.



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

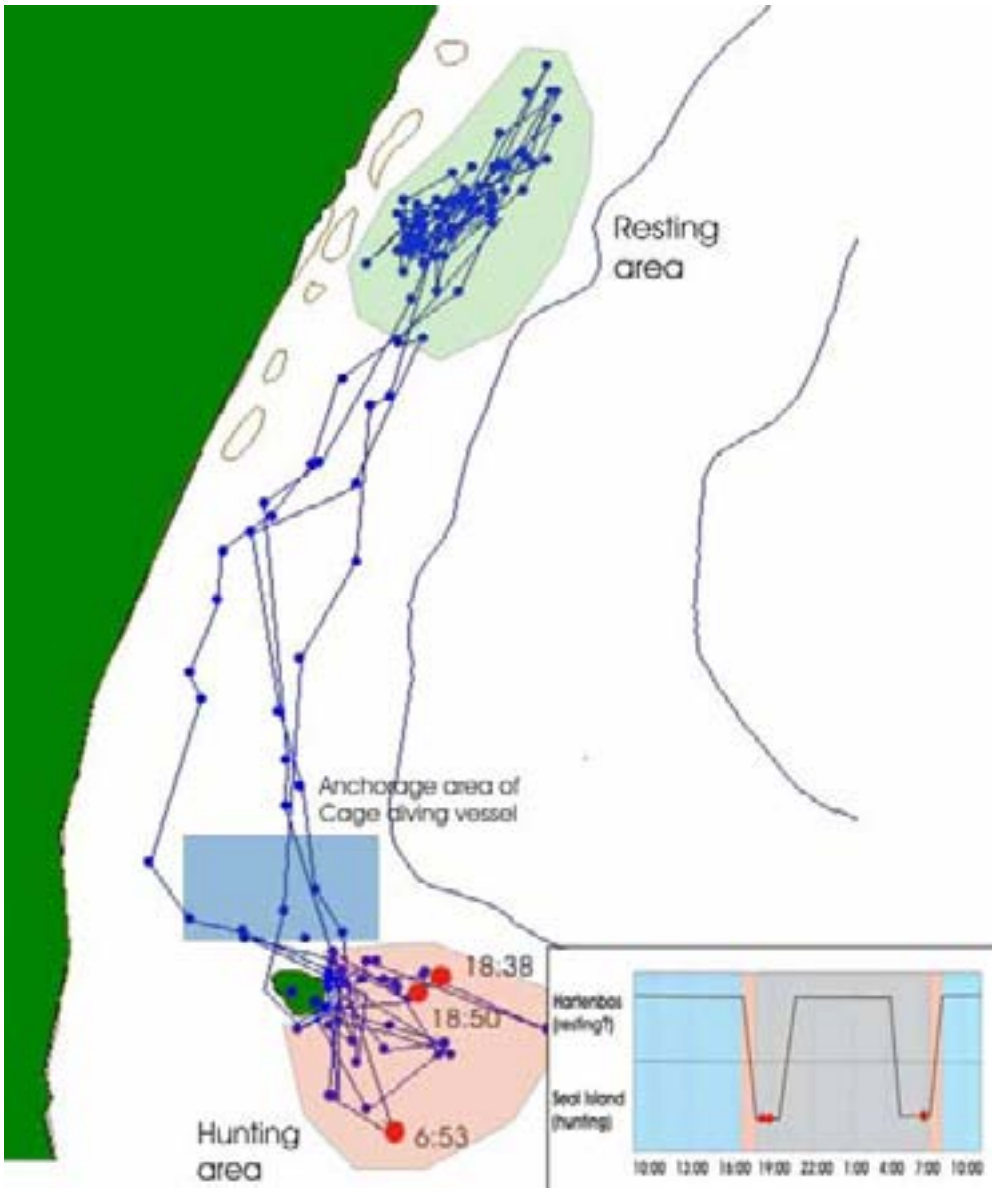
making a higher number and ratio of attempts for the bait (Figures 8A,B). There was a slight, non-significant, trend towards spending a greater proportion of a days visit in very near proximity to the boat (Fig. 8D). However, most obvious, was that all four sharks 'speed of arrival' to the boat significantly 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.

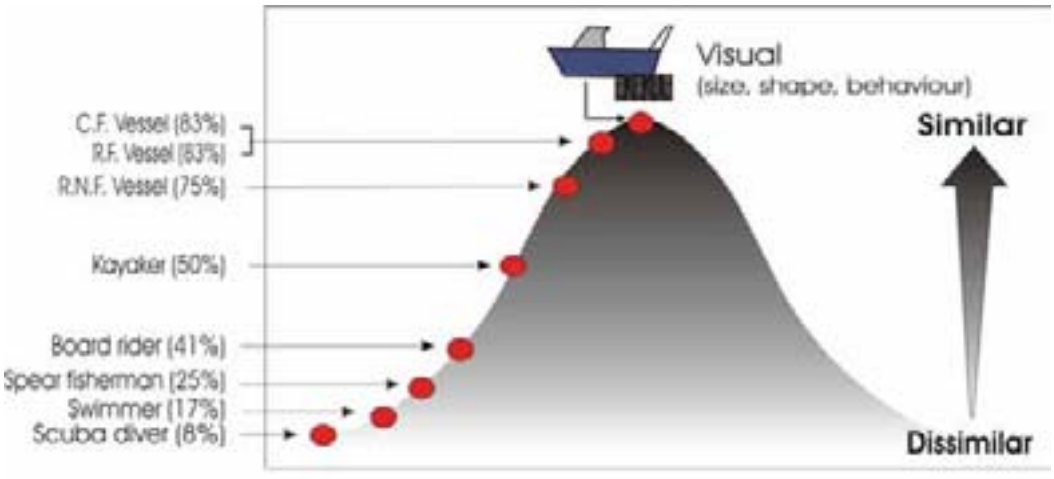
The sensory stimulus that entices the white shark to the 'cage diving vessel' are initially 'smell' and later, when specifically identifying the locality of potential food, it is 'vision' and 'smell' (previously discussed). Thus similarity in 'olfactory' and 'visual' stimulation is required for a conditioned 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.

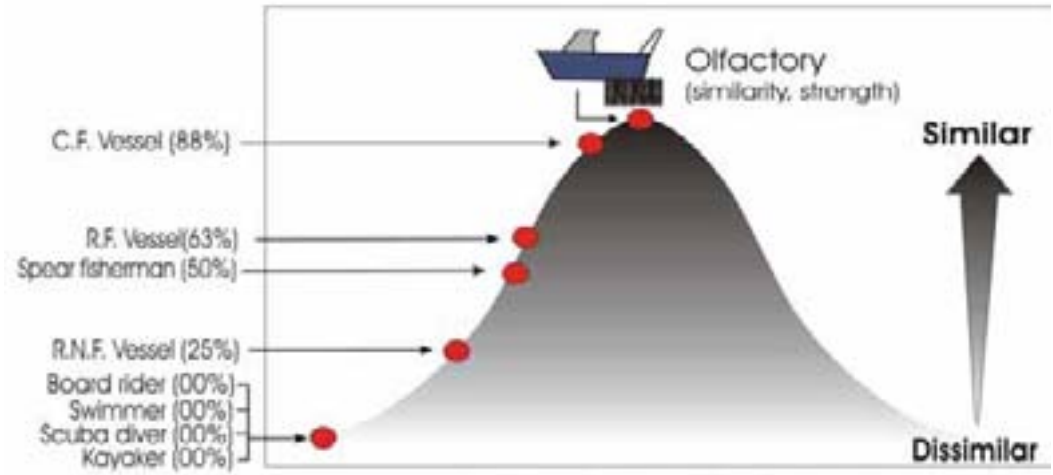
6. Management of the cage diving industry

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.

8. Acknowledgements

This paper represents a review of a number of research projects and initiatives that have been conducted throughout South Africa by the authors, supervisors and a number of collaborators.

Such work would not have been possible without the support and assistance of many institutes and individuals. In particular, the Save Our Seas Foundation (SOSF), the World Wide Fund for Nature - South Africa (WWF-SA) and International Fund for Animal Welfare (IFAW) for sponsorship and logistical support of the various research projects used in this review. The University of Pretoria (UP), University of Cape Town (UCT), National Research Foundation (NRF) and Marjay Trust have provided various postgraduate bursaries and funding to the contributing authors. The South African Navy (Simon's Town) and The Institute for Maritime Technology provided additional logistic support.

Scientific observers and assistants included; Tina Aydon, Dan Betts, Taffeta Bourke, Andy Brandy Casagrande, Julian Charivas, Ross Coventry, Neil Crooks, Marie Cuvier John Daniels, Ingrid, Lauren Ewing, Kathryn Ferguson, Lisa Haanke, Jennifer Hankock, Darren Hunniford, Amy Jewiss, Sanjay John, Nick Jones, Graham Horton, Jennifer Kiab, Sue Fen Kwa, Theodorus Koutroukides, Tamara Lodge, Mario, Andrea Marshall, Hannah Medd, Johann Mourier, Danny Muir, Pam Porteous, Ben Savage, Shane, Timo Seckler, Catharine Smith, Trey Snow, Peter Stratford, Catherine Vermeulen, Katja Walther, Lelani Weitz, Gregory Wright, Bethen Young.

We would also like to thank the following white shark cage diving operators for voluntarily participating in this assessment program or for their valued logistic support: Shark Africa, Marine Dynamics, White Shark Diving Tours, White Shark Diving Company, White Shark Adventures, Ecoventures, Shark Lady Adventures, Shark Diving Unlimited. Finally, we would like to acknowledge the work of Mrs. Irma Maharaj, who completed a much-needed assessment of marine-based tourism in Gansbaai.

9. References

Anon., 2000. Oxford dictionary of biology, 4th edn. Oxford University Press, Great Britain, p. 140

Baum, JK; Myers, RA; Kehler, DG; Worm, B; Harley, SJ; Doherty, PA, 2003. Collapse and Conservation of Shark Populations in the Northwest Atlantic, Science (Washington) [Science (Wash.)]. Vol. 299, no. 5605, pp. 389-392. 17 Jan

Bruce, B.D. 1992 Preliminary observations on the biology of the white shark (Carcharodon carcharias) in South Australian waters. Aust. J. Mar. Freshwat. Res. 43: 1-11.

Chirlanda, S., Enquist, M., 2003. A century of generalisation. Animal Behavior 66, 15--36

Compagno, L.J.V. 1991. Government protection for the great white shark (Carcharodon carcharias) in South Africa. S. Afr. J. Sci. 87: 284-285.

Fa, J.E., 1992. Visitor-directed aggression among the Gibraltar macaques. Zoology Biology 11, 43--52.

Johnson R.L., 2003. Behavioural ecology of the white shark (*Carcharodon carcharias*) at Dyer Island, South Africa. M.Sc Thesis, University of Pretoria, Pretoria, South Africa

Maharaj, I., Hara, M. & Pithers, L. 2003. Marine based tourism in Gansbaai: A socio-economic study. Internal report for DEAT, South Africa,

Marine Living Resources Act No. 18 of 1998. Government Gazette No. 18930, Republic of South Africa

McDougal, C., 1980. Some observations on tiger behavior in the context of baiting. Journal of Bombay Natural History Society 77, 476--485.

Oosthuizen, W.H. Personal Communication, Principle Oceanographer, Department of Environmental Affairs and Tourism.

Orams, M.B., 1995. Development and management of a feeding program for wild dolphins at Tangalooma, Australia. Aquatic Mammals 21(2), 137--147

Orams, M.B., 2000. Feeding wildlife as a tourism attraction: a review of issues and impacts. Tourism management 23(3), 281--293

Shackley, M., 1998. 'Stingray city' - managing the impact of underwater tourism in the Cayman Islands. Journal of Sustainable Tourism 6(4), 328--338

Stevens, J.D., Bonfil, R. Dulvy, N.K. $ Walker, P.A. 2000. The effects of fishing sharks, rays, chimeras (chondrithyans) and the implications for marine ecosystems. J. Mar. Sci. 57: 476-494.

Walpole, M.J., 2001. Feeding dragons in Komodo National Park: A tourism tool with conservation complications. Animal Conservation 4, 67--73.

Wrangham, R. W., 1974. Artificial feeding of chimpanzees and baboons in their natural habitat. Animal Behaviour 22, 83--93

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

S.J. Lamberth

Marine and Coastal Management, Private Bag X, Roggebaai, 8012
Email: Lamberth@deat.gov.za

Abstract

Public perception has been that an increase in the near-shore occurrence of white sharks (*Carcharodon carcharias*) in False Bay can at least be partly attributed to beach-seine operations attracting sharks into the surf-zone. To address these concerns, all available beach-seine catch and effort data from the False Bay fishery was reviewed. A total of 27 cartilaginous species from 15 families were recorded in 11 400 hauls from 1974 - 2006. Most (98 %) of these comprised small benthic mollusc and crustacean feeders such as smooth hound-sharks (*Mustelus mustelus*) and lesser guitarfish (*Rhinobatos annulatus*). Large sharks such as white shark (*C. carcharias*) and ragged tooth shark (*Carcharias taurus*) were rare occurring in less than 0.2 % of hauls. The only medium to large sharks to occur frequently (15 % of hauls) in any significant numbers (0.3 per haul) were bronze whalers (*Carcharhinus brachyrus*) of which in excess of 3 000 were caught. The relatively high numbers of *C. brachyrus* compared to *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 former species. Overall, the frequency of occurrence of *C. carcharias* in the nets is much lower than one would predict from the high number of observations in the surf-zone. Beach-seine fishing rights in False Bay have been reduced from more than 170 in the 1970s to 5 in the present day. There has been no corresponding decrease in shark incidents, the converse being closer to the truth as shark incidents have increased from 2 in the 1970s to 6 during 2000 – 2005. Overall, there was no significant relationship between beach-seine and white shark activity in False Bay. The most likely scenario with regards to the increase in *C. carcharias* activity is that, prior to their protection in the early 1990s, mortality of white sharks was high due to their trophy status and much higher effort in most commercial and recreational fisheries at that time. In all, sandy, snag free beaches are limited but essential requirements for successful commercial beach-seining and recreational bathing. User conflict is inevitable but it would not be scientifically or legally justifiable to exclude beach-seine nets from recreational use areas.

Citation: Lamberth S J. 2006. A review of White Shark and other chondrichthyan interactions with the beach-seine (treknet) fishery in False Bay, South Africa. *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. The False Bay beach-seine fishery: a brief history

Fishing with nets was unknown to the indigenous peoples of the Cape who used spears, gorges (hook & line precursors) and various traps to catch fish. Even the use and antiquity of traps is under dispute with evidence suggesting they may be European in origin. Beach-seine nets were introduced into the Cape during the mid 1600s. For the first 30 years, to ensure that settlers and soldiers were engaged in more honest pursuits, all fishing was prohibited except by permission of the fort's commander (Thom 1952). In 1687, the first incursion into False Bay began when the Council of Policy and Justice gave conditional approval for the burghers of the Stellenbosch District to fish at the Eerste River Mouth using beach-seine nets. Much of their catch would have been for fertilizer and to feed farm-workers and slaves, with a limited number of fish reaching market.

Over the next 200 years, the beach-seine fishery expanded and remained the mainstay of the South African fresh fish market until the late 1800s, the 40 False Bay operators even having dedicated railway "freezer" carriages to transport their catch to the interior (Gilchrist 1899). Thereafter, with the advent of trawling, purse-seining, motorised line-boats and set / gill-netting, the importance of beach-seining declined considerably. From the early 1900s until the 1960s, there exists very little information on the False Bay beach-seine fishery save that there were 62 beach-seines and 17 "Roosman" nets (sinking beach-seines) operating in the 1920s (Anon 1922). By the 1960s there were in excess of 170 (De Villiers 1987).

Prior to the 1960s conflict surrounding the beach-seine fishery was low, mostly involving disputes with the gillnet fishery and mostly solved by legislation separating the two fisheries. Thereafter, changes in public perceptions, complaints from anglers and conservation bodies over beach-seine catches of linefish in False Bay, as well as complaints from professional netters about there being too many amateurs were addressed by various investigations; the Yeats commission (Yeats *et al* 1966), Treurnicht Commission (Treurnicht *et al* 1980) and Theart Committee (Theart *et al* 1983). These investigations led to a permitting system for which management policy dictated that only *bona fide* fishers could qualify. Catch reporting became compulsory, netting in False Bay was restricted to daylight hours and numerous gear and area restrictions were put in place. A sustained process of attrition saw the number of beach-seine operators in False Bay being reduced from well over 100 in the 1960s to only 15 by the beginning of 1984.

The Diemont Commission (Diemont *et al* 1986) felt that the reduction in beach-seine permits had achieved the purpose of reducing effort and protecting vulnerable species without negatively impacting on *bona fide* fishers or the harder supply to the local market. They observed however, that the pressure from recreational angling and conservation groups to end this fishery should not be underestimated. This observation was borne out over the following five years as sustained pressure from these groups and the influence of emotional and subjective media articles (e.g. "The Killing Waters" Clark 1988) resulted in the imposition

of gear, temporal and spatial restrictions that were all but crippling to the industry. Consequently, the number of beach-seine operators in False Bay had been reduced to seven by the end of 1990.

The concerns expressed by angler and conservation groups were, amongst other; that large beach-seine catches of juvenile and adult "angling fish" in False Bay were responsible for the decline in anglers' catches, that seines in the vicinity of river mouths were resulting in high mortalities of spawning aggregations and juvenile fish entering and leaving the estuarine nursery area, nets were damaging the benthic flora and fauna and that seine operations were intruding into Marine Protected Areas (Lamberth 1993). There was also a perception that large-scale mortalities of cartilaginous species (sharks and rays) occurred and were causing ecological imbalances within False Bay. These concerns were addressed by a three-year study that commenced in 1991 and intended to provide management with a scientific basis for the long-term resolution of the conflict surrounding the fishery.

The study's findings indicated that most of these concerns were unfounded and that, with the exception of white steenbras (*Lithognathus lithognathus*), beach-seining was not having any major detrimental effects on most fish stocks, nor on the ecological interactions in False Bay. It was noted, that despite these research findings, conflict between the beach-seine fishery and recreational anglers was unlikely to be resolved due to the considerable overlap in the species composition of the catches of the two groups and the fact that they were competing for a limited and diminishing resource. However, the restrictions on the fishery were revised such that it was once more economically viable.

Since then, and the completion of a national assessment of the beach-seine and gillnet fisheries, the total allowable effort (TAE) in the fishery has been revised. The number of beach-seine operators in False Bay has been reduced to five. Conflict continues to exist between recreational anglers, beach-seine fishers and management, mostly over catches of yellowtail (*Seriola lalandii*) but also over other linefish species. Adding to the conflict is the perception amongst some anglers and the public that the nets or their catch are responsible for attracting white sharks into the surf-zone and are ultimately responsible for the increase in deaths or injuries attributed to this species.

2. The present day

Area restrictions

Since the allocation of medium term fishing rights in 2003 there have been five beach-seine right holders in False Bay (Table 1). There were an additional eight available rights between Scarborough and Melkbostrand but only three of these were allocated in 2003.

Beach-seine permit conditions are issued under the Marine Living Resources Act (MLRA, 1998) whereas access to the beach to exercise one's fishing right is through the National

Environmental Management Act (NEMA). When in conflict with any other act, provincial or local ordinance, both these Acts, and therefore permit conditions and right to fish, have seniority. However, beach-seine rights (and beach access) are only issued for the areas designated and, when applicable, the permit holder may only operate with the permission of the relevant authority in Marine Protected Areas, National Parks, Provincial Parks and Nature Reserves, ESCOM areas, National Ports Authority areas and South African National Defence Force (SANDF) areas.

To put the above in perspective, most beach-seine concessions in False Bay and the rest of Cape Town either fall in or contain one or more of these strategic areas. By example, the entire beach-seine Area 18 (Smitswinkel Bay to Fish Hoek) falls within the Table Mountain National Park, but also comprises substantial MPA and SANDF areas. It follows that, excluding rocky regions for obvious reasons, the remaining available fishing area is small. This small area includes most recreational bathing or water-sport areas.

Table 1. Total Allowable Effort (TAE, number of rights holders) for each beach-seine area in the Cape Town surrounds. Levels of effort are designed to facilitate recovery of the harder stock and based on the number of fishers who could maintain a viable income in each area. Areas 14 & 15 have been consolidated.

Area	Locality	Beach-seine
14 & 15	Milnerton Lighthouse to Bokpunt (Melkbos)	3
16	Houtbay beach	2
17	Longbeach-Scarborough	3
18	Smitswinkel Bay, Simonstown, Fishoek	2
19	Muizenberg-Strandfontein	2
20	Strandfontein-Monwabisi	0
21	Macassar	1

A similar situation exists for Area 19 (Muizenberg-Strandfontein) where beach-seine fishers were prevented from fishing adjacent to Neptunes Corner due to excessive catches of sub-adult white steenbras and conflict with anglers. However, this is the only stretch in Area 19 where yellowtail “frequently” occur and operators were suffering loss of income. Consequently, beach-seine right holders in Area 19 were given the concession to operate in the area between the Sandvlei Mouth and Neptune’s Corner on condition that only yellowtail are targeted and landed and provided that arrangements are made with the local Marine and Coastal Management office prior to the commencement of fishing. All other species caught between Sandvlei Mouth and Neptunes Corner have to be returned to the water alive. In reality, yellowtail appear infrequently and beach-seining seldom occurs here for more than five days each year. Conflict however, does occur but now appears to be between beach-seine fishers and business owners rather than anglers the former who fear loss of income should any fatality due to sharks occur.

User conflict has existed and will continue to exist between commercial fishers, recreational fishers and the public throughout South Africa, False Bay being no exception. The question has been raised as to whether the rights of beach-seine fishers are so much greater than those of recreational users such that they could not be restricted to non-recreational areas. It must be remembered that beach-seine operators have a commercial fishing right granted under the MLRA whereas recreational users do not. The fishing right confines operations to a specific area much of which has already been reduced through, amongst other, MPAs or SANDF areas. The reality is that if beach-seiners were restricted to non-recreational use areas, there would be little if any space left for them to fish. In turn, similar to their being allowed access to "linefish" species that they traditionally exploited, False Bay beach-seine fishers can claim a traditional right of access to the shore as they have been in operation for the last 300 years. Further, the perception that beach-seine operations attract white sharks remains just that. It would not be legally (or ethically) justifiable to exclude this fishery merely to create a false sense of security amongst beach users.

Gear and catch restrictions

Beach-seine operators in False Bay may not use motorised boats to set their nets nor may they use powered winches or vehicles to haul the nets. Right holders are allowed to have two nets on the beach but may only have one net in the water at any one time. Nets are restricted to 275 m in length, 5 m depth and a mesh size of 44-90 mm. Hauling ropes may not exceed 600 m in length and the net must be positively or neutrally buoyant. The cod-end (bag) has to have a drawstring such that it may be opened to facilitate the release of prohibited species alive.

In addition to harders *(Liza richardsonii*), St Joseph shark (*Callorhinchus capensis*) and 'bait species"(e.g. maasbunker *Trachurus trachurus*), beach-seine operators in False Bay are allowed to catch and retain exploitable linefish species such as yellowtail (*Seriola lalandii*) and silver kob (*Argyrosomus inodorus*). They may not catch and retain prohibited species such as white sharks (*Carcharodon carcharias*) or decommercialised species such as white steenbras (*Lithognathus lithognathus*) and belman (*Umbrina robinsonii*). Incidental catches of these species must be returned to the water alive. They must also adhere to the size regulations and closed seasons governing the fish that they catch.

3. Beach-seine catches

Available data comprises records of over 10 000 beach seine hauls from 1974 – 2005. These data vary in accuracy from the low confidence commercial catch returns (MCM, Netfish System) to medium confidence diarised hauls (J. Petty, beach seine right holder) to high confidence monitored catches (Lamberth *et al* 1993).

Twenty-seven cartilaginous species from 15 families have been recorded from over 10 000 beach-seine hauls in False Bay (Table 2). Numerically, none of these species comprised

more than one percent 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 this catch.

The only large sharks (>2 m) to occur in any significant numbers (0.3 per haul) were bronze whalers (*Carcharhinus brachyurus*) of which in excess of 3 000 were caught (Table 2). This is far greater than catches of white shark (*Carcharodon carcharias*) of which less than 20 were caught or one every 500 hauls. Other large sharks present in low to very low numbers were dusky shark (*Carcharhinus obscurus*), sandbar shark (*Carcharhinus plumbeus*), sevengill cowshark (*Notorhynchus cepedianus*), mako (Isurus oxyrinchus), ragged tooth (*Carcharias taurus*) and hammerhead (*Sphyrna zygaena*). The size frequency distributions of all of these species overlap with that of C. carcharias which suggests that they may often be confused with each other. Indeed, beach goers are often convinced that medium sized houndsharks (*Mustelus 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 are hard pressed to distinguish between different species of sharks when the individuals observed are in silhouette and of equivalent size (Fig. 1). Identification becomes even more difficult when the silhouettes are viewed through water, obliquely and at a distance, from the beach or mountainside vantage point.

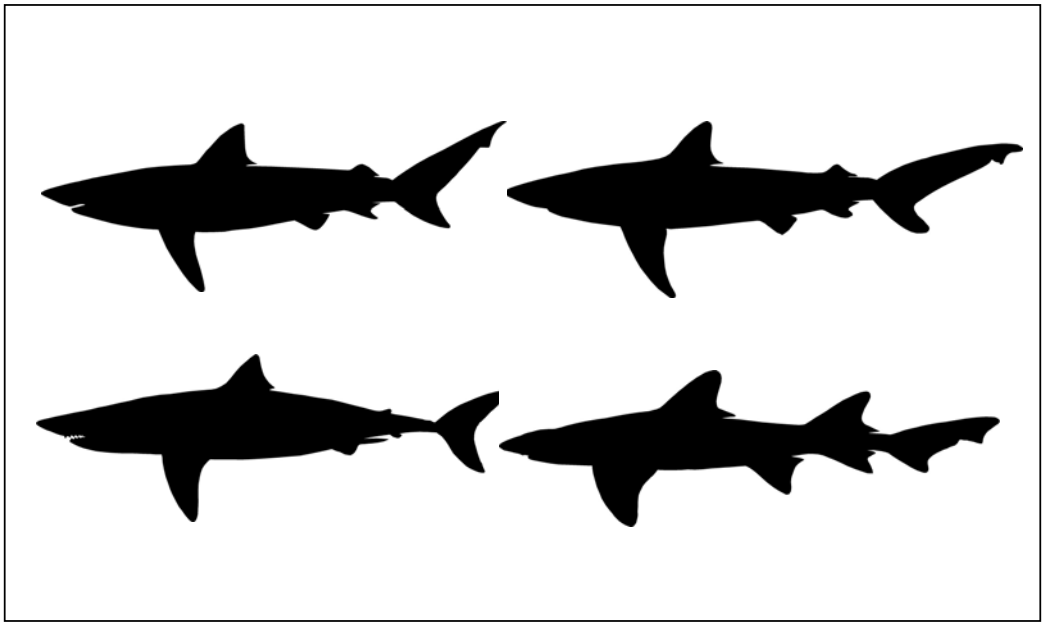


Figure 1. Shark silhouettes clockwise from top left; bronze whaler (*Carcharhinus brachyrus*), dusky shark (*Carcharhinus obscurus*), gullyshark (*Triakis megalopterus*) and white shark (*Carcharodon carcharias*). Adapted from Compagno *et al*. 1989.

Table 2. Summary of information of all sharks, skates, rays and chimaerids recorded caught by the False Bay beach-seine fishery in 2001 diarised hauls 1974-1987 (J. Petty), 311 monitored hauls 1991-1993 (Lamberth 1994), 8500 hauls reported in catch returns 1983-2006 (Marine & Coastal Management, Netfish System) and 600 observed hauls 1993-2006 (C. Fallows personal observations). Lengths at maturity after Compagno 2005.

