

Beach visitors' perceptions of shark hazard mitigation in South Africa: Implications for shark conservation

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Declaration

I, Jealandri van der Westhuizen, identity number 9603180278089 and student number 26035588, hereby declare that this research submitted to the North-West University, for the master's dissertation: Beach visitors' perceptions of shark hazard mitigation in South Africa: Implications for shark conservation, is my own independent work and complies with the Code of Academic Integrity, as well as other relevant policies, procedures, rules and regulations of the North-West University; and has not been submitted before to any institution by myself or any other person in fulfilment of the requirements for the attainment of any qualification.



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Abstract

Sharks are very important species in the marine ecosystem; however, they face several threats. One of these includes lethal shark hazard mitigation. Shark hazard mitigation strategies are normally adopted on popular recreational beaches around the world to prevent encounters of humans with sharks in the water. Beach visitors (ocean users and non-users) are the user group directly affected by this management technique. It is necessary to understand their perceptions of sharks and shark hazard mitigation, as this can have implications for shark conservation. The goal of the present research was partly to address this very necessity. Three objectives were set for this purpose. These were to conduct a literature study in relation to the goal of the study, which focussed on different topics related to sharks, human-shark interactions, shark hazard mitigation, and the depiction of sharks by the media (shark framing); to perform quantitative research on beach visitors' perceptions of sharks and shark hazard mitigation, paying attention to the socio-demographic and geographic variability of perceptions; and to use the results to make useful recommendations concerning management of recreational beaches and, importantly, concerning shark conservation. The study was conducted in South Africa, which is known for adopting lethal and non-lethal shark hazard mitigation strategies on popular recreational beaches. The study followed a quantitative, descriptive, non-experimental design using a structured questionnaire as the measuring instrument, targeting 1 138 people visiting five beaches in South Africa. The beaches adopted lethal, non-lethal and sporadically non-lethal (mixed) shark hazard mitigation strategies. The questionnaire comprised mainly close-ended questions on demography, water use, and perceptions of sharks, human-shark interactions, shark hazard mitigation and shark framing. The data collected were captured in Microsoft Excel and then analysed using Statsoft Statistica and IBM SPSS. The results showed that perceptions of sharks and shark hazard mitigation varied across different socio-demographic groups (variation was assessed using descriptive statistics, correlations (r_s) and, t -tests). They also showed that perceptions of sharks and shark hazard mitigation varied geographically (variation was assessed using descriptive statistics, cross tabulations, and ANOVAs), and that this geographic variation tended to reflect the type of shark hazard

mitigation adopted at specific beaches under study. A factor analysis performed on Likert-scale items from the questionnaire identified three categories of beach visitors' perceptions (factors) including: Knowledge (of sharks), Media (framing), and Interactions (human-shark). Overall, the results confirmed that beach visitors had positive attitudes towards sharks and, while perceptions of shark hazard mitigation were variable, visitors could be disposed to favour strategies to mitigate encounters with sharks that are non-invasive to sharks. The recommendations of the study are made for recreational beach managers, scientists, academics, practitioners, decision makers, the government, the media, and the general public with a focus on beach visitors. Some important recommendations include more and better education of recreational beach users concerning sharks and concerning the detrimental effects of lethal shark control on these vulnerable yet ecologically critical species; and the promotion of non-lethal shark control to preserve recreational popularity of beaches.

Keywords: Human-wildlife conflict, Shark hazard mitigation, Perception, Conservation, Beach visitor, Media framing, Human-shark interaction.

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List of Acronyms

CA	Correspondence analysis
CEFA	Confirmatory exploratory factor analysis
Cohen's <i>d</i>	Practical effect size
EFA	Exploratory factor analysis
FAO	Food and Agriculture Organization of the United States
GDP	Gross Domestic Product
ISAF	The International Shark Attack File
IUCN	International Union for Conservation of Nature
KMO	Kaiser-Meyer-Olkin
KZN	KwaZulu-Natal
KZNSB	KwaZulu-Natal Sharks Board
MPA	Marine Protected Area
NMBT	Nelson Mandela Bay Tourism
NSRI	National Sea Rescue Institute
NSW	New South Wales
<i>p</i>	Probability
POD	Personal Oceanic Device
<i>r_s</i>	Spearman's rank order correlation
USA	United States of America
WWF	The World Wide Fund for Nature
χ^2	Chi-square

Chapter one

INTRODUCTION AND PROBLEM STATMENT

1.1 INTRODUCTION

Wildlife and people increasingly interact under many different circumstances. This interaction causes a human-wildlife conflict. Human-wildlife conflict is considered a serious conservation threat, whereby humans influence wildlife negatively and wildlife influences humans negatively, in a *vice versa* situation (Draheim, Madden, McCarthy & Parsons, 2015:3). If the conflict is resolved, people and wildlife are expected to live in harmony with each other, supporting conservation and coexistence.

One of the human-wildlife conflicts most contemporarily discussed is the human-shark conflict (Neff, 2012:89). Indeed, the world today faces a great challenge linked to the relationship between humans and sharks. Human-shark interactions, as well as the way they are viewed by the media and the public, have had an intense influence on policy decisions and shark conservation management (Apps, Dimmock, Lloyd & Huveneers, 2017:327; Neff, 2014:107). The human population has been growing and the majority of people live in coastal areas, which are attractive both as habitat and as spaces for recreation and leisure (Creel, 2003:1). Beaches have become overpopulated with visitors and residents, increasing the likelihood of interactions between humans and sharks, and adding pressures on governments to act in support of bather protection programmes that can be detrimental to sharks (Dickman, 2010:458).

Additionally, sharks already face some threats from anthropogenic activities including overfishing, bycatch, pollution, and habitat removal (Sutcliffe & Barnes, 2018:27). These threats are causing changes in shark population parameters and can lead to the extinction of shark species (Simpfendorfer, Heupel, White & Dulvy, 2011:518). The effects of such changes would have implications for ocean ecosystems as well as “human” ecosystems. Many shark species take up an apex predatory position and help in stabilising the marine ecosystem, for example by removing the weak species and indirectly maintaining habitats such as coral reefs and seagrass (Stevens, Bonfil, Dulvy & Walker, 2000:477). Removing or losing sharks would imply cascade effects, which would ultimately influence the status of fisheries on which human populations

depend for subsistence (Shark Savers, 2019). Additionally, the loss of sharks would affect the revenue of local economies relying on tourism, given the recent economic value attributed to sharks as a non-consumptive tourism product globally (Vianna, Meekan, Rogers, Kragt, Alin & Zimmerhackerl, 2018:223).

The way governments and decision makers tend to handle the risks of human-shark interactions and their potential conflicts is adding pressure to an already escalating situation, which jeopardises the future of shark species globally (Sabatier & Huveneers, 2018:338). Indeed, efforts to solve these conflicts have been mostly prioritising human needs and placing shark conservation second (Neff & Yang, 2013:68). These interventions, from here on referred to as shark hazard mitigation, have come in disparate forms, but have been primarily characterised by lethal control of sharks through the use of nets, baited hooks (drumlines), and active culling (Neff & Yang, 2013:545). There are, however, other forms of shark hazard mitigation, which do not involve shark fatalities. These include shark spotting and the use of electrical shark repellents, drones, helicopters and boats (Simmons & Mehmet, 2018:111; Engelbrecht, Kock, Waries & O'Riain, 2017:1).

Shark hazard mitigation and, more specifically, lethal mitigation is characterised by much controversy, which is discussed in the literature background. The primary issue at hand is that lethal shark hazard mitigation defies the very idea behind solving human-shark conflicts, as the solution involves procedures that do not lead to a win-win situation for people and sharks, but uniquely benefit people (Neff & Yang, 2013:68). Additionally, shark hazard mitigation is often adopted on the basis that this is what the public demands to feel safe, while this may not be the case (Pepin-Neff & Wynter, 2019:93). The media also play a role in the treatment of sharks. According to Sabatier and Huveneers (2018:340), the negative portrayal of sharks through the media influences the government and different policies. Gray and Gray (2017:288) state that government policies are driven by media portrayals and do not focus on the facts. Another element of controversy is how governments are enabled to override jurisdiction, which is set in place to protect sharks, so that lethal shark control can be implemented (Gibbs & Warren, 2015:126). Finally, lethal shark hazard mitigation methods also target other species such as sea turtles and rays as bycatch (Oliver, Braccini, Newman & Harvey, 2015:56). This is a cause of great concern as other species are also at risk.

The importance of human dimension research aimed at enhancing shark conservation has been highlighted in recent research gap analyses performed and published by top shark scientists around the world (Huveneers, Apps, Becceri-Garcia, Bruce, Butcher, Carlisle, Chapple, Christiansen, Cliff, Curtis & Daly-Engel, 2018:2; Gallagher, Vianna, Papastamatiou, Macdonald, Guttridge & Hammerschlag, 2015:366). Scientists have been advocating the

necessity of carrying out human dimensions research for four main purposes (Neff, 2014:68). First, to voice true public attitudes towards sharks and their conservation to inform policy. Second, to understand and address the complex nature of human dimensions of sharks and their management. Third, to explain the factors that influence public knowledge and opinion. Last, to design and test ways to steer and shape public opinion in favour of shark conservation. Research examples show that, generally, people respect sharks and take responsibility for their actions in the water even after being affected by a shark-related incident (Neff & Yang, 2013:65). Other research (Pepin-Neff & Wynter, 2018b:222) shows that some important attitudes like fear or perceived intentionality of shark bites can negatively shape public opinion of sharks and their conservation, but can also be mitigated easily by knowledge and pride. Acuña-Marrero, De La Cruz-Modino, Smith, Salinas-De-León, Pawley & Anderson (2018:122) stated that the complexity of human attitudes, and what influences these attitudes, should be better understood to foster support for the conservation of sharks. For instance, attitudes towards sharks may be similar across different socio-demographic parameters or may be multifaceted among different populations, with important implications for shark conservation management.

The purpose of this study was to contribute to the growing body of knowledge regarding human dimensions research on sharks and shark hazard mitigation to give support to shark conservation. In particular, this study assessed beach visitors' perceptions of sharks and shark hazard mitigation, how these are affected by socio-demographic and geographic factors, and what the implications are for shark conservation and for shark hazard mitigation. By perceptions, the research referred to factors including knowledge, attitude, and self-reported behaviour. When referring to beach visitors, this study covered a sphere of tourism including day visitors and overnight visitors to beach localities, although local residents are also included (Lucrezi & van der Walt, 2016:84). This study selected South Africa as the theatre of the research, considering that the country hosts important shark species (e.g. great white sharks, tiger sharks, ragged toothed sharks), that have been affected by human-shark interactions and shark bite incidents, and that it implements a mixture of shark hazard mitigation strategies including lethal and non-lethal (Engelbrecht *et al.*, 2017:1; Neff & Yang, 2013:545; Cliff & Dudley, 2011:700). This study specifically targeted people who are likely to engage in water-based activities, with the possibility of encountering sharks, and are affected by any locally implemented shark hazard mitigation strategy (Fraser-Baxter & Medvecky, 2018:109; McPhee, 2014:478; Neff, 2012:88).

The following section provides a background to this research, by expanding on the main topics under consideration, and describing the case study.

1.2 BACKGROUND TO THE STUDY

1.2.1 Threats to the oceans and sharks

Oceans are facing a great number of threats that are hindering the proper functioning of the ecosystems. The World Wide Fund for Nature (WWF) (2017) has identified eight major threats. The first one is unsustainable fishing. The second threat is climate change, which causes ocean acidification, sea level rise and coral bleaching. The third threat is shipping. Oceans today are used to ship products all over the world. This places enormous stress on the oceans as they experience oil spills, the discarding of biocides as well as anchor damage. The fourth threat is inadequate protection. This means that the oceans are not sufficiently protected and sensitive habitats are put at risk. The fifth threat is aquaculture. People are farming fish and shellfish, which damages the ecosystems. The sixth threat is gas and oil. The reserve below the ocean floor which provides gas, oil and other minerals requires drilling to access these resources. The seventh threat is the growing tourism sector. More people tend to visit the coastal areas and offshore areas, which places enormous stress on the oceans. The final major threat is pollution. The presence of more people on the coastal areas leads to more litter on beaches, sewage flow into the oceans as well as toxic chemicals entering the ocean.

Based on this, sharks are facing important threats, as a consequence of increasing pressures on ocean ecosystems (Jabado, Kyne, Pollom, Ebert, Simpfendorfer, Ralph, Al Dhaheri, Akhilesh, Ali, Ali & Al Mamari, 2018:1046). Sharks are biologically vulnerable and are being exploited mainly through fishing. They are not able to endure the prolonged periods of exploitation, as they grow very slowly and breed late in their lifespan (Simpfendorfer *et al.*, 2011:518). Sharks are also immensely popular in fin trading. Their fins are cut off to make soup, with shark fins being the most exclusive seafood product (Buckley & Hile, 2007:21). Sharks are often caught as bycatch (Buckley & Hile, 2007:29). Sharks are additionally threatened by sub-sea cables (Gopnik, Fieseler, Cantral, McClellan, Pendleton & Crowder, 2012:1143). There are several communication cables on the ocean floor that produce electric and magnetic fields. This can affect a shark's behaviour. Finally, sharks are targeted in bather protection programmes (shark hazard mitigation) using nets, drumlines, and culling (Philpott, 2002:455). The threats that sharks are facing should be of great concern, as sharks are top predators in the food chain and serve a unique ecological function (Bornatowski, Navia, Braga, Abihoa & Corrêa, 2014a:1588).

1.2.2 Beach tourism and its relation to shark hazard mitigation

Coastal and marine tourism are among the fastest growing types of tourism and are associated with an increasing number of tourism facilities and tourists (Liu, Liu, Zhang, Qu & Yu, 2018:63; Chen & Bau, 2016:88). Beach tourism is a relatively modern form of tourism which falls under coastal and marine tourism, and only became notable in the 19th century (Picken, 2018:2). Beach tourism is extremely important to many marine and coastal regions as it offers substantial potential for employment and economic growth (Dwyer, 2018:302). Klein and Dodds (2018:40) stated that beach tourism allows for more leisure and recreation, and is therefore a vigorous component of economic growth.

Since beach tourism makes a significant economic contribution to tourist destinations and coastal economies, it becomes very important for the relevant local authorities to understand and manage the factors affecting beach environments and the trends of beach tourism (Chen & Bau, 2016: 88).

Human-shark conflicts have been discussed in the contexts of what they could imply for beach tourism in various countries such as Australia, the USA, and South Africa (Hammerton & Ford, 2018:287). Many shark bite incidents have involved beach visitors using the ocean for activities like surfing and swimming, and the perception of managers and governments has been that the occurrence of shark bite incidents would need to be prevented or counteracted with actions (Pepin-Neff & Wynter, 2018a:6). These actions have included the implementation of shark hazard mitigation, justified by the need to protect tourism assets (Cliff & Dudley, 2011:700).

1.2.3 The history of human-shark conflicts and shark hazard mitigation

The history of the human-shark conflict is complex and dates back to the times of ancient Greek mythology and Biblical accounts, where sharks are described as sea monsters with impenetrable armours and fearsome teeth (Mojetta, Travaglini, Scacco & Bottaro, 2018:31). Another important historical conflict has also been between sharks and fishers, who would see sharks not only as a fishing product but also as a fishing competitor (Glaus, Adrian-Kalchhauser, Piovano, Appleyard, Brunnschweiler & Rico, 2019:252).

When looking at the most recent history, especially following World Wars I and II, it is easy to understand that an increasing use of the coast and the oceans for habitat, tourism and recreation has contributed significantly to increasing the chance of human-shark interactions (Hammerton & Ford, 2018:284; Thompson, 2016:47).

An increase in the number of shark bite incidents over recent decades has led to the creation of a new conflict, which has been greatly discussed in previous literature and in the media (Sabatier & Huveneers, 2018:338). What appears to have exacerbated this conflict and its consequences is the coming of a new era for the media, embodied by the “Jaws” movie series of 1975 (Neff, 2015:115). The movie series criminalised sharks and sparked awareness and fear of human-shark interactions. Shark bite incidents gained attention amongst people and in the media, leading to a public outcry for bather protection. Governments then started to act by introducing the first types of shark hazard mitigation, which tended to be lethal to sharks (Fraser-Baxton & Medvecky, 2018:110; Thompson, 2016:46; McCagh, Sneddon & Blache, 2015:271).

Today, lethal shark hazard mitigation is still implemented across some locations globally, such as Australia, Russia, Reunion, the USA, Mexico, Egypt, Seychelles, and South Africa (Neff & Yang, 2013:545). This type of mitigation continues to exist, despite mounting evidence of its dubious efficacy, as well as growing opposition on behalf of scientists, conservationists, and members of the public (Hammerton & Ford, 2018:276).

1.2.4 The role of the media in shaping public opinion and government decisions on shark hazard mitigation

The media have been held responsible for having a negative influence on shark conservation, by influencing public opinion of sharks and government decisions to implement lethal shark hazard mitigation (Muter, Gore, Gledhill, Lamont & Huveneers, 2013:188). This happens through negative framing, which is a process whereby the media tell people how to think and act about a certain topic (Sabatier & Huveneers, 2018:339). In a content analysis of media, Muter *et al.* (2013:188) found that the news reports tend to highlight the risks that sharks present for humans, despite the fact that sharks are facing the risk of extinction, mainly due to human impact. O’Byrhim (2009:22) also found that the media play a vital role in creating negative perceptions and attitudes towards sharks and stated that there should be a clear line between fact and fiction. The media often see sharks as “man-eaters” and killers, arguing that ocean users are at risk.

Gibbs (2018:216) claimed that when a shark bite incident or even a shark sighting occur, an intense debate arises on social media as well as in traditional media such as newspapers. False information is prominent in and worsened by the media. This deceives people and can be a reason why humans end up forming a negative perception of sharks. Gibbs (2018:217) also stated that, when a human-shark interaction takes place, the media place sharks in a negative

light, describing them as aggressive animals. Media coverage about shark bite incidents can lead to a reduction in beach use for tourism and recreation (Gibbs & Warren, 2015:120). This latter issue has been moving governments to implement lethal shark control to protect tourism, which is a source of income for coastal economies (see Section 1.2.2). Whether the media have had a significant influence on policy and government decisions concerning sharks is a complex matter. However, it has been suggested that government actions aiming to protect ocean users from sharks have been founded on media spurs (Muter *et al.*, 2013:189). Nevertheless, recent research has shown that the media are slowly changing their narratives, focussing more on ecocentric ones that support shark conservation (Frazer-Baxton & Medvecky, 2018:117; Sabatier & Huveneers, 2018:342). This supports the onset of a so-called “Save the Sharks” movement, involving a shift in public opinion of sharks (Pepin-Neff & Wynter, 2019:87).

1.2.5 The importance of human dimension research

Research is still growing to understand public perceptions concerning sharks and shark hazard mitigation, and how these vary according to different parameters (Simpfendorfer *et al.*, 2011:518). Research on public perceptions, which can include knowledge, attitudes and behavioural aspects, is very important as it can inform decisions and policies regarding the protection of sharks and the solutions of the human-shark conflict in a win-win way (Pepin-Neff & Wynter, 2019:88). Some of the research carried in the last three years and focussing on human dimensions of sharks and shark hazard mitigation is displayed in Table 1.1.

Table 1.1: Examples of public opinion research on shark hazard mitigation conducted in 2017-2020

Author(s), Year & Country	Main aim	Main Findings
Gray & Gray (2017), Sydney, Australia	“Better understanding public, and most importantly, beach and ocean user attitudes to shark bite mitigation strategies for incorporation into the development of socially acceptable government policies concerning human wildlife interactions.”	• Most beach visitors are aware of shark nets at the beaches under study. • There is a strong support for the use of nets amid those who were interviewed.
Pepin-Neff & Wynter (2018a), Ballina & Perth, Australia	“Understanding public attitudes immediately following shark bites.”	• Majority of communities prefer non-lethal policies. • Communities believe that shark bites are accidental.
Pepin-Neff & Wynter (2018b), Australia	“Investigating the relationships between fear, perceived intentionality, attitudes to and perceptions of sharks	• More and quicker information about a shark bite incident, provides ways to convey the information to

	and shark behaviour, and policy preferences.”	more people. • Low levels of blame and high levels of pride were found.
Sabatier & Huveneers (2018), Australia	“Understanding media coverage of wildlife-related risk.”	• Negative media framing of wildlife behaviour occurs, affecting human perception and attitudes. • Most humans rely on media to determine the risk of interactions.
Fraser-Baxter & Medvecky (2018), New South Wales, Australia	“Investigate the media's reporting of public and political responses to human-shark interactions in N.S.W in 2015”	• Media discourse was ecocentric and not sensationalized. • Public's perceptions are evolving, and lethal mitigation is less justified.
Acuña-Marrero <i>et al.</i> (2018), Galapagos	“Understanding human attitudes towards sharks.”	• Attitudes are complex and variable. • Aesthetic values influenced attitudes towards sharks the most.
Pepin-Neff & Wynter (2019), Australia	“Demonstrating that feelings of pride toward sharks can serve as an opposing force to fear.”	• High levels of pride, low levels of fear are found among people. • People with high levels of pride, support shark nets.

Source: Author's own compilation

The table only shows some of the research done in the last three years as this period has seen a rapid increase in the number of publications on the matter, particularly in response to lethal shark control policies implemented in Western Australia. The research has been focussing mostly on assessing whether lethal shark control has public support. The main findings point to a lack of support for lethal shark control among the public (Table 1.1). However, it is understood that public perceptions of sharks and shark hazard mitigation are likely to be affected by important variables. These can include the socio-demographic background of people, uses (e.g. water user *versus* non-user, surfers *versus* divers, fishers *versus* tourists), and other contextual factors (Simmons & Mehmet, 2018:112; Crossley, Collins, Sutton & Huveneers, 2014:115). Understanding the influence of these factors on public perceptions is critical to design the proper strategies of communication, education, and management concerning sharks and shark hazard mitigation (Huveneers *et al.*, 2018:8).

1.2.6 South Africa: a case study offering insight

South Africa is a hotspot for shark conservation. It was the first country protecting the great white shark (*Carcharodon carcharias*) in the 1990s (Wintner, 1999:153). South Africa is also one of the top countries affected by human-shark interactions and shark bite incidents

(Chapman & McPhee, 2016:80). In turn, South Africa was the first country to successfully implement revolutionary methods of shark hazard mitigation, like the Shark Spotters programme and shark exclusion nets (Neff, 2014:115; Kock, Titley, Petersen, Sikweyiya, Tsotsobe, Colenbrander, Gold & Oelofse, 2012:448). Today, South Africa hosts different shark hazard mitigation programmes, both lethal and non-lethal, mainly including shark nets and baited hooks in KwaZulu-Natal (KZN), historically managed by the KwaZulu-Natal Sharks Board (KZNSB), and Shark Spotters in the City of Cape Town, although other methods are used in other locations, depending on the circumstances (Engelbrecht *et al.*, 2017:2; Cliff & Dudley, 2011:700). South Africa has different legislations in place such as the “Animal Protection Act”, the “Marine Living Resource Act” and the “National Environmental Management Act” to help regulate shark hazard mitigation (Department of Environmental Affairs, 2015).

What is noteworthy is that the variability of shark hazard mitigation methods in South Africa could have a heterogeneous effect on the awareness, understanding, opinion and support among ocean users concerning sharks, their conservation and shark hazard mitigation. In turn, this heterogeneity could have important implications for the management of shark conservation and shark mitigation in South Africa, but also globally. An example is provided by a study of ocean users in the City of Cape Town, which demonstrated that the area where non-lethal shark control is implemented is characterised by strong public pride in the local shark population, which remained unchanged even after a fatal shark bite incident (Neff & Yang, 2013:65). However, research in South Africa that takes advantage of the wide scope of mitigation types used at different geographic locations remains limited, mostly to review papers (e.g. Chapman and McPhee, 2016; Neff, 2014; Philpott, 2002).

1.3 PROBLEM STATEMENT

The oceans today face important challenges, such as global climate change, the reduction of water quality and the extinction of species (Chapman & McPhee, 2016:72). Sharks play an important role in maintaining the stability of marine ecosystems (Garla, Freitas, Calado, Paterno & Carvalho, 2015:128). However, shark species are threatened and their populations are rapidly declining due to human impacts from overfishing and bycatch to pollution (Bornatowski, Braga & Vitule, 2014b:12).

Coastal areas are overpopulated and overdeveloped, as a result of increased human populations globally and the increased appeal of coastal areas as destinations for leisure and recreation (Doody, 2004:129). The growing use of the coast for water-based activities such as surfing, fishing and swimming has amplified opportunities for accidental human-shark interactions resulting in incidents like shark bites. As a consequence, many governments

around the world have adopted protection programmes for beach visitors which are lethal to shark species. Such programmes have been implemented regardless of the threatened status sharks are facing and are surrounded by controversy from many points of view (Chapman & McPhee, 2016:72). Additionally, these programmes are often grounded on the presumption that the public demands their implementation, while this is not necessarily the case (Pepin-Neff & Wynter, 2018b:222). Indeed, many government decisions to act aggressively, for instance through shark culling programmes, are erroneously motivated by biased and sensationalised narratives provided by the media (Sabatier & Huveneers, 2018:340).

Scientists have advocated for research agendas that will shed light on the factual public perceptions of sharks, their conservation, and the management of shark hazard mitigation (Huveneers *et al.*, 2018:9). Pepin-Neff and Wynter (2018a:1) stated that it is important to understand public attitudes as they present real-time data, which can assist in shark conservation efforts. Understanding and unpacking the complexity of human perceptions of sharks and shark hazard mitigation are critical steps to solve the human-shark conflict constructively. Geographic, socio-demographic, attitudinal and behavioural components all represent factors to consider in assessing the variation of public attitudes towards sharks and their mitigation. In this regard, South Africa offers opportunities to address this multiplicity of factors against a backdrop of heterogeneous mitigation strategies. Beach visitors can be considered an effective target for this type of assessment, as they are likely to engage in water-based activities, and thus to be involved in various forms of human-shark interactions. These people are also affected by locally implemented shark hazard mitigation strategies.

Based on this argument, the following research questions were formulated:

- Do perceptions of sharks and shark hazard mitigation **vary** according to the **socio-demographic** profile of beach visitors?
- Do perceptions of sharks and shark hazard mitigation **vary geographically**, that is, across beach destinations using different shark hazard mitigation strategies?
- What are the possible **implications of any variation** in perceptions among beach visitors, for beach management and shark conservation management in South Africa?

1.4 GOAL OF THE STUDY

The following goal and underlying objectives were set for this study.

1.4.1 Goal

To assess the perceptions of beach visitors, including ocean users and non-users, with regards to sharks and shark hazard mitigation in South Africa.

1.4.2 Objectives

The following objectives are set for this study:

1.4.2.1 Objective 1

To conduct a literature (scholarly and web-based) study in relation to the goal of the study, focussing on the following topics: 1) the importance of ocean ecosystems, and global threats to the oceans; 2) the global importance of sharks and the threats they face; 3) the history of human-shark interactions and how humans have dealt with sharks; 4) the different types of interactions and shark bite statistics; 5) shark hazard mitigation types, their history and application; 6) beach tourism and its relation to shark hazard mitigation; 7) human perceptions of sharks and shark hazard mitigation, and the variation in perceptions according to socio-demographic, geographic, use, and external influences; 8) media treatment of sharks and their influence in shark management; and 9) human-shark interactions, shark hazard mitigation and public opinion research on sharks in South Africa.

1.4.2.2 Objective 2

To perform quantitative research – to answer the research questions. The research was based on data from questionnaires handed out to beach visitors at five selected beaches. These are located in three South African provinces, KZN, Eastern Cape, and Western Cape, and use a mixture of shark hazard mitigation strategies.

1.4.2.3 Objective 3

To use the results of the quantitative research to draw up useful recommendations with regards to beach-based recreation in areas where interactions with sharks are possible, shark hazard mitigation, and shark conservation management in South Africa. These recommendations are intended for recreational beach managers, scientists, academics, practitioners, decision makers, the government, the media, and the general public, both in South Africa and globally, where applicable.

1.5 RESEARCH METHODOLOGY

1.5.1 Literature Study

The literature study was based on specific keywords, such as: “human-wildlife conflict”, “shark hazard mitigation”, “attitude”, “perception”, “conservation”, “media framing”, “behaviour”, “beachgoer/beach visitor”, and “human-shark interaction”. The literature study was completed by analysing different peer-reviewed articles, published dissertations, theses, books and book chapters, newspapers, online magazines, and various other academic and tourism-related resources. The resources mostly came from library collections and the internet. Scientific databases such as Google Scholar, Scopus, Science Direct, EBSCOhost and Web of Science assisted in finding the most recent, relevant information regarding the specific study. With the help of these sources, an analysis regarding the elements listed in Objective 1 was done and this is outlined in Chapter 2.

1.5.2 Empirical Research

The following section highlights the different aspects that assisted in conducting empirical research. This section is laid out in full in Chapter 3.

1.5.2.1 Research design and method of data collection

The research followed a quantitative, descriptive, and non-experimental design, using a structured questionnaire survey targeting people visiting various beaches as the measuring instrument.

1.5.2.2 Population

This study targeted visitors to selected beaches in South Africa. The choice of beach visitors as the target group in this study enabled the researcher to access active and potential recreational ocean users who may be affected by shark hazard mitigation. The research excluded other important groups that may be affected by shark hazard mitigation strategies, such as the fishing sector. However, the investigation of these groups was beyond the scope of this research, which rather focussed on the beach-based tourism and recreation management aspect of shark hazard mitigation.

Five beaches in three South African provinces were selected for this study (Figure 1.1), based on popular ocean-based activities, the presence of a variety of shark species in the area, previous human-shark interactions reported in the media, and local shark hazard mitigation strategies. Durban (KZN) and the City of Cape Town (Western Cape) host the best-known

shark hazard mitigation programmes in the country, namely the KZNSB (Durban) and Shark Spotters (City of Cape Town) (Engelbrecht *et al.*, 2017; Cliff & Dudley, 2011). The other three locations were in Jeffreys Bay (Eastern Cape), Port Elizabeth (Eastern Cape), and Mossel Bay (Western Cape). These locations sporadically implement a mixture of non-lethal shark hazard mitigation initiatives, such as aerial surveys and boat surveys, together with lifesavers.



Figure 1.1: Map of locations selected for this study. Credits: Google Maps

1.5.2.3 Development of measuring instrument

The questionnaire (Annexure A) used to collect data was developed on the basis of previous studies on the human dimensions of sharks and shark hazard mitigation (Gibbs & Warren, 2015; Crossley *et al.*, 2014; Friedrich, Jefferson & Clegg, 2014; Neff & Yang, 2013), although a number of questions were new. The questionnaire was structured to include questions on socio-demographic background, perceptions of sharks and shark hazard mitigation, and opinions regarding sharks, framing of sharks by the media, human-shark interactions, and shark hazard mitigation. More detail is provided in Chapter 3.

1.5.2.4 Sampling

This study used probability sampling, which is of great benefit because it guarantees fairness. The appropriate sampling technique for this study was simple random sampling. Beach-based sampling was done according to calculations on sample sizes and recommended beach survey quotas (Williams & Micallef, 2009:10). Sampling occurred over a series of fieldtrips between

2016 and 2018 both in the winter and summer months. More information about the sampling is provided in Chapter 3.

1.5.2.5 Data Analysis

The data collected from the questionnaire were first entered into Microsoft Excel. The data matrix was then moved to the software Statsoft Statistica (Version 13.2, 2016) and IBM SPSS (Version 26.0, 2019) which were used to analyse the data. Initially, descriptive statistics, breakdown statistics and frequency tables were used to describe the data. Following this analysis, various statistical methods were used to understand the data and answer the first two research questions. These included cross tabulations, Mann-Whitney U test, correspondence analysis (CA), exploratory and confirmatory factor analysis (EFA and CEFA), reliability tests, nonparametric correlations (r_s), t -tests, and ANOVAs (with post-hoc tests). For the t -tests and ANOVAs it was ensured that the data met assumptions of normality and homogeneity of variance. Using the main results of this study, an analysis of strengths, weaknesses, opportunities, and threats (SWOT) associated with beach visitors' perceptions of sharks and shark hazard mitigation was performed to help answer the third research question.

1.6 DEFINING THE CONCEPTS

The following concepts were used during the study:

1.6.1 Human-wildlife conflict

Torres, Oliveira & Alves (2018:421) describe the human-wildlife conflict as a conflict which occurs when the deeds of one animal have a destructive effect on the other. Draheim *et al.* (2015:3) support this definition and describe the human-wildlife conflict as a conflict which takes place when wildlife influences humans in a negative manner and *vice versa*. Human-wildlife conflict is also seen as a conflict which arises when the actions by wildlife or humans have an impact on each other (Guerra, 2019:369). Therefore, it is safe to describe the human-wildlife conflict as a conflict which may take place when humans and wildlife interact.

1.6.2 Shark hazard mitigation

Crossley *et al.* (2014:154) describe shark hazard mitigation as strategies in place to decrease the risk of encounters between humans and sharks. Williams and Micallef (2009:121) support this definition and describe shark hazard mitigation as the actions taken to reduce the possible damage caused by shark hazards. Thus, it can be said that shark hazard mitigation measures

are in place to reduce the contact between humans and sharks, to minimise certain hazards that can take place.

1.6.3 Perception

The Collins Dictionary (2019a) defines perception as the impression one has of something. Perception is also an opinion or belief held by people (Cambridge Dictionary, 2019a). Hatfield (2001:11202) supports this definition and describes perception as an awareness of something such as a business opportunity, a maths problem or even feelings and thoughts.

1.6.4 Conservation

Cambridge Dictionary (2019b) defines conservation as the protection of species or natural areas specifically from destructive activities. Conservation is also defined as actions that will increase the likelihood of species and habitats continuing in the wild (Leader-Williams, Adams & Smith, 2011:5). Sandbrook (2015:565) supports this definition and describes conservation as: “Actions that are intended to establish, improve or maintain good relations with nature.”

1.6.5 Beach visitor

The Collins Dictionary (2019b) defines beach visitor as a person who often visits the beach. Gibbs and Warren (2015:117) describe ocean users as people who make use of the ocean as part of their everyday lives. Beach visitors can include swimmers, divers, sunbathers, and surfers, among others.

1.6.6 Media framing

Entman (1993:111) defines media frames as a variable that influences public opinion and political decision-making. Framing is described as the way in which something is presented to a certain audience. This means that the media focus attention on certain topics and events. Media framing is thus how the media attract the public eye to specific subjects (Arowolo, 2017).

1.6.7 Human-shark interaction

Cambridge Dictionary (2019c) defines an interaction as an incident where two or more things connect with, communicate to, or respond to each other. Collins Dictionary (2019c) defines an interaction as a shared influence or encounter. A human-shark interaction is therefore when a

human and a shark connect, communicate, or respond to one another and where there is an encounter taking place.

1.7 ETHICAL CONSIDERATIONS

The following ethical considerations were applied to this study:

- 1) This study was approved by the Faculty of Economic and Management Sciences Research Ethics Committee (EMS-REC) at the North-West University under the ethics code **NWU-00403-19-A4**.
- 2) About the handling of the participants' data at any phase during this study, there was no occasion in which the identity of the participants had to be made known. All data were treated anonymously.
- 3) No sensitive data were requested throughout the research, respecting the privacy of the participants.
- 4) By agreeing to take part in the research, the objectives of which were always clearly outlined upon invitation, the participants provided informed consent and were free to leave the research at any moment by deciding not to complete a questionnaire survey. The data were handled according to national laws on privacy.
- 5) The data were managed by the researcher and by the promoter, and were also temporarily handled by the statistician, under the supervision of the researcher and the promoter. The data are stored within repositories which are accessible to the North-West University. The data will remain the property of the North-West University.

1.8 PRELIMINARY CHAPTER CLASSIFICATION

The study comprised of the following five chapters:

Chapter 1: Introduction, background, problem statement, goal and objectives of the study, methodology, definition of the key concepts, ethical considerations, preliminary chapter classification. This chapter gave a broad overview of the study and justified the research.

Chapter 2: Literature study. Themes covered included those listed under Objective 1.

Chapter 3: Materials and methods, including a detailed description of the locations studied, the research design, population and sampling, and data analysis. Study limitations were also discussed here.

Chapter 4: Results from the study, including a detailed description of the sample and all the data collected during the study. Tables and figures were also used to report the findings.

Chapter 5: Conclusions and recommendations. Conclusions were made based on the findings of the research. The focus was given to research on public perceptions of sharks and shark hazard mitigation, recommended policy and management changes, and recommended actions such as education. This section also included the SWOT analysis mentioned in the Methodology section of this proposal.

Chapter two

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this chapter was to conduct a literature review concerning specific topics relevant to the study. The topics include the importance of the ocean ecosystems and threats the faced by the oceans; the global importance of sharks and the threats they face; the history of human-shark interactions and how humans have dealt with sharks; types of human-shark interactions and shark bite statistics; types and history of shark hazard mitigation; beach tourism and its relation to shark hazard mitigation; research on human perceptions of sharks and shark hazard mitigation; the role of the media in portraying sharks and influencing shark management; and human-shark interactions, shark hazard mitigation and public opinion research on sharks in South Africa.

2.2 THE IMPORTANCE OF THE OCEAN ECOSYSTEMS AND THREATS TO THE OCEANS

The ocean ecosystem is the largest ecosystem on planet earth and is a life support system (Longo & Clark, 2016:464). Without healthy oceans, it would not be possible for any organism to survive and thrive. According to Bailey (2018:190), the oceans contain 97% of the water on earth and cover 70% of its surface. Oceans produce half of the oxygen that humans breathe, and a sixth of the animal proteins that humans eat (Marine Conservation Institute, 2019; Hazen, Scales, Maxwell, Briscoe, Welch, Bograd, Bailey, Benson, Eguchi, Dewar & Kohin, 2018:1). Bailey (2018:190) states that carbon dioxide is captured and stored by the oceans and, through this absorption, the impacts of climate change on the planet are reduced. Oceans also play a role in other biochemical cycles such as the nitrogen cycle (Furtado, 2019:221) and the hydrological cycle, as water is evaporated from the oceans and then deposited as rain (Costanza, 1999:199).

The productivity and diversity of the oceans are vital elements for all humans (Bennet, 2019:244). Van der Veecken (2017) claims that there are five reasons that the oceans are so important for humankind and other species on the planet (Figure 2.1). The first reason is that the oceans provide more oxygen than rainforests (Guest, Lotze & Wallace, 2015:102). It is often believed that the primary source of oxygen is rainforests. However, it is found that rainforests only provide approximately 28% of the oxygen on planet earth.



Figure 2.1: The importance of the oceans

Source: Witt, 2018

The second reason is that oceans regulate the earth's climate (Guest *et al.*, 2015:102). The oceans are responsible for absorbing the heat. The warm water is then transported to the poles, and the cold water is transported to the tropics. Without currents, there would be extreme weather in some regions. The oceans also regulate droughts and rain. The rain that the land gets comes directly from the oceans, and therefore the oceans are a global climate control system.

The third reason is that the oceans are an important source of food. Oceans account for 15.7% of animal protein (through fish species) that is consumed by people globally. Other species are also consumed which can lead to an even higher consumption rate (European Commission, 2012:8).

The fourth reason is that many jobs are created through the oceans (Guest *et al.*, 2015:102). About 59.6 million people are engaged in aquaculture and fisheries, and 90% of the trade around the world is dependent on the oceans (Food and Agriculture Organisation of the United States (FAO), 2018:5).

The final reason is that the oceans have therapeutic properties. Research shows that the blue spaces can reduce stress and improve one's mood. This can promote the wellbeing and health of humans (Finlay, Franke, McKay & Sims-Gould, 2015:98).

Despite all of this, very little is known about the oceans, and the benefits provided by the oceans are jeopardised by several threats, mainly originating from human impacts (Guest *et al.*, 2015:98). There are five principal threats faced by the oceans today. One is climate change (Kennedy, 2018; Brown & McLachlan, 2002:70). The ocean absorbs masses of heat that global warming generates. This results in sea levels rising as glaciers and ice sheets melt. Global warming also causes warmer ocean water, which tends to lead to more tropical storms. Rising temperatures destroy coral reefs and other marine ecosystems due to oxygen deprivation. This results in the growth of more algae and parasites and in the extinction of species that live in these ecosystems (Warner & Schofield, 2012:2-4).

The second threat is pollution. Pollution is a broad term and is seen as any substance that is present in the environment and has a harmful effect. There are several types, such as thermal pollution, plastic pollution, oil pollution, and underwater noise pollution. Thermal pollution takes place when factories discharge waste into the ocean that has a very high or very low temperature. Small changes to the ocean temperature lead to thermal shock to marine life. Changes in ocean temperature lead to migration of species, oxygen depletion and slower metabolism in species (Mihaylo, 2019; Brown & McLachlan, 2002:67).

Another prominent type of pollution in the oceans is plastic pollution. Jambeck, Geyer, Wilcox, Siegler, Perryman, Andrady, Narayan & Law (2015:768) claim that 2.5 billion tonnes of waste were generated by 192 countries bordering the ocean in 2010. Of these, 275 million tonnes were plastic, and approximately 31.9 million tonnes were coastal plastic waste. Yearly, an estimate of 8 million tonnes of plastic enter the ocean (Figure 2.2). Much of this plastic is ingested by species such as turtles, fish, and seabirds. Species eat this plastic debris which then causes deferred ovulation, reproductive failure, lowered steroid hormone levels and a blockage in the gastric systems (Derraik, 2002:845). Plastic is not biodegradable, which causes microplastics to be released into the food chain over time. Plastic also contains chemicals that

absorb pesticides and other contaminants, which are harmful to species (GESAMP, 2015:49). Plastic settles in sediments where it “lives on” for years to come.



Figure 2.2: Statistics of plastic pollution

Source: McCauley, 2018

The oceans are used as a route to ship products and people from one country to another. As a result of vessel incidents at sea, oil spills can take place (Mambra, 2017; Brown & McLachlan, 2002:67). Oil spills have a great number of negative effects on fish species and can lead to enlarged livers, reduced growth, fin erosion and changes in heart rates.

Underwater noise pollution from oil rigs causes species to migrate, it reduces the ability of species to communicate with each other and to hear cues that are needed for survival, and it disrupts the species' reproductive patterns (Iverson, Fisk, Hinch, Mills Flemming, Cooke & Whoriskey, 2019:5; National Ocean Service, 2018; Mambra, 2017).

The third threat that the oceans are facing is overfishing (Figure 2.3). Overfishing is the term used when species are taken from the ocean at a higher rate than that of reproduction (Hilborn & Hilborn, 2012:3). Overfishing limits the proficiency of fisheries and reduces the diversity of fish species (Kennedy, 2018; Costanza, Andrade, Antunes, Van Den Belt, Boesch, Boersma, Catarino, Hanna, Limburg, Low, Molitor, Pereira, Rayner, Santos, Wilson & Young, 1999:177). This causes species to become extinct.

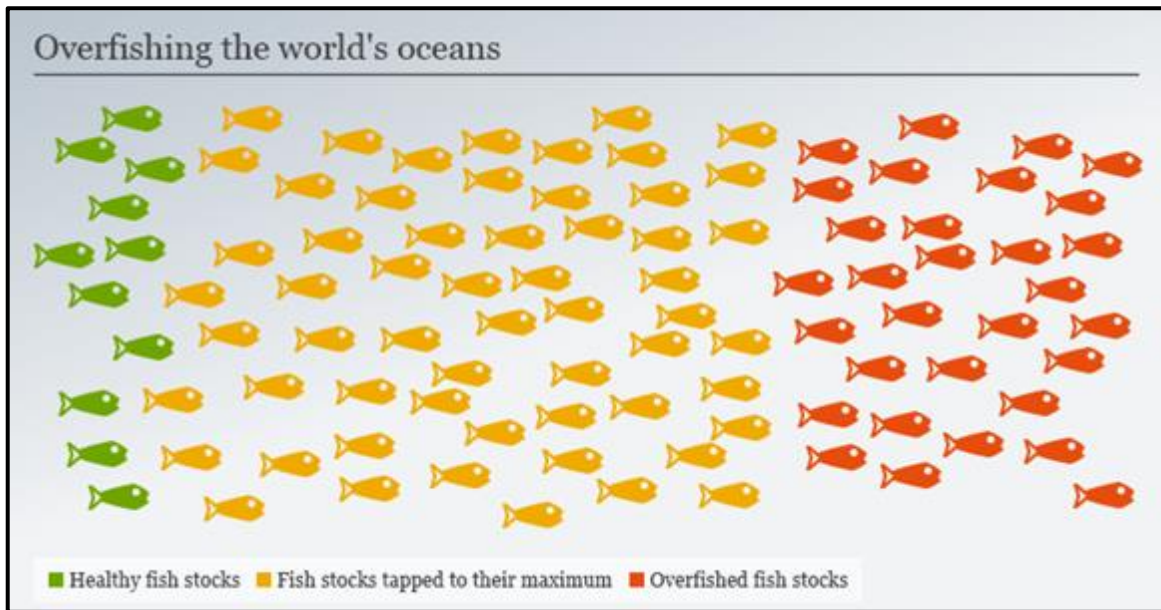


Figure 2.3: Overfishing
Source: Osterath, 2017

The fourth threat faced by the oceans is the growing tourism sector. According to Doody (2004:129), more people tend to visit coastal areas and offshore areas, and people start new housing developments along the receding coastlines, so they also tend to visit these areas frequently. This phenomenon causes the coastlines to be locked into what is called a coastal squeeze, with pressures from land (development) and pressure from the sea (sea-level rise). This results in the loss of habitats, wildlife disturbance, and pollution due to littering and wastewater discharge, among other effects (Kennedy, 2018; WWF, 2017).

