UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

APPLICATION OF THE DPSIR FRAMEWORK IN THE ASSESSMENT OF MARINE PROTECTED AREAS IN SOUTH AFRICA: A STUDY OF KWAZULU–NATAL AND THE EASTERN CAPE PROVINCES

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Ethics protocol number: H18/06/12

A dissertation submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science.

School of Geography, Archaeology and Environmental Studies

November 2019

DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

(Signature of candidate)

4 day of November 2019 at the University of the Witwatersrand, Johannesburg

ABSTRACT

With increasing rates of fisheries consumption, pollution, development and tourism, coastal zones remain threatened. Consequently, Marine Protected Areas (MPAs) have fast become the preferable method of marine conservation worldwide, including in South Africa. MPAs entail the designation of a marine area and the placement of restrictions on activities to manage threats faced by the area. Their effectiveness in doing so however remains questionable. Drawing on field-based data collected from three MPAs in South Africa; Aliwal Shoal, Trafalgar and Pondoland, this dissertation will assess the effectiveness of the three MPAs through the application of the DPSIR framework. The aims of this study are to firstly, investigate the extent to which the DPSIR framework can be applied in the effective management of MPAs. Secondly, to investigate the ways in which current management approaches are effective in the management of marine resources.

A series of semi-structured interviews were conducted with independent conservationists, divers, fishermen, researchers and MPA managers. The sites were visited four times where interviews were conducted, observations were made, and photographs were taken. Research findings suggest that two of the three MPAs were partly successful in managing the different threats they face. It is argued that part of this difference speaks to the deferring managerial design and strategies. It was also found that MPAs are plagued by land-based environmental threats that fall out of their jurisdiction and therefore their management. Furthermore, a lack of data centred on MPAs and their species numbers makes it difficult to determine if the MPA is effectively conserving certain fish species and marine resources. It is therefore argued that for MPAs to effectively respond to the pressures they face, managerial designs and strategies must be integrated and implemented.

In memory of my grandmother and grandfather,

Giacomina and Eduardo Mendes.

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Professor Mulala Danny Simatele, for his guidance and encouragement from my second year to my masters.

I would also like to extend my gratitude to all the respondents who agreed to be interviewed for this study, your insight was truly valuable.

This year has been more challenging than I could have ever imagined, and I must therefore thank my family for their support, especially my mother and father for the endless pages of proof reading. A special mention to my brother, whose purist of attaining as many degrees as possible has motivated me to do the same.

To my friends and boyfriend, I cannot express how grateful I am. You have all been incredibly helpful throughout this paper and a welcomed escape from my studies for past six years, thank you.

"If I have seen further than others, it is by

standing upon the shoulders of giants"

-Sir Isaac Newton

TABLE OF CONTENTS

Content **_____Page**

LIST OF FIGURES

Figure **Page**

LIST OF TABLES

Table **Page**

LIST OF ABBREVIATIONS

ADI- Area of Direct Influence

AII- Area of Indirect Influence

CBA- Critical Biodiversity Assessment

DAFF- Department of Agriculture, Forestry and Fisheries

DEA- Department of Environmental Affairs

DEAT- Department of Environmental Affairs and Tourism

DPSIR- Driving forces- pressures- state- impact and response

EBSAs- Ecologically or Biologically Significant Areas

ECPTA- Eastern Cape Parks and Tourism Agency

EEZ- Exclusive Economic Zone

EIA- Environmental Impact Assessment

EKZN- Ezemvelo KwaZulu-Natal

ERM- Environmental Resources Management

FAO- Food and Agriculture Organization of the United Nations

GDP- Gross Domestic Product

ICMA- Integrated Coastal Management Act, Act No. 24 of 2008

ICZM-Integrated Coastal Zone Management

MPAs- Marine Protected Areas

Nm- Nautical mile

NGO- Non-Governmental Organisation

NEMA- National Environmental Management Act, Act no. 107 of 1998

SASSI- South African Sustainable Seafood Initiative

WWF- World Wildlife Fund

CHAPTER ONE

FRAMES OF REFERENCES

1.1 INTRODUCTION

Coastal ecosystems are arguably one of the most valued ecosystems in the world, yet they are incredibly vulnerable to many human induced threats such as pollution, habitat loss, coastal development, offshore drilling, tourism and overconsumption (Tunley 2009). Due to the ever increasing human footprint on these areas, the need for effective coastal management arises. MPAs are marine reserves designed to manage, protect and conserve coastlines and the fauna and flora within marine ecosystems (Edgar *et al.* 2007). Alison *et al.* (1998), argue that Marine Protected Areas (MPAs) have become a strongly advocated tool for marine conservation globally (Allison et al. 1998). Furthermore, the World Wildlife Fund (WWF) describes MPAs "the foundation of marine conservation in South Africa" (Tunley 2009: 8). Various studies have stressed the importance of MPAs in managing marine environments (Tunley 2009; Edgar *et al.* 2007 and Sink 2016:1). Nevertheless, a large body of work arises that analyses their effectiveness (Kelleher *et al.* 1995; McClanahan 1999; Rudd *et al.* 2001; Jameson *et al.* 2002).

A study conducted by McClanahan (1999: 321) states that 90% of MPAs in East Asia have failed to meet their management goals. This is due to a lack of implementation enforcement, a lack of recognition and therefore support from national government Similarly, Jameson *et al.* (2002), critiques MPAs by stating that most of them fail to meet their objectives due to poor management. Furthermore, a study conducted by Rudd *et al.* (2001:198) in Turks and Ciacos yielded similar results. Similarly, Kelleher *et al.* (1995:7) conducted an evaluation of MPAs across 18 different marine regions around the world and found that only 117 of the 1306 MPAs, which equates to 8.9% of the areas, achieved their management objectives. The effectiveness of MPAs varies across different areas and it is therefore important to understand, within a South African context, whether MPAs are effectively conserving marine ecosystems. As observed by McClanahan (1999:325), for MPAs to be effective, conservationists need to look at the various relationships and elements that influence the area. If these elements are ignored, "much conservation will remain a trial and error political process where nature may frequently suffer from both good and bad political intentions, but also from ecological and economic naivety". Therefore, in order to have effective MPAs, various relationships, influencing factors and interconnecting elements and forces must be identified. The driver, pressure, state, impact and response (DPSIR) framework is an effective initiative to categorize and implement these processes.

The framework was first introduced in 1999 by the Organization of Economic Cooperation and Development and the European Environmental Agency (Gari *et al.* 2015). The framework was used as a tool to identify environmental problems by analysing key relationships between society and the environment (Mateus and Compuzano 2008). It simplifies and structures issues that are later presented to policy makers. The framework consists of four elements. *Driving Forces*, which may be social, economic or environmental developments, exert *Pressures* on a given environment. Due to these pressures, the *State* of the environment changes. Consequently, *impacts* on the environment occur which drive a societal *Response.* The response then influences the other elements of the framework (Borja *et al.* 2006; Svarstad *et al.* 2008; Atkins *et al.* 2011 and Tscherning *et al.* 2012).

However, according to Carr *et al.* (2007: 545), the framework is criticized for being too simple, not analysing deeper trends, failing to understand cause-effect relationships and adopting a linear approach in its analysis. To prevent this Carr *et al.* (2007: 545), stress the DPSIR framework must not be applied as a model that merely seeks to categorize and recount to policy makers but rather a means and conceptual framework to understand the deeper relationships between society and the environment (Borja *et al.* 2006). In addition to the response by Carr *et al.* (2007), many studies have proved the DPSIR framework is a useful tool to be used in various aspects of environmental management (Agyemang *et al.* 2007; Mateus and Campuzano 2008; Odontsetseg *et al.* 2011; Song and Frostell 2012). As stated above by McClanahan (1999) for MPAs to be effective, complex interconnecting relationships must be understood. The DPSIR framework is a tool that seeks to achieve this. Therefore, an application of the DPSIR framework will be instrumental in analysing the effectiveness of Marine Protected Areas.

1.2 THEORETICAL CONSIDERATIONS

According to the Southern African Sustainable Seafood Initiative (SASSI), 83% of global fisheries are overexploited (SASSI 2018). Coastal fishing accounts for about 10% of South Africa`s R9 billion offshore fishing industry and employs over 2 000 fishermen (DAFF 2015:7). According to SASSI (2018), 312 million kg of seafood is consumed each year in South Africa, 50% of which is locally caught. As a result, 32 fish species are listed by SASSI as orange or red, in other words, they are unsustainable populations (SASSI 2018). This overconsumption puts pressure on South Africa's marine environments leading to a collapse or changes in food webs, ultimately resulting in a complete loss of ecosystem services (Mateus and Campuzano 2008:32). In addition to the fishing sector, tourism is another driving force exerting pressure on marine environments (Ojeda-Martinez *et al.* 2009; Gari *et al.* 2015). Coastal tourism can be directly linked to increasing coastal

development as well as increasing pollution (Griffiths *et al.* 2010; Ballance *et al.* 2000). Both threats have a negative impact on the state of the environment. However, the relationship between each sector and the underlying economic system of capitalism is important to note. According to Foster (1992), Marx states capitalism has two contradictions, one of which is "the absolute general law of environmental degradation under capitalism" (Foster 1992: 77). Capitalism is often framed as a solution to environmental degradation however, as noted by Magdoff and Foster (2011: 8), "capitalism is not the solution but the problem." The authors further argue that with capitalism, "labour is its father and the earth its mother. Capitalism grows, Marx contends, by exploiting the former and robbing the latter" (Foster 1992: 79).

Marine Protected Areas are established out of this context to manage and conserve marine environments. The first MPA established in South Africa, the Tsitsikamma National Park MPA, is a quintessential example of how marine reserves may be effective in managing marine environments. A study conducted by Gell and Roberts in 2003 indicated that the fish species of *Chrysoblephus laticeps* grew 42 times more than surrounding species in non-protected areas (Gell and Roberts 2003: 448). This study will therefore seek to determine how effective MPAs are in marine conservation. To achieve this, the DPSIR framework will be applied to three MPAs in South Africa, Aliwal Shoal, Trafalgar and Pondoland, in order to identify the *driving forces*, which cause *pressures* that change the *state* of and *impact* the environment. The effectiveness of MPAs as a *response* in managing the elements above will then be assessed. Through this, gaps and challenges in the management of MPAs in South Africa will be identified.

1.3 RESEARCH QUESTIONS

In view of the above arguments, the following questions will guide the research process:

I. What are the forces and pressures that affect the effective management of the Marine Protected Area in the three study sites?
II. In what ways are MPAs effective in the sustainable management of marine and coastal resources in the three study sites?
III. To what extent can the DPSIR framework be used in the effective management of marine and coastal resources in the study sites?
IV. What are the implications of the findings of this study in a wider context, particularly in coastal regions of sub-Saharan African countries?

1.4 RESEARCH AIMS AND OBJECTIVES

The aim of this study is twofold;

I. To investigate the extent to which the DPSIR framework can be applied in the effective management of MPAs.

II. To investigate the ways in which current management approaches are effective in the management of marine resources.

In light of the aims above, the overall objective was to identify the factors within the DPSIR framework for each MPA.

The specific objectives are therefore as follows;

I. Identify the social and economic factors affecting Marine Protected Areas and their consequential impacts on the environment.

II. Assess the effectiveness of the identified management designs and strategies by application of the DPSIR framework

III. Identify gaps and challenges to marine resource management in South Africa.

1.5 SUMMARY OF LITERATURE

This section is dedicated to summarizing the literature that will be reviewed in Chapter 2. The literature will focus on defining key concepts to the discourse of coastal management. It will contextualise the literature from a global, regional and local perspective in an attempt to highlight the threats and both the economic and ecological values of coastal zones. The establishment of MPAs as a coastal management approach will be discussed across all spheres. Lastly, the DPSIR framework will be reviewed.

A "coastal zone" is defined in the Integrated Coastal Management Act (ICMA), Act 24 of 2008 as "the area comprising coastal public property, the coastal protection zone, coastal access land and coastal protected areas, the seashore, coastal waters and the exclusive economic zone and includes any aspect of the environment on, in, under and above such area". Coastal protected areas include marine protected areas under section 9 of the Protected Areas Act, Act no. 57 of 2003. The reach of the coastal zone extends out to 200 nautical miles (nm), which is 370 km from the low water mark.

1.5.1 VALUE OF COASTAL ZONES

Coastal zones are both ecologically and economically valuable. Globally, coastal environments provide food, water storage and supply through desalination, minerals, water purification, air quality and regulation, coastal protection, climate and weather regulation, lifecycle maintenance, pharmaceuticals, and aesthetic and tourism values (Kelleher *et al.* 1995:2; Barbier *et al.* 2011: 170; Liquete *et al.* 2013: 5).

Specifically, and perhaps the greatest service provided is that of consumptive use. According to the Food and Agriculture Organization of the United Nations (FAO), the amount of fish consumption reached 20kg per capita for 2014 (FAO, 2016: 2). In 2014, developing countries exported US$ 80 million worth of fish and fishery products combined (FAO 2016: 7). China alone exported a total of US$ 20 980 million in 2014; a growth of 12% from 2004 (FAO 2016:53).

This global value of coastal zones can also be seen regionally in Sub-Sahara Africa. In Nigeria, the oil sector contributes to 20% of the country's Gross Domestic Product (GDP) and 95% of the country's foreign exchange (Nwilo and Badejo 2006:117). In Ghana, coastal tourism created 234 679 jobs in 2008. The fishing sector alone accounts for 4.5% of Ghana's GDP. Furthermore, it employs an estimated two million people (Lawson *et al.* 2012:32). In Tanzania, the fisheries sector contributes to 5% of the mainland's GDP and 10% to Zanzibar's GDP (Jiddawi and Ohman 2002: 518). The country earns USD 12.6 million from fisheries exports.

In comparison, this value can be further scaled down when looking at South Africa. With its 2 798km long coastline, South Africa's fisheries sector contributes to 0.5% of South Africa's GDP (WWF 2016:9). The hake fishery sector alone provides an estimated 30 000 jobs and an annual value of R5.2 billion (DAFF 2015:15). Coastal environments also hold indirect value. Coastal goods and services through recreation and tourism contribute 35% to South Africa's GDP (WWF 2016: 11).

1.5.2 THREATS FACING COASTAL ZONES

While coastal zones possess a vast array of ecological and existing, as well as potential economic value, they nonetheless remain threatened. A consensus amongst literature may be found that states pollution, overexploitation, development and habitat destruction are the greatest threats facing coastal zones (Crain *et al.* 2009: 39; Halpern *et al.* 2008: 948; Goble *et al.* 2014; Allison *et al.* 1998: 81; Attwood *et al.* 1997:341). With the high rates of consumption explained above, fishing is listed as the number 1 one threat to coastal environments globally, and specifically in Sub-Sahara Africa and South Africa Sink *et al.* (2012:244). In 2014 the global total marine capture fishery production was estimated at 81,5 million tonnes. Due to the high consumption rates, 80% of the

world's fish stocks are over or fully exploited (FAO 2008:34). According to Lawson *et al.* (2012:38), "the fish stocks in Ghana are generally thought to be at or nearing their maximum levels of exploitation".
This threat is echoed in Tanzania where fish stocks are rapidly depleting (Jiddawi and Ohman 2002). Due to high consumption rates of seafood in South Africa, 42% of marine and coastal areas are listed as threatened (Sink *et al.* 2012: 243). According to a report published by the Department of Agriculture, Forestry and Fisheries (DAFF), abalone, silver kop, steenbras, seventy-four, squid, bluefin tuna, southern cape oysters, whitetip, blue and hammerhead sharks, to name a few, are all listed as heavily depleted (DAFF 2015).

A second threat to coastal environments is pollution. It has been estimated that 8 million tonnes of plastic enter the ocean each year globally, an equivalent of one truck load a minute (WWF 2016: 28). It has also been estimated that 270 000 tonnes of plastic particles are currently floating in the ocean (Prata 2018: 284). However, pollution remains regionally and locally specific. In a country like Nigeria, pollution takes on another form. Due to its richness in oil, the countries coastline is no stranger to oil spills. The largest oil spill in Nigeria's history occurred in 1980 when an offshore oil well blew up. 200 000 barrels of oil spilled into the Atlantic Ocean and damaged an estimated 340 hectares of mangroves (Nwilo and Badejo 2006:123). Furthermore, in a country like South Africa pollution in the form of sewerage, resulting in the release of heavy metals and other pollutants, is the greatest concern at present.

Marine invasive species is an additional global threat to coastal environments (Bax *et al.* 2003). Marine invasive species are species that are introduced, on purpose or accidentally, into a marine environment that dominate the native fauna and flora. According to Bax *et al.* (2003: 314), 252 alien marine species were identified in Australia and 159 alien species in New Zealand. Invasive species compete for resources with native species and often lead to a decline in their populations. This is a threat also observed along South Africa's coastlines. Sink *et al.* (2012: 215) identified 8 known marine invasive species affecting the South African coastline.

A threat that remains specific to a few regions in Sub-Sahara Africa is poverty. Poverty is defined as living on less that USD 2 a day. By this standard, 46% of the population in Sub-Saharan Africa live-in poverty (Lawson *et al.* 2012: 30). The poor often depend on the harvesting, consuming and selling of natural resources to survive. When in coastal areas, this involves the harvesting of fish, seafood, corals, shells or seaweed. A study conducted by Tobey and Torell (2006) discussed MPAs in Tanzania and Zanzibar, an island off Tanzania. They found that often MPAs fail at conservation due to poverty; "poverty may be a limiting factor to conservation efforts in that poverty sometimes

forces people to use destructive fishing practices or break management rules" (Tobey and Torell 2006:853).

1.5.3 COASTAL ZONE MANAGEMENT

Across Africa, conservation and coastal management is heavily criticised. Boateng (2006: 110) argues that; "in Africa, institutions and policies regarding management and access to coastal and marine space are not effectively developed to ensure participation and equity." While a few success stories emerge out of Sub-Sahara Africa, implementation remains an issue. This is attributed to a lack of capacity and finances, conflicting departmental functions, a lack of legislation and inadequate guidelines (Lawson *et al.* (2012). A similar situation is seen in South Africa such as lack of human capacity and finances, implementation of the legislation and policies is lacking Goble *et al.* (2014:37).

MPAs are an alternative tool used for coastal conservation. MPAs are defined as "any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment" (Agardy *et al.* 2003: 355). Today, MPAs have become the mainstream method of coastal conservation (McClanahan 1999: 321; Agardy *et al.* 2003), with 5% of the world's oceans are protected under MPAs (Lewis *et al.* 2017:7).

Francis *et al.* (2002), conducts a study where the effectiveness of 28 MPAs across East Africa is assessed. Overall, it was found that biodiversity increased in many of the MPAs studied and most were well maintained, even though some lacked management plans and adequate personnel. It is further argued by Francis *et al.* (2002: 509) that enforcement in these MPAs is weak and inefficient and the level of management and stakeholder participation is lacking. Similarly, a study conducted by Tobey and Torell (2006) discussed MPAs in Tanzania. They found that conservation has improved in areas that fall under the protection of a MPA, however they still face various challenges. There are currently twenty four MPAs located along the coastline of South Africa (Chadwick *et al.* 2014). A study conducted by the World Wildlife Fund South Africa evaluates all the MPA in South Africa. Non-compliance, lack of staff, insufficient funds and lack of enforcement are all identified as factors that lead to ineffective MPAs (Chadwick *et al.* 2014:32). Similar results are found across global, regional and local scales, that show Marine Protected areas can be effective but often fail to reach their full potential due to various reasons.

1.5.4 DPSIR FRAMEWORK

The DPSIR framework is a tool that allows for the identification and description of environmental problems by defining and linking the cause-effects in relationships between anthropogenic activities, the environment and the socio-economic consequences (Carr *et al.* 2007: 543; Mateus and Campuzano 2008: 2; Gari *et al.* 2014:63). Each letter of the DPSIR framework accounts for a factor. "*Driving forces*, in the form of social, economic or environmental developments, exert *Pressures* on the environment and, as a consequence, the *State* of the environment changes. This leads to *Impacts* that may elicit societal *Responses* that feeds back to the Driving forces, Pressures, State, or Impacts" (Svarstand *et al.* 2008:117). The framework is aimed at policy makers to easily identify issues in their respective area. It has been applied to reef fisheries management in Kenya (Mangi *et al.* 2007); watershed management (Karageorgis *et al.* 2005), the state of rivers in the Balkans (Skoulikidis 2009) and deforestation in Malaysia (Sarmin *et al.* 2016) to name only a few. The framework however is not without its critics.

Tscherning *et al.* (2012:104), argue that the framework often analyses one on one relationships, failing to identify intricate interrelationships. The framework, while aimed at policy makers, is also criticised for being too expert and specialist centred (Gari *et al.* 2014: 71). Referencing, Gari *et al.* (2014:71), summaries the main criticisms of the framework. Firstly, it creates a set of stationary unidirectional indicators that fail to describe changing dynamics in an environment. Secondly, it fails to capture trends in each factor. Lastly, the identified relations are often blurred. Carr *et al.* (2007: 546), believes that when the framework is used as a model, problems arise and critiques form. The DPSIR framework is a means of categorising and disseminating information and identifying relationships and is not a panacea to all problems.

1.6 SUMMARY OF METHODOLOGY

The objective of this section is to introduce the research methodology that was used to determine the effectiveness of MPAs through the application of the DPSIR framework. The research methodology that was adopted was a grounded methodology that is rooted in the interpretivist paradigm. A mixed methods approach that combines qualitative and quantitative methods was adopted.

The research study was South African based and was focused on three MPAs in Kwa-Zulu Natal and the Eastern Cape. These are Aliwal Shoal, Trafalgar and Pondoland. Aliwal Shoal runs 18.3km

along the coast and extends 7km offshore. It was established in 2004 to conserve its wide variety of fish and shark species. For this reason, it is also a popular scuba diving site (Tunley 2009). Trafalgar was established in 1979 and focuses on protecting its marine fossils (Tunley 2009). It is also the smallest MPA in South Africa as it extends 1,85km offshore and runs along 4,8km of coastline. Pondoland is 90km long, making it the largest MPA in South Africa. This MPA centres around conserving whales, dolphins and depleted fish stocks (Tunley 2009). The above MPAs were chosen for various reasons. Mainly due to their differing sizes, managerial types and designs and differing biodiversity they aim to conserve.

Interviews, observations, photographs, and a review of literature were all used as data collection tools. Divers and fishermen, both locals and tourists, local conservationists, who were identified in a previous study, researchers and the MPA manager were interviewed for Aliwal Shoal. The local conservationists, researches and MPA manager also highlighted issues surrounding Trafalgar. The MPA manager for Pondoland, researchers and locals were interviewed to determine issues surrounding Pondoland. Through the interview process, the respondents provided views on the management of the MPA and its effectiveness, MPA demarcation and knowledge of laws. Furthermore, threats facing each MPA, its driving force and impact on the environment were also explored through these interviews. In total, 33 interviews were conducted, 25 from Aliwal Shoal and Trafalgar and 8 from Pondoland.

To substantiate the findings gained from the interviews conducted above, observations were also conducted in the area. This method aided in identifying interactions and behaviours in the MPAs, as well as determining if the areas were policed and well demarcated. Photographs were also taken of any policing, demarcation and signage. Lastly, policies in the form of management plans were analysed to aid in determining the role of the MPA and how the management authority aims to manage the MPA.

1.7 ETHICAL CONSIDERATION

This research study involved interviewing tourists, residents and local authorities, therefore ethical issues such as confidentiality, anonymity and consent were be considered. The researcher applied for ethical clearance from the University of Witwatersrand before conducting research. The research clearance number for the University of Witwatersrand is H18/06/12. Research permits for the Eastern Cape and KwaZulu-Natal were required before fieldwork could commence. Permits and research clearance was granted, and their clearance numbers are as follows; for the Eastern Cape, RA0298, for KwaZulu-Natal, MSP 190. Copies of agreements and certificates can be found in appendix D. The construction of the interview ensured the respondents were not

harmed in anyway, emotionally or physically based on their reply. The study conducted did not ask any politically sensitive questions or questions that may put the participant under risk.

1.8 SCOPE OF THE STUDY AND LIMITATIONS

The study concentrated on three Marine Protected Areas within two South African provinces and ceased to analyse or compare it to MPAs elsewhere. This study focused on the DPSIR framework and the application of this framework to assess the effectiveness of MPAs. The study sites were visited four times due to financial constraints and university obligations. Accordingly, where face to face interviews were not possible, the interview was sent via email. The study did not analyse the physical formation of the coastal areas in question. The study also focused on the three MPAs within their jurisdiction according to the initial declaring legislation. As of the 27th of May 2019, Trafalgar and Aliwal Shoal have been expanded under Operation Phakisa. The new boundaries and area of jurisdiction were not studied.

1.9 STRUCTURE OF DISSERTATION

This dissertation is comprised of 6 chapters in total. **Chapter one** is research conceptualising. **Chapter two** consists of theoretical considerations and a review of literature. The methodological considerations are discussed in **chapter three**. Empirical evidence will be given in **chapter four**. **Chapter five** will be comprised of data analysis and discussion and lastly, concluding thoughts, recommendations and ideas for future research will be given in **chapter six**.

CHAPTER TWO

THEORETICAL CONSIDERATIONS AND LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discussed the historical and contemporary arguments presented within the existing literature focused on marine management, Marine Protected Areas and the DPSIR framework. Through this discussion, the literature will be contextualized from a global, regional and local perspective. This will seek to describe the value of, and the threats facing coastal zones on different geographical scales and trace the current state of coastal management strategies in place. A literature review is important to the research process for the following reasons. According to Hart (2018: 31), it distinguishes between what has been done from what needs to be done. It allows the researcher to gain new perspectives as well as identify relationships. The literature review establishes a historical context and lastly, it enhances the subject's vocabulary. Therefore, in view of these observations this chapter is divided into 3 main sections; global, regional and local.

Firstly, key concepts for the study were defined. This will seek to clarify the nomenclature surrounding coastal environments and place marine protected areas within this discourse. Secondly, the literature will be contextualized from a global perspective. Here, threats facing coastal zones, as well as the value of coastal zones globally, will be given. This will be followed by a look at global arguments surrounding coastal management and the establishment of MPAs around the globe. Next, a regional perspective will be given where, similarly to the above, threats and values facing coastal zones in Sub-Saharan Africa will be discussed. A look at coastal management and MPAs in Sub-Saharan Africa will then be given. The same above layout will be used from a local, South African perspective. Section 5 of the literature review will discuss critiques surrounding MPAs. This literature review will then introduce the DPSIR framework, give examples of its successes and highlight some critiques. Lastly, the chapter will conclude by identifying gaps within the literature.

2.2. DEFINING KEY CONCEPTS AND TERMS

McFadden (2007:439) defines integrated coastal zone management ICZM as "the integrated planning and management of coastal resources and environments in a manner that is based on the physical, economic and political interconnections, both within and among dynamic coastal

systems, which when aggregated together, define a coastal zone." Today, ICZM has become the preferred governing framework for coastal zones. Similarly, Buono *et al.* (2015: 21) define ICZM as "a dynamic process for the sustainable management and use of coastal zones, taking into account at the same time the fragility of coastal ecosystems and landscapes, and the diversity of activities and uses".

A "coastal zone" is defined in ICMA, as "the area comprising coastal public property, the coastal protection zone, coastal access land and coastal protected areas, the seashore, coastal waters and the exclusive economic zone (EEZ). This includes any aspect of the environment on, in, under and above such area". Coastal protected areas include marine protected areas under section 9 of the Protected Areas Act, Act no. 57 of 2003. Coastal Waters, according to ICMA, are marine waters that form part of the internal and territorial waters of the Republic, which equates to 12 nautical miles from the low water mark (Figure 2.1). In this description, the area that surpasses the 12-nautical mile mark and extends to 200 nautical miles out to sea is referred to as the exclusive economic zone, under section 7 of the Maritime Zones Act, Act 15 of 1994. Simply stated, the reach of the coastal zone extends out to 200 nautical miles, which is 370 km from the low water mark. Therefore, this study shall refer to the area wherein MPAs fall as coastal zones or coastal environments.

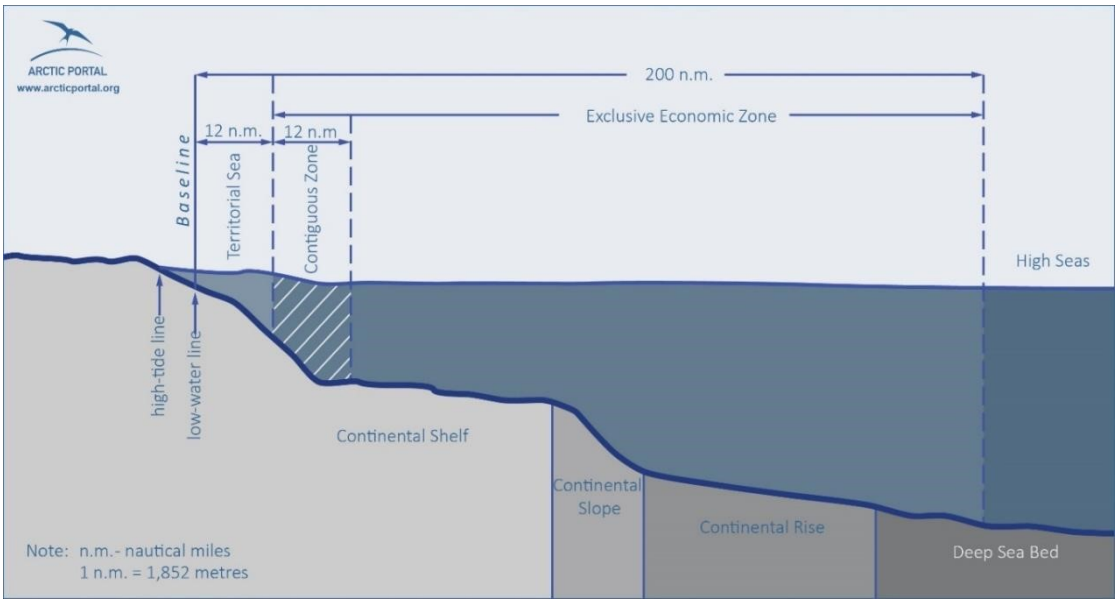

Figure 2.1: The division of maritime zones (Source: The Artic Portal 2017)

2.2.1 CRITIQUING GLOBAL DEFINITIONS

According to Barbesgaard (2018), the desire to establish these boundaries and territories in the ocean are linked with the underlying economic system of capitalism and therefore the need to develop production practices, trade and shipping routes and geopolitics in the world market. The establishment of boundaries establishes where a country can or cannot extract resources. "For centuries, a wide range of interested parties, not least states, have been deeply engaged in defining and delimiting property rights over maritime and coastal resources under the competitive dynamics of capitalism" (Barbesgaard 2018: 134). According to Coe (2013: 55), capitalism is profit-oriented, and growth centred. This desire to establish boundaries is so that the country can establish trade routes, extract resources from their designated area, in the form of oil, or fisheries products and ultimately gain profit. According to Petrella (2000:67), anything which contributes to the creation of new financial capital has value may be used to create profit. The value that coastal zones hold will be discussed next on a global, regional and local scale.