			Number per haul	% of shark & 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	
Callorhinchidae	*Callorhinchus capensis*	St Joseph	5.273	15.800	0.226	40.2	12-101	58	34
Carcharhinidae	*Carcharhinus brachyurus*	Bronze whaler	0.322	0.963	0.014	15.1	48-305	200	95
	Carcharhinus obscurus	Dusky shark		0.000	<0.001			280	
	Carcharhinus plumbeus	Sandbar shark	<0.001	<0.001	<0.001	<0.01		180	
Dasyatidae	*Dasyatis brevicaudata*	Shorttail stingray	0.010	0.029	<0.001	1	46-200		
	Dasyatis chrysonota	Blue stingray	3.450	10.337	0.148	29.6	15-80	58	92
	Gymnura natalensis	Diamond ray	0.058	0.173	0.002	4.5	106-180	100	0
Hexanchidae	*Notorynchus cepedianus*	Sevengill cowshark	<0.001	<0.001	<0.001	0.1		200	
Lamnidae	*Carcharodon carcharias*	Great white shark	0.002	0.010	<0.001	0.2	195	240	100
	Isurus oxyrinchus	Shortfin mako	<0.001	<0.001	<0.001	0.1		275	
Myliobatidae	*Myliobatis aquila*	Eagle ray	4.900	14.682	0.21	35	14-116	54	92
	Pteromylaeus bovinus	Duckbill ray	0.013	0.039	0.001	1.3	50-114	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	220	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	80	100
Rhinobatidae	*Rhinobatos annulatus*	Lesser guitarfish	14.814	44.384	0.634	73.3	15-95	70	89
Scyliorhinidae	*Halaelurus natalensis*	Tiger catshark	0.003	0.010	<0.001	0.3	46	42	0
	Haploblepharus edwardsii	Puffadder shyshark	0.029	0.087	0.001	1	30-58	41	33
	Poroderma africanum	Pyjama shark	0.010	0.029	<0.001	0.6	48-80	58	66
Sphyrnidae	*Sphyrna zygaena*	Smooth hammerhead	0.002	0.006	<0.001	0.1		240	
Torpedinidae	*Torpedo fuscmaculata*	Electric ray	0.003	0.010	<0.001	0.3	40		
Triakidae	*Galeorhinus galeus*	Soupfin shark / vaalhaai	0.029	0.088	<0.001	0.3		130	
	Mustelus mustelus	Houndshark	4.177	12.515	0.179	36.3	21-160	70	49
	Triakis megalopterus	Spotted gully shark	0.013	0.039	0.001	1	140-180	140	0

The frequency of occurrence of *C. barchyurus* (15 % of hauls) is orders of magnitude greater than that of *C. carcharias* (0.1-0.2 % of hauls) (Table 2). This, supported by overlapping size frequencies, suggests, that the high frequency of "white sharks" observed by the public and spotters may often be *C. brachyrus* rather than *C. carcharias*. In turn, *C. brachyrus* may often be observed following beach-seine nets into the shallows and may even beach themselves chasing fish. Shark anglers will often take advantage of this behaviour by casting their baits behind the nets. To date, no white sharks have been caught in this manner. On the other hand, beach-seine fishers may often see *C. carcharias* prior to a haul, but they seem to disappear once the net is set, seldom being caught. Overall, the frequency of occurrence of *C. carcharias* in the seine nets is much lower than one would predict from the relatively high number of observations made from various vantage points. Mistaken identity aside, this suggests, that *C. carcharias* may actually be avoiding the nets.

Table 3. 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.

		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 marmorata	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		**2867**	**2209**	**1446**	**2485**	**4541**	**1848**	**1576**	**2779**	**2938**	**5001**	**844**	**1322**
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**
Number of shark & ray species		**12**	**13**	**14**	**9**	**10**	**3**	**3**	**5**	**3**	**5**	**11**	**11**
Mean number of sharks & rays per haul		**58**	**39**	**37**	**14**	**22**	**6**	**22**	**14**	**3**	**17**	**29**	**40**

Beach-seine chondrichthyan catches are strongly seasonal with 11-14 species occurring in the summer months (November-March) as opposed to a low of 3 species in winter (June-July), (Table 3). Most *C. carcharias* recorded in the nets have been juveniles (180-200 cm) and all have been caught in February / March when catches of other sharks and rays are near their highest. This may be due to these individuals being netted whilst foraging their smaller shark and ray prey (C. Fallows pers obs). In support of this hypothesis, is the high number, 6-10 per haul, of hound-sharks (*Mustelus mustelus*) that appear in the nets at this time. In reality, a multitude of factors, physical and biological are likely to play a role. Examination of individual hauls indicate that summer upwelling may also be a contributing factor towards increased catches with cold upwelled water driving many fish, including sharks into the warmer shallows (Lamberth *et al* 1994).

Table 4. Summary of the number of beach-seine operators, effort, catches of the main target species and white shark (C. carcharias) incidents (G. Cliff, KZN Sharks Board, unpublished data) in False Bay from 1970-2005. Correlations, trends and significance levels are given. No significant relationships existed between the number of beach-seine operators, their catches and white shark incidents. Data represents over 10 000 hauls.

	1970-1974	**1975-1979**	**1980-1984**	**1985-1989**	**1990-1994**	**1995-1999**	**2000-2005**	**r^2**	**Trend**	**Significance**
Beach-seine operators	170	60	15	9	7	7	5	0.657	-	p>0.05
Net-days per annum	605	1259	551	1336	1179	991	1297	0.0004	+	p>0.05
L. richardsonii (t/yr)	136	192	155	235	177	149	235	0.032	+	p>0.05
L. lithognathus (t/yr)	41	58	37	16	33	18	4	0.764	-	p>0.05
S. lalandii (t/yr)	2	2	28	72	128	87	90	0.431	+	p>0.05
P. saltatrix (t/yr)	4	6	6	5	7	4	9	0.186	+	p>0.05
C. carcharias incidents	2	0	3	2	2	4	6			

The number of beach-seine operators in False Bay has declined from over 170 in the early 1970s to five in the present day (Table 4). White shark incidents on the other hand, have increased from 2 in the 1970s to 6 from 2000-2005. Therefore, contrary to public opinion, there exists a negative correlation between beach-seine activity in False Bay and incidents involving *C. carcharias*. However, the correlation is statistically insignificant. In turn, there exists a weak and insignificant positive correlation between days fished and *C. carcharias* incidents (Table 4). Overall, there appears to be no significant relationship between beach-seine and white shark activity in False Bay. Probably the only argument that could be made is that, prior to their protection in the early 1990s, mortality of white sharks was high due to their trophy status and much higher effort in most commercial and recreational fisheries at that time.

Liza richardsonii, L. lithognathus, S. lalandii and *P. saltatrix* provide over 85 % of the False Bay beach-seine catch. Assuming that catch per year reflects abundance, no significant relationship exists between catches of these species and *C. carcharias* incidents (Table 4). The relatively strong but insignificant negative relationship attributed to *L. lithognathus* is a good example of a false correlation caused by stock collapse and decommercialisation of this species. In all, the data suggest, that *C. carcharias* incidents in False Bay have no strong link to beach-seine effort and catches. This also seems to be the case elsewhere in the world where with the exception of recreational angling, tuna cages and the abalone diving industry, *C. carcharias* incidents and 'bycatch" are rare. This is borne out by specific mention of a reasonable shark bycatch but no beach-seine / *C. carcharias* interactions in the Western Australia beach–seine fishery and "surprisingly" none in the longline fishery (Western Australia, State of the Fisheries Report 2001).

4. References

Anon, 1922 – The fishing industry of the Cape Coast. *S. Afr. J. Ind***. 5**: 303-306.

Clarke, J. 1988 – The killing waters. *The Star*, 5 March 1988.

Compagno, L.J.V., Ebert, D.A. and M.J. Smale 1989 – *Guide to the Sharks and Rays of Southern Africa*. Struik, Cape Town, 160 pp.

Fisheries Western Australia – State of the Fisheries Report 2000 / 2001

De Villiers, G. 1987 – Harvesting harders *Liza richardsonii* in the benguela upwelling region. *South African Journal of Marine Science*, **5**: 851-862.

Diemont, M.A., Barrie, F.G., Stoops, W.H., Ramsay, R. and E.H.B. Goldschmidt 1986 - Report of the Commission of Inquiry into the Allocation of Quotas for the Exploitation of Living Marine Resources. Government Printer, Pretoria.

Gilchrist, J.D.F. 1899 – *Report of the Marine Biologist, Department of Agriculture, Cape of Good Hope, for the year 1898*. Cape Town, Government Printer: 362 pp. + 21 charts.

Hutchings, K. and S. J. Lamberth 2002 – Socio-economic characteristics of gillnet and beach-seine net fishers in the Western Cape, South Africa. *South African Journal of Marine Science,* **24**: 243-262.

Hutchings, K. and S. J. Lamberth 2002 – By-catch in the gillnet and beach-seine fisheries in the Western Cape, South Africa. *South African Journal of Marine Science,* **24**: 227-241.

Hutchings, K. and S. J. Lamberth 2003 - The likely impacts of an eastward expansion of the inshore gill-net fishery in the Western Cape, South Africa: implications for management. *Marine and Freshwater Research*, **54**:39-56.

Lamberth, S. J. and B.A. Bennett 1993 – When is an angling fish not an angling fish? Evidence from beach-seine catches in False Bay. *Special Publication Oceanographic Research Institute* **2:**153-156.

Lamberth, S. J., Bennett, B. A. and B. M. Clark 1994 – Catch composition of the commercial beach-seine fishery in False Bay, South Africa. *South African Journal of Marine Science* **14**: 69-78.

Lamberth, S. J., Bennett, B. A. and B. M. Clark 1995 – The vulnerability of fish to capture by commercial beach-seine nets in False Bay, South Africa. *South African Journal of Marine Science* **15**: 25-31.

Lamberth, S. J., Bennett, B. A., Clark, B. M. and P. M. Jansenns 1995 – The impact of beach-seine netting on the benthic flora and fauna of False Bay, South Africa. *South African Journal of Marine Science* **15**: 115-122.

Theart, J.D, F.G.A. Thear and H.B. Crous 1983 - Verslag van die takkomitee na die uitrekening en benutting van net permitte. Unpublished Report, Chief Directorate, Marine Development, Cape Town, 135pp.

Thom, H.B. 1952 – *The Journal of Jan Van Riebeeck*. 1. A.A. Balkema; Cape Town: 395 pp.

Treurnicht, N.F., Albertyn, J.T., Bartlett, G.S., Delport, W.H., Lorimer, R.J., Marais, P.S., Myburgh, P.A., Pretorius, N.J., Van Rensburg, H.M.J., Wessels, L. and J.W.E. Wiley 1980 - Report of the Commission of Enquiry into certain aspects of the Conservation and Utilization of the Living Marine Resources of South Africa. Commission of Enquiry Report No. R.P. 93/1980. Pretoria, Government Printer.

Yeats, P.J., Von Bonde, C.T.F., Louw, J.P., Morkel, D.T. and V. Hare 1966 - Inquiry into fishing between Cape Point and Danger Point. Commission of Inquiry Report to the State President of the Republic of South Africa.

Is there a relationship between White Shark presence and the management of city estuaries and river mouths?

Gregg Oelofse[1], Kock A [2], Johnson R [3], and Haskins C[1].

[1]*City of Cape Town, 44 Wale Street, City of Cape Town;*

Email: Gregg.oelofse@capetown.gov.za

[2] *Shark Research Centre, Iziko South African Museum,*

[3] *Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria*

Abstract

Following the number of high profile shark attacks in Cape Town over the last five years, speculation around the role that estuary mouths, stormwater and wastewater outflows may have played in attracting sharks to the area has grown. Four attacks (two fatal) have all taken place within 500m of estuary mouths or outflows increasing perceptions that these areas are possible "hotspots" of white shark activity. This paper investigates the relationship between White Shark occurrence and river and estuary mouths and discusses the role that nutrient load and estuary mouth manipulation, as part of the City's catchment management strategy, may play in white shark presence. Sufficient evidence to make definitive statements is lacking, however preliminary research findings indicate a possible link between white shark behavioural patterns and river mouths. No evidence currently exists to suggest that this potential link is related in any way to either higher nutrient loads as a result of urban run-off, or the manipulation of estuary mouths as part of holistic catchment management practises. Further research is required before definitive statements are made. It is argued in this paper that the first priority for recreational safety is identifying if and where white shark "hotspots" exist as well as the spatial and temporal trends around those "hotspots" as opposed to why "hotspots" may exist. The current research project investigating White Shark ecology and behaviour in False Bay is likely to provide greater clarity on the role of estuaries and outflows in white shark behavioural patterns, thereby providing significant and crucial information to recreational safety within Cape Town.

Citation: Oelofse G, Kock A, Johnson R and C Haskins. 2006. Is there a relationship between White Shark presence and the management of city estuaries and river mouths? *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. Introduction

Cape Town Cape Town has a number of estuaries and river mouths along its coastline, which in comparison to other areas along the South African coast are relatively small with low flow outputs. Nevertheless, they are an integral part of the City's terrestrial and coastal landscape and ecology.

Many of the City's estuaries and rivers that drain into the ocean are heavily impacted by urban run-off, waste water effluent and development. As such, the rivers and estuaries that do enter the ocean off Cape Town are generally impacted, flow affected systems with high nutrient loads. In addition to the rivers and estuaries, there are a number of wastewater effluent outfalls and stormwater outlets, illustrated in Figure 1, spread along the City's coastline.

Figure 1. Illustration of the high number of wastewater and stormwater outlets along a section of the False Bay coast between Muizenberg and Strand

Following the attack on JP Andrew in April 2004, much speculation surrounded the timing of the attack with that of the scheduled opening of the Zandvlei Estuary mouth by the City of Cape Town. The suggested association was that the opening of the mouth released a pulse of concentrated nutrient rich water and nursery fish into the shore break, thereby attracting the related chain of predators to the area, including Great White Sharks. The Zandvlei mouth is approximately 500 metres from Muizenberg corner where JP Andrew was attacked.

This speculated association of attacks with that of river outflows is further increased when it is considered that the other three attacks (two fatal) that have taken place in the inshore in the last five years, took place within 500m of outflows; namely the Silvermine River at Fish Hoek and Wildevoelvlei at Noordhoek Dunes.

This paper investigates the relationship of White Shark occurrence with river and estuary mouths and discusses the role that nutrient load and estuary mouth manipulation, as part of

the City's catchment management strategy, may play in white shark presence and attack. Sufficient evidence to make definitive statements is lacking, however the paper presents the available information and attempts to deduce whether this issue as a whole deserves further investigation.

2. Rivers and Estuary Management

The City's rivers and catchments are managed by the Department of Catchment, Stormwater and River Management. In terms of this paper, the focus around the association of white sharks to estuaries and outflows, and therefore the possible risk to recreational users, sits within two distinct water management issues, namely;

- The physical intervention by the City in opening and closing estuary river mouths and how this may influence the presence of White Sharks
- The higher nutrient load of certain City rivers', estuaries and stormwater outfalls entering the inshore region and how this may influence white shark presence.

Physical Intervention: Opening and Closing of Estuary and River Mouths

The City's policy on actively opening and closing river and estuary mouths is to refrain from doing so unless absolutely necessary so as to avoid a possible flood situation, or in mitigation against a build up of nutrients and/or loss of salinity within the systems.

Flood situations may arise if a river mouth has been closed due to natural factors such as low flow conditions and sand build up on the beach, common during the Cape summer, in conjunction with a heavy rain episode. In this instance, if surrounding property is potentially under threat of flooding, the City may physically open the mouth as a preventative measure. In other cases, higher than normal nutrient levels (caused by a wastewater treatment works malfunction) and which could lead to algal blooms, have in the past been mitigated through the opening of river mouths. Finally, the Silvermine River Mouth is manipulated if the river mouth migrates towards Clovelly Station potentially undermining infrastructure. These interventions are by far the exception rather than the norm.

There is one exception however, to this policy, and that is the planned and ongoing opening and closing of the Zandvlei Estuary mouth. The Zandvlei Estuary mouth is left open throughout winter due to the higher flow as a result of seasonal winter rainfall. However, during summer months, the mouth is actively closed following a spring high tide and then breached (opened).

The primary reason for manipulating the Zandvlei Estuary Mouth is to attempt to keep the salinity levels in the vlei above 8 – 10ppt. Adequate levels of salinity are required to support floral and faunal components (such as Sago pondweed and their associated communities of epiphyton and periphyton, tube worm and sand prawn), all of which are essential

components of estuary ecology and water quality maintenance. In addition, the estuary mouth is manipulated at certain times of the year (usually at the end of winter) to regulate the water level to ensure enough recreational water depth. Using spring tides, and manipulating the mouth, the Catchment Management Department "flushes" the estuary aiding the ecological functioning and integrity of the estuary. This "aided flushing" of the Zandvlei estuary has significantly boosted the ecological condition of the estuary and is considered a highly successful environmental intervention. Zandvlei Estuary recorded Total Phosphorous mg/lire results of below the Eutrophic and Hypertrophic limit of 0,125 mg/l for 2000, 2001, 2002, 2003 and 2004 (Catchment, Stormwater and River Management Report, City of Cape Town, 2003-2004). However, as a result of this intervention, there is a periodic release of moderate concentrations of nutrients into the inshore area.

Rivers, Estuaries and Stormwater outflows: High nutrient Content

The City of Cape Town has a urban population of 3,2 million people and is currently experiencing a growth and development boom. This translates into greater surface-area of hard surfaces increasing levels of urban run-off, increased capacity demands on existing and dated sewage treatment works, natural river flow interruptions, greater levels of nutrients and chemical pollutants in the environment (fertiliser, animal and human waste products, solvents and soaps and industrial by-products) and a loss of natural water ecosystem services such as purification and attenuation through seasonal wetlands having been lost to development. The cumulative effect of these urban pressures is a decrease in the ecological state of the City's river and catchment system. This results in poor water quality high in nutrients entering the inshore at many river, estuary and stormwater outflows. However the impact on City rivers and estuaries is not uniform across the City, some are highly altered heavily impacted systems while others retain relatively high water quality standards. Of the three outlets in question (Zandvlei Estuary, Silvermine River and Wildevoelvlei) only one, the Wildevoelvlei has a high nutrient load as a result of receiving treated wastewater effluent. Wildevoelvlei exceeded the Eutrophic and Hypertrophic phosphorous limit of 0,125 mg/l for 2000, 2001, 2002, 2003 and 2004 by more than 400% each year (Catchment, Stormwater and River Management Report, City of Cape Town, 2003-2004). The Zandvlei Estuary is classed as moderate in terms of nutrient load, receiving only urban and stormwater run-off, while the Silvermine River is one of the cleanest urban rivers in Cape Town with 100% compliance with DWAF Ecoli guidelines and phosphorous levels well below the limit (0,016 mg/l) (Catchment, Stormwater and River Management Report, City of Cape Town, 2003-2004).

This is in comparison to other outlets such as the Zeekoevlei outlet that is permanently open and flowing with high nutrient loads from the Cape Flats Wastewater Treatment Works and the Eerste River Estuary, also permanently open, which carries the treated effluent from the Macassar Wastewater Treatment Works. Both outlets have high phosphorous levels above eutrophic and hypertrophic levels.

Stormwater outflows are seasonal, with very little or no flow during the Cape's dry summer months and with increased flow in winter as a result of high rainfall episodes. Further, it should be noted that nutrient pollutant inflow levels to the City's rivers, estuaries and stormwater outlets are highest at the beginning of winter with initial winter rains flushing accumulated nutrients from streets, urban areas and pipe networks, whilst conversely being lowest during the summer months.

Shark Presence: Is there a relationship?

Preliminary evidence from False Bay (Kock pers.com)

There is a large-scale research project monitoring white shark presence within False Bay. Monitoring equipment has been placed all along the coast and to date white sharks have been detected on all 30 monitors located between Cape Point and Koeël Bay (Kock pers.com). Preliminary data indicates that inshore areas with the highest recorded shark activity are Simon's Town, Fish Hoek, Kalk Bay, Muizenberg, Standfontein and Macassar. Less activity has been recorded at Cape Point, Partridge Point, Gordon's Bay and Koeël Bay.

In certain key areas, like Muizenberg, more than one monitor has been deployed to address specific questions related to that area. Monitors have been deployed at Baily's Cottage, Joan's Bouy, Zandvlei and Sunrise Beach approximately 500 m from shore. Preliminary data indicates that the monitor closest to the Zandvlei mouth at Muizenberg detected the highest relative shark activity (Kock pers. com) (Fig 2), however it's not possible at this stage to differentiate between whether this is a natural 'hotspot' for white sharks or whether they are attracted locally to the breaching of the Zandvlei mouth. Such confirmation will only be reached after more months of monitoring. However, because all four monitors show the same seasonal pattern of shark presence (Fig. 2) and this seasonal pattern is reflected at other inshore sites around the bay, like Simon's Town, Gordon's Bay and Fish Hoek (Kock *et al*. 2006), it suggests that the presence of white sharks at Muizenberg is not governed by bi-monthly events, like the breaching of the Zandvlei mouth.

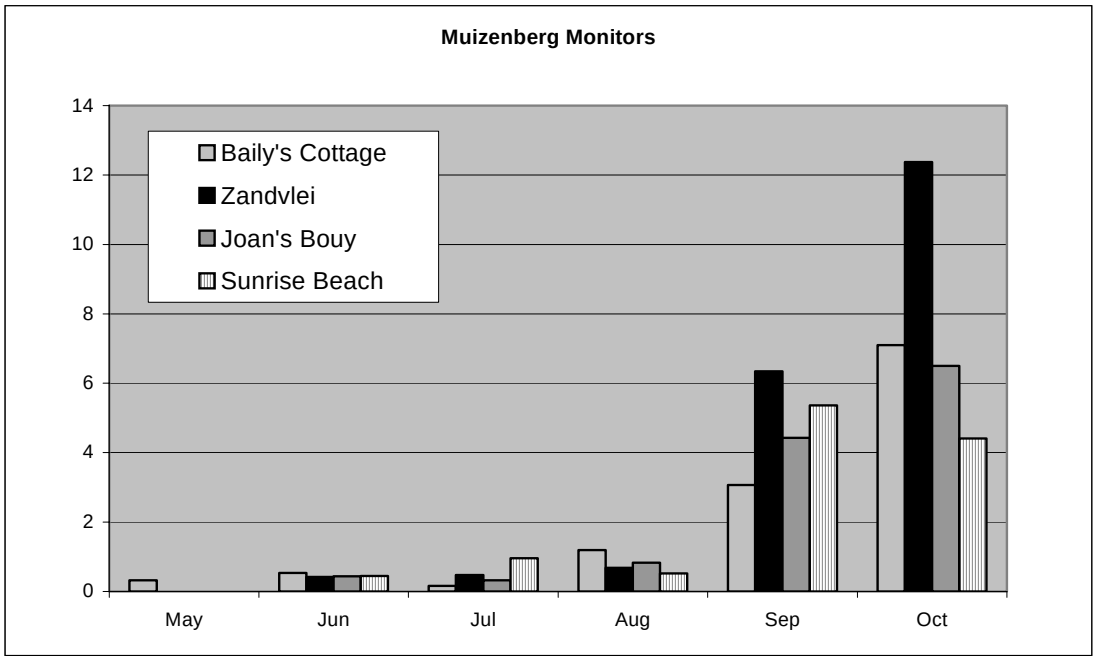


Figure 2. Shark activity (acoustic detections per shark per day) recorded on four acoustic monitors deployed in Muizenberg from May – October 2005.

Preliminary evidence from Mossel Bay (Johnson pers.com)

Research conducted at Mossel Bay did reveal a possible association between white sharks and river mouths. However, at present it is impossible to determine the causative influence that river mouths may be having on white sharks distribution within Mossel Bay.

Three sharks were manually tracked for a combined effort of over 600 hours during which position, water depth, water temperature and bottom structure were routinely recorded at 10 minute intervals. The results revealed distinct behavioural patterns unique to individual size classes.

The largest sharks, a circa 420cm female was primarily associated with waters near to Hartenbos river mouth and Seal Island. On only one occasion was this shark located outside of these core areas. The shark's behaviour was typified by patrolling behaviour in the early mornings and late afternoons in waters adjacent to the seal Island apparently hunting for seals departing from or returning to Seal Island (Fig. 3). The remainder of the time, the shark swam circa 3kms towards Hartenbos river mouth and swam in a restricted area 'opposite to' and 'south of' Hartenbos river mouth (Fig 1). The northern edge of the river mouth appeared

to represent the northern most limit of the sharks' home range over the various 24hour periods.

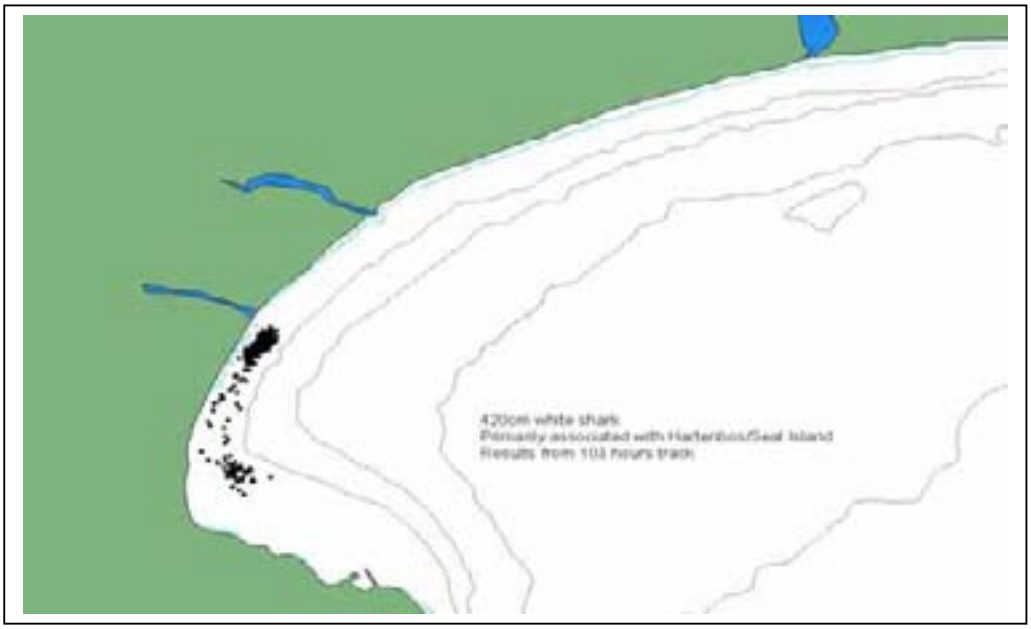


Figure 3. Illustration of the behavioural patterns of a 420cm female White Shark in Mossel Bay over 103 hours of tracking

The smallest white shark was exclusively observed in the Grootbrak region. Its small size and behaviour suggested that it occupied this area to feed off available fish. Its absence from Seal Island further suggests an inability or unwillingness to hunt seals. These findings are consistent with other work on white sharks that has shown a shift in diet from fish to seals as sharks grow in size. The sharks patrol area stretched from the north eastern edge of Grootbrak river mouth along the coastline some 5km to the South west (Fig. 4). The apparent patrolling area was larger than the aforementioned larger shark and we suspect this is related to the more variable spatial distribution of available fish prey (in comparison to pinniped prey).

Figure 4. Illustration of the behavioural patterns of a 280cm White Shark in Mossel Bay over 18 hours of tracking

A 350cm female shark was also extensively tracked, and her behaviour varied between the larger and smaller sharks behavioural patterns. That is, occasionally the shark would be located in the Hartenbos/Seal Island region, where she would perform early morning and late afternoon patrols of Seal Island. Such patrols would be interspersed with 'resting' periods opposite Hartenbos river mouth (Fig 5. Track C).

Alternatively she was frequently located at Grootbrak, where her behaviour was typified by patrolling the 5km stretch of coastline from Grootbrak river mouth extending to the South west (Fig. 5 Track B). On three occasions we had the opportunity to track her swimming between Grootbrak and Hartenbos (Fig 5. Track A). These movements were direct and coastal occurring at both day and night. On all occasions, 'the turn back point' occurred 'at' or 'just beyond' Grootbrak's river mouth. This suggests that the river mouth and associated abiotic changes (e.g. salinity) may have been utilised as a navigational clues.

Although the behaviours of these three sharks in Mossel Bay appear closely aligned with river mouths, a number of other possibilities exist to explain the observed patterns of habitat use. The area opposite Hartenbos river mouth (extending to the South) is characterised by extensive exposed reef, as opposed to sand bottom which dominates the remainder of the area. As such, the attraction to this area may be 'as' strongly related to the presence of reef, as it is to the presence of the river mouth.