The fifth and final threat is the poaching of marine species. Poaching is the illegal harvesting of animals (Willson & Clarke, 2019:126). This results in the loss of species that cannot reproduce fast enough (Willson & Clarke, 2019:126; Bergseth, Gurney & Cinner, 2018; Kennedy, 2018).

In essence, the oceans play a crucial role in the existence of species, although they also face a series of important threats (Table 2.1) which can jeopardise their functioning and the survival of species.

Table 2.1: Threats the oceans are facing and the consequences thereof

Threat	Consequence
Climate Change	• Sea level rise • Rising temperature • More tropical storms • Less oxygen

	• Loss of ecosystems
Pollution	• Loss of ecosystems • Loss of species • Reduced growth of species • Fin erosion of fish • Blockage in gastric systems of species • Slowing of metabolism of species
Overfishing	• Loss of species • Loss of ecosystems • Reduced diversity of fish species
Growing tourism sector	• Loss of habitats • Pollution caused by humans
Poaching	• Loss of species

Source: Author's compilation

2.3 SHARKS: ECOLOGICAL ROLE, IMPORTANCE FOR HUMANKIND, AND THREATS THEY ARE FACING

Sharks are apex predators that play an important role in marine ecosystems (Hammerschlag, Barley, Irschick, Meeuwig, Nelson & Meekan, 2018:129) (Figure 2.4). Apex predators are defined as species that inhabit the top position in a community in terms of trophic (food) dynamics and are sometimes also called top predators. Apex predators and normally large animals are in charge of arranging the food webs both indirectly, such as by modifying the behaviour of different prey, as well as directly by predation (Roff, Doropoulos, Rogers, Bozec, Krueck, Aurellado, Priest, Birrell & Mumby, 2016:395). This means that sharks prey on species at the bottom of the food chain, which then helps maintain a healthy balance in the ecosystem. Griffin, Miller, Freitas & Hirshfield (2008:1) described sharks' diets as being extensive, which means that they can choose different species to feed on when populations are low and can control the scattering of prey by intimidating these species. Species adapt their activity level as a result of fear of shark predation; this causes shifts in lower trophic levels. Sharks also play a role in keeping the carbon cycle in motion (Bergen, 2013). They feed on dead species from the seafloor, which automatically removes carbon from the ocean and prevents the outbreaks of different diseases (Helfman & Burgess, 2014:21).

The absence of sharks at the top levels of the food chain would lead to depopulation as well as overpopulation at lower levels (Bornatowski *et al.*, 2014a:1591; Helfman & Burgess, 2014:21). Griffin *et al.* (2008:9) stated that "the loss of sharks in a reef ecosystem can trigger a chain reaction felt throughout the entire food web."

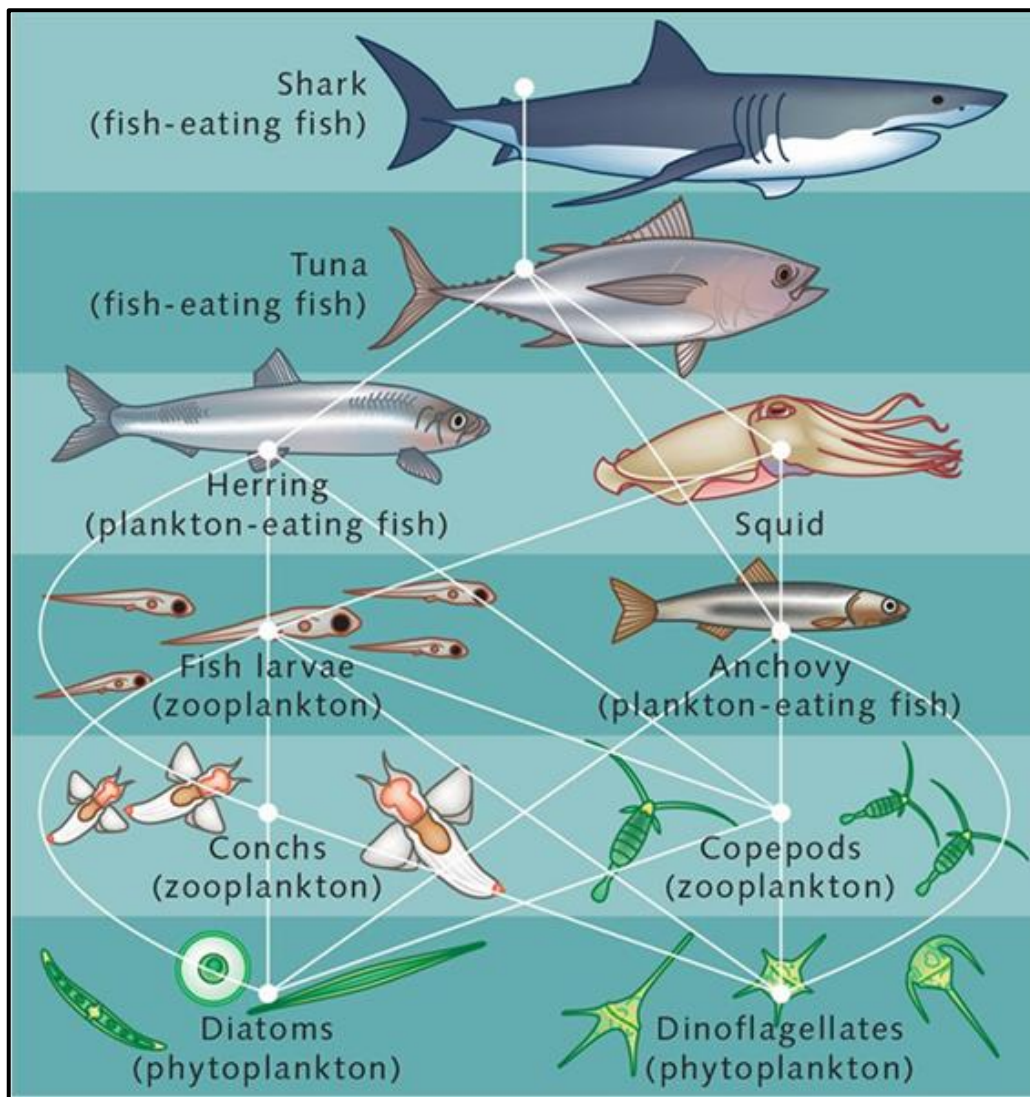


Figure 2.4: Ocean food web

Source: Bücker *et al.*, 2013

Not only do sharks play an important role ecologically, but they are of crucial importance to human beings. As a food, sharks are a source of protein (Bornatowski *et al.*, 2014b:12), and a direct source of medicine for the treatment of human diseases such as bone diseases. For instance, parts of the shark's cartilage are used to produce anticancer drugs (Helfman & Burgess, 2014:21, 161-162).

Sharks are worth millions of US dollars (\$) for the tourism industry and they provide 4% of the overall economic benefit in this industry (Johnson, 2017; Pires, Garla & Carvalho, 2016:32). When looking at shark cage diving in Gansbaai, South Africa, alone, there is approximately US\$19 400 000.00 contribution to the economy (Dearden, Topelko & Ziegler, 2008:57). Shamir, Shamir, Tchernov, Scheinin & Becker (2019:407) pointed out that 590 000 shark watchers spend US\$314 million per year, globally, which supports approximately 10 000 jobs. The shark watching industry also creates jobs as there is an increase in the demand for accommodation, food, transport, photography, and nature interpretation. This industry can also

contribute indirectly to the economy, as people participate in other activities in the area where the shark watching takes place (McKay, 2019:285; Torres, Bolhão, Da Cunha, Vieira & Dos Santos Rodrigues, 2017:21).

Sharks are under many threats, and the majority of these are related to human pressures and impacts. An estimate of 100 million sharks are killed every year, and shark populations have decreased by 70-90% since 1950 (Shamir *et al.*, 2019:406; Tran, 2019:242; IUCN, 2018; Dearden *et al.*, 2008:50). According to the most recent International Union for Conservation of Nature (IUCN) statistics, there are approximately 465 shark species, of which 11 (2.4%) are critically endangered, 15 (3.2%) are endangered, 48 (10.3%) are vulnerable and 74 (15.9%) are near threatened (IUCN, 2019).

Table 2.2: Species changed on IUCN red list (2018-2019)

Scientific Name	Common Name	IUCN Red List (2018) Category	IUCN Red List (2019) Category
<i>Cephaloscyllium albiglunum</i>	Whitfin Swellshark	NT	CR
<i>Isurus oxyrinchus</i>	Shortfin Mako	VU	EN
<i>Isurus paucus</i>	Longfin Mako	VU	EN
<i>Odontaspis noronhai</i>	Bigeye Sand Tiger	DD	LC
<i>Pseudocarcharias kamoharui</i>	Crocodile Shark	NT	LC
<i>Squalus albifrons</i>	Eastern Highfin Spurdog	DD	LC
<i>Squalus chloroculus</i>	Greeneye Spurdog	NT	EN
<i>Squalus crassispinus</i>	Fatspine Spurdog	DD	LC
<i>Squalus nasutus</i>	Western Longnose Spurdog	DD	NT
<i>Squalus notocaudatus</i>	Bartail Spurdog	DD	LC
<i>Squatina africana</i>	African Angelshark	DD	NT
<i>Squatina argentina</i>	Argentine Angelshark	EN	CR
<i>Squatina dumeril</i>	Atlantic Angelshark	DD	LC
<i>Squatina occulta</i>	Hidden Angelshark	EN	CR
<i>Trygonoptera galba</i>	Yellow Shovelnose Stingaree	DD	LC
<i>Trygonoptera imitata</i>	Eastern Shovelnose Stingaree	NT	LC
<i>Trygonoptera testacea</i>	Common Stingaree	LC	NT

Note: Ex= Extinct; EW=Extinct in the wild; CR= Critically Endangered; EN=Endangered; VU=Vulnerable; LR/cd= Lower risk/conservation dependent; NT= Near Threatened; DD= Data deficient and LC= Least concern

Source: IUCN, 2019

Table 2.2 shows how the status of some shark species on the IUCN red list has changed from 2018 to 2019. The figures show that one species can go from near threatened to critically endangered in the time frame of one year (IUCN, 2019). The status of sharks on the red list will change annually as they face a variety of human threats, six of which – the main ones – are described as follows.

The first major threat that sharks are facing is bycatch. Keledjian, Brogan, Lowell, Warrenchuck, Enticknap, Shester, Hirshfield & Cano-Stocco (2014:6) describe bycatch as “the capture of non-target fish and ocean wildlife, including what is brought to port and what is discarded at sea, dead or dying.” Researchers found that around 50% of the shark production globally, comprised of sharks caught through bycatch (Oliver *et al.*, 2015:87).

The second threat to sharks is prolonged exploitation, exacerbated by the fact that sharks are biologically vulnerable (Mardhiah, Booth, Simeon, Muttagin, Ichsan, Prasetyo & Yulianto, 2019:1). Sharks cannot endure prolonged periods of exploitation. They grow very slowly and breed very late in their lifespan, producing a limited number of young. This causes them to be integrally vulnerable to overexploitation, as they recover at a very slow rate (Mardhiah *et al.*, 2019:1; Shamir *et al.*, 2019:407; Simpfendorfer *et al.*, 2011:518).

The third threat faced by sharks is trading. Shark meat lies at the top of the international trade list, making sharks vulnerable to exploitation (Bornatowski *et al.*, 2014b:12). Shark products such as their teeth, fins, and jaws are also in huge demand, which causes an increase in shark catching efforts (O'Bryhim, 2009:8). Sharks are exploited for their fins which are used in the preparation of traditional dishes (Tran, 2019:240). This is a serious threat, causing shark fins to be the most exclusive seafood product (Dearden *et al.*, 2008:50; Buckley & Hile, 2007:21).

The fourth threat is the usage of lethal shark control such as nets, drumlines, and culling to protect ocean users in different countries around the world. Sharks need to stay in constant motion to breathe and once they get caught in nets they cannot move, which results in their death (Dearden *et al.*, 2008:50; Buckley & Hile, 2007:29; Philpott, 2002:455). Sharks are also actively pursued and killed during culling campaigns in countries like Australia (Gibbs & Warren, 2015).

The fifth threat is that of sub-sea cables. There are several communication cables on the seafloor that produce magnetic and electric fields, which may negatively affect the sharks' behaviour, including their feeding behaviour (Kimber, Sims, Bellamy & Gill, 2014:56). Meyer, Holland & Papastamatiou (2005:130) found that, under the influence of electromagnetic fields from sub-sea cables, sharks who swim steadily start swimming faster in anticipation of food.

The sixth and final threat is tourism development. Coastal developments can cause different sharks' habitats, such as mangroves, to be removed. This mainly results in young sharks losing their nursing grounds (Dearden *et al.*, 2008:50).

The organisation Sea Shepherd (2014) portrays Captain Paul Watson's famous words concerning sharks and the importance of protecting sharks: "If there is one message we are trying to get across here is it that, if we can't save the whales, and the sharks, the turtles, the fish, the great whites and tiger sharks, we are not going to save the oceans. And if the oceans die, we die; we can't live on this planet with a dead ocean." Therefore, humankind has a great responsibility to protect sharks from the threat of extinction that is generated by human impacts.

According to Shiffman and Hammerschlag (2016:806), there are several regional, national, and international policies in place to protect sharks. However, each policy differs extensively in intent, scope and effectiveness. The policies in place can be divided into two groups, limit-based policies and target-based policies. Limit-based policies are policies that ban certain fisheries that have no specific species focus. Target-based policies are policies that allow sustainable fishing through quotas. Table 2.3 gives examples of different limit- and target-based policies.

Table 2.3: Limit- and Target-based policies

Limit-based Policies	Definition
No-take marine protected areas	Area of the ocean where all commercial fishing is banned
Shark-fin bans	Illegal to buy, sell, or trade shark fins
Nation-wide bans on any commercial fishing or landing of sharks (shark sanctuaries)	Shark sanctuaries ban commercial fisheries exploitation of sharks within the entire exclusive economic zone of a country
Target-based Policies	Definition
Strict bans on take for particularly threatened species	Banning fisheries' exploitation of species whose populations are low while allowing exploitation of other co-occurring species (e.g. a zero quota, a prohibited species list, US. Endangered Species Act listing)
Fisheries quotas	Restrictions on the total number (or weight) of a species or species complex that can be exploited by fisheries based on scientific assessment of the population status and life history of that species
Year-round closures in certain areas	Banning fishing (or fishing for specific species or fishing using specific gear) in a particular area (e.g. a bycatch hotspot, a nursery area, an important migration route) permanently
Gear restrictions and required gear modifications aimed at reducing bycatch	Regulations that require fishers to modify fishing gear (or ban certain types of gear) to reduce accidental catch of non-target species
Time-restricted area closures	Banning fishing (or fishing for specific species or fishing using specific gear) in a particular area (e.g. a bycatch hotspot, a nursery area, an important migration route) during some times

	of the year
Shark-finning bans	Banning removal of shark fins and disposing of the carcass at sea, including fin:carcass ratios and fins naturally attached policies
CITES Appendix II listing	Listing on Appendix II of the Convention on International Trade in Endangered Species requires countries to certify that trade in that species did not harm the population and requires monitoring
CITES Appendix I listing	Listing on Appendix I of the Convention on International Trade in Endangered Species bans international trade in that species

Source: Shiffman & Hammerschlag (2016:807)

A well-known way to protect sharks is the establishment of marine protected areas (MPA). Welch, Pressey & Reside (2018:106) define MPAs as “a way to mitigate the decline of biodiversity and to reduce the effects of fisheries on bycatch of vulnerable species.” Knip, Heupel & Simpfendorfer (2012:200) explained that MPAs are used as management and conservation measures to shelter species, such as sharks, that are vulnerable. In South Africa, 20 new MPAs were established in early 2019 and, on the east coast of Australia, 26 MPAs were accepted between 2001 and 2009 (Save Our Seas Foundation, 2019; Lynch, Harcourt, Edgar & Barrett, 2013:1341). Altogether there are 42 MPAs in South Africa (Figure 2.5). According to the MPA Forum SA (2019), MPAs are grouped under three categories: Restricted areas, where the harvesting of all plant and marine life is forbidden/banned; Controlled areas, where permits are needed to snorkel and fish; and Restricted and controlled areas, where management is permitted to control the restriction of marine extraction. MPAs maintain vital life support systems and ecological processes, allowing the recovery of different species including sharks (Welch *et al.*, 2018:106). If properly managed, these MPAs hold the potential to protect the ecosystems therein indefinitely.



Figure 2.5: MPAs in South Africa

Source: Save Our Seas Foundation, 2019

The effective protection of shark populations and species requires concerted efforts from international policies, modified fisheries regulations, and ad hoc conservation instruments (Friedrich *et al.*, 2014:4). These efforts should be underpinned by sound data on shark biology and ecology, on the socio-economic and ecological impacts of the declines of shark populations, and on the human dimensions of sharks and of relevant shark-management strategies. Sharks, however, remain poorly protected by overarching international policy (Techera & Klein, 2011:73). Existing forms of protection have limited scope and effect, mainly targeting popular species and sometimes being set aside for the sake of implementing controversial practices including lethal shark control (Gibbs & Warren, 2015:123). Some forms of protection may not be enforced in countries where financial resources are limited (Philpott, 2002:460). Finally, non-governmental organisations (NGOs) focussing on shark protection possess low political influence, despite efforts to raise awareness and educate the public (Techera & Klein, 2011:73).

2.4 THE HISTORY OF HUMAN-SHARK INTERACTIONS AND HOW HUMANS HAVE DEALT WITH SHARKS

Humans and sharks have a long history of interactions, mainly due to the strong dependence of the former upon the resources of the ocean for food, travel and tourism. According to Mojette *et al.* (2018:31) human interactions with sharks date back to ancient Greek mythology and Biblical

accounts, where sharks were seen as animals that had a connection with the divine. Humans started navigating the oceans for fishing purposes 42 000 years ago. However, proper information on the history of human-shark interactions is very scant and is restricted to the last few centuries, as these interactions started long before people could keep records in written form. The first documented relationships between sharks and humans date back to the Bronze Age (3000 BC - 1200 BC) where, according to archaeological studies, humans caught and ate small and large sharks (Mojetta *et al.*, 2018:36).

The first shark attack presumably happened in the 1700s and several stories have been written about it, transforming the event into a sort of myth. Masur (1994:427) reported that Brook Watson was a 14-year-old boy who was attacked by a shark in 1749. Brook went for a swim in the Havana Harbour in Cuba, where he floated next to merchant ships. A shark bit his leg, which had to be amputated after the attack. The legalisation of swimming in Australia in the 1830s led to a number of interactions between humans and sharks, including fatal ones. According to Castro (2017:15), the first reported shark bite in Australia took place in Sydney and was documented in 1915. In 1916, curiosity about shark behaviour increased after a group of people were fatally wounded by sharks, in the waters of New Jersey in the USA (Helfman & Burgess, 2014:172; Neff & Hueter, 2013:66). Shark fisheries initiated in North America in the late 1930s when humans discovered that sharks could be used for oil and leather (Castro, 2017:15).

Based on the work of Neff and Hueter (2013:66-67), it was found that interactions with sharks increased during World War II (1939-1945), when thousands of troops were deployed across the Pacific Ocean. Just when the end of World War II was near, the *USS. Indianapolis* sank resulting in 60-80 humans being killed by sharks. This was due to the amount of blood in the ocean as some people had injuries. This event brought sharks and shark repellents to the governments' attention, which led to the development of a chemical shark repellent, known as the "Shark chaser", which was distributed for US. military personnel at sea (Carrier, 2017:17). The fact that this repellent was only partly effective led to more research being done to focus on the problem.

After World War II, leisure time and quality of life increased in several countries, and humans began using beaches for recreational activities at an increasing rate. The growing population, improved methods of transport and shorter working hours led to the increased use of the oceans for swimming, snorkelling, and surfing. These elements brought more people in contact with sharks (Neff & Hueter, 2013:67).

After the release of the movie “*Jaws*” in 1975, the public became terrified to use the oceans (Neff, 2015:114; Resko & Johnson, 2014:28; Neff & Hueter, 2013:68). *Jaws* portrayed a clear message that sharks actively hunt humans. Dearden *et al.* (2008:68) described how divers cancelled their diving lessons, and diving equipment shops suffered as a consequence. In 1985-1992, however, shark diving was popularised. Divers finally accepted that sharks are a part of the ocean, and this is when shark popularity grew. People wanted to experience the adrenaline associated with shark diving and interactions with sharks in their natural habitat. Divers started developing respect for sharks (Dearden *et al.*, 2008:70). Shark diving exploded in popularity in 1993, which resulted in more people wanting to interact with sharks. Shark dive sites over the world popularised shark feeding, by advertising humans petting, feeding and holding sharks. Dive sites started using sharks as an attraction to make money and were rated according to the number of sharks that divers could find there (Dearden *et al.*, 2008:72; Topelko & Dearden, 2005:110). Shark tourism became a very popular form of tourism, directly associated with wildlife tourism, contributing to the conservation of shark species (Shamir *et al.*, 2019:407). Whatmough, Van Putten & Chin (2011:755) explained that recreational divers turned from hunters to “nature-appreciating observers”. This was due to the increased awareness of conservation. More positive opinions of sharks increased in the mid-1990s, with sharks being growingly seen as harmless creatures rather than man-eating villains (Figure 2.6).

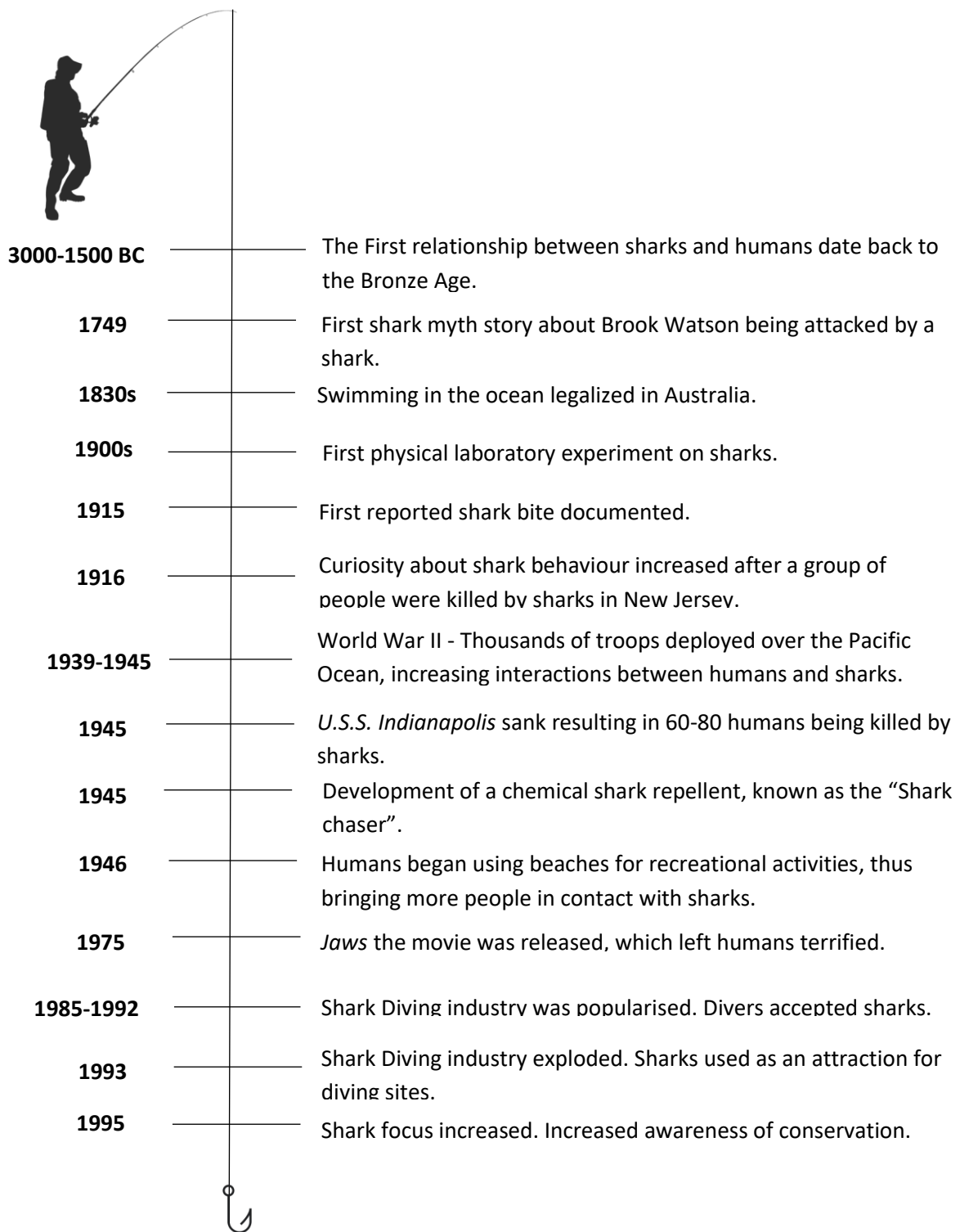


Figure 2.6: Timeline on human-shark interactions

Source: Author's compilation

Today, some humans are fascinated by sharks, while others still fear sharks. Table 2.4 was prepared by Friedrich *et al.* (2014:4) and illustrates the different ways humans perceive sharks, based on a study of visitors to an aquarium in Plymouth, UK. There was a total of 135 respondents, of whom 64% felt positively towards sharks, and 26% felt negatively towards sharks. The majority of the respondents saw sharks as exciting, wonderful and charismatic.

Table 2.4: Shark associations made by aquarium visitors in the UK

I consider sharks to be...	Percentage %
Positive	64
Fascinating, exciting, wonderful, charismatic, etc.	18
Interesting	12
Endangered	10
An essential part of the marine ecosystem, should be left alone in their environment	8
Beautiful	4
Efficient, important predators	4
Not dangerous, misunderstood	4
Two-sided: amazing, attractive yet wild, dangerous	2
We do not know enough about them	2
Should be protected	1
Neutral	10
Animals, fish	5
Big	5
Negative	26
Scary, dangerous, big teeth	25
Dull	1

Source: Friedrich *et al.*, 2014:4

According to a meta-analysis of articles on sharks and rays conducted by Whatmough *et al.* (2011:760), sharks were seen as dangerous before 1975. However, perceptions changed and, by 1984, sharks started to be seen as exciting creatures (Figure 2.7). This showed a change in perceptions due to wildlife conservation becoming more popular.

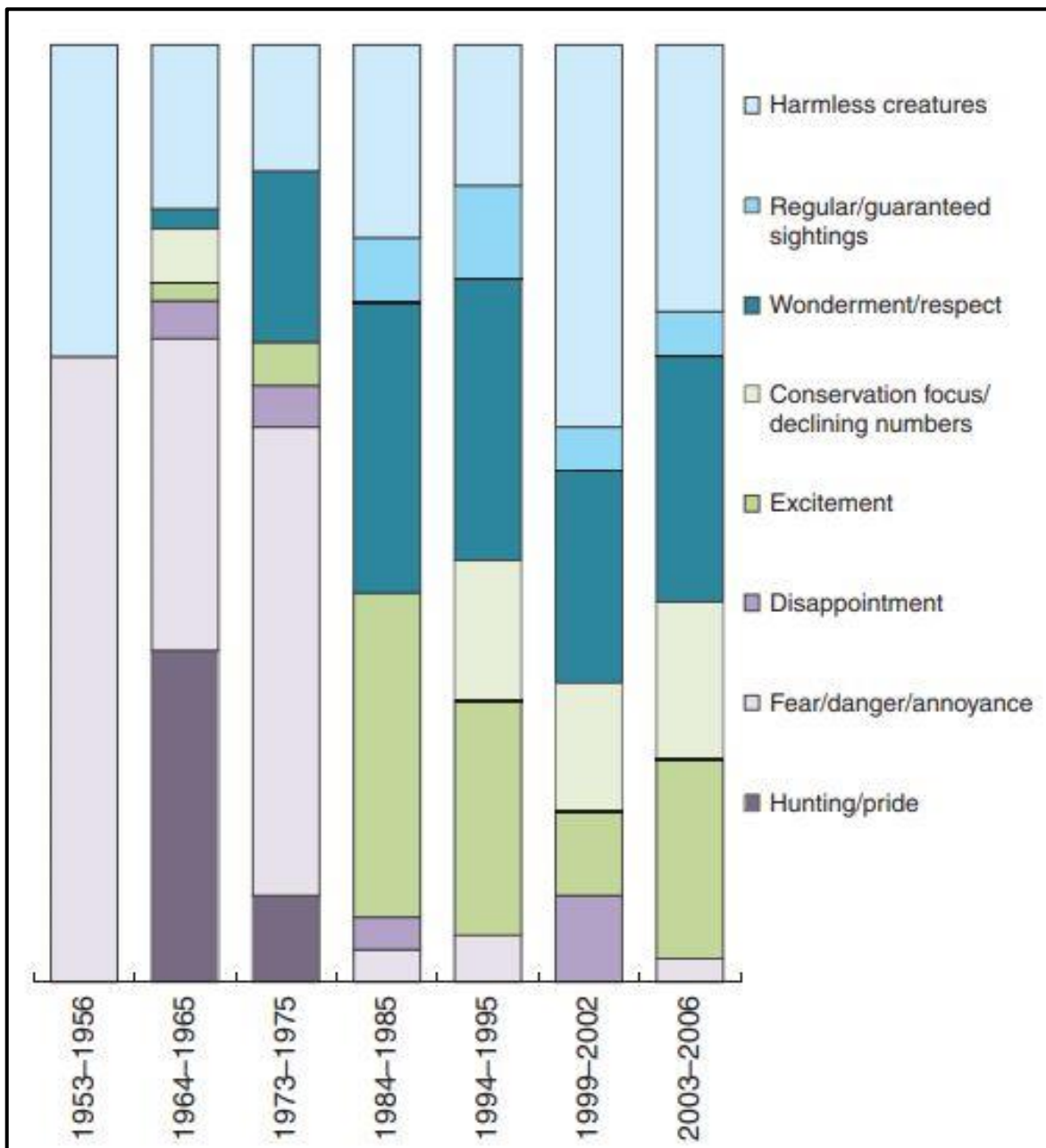


Figure 2.7: Proportion of themes which occurred in articles of sharks and rays from 1953 to 2006

Source: Whatmough *et al.*, 2011:760

Castro (2017:28) claimed that an unusual transformation has been taking place, whereby sharks are increasingly seen as protected and symbolic animals and are decreasingly feared by society. The author added that there is a shark-enthusiast community that has an increased curiosity and obsession with sharks. This community abides by a new phenomenon of totemism, whereby humans have an emotional relationship with sharks and sharks become sacred to humans. Despite the growing concern for and positive opinion on sharks, a degree of fear still remains in some societies (Castro, 2017:28; Simmons & Mehmet, 2018:115). This fear may make it difficult to implement conservation actions, since the conservation of sharks rests partially on public acceptability and support (Pepin-Neff & Wynter, 2018b:222).

2.5 TYPES OF HUMAN-SHARK INTERACTIONS AND SHARK BITE STATISTICS

According to Neff and Hueter (2013:70), humans and sharks interact on different levels. The most basic form of interaction is the shark sighting, which is when a person spots a shark in the water. The second level of interaction is a shark encounter, which takes place when physical contact occurs between humans and sharks, not resulting in a bite. The third level of interaction is shark bites, which can lead to minor or moderate injuries. The final level of interaction is fatal shark bites. This is when a shark bites a human, and due to the loss of body tissue and blood, the result is death.

Interactions between people and sharks can be either provoked or unprovoked (Neff & Hueter, 2013:67). The former kind takes place when a human initiates it, for example when a shark is caught, injured or disturbed, while the latter kind involves no human provocation of the shark (Neff & Hueter, 2013:67). Helfman and Burgess (2014:175-176) classify an unprovoked attack according to five motives. “(1) Bumps or bites, where a shark wants to test the edibility of something (2) Aggressive bites, where a human is a threat, (3) Territorial defence, (4) Where a shark mistakes a person for something else, such as a seal and (5) True feeding attacks.”

The International Shark Attack File (ISAF) is the only scientifically, comprehensive database in the world consisting of all the known shark attacks and is kept at the Florida Museum of Natural History (Florida Museum, 2020). The ISAF team compiled a table (Table 2.5) of the history of confirmed unprovoked shark attacks (both fatal and non-fatal) from 1580-2018, for the top 20 countries (Florida Museum, 2020).

Table 2.5: Unprovoked shark bite incidents from 1580-2020

Country	Total	Country	Total
The USA.	1483	Fiji Islands	22
Australia	652	Egypt	22
South Africa	256	New Caledonia	16
Brazil	107	Japan	15
New Zealand	52	Greece	15
Papua New Guinea	48	India	14
Reunion Island	47	Italy	13
Mexico	41	Hong Kong	13
Bahama Islands	32	Cuba	13
Iran	23	Ecuador	12

Source: Florida Museum, 2020

The table shows that over 439 years, 1483 unprovoked shark bite incidents took place in the USA, 652 in Australia and 256 in South Africa. When considering how many bite incidents took place over 439 years the table indicates that, statistically, the likelihood of being killed by a shark remains very small when compared with other unlikely incidents such as being hit by a coconut (Pepin-Neff, 2019:19). Chapman and McPhee (2016:72), Ferretti, Jorgensen, Chapple, De Leo & Micheli (2014:412) and McPhee (2014:478) explained that shark bite incidents have been increasing all over the world. However, Chapman and McPhee (2016:72) argued that the increase in incidents can be a result of an increasing human population, as well as habitat modification, climate change and changes in water quality. Ferretti *et al.* (2014:412) explained that, although there has been an increase in shark bite incidents, there has been a decrease in individual attack risk. This can be due to an undetected shark population decline as well as changes in the spatial distribution of both sharks and people. Neff and Hueter (2013:65) indicated that the phrase “shark attack” was used in some cases where humans and sharks did not even come in contact. This resulted in shark bite statistics being overrepresented because of the incorrect use of the phrase.

2.6 TYPES AND HISTORY OF SHARK HAZARD MITIGATION

Shark hazard mitigation strategies are defined by Crossley *et al.* (2014:154) as actions taken to decrease the encounters between sharks and humans in the water. These are categorised under lethal and non-lethal strategies (Cliff & Dudley, 2011:700). Examples of lethal methods include nets and baited hooks or drumlines, while non-lethal methods mainly include the spotting of sharks and information provided to bathers on how to minimise risks of encountering sharks. Very recently introduced non-lethal methods include drones, which are also called unmanned aerial vehicles or remotely piloted aircraft systems. Table 2.6 shows when and where the main mitigation strategies were first implemented.

Table 2.6: Implementation of the mitigation strategies

Mitigation Strategy	When	Where	Source
Lifeguards	1800s	Philadelphia, Pennsylvania, USA.	Brewster (2018:5)
Aerial surveys/ patrols	1930	New South Wales, Australia	Pepin-Neff (2019:8)
Nets	1930s	New South Wales, Australia	Meeuwig & Ferreira (2014:297)
Drumlines	1960s	Queensland, Australia	Gibbs (2018:206)
Electrical shark repellent	1992	KwaZulu-Natal, South Africa	Thompson (2016:105)
Shark Spotters	2004	Cape Town, South Africa	Shark Spotters (2019a); Pepin-Neff (2019:8)
Shark Repellent cable	2014	Cape Town, South Africa	KwaZulu-Natal Sharks Board

			(2019a)
Drones	2018	Australia	Colefax, Butcher, Kelaheer & Browman (2018)

Source: Author's compilation.

Based on the table, it is clear that there are several mitigation strategies in place, with lifeguards being the first strategy that was implemented. The various strategies are described in more detail below.

2.6.1 Trained lifeguards and information boards

Lifeguards and information boards are seen as a non-lethal shark hazard mitigation method, which is used to inform and assist humans with regards to human-shark interactions. A lifeguard, also known as a lifesaver, is defined as “an emergency service worker who is responsible for overseeing the safety of patrons at aquatic facilities” (MacMillan, 2008:364). A lifeguard usually monitors the swimmer's behaviour, and when swimmers are distressed in the water, the lifeguard jumps in and assists the person (Figure 2.8) (Branche, 2001:7). As reported by the American Red Cross (2012:2), a lifeguard has primary responsibilities that include preventing injuries, monitoring different activities, implementing rules and regulations, and quickly and effectively responding to emergencies. A lifeguard also has secondary responsibilities such as testing the water chemistry, assisting ocean users, and completion of reports. Lifeguards also play a crucial role in shark hazard mitigation. In South Africa, for example, the National Sea Rescue Institute (NSRI) has volunteers equipped with emergency shark kits to assist humans with any shark-related incidents (Stander, 2018).



Figure 2.8: Lifeguard on duty

Source: Engelbrecht, 2019

Information regarding sharks and human-shark interactions is also provided at the beaches, often in the form of signs and boards, to inform ocean users of the importance of

sharks and to warn them when sharks are sighted (Figure 2.9, 2.10, 2.11, 2.12 and 2.13). Matthews, Andronaco & Adams (2014:312) divided the beach signs into four categories. These categories include emergency information and location, lifeguard information, prohibitions, and safety hazard symbols. The researchers also found that the majority of the people tend to notice safety hazard symbols and act accordingly.



Figure 2.12: Information board on sharks at Muizenberg
Source: Apple, 2011



Figure 2.9: Warning board on sharks in KZN
Source: Free city guides, 2019



Figure 2.11: Shark warning board in Cape Cod
Source: Greenberg, 2019



Figure 2.13: Safety at the shore board
Credits: S. Lucrezi



Figure 2.10: Board on shark nets
Credits: S. Lucrezi

2.6.2 Aerial surveys

Aerial surveys are a non-lethal shark hazard mitigation method implemented to detect, identify and scan sharks and other marine wildlife (Bryson & Williams, 2015:6) (Figure 2.14). Aerial surveys were first implemented in New South Wales, Australia, in 1930 (Pepin-Neff, 2019:8).

Aerial surveys usually make use of one pilot, one observer and one data recorder. The observer's job includes the detection and identification of the species, while the data recorder's job is to record the count of each finding. The surveys take place during different times of the day, and the total speed is determined by the aircraft that is in use. One to three hours are required to complete a survey, for both helicopters and fixed-wing aircraft. The aircraft flies at an altitude of 100-150m and can cover 100-200km of coastlines in one flight. Aerial surveys are normally done three times a week; however, this can sometimes be limited due to factors such as the presence of clouds and the reflection of the sun that can influence detectability, which can influence efficacy. Robbins, Peddemors & Kennelly (2012:26-27) claimed that aerial surveys can be an effective measure to prevent shark encounters, although their efficiency in detecting potentially dangerous sharks is still being tested. The authors also claimed that fixed-wing aircraft are less effective than helicopters at sighting shark species.

Very recently, drones were introduced as a form of aerial shark survey and non-lethal shark hazard mitigation (Colefax *et al.*, 2018). Studies have already demonstrated the efficacy of drones in monitoring sharks in nearshore waters and alerting bathers (Colefax, Kelaher, Pagendam & Butcher, 2020; Butcher, Piddocke, Colefax, Hoade, Peddemors, Borg & Cullis, 2019). However, since drones for shark surveillance and bather protection are a new technology, their social license to operate is still being tested, so far yielding positive outcomes (Stokes, Apps, Butcher, Weiler, Luke & Colefax, 2020).



Figure 2.14: Aerial Survey

Source: Burbury, 2017

2.6.3 Shark Nets

As reported by Erbe, Wintner, Dudley & Plön (2016:2-3) shark nets, also known as bather protection nets, are a lethal mitigation strategy which was first installed in KwaZulu-Natal (KZN), South Africa, in 1952 with the intent to protect ocean users from sharks (Meeuwig & Ferreira, 2014:297). The Parliament of Australia (2017:57-58) indicated that shark nets are also implemented in New South Wales and Queensland, Australia. The nets in Australia are used to “reduce the number of potentially dangerous sharks in particular areas rather than to create an impenetrable barrier against shark attack”. These nets contain warning devices which alert whales and dolphins, to reduce the number of unwanted species getting tangled up. Nets in New South Wales are only installed between 1 September and 30 April every year at 51 beaches along the coast of the state, while there are 35 nets in Queensland that are installed throughout the whole year (Sumpton, Taylor, Gribble, McPherson & Ham, 2011:37-38).

In South Africa, the maximum number of nets was reached in the 1990s, with a total of 44km of nets along the coast of KZN, covering 44 beaches (Figure 2.15). The nets are managed by the KwaZulu-Natal Sharks Board (KZNSB).



Figure 2.15: Drumlines and Nets in KwaZulu-Natal

Source: KwaZulu-Natal Sharks Board, 2019c

A net is normally 213.5m in length and 6.3m in-depth and is parallel to the coast, located approximately 400m from the coast. The mesh of the net is usually stretched at 51cm. The nets are secured at each end to the ocean floor through anchors, and animals are caught in 10-14m of water depth, which is normally in the upper half of the nets (Figure 2.16). Nets in KZN are normally inspected daily from Monday through Friday by KZNSB staff; the gender and length of each individual of a shark species and the location and date of when the capture took place are then recorded (KZNSB, 2019b; Dicken, Hussey, Christiansen, Smale, Nkabi, Cliff & Wintner, 2017:3). Shark nets catch approximately 600-1500 sharks every year and also bycatch including whales, dolphins, and turtles, among others (Meeuwig & Ferreira, 2014:297). Sharks that are caught in the nets are usually euthanized if found alive (Gibbs, 2018:203).

Nets in South Africa have been reduced by one third between 1999 and 2004, to help limit the amount of bycatch (Erbe *et al.*, 2016:2). The KZNSB (2019b) indicates that there have been no serious human injuries and fatalities in Durban since the nets have been introduced and that there have been 11 serious injuries and 16 fatalities at other KZN beaches since 1960.

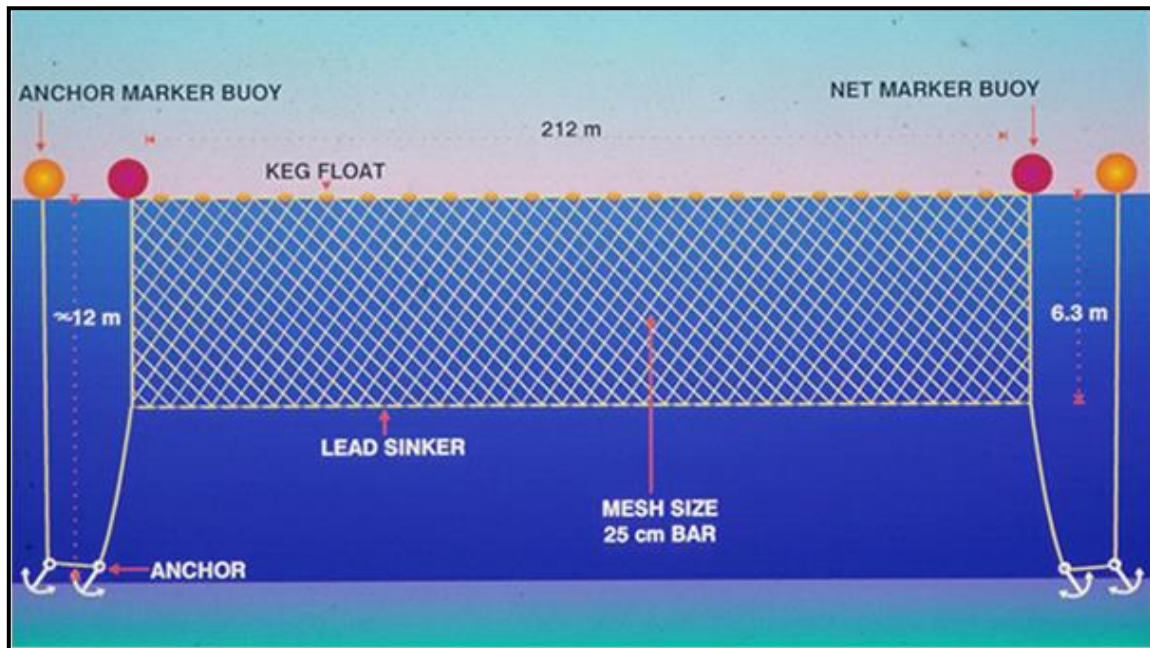


Figure 2.16: Shark nets

Source: KwaZulu-Natal Sharks Board, 2019b

2.6.4 Drumlines

Baited hooks, hereafter referred to as drumlines, are a lethal strategy of shark hazard mitigation that has been designed and implemented with the intent to reduce the chance of human-shark interactions, by limiting the number of sharks in coastal waters that are used for recreation (Figure 2.17). Drumlines were first implemented in Queensland, Australia in the 1960s and are also implemented in South Africa, along the beaches of KZN (Table 2.6; KZNSB, 2019b; Gibbs, 2018:206). The KZNSB (2019d) states that drumlines have been implemented to reduce the number of nets, with the idea of limiting indiscriminate bycatch by nets, while still acting as a barrier between ocean users and sharks.