2.3 CONTEXTUALISING THE LITERATURE: A GLOBAL PERSPECTIVE

Around the globe, coastal zones are known to be both economically and ecologically valuable ecosystems. Barbier *et al.* (2011: 170), describes ecosystem services as benefits gained from nature that contribute to society. These services are further divided into provisions, such as regulations, maintenance and cultural benefits. Coastal environments provide society with food, water storage and supply through desalination, minerals, water purification, air quality and regulation, coastal protection, climate and weather regulation, lifecycle maintenance, pharmaceuticals, and aesthetic and tourism values (Kelleher *et al.* 1995:2; Barbier *et al.* 2011: 170; Liquete *et al.* 2013: 5). Coral reefs on their own provide a variety of services such as, nutrient cycling, coastal protection, raw materials, maintenance of fish stocks and tourism in the form of scuba diving (Barbier *et al.* 2011:175).

Arguably, the greatest ecosystem service provided by these environments is of consumptive use. According to the FAO, global fish consumption reached 20kg per capita for 2014 (FAO, 2016: 2). In their most recent publication, the FAO (2018:2) state that per capita fish and fishery production has increased to 20.2kg in 2015 with the amount increasing 1.5% per year. It can therefore be argued that this increase in numbers each year shows the large amount of fish and fishery products extracted from the ocean and points to a potential food shortage. As argued by Barbesgaard, (2018:142), in a capitalist society to conserve the ocean, it must first be shown what monetary value it holds. This is echoed in Hannigan (2017: 22), "in the postmodern capitalist era there is a

relentless pressure to construct oceans as empty spaces whose importance is defined entirely by their value as sources of energy and other resources and/or as territories up for grabs in geopolitical rivalries". According to Liquete *et al.* (2013: 1), oceans contribute more than 60% of the total economic value of the biosphere. In 2014, developing countries exported US$ 80 million worth of fish and fishery products combined (FAO 2016: 7). China alone exported a total of US$ 20 980 million in 2014; a growth of 12% from 2004 (FAO 2016:53). The waters surrounding the Philippines, Malaysia and Indonesia are within a region known as the Coral Triangle. The value of fisheries around the coral reefs of this region was estimated at $2.4 billion a year (Kamil *et al.* 2017:73).

It is therefore concluded that oceans hold tremendous economic value. Furthermore, Figure 2.2 below indicates both the direct and indirect value of the global ocean. The direct output of the ocean from fisheries, mangroves, coral reefs and seagrass was estimated at R98,6 trillion. An indirect output such as tourism is valued at R111,5 trillion. Barbesgaard, (2018:142) stresses the figure produced by the WWF (figure 2.2) gives policy makers the ability to account for the costs of their actions when exploiting the oceans. In a capitalist society, policymakers are money oriented (Coe *et al.* 2013:61). Ultimately, coastal zones provide various ecosystem services from pharmaceuticals to flood control. They are not only ecologically valuable, but due to the value placed on them, they are economically valuable as well.

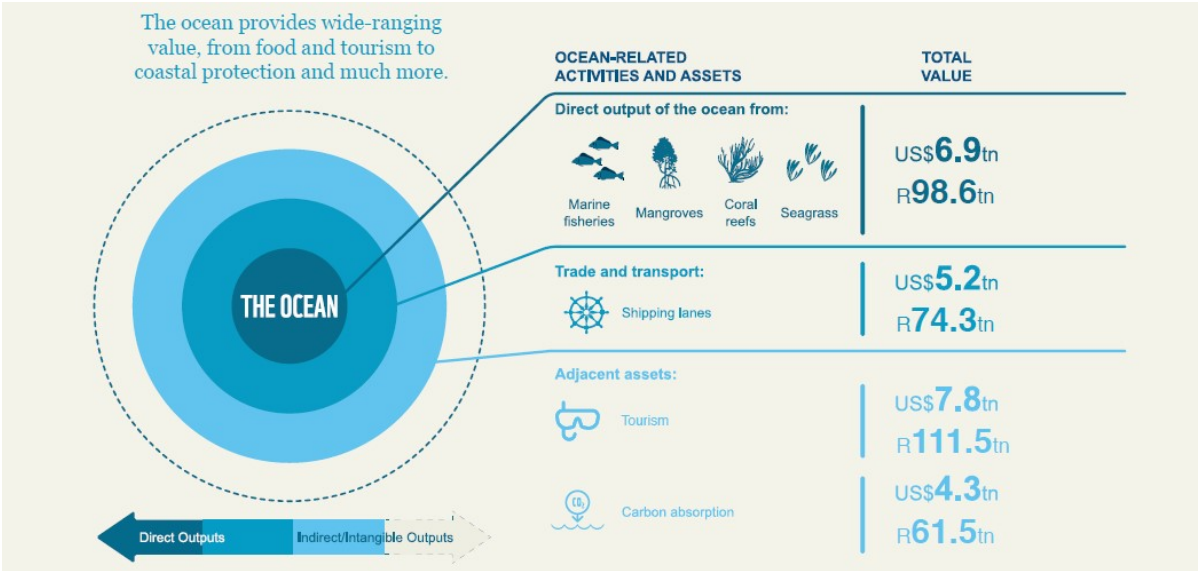

Figure 2.2: Illustration depicting the global asset value of the ocean (Source: WWF 2016: 9)

As highlighted above, coastal and marine ecosystems hold tremendous financial and ecological value globally. Nonetheless, numerous human activities pose a threat to these ecosystems. A consensus amongst literature may be found that states pollution, overexploitation, development and habitat destruction are the greatest threats facing coastal zones (Attwood *et al.* 1997:341; Allison *et al.* 1998: 81; Halpern *et al.* 2008: 948; Crain *et al.* 2009: 39; Goble *et al.* 2014). With the high rates of consumption explained above, fishing is listed as the number 1 threat to coastal environments (Sink *et al.* 2012: 244). In 2014, the global total marine capture fishery production was estimated at 81,5 million tonnes (FAO 2018). This number decreased to 79,3 million tonnes in 2016 (FAO 2018: 9).

According to the FAO (2018:8), this decline is mainly attributed to the impacts of El Nino as the upwelling of cold water is reduced. This change in the strength and timing of coastal upwelling causes fish species to migrate and causes growth and abundance changes (Kumar *et al.* 2014). Of the 81,5 million tonnes of fishery products produced in 2014, China were the top producers with 14 million tonnes (FAO 2016:4). This number increased to 15, 2 million tonnes in 2016 (FAO 2018:9). In 2014, 4,6 million fishing vessels were estimated around the world. Due to the high consumption rates mentioned above, 80% of the world's fish stocks are over or have been fully exploited (FAO 2008:34). In 2014, 13 out of the 25 major fishing countries, including China, Indonesia and Norway, increased their catches by more than 100 000 tonnes compared with 2013 (FAO 2016: 10). The high amount of resource extraction highlighted above could lead to changes in the ecosystem. A decline in one species of fish in one ecosystem can lead to a collapse and have a domino effect on other ecosystems causing further collapses. None of the articles described above trace the root of these threats, which however, is argued by Bradshaw (2004) Hannigan (2017), and Barbesgaard (2018), as capitalism. "The central problem of declining fish stocks is not the 'tragedy of the commons' (too many fishers for too few fish), it is the commodification of sea fisheries and agriculture" (Hannigan 2017: 16). The capitalist system places monetary value on the ecosystem, driving the fishing sector for example, and it is this value then leads to its inevitable decline.

Pollution, as argued by Thushari *et al.* (2017), is another threat to coastal environments. It has been estimated that 8 million tonnes of plastic enter the ocean each year, an equivalent of one truck load a minute (WWF 2016: 28). Furthermore, Thushari *et al.* (2017: 349), argue "plastic production has doubled worldwide over the past 15 years due to its durability, low cost, attractive appearance, and light weight. As a result, approximately 89% of coastal and marine debris is plastic". In Thailand, 45% of coastal debris found in the Chonburi province of Bangkok is plastic. In Japan this number increases to 70%. In Wales, 80% of marine debris is plastic (Thushari *et al.* 2017: 124).

Larger articles of plastic are broken down into micro, smaller than 5 mm, and nano-plastics (Prata 2018: 284). As a result, it has been estimated that 270 000 tonnes of plastic particles are currently floating in the ocean (Prata 2018: 284).

It is therefore argued that pollution in the form of plastic remains a tremendous threat to marine life as microplastics are ingested by zooplankton and phytoplankton, inhibiting mobility, photosynthesis and inducing stress (Thushari *et al.* 2017; Prata 2018: 284). This then affects other organisms that feed off the plankton. As argued by Laist (1987) and Thushari *et al.* (2017) the larger articles of plastic, such as fishnets, can result in the animal becoming tangled and can lead to mortality.

In addition, Diaz and Rosenburg (2008: 926) state coastal hypoxia, caused by eutrophication and heavy metals from sewerage, as a threat to coastal environments causing 'dead zones' (Diaz and Rosenburg 2008: 926). It is estimated that there are 500 dead zones globally, causing a collapse in the ecosystem (Diaz and Rosenburg 2008: 926). As shown in Figure 2.3, dead zones are a global problem, but they are mainly situated around the northern hemisphere and are associated with a high human footprint. Studies on coastal hypoxia are elsewise, limited.

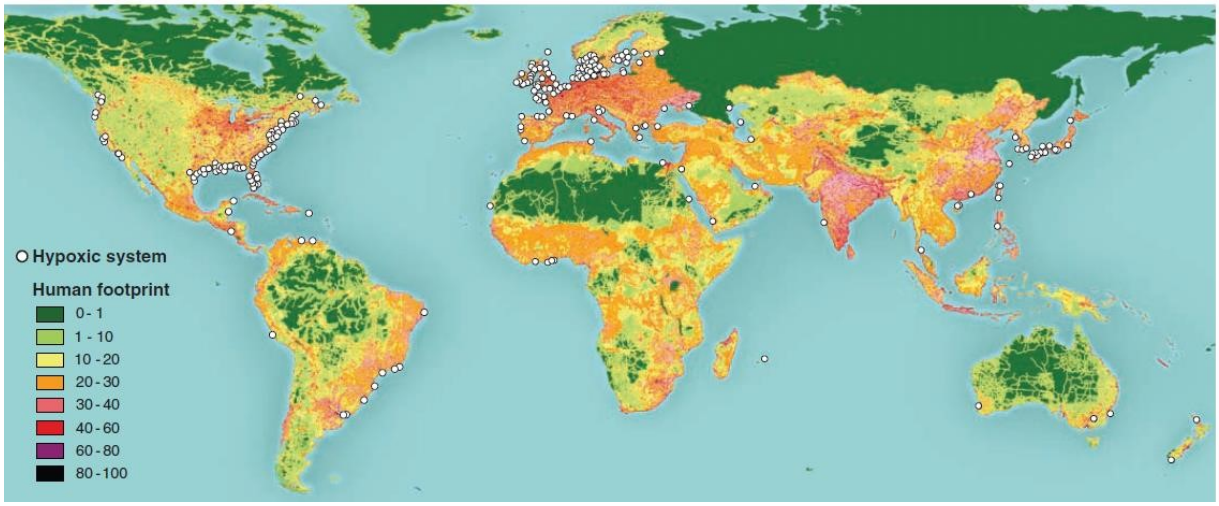

Figure 2.3: Map showing the global distribution of eutrophication- associated dead zones (Source: Diaz and Rosenburg 2008: 927).

Marine invasive species is another global threat to coastal environments (Bax *et al.* 2003). According to Bax *et al.* (2003: 314), 252 alien marine species were identified in Australia and 159 alien species in New Zealand. Out of the 400 marine species in Pearl Harbour, Hawaii, 91 are alien. Invasive species compete for resources with native species and often lead to a decline in their populations. In San Francisco Bay, the Asian clam, *Potamocorbula amurensis*, has been blamed for the collapse of local fisheries (Bax *et al.* 2003: 314). It can therefore be concluded that both coastal hypoxia and marine invasive species remain a threat to coastal zones globally.

It is argued that one of the less sought threats to coastal environments is the human perception of them from the beginning (Hannigan 2017). While there is a general interest and knowledge amongst society that coastal ecosystems are important and need conservation, "it is widely assumed that the ocean and especially the deep sea is devoid of human beings" (Hannigan 2017: 9). This, "out of sight out of mind" mentality disassociates humans and our connection to the ocean. While coastal zones hold value, they are seen as less important. "In effect we think of the oceans as being neither particularly valuable to us, nor particularly threatened." (Agardy 1997:10). According to Hannigan (2017: 24), oceans must be viewed differently and as a distinctive and vital ecosystem in which connections between physical space and human interaction are highlighted.

To summarise, it is therefore argued that, coastal environments on a global scale are faced with numerous threats such as pollution, in the form of plastics and heavy metals, overexploitation of marine species and an introduction invasive species. It is out of this context that the need for effective coastal management, that allows for the replenishment and protection of coastal zones arises.

According to Mudge, (2018) coastal management in the Philippines was implemented in the 1980's, today however, interest in coastal management has faded. Implementation is poor and slow, furthermore, due to lack of monitoring and evaluation programmes, data is lacking. While a lack of data was attributed to the insufficient coastal management in the Philippines, Manrique *et al.* (2018) argue that in Ecuador, coastal management is mainly affected by politics. Weak institutional capacity and slow implementation is attributed to a government that lacks interest in coastal zones Manrique *et al.* (2018). Similarly, to both the Philippines and Ecuador, Pomeroy *et al.* (2016: 24), attribute "weak marine resource governance, including corruption, lack of participation, poor enforcement, weak institutional capacity, inadequate information, and growing maritime in security" as challenges to successful coastal management in Southeast Asia. Tiquio *et al.* (2017) further add to this list by stating that there is a lack of legally binding policies in Southeast Asia focusing on coastal management, even though the coastal area holds vast potential tourism values. According to Kamil *et al.* (2017: 73), "the value of a square kilometre of healthy coral reef in the

Southeast Asia region is in the range of US$23,100 to US$270,000 a year." Yet, as explained above, the area remains poorly managed.

According to Barragan *et al.* (2005), a lack of resources, and civil society combined with poorly connected legislation all lead to inefficient coastal management in Chile. Stepanova (2015), analyses coastal management in four European countries; Italy, Belgium, the UK and Sweden. It is found that deficits in research, low inclusiveness, lack of institutional mechanisms for mediation, power imbalances and a lack of transparency all set back coastal management in the countries listed above. It can therefore be concluded that various countries around the world, developed, or developing, east and west, face similar issues regarding coastal management.

2.3.1 THE ESTABLISHMENT OF MARINE PROTECTED AREAS

It has been shown above that globally, coastal environments are economically valuable and contribute greatly to a country's economy. However, they are also vulnerable to many threats and as argued above, traditional coastal management strategies aimed at dealing and managing these threats have had limited success. It is therefore out of this context that Marine Protected Areas emerge as a successful form of coastal management globally.

MPAs are defined as "any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment" (Agardy *et al.* 2003: 355). During World War two, fishing in the North Sea completely ceased due to wartime movement. This temporary termination of fish consumption allowed previously exploited species to reproduce, leading to a rise in fish stock numbers. Claudete (2012) argues that this unexpected pause was the beginning of the thought process behind Marine Protected Areas. Fisheries began to temporarily close off areas to allow for fish stocks to increase (National Research Council (NRC) 2001:145). Regardless, marine ecosystems globally continued to be heavily exploited in the 1950s and 1960s. The need to develop sustainable strategies was required and prevalent. In 1958, four conventions were established under the Geneva conventions on the Law of the Sea. Namely, the Convention on the Continental Shelf, the Convention on the High Seas, the Convention on Fishing, and the Convention on Conservation of the Living Resources of the High Seas. These conventions were instrumental as they established an international framework advocating for the protection of marine environments (NRC 2001:147). From 1973-1977, the United Nations Conference of the Law of the Sea refined the goals and legislation of MPAs globally. It was only in 1994 that the EEZ of 200 nm out to sea was defined. This played an important role in establishing the jurisdiction of zones that countries could conserve. According to Agardy *et al.*

(2003:354), in 1995 the estimated number of MPAs globally was 1306. This number has increased dramatically and MPAs are now the mainstream method of coastal conservation (McClanahan 1999: 321; Agardy *et al.* 2003). Today, only 5% of the world's oceans are protected under MPAs with this number expected to rise (Lewis *et al.* 2017:7).

With its 250 MPAs, China has one of the largest MPA networks in the world. However, as argued by Li and Fluharty (2017), the management of these MPAs remain unimpressive. Inadequate laws, political drive, user conflicts and a lack of resources remain as challenges to China's MPAs (Li and Fluharty 2017: 78). Similar results were found by Kamil *et al.* (2017) in Southeast Asia, where user conflict was identified as an issue facing MPAs in Southeast Asia. The authors stresses that MPAs need not only analyse the environmental impacts but the social impact as well. "This complex feedback between environmental and socioeconomic aspects needs to be understood using a broader set of criteria" (Kamil *et al.* 2017: 79). Gerhardinger (2011), argues that similarly to China, poor management and policies, insufficient legislation and a lack of resources affect the effectiveness of Brazil's MPAs. Nonetheless, Brazil's MPAs still conserve their marine resources and progress has been made over the years. MPAs still hold value and success stories from around the globe may be found as they remain the most appropriate tool in conserving marine resources.

The Luiz Saldanha Marine Park in Portugal is seen as a successful MPA as numbers of Senegalese Sole have increased in the area over the years (Abecasis *et al.* 2014). The MPA also allows for moderate levels of spill-over- where fish species reproduce and grow out of an area (Abecasis *et al.* 2014). Friedlander *et al.* (2017), argues that MPAs in Palau, a country in Oceania, have been effective in conserving the countries marine resources; "MPA effectiveness in Palau has been enhanced through the use of traditional knowledge combined with expert science and the development of MPA networks" (Friedlander *et al.* 2017: 14). MPAs analysed by Garcia-Charton (2008) in the Mediterranean were found to have reversed the negative ecosystem impacts of fisheries in coastal zones. With reference to the above examples, it can therefore be argued that while some regions MPAs face challenges, such as a lack of resources, MPAs can effectively manage coastal zones. As mentioned in a quote by Kamil *et al.* (2017) above, complex relationships between both social and environmental factors need to be looked at for MPAs to be truly successful.

2.4 CONTEXTUALISING THE LITERATURE: A SUB-SAHARAN PERSPECTIVE

In 2014, an estimated 4.6 million fishing vessels were in the ocean, of which 15% were from Africa (FAO 2016:5). In 2014, 56.6 million people were involved in aquaculture and fishery capture

globally (FAO 2018:31). This number increased in 2015 to 60 million fishers with the number declining to 59 million the following year. In 2014, 10% of the fishers involved in the industry were from Africa (FAO 2018:31). Nonetheless, there is a scarcity of studies focusing on coastal management in Africa, as only studies focusing on South Africa, Kenya, Tanzania, Nigeria and Ghana were found.

With a coastline of 550km, Ghana is often mentioned in studies around coastal environments (Amlalo 2006:149). The area is an example of an African country that is under threat from a growing fishery and tourism sector, industry and mining. 6.5% of the land in Ghana is coastal but it is home to 25% of the nation and 80% of the industrial establishments (Amlalo 2006:149). It can be noted that the coastal zone of Ghana is highly populated and important to the country. According to Lawson *et al.* (2012:38), "the fish stocks in Ghana are generally thought to be at or nearing their maximum levels of exploitation." This threat is echoed in Tanzania where fish stocks are rapidly depleting (Jiddawi and Ohman 2002). Destructive fishing methods like spearfishing and dynamiting are commonly used to increase fish yields (Jiddawi and Ohman 2002: 521). With reference to Figure 2.4, reef fish, lobsters and small and large palagics have decreased over the years. From both Ghana and Tanzania, the growth in population has led to higher demand in fish stock leading to its decline. Whilst overfishing may be the biggest threat to coastal environments in some African countries, to Nigeria oil spills are the biggest area of concern (Nwilo and Badejo 2006:117).

With its 853 km long coastline, Nigeria is the largest producer of oil in Africa and the 6th in the world (Nwilo and Badejo 2006:117). This richness in oil however, results in negative environmental consequences. The largest oil spill in Nigeria's history occurred in 1980 when an offshore well blew up. 200 000 barrels of oil spilled into the Atlantic Ocean and damaged an estimated 340 hectares of mangroves (Nwilo and Badejo 2006:123). Oil spills are harmful to the marine environment as they kill fauna and flora, settle on beaches and affect terrestrial organisms, sink to the ocean floor and effect bottom- dwelling organisms, poison algae, disrupt food chains and contaminates the flesh of fish (Nwilo and Badejo 2006:124).

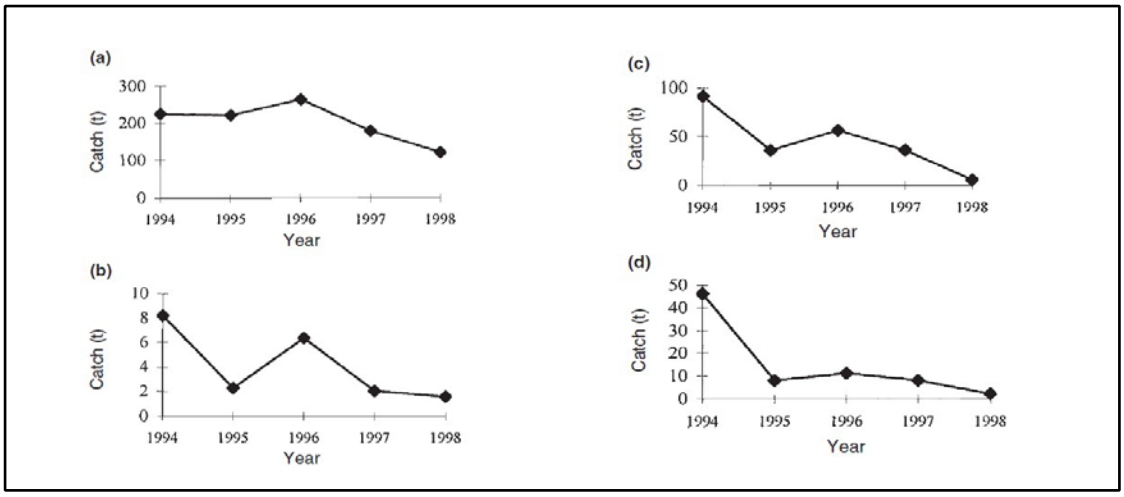

Figure 2.4: Graphs showing the annual catch of different species in Chwaka Bay, Zanzibar. (a) reef fish (b) lobsters (c) large pelagics (d) small pelagics (Source: Jiddawi and Ohman 2002: 523)

The last threat to coastlines across sub-Sahara Africa, expressed across the limited literature, is poverty. Poverty is defined as living on less that USD 2 a day. By this standard, 46% of the population in Sub-Saharan Africa live in poverty (Lawson *et al.* 2012:30). As a result, the poor often depend on the harvesting, consuming and selling of natural resources to survive. When in coastal areas, this involves the harvesting of fish, shells or seaweed. A study conducted by Tobey and Torell (2006), discussed MPAs in Tanzania and Zanzibar, an island off of Tanzania. They found that often MPAs fail due to poverty; "poverty may be a limiting factor to conservation efforts in that poverty sometimes forces people to use destructive fishing practices or break management rules" (Tobey and Torell 2006:853). Thus showing a relationship between the economic status of a country and the marine resources.

Coastal zones in Sub-Sahara Africa also contribute greatly to a country's economy. In 2008, coastal tourism created 234 679 jobs in Ghana. The fishing sector accounts for 4.5% of Ghana's GDP and as mentioned above, 80% of Ghana's industrial establishments are located on the coast. Furthermore, it employs an estimated two million people (Lawson *et al.* 2012:32). This is also seen in in Nigeria where the oil sector contributes to 20% of the country's GDP and 95% of the country's foreign exchange (Nwilo and Badejo 2006:117). Similarly, in Tanzania, the fisheries sector contributes to 5% of the mainland's GDP and 10% to Zanzibar's GDP (Jiddawi and Ohman 2002: 518). The above evidence illustrates that similarly to the countries discussed in section 2.3, such as China, Sub-Saharan countries also economically benefit from coastal zones, through resource extraction and the creation of jobs.

It has been shown above that marine environments in Sub-Sahara Africa are both economically valuable and highly threatened. However, across Africa conservation and coastal management is

heavily criticised. Boateng (2006: 110) argues that; "in Africa, institutions and policies regarding management and access to coastal and marine space are not effectively developed to ensure participation and equity." Yet, Boateng (2006) does give two examples of successful coastal management. First is in Madagascar where the Wildlife Conservation Society, a NGO, implemented integrated coastal management strategies along the coastline to promote collaboration between environmental managers, control fishing, combat coastal reef degradation an protect fauna and flora. The second example given discusses turtle conservation in Ghana. Loggerhead, Leatherback and Hawksbill turtles in the area were highly threatened due to coastal erosion, predation and human exploitation (Boateng 2006). The Ghana Wildlife society, a NGO, stepped in to promote conservation. They involved and educated local coastal communities through educational programmes and workshops. Locals were encouraged to report siting's, nesting sites were identified and monitored, and fishermen were encouraged to release turtles back into the water if caught. While both of these studies show successful cases of management and conservation in an African context, they both involved NGOs not government participation. However, Lawson *et al.* (2012) criticises the implementation of coastal management in Ghana by looking at the Ghanaian government and their legislation. The failure was attributed to lack of capacity and finances, conflicting departmental functions, lack of legislation and inadequate guidelines.

Nwilo and Badejo (2006:117) acknowledge that Nigeria has various legislation and policies in place to conserve and manage coastal environments, such as the Oil Pollution Act of 1999 and the Niger Delta development committee, however they lack human resources for monitoring and policing, making them unsuccessful. Similarly, Khamis *et al.* (2017) argue that in Zanzibar, various legislation and policies exist including the Fisheries Act of 2010 and the Zanzibar Fisheries policy of 2014 to name a few, however, despite the vast array of legislation in place, locals remain reluctant to comply and as a result, management has become *ad hoc* and piecemeal. "The lack of harmonization between the co-occurring traditional and modern management systems coupled with poverty and high resource dependence have resulted in the incoherent situation described in this paper" (Khamis *et al.* 2017:131).

Coastal zones in sub-Sahara Africa hold similar values to those expressed globally. They are also subjected to similar threats, such as pollution and overexploitation. It has been shown above that there are limited effective coastal management strategies in sub-Sahara Africa, MPAs could therefore be the solution to coastal management in Sub-Sahar Africa.

2.4.1 MARINE PROTECTED AREAS IN SUB-SAHARA AFRICA

In July 2003, the African convention on the Conservation of Nature and Natural Resources was amended to promote the establishment of community-based protected areas and address gaps in the conservation of biodiversity. This, in conjunction with the World Parks Congress in 2003 which agreed on new commitments and policy guidance for protected areas worldwide, framed the establishment of MPA's in Africa (Tobey and Torell 2006: 835).

Francis *et al.* (2002), conducts a study where the effectiveness of 28 MPAs across East Africa was assessed. MPAs in East Africa aim to "conserve and manage the extraordinary/unique variety of the marine and coastal biodiversity for the benefit of the present and future generations" (Francis *et al.* 2002:504). The authors use four factors to assess the MPAs. Firstly, an increase in biodiversity. Secondly, the establishment of functional features. Thirdly, user compliance and lastly, stakeholder participation. Overall, biodiversity increased in many of the MPAs studied and most were well maintained, even though some lacked management plans and adequate personnel. The authors go on to further argue that the enforcement of these MPAs is weak and inefficient and the level of management and stakeholder participation is lacking (Francis *et al.* 2002: 509). MPAs in East Africa often lack sustainable and sufficient funding and are therefore NGO funded; "this is illustrated by the fact that NGO supported MPAs with external funding often are more successful in managing protected areas" (Francis *et al.* 2002: 506). According to the authors, MPAs in East Africa will only succeed if "the MPAs are linked up to the broader strategies for sustainable development of the countries; local communities and other key stakeholders are involved in their establishment process and management and adequate (human and financial) resources are available to support key activities" (Francis *et al.* 2002: 511).

Similarly, a study conducted by McClanahan *et al.* (2005) in Kenya found that the main challenges to MPAs in the region include a lack of financing, user-conflict and a lack of specific regulations. However, as stated by the authors "although the MPAs of Kenya face some serious constraints there are indications that the long-term outlook may look good". These include management plans that have been established where stakeholders were involved, the MPAs have conserved fish species and lastly the MPAs have improved coral reef habitats. A study conducted by Tobey and Torell (2006) discussed MPAs in Tanzania which is similar to the one in Kenya, the authors found that conservation has improved in areas that fall under the protection of a MPA, however they still face various challenges. The MPAs are not welcomed by the locals as it reduces their food source and results in conflict between them and the enforcers. As reported by Tobey and Torell (2006: 845), the MPAs are too large and there are not enough people to patrol the area. The Menai Bay MPA covers 467 km^2 but only one boat is on the site patrolling. Mafia Island Marine Park is

the largest MPA in the Indian Ocean spanning over 822km^2. This MPA only has three patrol boats (Tobey and Torell 2006: 838). The authors conclude by stressing the need for effective MPAs as it will benefit the coastal communities, the nation's economy, and the country as a whole. It can therefore be concluded that MPAs in a Sub-Sharan context face similar challenges than those in Brazil, Southeast Asia and China. Likewise, they also hold value and potential in conservation.

2.5 CONTEXTUALISING THE LITERATURE: A SOUTH AFRICAN PERSPECTIVE

South Africa's coastline is 2 798km long and is home to 12 914 marine species (WWF 2016:4). As a result, coastal zones hold tremendous potential economic value to the country, contributing 0.5% of South Africa's GDP (WWF 2016:9). 100 000 people rely on fisheries for their livelihoods in South Africa (WWF 2016: 9). The Sseaweed sector alone provides 300 jobs and is estimated to be worth at least R35 million annually (DAFF 2015:42). Likewise, the hake industry provides an estimated 30 000 jobs and an annual value of R5.2 billion. The hake fishery is unmistakably the most valuable marine fishery in South Africa (DAFF 2015:15). It has also been reported that coastal environments hold tremendous indirect economic value. Coastal goods and services through recreation and tourism contribute 35% to South Africa's GDP (WWF 2016: 11). It can therefore be said that South Africa benefits greatly from coastal zones in a similar fashion to the countries given in the above sections.

Various factors pose a threat to South Africa's coastal zones, one being overconsumption. In South Africa, 312 000 tonnes of seafood are eaten annually (WWF 2016: 9). Per capita seafood consumption for South Africa therefore sits at 6.25 kg of seafood per year. As a result, in South Africa, 42% of marine and coastal areas are listed as threatened (Sink *et al.* 2012: 243). With reference to figure 2.5, in 2016 and 2018, only 29% of fish stocks are sustainably utilized. 20% of fish stocks were listed as unknown, with the number increasing to 23% showing room for further research to be done and "suggesting we have limited or conflicting information on 23% of all the species we extract" (WWF 2018: 3). The percentage of overexploited fish stocks dropped by 4% due to an increase of the number of species assessed by DAFF (WWF 2018:3). According to a report published by DAFF (2015) abalone, silver kop, steenbras, seventy-four, squid, bluefin tuna, Southern Cape oysters, whitetip, blue and hammerhead sharks, to name a few, are all listed as heavily depleted. If current trends persist, per capita seafood consumption in South Africa will increase and more species will be listed as overexploited.