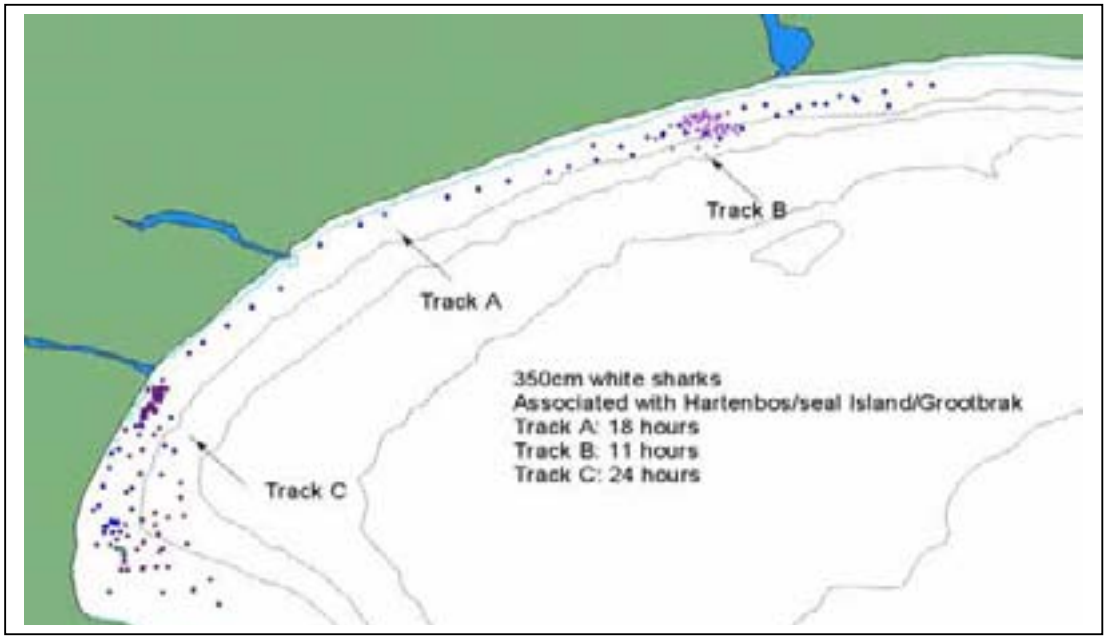


Figure 5. Illustration of the behavioural patterns of a 350cm female White Shark in Mossel Bay over 53 hours of tracking.

Furthermore, Kleinbrak River is consistently ignored by white sharks in the Mossel Bay region. Kleinbrak River is open almost consistently, in contrast to both Hartenbos and Grootbrak Rivers which open rarely and typically only following heavy rains. The status (open or closed) of both Grootbrak and Hartenbos river appear to have no effect on the behaviour of sharks in Mossel Bay, with sharks been attracted to these areas consistently. If the presence of the rivers are acting as a causative attraction for white sharks to congregate then it appears irrelevant whether the river mouths are open or closed. This would make sense particularly if the presence of such outlets are been used as navigational or orientation clues for patrolling white sharks. It is more feasible to expect that white sharks can detect small variations in salinity (associated with leaching) or other non apparent environmental clues that can enable white sharks to consistently orientate themselves in space independent of random and sporadic terrestrial weather patterns.

3. Discussion

Assuming that based on the research to date (the preliminary evidence shown on the bottom monitors in False Bay and tracking in Mossel Bay) that river and estuary mouths may be potential “hotspots” for white shark activity, for the purpose of this paper, a clear distinction needs to be made between the issues under discussion.

Opening and closing of the Zandvlei mouth

Although the preliminary evidence may suggest that white shark presence is higher at the Zandvlei mouth, it is still unclear whether the higher presence of sharks is as a direct result of the planned flushing of the estuary. The work by Ryan Johnson in Mossel Bay suggests that the status of the mouth (open or closed) had little influence. In other words, the presence of the white sharks at the Zandvlei mouth may very likely be a natural phenomenon with white sharks choosing the estuary mouth habitat for a range of ecological reasons. If this is the case, then the speculation around the attack on JP Andrew and the continued risk to recreational users due to the ongoing planned opening and closing of the mouth is not a valid concern.

It may also be argued that the actual nutrient pulse created by the highly periodic opening of the estuary mouth is insignificant in comparison to the daily outflow of high nutrient water some 1200m to the east at the Zeekoevlei outlet. However on current information it is impossible to make the distinction between shark presence as a result of the estuary mouth or presence as a direct result of estuary flushing.

Before motivating therefore that further research must be undertaken to assess and determine this distinction or for the City to act in a precautionary manner and stop breaching, it is worth considering the practicality of this management intervention. Would the current situation of relatively few attacks and arguably low risk to recreational users warrant the review of the current catchment management policy to the detriment of the entire ecology of the estuary?

It is argued in this paper that the current situation (shark risk) would not warrant ceasing estuary manipulation and the ecological degradation of the Zandvlei estuary. Further, even if it was decided to stop active manipulation of the mouth, the natural flow regimes during winter rainfall would periodically open the mouth thus retaining some of the risk. Therefore to stop the active management of the estuary and risk significant ecological, health, social and economic impacts and costs, in order to only slightly lower the presently very low risk of shark attack, cannot be motivated. Rather, if estuary mouths are identified as shark hotspots, estuary management options should not be reconsidered, but a range of alternative management options implemented. These alternative management options could include

- ensuring that the public and recreational users are aware that estuary mouths are areas of increased shark activity and therefore increased risk of attack
- ensuring adequate warning signs are in place
- strengthening the shark spotting and warning programme

High nutrient river and stormwater outflows

Less information currently exists to determine if the nutrient load of small river outflows such as the Silvermine River are a factor in increasing white shark activity. The distinction again would need to be made to assess whether rivers alone are risk factors or whether high nutrient load of rivers increase the presence of White Sharks. Initial information suggests that there is no relationship between nutrient load and White Shark activity. Fish Hoek has recorded some of the highest summer White Shark activity by both the Shark Spotting Programme and by Alison Kock's research programme (Kock pers. Com). As described earlier, the Silvermine River is of some of the highest water quality in Cape Town. In addition, the greatest nutrient load is experienced during early winter and not mid-summer, which is the peak in shark presence. This alone would suggest that there is no relationship with nutrient load and White Shark presence. However, further research would need to be undertaken to determine definitively whether river mouths and / or nutrient load are factors in increasing White Shark activity in the inshore region and therefore increased risk of attack.

4. Concluding Discussion and Recommendations

Although preliminary evidence may suggest that some estuary and river mouths are areas of higher white shark presence and activity, there is little scientific confidence in this conclusion at present. Further, much more research would need to be done to determine whether the high nutrient loads of urban outfalls and river mouths is a contributing factor to this possible increased presence.

It suggested that from the arguments presented in this paper that the critical issue for recreational safety is not whether flushing or nutrient load is a pull factor for white sharks, but rather understanding if and where White Shark "hotspots" may exist. This question is currently being addressed by a research project investigating White Shark ecology and behaviour in False Bay. The aim of the study includes identifying spatial and temporal trends of white shark presence and activity.

However, for improved understanding of shark ecology and long-term conservation strategies, understanding shark spatial and temporal trends and the associated "pull" factors, does become critical. The current research therefore has the potential to not only greatly advances the ecological understanding of white sharks and their behaviour, but contribute significantly to recreational safety of coastal users by identifying shark "hotspots". Support of the current research programme is therefore essential.

It is therefore recommended that:

- The City actively supports and endorses the research that is underway that may identify 'hot spots of shark activity
- The City ensures that the research findings form part of its long-term planning
- If the information gathered as part of the research begins to suggest more strongly that a link between estuary, river and stormwater outflows with white shark presence does exist, that the City acts immediately to warn and inform the public through a range of mediums

The seal population of Seal Island, False Bay

S.P. Kirkman[1], W.H. Oosthuizen[2] & M.A. Meÿer[2]

[1]*Avian Demography Unit, Rondebosch 7701, Cape Town*
Email: skirkman@deat.gov.za

[2] *Marine and Coastal Management, Department of Environmental Affairs and Tourism, Private Bag X2, Roggebaai 8012, South Africa*

Abstract

- Seal Island is the only seal breeding colony in False Bay, and is currently the second largest seal breeding colony in South Africa.
- The seal population of Seal Island had been drastically reduced and possibly extirpated, as a result of over-exploitation between the 17th and 19th centuries. The population recovered during the 20th century, under controlled harvesting.
- Counts and estimates of pup numbers, and harvest returns, indicate that there has been little change in island's population in the last fifty years, apart from depressed pup counts in the 1980's (related to human disturbance), and year to year fluctuations in pup counts (possibly weather related).
- There has been no seal harvesting or any attempts at hands-on management of the seal population of Seal Island since 1990, when a moratorium was placed on seal harvesting in South Africa.
- The annual arrival of white sharks to the vicinity of Seal Island (March-April) corresponds with the time when the pups of the year begin to spend prolonged periods of time in the water, supplementing their diet with prey caught nearby their colony. Their departure corresponds with the time of weaning (August-September).
- The dispersal of white sharks to inshore areas of False Bay (September-October) is well in advance of the seal pupping season (November-December), when new-born pups may be washed off the island.
- New-born pups washed off the island between late November and early January apparently constitute a highly variable food source, both within and between pupping seasons.
- There is no evidence that white sharks utilize the pups washed off the island during the pupping season as a food source.

Citation: Kirkman S P, Oosthuizen W H and M A Meÿer. 2006. The seal population of Seal Island, False Bay. *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. Introduction

Seal Island is a barren rock 2 ha in area, with a maximum elevation of 6 m (Rand 1963), and is the only breeding locality of the Cape fur seal *Arctocephalus pusillus pusillus* in False Bay (Figure 1). Seals also haul out at a few other small rocks in the bay, such as those at Partridge Point near Simonstown, but do not breed there (Oosthuizen and David 1989). Of the extant seal breeding colonies in South Africa (Figure 2), Seal Island is the second largest (after Kleinsee) in terms of pup production, and the largest occurring on an island (MCM unpublished data).

A number of ecosystem management issues within False Bay have been raised as possible links to the recent spate of shark attacks in the Cape Town area. These include the possibility that sharks are attracted to the inshore areas of False Bay by the availability of fur seal pups washed off the island and inshore in adverse weather conditions. This paper attempts to put such speculation into perspective, by discussing aspects of the fur seals' annual cycle that have relevance to the spatio-temporal distribution of white sharks *Carcharodon carcharias* in False Bay. The history of the Seal Island seal breeding colony, from the time of the early European settlers to the present, with reference to exploitation, management and trends in population size, are briefly reviewed.

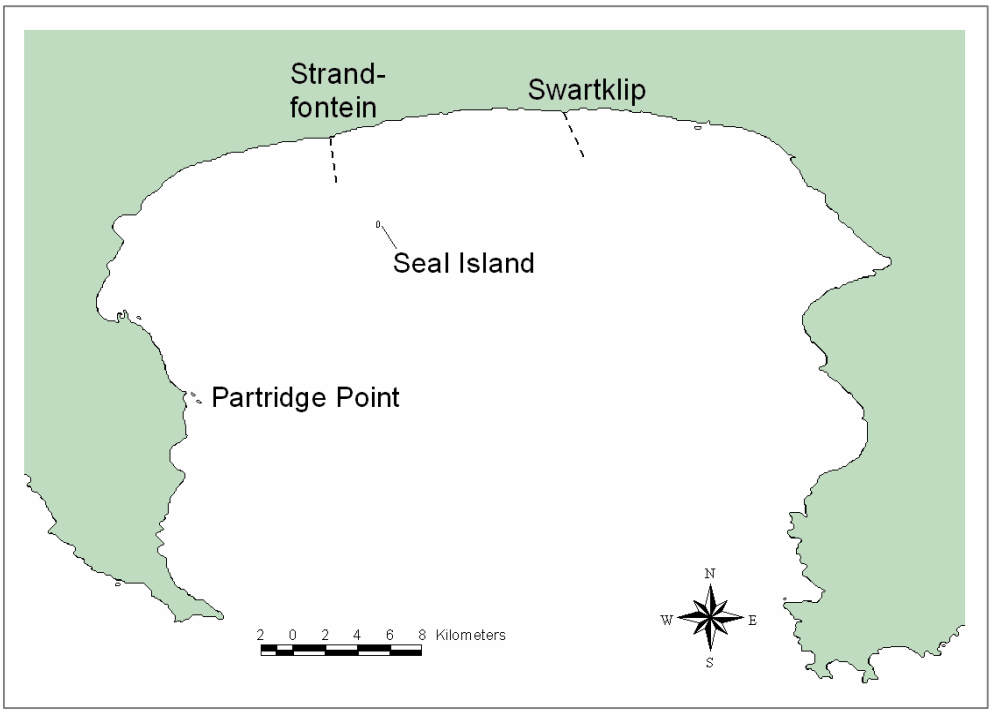


Figure 1. The location of Seal Island in False Bay, indicating the stretch of beach from where pup carcasses were removed by the Westridge Cleansing Department.

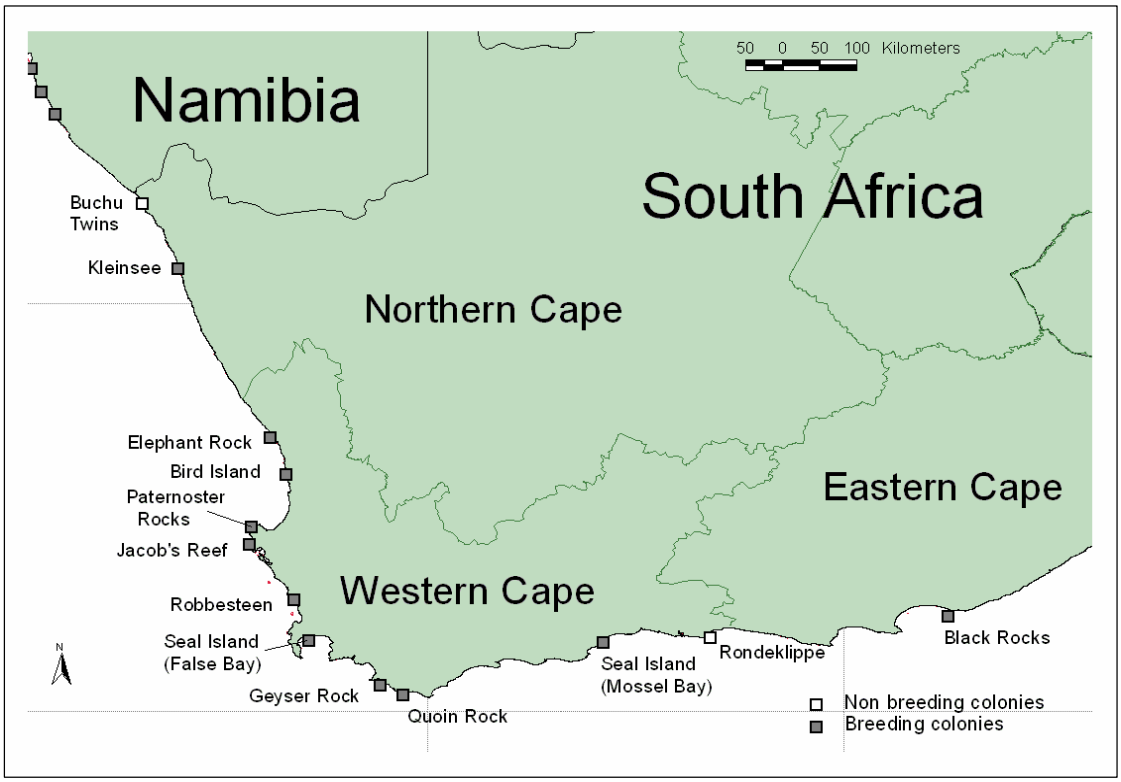


Figure 2. Locations of seal breeding colonies in South Africa.

2. Historical records, 17th century–1950

At the time of the first recorded visit to the island by Simon van der Stel in November 1687, Seal Island apparently supported gannets, gulls and a large seal population (Brock *et al*. 1976 cited by Shaughnessy 1984). Subsequently, there is no information on the fauna of the island until the reports of several travellers that visited the island between 1772 and 1798. These included Sparrman (1785), Pages (1782), Percival (1804) and Barrow (1801), and it is apparent from their accounts (cited by Shaughnessy 1984) that seals were abundant at the island towards the end of the 18th century and were being hunted by fishermen. Penguins were also reported to be present on the island.

Early in the 19th century, permission to harvest seals on Seal Island was being granted to applicants by the Governor of the Cape Colony (Shaughnessy 1984). However, there is evidence that the seal population at the island was considerably diminished by 1819 and possibly absent from the island during the last third of the 19th century and the beginning of the next century (Curtis 1819, Layard 1867, Moseley 1892, Cape of Good Hope 1905, cited

by Shaughnessy 1984). If so, then Seal Island constitutes one of more than 20 locations from where the Cape fur seal was extirpated through unsustainable harvesting by the beginning of the 20th century (Rand 1972, Best and Shaughnessy 1979).

The collapse of the Cape fur seal population between the 17th and 19th centuries has been attributed to uncontrolled harvesting (Jackson 1894, Best 1973) and the activities of guano collectors at many offshore islands (Rand 1952). During this period, harvesting was unrestricted in terms of numbers, largely indiscriminate with regard to the sex and age of seals, and frequently coincided with the breeding season, resulting in extreme disturbance. Seabird populations increased at several of the islands formerly populated by seals, and many of these, including Seal Island, were managed for guano production after the 1840's, further preventing the recovery of seals at these islands (Rand 1952). The collection of guano at Seal Island ceased in 1949 (Shaughnessy 1984).

The first legal protection afforded to Cape fur seals was the Fish Protection Act of 1893, which stipulated that no seals could be taken without a permit (Jackson 1894). In the case of Seal Island, this protection was twice retracted (1905 and 1930) and restored (1909 and 1934) during the first half of the 20th century. In 1905 it was reported that there were no seals present on Seal Island (Cape of Good Hope 1905 cited by Shaughnessy 1984), although harvesting was allowed there during the first decade of the 20th century. Due to the lack of records, the status of the seal population at Seal Island from then until 1951, when regular harvests by the Government Guano Islands Division commenced, is sketchy. However, numbers were apparently very low for much of this period, as it was reported that not more than ten seals were seen on the island on any single occasion during 1939 (Anonymous 1977), and no harvesting occurred between 1942 and 1950 (Wickens *et al*. 1991).

3. 1951–present

Management

By the 1950's, the seal population at Seal Island had recovered dramatically, and between 1951 and 1975, immature seals (mostly pups-of the year, but also bulls less than 3-years-old and cows less than 2-years-old –Rand 1972), were being taken by Government sealers at a rate of c. 2 900 per a year (Figure 3). Mature bulls were killed in only one year (1963), ostensibly to reduce their numbers (Rand 1972).

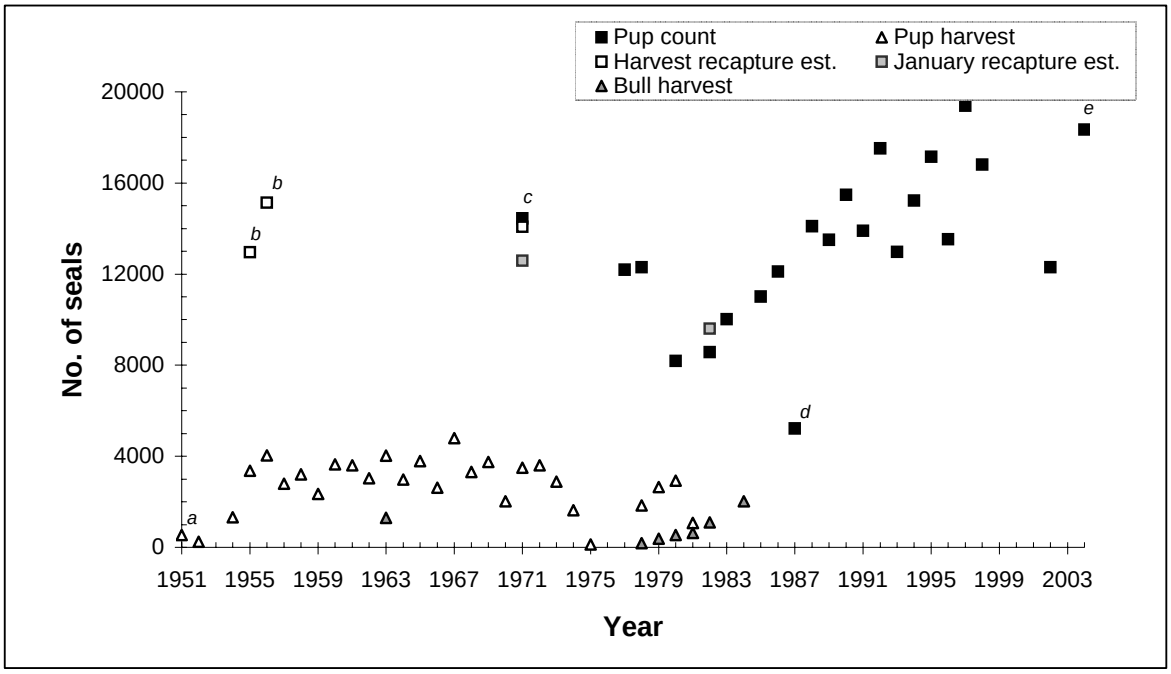


Figure 3. Counts and estimates of pup numbers, and records of pup and bull harvests, at Seal Island between 1951 and 2004 (see text for explanations of legends). The arrow indicates when commercial seal harvesting stopped in South Africa. a ¬¬– half of 1100, the sum total of pups taken at Seal Island and Jacob's Reef in that year; b – considered as over-estimates by Shaughnessy (1984); c – probably an undercount, as photographs taken on 3 January; d – coincided with disturbance program, an additional c. 4000 pups found washed up on mainland; e – digital photographs used, therefore quality enhanced. [Pup counts – Best and Rand (1975), Shaughnessy (1987), David (1991), MCM unpublished data; January recapture estimates – Best and Rand (1975), Shaughnessy (1993); Harvest recapture estimates – Shaughnessy (1984, 1993); Pup and bull harvest records – Rand (1972), David (1991)].

Government sealing at Seal Island ended soon after the Fish Protection Act of 1893 was replaced by Seabirds and Seals Protection Act in 1973. A private concession to harvest seals was awarded in 1978, for five years. Upper limits to the quota were set at 4,500 immature seals and 1,000 bulls, with the possibility of adjustments should censuses indicate population fluctuations (Shaughnessy 1984). These quotas were not met, with the exception of the bull quota in 1982. The last pup harvest at Seal Island occurred in 1981. After 1983, when the market for pup pelts collapsed worldwide as a result of pressure from conservation organizations, the harvesting of pups at Seal Island was economically non-viable.

The increase in the seal population in False Bay triggered condemnation from fishermen (Anonymous 1977), and in 1984 the Minister of Environment Affairs and Tourism announced that 5,000 bulls would be culled at Seal Island. Whereas bull harvesting had previously been restricted to the month of November to limit disturbance during the pupping season, the restriction was not imposed for this cull, which commenced in late November. Because of

this and the lack of scientific basis for the cull, considerable controversy surrounded this matter (Comrie-Greig 1985). Less than half the targeted number of bulls were taken, but several hundred seals, including pups, were found washed up on False Bay beaches, many of them likely victims of the disturbance caused by the cull.

There was further controversy two years later when the same Minister sanctioned a seal disturbance program at Seal Island, devised by members of the fishing industry to reduce the seal population there (Yeld 1987). Personnel were stationed on the island to interfere with the breeding habits of the seals. Very few seals were born on the island in that year (Figure 3), and several thousand pups were found washed up on False Bay beaches. The program apparently failed to reduce the pregnancy rate of the population, perhaps because mating was ubiquitous in the sea around the island during the program (M. Meÿer pers. obs.), and the pup count of the following year surpassed all previous counts since 1971. Since 1990, a moratorium on seal harvesting has existed in South Africa, and there has been no further harvesting or attempts at hands-on management of the seal population on Seal Island.

Trend in population size

Two techniques have been used as the basis for assessments of Cape fur seal numbers, namely counts of pups on aerial photographs, taken when the maximum number of pups is expected in the colony (17–22 December), and pup population size estimates from tag-recapture experiments (Shaughnessy 1987, 1993). Pup numbers are used for the following reasons: (a) they are the only demographic category that are all confined to land simultaneously, during their first few weeks of life, (b) their small size and the black pelage (of their first ten weeks of life) permit them to be easily distinguished from other age classes, and (c) their small size, inability to flee quickly, and habit of forming large crèches, permit them to easily be restrained and tagged.

It is recognized that both techniques underestimate pup production (Shaughnessy 1987, 1993). In the case of tag-recapture experiments, it is the number of pups at the time of tagging (~20 January) that is estimated from the ratio of tagged to untagged pups in the population at the time of recapture. Actual pup production is underrepresented due to mortality between birth and recapture. In the case of the aerial photographic counts: (a) a proportion of pups die before the survey and a small proportion may be born after the survey, and (b) pups may be hidden in crevices or shadows, or may form tightly-bunched crèches that are difficult to count.

Due to the large number and wide distribution of Cape fur seal colonies, aerial photographic counts are the most practical means of assessing the population, and therefore comprise the longest and most complete time series of pup numbers. Moreover, they have been conducted more frequently at Seal Island than at most of the more distant seal colonies (MCM unpublished data), due to the convenient location of island. Despite inherent biases (see above), counts from aerial photographs are useful indicators of relative pup abundance

Shaughnessy (1987), although improvements in the quality of photographs due to changes in photographic equipment may inflate estimates of the rates of change in pup numbers over time (Anonymous 1991).

Tag-recapture population estimates have been obtained from recaptures made approximately one week after tagging (January recapture estimate), or from pups dispatched during the winter harvest, provided such a harvest was undertaken (harvest recapture estimate). However, the technique is time-consuming and costly, and has seldom been applied at Seal Island. The 1971 and 1982 tag-recapture estimates are included in Figure 3 as validation for the corresponding aerial photographic counts. Tag-recapture estimates from 1955 and 1956 were considered by Shaughnessy (1984) to be over-inflated, due to some of the technique's basic assumptions being compromised. However, these early estimates are not improbable, considering that a comparable estimate was obtained in 1971, when the harvest returns of pups was also comparable to 1955 and 1956 (Figure 3).

In Figure 3 (and Figure 4), pup counts from aerial photographs are aligned with the years in which the focal cohorts were weaned, to correspond with the harvesting records and tag-recapture estimates. For example, the result of the aerial photographic census that took place in December 1986 is aligned with 1987. The initial count at Seal Island (Figure 3) was in fact conducted on 3 January 1971, and is therefore probably an undercount compared with subsequent counts, as pup numbers show a decrease through natural mortality from the maximum by the end of December (Shaughnessy and Best 1975). Disregarding the low pup count of 1987 that resulted from deliberate disturbance to the breeding colony, a dip in pup numbers, relative to other years, is apparent in the early 1980's. This may have been influenced by bull harvesting that took place at this time. Bull harvesting was restricted to November to limit disturbance to the breeding season, but since approximately 50% of births occur in November according to Shaughnessy and Best (1975), disturbance from harvesting could conceivably have resulted pup mortality and lowered pup counts.

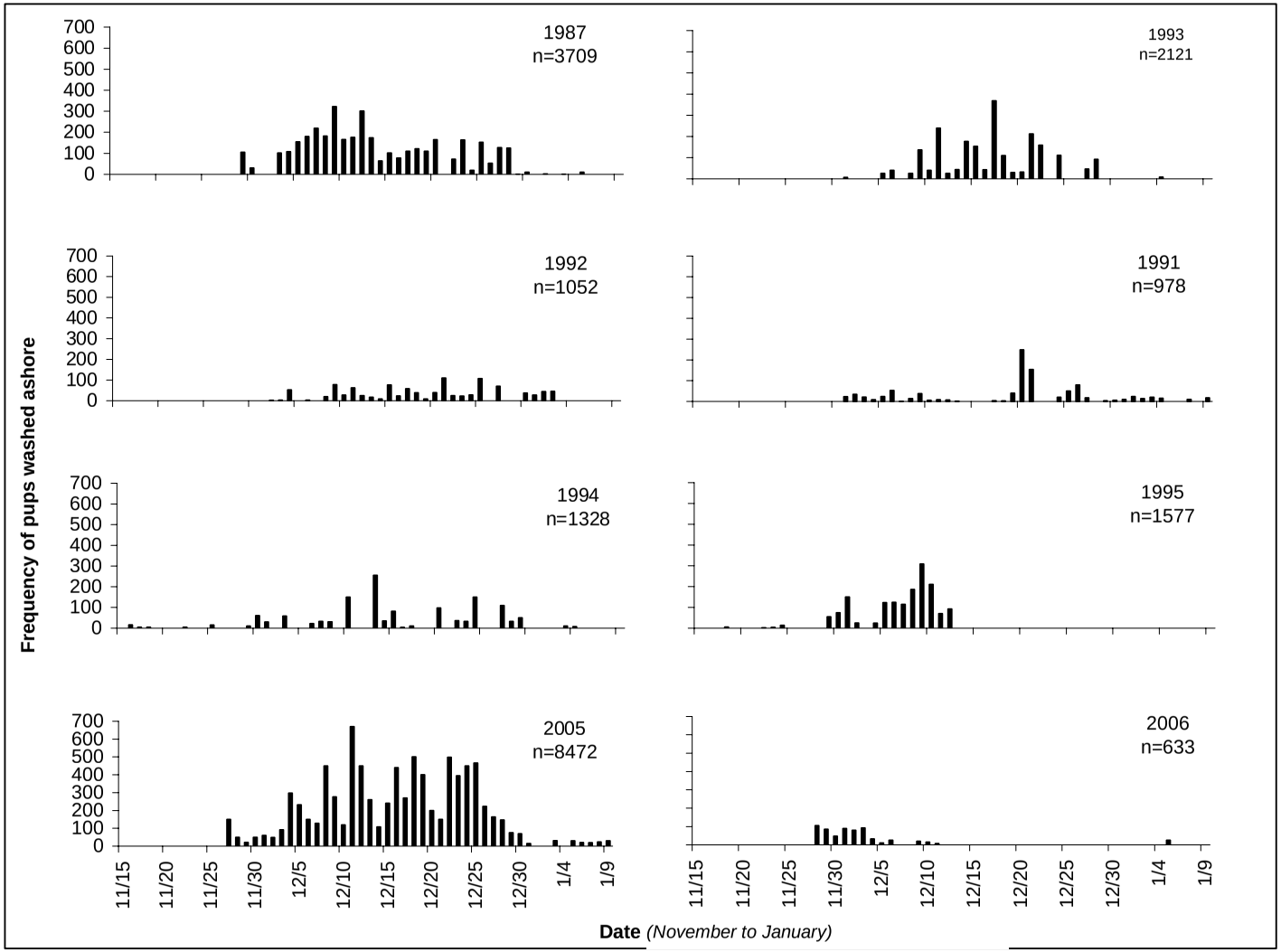


Figure 4. Numbers of pups found washed up on beaches from Strandfontein to Swartklip, and removed by the Westridge Cleansing Department, during daily searches coinciding with the pupping season (November – January). Only eight years of data were available from 1987 to the present.