Drumlines use baited hooks to capture sharks (Parliament of Australia, 2017:60). They are positioned parallel to and normally around 450-800m from the coast, usually in waters no deeper than 6-12m. They consist of a single hook, which is suspended from a buoy using a rope attached to an anchor. The hook is approximately 2m from the ocean floor when it is low tide and has fresh bait on it. The anchor prevents the drumline from moving in different tides. In Australia, drumlines are inspected 20 days per month and, in South Africa, drumlines are inspected every Monday through Friday (Sumpton *et al.*, 2011:38). Once a shark gets caught on the hook, a signal is released by an attached communication unit, which contacts the people responsible via email, text message or phone call. In Australia, after the shark is handled by the responsible team, if alive it is usually tagged and released 1km offshore (Guyomard, Perry, Tournoux, Cliff, Peddemors & Jaquemet, 2019:8; KZNSB, 2019b; NSW Government, 2018).

However, drumlines are also associated with the culling of sharks, as individuals are often killed after being caught (McCagh *et al.*, 2015:271).

Gibbs and Warren (2014:103) argued that it is difficult to assess whether or not a drumline is effective. The reason being that shark bite rates were low before the installation of drumlines, and the low rate continues today after drumlines have been installed. However, drumlines appear to reduce the ecological impact of shark control on species that are not targeted. For this reason, drumlines are considered to be a good alternative to nets. According to the KZNSB (2019b), the drumlines that are installed in South Africa (17 beaches; Figure 2.17), have replaced 50% of the shark nets, reducing the bycatch of unwanted species by 47.5% overall. Cliff and Dudley (2011:702) indicated that bycatch has declined from 606 per year in the 1980s to 456 per year in the 2000s.

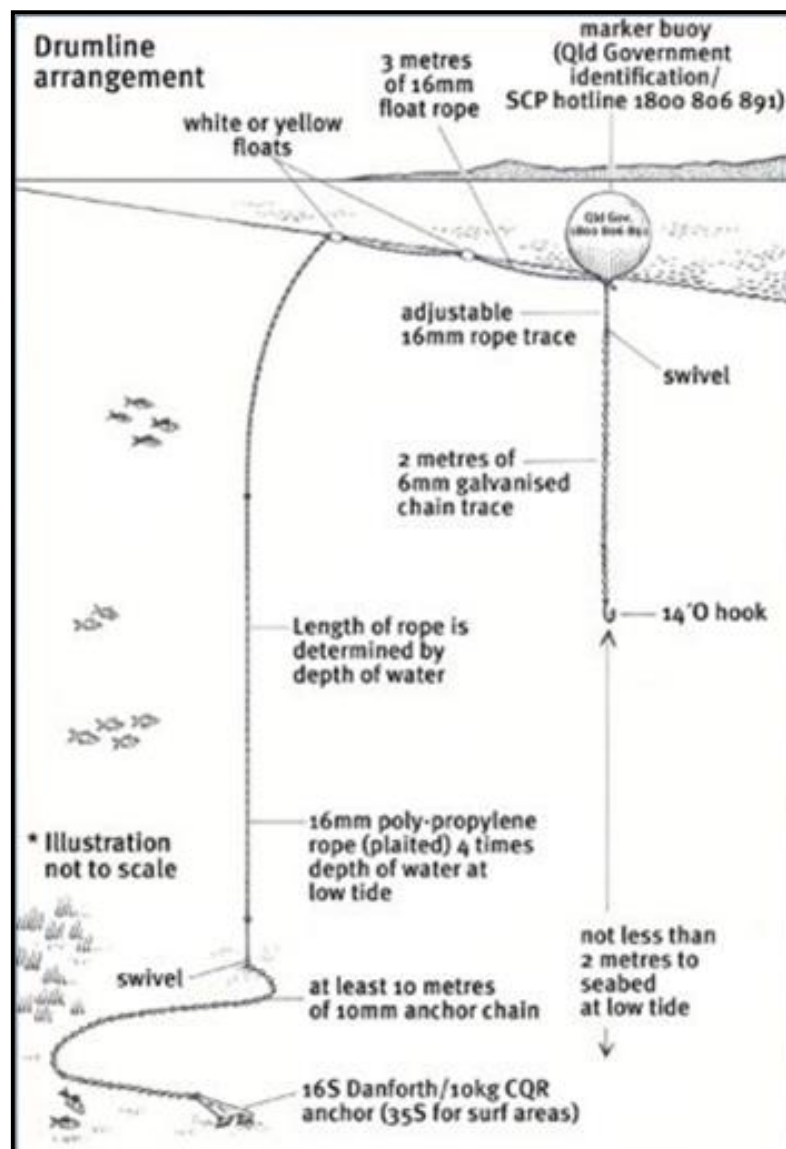


Figure 2.17: Drumline

Source: Parliament of Australia, 2017:60

2.6.5 Electrical shark repellents

Electrical shark repellents/deterrents are one of the non-lethal strategies implemented to reduce the chance of human-shark interactions (Figure 2.18). The first electrical shark repellent (shark POD (Personal Oceanic Device)) was used in KZN, South Africa, in 1992. The Shark POD was the first effective shark repellent device (Thompson, 2016:105). Electrical shark repellents include devices that are used by ocean users and can be worn, for example around the ankle. A typical device has a 2.2m antenna which generates an electromagnetic field using two electrode plates. When the device is in seawater, the electric circuit is complete, which results in an electromagnetic field being generated (Egeberg, Kempster, Hart, Ryan, Chapuis, Kerr, Schmidt, Gennari, Topak & Collin, 2019:3; Kempster, Egeberg, Hart, Ryan, Chapuis, Kerr, Schmidt, Huveneers, Gennari, Yopak & Meeuwig, 2016:5). The field leads to an avoidance response by the sharks' electrosensory system. The repellent has a 120V wave pulse and a frequency of 1-2Hz. This can keep a shark approximately 3m away (Hart & Collin, 2015:48).

Thompson (2016:106) stated that the efficiency of different shark repellent devices can vary, with some needing more testing before they can be introduced into the market. For example, in 2011, attention was focussed when a white shark killed the spokesperson of Shark Shield, a shark deterrent, while he had the device with him. Surfers have also been interrogating the effectiveness of the device (Thompson, 2016:106).

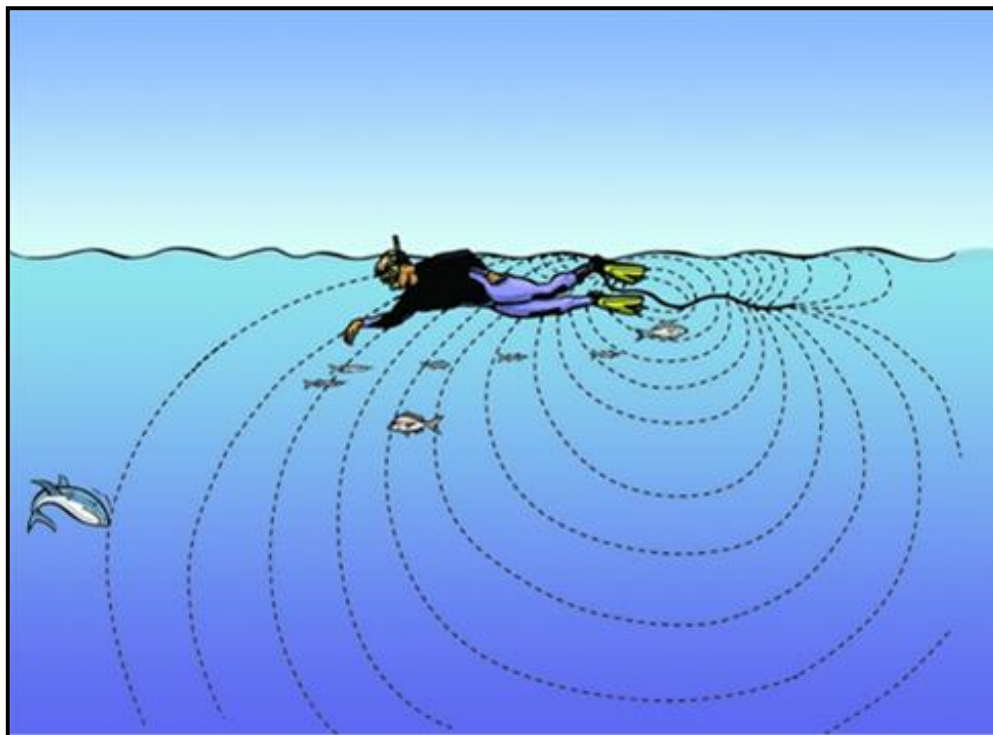


Figure 2.18: Electric shark repellent device

Source: Shark Safe, 2010

2.6.6 Shark Spotting and the Shark Spotters programme

Shark spotting is one of the non-lethal strategies in place to minimise human-shark interactions (Engelbrecht *et al.*, 2017:1). This form of mitigation aims to create a balance between the needs of ocean users and eco-friendly strategies to reduce risks of human-shark interactions; so far the strategy has successfully reduced spatial overlap between people and sharks (Engelbrecht *et al.*, 2017:2; Kock *et al.*, 2012:448). Shark spotting gained much attention when it was officially implemented as a programme in Cape Town, South Africa, in 2004 (Table 2.6). The Shark Spotters programme is funded by the City of Cape Town and the Save our Seas Foundation (Shark Spotters, 2019b; Kock *et al.*, 2012:449).

Cape Town has many mountains close to popular beaches, which contributes to the effectiveness of this programme. Trained shark spotters make use of viewpoints on mountains that are close to the beach (normally 100-150m above sea level). The shark spotters communicate their observations to the people on the ground, who then use flags or siren systems at the beach to notify the ocean users if a shark is spotted. The flag system consists of four flags, each having a different meaning (Figure 2.19). A green flag indicates that no sharks have been seen and the spotting conditions are good. A black flag indicates that no sharks have been seen and the spotting conditions are poor. A red flag indicates that a shark has been spotted recently, while a white flag with a black shark indicates that there is a shark near the shore. The white flag is the only flag that is accompanied by a siren. When the siren goes off, ocean users are encouraged to get out of the water. The beach will remain closed until the sightings clear up, and the spotted shark has left the surf zone (Kock *et al.*, 2012:453-454).

The Shark Spotters programme operates at various locations in Cape Town (Figure 2.20) and has recorded 2500 shark sightings from November 2004 to February 2019 (Shark Spotters, 2019b). Data are constantly collected as part of the programme, which assists in determining high-risk areas as well as the probability of shark encounters. The programme also assists in the collection of information on shark behaviour (Domeier, 2012:495).



Figure 2.19: Shark Spotters' flag warning system

Source: Kock *et al.* 2012:453

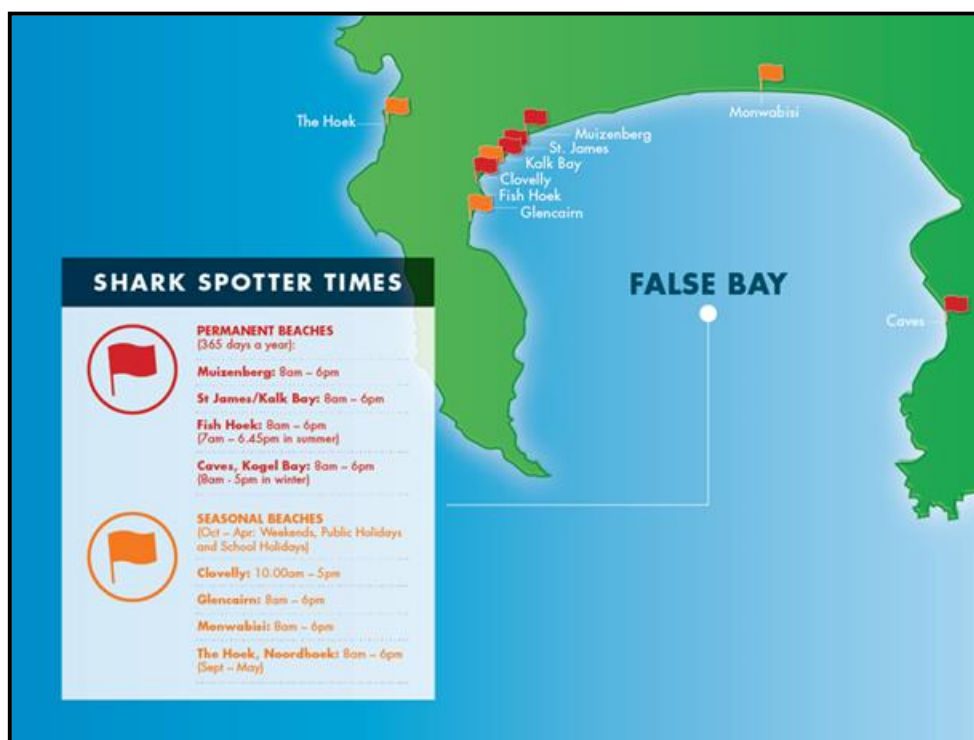


Figure 2.20: Shark Spotters Programme in areas of Cape Town

Source: Shark Spotters, 2019c

2.6.7 Shark repellent cable

Aside from repellent devices that can be worn by ocean users, other forms of shark repellent are being tested as a viable substitute for lethal shark control measures like nets and drumlines. An example is the shark repellent cable. This mitigation strategy consists of a fixed seafloor cable parallel to the beach with electrodes that are on both sides of the cable. The cable

radiates an electronic signal which has a low frequency (KZNSB, 2019a). This electronic signal deters white sharks (Figure 2.21). The KZNSB (2019a) in South Africa has been experimenting with the shark repellent cable, which was legalised by the Department of Environmental Affairs. The KZNSB has been investigating the use of this technology as an alternative to the nets that are already in use. The cable is being tested at the Glencairn beach in Cape Town, since 2014. It is monitored continuously by the use of a video camera and by the Shark Spotters programme. The records from the shark spotters are then analysed by the scientists from the KZNSB to determine how the electronic signal from the cable affects the white sharks.

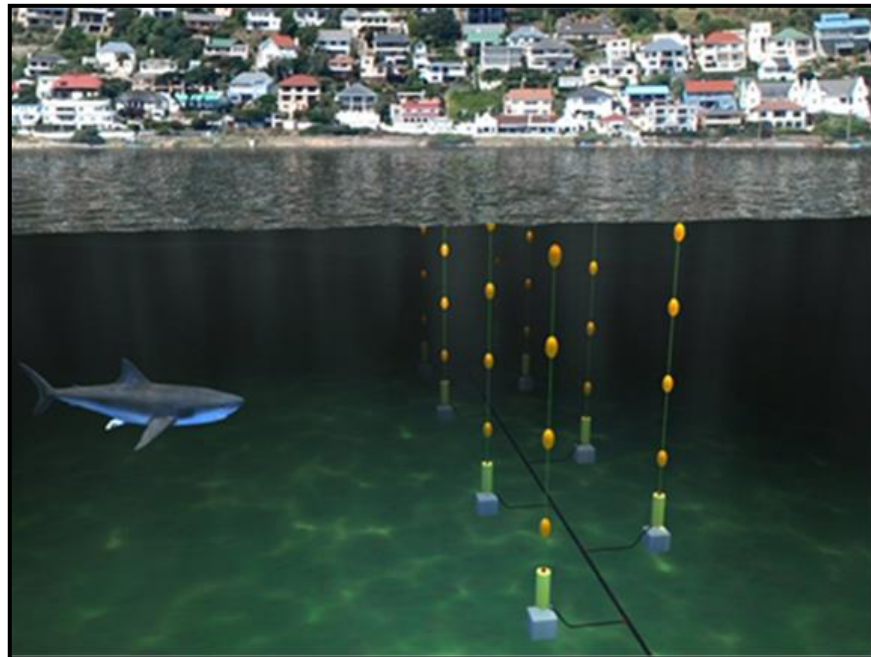


Figure 2.21: Shark Repellent Cable

Source: KwaZulu-Natal Sharks Board, 2019a

2.7 BEACH TOURISM AND ITS RELATION TO SHARK HAZARD MITIGATION

Beach tourism (including also beach recreation) is an important industry for many coastal countries. It is defined in different ways, and therefore, a summary of various definitions is provided in Table 2.7.

Table 2.7: Beach tourism definitions

Source	Definition of beach tourism
Ikhsan, Sejati & Mutiana (2019:44)	“Beach tourism is tourism based at a beach that has attractions including physical factors, facilities, and others.”
Setyaningshi, Yuliani & Winarto (2019:184)	“Beach tourism is tourism that is widely associated with activities on the water, in areas such as lakes, beaches, bays, or sea, which are managed in an integrated and planned manner, so that they are

	ready to receive tourist visits.”
Jusoh (2018:144)	“Beach tourism is considered travel for recreational, leisure or business purposes specifically on beaches.”
Saayman & Saayman (2017:1436)	“Beach or marine tourism is defined as recreational activities that involve travel away from one’s place of residence and that have as their host or focus the marine environment.”

Source: Author’s compilation

Dodds and Holmes (2019:158) argued that beach tourism is an economic driver and is also considered to be a popular type of tourism. The same authors (2018:40) also claimed that beaches are seen as recreational areas that attract ocean users, which finally leads to increased business locally. Ocean users would spend an average of US\$50 per day when visiting the beach (Klein & Dodds, 2018:40). Beach tourism is also a key contributor to the Gross Domestic Product (GDP) and economic growth of several countries (Dodds & Holmes, 2019:159; Holzner, 2011:923). When looking at the USA alone, Houston (2018:3) indicated that beach tourism generates US\$45 billion in taxes annually, by supporting 2.5 million jobs.

When managed improperly, beach tourism can have negative environmental and ecological impacts. For example, beach tourism can be directly or indirectly responsible for the degradation of beaches through various human pressures. These include trampling, crowding, urban development (e.g. the construction of hotels and shops) resulting in habitat loss, pollution (litter, noise, light, wastewater, chemical), and wildlife disturbance, among others (Dodds & Holmes, 2019:159; Schlacher, Luzrezi, Connolly, Peterson, Gilby, Maslo, Olds, Walker, Leon, Huijbers & Weston, 2016:62; Doiron & Weissenberger, 2014:21; Peterson & Bishop, 2005:887). Figure 2.22 displays different ways that human activities can influence the environment through beach tourism.

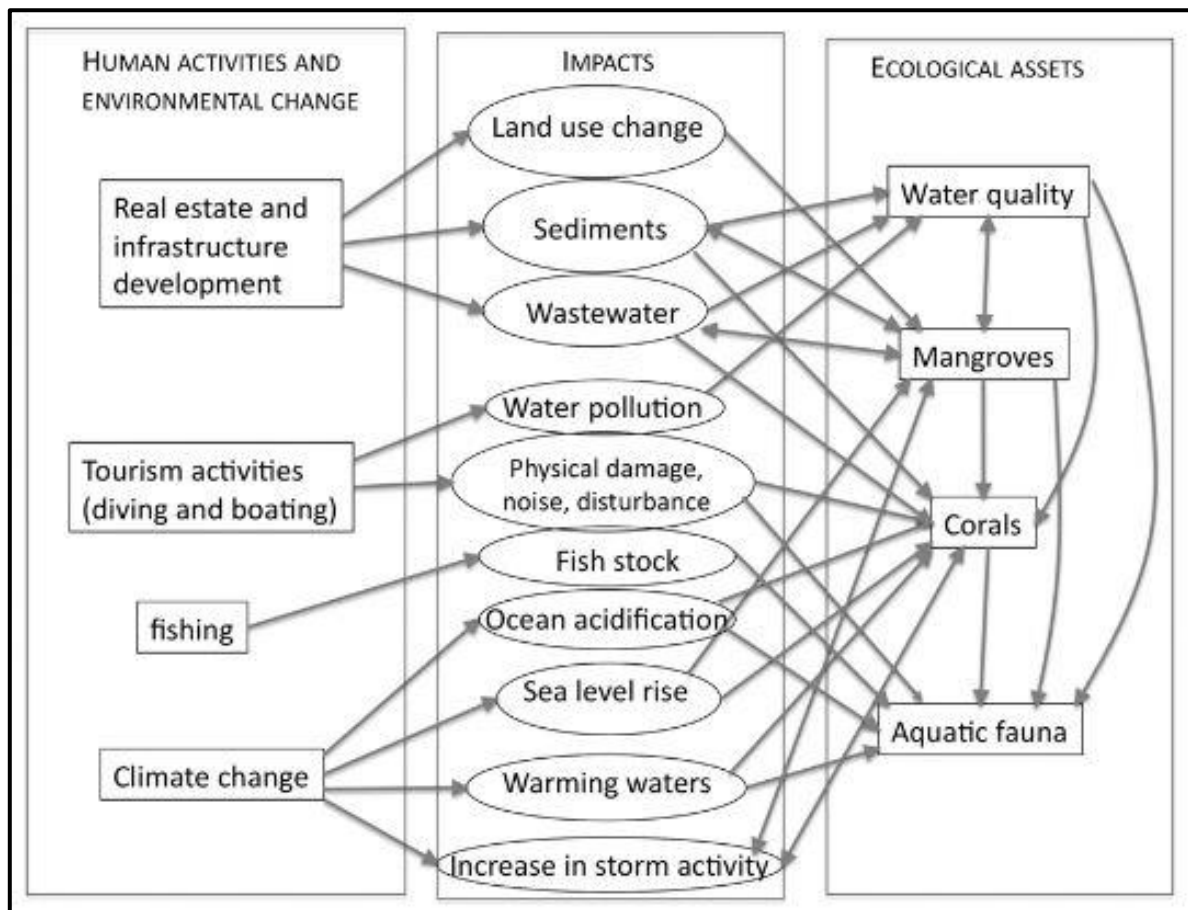


Figure 2.22: Human impacts on beaches

Source: Doiron & Weissenberger, 2014:24

Shark hazard mitigation can be strongly related to beach tourism, as shark hazard mitigation strategies are usually implemented on beaches that are popular surf and swimming destinations (Gibbs, 2018:4; Gray & Gray, 2017:282). Beaches that are important for recreation and tourism usually have strategies in place to protect humans from sharks (Parliament of Australia, 2017:49). Indeed, sharks are generally listed as a type of biological hazard associated with beach-based tourism and recreation (McLachlan, Defeo, Jaramillo & Short, 2013:262). One of the arguments for shark hazard mitigation programmes is that they are implemented to protect ocean users and tourism from potential shark bite incidents and their consequences (Cliff & Dudley, 2011:700). However, there are several issues related to this argument and the management of shark hazard mitigation and beach-based tourism, especially concerning controversial measures of mitigation.

One of these issues, and perhaps the most critical one, is that lethal shark control strategies tend to sacrifice the ecological integrity of coastal ecosystems in favour of ocean users' protection, without a balance (Hammerton & Ford, 2018:287). This problem ties in with the previous arguments concerning human impacts on beaches and adjacent ecosystems. Figure 2.23 is a schematic representation of the negative feedback loop resulting from lethal

shark control for beach-based tourism, which can affect not only sharks, but also the fulfilment of human needs and the delivery of ecosystem services.

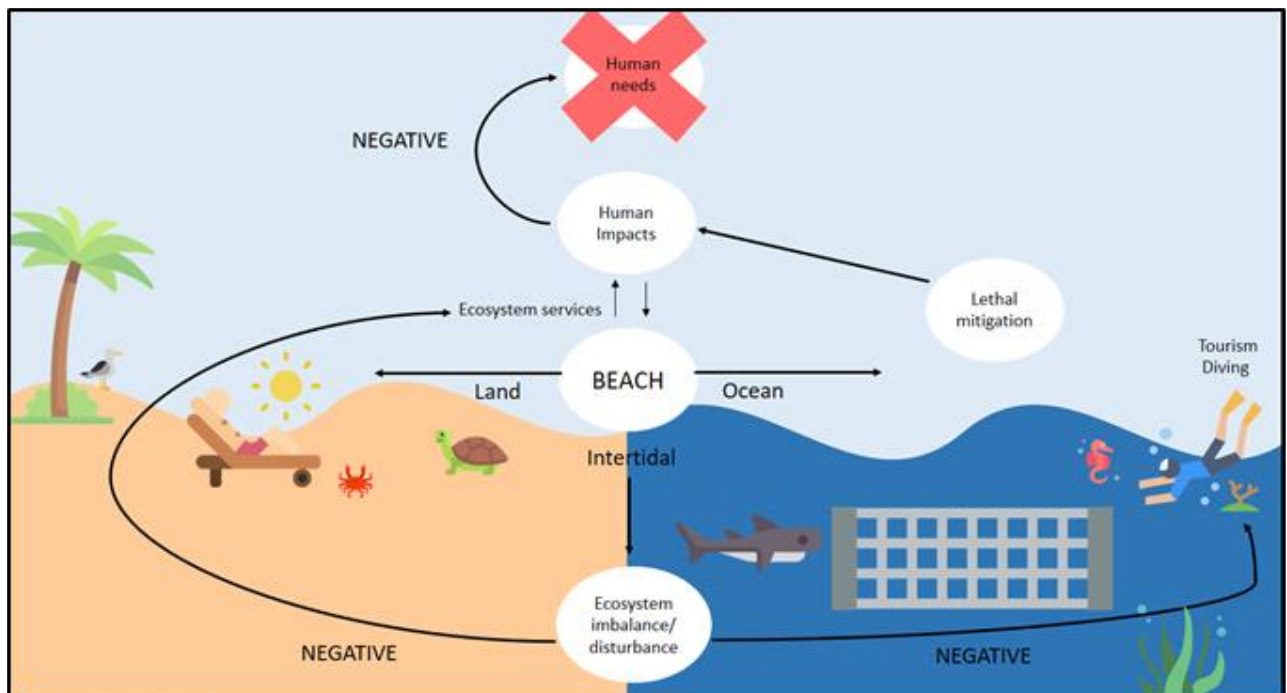


Figure 2.23: Conceptual model of impacts

Source: Author's compilation

From the figure it is clear that there are ecologically damaging treatments of sharks resulting from various human needs which are in conflict with conservation agendas, specifically, beach-based recreation resulting in the implementation of lethal shark control. When looking at human needs, there are three dimensions that humans make use of: land, the intertidal zone and the ocean. For humans to use the ocean, lethal mitigation measures such as shark nets are in place to protect humans from sharks. This leads to an ecosystem imbalance and disturbance. When an ecosystem disturbance takes place, ecosystem services fulfilling other human needs, such as tourism activities including scuba diving, are affected negatively. The result is that these human needs can no longer be fulfilled.

Another issue is that ocean users may not be aware of locally implemented shark hazard mitigation at recreational beaches, which could have an impact on the effectiveness of the mitigation strategy or the social licence to operate. Gray and Gray (2017:283) found that ocean users were aware of shark hazard mitigation strategies on local beaches in Sydney, Australia; however, they only had a basic understanding of how these mitigation measures worked and tended to misestimate their efficacy. Crossley *et al.* (2014:159) indicated that most of the ocean users they interviewed in New South Wales and South Australia were aware of shark hazard mitigation strategies in place, including nets and aerial surveys, but had a better knowledge of the former rather than the latter. In a recent study at the Hibiscus Coast in KZN, South Africa, it

was revealed that tourists were unaware of the local bather protection programme implemented by KZNSB, including nets and drumlines (Lucrezi, Geldenhuys, Van Der Merwe & Saayman, 2018:953). Similar research showed that only 27% of beach visitors interviewed in Muizenberg, Cape Town, could identify the shark spotting flag on the beach as representing the Shark Spotters programme (Lucrezi, Saayman & Van Der Merwe, 2015:216).

A third issue is that ocean users may not necessarily choose beaches based on shark mitigation strategies but may select their destinations based on other reasons, such as convenience or aesthetic qualities of the beach environment (Crossley *et al.*, 2014:162). The last issue is that ocean users may oppose shark hazard mitigation or at least some types. Gray and Gray (2017:287) found that ocean users in Sydney, Australia, favoured the use of shark nets, while they did not agree with culling and killing of sharks. The authors argued that most of the participants in their study were aware of the nets being in place. However, only a few people knew exactly how nets worked. The authors also explained that the nets have been implemented for a very long time (70+ years) in the area studied, therefore, respondents were familiar with and supportive of the nets.

Based on these issues, it is important to have a proper understanding of the perceptions of beach-based tourists and recreationists, including ocean users, regarding shark conservation and shark hazard mitigation, in order to find the appropriate management strategies that will benefit the conservation of sharks and tourism. This is discussed in the table in the next section.

2.8 RESEARCH ON THE HUMAN PERCEPTIONS OF SHARKS AND SHARK HAZARD MITIGATION

Research conducted on the human perceptions of sharks and shark hazard mitigation strategies was examined in depth to gain a broader insight into how the public perceives sharks and shark hazard mitigation. In Table 2.8, a summary of recent studies concerning these topics is shown. The table reports studies on beach users, recreational ocean users (such as fishers) and the general public. Scuba divers were considered a standalone user group – generally known to hold positive attitudes and behaviour concerning sharks (Lucrezi, Bargnesi & Burman, 2020) – and were thus not included in the summary below.

Table 2.8: Studies conducted on human perceptions of sharks with a focus on shark hazard mitigation

Reference	Location	Aim of the study	Population under study	Method used to collect data	Main results	Main recommendation/reflections
Afonso, Roque, Fidelis, Veras, Conde, Maranhão, Leandro & Hazin (2020)	North-eastern Brazil	Assess the effect of socio-demographic and environmental factors on knowledge and perceptions of sharks	People visiting coastal areas (with more or less frequency of shark bite incidents)	Questionnaire survey	Socio-demographic and location (hazardous <i>versus</i> non-hazardous areas) factors affected perceptions (e.g. low education level resulted in negative perceptions)	Specific outreach in hazardous areas, nature experiencing strategies
Stokes <i>et al.</i> (2020)	New South Wales, Australia	Assess perceptions of drones to survey sharks	Beach users	Online questionnaire survey	The beach users (88%) supported drones as a shark hazard mitigation strategy	More education efforts on drones and their efficacy as shark hazard mitigation methods

Lucrezi, Ellis & Gennari (2019)	South Africa	To investigate the influence of attitudes and knowledge concerning sharks on attitudes and behaviour towards shark hazard mitigation and shark framing (sharks' depictions by the media)	Beach users	Questionnaire survey	Positive attitudes and knowledge concerning sharks make beach users more personally responsible and less dependent upon shark hazard mitigation. Shark framing is viewed negatively by those who have a positive opinion of sharks	More opportunities for humans to interact with sharks and more exposure to positive narratives on sharks are needed
Mehmet & Simmons (2019)	New South Wales, Australia	To understand the attitudes of the community concerning shark management	Social media users	Social media review (Netvizz)	Humans prefer non-lethal measures of shark hazard mitigation, rather than lethal measures and these individuals are in favour of new technologies	Future research is needed
Pepin-Neff & Wynter (2018a)	Sydney, Australia	To understand the effects of fear on policy preferences regarding shark bite prevention	Visitors to the SEA Life aquarium	QuickTapSurvey software on iPads	Low levels of blame and high levels of pride for bite incidents are found, and 41.9% of the respondents feel that swimmers are to blame for incidents	More attention is needed to the way fear-reducing messages influence policy preferences
Pepin-Neff & Wynter (2019,	Ballina and Perth, Australia	To understand public perceptions and attitudes after shark	Coastal communities affected by shark	Phone survey	Respondents prefer non-lethal mitigation strategies and believe that shark	Different approaches to human-wildlife conflict are needed

2018b)		bites	bites		bites are accidental. Support for lethal strategies correlates positively with fear	
De la Lama, De La Puente & Riveros (2018)	Peruvian coast	To understand the attitudes and knowledge of Peruvians concerning sharks and shark meat consumption	Residents	Questionnaire survey	55.4% of the respondents have negative attitudes towards sharks. The individuals fear them and see them as man-eaters	Communication campaigns are required as well as the encouragement of sustainable shark meat consumption
Curtin & Papworth (2018)	United Kingdom	To understand attitudes towards dolphins and sharks	Individuals with and without a biology background	Online survey and discrete choice experiments	Attitudes towards sharks are more negative than attitudes towards dolphins. Individuals who have positive attitudes towards sharks are more likely to donate money for shark conservation and these individuals also have a biology background	More information on flagship species is needed to gain support for sharks
Simmons & Mehmet (2018)	New South Wales, Australia	To identify ocean and beach users perceptions and preferences regarding shark hazard	Communities and beach and ocean users	Sentiment analysis and focus groups	Nets are criticised, and drones and Clever buoys are seen as the preferred strategies	Future research regarding social media and policy preferences is needed

		mitigation strategies				
Acuña-Marrero <i>et al.</i> (2018)	Galapagos Islands	To understand whether or not attitudes towards sharks differ according to demographic groups (male and female) and visitors vs. residents	Residents and visitors	Questionnaire survey	Experience and knowledge of sharks influence humans' perceptions and attitudes (83% of residents and 64% of visitors have experience with sharks). Behavioural responses, such as support for shark protection show correlations with perceptions and attitudes	Positive attitudes towards sharks should be promoted by using strategies that encourage shark conservation
Gray & Gray (2017)	Sydney, Australia	To understand beach users' attitudes towards shark bite mitigation measures	Beach users	Interviews	Most respondents (83%) are aware of nets and support the use of the nets (60% +)	Better public education is needed
McClellan, Press, Mandelman, Burgess, Cooke, Nguyen & Danylichuk (2016)	The USA.	To identify recreational anglers' fishing behaviour towards and perceptions of sharks	Recreational anglers	Online survey	86% of the anglers have positive perceptions toward shark conservation and sharks, and 89% have a desire to release sharks in such a way that they still survive	Importance of sharks and threats to sharks can be leveraged to increase support for shark conservation

Nosal, Keenan, Hastings & Gneezy (2016)	California, USA.	To understand whether or not ominous background music that accompanies shark footage influences viewers' perceptions of sharks	Viewers of shark documentaries	Web-based survey tool (Qualtrics)	People rate sharks negatively after watching a 60-second video clip of sharks with portentous background music, compared to people who watch the same clip with uplifting background music	Public awareness on the effect of background music in shark documentaries is needed
Tsoi, Chan, Lee, Ip & Cheang (2016)	Hong Kong	To investigate primary school students' understanding of environmental concepts and to discover their misconceptions about sharks	11- and 12-year old primary school students	Questionnaire survey	Students lack knowledge regarding sharks and their ecological importance	A more effective foundation for environmental education is needed, such as incorporating a food-web model into the food chain model in school education
Gallagher <i>et al.</i> (2015)	Florida, USA.	To investigate the significance of demographic variables and knowledge in understanding the vulnerability of sharks	Recreational anglers	Online survey	76% of the anglers know about the conservation of sharks; however, they are unaware of some angling threats to sharks	Effective programmes on the impacts of angling on shark survival are needed
Garla <i>et al.</i> (2015)	Brazil	To understand the attitude and knowledge of tourists	Tourists and residents	Interviews	Tourists have a higher knowledge of sharks and a more positive attitude	Innovative cooperation is needed between environmental institutions and management to

		and residents concerning shark species in a marine protected area (MPA)			towards shark species than residents	improve knowledge and awareness
Gibbs & Warren (2015)	Western Australia	To investigate the attitudes that ocean users have towards shark hazard mitigation methods, and to understand the experiences ocean users have when encountering sharks	Ocean users	Questionnaire survey	Ocean users adjust their practices to reduce the risk of encountering sharks, and they oppose the lethal mitigation strategies that are in place	More research and education programmes are needed
Palmer (2015)	Southern California coast, USA.	To understand the cultural knowledge that humans have of sharks	Beachgoers and surfers	Interviews	73% of respondents indicate that they are afraid of sharks; however, 79% indicate that sharks are not man-eaters	Public education and additional research are needed
O'Bryhim & Parsons (2015)	Chantilly, Virginia, USA.	To understand how different variables increase knowledge of and improve attitudes towards sharks	Customers of an automotive dealership	Questionnaire survey	General knowledge of sharks is low, and understanding a person's knowledge about sharks can help with the determination of their attitudes and perceptions. Higher knowledge leads	Educational programmes need to be developed

					to more positive attitudes	
Friedrich <i>et al.</i> (2014)	United Kingdom	To investigate public perceptions of shark conservation and sharks in general	Visitors at the National Marine Aquarium in Plymouth	Questionnaire survey	97% of the respondents state that not all sharks are a threat to humans, and 99% indicate that sharks are very important for the marine ecosystem	Further investigation is needed
Crossley <i>et al.</i> (2014)	New South Wales and South Australia, Australia	To determine beachgoers' awareness, attitudes and behaviour concerning shark hazard mitigation strategies	Beachgoers	Questionnaire survey	90% of beachgoers are aware of mitigation strategies in place; however, only 0.5% of the respondents choose beaches because of the strategies in place	Education on the real risks of shark 'attacks' is needed as well as further research with regards to the emotional response to shark attacks
Neff & Yang (2013)	Fish Hoek and Muizenberg, South Africa	To evaluate public attitudes towards sharks before and after a shark bite incident	Beach communities	Questionnaire survey	Attitudes towards sharks may be independent of shark bites	More research is needed
Tsoi (2011)	Hong Kong	To understand children's conceptual understanding and perceptual belief of sharks	School pupils	Questionnaire survey	Children believe that misfortune is associated with sharks (18.6%) and that sharks should be killed (26.5%)	A better understanding of the perception of sharks in schools is needed

Source: Author's compilation

Table 2.8 summarises 23 studies carried out from 2011 to 2020, concerning human perceptions of sharks and shark hazard mitigation. Most of the research was conducted in places where shark hazard mitigation programmes are in place, such as Australia, the United States, and South Africa, or where there is a conflict between humans and sharks, such as the Peruvian Coast or Brazil. The bulk of the research was conducted in Australia because shark hazard mitigation policies are highly debated at this moment in the country. Only two studies were conducted in South Africa. However, the country offers opportunities to carry out research that can yield interesting results, for four reasons: 1) it is the top third country where shark bite incidents have been recorded (Chapman & McPhee, 2016:75), 2) it hosts many species of sharks involved in shark bite incidents (Chapman & McPhee, 2016:76), 3) it hosts different types of shark hazard mitigation, including lethal and non-lethal (Engelbrecht *et al.*, 2017; Cliff & Dudley, 2011), and 4) it offers an opportunity to investigate different types of ocean users, from surfers to scuba divers.

All of the above studies focussed mainly on understanding perceptions of sharks and shark hazard mitigation strategies, some also before and after a shark bite incident, and investigated preferences of ocean users in dealing with the human-shark conflict. Two studies focussed on identifying whether or not school children are aware of the importance of sharks (Tsoi *et al.*, 2016; Tsoi, 2011) and whether or not background music that accompanies shark footage creates a negative perception of sharks (Nosal *et al.*, 2016). Four studies focussed on understanding if perceptions of and attitudes towards sharks and shark hazard mitigation differ based on demographic background (Acuña-Marrero *et al.*, 2018; Curtin & Papworth, 2018; Gallagher *et al.*, 2015). The populations under investigation in these studies consisted of coastal communities, ocean users, social media users, recreational anglers, viewers of shark documentaries, tourists, and school pupils. Thus, a variety of populations were used to gain a broad insight into perceptions of sharks and shark control. The majority of the studies made use of phone surveys, questionnaires and interviews to collect the data needed through a purposive sampling strategy.

The researchers of the above studies mostly found that ocean users have a positive perception of sharks and prefer or support non-lethal mitigation methods that are not harmful to sharks (Stokes *et al.*, 2020; Mehmet & Simmons, 2019; Pepin-Neff & Wynter, 2019; Pepin-Neff & Wynter, 2018b ; Simmons & Mehmet, 2018; Garla *et al.*, 2015; Gibbs & Warren, 2015). Sharks are also seen as very important to the marine ecosystem, and humans do not always perceive sharks as man-eaters (Palmer, 2015; Friedrich *et al.*, 2014). Other researchers found that anglers have positive perceptions of sharks; however, they are unaware of some threats faced by sharks (McClellan Press *et al.*, 2016; Gallagher *et al.*,

2015). Researchers such as Tsoi *et al.* (2016) and Tsoi (2011) found that school students lack knowledge regarding sharks and their importance, and that they believe that sharks are associated with misfortune. This can be a result of the lack of understanding children may have on sharks. The majority of the researchers indicated that humans who fear sharks and have a lack of knowledge about sharks are most likely to support lethal shark hazard mitigation strategies and vice versa (Acuña-Marrero *et al.*, 2018; Pepin-Neff & Wynter, 2018a; Pepin-Neff & Wynter, 2018b; O'Bryhim & Parsons, 2015). De La Lama *et al.* (2018) found that, despite living on the coast, people might fear sharks, may see them as man-eaters, and engage in unethical shark consumption, but this behaviour could result from poor public knowledge about sharks in general.

The researchers of these studies made several recommendations. However, the most common recommendation was that more education and research are needed on the topics studied. Researchers also stated that more opportunities should be given for humans and sharks to interact, and that shark conservation should be better promoted and encouraged. From the recommendations, it is evident that there is still a research gap about the understanding of how the public, including ocean users, perceives sharks and shark hazard mitigation.

2.9 THE ROLE OF THE MEDIA IN PORTRAYING SHARKS AND INFLUENCING SHARK MANAGEMENT

Research conducted on the media's portrayal of sharks was broadly examined to gain a better insight into shark framing and its influence on shark management. The reason for this examination was three-fold: 1) the media are often blamed for putting sharks under a negative light, instigating fear; 2) the media have been accused of misrepresenting and melodramatising shark bite incidents; 3) the media have also been claimed to partly influence political decisions to implement lethal shark control (Neff, 2015:115; Muter *et al.*, 2013:188; Neff & Hueter, 2013:68). Table 2.9 displays the results of the examination done on the literature on these topics.

Table 2.9: Studies conducted on media portrayal of sharks

Reference	Location	Aim of the study	Type of media under consideration	Method used to collect data	Main results	Main recommendations/reflections
Hardiman, Burgin & Shao (2020)	Australia	To determine how human-shark interactions and sharks are portrayed in newspapers during a certain period	Newspaper	Media discourse analysis	Most articles focussed on the interactions where an injury took place and tabloids are more prone to provide sensationalised news	No pattern between newspapers were found
Le Busque, Roetman, Dorrian & Litchfield (2019)	Australia	To determine how often the word "sharks" occurs on Australian media Facebook pages	Facebook	Content and thematic analysis	Shark news stories are frequent and widespread and interactions are labelled as attacks	Future research regarding social media posts is needed

Bornatowski, Hussey, Sampaio & Barreto (2019)	Globally	To determine if there is a geographic bias in reporting human-shark interactions	Articles	Literature search	There is a geographic bias in destructive reporting of human-shark interactions	Increased communication is needed between stakeholders to develop rules for the media reporting sharks
Hardiman, Burgin & Shao (2019)	Australia	To investigate narratives in newspapers regarding measures used to reduce the risk of shark encounters	Newspaper (The Telegraph), compared with data from ISAF (International Shark Attack File database)	Media discourse analysis	The most mentioned shark hazard mitigation measure is lethal control	More education and risk acceptance are needed
Bombieri, Nanni, Delgado, Fedriani, López-Bao, Pedrini, & Penteriani (2018)	Globally	To analyse media reports of interactions between predators and humans	Media reports	Content analysis	Sharks have the highest percentage of graphic elements in the media portrayals	Graphic elements in media should be reduced to reduce the amount of fear
Sabatier & Huveneers (2018)	Western Australia	To understand the media's portrayal of encounters between wildlife and humans and how it influences human attitudes	Newspaper articles	Content analysis	When fatal human-wildlife incidents occur, the media negatively frame the behaviour of wildlife which exaggerates public fear and anxiety	Conservation scientists and government agencies should better engage with the media to ensure the divulgation of accurate information

Fraser-Baxter & Medvecky (2018)	New South Wales, Australia	To investigate the reporting of the media concerning the political and public responses to human-shark interactions	Newspapers	Content analysis	Media reports about human-shark interactions in New South Wales are ecocentric rather than sensationalised	Future investigation into policy preferences and human attitudes with regards to human-shark interaction is needed
Evans (2015)	Globally	To determine how the Discovery Channel's Shark Week portrays sharks, and to determine if this portrayal has changed after 2010	Episodes of Shark Week in the Discovery Channel	Video content analysis	Discovery Channel continues to portray sharks as killers even after more science frames have been added to the show	More support is necessary from the media and the public to help with shark conservation
McCagh <i>et al.</i> (2015)	Western Australia	To understand the media and public role in decision making about the implementation of drumlines	Newspapers	Media discourse analysis	There is a connection between the decision to install drumlines and public pressure; however, there is no connection between public support and culling programmes	The policymakers need to revise their approach to developing shark hazard mitigation programmes, through engagement with the public, to gather support for non-lethal shark hazard mitigation strategies
Boissonneault, Gladstone, Scott & Cushing (2015)	Australia	To analyse printed media's depiction of the grey nurse shark, and to understand whether this has changed over the years	Newspapers published between 1969 and 2003	Content analysis	More articles regarding the grey nurse shark have been published towards the end of the studied period. Of these, only 37% of the news articles give a positive depiction of sharks	Public attitudes should be analysed to understand whether or not these articles are relevant and true

Muter <i>et al.</i> (2013)	Australia and the USA.	To describe the context of shark-related articles in high-profile news media in the USA and Australia throughout 2000-2010	Newspapers	Content analysis	Most articles highlight the risks of sharks to people	Conservation professionals should engage with the media to emphasise the rarity of sharks bite incidents, and they should also discuss the measures that ocean users can take to prevent shark encounters
Whatmough <i>et al.</i> (2011)	Australia and Asia	To identify recreational divers' experience with sharks and rays	SportDiving Magazine	Content analysis	Attitudes towards rays and sharks have changed. Recreational divers have changed from "adventure-seeking hunters" to "nature-appreciating observers"	Detailed surveys targeting authors, editors and readers are needed

Source: Author's compilation

The table counts 12 studies on the media's portrayal of sharks. This research was conducted between 2011 and 2020, although some of it pertains to media published during the 20th and 21st centuries. The bulk of the literature was conducted in Australia, as several shark species inhabit the waters surrounding the country, and Australia is the hub of much debate concerning shark hazard mitigation. This results in sharks being a prevalent point of discussion in the media.