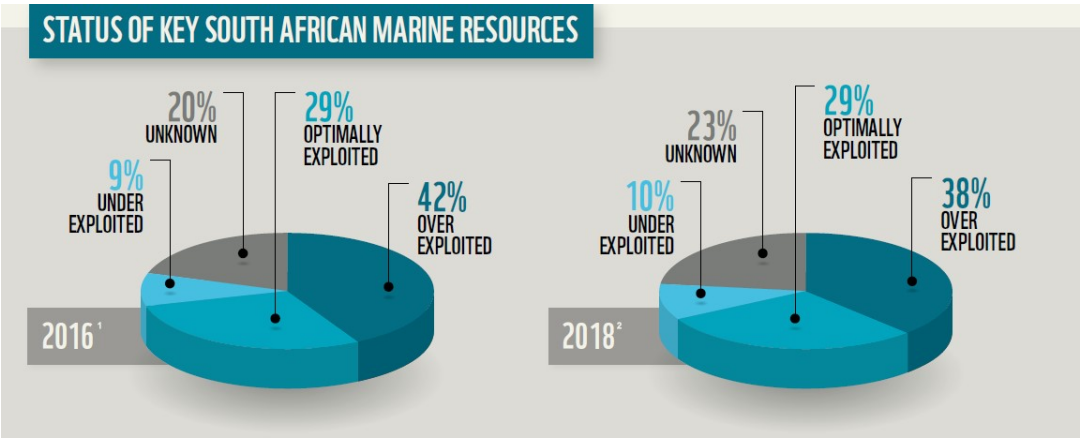

Figure 2.5: Pie charts indicating the status of South Africa's fish stocks in 2016 and 2018 (Source: WWF 2018: 4)

Another threat facing South Africa's coastal zones is pollution, specifically pollution in the form of sewerage. In South Africa, 60 licensed pipelines discharge effluent wastewater along South Africa's coastline. 287 million meters[3] of wastewater is discharged in South Africa annually (WWF 2016: 28). Griffiths *et al.* (2010:11), state that sewerage contains heavy metals and while these are necessary to organism functioning, an excessive quantity can be toxic.

Sink *et al.* (2012) reported that invasive species threaten South Africa's coastline. Sink *et al.* (2012: 215) identify 8 known marine invasive species affecting the South African coastline including the Pacific barnacle, European green crab, the Pacific Oyster and importantly for this study, *Ciona intestinalis,* commonly called the Sea Vase and the *Mytilusgallo provincialis* known as Mediterranean mussel both affecting the research site. *Ciona intestinalis* is believed to have been introduced in South Africa in 1955. As reported by the authors, these species poses an immense threat to coastal ecosystems and a country's economy. This fouling organism competes with native species and has a negative impact on local economies at it smothers mussels (Sink *et al.* 2012: 218). Two other lesser studied and known threats plague the South African coastline, illegal alluvial sand extraction and offshore drilling.

According to Chevallier (2014), sand is illegally extracted along the beaches of KZN and the Eastern Cape for the heavy minerals it contains, including Rutile and Zirconium. It is argued that this extraction is amplified by the high demand from the construction industry in South Africa. The extraction of sand from dunes along beaches removes stabilizing vegetation, changes structures of ecosystems, can cause damage to coastal properties and infrastructure as dunes act as a coastal flooding buffer (Chevallier 2014: 2).

Offshore drilling is another threat to South Africa's coastlines. Recently, Sasol and ENI South Africa have appointed Environmental Resources Management (ERM) to undertake an EIA, in

accordance with NEMA, 1998 (Mahlatsi 2018). The EIA is aimed to identify and assess potentially significant impacts related to the proposed exploration drilling within block ER236 off the East Coast of South Africa (ERM 2018). The drilling will determine whether there is any commercially viable oil and gas under the seabed and, if approved, will take place as early as November 2019 (Bennie 2011). With reference to figure 2.6, Block ER236 overlaps with the proposed Protea Banks MPA (an extension of Trafalgar), Aliwal Shoal and iSimangaliso MPA, north of Durban (ERM 2018). "Although the areas of interest for well drilling do not overlap with any existing or proposed Marine Protected Areas (MPAs) and Ecologically or Biologically Significant marine areas (EBSAs), there are numerous MPAs, proposed MPAs, EBSAs and Hope Spots in the Area of Indirect Influence" (ERM 2018:239). The Area of indirect influence (AII) includes the entire block and extends past East London, therefore including Amathole, Dwesa-Cwebe, Hluleka and important to note, Pondoland MPA. It is noted that while the drilling is not within any MPAs, the entire block including the AII may be affected by an unplanned event (ERM 2018:101).

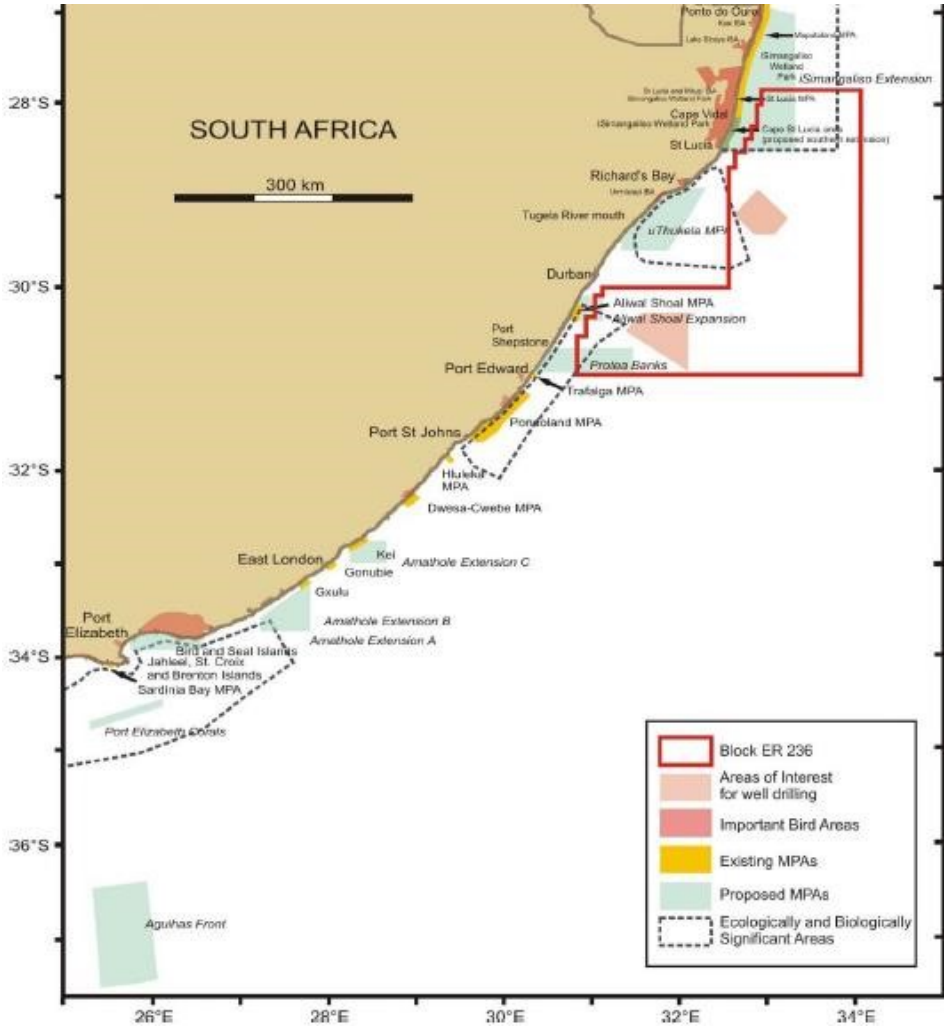

Figure 2.6: Map showing Block ER 236, existing MPAs and proposed MPAs. (Source: ERM 2018: 102)

It has been reported above that coastal environments contribute greatly to South Africa's economy and contribute significantly to the country. However, these environments remain unstable and threatened by issues such as pollution, overfishing, sand mining and offshore drilling. It is therefore out of this context that the need for integrated coastal management focusing on resource extraction, industry and pollution is rife.

Torell (2000: 353), report that South Africa along with Tanzania are at the forefront of Coastal management in Africa. South Africa has a wide variety of legislation and policies focused on coastal conservation and management including the mineral and Petroleum Resources Development Act (Act 28 of 2002), the Protected Areas Act (Act 57 of 2003), the Biodiversity Act (Act 10 of 2004) and most importantly, The Integrated Coastal Management Act (Act 28 of 2008) which is to be used in conjunction with the National Environmental Management Plan (NEMA) (Goble *et al.* 2014: 32).

Goble *et al.* (2014:37) argue that due to a lack in human capacity and finances, implementation of the legislation and policies mentioned above is difficult. 3 years later, Goble *et al.* (2017), conduct a study using the DPSIR (Driving forces, Pressures, State, Impacts and Responses) framework to assess the implementation of the Act in KwaZulu-Natal. Through interviews, the authors find that implementation of the Act is the greatest challenge. Human and financial constraints limit the Acts implementation and therefore, the Acts targets are often not met. Sowman and Malan 2018, echo these findings in a study conducted which discussed the progress made since the ICMA was established in 2008. The authors state that implementation often fails due to a lack of political will, insufficient human and financial resources, confusion over jurisdiction and inadequate civil-society participation (Sowman and Malan 2018: 121). However, could coastal management achieved through MPAs in South Africa be more effective?

2.5.1 MARINE PROTECTED AREAS IN SOUTH AFRICA

There are currently 24 MPAs located along the coastline of South Africa (Chadwick *et al.* 2014). MPAs are proclaimed under Section 43 of the Marine Living Resources Act, Act 18 of 1998. Marine protected areas are established with the intent to protect and conserve threatened species, protect habitats and facilitate fishery management. The Tsitsikamma MPA was established in 1964 and is the oldest MPA in South Africa and Africa. The management of MPAs in South Africa varies from entirely municipality managed to government and provincial affiliated agencies such as the Eastern Cape tourism agency or KZN wildlife. A study conducted by the World Wildlife Fund South Africa evaluates all the MPA in South Africa. Non-compliance, lack of staff,

insufficient funds and lack of enforcement are all identified as factors that lead to ineffective MPAs (Chadwick *et al.* 2014:32). MPAs in South Africa, are either controlled, restricted or both. Most are offshore with some exceptions. A restricted zone is a demarcated area where no fishing may take place, and only divers with permits may use the area. Vessels are also not allowed to be anchored. A controlled zone limits fishing to those who have a permit and the catch is limited to those on the sustainable list. No traps, fishing nets nor shark nets are allowed in MPAs in South Africa. In 2014, Operation Phakisa, an initiative led by the South African government was launched. With relevance to this paper, Operation Phakisa will see the expansion of two MPAs and the establishment of 20 new ones along the South African coastline. This will increase the extent of South Africa's MPA coverage from 0,5% to 5%. Operation Phakisa "aims to increase the representation of marine habitats in South Africa's protected area network. In its current form, it could provide the first protection to 46 of 54 habitats that are currently without protection" (Sink 2016: 1).

2.6 CRITIQUES OF MARINE PROTECTED AREAS

Marine Protected Areas have various goals depending on the literature. Ultimately, they can be summarised as the following. Firstly, to conserve biodiversity and marine habitats (NRC 2001:21; Chadwick *et al.* 2014). Secondly, to protect overexploited and threatened species allowing them to replenish habitats (NRC 2001:21; Chadwick *et al.* 2014). Third, to preserve and restore the viability of habitats (NRC 2001:22). Fourth, to manage fishery catchment and species exploitation rates (NRC 2001: 23). Under section 43 of the Marine Living Resources Act, Act 18 of 1998, Marine Protected Areas are established "(a) for the protection of fauna and flora or a species of fauna or flora and the physical features on which they depend; (b) to facilitate fishery management by protecting spawning stock, allowing stock recovery, enhancing stock abundance in adjacent areas". However, it has often been noted by various scholars that MPAs do not reach their intended goals and are not an effective management tool in coastal conservation (Kelleher *et al.* 1995; McClanahan 1999; Rudd *et al.* 2001; Jameson *et al.* 2002).

Jameson *et al.* (2002), critiques MPAs by stating that most of them fail to meet their objectives due to poor management. Kelleher *et al.* (1995:7) conducted an evaluation of MPAs across 18 different marine regions around the world and found that only 117 of the 1306 MPAs, which equates to 8.9%, of the areas achieved their management objectives. According to Agardy *et al.* (2011:226), MPAs fail due to either a poor initial design, small size of the protected area, poorly managed area and a negative influence from surrounding ecosystems. A study conducted by McClanahan *et al.* (2006:1408), found that four factors are associated with effective conservation through MPAs;

compliance, visibility of the MPA, time since establishment and wealth of the area. Allison *et al.* (1998) states that MPAs are necessary but are not enough in coastal conservation, mainly due to their location and size. Allison *et al.* (1998) also argue that marine conservation is on a scale much larger than what MPAs can encompass. Thus, for conservation to be effective the area must be large enough to conserve species that are both stationary and mobile, therefore before establishment, the range of the critical species needs to be determined. Water flow and transport should be considered, and activities situated up stream must be monitored. Ultimately, before MPAs are established, factors such as location, stream flow, size and critical species and their range should be considered to ensure maximum species conservation. Therefore, the planning stage must be as thorough as the implementation stage.

2.7 DPSIR FRAMEWORK

The DPSIR framework allows for the description of environmental problems by defining and linking the cause-effects relationships between anthropogenic activities, the environment and the socio-economic consequences (Carr *et al.* 2007:543; Mateus and Campuzano 2008; Gari *et al.* 2014:63). It is applauded for its simplicity and easy design, allowing complex relations to be summarised. The framework was originally developed from the Stress-Response model, prepared by Statistics Canada in the 1970s. This model was further extended by the Organization for Economic Co-operation and Development as well as the United Nations resulting in the Pressures, States and Response framework (Mateus and Campuzano 2008: 30). Finally, in the 1990s the framework was extended once more by the European Environmental Agency and the Organisation of Economic cooperation and Development to form the DPSIR model used today (Mateus and Campuzano 2008: 30; Gari *et al.* 2014:63). Each letter in the framework accounts for a factor. "*Driving forces*, in the form of social, economic or environmental developments, exert *Pressures* on the environment and, as a consequence, the *State* of the environment changes. This leads to *Impacts* that may elicit societal *Responses* that feeds back to the Driving forces, Pressures, State, or Impacts" (Svarstand *et al.* 2008:117). The framework has been applied to reef fisheries management in Kenya (Mangi *et al.* 2007); watershed management (Karageorgis *et al.* 2005), the state of rivers in the Balkans (Skoulikidis 2009) and deforestation in Malaysia (Sarmin *et al.* 2016) to name only a few. The framework, though widely applied, is not without its critiques.

The framework is both praised and critiqued for its simplicity. Through its step by step categories, some state that it misses out on links and broader trends. Tscherning *et al.* (2012:104), explains that the framework often analyses one-on-one relationships, failing to identify complex interrelationships. The framework is also criticised for being too expert centred, prohibiting its

access to policy makers and revolving its application around specialists (Gari *et al.* 2014: 71). Gari *et al.* (2014:71), summarizes the main criticisms of the framework. Firstly, it creates a set of static indicators that fail to describe changing dynamics in a system. Secondly, it fails to capture trends in each factor. Thirdly, the widely praised cause-effect relations are often blurred, and lastly, it implies unidirectional, casual chains, already explained above as omitting complex relations. Gari *et al.* (2014:72) goes on to further critique DPSIR case studies and states a main problem with studies that apply the framework is that they often define the terms under the framework incorrectly. Carr *et al.* (2007: 546), believes that when the framework is used as a model, problems arise and critiques form. The DPSIR framework is a means of categorising and disseminating information and is not a panacea to all problems.

2.8 GAPS IN KNOWLEDGE

In view of the above literature, the following can be said. Firstly, while coastal environments across the globe are all exposed to the same main threat, overconsumption of marine resources, other threats remain location specific. Secondly, coastal environments on a global, regional and local scale remain both ecologically and economically valuable due to its wide, but limited, array of resources. Thirdly, coastal management on a global, regional and local scale may be successful in some cases, however it leaves room for improvement. Lastly, in some cases, MPAs have been shown to be a successful tool in the effective management of coastal areas when managed and implemented correctly. However, at present, there is no literature that seeks to analyse the interconnecting relationships underlying the threats faced by MPAs and how these affect the effectiveness of MPAs as a management tool. This study will therefore use the DPSIR framework to assess the effectiveness of MPAs in managing coastal zones in South Africa.

CHAPTER THREE

METHODOLOGICAL CONSIDERATIONS

3.1 INTRODUCTION

Research methodology is a way of methodically collecting, examining and interpreting observations to answer the research questions (Kumar 2014: 10). It is used to determine the assumptions that underlies the various techniques and the need to know the criteria by which certain methods are applicable to certain problems (Kothari 2004: 8). Methodology is important as it allows for the research to be replicated; it proves the studies credibility. According to Kumar (2014:2), it is important as it "helps to understand and formulate guiding principles that govern a particular procedure in your practice, develop and test new ways that contribute to the advancement of your practice and profession". Examples of research methodologies that can be used include reflexive or reflective and grounded theory.

In this chapter, the first section will deal with the research philosophy, in the form of a paradigm. This will be followed by a description of the research methodology adopted for this study as well as the methods. Thirdly, a description of the research site will be given. Section 3.4 will then look at the research design, where the sampling procedure and target populations are identified, and data collection tools are explained. Lastly, a look at data analysis is given before highlighting the methodological reflections

3.2 RESEARCH PARADIGMS

A paradigm is "a set of basic beliefs based on ontological, epistemological and methodological assumptions" (Guba and Lincoln 1994: 107). According to Mackenzie and Knipe (2006), paradigms are a theoretical framework that influence the way knowledge is studied and interpreted. Paradigms or worldviews "provide a philosophical foundation for methods research" (Creswell 2013: 303). There are many paradigms dominating the research sphere as old methods are constantly being reinvented (Meerwald 2013: 44). These include, positivism, post-positivism, interpretivist, constructivist and transformative paradigms.

Positivism is a paradigm rooted in empirical and reductionist research which is performed by objective, expert researchers (O'Leary 2017: 14). Studies under this paradigm are hypothesis driven and experimental (Mackenzie and Knipe 2006; O'Leary 2017). Researchers under this paradigm assume that the social world and the natural world can be studied in the same manner (Mackenzie

and Knipe 2006:3). This assumption became heavily critiqued and after World War 2 a new paradigm emerged that responded to the limited thinking of positivism. As stated by Mackenzie and Knipe (2006:3), "post-positivists work from the assumption that any piece of research is influenced by a number of well-developed theories apart from, and as well as, the one which is being tested". This paradigm is holistic and inductive by nature.

Interpretivist or constructivist paradigm grew out of hermeneutics (Mackenzie and Knipe 2006:3). The interpretivist paradigm generates a theory through the research process. This paradigm is widely used in the social sciences as it seeks to understand the world of human experience and relies on the participants views of the situation in question. Therefore, qualitative methods such as interviews, observation and document review are key under this paradigm.

In the late 1980's, a dissatisfaction with the existing paradigms dominating the research discourse bought about the transformative paradigm, also referred to as critical theory. This paradigm critiques prior paradigms as neglecting minority race groups, disabled people and only focusing on male perspectives. Feminist theory, neo-Marxist and political theory are associated with this paradigm.. The paradigm also stresses the creation of a theory at the end of the research process as well as an emphasis on social relations.

3.2.1 RESEARCH METHODOLOGY

As described above, the research methodology is a way of methodically collecting, examining and interpreting observations to answer the research questions. Research methods however refer to the manner in which research will be collected. Reflective methodology is an example of the former which draws attention to "the way different kinds of linguistic, social, political and theoretical elements are woven together in the process of knowledge development, during which the empirical material is constructed, interpreted and written" (Alvesson and Skoldberg 2009: 9). This methodology stresses the need to use logical techniques but focus on the political-ideological character of the researcher.

Grounded theory uses methodological techniques to generate theories (Alvesson and Skoldberg 2009: 53). It is a methodology widely used in recent studies as it captures complexity of social life and reflects meaning. This methodology captures understanding and is a way to understand why and how structures and conditions might arise and under which conditions these change. This methodology aligns with the interpretivist paradigm discussed above (Alvesson and Skoldberg 2009:53).

According to Mackenzie and Knipe (2006), once the research paradigm and research approach are established, the research method is next. Kumar (2014) states that there are three methods of

enquiry; quantitative, qualitative and mixed methods approach. Quantitative research is rooted in rationalism and adopts a rigid, structured methodology where measurements and numbers are forefront. Contrast to this, qualitative research is rooted in empiricism where flexible, open and unstructured approaches are used to answer research questions. Qualitative research is focused around using description and narration to describe observation and experience. Mixed methods approach combines two or more approaches to select the best method to answer the research questions. Typically, qualitative and quantitative approaches are combined.

For this dissertation, the research methodology was rooted in interpretivist thought as it sought out to interpret participants views on a particular phenomenon. In line with this paradigm is grounded theory. Both grounded theory and the interpretivist paradigm use both qualitative and quantitative research methods. Therefore, a mix methods approach was deemed appropriate for this study. Qualitative data was used and gathered from interviews, while statistics forming the basis of quantitative data added the discussion.

3.3 DESCRIPTION OF THE RESEARCH SITE

Three Marine Protected Areas were studied. Mainly, Aliwal Shoal and Trafalgar, located on the south coast of KwaZulu-Natal and, Pondoland located in Northern Eastern Cape (figure 3.1). The oceanographic system around South Africa is dominated by two current systems: the cold Benguela current to the west and the warm Agulhas current which flows across the East coast of South Africa bringing nutrient poor tropical waters from the Indian ocean (Griffiths *et al.* 2010: 2). South Africa's coastline is divided into 5 bioregions and 4 offshore bioregions (figure 3.2). The sites chosen for this study fall under the Subtropical Natal and Agulhas Bioregions as well as the West Indian Offshore Bioregion (Griffiths *et al.* 2010: 3).

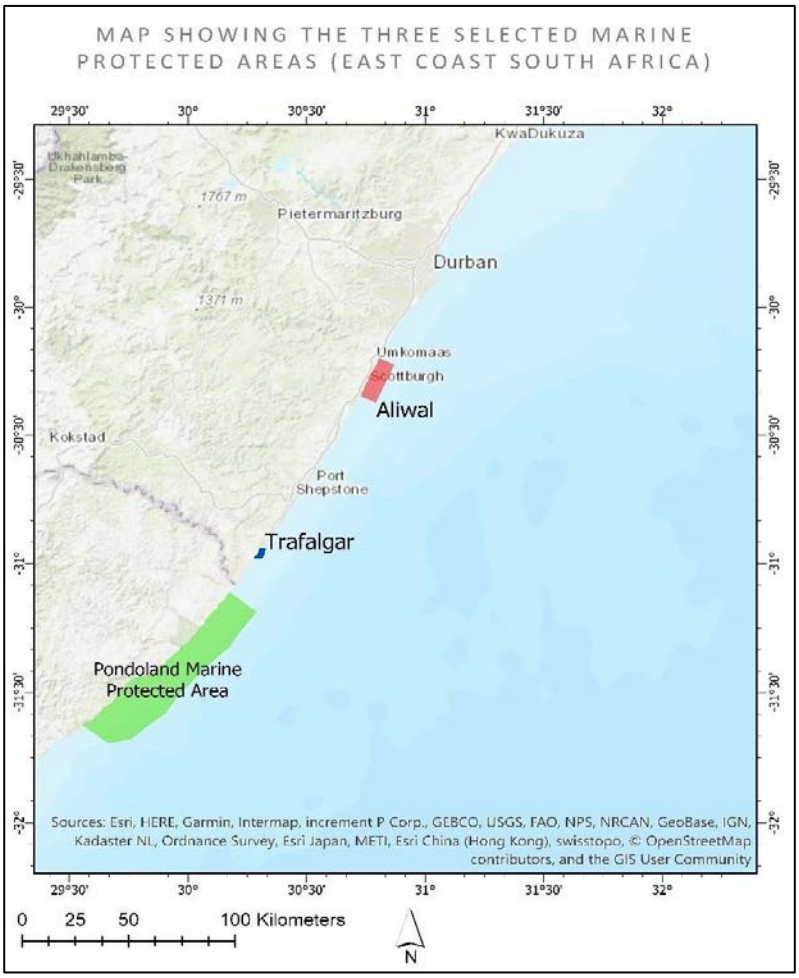

Figure 3.1: Map showing the location of the three Marine Protected Areas studied. Map made using ESRI ARCGIS Software

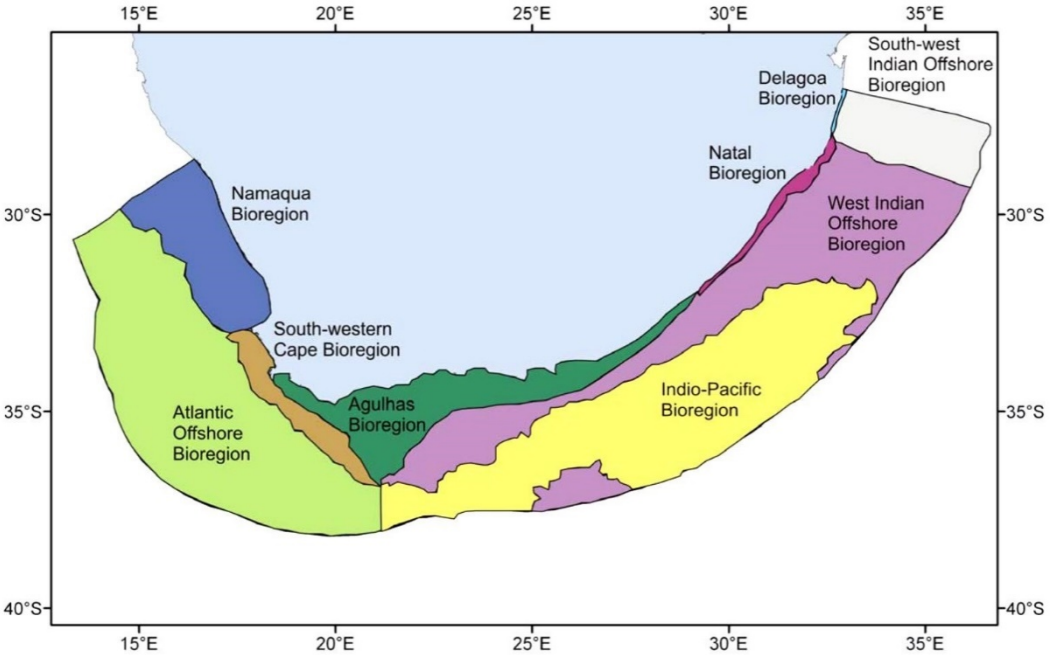

Figure 3.2: Map showing the coastal bioregions of South Africa (Source: Griffiths *et al.* 2010: 4)

A) ALIWAL SHOAL

Aliwal Shoal is situated at 30°14'34.0"S 30°49'24.0"E. It is 50 km south of Durban and was declared a Marine Protected Area in 2004 under the Marine Living Resources Act (Dicken and Hosking 2009: 228; Tunley 2009: 126). The MPA is 18.3 km long, beginning at the town Umkomaas and ending at the Mzimayi River, and extends out to 7km offshore (Tunley 2009: 125). The area includes a shoal and two shipwrecks which both fall under the two restricted zones. Here, no fishing, or anchoring of vessels is allowed. The surrounding area within the MPA is a controlled zone where fishing is allowed, provided a permit is presented (figure 3.3).

The warm Agulhas current spreads across the area and as a result, the area is home to tropical and subtropical species including various shark species including, whale sharks, tiger, ragged toothed, hammerhead blacktip and dusky sharks, as well as turtles, fish species, reptiles and 15 hard and 4 soft coral species (EKZN 2006:5; Tunley 2009:126) (figure 3.4). During their migration north in winter, sharks mate along the Shoal and humpback whales that are on route to Mozambique in search for warmer waters also visit the Shoal. A study conducted by Harris *et al.* (2012), uses the Marxan conservation planning software to assess critical biodiversity areas along the KZN coast. Optimal refers to areas functioning at "best" and are optimally located to meet biodiversity targets (Harris *et al.* 2012). While irreplaceable areas of "significantly high biodiversity value and in some cases are the only localities for which the conservation targets for one or more of the biodiversity features can be achieved i.e. there are few, or no, alternative sites available" (Harris *et al.* 2012: 9). With reference to figure 3.5, Aliwal Shoal MPA lies over both a Critical Biodiversity Assessment (CBA) category of optimal and irreplaceable. Specifically, its restricted zone, shown in red, falls under the irreplaceable zone.

Figure 3.3: Map showing the Aliwal Shoal Marine Protected Area (Source: Chadwick *et al.* 2014: 121).