After 1987, the pup counts have averaged c. 15,500, fluctuating between c. 13,000 and c. 19,400. Due to the large fluctuations, it would not make sense to estimate a rate of increase in population size by a simple calculation between the first and last counts of the time series. Furthermore, mathematical models fit the data poorly, and give an inflated rate of increase due to the lack of data points during 1971–1981, relative to the later years. Visual inspection of the entire time series of pup counts indicates that, notwithstanding year to year fluctuations, and keeping in mind that the initial (1971) count was likely an undercount, pup numbers have remained more or less constant over the time series, except for the depressed numbers in the early 1980's. According to Shaughnessy (1984), the size of the seal population is probably larger than it would have been before commercial exploitation began, considering the absence of gannets on the island in the present time. Considering the numbers of pups carcasses found washed up on False Bay beaches in some years (Figure 4), the fluctuations in pup counts between years may be accounted for by weather conditions and related pup mortality, leading up to the date of aerial surveys.

4. The annual cycle in relation to white shark activity

According to Shaughnessy and Best (1975), few pups are born at Seal Island before the middle of November, and the median pupping date is 1 December (i.e. half of the pups are born by this date), though the temporal distribution of pupping may vary from year to year. Between birth and weaning, mothers alternate foraging trips to sea with periods spent in the colony suckling their pups (David and Rand 1986). According to Rand (1967), pups acquire swimming ability slowly, and the majority are only proficient in the water after some months of experience in sheltered water. By four months of age (March-April), pups have moulted their natal pelage and are protected by a warm, water-repellent coat. Therefore they can stay in the water for prolonged periods, and are able to supplement their diet with crustaceans and fish that they catch in the waters nearby their colony (Rand 1959). By seven months of age (June-July), pups may forage at some distance from the colony, staying away for up to two or three days at a time (Rand 1967). The age of weaning is variable, but is generally between 8 and 11 months of age, or July to October (David and Rand 1986), peaking in September (M. Meÿer pers. obs.).

According to the preliminary results of acoustic surveys (A. Kock unpublished data), the time when white sharks return to the vicinity of Seal Island, after several months of absence, coincides with the period when pups begin to spend prolonged periods of time in the water around the island (March–April). Moreover, the period when white shark activity is highest around the island coincides with the time when pups can be expected to travel back and forth between the colony and more distant foraging areas (July-August). At the time of weaning (August-September), sharks apparently leave the island's vicinity, and no sharks are present there by October, which is also marked by the end of the shark-cage diving season. White shark activity inshore increases in September-October (A. Kock unpublished data), well in

advance of the commencement of the birth of the following cohort of pups, which commences in November.

Considering the high density of seals at the island, and the exposed nature of the island to high seas from the South or South–East, young, inexperienced pups are vulnerable to being swept off the island and drowned. According to M.A. Meÿer (per. obs.) pups are most at risk when they are congregated near the water's edge in strong South-Easterly weather, coinciding with a rising tide. many pups washed off Seal Island are washed ashore the beaches inshore of the island.

The numbers of pups removed from the beaches by the Westridge Cleansing Department, during daily cleanup operations, can be used as an index of the availability of pups in the inshore area to white sharks. The following is apparent from several years of records provided by the Department, and summarized in Figure 4: (a) The numbers of pups washed off the island fluctuate between years. In 2005 (December 2005 – January 2005) the average number of pups washed up per day over a 30 day period exceeded 160, whereas the corresponding average the following year was just 12. (b) The numbers washed off the island also fluctuate greatly within years. It is therefore apparent that pups washed off the island would constitute a highly variable food source to white sharks. Furthermore, white shark researchers active in the Bay during the pupping season have not seen evidence that white sharks utilize pups washed off the island as a food source (A. Kock pers. comm., M.A. Meÿer pers. obs.). Neither has there been any such evidence from the state of pups found washed up on the beaches.

5. Conclusions

- The seal population at Seal Island appears to have been stable during the last fifty years, except for year to year fluctuations in pup numbers (possibly weather-related), and depressed pup numbers in the 1980's (related to human disturbance).

- The presence of white sharks in the vicinity of Seal Island (March-April to August-September) corresponds with the period when pups of the year become active in the waters around the island, to the time of weaning.

- The dispersal of white sharks from Seal Island to the inshore (September-October) is well in advance of the period when new born pups are washed off Seal Island (November-January).

New born pups washed off Seal Island are available within a relatively restricted window of time (late November-early January) and would constitute a highly variable food source, both within and between pupping seasons, judging from the numbers of carcasses found washed

up on the beaches. There is no evidence that white sharks utilize pups washed off the island as a food source.

6. Acknowledgements

The Westridge Cleansing Department is thanked for making data available to the authors.

7. References

Anonymous. 1977. Eighth annual report, False Bay Conservation Society. 22 pp. Cape Town.

Barrow, J. 1801. An account of travels into the interior of southern Africa, in the years 1797 and 1798, Vol. 1. T. Cadell (Jr) & W. Davies, London.

Best, P. B. 1973. Seals and sealing in South and South West Africa. *The South African Shipping News and Fishing Industry Review* **28**:49-57.

Best, P. B., and R. W. Rand. 1975. Results of a pup-tagging experiment on the *Arctocephalus pusillus* rookery at Seal Island, False Bay, South Africa. *Rapport P.-v. Reunion, Journal du Conseil international pour l'exploration de la mer* **169**:267-273.

Best, P. B., and P. D. Shaughnessy. 1979. An independent account of Captain Benjamin Morrell's sealing voyage to the south-west coast of Africa in the Antarctic, 1928/29. *Fisheries Bulletin of South Africa* **12**:1-19.

Brock, B. B., B. G. Brock, and H. C. Willis. 1976. Historical Simon's Town. A.A. Balkema, Cape Town.

Cape of Good Hope 1905. [Letter from the Assistant Under-secretary for Agriculture to the Municipal Clerk, Kalk Bay, dated 22 July 1905] (Cape Archived Depot Cape Town, 3/KBY 37 Letters Received Kalk Bay Municipality, Folio 1531).

Comrie-Greig, J. 1985. The South African seal cull 1984. Editorial. *African Wildlife* **39**:2-4.

Curtis, C. G. 1819. An account of the colony of the Cape of Good Hope, with a view to the information of immigrants. Rest Fenner, London.

David, J. H. M. 1991. History and Current Status of the Seal Population in False Bay. *Transactions of the Royal Society of South Africa* **47**:641-647.

David, J. H. M., and R. W. Rand. 1986. Attendance behaviour of South African fur seals. Pages 126-141 *in* R. L. Gentry and G. L. Kooyman, editors. Fur seals: maternal strategies on land and sea. Princeton University Press, Princeton.

De Vos, A. 2005. Spatio-temporal patterns of Cape fur seal (*Arctocephalus pusillus pusillus*) movements in relation to predation risk by Great white sharks (*Carcharon carcharias*) in False Bay, South Africa. BSc (Honours) thesis. University of Cape Town, South Africa.

Jackson, C. H. 1894. Memorandum on working of the Guano Islands: Annual report for the season 1893-1894. *In* Annexures to the Votes and Proceedings of the House of Assembly, Cape of Good Hope. G66-1894: 6pp.

Layard, E. L. 1867. The birds of South Africa. Juta, Cape Town.

Moseley, H. N. 1892. Notes by a naturalist: an account of observations made during the voyage of the H.M.S. 'Challenger' round the world in the years 1872-1876. etc. John Murray, London.

Oosthuizen, W.H. and David, J.H.M. 1988. Non-breeding colonies of the South African (Cape) fur seal *Arctocephalus pusillus pusillus* in southern Africa. *Investigational Report of the Sea Fisheries Research Institute, South Africa* **132**:17 pp.

Pages, F. M. F. 1782. Voyages autour du Monde et vers les deux Poles, par Terre et par Mer, pendant les Annees 1767, 1768, 1769, 1770, 1771, 1773, 1774 et 1776, Vol 1. Moutard, Paris.

Percival, R. 1804. An account of the Cape of Good Hope. C. &. R. Baldwin, London.

Rand, R. W. 1952. Fur seals: research and management. *Commerce and Industry* **11**:35-40.

Rand, R. W. 1959. The Cape fur seal (*Arctocephalus pusillus pusillus*). Distribution, abundance and feeding habits off the southwestern coast of the Cape Province. *Investigational Report, Division Sea Fisheries, South Africa* **34**:75 pp.

Rand, R. W. 1963. The biology of guano-producing seabirds. 4. Composition of colonies on the Cape islands. *Investigational Report, Division Sea Fisheries, South Africa* **43**:32 pp.

Rand, R. W. 1967. The Cape fur seal (*Arctocephalus pusillus pusillus*). 3. General behaviour on land and at sea. *Investigational Report*, *Division of Sea Fisheries, South Africa* **60**:1-39.

Rand, R. W. 1972. The Cape fur seal *Arctocephalus pusillus*. 4. Estimates of population size. *Investigational Report, Division of Sea Fisheries, South Africa* **89**:17pp.

Shaughnessy, P. D. 1984. Historical population levels of seals and seabirds on islands off southern Africa, with special reference to Seal Island, False Bay. *Investigational Report of the Sea Fisheries Research Institute, South Africa* **127**:61pp.

Shaughnessy, P. D. 1987. Population size of the Cape fur seal Arctocephalus pusillus. 1. From aerial photography. *Investigational Report of the Sea Fisheries Research Institute, South Africa* **130**:56 pp.

Shaughnessy, P. D. 1993. Population size of the Cape fur seal Arctocephalus pusillus. 2. From tagging and recapturing. *Investigational Report of the Sea Fisheries Research Institute, South Africa* **134**:70 pp.

Shaughnessy, P. D., and P. B. Best. 1975. The pupping season of the Cape fur seal *Arctocephalus pusillus pusillus*. Unpublished report, Sea Fisheries Branch, South Africa, 8 pp.

Sparrman, A. 1785. A voyage to the Cape of Good Hope towards the Antarctic Polar Circle, round the world and to the country of the Hottentots and the Caffres from the year 1772-1776, Vol. 1. Pages 331 *in* V. S. Forbes, editor. Van Riebeeck Society (Translated from Swedish by J. and I. Rudner in 1975), Cape Town.

Wickens, P. A., J. H. M. David, P. A. Shelton, and J. G. Field. 1991. Trends in Harvests and Pup Numbers of the South-African Fur-Seal - Implications for Management. *South African Journal of Marine Science* **11**:307-326.

Yeld, J. 1987. Fur flies over seal shooing. *African Wildlife* **42**:2-11.

Mitigation

International review of responses to shark attack

Sheldon F.J. Dudley

Natal Sharks Board, Private Bag 2, Umhlanga Rocks, 4320, South Africa
Email: dudley@shark.co.za, www.shark.co.za

Abstract

Intervention in response to shark attack has varied in its nature between locations and its extent appears to have been determined by the economic consequences of attacks. Types of response have included the use of (i) shark capture devices, (ii) shark exclusion methods, (iii) shark detection methods and (iv) programs to educate the public about behavioural measures that would reduce the risk of attack. Shark fishing using either anchored, large-mesh gillnets or baited drumlines has been effective in reducing the risk of shark attack at surf beaches but carries an environmental cost in terms of catches both of sharks and other animals. Shark exclusion methods (barriers) provide complete protection but are suited to sheltered conditions where there is little or no surf. The effectiveness of surveillance in order to alert water users to the presence of sharks is difficult to quantify and depends upon conditions of good visibility. The International Shark Attack File documents all known shark attacks and investigates patterns but it does not co-ordinate responses to attacks. Few authorities have made formal policy statements with regard to prioritizing recreational safety over shark conservation. All countries where shark capture devices are used have implemented, or at least have drafted, a national plan of action for the conservation and management of sharks.

Citation: Dudley S F J. 2006. International review of responses to shark attack. *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. Introduction

A number of cities or regions of the world have been affected by shark attack but the response to this has varied, with the economic effect of shark attack and/or public demand appearing to have determined whether physical intervention was used to reduce the risk of attack. This report summarises responses at a number of different locations but in most cases the processes that led to each given response are not well documented.

2. Regional responses

Responses can be broadly categorised into three types; (i) shark capture devices, (ii) shark exclusion devices and (iii) shark detection methods. A fourth response might simply be determined “public education”, in which members of the public are advised about conditions in which it is generally safe (or unsafe) to enter the sea, or are informed that risk of shark attack is generally low.

Shark capture devices reduce the risk of shark attack at a protected beach primarily through reducing numbers of sharks in the vicinity of that beach. Hence such devices, despite having proven very effective (achieving a reduction in excess of 90% in the rate of shark attack at the beaches of KwaZulu-Natal, for example), do not provide complete protection. By contrast, the shark exclusion devices used to date have provided absolute protection but they have generally not been suited to surf conditions. Shark detection methods currently involve human observation (as opposed to automated surveillance) and their effectiveness is dependent upon favourable sea conditions, including water clarity.

(i) Shark capture devices

(a) New South Wales (NSW), Australia

Shark nets (large-meshed, anchored gillnets) were installed off the beaches of Sydney, Australia, in September 1937 (Dudley 1997 and references therein). Coppleson and Goadby (1988) explain the motivation as follows: "Before meshing was introduced… shark attacks off Sydney beaches were becoming so frequent that there was a pronounced lack of confidence in bathing, and in 1934 the New South Wales Government set up a special Shark Menace Advisory Committee to investigate and report on the best methods of protecting bathers" (pp 247-248). By 1992 there were 49 bathing areas protected between Newcastle, which is to the north of Sydney, and Wollongong, to the south. The nets are each 150 m long by 6 m deep, have a black mesh of 50-60 cm (stretched) and are set coast-parallel in about 10 m of water about 500 m from shore.

The nets are in place for eight months of the year, with the winter months of May to August being excluded as a cost-saving measure. The nets are moved between beaches such that

each protected beach has one or two nets for about nine days per month, in season. The underlying rationale is that this constitutes sufficient fishing effort to reduce shark numbers in the vicinity of each protected beach to reduce adequately the risk of shark attack.

The NSW program has been very effective in reducing the risk of shark attack, with only three or four attacks at protected beaches since the introduction of nets and none since the 1950s (Dudley 1997). Between 1897 and the introduction of nets, there were 29 attacks (fourteen fatal) at the surf beaches of Sydney and Wollongong. The three species that were probably responsible for most of those attacks were the great white shark *Carcharodon carcharias*, the bull, or Zambezi, shark *Carcharhinus leucas* and the tiger shark *Galeocerdo cuvier*.

(b) Queensland, Australia (www2.dpi.qld.gov.au/fishweb/2920.html)

In 1962 the Queensland Government introduced both nets and baited drumlines off a number of bathing beaches (Dudley 1997 and references therein). Nets and drumlines both achieve their protective function by fishing for sharks, but drumlines take a reduced bycatch in comparison with nets.

In mid 2005 there were ten centres with protected beaches, distributed between the Gold Coast in southern Queensland and Cairns in the north, a total distance of some 1700 km. The total amount of gear deployed to protect beaches amounted to 32 shark nets and 332 drumlines, with some beaches protected by one type of gear only and some by a combination (T. Ham, Queensland Department of Primary Industries and Fisheries, pers. comm.). The nets are 189 m long by 3-5.6 m deep, have a white mesh of 50 cm (stretched) and are set coast parallel in 3.5-15 m of water about 200 m beyond the surfline (Dudley 1997). A drumline consists of a single, large baited hook suspended from an anchored float. A beach is protected typically by either one net or about five drumlines.

The gear is serviced on between 10 and 16 days in each 28 day period, with 14 days being the norm. The gear is in place throughout the year at most of the ten centres, but at Cairns there is a six week closed period in February/March because of cyclone activity and in the Capricorn Coast area there is a six week closed period in July/August because it is low season (T. Ham, pers. comm.).

The Queensland Shark Control Program (more recently known as the Queensland Shark Safety Program) has been effective in reducing the risk of shark attack. In 2006, 44 years after the inception of the Program, the first fatal attack was recorded at a beach with protective equipment in place (B.H. Lane, Queensland Department of Primary Industries and Fisheries, pers. comm.). As is the case in New South Wales, the three species believed to have been responsible historically for most of the attacks off the Queensland coast were the great white, bull and tiger sharks.

A questionnaire survey of beachgoers in Queensland, Australia, revealed that beach safety is a critical element of a beach experience and that beach safety is associated with protection from shark attack (Richards 1997). More recently, a review of the Queensland program observed the following: "The risk of shark attack is extremely low. For example, it is much more likely that swimmers will die in an accident getting to the beach than by shark attack at the beach. In spite of this reality, however, shark attack is an issue which poses particular fear for many swimmers and there is little doubt that the SCP has reduced the risk of attack at many beaches where nearby communities have a very significant reliance on tourism. This is important in a State which boasts thirty million beach visitations per year" (Anon 2001, p3).

(c) KwaZulu-Natal (KZN), South Africa (www.shark.co.za)

After a decade in which some 21 shark attacks, of which seven were fatal, occurred at Durban's beaches and had become a factor affecting tourism, shark nets were introduced by the Durban City Council in 1952 (Davies 1964, Dudley 1997 and references therein). Attacks by large sharks ceased immediately at Durban but continued to occur at other KZN beaches, leading to the introduction of nets at other locations in the 1960s. The motivation for the introduction of nets was that the attacks had led holidaymakers to lose confidence in the safety of the beaches of KZN and to vacate coastal resorts (Anon 1963, Davies 1964, Wallett 1983):

> *"The outbreak of attacks which began in 1957 caused very great consternation in Natal and had the effect of driving visitors away from the South Coast and caused them to cancel reservations for future vacations. The Natal South Coast is a resort area extending approximately 100 miles along the coast of Natal from Durban to Port Edward and its economy is almost entirely dependent on tourism. Because of this, the sudden outbreak and high incidence of shark attack resulted in a serious economic recession in the area" (Davies 1964, p71).*

Research conducted by the Human Sciences Research Council in 2000 revealed that 87% of KZN's domestic tourists are attracted to this province as a result of its beaches (J. Seymour, Tourism KwaZulu-Natal, pers. comm.). It is estimated that the KZN domestic tourist market sustains at least 147 000 jobs on an annual basis (J. Seymour, pers. comm.). Focus groups held by Tourism KwaZulu-Natal have yielded similar findings to those of Richards (1997) i.e. emphasizing that beachgoers in this province associate beach safety with protection from shark attack (J. Seymour, pers. comm.).

The nets are 213.5 m long by 6.3 m deep, have a black mesh of 51 cm (stretched) and are set coast-parallel in 10-14 m of water some 300-500 m from shore. The nets in use at Durban and off the Bluff differ in specification, being 304.8 m long and having yellow mesh. In May 2006 there were 38 net installations, some protecting more than one bathing area. In September 1999 the Natal Sharks Board (NSB) began a program of reducing the number of

nets protecting each beach, with the result that the total length of netting on the KZN coast has been reduced by about 30%. Each protected bathing area now typically is protected by two nets.

The nets are serviced at first light each weekday (i.e. 20 times per month) and each net is replaced with a clean one every 10 days. The nets are removed from beaches affected by the annual sardine run for several weeks each year to prevent captures of predators associated with the sardine shoals.

A small number of drumlines has been introduced in place of netting and the intention is to replace more nets with drumlines during the course of 2006. Drumlines are more selective shark fishing devices than shark nets, both in terms of shark species caught and in terms of bycatch species that pose no threat to people.

At protected KZN beaches the nets have reduced by over 90% the rate of shark attacks resulting in a fatality or serious injury (Dudley 1997). The three species associated historically with most attacks are the great white, Zambezi (bull) and tiger sharks, with the Zambezi shark believed to have been responsible for most of the incidents that took place within the surf zone (Cliff 1991).

From 2000 to 2005, inclusive, the mean annual catch of animals other than sharks was as follows: sea turtles (five species), 49 animals caught, of which 50% were released alive; dolphins (primarily three species), 68 animals caught, 1% released; rays (primarily seven species), 241 animals caught, 53% released. In addition, about 70 teleosts were caught each year.

(d) Dunedin, New Zealand

Three beaches at Dunedin, New Zealand, are protected by two shark nets each, set permanently between December and February (M.P. Francis, pers. comm., in Dudley and Gribble 1999). Each net measures 100 m x 5.5 m with a mesh size of 30 cm. Dunedin is on the east coast of South Island. Nets were first installed in late 1969 after four shark attacks, three of them fatal, occurred on surfers, swimmers and divers between 1964 and 1968. Great white sharks were believed to have been responsible for the attacks, and 14 great white sharks were captured in the nets in the seasons of 1973-74, 1974-75 and 1975-76. No white sharks have been caught since the mid-1980s (C.A.J. Duffy, New Zealand Department of Conservation, pers. comm.). Since the deployment of nets there have been no attacks at the protected beaches when nets were present, and none at all in the Dunedin area since 1973 (M.P. Francis, pers. comm.). The continued usefulness of the nets is questionable but they remain in place because of public opinion (C.A.J. Duffy, pers. comm.).

(e) Recife, Brazil

Between 1992 and 2004 some 45 shark attacks, 13 of them fatal occurred off the beaches of Recife, Brazil, a location popular for surfing and bathing. These attacks were estimated to reduce tourism to the state of Pernambuco by between 3 and 10 per cent, amounting to losses of approximately USD20m (A.F.C. Santos, Instituto Praia Segura, pers. comm.). The attacks led to a ban on venturing further than a few metres into the sea. A number of workshops were held, to which delegates from South Africa (the NSB), Australia and the USA were invited, to address the matter. Resulting from a workshop held in 2004, 20 drumlines and two longlines with 100 hooks each were deployed in September of that year to fish for sharks off the beaches of Recife. By March 2006 no further shark attacks had taken place (F.H.V. Hazin, Universidade Federal Rural de Pernambuco, pers comm.). The catch has included 15 tiger sharks, four bull sharks and two blacktip sharks *Carcharhinus limbatus*, as well as 50 blacknose sharks *C. acronotus* and several other species. All live sharks except the tiger, bull and blacktip sharks are released and are tagged where possible. Each week all lines are set at dusk and retrieved at dawn for a four-day period that encompasses the weekend. The longlines are set about 1 km from shore and parallel to the coast, and the drumlines are set about 200 m from shore.

(f) Hawaii (hawaiisharks.com)

The tiger shark is responsible for most shark attacks in Hawaii (Wetherbee *et al.*, 1994, cited by Dudley and Gribble 1999). Between 1959 and 1976 the state government of Hawaii spent over USD300,000 on shark control programs. The effectiveness of the control programs in terms of removing large sharks from coastal waters was questioned by Wetherbee *et al.* (1994), who argued that the programs did not appear to have had measurable effects on the rate of shark attacks in Hawaiian waters.

Between November 1991 and December 1992 Hawaii experienced seven shark attacks, three of which were fatal (R.R. Honebrink, Hawaii Department of Land and Natural Resources, pers. comm.). There was considerable public anxiety and media attention. Renewed fishing for tiger sharks took place around the island of Oahu and by 1994 or 1995 about 100 tiger sharks had been caught (B.M. Wetherbee, pers. comm., in Dudley and Gribble 1999). At the same time, however, the Department of Land and Natural Resources convened a Shark Task Force to recommend policy for managing shark attacks. The Department funded research into tiger shark movements to determine whether fishing for sharks after an attack would reduce the risk of further attacks. The resultant research by Holland *et al.* (1999) showed that tiger sharks moved long distances around the Hawaiian Islands and this led to the cessation of shark fishing, on the grounds that it was unlikely that such fishing would catch the specific shark responsible for a given attack (B.M. Wetherbee, pers. comm.).

The Hawaii Visitors Bureau liaises with the Shark Task Force. There is concern about the effects of shark attack on tourism, given that tourism is Hawaii's primary industry, but there has never been a recorded decline in visitor numbers as a result of shark attack (R.R. Honebrink, pers. comm.).

(ii) Shark exclusion devices (physical barriers)

Shark exclusion devices in the form of hard structures that enclosed the bathing area and provided a barrier to sharks were constructed at several locations in the early- to mid-1900s. Locations included Durban (1907), various beaches on the KZN south coast (late 1950s), Coogee, NSW (1929) and the coast of Croatia (some known still to be in existence as recently as 1995) (Dudley and Gribble 1999). A fence is reported to have been used to protect the private beach at the Florida home of a former US president (Reader's Digest 1986). Other locations where barriers were built were included Townsville, Queensland, and Maputo, Mozambique. Where the barriers were built at exposed beaches with surf conditions (e.g. Coogee and the coast of KZN), they proved impractical to maintain and no longer exist (Davies 1964, Coppleson & Goadby 1988).

Physical barriers remain in use at a number of locations with sheltered or semi-sheltered conditions i.e. with little or no wave action. Such locations include Sydney Harbour, Botany Bay and Port Hacking (all NSW) (D.D. Reid, NSW Department of Primary Industries, pers. comm.), the marinas on Queensland's Gold Coast and the beaches of Hong Kong. Some of the physical barriers are not hard structures but consist of small-mesh, multistrand netting that completely spans the water column.

Barrier nets in Hong Kong waters were installed in response to public demand after several shark attacks took place in the 1990s (R. Kwok, Hong Kong Department of Agriculture, Fisheries and Conservation, pers. comm.). The Department of Leisure and Cultural Services, which oversees the management of bathing beaches, had barrier nets installed at 32 beaches (www.lcsd.gov.hk/beach/en/). (The NSB was contracted to install barrier nets at six of the beaches in 1996.) Hong Kong constitutes an unusual case in that the beaches are not all sheltered, with some having conditions of small surf. Exclusion nets are less easy to maintain in such conditions, not only because they run through the surf zone to the beach but also because that section of the net that is parallel to the beach offers considerable resistance to breaking surf and to currents. Also, typhoons sometimes occur in Hong Kong and can cause considerable damage to the nets.

(iii) Shark detection methods

Shark detection methods tend to consist simply of lifeguards keeping watch from towers, or occasionally aerial patrols. In Hawaii, no beaches have shark spotters other than lifeguards, with aerial patrols regarded as too expensive. If a shark is sighted signs are posted that read "Warning Sharks Sighted" with an "international-style" logo (R.R. Honebrink, pers. comm.). In

addition, officials from various agencies speak to people on the beach and in the water and co-ordinate with the local media. Aerial patrols have been used in places such as Adelaide (South Australia) and Perth (Western Australia, Blackweir and Beckley 2004). Shark surveillance flights have taken place each summer off the beaches near Perth, Western Australia, since 2001/2002 but the total number of sharks sighted has been very small (McAuley *et al.* 2005). In the 2004/2005 season (October-February), for example, only 6 sharks were seen in 542 hours of recorded flying time. In addition, only one large shark has been sighted since size information was first recorded (2002/2003), suggesting either that large sharks are uncommon in Perth metropolitan waters and/or there is a low probability of sighting those large sharks that are present (McAuley *et al.* 2005).

In Hong Kong, a warning flag is erected if a shark is sighted in the vicinity of a bathing beach and the public is asked not to enter the water (www.lcsd.gov.hk/beach/en/atten-warning.php).

In New Zealand, the netted beaches at Dunedin and some of the other popular beaches around the Otago Peninsula have shark bells that are rung by surf lifesavers in the event of a shark sighting (C.A.J. Duffy, pers. comm.). Shark bells are also rung by surf lifesavers at several patrolled beaches in northern New Zealand but most beaches are unpatrolled. When sharks are sighted near swimmers surf lifesavers usually try to herd them offshore using the small inflatable boats that are used for rescues (C.A.J. Duffy, pers. comm.).