The studies mainly focussed on determining how the media portray sharks and how this portrayal influences the conservation of sharks. This was done in various ways, for example, by identifying how many times the word “shark” occurs on Facebook pages (Le Busque *et al.*, 2019), or by describing the context and content of shark-related news articles (Muter *et al.*, 2013). The types of media that were investigated in these studies consist of Facebook pages, newspaper articles, media reports, episodes of television series, and magazine articles. The method that the researchers used mainly consisted of content analysis and media discourse analysis. These methods helped in identifying certain words and assisted in understanding what was meant by using these words.

The researchers found that human-shark interactions are mentioned in the media mostly as ‘attacks’ (Le Busque *et al.*, 2019) and that the most mentioned shark hazard mitigation measure is lethal control, such as the use of nets and drumlines (Hardiman *et al.*, 2019). Researchers such as Bombieri *et al.* (2018), Sabatier and Huveneers (2018) and Boissonneault *et al.* (2015) found that articles about sharks contained the highest percentage of graphic elements, and that a small percentage of articles published on sharks contained positive narratives about sharks. This way of framing sharks may result in public fear and anxiety. Muter *et al.* (2013) also found that newspapers highlighted the risks of sharks to people and not the risks of people to sharks. This narrative may also contribute to public fear of sharks.

When considering this, it is clear that the media could play a negative role as they provide contrasting – or incorrect – information about sharks and human-shark interactions. However, some studies have revealed that the media have been changing their rhetoric on sharks and that the public is responding positively to this rhetoric. For example, Muter *et al.* (2013) explained that there is an increasing number of media stories documenting the importance of sharks and focussing on the positive effects of sharks, and also stories narrated by shark bite victims who want to protect sharks. Similarly, O’Byrne and Parsons (2015) found that the Discovery Channel’s television programme “Shark Week” has been increasing public knowledge of sharks and promoting positive attitudes towards shark conservation.

The researchers made several recommendations; the most prominent ones were that communication between stakeholders to develop rules for the media in reporting sharks is needed, and that support from the public and policymakers is desirable. It was also suggested that conservation scientists should engage more with the media to ensure that accurate information is portrayed, as some of the information is only from word of mouth or inaccurate. Media portrayals currently represent one of the top shark-related research priorities, according to managers (Huveneers *et al.*, 2018:4). Therefore, more research on this specific topic could greatly benefit the endeavours towards proper treatment of shark-related information, including human-shark interactions, as well as efforts to protect sharks and manage ocean use sustainably.

2.10 HUMAN-SHARK INTERACTIONS, SHARK HAZARD MITIGATION AND PUBLIC OPINION RESEARCH ON SHARKS IN SOUTH AFRICA

Human-shark interactions normally take place as a result of humans making use of sharks' habitat. South Africa has a long coastline, and its waters host several shark species, resulting in several human-shark interactions taking place. When looking at the rates of shark bite incidents, South Africa ranks amongst the top countries (Florida Museum, 2020; Lemahieu, Blaison, Crochelet, Bertrand, Pennober & Soria, 2017:73; Caldicott, Mahajani & Kuhn, 2001:452). Records of shark bite incidents only started in 1905, and ever since only 256 unprovoked attacks were reported for the country, where 103 were in the Eastern Cape, 90 in KZN, 55 in the Western Cape and eight were insufficient for judgment (Figure 2.24). The incidents mainly involved white sharks, bull sharks and tiger sharks (Shark Spotters, 2018).

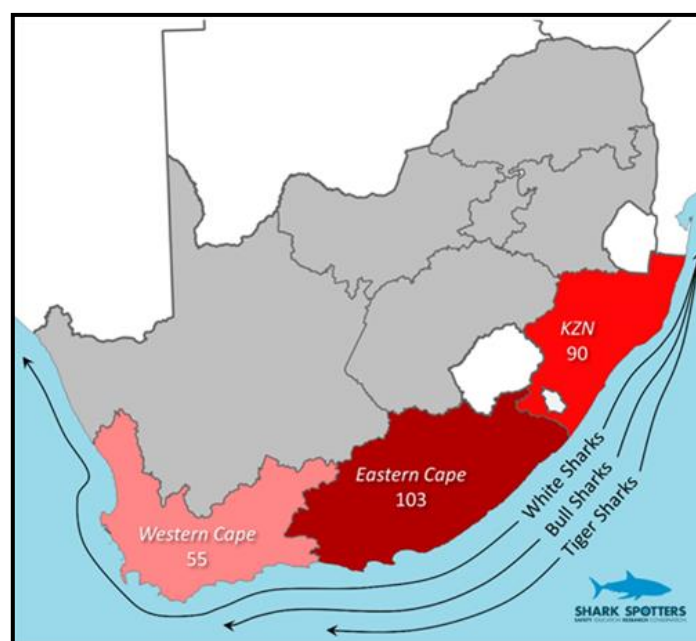


Figure 2.24: Unprovoked shark attacks in South Africa from 1905-2018
Source: Shark Spotters, 2018

There are many locations in the South African coast and oceans where human-shark interactions can take place. Examples include the areas directly backing the surf break on ocean beaches, and the surf zone visited by a great number of ocean users (Lagabriele, Allibert, Kiszka, Loiseau, Kilfoil & Lemahieu, 2018:4).

South Africa implements large-scale shark hazard mitigation programmes to protect ocean users from the risk of shark bite incidents, and to minimise human-shark interactions. These programmes consist of both lethal and non-lethal strategies as well as different legislations, and are mainly managed by Shark Spotters in the City of Cape Town, Western Cape, and the KZNSB in KZN. Lethal strategies that are used include nets and drumlines (baited hooks), while non-lethal strategies that are used include shark spotting, information, education and monitoring (Pepin-Neff, 2019:91; Engelbrecht *et al.*, 2017:1; Cliff & Dudley, 2011:700). Different laws are in place such as “The Marine Living Resource Act”, “The Animal Protection Act”, as well as “The National Environmental Management Act” to help regulate shark hazard mitigation (Department of Environmental Affairs, 2015).

While shark hazard mitigation is implemented in South Africa, research on the ocean users’ perceptions of sharks and shark hazard mitigation in the country is still limited, with only two studies published. The first one is by Neff and Yang (2013) and reports research carried out in Cape Town, regarding local ocean users’ perceptions of sharks and the local shark hazard mitigation strategies used. Surveys were conducted in Muizenberg and Fish Hoek regarding the respondents’ level of pride in sharks and level of confidence in beach safety strategies, such as the Shark Spotters programme and lifeguards. It was found that levels of pride were unchanged after a shark bite incident, and confidence in beach safety was also unchanged. This led to the conclusion that attitudes regarding sharks are independent of shark bite incidents. This research suggests that shark bite incidents do not necessarily lead to negative attitudes toward sharks. However, the authors indicated that more research regarding this topic is needed to gain more insight. A second, more recent study was done by Lucrezi *et al.* (2019), on the putative influence of knowledge of sharks and attitudes towards sharks on attitude and behaviour towards shark hazard mitigation and shark framing. The study targeted beach visitors across South Africa using a questionnaire survey, and the hypotheses were tested using structural equation modelling. The authors found that knowledge and positive attitudes were able to increase personal responsibility in water safety and views that shark framing is still negative. Although the perceived intentionality of sharks in bite incidents, as well as perceived risk from sharks, had a negative influence on personal responsibility and perceptions of shark framing, such perceptions could be moderated by positive beliefs concerning sharks. The

researchers concluded that more work is advised to properly understand the many influences, both demographic and context-specific, on the public opinion of sharks in South Africa.

Importantly, a few studies have discussed shark-based tourism in South Africa and its relevance for the local national economy and for shark conservation. Examples include studies by Lucrezi *et al.* (2020), McKay (2019:283-297), and Dicken and Hosking (2009:227-232). These studies shed more light on the opinion that different ocean user groups may have about sharks in South Africa, thus pointing to the complexity of the dynamics between humans and sharks in the country. The studies showed that shark tourism is highly valued among ocean users and that South Africa attracts a large number of national as well as international tourists, for the purpose of seeing sharks in their habitat. This happens especially in the provinces where shark hazard mitigation programmes are implemented, such as KZN (Sodwana Bay, Aliwal Shoal and the Protea Banks), and the Western Cape (False Bay, Gansbaai and Mossel Bay). Shark diving, which includes scuba diving or free diving and snorkelling with sharks boomed in the 1990s in South Africa, and has ever since contributed millions of US dollars (US\$) to the national economy (McKay, 2019:283). Dicken and Hosking (2009:227) indicated that shark diving is a growing element in the international tourism sector, and the researchers also stated that Gansbaai generates around US\$2.05 million per year with shark cage diving, while Aliwal Shoal generates around US\$1.62 million per year with tiger shark tourism (McKay, 2019:285). This suggests that at least some ocean user groups are strongly supportive of sharks and their conservation, as they are willing to pay top dollar to have some interaction with sharks. Also, the majority of the respondents (95.9%) from the study by Dicken and Hosking (2009:227) claimed that they felt safe around the sharks and did not feel threatened while they had an interaction with sharks underwater. This can indicate that the diving community values sharks as well as the conservation of sharks.

Public opinion research focussing on shark hazard mitigation is very important, as it can enlighten decisions and policy regarding the conservation and protection of sharks, and it can also help find an eco-friendly solution to minimise interactions between humans and sharks (Pepin-Neff & Wynter, 2018a:6). South Africa offers opportunities for new research endeavours on this topic, not only given the evident research gap in the country, but especially since the country hosts different shark hazard mitigation programmes (Cliff & Dudley, 2011:700). New research will enable comparisons of the way ocean users understand and perceive sharks and shark hazard mitigation programmes, making it possible to reflect on avenues to enhance sustainable shark control programmes not only in South Africa, but also internationally.

2.11 CONCLUSION

This chapter discussed relevant topics concerning sharks and shark hazard mitigation. It gave insight on the importance of the ocean and sharks and the threats they are facing, the history and types of human-shark interactions, different shark hazard mitigation strategies, and beach tourism and its relation to shark hazard mitigation. This chapter also presented two literature review tables, describing research conducted on human perceptions of sharks and shark hazard mitigation, and the role of media in portraying sharks and influencing shark management. The chapter was concluded with a discussion of the limited research on human perceptions of sharks and shark hazard mitigation in South Africa, highlighting an evident gap that can be filled through more research. This chapter was summarised in Chapter 5.

Chapter three

METHODS AND MATERIALS

3.1 INTRODUCTION

In this chapter, the study locations where the research was carried out are described. In describing these locations, the following characteristics are considered: their geographic position, the type of beach tourism present, beach management measures in place, shark species in the local area, reported human-shark interactions, shark hazard mitigation strategies in place (if any), and the profile and reported environmental perceptions of the visitors to the study locations according to literature. The research design, materials and methods of data collection, and data analysis are also discussed in this chapter.

3.2 STUDY LOCATIONS

Five locations, characterised mainly by sandy beaches, were selected for this study (Figure 3.1). The locations were Muizenberg in False Bay (City of Cape Town), Hartenbos in Mossel Bay, Jeffreys Bay, Hobie Beach in Port Elizabeth, and Durban Beach in Durban. The first two locations are in the Western Cape province; the second two are in the Eastern Cape province, and the last one is in the KwaZulu-Natal (KZN) province. The selection of these study locations was based on the variety of ocean uses, popularity, the presence of known shark species in the area, the fact that shark bite incidents have occurred in some of these areas, and the presence of local shark hazard mitigation strategies and various management measures, such as the blue flag award. A more detailed description of the locations is provided as follows.



Figure 3.1: Map of study locations

Credits: Google Maps

3.2.1 Muizenberg (False Bay, City of Cape Town), Western Cape

Muizenberg beach, in False Bay (Figure 3.2), Western Cape ($34^{\circ}6'30.00''\text{S} - 18^{\circ}28'14.43''\text{E}$) is a famous beach in the City of Cape Town. It is a surfing hotspot and is also known for its coastal tourism (Williams & Micallef, 2009:26). Muizenberg beach attracts local as well as international people throughout the year (Ballance, Ryan, & Turpie, 2000:210). Muizenberg beach has been also a blue flag beach for the eleventh consecutive year in 2019/2020. The blue flag is seen as an eco-label which is awarded to beaches that meet the requirements of the Blue Flag programme. This means that the beach is clean and safe and has well-managed facilities in place, but it also means that the beach implements good management practices – such as environmental monitoring – in accordance with eco-friendly principles, and that environmental education is provided at the beach including information on the importance and vulnerability of sharks (WESSA, 2020; Lucrezi *et al.*, 2015:220).

The waters around Muizenberg beach host different shark species which include the dusky shark, the bronze whaler, and the great white shark (Lamberth, 2006:724). Muizenberg beach is also a beach where human-shark interactions take place, mainly shark sightings by surfers and bathers in the water. Interactions have included very rare fatal and non-fatal bite incidents; the most recent one was a non-fatal bite of a surfer in August 2014 (Sharkattackdata.com, 2020). Muizenberg beach has a shark hazard mitigation strategy in place, which is the main strategy used. This is the Shark Spotters programme, which is a non-lethal measure also promoting shark conservation (Shark Spotters, 2019b; Engelbrecht *et al.*, 2017:1; Kock *et al.*, 2012:44). The Shark Spotters programme is described in Chapter 2 (2.2.6).

Recent work by Lucrezi *et al.* (2018) and Lucrezi *et al.* (2016) indicated that the visitors to Muizenberg beach are 27-40 years old, mainly local residents or international visitors with postgraduate or professional education. Studies by Lucrezi *et al.* (2018) and Lucrezi and Van der Walt (2016) concluded that visitors to Muizenberg are sensitive to some potential hazards including rip currents and sharks, and desire to attain more environmental information and education. A study by Lucrezi *et al.* (2015) conducted in 2014 also showed that only 40% of surveyed visitors to Muizenberg were aware of the existence of the Shark Spotters programme, and an even lower proportion was aware of management measures including the blue flag implemented locally. These findings may be related to the presence of a large number of international visitors, and not necessarily to a lack of education and information effort locally. International visitors, however, have been demonstrated to be supportive of eco-friendly beach management practices (Lucrezi & van der Walt, 2016), which can have positive implications for the management of the local beach.



Figure 3.2: Muizenberg Beach, False Bay, Cape Town
Credits: S. Lucrezi

3.2.2 Hartenbos (Mossel Bay), Western Cape

Hartenbos in Mossel Bay (Figure 3.3), Western Cape ($34^{\circ}7'37.87''\text{S}$ – $22^{\circ}7'7.16''\text{E}$) is a family-friendly beach which is very popular to ocean users (Saayman, Slabbert & van der Merwe, 2009:86). Hartenbos is a famous area for shark cage diving as well as shark research (Johnson & Kock, 2006:40). It has been also a blue flag beach for eleven consecutive years including the 2019/2020 bathing season (WESSA, 2020).

Hartenbos is close to Seal Island, which is approximately 1km offshore. Seal Island is famous for hosting a large colony of Cape fur seals which are a food source for great white sharks; the latter form an important congregation in the waters of the bay (Jewell, Johnson, Gennari & Bester, 2013:883). Human-shark interactions take place at Hartenbos but fatal and non-fatal bites have been extremely rare. According to Sharkattackdata.com (2020), there were only three bite incidents recorded in Hartenbos, where only one incident was fatal in 2014. Hartenbos does not currently have any official shark hazard mitigation in place. The locals, however, occasionally take initiatives to prevent human-shark interactions from taking place, such as trained lifeguards, aerial surveys, and shark spotting (ZigZag, 2015). All these practices are compatible with good management as required for blue flag beaches.

A study done by Lucrezi *et al.* (2018) showed that beach visitors to Hartenbos are aged 15-76 years old, possess higher education qualifications, are largely second home owners from the Western Cape and desire family time. Importantly, they make large use of the ocean through water-based activities. According to Lucrezi *et al.* (2018) and Lucrezi and Van der Walt (2016), beach visitors to Hartenbos are aware of local water hazards such as rip currents and sharks, but are more sensitive to and concerned about problems including pollution and environmental degradation at the beach. The same visitors favour the presence of environmental education and information at the beach.



Figure 3.3: Hartenbos, Mossel Bay

Credits: S. Lucrezi

3.2.3 Jeffreys Bay, Eastern Cape

Jeffreys Bay (Figure 3.4), Eastern Cape (34°1'51.73"S – 24°55'57.46"E) is a very famous surfing hotspot, which hosts surfing competitions all year round (Van der Merwe, Slabbert & Saayman, 2011:457). This attracts local as well as international tourists who compete in these surfing tournaments (Jeffreysbay Tourism, 2020). The supertubes ("the best wave in Africa") can be found at Dolphin beach, which has received the blue flag status for eight consecutive years including the 2019/2020 bathing season (Safarinow, 2020; WESSA, 2020).

The waters of Jeffreys Bay host several shark species such as the bull shark (Zambezi shark), the great white and the ragged tooth shark (ShowMe, 2019; Dicken, Smale & Booth, 2006:128). Human-shark interactions take place in Jeffreys Bay, with bite incidents being extremely rare. Sharkattackdata.com (2020) indicates that there were eight shark bite incidents in Jeffreys Bay between 1989 and 2015, where seven were non-fatal and one, in 2013, fatal. Jeffreys Bay does not have any known shark hazard mitigation strategies in place. However, lifeguards are deployed from November to April every year and shark hazard mitigation plans are put in place during surfing competitions. These include aerial surveys, drones and jet skis which are all non-lethal to sharks (Safarinow, 2020; Mills, 2017).

A study done by Saayman *et al.* (2009) showed that beach visitors to Jeffreys Bay are, on average, 37 years old, possess school education or a diploma/degree, and a large proportion of them are surfers. Jeffreys Bay has received media attention due to a shark sighting resulting in a competitor at the Corona Open J-Bay 2017 surfing championship being pulled out of the water to safety. The same person had been involved in a physical interaction with a shark, from which he escaped unharmed, during the same competition held in Jeffreys Bay two years earlier (Mills, 2017). These events resulted in media hype to which, however, the people of the community of Jeffreys Bay, as well as surfers and shark experts, responded in support for sharks (Africa Geographic, 2015). In particular, it was declared that people would not stop using the ocean and that they were aware of the risks involved. Additionally, non-lethal shark hazard mitigation measures were favoured as possible ways to reduce risks, while there was firm opposition to shark nets.



Figure 3.4: Supertubes, Jeffrey's Bay

Credits: S. Lucrezi

3.2.4 Hobie Beach, Port Elizabeth, Eastern Cape

Port Elizabeth (Figure 3.5), Eastern Cape ($33^{\circ}59'28.8960''\text{S}$ – $25^{\circ}39'24.8832''\text{E}$) is a very popular family destination. Hobie Beach in Port Elizabeth is a popular swimming beach and is also known for activities including body boarding, surfing, and playing in the sand. Hobie Beach also hosts several events and sports competitions all year round such as the IRONMAN competition, the Splash festival, the boardsailing championships and beach volleyball tournaments, which attract many international tourists (Nelson Mandela Bay Tourism (NMBT), 2020; SAVenues, 2020a). Many such events involve ocean use. Hobie Beach has been awarded the blue flag status for the term 2019/2020, after receiving it for six consecutive years (WESSA, 2020).

The waters of Port Elizabeth are home to shark species such as the great white shark, the ragged tooth shark and the hammerhead shark (Raggy Charters, 2020). Aqua Planet (2020) indicates that the tiger shark can also be found in the waters of Port Elizabeth. Importantly, Port Elizabeth is one of the main locations in South Africa for shark cage diving tourism (Johnson & Kock, 2006). Human-shark interactions take place in Port Elizabeth but bite incidents have been very rare. According to Sharkattackdata.com (2020), 17 bite incidents have been historically recorded here, with only two being fatal (the most recent one reported in 1930). Port Elizabeth does not have any known shark hazard mitigation in place. However, the swimming beaches are patrolled by lifeguards during the summer months (NMBT, 2020).

There are no recent data describing in detail the profile of beach visitors to Port Elizabeth, as several studies have been treating them and beach visitors to other destinations as a group (Friedrich, Stahl, Fitchett & Hoogendoorn, 2020; Eagleton & Du Plessis, 2019). Additionally, there having been no shark bite incidents in the area recently, there is no real information on the current public opinion of sharks pertaining to Port Elizabeth. The present study therefore fills some of the knowledge gaps related to the profile and perceptions of beachgoers from this study location. From what can be gathered, Port Elizabeth hosting the Bayworld Oceanarium and the Nelson Mandela Metropolitan University, as well as various shark diving charters, there is a strong sense of ocean stewardship and conservation among the local people and the visitors to Port Elizabeth's coastal area, especially revolving around the threatened ragged tooth shark (Reid, 2011).



Figure 3.5: Hobie Beach, Port Elizabeth

Credits: Google photos

3.2.5 Durban Beach, Durban, KwaZulu-Natal

Durban Beach in Durban (Figure 3.6), KZN ($29^{\circ}52'4.00''\text{S}$ – $31^{\circ}2'55.71''\text{E}$) is a very popular bathing destination, which is surrounded by the uShaka Marine World. The beach attracts local as well as international visitors and is also a well-known hotspot for kitesurfing, kayaking and surfing for beginners (SAVenues, 2020b). Durban Beach has been awarded the blue flag status for the term 2019/2020, after receiving it for five consecutive years (WESSA, 2020).

Durban hosts several shark species in its waters, such as the ragged tooth shark, the tiger shark, the bull shark (Zambezi shark), and the hammerhead shark (Dudley & Simpfendorfer, 2006:226). According to Sharkattackdata.com (2020), 46 bite incidents have been recorded for the waters of Durban, where the latest one was in 2008 and was non-fatal. KZNSB is the oldest shark hazard mitigation organisation in South Africa and is responsible for implementing several shark hazard mitigation strategies in Durban and KZN for a total of 37 beaches. These strategies are mainly nets, followed by drumlines; both these strategies are lethal to sharks. Drumlines are being implemented to gradually replace the nets, to help reduce the amount of bycatch (KZNSB, 2019b; Cliff & Dudley, 2011:702). At Durban Beach only nets are used, while the drumlines are mainly located south of Durban (Cliff & Dudley, 2011:703). Nets and drumlines are removed when the weather is severe and during certain events, such as the Sardine Run. When the nets are removed, banned bathing is adopted (KZNSB, 2019b; Dudley & Simpfendorfer, 2006:226).

Research by Lucrezi *et al.* (2018) indicates that visitors to the beaches of KZN around Durban tend to originate from KZN or Gauteng and possess a high school diploma or university degree. These people are recreation-oriented water users but value the provision of environmental education and information. The same and other research (Lucrezi & Van der Merwe, 2015) covering six beaches south of Durban demonstrated that some beach visitors are unaware of local beach management measures, such as the blue flag and even shark nets and drumlines.



Figure 3.6: Durban Beach, Durban

Credits: Tripadvisor

3.3 EMPIRICAL RESEARCH

The following section describes in detail the different aspects that were addressed in conducting empirical research for this study.

3.3.1 Research design and method of data collection

The research for this study followed a quantitative, descriptive and non-experimental design, using a structured questionnaire survey targeting people visiting various beaches as the measuring instrument. Descriptive research is used to describe the characteristics of a given area or interest. It is also used to represent the frequency of a certain phenomenon (Dulock, 1993:154). Burns and Bush (2014:118) describe quantitative research as research which has a set of structured questions administered with predetermined response options. There are two benefits of a quantitative study (Choy, 2014:101. One is that the numerical data collected enable contrasts between groups and organisations; the other is that it can be quickly administered and gauged.

3.3.2 Population

This study targeted beach visitors to the selected study locations described in section 3.2 of this chapter. The term “beach visitors” here is intended to include visitors to the beach, encompassing both tourists and residents, who may or may not enter the water and engage in water-based activities (e.g. surfing, swimming). This distinction was used to partition the variation of perceptions across user groups including residents and non-residents, as well as water users and non-users. The selection of beach visitors as the target group in this study excluded other important groups in public who may be affected by shark hazard mitigation, such as fishers. However, the selection was based on the beach-based tourism and recreation management scope of this thesis, and followed grounded arguments in the literature, where coastal and water users are considered to be important groups of people who are likely to experience encounters with sharks, are directly affected by shark hazard mitigation strategies, and are also likely to affect policy and decision making revolving around beach management and shark hazard mitigation (Gibbs & Warren, 2015:117).

3.3.3 Development of the measuring instrument

The questionnaire (Annexure A) for the survey that was conducted for this study was developed on the basis of previous studies on the human dimensions of sharks and shark hazard

mitigation (Neff & Yang, 2013; Crossley *et al.*, 2014; Friedrich *et al.*, 2014; Gibbs & Warren, 2015). A number of questions therein were also newly designed for the purpose of answering the research questions.

The questionnaire was structured into three sections mainly characterised by closed-ended questions – binary, ordinal, nominal, and multiple choice – although there were also some open-ended questions that were transformed into dummy variables for analysis. The first section included demographic questions such as gender and year of birth, as well as questions on beach and water use, on the main properties sought at the beach and the greatest perceived risk at the beach. The second section included questions on perceptions of sharks and shark hazard mitigation (awareness of shark species in the area visited, attitude towards sharks and perceived safety from shark encounters at the local beach, perceptions of the meaning of shark ‘attacks’ and human-shark interactions, awareness and perceptions of different types of shark hazard mitigation strategies). The third and last section consisted of respondents’ opinions regarding topics including sharks, the framing of sharks by the media, human-shark interactions, and shark hazard mitigation strategies. The respondents were invited to express an opinion on statements relating to these topics by using a six-point Agreement Likert scale (1 = strongly disagree to 5 = strongly agree, and 6 = I do not know).

3.3.4 Sampling

There are two sampling methods that can be used: probability- and non-probability sampling. Maree (2016:192) states that when using probability sampling, the selection of rudiments is completely random, whereas non-probability sampling never makes use of random selections, but rather looks for the most suitable groups. In this study probability sampling was deployed, which is of great benefit because it guarantees fairness. The appropriate technique for this study was simple random sampling.

Beach-based sampling was done according to recommended beach survey quotas (Williams & Micallef, 2009:10). The population was characterised by people visiting the beaches at the study locations, as described in section 3.3.2. Since the actual population size for the study locations could not be found, sample sizes were estimated using available statistics for the study locations – 400 surveys per beach with 95% confidence level and 5% margin of error. Given the relatively large number of study locations chosen, and the sampling effort required to achieve a total sample of 2 000 as estimated for this study, some sample size issues were anticipated. Therefore, it was decided that sampling effort would reflect not the study locations, but the typologies of mitigation strategies under investigation, lethal shark control, non-lethal shark control, and a mixture of no shark control and sporadic non-lethal shark control. This led

to the creation of three categories of study locations, namely KZNSB (Durban Beach), Shark Spotters (Muizenberg) and Mixed (Hartenbos, Jeffreys Bay, Hobie Beach). For each category, an estimate of 400 questionnaires was allocated for a total of 1 200, although more questionnaires were available should the sampling be more efficient than expected.

Data were collected from the end of 2016 to the middle of 2018, during holiday periods including both winter and summer months corresponding with moderate to high recreational water use and shark sightings at the study locations (Engelbrecht *et al.*, 2017; Cliff & Dudley, 1991). Each sampling trip included approximately four days of sampling. On each sampling day, between 09:00 and 16:00, two fieldworkers approached beachgoers at random, inviting them to participate in the survey. The fieldworkers were instructed to leave participants to complete the survey on their own and not to suggest possible answers to the questions. The time required to complete the surveys was approximately ten minutes. As anticipated, the sampling effort yielded more data from the locations of Durban Beach (KZNSB; $n = 257$) and Muizenberg (Shark Spotters; $n = 586$). Therefore, the data collected at the remaining locations ($n = 295$) were grouped into one main category – Mixed – and pooled for the main analysis. The total sample was 1 138 beach visitors.

3.3.5 Data Analysis

The data collected from the questionnaire survey were first entered into Microsoft Excel; the data matrix was then moved to the software Statsoft Statistica (Version 13.2, 2016) and IBM SPSS (Version 26.0, 2019) which were used to analyse the data. Initially, descriptive statistics, breakdown statistics and frequency tables were used to describe the data. Following this analysis, various statistical methods were used to understand the data and answer the first two research questions. These methods are described as follows.

3.3.5.1 Cross tabulation (Pearson's χ^2)

Cross tabulation is a statistical data analysis method used to assess the relationships between different variables. This method is also known as cross tabs or contingency tables. This analysis is performed to determine the relationships between the data that may not be seen by the eye. Cross tabulations are usually performed on categorical data (data that can be divided into categories) (Aprameya, 2016). Pearson's Chi-square (χ^2) test is a statistical data analysis method used to establish if there is a relationship between variables using categorical data. This test simply tells whether the cross tabulations are significant (Laerd Statistics, 2018a).

3.3.5.2 Correspondence analysis

Correspondence analysis (CA) is a statistical data analysis method used to quantify data. It assigns values/coordinates that represent columns and rows in a data set. These values/coordinates have geometric properties which are used to create maps/graphs showing the relationship between different variables. CA is usually performed on categorical data (Greenacre, 2017:1; Greenacre, 2002:6).

3.3.5.3 Exploratory factor analysis and reliability test

Exploratory factor analysis (EFA) is a statistical data analysis method used on multivariate data, to reduce the size of the dataset by identifying relationships between questionnaire items, and extracting hidden factors underlying the items (Stevens, 2012:343). Confirmatory exploratory factor analysis (CEFA) is a type of EFA that is used to verify the factor structure of a set of variables which are extracted from a larger pool of items and are anticipated by the researcher to form a factor (Stevens, 2012:344). Reliability tests, which follow EFA, determine that the factor scores derived from EFA have internal consistency (represented by the Cronbach's α value) (Nunnally & Bernstein, 1994:248-292). According to Yong and Pearce (2013:80), a sample size of at least 300 is needed to perform an EFA, as an EFA is more effective with large sample sizes.

3.3.5.4 Spearman's rank order correlation (r_s)

Spearman's rank order correlation (r_s) is a nonparametric statistical data analysis test that evaluates the degree of correlation between variables that are independent (Gauthier, 2001:359). This test measures the direction and strength (positive or negative) of the relationship between two independent variables (Laerd Statistics, 2018b). This analysis is usually performed on paired/ordinal data (Raghute, 2019).

3.3.5.5 Test of homogeneity of variance

The homogeneity of variance tests that were used in this study included the Levene's test (Levene, 1960) and the Brown-Forsythe test (Brown & Forsythe, 1974:364) for homogeneity of variance, which transform dependent variables to check for statistical dispersion. These tests assume that samples or groups have equal variances. The Levene's test is less sensitive than other tests, and for the construction of the transformed variables it uses deviations from group means. The Brown-Forsythe test is a more robust test which uses deviations from group

medians, resulting in a lower likelihood to erroneously conclude that the assumption of equal variances has been violated.

3.3.5.6 T-test and non-parametric Mann-Whitney U test

The *t*-test (also known as independent sample *t*-test) is a statistical data analysis method used to explore the statistical differences between two variables or groups (Veal, 2017; Hole, 2009:1). A *p*-value of ≤ 0.05 is required for a *t*-test outcome to be significant (Pallant, 2016:247). The Mann-Whitney U test (Wilcoxon, 1992:196; Mann & Whitney, 1947:50) is used to compare variables between two independent groups. This test is used when the dependent variable is ordinal, but not distributed normally. It is the non-parametric alternative with regards to the *t*-test.

3.3.5.7 ANOVA and post-hoc test (Games Howell)

ANOVA (Analysis of Variance) is a statistical data analysis method used to explore the statistical differences between three or more variables or groups (dependent and independent). This test is similar to the *t*-test; however, it focusses on more variables (Pallant, 2016:259). When $p \leq 0.05$ in ANOVA, a post hoc test is used to validate where the differences between the groups occurred. The Games Howell test (Games & Howell, 1976:113) is a particular type of post hoc test that is used in cases where homogeneity of variances is not met.

3.3.5.8 Practical effect size (Cohen's *d*)

Practical effect size (also known as Cohen's *d* – Cohen, 1988) is used to test the amount of difference between different groups or variables (Maree, 2016:233; Durlak, 2009:918). Effect sizes are independent with regards to the sample size (Durlak, 2009:918). When looking at the effect sizes, Ellis and Steyn (2003:52) indicated that $d = 0.2$ is a small effect size, while $d = 0.5$ is a medium effect size and $d = 0.8$ is a large effect size. The larger the effect size the more significant the results (Higgs, 2013).

3.4 STUDY LIMITATIONS

The study had a few limitations which are discussed below and should be considered in future, similar research:

- The study was only conducted at five beaches in South Africa. Surveys including other beaches in the country may have provided more comprehensive information on the study topic. However, the study guarantees representation of the beaches implementing the main shark hazard mitigation strategies in the country.
- A limited number of questionnaires was obtained from three of the study beaches, which resulted in data from the three locations having to be pooled together. This, however, was already anticipated before the survey was conducted.
- The selection of the population may have influenced the data. This means that, while this study focussed on beach visitors, which included water users and non-users, the inclusion of other stakeholders or a better focus on some beach visitor types (e.g. surfers) may have enriched the data and improved the interpretation thereof.
- Some questions may have been formulated vaguely, resulting in some misunderstandings among the participants. While this problem cannot be easily solved due to the subjective interpretations of questions in surveys, precautions were taken by having the fieldworkers available to explain any unclear sentences to the participants when needed. Statements which were likely misunderstood were also clearly identified during the data analysis process and interpreted with caution.

3.5 CONCLUSION

The purpose of this chapter was to outline the materials and methods used in this study. In this chapter, the five study locations were described. The research for this study followed a quantitative, descriptive and non-experimental design and simple random sampling was used. A questionnaire survey was deployed which targeted beach visitors. The questionnaire was structured into three sections consisting of demographic questions, questions on the perceptions of sharks and shark hazard mitigation and, questions on the respondents' opinions regarding sharks, shark framing, human-shark interactions, and shark hazard mitigation strategies. The data were captured in Microsoft Excel and were then analysed by the software Statsoft Statistica and IBM SPSS. The analysis included cross tabulations, correspondence analysis, exploratory and confirmatory factor analysis, reliability tests, nonparametric correlations (r_s), t -tests and non-parametric equivalent, and ANOVAs (with post-hoc tests). For the t -tests and ANOVAs it was ensured that the data met assumptions of normality and homogeneity of variance. The following chapter (Chapter 4) describes the results pertaining to this study.

Chapter four

DESCRIPTIVE AND EXPLORATORY RESULTS

4.1 INTRODUCTION

The purpose of this study was to conduct a quantitative survey (see Objective 2 in Chapter 1) to determine beach visitors' perceptions of sharks and shark hazard mitigation, whether they **vary** according to the **socio-demographic** profile of beach visitors, and whether they also **vary geographically**, that is, across locations using different shark hazard mitigation strategies. This assessment was done by identifying the profile of the respondents at five beach locations in South Africa through demographic questions, such as gender, education, origin and ocean use, as well as questions on various perceptions of sharks (including knowledge, shark framing by the media and human-shark interactions) and shark hazard mitigation. In this chapter, the results of the study are described in detail and discussed in light of previous literature.

4.2 DESCRIPTIVE RESULTS

The descriptive results of this study are reported under three sections. The first section provides a demographic profile of the respondents and beach use. The second section outlines perceptions of sharks and shark hazard mitigation (awareness of shark species in the area visited, attitude towards sharks and perceived safety, perceptions of shark 'attacks' and human-shark interactions, awareness and perceptions of shark hazard mitigation strategies). The third section consists of respondents' opinions regarding sharks, shark framing (communication, media and sharks), human-shark interactions, and shark hazard mitigation strategies. Tests reported here include cross tabulations (including Pearson's χ^2), Mann-Whitney U test and correspondence analysis. Later in this chapter, data from Muizenberg (False Bay, Cape Town) are categorised under the group **Shark Spotters**, data from Durban Beach (Durban) under the group **KZNSB (KwaZulu-Natal Sharks Board)** and data from Hobie Beach (Port Elizabeth), Jeffreys Bay, and Hartenbos (Mossel Bay) under the group **Mixed**. These latter three are locations without any established mitigation but implementing sporadic non-lethal mitigation

strategies at specific times during the year – for instance, during surfing competitions. There were only 156, 93, and 46 respondents respectively at these locations. This resulted in a small sample per location, and since the locations share similarities in the way shark hazard mitigation is implemented, the data from each were pooled together (as explained also in section 3.3.4).

4.2.1 Profile of the respondents

Table 4.1 displays the profile of the beachgoers who participated in this research. When looking at the table, it is clear that the majority of the respondents were female (60% or higher) in all cases except in Hobie Beach (Port Elizabeth), where males were in greater proportion (54%). Considering the three categories of study location (Shark Spotters, KZNSB and Mixed), cross tabulation results show that there was no significant difference in gender distributions between these categories (Pearson's $\chi^2 = 1.89$, $p = 0.39$). Mann-Whitney U tests show that visitors under the category Mixed were significantly older than those under both the Shark Spotters category ($U = 57751.50$, $Z = 3.65$, $p < 0.001$) and the KZNSB category ($U = 25595$, $Z = 2.10$, $p = 0.04$). Nevertheless, the average age of the respondents remained within the early thirties to late thirties bracket. The majority of the visitors possessed a tertiary education qualification (50%-74%). Cross tabulation results show that there was no significant difference in education level (high school or tertiary) between the categories Shark Spotters, KZNSB and Mixed (Pearson's $\chi^2 = 0.51$, $p = 0.77$).

The respondents tended to come from the provinces where the data were collected (when not from overseas), although many were not local residents of the areas under study. The majority of respondents were South African residents and only Muizenberg (False Bay), Hobie Beach (Port Elizabeth) and Hartenbos (Mossel Bay) had respondents from outside South Africa. Cross tabulation results show that there was a significant difference in origin (South African or foreigner) between the categories of study locations, with KZNSB having the most South Africans, followed by Mixed and finally Shark Spotters, which had the most foreigners (Pearson's $\chi^2 = 148.28$, $p < 0.001$).

The respondents were mostly single (46%-66%) or married (30%-45%) and they indicated that they were mainly paid workers (49%-70%) and students (28%-38%). Similar profiles of beach visitor are also described in recent literature from South Africa, especially concerning the locations under study, as well as other locations globally such as Australia (Lucrezi *et al.*, 2018; Gray & Gray, 2017; Lucrezi *et al.*, 2016; Lucrezi & van der Walt, 2016; Gibbs & Warren, 2015).

The respondents mostly participated in water-based activities such as swimming (45%-80%) and land-based activities such as walking (47%-77%) and sunbathing (33%-66%). The majority of the respondents were water users (51%-85%). Cross tabulation results show that there was a significant difference in water use between the categories Shark Spotters, KZNSB and Mixed (Pearson's $\chi^2 = 46.87$, $p < 0.001$). Specifically, KZNSB had the most water users, followed by Mixed and last Shark Spotters.

In answer to what they looked for when choosing a beach and what they thought the greatest risk is when visiting a beach, respondents from all five study locations claimed that they looked for cleanliness and safety, as well as good waves in the surfing hotspots such as Hobie Beach (Port Elizabeth) and Jeffreys Bay. They felt that theft, drowning and sunburn were the greatest risks when visiting the beach. Respondents from all the study locations also indicated that sharks are a risk when visiting the beach, although the percentage of respondents who provided this indication was very low (12%-29%). These results align with existing literature from South Africa and internationally, where beach visitors prioritise environmental quality (cleanliness of water and beachscape) and safety, and consider crime, drowning and sunburn as top risks (Crossly *et al.*, 2014). These risks are confirmed to be factual in beach recreation (Pranzini, Pezzini, Anfuso & Botero, 2018).

Table 4.1: Profile of the respondents

Aspects	Durban Beach	Muizenberg	Hobie Beach	Jeffreys Bay	Hartenbos
Gender	67% Female; 33% Male	60% Female; 40% Male	46% Female; 54% Male	65% Female; 35% Male	67% Female; 33% Male
Age	$\bar{X}$ = 34 years min-max = 18-79 Std. Deviation = 13.91 Std. Error = 0.558	$\bar{X}$ = 33 years min-max = 18-71 Std. Deviation = 12.91 Std. Error = 0.929	$\bar{X}$ = 36 years min-max = 18-60 Std. Deviation = 13.77 Std. Error = 1.177	$\bar{X}$ = 38 years min-max = 18-78 Std. Deviation = 13.52 Std. Error = 1.512	$\bar{X}$ = 38 years min-max = 18-75 Std. Deviation = 15.89 Std. Error = 2.513
Highest level of education	67% Tertiary; 33% High school	68% Tertiary; 32% High school	66% Tertiary; 34% High school	74% Tertiary; 26% High school	50% Tertiary; 50% High school
Province of residence	KwaZulu-Natal (57%) Gauteng (24%)	Western Cape (49%); Outside SA (44%)	Eastern Cape (42%); Outside SA (25%)	Eastern Cape (69%)	Western Cape (37%); North West (22%)
Country of origin	South Africa (94%) International (6%)	South Africa (56%) International (44%)	South Africa (75%) International (25%)	South Africa (86%) International (14%)	South Africa (98%) International (2%)
Marital status	Single (55%); Married (39%); Divorced (4%); Widowed (2%)	Single (66%); Married (30%); Divorced (3%); Widowed (1%)	Single (49%); Married (45%); Divorced (5%); Widowed (1%)	Single (51%); Married (44%); Divorced (4%); Widowed (1%)	Single (46%); Married (41%); Divorced (9%); Widowed (4%)
Occupation	Paid worker (63%); Student (20%); Retired (9%); Unemployed (6%); Unpaid worker (2%)	Paid worker (55%); Student (28%); Retired (6%); Unemployed (8%); Unpaid worker (3%)	Paid worker (65%); Student (17%); Retired (9%); Unemployed (6%); Unpaid worker (3%)	Paid worker (70%); Student (13%); Retired (13%); Unemployed (3%); Unpaid worker (1%)	Paid worker (49%); Student (38%); Retired (9%); Unemployed (4%)
Local resident	No (55%); Yes (43%); Missing data (2%)	No (64%); Yes (33%); Missing data (3%)	No (58%); Yes (40%); Missing data (2%)	No (62%); Yes (37%); Missing data (1%)	No (70%); Yes (30%)

Activities done at beach	Swim (68%); Sunbathe (66%); Walk (62%); Surf (25%)	Sunbathe (66%); Walk (47%); Swim (45%); Surf (14%)	Walk (66%); Swim (54%); Sunbathe (33%); Surf (8%)	Walk (77%); Swim (46%); Sunbathe (40%); Surf (19%)	Swim (80%); Walk (50%); Sunbathe (41%); Surf (26%)
Water user	Yes (75%); No (21%); Missing data (4%)	Yes (51%); No (45%); Missing data (4%)	Yes (57%); No (37%); Missing data (6%)	Yes (58%); No (37%); Missing data (5%)	Yes (85%); No (13%); Missing data (2%)
What do you look for at beach?	Cleanliness; Safety	Cleanliness; Safety; No wind	Cleanliness; Safety; Waves	Cleanliness; Safety; Waves	Cleanliness; Safety
Greatest risk at this beach	Sharks (12%) Other risks: Theft; Drowning; Sunburn (88%)	Sharks (19%) Other risks: Drowning; Sunburn; Theft (81%)	Sharks (14%) Other risks: Theft; Drowning (86%)	Sharks (20%) Other risks: Theft; Sunburn (80%)	Sharks (29%) Other risks: Theft; Drowning (71%)

Source: Researcher's findings from SPSS Version 26

4.2.2 Perceptions of sharks and shark hazard mitigation

4.2.2.1 Awareness of shark species in the area visited

When the respondents were asked what shark species can be found in the area they were visiting, those from Muizenberg (Shark Spotters) indicated that the great white shark (56%) and the tiger shark (15%) could be found locally. The respondents from Durban Beach (KZNSB) indicated that the great white shark (37%), the tiger shark (27%), the Zambesi shark (25%) and the hammerhead shark (23%) could be found in the area they were visiting. The respondents from Hartenbos, Hobie Beach and Jeffreys Bay (Mixed) indicated that the great white shark (54%), the ragged tooth shark (26%) and the hammerhead shark (22%) are found in the local area (Table 4.2).