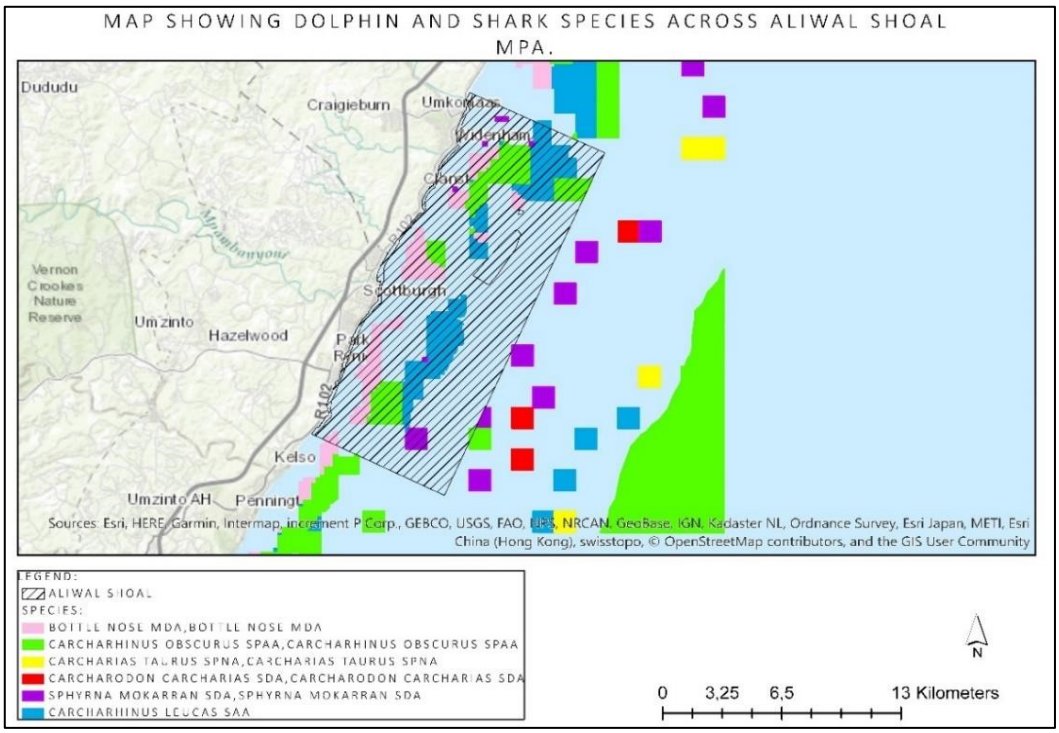

Figure 3.4: Map showing dolphin and shark species across Aliwal Shoal MPA. Map made using ESRI ARCGIS Software

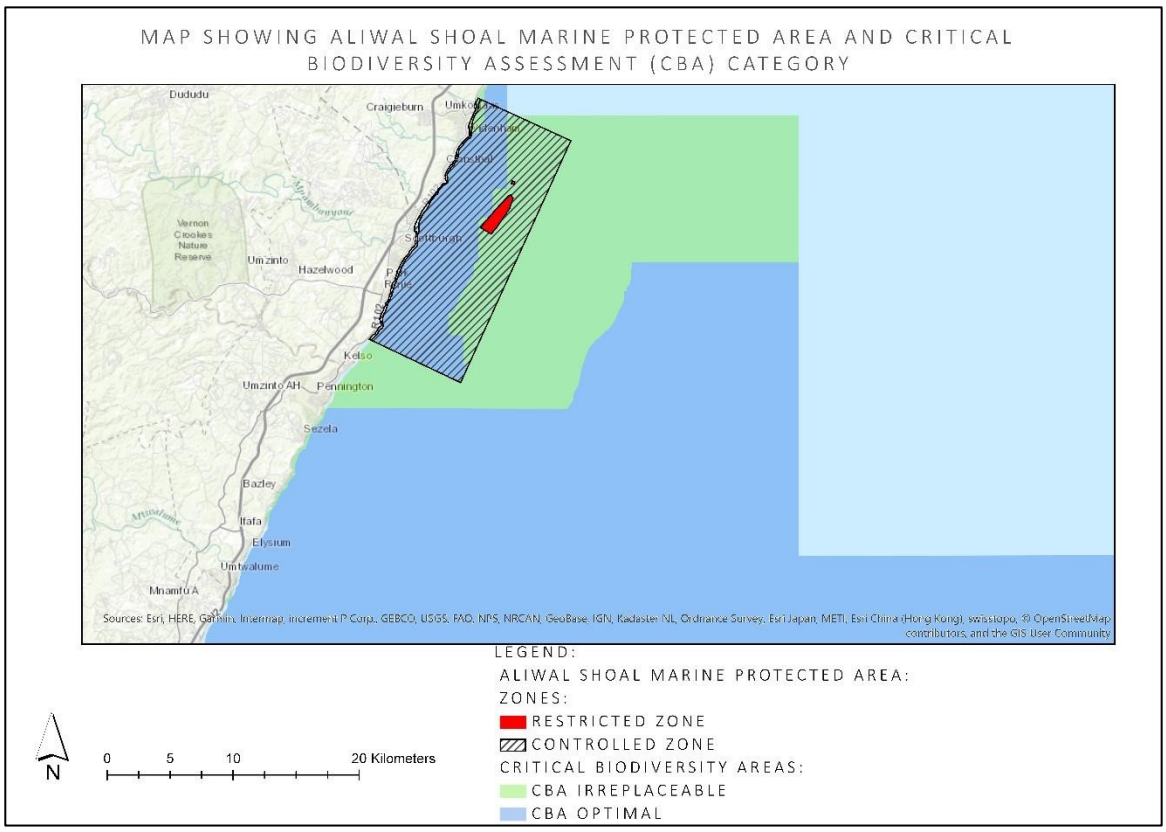

Figure 3.5: Map showing Aliwal Shoal MPA and CBA category. Map made using ESRI ARCGIS Software

Due to its high density of shark species, the area is one of South Africa's top scuba diving locations. An estimated 40 000-80 000 divers visit the MPA annually (EKZN 2006:5). The MPA was therefore established to conserve and protect all marine fauna, flora and their habitat, some endemic to South Africa.

The Marine Protected area is under jurisdiction of the Ethekwini Municipality and is an example where the municipality does not manage the MPA, but rather the area is managed by Ezemvelo KwaZulu-Natal (EKZN) wildlife, the conservation management agency and authority for KwaZulu-Natal. The largest town in the MPA is Umkomaas, this is a small industrial coastal town established in 1861 as a harbour to export sugar. Umkomaas has a total population of 2716 with 46% of the population having a matric. With reference to figure 3.6, the north section of the MPA has a population ranging from 400-1000 people with the number decreasing to between 100-200 people as one goes further south. The people of Umkomaas rely greatly on the MPA and economically benefit from the increase in divers (Dicken and Hosking 2009:227). Under Operation Phakisa, an expansion of Aliwal Shoal has been proposed (figure 3.7). The expansion will increase the MPA by 8,5 km north along the coastline and 12km offshore, to increase the amount of South Africa's coastline listed as protected.

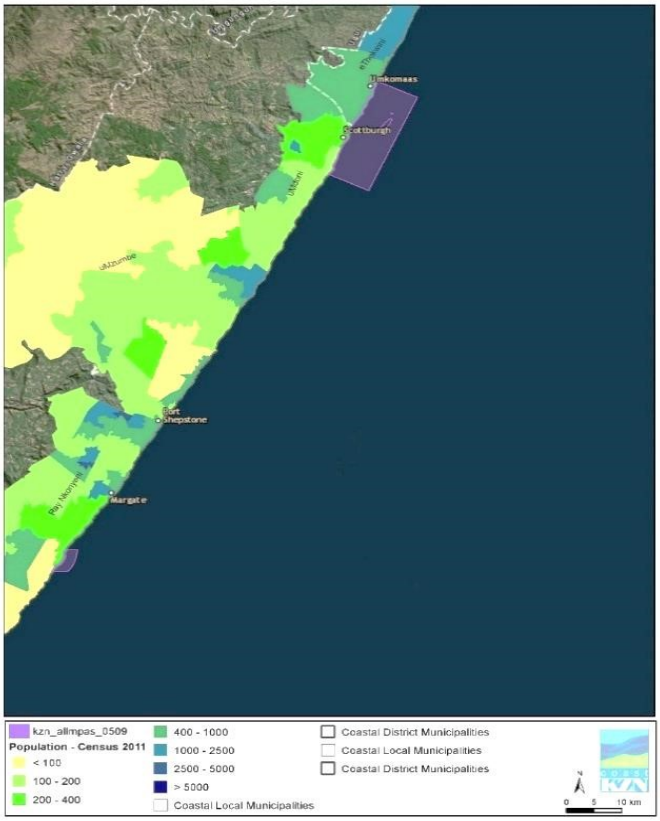

Figure 3.6: Map showing population according to the 2011 census. Trafalgar and Aliwal Shoal MPA indicted in purple. Map made using ESRI ARCGIS Software

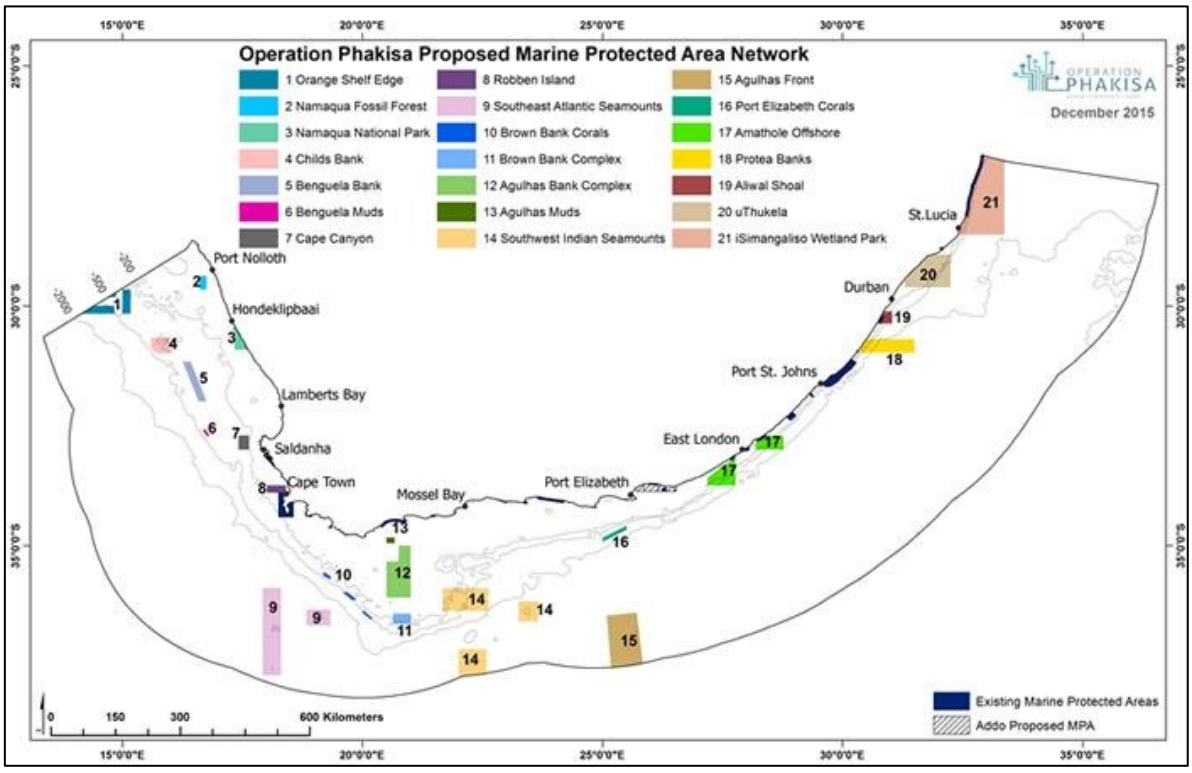

Figure 3.7: Map showing the proposed Marine Protected Areas under Operation Phakisa. Aliwal Shoal indicated as number 19 and Trafalgar and Protea Banks shown as number 18. (Source: https://www.environment.gov.za/mediarelease/molewa_22newproposed_mpas)

B) TRAFALGAR

Trafalgar Marine Protected Area is situated 100km south of the Aliwal Shoal MPA between Marina Beach and Mpenjati (figure 3.8). The coordinates for the area are 30°57'51.6"S 30°18'10.8"E. The MPA is 4.8 km long and extends 1,8 km offshore, making it one of the smallest marine protected areas in South Africa (Tunley 2009:120). The area falls under the jurisdiction of the Ugu District municipality however, similarly to Aliwal Shoal, the area is managed by the EKZN Wildlife.

The Marine Protected area was established in 1979 to protect its marine fossil deposits. It was only officially declared under the Marine Living Resources Act (MLRA) in 2000. With reference to figure 3.9, the area falls under the CBA category of irreplaceable. The MPA is bordered by four coastal towns, Trafalgar, San Lameer, Southbroom and Palm Beach. The population of Southbroom is 1615 people with 39% of the population obtaining a matric while the population of Palm Beach was noted at 529 people in 2011. Figure 3.6 shows the population of Trafalgar as between 200-400 people. Similarly, to Aliwal Shoal, a proposal to expand Trafalgar under Operation Phakisa has been drafted. The proposed area will extend 115km offshore from where Trafalgar MPA ends and will expand the area by 30 km along the coastline (figure 3.7). This expansion was proposed to include shark species, deep water coral reefs, diverse sponges, soft corals and shark species found in Protea Banks.

Figure 3.8: Map showing the Trafalgar Marine Protected area (Source: Chadwick *et al.* 2014: 116)

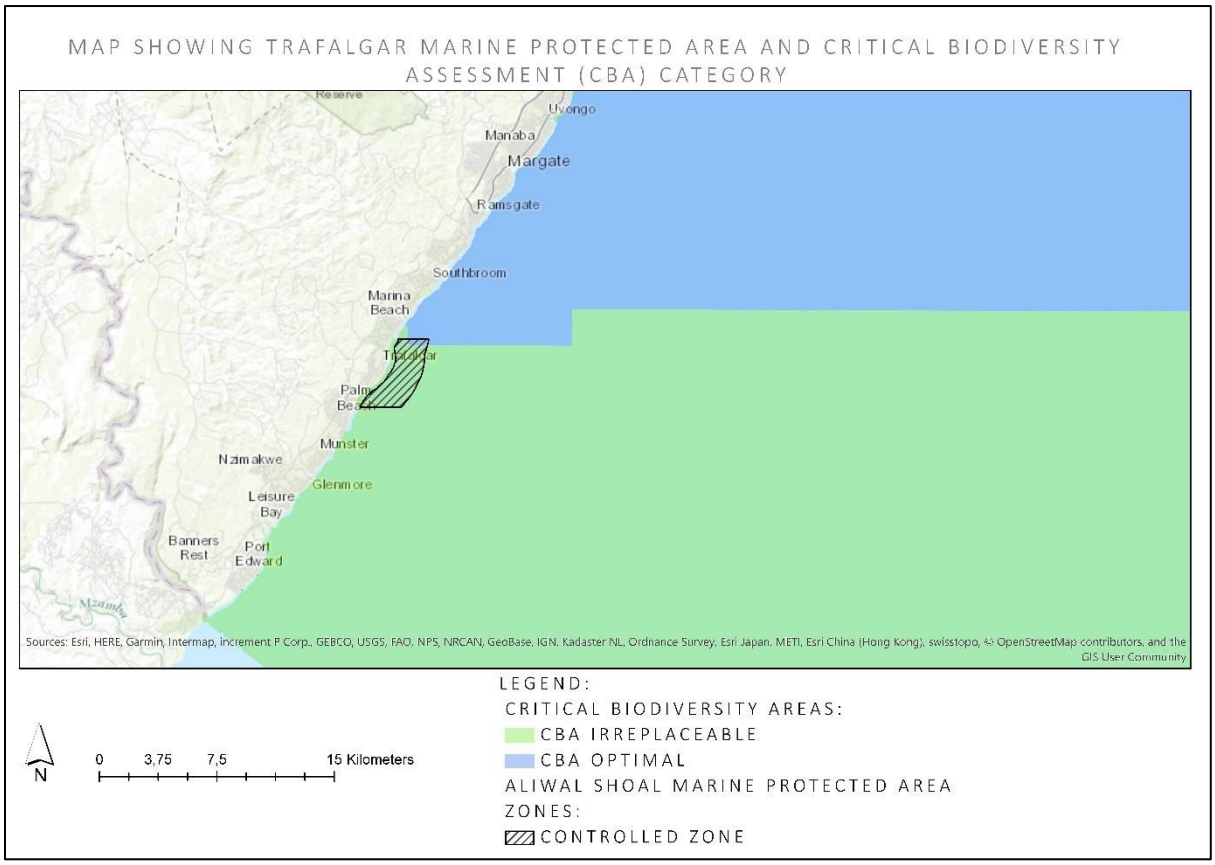

Figure 3.9: Map showing Trafalgar MPA and CBA category. Map made using ESRI ARCGIS Software.

C) PONDOLAND

Pondoland is the largest MPA in South Africa ranging 18,52 km offshore and spans across 90km of rocky and sandy shoreline starting at 31° 06.6'S; 030° 10.5'E to 31° 37.4'S; 029° 33.2'E (Tunley 2009:113). The MPA which ranges across 1300 square km begins at the Mzamba River, 13km south of Port Edward and ends at the Mzimvuba River at Port St Johns. Pondoland MPA falls within the Eastern Cape province, specifically the Alfred Nzo and O.R Tambo district municipalities (Sunde and Isaacs 2008). The MPA is managed by the Eastern Cape Province Tourism Authority. In 1991 the Mkambati MPA was declared under the Sea Fisheries Act, Act 58 of 1973. In 2000 it was then proclaimed under the MLRA as a 11,5 km no-take MPA.

Later in 2004 the Mkambati MPA was incorporated within the Pondoland MPA and was proclaimed under the MLRA (Chadwick *et al.* 2014: 109). The Ndengane community resides 2 km away from the shoreline within this MPA (Sunde and Isaacs 2008). According to the MLRA government gazette No 202, 2004 section 5, the MPA is divided into the following; 2 offshore controlled zones, 1 offshore restricted zone, 5 inshore controlled zones and 4 inshore restricted zones (figure 3.10). The activities restricted in each zone will be discussed in Chapter 4.

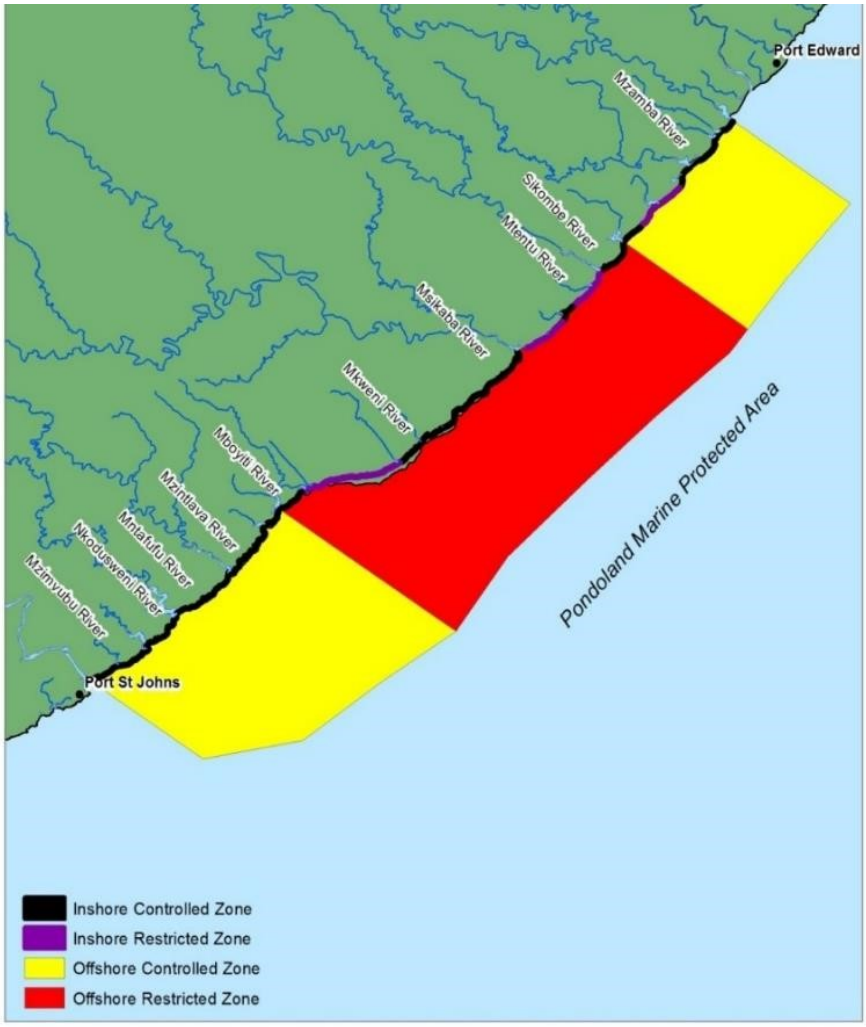

Figure 3.10: Map showing the Pondoland Marine Protected area (Source: Chadwick *et al.* 2014:108)

3.3.1 IMPORTANCE OF THE RESEARCH SITES

The research sites wer chosen firstly due to their accessibility. Aliwal Shoal is a 6-hour drive from Johannesburg and accommodation is provided nearby. Secondly, the three research sites were unique in that they offered the opportunity of assessing the different managerial strategies and designs. Marine Protected Areas in South Africa are either controlled, restricted or both. They may also either be offshore, inshore or both. This refers the MPAs managerial design. All three MPAs selected adopt differing managerial designs. Each managerial design entails different managerial strategies in the form of policies and management plans. Furthermore, Aliwal Shoal and Trafalgar are both managed by EKZN Wildlife while Pondoland is managed by the Eastern Cape Province Tourism Authority. Including two different managerial authorities will expand the scope of the study to examine differing managerial methods.

Of further interest is the varying scales. Trafalgar is currently the smallest MPA in South Africa, contrast to this is Pondoland, the largest. The final reason the three sites have been chosen is due to their different marine biology they aim to conserve. Trafalgar prohibits the extraction of its 100 million-year-old intertidal fossils. Aliwal Shoal focuses on the conservation of its shark species, many of which are listed as endangered or threatened on the IUCN Red List (2016). Pondoland MPA is mainly concerned with replenishing depleted line fish stocks. The MPA is also within the area that hosts the annual Sardine Run and is also a haven for whales and dolphins. To sum up, the three areas chosen will represent the different types of MPAs in terms of managerial types, designs and scales. The areas are also concerned with the conservation of different marine species, which might be affected by the offshore drilling proposed and discussed above.

3.4 RESEARCH DESIGN

This research paper discussed the Marine Protected Areas identified as Aliwal Shoal and Trafalgar situated in KwaZulu-Natal and Pondoland situated in north Eastern Cape. The research process took over 1 year and will consist of 4 phases.

Phase 1 identified the social and economic factors affecting Marine Protected Areas and their consequential impacts on the environment. This was done through interviews and a review of literature. Phase 2 was an assessment of the effectiveness of the identified management strategies through the application of the DPSIR framework. The next phase was to analyse the data collected to identify gaps and challenges to marine management resources. These phases were necessary in order to determine the effectiveness of MPAs in sustainable coastal conservation

3.4.1 TARGET POPULATION AND SAMPLING PROCEDURE

This section is dedicated to identifying the target population that will be used in this study as well as the sampling procedure. A sample is a sub-group of the population that will be used in the study. According to Gay *et al.* (2006: 143), the qualitative sampling procedure selects individuals for the research task that are seen, by the researcher, to be good informants for the research process. The target population is defined by Gay *et al.* (2006: 130) as a "population to which the researcher would ideally like to generalize study results to". By using the qualitative sampling procedure, the following groups of people were identified for the target population.

For Aliwal Shoal, divers and fishermen were interviewed. The fishermen that were interviewed were either found along the coastline or were 'formal' fishermen who had arranged trips through

fishing charters. According to Olbers (2017:9), 3967 boat launches were recorded in Aliwal Shoal in 2015, of which 36% were consumptive. Therefore, 1428 fishing vessels left Aliwal Shoal in 2015. According to Dicken and Hosking (2009: 228), 40 000 divers visit Aliwal Shoal every year. There are also 5 diving operators in the area (Dicken and Hosking 2009: 228). Interviewing divers and fishermen, who are the main users of the MPA, allowed for questions of MPA zoning, knowledge of restrictions, level of enforcement and public acceptance of the MPA to be explored. Local fishermen were also targeted for interviews to determine their views on the management and restrictions on the area. Ground truthing was conducted to determine the number of fishermen using the MPA. The site was visited daily at 8am for one week. The number of fishermen using traditional fishing methods of a line and fishing rod were counted. It was found that on average, 15 fishermen visit the site per day during peak season.

The following week, ground truthing was conducted in Trafalgar where the site was visited at 8am for one week and the same characteristics were observed. This yielded different results with an average of 11 fishermen per day across the observed week, with the number peaking on weekends. Similarly, for Pondoland, locals were the target for the interviews to gage their views on the MPA, its enforcement, and effectiveness. According to the 2011 local census the population of Port St Johns, the Southernmost town of the MPA is 156 136 residents.

For Aliwal Shoal and Trafalgar, local conservationists, which have been identified through a previous study, were interviewed. These conservationists are independent entities, separate from managing boards that provided the researcher with information regarding the issues the conserved area is facing as well as their view on the effectiveness of the MPA. These conservationists attend council meetings and are part of public forums. Lastly, the managers and researchers employed by the managing authorities of all three identified MPAs were interviewed. This target population was found to be invaluable as it highlighted their views on the threats impacting the area as well as the challenges, they face in managing MPAs.

Out of the identified target population given above, the sample population will now be determined. This is summarised in table 3.1 and 3.2. As stated above, there are 5 diving charters in Aliwal Shoal and 40 000 divers visit Aliwal Shoal every year (Dicken and Hosking 2009: 228). There were also 1428 fishing trips in Aliwal Shoal in 2015. Therefore, in order to have a sample population that is reflective of the divers in this MPA, 10 interviews were distributed to each dive charter. These dive charters also offer fishing expeditions. 10 different interviews were distributed to each dive charter specifically for fishermen. The owners of the charters agreed to distribute these to clients after dives or fishing trips. 5 months later, these were collected. As mentioned above, through the use

of group truthing, it was established that an average of 15 fishermen use Aliwal Shoal per day during peak season. In order to have a population that is reflective, a third of the fishermen were interviewed.

Through the use of ground truthing, it was found that Trafalgar MPA saw an average of 11 fishermen use the area per day. It was purposefully decided that 30% of the fishermen were interviewed.

As mentioned above the population of Port St Johns is 156 136. However, this is just one town in the MPA. Accessibility of Pondoland also posed difficulty to the study, therefore only 5 locals from the Southernmost town, Port St. Johns were interviewed.

To fully understand the challenges in managing a MPA and to determine the threats they face, the managers and researchers of each MPA will be interviewed. These officials have already been identified through the managing organisations website. Snowball and deliberate sampling was applied here. Snowball sampling refers to using one contact to help you recruit another one which in turn will direct you to talk to an additional person (Flowerdew and Martin 1997:116). However, this method is not without its critiques. According to Flowerdew and Martin (1997), it is important to use multiple contact points in order to have a range of viewpoints and widen the sample population whilst keeping the participants appropriate for the study. This sampling method allowed for the correct participants, with specific criteria, to be identified easily. Snowball sampling was also used when interviewing local conservationists who may have alternative contacts, areas and fields.

With reference to table 3.1 below, 1 MPA manager was interviewed as both Trafalgar and Aliwal Shoal are managed by the same official. The local conservationists, as well as the researchers were all knowledgeable about both Aliwal Shoal and Trafalgar. As a result, the total number of interviews conducted on the two KZN MPAs, Aliwal Shoal and Trafalgar comes to 25. With reference to table 3.2, Pondoland is managed by a different managing authority, therefore a different MPA manager was interviewed. 2 researchers working under the managing authority, and who were therefore only knowledgeable on Pondoland MPA, were interviewed. Lastly, 5 locals from Port St. Johns were interviewed. Thus, 8 interviews on Pondoland were conducted bringing the total number of interviews conducted in this study to 33.

Table 3.1: Table showing the target and sample population for Aliwal Shoal and Trafalgar

ALIWAL SHOAL		TRAFALGAR	
Target population	Sample population	Target population	Sample population
Chartered fishermen - 1428 fishermen	10 interviews given to the 5 identified dive charters set aside for fishermen **3 out of the 50 returned**		
Divers - 40 000 divers	10 interviews given to the 5 identified dive charters **7 out of the 50 returned**		
Local fishermen on beaches	15 identified, **5 interviewed**	Local fishermen on beaches	11 identified, **3 interviewed**
MPA manager	**1 interview**		
Local conservationists	**2 interviews**		
Researchers	**4 interviews**		
Total interviews for both MPAs	**25 interviews**		

Table 3.2: Table showing the target and sample population for Pondoland MPA

PONDOLAND	
Target population	Sample population
Locals - 156 136 locals in Port St Johns	**5 interviews**
MPA manager	**1 interview**
Researchers	**2 interviews**
Total interviews conducted on Pondoland	**8 interviews**

3.4.2 DATA COLLECTION TOOLS

This dissertation was based on qualitative and theoretical research. Qualitative research is the "collection, analysis and interpretation of comprehensive narrative and visual" (Gay *et al.* 2006: 7). Several qualitative data collection tools will be used in this research process. Firstly, interviews will be conducted with relevant personnel. Secondly, questionnaires will be sent out and lastly, a rapid appraisal and review of legislation and existing literature will be conducted, completing the theoretical aspect of this research paper.

3.4.2.1 INTERVIEWS

Using interviews to collect data involves communication in which knowledge is obtained from one person to the other (Gay *et al.* 2006: 386). The method of collecting information through personal interviews is typically carried out in a structured, semi-structured or unstructured way (Kothari 2004: 97). Structured interviews involve predetermined questions with brief answers. Similarly, semi-structured interviews are also predetermined, however the answers to the questions are more open ended and provide room for elaboration. Unstructured interviews revolve around one question which prompts a casual discussion about a topic (Gay *et al.* 2006: 386). For this dissertation, both structured and semi-structured interviews were conducted. While Kothari (2004) argues that interviews have valuable qualities, such as gaining in depth information on topics in a short time, it is also noted that there are weaknesses in using interviews to gain data. These weaknesses include; the possibility of bias, willingness to respond and, the time-consuming nature of interviews.

3.4.2.2 PHOTOGRAPHS

Photography is another method used in the field to obtain data. Photography allows for the capturing of a precise and specific phenomena (Collier and Collier 1986). However, as stated by Lewis-Beck *et al.* (2004), because photography fixes attention on one particular subject, the role it plays is limited and it must therefore be accompanied with other collection methods. Even though its role may be limited, photographs nonetheless hold value as they record and preserve images that may be forgotten in the field, "the memory of film replaces the notebook" (Collier and Collier 1986: 9). By doing so, they remain a reliable, holistic and accurate tool in the research process.

3.4.2.3 OBSERVATIONS

According to Kothari (2004), the observation method is a commonly used research method. "Observation is a purposeful, systematic and selective way of watching and listening to an

interaction or phenomenon as it takes place" (Kumar 2014: 173). As stated by Lewis-Beck *et al.* (2004:752), observation is a collection of verbal and nonverbal behaviour. Observations may be controlled and uncontrolled (Kothari 2004; Kumar 2014). When observations are done in a natural setting, they are said to be uncontrolled. When a stimulus is introduced, or observations are prearranged this is termed controlled (Kothari 2004; Kumar 2014). Typically, observations are used to expand and validate data obtained using other collection methods (Lewis-Beck *et al.* 2004).

Observations do however have various limitations that the researcher must be made aware of. When people are aware of the observations, their behaviour may change (Kumar 2014: 174). Observation is also disposed to observer bias when the observations are interpreted. Information extracted through this data collection tool is also limited and must therefore be combined with other methods (Kothari 2004: 96).

3.4.2.4 RAPID APPRAISAL AND REVIEW OF LITERATURE AND POLICIES

This method to collect data entails examining various types of records or documents, such as the existing policies focusing on marine protected areas in South Africa and drawing out the important information (Gay *et al.* 2006: 389). Any literature that focuses on coastal zones and marine conservation, specifically MPAs and studies conducted on MPAs in South Africa was examined. Policies in the form of MPA management plans were also examined to determine what the MPA aims to do and where the MPA jurisdiction and boundaries lie.

3.4.3 DATA ANALYSIS

Qualitative research was used in this study and involves the combination of various sources of data. As mentioned above, these include observation, questionnaires, interviews and reviewing legislation and literature. While qualitative data can be descriptive and non- numerical, answers to close ended questions can create nominal data. Basic statistics like mean, median and mode were used to represent this data. Charts, graphs, tables and diagrams were used to display the findings (Kothari 2004:78). GIS software, ArcGIS, was also used. Shapefiles were acquired through the interview process and maps were created. A map was created showing where the photographs taken during field work fall within the MPA.

Software was be used to aid in the data analysis process. The software that was used is *Nvivo 11*. *Nvivo 11* is a qualitative data means of analysis that is used to organize and analyse forms of data. Using codes and queries, large sets of data may be displayed in charts, graphs, word clouds, tree

maps or word trees (Edhlund and McDougall 2017: 12). Selected interview questions were transcribed onto a word document which was uploaded to this software. Depending on the question, either a text search or word frequency query were run to identify the most frequently used words, and what words were associated with them to display word trees and word clouds. This software has been used before in a previous study and is therefore easily accessible, free and interface friendly.