(iv) Public education

According to B.M. Wetherbee (pers. comm.), the state of Hawaii heeded a call by fisheries biologists to fund shark research and public education rather than shark control. R.R. Honebrink (pers. comm.) confirms that funding was allocated to education and outreach. The media in Hawaii are reminded that “numbers of shark incidents spike for unknown reasons (perhaps just due to their randomness), then go back to "normal," and this is something that occurs all over the world” (R.R. Honebrink, pers. comm.). Honebrink speculates that Cape Town may have experienced something similar, and reports that a “spike of activity” is currently being experienced on the island of Maui (March 2006).

In Hong Kong, the Department of Leisure and Cultural Services has on its website a list of precautionary measures that members of the public can take to reduce the risk of shark attack (www.lcsd.gov.hk/beach/en/atten-safety.php). Similar information is available on such websites as those of the International Shark Attack File (www.flmnh.ufl.edu/fish/sharks/Attacks/relariskreduce.htm), the Natal Sharks Board (www.shark.co.za/attack.htm), the Australian Shark Attack File (www.zoo.nsw.gov.au/content/view.asp?id=234) and the Hawaiian Shark Task Force (hawaiisharks.com/dosdonts.html).

(v) Other types of response

The Hawaiian Shark Task Force developed shark incident protocols, which include closing beaches one mile either side of an attack site until noon the following day (R.R. Honebrink, pers comm.). It is probable that similar responses occur in other parts of the world. The Western Australian Department of Fisheries, for example, has also drawn up a "shark incident emergency response plan" (R. McAuley, Western Australian Department of Fisheries, pers. comm.).

More shark attacks are recorded in the waters of the USA than any other country, and the state with the largest number of incidents is Florida (www.flmnh.ufl.edu/fish/sharks/isaf/isaf.htm). The large number of records is partly a reflection of the fact that the International Shark Attack File is based in the USA but it is also a consequence of the fact that very large numbers of people enter US waters for recreational purposes. Many of the incidents, particularly in Florida, involve minor bites inflicted by species such as blacktip sharks and spinner sharks *Carcharhinus brevipinna*, but more serious bites involving bull and tiger sharks do occur in Florida waters and incidents involving white sharks occur in Californian waters and elsewhere. It is of particular interest that shark attack has not led to the introduction of protective measures at mainland beaches, in contrast to what has happened in other parts of the world as discussed above.

3. Discussion

The workshop organisers asked that, in addition to describing the approaches to shark attacks taken by other countries and cities, this report should also consider the following key points and questions:

- ***Is there an international coordinating body or forum on shark safety and shark attacks?***

The following text describes the activities of the International Shark Attack File and is taken from its website (address above):

> "The International Shark Attack File is a compilation of all known shark attacks that is administered by the American Elasmobranch Society and the Florida Museum of Natural History. The American Elasmobranch Society is a professional organization comprised of international workers studying sharks, skates and rays. More than 4,000 individual investigations are currently housed in the File, covering the period from mid-1500's to present. Many of the data in the File originate from the voluntary submissions of numerous cooperating scientists who serve worldwide as regional observers. Regional observers forward investigations of attacks in their areas for integration into the File."

The NSB, for example, supplies the ISAF with shark attack statistics from South Africa. The ISAF website acknowledges, however, that "information from Third World countries is especially poor, and in other areas efforts are sometimes made to keep attack quiet for fear of bad publicity".

On the website are summary statistics, information about relative risk of shark attack (i.e. compared to other risks), advice on how to minimise the risk of attack and information about how, when and where sharks attack. The ISAF does not have a co-ordinating role in terms of response to shark attack, with such response being the prerogative of affected local or provincial authorities.

- ***Are there accepted norms and standards?***

  There is no threshold frequency of shark attack above which an official response will be initiated, nor is there a standardised response to shark attack. It would appear that responses are initiated when frequency of shark attack reaches a level such that there are negative economic consequences and/or there is sustained public demand. Shark attack is not a phenomenon that readily lends itself to statistical analysis, in terms of identifying specific causes or forecasting short-term trends. It is the opinion of ISAF, however, that longer term (decadal) trends are largely a reflection of increasing numbers of people in the water.

- ***Do other cities/countries prioritise recreational safety over shark conservation?***

  Formal policy statements are seldom made in this regard. Some of the longer term shark safety programs were initiated at times when shark conservation was of low priority. It is not axiomatic, however, that recreational safety and shark conservation (as opposed to preservation) are mutually exclusive. It is not the intention of any shark control program to exterminate any species of shark from a nation's waters, but rather to fish for those that come into the immediate proximity of protected beaches. The effect of shark safety programs on shark populations has been addressed on a number of occasions in the literature, the most recent publication for the KZN program being that of Dudley and Simpfendorfer (2006). Similar publications exist for Queensland (e.g. Simpfendorfer 1993) and NSW (Reid and Krogh 1992).

  In 1992 and 1996 State Government Ministerial Enquiries concluded that any changes to the Queensland Shark Control Program "must be made with due regard to its primary responsibility, that of protecting human life" (Gribble *et al.* 1998, p651). The latest public statement by the government of Queensland is as follows: "The Queensland government is committed to a Shark Control Program to minimise the risk of shark attack on specific beaches while reducing inadvertent impacts on non target species" (B.H. Lane, pers. comm.). In addition, local governments throughout Queensland support the program, as does Surf Lifesaving Queensland (B.H. Lane, pers. comm.).

  The NSW Minister for the Department of Primary Industries (which includes Fisheries) has stated that public safety will always take precedence over shark conservation (D.D. Reid, pers. comm.).

- ***What resources, capacity and financial, are invested by other cities in shark safety measures?***

  The current annual budget for the Queensland Shark Control (or shark safety) Program is AUD1.7m (ZAR8.5m) (B.H. Lane, pers. comm.) and that for the NSW program is approximately AUD700,000 (ZAR3.5m) (D.D. Reid, pers. comm.). The budget of the NSB is approximately ZAR32m. Reasons for the substantial difference between the KZN program and those of the two Australian states are discussed by Dudley and Gribble (1999), but essentially the differences lie in the facts that (i) the Australian programs use the infrastructure of state fisheries organisations whereas the NSB does not and (ii) the process of surf launching in KZN requires a minimum of five crew members per boat, including the skipper, whereas the Australian contractors, who put to sea from harbours, may operate with a skipper only or with just one additional crew member. Other differences in scope include a dedicated research component in KZN, the landing of all shark carcasses for research purposes and the provision of a year-round service. Most Queensland beaches are also protected throughout the year but in NSW the service is provided for eight months of the year only. Finally, in NSW the shark fishing gear is moved between beaches that are in close proximity to each other, whereas in Queensland and KZN gear is deployed continuously off each protected beach.

  In Hong Kong, costs provided by the Department of Leisure and Cultural Services are as follows; (i) installation cost of shark net at one beach HKD490,000, (ii) maintenance services for shark nets at 6 beaches HKD6,551,965 for 11 months and (iii) inspection services for shark nets at 6 beaches HKD182,100 for 12 months (G. Ng, Hong Kong Government 1823 Citizen's Easy Link, pers. comm.). Given that there are 32 protected beaches, these figures would extrapolate to a one-off installation cost of approximately HKD15.7m (ZAR13.4m) followed by annual costs of some HKD35.7m (ZAR30.5m).

- ***Is "swimming at your own risk" a commonly accepted international norm?***

  Those countries that do not place restrictions on swimming have either explicitly or implicitly adopted a policy of "swimming at one's own risk", at least in the context of shark attack. Even those places that have protective measures in place, such as Queensland and KZN, nevertheless have an understanding that people swim at their own risk. In KZN, for example, sign boards that make this clear are erected at protected beaches. Significantly, measures to reduce risk of shark attack were introduced at the beaches of KZN when the public effectively decided that the risk was unacceptable and opted to depart from coastal resorts.

  In NSW swimming at one's own risk is generally accepted by board riders but not by swimmers (D.D. Reid, pers. comm.).

- ***What shark conservation programmes/initiatives are in operation in areas where shark safety measures are in place?***

  Queensland has a limited research program funded to AUD100,000 (ZAR502,000) per year for five years. This is aimed mainly at measures to reduce bycatch (B.H. Lane, pers. comm.). In NSW only about AUD10,000 (ZAR50,200) is spent annually on research (D.D. Reid, pers. comm.). More generally, in NSW great white sharks and grey nurse (or spotted ragged-tooth) sharks *Carcharias taurus* may not be landed or targeted by commercial or recreational fishing. In addition there are restrictions on fishing in areas of critical habitat for grey nurse sharks. Shark nets in NSW have been declared a key threatening process for great white and grey nurse sharks (average annual catches of five sharks and one shark, respectively), requiring the government to take some remedial action, but no such action has been taken to date (D.D. Reid, pers. comm.).

  In KZN, the NSB records catches to the level of each individual animal, in the case both of sharks and other species. Since 1999 the total length of netting in use on the KZN coast has been reduced by about 30%, with the aim of reducing catches. The introduction of drumlines as a measure to reduce bycatch has been mentioned above. All live animals are released from the nets, with sharks and some rays being tagged where possible. In recent years it has become standard practice to remove nets for several weeks each winter to reduce catches of predators accompanying shoals of sardines *Sardinops sagax* during the annual sardine run.

  FAO developed an International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks) and called upon all states to produce a Shark Assessment Report (SAR) and, in the case of those states that have shark fisheries, a National Plan of Action (NPOA) (Fowler and Cavanagh 2005). Australia, New Zealand, South Africa, Brazil and the USA, all of which have commercial shark fisheries, have either implemented an NPOA or have one in draft form. In addition, most of these nations have banned the practice of finning. For detailed regional accounts see Chapter 7 (Regional Overviews) in Fowler *et al.* 2005.

  There is no shark conservation initiative in Hong Kong (Y. Sadovy, University of Hong Kong, pers. comm.), which has the world's largest shark fin market, but the Hong Kong beach protection program does not utilise shark capture devices.

4. References

Anon. 1963. Combating of shark menace along the Natal coast in the interest of tourist promotion. Ministry of Information and Tourism, Pretoria. Memorandum Ref. No. M1, 14 November 1963.

Anon. 2001. Review of Queensland Shark Control Program. Consultation Draft. Queensland Department of Primary Industries. 37pp.

Blackweir, D.G. and L.E. Beckley. 2004. Beach usage and aerial surveillance for sharks in Perth metropolitan waters. Australian Marine Sciences Association Conference, Hobart, Australia. July 2004.

Cliff, G. 1991. Shark attacks on the South African coast between 1960 and 1990. *South African Journal of Science* **87**(10): 513-518.

Coppleson, V.(M.) and P. Goadby. 1988. *Shark Attack. How, Why, When and Where Sharks Attack Humans.* Angus and Robertson, Sydney: 262 pp.

Davies, D.H. 1964. *About Sharks and Shark Attack.* Shuter and Shooter, Pietermaritzburg: 237 pp.

Dudley, S.F.J. 1997. A comparison of the shark control programs of New South Wales and Queensland (Australia) and KwaZulu-Natal (South Africa). *Ocean & Coastal Management* **34**(1): 1-27.

Dudley, S.F.J. and N.A. Gribble. 1999. Management of shark control programs. In R. Shotton (ed.). Case studies of the management of elasmobranch fisheries. *FAO Fisheries Technical Paper* **378***(2)*. Rome, FAO: 819-859.

Dudley, S.F.J and C.A. Simpfendorfer. 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.

Fowler, S.L. and R.D. Cavanagh. 2005. Chapter 6. International conservation and management initiatives for chondrichthyan fish. In Fowler, S.L., Cavanagh, R.D., Camhi, M., Burgess, G.H., Cailliet, G.M., Simpfendorfer, C.A. and J.A. Musick (comp. and ed.). *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes. Status Survey.* IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK: 58-69.

Fowler, S.L., Cavanagh, R.D., Camhi, M., Burgess, G.H., Cailliet, G.M., Simpfendorfer, C.A. and J.A. Musick (comp. and ed.). *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes. Status Survey.* IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.

Gribble, N.A., G. McPherson and B. Lane. 1998. Effect of the Queensland Shark Control Program on non-target species: Whale, dugong, turtle and dolphin: A review. *Marine and Freshwater Research* **49**(7): 645-651.

Holland, K.N., B.M. Wetherbee, C.G. Lowe and C.G. Meyer. 1999. Movements of tiger sharks *(Galeocerdo cuvier)* in coastal Hawaiian waters. *Marine Biology* **134**(4): 665-673.

McAuley, R., R. Lenanton and D. Blackweir. 2005. Shark aerial surveillance flights 2004/2005, summary report. Unpublished report, WA Dept. of Fisheries.

Reader's Digest. 1986. *Sharks, Silent Hunters of the Deep.* Reader's Digest Services Pty Ltd, Surry Hills, NSW: 208 pp.

Reid, D.D. and M. Krogh. 1992. Assessment of catches from protective shark meshing off New South Wales beaches between 1950 and 1990. In *Sharks: Biology and Fisheries*. J.G. Pepperell (ed.). *Australian Journal of Marine and Freshwater Research* **43**: 283-96.

Richards, F. 1997. Beach visitation and health and safety awareness report. Department of Tourism, James Cook University, Townsville.

Simpfendorfer, C. 1993. The Queensland Shark Meshing Program: analysis of the results from Townsville, north Queensland. In *Shark Conservation*. J.G. Pepperell, J. West and P. Woon (eds). Proceedings of an international workshop on the conservation of elasmobranchs, Sydney, Australia, 24 February 1991. pp. 71-85. (Zoological Parks Board of NSW: Mosman.)

Wallett, T. 1983. *Shark Attack in Southern African Waters and Treatment of Victims*. Struik, Cape Town: 184 pp.

Shark deterrent options for Cape Town

Sheldon F.J. Dudley, G. Cliff, M.D. Anderson-Reade,
G.E. Charter and P.W. von Blerk

Natal Sharks Board, Private Bag 2, Umhlanga Rocks, 4320, South Africa
Email: dudley@shark.co.za, http://www.shark.co.za

Abstract

Various methods that have been used to reduce the risk of shark attack at surf beaches in various parts of the world were considered for potential application at the beaches of the Cape Peninsula. These methods fall into three categories; (i) shark capture, (ii) shark exclusion or repulsion and (iii) shark detection. Shark capture devices (shark nets or drumlines) function by reducing the number of potentially dangerous sharks in the vicinity of a protected beach. They have proven very effective elsewhere in the world but their effectiveness in Cape waters may depend upon the extent to which individual great white sharks *Carcharodon carcharias* spend extended periods in specific localities. An alternative consideration is that targeting of this protected species in a focal area of its distribution may result in unsustainable catches. Shark exclusion nets may be effective at beaches with small surf conditions, such as the southern end of Fish Hoek beach, but there are concerns about the potential accumulation of drift kelp against the nets and the potential disruption of the beach seine fishery. Research into electrical repellents is ongoing and Fish Hoek beach may prove to be a suitable test site for future prototype devices. The use of sonar to detect sharks approaching a beach may prove impractical in shallow, turbulent conditions but a full desktop evaluation should be conducted. The use of spotters to keep watch for sharks is addressed elsewhere.

Citation: Dudley S F J, Cliff G, Anderson-Reade M D, Charter G E and P W von Blerk. 2006. Shark deterrent options for Cape Town. *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. Introduction

A variety of methods have been attempted in order to reduce the risk of shark attack, either in the context of providing protection for individuals or for protecting entire bathing areas. Methods of reducing the risk of shark attack in a given bathing area, other than public education about precautionary measures, fall into three broad categories; (i) shark capture, (ii) shark exclusion or repulsion and (iii) shark detection. In this report those methods that have potential application in the context of Cape Town's beaches are described, and comment is provided on their suitability. The report is not a technical manual, however. Technical specification could be provided or developed for selected methods as required.

2. Shark capture methods

(i) Shark nets

Shark nets are effectively large meshed, anchored gill nets that fish for sharks in fixed locations in the immediate vicinity of protected beaches. They are in use in KwaZulu-Natal (South Africa), New South Wales and Queensland (Australia) and Dunedin (New Zealand). Essential specifications are provided in the International Review section (this workshop), and further detail is provided by Dudley (1997).

Practicality, operation and logistics

Shark nets are a practical option at surf beaches because they are set parallel to the shore and beyond the surf zone where, although they have to withstand swell and currents, they are not exposed to breaking surf. In KwaZulu-Natal (KZN), a bathing area is typically protected by two nets each measuring 213.5m by 6.3 m. The number of nets does vary according to beach characteristics, however. The net panels are constructed from black, multifilament polyethylene twine and have a stretched mesh of 51 cm. The nets are inspected each weekday (a process known as meshing) from an open-decked skiboat equipped with outboard motors. Most of the boats in KZN are launched through the surf and hence require a crew of four in addition to the skipper. Minor damage to the nets is repaired at sea. The nets tend to accumulate silt and marine growth and hence each net is replaced with a clean one approximately every 10 days. Fouling rates may vary with temperature. All live animals are released, with sharks and rays being tagged where possible. Badly decomposed animals are discarded at sea and but dead animals are otherwise taken ashore for research purposes.

Financial cost of implementation and maintenance

In the context of Cape Town, it would be possible to put to sea from harbours and this would reduce the required number of crew to just one, in addition to the skipper. Boats can be equipped to deploy and retrieve nets mechanically and the reduction in staffing costs would result in considerable savings. The material cost of a shark net, with anchors, floats and

sinkers, is approximately ZAR5340,00. A full costing for the deployment of shark nets would need to take into account factors such as length of bathing season, number of protected bathing areas, type and number of boats required, crew requirements, data collection and storage and whether captured animals would be retained for research purposes or discarded at sea.

Effectiveness in preventing shark attack

Shark capture devices such as nets and drumlines (see below) reduce the risk of shark attack by fishing for potentially dangerous sharks in the immediate vicinity of a protected beach. By bringing about a local reduction in shark numbers, particularly of those species that are resident for part or all of the year, the risk of an encounter between a shark and a person in the water is reduced. Shark nets have been extremely effective. For example, there has been no attack by a large shark at Durban's beaches since nets were deployed in 1952 (Dudley and Simpfendorfer 2006), and the rate of attack resulting in death or serious injury at other protected beaches on the KZN coast has been reduced by over 90% (Dudley 1997). Capture devices cannot, however, provide total protection, which can only be achieved through the use of physical barriers that exclude sharks from a given area.

The species of shark responsible for most shark attacks on the KZN coast in the years prior to the introduction of nets was the Zambezi, or bull, shark *Carcharhinus leucas* (Davies 1964, Cliff 1991). The bull shark may occupy, seasonally, small home ranges and hence shark net installations may have brought about substantial reductions in numbers in the vicinity of protected beaches (Cliff and Dudley 1991). This is probably the primary mechanism whereby shark nets in KZN have achieved their effectiveness (Wallett 1983, Cliff and Dudley 1991).

All shark attacks resulting in death or serious injury in the vicinity of the Cape Peninsula are probably attributable to the great white shark *Carcharodon carcharias*. A research project is under way to investigate movement and residency patterns of white sharks in False Bay (A. Kock, Save Our Seas Foundation, pers. comm.). If that research reveals that individual white sharks remain in a given area for a prolonged period, then fishing for those individuals may be an effective means of reducing the risk of shark attack in that particular area. Further, if the presence of white sharks off the beaches is seasonal, it may be possible to fish in season only. Given that white sharks appear to be relatively abundant in False Bay, however, the removal of one or more individuals from a particular area may be futile if those individuals are rapidly replaced by others. Also, if the research shows that individual animals do not remain in a given area for prolonged periods, fishing for transient animals will be of limited value in terms of providing protection from shark attack. It is probably not coincidental that the last two attacks by large sharks at netted beaches in KZN (Ballito in 1980 and Umtentweni in 1999) were attributable to white sharks (transient visitors) rather than bull sharks (Natal Sharks Board, unpubl. data).

Dunedin is the only location where shark attacks were probably all attributable to great white sharks and where shark fishing devices were subsequently used to reduce the risk of attack (see International Review section). No attacks have been recorded since the introduction of shark nets at Dunedin, but the sample size (number of attacks pre-netting) is small and Dunedin, unlike False Bay, is not a location where white shark numbers are particularly concentrated (C.A.J. Duffy, New Zealand Department of Conservation, and M.P. Francis, National Institute of Water and Atmospheric Research, Wellington, pers. comm.).

Ecological cost and impact

Catches in shark nets deployed off beaches in False Bay and on the west coast of the Cape Peninsula may include any animal large enough to become entangled in a 51 cm mesh. Shark species may include great white *Carcharodon carcharias*, bronze whaler *Carcharhinus brachyurus*, spotted ragged-tooth *Carcharias taurus*, soupfin *Galeorhinus galeus*, spotted sevengill cowshark *Notorynchus cepedianus*, smooth hammerhead *Sphyrna zygaena* and possibly others. Marine mammal species may include Cape fur seal *Arctocephalus pusillus*, dusky dolphin *Lagenorhynchus obscurus*, bottlenose dolphin *Tursiops aduncus*, Heaviside's dolphin *Cephalorhynchus heavisidii* and, in season, southern right whale *Balaena glacialis*. Other taxonomic groups may include rays and sea turtles. Teleosts tend to be caught only occasionally because of the large size of the mesh.

The great white shark enjoys protected species status in South African waters. While this status was conferred as a precautionary measure rather than on the basis of evidence of declining stocks (Compagno 1991), False Bay appears to be a focal area for the distribution of this species and there is the potential for shark nets deployed in False Bay to catch large numbers of white sharks. Indeed, it would be through the capture of white sharks that shark nets would achieve their function of protecting bathers and other sea users. Also, the Heaviside's dolphin, although apparently not commonly found in False Bay (P.B. Best, University of Pretoria, pers. comm.), is endemic and catches in West Coast set nets have been identified as a concern (Friedmann and Daly, 2004). Potential entanglement of southern right whales in shark nets would also be of concern.

A body of literature exists that focuses on the effects of beach protection programs on populations of potentially dangerous shark species as well as bycatch species (Dudley and Simpfendorfer 2006 and references therein). It is difficult to anticipate in advance the numbers of each species that may be caught in shark nets deployed off Cape beaches, and hence whether such captures are likely to threaten any given population. Given this uncertainty, the use of capture devices such as shark nets should probably be considered only if it is imperative to achieve a significant reduction in risk of shark attack and if the use of capture devices is regarded as the only practical method.

(ii) Drumlines

Practicality, operation and logistics

Like shark nets, drumlines are also a practical option at surf beaches because they are set beyond the surf zone and hence are not subjected to surf conditions. Drumlines have been used, together with nets, in Queensland's Shark Control Program since inception in 1962. A drumline consists of a 14/0 Mustad shark hook suspended from a large anchored float (an illustration is provided at http://www2.dpi.qld.gov.au/fishweb/2920.html). The gear is serviced on between 10 and 16 days in each 28 day period (T. Ham, Queensland Department of Primary Industries and Fisheries, pers. comm.). The hooks are typically baited with mullet *Mugil cephalus*. At Recife, Brazil, the bait typically used includes escolar (*Lepidocybium flavobrunneum*) and oilfish (*Ruvettus pretiosus*). The last two species belong to the family Gempylidae, to which the Cape snoek *Thyrsites atun* also belongs. A small number of drumlines is currently in use, together with nets, at Richards Bay, KZN, where the hooks are baited each weekday with southern rover *Emmelichthys nitidus*.

A problem that has emerged during experimentation with drumlines in KZN is one of theft of equipment at sea and the potential for theft would need to be addressed if drumlines were to be deployed in Cape waters.

Financial cost of implementation and maintenance

Drumlines are more easily handled devices than shark nets and potentially the gear could be serviced from a smaller boat than would be required if nets were to be deployed. A skipper and one crew member would be adequate. The material cost of a drumline is approximately ZAR1,100. The number of drumlines deployed per protected bathing area is variable but would average about five. Purchase of suitable bait represents an ongoing cost, as does replacement of corrodible parts such as hooks and small shackles. As is the case with shark nets, a full costing for the deployment of drumlines would depend upon factors such as the total quantity of gear to deployed, boat requirements, staff requirements etc. and should be deferred pending a decision to investigate further the use of such equipment.

Effectiveness in preventing shark attack

Drumlines, like shark nets, reduce the risk of shark attack by fishing for potentially dangerous sharks in the immediate vicinity of a protected beach. Also like shark nets, drumlines cannot provide total protection, which can only be achieved through the use of physical barriers that exclude sharks from a given area. While some Queensland beaches are protected by both nets and drumlines, many are protected by drumlines only. The Queensland Shark Control Program has been extremely effective in reducing the risk of shark attack, with only one fatal attack having occurred at a protected beach in 44 years of operation.

For drumlines in the Cape to achieve the effect of reducing numbers of potentially dangerous sharks in the vicinity of a given beach it would be necessary for them to catch great white sharks. Experiments conducted in KZN have shown that they are capable of doing so (Dudley *et al.* 1998). It should be pointed out, however, that while the Natal Sharks Board (NSB) is introducing drumlines in place of some nets on the KZN coast, it is the intention to use both types of gear for the foreseeable future. This approach was recommended by Gribble *et al.* (1998), who suggested that use of mixed gear would optimise shark catch and maintain bather safety yet reduce bycatch relative to the use of nets alone.

Dudley *et al.* (1998) addressed the question of whether sharks might be attracted to an area by the presence of baits. Springer and Gold (1989) suggested that the distance over which sharks are thought to be sensitive to olfactory stimuli is of the order of hundreds of metres, as opposed to kilometres. Hence, while attraction to a baited hook is clearly the mechanism whereby drumlines function, it is suggested that the baits are likely to attract only those sharks that are already in the vicinity of the bathing beach.

Discussion about the likely effectiveness of using shark fishing gear at Cape beaches to reduce the risk of shark attack by great white sharks, specifically, is provided in the section on shark nets. Similar considerations apply in the case of drumlines.

Ecological cost and impact

The advantage of drumlines, in comparison with shark nets, is that they are more selective in terms of shark species captured and also take a considerably reduced bycatch of other taxonomic groups (Dudley *et al.* 1998, Gribble *et al.* 1998). The large size of the hook (14/0) results in negligible catches of teleosts, but sharks such as the bronze whaler (*Carcharhinus brachyurus*) would probably be caught. It is also possible that sea turtles and marine mammals (fur seals and even dolphins) may attempt to take the baits. As in the case of shark nets, however, to introduce fishing gear specifically to catch white sharks in what appears to be a local centre of the species' distribution would probably be ill advised.

Shark exclusion or repulsion

(i) Exclusion nets

Practicality, operation and logistics

Exclusion nets function by completely surrounding a bathing area and physically excluding sharks from entering that area. They are in use in places such as Hong Kong, Sydney harbour and the marinas on Queensland's Gold Coast. The NSB was contracted to install barrier nets at six Hong Kong beaches in 1996 and hence has experience of such structures. The Hong Kong nets installed by the NSB were constructed of multistrand polyethylene and had a mesh of 30 mm bar (60 mm stretched). Nylon would be preferable to polyethylene in that it can be impregnated with antifoulant, although consideration would have to be given to selecting an antifoulant that would provide as little environmental contamination as possible.

The mesh was hung on the flag (i.e. the shape of the mesh was square rather than the typical diamond mesh of a gillnet), to minimise the potential to catch small fish. Use of multifilament material also reduced capture efficiency. Escape panels 1 m wide and with a mesh of 60 mm bar were inserted into the nets at intervals to allow small fish to move freely through the net. The Hong Kong exclusion nets had floats on the top (head) rope, weights (sinkers or chain) on the bottom (foot) rope and were anchored in various manners according to the local conditions at each beach. The nets were able to withstand the impact of a large shark swimming into them not only because of the high breaking strain of the netting material but also because of the "give" of the net (i.e. the nets were not hung taut).

Such nets are suited only to beaches with small surf conditions and it must be possible to retrieve the nets ahead of forecast storm conditions. The nets can be run perpendicular to the shore through small surf but the section that runs parallel to the shore should be well beyond the surf zone. A suitable location on the Cape Peninsula may be the southern end of Fish Hoek beach, for example, and any other beaches with similar conditions. Exclusion nets would not be suitable at exposed beaches such as those between Muizenberg and the Strand.

Financial cost of implementation and maintenance

Current costings have not been obtained but all materials, with the possible exception of appropriate antifoulant, are locally available. Cost will depend upon the size of the protected bathing area which will determine the length of netting required.