Table 4.2: Familiarity with shark species in the area visited

Shark Species	Shark Spotters (%)	KZNSB (%)	Mixed (%)
Great white	56	37	54
Tiger shark	15	27	19
Bronze whaler	3	5	4
Blacktip shark	2	17	5
Dusky shark	3	12	4
Soupfin shark	2	3	1
Hammerhead shark	11	23	22
Spinner shark	2	2	2
Zambesi shark	2	25	10
Sandbar shark	5	11	6
Ragged tooth shark	7	19	26

Note: Percentages do not add up to 100%, as respondents could choose more than one option

Source: Researcher's findings from SPSS Version 26

A correspondence analysis was done to explore the relationship between the study locations and the type of shark species the participants claimed could be found locally. When looking at Figure 4.1, it can be seen that respondents from the study locations correctly identified a number of species of sharks found locally. Respondents tended to be aware of local species including those involved in shark bite incidents (Midway *et al.*, 2019; Chapman & McPhee, 2016). The outliers tended to be the soupfin shark, the spinner shark and the bronze whaler, reflecting Table 4.2.

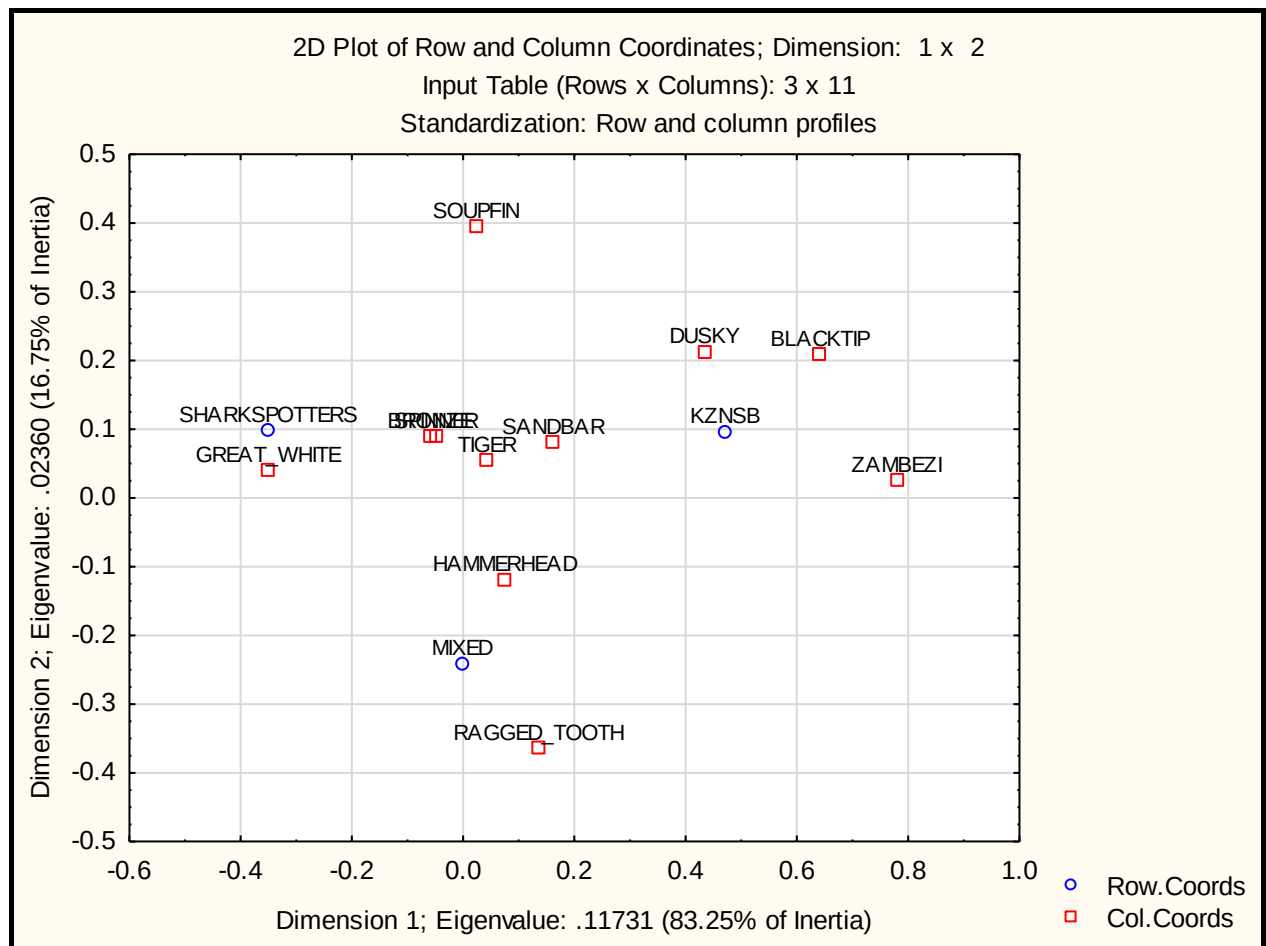


Figure 4.1: Correspondence analysis on familiarity with shark species to be found in the area visited

Source: Researcher's findings from SPSS Version 26

4.2.2.2 Attitude towards sharks and perceived safety

A few questions were asked on participants' perceptions of sharks and, from the answers, provided in Table 4.3, it is clear that respondents had mixed feelings towards sharks. Indeed, they described sharks positively ("beautiful, awesome, misunderstood") as well as negatively ("dangerous and scary"). About half (45%-54%) of the beach visitors ascribed fear to sharks. The respondents, however, also omitted sharks as the greatest risk when visiting the beach (81%-88%) (this was a dummy variable generated from the open-ended question "what do you believe is the greatest risk at this beach?"), and indicated that humans are indeed the greatest risk faced by sharks (66%-77%), with no statistically significant difference between study locations (Pearson's $\chi^2 = 4.64$, $p = 0.10$, and Pearson's $\chi^2 = 5.90$, $p = 0.05$ respectively) (Table 4.3). Similarly, while fear of sharks (this was a dummy variable generated from answers to the open-ended question "describe sharks in one word") was slightly greater for the Shark Spotters category compared with the remaining categories, this difference was borderline (Pearson's $\chi^2 = 6.25$, $p = 0.05$).

Looking at Figure 4.2, respondents indicated that they mostly felt safe to very safe from the possibility of a shark encounter at the local beach. Overall 68%-80% felt safe. The Mixed category felt less safe than the other two categories (Pearson's $\chi^2 = 15.81$, $p < 0.001$), although respondents there still generally felt safe (40%) to very safe (28%). This finding relates to research by Crossley *et al.* (2014), who found that beach visitors in South Australia and New South Wales felt safe from shark encounters at the locations they were visiting (rated 7.5/10 for safety).

Thus, while respondents partly perceived sharks as dangerous and scary, they did not perceive sharks to be the greatest risk when visiting the beach and also felt safe from the possibility of a shark encounter. The majority indicated that there are other risks greater than sharks when going to the beach. The respondents were also well aware that humans are the greatest risk faced by sharks. These results are in line with existing literature showing that although people may be afraid of sharks, this will not necessarily translate into negative feelings towards sharks (Bargnesi, Lucrezi & Ferretti, 2020; Lucrezi *et al.*, 2020; Pepin-Neff & Wynter, 2018b; Chapman & McPhee, 2016; Friedrich *et al.*, 2014).

Table 4.3: Attitude towards sharks

Aspects	Shark Spotters	KZNSB	Mixed
Describe sharks in one word	Dangerous and scary (44%) Beautiful, awesome, misunderstood (29%) Neutral (14%) Missing data (13%)	Dangerous and scary (37%) Beautiful, awesome, misunderstood (34%) Neutral (12%) Missing data (17%)	Dangerous and scary (41%) Beautiful, awesome, misunderstood (40%) Neutral (16%) Missing data (3%)
Afraid of sharks (dummy variable)	54%	47%	45%
Shark greatest risk (dummy variable)	No (81%)	No (88%)	No (82%)
Greatest threat to sharks	Humans (72%) Other (28%)	Humans (69%) Other (31%)	Humans (66%) Other (34%)

Source: Researcher's findings from SPSS Version 26

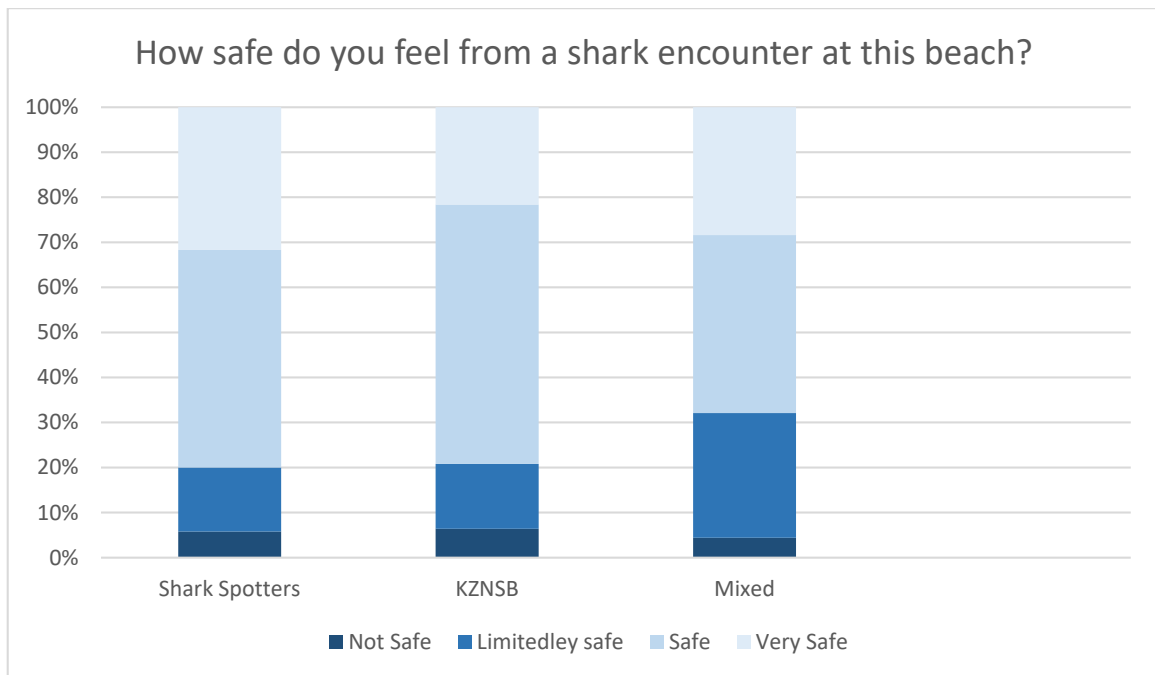


Figure 4.2: Perceived safety from possible shark encounters at the beach

Source: Researcher's findings from SPSS Version 26

4.2.2.3 Perceptions of shark 'attacks' and human-shark interactions

Respondents were asked a few questions to indicate how they perceived shark 'attacks' as well as human-shark interactions (Table 4.4). The majority of the respondents indicated that a shark 'attack' is "when a shark bites a person" (75%-77%), "when a shark kills a person" (43%-50%) and "when a shark bites a board" (e.g. a surf board) (45%-51%). This result shows that, overall, respondents associated a shark 'attack' with an interaction between human and shark involving a bite and possibly resulting in injury or fatality. Forty-six to fifty-seven percent (46%-57%) of the respondents indicated that a human-shark interaction is "when a shark swims near a person", and 46%-53% indicated that a human-shark interaction is "when a shark hits a person or a board". This shows that a human-shark interaction was mainly seen as an interaction excluding bites. Neff and Hueter (2013) described the importance of properly classifying human-shark interactions (which include fatal bite incidents as well) and removing the expression "shark attack" from media narratives, as it is normally used to criminalise the nature of shark encounters and is wrongfully deployed to also describe interactions that do not result in bite incidents. The results from this study signify the importance of adopting such an approach to promote the appropriate narratives and descriptions of human-shark interactions and reduce negative consequences for sharks.

Table 4.4: Perceptions of shark attacks and human-shark interactions

Aspects	Shark Spotters	KZNSB	Mixed
What is a shark attack? *	When a shark bites a person (77%); When a shark kills a person (50%); When a shark bites a board (46%)	When a shark bites a person (76%); When a shark bites a board (45%); When a shark kills a person (43%)	When a shark bites a person (75%); When a shark bites a board (51%); When a shark kills a person (44%)
What is a human-shark interaction? *	When a shark swims near a person (57%); When a shark hits a person/board (46%)	When a shark swims near a person (46%); When a shark hits a person/board (53%)	When a shark swims near a person (50%); When a shark hits a person/board (46%)
Been involved in an interaction with a shark?	12%	21%	14%
What type of interaction have you had with sharks?	Diving	Cage diving	Diving/Cage diving

Note: Percentages do not add up to 100%, as respondents could choose more than one option

Source: Researcher's findings from SPSS Version 26

A correspondence analysis was done to explore the relationship between the study locations and the respondents' views of a shark 'attack'. When looking at Figure 4.3, it can be seen that respondents from Muizenberg (Shark Spotters) mainly indicated that a shark 'attack' is when a shark kills a person. The reason may be that the great white shark, which has been involved in bite incidents, is found in this area, and that some shark-related human fatalities occurred in the area over the last decade (Sharkattackdata.com, 2020). Respondents from Durban Beach (KZNSB) mainly indicated that a shark 'attack' is when a shark bites a person. This may be due to the knowledge that shark species involved in bite incidents are found locally. The respondents from Hartenbos, Hobie Beach and Jeffreys Bay (Mixed) specified that a shark 'attack' is when a shark hits a person or a board and when a shark bites a board. The respondents from the Mixed category were at beaches where surfing is predominant. This can be the reason why they perceived a shark 'attack' as a shark biting a board.

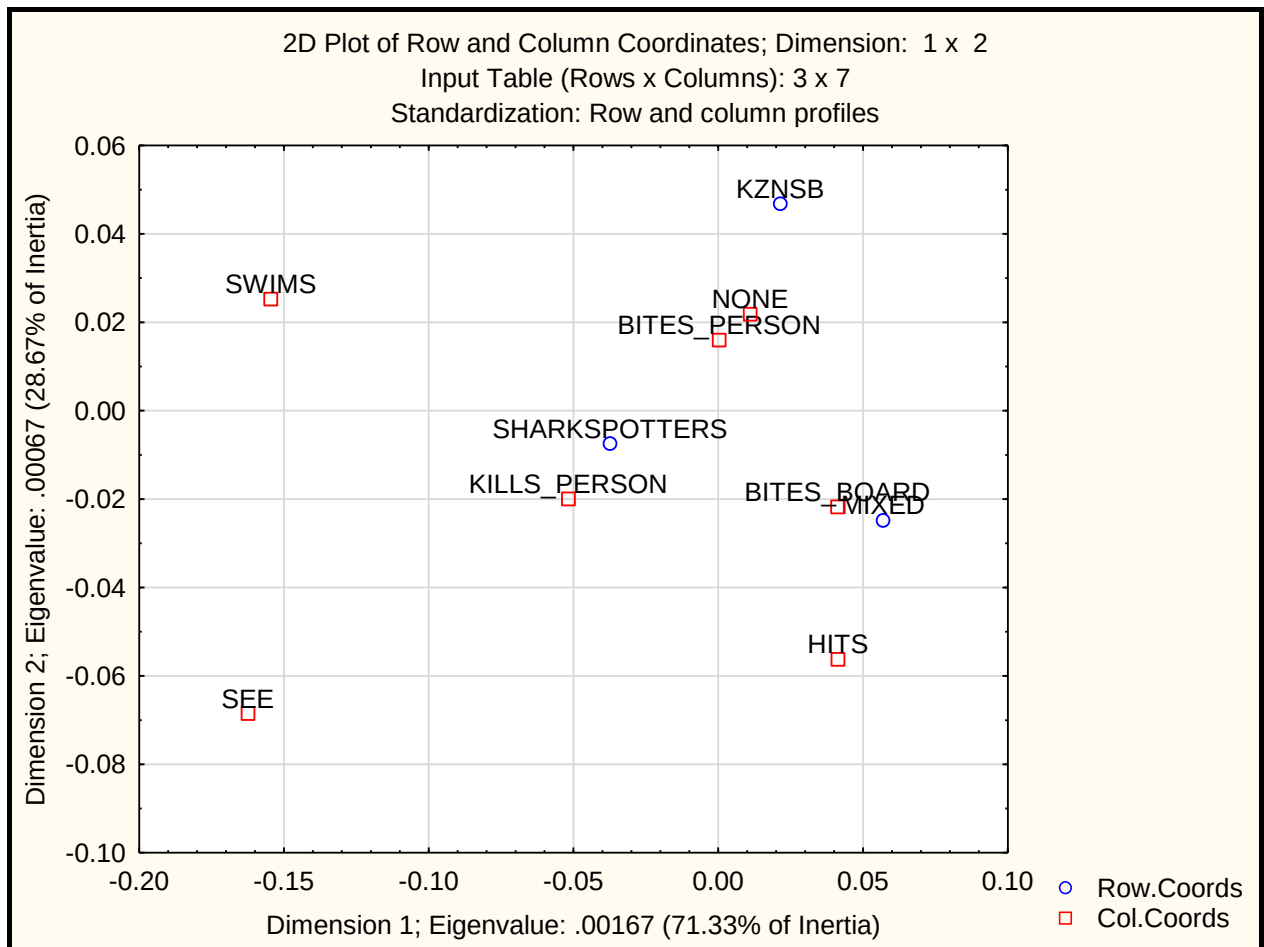


Figure 4.3: Correspondence analysis on respondents' definition of a shark attack

Source: Researcher's findings from SPSS Version 26

A correspondence analysis was done to explore the relationship between the study locations and the respondents' views of a human-shark interaction. From Figure 4.4, it is clear that respondents from Muizenberg (Shark Spotters) tended to perceive a human-shark interaction as spanning various possibilities, compared with visitors from the other study locations, who tended to see a human-shark interaction as mainly a non-lethal encounter. Visitors in Muizenberg could have possessed a more sophisticated understanding of human-shark interactions as including different typologies of interaction (Neff & Hueter, 2013).

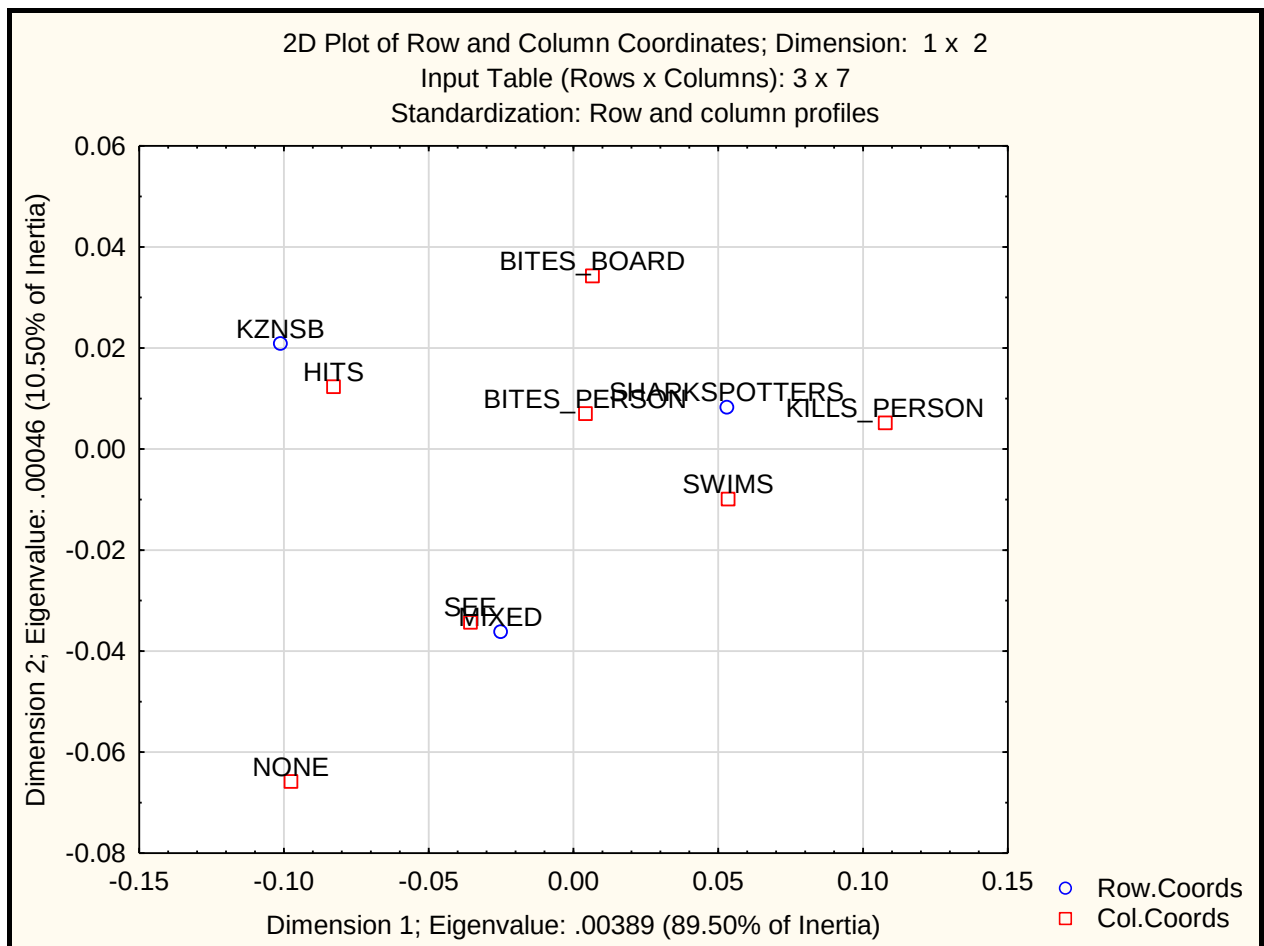


Figure 4.4: Correspondence analysis on respondents' definition of human-shark interactions

Source: Researcher's findings from SPSS Version 26

Table 4.4 shows that only a few respondents had an interaction with a shark (12%-21%). This may be due to respondents being unsure of some interactions (e.g. being unaware that seeing a shark in an aquarium is also an interaction). The respondents who had an interaction with a shark indicated that the interaction happened when they were diving and when they were shark cage diving. These types of interactions have been previously identified to be antecedent of positive feelings towards sharks, including tolerance and support (Lucrezi *et al.*, 2020; Acuña-Marrero *et al.*, 2018; Friedrich *et al.*, 2014).

4.2.2.4 Awareness and perceptions of shark hazard mitigation strategies

The respondents' awareness and perceptions of different shark hazard mitigation strategies were investigated. The reason was to understand whether the respondents were aware of different mitigation strategies in place globally and at the beaches under study, and whether they perceived the different strategies as effective or harmful to shark species. The main results on awareness of various mitigation strategies are displayed in Table 4.5.

Table 4.5: Respondents' awareness and perceptions of shark hazard mitigation strategies

Strategy	Awareness			Effective			Harmful		
	Shark Spotters (%)	KZNSB (%)	Mixed (%)	Shark Spotters (%)	KZNSB (%)	Mixed (%)	Shark Spotters (%)	KZNSB (%)	Mixed (%)
Shark Spotters	60	28	43	20	5	15	2	1	0
Shark Nets	49	73	57	20	32	18	15	18	19
Trained lifeguards	40	35	37	2	2	4	0	0	0
Information boards	39	29	34	3	1	2	1	0	0
Banned bathing	27	25	24	6	4	2	0	0	0
Boat spotting	18	10	22	1	1	2	1	0	0
Aerial surveys	17	13	23	2	2	7	0	0	0
Swimming in clear water	15	16	12	1	2	0	0	0	0
Drumlines	13	15	15	2	2	1	1	3	2
Staying in water as a group	11	7	8	0	0	1	0	0	0
Electrical shark repellent	10	16	16	3	3	7	23	16	18
Shark repellent cable	8	11	9	1	2	1	3	5	3
Acoustic tracking	5	4	9	2	2	1	0	1	1
Unsure	15	13	17	37	42	39	54	56	57

Source: Researcher's findings from SPSS Version 26

When looking at Table 4.5, it is evident that a large group of respondents were aware of different shark hazard mitigation strategies in place, although many were unsure whether or not the strategies are effective (37%-42%) and harmful to shark species (54%-57%). This indicates that the respondents had basic awareness of the strategies, but they were somewhat unaware of how these strategies work. When the respondents were asked what strategies they were familiar with, those from Muizenberg (Shark Spotters) indicated that they were mainly familiar with Shark Spotters (60%), shark nets (49%), trained lifeguards (40%) and information boards (39%). The reason for this may be because shark spotting, trained lifeguards and information boards are in place in this area, and nets are a popular strategy used in South Africa and internationally.

The respondents from Durban Beach (KZNSB) were mainly familiar with shark nets (73%), trained lifeguards (35%), information boards (29%) and Shark Spotters (28%). Some of these strategies are implemented in the area, while Shark Spotters is a popular shark hazard mitigation strategy implemented in South Africa.

The respondents from Hartenbos, Hobie Beach and Jeffreys Bay (Mixed) were mainly familiar with shark nets (57%), Shark Spotters (43%), trained lifeguards (37%) and information boards (34%). The beaches of this group are in the middle between Cape Town and Durban and therefore the people visiting them might have knowledge regarding the strategies in place around them. Shark nets and the Shark Spotters programme are not implemented in Hartenbos, Hobie Beach and Jeffreys Bay. The reason for the respondents' awareness regarding these strategies can be that these are the most popular strategies used in South Africa to mitigate encounters with sharks in the water.

A correspondence analysis was done to explore the relationship between the study locations and the respondents' familiarity with different shark hazard mitigation strategies. When looking at Figure 4.5, it can be seen that respondents tended to be more familiar with strategies that were in place in the area they were visiting. Respondents from Muizenberg (Shark Spotters) tended to be familiar with Shark Spotters, as well as other non-lethal strategies promoted locally. Respondents from Durban Beach (KZNSB) were familiar with shark nets, drumlines and the shark repellent cable, which is a new technique being tested by KZNSB. The respondents from Hartenbos, Hobie Beach and Jeffreys Bay (Mixed) were familiar with aerial surveys, boat spotting, and acoustic tracking which are deployed occasionally in these areas, for example, during surfing competitions. The outliers were electrical repellents and swimming in clear water, among other strategies.

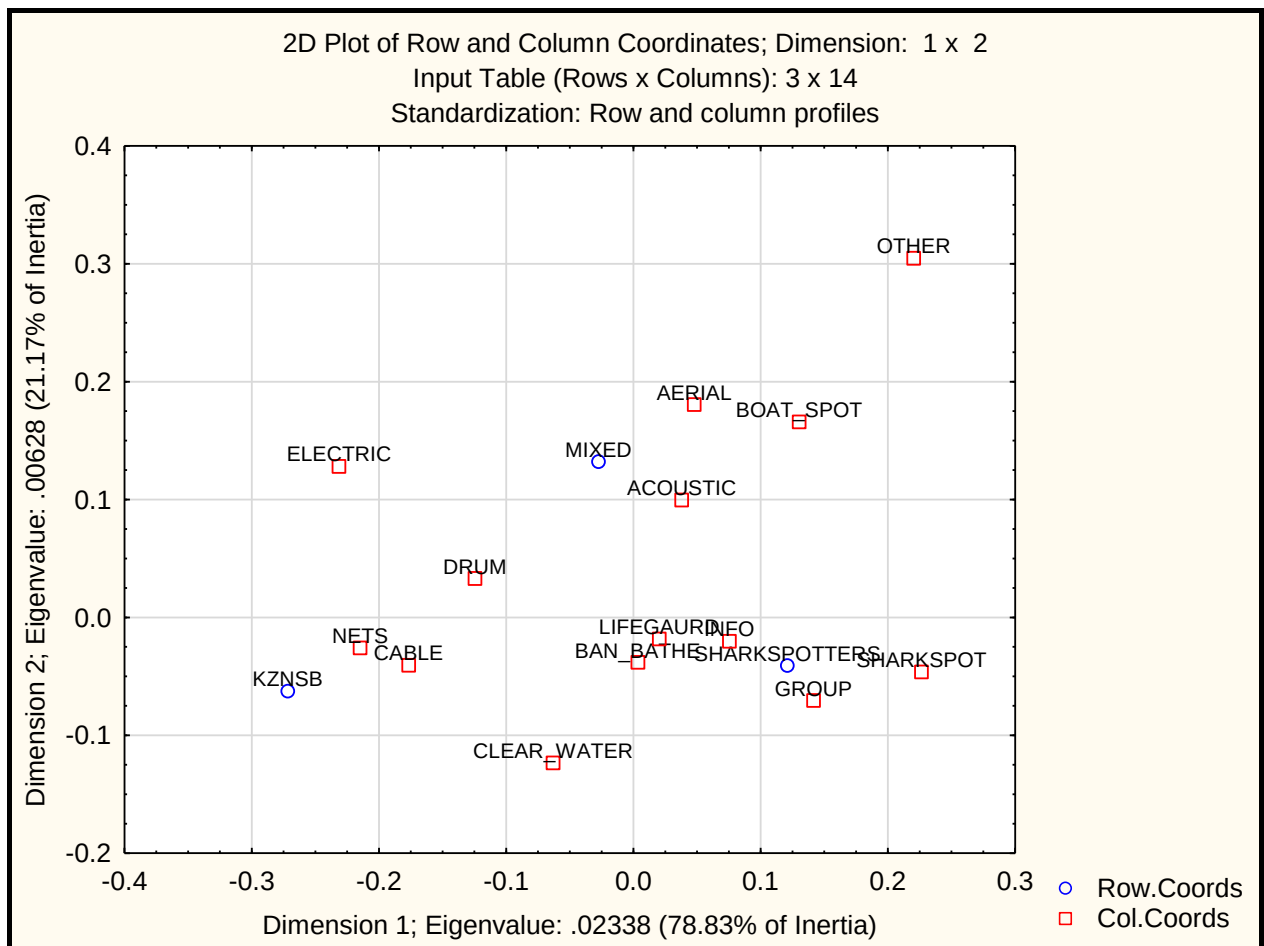


Figure 4.5: Correspondence analysis on familiarity with shark hazard mitigation strategies

Source: Researcher's findings from SPSS Version 26

The respondents were asked to indicate which strategies are effective and which strategies are harmful to shark species (Table 4.5). The respondents from Muizenberg (Shark Spotters) specified that Shark Spotters (20%) and shark nets (20%) are effective. The same respondents indicated that electrical shark repellents (23%) and shark nets (15%) are harmful to shark species. The respondents from Durban Beach (KZNSB) indicated that shark nets (32%) are effective and that shark nets (18%) and electrical shark repellents (16%) are harmful to shark species. The respondents from Hartenbos, Hobie Beach and Jeffreys Bay (Mixed) specified that shark nets (18%) and Shark Spotters (15%) are effective and that shark nets (19%) and electrical shark repellents (18%) are harmful to sharks. However, when pooling the various strategies in Table 4.5 into two categories, namely lethal and non-lethal, the respondents from KZNSB claimed lethal shark control to be most effective as opposed to the other categories, while non-lethal shark control was claimed to be most effective by the other categories as opposed to KZNSB (Pearson's $\chi^2 = 30.87$, $p < 0.001$). This result may indicate a sense of support for locally implemented mitigation strategies (lethal for KZNSB, non-lethal for Shark Spotters and Mixed) by the various groups of participants.

Shark nets and drumlines may be effective but are lethal to sharks. Electrical shark repellents, which constitute a non-lethal strategy, were perceived as harmful to sharks, even more so than nets. The reason for shark nets not being perceived as harmful to sharks may lie with the manner in which shark nets are promoted to the public, namely, as passive barriers deterring sharks and excluding them from areas frequented by bathers (McCagh *et al*, 2015; Neff, 2012). Electrical shark repellents may be perceived as making use of electrical discharges physically harming sharks, although further research could seek a better interpretation for this particular finding.

The respondents were invited to indicate if the beach that they visited adopted methods to prevent human-shark interactions from taking place (Figure 4.6). Visitors under the KZNSB category tended to be most aware of locally implemented strategies, followed by visitors of Shark Spotters and last of the Mixed group (Pearson's $\chi^2 = 21.14$, $p < 0.001$). The respondents from Muizenberg (Shark Spotters) indicated that the beach did have methods in place (39%) namely the Shark Spotters programme; however, 31% of the respondents were unsure whether the beach had methods in place and the remaining 30% indicated that there were no methods in place. The respondents from Durban Beach (KZNSB) specified that there were methods in place (55%), namely the shark nets. Twenty-seven percent (27%) were unsure if there were methods in place and 18% claimed that no measures were in place. The respondents from Hartenbos, Hobie Beach and Jeffreys Bay (Mixed) gave mixed answers, with 29% indicating that there were no measures in place, 35% indicating that there were methods in place, mainly mentioning lifeguards and occasional shark spotting, and 36% being unsure whether there were measures in place. Interestingly, 7% of the respondents under the Mixed category mentioned that there were shark nets in place.

These results show some kind of awareness among respondents about the shark hazard mitigation methods in place at study locations. However, there was also an evident gap in knowledge. For instance, visitors in the KZNSB category were probably more aware due to the majority of them being from South Africa, being ocean users, and also due to the established nature of the KZNSB programme in comparison with the younger Shark Spotters programme. Additionally, some Hartenbos, Hobie Beach and Jeffreys Bay (Mixed) respondents were evidently confused since nets are not in place at any of the three locations. The findings echo recent research conducted in South Africa, where beachgoers were found to be unaware of locally implemented shark hazard mitigation strategies (Lucrezi *et al.*, 2018, 2015).

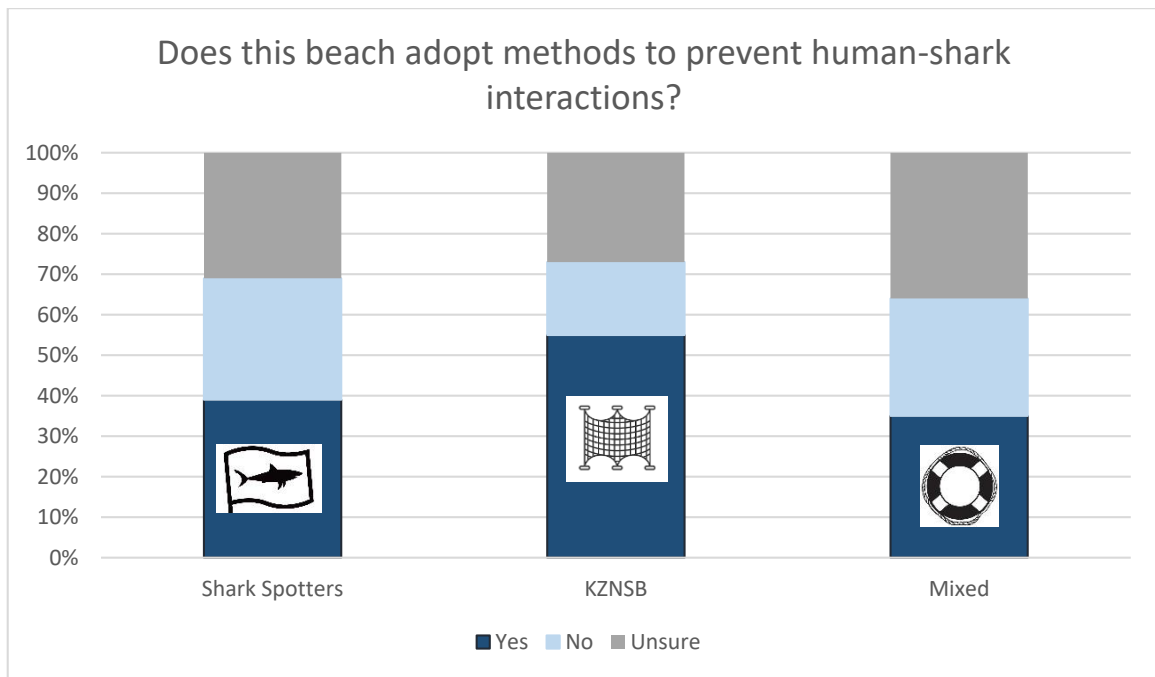


Figure 4.6: Awareness of shark hazard mitigation methods implemented at the beaches under study

Source: Researcher's findings from SPSS Version 26

4.2.3 Agreement with statements concerning sharks, shark framing, human-shark interactions and shark hazard mitigation

The following section includes respondents' level of agreement with different statements concerning sharks, shark framing (the treatment of sharks by the media), human-shark interactions and shark hazard mitigation. Agreement was provided using a five-point Likert scale (1= Strongly disagree to 5= Strongly agree) and the respondents were also given the possibility to answer "I do not know" to a given item.

Table 4.6 provides results of the mean scores of each item, according to each category of mitigation (Shark Spotters, KZNSB, and Mixed). It is noteworthy to mention that some statements that were formulated as positive statements were changed to negative statements to ease statistical analysis (this is indicated in Table 4.6 and later on in other tables). Statistical comparisons of items between categories are described in section 4.3.2.3. As indicated in Table 4.6, there was a general level of agreement with the majority of statements, particularly among beachgoers under the Shark Spotters category. The fact that beachgoers under the Shark Spotters category tended to show higher levels of agreement with many statements suggests that people visiting Muizenberg had a more sophisticated understanding of certain aspects related to the knowledge of sharks, media framing, human-shark interactions and shark hazard mitigation. This possibility is better explored in section 4.3.2.3.

Statements the respondents agreed with the most were: “Human-shark interactions can happen when a shark feels threatened and defends itself” ($\bar{x}_{\text{Shark Spotters}} = 4.15$, $\bar{x}_{\text{Mixed}} = 4.09$, $\bar{x}_{\text{KZNSB}} = 4.00$), “Some books, movies and articles have increased fear of sharks among people” ($\bar{x}_{\text{Mixed}} = 4.31$, $\bar{x}_{\text{KZNSB}} = 4.27$, $\bar{x}_{\text{Shark Spotters}} = 4.27$), and “Programmes that prevent human-shark interactions create jobs” ($\bar{x}_{\text{KZNSB}} = 4.21$, $\bar{x}_{\text{Shark Spotters}} = 4.05$, $\bar{x}_{\text{Mixed}} = 4.00$). There were some statements the respondents tended to be neutral about. These included: “Preventing human-shark interactions is not a responsibility of the government” ($\bar{x}_{\text{Mixed}} = 3.11$, $\bar{x}_{\text{KZNSB}} = 3.05$, $\bar{x}_{\text{Shark Spotters}} = 2.92$), “Sharks are generally not dangerous” ($\bar{x}_{\text{Shark Spotters}} = 3.33$, $\bar{x}_{\text{Mixed}} = 3.28$, $\bar{x}_{\text{KZNSB}} = 3.05$), and “I am not on this beach because human-shark interactions are prevented here” ($\bar{x}_{\text{Shark Spotters}} = 3.72$, $\bar{x}_{\text{Mixed}} = 3.27$, $\bar{x}_{\text{KZNSB}} = 3.14$).

Table 4.6: Respondents' agreement with statements regarding sharks, shark framing, human-shark interactions and hazard mitigation.

ASPECTS	KZNSB		SHARK SPOTTERS		MIXED	
	MEAN	LEVEL	MEAN	LEVEL	MEAN	LEVEL
Sharks						
Sharks tend to NOT reproduce rapidly	3.76	Agree	4.08	Agree	3.78	Agree
Shark species are NOT well protected globally	3.66	Agree	3.87	Agree	3.84	Agree
The role of sharks in marine ecosystems can NOT be easily replaced by other species	3.99	Agree	4.11	Agree	3.95	Agree
Sharks' natural food source could be abundant in this area	3.98	Agree	4.37	Agree	4.12	Agree
Shark framing						
'Shark attack' is NOT a good expression to describe human-shark interactions	3.66	Agree	3.67	Agree	3.57	Agree
The media do NOT talk about human-shark interactions in the proper way	3.55	Agree	3.81	Agree	3.68	Agree
Learning about sharks as children has AN effect on what people think of sharks as adults	3.68	Agree	3.77	Agree	3.47	Neutral
Some books, movies and articles have increased fear of sharks among people	4.27	Agree	4.27	Agree	4.31	Agree
Human-shark Interactions						
Human-shark interactions do NOT happen because sharks hunt humans	3.96	Agree	3.99	Agree	4.10	Agree
Sharks that bite people are NOT likely to do it again in the future	3.35	Neutral	3.78	Agree	3.48	Neutral
Sharks are generally NOT dangerous	3.05	Neutral	3.33	Neutral	3.28	Neutral
Human-shark interactions can happen because sharks mistake humans for their prey	3.82	Agree	3.94	Agree	3.93	Agree

Human-shark interactions can happen when a shark feels threatened and defends itself	4.00	Agree	4.15	Agree	4.09	Agree
Most reported human-shark interactions are shark bites	3.76	Agree	3.61	Agree	3.71	Agree
Shark hazard mitigation						
Preventing human-shark interactions is NOT a responsibility of the government	3.05	Neutral	2.92	Neutral	3.11	Neutral
People who get in the water are responsible for making sure it is safe to do so	3.94	Agree	3.97	Agree	4.05	Agree
Programmes that prevent human-shark interactions create jobs	4.21	Agree	4.05	Agree	4.00	Agree
I am NOT on this beach because human-shark interactions are prevented here	3.14	Neutral	3.72	Agree	3.27	Neutral

Note: Capitalisation refers to statements that were originally formulated in one way (positive or negative) and were later changed for analysis

Source: Researcher's findings from SPSS Version 26

Figure 4.7 displays response frequencies for the three locations combined, giving an alternative representation of how the pooled group of respondents agreed with the various statements. The statements that the respondents agreed with in higher frequency (agreed or strongly agreed with) included: "Some books, movies and articles have increased fear of sharks among people" (72%), "Human-shark interactions do not happen because sharks hunt humans" (66%), "People who get in the water are responsible for making sure it is safe to do so" (65%), "Human-shark interactions can happen when a shark feels threatened and defends itself" (64%), and "Human-shark interactions can happen because sharks mistake humans for their prey" (64%). The statements the respondents disagreed with the most (where 30% or more participants disagreed with or strongly disagreed with them) included: "Preventing human-shark interactions is not a responsibility of the government", "Learning about sharks as children has an effect on what people think of sharks as adults", "Sharks are generally not dangerous", and "Sharks that bite people are not likely to do it again in the future".

Respondents' agreement with statements regarding sharks, shark framing, human-shark interactions and shark hazard mitigation

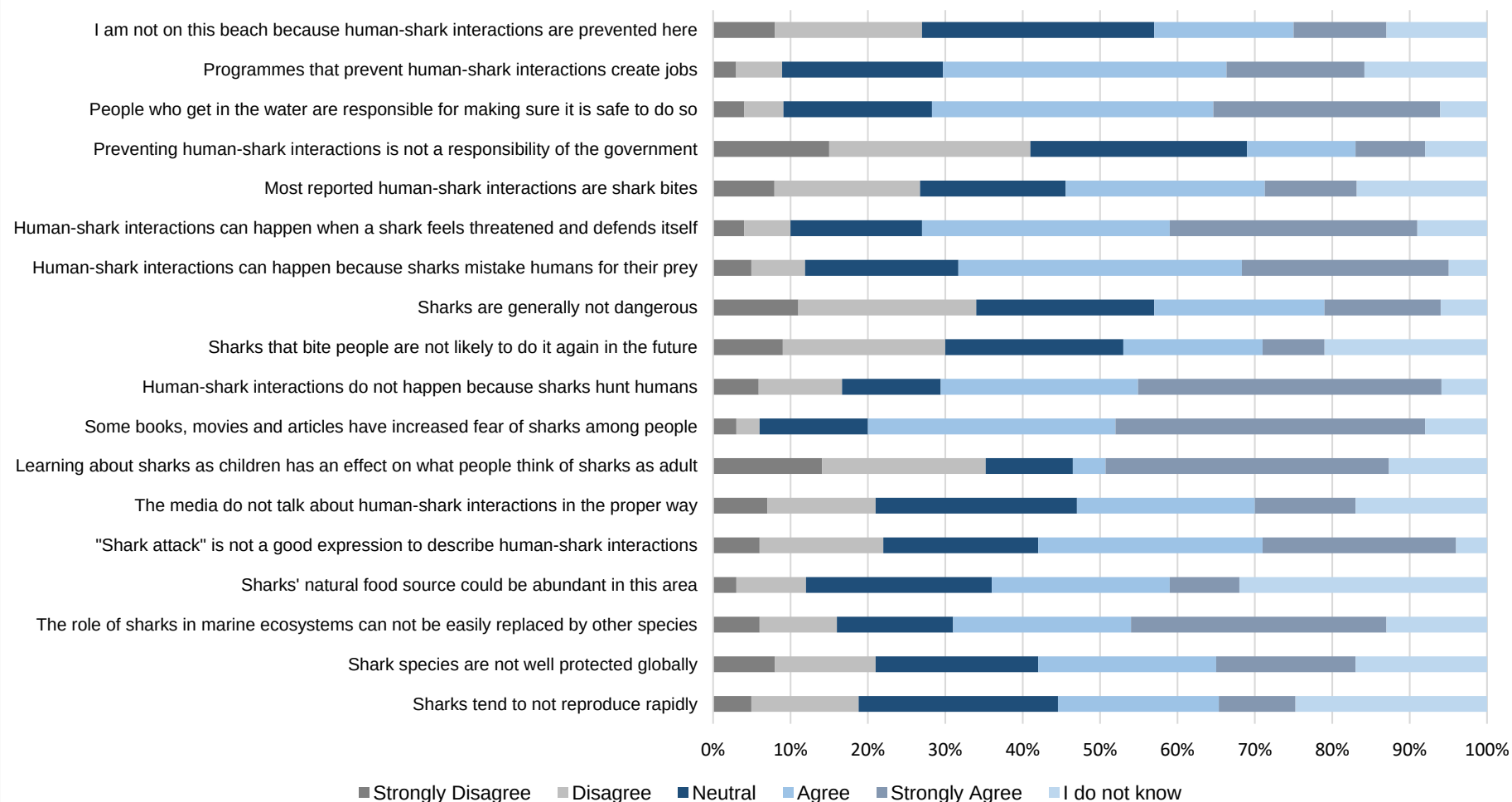


Figure 4.7: Frequencies on respondents' agreement with statements regarding (bottom up) sharks, shark framing, human-shark interactions and shark hazard mitigation

Source: Researcher's findings from SPSS Version 26

These results suggest that, overall, the respondents seemed to have some knowledge of sharks. For example, they were partly aware of ecological aspects of sharks and had an understanding of the reasons why human-shark interactions could happen. Friedrich *et al.* (2014) found that aquarium visitors interviewed in the UK were aware that sharks are very important to the marine ecosystem. Acuña-Marrero *et al.* (2018) found that knowledge of sharks makes ocean users more personally responsible and less dependent on existing shark hazard mitigation strategies. O'Bryhim and Parsons (2015) similarly showed how knowledge of sharks could result in support for their conservation. Therefore, the knowledge displayed here could have positive outcomes in terms of perceptions, attitude and behaviour concerning sharks and shark hazard mitigation.