3.5 METHODOLOGICAL REFLECTIONS

The methodology discussed above was beneficial in answering the research questions and the research objectives, however there were unforeseen challenges that occurred during the research process. These are discussed below.

The research paper focused on MPAs located along the south coast of KZN and the northern coast of the Eastern Cape. As a result, time constraints and financial implications posed some difficulty. The sites were nonetheless visited various times. During these visits, interviews were conducted in person, however, this was not always possible as schedules did not align. This was overcome through emailing an interview sheet to the participant. While this was not as effective as some questions were not filled out with enough detail, it still allowed for valuable information to be extracted.

The interviewing of divers and fishermen from Aliwal Shoal posed another difficulty as the return rate was much lower than expected. Each of the five identified charters were given 10 interviews for divers and 10 for fishermen. These were left with the charters and collected after 5 months. Of the 50 interviews left for fishermen, 3 were returned making the return rate 6%. Of the 50 left for divers, 7 were returned meaning only 14% of the interviews were retuned.
Another difficulty faced was determining the target and sample population. No data was found stating how many fishermen use the MPA itself. This was overcome through the use of ground truthing.

Nevertheless, the biggest constraint faced was the accessibility of Pondoland MPA. As mentioned in section 3.3, Pondoland is the largest MPA in South Africa, spanning 90km along the north coastline of the Eastern Cape. The area is not accessible by road and fishing vessels that launch out of Port Edward or Port St Johns (figure 3. 10) do not go along the coastline as the sea is too rough.

A visit to the largest town within the MPA, Port St Johns, was arranged and interviews were conducted, however observations of the entire area seemed to be impossible at the time. It was thanks to my father and a contact he made that we were able to hire a gyrocopter for a morning presenting the opportunity to view the entire length of the coastline twice (figure 3.11). This method made observations of the area easy as we flew close enough to take photos and make observations. Without this intervention the area would not have been studies on an effective level.

Figure 3. 11 Photograph of gyrocopter used for aerial observations and photographs

CHAPTER FOUR
EMPIRICAL EVIDENCE

4.1 INTRODUCTION

This chapter is dedicated to presenting the empirical evidence obtained through the data collection process to answer the research questions of this study. With reference to section 1.3, the research questions of this study are as follows. Firstly, what are the economic and political driving forces and pressures affecting Marine Protected Areas? Once this is complete, the impact these factors have on the environment will be identified through an evaluation of the state of the environment. The second research question is to identify in what ways MPAs are effective in the management of coastal resources. Here, the effectiveness of the identified management designs and strategies, adopted by each MPA, in managing the identified pressures will be looked at. This chapter is structured as follows: firstly, the research questions used to determine each of the DPSIR factors will be given. Secondly, the driving forces, pressures, state and impact for each MPA will be given. Here, the data collected through the research process, either through interviews, photographs, observations or a review of literature, will be expanded upon. Lastly, the managerial strategies and designs, and therefore the response, adopted by each MPA will be given.

4.2 THE DPSIR FRAMEWORK

The first research question in this dissertation was to identify each of the DPSIR factors for each MPA. According to Gari *et al.* (2015:64), "driving forces describe the social, demographic and economic developments in societies and the corresponding changes in lifestyles, overall levels of consumption, and production patterns". Put simply, driving forces are economic, social and environmental developments (Svarstad *et al.* 2008: 117). These forces then exert pressures on the environment. As explained by Borja *et al.* (2006: 85), "pressures are the ways that these drivers are actually expressed, and the specific ways that ecosystems and their components are perturbed". The state aspect of the DPSIR framework refers to "changes in ecosystem processes that influence biodiversity and change the ecological state of ecosystems" (Mateus and Campuzano 2008: 29). State indicators look at quality, and quantity to describe changes in an environment. "The changes in state produce impacts on the functions of the environment, such as human and ecosystem health, resources availability, losses of manufactured capital, and biodiversity" (Gari *et al.* 2015: 64). Therefore, impacts should look at both society and the environment (Svarstad *et al.* 2008). The response aspect of the DPSIR framework refers to actions taken by groups, individuals or government to adapt to changes in the state of the environment (Gari *et al.* 2015: 64). Atkins *et al.*

(2011: 218) argue that "our response is not of the management of the pressure but of the consequences of that pressure". Furthermore, Carr *et al.* (2007: 544), argues that the response factor looks at "actions taken to address changes in state, either by reducing pressures or improving the state in some other manner"

In order to identify the factors mentioned above, interviews with MPA managers, researchers working for MPA managing authorities, local conservationists, fishermen and divers were conducted. The interview transcript can be found in appendix B. Observations, photographs and a review of literature were also used.

In order to identify the pressures and drivers of the pressures for each MPA, the following two questions were posed. Firstly, *what is the greatest threat facing the area*? Answers to this question aided in determining the Pressure aspect of the DPSIR framework. The follow up question of *what causes this threat* was then asked. This refers to the driving force behind the pressure. Respondents were able to select from a possible 4 options for both the Driving Forces and Pressures. The categories for both the drivers and pressures were selected based off a review of literature (table 4.1). A consensus was found among literature that stated tourism, development, and the fisheries sector were the main driving forces behind environmental pressures. Likewise, pollution, overexploitation and invasive species were identified as the main pressures. The category "other" was added to the selection for both driving forces and pressures to allow for the participant to state any other factors they felt were omitted and affected the MPA.

In order to determine the change in state for each MPA, as well as the impact on the environment, a review of literature was conducted. Furthermore, the following question was also posed to respondents for each MPA:

> *How do you feel the declaration of [insert relevant MPA] has benefited the environment? (Please list examples if possible)*

Table 4.1: Table showing factors selected for driving forces and pressures as well as citations

	FACTOR	CITATION
Driving forces	Tourism	Gari *et al.* 2015: 68 Ojeda-Martinez *et al.* 2009
	Development	Borja *et al.* 2006:85
	Fisheries sector	Borja *et al.* 2006:86 Ojeda-Martinez *et al.* 2009 Gari *et al.* 2015:68
Pressures	Pollution/emissions	Borja *et al.* 2006:86 Mattas *et al.* 2014:1047
	Resource extraction/overexploitation	Borja *et al.* 2006:86 Atkins *et al.* 2011
	Invasive Species	Borja *et al.* 2006:86 Roura-Pascual *et al.* 2009

4.2.1 ALIWAL SHOAL MARINE PROTECTED AREA

This section will seek to provide evidence that identifies each factor under the DPSIR framework. With reference to table 3.1 in Chapter 3, 22 interviews were conducted focusing on Aliwal Shoal. 3 fishermen, 7 divers, 5 local fishermen, 1 MPA manager, 2 local conservationists and 4 researchers were interviewed.

A) PRESSURES

The question: *what is the greatest threat facing the area* was posed to the 22 participants. Figure 4.1 below graphically illustrates the respondent's answers this question. 8 of the 22 respondents, which equates to 36%, stated overexploitation as a pressure exerted on Aliwal Shoal. 6 of the 22 respondents stated pollution as the biggest threat. While surprisingly 7 respondents chose the option 'other' (figure 4.1). The category 'other' refers to a pressure that was not listed as pollution, invasive species or overexploitation. Out of the 7 respondents that selected the category 'other', 5 believed the most pressing issue facing the MPA was potential oil drilling, this equates to 22% of the respondents. Other answers included shark chumming and user conflict.

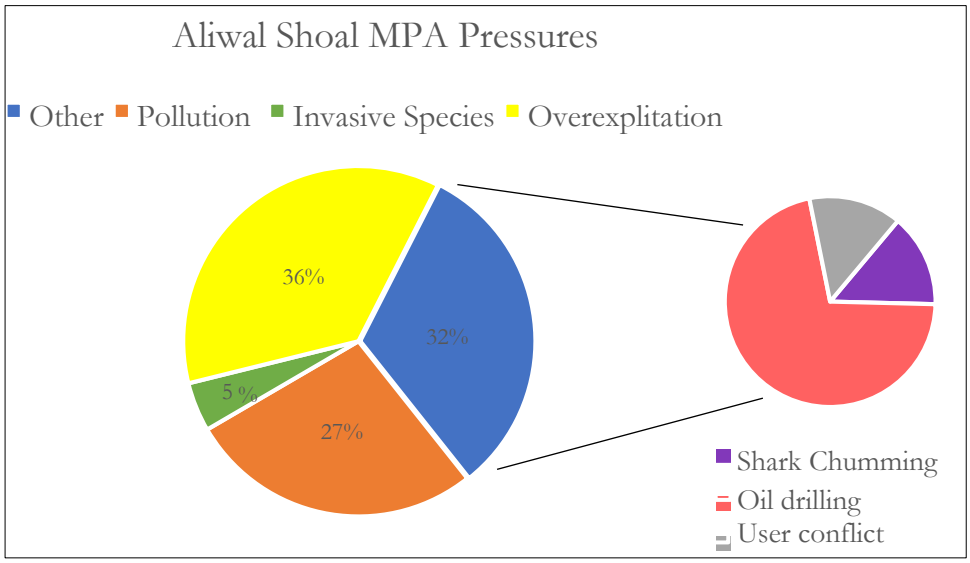

Figure 4.1: Pie chart showing pressures exerted on Aliwal Shoal MPA. Chart based on field data (see Appendix C, table i)

Resource extraction

Resource extraction or overexploitation is used to describe harvesting or extraction of a resource at a higher rate than its capacity to regenerate (Ojeda- Martinez *et al.* 2009:92). As mentioned above, 36% of respondents mentioned overexploitation as the greatest threat facing Aliwal Shoal. According to Ojeda- Martinez *et al.* (2009), this is mainly attributed to fishermen that are either tourists or locals. Figure 4.2 below is a photograph taken of a sign advertising a fishing charter where tourists can "keep all the fish you catch." At present, data is limited, as there is no data indicating annual catch for Aliwal Shoal.

Figure 4.2: Photograph showing a fishing charter sign. Photo taken 2nd April 2018 at 7:40.

Pollution

Pollution was identified as another pressure exerted onto Aliwal Shoal as it was stated by 27% of respondents. Saiccor SAPPI paper plant is located along the banks of the Umkhomazi river. The same river which geographically marks the start of the Aliwal Shoal MPA (figure 4.3). Producing 800 000 tonnes of dissolving wood pulp (DWP), it is the world's single largest paper plant for DWP (SAPPI, 2019). A pipeline 5km north of Aliwal Shoal is s commissioned to discharge 48 650 000m^3 per year of industrial effluent (WSP 2018: 46).

Figure 4.3: Map showing the location of the Saiccor SAPPI paper plant. The start of Aliwal Shoal MPA is indicated with a red star. (Source: WSP 2018:19)

Another form of pollution affecting the area was fishing gear, nets and lines that are left behind. This is in line with Ojeda- Martinez *et al.* (2009:93) who argue that "pollution, although not an objective of fishing, is a direct consequent operational pressure on the habitats and species affected" (Ojeda- Martinez *et al.* 2009:93). Fishermen may leave their gear, nets and lines behind after they are finished using them, either on the beach where they get washed into the ocean or leave them in the water itself. Olbers (2018) conducted an annual report on Marine strandings for 2017 where each stranded animal is documented. According to Olbers (2018: 11), "in 2017 there was a relatively high percentage (13%) of animals who had been injured by fishing gear".

Other

Three other pressures were mentioned by participants. Namely; oil drilling, shark chumming and user conflict. Oil drilling was mentioned by 5 of the participants as a pressure facing the MPA. As mentioned in chapter 2, section 2.5, ENI and Sasol have made a proposal to drill for oil and gas in block ER236 off the East coast of South Africa. With reference to figure 4.4 below, the southern Area of Interest (AOI), falls within the research site. The Southern AOI is approximately 70km away from Aliwal Shoal. At the time this dissertation is being written, ENI have just concluded their public participation phase as part of their EIA and drilling is due to commence in November 2019.

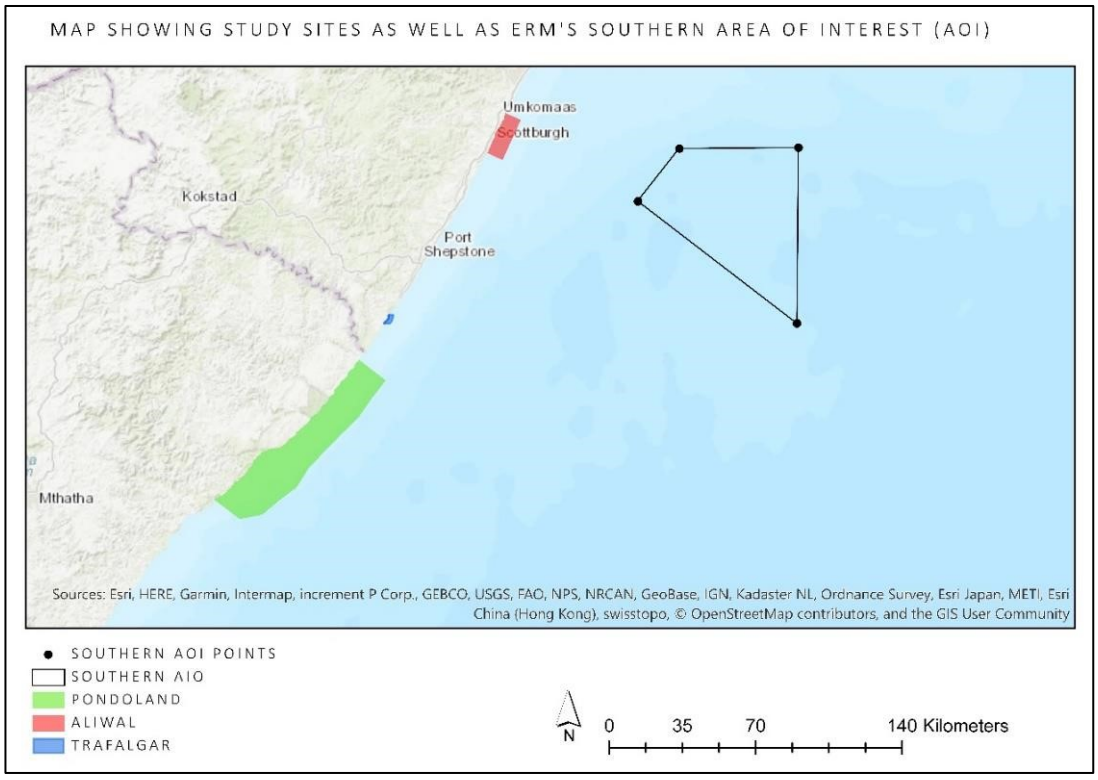

Figure 4.4: Map showing Southern Area of Interest as well as the three MPAs focused on in this study. Map made using ESRI ArcGIS software. Map made using ESRI ARCGIS Software

The second pressure mentioned under the category 'other' was shark chumming or baited shark diving. "In recent years, some dive-charter operators have started using baits and chum in order to provide the opportunity of diving or swimming with bait-attracted tiger sharks" (Dicken and Hosking 2009:228). As described by Aliwal Shoal Scuba, "we set up two bait drums on each shark dive. One is set high up in the water column that attracts the smaller oceanic blacktip sharks, and the second drum is set much deeper to attract larger sharks such as tiger and bull sharks" (Aliwal Shoal Scuba 2019).

The last pressure mentioned under the category 'other' was user conflict. This conflict arises when users of the MPA have perceived and differing views on who has rights to the area. "Conflicts have arisen between divers and fishermen, charter and commercial fishers and ski-boat fishers and the diving community partaking in tiger shark chumming" (Tunley 2009: 126). One fisherman stated;

Those divers, they're the problem, they go in there and chase away our fish. (Pers. Com, 2019a)

This echoes that perceived notion of who should be using the MPA, and how some uses affect others. Fishermen along the beach felt divers are chasing away their potential catches. However, divers, worry about charter boats anchoring above them. Charter fishing boats worry that the chumming of the sharks chase away their catches.

B) DRIVING FORCES

The above section listed the pressures Aliwal Shoal MPA is exposed to. The following section will now provide evidence for the driving forces behind these pressures. After the participants were asked what they felt the biggest threat facing the area was, the question of *what causes this threat* was asked. Figure 4.5 below illustrates the respondent's answers. Tourism and the fisheries sector each received 8 mentions with development getting 6. No participant selected 'Other'.

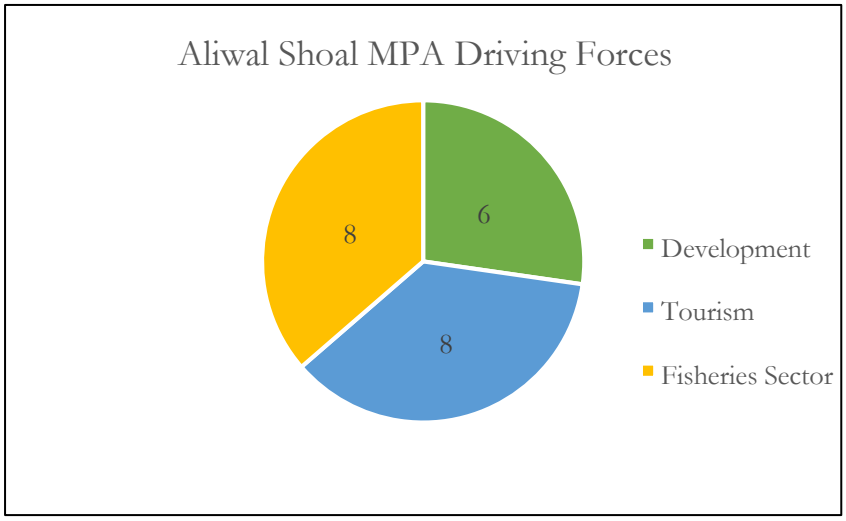

Figure 4.5: Pie chart showing driving forces for Aliwal Shoal based off respondents' answers during interviews. Chart based on field data (see Appendix C, table ii)

Tourism

According to Ugu South Coast Tourism (2018: 17), 477 000 tourists visited the South Coast in 2013 with the number increasing to 656 000 in 2017. The statistics above illustrate tourism in the area is rapidly increasing and is a driving force affecting Aliwal Shoal. Furthermore, as stated by Odega-Martinez *et al.* (2009:93), "ocean and coastal tourism is widely regarded as one of the fastest growing sectors of contemporary tourism, indeed tourism is the driving economic sector in many coastal zone areas" (Odega-Martinez *et al.* 2009:93). Tourism was further highlighted as a driving force in the area when looking at the following quotes from respondents;

> *"Tourism is definitely a problem, you can see each year it gets worse and worse, more and more"* (Pers. Com, 2019b)

> *"Aliwal Shoal attracts a lot of tourists, peak season we can't keep up"* (Pers. Com, 2019c)

One of the main activities conducted by tourists visiting the area is SCUBA diving. Umkomaas, the main city within Aliwal Shoal, had 3967 licensed boat launches in 2015. 37% of which were consumptive and 63% were for diving. Based on these numbers, 2500 launches for SCUBA diving alone were recorded in 2015 for Aliwal Shoal (Olbers 2017). If each launch has an average of 7 divers on board, this would equate to 17 500 divers visiting Aliwal Shoal. However, according to EKZN (2006:5), the area experiences roughly 40 000 dives per year. Figure 4.6 below is a photograph showing a shark cage diving boat that has just beached in Aliwal Shoal.

Figure 4.6: Photograph showing a shark cage diving boat beaching after a dive. Photograph taken on the 2nd April 2018 at 7:43 AM.

Tourists visiting Aliwal Shoal conduct other activities aside from SCUBA diving, one: being fishing, either along the beach of through a charter. This is in line with what EKZN (2006: 5) agues; "for the last few decades Aliwal Shoal has attracted fishers, spear fishers and SCUBA divers." 3% of boat launches in 2015 across the whole of KZN were for fishing. This included private fishing, chartered fishing, commercial fishing and spearfishing (Olbers 2017:5).
It can therefore be said that tourism was the driving force of resource extraction done by visiting recreational fishermen, pollution in the form of nets and gear that get let behind, and shark chumming as more divers visit the area which leads to the need to attract sharks to meet a demand. However, tourism was not the only driving force identified.

Fishing sector

The "fisheries sector" refers to local, perennial fishermen and not tourists who visit the area to fish. Through interviews and observations done in the initial phase of the research process, it was found that Aliwal Shoal was not subjected to any large scale, commercial fishing, but rather, small scale, local fishermen that visit the area throughout the year. The 5 local fishermen that were interviewed in the area were asked how often they visit the MPA. Figure 4.7 below graphically represents this.

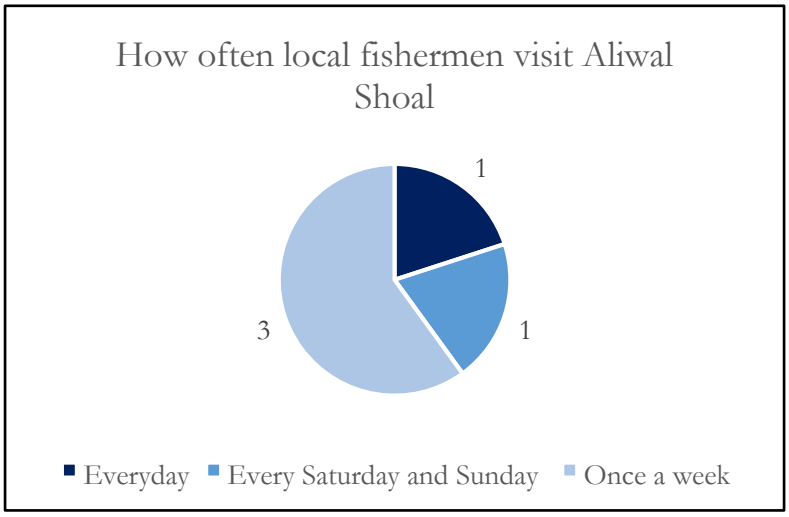

Figure 4.7: Pie chart showing how often local fishermen fish in Aliwal Shoal. Chart based on field data (see Appendix C, table iii)

"On a good day there are over 2000 people on the beach fishing along the coast and around 20 00 people per year" (Pers. Com, 2018d)

Most of the participants, 3 of the 5, stated they visited the area once a week. Ground truthing that was conducted in the area found that there was an average of 15 fishermen in the area per day. All

were using standard bait and fishing lines. The fisheries sector, like tourism is therefore the driving force behind resource extraction, pollution and user conflict.

C) STATE AND IMPACT

As mentioned above, Aliwal Shoal MPA faces the following pressures; resource extraction, pollution and oil drilling. The forthcoming section will provide evidence showing the impact these pressures have on the state of the environment.

Resource extraction

Resource extraction was identified as a pressure in Aliwal Shoal. Both locals and tourists visit Aliwal Shoal to fish. However, there is currently no scientific research showing depleted stocks in Aliwal Shoal. Furthermore, no data exists to indicate how this pressure impacts the environment of Aliwal Shoal. However, a study conducted by Robbins *et al.* (2006) in Australia found that reef shark populations were heavily depleted on overfished reefs. This study shows a link between apex predator decline and resource extraction. This is further substantiated by Roff *et al.* (2016), where the authors argue that an increase in fishing pressures leads to a decline in shark species. Figure 4.8 below shows the ecological role of sharks as apex predators on coral reefs and the role of coral reefs on sharks. With reference to figure 4.8, coral reefs provide nursery areas for reef sharks, and prey sources for larger apex sharks in the form of smaller fish species. Sharks aid in nutrient cycling on coral reefs, biocontrol of invasive species, behavioural modification and aid in the removal of weak individuals (Roff *et al.* 2016). Therefore, it can be argued that resource extraction changes the state of the environment through a decline in fish species, as a result, coral reefs and shark species are negatively impacted.

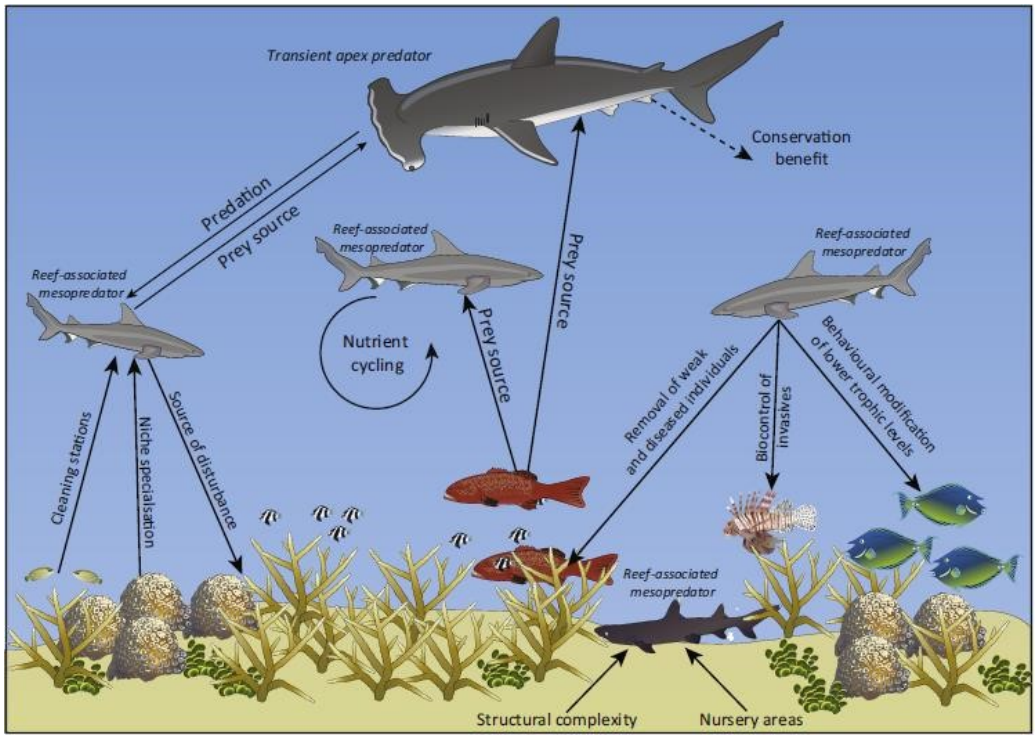

Figure 4.8: Image showing the ecological role of sharks on coral reefs and the ecological role of coral reefs on sharks. (Source: Roff *et al.* 2016: 404).

Pollution

Another pressure faced by Aliwal Shoal is pollution. Pollution here was divided into two, pollution from abandoned gear, hooks and nets and pollution as a result of an increase in boat activity. The former will be discussed first.

According to Olbers (2018), in 2016, 6 animals, five birds and one turtle, were recorded to have been affected by marine debris. Furthermore, in 2017, 11 animals, ten birds and one whale, were recorded that had been entangled by or had ingested fishing gear. "In all cases, marine debris appeared to be cause of stranding and/or death" (Olbers 2018:11). Below is a graph taken from the same article that shows the status of animals found ashore as a result of marine debris in 2017 (figure 4.9). Only two individuals were found live and released.

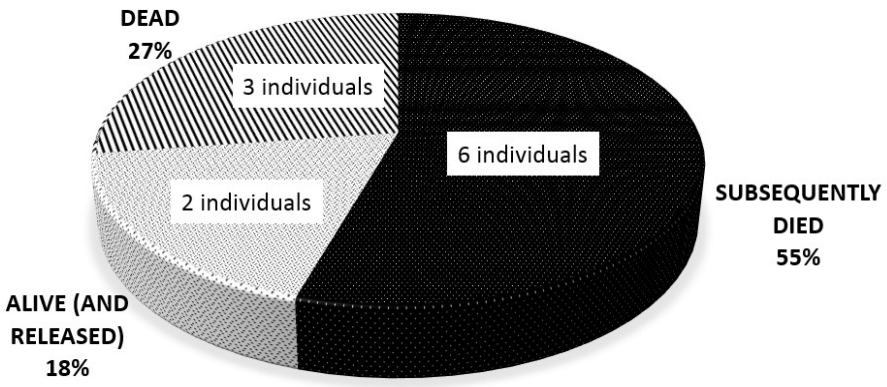

Figure 4.9: Pie chart showing status of marine animals after coming ashore. (Source: Olbers 2018:11).

As explained above, Aliwal Shoal is a popular area amongst tourists for charter fishing and SCUBA diving. Consequently, boat activity within the shoal has increased. According to Olbers (2017), Umkomaas, the town within Aliwal, had 3967 boat launches for 2015. Van der Schyff (2018), conducted a study comparing heavy metal concentrations in corals from the Mascarene Islands with those collected from Sodwana and Aliwal Shoal. The study found, among other things, that concentrations of nickel (Ni) were exceptionally high in corals from Sodwana and Aliwal Shoal (van der Schyff 2018: 92). This high concentration of Ni is attributed to an increase in boat activity; "the large volume of boat traffic in Sodwana and Aliwal is an external anthropogenic source of Ni in the marine environment" (van der Schyff 2018: 92). A high amount of Ni in a marine environment has a major impact on coral. Referencing Ali *et al.* (2011), van der Schyff (2018:92) states a "significant correlation between dead coral cover on reefs in the Red Sea, and high Ni and Co concentrations", of which Aliwal Shoal has both. Aliwal Shoal also experiences high concentrations of Copper (Cu), Arsenic (As) and Mercury (Hg). All of which could lead to coral bleaching and "reduced reproductive success, gamete fertilization inhibition, larval mortality, and reduced larval settlement" (van der Schyff 2018:89).

Shark chumming

Shark chumming was also identified as a pressure exerted onto Aliwal Shoal MPA. According to Dicken (2014), at present, no permit is required to bait for sharks in Aliwal Shoal. Shark chumming, according to Dicken and Hosking (2009) remains highly supported. Through their study it was found that 88,5% of divers supported the baiting of sharks Dicken and Hosking (2009: 229).
Contrary evidence however can be found. Dicken (2014: 42), stated that 79.6% of divers interviewed were against shark baiting and only 2 of the 12 operators in the area were in favour of using bait to attract sharks. As stated by one respondent;

As divers yeah, we are against baiting, but as a company that needs to make money, we're for it (Pers. Com, 2019e)

According to Dicken and Hosking (2009: 231), the baiting of sharks has "the potential to negatively affect their target species by altering their behavioural patterns or by conditioning them to associate humans with food."

SAPPI paper plant

Saiccor SAPPI paper pant is located along the Umkhomazi river, the geographical marker for the beginning of Aliwal Shoal MPA. According to Van Der Schyff (2018:27), in 1955 the paper plant released their first effluent into the ocean. In 1963, a 6.5km pipeline was installed 5km north of Aliwal Shoal. The line is commissioned to discharge 48 650 000m^3 per year of industrial effluent (WSP 2018: 46). Effluent here refers to treated wastewater with metals such as zinc, nickel and copper remover according to regulations (SAPPI 2019). According to Van Der Schyff (2018: 73), industrial activities like the paper plant release metals into the ocean and this will have negative effects on the coral and could lead to a collapse in coral reefs.