A small inflatable boat and a staff of two to three qualified boat operators and divers would be required in order to maintain exclusion nets at one or more beaches. The team would check periodically (perhaps twice a week) the integrity of each net and conduct *in situ* repairs of minor damage. A larger team may be required to deploy and retrieve the nets but this would only need to be done at the beginning and end of each swimming season or in anticipation of severe storm conditions. Local lifeguards could be trained to conduct daily surface inspections of the net at each beach, to remove flotsam (kelp, plastic packets etc.) that had drifted into the net and to report any apparent problems to the maintenance team.

Effectiveness in preventing shark attack

An intact exclusion net provides complete protection from shark attack.

Ecological cost and impact

Exclusion nets are not designed to catch fish and hence the ecological cost is minimal. There is the potential for entanglement with southern right whales. Another consideration would be the selection of an antifoulant that would not constitute a general contaminant.

If an exclusion net were to be deployed at Fish Hoek beach, for example, there is the possibility that such a net may exclude shoals of mullet targeted by the local beach seine fishery. Consideration could be given to increasing the area of the escape panels to facilitate the movement of such shoals.

(ii) Other physical barriers

Other than the exclusion nets described above, various forms of physical barrier (shark fence) have been used in the past. Physical barriers of various designs were erected at a number of beaches on the KZN south coast in 1958 but it soon became apparent that the cost of maintenance in surf conditions was prohibitive (Wallett 1983). Prior to that, a large enclosure with a diameter of about 100 m had been erected off Durban's beachfront in 1907 (Davies 1964). This was constructed of steel piles with vertical steel grids between them. It was eventually demolished in 1928 because of the damage it had sustained from wave action, corrosion and the high cost of maintenance (Davies 1964). A physical barrier was also built at Coogee in New South Wales, Australia (Anon 1935), but also proved impractical to maintain in heavy surf (Coppleson and Goadby 1988).

Less substantial (in terms of quantity of materials) physical barriers are still in use in places such as Sydney Harbour, Botany Bay and Port Hacking (D.D. Reid, NSW Department of Primary Industries, pers. comm.). These are made from a variety of materials, such as interlocking steel rings, and are suited only to sheltered conditions.

It may be possible to construct a semi-circular physical enclosure, similar to that built off Durban in the early 20th century, at a place like Muizenberg, for example. Modern materials and engineering methods are certain to be superior to those used previously, but costs are nevertheless likely to be extremely high and it is unlikely that a sufficiently large body of water could be enclosed to meet the requirements of the surfing community. An alternative design may be to build two parallel piers, similar to those that presently exist off Durban's beachfront, and to install a barrier, consisting of some form of grid, between them. Again, costs would be very high and it may be impractical to enclose a sufficiently large body of water. Also, such structures would probably be regarded as aesthetically undesirable. The construction of a pier is being proposed off the Umhlanga beachfront that would serve the dual purpose of carrying a stormwater outfall offshore as well as providing a public walkway for tourists. There may be a role for such multi-purpose piers on the False Bay coast.

(iii) Electrical repellents

The organisers of this workshop specifically asked for comment on the personal electrical repellents that are available to the public and whether their use can be recommended with confidence by the Shark Working Group. The product currently on the market is called the Shark Shield and it is manufactured by an Australian company, SeaChange Technology Pty Ltd (www.sharkshield.com), under licence to the Natal Sharks Board. The Shark Shield uses the electrical wave form patented by the NSB and originally used in the predecessor of the

Shark Shield, the SharkPOD Diver Unit. The SharkPOD was tested at Dyer Island using a protocol which tested the ability of great white sharks to access baits shielded by the electrical field (Smit and Peddemors, 2003). These authors concluded the following: "…the probability of an attack [on the bait] in at most five minutes was reduced from about 0.70 in power-off mode to about 0.08 in power-on mode and in a period of at most 10 minutes from 0.90 to 0.16" (p59). Smit and Peddemors (2003) pointed out that, under the conditions of the test protocol, the white sharks were in a heightened predatory mode and yet the probability of highly motivated sharks being able to access the baits was greatly reduced by the presence of the electrical field.

The Shark Shield is available in various configurations for different applications (diving, surfing, spearfishing, snorkelling, etc.) yet all generate the same wave form as the original SharkPOD. The device is not intended for swimmers, however. All forms of the Shark Shield have been evaluated in the field by NSB staff in similar manner to the SharkPOD and have been found to be effective, although the results have not been published.

The individual electrical repellent devices were not designed for use in an array format (i.e. that would incorporate multiple devices) but it remains the intention of the NSB and SeaChange to produce a form that is suitable for protecting entire bathing areas. Deployment in surf conditions presents engineering challenges that need to be addressed and research and development funding needs to be secured. There is the potential, however, for testing of prototype devices at locations such as Fish Hoek, where, for example, the shark spotters could film the response of white sharks to the electrical field.

(iv) Other repellents

Various other methods of repelling sharks have been assessed by various researchers but these have either been ineffective or have not yet proven to have practical application for protection of a beach. Examples include sonic repellents (Klimley and Myrberg 1979), bubble curtains (Springer and Gilbert 1963) and chemical repellents (Sisneros and Nelson 2001 and references therein). A popular review of research into repellents is provided by Scott Johnson (1999). Research into chemical repulsion is ongoing in the USA (Stroud *et al.* 2004) but no product yet exists. Indeed, the initial objective of that research is to reduce bycatch of sharks on longlines by treating the baits with a substance that selectively repels sharks (National Geographic 2005). With regard to beach protection, the researchers suggest that chemical repellents could ultimately be used to chase a shark from an area once it has been detected (National Geographic 2005).

Shark detection

The use of spotters to observe sharks approaching a bathing area is addressed elsewhere at this workshop. Another method that has been postulated is the use of sonar to detect sharks. This was first suggested to the NSB in 1996 when the Hong Kong authorities asked for sonar

to be investigated as a means of determining whether a shark had entered a bathing enclosure. Enquiries indicated that the useful range of sonar in shallow water was severely limited and hence one may have needed a number of sonar arrays to insonify a sufficiently large area. The concept was not pursued at the time but, following shark attacks at Cottesloe Beach near Perth in 2000, the Department of Fisheries, Western Australia, was reported in 2001 to be considering the use of sonar to detect sharks (http://ens-newswire.com/ens/oct2001/2001-10-08-02.asp). It seems, however, that the equipment was considered too expensive and that the safety benefits conferred would be questionable and hence there was no formal feasibility study (R. McAuley, Department of Fisheries, Western Australia, pers. comm.).

In 2005 the NSB was approached by a local interest group who proposed that the concept be revisited. This group suggested that sonar technology has advanced considerably since 1996. Basic physical limitations remain, however, including the fact that sonar is apparently of little value in aerated water such as would be found in surf conditions. Also, the cost of the equipment remains high. Information required to evaluate this possibility further includes: (i) the range of detection of a single sonar array under shallow-water conditions (would more than one array be needed to give adequate early-warning to surfers at a beach such as Muizenberg, for example?), (ii) the method of deployment (would each sonar array be suspended from an anchored platform, for example, and what power source would be used?) and (iii) the total cost of purchasing and operating a sonar system at such a beach, including whether a full-time operator would be required to watch a screen or whether target recognition can be automated. The NSB has not pursued the subject but has suggested to the interest group that the issues listed above should be investigated further.

As an alternative approach to the use of sonar to detect sharks the Western Australian government has continued to fund seasonal aerial surveillance flights, although these appear to be of questionable benefit (R. McAuley, pers. comm.). Further information is provided in the International Review section (this workshop).

3. Recommendations

No simple solution exists to the problem of reducing risk of shark attack at a surf beach. Capture devices such as nets or drumlines have proven very effective elsewhere but they may be less effective in Cape waters unless it can be shown that individual white sharks are seasonally resident off the beaches in question. Irrespective of effectiveness, the use of capture devices to target white sharks in False Bay, an apparent focal point of the distribution of the population, may result in unsustainable mortalities. Finally, and irrespective of sustainability, the targeting of white sharks in False Bay would be controversial. Hence the use of capture devices is not recommended.

Shark exclusion nets may have application at certain sheltered locations such as the southern end of Fish Hoek beach. Such nets are not designed to catch animals which is a

significant advantage over capture devices. The potential disruption of beach seine fisheries would need to be addressed and it is possible that the use of shark exclusion nets and beach seining are incompatible activities. It is recommended that exclusion nets be considered further for those few localities where conditions may be conducive to their use.

Other forms of physical barrier are very expensive to construct and maintain at surf beaches. It is possible that the construction of two multi-function piers on the north shore of False Bay could allow an exclusion grid of some sort to be suspended between them. The piers could carry stormwater outfalls offshore and provide public walkways. The effect of such piers on sand movement, with the potential for beach erosion, would have to be evaluated, as would aesthetic impact. It is recommended that such factors receive preliminary evaluation but it is likely that the construction of such piers would prove prohibitively expensive.

There is the potential for the development of electrical repellents for the protection of surf beaches but such repellents are not currently available. Should a prototype be developed by the Natal Sharks Board it may be possible to conduct field evaluations at a Peninsula beach. The NSB would liaise with Marine and Coastal Management and the Cape Town city authorities in this regard.

There is also the potential for use of sonar to detect sharks off surf beaches but a desk top feasibility study would need to be carried out. Costs are likely to be high and there may be range limitations in shallow water conditions.

4. References

Anon. 1935. *Report of the Shark Menace Advisory Committee on suggested methods of protecting bathers from shark attack.* Legislative Assembly, New South Wales. Government Printer, Sydney: 45 pp.

Cliff, G. 1991. Shark attacks on the South African coast between 1960 and 1990. *South African Journal of Science* **87**(10): 513-518.

Cliff, G. and S.F.J. Dudley. 1991. Sharks caught in the protective nets off Natal, South Africa. 4. The bull shark *Carcharhinus leucas* Valenciennes. *South African Journal of Marine Science* **10**: 253-270.

Compagno, L.J.V. 1991. Government protection for the great white shark (*Carcharodon carcharias*) in South Africa. *South African Journal of Science* **87**(7): 284-285.

Coppleson, V.(M.) and P. Goadby. 1988. *Shark Attack. How, Why, When and Where Sharks Attack Humans.* Angus and Robertson, Sydney: 262 pp.

Davies, D.H. 1964. *About Sharks and Shark Attack.* Shuter and Shooter, Pietermaritzburg: 237 pp.

Dudley, S.F.J. 1997. A comparison of the shark control programs of New South Wales and Queensland (Australia) and KwaZulu-Natal (South Africa). *Ocean & Coastal Management* **34**(1): 1-27.

Dudley, S.F.J., R.C. Haestier, K.R. Cox and M. Murray. 1998. Shark control: experimental fishing with baited drumlines. *Marine and Freshwater Research* **49**(7): 653-661.

Dudley, S.F.J & C.A. Simpfendorfer. 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.

Friedmann, Y. and B. Daly (eds). 2004. *Red Data Book of the Mammals of South Africa: A Conservation Assessment.* CBSG Southern Africa, Conservation Breeding Specialist Group (SSC/IUCN), Endangered Wildlife Trust, South Africa: 722 pp.

Gribble, N.A., G. McPherson and B. Lane. 1998. Shark control: a comparison of meshing with set drumlines. *In* Gribble, N.A., G. McPherson and B. Lane (eds) *Sharks and Man: Shark Management and Conservation*. Proceedings of an international shark workshop, Second World Fisheries Congress, Brisbane, Australia, 2 August 1996. Queensland Government Printer: 98-124.

Klimley, A.P. and A.A. Myrberg, Jr. 1979. Acoustic stimuli underlying withdrawal from a sound source by adult lemon sharks *Negaprion brevirostris* (Poey). *Bulletin of Marine Science* **29**(4): 447-458.

National Geographic. 2005. Shark Shields: Electric, Chemical Repellents Show Promise. (http://news.nationalgeographic.com/news/2005/07/0720_050720_sharkshields_2.html)

Scott Johnson, C. 1999. Repelling sharks. *In* J.D. Stevens (ed.). *Sharks* (2nd edn). Checkmark, New York: 196-205.

Sisneros, J.A. and D.R. Nelson. 2001. Surfactants as chemical shark repellents: Past, present, and future. *Environmental Biology of Fishes*. **60**: 117-129.

Smit, C.F. and V. Peddemors. 2003. Estimating the probability of a shark attack when using an electric repellent. *South African Statistical Journal* **37**: 59-78.

Springer, S. and P.W. Gilbert. 1963. Chapter 18. Anti-shark measures. *In* P.W. Gilbert (ed.) *Sharks and Survival*. D.C. Heath, Boston: 465-476.

Springer, V.G. and J.P. Gold. 1989. *Sharks in Question: the Smithsonian Answer Book*. Smithsonian, Washington, DC: 187pp.

Stroud, E.M., M.M. Herrmann and S.H. Gruber. 2004. Semiochemicals as shark repellents - identification and behavioral responses. Abstract. American Elasmobranch Society 20th annual meeting, Norman, Oklahoma, 26-31 May 2004. (www.flmnh.ufl.edu/fish/organizations/aes/abst2004.htm)

Wallett, T. 1983. *Shark Attack in Southern African Waters and Treatment of Victims*. Struik, Cape Town: 184 pp.

Shark spotting as a water safety programme in Cape Town

Gregg Oelofse[1] and Yvonne Kamp[2]

[1]*City of Cape Town, 44 Wale Street, 8001*
Email: Gregg.oelofse@capetown.gov.za

[2]*Shark Spotting Programme Coordinator*
Email: Yvonne@natureconservation.co.za

Abstract

Anecdotal evidence from water users points to a marked increase in the number of White Sharks occurring in the inshore area, particularly in summer. As a result shark spotting in Cape Town developed out of a safety need driven at the local and community level. Two exceptionally successful shark spotting and warning programmes have been in operation for 18 months. These two programmes evolved with little or no assistance from authorities and have since become regarded as essential programmes that must be supported. Intervention by NGO's and finally from the City of Cape Town has provided the opportunity to expand and enhance the shark spotting programmes. Although limitations in the programmes do exist, shark spotting should be considered a core component in a long term safety programme in Cape Town. Additional benefits of the programme include social and economic opportunities of job creation and skills development. An estimated annual budget of close to R900 000 to operate shark spotting and warning at 10 of the City's roughly 40 beaches must be considered within a much broader economic and social context of the possible costs and losses associated with increased or regular shark attacks. A range of financial opportunities exist, including those within the principle of sustainable resource use through providing funding from non-consumptive uses, must be considered and explored further. Shark spotting as an effective component of a broader long term safety strategy must be actively supported by all levels of government.

Citation: Oelofse G and Y Kamp. 2006. Shark spotting as a water safety programme in Cape Town. *In* Nel DC & Peschak TP (eds) *Finding a balance: Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. Introduction

Cape Town has over the last three to four years experienced an increase in the number of White Sharks occurring in the in-shore zone. Although no scientific data exists to support this or indicate otherwise, anecdotal evidence from water users suggests that in-shore occurrence has increased markedly. Further, Cape Town has experienced nine attacks between 2000 and 2005, six on individuals and three small craft (kayaks/surfski's). Three of the attacks have been fatal; one loss of a limb, one serious injury, one minor injury and three damaged small craft.

In response to these events and the increased fear by water users, particularly in False Bay, two community driven programmes were started out of a need to improve the safety of recreational water users.

This paper provides an overview of these two programmes, how they have evolved and assesses the financial implications and limitation of the programmes.

2. History and background

Shark spotting and warning started on an ad hoc basis and very informally at Muizenberg Corner, where individuals, at the time working as car guards, were asked by organisers of surfing competitions to sit on the mountain above the beach and inform the contest organisers if any sharks were visible. At the same time, spotters for the trek net fisherman at Fish Hoek would inform the local Law Enforcement officers if and when they sighted a shark.

In November 2004, in a completely separate initiative, Patrick Hayes, a volunteer student from Cardiff Wales was asked by the City of Cape Town to sit above Muizenberg Corner on a daily basis to record all sightings of sharks. Patrick's role at the time was not envisaged as a safety role, but rather as a means to assess the situation. Patrick's first day of data collection above Muizenberg coincided with the fatal attack on Mrs Tyna Webb on the 15th November 2004.

Following the attack on Mrs Webb, the shark spotting programmes at both beaches grew in stature, as well as formality, overnight.

Both programmes were initially developed independently by the two communities involved. A brief history of both follows.

3. Muizenberg Shark Spotting Programme

The development of the programme at Muizenberg was formalised and initiated by a group of concerned citizens headed by Mr Greg Bertish. With little or no help from the authorities,

and with financial donations from concerned citizens, surfers and local business, Greg Bertish and his team managed to employ three full time spotters, install a shark alarm at the beach, develop a protocol for warning and closing the beach and provide the spotters with radio's, sunglasses and binoculars. As a result, since the 15th November 2004 from 8.30am to 1700 (and sometimes longer) there has been a spotter on the mountain every day seven days a week. The programme has been exceptionally successful and has closed the beach due to shark presence on numerous occasions. The programme has also restored a significant degree of confidence by recreational user-groups. The data recorded by the spotters at Muizenberg is presented in this paper.

4. Fish Hoek Shark Spotting Programme

Similarly, the establishment of the shark spotting programme at Fish Hoek was driven by a concerned community. Fish Hoek beach had existing formal structures through which the programme was developed including an active Ward Councillor, a greater presence of Law Enforcement officials on the beach, and key to the programme, a successful, active and well funded Lifesaving Club. As with Muizenberg beach, this community based programme provided a shark alarm, salaries for the spotters on the mountain, radio's and a seven day a week full time shark spotting and safety programme that has also been highly successful in both shark warning and restoring recreational user confidence.

5. Involvement of the Authorities

It must be noted that active involvement by authorities in the shark spotting programmes and in providing financial assistance were slow in response to a clear community safety need. An active and greater involvement at an earlier stage should have taken place.

Throughout the time that both spotting programmes have been in effect, the City of Cape Town's Environmental Management Department has collected and collated the data recorded by the spotters of each sighting. These results are presented below. In addition, the City's Environmental Management Department worked with role-players to develop and finalise the safety protocols. However, both spotting programmes, particularly the Muizenberg programme made continued requests to the City for assistance for both equipment and funding. Little or no help to the two programmes was forthcoming from the Council. It was only after 12 months, in November 2005 that the City finally provided an initial R400 000 of funding for the two existing programmes as well as a commitment to expanding shark spotting to additional areas.

The financial involvement by the City led to the following short term developments:

- Standardisation of the flag system at all participating beaches
- Over the season period of December 2005 to January 2006, shark spotting programmes, with assistance from the City, were operated by the lifesaving clubs at

Monwabisi, Mnandi, Strandfontein, Blue Waters and Sunrise beaches. (These additional programmes ceased to function when the lifesaving contract for the season ended in January 2006).

6. Non-Governmental Organisations Get Involved

In November 2005, the shark spotting programme received a significant boost from two NGO's. In the first instance, AfriOceans Conservation Alliance provided the first ever shark warning and information sign boards for Cape Town's beaches. These sign boards have been extremely successful in creating awareness amongst beach users of the presence of sharks in the in-shore region, as well as providing information on the shark spotting programmes. Secondly, in a significant boost to shark safety, the WWF Sanlam Marine Programme has provided funding for two years to employ a full time Shark Spotting Coordinator. This is considered a significant step in growing the programme and establishing its long term sustainability.

7. Results

The following table presents the results of White Shark sightings at both Muizenberg and Fish Hoek beaches and for the short period that the programmes were operational at the additional five beaches. The results are reflective of shark sightings and not necessarily beach closures. However, due to the nature of Fish Hoek beach as a small bay, sightings do reflect the siren being sounded and the beach cleared. At Muizenberg which is more exposed to the open ocean, the spotters monitor the sharks' movements and only close the beach when it is considered necessary. Sightings therefore do not correlate to beach closures at Muizenberg.

Table 1: Shark Sightings for 2005

Month	Muizenberg	Fish Hoek	Monwabisi	Mnandi	Blue Waters	Strandfontein	Sunrise
Jan	8	0	NA	NA	NA	NA	NA
Feb	3	0	NA	NA	NA	NA	NA
Mar	6	0	NA	NA	NA	NA	NA
Apr	0	0	NA	NA	NA	NA	NA
May	0	0	NA	NA	NA	NA	NA
Jun	1	0	NA	NA	NA	NA	NA
Jul	0	0	NA	NA	NA	NA	NA
Aug	0	0	NA	NA	NA	NA	NA
Sept	13	4	NA	NA	NA	NA	NA
Oct	42	21	NA	NA	NA	NA	NA
Nov	45	4	NA	NA	NA	NA	NA
Dec	14	4	1	0	0	1	1
Total / yr	**132**	**33**	**1**	**0**	**0**	**1**	**1**

Table 2: Shark Sightings for January to March 2006

Month	Muizenberg	Fish Hoek	Monwabisi	Mnandi	Blue Waters	Strandfontein	Sunrise
Jan	14	11	3	0	4	0	2
Feb	5	14	NA	NA	NA	NA	NA
Mar	4	13	NA	NA	NA	NA	NA
Total / yr	**23**	**38**	**3**	**0**	**4**	**0**	**2**

8. Discussion

Limitations and Constraints as a Safety Programme

As successful as both programmes have been - it is almost certain that without both programmes, Cape Town would have experienced more shark attacks - the programmes do have limitations. These limitations must be considered when assessing shark spotting as part of the overall shark safety strategy for Cape Town.

The following are considered limitations to the effectiveness of the programmes in preventing shark attacks:

1. **Visibility**: Shark spotting is dependent on visibility, both from an elevated point as well as general sea and weather conditions. The programmes at Monwabisi, Strandfontein, Mnandi, Sunrise and Blue Waters have low points of elevation and in these cases the sharks are only sighted when they are in much closer proximity to bathers. Poor weather and sea conditions also impact on the ability of spotters to sight sharks. This has been addressed by using a black flag system, warning beach users that visibility is poor.
2. **Human Error**: As spotters undertake long shifts in difficult conditions (little shelter from the elements: rain, wind, heat) it is unrealistic to expect spotters to maintain the same level of attentiveness for an entire 8-10 hour day, at times going months without a sighting.
3. **Clearing the water**: A number of examples illustrate that even when a sighting is confirmed, warning water users and clearing the water may have its difficulties. This includes:
    - Bathers not hearing the siren or mistaking it for the train siren
    - Electricity failure causing the siren not to work (this has happened more than once at Muizenberg)
    - No lifesaving staff on duty during the week in out-of-season periods to launch a rubber duck to assist people and ensure the water is cleared
    - Water users choosing not to respond to the alarm

4. **Operating hours**: Shark spotting requires permanent staff to be on duty. Operating hours often do not correspond with the hours that water users choose to use the beach. At both Fish Hoek and Muizenberg, bathers and surfers are often in the water long before the spotters are on duty and in long after the spotters have ended for the day.
5. **Open Water Users**: Shark spotting programmes are unable to assist and warn recreational users that use open water. Kayakers and surfski's have on numerous occasions returned to both beaches and have had to paddle back in through the surf after the beach has been closed and white sharks are in the surf line.

Estimated Costs of Shark Spotting programme

This section of the paper assess in general terms the financial costs of running full time spotting programme at beaches, firstly on a full time basis and then only during weekends, public holidays school holidays.

The financial costs include equipment (capital costs) as well as operating costs. The following is a simplistic breakdown of the costs involved.

a) ***Equipment***

The following is a list of the minimum set of equipment required to undertake shark spotting.

- Shark Alarm: R10000
- Flags: R1000
- Polaroid Sunglasses: R300
- Binoculars: R2000
- Two radios': R2000
- Cell Phone and contract: R2200
- Annual maintenance of equipment: R5000

Total cost of the minimum set of equipment for shark spotting: R15000

b) ***Staff costs (full time)***

At a minimum three spotters working in shifts seven days a week

Daily cost per person (average): R125 per person per day
Two spotters per day, seven days a week: 60 person days
Cost per month: R7500

Total cost per annum of full time shark spotting: R97,200

c) *Part time spotting*:

Start up costs: R15000 (as above)
Daily cost per person (average): R125 per day per person
Average year has 104 weekend days, 16 public holidays and 50 holiday days
170 days at two person shifts

Total running cost per annum of running part time shark spotting: R42,500

d) *Total costs of an expanded programme*

If the City were to have at least 10 of its roughly 40 beaches with shark spotting programmes the total costs would be:

Start up costs: R150,000
Running costs (full time): R970,000 per year
Running costs (part time): R425,000 per year
Running costs (equal mix of full and part time): R700,000 per year

Sustainability and financial opportunity

Using the estimates above, financial sustainability of shark spotting is a limiting factor. The financial model above indicates that following an initial R150,000 capital investment, funding of at least R700 000 per year would be needed to fund and maintain a reasonable geographic spread of shark spotting programmes in Cape Town. In addition, the WWF Sanlam Marine Programme funding will end after two years and an additional R140,000 per annum would need to be found to fund the Shark Spotting Coordinator. Long term secure financing must be sourced if shark spotting is to be considered one of the core shark safety measures in Cape Town.

Opportunities

It is important, however within the context of a growing economy, such as in South Africa, to identify direct and indirect opportunities that arise through programmes such shark spotting and the additional benefits that accrue through the spending of funds.

1. **Employment creation**: The Muizenberg programme has provided three jobs to previously unemployed individuals. Fish Hoek as provided two jobs to previously unemployed individuals. Expansion of the programme to 10 beaches would create in the order of 25 – 30 sustainable jobs
2. **Skills development**: Through the spotting programme a number of skills development opportunities could be created for the shark spotters with a designed programme to see spotters move through the system and onto better job opportunities. Further, as is evident with the current shark spotters, a greater sense

of responsibility, confidence and social standing are indirect benefits of the programme

3. **Combining with lifesaving**: In Cape Town, full time lifesavers are not employed (as in Durban). The shark spotting programme could combine with lifesaving clubs to provide shark spotting and lifesaving programmes by using lifesavers as shark spotters. In this way, the public would receive two services.

Financing Opportunities

The following are a range of opportunities that could be motivated to provide the financing for the programme in the long term, either solely or in combination

1. Local government: Local government (City of Cape Town) should commit annual funding to the programme. Shark Spotting falls well within the public and business interest of Cape Town
2. Local Government: Local government (City of Cape Town) should consider absorbing the post of Shark Spotting Coordinator into its structures, thus providing a full time position.
3. Provincial and National government: Providing funds as part of the skills development and public works programmes
4. Commercialisation of White Sharks: Although not intending to link cage diving with shark occurrence, it is a well acknowledged principle that funds generated through the non-consumptive use of species should be re-invested in their conservation. Shark spotting must be considered a conservation initiative as it minimises conflict between the species. Cage diving and filming (False Bay has arguably the highest level of white shark film and documentary making in the world) generate extensive revenue based on the high occurrence of White Sharks in the Western Cape. A safety and research levy could be derived from the commercialisation of White Sharks (from cage diving operations and filming) that would help fund both shark spotting and future research.
5. Sponsorship: Business and private sector contributions and sponsorship could be sought to fund and finance the programme as well as fund or sponsor the skills development aspect of the programme.

9. Conclusion

Shark Spotting, although with its limitations, should be considered a viable and successful core component to any long term shark safety strategy. Further, it is essential that shark spotting be recognised for the multi faceted programme that it is, namely:

- A public safety programme
- A programme that contributes to research and improve our understanding of White Sharks,

- A programme that creates employment opportunities,
- A programme that could provide opportunity for skills development within a developing country.
- A programme that should be considered a key conservation programme

It is imperative that the efforts started by concerned individuals and communities be taken forward in a coordinated approach that is well funded and resourced to ensure the long term sustainability of the initiative. If shark spotting is to be successful it will require the commitment of all organisations, specifically National, Provincial and Local government.

An estimated annual cost of R900,000 may seem high, but this must be considered in a far greater economic and social context. The potential loss of income and economic activity to the metropolitan region due to shark attacks is and could be much higher. This includes the possible loss of employment opportunities, growth in tourism and impacts on small localised business as a result of shark attacks. Further, it must be noted that the annual cost of R900,000 also creates anywhere between 25 and 30 jobs as well as skills and capacity development.

Shark spotting must however be considered as a central component to a long term shark safety strategy, and not as the only safety strategy. Public education and awareness, research and other interventions must be developed as part of the holistic strategy that compliments shark spotting.

It is therefore recommended that:

- Shark spotting be rolled out to a range of appropriate beaches across Cape Town ensuring a geographical spread of safety programmes
- The shark spotting programme becomes more formalised and partners/integrates with lifesaving
- The shark spotting programme invests in the skills and capacity development of the shark spotters
- Shark spotting is funded through a range of mechanisms, including local government, while white shark activities should be considered as a key funding mechanism within the principle of conservation of species funded through sustainable species use.

Recreational safety

Recreational trends and safety in waters of the Cape as it relates to risk of interactions with sharks

Mark Dotchin

Chairman Western Province Lifesaving,
6 Glenluce Crescent, Edgemead, Cape Town

1. Introduction

The objective of this paper is to provide the reader with an understanding of the types of recreational activities taking place along our coastline (South Africa), understand the trends and provide an indication of the safety controls that are in place. It is endeavoured to position such activities as they are impacted on by the potential presence of white sharks.