The respondents had an understanding of how the media have been increasing fear of sharks in humans, due to a predominantly negative treatment of sharks. Sabatier and Huveneers (2018), Nosal *et al.* (2016) and Evans (2015) indicated that the media tend to play a negative role in shaping opinions regarding sharks and shark hazard mitigation. The authors argued how the media often negatively frame sharks and portray sharks as killers, which exaggerates fear among ocean users with potential negative effects on shark conservation. The participants in this study partly understood this type of framing and were critical of it. However, the statements to which beachgoers were, on average, neutral to, as well as those they disagreed with in higher proportion, indicate that sharks were partly perceived as dangerous, and that the participants may believe in theories of rogue sharks (sharks acquiring a taste of human flesh). This can be due to the negative role the media often play in shaping these misperceptions about sharks. The endorsement of false myths around sharks by the media would necessitate urgent rectification, as it can lead people to support lethal shark control, which would work against shark conservation efforts (Neff, 2015; Thaler & Shiffman, 2015; Neff & Heuter, 2013).

Importantly, the participants in this study did not appear to be entirely dependent on shark hazard mitigation, believing in personal responsibility in mitigating risks in the water. According to Pepin-Neff and Wynter (2019, 2018b), and Gibbs and Warren (2015), ocean users are capable of and willing to adjust their practices to reduce human-shark interactions from taking place, and they also believe that shark bites are accidental. However, the participants in this study believed that government has some responsibility in preventing human-shark interactions. This could imply that ocean users want to be responsible and minimise risks, but still claim some assistance from local management authorities.

4.3 EXPLORATORY RESULTS

This section discusses the results that were obtained from the exploratory analysis that was performed on the main data. This consists of an exploratory and confirmatory factor analysis, reliability tests, nonparametric correlations (r_s), t -tests and ANOVAs.

4.3.1 Exploratory factor analysis results

The following outlines the results of various exploratory factor analyses performed on the Likert-scale data characterising perceptions of sharks, shark framing by the media, human-shark interactions and shark hazard mitigation.

4.3.1.1 Exploratory factor analysis and reliability tests on Likert-scale data

Two exploratory techniques were first used on the Likert-scale data. The first technique is the exploratory factor analysis (EFA), normally employed to reduce the size of a dataset by identifying relationships between questionnaire items, and extracting latent factors (determined by eigenvalues and factor loadings as cut-off criteria, and then calculated as factor scores) underlying the items (Stevens, 2012:343). The second technique is reliability tests, which ascertain that the factor scores derived from EFA have internal consistency (represented by the Cronbach's α value) (Nunnally & Bernstein, 1994:248-292).

A single EFA was first performed for the Likert scale questions (18 statements). The Kaiser-Meyer-Olkin (KMO) value was 0.871, which showed that the data were suitable for factor analysis. To determine the number of factors, Kaiser's Criterion was used, where all eigenvalues greater than one form factors (Maree, 2016:242). Three factors were identified using the eigenvalues, explaining 46% cumulative variance in the data (Table 4.7).

Table 4.7: Total variance explained for three factors

Component	Eigenvalue	% of Variance	Cumulative %
1	4.618	25.658	25.658
2	2.558	14.209	39.866
3	1.163	6.461	46.327
4	0.961	5.340	51.667

Source: Researcher's findings from SPSS Version 26

All items that had a factor loading of 0.4 or more (Stevens, 2012:369) contributed to a factor (Table 4.8). The items that, according to loadings, were suitable for more than one factor, were examined and moved to the factor where they suited best.

Table 4.8: Exploratory factor analysis on Likert-scale data with three factors

	Factor 1	Factor 2	Factor 3
23. Shark species are NOT well protected globally	0.723		
24. The role of sharks in marine ecosystems canNOT be easily replaced by other species	0.692		
6. Sharks tend to NOT reproduce rapidly	0.691		
16. Sharks are generally NOT dangerous	0.649		
15. Learning about sharks as children has AN effect on what people think of sharks as adult	0.642		
4. The media do NOT talk about human-shark interactions in the proper way	0.634		
2. 'Shark attack' is a NOT good expression to describe human-shark interactions	0.626		
12. Sharks that bite people are NOT likely to do it again in the future	0.619		
1. Human-shark interactions do NOT happen because sharks hunt humans	0.612		
25. I am NOT on this beach because human-shark interactions are prevented here	0.598		
19. Most reported human-shark interactions are shark bites	-0.496		
17. Some books, movies and articles have increased fear of sharks among people		0.694	
7. Human-shark interactions can happen when a shark feels threatened and defends itself		0.644	

20. Programmes that prevent human-shark interactions create jobs		0.619	
3. Human-shark interactions can happen because sharks mistake humans for their prey		0.607	
8. People who get in the water are responsible for making sure it is safe to do so		0.599	0.349
5. Preventing human-shark interactions is NOT a responsibility of the government		-0.362	0.615
10. Sharks' natural food source could be abundant in this area		0.489	0.524

Source: Researcher's findings from SPSS Version 26

After examining the factors and underlying items resulting from this first EFA, it was decided that the factors did not relate to established constructs in the literature. It was then opted for an EFA using four factors to examine whether these were more appropriate in the light of established literature. Although Kaiser's criteria suggested that only three factors ought to be used, as only three factors had an eigenvalue above one, it was decided to explore the inclusion of another factor to bring the total variance explained above 50% (Table 4.7). The results of this EFA (factors and loadings) are presented in Table 4.9.

Table 4.9: Exploratory factor analysis on Likert-scale data with four factors

	Factor 1	Factor 2	Factor 3	Factor 4
23. Shark species are NOT well protected globally	0.723			
24. The role of sharks in marine ecosystems canNOT be easily replaced by other species	0.692			
6. Sharks tend to NOT reproduce rapidly	0.691			
16. Sharks are generally NOT dangerous	0.649			
15. Learning about sharks as children has AN effect on what people think of sharks as adult	0.642			
14. The media do NOT talk about human-shark interactions in the	0.634			

proper way				
2. 'Shark attack' is a NOT good expression to describe human-shark interactions	0.626			0.355
12. Sharks that bite people are NOT likely to do it again in the future	0.619			
1. Human-shark interactions do NOT happen because sharks hunt humans	0.612			0.425
25. I am NOT on this beach because human-shark interactions are prevented here	0.598			-0.418
17. Some books, movies and articles have increased fear of sharks among people		0.694		
7. Human-shark interactions can happen when a shark feels threatened and defends itself		0.644		
20. Programmes that prevent human-shark interactions create jobs		0.619		
3. Human-shark interactions can happen because sharks mistake humans for their prey		0.607		
8. People who get in the water are responsible for making sure it is safe to do so		0.599	0.349	
5. Preventing human-shark interactions is NOT a responsibility of the government		-0.362	0.615	
10. Sharks' natural food source could be abundant in this area		0.489	0.524	
19. Most reported human-shark interactions are shark bites	-0.496			0.524

Source: Researcher's findings from SPSS Version 26

After examining the items and the factors, it was decided that the factors still did not relate to established constructs in the literature. It was then opted for a confirmatory factor analysis done in an exploratory way (CEFA).

4.3.1.2 Confirmatory exploratory factor analysis on Likert-scale data

For the CEFA, four factors were created according to literature (also refer to Chapter 2). These are:

Basic knowledge of sharks or simply “**Knowledge**” (“Sharks tend to not reproduce rapidly”, “Sharks' natural food source could be abundant in this area”, “Shark species are not well protected globally”, “The role of sharks in marine ecosystems cannot be easily replaced by other species”);

Shark framing by the media or simply “**Media**” (“Learning about sharks as children has an effect on what people think of sharks as adult”, “The media do not talk about human-shark interactions in the proper way”, “‘Shark attack’ is a not good expression to describe human-shark interactions”, “Some books, movies and articles have increased fear of sharks among people”);

Human-shark interactions or simply “**Interactions**” (“Sharks are generally not dangerous”, “Sharks that bite people are not likely to do it again in the future”, “Human-shark interactions do not happen because sharks hunt humans”, “Human-shark interactions can happen when a shark feels threatened and defends itself”, “Human-shark interactions can happen because sharks mistake humans for their prey”, “Most reported human-shark interactions are shark bites”); and

Shark hazard mitigation or simply “**Mitigation**” (“I am not on this beach because human-shark interactions are prevented here”, “Programmes that prevent human-shark interactions create jobs”, “People who get in the water are responsible for making sure it is safe to do so”, “Preventing human-shark interactions is not a responsibility of the government”).

Looking at the factor **Knowledge**, the KMO value was 0.674, which indicates that the data were suitable for factor analysis. The eigenvalue was 1.964. When looking at Table 4.10, it is clear that item 10: “Sharks' natural food source could be abundant in this area”, did not fit into this factor as the loading was below 0.40, which is the cut-off value. A reliability test was performed to understand whether or not item 10 should be removed from this factor. The Cronbach's Alpha (α) value with inclusion of item 10 was 0.467, which is below the cut off value of 0.6, and the inter-item correlation of this statement with the total was -0.170. The α value, however, changed to 0.715 when statement 10 was removed from this factor. The decision was then made to remove statement 10 as the resulting factor had good reliability. The factor score for the factor **Knowledge** was calculated as the average of the scores of all items (three items) therein.

Table 4.10: Confirmatory exploratory factor analysis for factor Knowledge

	Factor 1- Knowledge
23. Shark species are NOT well protected globally	0.819
24. The role of sharks in marine ecosystems canNOT be easily replaced by other species	0.809
6. Sharks tend to NOT reproduce rapidly	0.741
10. Sharks' natural food source could be abundant in this area	-0.300

Source: Researcher's findings from SPSS Version 26

Concerning the factor **Media**, the KMO value was 0.649, which indicated that the data were suitable for factor analysis. The eigenvalue for this factor was 1.724. Looking at Table 4.11, it is clear that item 17: "Some books, movies and articles have increased fear of sharks among people", did not fit into this factor as the loading value was below 0.40, which is the cut-off value. A reliability test was done to understand whether or not item 17 should be removed from this factor. The α value with inclusion of item 17 was 0.553, which is below the cut off value of 0.6, and the inter-item correlation of this statement with the total was 0.155. The α value, however, changed to 0.607 when statement 17 was removed from this factor. The decision was then made to remove statement 17, as the resulting factor was more reliable. The factor score for the factor **Media** was calculated as the average of the scores of all items (three items) therein.

Table 4.11: Confirmatory exploratory factor analysis for factor Media

	Factor 2- Media
14. The media do NOT talk about human-shark interactions in the proper way	0.769
15. Learning about sharks as children has AN effect on what people think of sharks as adult	0.743
2. 'Shark attack' is a NOT good expression to describe human-shark interactions	0.705
17. Some books, movies and articles have increased fear of sharks among people	0.291

Source: Researcher's findings from SPSS Version 26

With regards to the factor **Interactions**, the KMO value was 0.658 and the eigenvalue was 1.987. Table 4.12 indicates that statement 19: "Most reported human-shark interactions are shark

bites”, did not fit into this factor as the loading value was below 0.40, which is the cut-off value. The table also suggests that statement 3 (“Human-shark interactions can happen because sharks mistake humans for their prey”) and statement 7 (“Human-shark interactions can happen when a shark feels threatened and defends itself”) should form their own factor. A reliability test was done to understand whether or not item 19 should be removed from this factor. The α value with inclusion of item 19 was 0.273, which is below the cut off value of 0.6, and the inter-item correlation of this statement with the total was -0.215. The α value, however, changed to 0.474 when statement 19 was removed from this factor. The α value remained still below the cut off value of 0.6 and therefore, the decision was made to remove statement 3 and 7 as well. The α value changed to 0.66 when these three statements were removed. The factor score for the factor **Interactions** was calculated as the average of the scores of all items (three items) therein.

Table 4.12: Confirmatory exploratory factor analysis for factor Interactions

	Factor 3- Interactions	
	1	2
16. Sharks are generally NOT dangerous	0.784	
12. Sharks that bite people are NOT likely to do it again in the future	0.766	
1. Human-shark interactions do NOT happen because sharks hunt humans	0.674	
19. Most reported human-shark interactions are shark bites	-0.554	0.311
3. Human-shark interactions can happen because sharks mistake humans for their prey		0.803
7. Human-shark interactions can happen when a shark feels threatened and defends itself		0.774

Source: Researcher’s findings from SPSS Version 26

The factor **Mitigation** had a KMO value of 0.514, and the eigenvalue for this factor was 1.344. Table 4.13 suggests that two factors emerged, where statement 20 (“Programmes that prevent human-shark interactions create jobs”) and 8 (“People who get in the water are responsible for making sure it is safe to do so”) were grouped together and statement 5 (“Preventing human-shark interactions is not a responsibility of the government”) and 25 (“I am not

on this beach because human-shark interactions are prevented here”) were grouped together. A reliability test was done to understand whether or not two factors should be created. The α value for statement 20 and 8 was 0.410, and for statement 5 and 25 was 0.180, both below the cut off value. The decision was then made not to have at all a factor **Mitigation**, but standalone items.

Table 4.13: Confirmatory exploratory factor analysis for factor Mitigation

	Factor 4- Mitigation	
	1	2
20. Programmes that prevent human-shark interactions create jobs	0.780	
8. People who get in the water are responsible for making sure it is safe to do so	0.628	0.510
5. Preventing human-shark interactions is NOT a responsibility of the government	-0.532	0.476
25. I am NOT on this beach because human-shark interactions are prevented here		0.745

Source: Researcher's findings from SPSS Version 26

The table below (Table 4.14) gives a summary of the three final factors with the factor loadings for each item, mean factor scores, α values and inter-item correlations.

Table 4.14: Confirmatory exploratory factor analysis results – final for three factors

	Factor 1- Knowledge	Factor 2- Media	Factor 3- Interactions
23. Shark species are NOT well protected globally	0.819		
24. The role of sharks in marine ecosystems canNOT be easily replaced by other species	0.809		
6. Sharks tend to NOT reproduce rapidly	0.741		
14. The media do NOT talk about human-shark		0.769	

interactions in the proper way			
15. Learning about sharks as children has AN effect on what people think of sharks as adult		0.743	
2. 'Shark attack' is a NOT good expression to describe human-shark interactions		0.705	
16. Sharks are generally NOT dangerous			0.784
12. Sharks that bite people are NOT likely to do it again in the future			0.766
1. Human-shark interactions do NOT happen because sharks hunt humans			0.674
Mean factor score	3.47	3.41	3.36
α value	0.723	0.617	0.660
Inter-item correlation	0.464	0.351	0.393

Source: Researcher's findings from SPSS Version 26

The results showed that the factor **Knowledge** had a mean score of 3.473, an α value of 0.723 and an inter-item correlation of 0.464. This factor had the highest average score compared with the other two factors (which follow). The factor **Media** had a mean score of 3.41, an α value of 0.617 and an inter-item correlation of 0.351. The factor **Interactions** had a mean value of 3.36, an α value of 0.660 and an inter-item correlation of 0.393. Table 4.15 gives a summary of the statements that were removed from the above factors. The table also gives the mean score of each statement.

Table 4.15: Statements removed from factors with their mean score

Statement	Mean
3. Human-shark interactions can happen because sharks mistake humans for their prey	3.80
5. Preventing human-shark interactions is NOT a responsibility of the government	2.73
7. Human-shark interactions can happen when a shark feels threatened and defends itself	3.90
8. People who get in the water are responsible for making sure it is safe to do so	3.85
10. Sharks' natural food source could be abundant in this area	3.39
17. Some books, movies and articles have increased fear of sharks among people	4.13

19. Most reported human-shark interactions are shark bites	3.19
20. Programmes that prevent human-shark interactions create jobs	3.72
25. I am NOT on this beach because human-shark interactions are prevented here	3.08

Source: Researcher's findings from SPSS Version 26

The data tended to form three reliable groups of statements related to knowledge about sharks, perceptions of shark framing by the media, and perceptions of human-shark interactions. The statements that were not included in these factors were equally valuable and are discussed in relation to other data in this chapter. A brief discussion follows concerning the conclusions that can be drawn from the factor analysis and the factor scores.

Factor 1: Knowledge

The respondents seemed to have a fair understanding of some basic principles of the ecology of sharks, including their ecological role, their reproduction, and the presence of shark's prey locally. Previous studies have shown that the enhancement of knowledge of sharks can lead to the development of positive attitudes and behaviour towards sharks and shark conservation. The more knowledge people possess, the more positive they tend to think and act towards sharks (Acuña-Marrero *et al.*, 2018; Curtin & Papworth, 2018; Gallagher *et al.*, 2015; Garla *et al.*, 2015; O'Bryhim & Parsons, 2015; Friedrich *et al.*, 2014). Knowledge remains one of the essential elements that need to be enhanced among the public to lessen the pressures faced by sharks (e.g. fishing, lethal shark hazard mitigation) and to support shark conservation. In the case of beach visitors and ocean users, possibilities to enhance knowledge are discussed in Chapter 5.

Factor 2: Media

The respondents tended to believe that the media play an important role in shaping public opinion of sharks and human-shark interactions; however, the media often use the wrong language and narratives to describe sharks and human-shark interactions, which can lead to negative perceptions about sharks. The respondents tended to understand that they have to be careful about the media's treatment of sharks. Studies done by Bombieri *et al.* (2018), Sabatier and Huveneers (2018), Muter *et al.* (2013), and O'Bryhim (2009) indicated that the media are influential on the public opinion of sharks, and that it is important to change the narratives to protect sharks and gather support for shark conservation. Ways in which positive shark-related narratives can be introduced and affect beach visitors and ocean users are addressed in Chapter 5.

Factor 3: Interactions

The respondents tended to understand that sharks do not hunt humans, but there was partial belief that sharks acquire a taste for human flesh (rogue sharks). Thus, it is still important that the media take proper care in informing the public about sharks and human-shark interactions, particularly

when false and unfounded myths are involved. Researchers such as Bornatowski *et al.* (2019), Le Busque *et al.* (2019), Frazer-Baxter and Medvecky (2018), Sabatier and Huveneers (2018), Evans (2015), and Muter *et al.* (2013) claimed that the media report sharks and human-shark interactions in a negative way, which aggravates fear. These researchers also added that the media have been “selling” the rogue shark theory, which leads to a negative reaction of people towards sharks. Ways to counteract the potentially negative effects of certain types of shark framing in a context of beach recreation and ocean use are laid out in Chapter 5.

4.3.2 Results from Spearman’s rank order correlation coefficient, *t*-tests and ANOVAs

This section discusses the results obtained from the Spearman’s rank order correlations (r_s), *t*-tests and ANOVAs. The Spearman’s rank order correlation coefficients are discussed first. Correlations were used to explore unique relationships between variables. The *t*-tests were performed to partition the variation of beach visitors’ responses (the Likert-scale data) across socio-demographic parameters, but also across binary data related to perceptions (e.g. fear of sharks). The ANOVAs were performed to assess the variation of beach visitors’ responses (the Likert-scale data) across study locations (Shark Spotters, KZNSB, Mixed).

4.3.2.1 Results of Spearman's rank order correlations (r_s)

The following table (Table 4.16) displays the results of the Spearman's rank order correlations (r_s) that were performed on the raw data to investigate unique relationships. The matrix in Table 4.16 is divided into three parts. The first one includes the names of the variables and numbers assigned to them, then correlations between all variables and socio-demographic data. The second part includes correlations among variables which did not constitute part of the Likert scale of agreement, and between the same and the rest of the variables which were in the Likert scale. The last part includes correlations among Likert scale variables.

Table 4.16: Coefficients from Spearman's rank order correlations (r_s)

		1	2	3	4	5	6	7
1	Season (0 = winter, 1 = summer)	1.00						
2	Gender (0 = male, 1 = female)	0.04	1.00					
3	Age (continuous)	-0.08	-0.07	1.00				
4	Education (0 = school, 1 = tertiary)	-0.01	-0.03	0.27	1.00			
5	Origin (0 = foreign, 1 = South Africa)	-0.30	-0.01	0.03	-0.17	1.00		
6	Resident (0 = no, 1 = yes)	-0.08	-0.02	-0.02	-0.09	0.38	1.00	
7	Water user (0 = no, 1 = yes)	-0.14	-0.04	-0.16	-0.10	0.22	0.09	1.00
8	Greatest risk (0 = shark, 1 = no shark)	-0.07	-0.01	0.07	0.08	0.04	-0.02	-0.05
9	Fear of sharks (0 = yes, 1 = no)	-0.08	-0.16	-0.05	0.06	0.03	0.05	0.09
10	Perceived safety from sharks (1 = limitedly safe to 4 = very safe)	0.06	-0.10	-0.04	0.09	-0.08	0.02	0.00
11	Effective mitigation strategy (0 = lethal, 1 = non-lethal)	0.10	0.04	-0.03	0.05	-0.10	-0.04	-0.03
12	Harmful mitigation strategy to sharks (0 = unlethal, 1 = lethal)	-0.14	-0.15	0.13	0.17	0.08	0.02	0.07
13	Does this beach implement mitigation strategy (0 = no, 1 = yes)	-0.07	0.03	0.06	-0.01	0.12	0.09	0.14
14	Greatest threat to sharks (0 = not human, 1 = human)	-0.07	-0.03	0.06	0.09	0.02	-0.01	0.03
15	Human-shark interactions no NOT happen because sharks hunt humans	-0.03	0.00	0.03	0.08	0.00	0.01	0.03

16	'Shark attack' is a NOT good expression to describe human-shark interactions	-0.04	-0.02	-0.04	0.00	-0.03	0.03	0.01
17	Human-shark interactions can happen because sharks mistake humans for their prey	-0.01	-0.02	0.01	0.11	-0.11	-0.08	0.03
18	Preventing human-shark interactions is NOT a responsibility of the government	-0.07	-0.04	0.10	-0.08	0.05	0.03	0.02
19	Sharks tend to NOT reproduce rapidly	0.01	-0.01	0.03	0.07	-0.06	-0.01	0.01
20	Human-shark interactions can happen when a shark feels threatened and defends itself	0.03	0.12	-0.07	0.09	-0.11	-0.07	-0.04
21	People who get in the water are responsible for making sure it is safe to do so	-0.05	0.02	0.08	0.03	-0.04	-0.03	-0.06
22	Sharks' natural food source could be abundant in this area	0.05	-0.08	0.08	0.05	-0.04	0.01	0.01
23	Sharks that bite people are NOT likely to do it again in the future	0.01	0.02	-0.08	0.03	-0.07	0.05	-0.02
24	The media do NOT talk about human-shark interactions in the proper way	-0.03	-0.04	-0.07	0.08	-0.07	0.03	-0.02
25	Learning about sharks as children has AN effect on what people think of sharks as adult	0.03	0.03	-0.04	0.07	-0.19	-0.07	-0.03
26	Sharks are generally NOT dangerous	0.05	0.01	-0.02	0.08	-0.12	0.00	-0.05
27	Some books, movies and articles have increased fear of sharks among people	0.00	0.06	0.01	0.06	-0.07	-0.06	-0.05
28	Most reported human-shark interactions are shark bites	-0.09	0.07	0.05	-0.05	0.10	0.00	0.01
29	Programmes that prevent human-shark interactions create jobs	0.05	0.00	0.10	0.06	-0.02	-0.04	-0.04
30	Shark species are NOT well protected globally	0.01	0.02	-0.04	0.11	-0.15	-0.02	-0.07
31	The role of sharks in marine ecosystems canNOT be easily replaced by other species	0.01	-0.02	0.00	0.12	-0.14	0.03	0.01
32	I am NOT on this beach because human-shark interactions are prevented here	0.10	-0.01	-0.10	0.14	-0.18	-0.03	-0.10

	8	9	10	11	12	13	14
8	1.00						
9	0.18	1.00					
10	0.20	0.20	1.00				
11	0.04	0.02	-0.01	1.00			
12	0.15	0.14	0.13	0.02	1.00		
13	0.00	0.02	0.00	-0.01	0.02	1.00	

14	0.09	0.14	0.06	-0.04	0.15	0.00	1.00
15	0.08	0.21	0.07	0.04	0.16	0.03	0.16
16	0.11	0.17	0.06	0.05	0.09	0.01	0.11
17	-0.01	0.03	0.04	-0.02	0.11	0.04	0.13
18	0.06	0.05	0.04	0.04	-0.03	-0.03	-0.03
19	0.16	0.18	0.17	0.07	0.24	-0.03	0.14
20	0.01	0.02	0.05	-0.03	-0.01	0.04	0.07
21	0.04	0.10	0.08	0.01	0.07	0.08	0.11
22	-0.10	0.04	-0.02	-0.06	-0.01	0.04	0.03
23	0.06	0.20	0.13	0.13	0.13	0.00	0.03
24	0.08	0.12	0.04	0.07	0.14	-0.02	0.14
25	0.10	0.16	0.12	0.06	0.10	0.03	0.11
26	0.07	0.29	0.15	0.09	0.14	-0.08	0.11
27	0.03	0.08	0.04	-0.04	0.11	0.03	0.06
28	0.00	-0.12	-0.05	-0.02	-0.08	0.02	0.04
29	0.00	0.07	-0.02	0.05	0.11	-0.02	0.13
30	0.08	0.22	0.13	0.13	0.19	-0.06	0.10
31	0.14	0.21	0.15	0.09	0.13	0.00	0.14
32	0.14	0.18	0.08	0.12	0.15	-0.15	0.07

	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
15	1.00																	
16	0.51	1.00																
17	0.12	0.05	1.00															
18	0.14	0.14	-0.18	1.00														

19	0.39	0.38	0.17	0.18	1.00													
20	0.06	0.00	0.30	-0.24	-0.03	1.00												
21	0.11	0.10	0.24	-0.05	0.07	0.34	1.00											
22	0.01	-0.12	0.18	-0.07	-0.11	0.14	0.30	1.00										
23	0.33	0.29	0.04	0.22	0.35	-0.11	0.00	-0.15	1.00									
24	0.31	0.37	0.06	0.09	0.39	0.09	0.10	-0.11	0.35	1.00								
25	0.31	0.33	0.20	0.06	0.42	0.09	0.13	-0.06	0.28	0.39	1.00							
26	0.38	0.34	0.05	0.17	0.38	0.02	0.07	-0.07	0.45	0.36	0.36	1.00						
27	0.17	0.11	0.35	-0.13	0.18	0.35	0.33	0.22	0.00	0.21	0.20	0.12	1.00					
28	-0.15	-0.25	0.13	-0.17	-0.30	0.11	0.06	0.11	-0.29	-0.21	-0.22	-0.28	0.06	1.00				
29	0.01	0.00	0.24	-0.18	0.04	0.28	0.24	0.28	-0.10	-0.01	0.08	-0.03	0.34	0.14	1.00			
30	0.37	0.36	0.16	0.03	0.43	0.08	0.15	-0.11	0.36	0.42	0.46	0.41	0.25	-0.31	0.03	1.00		
31	0.41	0.40	0.23	0.02	0.44	0.16	0.20	-0.06	0.32	0.42	0.49	0.34	0.30	-0.21	0.08	0.59	1.00	
32	0.22	0.27	0.03	0.08	0.35	0.02	0.04	-0.11	0.33	0.31	0.36	0.32	0.11	-0.34	-0.02	0.44	0.37	1.00

Note: Bold values in blue indicate statistical significance at $p \leq 0.05$

Note: Numbers in bold in the leftmost column and top row in each section indicate Likert-scale items (1 = Strongly disagree to 5 =Strongly Agree)

Source: Researcher's findings from Statsoft Statistica Version 13.2

Several conclusions can be drawn from the table. When looking at the demographic section, the first thing that is evident is that age and education were positively correlated. This means that the older the respondents were, the more educated they were. Another prevalent finding is that foreign visitors tended to visit the beaches in the summer months and they also had a higher education qualification than South African respondents, suggesting that they perhaps had more knowledge (concerning sharks). Respondents from South Africa contained the largest proportion of residents, and ocean use was more prevalent among South African respondents. These results concur with recent studies by Lucrezi *et al.* (2018, 2015), and Lucrezi and Van der Walt (2016), concerning the profile of beach visitors in South Africa and their level of ocean use according to various demographic parameters.

With regards to relationships between demographic variables and perceptions of sharks, females from this study were more afraid of sharks than men and they also claimed that non-lethal shark hazard mitigation is more harmful to sharks than lethal shark hazard mitigation. On the contrary, respondents with better education understood that lethal shark hazard mitigation is more harmful to sharks than non-lethal shark hazard mitigation. These findings are supported by existing literature on the roles of gender and education in various perceptions of sharks (Acuña-Marrero *et al.*, 2018; O'Bryhim & Parsons, 2015). Water users from the study were more likely to know that the beach they were visiting had a shark hazard mitigation strategy in place, in line with research by Gray and Gray (2017) and Gibbs and Warren (2015). Foreigners, who mainly came from Europe and the USA, tended to possess greater knowledge about some aspects of sharks and shark framing. This finding reflects research showing that people from these countries may be positively influenced by the exposition to conservation-oriented shark-based programming and information (Evans, 2015; O'Bryhim & Parsons, 2015), and may be aware of certain shark-related issues (e.g. overfishing) that are particularly critical in their countries of origin (Friedrich *et al.*, 2014). Foreigners also tended not to select the local beach based on the presence of shark hazard mitigation. This may be due to the beach selection criteria being driven by popularity rather than other factors among these people (Lucrezi *et al.*, 2018).

With regards to the relationships between perceptions, it can be seen that people who did not perceive sharks as a risk were also not afraid of sharks, and these people did not feel that their safety was under risk due to the local presence of sharks. Additionally, they believed that lethal shark control was most harmful to sharks, concurring with findings in the literature concerning the relation between perceived risk from sharks and other attitudes towards sharks (Gibbs & Warren, 2015; Crossley *et al.*, 2014; Friedrich *et al.*, 2014). People who knew that lethal shark control is most harmful to sharks also agreed that humans are the greatest threat to

sharks, did not select the beach they were visiting based on local shark hazard mitigation, and had more knowledge of sharks. People who had greater levels of knowledge also had more positive attitudes towards sharks. For example, more knowledge was associated with lower levels of fear of sharks, concurring with recent studies (Acuña-Marrero *et al.*, 2018; O'Bryhim & Parsons, 2015). Another finding indicates that people who knew that sharks do not hunt humans also felt that humans are the greatest threat to sharks. These people were likely to reject the idea of intentionality in shark bite incidents and to feel the human responsibility in causing the threatened status of sharks globally (Garla *et al.*, 2015; Friedrich *et al.*, 2014). Interestingly, in this study, knowledge of the presence of local shark hazard mitigation was positively correlated with choosing the local beach based on the presence of shark hazard mitigation. Therefore, there was a clear link between awareness of local shark hazard mitigation and beach selection based on it, which was in turn related to ocean use (Gray & Gray, 2017; Gibbs & Warren, 2015).

When looking at the last part of the table (statements 15-32) it is found that items belonging to the same category, for example knowledge, media and interactions, tended to be correlated with each other, and when attitudes and knowledge were positive, there was also less dependence on locally implemented shark hazard mitigation (Crossley *et al.*, 2014). The coefficients for statement 28 ("Most reported human-shark interactions are shark bites") were mainly negative. This may be due to the fact that respondents interpreted the statement in a particular way. It is possible that they felt that the statement was offensive towards and misrepresenting of sharks, thus the negative correlation with positive attitudes towards and knowledge of sharks.

4.3.2.2 T-test results

The following section includes the results of *t*-tests, which were used to compare scores from the Likert-scale items (including the three factors emerged from factor analysis and the standalone items) between categories of binary variables in this study.

4.3.2.2.1 T-test results comparing Likert-scale data according to season

Table 4.17 shows the results of an Independent Samples *t*-test which compared the Likert-scale data (assessing perceptions including knowledge, media framing, human-shark interactions and shark hazard mitigation) between seasons (winter *versus* summer). The central limit theorem (CLT) states that, for large sample sizes, normality assumptions are met. This justified the use of this test on the data.

The data were collected over two seasons, and seasonality may have affected the variation in the data. Therefore, this test was deemed important. The table shows means of the variables for each season (with standard deviation), and values indicating a statistically significant or non-significant difference between these means (p). The p values reported are based on equal variances not assumed (thus assuming that the data did not have homogeneity of variance). The table also shows effect sizes (Cohen's d), where 0.2 would be small, 0.5 would be moderate and 0.8 would be large.

According to the table, means were only significantly different for three variables, with small effect sizes. Specifically, agreeing that government is responsible for preventing human-shark interactions was more prevalent in summer compared with winter. Additionally, visitors interviewed in winter tended to agree more that most reported human-shark interactions by the media are shark bites. Finally, people interviewed in summer were less likely to have chosen the beach they were visiting because of a locally implemented shark hazard mitigation strategy.

Table 4.17: *T*-test results comparing Likert-scale data between seasons (winter vs. summer)

Factors/Statements	Winter			Summer			p -value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.46	1.07871	383	3.48	1.00487	482	0.800	0.02
Factor 2: Media	3.44	0.97754	409	3.39	0.99468	505	0.404	0.05
Factor 3: Interactions	3.37	1.01456	408	3.35	1.00797	511	0.850	0.01
Human-shark interactions can happen because sharks mistake humans for their prey	3.81	1.095	380	3.80	1.060	466	0.869	0.01
Preventing human-shark interactions is NOT a responsibility of the government	2.83	1.190	349	2.65	1.184	451	0.038*	0.15
Human-shark interactions can happen when a shark feels threatened and defends itself	3.88	1.136	353	3.92	1.030	435	0.596	0.04
People who get in the water are responsible for making sure it is safe to do so	3.89	1.096	363	3.83	1.011	455	0.398	0.06
Sharks' natural food source could be abundant in this area	3.34	1.020	275	3.43	1.003	315	0.281	0.09
Some books, movies and articles	4.17	1.064	351	4.10	0.929	447	0.314	0.07

have increased fear of sharks among people								
Most reported human-shark interactions are shark bites	3.31	1.258	320	3.09	1.162	399	0.011*	0.18
Programmes that prevent human-shark interactions create jobs	3.68	1.047	312	3.75	0.952	420	0.359	0.7
I am NOT on this beach because human-shark interactions are prevented here	2.94	1.196	337	3.20	1.133	421	0.003*	0.22**

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

In summer the water is used more, which can lead to greater expectations from people that government prevents human-shark interactions by implementing measures (not necessarily lethal measures). The respondents interviewed in the winter agreed more that the most reported human-shark interactions by the media are shark bites. This can be because winter beach users are more sophisticated and sensitive towards sharks and conservation than the summer “mass” beach users. Summer respondents were also less likely to have chosen the beach they were visiting based on the mitigation strategies in place. This may be because, in summer, there are more visitors, more mass tourism (international visitors as well), and therefore people may visit beaches for their popularity rather than local beach management reasons.

4.3.2.2.2 T-test results comparing Likert-scale data according to gender

Table 4.18 shows the results of an Independent Samples *t*-test which compared the Likert-scale data between genders (male *versus* female). Gender may have affected the variation in the data, as males and females could differ in their perceptions. Therefore, this test was deemed important. The table shows means of the variables for each gender (with standard deviation), *p* values based on equal variances not assumed, and effect sizes (Cohen’s *d*).

According to the table, means were only significantly different for two variables, with small effect sizes. Females tended to agree more that human-shark interactions can happen when a shark feels threatened and defends itself. They also tended to agree more that some books, movies and articles have increased fear of sharks among people.

Table 4.18: T-test results comparing Likert-scale data between genders (male vs. female)

Factors/Statements	Male			Female			p-value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.45	1.07871	351	3.47	1.00487	497	0.770	0.02
Factor 2: Media	3.40	0.97754	360	3.41	0.99468	535	0.961	0.00
Factor 3: Interactions	3.33	1.01456	363	3.37	1.00797	537	0.566	0.04
Human-shark interactions can happen because sharks mistake humans for their prey	3.82	1.095	336	3.79	1.060	493	0.681	0.03
Preventing human-shark interactions is NOT a responsibility of the government	2.78	1.190	316	2.69	1.184	468	0.279	0.08
Human-shark interactions can happen when a shark feels threatened and defends itself	3.74	1.136	318	4.01	1.030	457	0.001*	0.24**
People who get in the water are responsible for making sure it is safe to do so	3.82	1.096	324	3.88	1.011	478	0.396	0.06
Sharks' natural food source could be abundant in this area	3.48	1.020	252	3.32	1.003	329	0.057	0.16
Some books, movies and articles have increased fear of sharks among people	4.04	1.064	321	4.19	0.929	416	0.041*	0.14
Most reported human-shark interactions are shark bites	3.08	1.258	296	3.25	1.162	409	0.077	0.13
Programmes that prevent human-shark interactions create jobs	3.70	1.047	301	3.73	0.952	416	0.697	0.03
I am NOT on this beach because human-shark interactions are prevented here	3.11	1.196	299	3.08	1.133	446	0.725	0.03

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

These results partly differ from others showing that females may have less knowledge of sharks or have less positive attitudes towards animal species which invoke fear, such as sharks, compared with males (O'Bryhim & Parsons, 2015). Indeed, these results are more in line with recent work which demonstrated that females may be supportive of sharks and their

conservation (Curtin & Papworth, 2018). While females could be more afraid of sharks (see section 4.3.2.1) they may also be aware of the origin of this fear and may still be supportive of shark conservation.

4.3.2.2.3 T-test results comparing Likert-scale data according to education level

Table 4.19 shows the results of an Independent Samples *t*-test which compared the Likert-scale data between education levels (school *versus* tertiary). Education level may have affected the variation in the data, as respondents with tertiary education could have more knowledge of sharks than respondents with a high-school diploma or equivalent. Therefore, this test was deemed important. The table shows means of the variables for each education level (with standard deviation), *p* values based on equal variances not assumed, and effect sizes (Cohen's *d*).

The table indicates that means were significantly different for five statements, with small effect sizes. The tertiary-education respondents agreed more with the statements which regarded knowledge. They also agreed more that human-shark interactions can happen because sharks mistake humans for prey, and when a shark feels threatened and defends itself. They agreed more that government is responsible for preventing human-shark interactions but were less likely to have chosen the beach they were visiting based on locally implemented shark hazard mitigation strategies.

Table 4.19: T-test results comparing Likert-scale data between education levels (school vs. tertiary)

Factors/Statements	School			Tertiary			<i>p</i> -value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.32	1.01848	257	3.54	1.04233	585	0.003*	0.22**
Factor 2: Media	3.34	0.96158	271	3.44	1.03508	617	0.171	0.10
Factor 3: Interactions	3.27	0.95037	277	3.40	1.03508	617	0.058	0.13
Human-shark interactions can happen because sharks mistake humans for their prey	3.69	0.987	251	3.86	1.109	570	0.026*	0.16
Preventing human-shark interactions is NOT a responsibility of the government	2.88	1.195	233	2.66	1.166	544	0.020*	0.18
Human-shark interactions can happen when a shark feels threatened and defends itself	3.79	1.045	224	3.95	1.089	542	0.046*	0.15

People who get in the water are responsible for making sure it is safe to do so	3.82	1.024	238	3.87	1.070	557	0.588	0.04
Sharks' natural food source could be abundant in this area	3.33	0.917	172	3.41	1.065	400	0.337	0.08
Some books, movies and articles have increased fear of sharks among people	4.08	0.940	229	4.16	1.011	545	0.336	0.07
Most reported human-shark interactions are shark bites	3.27	1.166	204	3.14	1.227	495	0.194	0.10
Programmes that prevent human-shark interactions create jobs	3.64	1.000	212	3.75	0.992	502	0.149	0.12
I am NOT on this beach because human-shark interactions are prevented here	2.81	1.116	219	3.17	2.159	519	0.000*	0.31**

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

The results suggest that tertiary-education respondents possessed more shark-based knowledge compared with school-education respondents. These results are similar to those of recent studies revolving around knowledge and environmental perceptions among beach visitors in South Africa (Lucrezi et al., 2018; Lucrezi & Van der Walt, 2016). These studies found that beachgoers possessing higher education level tend to have more environmental awareness and favour beach management approaches that would be as harmless as possible towards the environment and ecosystems. Thus, while desiring government intervention to prevent interactions with sharks the beachgoers may be unlikely to wish for lethal measures to be implemented. Acuña-Marrero et al. (2018), and O'Bryhim and Parsons (2015) found that people who have more knowledge of sharks will have more positive perceptions of and attitudes towards sharks and their conservation. Thus, the tertiary-education respondents could also have more positive perceptions of sharks.

4.3.2.2.4 T-test results comparing Likert-scale data according to origin

Table 4.20 shows the results of an Independent Samples *t*-test which compared the Likert-scale data according to origin (foreign *versus* South African). Origin may have affected the variation in the data, as foreign and South African respondents could differ in several ways. Therefore, this test was deemed important. The table shows means of the variables for each origin type (with

standard deviation), p values based on equal variances not assumed, and effect sizes (Cohen's d).

According to the table, means were significantly different for seven variables, with small to medium effect sizes. The factors **Knowledge**, **Media** and **Interactions** had greater scores among foreign respondents. Additionally, foreign respondents agreed more that human-shark interactions can happen because sharks mistake humans for their prey, and when a shark feels threatened and defends itself. South African respondents tended to agree more that most reported human-shark interactions by the media are shark bites. Finally, foreign respondents were less likely to have chosen the beach they were visiting because of locally implemented shark hazard mitigation strategies.

Table 4.20: T-test results comparing Likert-scale data according to origin (foreign vs. South Africa)

Factors/Statements	Foreign			South Africa			p -value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.73	0.97111	248	3.37	1.04565	611	0.000*	0.34**
Factor 2: Media	3.59	0.94611	265	3.34	0.99640	643	0.000*	0.26**
Factor 3: Interactions	3.48	1.04586	267	3.31	0.99438	646	0.027*	0.16
Human-shark interactions can happen because sharks mistake humans for their prey	3.97	1.066	240	3.74	1.073	601	0.006*	0.21**
Preventing human-shark interactions is NOT a responsibility of the government	2.61	1.082	231	2.77	1.218	563	0.061	0.14
Human-shark interactions can happen when a shark feels threatened and defends itself	4.05	1.106	226	3.85	1.059	556	0.017*	0.19
People who get in the water are responsible for making sure it is safe to do so	3.92	1.048	240	3.83	1.057	572	0.267	0.08
Sharks' natural food source could be abundant in this area	3.48	0.921	135	3.36	1.046	450	0.194	0.12
Some books, movies and articles have increased fear of sharks among people	4.19	1.063	232	4.11	0.952	560	0.343	0.07
Most reported human-shark interactions are shark bites	2.98	1.287	188	3.26	1.170	525	0.009*	0.22**
Programmes that prevent human-	3.75	1.033	213	3.72	0.972	515	0.753	0.03

shark interactions create jobs								
I am NOT on this beach because human-shark interactions are prevented here	3.41	1.096	214	2.95	1.154	538	0.000*	0.40**

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

These results are similar to those of recent work comparing foreign and domestic tourists visiting South African beaches (Lucrezi *et al.*, 2018; Lucrezi & Van der Walt, 2016; Lucrezi *et al.*, 2015). According to these studies, foreign beach visitors tend to show strong pro-conservation attitudes compared with domestic visitors, and tend to select beaches not based on locally implemented management strategies, which are instead favoured by their domestic counterparts. Foreign respondents may have more knowledge regarding sharks, their framing, and human-shark interactions for various reasons. Seeing that they mostly originated from Europe and the USA, it is possible to postulate that they had been exposed to greater levels of shark-based programming (e.g. Shark Week) and pro-shark media campaigning, leading to greater levels of knowledge and understanding concerning sharks and shark framing (Evans, 2015; O'Bryhim & Parsons, 2015).