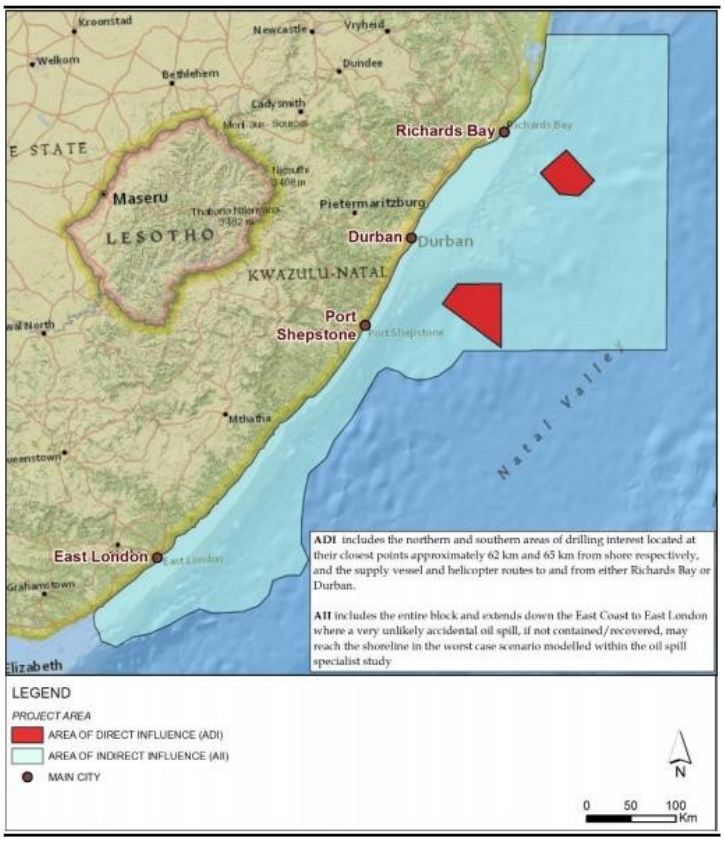

Figure 4.10: Map showing Area of direct influence in red and area of indirect influence in light blue (Source: ERM: 2018:66)

Oil drilling

As mentioned in section 4.2.1, 5 of the respondents mentioned oil drilling as a pressure Aliwal Shoal face. As mentioned by ERM in their final EIA; "although no existing protected areas fall within the project's ADI, there are a number of protected areas within the projects potential AII (particularly the area in which the impact of unplanned events may be felt)" (ERM 2018). The above quote illustrates that although no MPAs fall within their Area of Direct Influence (ADI), which is the actual locations set aside for drilling, they fall within the area of indirect influence (AII) meaning they could be affected if a worst case scenario oil spill were to occur (figure 4.10). Figure 4.11 below shows a buffer zone of 27 nm and 50nm, 50km and 90km respectively, around the southern Area of interest as well as the 3 MPAs chosen for this dissertation. The marine area affected by an oil spill ranges from between 4000km to 35km (Martin 2018). For instance, the infamous Deepwater Horizon oil spill in the Gulf of Mexico affected 4000km of coastline (Martin 2018: 48). While an oil spill in Singapore in 2010 affected 35km of coastline. A year before, an oil spill in Australia affected 60km of coastline (Martin 2018: 142). Therefore, a buffer zone of 50 and 90km was created.

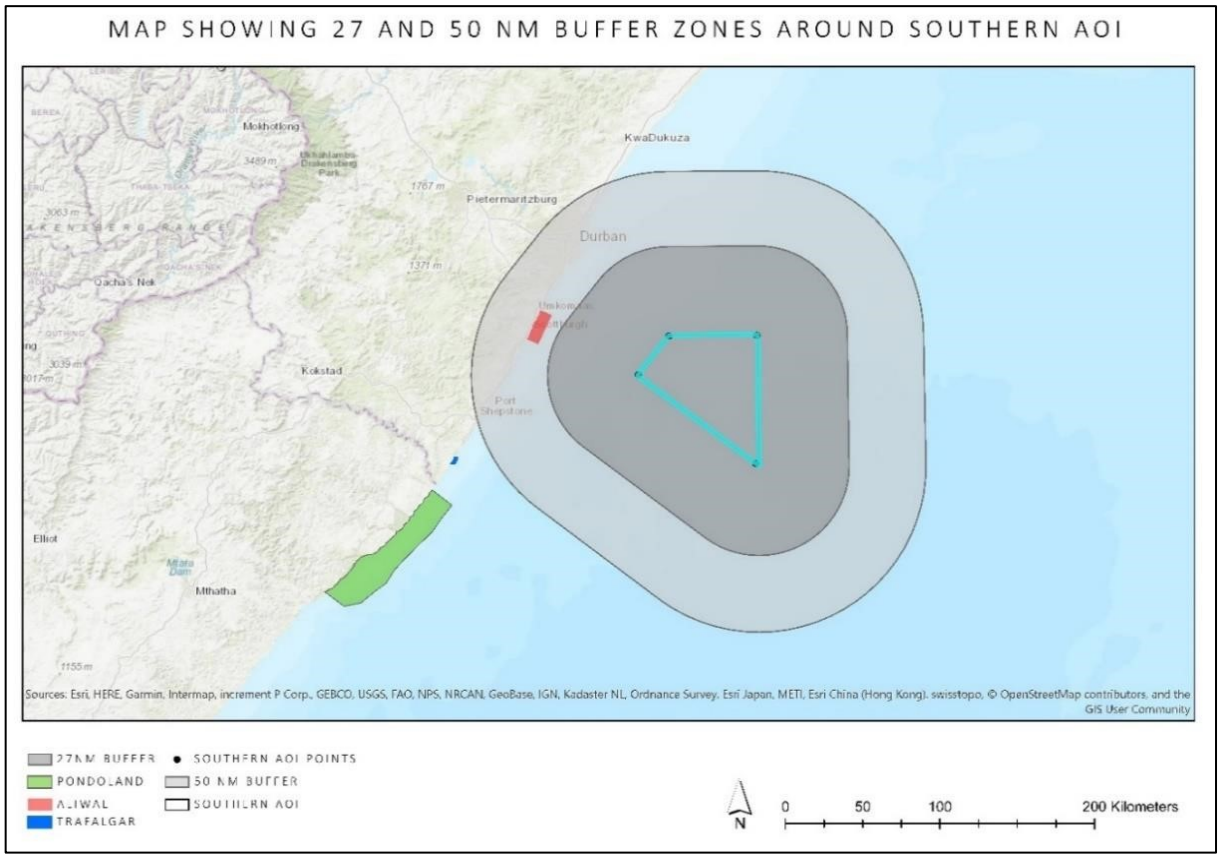

Figure 4.11: Map showing 27 and 50nm buffer zones around ERMs southern Area of interest. Map made using ESRI ARCGIS Software

As shown in the map, figure 4.11, if a 90km oil spill were to occur, Aliwal Shoal would be affected. Oil would reach the coastline from Durban north and as far down as Port Shepstone. The strong Agulhas current flowing south, which was not accounted for in this map, would move oil further down the coast, meaning Trafalgar and Pondoland MPAs could also be affected. This is in line with a comment made by a participant during in the public participation phase of ERMs EIA;

> *"The Agulhas current flows down the east coast of Africa and is one of the fastest currents in the ocean flowing south. Because of its physical properties, any spill will enter the current and quickly make its way down the coast."* (ERM 2019: 59)

However, ERM responded by saying their contingency plan in case of a spill has considered all factors;

> *"Spills at sea will be immediately contained by the supply vessels, which host onboard offshore booms and skimmers, plus dispersants spraying systems and a small volume of dispersants for immediate response. Additional oil spill response equipment will be stored at the logistic base in a readily deployable state. In the unlikely case of larger spills, Eni has a contract with a global provider, Oil Spill Response Limited, which will intervene in 24-48 hours providing oil spill response equipment and oil spill dispersants."* (ERM 2019: 277)

The public comments were run through qualitative analysis software, *Nvivo 12*. A word tree query was run, and the results can be seen in figure 4.12 The larger the word, the more frequently it was said. Words like oil, drilling, exploration, response, marine, project and impact were noticeably the most frequently mentioned words. However, with reference to figure 4.12 main issues of concern raised by the public can be identified. Oil spill, fishing, species and noise pollution were all frequently mentioned.

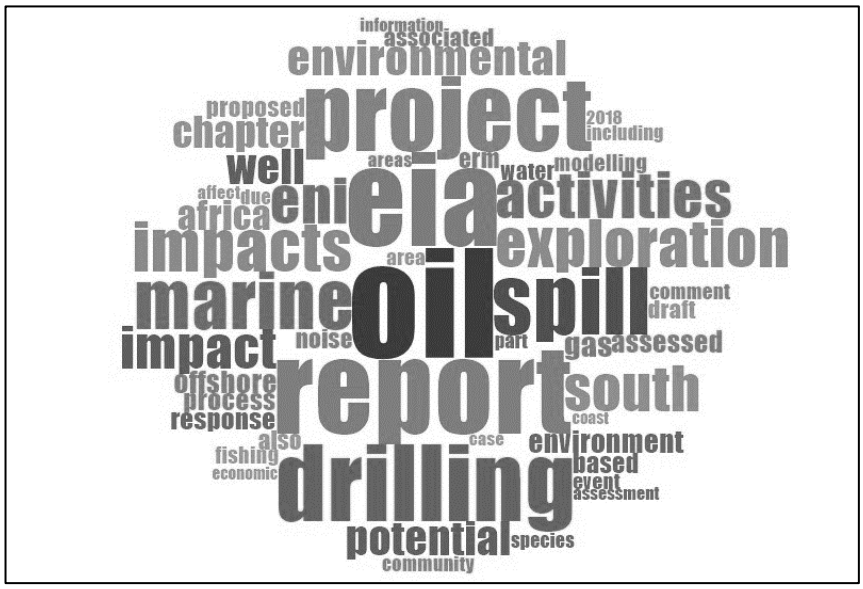

Figure 4.12: Word cloud constructed using *Nvivo 12* software

The word 'spill' was mentioned 1846 times and the word 'noise' was mentioned 613 times. ERM however state that all the above have been highlighted and taken into account in their EIA.

According to ERM (2018: 193), noise levels are expected to be between 130 and 182 dB re 1µPa at 1 m. As stated by ERM:

> *Underwater noise generated during the project could affect a wide range of fauna; from benthic invertebrates and demersal species residing on the seabed in the vicinity of the wellhead, to those invertebrates and vertebrates occurring throughout the water column and in the pelagic habitat near the surface.*

However, while these levels are audible for marine animals ERM state they will not cause any harm or injury, it may however "induce localised behavioural changes or masking of biologically relevant sounds in some marine fauna". Additionally, a study conducted in Australia by Di Lorio and Clark (2009: 51), found that communication between blue whales changed when exposed to seismic activity at levels typically found during oil drilling. This change in vocal behaviour will ultimately hinder their ability to detect biologically relevant signals. Furthermore, in 2018, 150 pilot whales were beached in western Australia. While the exact cause for this phenomenon is yet to be determined, it is speculated to be linked to noise pollution levels (Gaia 2018).

According to a separate word frequency query run using *Nvivo 12*, the plural 'coelacanths' was mentioned 266 times and 'coelacanth' was mentioned 104 times in the public comments. Coelacanths are large fish that grow up to 1.8 m in length. They were thought to have gone extinct 65 million years ago until discovered in 1938 in South Africa. Coelacanths are found in deep water caves along South Africa's east coast and overhangs and are listed as critically endangered as well as under Appendix I (Endangered Species) of CITES (ERM 2019). However, ERM (2019) stated that there are no caves or known coelacanth habitats in area of drilling and an oil spill is "highly unlikely to 1) reach coelacanth habitats, and 2) be of sufficient concentration to be lethal. Therefore, the risk significance of a spill on coelacanths was assessed as Minor" (ERM 2019: 137) One respondent however remained sceptical:

> *Even if they find a coelacanth on the actual borehole, they'll still drill* (Pers. Com, 2018f)

4.2.2 TRAFALGAR MARINE PROTECTED AREA

A) PRESSURES

Similarly, to Aliwal Shoal, the following question was posed to respondents; *what is the greatest threat facing the area?* 6 of the 10 respondents listed overexploitation as a pressure facing Trafalgar (figure 4.13). While 3 of the 10 listed other. Oil drilling, tourism, harvesting and no management where all given as pressures under the category "other". The possible threat posed by the oil drilling was only mentioned by one respondent. It can therefore be said that the main pressure facing Aliwal Shoal is overexploitation, including the extraction of fossils.

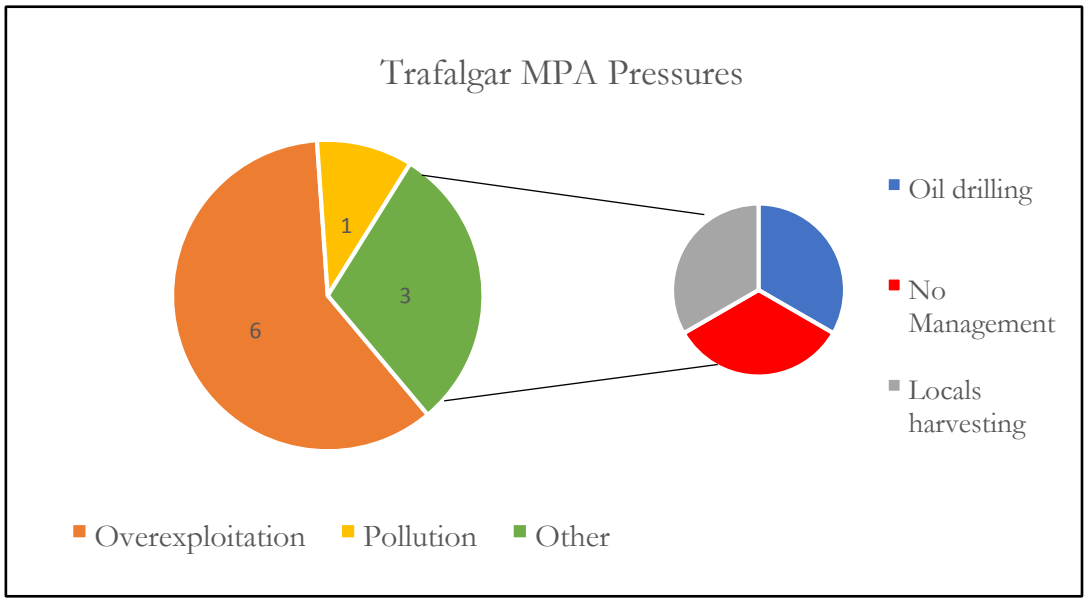

Figure 4.13: Pie chart showing pressures exerted on Trafalgar MPA. Chart based on field data (see Appendix C, table iv)

Overexploitation

There is currently no data showing the number of fossils located along the coastline of Trafalgar, nor is there baseline data for this.

B) DRIVING FORCES

With reference to the section above, overexploitation was identified as the main pressure facing Trafalgar. However, it is important to note what drives this pressure. As a result, the following question was posed to respondents; *with reference to the above, what causes this threat*? As shown in Chapter 3, table 3.1, 3 local fishermen, 1 manager, 2 conservationists and 4 researchers were asked

this question. All 6 of the 10 respondents that stated overexploitation as the greatest threat to Trafalgar, attributed this to the fisheries sector. Whilst 2 of the 10 stated 'poverty' and 'government' respectively, as driving forces under the option 'other'. Development and tourism also received one mention each (figure 4.14). Thus, the main driving force affecting the environment of Trafalgar, as identified through interviews, was the fisheries sector, similarly to Aliwal Shoal.

Fishing sector

Trafalgar is a popular fishing spot for locals. Figure 4.15 below is a photograph that was taken during initial field observations in March/April 2018. The image shows a common site along Trafalgar MPA- three local fishermen using standard fishing lines. Ground truthing conducted in the area showed that there were an average of 11 people fishing in Trafalgar per day. While exact boat launch numbers for Trafalgar are not available, a study conducted by Olbers (2017), does note numbers for Glenmore, a town located approximately 9km away from Trafalgar. 309 boat launches were recorded in Glenmore in 2015 (Olbers 2017: 6). 97% of which were for consumptive use (Olbers 2017: 7).

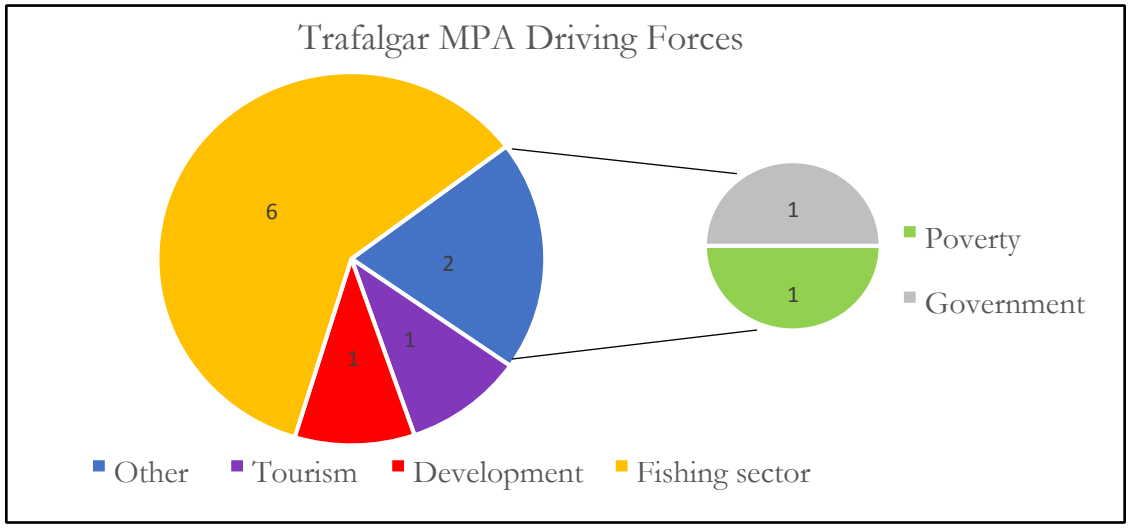

Figure 4.14: Pie Chart showing Driving forces for Trafalgar, based off interviews. Chart based on field data (see Appendix C, table v)

Figure 4.15: Image showing three local fishermen in Trafalgar MPA. Picture taken on the 31st March at 4:34PM.

Poverty was listed by one respondent as a driving force. They then listed "locals harvesting" as the corresponding pressure. The respondent mentioned that;

> *The rural community further from Trafalgar know the value of the fossils along the rocks. The area is no longer well policed so they have free reign to harvest the fossils. This to me an issue of serious importance that the officials don't consider.* Pers.Com, 2019g

It can therefore be said that overexploitation is the main pressure facing Trafalgar. However, locals harvesting fossils along the beach was also highlighted.

C) STATE AND IMPACT

As mentioned above, the main pressure Trafalgar MPA faces is overexploitation, particularly of their marine fossils. The following section will provide evidence showing the impact this pressure has on the state of the environment.

Resource extraction

Resource extraction in Trafalgar occurs in two ways. Firstly, as shown in Figure 4.15 above, extraction may be in the form local fishermen fishing along the beach. Or as mentioned by participant, extraction could be in the form of locals illegally harvesting the marine fossils found along the rocks. Trafalgar MPA was originally established to conserve its 100-million-year-old marine fossils.

The state of the environment of Trafalgar as well as the impact the resource extraction has had on this MPA is difficult to determine as according to the WWF (2013), "the last major biodiversity

survey was undertaken in 1998". Due to this lack of data it is difficult to conclude what impact fossil harvesting and fishing has had on the MPA.

4.2.3 PONDOLAND MARINE PROTECTED AREA

A) PRESSURES

With reference to chapter 3, table 3.2, 8 interviews were conducted on the Pondoland MPA. These comprised of 5 locals, 1 MPA manager, and 2 researchers. The participants were asked what they felt the greatest threat to the area was. The results are as follows. Five of the 8 participants listed overexploitation as the main pressure facing the area. One stated pollution and two respondents specified sand mining as a pressure under the option "other".

Overexploitation

62,5 % of respondents stated overexploitation as the main pressure facing this MPA. When the Pondoland MPA was established, its main area of concern were its fish stocks. *Cymatoceps nasutus*, *Petrus rupestris* and *Polysteganus undulosus* are some of the overexploited fish in the MPA.

Sand mining

25% of the participants listed sand mining as a threat to the area. The Eastern Cape is rich in resources and minerals. Australian company Mineral Commodities' South African subsidiary Transworld Energy and Mining (TEM) has been attempting to mine for titanium, ilmenite and zircon in the Xolobeni region of the Eastern Cape since 2007 (Mahlatsi 2018:616). The mining project has been highly criticised and publicised as the Xolobeni community are opposed to the state supported proposal. Figure 4.16 below shows the Xolobedi region and its highly sought-after red dunes. In 2007, after TEM submitted their application, the Amadiba Crisis Committee was formed (Mahlatsi 2018: 616). Part of their appeal was that the mine would ruin the natural environment and the Xolobeni was part of the Pondoland MPA and therefore, no mining may occur here (Sebola 2017: 18). Nonetheless, in 2008 the department of minerals and energy granted the mining right to the mining company (Sebola 2017). Conflict grew in the area between the community, the state and TEM. In 2011, the mining right was withdrawn pending more environmental impacts to be assessed, and to ensure that the community give their consent to the mining. At the time this paper is being written, the community and the mining company remain at a stalemate.

Figure 4.16: Aerial photograph showing red dunes of the Xolobeni community and possible mining site. The Pondoland MPA, indicated by a red arrow, runs along the coast. Photograph taken on the 29 December 2018 at 9:40. Coordinates: 31°10'52.1"S 30°07'03.8"E.

B) DRIVING FORCES

As mentioned above, two main pressures were identified; overexploitation and sand mining. What drives these pressures will be mentioned next. The same five participants that stated overconsumption as a pressure, stated that the fisheries sector was the corresponding driving force. The remaining 3 respondents listed development as the driving force behind pollution and sand mining.

Fisheries sector

According to Chadwick *et al.* (2014: 107), recreational and commercial boat-based fishing does occur in offshore sections of the MPA. According to government notice No. 202 of 2004, the declaration of Pondoland MPA sought out to do the following. Protect marine ecosystems and populations of threatened species. Protect important fish species and allow for their populations to recover. Lastly, regulate non-consumptive marine activities. The MPA was therefore established to restore depleted fish stocks (Maggs *et al.* 2013). This evidence is in line with data collected from interviews and confirms that the driving force leading to overexploitation in Pondoland is the fisheries sector.

C) STATE AND IMPACTS

As mentioned above, the main pressures exerted onto Pondoland MPA are resource extraction and sand mining. The next section will provide evidence showing the impact these pressures have on the state of the environment of the Pondoland MPA.

Sand mining

Figure 4.16 above shows the red sands of the Xolobeni community and a highly contested titanium mining site. Various studies have been conducted highlighting the social impact the mine has had on the community thus far (Bennie 2011; Sebola 2017; Mahlatsi 2018). Mahlatsi (2018: 625) argues that "the proposed mining project in Xolobeni threatens not only the livelihoods and future of the Amadiba, but the very source of their being. This is because the African view of land extends beyond an economic perspective and beyond land simply being a resource used for the production of agricultural commodities that are created for the market. Land to African people is also spiritual." Bennie (2011), argues that the 885 hectares of land that will be dug will not benefit the community in any way. Furthermore, it is argued by Sebola (2017) that community members have died as a result of the protests. In 2001, a community member, and main activist against the mine, was assassinated. In 2004 and again in 2005, 2 community members died during protest actions when they were met by police and clashed with the mine's security forces. As put by Mahlatsi 2018: 626), "to displace people from their ancestral land and sell it to a foreign mining company is to strip them of their very right of citizenship." Therefore, it can be said that the mine will negatively impact the livelihoods of the Xolobeni community.

According to Bennie (2011: 46), "the environmental impacts of the proposed mining would be significant and would affect wetlands and estuaries, which would in turn affect the animal and plant species that are dependent on them as sources of survival." However, no studies have been done specifically looking at the environmental impacts the mine will have on the area and the MPA. To sum up as put by (Bennie 2011: 47) the mine will "lead to an ecologically degraded environment and communities that are pushed towards greater dependence on economic resources beyond the land"

Resource extraction

Resource extraction in Pondoland has been an issue since the 1960s when fish stocks began to decline (Maggs 2011: 2). In 2000, a state of emergency was declared for the fisheries sector by the minister of DEAT (Maggs 2011: 2). This was due to the rapid decline in line-fish stocks in South Africa due to overexploitation. Pondoland MPA was originally established out of this context to rebuild depleted line-fish stocks (Maggs 2011: 10). *Cymatoceps nasutus*, *Petrus rupestris* and *Polysteganus*

undulosus were some of the overexploited species in the MPA (Maggs 2011: 1). However, as agued by Griffiths and Lamberth (2002: 245), the impact this overfishing has had on the ecosystem has not been determined; "circumstantial evidence suggests that depletion of stocks of large predators may have had substantial ecosystem effects, but this remains to be quantified." The authors further go on to say that "although there has been no empirical research on the ecosystems effects of line fishing in South Africa, most of the depleted species are important predators of both benthic and pelagic organisms and their removal is likely to have precipitated substantial changes to the species diversity and the trophic pathways (of pelagic and demersal food webs), of shallow (<·100·m) subtidal ecosystems" (Griffiths and Lamberth 2002: 246). It can therefore be said that a decline in line fish species could reduce the links of reef ecosystems with the food web, however, additional research is needed to provide a clear undertraining of the impact overfishing has on marine ecology in South Africa.

4.3 THE EFFECTIVENESS OF MARINE PROTECTED AREAS

The above sections provided evidence for each factor of the DPSIR framework, except the response. This section will seek to provide evidence addressing the second research question; in what ways are MPAs effective in the sustainable management of marine and coastal resources in the three study sites? In order to answer this research question, the *response* aspect of the DPSIR framework was looked at. The following research questions were posed to the respondents;

> *Do you believe each MPA is clearly demarcated from surrounding areas?*
>
> *Do you believe the laws of MPAs are clearly visible and are public knowledge?*
>
> *Do you believe the MPAs are well managed?*
>
> *Pondoland is currently the largest MPA in South Africa. Do you feel the size of Pondoland MPA impacts the management of the area? (Please elaborate if possible)*

Observations as well as a review of literature was also conducted to answer this research question. This section will be laid out as follows. In order to determine how effective MPAs are as a response, one must first look at what the response is. This will be done by looking at the different managerial strategies and designs adopted by each MPA. Issues of MPA demarcation, size and laws will then be laid out to answer the question sated above, in what ways are MPAs effective in managing coastal zones.

4.3.1 IDENTIFYING MPA MANAGERIAL STRATEGIES AND DESIGNS

For the purpose of this research study, managerial strategies will refer to the MPA management plans and policies. Managerial designs will refer to the type of conservation approach used and the size of the MPA. In this case, managerial designs are controlled and restricted zones.

Table 4.2 below shows the activities allowed or prohibited in Aliwal Shoal depending on the managerial design. As mentioned in Chapter 3, section 3.3, Aliwal Shoal consists of two restricted zones and one controlled zone. With reference to table 4.2 below, fishing from a vessel between 4am and 6pm is prohibited in the restricted area. However, fishing is allowed in the controlled area only if sustainable fish (listed in their management plan) are caught and the person holds a valid fishing license According to the Aliwal Shoal management plan, patrols will be conducted along the area where fish species and permits are checked. No shark nets, nor fishing nets are allowed and scuba diving is allowed in both areas, but permit is required. The managerial design is further broken down by a respondent below;

> *Only the crown area of the Aliwal Shoal reef complex (a few hectares in extent) and the wreck of the Produce are protected as no-take areas within the Aliwal Shoal MPA. Within these areas there has been visible recovery particularly of reef fish which were formerly heavily fished in this area (this observation is based on anecdotal evidence from divers rather than scientific research). The zonation of the Aliwal Shoal MPA has also succeeded in resolving much of the user conflict that use to exist in the crown area (i.e. conflict between scuba divers, spearfishermen and skiboat fishermen). Other than this, the environmental benefits have been limited.* (Pers.Com, 2019h)

Table 4.2: Table showing the activities allowed in each MPA under each MPA managerial design; controlled and restricted (Adapted from EKZN 2006: 23; Field based findings and DEAT 2004).

TRAFALGAR CONTROLLED MARINE PROTECTED AREA	
Activity:	
Spear fishing	No
Fishing onshore	P*
Fishing from a vessel	No
Fossil collecting	No
Bait collection	No
Vehicles	No
Shark Nets	Allowed

ALIWAL SHOAL		
	CONTROLLED	RESTRICTED
Activity:		
Fishing from vessel between 4 am and 6 pm	P*	No
Fishing from shore	P*	N/A
Sprearfishing from vessel between 4 am and 6 pm	P*	No
Spearfshing from shore at all hours	P*	N/A
Shark nets	No	No
Fishing nets	No	No
Traps	No	No
Anchoring of vessels	No	No
Scuba Diving	Yes[2]	Yes[2]

PONDOLAND				
	INSHORE		OFFSHORE	
	CONTROLLED	RESTRICTED	CONTROLLED	RESTRICTED
Fishing	P*	No	P*	No
Spearfishing	No	No	No	No
Vessels	N/A	N/A	P*	Yes[1]
Scuba Diving	N/A	N/A	Yes[2]	Yes[2]

P*- Permitted only with fishing licence and only listed sustainable species

Yes[1]- SCUBA diving permit for both divers and operator required

[C] No person may be in the possession of an armed speargun

Aliwal Shoal also has a MPA management plan that was established in 2006. The plan addresses resource use, boundary demarcation, regulations and resource monitoring and also includes a compliance plan. The management plan states that markers and signage will be installed on the shore and the restricted area, located offshore, will be marked by buoys placed at 0.5km intervals (EKZN 2006: 24). However only 32% of respondents that were interviewed felt Aliwal Shoal was well demarcated from surrounding areas (figure 4.17). Similarly, only 32% of respondents felt the laws and regulations of the were clearly visible (figure 4.18). According to the MPA management plan (2006), the area will also require "boat patrols in the MPA, diver patrols, resource inspections at launch sites, and shore patrols. The intention is to conduct patrols daily and to have an EKZN Wildlife Officer regularly based at the launch sites to check permits" (EKZN 2006: 25).

With reference to figure 4.19, when respondents were asked the question: *do you believe the area is well managed*? 60% of respondents stated 'no'. This was attributed to a lack of policing, an outdated management plan, lack of funds and compliance. Policing and monitoring of the area is done by the management authority, which in this case is Ezemvelo KZN Wildlife. It was also bought to light that the contract between them and DAFF has been terminated. As stated by two respondents:

> *Having Ezemvelo KZN Wildlife's Department of Agriculture, Forestry and Fisheries contract terminated in 2016 in areas adjacent to the MPA has had far reaching impacts on both the MPA's and the remaining KZN coastline. In the long term, all sectors will be affected including the fisheries, to tourism and economic development.* (Pers. Com, 2018i).