The region that will be considered can be generally defined as the South African coastline. However specific reference will be made to the Western Cape area.

2. Range of Recreational Activities

The array of recreational activities that occur along our coastline is vast and diverse and in many cases totally uncoordinated. Whilst the following is not an exhaustive list it does provide an indication of the activities that will be debated.

- Bathing
- Surfing – including body-boarding
- Kite surfing
- Windsurfing
- Surf skiing (off-shore kayaking)
- Surf lifesaving (competition activities)
- Long distance swimming
- Triathlon (swimming element)
- Fishing
- Spear fishing
- Diving and snorkelling

Citation: Dotchin M. 2006. Recreational trends and safety in waters of the Cape as it relates to risk of interactions with sharks. *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

The following activities will not be discussed, as the impact on the activities by the shark population is very minimal, not applicable or are outside the theme of this brief.

- Motor powered boating and jet skiing
- Water skiing & wake boarding
- Sailing - including hobie cats
- Commercial fishing
- Commercial diving

Whilst there may be some more obscure activities that have not been considered the above would encompass more than 95% of all of the recreational activities within the inshore area of the South African coastline.

3. Structure of Activity

Before the trends around the activities are discussed I feel that it is important to categorise the activities into some broad groupings. In so doing we are able to establish an understanding as to the activities safety protocols and potential reduced / increased exposure to shark attacks.

For the purposes of this brief I have determined two broad categories namely:

- Formal recognised coordinated activities, and
- Informal uncoordinated pastimes.

The above categories have been structured purely to categorise activities in line with the potential safety and first aid that would be on hand should shark activity or a shark attack occur. Whilst there is none or little evidence in place to confirm that the more formal the activity the less likelihood the chance of a shark activity and or attack, it is reasonable to expect that where specific safety controls are being maintained one can expect that the exposure to the risk is reduced.

The following table categorises the activities

Formal Activity	**Informal Pastimes**
Surf skiing (*structured races*)	Bathing
Triathlon	Surfing, body-boarding (other)
Long distance swimming (*structured races*)	Kite surfing
Surf lifesaving (*competition activities*)	Windsurfing
Surfing, body-boarding (*structured competitions*)	Diving and snorkelling
	Surf skiing (other)
	Long distance swimming (other)
	Spear fishing *
	Fishing
	Diving and snorkelling *

** It is my understanding that there are very limited structured diving, cage diving and spear fishing activities.*

The events that are categorised as formal activities can be expected to have the following support and safety procedures and equipment in place all of which would assist with any possible incident, including a shark attack.

- Motorised support craft
- Duty lifeguards
- NSRI on standby
- First aid personnel, usually paramedics

The majority of the formal events are coordinated under structured committees that have regional and national bodies. One of the main concerns of such bodies is safety and guidelines are produced to ensure the safety of participants is usually in place. It therefore stands to reason that participants in formal activities are more secure.

The majority of individuals that undertake most of the leisure activities that fall under the heading of informal pastimes have little or no safety training or equipment, therefore substantially increasing the exposure to risk. In addition the activities are sometimes undertaken in remote areas that are not patrolled by the rescue personnel (NSRI & Lifesaving South Africa) again increasing the risk factors.

A conclusion could be drawn that the risk factor associated to recreational activities and shark attack could be reduced if the activity is within a formal structure in an area that has patrolled rescue personnel.

4. Trends Relating to Recreational Activities

Although I have not been able to access any official statistics that describe the demographics of the recreational activities along our shoreline and the following comments are built on my observations over the last 30 years, the reports and input from rescue personnel and members of some of the formal activities listed above.

Over the last 30 years there has been an increase in the variety of activities undertaken along our coastline and in general we are finding the beaches especially in the metropolitan areas accommodating substantially more beachgoers. This is mostly due to increased urbanisation, increased tourism (both international and local) and more recently the economic growth that has been experienced in South Africa has allowed more people to partake in more outdoor recreational activities.

The traditional activities such as bathing and surfing continue to be very popular. They have been complemented by a range of other activities including windsurfing and kite surfing that have resulted in a substantial increase in the number of people in our waters. Many places along the SA coastline are recognised as top class international standard windsurfing and kite surfing locations. With the normalisation of the South African political environment many of these locations are very well populated with international surfers. Many of these guests to our country are very unfamiliar with the conditions and potential risk of shark activity as the potential for shark exposure in their native waters is much lower than our waters.

Over the last 10 years there has also been an explosion of individuals involved with surf skiing. At many of the structured formal competitions there are up to 350 entries for such races. Most of the coastal provinces hold up to three formal races per week. The picture below shows the start of one of the surf ski races in Durban (Addington Beach), where over 500 paddlers took part. Historically many of the surf skiers came from the lifesaving movement (surf skiing is a rescue and competition endeavour in surf lifesaving), and as such were aware of the dangers that they were being exposed to. More recently we are seeing many more people without a lifesaving / rescue service background taking up this activity. The organisations arranging the formal races have engaged the safety issues for their competitors with vigour and they have insisted on the use of certain safety equipment such as lifejackets and flares.

A recreational activity that seems to have been directly affected by shark activity is that of diving and more specifically spear fishing. The number of spear fishers seems to have at best been maintained. There may even have been some slight reduction in individuals partaking in this activity. The nature of the activity does increase the likelihood of interaction with sharks (the presence of blood and potential to feed can attract sharks).

5. History of Attacks and Impact on Activity

Other papers in this report have covered the number of shark attacks, the location and timing, this brief endeavours to provide an insight into the impact of the attacks on the recreational activity.

What recreational users are seeking is an explanation as to the trends that seem to have developed. Historically there seem to have been groupings of attacks. In the 1940's there were 5 fatal attacks in the Amanzimtoti region. In 1997 there were 6 attacks between Cape Town and Port Elizabeth and more recently there has been a series of attacks in the Cape Town district.

There have also been some shark attacks on spear fisherman that have been fatal, in the recent past a spear fisherman in False Bay, near Rooi Els was fatally attacked by a shark (presumed to be a White Shark). These attacks have seen many spear fishermen refraining from continuing with their activity / sport.

We have also seen attacks on surfers in the recent past. The highly publicised attack on a young surfer (not fatal), at surfers corner in Muizenberg resulted in the local waters experiencing vastly reduced numbers in the surf. The shark spotters were first introduced at Muizenberg, which saw the numbers of surfers start to normalise.

The fatal attack on a bather in Fish Hoek bay in 2004 had a dramatic effect on the recreational activity in the bay. Fish Hoek has had a previous attack in the 1970's. The bay had historically been a well-populated area for recreational activity as, the conditions made it very popular with bathers, surfers and surf skiers. The attack immediately attracted the attention of much of the local and national media, which was one of the factors that saw almost a total suspension of all water activity in the bay. Once again the presence of shark spotters has seen the numbers of bathers, surfers and surf skiers start to recover but they are below the numbers that frequented the waters prior to the 2004 attack. This attack has also had a negative effect on the number of members at the local lifesaving club, still one of the largest lifesaving clubs in the Country. However the number of members, especially nippers (8 to 13 years olds), are down on the pre 2004 membership.

The picture below shows the very picturesque Fish Hoek bay, a very popular holiday destination for many travellers. The view is very similar to that that is enjoyed by the shark spotters that keep watch over the bay. The partnership between the rescue personnel (Fish

Hoek Lifesaving Club), the law enforcement and the local authorities has been a great success and a model that has the potential to be exported to many other venues along our coast.

Surf Skiing continues to grow in spite of several attacks. In recent years there have been incidents involving sharks and ski paddlers in the Fish Hoek region. On two occasions the skis were damaged when the shark attacked leaving the paddlers in the sea. Both of the paddlers swam to safety. Due to the relatively isolated (Fish Hoek region) nature of the interference by sharks on surf skiers the effect on the activity has been minimal. The number of participants is still very strong and growing. The growth may have however have been stronger had the incidents on surf skiers not happened.

Bathing along our shores is a very popular activity and we see many organised off shore swimming activities happening, including triathlons. From reports that I have received the overall number of participants has generally been maintained or increased slightly. However, the Fish Hoek mile (across the Fish Hoek bay), has experienced a drop in numbers.

The competitive elements of surf lifesaving, which contains events that include swimming, surf skiing and board activities has over the last few years seen a slight reduction in the number of competitors. The reason for the reduction in some places could be a result of shark activity. However this is not a general trend and whilst we are seeing a reduction in the number of lifeguards who compete, the number of voluntary life guarding movement is in fact increasing in certain provinces.

In general the effect of shark attacks and presence does have an impact on the activities. However to say that we can see a trend developing would be incorrect. The effect of shark presence does have a short-term impact, which has seen people avoiding areas where recent attacks have happened. In spite of shark activity our shores are still well populated active recreational areas.

6. Considerations to Reduce Exposure and Risk

The most obvious method of avoiding the risk of negative interaction with white sharks is to refrain from indulging in offshore water activities. However the comments above with respect to the trends illustrates that our shores continue to be very popular recreational locations. This being the case one needs to understand the issues that can ensure that the risk of exposure is reduced. The following are guidelines to assist members of the public that undertake recreational activities:

- Understand the environment that you are in. This extends not only to the possible interaction with sharks but also surf and weather conditions.
- Establish the proximity to lifeguards and other rescue personnel
- In the KwaZulu Natal region some of the beaches have shark nets (not deemed to be ecologically friendly).
- Cape Town has a series of shark spotters at certain beaches that experience higher amount of shark activity. At these beaches it is safer to swim when the spotters are on duty. Check the flags to ensure that they are on duty and whether they have good visibility.
- Entering the water near river mouths is considered to be a higher risk, especially when rivers are flooding and the water is murky.
- Risk could be higher when there is a large amount of fishing activity in the area.
- Do not enter the water where effluent or sewerage is deposited in the sea. This could be via broken sewer pipes or from informal settlements deposits into the river systems.
- Diving near places of high seal concentrations (e.g. breeding islands)

7. The way forward

It is very gratifying to see the investment that many of the local government bodies, NGOs and research institutions are making into understanding the shark population and educating the public. It is only with a greater understanding of sharks that we will be in a position to react and behave in a manner that will reduce the attacks.

The reality is that sharks represent a very low risk but very real risk to our recreational users and when attacks take place they are very highly publicised and create highly charged reaction from some sectors of the public. The response by the ecologically and

environmentally sensitive sectors of our population seems to be growing in voice and a better balance of reaction is being heard.

The sharks are an important part of our marine ecosystems and recreational activities remain and will continue to be an important pastime / sport for our population. It stands to reason that we must learn to respect the presence and take actions that do not negatively affect the natural habits of the sharks.

Emergency Response to shark attacks along the Western Cape Coastline

Craig Lambinon

National Sea Rescue Institute
Email: lambinon@mweb.co.za

1. Emergency Medical Services (EMS) and Rescue response and coordination

The correct EMS and Rescue response to a shark attack is similar to any priority 1 emergency response involving an accident at sea.

The current emergency response is coordinated jointly by the National Sea Rescue Institute (NSRI) helicopter duty coordinator, Station Commander of the closest NSRI rescue station and duty coxswain of the responding NSRI Station boat, Cape Town Port Control and Metro Control and responding EMS personnel. Joint coordination often includes the SA Police Services (SAPS) Flying Squad control room, responding police divers, SAPS patrol officers, air wing, water wing, lifeguard's on duty at the affected beach, law enforcement officers, fire and rescue services, and private ambulance services.

In the Western Cape, ultimately, the NSRI helicopter rescue duty coordinator is in direct contact with all responding bodies and receives regular updates and appraisals of the situation at hand. This information is passed down to all responsible control centers by the NSRI helicopter duty controller. All responding resources are updated, usually, while responding. This situation is unique to the Western Cape.

Once emergency response teams arrive on-scene, coordination of a rescue operation falls upon the helicopter rescue team on-scene and the NSRI rescue craft on-scene but the NSRI helicopter rescue coordinator continues to receive information which is passed onto the relevant control rooms.

Citation: Lambinon C. 2006. Emergency Response to shark attacks along the Western Cape Coastline. *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

Where surf lifeguard's have launched rubber ducks in a rescue effort they are on-scene controllers until handed over to the NSRI or Metro.

Where the patient/s have already been brought to shore initial basic lifesaving protocols are initiated by lifeguards and/or members of the public and handed over to the first arriving intermediate or advanced life support paramedics. Once a paramedic is in attendance (patient ashore) they assume control unless a trauma doctor takes over command.

Where victim/s are missing a search is coordinated by the NSRI and where the search is unsuccessful it is then handed over to the SAPS, namely the police Dive Unit who may get assistance from the NSRI, Navy, Navy Dive Unit, Metro, Metro Divers and Police Port of Entry Services (Water Wing).

The 3 NSRI helicopter rescue duty controllers are: Ian Klopper, Phil Ress and Craig Lambinon. A typical scenario includes port control, Metro control, ambulance control or SAPS flying squad control receiving information of a suspected shark attack at a particular address. Any one of these Control room's push a 4-warn button on a consol in their control room which automatically activates the NSRI helicopter rescue coordinator who gathers exact information from the original caller (member of the public, lifeguard station, alternative control room) in conjunction with the NSRI duty controller of the nearest NSRI station to the attack. Resources are dispatched while this information is being gathered and processed. Dispatched resources are updated while they are responding and further resources dispatched if necessary.

In a situation of a shark attack the NSRI helicopter rescue coordinator, in conjunction with the NSRI duty controller of the nearest NSRI station activates a helicopter rescue service (which may include the Metro Red Cross AMS helicopter and/or the Vodacom Netcare 911 Surf Rescue helicopter), 1 or 2 rescue craft from the nearest NSRI rescue station, a Metro ambulance and Metro response paramedic, the nearest private ambulance service, volunteer ambulance medics (local community) or known doctors/medics who are part of the EMS system closest to the incident, the SAPS dive unit, local fire and rescue services.

These are the basic resource requirements necessary for dealing with the gravity of a shark attack and the many possibilities surrounding an attack.

2. Incorrect response activation protocol

In many cases of previous shark attacks members of the public and officials who become aware of the attack delay the necessary response by notifying the wrong bodies of the situation.

These include:

1. Members of the public who notify their own known response to a disaster including:
    - Security firms that they are members of (these security firms activate private ambulance services who respond without notifying the necessary authorities).
    - Their own membership EMS response system (usually private EMS services) who respond without notifying the necessary authorities.
    - A private ambulance service is notified and responds without notifying Metro or the NSRI.

2. Official bodies that often activate the incorrect response to an emergency of this nature.
    - Lifesaving clubs who activate their own EMS response mechanism (usually private EMS services).
    - Law Enforcement bodies that activate their own EMS response system (usually local fire and rescue response).
    - Local Private EMS bodies that activate their local EMS systems, failing to inform Provincial or Sea Rescue authorities.
    - SA Police Services who activate police resources to investigate prior to activating an EMS response.
    - Nature Conservation who inform local EMS response teams or Private EMS response teams and Metro/SAPS/NSRI are oblivious of situation until much later often when it is realised by on-scene personnel that a broader or more sophisticated response is required to deal with the incident.

3. In some cases of previous shark attacks in the Western Cape the public have informed the media prior to activating an emergency response. The media then call the NSRI to find out more details but the NSRI battle to glean further information in order to initiate a response.

3. Summary

A call of this nature requires 2 control rooms in the Western Cape to be notified. Once notified the entire EMS and Search and Rescue system is activated and the correct resources to deal with an operation of this nature are activated.
These 2 control rooms are Cape Town Port Control (021) 4493500 and Metro Control (021) 9489900.

Who are trained to deal with shark attack emergency response?

Training for shark attacks are part of the syllabus of basic, intermediate and advanced life support paramedic courses and trauma doctors affiliated to emergency response units are trained to deal with shark attacks. These protocols follow the emergency medical response to a trauma patient and are not necessarily specifically designed to deal with injuries or circumstances surrounding a shark attack.

Lifesaving and the NSRI deal with training for shark attacks in an informal manner but rely on trained basic, intermediate and advanced life support members of their organizations to guide them in an actual incident. Ambulance Services deal with a shark attack as per any other form of trauma response emergency. In essence there is no formal course that deals specifically to a shark attack.

Emergency Medical Training (EMT) paramedic Ian Klopper has been researching Medical protocols for shark attacks following his personal involvement with the JP Andrews attack in Muizenberg. Under the guidance of trauma specialists EMT is currently in the final stages of presenting a specialist medical protocol specifically designed to deal with a shark attack victim. Some of the conclusions may be ground breaking views that challenge the current standard medical protocols for this type of incident.

Are all beaches equipped with up-to-date shark attack kits?

Not all beaches guarded by lifeguards are equipped and beaches not patrolled by lifeguards do not have this equipment. Some beaches that have lifeguard stations have shark attack kits and modern equipment that would normally be used in an incident of this nature while other beaches with lifeguard stations have little equipment at all, let alone shark attack kits.

The general consensus appears to be that lifeguards are equipped to deal with an incident of this nature at various levels depending on the training and membership of individuals. Lifeguard stations would initiate basic first aid and activate ambulance and rescue services, local doctors and/or the NSRI to assist further.

Beaches that do not have lifeguard stations are reliant on members of the public to initiate basic first aid and to activate the authorities but no equipment is readily available barring some beaches that have torpedo buoys that may assist with a rescue attempt.

Are these kits easily accessible?

The lifeguard stations that have kits make them easily accessible only during times that lifeguards are on active duty. The kit (where specific 'Shark Attack boxes" are kept) consist of a flag, bandages, trauma pads, sterile gloves, suction unit. Some lifeguard stations also have splints and oxygen (trauma bags) and only some have BVMR's and Intravenous therapy.

Not all lifeguard stations have these kits and/or equipment of this nature.

Are the public and recreational user groups trained to respond to shark attacks?

There is no formal training available that specifically instructs on dealing with the response to a shark attack.

Mostly, it is dependant upon that these groups to notify the necessary emergency response organisations. If any qualified first aider, nurse, doctor is on-scene they would be capable of initiating basic first aid to a victim without equipment.
Most cases where the public have become involved, it has been to assist victims from the surf, stop bleeding using unconventional methods, and begin CPR (even when not correctly performed).

What are the standard medical protocols for attending to a shark attack victim?

The medical protocols in essence are the same as dealing with a trauma patient but specific modifications to deal with medical procedures for shark attack victims appear to challenge conventional methods ie: maintaining a hypothermic state in a shark attack victim. A draft document will be available from EMT in the near future, but this will require further refinement.

What is the average response time to an attack?

The average response time following a call to Port Control on (021) 4493500 is about 20 minutes.

A call via 082911 would add a further estimated 5 minutes for the 082911 control room to process the information and either transfer caller to (021) 4493500 or activate info to (021) 4493500 who will then activate the medical and rescue resources.

A call to SA Police Control (10111) or Ambulance Control (10177) will be the same as Metro or Port Control due to the 4-warn system that exists in the Western Cape.

This is an average response time but in many cases in and around the peninsula the response time has been as little as 2 minutes due to the NSRI's broad network of volunteers and local EMS response affiliations.

Delays would mostly be found by members of the public delaying calling a control room or where cell-phone signal is not available.

Are the public aware of who to call for a shark attack emergency response?

For shark attacks in the Western Cape we would prefer the public to dial port control directly (021) 449 3500.

Based on previous incidents this has not been followed barring a few cases only.

How critical are the first 20 minutes following an attack?

Very critical for many reasons:

- If the patient is still in the water a rescue needs to be executed.
- If the patient is out of the water it is very likely advanced medical care will be required urgently.
- If the victim is missing a search needs to urgently be thoroughly carried out as fast as possible as if the victim is found advanced medical care will most certainly need to be administered urgently.
- The possibility that a patient will bleed out in the first 20 minutes and/or require defibrillation within the first 20 minutes if cardiac activity present.

How many shark attack drills are carried out per annum?

Lifesaving stations would incorporate shark attack drills as part of normal training in evacuating an injured bather from the surf with trauma injuries.

The NSRI carry out no known shark attack drills but incorporate the training of any trauma victim as applied (standard) to a shark attack victim.

The Emergency Medical Services carry out no known drills dealing specifically with shark attacks.

Communications

The role of government in demystifying sharks and shark attacks

Michelle Preen[1] and Ruth Richards[2]

[1]*Communications & Marketing, Environmental Resource Management Department, City of Cape Town*
[2]*Intern, Environmental Resource Management Department, City of Cape Town*

Abstract

There is no doubt that government agencies, in partnership with other stakeholders, have an important role to play in environmental education and public awareness around sharks. However, currently there is no clarity on the roles of various tiers of government and no co-ordinated communications strategy. Interventions are ad hoc and/or reactive. Numerous misconceptions about sharks and much media hype around attacks make this a significant communications challenge. In addition, communications and education are often seen as a 'nice to have' with little funding committed. Cape Town has adopted a unique approach to the shark safety issue, which is non-intrusive, seeking to mitigate between people and sharks, and thereby linking safety and conservation. This approach needs to include a proactive, co-ordinated education and awareness strategy, undertaken in collaboration with relevant stakeholders. Through implementation of this strategy, misconceptions and the current media hype that surrounds a shark incident should be minimised. It is important too to establish better relationships with the relevant media and encourage media responsibility. Heightened awareness by the public should lead to more responsible recreational use of the ocean. This should lead to fewer potential interactions between sharks and people, which in turn should result in fewer shark attacks.

Citation: Preen M and R Richards. 2006. The role of government in demystifying sharks and shark attacks. *In* Nel DC & Peschak TP (eds) *Finding a balance: Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. Introduction

This paper aims to assess the importance and role of government in information, communication and awareness in demystifying sharks and shark attacks. It intends to provide context and understanding for the provision of information to the public, in order to empower them to make informed decisions in their use of and interaction with the ocean.

2. Context

Shark attacks and the presence of sharks in the inshore region receive significant media coverage and public attention.

In addition, factual accounting of both the events and context around each attack are questionable. Following an attack, a range of so-called experts and organisations are requested to give comment regarding the attack and sharks in general. Due to the emotive nature of shark attacks and sharks, myths are often perpetuated and confusion is created. Coupled with this, relatively little is known about shark behaviour with regard to shark attacks in Cape Town

There is also the fact that a lot of hype has been created by movies such as *Jaws* and that sharks are not 'cuddly' creatures.

Currently, no co-ordinated communications strategy exists.

3. Cape Town's approach to the shark issue

Cape Town has adopted a unique approach to the shark safety issue, which is non-intrusive, seeking to mitigate between people and sharks. In this way, safety and conservation are linked. It is a holistic approach which includes a co-ordinated research effort, a shark spotting programme, and an education and awareness component. A range of partners are currently involved. These include Department of Environmental Affairs and Tourism: Marine and Coastal Management Branch, Provincial Government of the Western Cape, WWF Sanlam Marine Programme, Iziko Museum Shark Research Institute, Natal Sharks Board, National Sea Rescue Institute, South African Lifesaving, as well as a number of marine research specialists and NGOs.

4. Role of government

Government agencies have an important role to play in Environmental Education (EE) and public awareness. Communication around shark safety and awareness is one component of this broader responsibility.

Providing effective environmental education to the public should demystify the issue of sharks and shark attacks, as well as empower the public to make informed decisions about their use of the ocean, through making them aware about the possible risks involved. An informed public, in addition to the implementation of an early warning system such as the shark spotting programme, should result in fewer shark attacks which will aid government in their management of the shark issue.

White sharks are threatened by finning, fishing and bad publicity. It is a further responsibility of government to help maintain and conserve regional/local shark populations, as sharks are an important aspect of biodiversity both nationally, and locally within the City of Cape Town. Sharks also play a vital role at the top of the marine food chain. It is therefore imperative that a balance between the ecological and social aspects of the shark issue be reached so that the twin goals of conservation and shark safety can be attained.

We believe that an increase in shark safety awareness will not only benefit the ocean-using public in terms of safety, but will also aid conservation. Heightened awareness should lead to more responsible recreational use of the ocean by the public, which in turn should result in fewer shark attacks. Increased responsibility by the public would include heeding alerts from shark spotters, as well as paying attention to signage and safety tips supplied, regarding where and when it is best not to swim, for example. By decreasing the potential interactions between sharks and people, the likelihood of attacks should be reduced.

The presence of sharks in the region, and especially shark attacks, receive much attention from the media. Reduced media hype will be a consequence of fewer attacks and should therefore also result in a decreased public resentment of sharks. In the past, the content and context of many media reports have been questionable and have aroused public sensation and perpetuated myths. In other areas, in the past, public resentment toward sharks has resulted in increased shark hunting and initiatives such as shark nets which can pose a hazard not only to sharks but to other large marine animals as well.

All tiers of government – national, provincial and local – have a role to play in educating the public on the shark issue. A co-ordinated approach, in collaboration with other partners, is however vital. Such an approach will prevent duplication of communications and hence confusion of the public which may result if they are confronted with a number of separate education campaigns, programmes and messages. It is also important with respect to interacting with the media.

Each tier of government will have a different role to play, but by working together, all aspects of communications, EE and awareness should be covered. The focus of national government, more specifically the Department of Environmental Affairs and Tourism's Marine and Coastal Management Branch (DEAT: MCM), is primarily on conservation and research. The focus of provincial and local government, on the other hand, would be more around the social aspects of tourism and shark safety. Ultimately the experience people have with

sharks occurs on the City's beaches and programmes are needed on the ground, preferably in partnership with local communities.

5. Approach

The approach adopted cannot be viewed in isolation and needs to form part of a broader coastal awareness and education communications plan. The white shark, however, could be made the icon of the campaign, in an effort to raise awareness and engender respect for the white shark.

Education and awareness around the shark issue need to be ongoing. The presence of white sharks around the Cape coast is not a problem to be solved, but rather an ongoing issue that requires a change in public perception to prevent conflict from arising between people and sharks. Effective environmental education should lead to a change in behaviour, towards safer ocean recreation and a move towards public acceptance of the shark as an important part of our ecological heritage.

A co-ordinated communications strategy should be developed, which enables the approach to be **proactive** rather than reactive, not only gaining momentum when an attack takes place. Consideration should also be given to referring to shark bite incidents rather than shark attacks.

We need to be educating people about sharks and raising awareness about the issues, but we also need to be informing people about what is being done in terms of shark safety. We need to be open and honest – communicating what we know and what we don't know. Education and awareness initiatives need to be based on sound knowledge and research. In addition, we need to be interacting with the media around the issue.

A multifaceted approach to shark safety education and awareness is important as this will ensure that the right people receive the right messages at the right times and places.

A number of initiatives can be developed. Estimated budget requirements are given where applicable. Strategically these initiatives need to form part of a broader coastal awareness and education communications plan, and could include the following:

In an effort to establish better relationships and encourage media responsibility:

- Hold a media briefing session (to give background data and research)
- Establish an integrated media communication protocol that is followed in the event of an attack. This would include all tiers of government and other role-players and would ensure that we are speaking with one voice.
- Partner with the media (radio and community newspapers) to provide regular updates on shark sightings, to increase awareness of shark activity and when shark presence is high. Regular media reports could have an additional benefit in that accountable

partnerships with the media are developed and reinforced. When a shark attack does happen, this may result in more factual and less emotive reporting.

Other communications initiatives could include:

- Review of existing resources and programmes (e.g. signage)
- Survey / Design FAQs to dispel common myths and misconceptions
- Develop a "sharks in schools" programme, as part of a broader coastal schools programme, to be run at strategic times, before the summer holidays, for example. This could be linked to existing schools programmes. *[R900 000 over 3 years, with approximately one third (R300 000) directly or indirectly for shark education]
- Develop a City-focused coastal community capacity building programme to complement the Coastcare Sustainable Livelihoods Programme. *[R2 250 000 over 5 years, with approximately 10% to be used for shark awareness and education]
- Run a capacity building programme for the shark spotters. [R100 000]
- Develop a tourism beach safety booklet explaining the risks of ocean recreation for each beach/coastal recreation site (e.g. include surf spots etc.) within the City, including shark safety risks, where applicable, and tips for safe ocean recreation. This is to be aimed at tourists and local beach users alike. *[R500 000]
- Produce pamphlets aimed at certain groups of beach users e.g. bathers, surfers, anglers etc. to be strategically located to reach these groups. For example: pamphlets at surf shops for surfers, pamphlets at hotels for tourists. Strategic timing for pamphlet distribution is important, especially before and during peak holiday season. *[R150 000 annually]
- Work with partners to raise general awareness through holding targeted information talks on sharks, and other focused initiatives, such as a special day, or events.
- Set up / use an existing website and publicise it

**These initiatives are unfunded at present and partners would be required to make them a reality.*

Communication in the form of pamphlets and signboards at beaches is one way of increasing awareness in the right places. The signboards on sharks currently up at strategic beaches are an important asset to the communications effort. It is important that beaches are not 'overrun' by signage but when new signage is needed, the design and information conveyed should be carefully considered.