4.3.2.2.5 T-test results comparing Likert-scale data according to local residence

Table 4.21 shows the results of an Independent Samples *t*-test which compared the Likert-scale data between respondents who were local residents and those who were not. Local residence may have affected the variation in the data, as some of the perceptions of local people could be more refined compared with non-residents. Therefore, this test was deemed important. The table shows means of the variables for each group (with standard deviation), *p* values based on equal variances not assumed, and effect sizes (Cohen's *d*).

According to the table, means were only significantly different for one variable, with a small effect size. Respondents who were non-resident locally tended to agree more that human-shark interactions can happen because sharks mistake humans for their prey. It is likely that this result was partly due to the confounding effect of the variable "origin", which was correlated with this variable.

Table 4.21: *T*-test results comparing Likert-scale data according to local residency (no vs. yes)

Factors/Statements	No			Yes			<i>p</i> -value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.48	1.06666	535	3.47	0.97896	321	0.864	0.01
Factor 2: Media	3.42	1.00959	564	3.42	0.95955	338	0.966	0.00
Factor 3: Interactions	3.35	1.02200	571	3.39	0.98992	335	0.530	0.04
Human-shark interactions can happen because sharks mistake humans for their prey	3.88	1.055	522	3.71	1.091	312	0.027*	0.16
Preventing human-shark interactions is NOT a responsibility of the government	2.69	1.173	491	2.78	1.210	300	0.330	0.07
Human-shark interactions can happen when a shark feels threatened and defends itself	3.96	1.092	481	3.86	1.034	297	0.177	0.10
People who get in the water are responsible for making sure it is safe to do so	3.88	1.030	512	3.80	1.109	297	0.271	0.08
Sharks' natural food source could be abundant in this area	3.38	0.955	342	3.37	1.098	242	0.899	0.01
Some books, movies and articles have increased fear of sharks among people	4.17	0.976	493	4.07	0.999	296	0.143	0.11
Most reported human-shark interactions are shark bites	3.19	1.232	430	3.18	1.171	279	0.881	0.01
Programmes that prevent human-shark interactions create jobs	3.76	0.966	454	3.66	1.035	268	0.192	0.10
I am NOT on this beach because human-shark interactions are prevented here	3.11	1.121	467	3.04	1.215	281	0.456	0.05

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

4.3.2.2.6 *T*-test results comparing Likert-scale data according to water use

Table 4.22 shows the results of an Independent Samples *t*-test which compared the Likert-scale data according to water use (no *versus* yes). Water use may have affected the variation in the

data, as water users may perceive sharks and mitigation in a different way from non-users. Therefore, this test was deemed important. The table shows means of the variables according to water use (with standard deviation), *p* values based on equal variances not assumed, and effect sizes (Cohen's *d*).

According to the table, means were only significantly different for one variable, with a small effect size. Specifically, water users were significantly more likely than non-users to select the beach they were visiting based on the presence of a local shark hazard mitigation strategy.

Table 4.22: T-test results comparing Likert-scale data according to water use (no vs. yes)

Factors/Statements	No			Yes			<i>p</i> -value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.53	1.04616	292	3.47	1.01746	547	0.460	0.05
Factor 2: Media	3.46	1.02158	319	3.42	0.95534	569	0.549	0.04
Factor 3: Interactions	3.39	1.05318	318	3.35	0.97753	573	0.589	0.04
Human-shark interactions can happen because sharks mistake humans for their prey	3.76	1.105	282	3.83	1.055	540	0.401	0.06
Preventing human-shark interactions is NOT a responsibility of the government	2.69	1.168	278	2.75	1.195	500	0.489	0.05
Human-shark interactions can happen when a shark feels threatened and defends itself	3.94	1.099	266	3.87	1.070	501	0.375	0.07
People who get in the water are responsible for making sure it is safe to do so	3.92	1.034	276	3.80	1.070	520	0.130	0.11
Sharks' natural food source could be abundant in this area	3.38	0.984	181	3.38	1.033	395	0.986	0.00
Some books, movies and articles have increased fear of sharks among people	4.18	0.987	271	4.10	0.990	505	0.262	0.08
Most reported human-shark interactions are shark bites	3.16	1.252	240	3.19	1.176	459	0.799	0.02
Programmes that prevent human-shark interactions create jobs	3.79	0.935	242	3.68	1.019	467	0.156	0.11
I am NOT on this beach because human-shark interactions are	3.25	1.162	256	3.01	1.139	3.01	0.007*	0.21**

prevented here								
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Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)****

(Mok et al., 2017; Ellis & Steyn, 2003)

Research has found that people who do not enter the water are unlikely to select beach destinations based on locally implemented shark hazard mitigation (Crossley et al., 2014). Water users may select beaches where shark hazard mitigation is implemented, but tend to choose beaches where non-lethal methods are implemented rather than lethal ones (Gray & Gray, 2017; Gibbs & Warren, 2015). This may be partly the case of this study (the results of a comparison of this specific variable between study locations are discussed in 4.3.2.3).

4.3.2.2.7 T-test results comparing Likert-scale data according to perceived risk from sharks

Table 4.23 shows the results of an Independent Samples *t*-test which compared the Likert-scale data between participants who perceived sharks as the greatest risk when visiting the beach, and participants who did not (shark versus no shark). Perceived risk from sharks may have affected the variation in the data, as people who perceive sharks as a risk could, for example, select a beach destination based on the presence of shark hazard mitigation strategies. Therefore, this test was deemed important. The table shows means of the variables for each group (with standard deviation), *p* values based on equal variances not assumed, and effect sizes (Cohen's *d*).

According to the table, means were significantly different for four variables, with small effect sizes. The factors **Knowledge**, **Media**, and **Interactions** had greater scores among respondents who did not claim sharks are the greatest risk when visiting the beach. These people were also less likely to have chosen the beach they were visiting based on the locally implemented shark hazard mitigation strategy.

Table 4.23: T-test results comparing Likert-scale data according to perceived risk from sharks (shark vs. no shark)

Factors/Statements	Shark			No Shark			<i>p</i> -value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.20	1.01338	127	3.59	1.01961	596	0.000*	0.39**
Factor 2: Media	3.20	1.02008	129	3.54	0.95253	637	0.001*	0.34**
Factor 3: Interactions	3.23	0.99968	130	3.44	0.99679	638	0.032*	0.21**
Human-shark interactions can	3.89	0.960	123	3.82	1.109	586	0.473	0.06

happen because sharks mistake humans for their prey								
Preventing human-shark interactions is NOT a responsibility of the government	2.56	1.217	121	2.75	1.192	553	0.116	0.16
Human-shark interactions can happen when a shark feels threatened and defends itself	3.89	1.095	119	3.93	1.081	538	0.728	0.04
People who get in the water are responsible for making sure it is safe to do so	3.79	1.034	123	3.87	1.059	568	0.433	0.08
Sharks' natural food source could be abundant in this area	3.55	1.103	88	3.32	1.030	399	0.079	0.21**
Some books, movies and articles have increased fear of sharks among people	4.11	0.954	117	4.17	0.979	551	0.555	0.06
Most reported human-shark interactions are shark bites	3.14	1.229	99	3.14	1.229	501	0.967	0.00
Programmes that prevent human-shark interactions create jobs	3.69	1.147	110	3.74	0.976	499	0.681	0.04
I am NOT on this beach because human-shark interactions are prevented here	2.79	1.037	107	3.20	1.184	528	0.000*	0.35**

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

These respondents evidently did not feel threatened by sharks, possibly as a result of more knowledge, and consequently believing that the media negatively frames sharks by depicting them as something that they are not. They may not need to select a beach based on any locally implemented shark hazard mitigation as they feel that sharks do not pose a risk. Studies by Gibbs and Warren (2015) and Friedrich *et al.* (2014) indicated that people may not feel threatened by sharks nor perceive them as a risk. This is in contrast with Crossley *et al.* (2014), who found that people listed sharks as the second greatest risk they faced when going to the beach. De La Lama *et al.* (2018) found that people who have poor knowledge of sharks see them as a threat and a risk. This can suggest why respondents in this study who had more knowledge of and positive attitudes towards sharks did not see sharks as a risk – a finding which has emerged in recent studies as well (Pepin-Neff & Wynter, 2019, 2018b; Acuña-Marrero *et al.*, 2018; O'Bryhim & Parsons, 2015).

4.3.2.2.8 T-test results comparing Likert-scale data according to fear of sharks

Table 4.24 shows the results of an Independent Samples *t*-test which compared the Likert-scale data between participants who feared sharks and participants who did not (fear *versus* no fear). Fear of sharks may have affected the variation in the data, as people who fear sharks could, for example, agree more with the statements that are negative towards sharks. Therefore, this test was deemed important. The table shows means of the variables for each group (with standard deviation), *p* values based on equal variances not assumed, and effect sizes (Cohen's *d*).

According to the table, means were significantly different for six variables, with small to medium effect sizes. The factors **Knowledge**, **Media**, and **Interactions** had greater scores among respondents who did not fear sharks. These people also agreed more that people who get in the water are responsible for making sure it is safe to do so, and these people were also less likely to have chosen the beach they were visiting because of a locally implemented shark hazard mitigation strategy. The respondents who feared sharks agreed more that most reported human-shark interactions by the media are shark bites.

Table 4.24: T-test results comparing Likert-scale data according to fear of sharks (fear vs. no fear)

Factors/Statements	Fear			No Fear			<i>p</i> -value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.23	0.99231	373	3.73	1.01898	424	0.000*	0.47***
Factor 2: Media	3.25	0.95531	398	3.64	0.96220	445	0.000*	0.40**
Factor 3: Interactions	3.10	0.97225	401	3.65	0.96	446	0.000*	0.56***
Human-shark interactions can happen because sharks mistake humans for their prey	3.80	1.022	362	3.82	1.127	419	0.872	0.01
Preventing human-shark interactions is NOT a responsibility of the government	2.67	1.170	345	2.79	1.220	401	0.150	0.10
Human-shark interactions can happen when a shark feels threatened and defends itself	3.92	1.054	343	3.94	1.090	381	0.740	0.02
People who get in the water are responsible for making sure it is safe to do so	3.76	1.048	351	3.95	1.047	404	0.011*	0.19
Sharks' natural food source could be abundant in this area	3.32	0.998	245	3.41	1.047	303	0.300	0.09

Some books, movies and articles have increased fear of sharks among people	4.10	0.950	337	4.18	1.023	396	0.228	0.09
Most reported human-shark interactions are shark bites	3.32	1.158	300	3.03	1.262	360	0.002*	0.23*
Programmes that prevent human-shark interactions create jobs	3.63	1.034	312	3.79	0.966	362	0.049	0.15
I am NOT on this beach because human-shark interactions are prevented here	2.91	1.126	334	3.31	1.160	366	0.000*	0.35*

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

Respondents who were not afraid of sharks may have been so as a result of more knowledge, also leading to the belief that the media negatively frame sharks. They may also not need to select a beach based on any locally implemented shark hazard mitigation as result of lack of fear. Pepin-Neff and Wynter (2018b, 2019) and Acuña-Marrero *et al.* (2018) found that fear can lead to a negative attitude and thoughts about sharks. This can result in people supporting lethal shark hazard mitigation measures, choosing beaches based on the implementation of shark hazard mitigation, and supporting negative shark framing. The results of this study are positive concerning the effect of lack of fear on various perceptions, but attention ought to be paid to those who did fear sharks, for the potential negative effect of this attitude.

4.3.2.2.9 T-test results comparing Likert-scale data according to perceived threats to sharks

Table 4.25 shows the results of an Independent Samples *t*-test which compared the Likert-scale data between participants who felt that humans are a threat to sharks and participants who did not (not human *versus* human). This perception may have affected the variation in the data, as respondents who felt that humans are a threat to sharks could have more positive perceptions of sharks. Therefore, this test was deemed important. The table shows means of the variables for each group (with standard deviation), *p* values based on equal variances not assumed, and effect sizes (Cohen's *d*).

According to the table, means were significantly different for six variables, with small to medium effect sizes. The factors **Knowledge**, **Media**, and **Interactions** had greater scores among respondents who felt that humans are a threat to sharks. These people also agreed

more that human-shark interactions can happen because sharks mistake humans for their prey, that people who get in the water are responsible for making sure it is safe to do so, and that programmes that prevent human-shark interactions create jobs.

Table 4.25: T-test results comparing Likert-scale data according to perceived threats to sharks (not human vs. human)

Factors/Statements	Not Human			Human			<i>p</i> -value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.19	0.95388	55	3.68	1.01192	540	0.001*	0.48***
Factor 2: Media	3.17	0.86085	60	3.62	0.93967	558	0.000*	0.49***
Factor 3: Interactions	3.19	0.90053	61	3.56	0.97051	557	0.004*	0.38**
Human-shark interactions can happen because sharks mistake humans for their prey	3.54	0.972	56	3.92	1.089	527	0.007*	0.35**
Preventing human-shark interactions is NOT a responsibility of the government	2.87	1.138	52	2.76	1.208	500	0.546	0.08
Human-shark interactions can happen when a shark feels threatened and defends itself	3.82	0.953	51	3.97	1.075	487	0.302	0.14
People who get in the water are responsible for making sure it is safe to do so	3.63	1.024	48	3.97	1.026	518	0.029*	0.34**
Sharks' natural food source could be abundant in this area	3.32	0.852	37	3.39	1.060	374	0.662	0.06
Some books, movies and articles have increased fear of sharks among people	4.06	1.027	43	4.24	0.974	491	0.208	0.18
Most reported human-shark interactions are shark bites	2.96	1.240	53	3.13	1.271	439	0.344	0.14
Programmes that prevent human-shark interactions create jobs	3.44	0.881	43	3.80	0.996	453	0.015*	0.36**
I am NOT on this beach because human-shark interactions are prevented here	2.93	1.096	54	3.19	1.176	473	0.103	0.22**

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

These results indicate a positive relationship between perceiving humans as a threat to sharks, and positive knowledge and attitudes concerning sharks. People who know basic shark facts and share positive attitudes towards sharks are likely to be those who correctly identify the greatest threats faced by sharks. Pepin-Neff & Wynter (2019, 2018b), Acuña-Marrero *et al.* (2018), and O'Bryhim and Parsons (2015) found that people who have more knowledge of sharks have more positive attitudes towards sharks. Respondents who believed that humans are the greatest risk faced by sharks also agreed there is a personal responsibility when getting into the water, which suggests a sense of independence from shark hazard mitigation strategies and possibly respect for sharks. Gibbs and Warren (2015) indicated that people who possess more knowledge regarding sharks (e.g. ecology and threats) are more likely to adjust their practices to reduce any in-water risks. This factor also correlates with positive attitudes towards sharks.

4.3.2.2.10 T-test results comparing Likert-scale data according to perceived safety

Table 4.26 shows the results of an Independent Samples *t*-test which compared the Likert-scale data between participants who felt safe from the possibility of a shark encounter at the beaches under study and participants who did not (unsafe *versus* safe). This perception may have affected the variation in the data, as respondents who felt safe may have more positive perceptions towards sharks. Therefore, this test was deemed important. The table shows means of the variables for each group (with standard deviation), *p* values based on equal variances not assumed, and effect sizes (Cohen's *d*).

According to the table, means were significantly different for two variables, with small effect sizes. The factors **Knowledge** and **Interactions** had greater scores among respondents who felt safe from the possibility of a shark encounter.

Table 4.26: T-test results comparing Likert-scale data according to perceived safety (unsafe vs. safe)

Factors/Statements	Unsafe			Safe			<i>p</i> -value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.25	1.04758	192	3.54	1.03172	660	0.001*	0.27**
Factor 2: Media	3.28	0.97550	199	3.45	0.99474	702	0.037	0.17
Factor 3: Interactions	3.18	1.02300	204	3.41	1.00609	701	0.006*	0.22**
Human-shark interactions can happen because sharks mistake humans for their prey	3.75	1.071	185	3.83	1.071	647	0.347	0.08

Preventing human-shark interactions is NOT a responsibility of the government	2.62	1.215	167	2.75	1.176	620	0.222	0.11
Human-shark interactions can happen when a shark feels threatened and defends itself	3.90	1.058	163	3.91	1.088	614	0.862	0.02
People who get in the water are responsible for making sure it is safe to do so	3.80	1.148	174	3.87	1.038	629	0.473	0.06
Sharks' natural food source could be abundant in this area	3.43	1.043	113	3.38	1.012	470	0.600	0.05
Some books, movies and articles have increased fear of sharks among people	4.13	1.031	174	4.14	0.975	611	0.952	0.01
Most reported human-shark interactions are shark bites	3.24	1.196	153	3.18	1.211	555	0.592	0.05
Programmes that prevent human-shark interactions create jobs	3.77	1.034	156	3.72	0.983	566	0.588	0.05
I am NOT on this beach because human-shark interactions are prevented here	3.03	1.075	161	3.10	1.176	588	0.500	0.06

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

Respondents who indicated that they felt safe from the possibility of a shark encounter tended to have more knowledge regarding sharks and human-shark interactions. This can be due to the fact that they had positive perceptions as more knowledge leads to more positive attitudes (Pepin-Neff & Wynter, 2019, 2018b; Acuña-Marrero et al., 2018; O'Bryhim & Parsons, 2015). Feeling safe is a positive feeling which has been recorded in other, similar research on beach visitors and perceptions of shark hazard mitigation (Crossley et al., 2014). Respondents may feel safe from the possibility of a shark encounter as a result of proper knowledge regarding sharks and regarding human-shark interactions.

4.3.2.2.11 T-test results comparing Likert-scale data according to perceived effectiveness of lethal and non-lethal shark hazard mitigation

Table 4.27 shows the results of an Independent Samples *t*-test which compared the Likert-scale data between participants who indicated that the most effective shark hazard mitigation methods were non-lethal methods, and participants who felt that the most effective methods

were lethal methods (lethal *versus* non-lethal). This perception may have affected the variation in the data, as respondents who indicated that the most effective methods are non-lethal may perceive sharks positively. Therefore, this test was deemed important. The table shows means of the variables for each group (with standard deviation), *p* values based on equal variances not assumed, and effect sizes (Cohen's *d*).

According to the table, means were significantly different for three variables, with small effect sizes. The factors **Knowledge** and **Interactions** had greater scores among respondents who felt that the most effective methods are non-lethal. These people were also less likely to have chosen the beach they were visiting because of a locally implemented shark hazard mitigation strategy.

Table 4.27: *T*-test results comparing Likert-scale data according to perceived effectiveness of lethal and non-lethal shark hazard mitigation (lethal vs. non-lethal)

Factors/Statements	Lethal			Non-Lethal			<i>p</i> -value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.45	1.03047	246	3.69	0.97755	381	0.004*	0.23**
Factor 2: Media	3.45	0.99085	259	3.58	0.9352	393	0.096	0.13
Factor 3: Interactions	3.34	0.93094	261	3.49	1.01032	397	0.047*	0.15
Human-shark interactions can happen because sharks mistake humans for their prey	3.89	1.040	244	3.87	1.007	361	0.856	0.01
Preventing human-shark interactions is NOT a responsibility of the government	2.66	1.212	228	2.76	1.195	353	0.323	0.08
Human-shark interactions can happen when a shark feels threatened and defends itself	4.02	1.038	232	3.96	1.067	337	0.502	0.06
People who get in the water are responsible for making sure it is safe to do so	3.91	1.067	239	3.93	1.064	360	0.812	0.02
Sharks' natural food source could be abundant in this area	3.46	0.977	177	3.33	1.049	251	0.168	0.13
Some books, movies and articles have increased fear of sharks among people	4.26	0.945	299	4.18	0.979	353	0.367	0.08
Most reported human-shark interactions are shark bites	3.17	1.252	199	3.11	1.236	313	0.582	0.05

Programmes that prevent human-shark interactions create jobs	3.70	1.046	210	3.82	0.934	318	0.160	0.12
I am NOT on this beach because human-shark interactions are prevented here	2.96	1.212	211	3.26	1.130	241	0.004*	0.25**

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

Respondents who indicated that the most effective mitigation methods are non-lethal tended to have more knowledge of sharks and human-shark interactions. They were also less likely to choose a beach based on the local shark hazard mitigation strategy in place. This result may be due to positive attitudes generally shared among these respondents. Perceiving non-lethal shark control as most effective may be related to knowledge and also to an understanding that lethal methods are unethical (Pepin-Neff & Wynter, 2019, 2018b; Acuña-Marrero *et al.*, 2018; O'Bryhim & Parsons, 2015). Simmons and Mehmet (2018), Gibbs and Warren (2015), and McCagh *et al.* (2015) also showed that the effectiveness of lethal strategies may not be trusted by the public as a result of knowledge of sharks and their condition, as well as general distrust in the effectiveness of lethal shark control *versus* non-lethal control. The fact that some respondents indicated that the most effective strategies are non-lethal ones shows support for shark conservation. This may also be the reason why they did not choose beach destinations based on locally implemented shark hazard mitigation strategies.

4.3.2.2.12 T-test results comparing Likert-scale data according to perceived harm of lethal and non-lethal shark hazard mitigation to sharks

Table 4.28 shows the results of an Independent Samples *t*-test which compared the Likert-scale data between participants who indicated that the most harmful shark hazard mitigation methods to sharks are lethal methods, and participants who felt that the most harmful methods to sharks are non-lethal methods (non-lethal *versus* lethal). This perception may have affected the variation in the data, as respondents who indicated that most harmful methods to sharks are lethal may share positive attitudes towards sharks. Therefore, this test was deemed important. The table shows means of the variables for each group (with standard deviation), *p* values based on equal variances not assumed, and effect sizes (Cohen's *d*).

According to the table, means were significantly different for seven variables, with small effect sizes. The factors **Knowledge**, **Media**, and **Interactions** had greater scores among respondents who felt that the most harmful mitigation methods to sharks are lethal. These people also agreed more that human-shark interactions can happen because sharks mistake

humans for their prey, that some books, movies and articles have increased fear of sharks among people, and that programmes that prevent human-shark interactions create jobs. These people were also less likely to have chosen the beach they were visiting because of a locally implemented shark hazard mitigation strategy.

Table 4.28: T-test results comparing Likert-scale data according to perceived harm of lethal and non-lethal shark hazard mitigation to sharks (non-lethal vs. lethal)

Factors/Statements	Non-Lethal			Lethal			p-value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.54	0.97433	288	3.92	0.94521	205	0.000*	0.39**
Factor 2: Media	3.51	0.92494	298	3.74	0.90041	210	0.005*	0.25**
Factor 3: Interactions	3.37	1.00134	299	3.71	0.85183	211	0.000*	0.34**
Human-shark interactions can happen because sharks mistake humans for their prey	3.83	1.065	284	4.05	0.986	194	0.023*	0.20**
Preventing human-shark interactions is NOT a responsibility of the government	2.74	1.127	265	2.68	1.282	189	0.647	0.04
Human-shark interactions can happen when a shark feels threatened and defends itself	3.96	1.105	267	3.97	1.034	186	0.930	0.01
People who get in the water are responsible for making sure it is safe to do so	3.89	1.067	279	4.04	0.974	200	0.112	0.14
Sharks' natural food source could be abundant in this area	3.41	0.962	189	3.36	1.128	147	0.654	0.05
Some books, movies and articles have increased fear of sharks among people	4.19	1.000	258	4.40	0.874	192	0.018*	0.21**
Most reported human-shark interactions are shark bites	3.17	1.213	221	2.95	1.337	177	0.086	0.17
Programmes that prevent human-shark interactions create jobs	3.70	1.019	238	3.92	0.922	176	0.021*	0.22**
I am NOT on this beach because human-shark interactions are prevented here	3.06	1.157	253	3.39	1.140	186	0.002*	0.29**

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

These results are similar to those pertaining to perceived effectiveness of lethal and non-lethal shark hazard mitigation strategies. People who possessed greater levels of knowledge and positive attitudes towards sharks were also those who understood that lethal shark hazard mitigation strategies are detrimental to sharks. These findings are in accordance with research by various authors (Acuña-Marrero *et al.*, 2018; O'Bryhim & Parsons, 2015). The respondents who understood the harm of lethal control strategies to sharks were also less likely to choose a beach based on the local shark hazard mitigation in place. This can be due to awareness that many beaches nationally implement lethal strategies, resulting in lack of support for these strategies as they are seen as harmful (Mehmet & Simmons, 2019).

4.3.2.2.13 T-test results comparing Likert-scale data according to local shark hazard mitigation awareness

Table 4.29 shows the results of an Independent Samples *t*-test which compared the Likert-scale data between participants who indicated that there were shark hazard mitigation strategies in place at the beach they visited and participants who indicated that there were not (no *versus* yes). This variable may have affected the variation in the data, as respondents who indicated that shark hazard mitigation strategies were in place at the beach they visited may have more knowledge regarding mitigation measures. Therefore, this test was deemed important. The table shows means of the variables for each group (with standard deviation), *p* values based on equal variances not assumed, and effect sizes (Cohen's *d*).

According to the table, means were significantly different for two variables, with small effect sizes. People who claimed that there were shark hazard mitigation strategies in place locally also agreed that those who get in the water are responsible for making sure it is safe to do so. The respondents who indicated that shark hazard mitigation measures were not in place were less likely to have chosen the beach they were visiting because of a locally implemented shark hazard mitigation strategy.

Table 4.29: T-test results comparing Likert-scale data according to local shark hazard mitigation awareness (no vs. yes)

Factors/Statements	No			Yes			<i>p</i> -value	Effect size
	Mean	Std. Dev	N	Mean	Std. Dev	N		
Factor 1: Knowledge	3.51	1.01740	275	3.46	1.05569	424	0.479	0.05
Factor 2: Media	3.45	0.97786	280	3.43	0.98980	445	0.719	0.03

Factor 3: Interactions	3.38	1.00199	285	3.35	1.01322	447	0.636	0.04
Human-shark interactions can happen because sharks mistake humans for their prey	3.78	1.103	256	3.89	1.019	421	0.202	0.10
Preventing human-shark interactions is NOT a responsibility of the government	2.77	1.189	245	2.68	1.202	399	0.342	0.08
Human-shark interactions can happen when a shark feels threatened and defends itself	3.86	1.159	244	3.98	1.027	388	0.187	0.10
People who get in the water are responsible for making sure it is safe to do so	3.76	1.073	255	3.93	1.035	407	0.047*	0.16
Sharks' natural food source could be abundant in this area	3.33	1.028	193	3.40	1.038	290	0.498	0.06
Some books, movies and articles have increased fear of sharks among people	4.08	1.080	251	4.19	0.924	392	0.172	0.10
Most reported human-shark interactions are shark bites	3.14	1.315	235	3.21	1.170	353	0.531	0.05
Programmes that prevent human-shark interactions create jobs	3.76	1.038	231	3.76	0.940	358	0.980	0.00
I am NOT on this beach because human-shark interactions are prevented here	3.30	1.199	237	2.96	1.132	382	0.001*	0.28**

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

Respondents who were aware of measures in place to reduce risks of interactions with sharks may have felt that, even though shark hazard mitigation is in place, one still has some kind of personal responsibility to help reduce potential risks (Lucrezi et al., 2019). Respondents who were not aware of any local shark hazard mitigation strategies tended not to use these strategies as a selection criterion in beach choice. The lack of interest in locally implemented shark hazard mitigation could have translated in lack of awareness regarding any potential measure in place, as it would be deemed unimportant.

4.3.2.3 ANOVA: comparison of Likert-scale data between locations

This section describes the results of ANOVAs comparing the Likert-scale data between categories of study locations (Shark Spotters, KZNSB, Mixed).

Table 4.30 shows the results of the ANOVA test which compared factors extracted (**Knowledge**, **Media** and **Interactions**) between study locations, with significance values (p) and effect sizes (Cohen's d). The tests of homogeneity of variance (Levene's test and Robust test – only the latter is reported in the table) show that the data met the assumptions of homogeneity of variance. The central limit theorem (CLT) also states that for large sample sizes (the sample size here is 1 138), normality assumptions are met.

According to the table, mean scores for the factors **Knowledge** and **Interactions** were, on average, lower under the KZNSB category compared with the other groups, and the factor **Media** was on average lower under the Mixed category compared with the other groups. No significant differences were found for the factors **Knowledge** and **Media**, as the p -values all exceeded 0.05 and the effect sizes (Cohen's d) were less than 0.2. There was a significant difference in the factor **Interactions** between locations, with a $p = 0.043$. Post-hoc tests (Games-Howell) show that the factor scores mainly differed (borderline significance just above 0.05) between KZNSB and the remaining case studies. Effect sizes, in particular, indicated a small significant difference between KZNSB and Mixed ($d = 0.22$). Specifically, the visitors in the Mixed category agreed more with the factor **Interactions** than those in the KZNSB category. The Games-Howell test also revealed that the factor score for **Knowledge** was almost significantly greater (borderline significance just above 0.05) among visitors in the Shark Spotters category compared with those in the KZNSB category.

This result indicates that visitors under the KZNSB agreed substantially less with statements related to **Interactions** than the Mixed group, and that the visitors from the Shark Spotters group had more knowledge compared with those of KZNSB. This may be due to the people under the KZNSB having the wrong, possibly negative, perceptions of human-shark interactions as a result of the implementation of lethal measures of shark control locally. Regarding knowledge, many visitors (44%) from the Shark Spotters category were foreign, originating from USA and Europe, and foreign origin was positively correlated with knowledge, thus the outcome reflected in the ANOVA result.

Table 4.30: ANOVA results and effect sizes for factor scores compared between locations

								Effect sizes	
Factors	Locations	N	Mean	Std. Deviation	p-value ANOVA	p-value Robust	Post Hoc (Games-Howell)	Shark Spotters with	KZNSB with
Factor 1: Knowledge	Shark Spotters	444	3.54	1.03598	0.114	0.113	SS and M=0.606		
	KZNSB	202	3.36	1.00051			SS and KZNSB=0.089	0.17	
	Mixed	219	3.45	1.06468			KZN and M=0.594	0.08	0.09
Factor 2: Media	Shark Spotters	466	3.46	0.98928	0.259	0.258	SS and KZNSB= 0.889		
	KZNSB	218	3.42	0.95565			SS and M= 0.242	0.04	
	Mixed	230	3.32	1.01919			KZNSB and M=0.570	0.13	0.09
Factor 3: Interactions	Shark Spotters	427	3.40	1.04055	0.043*	0.038*	SS and KZNSB= 0.055		
	KZNSB	205	3.21	0.94745			SS and M= 0.933	0.18	
	Mixed	214	3.43	0.99644			KZNSB and M=0.053	0.03	0.22**

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

Note: Post Hoc tests labels should be interpreted as follows: SS = Shark Spotters, KZNSB=KZNSB, M= Mixed

Table 4.31 shows the results of the ANOVA test which compared the statements that were removed from the factor analysis between study locations, with significance values (p) and effect sizes (Cohen's d). According to the table, mean scores for five of the statements ("Human-shark interactions can happen because sharks mistake humans for their prey", "Human-shark interactions can happen when a shark feels threatened and defends itself", "People who get in the water are responsible for making sure it is safe to do so", "Sharks' natural food source could be abundant in this area" and "I am not on this beach because human-shark interactions are prevented here") were, on average, lower under the KZNSB category compared with the other locations. Mean scores for three statements ("Preventing human-shark interactions is not a responsibility of the government", "Some books, movies and articles have increased fear of sharks among people", and "Most reported human-shark interactions are shark bites") were, on average, lower under the Shark Spotters category compared with the other locations and only one statement ("Programmes that prevent human-shark interactions create jobs") was lower under the Mixed category compared with the other locations.

Significant differences, however, were found only for three of the statements ("Preventing human-shark interactions is not a responsibility of the government", "Most reported human-shark interactions are shark bites", and "I am not on this beach because human-shark interactions are prevented here"), with p -values being 0.003, 0.026, and <0.001 respectively. Post-hoc tests (Games-Howell) for the first statement show that the mean score differed between Shark Spotters and the Mixed category (greater in the latter), with an effect size of $d = 0.21$. Post-hoc tests for the second statement show that the mean score differed between Shark Spotters and the KZNSB category (greater in the latter), with an effect size of $d = 0.23$. Post-hoc tests for the third statement show that the mean score differed between Shark Spotters and the remaining case studies, and was significantly greater with effect sizes of $d = 0.37$ for Shark Spotters *versus* KZNSB, and $d = 0.33$ for Shark Spotters *versus* Mixed.

It is probable that visitors under the Mixed category did not feel government responsibility very much as, locally, there is no strong presence of a government-regulated shark hazard mitigation strategy, while there is at the other study locations. The statement that most reported human-shark interactions are shark bites could have been interpreted as being offensive towards sharks. People in the Shark Spotters category, with more knowledge, may have seen this statement as wrong and offensive. On the contrary, people in the KZNSB category may have perceived this statement as true due to the implementation of lethal shark hazard mitigation locally. Lastly, the fact that respondents under the Shark Spotters category were apparently less dependent upon local shark hazard mitigation may be explained by the large presence of foreign visitors, resulting in other reasons (e.g. tourism and popularity) driving beach selection.

Table 4.31: ANOVA results and effect sizes for scores of statements that were removed compared between locations

								Effect sizes	
Statements	Locations	N	Mean	Std. Deviation	p-value ANOVA	p-value Robust	Post Hoc (Games-Howell)	Shark Spotters with	KZNSB with
Human-shark interactions can happen because sharks mistake humans for their prey	Shark Spotters	427	3.82	1.064	0.543	0.546	SS and KZNSB= 0.565 SS and Mixed= 0.996 KZNSB and Mixed=0.613		
	KZNSB	205	3.73	1.072				0.09	
	Mixed	214	3.83	1.100				0.01	0.09
Preventing human-shark interactions is NOT a responsibility of the government	Shark Spotters	415	2.65	1.156	0.033*	0.035*	SS and KZNSB= 0.776 SS and Mixed= 0.030* KZNSB and Mixed=0.252		
	KZNSB	183	2.72	1.165				0.06	
	Mixed	202	2.91	1.243				0.21**	0.16
Human-shark interactions can happen when a shark feels threatened and defends itself	Shark Spotters	400	3.92	1.129	0.398	0.383	SS and KZNSB= 0.514 SS and Mixed= 0.943 KZNSB and Mixed=0.387		
	KZNSB	186	3.81	1.135				0.10	
	Mixed	202	3.95	0.918				0.02	0.12
People who get in the water are responsible for making sure it is safe to do so	Shark Spotters	417	3.83	1.033	0.300	0.312	SS and KZNSB= 0.980 SS and Mixed= 0.311 KZNSB and Mixed=0.385		
	KZNSB	193	3.81	1.172				0.02	
	Mixed	208	3.95	0.992				0.12	0.12
Sharks' natural food source could be abundant in this area	Shark Spotters	285	3.40	1.045	0.167	0.160	SS and KZNSB= 0.373 SS and Mixed= 0.709 KZNSB and Mixed=0.135		
	KZNSB	146	3.26	1.011				0.13	
	Mixed	159	3.48	0.967				0.07	0.22**
Some books, movies and articles have increased fear of sharks among people	Shark Spotters	411	4.10	1.069	0.725	0.702	SS and KZNSB= 0.685 SS and Mixed= 0.924 KZNSB and Mixed=0.919		
	KZNSB	190	4.14	0.916				0.03	
	Mixed	197	4.17	0.881				0.06	0.04
Most reported human-shark	Shark Spotters	366	3.08	1.272	0.026*	0.020*	SS and KZNSB= 0.016*		

interactions are shark bites	KZNSB	173	3.38	1.106			SS and Mixed= 0.386	0.23**	0.13
	Mixed	180	3.22	1.151			KZNSB and Mixed=0.409	0.11	
Programmes that prevent human-shark interactions create jobs	Shark Spotters	387	3.74	1.051	0.236	0.210	SS and KZNSB= 0.861		
	KZNSB	165	3.79	0.909			SS and Mixed= 0.333	0.04	
	Mixed	180	3.62	0.941			KZNSB and Mixed=0.200	0.12	0.18
I am NOT on this beach because human-shark interactions are prevented here	Shark Spotters	383	3.28	1.148	0.000*	0.000*	SS and KZNSB= 0.000*		
	KZNSB	186	2.86	1.116			SS and Mixed= 0.001*	0.37**	
	Mixed	189	2.90	1.149			KZNSB and Mixed=0.923	0.33**	0.04

Note: * Statistically significant difference: $p \leq 0.05$ (Pallant, 2016:259)

Note: Effect sizes are categorised as small (0.2 – 0.4)**; medium (0.5 – 0.8)*** and large (greater than 0.8)**** (Mok et al., 2017; Ellis & Steyn, 2003)

Note: Post Hoc tests labels should be interpreted as follows: SS = Shark Spotters, KZNSB=KZNSB, M= Mixed

4.4 CONCLUSION

The purpose of this chapter was to outline the descriptive as well as exploratory results of this study, where the data from 1 138 questionnaires distributed at five beach destinations in South Africa were analysed. The descriptive results comprised the demographic profile of the respondents as well as the respondents' perceptions of sharks (including knowledge, shark framing by the media, and human-shark interactions) and shark hazard mitigation. Data analysis was performed to answer the first two research questions set for this study, specifically 1) Do perceptions of sharks and shark hazard mitigation vary according to the socio-demographic profile of beach visitors?, 2) Do perceptions of sharks and shark hazard mitigation vary geographically, that is, across beach destinations using different shark hazard mitigation strategies?

In summary, the following conclusions can be made concerning the results of this study:

- Perceptions of sharks and shark hazard mitigation varied according to socio-demographic parameters of beach visitors (Research Question 1). This outcome was achieved through descriptive statistics, correlations (r_s) and t -tests;
- Perceptions of sharks and shark hazard mitigation varied geographically, according to different beach destinations and different shark hazard mitigation strategies (Research Question 2). This outcome was achieved through descriptive statistics, cross tabulations, correspondence analysis, and ANOVA;
- There were significant relationships between various perceptions of sharks and shark hazard mitigation. This outcome was achieved through exploratory factor analysis, reliability tests, correlations (r_s) and t -tests;
- Importantly, it was found that the socio-demographic profile of the participants in this study differed in some respects between the categories of study locations investigated here (Shark Spotters, KZNSB, Mixed). This difference tended to influence the variation in the main data between study locations. This outcome was achieved through cross tabulations and Mann-Whitney U test.

Conclusions and recommendations concerning this study and addressing the third research question of this study are discussed in the following chapter (Chapter 5).

Chapter five

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The primary aim of this study was to assess of the perceptions of beach visitors, including ocean users and non-users, with regards to sharks and shark hazard mitigation in South Africa. To achieve this aim, three objectives were set in Chapter 1. These objectives were attained in the corresponding chapters.

The first objective was to conduct a literature (scholarly and web-based) study in relation to the goal of the study, focussing on several topics including the global importance of the oceans and threats to the oceans; the global importance of sharks and threats to sharks; the history of human-shark interactions; the different types of human-shark interactions; shark hazard mitigation types; beach tourism and its relation to shark hazard mitigation; human perceptions of sharks and shark hazard mitigation; media treatment of sharks (shark framing); and research on human-shark interactions, shark hazard mitigation and public opinion of sharks and shark hazard mitigation in South Africa. This objective was achieved in Chapter 2.

The second objective was to perform quantitative research by using a self-administered questionnaire survey targeting beach visitors. Five beaches were selected in Cape Town (False Bay), Mossel Bay, Jeffreys Bay, Port Elizabeth and Durban. The results consisted of a demographic profile and perceptions analysed via descriptive statistics, cross tabulations, Mann-Whitney U test, correspondence analysis, exploratory and confirmatory factor analysis, reliability tests, nonparametric correlations (r_s), t -tests, and ANOVAs (with post-hoc tests). This objective was achieved in Chapter 4.

The third and final objective was to draw up conclusions and useful recommendations relating to the human-shark conflict, beach-based recreation in areas where interactions with sharks are possible, shark hazard mitigation, and shark conservation management in South Africa. Recommendations are addressed to scientists, academics, practitioners, beach

managers, decision-makers, the government, the tourism sector, the media, and the general public (including ocean users and beach recreationists), both in South Africa and globally where applicable. This is achieved in the current chapter (Chapter 5).

Thus, the purpose of this chapter is to emphasize the goal and objectives of this research and to draw conclusions and recommendations accordingly.

5.2 CONCLUSIONS

This section includes a summary of the conclusions concerning the literature review (Chapter 2) and the results of the survey (Chapter 4), followed by a list of recommendations concerning this study in light of the summarised conclusions.

5.2.1 Conclusions from the literature review (Chapter 2) and the results (Chapter 4)

What follows is a summary of the conclusions on the literature view as explained and described in Chapter 2 and the conclusions from the results of the empirical research described in Chapter 4.

5.2.1.1 Chapter 2: A literature review

The main purpose of Chapter 2 was to expose research-based facts concerning the ocean, sharks, human-shark interactions, shark hazard mitigation strategies, beach tourism and its relation to shark hazard mitigation, shark framing, and human perceptions of sharks and shark hazard mitigation globally and in South Africa. The main conclusions regarding this chapter are summarised as follows:

- The ocean ecosystem is the largest ecosystem on planet earth (c.f.2.2).
- The oceans contain 97% of the water on earth and cover 70% of the surface (c.f.2.2).
- The oceans produce half of the oxygen humans breathe and a sixth of animal proteins humans eat (c.f.2.2).
- Oceans are important because they provide more oxygen than rainforests, they regulate the earth's climate, they are an important food source, jobs are created through them, and they have therapeutic properties (c.f.2.2).
- The oceans face several threats such as climate change, pollution (thermal pollution, plastic pollution, oil pollution, and underwater noise pollution), overfishing, the growing tourism sector, and poaching of marine species (c.f.2.2).

- Sharks are apex predators that prey on species below them in the food chain (c.f.2.3).
- Absence of sharks at the top levels of the food chain leads to depopulation and overpopulation at lower levels (c.f.2.3).
- Sharks are a source of protein and a direct source of medicine for treating human bone diseases (c.f.2.3).
- Sharks are worth millions of US\$ and provide 4% of the economic benefit in the tourism industry (c.f.2.3).
- 590 000 shark watchers spend as much as US\$314 million per year and support as many as 10 000 jobs globally (c.f.2.3).
- Sharks face several threats which are mainly related to human pressures and impacts (c.f.2.3).
- Approximately 100 million sharks are killed every year (c.f.2.3).
- Out of 465 shark species, 11 are critically endangered, 15 are endangered, 48 are vulnerable, and 74 are near threatened (c.f.2.3).
- Sharks face threats such as bycatch, prolonged exploitation, shark trading, lethal shark control (nets, drumlines, culling), sub-sea cables, and tourism development (c.f.2.3).
- Several regional, national, and international policies are in place to protect sharks (c.f.2.3).
- Limit-based policies ban certain fisheries and target-based policies allow sustainable fishing to reduce shark bycatch (c.f.2.3).
- Marine protected areas (MPA) are used as management and conservation measures that shelter vulnerable species such as sharks (c.f.2.3.).
- There are 42 MPAs in South Africa, consisting of three different categories: restricted areas, controlled areas, and restricted and controlled areas (c.f.2.3).
- Reports of human-shark interactions date back to Biblical accounts and ancient Greek mythology (c.f.2.4).
- Humans started navigating the oceans 42 000 years ago (c.f.2.4).
- The first properly documented relationships between humans and sharks date back to the Bronze age (3000 BC-1200 BC), where humans caught small sharks to eat (c.f.2.4).
- The first reported shark 'attack' presumably happened in 1749, when a 14-year-old boy, Brook Watson, was bitten by a shark (c.f.2.4).
- Swimming was legalised in 1830 in Australia, which led to human-shark interactions taking place (c.f.2.4).
- The first reported shark bite in Australia took place in Sydney and was documented in 1915 (c.f.2.4).
- In 1916, a group of people were killed by sharks in New Jersey, which led to an increase in curiosity about shark behaviour (c.f.2.4).

- During World War II (1939-1945), thousands of troops were deployed across the Pacific Ocean, leading to an increase in human-shark interactions (c.f.2.4).
- The *USS Indianapolis* sank in 1945, when the end of World War II was near, resulting in 60-80 humans being killed by sharks, due to the amount of blood in the ocean (c.f.2.4).
- In 1945, the first chemical shark repellent, the Shark Chaser, was developed after attention was brought to the government. This device was distributed to US. military at sea (c.f.2.4).
- Humans began to use beaches for recreational reasons in 1946, which brought more people in contact with sharks (c.f.2.4).
- *Jaws* was released in 1975, which led to the public being horrified to use the oceans (c.f.2.4).
- In 1985-1992 the shark diving industry was popularised, divers came to accept sharks and shark popularity grew (c.f.2.4).
- Shark cage diving boomed in 1993, and since then sharks have been used as an attraction for diving sites (c.f.2.4).
- In 1995, increased awareness of conservation led to more positive opinions of sharks (c.f.2.4).
- Sharks were seen as dangerous creatures but since 1984 perceptions started to change and sharks started to be seen as exciting creatures (c.f.2.4).
- There is a shark-enthusiast community who is obsessed with sharks (c.f.2.4).
- Totemism is when humans have emotional relationships with sharks and sharks become sacred to humans (c.f.2.4).
- Some people still fear sharks, which makes it difficult to implement conservation (c.f.2.4).
- Different levels of human-shark interactions exist namely: shark sighting, shark encounter, shark bites, and fatal shark bites (c.f.2.5).
- Human-shark interactions can be provoked (human initiates the interaction) or unprovoked (no human provocation) (c.f.2.5).
- The International Shark Attack File (ISAF) is a comprehensive database consisting of all the known 'shark attacks' (fatal and unfatal bite incidents) and is kept in the Museum of Natural History in Florida (c.f.2.5).
- Over 439 years, 1483 unprovoked shark bite incidents took place in the USA, 652 in Australia, and 256 in South Africa (c.f.2.5).
- An increase in shark bite incidents has been taking place due to an increasing human population and increased use of the coast and water (c.f.2.5).
- The expression "shark attack" has been used erroneously to describe interactions not resulting in bites; therefore, shark bite statistics have been overrepresented (c.f.2.5).