> *Ezemvelo wildlife did a good job. I would see them walking along the beach in their uniforms doing patrols daily. But lately, there's no one checking permits or bag catches* (Pers.Com, 2019j)

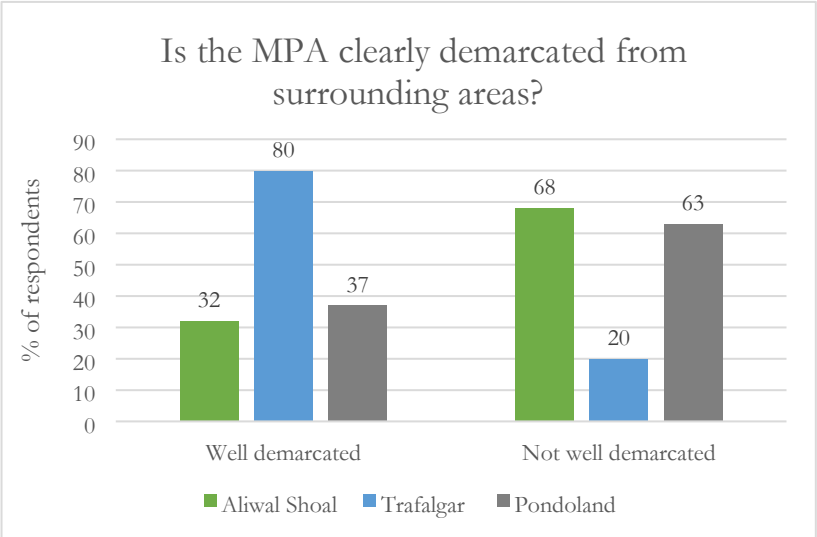

Figure 4.17: Graph showing respondents answers to whether the MPA is clearly demarcated from surrounding areas. Graph based on field data (See Appendix C, table vi)

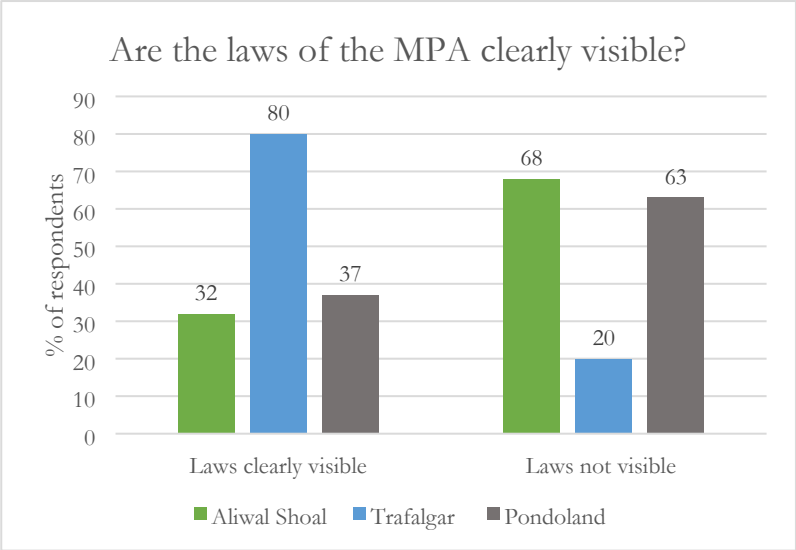

Figure 4.18: Graph showing respondents answers to whether the laws of the MPA are clearly visible. Graph based on field data (See Appendix C, table vii)

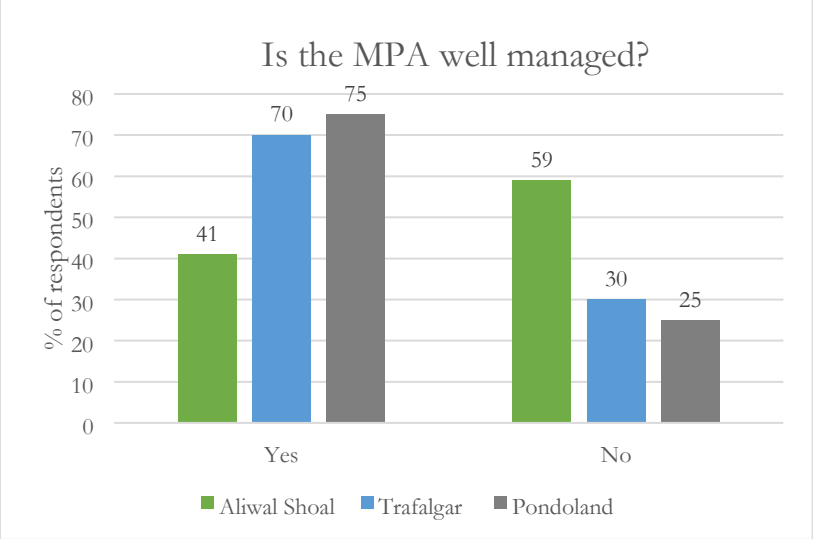

Figure 4.19: Graph showing respondents answers to whether the MPA is well manged. Graph based on field data (See Appendix C, table viii)

Trafalgar MPA as mentioned in section 3.3, is a controlled zone that is 4,8km long and extends 1,8km offshore. It is the smallest MPA in South Africa. As stated by one respondent, its size greatly impacts the amount of area it can manage;

> *Because of its small size and limited regulations/management, the Trafalgar MPA has not achieved a great deal in terms of environmental protection.* (Pers. Com, 2019k)

Figure 4.20 below is a photograph taken of a sign in Trafalgar showing the rules and regulations for the MPA. An overwhelming 80% of respondents felt Trafalgar was well marked and had laws and regulations that were clearly visible (figure 4.17 and figure 4.18). With reference to figure 4.20 and table 4.1, shore angling is allowed, however no bait or fossil collecting is allowed. Figure 4.21 below shows a list of prohibited species in the small box to the right and permitted fish species in the larger box. Permitted fish species refer to those which a permit is needed to catch and be in possession of. The species is subject to catch size, bag size and seasonality. For example, Shad or Elf fish have a minimum size of 30 cm and have a bag limit of 4. The season is closed from 1 October to 30 November. Trafalgar currently has no MPA management plan. However, 70% of respondents interviewed felt the area was well managed (figure 4.19).

Figure 4.20: Photograph taken of the only sign in Trafalgar MPA indicating prohibited activities. Photograph taken on the 31st March 2018 at 4:48

Figure 4.21: Photograph taken of the only sign in Trafalgar MPA indicating prohibited fish species . Photograph taken on the 31st March 2018 at 4:48

Pondoland MPA is divided into 2 offshore controlled zones, 1 offshore restricted zone, 5 inshore controlled zones and 4 inshore restricted zones. According to one respondent;

> *The area has been carefully divided into various no-take and controlled zones to ensure that the exploited species can replenish.* (Pers. Com, 2019l)

This MPA therefore exhibits a mixed managerial design. As stated by another respondent, the division of Pondoland into various designs was a process that involved various stakeholders;

> *Input from local communities, outside interested parties, staff from ECPTA, staff from DEA, and personnel from the three local municipalities in the Pondoland region had an opportunity to comment on the zonation on the MPA. Therefore, this zonation is the product of a joint effort between a number of staff and consultants from various associations and institutes.* (Pers. Com, 2019m)

Pondoland is also the largest MPA in South Africa and is 1300m^2. One respondent attributes Pondoland's vast size for its success in managing its coastline;

> *The size of the offshore no-take area of the Pondoland MPA (approximately 400 km^2) is one of the most important reasons why it has been so successful* (Pers. Com, 2019n)

The activities prohibited under each managerial design are summarised in table 4.2 above. No fishing or spearfishing is allowed in either inshore or offshore restricted zones. Fishing is however allowed in controlled zones, if the fish caught are listed as sustainable. A management plan has been drawn up for Pondoland MPA, however, it is awaiting approval from the DEA.

With refence to figure 4.17 and 4.20 above, 63% of respondents felt that the Pondoland MPA was not well demarcated and that the laws and regulations of the area were not visible. The above findings are in line with data gathered though aerial observations conducted in the area. Photographs were taken of any boundary demarcations and the coordinates were stored. These photographs were then laid on top of a georeferenced map of Pondoland (figure 4.22). Images 1,2 and 3, found in Appendix C, show the type of inshore demarcation. However, only three of these beacons were observed across the 90km long MPA. No signposts were observed in the major town of Port St Johns nor by the northern starting point of the MPA, Port Edward. Nonetheless, 75% of respondents felt the area was overall well managed (figure 4.19). Furthermore, as stated by one respondent, a researcher who frequently conducts studies in Pondoland;

> *Having been involved in monitoring the Pondoland MPA for the past 12 years I can categorically state that the Pondoland MPA has had an enormously positive effect on the environment, particularly in the offshore no-take area between the Sikombe and Mbotyi Rivers. This has included a recovery in many of the reef fish species that were formerly harvested in the area both in terms of abundance and size. There has also been a change in the fish community in the no-take area with more predatory species now occurring indicating better health of the ecosystem. There is also evidence of spill over from the no-take area enhancing fishing in the adjacent exploited areas.* (Pers. Com, 2019o)

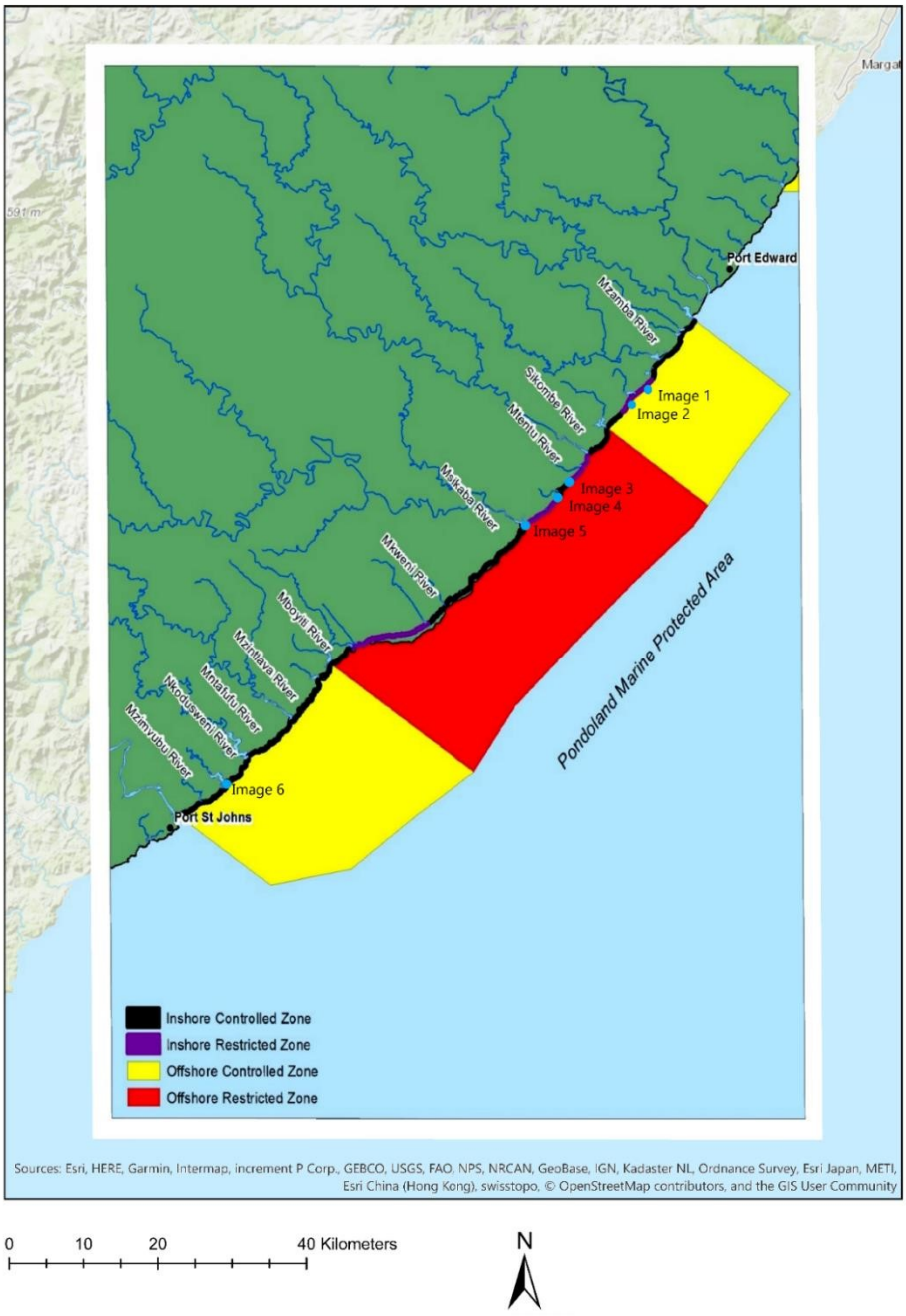

Figure 4.22: Map showing georeferenced image of Pondoland as well as labels showing exact location where images 1- 6 were taken. Map made using ESRI ARCGIS Software.

This chapter was dedicated to presenting the data obtained through interviews, observations and a review of literature to address the research questions. This chapter commenced with section 4.2 which provided evidence for the *drivers, pressures, state* and *impacts* for each of the MPAs. Section 4.3 then identified the *response* factor of the DPSIR framework by outlining the managerial designs and strategies for each MPA. Evidence was then presented showing whether the identified managerial designs were well demarcated, if the regulations and laws for each zone were public knowledge and overall, if the MPA was well managed.

CHAPTER FIVE DATA ANALYSIS AND DISCUSSION

5.1 INTRODUCTION

This chapter is dedicated to discussing and analysing the data presented in Chapter 4. This chapter will be laid out in accordance with the research objectives presented in Chapter 1. Firstly, the DPSIR framework will be applied to each MPA. Here, the social and economic driving forces, pressures, state and impacts will be discussed for each MPA in an attempt to highlight the interconnections between each factor. The second research objective is to assess the effectiveness of the identified management designs and strategies, and therefore assess the effectiveness of MPAs as a response in managing the pressures mentioned above.

5.2 PERSPECTIVES ON SOCIO-ECONOMIC FACTORS AND THEIR ENVIRONMENTAL IMPACTS ON MARINE PROTECTED AREAS

Section 4.2 above provided evidence for each factor of the DPSIR framework for the individual MPA study sites. This section will now apply the framework to each MPA in an attempt to analyse the cause and effect relationships between the driving forces, pressures, changes in state and corresponding impacts. Through doing so, it will seek to discuss similarities and differences across the three study sites. As a result, the first research objective of this dissertation will be addressed.

Chapter 4 sought to, among many things, identify the driving forces affecting each MPA. While there were shared driving forces across the sites, such as development and the fisheries sector, tourism was identified as an additional driving forces affecting only Aliwal Shoal. As mentioned in chapter 4 above, it was found that 656 000 tourists visited the South Coast of KZN in 2017 (Ugu 2018:17). This substantial influx of tourists leads to resource extraction, pollution, and shark chumming within the shoal (figure 5.1a). As mentioned in chapter 4, a substantial number of tourists visiting the area are scuba divers. According to Olbers (2017), 2500 boat launches were recorded in 2015. The large number of divers leads to an increase in boat activity and shark chumming. While data examining the effect that chumming has on sharks is limited, it is known to affect their behaviour as their reliance on food being provided by humans increases. Furthermore, the increase in boat activity in Aliwal Shoal also leads to an increase in heavy metals in the ocean including Nickel and Copper (van der Schyff 2018). The state of the environment then changes as the water becomes contaminated with these high concentrations of heavy metals. The impact of these heavy metal concentrations could have on the environment are severe (figure

5.1a). According to van der Schyff (2018), an increase in heavy metals leads to a decline in coral reproductive success and an overall loss in coral reef cover. As highlighted in Chapter 4, figure 4.8, an interdependent relationship exists between coral reefs and sharks. Sharks depend on coral reefs for food, and nursery habitats, as they protect juveniles from strong currents and have an abundant supply of food sources. It is therefore shown that a loss of coral cover could negatively impact the vast amount of shark species found in Aliwal Shoal and shown in chapter 3, figure 3.4. This is further substantiated by Roff *et al.* (2016: 404), "degraded coral reefs can have negative implications for shark populations". The above example illustrates the interconnected link between driving forces, pressures and consequential impacts on the environment. The increasing numbers of tourists visiting the Shoal leads to increasing boat activity, which can ultimately lead to a loss of coral cover, through the release of heavy metals. Due to the interconnected nature of ecosystems, the loss of coral cover may lead to a further decline in shark species. With reference to figure 5.1a, this negative environmental impact will then feedback to the driving force itself, as there are less sharks in the area to meet the demand of the growing tourist population. Shark chumming may therefore become even more popular to attract sharks to the Shoal to meet this demand.

Tourism, however, was not the only driving force behind heavy metal contamination in Aliwal Shoal. As presented in chapter 4, this pressure is further exasperated by the SAPPI paper plant. The plant also discharges heavy metals into the ocean. These heavy metals contaminate the water and the nearby coral species. This pressure however is driven by economic development. With reference to figure 5.1b, development also drives oil exploration in the area.

Sasol and ENI hold the right for exploration drilling in block 236. Its southern Area of interest falls 70km away from Aliwal Shoal MPA. It has been found that the oil drilling could lead to noise pollution, which ERM (2018) state will affect the behaviour of the marine animals. With reference to figure 4.11, if an oil spill of 90km were to occur, the Aliwal Shoal MPA will be overlapped and will be negatively affected. Furthermore, through analysing figure 4.11 it can be seen that if a 90km oil spill were to occur, it would fall 25km way from Trafalgar MPA and 50km away from Pondoland MPA. The strong Agulhas current that flows along the east coast of South Africa would push the oil further down south along the coast, reaching the two MPAs. Oil would spread into the Shoal and onto the coastline of all three MPAs creating a thick, insoluble layer over the water. This will lead to polluted water, disruption of animal migrations, a loss of species, especially rare, critically endangered coelacanths and sea birds, and will be a large economic cost to manage. Furthermore, it would be questionable whether funds would be readily available to carry out widespread rehabilitation and clean-up efforts.

With reference to Figure 3.5, the area surrounding the Shoal, which will be affected if a 90km spill were to occur, is listed under the CBA category as "irreplaceable". As mentioned in chapter 3, this CBA category means the area poses a "significantly high biodiversity value and in some cases are the only localities for which the conservation targets for one or more of the biodiversity features can be achieved i.e. there are few, or no, alternative sites available" (Harris *et al.* 2012: 9). It can be indisputably stated that if an oil spill were to occur, Aliwal Shoal and its rich biodiversity would be tainted.

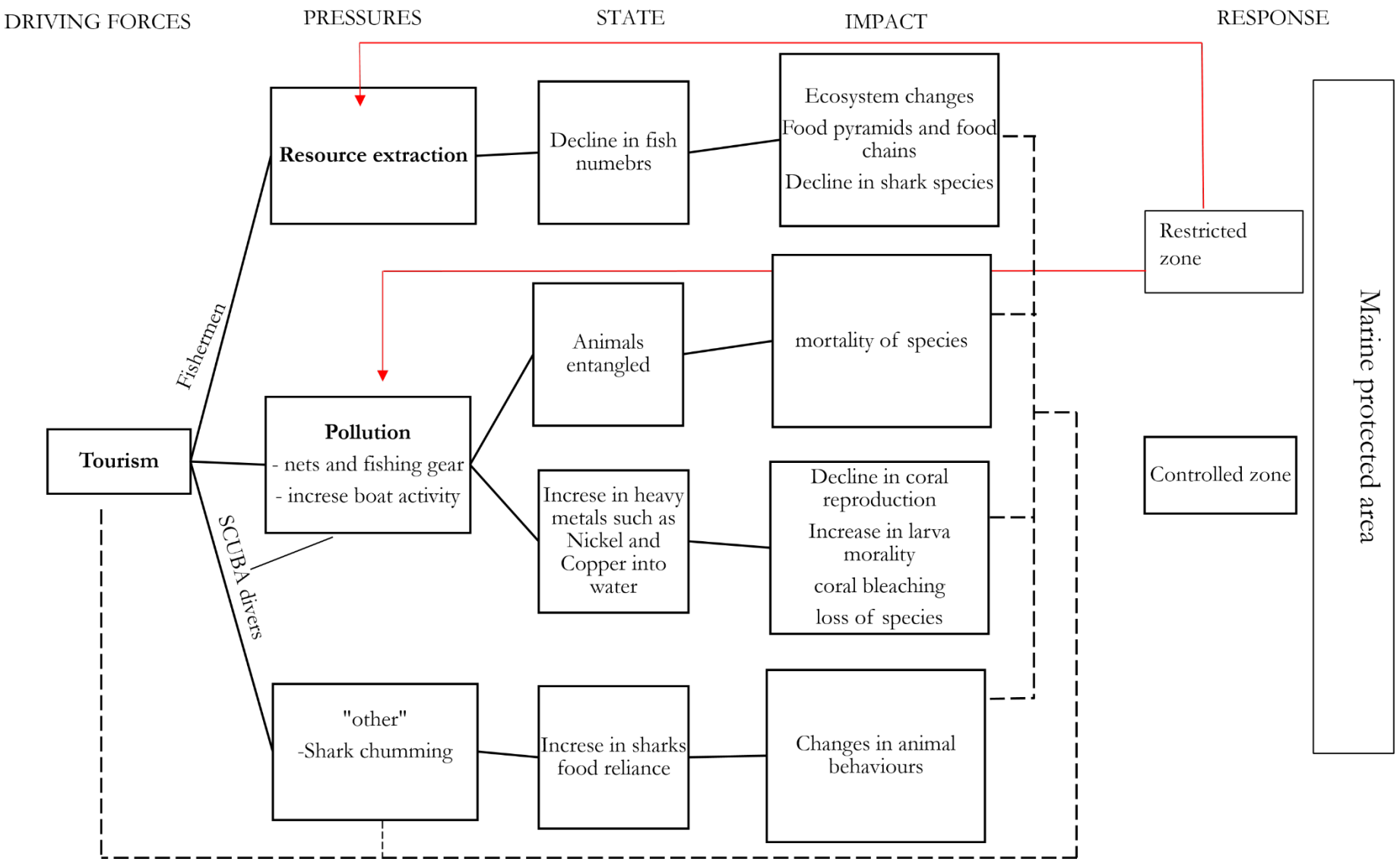

Figure 5.1a: DPSIR conceptual framework for the tourism sector in Aliwal Shoal MPA. Columns represent the cause-effect relations from the Driving forces to the Responses. Dashed lines indicate indirect causes that impact the driving forces. Red lines indicate that extent at which responses can act.

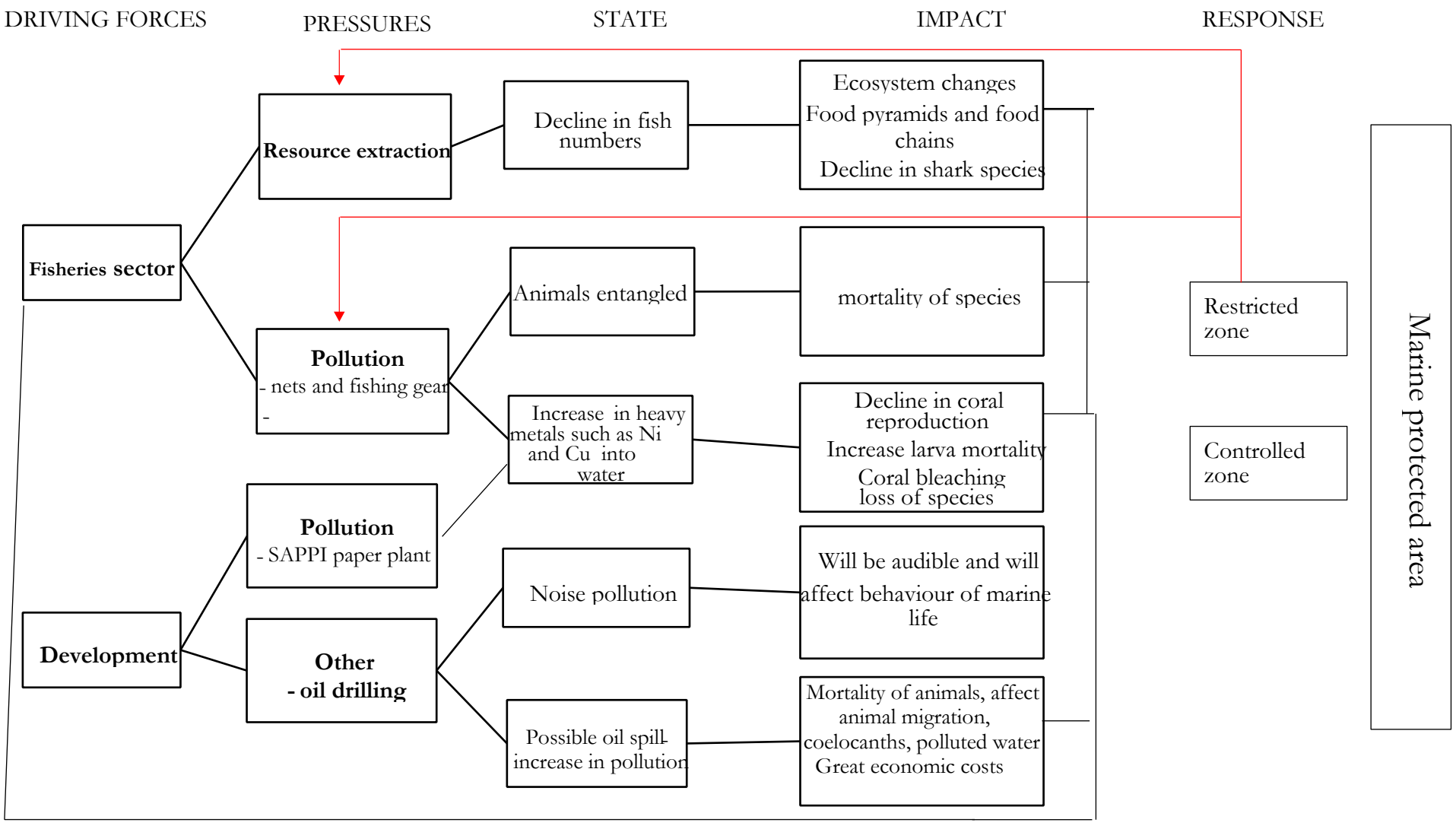

Figure 5.1b: DPSIR conceptual framework for the fisheries sector and development in Aliwal Shoal MPA. Columns represent the cause -effect relations from the Driving forces to the Responses. Dashed lines indicate indirect causes that impact the driving forces. Red lines indicate that extent at which responses can act.

As mentioned above, development has been identified as the driving force behind the SAPPI Saiccor paper plant and oil drilling in Aliwal Shoal. However, it has also been identified as a driving force in Pondoland MPA. With reference to figure 5.2 development in Pondoland drives the titanium dune mining in the area. This pressure leads to deforestation, an increase in erosion and pollution (Figure 5.2). Consequently, this leads to the destruction of the habitat, increase in chemicals into the ocean, more run-off into the river and therefore into the ocean. Marine life could subsequently be affected. This pressure could also have various social impacts including a loss of cultural land, increase in conflict and the community's dependency on the state could also increase.

With reference to Figure 5.2, development is not the only driving force identified in Pondoland but is accompanied by the fisheries sector. The fisheries sector characteristically the only driving force identified across all three-study sites. The fisheries sector in Pondoland drives the resource extraction in the area which leads to a decline in certain fish species. As a result, species diversity changes, large predator species in the area decline as their food source becomes scarce, food webs are disrupted and the ecosystem ultimately changes. This impact indirectly feeds back to the driving force itself. A decline in certain fish species will then negatively impact the fishing sector.

Similarly, to Pondoland, the fisheries sector also drives resource extraction in Aliwal Shoal, however, in this instance, tourism also influences the extraction of resources in the shoal. With reference to Figures 5.1a and 5.1b, both the fisheries sector and tourism drives resource extraction in Aliwal Shoal, in the form of local fishermen along the beach and tourists that hire chartered fishing vessels. Likewise, to Pondoland, the extraction of resources leads to a decline in fish species. This has resounding negative impacts on food webs and the overall ecosystem. A loss of fish species could lead to a decrease in larger predators such as sharks that prey on smaller fish. It was also found that the increasing fishing in the area, driven by both tourism and the fisheries sector, puts pressure on the MPA in the form of pollution. This changes the state of the environment as more pollution is introduced into the water, including fishhooks, nets and lines. As a result, animals are entangled and often die. This leads to the mortality of species and potential disruption of the ecosystem.

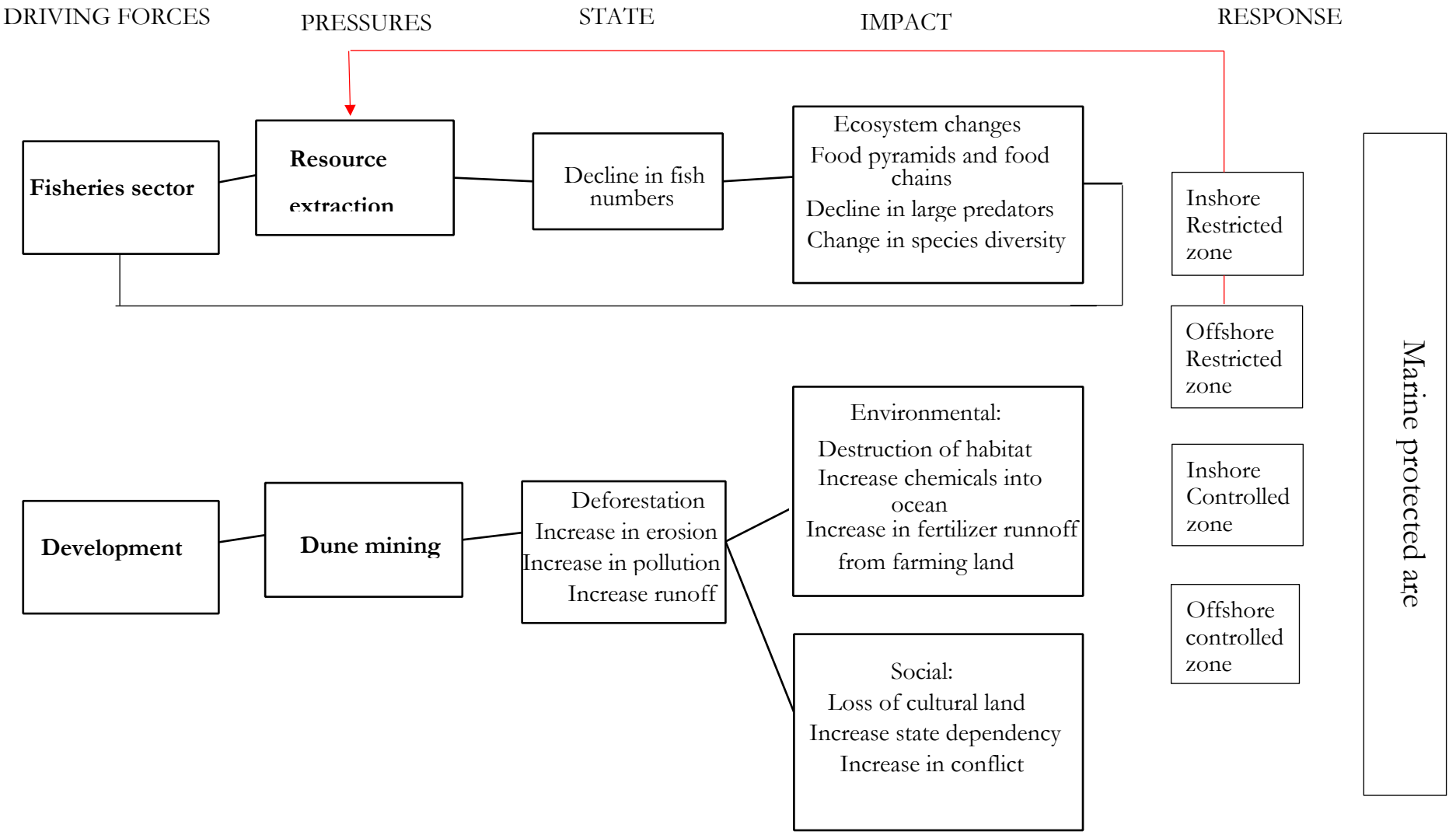

Figure 5.2: DPSIR conceptual framework for the fisheries sector and development in Pondoland MPA. Columns represent the cause-effect relations from the Driving forces to the Responses. Dashed lines indicate indirect causes that impact the driving forces. Red lines indicate that extent at which responses can act.