It is important that the communications strategy include an audit of programmes currently underway and resources currently available so as to avoid duplication, as well as some form of monitoring and evaluation, in order to establish the success of the programme, and make adjustments as and when necessary.

6. Resources required

Resources are needed for an effective communication and awareness programme. These include a budget, as well as human capacity to develop and implement the programme. The funding is probably the biggest constraint in terms of moving ahead with such a programme. Therefore the City promotes meaningful partnerships and would be open to partnerships with all tiers of government and other partners to ensure delivery of such a programme.

7. Conclusions

Communication and awareness are vitally important in moving towards a balance between white shark conservation and safe recreation. A strategic communication and awareness programme, developed and implemented in collaboration with a range of partners, will potentially lead toward an empowered public who will make informed decisions with respect to their recreational use of the sea, because they are aware of the inherent risks involved. This should lead to fewer shark attacks and also reduce the media hype and associated public misconceptions that result from shark attacks.

It is important for the public to know that there is a plan to increase safety and promote awareness of sharks. It is imperative that we communicate this to the public so that they understand that we are engaging with the issue and are committed to doing what we can to make ocean recreation safer for them.

In summary:

- This is a significant communications challenge – there are lots of misconceptions and much media hype
- Currently there is no co-ordinated communications strategy – it is *ad hoc* and/or reactive
- There is no clarity on the roles of various tiers of government, and Departments within local government
- Communications and education are often seen as a 'nice to have' with little funding committed.

8. Recommendations

- Formalise the Shark Working Group and include Communications in the TOR.
- Establish a communications task team with representatives from all tiers and government and other stakeholders.
- Draw up a White Shark Communications and Education Strategy.
- Source funding for White Shark Communications and Education.
- Hold a media briefing session and establish a media protocol.

The role of non-governmental organisations in demystifying sharks and shark attacks

Lesley Rochat

Executive Director
AfriOceans Conservation Alliance (AOCA) P O Box 22436, Fish Hoek, 7974

Abstract

The irresponsible media portrayal of sharks as bloodthirsty killing machines encourages fear and loathing of sharks, instead of offering any real understanding of shark behavior. Responsible information, communication and awareness are therefore crucial in assisting towards replacing misperceptions of sharks with interest, admiration and caring. Currently there are a number of organizations and companies involved with shark awareness at varying levels. Separate awareness and education elements distributed randomly to the public, however, lack cohesion and dilute overall objectives. A stand-alone education and awareness campaign, which promotes synergy of efforts at an independent, provincial and governmental level, is therefore suggested in order to address the need for clear communication to the general public. This campaign's main intent should be to dispel the myths around shark attacks and improve people's perceptions about white sharks (sharks in general), safe water use etc. The Save Our Seas Foundation Maxine, Science, Education and Awareness (SOSF M-Sea) Programme, a shark conservation programme initiated by an AfriOceans Conservation Alliance (AOCA), can be used as an example and model of a successful education and awareness initiative that has reached millions of people worldwide. Should the new campaign adopt a similar aggressive media strategy and promote responsible reporting, then the media that has successfully branded sharks as man-eaters can be used to change the very perceptions it has entrenched. Responsible media together with all the other suggested campaign elements would result in a paradigm shift in people's minds so that when an attack does occur, fear and panic is replaced with understanding and acceptance.

Citation: Rochat L. 2006. The role of non-governmental organisations in demystifying sharks and shark attacks. *In* Nel DC & Peschak TP (eds) *Finding a balance: Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. Introduction

There is nothing more terrifying that the cry of '*shark*!' when swimming in the ocean, but if sharks could they would be shouting 'People!' In truth, man is the major predator of sharks; it is us who feed on them: No shark is safe from exploitation as human populations grow and resources worldwide decrease. The World Conservation Union (IUCN) states that over 100 million sharks are being killed worldwide each year. Should this continue many shark species are threatened with extinction.

How important is communication and awareness in moving towards a balance between white shark conservation and safe recreation?

Added to the commercial exploitation of sharks is the poor perception people have of them: The irresponsible media portrayal of sharks, especially of the white shark in films such as Jaws, as bloodthirsty killing machines encourages fear and loathing, instead of offering any real understanding of shark behavior. Yet, once people understand the true nature of an animal, fear is often replaced with interest, admiration and caring. Information, communication and awareness are therefore crucial in assisting towards achieving this goal.

Shark attacks did not become a subject of particular public interest until the twentieth century. Several factors have contributed to the upswing in public awareness of shark attacks during the last sixty years. First and foremost has been the evolution of the press from parochial to a cosmopolitan newsgathering system that covers a larger portion of the world in a more rapid and comprehensive manner. Increased competition and a shift of journalistic values in certain quarters has contributed to more active searches for "shock' stories, i.e. those that titillate the public and promote sales. Needless to say, an examination of current weekly tabloids confirm that "shark eats man" is a best selling story line.[i]

Just as the media has successfully branded sharks as man-eaters so too can it be used to change the very perceptions it has entrenched. In the case of white shark attacks in the Western Cape, a broad reaching communication campaign that targets the general public, and that utilizes all avenues of communication i.e. radio, television, press, magazines, cinema and the Internet, including direct exposure such as public signage, pamphlet distribution, posters, and community presentations, is needed in order to debunk the myths about sharks that have come to be regarded as fact.

What role should non-profit agencies be playing in providing information to the public on sharks?

A successful example of a non-profit organization contributing positively towards providing information about sharks is AfriOceans Conservation Alliance (AOCA). AOCA initiated a unique shark conservation programme called the Save Our Seas Foundation Maxine, Science, Education and Awareness Programme (SOSF M-Sea)[ii]. The programme's main intent has been to drive a high profile national and international public awareness and education campaign that highlights the serious threats to shark populations worldwide due to overexploitation, and that assists in changing ruling perceptions that sharks are vermin and a danger to man. To date over 70 million people have been exposed to the aggressive media coverage this programme has generated, excluding the Internet coverage it has achieved, which has been considerable, thus imparting the programme's important shark awareness and education messages.

The above-mentioned programme experienced great difficulty in raising funds locally. This was largely due to the chosen subject matter, which most potential sponsors said they did not want to be associated with because of current ruling perceptions of sharks, regardless of the attractive exposure opportunities offered. Funding for this programme was therefore raised internationally by another non-profit organization, the Save Our Seas Foundation, who has a mutual interest in shark conservation.

Which non-governmental organizations currently play a role in the education and awareness of the public about sharks?

Shark Awareness - Cape Town Area

The following companies and organizations are involved in creating awareness about sharks in the immediate area:

- Iziko South African Museum provides information and education about sharks via its impressive *Sharkworld* exhibit, sponsored by the Save Ours Seas Foundation. Elements of the SOSF M-Sea Programme are also on display. The museums Shark Research Centre (SRC) serves as a local and international source of public information on the shark-like fishes, including lectures, advice to commercial fisheries and institutional research bodies, to the news media, and to film-makers. SRC promotes a factual view of the relationship of shark-like fishes to human activities[iii].
- Apex Images cc distribute a monthly newsletter to 3 500 subscribers and contribute to the spaghetti tagging of sharks caught in beach seine nets as part of the of the Oceanographic Research Institute's Tag and Release Programme. Chris Fallows gives talks to interested groups about white sharks.

- Dolphin Action and Protection Group began giving talks on sharks to local schools during 2005. A total of eleven schools were visited. Fund raising is underway in order to continue during 2006.
- AfriOceans Conservation Alliance (AOCA) a non-profit organization focuses its efforts predominantly on providing education and awareness to the public about sharks via the SOSF M-Sea Programme. Apart from their aggressive media strategy they have developed the following elements to promote education, awareness and the conservation of sharks:

  - Teacher workshops on sharks held at the Two Oceans Aquarium (TOA) educational department during which the educational material for schools produced by AOCA is distributed. This material includes: a teacher handbook on sharks (copies have been given to Yvonne Kamp, the new White Shark Spotter coordinator to provide information on sharks to the shark spotters), a DVD and a supporting poster;
  - Transporting children from coastal schools to TOA for a classroom-based lesson on shark conservation, plus an outreach programme to reach communities that do not have transport to attend workshops or lessons;
  - Various SOSF M-Sea Programme displays at the TOA: A kiddies dry display on sharks, a SOSF M-Sea Programme dry display, and a dedicated SOSF M-Sea Shark display.
  - Shark encounter signage for beaches – 54 signs were produced by AOCA as part of the SOSF M-Sea programme and are currently displayed at all the major beaches in Cape Town and Gansbaai;
  - 3 TV *Rethink the Shark* TV commercials which put shark attacks into perspective - unfortunately to date funds have been lacking to get these broadcasts or screened at local cinemas. 3 *Rethink the Shark* posters and T-shirt have also been produced to create further awareness;
  - A three part documentary series called *A Shark's Odyssey*, broadcast on SABC 2 50/50, which covers the work of the SOSF M-Sea Programme in a compelling way, and which strives to improve perceptions of sharks;
  - The AOCA website, which serves as a communication channel and provides extensive content on sharks for children and adults;
  - A high profile scientific research project which involves the tagging and releasing of captive ragged tooth sharks from the TOA, as well as the satellite tagging of wild sharks;
  - Satellite tag competitions with the goal of creating further awareness;
  - Brochures about the programme;
  - Talks to interested groups;
  - Participation in local festivals to promote awareness.

Shark Awareness – Outside of Cape Town

- Great White Shark Protection Foundation is based in Gansbaai. Apart from representing all the white shark operators they provide awareness about white sharks to the general public and advertises a help line for further information. When the SOSF M-Sea Shark Encounter signage was erected in Gansbaai they ran an awareness campaign, which included the distribution of pamphlets containing the information on the boards as well as the distribution of the Shark Work Book, produced by Dr Eric Ritter.
- The majority of the eight Gansbaai White Shark Operators are handing out the Shark Work Book, which contains information about white sharks, to their clients. 5000 books were printed and sponsorship was raised internationally.
- Eco Ventures, a white shark tour operator in Gansbaai, give approximately four talks per month to local schools, including disadvantaged communities, about white sharks and sharks in general. They also provide school field trips during which they invite pupils from local schools to join them on a white shark watching outing. Most of the other seven operators are also involved in creating awareness to schools and the general public. This year the operators aim to coordinate their awareness efforts.
- The White Shark Trust, Gansbaai – Michael Scholl gives talks on white shark conservation to schools, museums, and tourists both in S.A and overseas. The website *www.whitesharktrust.org* is also a important resource for re-educating the public about the true nature of Great Whites

What form should the education and awareness take? Coastal signage, pamphlets, workshops, regular communication?

The Need for a Campaign

Separate awareness and education elements distributed randomly to the public lack cohesion and dilute overall objectives. In order to achieve maximum reach and success, and by using the SOSF M-Sea Programme as an example and model of a successful education and awareness initiative, a separate and comprehensive information, education and awareness campaign is suggested. This stand alone campaign's main intent should be to dispel the myths around shark attacks and improve people's perceptions about white sharks (sharks in general), safe water use etc. It should be structured in such a way that it is sustainable over the long-term, designed to achieve maximum target audiences, while its various components should employ differing, yet integrated methods and media in order to achieve its overall objectives.

A number of communications strategies, working simultaneously across a multi-media spectrum, all drumming out their messages is required. Wherever possible elements from the

different communication strategies should sit side by side and be identified with this campaign's unique branding. Educational and awareness elements, which have already been produced by various organizations on the subject, could be incorporated. Where possible, and in order to avoid a blurring of objectives, they should be 're-packaged' with this campaign's branding so that "They speak with one voice," to coin an advertising term.

One of the advantages of designing a broad reaching, uniquely identifiable campaign of this nature, which offers high profile branding opportunities, is that there is greater potential for raising substantial sponsorship.

Suggested Campaign Elements

- ✓ TV/Cinema commercials (this is costly but there is the potential of using the Rethink the Shark commercials produced for the SOSF M-Sea Programme – peak tourist season is suggested for screenings);
- ✓ Pamphlets distributed at local cinemas where the ads are screened;
- ✓ Shark Signage (fortunately these boards have already been produced by AOCA but will require maintenance), additional signs may still be required;
- ✓ SMS awareness (this affords an opportunity to raise awareness while at the same time generate funds – these could be advertised at museums and aquariums already involved in creating awareness, and at cinema screenings of ads);
- ✓ Website (a website which supports the overall objectives of the campaign advertised on all supporting material, and which provides a host of additional information);
- ✓ Regular workshops/talks, especially after an attack, and in areas where shark attacks occur most frequently targeting the public;
- ✓ An information, awareness and educational workshop specifically designed for life savers and other beach authorities who are in direct contact with beach users;
- ✓ Campaign posters and pamphlets for distribution at peak season in particular;
- ✓ Campaign marketing elements such as T-Shirts and postcards for sale at restaurants and shops located close to beaches;
- ✓ Competitions marketed during peak season via the many other campaign elements can be an effective way in promoting further awareness and prizes can be sponsored.

Creating Synergy

The awareness efforts already underway by the various independent organizations and companies listed above can be tapped into to for both the resources they can contribute towards the campaign, and for the opportunities they have already established in reaching more people.

Ongoing Communication

An aggressive media-marketing component needs to be formulated, which promotes the campaign and any other information available from the Shark Working Group. It should be communicated via radio interviews, TV chat shows, short documentaries inserts for local TV, and press and magazine coverage. The communication needs to occur throughout the year, with a focus during peak seasons.

It is important that should there be a shark attack then specific information should be prepared in advance in order to communicate effectively with the public and answer any queries they might have related to the attack. This information is covered by the various topics of the White Shark Recreational User Interactions in Cape Town – Specialist Workshop.

Promoting Responsible Media

Maintaining contact with the press is a prerequisite for clear and effective communication with the public in order to ensure that the campaign goals and objectives are achieved.

The press should be made aware of whom to contact for comments in the event of a shark attack. This will ensure that communication is coordinated and the chances of it becoming dissipated amongst many different “experts” and organizations will be reduced. To ensure that the press knows who to contact a Press Evening/Campaign Launch Evening could be arranged at a venue such as the Two Oceans Aquarium during which the campaign is announced to the press and selected guests.

If a shark attack occurs a Press Release needs to be circulated immediately, with contact details of the spokesperson for further comment. Circulating press releases for comments to the Shark Working group for example dilutes the effectiveness of a quick response, which has the potential of balancing outside negative comments. Though circulating Press Releases might be necessary in some cases, an initial Press Release prepared in advance should be circulated immediately once an attack occurs. Apart from specific facts related to that particular incident it should include a set of general comments that support the overall objectives of the campaign. Speed is essential in nipping the issue in the bud and reminding the press whom they should be speaking to.

What should an awareness programme focus on? Should it focus on white sharks and their importance to a healthy ecosystem? Conservation programmes? Safety protocols and how to deal with a situation of an attack? Information on areas that may have greater risk of white shark presence?

Campaign Objectives

The campaign's primary objective will be to target the general public with the aim of:

- ✓ Dispelling myths about sharks and shark attacks;
- ✓ Educating the general public about safe water use, including safety protocols, and what to do if an attack occurs.

It is however not possible to improve understanding or perceptions of sharks without a holistic approach. Therefore in support of the campaign's primary objectives it will also cover:

- ✓ The important role sharks play in maintaining the delicate balance of the marine ecosystem – why we need them;
- ✓ Issues that threaten their long-term survival and the impact their loss will have on us;
- ✓ The general wonder of sharks i.e. their biology and habits. This will assist in promoting appreciation and understanding.

What resources are needed for an effective communication and awareness programme? Are these resources available?

A development phase that involves research needs to be proposed and budgeted for. This development phase should take into consideration resources already produced by the various companies and NGO's already involved in creating awareness, and include possibilities of collaborating with them and their current methods of reach. Once development is complete an in-depth proposal with a supporting detailed budget needs to be presented to determine both funding and additional resources required as per suggested campaign elements.

Should there be coordination between NGO's and the government in developing and implementing a communication protocol?

Coordination and consultation with the City of Cape Town and the Department of Environmental Affairs and Tourism (DEAT) and the NGO/company responsible for developing and implementing this campaign is important to ensure that the campaign's

strategy, objectives and communication is clearly defined and agreed upon. This will involve, during the development phase, a strategic planning process that will be adopted by the campaign in order to achieve these goals.

On a broader level this communication protocol should be included into a vision and a clear set of imperatives that our nation must understand, and adopt if sharks are to be conserved for future generations to come, and incorporated into government policies related to shark conservation.

2. Conclusion

Making a meaningful contribution towards improving people's perception of sharks, an animal that must remain one of the most maligned, and misunderstood of all creatures on Earth, will always be challenging. But through education and awareness lies hope for replacing fear and loathing of sharks with admiration and understanding. Then the need to preserve an animal that ruled its domain long before we took it upon ourselves to arrogantly assume we are superior to all other life becomes blatantly clear.

A successful campaign will have the effect of creating a paradigm shift in people's minds when an attack does occur from one of fear and panic to understanding and acceptance: Instead of jumping to conclusion as a result of lack of information, and being driven by emotions and media hype, the public's reaction will be reduced to one of calm acceptance that we do after all share our planet with other animals, some being top predators, and a chance encounter with one of them, though very rare, may occur.

3. References

[i] ISAF 2005 Worldwide Shark Attack Summary

[ii] The Save Our Seas Foundation M-Sea Programme is an AfriOceans Conservation Alliance initiative, in collaboration with Two Oceans Aquarium, sponsored by Save Our Seas Foundation. See www.aoca.org.za

[iii] Iziko South African Museum: www.museums.org.za/sam/src/sharks.htm

Sharks and shark bite in the media

Thomas P. Peschak

Marine Biology Research Institute, University of Cape Town, Cape Town
Email: tpeschak@iafrica.com, www.currentsofcontrast.com

Abstract

The fear of sharks is not something humans are born with but is a product of environment and culture. The power the media holds in influencing the public's perception of sharks is tremendous. Even to this day most people's fear of sharks can be traced back to when they first watched the film JAWS. Today weather by design or default the media continues to perpetuate a negative image of the deadly and dangerous shark. Shark stories, especially sensational shark bite stories sell and there is a definite conflict of interest between accurate and truthful reporting and money making in the competitive day-to-day news business. Shark stories however do not just have commercial appeal because of the public's voyeuristic sentiments, but also because hand in hand with the fear of sharks comes a thirst for information to control and rationalize that fear. The media therefore have a responsibility to ensure that its content is factually correct since it is nearly impossible for non-specialists to separate scientific facts from science fiction. However especially in the daily news sectors the media often fails in its responsibilities by reporting incorrect information, elevating non-qualified people and their opinions to expert status and by perpetuating shark myths. In order to facilitate a climate where the media can become a valuable role player it is recommended that a seminar and a handbook on sharks and shark bite be developed for media professionals. In addition a definitive list of shark experts willing to interact with media should be drawn up, the reporting of positive non-shark bite stories should be encouraged and the word "shark attack" be changed to shark bite in all communications.

Citation: Peschak T P. 2006. Sharks and shark bite in the media. *In* Nel DC & Peschak TP (eds) *Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop.* WWF South Africa Report Series - 2006/Marine/001.

1. Background

Our species' grossly exaggerated fear of sharks is neither innate nor driven by instinct. The fear of sharks is not something humans are born with, but instead is a product of the environment and culture we are immersed in. Today weather or not we come to fear or hate sharks during the course of our lives depends largely on the attitudes of the media that we (and our friends, work colleagues and relatives) are exposed to. The power that the popular media (newspapers, magazines, radio, television and film) holds when it comes to forming and influencing the public's perception of sharks is best illustrated by Steven Spielberg's 1975 film *JAWS.* The film that terrified audiences and broke all box office records of the day (grossing in excess of 260 million dollars) became a seminal turning point in the way the public perceived sharks, the great white in particular. Almost overnight the white shark went from being considered – at most – an obscure ocean dweller that few had ever heard of to a man-eating monster with a lust for wanton killing, and a creature that was best eradicated from our planet forever. The film's impact was unprecedented and as shark bite hysteria gripped the film-going world, some people refused point blank to ever set foot in a body of water again, not even a swimming pool hundreds of kilometres from the sea. In the wake of JAWS followed a Great White killing frenzy motivated and driven by an irrational and exaggerated fear of shark bites which was unearthed by this one work of fiction. Anglers and trophy hunters in the USA, Australia and South Africa set out to sea to kill as many Great Whites as possible. Everyone who returned with a dead shark was a celebrated hero. Despite the fact that sharks were already portrayed as dangerous and evil in the early accounts of sailors, shipwreck survivors and the first underwater explorers, most people's fear or hatred of sharks can be traced back to the time when they first watched JAWS.

However there are societies where sharks have never been perceived as harbingers of evil, man-eating monster or dangerous villains. In remote corners of the western Pacific sharks are worshipped and revered as gods; they are believed to harbour the souls of long departed and cherished ancestors. Sharks are also perceived in the way that western society perceives dolphins and oral history recounts stories of sharks, not dolphins rescuing islanders from shipwrecks and towing drowning victims to safety. From an early age children are exposed to sharks as playmates; in tropical lagoons they interact with juvenile reef sharks much like we would with puppies. It is also considered bad luck to kill sharks and it is strictly taboo to eat their meat. Interestingly enough dolphins are regularly killed in there hundreds during canoe hunts, their meat eaten and teeth used as currency. The existence of a society where sharks are revered as gods and Flipper is on the menu is surely enough proof that our fear of sharks is learned and not instinctual.

2. Sharks and the media today

In South Africa, unlike in the western Pacific, people share the western society's preconceived notion of sharks that has been deeply embedded into our psychology by years of media reporting. Studies have even shown that now just hearing the word SHARK causes measurable increases in heart rate and muscle tension in many people (the words dog, bear and tiger – creatures responsible for far more injuries or death - don't). Weather by design or default, the media perpetuates the fear of sharks and the negative image of the deadly and dangerous shark on a daily basis. The reasons for this are two-fold, first those who create media usually share the fear of sharks experienced by the public, in turn influencing their reporting and second it is a well-known fact that shark stories, especially sensational shark bite stories sell! When magazines or newspapers place sensationalistic shark photographs or headlines on the cover there is a significant increase in circulation. TV programs with titles such as "Shark Attack" or "Killer Sharks" also attract high viewing figures. This causes a clear conflict of interest for the media between accurate, truthful and objective reporting on sharks and trying to increase sales in the competitive day-to-day news business.

Shark stories however don't just have commercial appeal because of the public's voyeuristic sentiment to be entertained but also because hand in hand with the fear of sharks comes a thirst for information to control and rationalize that fear.

The public relies on the media not just for entertainment but for facts about sharks and shark safety and the media therefore have certain responsibilities when it comes to providing the public with news and information concerning sharks and shark bites. The media must ensure that its content are factually correct, non-sensationalistic and objective in nature since as it is difficult if not nearly impossible for non-specialists to separate scientific facts from science fiction. However especially in the daily newspaper and TV news sectors the media often fails in its responsibilities by reporting incorrect information, elevating non-qualified people and their opinions to expert status, listing theory as fact and perpetuating shark myths and over exaggerating the sense of threat from shark bites. There are of course exceptions and the shark stories penned by the environmental reporters of two Cape newspapers are often a model of balance and scientific accuracy, offering the occasional voice of reason amongst sensational media broadcasting.

It is unfair to lay all the blame squarely on the side of the media as there are also some shortcomings on how shark scientists, conservationists, government officials and NGO's deal and interact with the media concerning sharks and in particularly shark bites. At present there is no coordinated communication response in place to follow in the wake of a shark bite. Coordinated expert support and opinion is essential in order to facilitate a climate where the media can play a valuable and critical role. The shark research community and all others involved in shark matters must support the media with their knowledge and experience, so it can live up to the critical role that it should play in communicating accurately on shark related

issues to the public. While at present some scientists are doing a sterling job in keeping the media informed, some have grown synical of newspapers and TV documentaries after having been misquoted or having had their words twisted to further a hidden agenda. Having retired into the shadows of popularizing sharks, they now voice their much needed expert opinion only in scientific forums.

3. Key recommendations

- ***Shark Seminars for the Media***

  Reporters from all newspapers, radio and TV networks that regularly report on South Africa's sharks and shark bites should be invited to attend a shark seminar prepared and conducted by recognized experts. The seminar should incorporate but not be limited to topics such as shark behaviour, ecology, shark bites and shark conservation. Its primary role should be to assist in providing media professionals with the essential background knowledge needed in order for them to strive for greater accuracy in their reporting duties.

- ***Sharks and Shark Bite Media Handbook***

  An attractive and visually interesting shark and shark bite handbook should be created by recognized experts and include similar topics as the above suggested seminar. This would allow media professionals to have important facts and figures always close at hand, i.e. the number of and trends in shark bites, diet of sharks, white shark tourism legislation, facts about cage diving and chumming, recent relevant research results, etc. In order to maximize its potential it should be distributed frequently to all relevant media outlets.

- ***Approved List of Shark Experts***

  Great benefit would be derived from the creation of a list of recognized shark experts willing to interact with the media on a regular basis, summarizing their field of specialities, publications and contact details. This would enable media outlets to quickly contact reputable experts for advice and with questions. At present people with little knowledge or no qualifications are too often quoted as the relevant experts.

- ***Encourage Reporting of Non-Shark Bite Stories***

  Stories that report on sharks in a positive way should be encouraged and solicited by all sectors of the shark research and conservation community. NGO media liaison officers and scientists alike should regularly feed newspapers, radio and TV stations with engaging stories about shark research and shark conservation. This was for example very successfully done in 2005 by Marine and Coastal Management, the Wildlife Conservation Society and the White Shark Trust by creating an international media buzz concerning the double ocean crossing of a tagged great white shark "Nicole" from South Africa to Australia and back.

- ***Use Shark BITE instead of ATTACK***

  A "shark attack" is usually defined as any incident in which a shark initiates an aggressive or inquisitive behaviour towards a human and in which physical contact occurs. In the dictionary the entry under the word attack reads*: A violent attempt to hurt***.** This definition is only accurate for a small minority of shark incidents and just plain misleading in the rest. The term "shark attack" confounds people's fears and is inappropriate in this day and age of environmental enlightenment. Examining records of injuries caused by other animals, it was found that most are listed as bites and not attacks, i.e. dog bite, snakebite and not spider attack or monkey attack. The use of the word bite instead of attack in all documents and communications authored by shark scientists, NGO's and the government would go a long way in beginning to set a trend for less emotive sensationalism in the media's reporting about sharks.

- ***Promote the Sensitive use of Photographs***

  More often than not it is not staff news-photographers who supply specialized images (e.g. of sharks) to go with the text in newspapers and magazines. Images are most frequently sourced from freelance photographers, shark scientists, NGO's or shark tourism operators. Nonetheless too often have inappropriate images of white sharks with bloody gaping jaws been a feature on the front pages with the sole aim of selling papers. Most individuals with suitable shark photographs label themselves as shark conservationists and should therefore be encouraged to shy away from licensing images for uses that do not promote positive shark awareness and instead offer non-aggressive images. That means declining the occasional lucrative offer and insisting on having the mandatory right of approving the text in the photographs caption.

For further information:

City of Cape Town
7th floor, 44 Wale Street, Cape Town, 8001
PO Box 16548, Vlaeberg, 8018
Tel: 021 487 2284
Fax: 021 487 2255
www.capetown.gov.za

WWF South Africa
Millennia Park
16 Stellentia Avenue, Stellenbosch
Private Bag X2, Die Boord, 7613
Tel: 021 888 2800
Fax: 021 888 2888
www.wwf.org.za

Department of Environmental Affairs & Tourism
Marine & Coastal Management Branch
Foretrust Building, Foreshore, Cape Town, 8001
Private Bag X2, Roggebaai, 8012
Tel: 021 402 3911
Fax: 021 402 3364
www.environment.gov.za

Acknowledgements:
The City of Cape Town, the WWF Sanlam Marine Programme and the Department of Environmental Affairs & Tourism (DEAT) wish to thank the following organizations for their invaluable contribution to this process: AfriOceans Conservation Alliance (AOCA), BirdLife South Africa, Western Cape Department of Environmental Affairs and Development Planning (DEA & DP), Iziko SA Museum, Natal Sharks Board, National Sea Rescue Institute (NSRI), South African National Parks Board (SANParks), Western Province Lifesaving, White Shark Trust, University of Cape Town, University of Pretoria.

Citation:
Nel D.C. & Peschak T.P. (eds) 2006. Finding a balance: White shark conservation and recreational safety in the inshore waters of Cape Town, South Africa; proceedings of a specialist workshop. *WWF Report Series – 2006/Marine/001.*

For further information about Thomas P. Peschak, photographs of great white sharks or other African marine subjects go to www.currentsofcontrast.com or e-mail: tpeschak@iafrica.com.