- Lethal and non-lethal shark hazard mitigation strategies are used to prevent human-shark interactions (c.f.2.6).
- Lifeguards are the first known shark hazard mitigation strategy which was implemented already in the 1800s (c.f.2.6).
- Different shark hazard mitigation strategies, aside from lifeguards, include information boards, aerial surveys, nets, drumlines, electrical shark repellent, shark spotters, and shark repellent cable (c.f.2.6).
- Lifeguards are usually equipped with emergency shark-bite kits (c.f.2.6.1).
- Different beach signs exist namely: emergency information and location, lifeguard information, prohibitions, and safety hazard symbols (c.f.2.6.1).
- Aerial surveys were first implemented in Australia in 1930 (c.f.2.6.2).
- Aerial surveys take place during different times of the day and make use of one pilot, one observer and one data recorder (c.f.2.6.2).
- Drones are being tested as a novel non-lethal shark hazard mitigation strategy (c.f.2.6.2).
- Shark nets were first installed in Australia in the 1930s and in South Africa in 1952 (c.f.2.6.3).
- In South Africa, nets reached their maximum number in the 1990s, with a total of 44km of nets, covering 44 beaches (c.f.2.6.3).
- Nets in South Africa have been reduced by one third between 1999 and 2004, which reduced the amount of bycatch (c.f.2.6.3).
- Drumlines were first installed in Australia in the 1960s (c.f.2.6.4).
- Drumlines are implemented to reduce the amount of bycatch and make use of baited hooks to catch sharks (c.f.2.6.4).
- The first electrical shark repellent, the shark POD, was used in KwaZulu-Natal (KZN), in 1992 (c.f.2.6.5).
- The Shark Spotters programme was first implemented in Cape Town in 2004 and uses a four-flag system to alert ocean users of the presence of sharks (c.f.2.6.6).
- Shark Spotters has recorded 2 500 shark sightings from November 2004 to February 2019 (c.f.2.6.6).
- The KZN Sharks Board (KZNSB) has been experimenting with a shark repellent cable since 2004; this is being tested at the Glencairn beach in Cape Town (c.f.2.6.7).
- Beach tourism is an economic driver and is an extremely popular type of tourism (c.f.2.7).
- Beach tourism is a key contributor to the Gross Domestic Product (GDP) and economic growth of several countries (c.f.2.7).
- Beach tourism can have negative ecological and environmental impacts when managed improperly (c.f.2.7).

- Beach tourism is responsible for various negative impacts, such as trampling and crowding, which lead to habitat loss, pollution, and wildlife disturbance (c.f.2.7).
- Shark hazard mitigation is directly related to beach tourism, as it is usually implemented at popular swimming and surfing destinations to prevent human encounters with sharks. Beaches that are important for tourism normally have shark hazard mitigation strategies in place (c.f.2.7).
- Human needs may result in damaging treatments of sharks as these needs are often in conflict with conservation agendas (c.f.2.7).
- Human needs have three dimensions, land, the intertidal zone, and the ocean (c.f.2.7).
- For humans to use the oceans, lethal mitigation methods are implemented as a means to 'protect' humans. This leads to an ecosystem imbalance and disturbance (c.f.2.7).
- When the ecosystem experiences an imbalance, tourism activities which are non-lethal to sharks, such as scuba diving, can be affected negatively (c.f.2.7).
- Humans are usually aware of shark hazard mitigation measures in place at local beaches, but they do not necessarily know how these strategies work (c.f.2.7).
- Beaches are not necessarily chosen based on the shark hazard mitigation measures in place, but rather due to aesthetic qualities, popularity, and convenience (c.f.2.7).
- Based on the articles listed in table 2.8, concerning public opinion of sharks and shark hazard mitigation, it is seen that most research was conducted in places where shark hazard mitigation measures are in place. The bulk of this research was conducted in Australia, while only two studies were conducted in South Africa (this supports the importance of the present study). The populations under investigation consisted of ocean users, coastal communities, social media users, recreational anglers, tourists, school pupils, and viewers of shark documentaries. Knowledge regarding sharks is obviously low in children. Most ocean users prefer non-lethal shark hazard mitigation measures. Sharks are seen as very important to the marine ecosystem and humans do not always perceive sharks as 'man-eaters'. Some people realise that sharks are important, however they are unaware of the threats faced by sharks. Humans who fear sharks have a lack of knowledge about sharks and are more prone to support lethal shark hazard mitigation (c.f.2.8).
- Based on the articles listed in table 2.9, concerning the role of the media in portraying sharks (shark framing), it is clear that most of the studies were conducted in Australia. Human-shark interactions are mentioned in the media mostly as 'attacks' and most mentioned shark hazard mitigation strategies are lethal ones, such as drumlines and nets. Articles about sharks contain the highest percentage of graphic elements, which may result in public fear (c.f.2.9).
- South Africa ranks amongst the top countries with regards to 'shark attacks', with 256 unprovoked attacks reported (c.f.2.10).

- The 'attacks' in South Africa were caused by bull sharks, tiger sharks and great white sharks (c.f.2.10).
- Different laws are in place in South Africa to help regulate shark hazard mitigation (c.f.2.10).
- Most legislations in South Africa are implemented by Shark Spotters in Cape Town, and the KZNSB in KZN (c.f.2.10).
- Research on ocean users' opinion of sharks and shark hazard mitigation in South Africa is limited (c.f.2.10).
- Shark-based tourism is highly valued amongst ocean users in South Africa (c.f.2.10).
- Gansbaai in South Africa generates around US\$1.62 million per year with shark cage diving, and Aliwal Shoal around US\$1.62 million per year with tiger shark tourism (c.f.2.10).
- Some ocean users in South Africa, namely divers, claim that they feel safe around sharks and that they do not feel threatened when having an interaction with sharks underwater (c.f.2.10).
- Knowledge and positive attitudes towards sharks increase personal responsibility in the water (c.f.2.10).
- The dearth of research concerning perceptions of sharks and shark hazard mitigation in South Africa, which hosts important shark species, attracts international beach-based as well as shark-based tourism, and implements both lethal and non-lethal shark hazard mitigation strategies, justifies the importance of this study.

5.2.1.2 Chapter 4: Descriptive and exploratory results

The main purpose of Chapter 4 was to elaborate on the results of quantitative research on beach visitors' perceptions of sharks and shark hazard mitigation in South Africa. The results included the profile of beach visitors as well as perceptions of sharks (including knowledge, shark framing by the media and human-shark interactions) and shark hazard mitigation. The data were analysed using descriptive statistics, cross tabulations, Mann-Whitney U test, correspondence analysis, exploratory factor analysis, reliability tests, Spearman rank order correlations (r_s), t -tests, and ANOVAs (with post-hoc tests). What follows is a summary of these results.

5.2.1.2.1 Descriptive results

The descriptive results are summarised below. A total of 1 138 questionnaires were completed during this study. Respondents were grouped into three categories according to shark hazard mitigation strategy adopted at the sampled beaches: Shark Spotters, KZNSB and Mixed.

5.2.1.2.1.1 *Conclusions from the demographic profile*

Figure 5.1 indicates that the majority of the respondents across the five study locations were female (46%-67%), between 33 and 38 years old. These respondents mainly possessed a tertiary qualification (74%-50%) and were mainly from the provinces where the questionnaire was distributed (for example the respondents from Durban Beach were mostly from KZN). Most of these respondents were from South Africa (56%-98%) and single (46%-66%), paid workers (49%-70%) and not local residents of the area (55%-70%). Most respondents swam, sunbathed and walked when visiting the beach and 51%-85% of these respondents were water users. The respondents mainly looked for cleanliness and safety when selecting a beach and saw theft, sunburn and drowning as the greatest risk when visiting the beach (c.f.4.2.1).

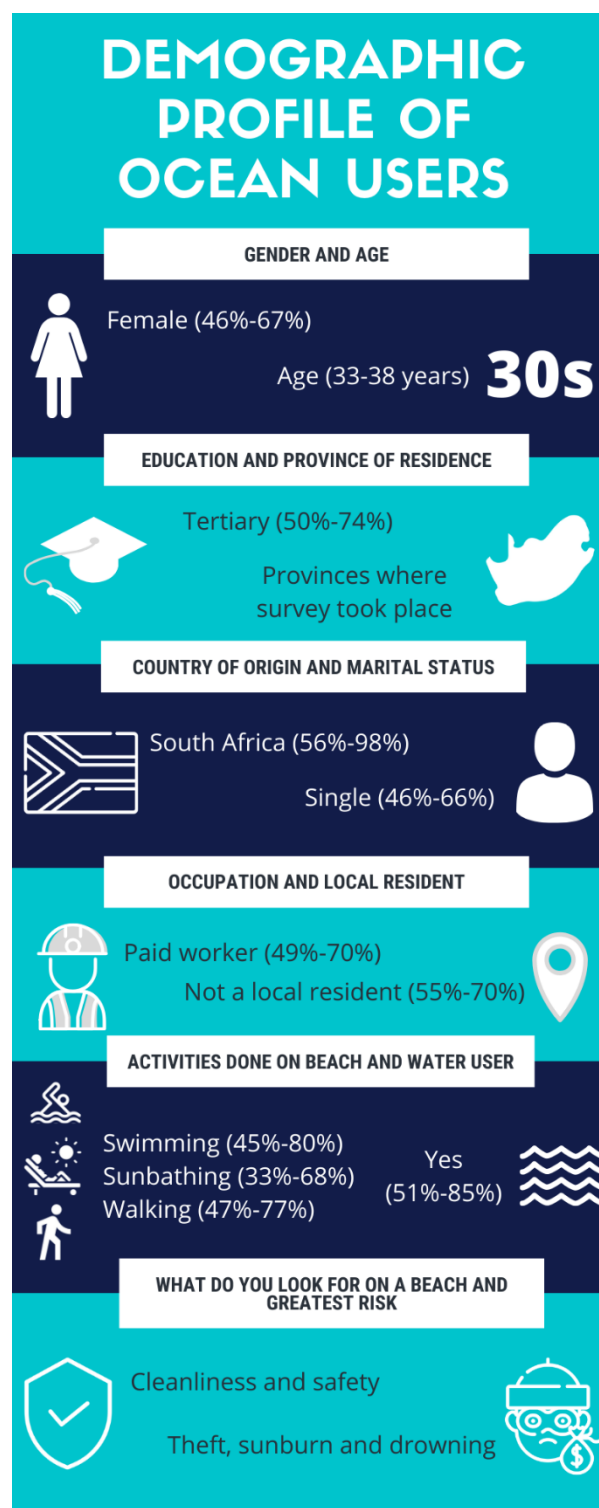


Figure 5.1: Summary of the profile of the respondents
Source: Author's compilation

5.2.1.2.1.2 *Conclusions from the perceptions of sharks and shark hazard mitigation*

What follows is a series of conclusions on beach visitors' awareness of shark species in the areas visited, attitude towards sharks and perceived safety from shark encounters at the beach, perceptions of 'shark attacks' and human-shark interactions, and awareness and perceptions of shark hazard mitigation strategies:

- Respondents tended to be aware of local shark species including those that are involved in shark bite incidents (e.g. Zambesi shark, great white shark, tiger shark) (c.f.4.2.2.1).
- Respondents had mixed feelings towards sharks, as some described sharks positively, while some negatively (c.f.4.2.2.2).
- Forty-five to fifty-four percent (45%-54%) of the respondents indicated that they were afraid of sharks; however, most indicated that sharks are not the greatest risk when visiting the beach (81%-88%) (c.f.4.2.2.2).
- The respondents indicated that humans are the greatest risk faced by sharks (66%-77%) (c.f.4.2.2.2).
- Overall, respondents felt safe to very safe from the possibility of a shark encounter at the beach (68%-80%) (c.f.4.2.2.2).
- Overall, respondents understood 'shark attack' and human-shark interactions differently (c.f.4.2.2.3).
- Respondents from the Shark Spotters category indicated that a 'shark attack' is when a shark kills a person; respondents from the KZNSB category indicated that it is when a shark bites a person and those from the Mixed category specified that it is when a shark hits a person or a board and when a shark bites a board (c.f.4.2.2.3).
- Respondents from the Shark Spotters category perceived a human-shark interaction as various things (from a sighting to a bite incident), compared to respondents from the KZNSB and Mixed categories, who perceived a human-shark interaction as a non-lethal encounter (c.f.4.2.2.3).
- Only 12%-21% of respondents had an interaction with a shark; interactions included diving and shark cage diving (c.f.4.2.2.3).
- A large group of the respondents were aware of the different shark hazard mitigation strategies in existence; however, many were unsure if the strategies are effective (37%-42%) and harmful to sharks (54%-57%) (c.f.4.2.2.4).
- The respondents were most familiar with shark nets, the Shark Spotters programme, trained lifeguards, and information boards (c.f.4.2.2.4).
- Respondents were more familiar with strategies that were in place in the area they visited (Shark Spotters for the Shark Spotters category; shark nets, drumlines and the shark

repellent cable for the KZNSB category; and aerial surveys, boat spotting, and acoustic tracking for the Mixed category) (c.f.4.2.2.4).

- The respondents from the Shark Spotters category indicated that Shark Spotters and shark nets are most effective. The respondents from the KZNSB category indicated that shark nets are most effective and the respondents from the Mixed category indicated that shark nets and shark Spotters are most effective (c.f.4.2.2.4).
- The respondents from the Shark Spotters category indicated that electrical shark repellents and shark nets are most harmful to shark species. The respondents from the KZNSB category indicated that shark nets and electrical shark repellents are most harmful. The respondents from the Mixed category indicated that shark nets and electrical shark repellents are most harmful (c.f.4.2.2.4).
- Overall, respondents from the KZNSB category claimed that lethal shark control is most effective compared to the other two categories who claimed that non-lethal shark control is most effective (Pearson's $\chi^2 = 30.87$, $p < 0.001$) (c.f.4.2.2.4).
- Shark nets may be effective, but they are lethal to sharks. The electrical shark repellent was seen as harmful to sharks. It is, however, one of the non-lethal methods (c.f.4.2.2.4).
- The respondents from the KZNSB category were most aware of the shark hazard mitigation strategies implemented locally, followed by the respondents of the Shark Spotters category and the Mixed category (Pearson's $\chi^2 = 21.14$, $p < 0.001$) (c.f.4.2.2.4).
- Thirty-nine percent (39%) of the respondents from the Shark Spotters category indicated that shark hazard mitigation measures (Shark Spotters programme) were in place locally (c.f.4.2.2.4).
- Fifty-five percent (55%) of the respondents from the KZNSB category indicated that shark hazard mitigation measures (shark nets) were in place locally (c.f.4.2.2.4).
- Thirty-five percent (35%) of the respondents from the Mixed category indicated that shark hazard mitigation measures (lifeguards and shark spotting) were in place locally (c.f.4.2.2.4).
- Seven percent (7%) of the respondents from the Mixed category indicated that shark nets were in place at the local beach (c.f.4.2.2.4).

5.2.1.2.1.3 Conclusions on Likert-scale data concerning sharks, shark framing, human-shark interactions, and shark hazard mitigation

What follows is a series of conclusions about the level to which respondents agreed with statements regarding sharks, shark framing, human-shark interactions and shark hazard mitigation:

- There was a general level of agreement with most of the statements, particularly for the Shark Spotters category, suggesting a more sophisticated understanding of various shark-related aspects in this category (c.f.4.2.3).
- Statements with the highest average scores of agreement were: “Human-shark interactions can happen when a shark feels threatened and defends itself”, “Some books, movies and articles have increased fear of sharks among people”, and “Programmes that prevent human-shark interactions create jobs” (c.f.4.2.3).
- Statements with the lowest average score of agreement were: “Preventing human-shark interactions is not a responsibility of the government”, “Sharks are generally not dangerous”, and “I am not on this beach because human-shark interactions are prevented here” (c.f.4.2.3).
- Statements with highest frequency of agreement were: “Some books, movies and articles have increased fear of sharks among people”, “Human-shark interactions do not happen because sharks hunt humans”, “People who get in the water are responsible for making sure it is safe to do so”, “Human-shark interactions can happen when a shark feels threatened and defends itself”, and “Human-shark interactions can happen because sharks mistake humans for their prey” (c.f.4.2.3).
- Statements with lowest frequency of agreement were: “Preventing human-shark interactions is not a responsibility of the government”, “Learning about sharks as children has an effect on what people think of sharks as adults”, “Sharks are generally not dangerous”, and “Sharks that bite people are not likely to do it again in the future” (c.f.4.2.3).

5.2.1.2.2 *Exploratory analysis results*

The conclusions from the exploratory analysis results of this study are presented below. These include conclusions from the exploratory factor analysis on the agreement scale data, Spearman’s rank order correlations (r_s), t -tests and ANOVAs.

5.2.1.2.2.1 *Conclusions from the exploratory factor analysis*

An exploratory factor analysis was originally performed on Likert-scale data. This was followed by a confirmatory exploratory factor analysis, where four factors were considered. However, several statements had to be removed from this analysis, as well as one factor. Finally, three reliable factors were identified:

- Factor 1 (**Knowledge**) comprised three statements: “Shark species are not well protected globally”, “The role of sharks in marine ecosystems cannot be easily replaced by other species”, and “Sharks tend to not reproduce rapidly” (c.f.4.3.1.2).
- Factor 2 (**Media**) comprised three statements: “The media do not talk about human-shark interactions in the proper way”, “Learning about sharks as children has an effect on what people think of sharks as adult”, and “‘Shark attack’ is a not good expression to describe human-shark interactions” (c.f.4.3.1.2).
- Factor 3 (**Interactions**) comprised three statements: “Sharks are generally not dangerous”, “Sharks that bite people are not likely to do it again in the future”, and “Human-shark interactions do not happen because sharks hunt humans” (c.f.4.3.1.2).
- The statements that were not included in these factors were equally valuable and were used for further analysis together with factor scores (c.f.4.3.1.2).

5.2.1.2.2.2 *Conclusions from the Spearman’s rank order correlations*

The results from the Spearman’s rank order correlations (r_s) are listed as follows:

- Age and education of the respondents were positively correlated, indicating that the older the respondents, the more educated they were (c.f.4.3.2.1).
- Foreign visitors had a higher education qualification and tended to visit the beaches in summer months (c.f.4.3.2.1).
- Ocean use was more prevalent among South African respondents (c.f.4.3.2.1).
- Females were more afraid of sharks and claimed that non-lethal shark hazard mitigation is more harmful than lethal forms (c.f.4.3.2.1).
- Respondents with a higher education qualification understood that lethal shark hazard mitigation is harmful to sharks (c.f.4.3.2.1).
- Water users were more aware of the shark hazard mitigation measures in place at the beach they visited (c.f.4.3.2.1).
- Foreigners (who were from the USA and Europe) had greater levels of knowledge than South African respondents (c.f.4.3.2.1).
- Foreigners tended not to select the beach based on the presence of shark hazard mitigation (c.f.4.3.2.1).
- Respondents who did not perceive sharks as a risk were also not afraid of sharks and they felt safe at the beach (c.f.4.3.2.1).
- Respondents who did not perceive sharks as a risk also believed that lethal shark control is most harmful to sharks (c.f.4.3.2.1).

- Respondents who knew that lethal shark control is most harmful to sharks also agreed that humans are the greatest threat faced by sharks, they did not select the beach based on the shark hazard mitigation in place, and had more knowledge of sharks (c.f.4.3.2.1).
- Respondents with more knowledge of sharks also had more positive attitudes towards sharks and did not select beaches based on the shark hazard mitigation in place (c.f.4.3.2.1).
- Respondents who were not afraid of sharks had more knowledge of sharks and positive attitudes towards sharks (c.f.4.3.2.1).
- Respondents who knew that sharks do not hunt humans also felt that humans are the greatest threat faced by sharks (c.f.4.3.2.1).
- Knowing of the presence of local shark hazard mitigation was positively correlated with choosing the local beach based on the presence of shark hazard mitigation (c.f.4.3.2.1).
- Items belonging to the same category, for example that of knowledge, of media framing and of human-shark interactions, tended to be correlated with each other, and when attitudes and knowledge were positive, there was also less dependence on locally implemented shark hazard mitigation (c.f.4.3.2.1).
- The coefficients for statement 28 ("Most reported human-shark interactions are shark bites"), were mainly negative probably due to the respondents' interpretation of this statement (c.f.4.3.2.1).

5.2.1.2.2.3 *Conclusions from the t-tests*

Conclusions from each *t*-test that was performed on the data are listed as follows:

- Agreeing that the government is responsible for preventing human-shark interactions was more prevalent among respondents interviewed in summer than in winter (c.f.4.3.2.2.1).
- Respondents interviewed in the winter agreed more than those interviewed in summer, that the most reported human-shark interactions are shark bites (c.f.4.3.2.2.1).
- Respondents interviewed in summer were less likely to choose the beach they were visiting because of the shark hazard mitigation in place (c.f.4.3.2.2.1).
- Females tended to agree more than males that human-shark interactions can happen when a shark feels threatened and defends itself, and that some books, movies, and articles have increased fear among people (c.f.4.3.2.2.2).
- The tertiary-educated respondents agreed more with the statements in the factor knowledge compared with those having a lower education level (c.f.4.3.2.2.3).

- The tertiary-educated respondents agreed more than those with lower education level, that human-shark interactions can happen because sharks mistake humans for prey; and that human-shark interactions happen when a shark feels threatened and defends itself (c.f.4.3.2.2.3).
- The tertiary-educated respondents agreed more than those with lower education level, that the government is responsible for preventing human-shark interactions, and were less likely to have chosen the beach they were visiting due to the shark hazard mitigation strategies implemented (c.f.4.3.2.2.3).
- Foreign respondents agreed more with the three extracted factors compared with South Africans (c.f.4.3.2.2.4).
- Foreign respondents agreed more than South Africans that human-shark interactions can happen because sharks mistake humans for prey and when a shark feels threatened and defends itself (c.f.4.3.2.2.4).
- South African respondents agreed more than foreigners that most reported human-shark interactions by the media are shark bites (c.f.4.3.2.2.4).
- Foreign respondents were less likely than South Africans to select a beach due to the locally implemented shark control measures (c.f.4.3.2.2.4).
- Non-residents agreed more than local residents that human-shark interactions can happen because sharks mistake humans for their prey (c.f.4.3.2.2.5).
- Water users were more likely than non-users, to select the beach they were visiting based on the shark hazard mitigation measure in place (c.f.4.3.2.2.6).
- All three factors had greater scores among respondents who did not claim sharks are the greatest risk when visiting the beach; these respondents were also less likely to choose the beach they were visiting due to the shark hazard mitigation measures in place, compared with people who perceived sharks to be the greatest risk (c.f.4.3.2.2.7).
- All three factors had greater scores among respondents who did not fear sharks; compared with people who feared sharks, these respondents were also less likely to choose the beach they were visiting based on the shark hazard mitigation measures in place, agreed more that people who get in the water are responsible for making sure it is safe to do so, and disagreed more that most reported human-shark interactions by the media are shark bites (c.f.4.3.2.2.8).
- All three factors had greater scores amongst the respondents who felt that humans are a threat to sharks, compared with those who did not. These respondents also agreed more that human-shark interactions can happen because sharks mistake humans for prey, that people who get in the water have responsibility in making sure it is safe to do so, and that programmes that prevent human-shark interactions create jobs (c.f.4.3.2.2.9).

- Two of the factors (**Knowledge** and **Interactions**) had greater scores amongst respondents who felt safe from the possibility of a shark encounter (c.f.4.3.2.2.10).
- Two of the factors (**Knowledge** and **Interactions**) had greater scores amongst respondents who felt that the most effective shark hazard mitigation methods are non-lethal. These people were also less likely to choose a beach based on the shark hazard mitigation measures in place (c.f.4.3.2.2.11).
- All three factors had greater scores amongst the respondents who felt that the most harmful shark hazard mitigation methods to sharks are lethal. These respondents also agreed more that human-shark interactions can happen because sharks mistake humans for prey; that some books, movies, and articles have increased fear of sharks among people; that programmes that prevent human-shark interactions create jobs; and were less likely to choose the beach based on the shark hazard mitigation measures in place (c.f.4.3.2.2.12).
- Respondents who claimed that shark hazard mitigation measures were in place locally agreed more that people who want to get in the water have a responsibility in making sure it is safe to do so, compared with people who claimed there were no measures in place or did not know (c.f.4.3.2.2.13).
- Respondents who claimed that no shark hazard mitigation measure were in place locally or did not know, were less likely to choose a beach based on the shark hazard mitigation measures in place (c.f.4.3.2.2.13).

5.2.1.2.2.4 *Conclusions from the ANOVAs*

Conclusions from the ANOVAs comparing data between the three categories of shark hazard mitigation created for this study (Shark Spotters, KZNSB and Mixed) are listed as follows:

- Mean scores for two factors (**Knowledge** and **Interactions**) were lowest under the KZNSB category, and the factor score for **Media** was lowest under the Mixed category (c.f.4.3.2.3).
- The factor **Interactions** had a significantly lower score for the KZNSB category compared with the Mixed category (c.f.4.3.2.3).
- The respondents from the Shark Spotters category had (borderline) significantly more **Knowledge** than the respondents from the KZNSB category (c.f.4.3.2.3).
- Mean scores for five statements (“Human-shark interactions can happen because sharks mistake humans for their prey”, “Human-shark interactions can happen when a shark feels threatened and defends itself”, “People who get in the water are responsible for making sure it is safe to do so”, “Sharks’ natural food source could be abundant in

this area” and “I am not on this beach because human-shark interactions are prevented here”) were lower under the KZNSB category compared with the other two categories (c.f.4.3.2.3).

- Mean scores for three statements (“Preventing human-shark interactions is not a responsibility of the government”, “Some books, movies and articles have increased fear of sharks among people”, and “Most reported human-shark interactions are shark bites”) were lower under the Shark Spotters category compared with the other two categories (c.f.4.3.2.3).
- The statement “Programmes that prevent human-shark interactions create jobs” was lower under the Mixed category, compared with the other two categories (c.f.4.3.2.3).
- Only three statements had significant differences between categories of study locations (“Preventing human-shark interactions is not a responsibility of the government”, “Most reported human-shark interactions are shark bites”, and “I am not on this beach because human-shark interactions are prevented here”) (c.f.4.3.2.3).
- The statement “Preventing human-shark interactions is not a responsibility of the government” had significantly lower score for the Shark Spotters category than the Mixed category (c.f.4.3.2.3).
- The statement “Most reported human-shark interactions are shark bites” had significantly lower score for the Shark Spotters category than the KZNSB category (c.f.4.3.2.3).
- The statement “I am not on this beach because human-shark interactions are prevented here” had significantly higher score for the Shark Spotters category than the remaining two categories (c.f.4.3.2.3).

5.3 SWOT ANALYSIS

Using the results of this study, an analysis of strengths, weaknesses, opportunities, and threats (SWOT) associated with beach visitors’ perceptions regarding sharks and shark hazard mitigation is discussed.

Table 5.1 gives a summary of the results (strengths, weaknesses) together with the relevant actions that can be taken (opportunities, threats). Strengths and weaknesses in the table are signified by positive and negative perceptions of sharks among the beach visitors surveyed. Opportunities are represented by actions that various stakeholders (e.g. media, government, scientists) can take, and the threats section contains the difficulties that are likely to be encountered in implementing these actions. Some of the opportunities listed in Table 5.1 are also better discussed in the next section in the form of recommendations.

Table 5.1: SWOT analysis regarding beach visitors' perceptions of sharks and shark hazard mitigation

Strengths	Weaknesses
Awareness of shark species in South Africa Knowledge of some biological aspects and ecological role of sharks Sharks are associated with awe and wonder Humans and human impacts are perceived as greatest threat to sharks Harmless human-shark interactions are reported by many Personal responsibility when using the ocean People feel safe from human-shark interactions irrespective of mitigation Familiarity with popular local shark hazard mitigation strategies Non-lethal shark control is considered to be effective Awareness of the ecological harm of lethal shark control The media are considered partly responsible for shaping negative public opinion Beaches are selected irrespective of shark hazard mitigation Human-shark interactions are understood to have various causes Awareness that sharks do not 'hunt' humans	Some reliance upon government to reduce risks of human-shark interactions Sharks are partly associated with fear and danger Poor knowledge of some aspects of shark ecology Limited knowledge/overestimation of fatal human-shark interactions in South Africa Uncertainty on the effectiveness and harm (to sharks) of shark hazard mitigation strategies 'Rogue shark' theory is not rejected Poor awareness of some shark hazard mitigation strategies Some non-lethal shark hazard mitigation strategies are considered harmful to sharks
Opportunities	Threats
Education and activities in schools (e.g. aquarium visits) Public education (sharks' ecology, human-shark interactions, shark hazard mitigation) Public engagement (reporting of positive shark encounters, Citizen Science) Stronger conservation narratives Debunking myths revolving around sharks Experimenting with non-lethal shark control in new locations More scientific research (e.g. willingness to contribute to shark conservation) Shark research volunteer tourism Effective/novel dissemination of scientific research Human-shark interactions, codes of conduct and best practice Positive branding Job creation External funding instruments for research and conservation Incentives to promote non-lethal shark control research	Uncontrolled negative framing and inappropriate shark narratives Poor/limited communication among stakeholders (e.g. scientists, media, government) Limited political power to NGOs and other conservation bodies Conflict of interests (e.g. mitigation programmes, ocean user groups) Diverse target groups (e.g. based on culture, ocean use, location) Poor/limited education and training (e.g. scientists, general public) Poor/limited collaboration among stakeholders (e.g. NGOs, government, scientists) Limited financial capacity (e.g. government, NGOs) Slow impact of initiatives on public opinion and conservation actions External influences (e.g. shark hazard mitigation policies in other countries)

Source: Author's compilation

5.4 RECOMMENDATIONS

The recommendations from this study are intended for beach managers, scientists, academics, practitioners, decision makers, the government, the tourism sector, the media, and the public (including ocean users and beach recreationists). While the results of this study enable the proposition of various actions and future research regarding sharks, beach-based tourism and shark hazard mitigation in South Africa, some of these propositions are also applicable internationally.

5.4.1 Recommendations from the results

The following is a list of recommendations emerging from the results of the empirical study, pertaining to beach management, tourism management, education, the media, and collaborations:

Beach management recommendations:

- This study identified geographic differences in the main data (according to socio-demographic characteristics of beach visitors and the characteristics of the local beach and shark hazard mitigation), in answer to one of the research questions. Therefore, one of the main recommendations is to ensure that beach management adopts systems that are context-specific (differential) and pay attention to the characteristics of the local beach and its visitors (see also Lucrezi *et al.*, 2018).
- More information boards concerning sharks, shark conservation, and how to avoid an encounter with a shark are needed at popular beaches, for users to understand the importance of sharks and endorse personal responsibility in ocean use.
- Organised educational activities (e.g. talks, games) can be implemented on beaches, throughout the summer peak season. These can be directed at children as well as adults and can cover aspects such as endangered marine species, the ocean and its importance, sharks and their importance, and threats to oceans and sharks.
- Beaches can adopt initiatives which can directly promote marine and coastal conservation. For example, for every bag of plastic that visitors pick up, they get a free ice cream. The plastic is then used to make bracelets that are sold. The money then goes towards shark and marine conservation (for example, <https://www.4ocean.com/>).
- Beach management programmes such as the Blue Flag ought to balance conservation and recreation by supporting and awarding beaches that deploy non-lethal shark hazard mitigation, to set an example for eco-friendly beach management practices and environmental education.

Tourism management recommendations:

- The results of this study show that the tourists visiting the beaches under investigation have different backgrounds, resulting in various perceptions regarding sharks and shark hazard mitigation. The results of this study lead to the recommendation that particular care is taken in informing, educating and engaging the domestic population of beach visitors.
- Opportunities where tourists can experience sharks and certain non-lethal mitigation measures in place, should be better promoted. For example, Cape Town has tours where the buses stop at the beach where the Shark Spotters are, to show them and educate them on this programme, why it is so different from other programmes and why it is important.
- Ocean activities that tourists engage in should have more educational aspects. For example, when tourists go shark cage diving, more information about threatened shark species should be given, and opportunities should be offered to participate in conservation either directly or indirectly.
- More tourism initiatives such as the Shark Warrior Adventures initiative (<https://www.sharkwarrior.com/>) are needed. The Shark Warrior Adventures initiative creates adventures for tourists (such as snorkelling, paddling and kayaking), and when tourists take part in these adventures they directly contribute towards the conservation of sharks and the natural environment. These activities can be useful in better engaging beach tourists in education regarding sharks.
- Tourism companies can start a campaign where tourists are asked to be environmental mediators. This entails signing an eco-pledge when visiting a beach or participating in a certain activity. This can support respect for the ocean, the environment, and the beaches amongst tourists. Initiatives of this sort have been adopted in New Zealand, and have created responsibility amongst visitors (Baynes, 2018). These campaigns are gaining momentum in South Africa, for example in aquaria (Mann, Ballantyne & Packer, 2018), and can extend to diving centres, beach management bodies, MPAs, and tour operators.

General educational recommendations:

- More education about sharks is needed. The public should be aware of the ecological and economic importance of sharks, the threats they face as well as the impacts humans have on them. This type of education may be incorporated in simple ways in

school curricula at a young age (e.g. food web models), as part of a general greater inclusion of Ocean Literacy (Nyman, 2018).

- More education with regards to shark hazard mitigation is needed. The public, including ocean users, should know the difference between lethal and non-lethal shark control as well as the functionality of different strategies. They should know what strategies there are in place over the country, how these strategies affect sharks and other species (bycatch) and how each strategy is supposed to work. For example, this study found a lack of understanding of electrical shark repellents, which were considered even more harmful than nets. Since electrical shark repellents constitute one of the non-lethal alternatives to lethal shark control and require a social license to receive funding and operate, it is important to ensure that their functionality is understood by the public. Shark nets, on the contrary, may receive support and may not be considered harmful because they are perceived as exclusion nets passively deterring sharks.
- The public should be better informed on the low incidence of shark bite incidents. This will help to understand their rarity in comparison with other risk factors (e.g. the chance of being hit by a coconut is greater than being bitten by a shark). This strategy may help reduce fear of sharks and fear of entering the ocean.
- More interaction opportunities between sharks and humans are needed to reduce levels of fear and to instil a sense of respect for and pride in sharks. For example, shark sightings in aquaria can already be powerful experiences which have been demonstrated to reduce fear of sharks (Pepin-Neff & Wynter, 2018b:227). Opportunities to see sharks in their natural habitat, for example through scuba diving, are also known to increase the levels of pride in sharks, especially in countries like South Africa where shark diving is popular (Lucrezi *et al.*, 2020).
- More information on endangered shark species needs to be provided to the public. This will help gain support for shark conservation. This type of information can be delivered, under the careful supervision of scientists, in various forms and through various channels of dissemination, from boards at the beach to specific information boards and sessions in aquaria, social networks, and TV shows and documentaries.

Media recommendations:

- Graphic elements such as horrific pictures about sharks should be removed from the media to help reduce the amount of fear amongst humans. Research has demonstrated that something as simple as the background music in a shark documentary can generate fear of sharks (Nosal *et al.*, 2016:1).

- Conservation specialists should engage with the media to ensure that they only publish accurate information, for example, the rarity of shark bite incidents and the personal measures that can be taken to prevent a shark encounter. Mojarad (2017:1363) pointed out the necessity for scientists to take a more prominent role in the social media to ensure that accurate information is disseminated to the public, as opposed to the misinformation shared by social media influencers.
- Social media networks, such as Instagram, Facebook and Twitter can be used to communicate accurate information about sharks, the importance of sharks and shark conservation, and the rarity of shark bite incidents. The proper use of the social media to disseminate the right information and promote positive narratives about sharks can increase support for shark conservation amongst humans. A very good example for South Africa is the newly formed Shark Attack Campaign (<http://www.sharkattackcampaign.co.za/>), a 3-year campaign and project (Shark & Ray Protection Project) supported by the Shark Conservation Fund and including several national and international experts from various backgrounds. The Project goals include knowledge improvement, increased legal protections, support and training for effective implementation of conservation measures, and advocacy and awareness to spur citizen action and support decision makers. Through a mixture of dissemination channels, the campaign hopes to inform the public and ocean users about the vulnerable status of sharks, recovery actions required and highlight the benefits of non-consumptive and sustainable use.
- The media can be more supportive of the distribution of documentaries about the ocean, the threatened species, and the ecosystems. These could slowly shift public opinion and reduce the effects of blockbusters such as *Jaws*.

Collaborations recommendations:

- More and better communication between stakeholders (conservationists, scientists, regulators, government, and shark conservation associations) is needed to develop rules or specific codes of conduct that the media must use when reporting anything on sharks. For example, the narratives revolving around sharks ought to be underpinned by a language that does not misinform the public. A typical example of this is the erroneous use of the expression “shark attack” to signify any type of human-shark interaction (Neff & Hueter, 2013).
- Positive attitudes towards sharks should be endorsed by using awareness and communication campaigns that are organised as a partnership between these stakeholders and encourage support for sharks.

- Different management and environmental institutions should cooperate (by sharing resources, knowledge and ideas) to help promote shark conservation by structuring initiatives that will increase human knowledge and improve attitudes towards sharks. For example, schools and aquaria can seek partnerships, where guest speakers can talk to the class, and where the school can visit the aquarium to have pupils learn more about sharks.
- A constant engagement between policymakers, conservationists, and the public is needed to gather support for non-lethal shark hazard mitigation strategies. For example, top-down approaches ought to be avoided and the positive opinion of the public on sharks needs to be considered in planning and policy making.

5.4.2 Recommendations for future research

The following is a list of recommendations emerging from the results of the literature review and the empirical study, pertaining to future research:

- More research that focusses on the perceptions of sharks by ocean users, and how the media influence these perceptions should be conducted in South Africa and internationally.
- Research on public knowledge of sharks (biology, ecology, threats), and on the perceived importance of sharks and shark conservation should be conducted worldwide, to identify areas in need of attention.
- Research on the human dimensions of shark hazard mitigation should continue to identify the required interventions in terms of understanding and social acceptance of non-lethal strategies.
- Research on how the South African media portray sharks but also shark hazard mitigation should be conducted to understand possible areas that need improvement.
- Research regarding different shark hazard mitigation strategies and the efficacy of these strategies, especially non-lethal ones, should continue to be conducted. This research should always be accompanied by studies of the public perceptions of such strategies for the sake of social licensing to operate and public acceptability.
- More research on the perceptions of sharks that focusses on specific user groups (surfer *versus* fisher) is required, to better understand the difference in perceptions and identify potential conflicts that need to be solved.
- Experimental research on the effectiveness of different forms of communication and experiences (such as aquarium sighting) on reducing the fear of sharks amongst

humans and generating positive feelings towards sharks, is still scant and requires further development.

This chapter consisted of the conclusions and recommendations concerning this study. From these, it is clear that there is much space for new research on the human perceptions of sharks and shark hazard mitigation in South Africa and internationally. More research will contribute to a better understanding of the relationship between humans and sharks and will also help to promote strategies to support shark conservation globally.

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ANNEXURE A: QUESTIONNAIRE

BEACH SURVEY SECTION A: DEMOGRAPHIC DETAILS

1. Gender

2. Year of birth

3. Highest level of education

No school	1
Still in school	2
Matric	3
Diploma, degree	4
Post-graduate	5
Professional	6
Other (specify):	7

4.1 Province of residence

Western Cape	1
Gauteng	2
Eastern Cape	3
Free State	4
KwaZulu-Natal	5
Mpumalanga	6
Northern Cape	7
North West	8
Limpopo	9
Outside RSA borders	10

4.2 If from outside RSA borders, please indicate country: _____

5. Marital status

Single	1
Married	2
Divorced	3
Widow/er	4
Other (specify):	5

6. Occupation

Student	1
Paid worker	2
Unpaid worker	3
Unemployed	4
Retired	5

7. Are you a local resident of this area?

Yes	1	No	2
-----	---	----	---

8. What do you do at this beach?

Sunbathe	1
Swim	2
Surf	3
Walk	4
Other (specify):	5

9. What is it that you look for when selecting a beach? _____

10. What do you believe is the greatest risk at this beach? _____

SECTION B: HUMAN-SHARK INTERACTIONS

11. If you could describe sharks in one word, what would that be? _____

12. What is a 'shark attack'? (You may select more than one option)

1	When a person in the water sees a shark
2	When a shark swims near a person
3	When a shark hits a person on his/her surfboard, kayak or other
4	When a shark bites a surfboard, kayak or other
5	When a shark bites a person
6	When a shark eats a person
7	None of the above

13. What is a 'human-shark interaction'? (You may select more than one)

1	When a person in the water sees a shark
2	When a shark swims near a person
3	When a shark hits a person or his/her surfboard, kayak or other
4	When a shark bites a surfboard, kayak or other
5	When a shark bites a person
6	When a shark eats a person
7	None of the above

14.1 Have you ever been involved in an interaction with a shark?

Yes	1	No	2
-----	---	----	---

14.2 If you answered 'YES', please describe the interaction/s:

15. How safe do you feel from sharks at this beach?

Not safe	1	Safe	3
Limitedly safe	2	Very safe	4

16. Which of the following methods used to prevent human-shark interactions are you familiar with?

Drum lines	1
Shark spotters	2
Shark nets	3
Banned bathing	4
Boat spotting	5
Electrical shark repellent	6
Shark repellent cable	7
Aerial surveys	8
Acoustic tracking	9
Information boards on the beach	10
Staying in the water as a group	11
Swimming, bathing etc. in clear water	12
Trained lifeguards	13
Other (specify):	14

17. Which of the above methods do you think is:

Most effective: _____

Most harmful to shark species: _____

18.1 Does this beach adopt method/s to prevent human-shark interactions?

Yes	1	No	2
-----	---	----	---

18.2 If 'YES', which one/s? _____

19. Which of these shark species can you find in this area? (please indicate all applicable)

Great white	1	Hammerhead shark	7
Tiger shark	2	Spinner shark	8
Bronze whaler	3	Zambezi shark	9
Blacktip shark	4	Sandbar shark	10
Dusky shark	5	Ragged tooth shark	11
Southern shark	6	Other (specify):	12

20. What do you think is/are the greatest threat/s to sharks? _____

SECTION C

21. Please indicate to what extent you agree to the following statements.

	I do not know					
	Strongly agree					
	Agree					
	Neutral					
	Disagree					
	Strongly disagree					
	1	2	3	4	5	6
Human-shark interactions can happen because sharks hunt humans	1	2	3	4	5	6
'Shark attack' is a good expression to describe human-shark interactions	1	2	3	4	5	6
Human-shark interactions can happen because sharks mistake humans for their prey	1	2	3	4	5	6
Preventing human-shark interactions is a responsibility of the government	1	2	3	4	5	6
Sharks tend to reproduce rapidly	1	2	3	4	5	6
Human-shark interactions can happen when a shark feels threatened and defends itself	1	2	3	4	5	6
People who get in the water are responsible for making sure it is safe to do so	1	2	3	4	5	6
Sharks' natural food source could be abundant in this area	1	2	3	4	5	6
Sharks that bite people are likely to do it again in the future	1	2	3	4	5	6
The media talk about human-shark interactions in the proper way	1	2	3	4	5	6
Learning about sharks as children has no effect on what people think of sharks as adults	1	2	3	4	5	6
Sharks are generally dangerous	1	2	3	4	5	6
Some books, movies and articles have increased fear of sharks among people	1	2	3	4	5	6
Most reported human-shark interactions are shark bites	1	2	3	4	5	6
Programmes that prevent human-shark interactions create jobs	1	2	3	4	5	6
Shark species are well protected globally	1	2	3	4	5	6
The role of sharks in marine ecosystems can be easily replaced by other species	1	2	3	4	5	6
I am on this beach because human-shark interactions are prevented here	1	2	3	4	5	6



Thank you for your co-operation!

Research done by TREES (Tourism Research in Economic Environs and Society), North-West University,
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ANNEXURE B: LANGUAGE EDITING CERTIFICATE

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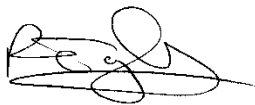
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16 August 2020

To whom it may concern

Language Editing – Dissertation – J. van der Westhuizen

I have reviewed the dissertation entitled “Beach visitors’ perceptions of shark hazard mitigation in South Africa: Implications for shark conservation” in terms of spelling, language and grammar and have made recommendations to the author concerning the changes necessary.



R. Taylor
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