Resource extraction is also seen in Trafalgar and is driven by two factors, poverty and similarly to both Pondoland and Aliwal Shoal, the fisheries sector (figure 5.3). As identified in chapter 4, the area is a popular fishing site for locals who use traditional fishing methods of a fishing rod and bait. This extraction of fish could lead to a decline in fish species and subsequent changes in ecosystems and disruption of food webs (figure 5.3). As mentioned in chapter 3, Figure 3.9, Trafalgar MPA and its surroundings fall under the CBA category irreplaceable. Similarly, to Aliwal Shoal, this means it is home to a wide variety of biodiversity with few alternatives available in South Africa. A loss of fish species will then have ramifications to the very driving force that contributed to the loss, the fishermen themselves. Contrary to Pondoland and Aliwal Shoal, resource extraction is not only pervasive to fish, but in the case of Trafalgar, also of its rare intertidal fossils. As mentioned in chapter 4, locals harvesting fossils along the beach was identified as another pressure faced by the area. The extraction of these intertidal fossils could lead to a decline in visitors in the area, who want to see the fossils along the rocks.

The use of the DPSIR framework has aided in identifying and analysing the driving forces, pressures, changes in state and environmental impacts affecting each MPA. Aliwal Shoal, Trafalgar, and Pondoland were all affected by resource extraction driven by the fishing industry. This pressure will lead to a decline in species, ecosystem changes, and changes in marine biodiversity, food web disruptions and a decline in large predators. However, it has been argued that the consequential impacts differ across the sites. For example, a loss of fish species in Aliwal Shoal could have a negative impact on the diving industry, while a loss of species in Pondoland could greatly affect the community as they rely on the fish as a source of sustenance. Furthermore, the type of resource extraction exhibited in Trafalgar was unlike the other sites and as a result, its impacts differ. Therefore, it can be said that through the use of the DPSIR framework, each MPA must be analysed separately as cause-effect relations differ. Additionally, the framework also identified development driven, land-based activities that impact both Aliwal Shoal and Pondoland MPA. These are the SAPPI paper mill and sand dune mining respectively. Oil drilling was also identified as a threat. Importantly, all three of the above-mentioned threats fall out of the MPAs jurisdiction. Nonetheless, it was concluded that the above MPAs are all affected by economic drivers in the form of development, fisheries sector or tourism, with some similar environmental impacts characteristically seen across all three sites. Namely, ecosystem changes, decline in species, disruption of food webs and a loss of apex predators. Through the use of the DPSIR framework, one is then able to track how these impacts affect the MPA and whether the MPA can effectively manage the issues discussed above.

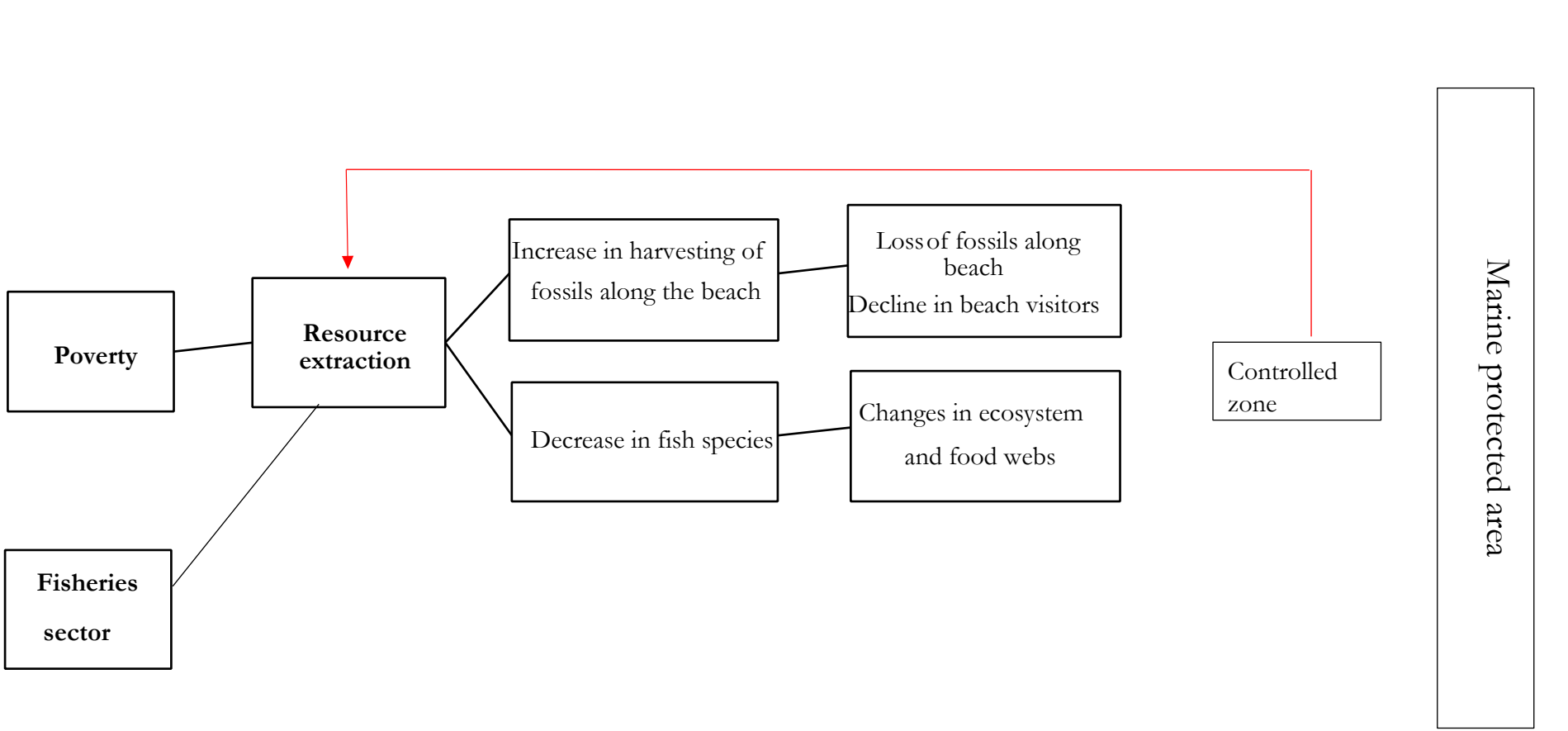

Figure 5.3: DPSIR conceptual framework for the fisheries sector and poverty in Trafalgar MPA. Columns represent the causeeffect relations from the Driving forces to the Responses. Dashed lines indicate indirect causes that impact the driving forces. Red lines indicate that extent at which responses can act.

5.3 DPSIR AND THE EFFECTIVENESS OF MARINE PROTECTED AREAS

Section 5.2 above applied the DPSIR framework to each MPA, in an attempt to highlight the interconnected relations within coastal areas. This section will address the second research objective of this study and will analyse the extent to which MPAs are an effective response mechanism, and therefore an effective management design and strategy. As mentioned in section 4.2, the response factor of the DPSIR framework is any policy or legislation put in place to address the change in state by reducing the pressures. With reference to figures 5.1-5.3 above, MPAs are identified as the response in the DPSIR framework. The type of response they acquire, i.e. their managerial designs and strategies were mentioned in section 4.3. Managerial designs refer to the approach taken by the MPA to respond to the pressure, for instance, whether an area is a restricted or controlled zone and how large the area is. Managerial strategies refer to the plans in place to manage the managerial designs. When discussing whether an MPA is an effective response to the identified pressures, both its managerial strategy and design needs to be analysed. Through this, the second objective of the dissertation will be addressed.

Aliwal Shoal's managerial design consists of a controlled zone and two restricted zones. It is also 12.6km^2, making it a medium sized MPA in relation to this study. In Aliwal Shoal, shark chumming was identified as a pressure facing the MPA. Yet, shark chumming is allowed in both the restricted and controlled zones within the Shoal, meaning the MPA has failed to respond to this pressure. Furthermore, there are no regulations on boat activity within this MPA. As a result, the area could see a decline in coral cover, and overall changes in the ecosystem. The type of managerial design adopted means the MPA only addresses issues within its jurisdiction, therefore, while the oil drilling and SAPPI paper plant will impact the MPA negatively, the MPA cannot respond to this pressure as it is out of its jurisdiction. Overexploitation was also identified as a pressure facing the MPA. The findings presented in chapter 4, table 4.2 show that fishing from a vessel, fishing from shore and spearfishing may still occur in the controlled zone, provided the species caught are listed as sustainable and fall under a certain length. No fishing is allowed in the restricted zones. The managerial design has therefore only partially responded to the overexploitation by limiting resource extraction only in the restricted area.

While the management design in Aliwal Shoal only partially responds to one of the identified pressures, the management strategy for this MPA does no better. The Aliwal Shoal MPA management plan states that daily patrols will be conducted and an EKZN officer will check

permits (EKZN 2006). Furthermore, markers and signage will be installed around the areas showing the management strategy has responded to the pressures, specifically overexploitation. However, as presented in chapter 4, only 32% of respondents that were interviewed, felt the area was well demarcated from surrounding areas (figure 4.17). Similarly, 32% of respondents felt the laws and regulation of the MPA were clearly visible (figure 4.18). This could be attributed to the lapsed, expired contract between EKZN and the DEA which expired in 2006, and as a result, the areas is no longer policed (Pers. Comm, 2019h and i). This point is further substantiated by the findings shown in figure 4.19, where 59% of the respondents felt the area was not well managed.

Similarly, to Aliwal Shoal, Trafalgar's managerial design and strategy also fail to respond to the identified pressures. Trafalgar MPA is 8.4km^2, making it the smallest MPA in this study and the smallest MPA in South Africa. As mentioned in chapter 4, (pers com 2019 k), Trafalgar's small size is one of the reasons the MPA is not effective in managing coastal resources, as the amount of coastline the area can conserve is limited. Furthermore, Trafalgar is a controlled zone. As identified in the above chapter, fossil extraction is the biggest pressure exerted onto the MPA. As shown in table 4.2, no fossil nor bait collection is allowed in this MPA in the controlled zone. This shows that Trafalgar's managerial design has responded to the pressure by implementing a controlled zone where extraction is illegal. However, similarly to Aliwal Shoal, Trafalgar is also managed by EKZN and the policing of the area has halted as the contract between EKZN and the DEA lapsed, meaning the extraction of fossils can still occur, despite regulations of the area stating otherwise.

Through analysing Aliwal Shoal and Trafalgar MPAs, the following can therefore be said. Firstly, both MPAs exhibit weak managerial designs. Aliwal Shoal's managerial design fails to account for the environmental threats such as shark chumming, boat activity, and pollution from the SAPPI paper plant (Van der Schyff 2018), and oil exploration. While Trafalgar does account for its environmental threats, its size makes conservation efforts difficult. Secondly, both MPAs display weak managerial strategies. Aliwal Shoal has a management plan that clearly outlines how the MPA will be policed, signed and demarcated however, this plan has not been implemented. Evidence discussed above shows the Shoal is not adequately demarcated, its laws are not public knowledge and the area is not policed. Contrary to Aliwal Shoal, Trafalgar does not have a management plan, but likewise, it is not policed. The above example illustrates that both MPAs fail to sufficiently respond to the pressures identified through the framework.

Furthermore, an analysis of both MPAs has shown the important link between management designs and strategies. The well-thought-out zonation of an area is rendered null and void if there is no policing in the MPA. It can therefore be concluded that managerial designs and strategies influence each other. In order for MPAs to successfully respond to pressures, both designs and strategies need to complement each other. In order for this to happen, data is needed.

As mentioned by a respondent in chapter 4, the restricted area of Aliwal Shoal has helped replenish depleted fish stocks (Pers. Com, 2019 j). However, this statement was based off of SCUBA diver observation and not scientific data. This quote illustrates a very important finding of this study- a lack of data on MPAs. It is therefore difficult to determine whether the MPA is effective in conserving marine resources as there is no baseline data. This lack of data means that because we cannot measure it, we cannot manage it. A similar discovery was made for Trafalgar, as there is currently no scientific data showing the number of fossils in the MPA, therefore it will be difficult to determine whether the MPA is effectively conserving them. However, Pondoland MPA differs to the above.

Unlike Aliwal Shoal and Trafalgar, data is available for Pondoland. The initial study to determine the zonation of the MPA provided baseline data on threatened fish species that has been used to compare with data today. Studies area also regularly conducted in the area by the Oceanographic Research institute, monitoring species growth.

Pondoland has adopted a mixed managerial design as it consists of 2 offshore controlled zones, 1 offshore restricted zone, 5 inshore controlled zones and 4 inshore restricted zones. However, similarly to Aliwal Shoal, the area is not clearly demarcated from surrounding areas and the laws of the MPA are not clearly visible (figure 4.17 and 4.20). With reference to figure 4.22, aerial observations conducted over the MPA substantiate these findings as only three markers were observed across the entire 90km MPA. Image 3,4 and 5, found in appendix C, show the type of markers used to show the start and end of an inshore controlled or restricted zone. No beacons were found showing the beginning of the MPA nor where it ends. Furthermore, no beacons were found along the north or south parts of the MPA. No signs were seen during observations and therefore, 63% of respondents felt the laws and demarcation of the MPA were not visible. This could be attributed to the fact that Pondoland MPA have drawn up a management plan for the area, however, it is awaiting approval from the DEA, meaning since its establishment in 2004, the area has had no management strategy.

However, even though Pondoland's managerial strategy is weak, studies have shown that the MPA is effectively responding the pressure of resource extraction identified in Chapter 4 through the
DPSIR framework. According to Maggs (2011: 53), "South Africa's most important line-fish species are more abundant and of a larger size in the Pondoland no-take area." The author goes on to say that "the Pondoland no-take area is providing refuge for depleted line-fish stocks, thereby achieving its primary objective and establishing the basis for the enhancement of adjacent fisheries." A study conducted by Maggs *et al.* (2013: 183) found that *Polysteganus praeorbitalis*, *Chrysoblephus puniceus*, *Epinephelus andersoni* and *Epinephelus marginatu,* which were 4 heavily exploited species are "afforded sufficient protection within the Pondoland MPA to potentially allow for stock rebuilding."

The data above shows the MPA was effectively addressing resource extraction. As argued above, similarly to Aliwal Shoal and Trafalgar, Pondoland is not well demarcated, the laws for the area visible, and the area has no managerial strategy. However, the data presented above shows the MPA has significantly addressed the threat of resource extraction. What then makes this MPA effective compared to Aliwal Shoal and Trafalgar. This can be answered when looking at respondents m and n answers in chapter 4, section 4.3.1. One respondent felt the MPAs size, about 400km^2 is the main reason for its success, while another believes it was its careful zonation.

The above evidence illustrates that the MPA's effective response in manging resource extraction is attributed to its managerial design. Unlike Trafalgar, Pondoland is currently the largest MPA in South Africa, therefore conserving a larger ecosystem. Pondoland also exhibits a mixed managerial design where areas were scientifically studied and specifically zoned to ensure optimum conservation of depleted fish stocks. As stated by one respondent, Pers. Com, 2019o, the zonation of the MPA included a variety of stakeholders, including local communities, managing authorities, and the DEA .

It is therefore argued that due to its managerial design (large size and mixed zonation) and constant monitoring that the MPA has effectively managed the resource extraction in the area. However, this was not the only pressure identified through the framework.

Through the use of the DPSIR framework in chapter 4, dune mining was identified as another pressure facing Pondoland. Figure 4.22 is a georeferenced map of Pondoland. Aerial photographs were taken and geomarked, using coordinates, onto the map. Image 1 and 2 found in appendix c, show the area where dune mining could potentially occur. The mining will occur close to the inshore restricted area. At present no study has been done to determine the environmental impact the mining will have on the area and the wider MPA. The mining will not occur in the MPA so similarly to Aliwal Shoal's land-based threats, the MPA has no jurisdiction to manage the consequential environmental and social threats.

The following can therefore be concluded. While Aliwal Shoal and Trafalgar's management designs failed in responding to the identified pressures, Pondoland's managerial design succeeded for two reasons. Firstly, Pondoland exhibits a mixed managerial design as the area is comprised of 2 offshore controlled zones, 1 offshore restricted zone, 5 inshore controlled zones and 4 inshore restricted zones. The zonation of these areas drew on stakeholder input and scientific knowledge and studies. Secondly, its success is also attributed to the large size of the MPA. However, as seen with both Aliwal Shoal and Trafalgar, Pondoland's management strategy is unsuccessful in responding to the resource extraction in the area. The area has been without a management plan for 15 years. Furthermore, considering its 90km length, 3 marking beacons are insufficient in zoning the area for the general public. The case study of Pondoland has again shown the important link between managerial designs and strategies.

5.4 BARRIERS AND GAPS IN MARINE RESOURCE MANAGEMENT

The above sections identified and discussed the socio-economic pressures and consequential impacts on each MPA. The response aspect of the DPSIR framework was then studied by analysing each MPAs managerial design and strategy, in an attempt to assess the effectiveness of MPAs in managing environmental pressures. The third research objective will now be addressed by highlighting barriers and gaps in marine resource management.

Six gaps and barriers have been identified through this study; jurisdiction, accessibility, lack of resources, management plans, identifying the threat and lastly, scientific data. Both Aliwal Shoal and Pondoland MPAs are currently or will be affected by land-based threats, namely the SAPPI paper plant, ERMs oil exploration and titanium dune mining. Because MPAs can only mange what falls within their area, they cannot manage this pressure. The limited geographical

jurisdiction that MPAs have, effectively exclude authorities from managing the land-based pressures in contiguous areas.

Another barrier identified in this study is that of accessibility. Accessibility was identified as a barrier particularly when studying Pondoland. Pondoland is 90km long and consists mainly of unspoilt, pristine coastline. It therefore has no supporting road networks or major highways along its route nor any substantial towns or cities. This barrier made the area difficult to study. Similarly, a study conducted by Tobey and Torell (2006), found that MPAs in Tanzania are too large to patrol and require a large amount of staff to police the area. The issue of accessibility could explain why Pondoland MPA is so poorly demarcated. However, this could also be attributed to the next barrier, a lack of resources.

Additionally, a lack of both financial and human resources was identified as another challenge in managing marine resources. Financial and human resources could aid in policing, increasing awareness, education, signage, implementation and demarcation of MPA zones. A lack of resources was also identified as a barrier for MPAs in East Africa (Francis *et al.* 2002), Chile (Barragan *et al.* 2005) and China (Li and Fluharty 2017).

An additional barrier identified in this study is a lack of management plans. Of the 3 MPAs studied, only one had a management plan. Management plans are crucial as they prioritise environmental issues and state how these will be addressed. Management plans highlight policing and enforcement procedures, finances, signage and demarcation and specify how the selected management design will be enforced and maintained. A study conducted by Francis *et al.* (2002) also identified a lack of MPA management plans as an issue towards conservation. In order for management plans to prioritize environmental threats and manage them, the threats need to first be identified. Identifying exactly what threats impact MPAs, which are the most pressing and how they are interconnected with other threats, is important in managing MPAs. This process could be aided through the use of the DPSIR framework. Pressures, and their consequential impacts are clearly identified and the interconnections between corresponding threats are made clear.

The final gap in managing marine resources is a lack of data. Pondoland was the only MPA with substantial species data showing how certain species have benefited from the restricted zone. It is therefore easier to show and prove that resource extraction has been effectively managed. Whereas data for Aliwal Shoal and Trafalgar is limited. According to Stepanova

(2015), data focusing on MPAs in Europe is also lacking. Additionally, Mudge (2018) finds that a lack of data and monitoring programmes hinders coastal management in the Philippines. Data studies are difficult, in particular the measurement of species diversity as they require specialists with the required expertise. The lack of financial resources available precludes the ongoing update of data. A lack of data can also be linked to a lack of human resources and management as there are not enough trained personal to manage data studies or, in fact, carry out data collection. Data is critical as it allows for entities to be measured and once they are measured and evaluated, they can be managed.

5.5 TOWARDS EFFECTIVE MARINE PROTECTED AREAS

The above section highlighted gaps and challenges in managing marine resources in South Africa, in an attempt to address the third research objective of this study. This section will now seek to contribute to the body of knowledge surrounding MPAs and to highlight the steps towards effective MPAs. Through doing so, the last objective of this study will be addressed,

The study of Aliwal Shoal, Trafalgar and Pondoland all yielded different results. Part of this difference speaks to the managerial design and strategy adopted by each MPA. As discussed above, Aliwal Shoal has a weak managerial design as the MPAs zonation did not account for the identified pressures. Trafalgar's managerial design was also found to be inadequate in responding to the identified pressures, but this is mainly due to its small geographical size. On the other hand, Pondoland's large size and mixed managerial design and zonation was attributed for its success in responding to the resource extraction in the area. Therefore, it can be categorically stated that for MPAs to effectively respond to the pressures identified through the framework, their managerial design must ensure the MPA is of an optimum size and is correctly zoned. This finding is supported by studies conducted by Agardy *et al.* (2011) and Chadwick *et al.* (2014) in South Africa. Furthermore, according to Edgar *et al.* (2014), conservation benefits of MPAs increased dramatically with the accumulation of 5 key factors; no take, well enforced, old, large and isolated. No-take refers to the areas managerial design, the area, according to the authors, should be notake or restricted to allow for stocks to replenish. The MPAs should also be well enforced and policed. The third factor is age, they count any MPA over 10 years as old. The fourth factor again speaks to the MPAs managerial design, any MPA over 100km^2 is counted as large. Lastly, the MPA should be isolated, meaning any reef habitats should be surrounded by deep water. With reference to figure 5.4, the first

factor towards effective MPAs is therefore managerial design (Agardy *et al.* 2011; Chadwick *et al.* 2014; Edgar *et al.* 2014).

As mentioned by Edgar *et al.* (2014), in order for MPAs to be effective, they should be well enforced and policed. This point is further substantiated by Chadwick *et al.* (2014). Furthermore, both authors agree that in order to do so, management plans are required (Chadwick *et al.* 2014 and Edgar *et al.* 2014). Additionally, according to (Chadwick *et al.* 2014; Mudge 2018) research and monitoring is vital to ensure adequate conservation efforts. The above three criteria refer to the managerial strategy of an MPA. In Aliwal Shoal, a thorough management plan exists that explains in detail how the MPA will be managed. However, due to poor implementation the MPA remains unmarked, badly signed and poorly policed. An absence of enforcement and policing measures can also be seen in Trafalgar and Pondoland. Additionally, both these MPAs have no management plans. As mentioned in the section above, a lack of data is also prevalent in Aliwal Shoal and Trafalgar, therefore making it difficult to measure the effectiveness and therefore manage the environmental impacts.

It can therefore be concluded, with reference to figure 5.4, that the second factor towards effective MPAs is a well thought out managerial strategy that encompasses a management plan, policing and enforcement procedures and research and monitoring. Furthermore, it was found in this study that demarcation, the visibility of MPA laws and research and skills development also fall under managerial strategies and also have an important role in MPA effectiveness.

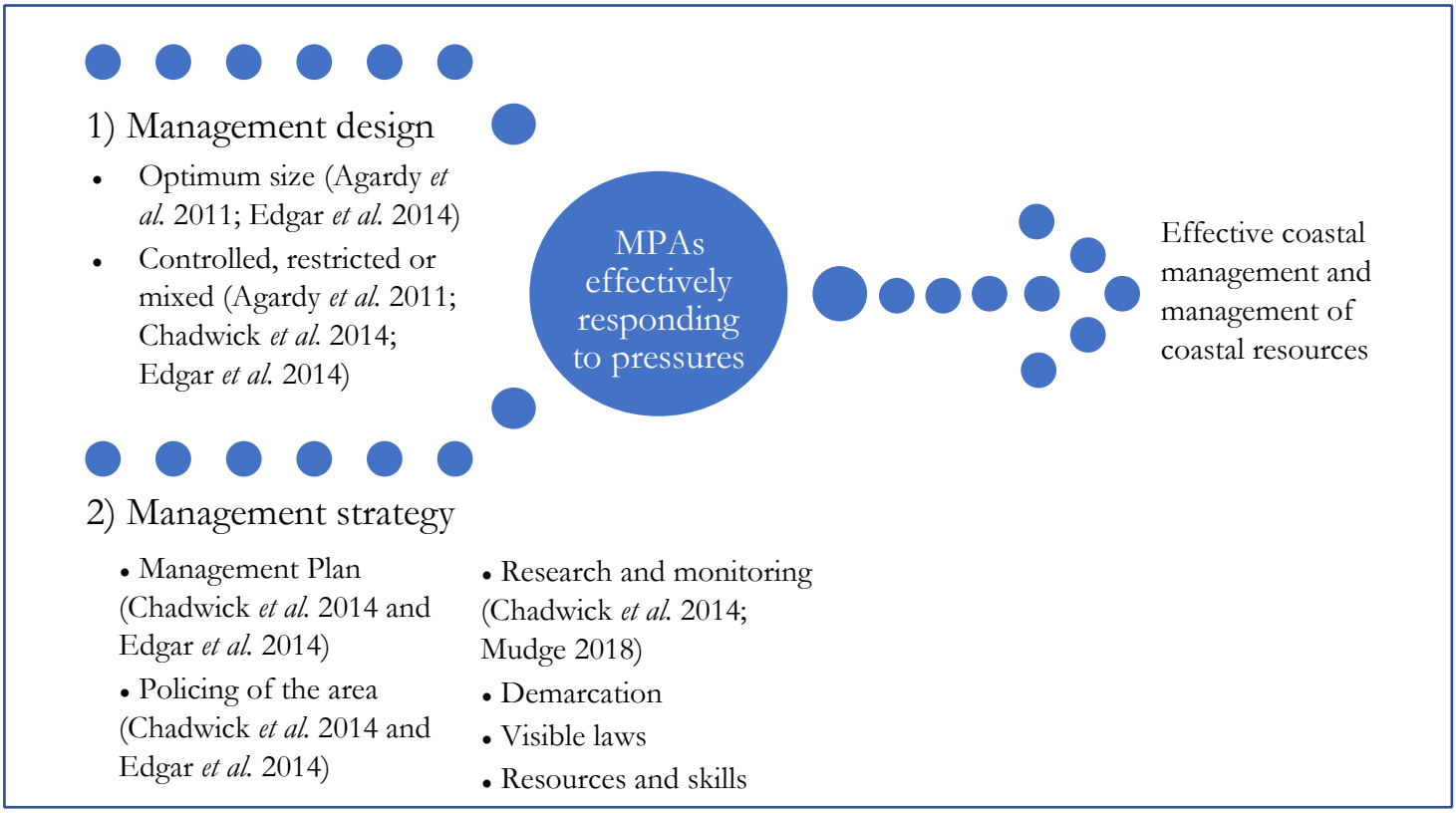

Figure 5.4 Diagram showing two factors needed in order for MPAs to effectively respond to pressures identified through the framework. In doing so, the MPAs will effectively conserve marine resources. Citations are given where findings correlate to previous research.

Additionally, it is important to note, that both managerial designs and strategies should complement each other and should work in unison. MPAs that are well zoned and cover a large area will not effectively conserve their resources in the absence of a cohesive management strategy behind them. In order to maximise conservation efforts, research and monitoring programmes should be established along with baseline data.

5.6 A SYNTHESIS

An application of the DPSIR framework highlighted interconnections between various factors for each MPA. Moreover, it allowed for cause-effect relations to be analysed. The chapter commenced by analysing Aliwal Shoal and determining the effectiveness of this MPA as a response. Aliwal Shoal is faced with the following pressures; resource extraction, boat activity, shark chumming, the paper plant, user conflict and oil drilling. It is argued above that the

current managerial strategies and designs in place within Aliwal Shoal do not affectively manage these threats, except for resource extraction within the restricted zones. Similar results were found when Trafalgar was analysed. The MPA has no management strategy, its managerial design is insufficient as its size is too small to conserve its resources and it is poorly policed, due to the lapsed service level contract. Furthermore, both Aliwal Shoal and Trafalgar have no baseline data, nor monitoring studies, making it difficult to determine how effective the MPAs have been in managing marine resources. Lastly, Pondoland was analysed and yielded different results. Ironically, while the area has no management strategy, no management plan, no clear signs, nor laws and is poorly demarcated, most respondents felt the MPA was, in fact, being effective in manging its marine resources. Additionally, studies regularly conducted in the area show the MPA is allowing for exploited fish stocks to replenish. This is mainly due to its mixed managerial design and large size. The early establishment of baseline data, which allows for comparison studies to be conducted allows for the areas effectiveness to be easily studied.

The three MPAs do respond to some of the pressures identified through the framework, but only to a very small extent. For MPAs to effectively respond to pressures, it is argued that thorough, and cohesive managerial designs and strategies need to be implemented. Furthermore, studies need to be done on each MPA where species are counted to establish species biodiversity and baseline data, which can be compared to future research and studied to determine if the MPA is successfully responding to resource extraction. Other pressures, such as shark chumming and boat activity in Aliwal Shoal need to be regulated to ensure negative impacts on the Shoal and its species cease. The DPSIR framework has also allowed for pressures that fall out of the jurisdiction of the MPA to be identified. Through the framework it was found that these pressures will have negative impacts on the MPAs. Specifically, the Saiccor paper plant, the oil drilling near Aliwal Shoal and the titanium sand mining in Pondoland. At present, data is very limited and determining the effectiveness of MPAs, in terms of conservation, remains challenging as it is difficult to manage and motivate interventions if the impact cannot be measured.

CHAPTER SIX CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

This dissertation has analysed the effectiveness of three Marine Protected Areas in South Africa through the application of the DPSIR framework. This chapter is dedicated to summarising the key findings of this dissertation. As well as providing recommendations, this chapter will also give suggestions on future research.

6.2 SUMMARY OF KEY FINDINGS

With the aid of interviews, visual and personal observations, photographs, and a review of literature, the following research objectives have been addressed.

Firstly, the driving forces and pressures affecting each MPA were identified in the form of social and economic threats. The consequential changes in state and impact on the environment were then identified through the use of the DPSIR framework. Resource extraction, titanium sand dune mining, shark chumming, pollution in the form of oil drilling and abandoned gear and nets, and the release of heavy metals were identified as pressures across the three MPAs studied. The resulting impacts these pressures could have on the environment, and have been observed in other countries, are identified as loss of species, species mortality, disruption of food webs and ecosystems, changes in animal behaviour and changes or a loss of coral cover. Furthermore, it is important to note that resource extraction was the only pressure identified across all three study sites. While there were some similarities when applying the framework to each site, each MPA yielded different results.

The second research objective was to assess the effectiveness of each MPA as a response in managing the above pressures identified above. This was done through an assessment of each MPAs managerial design and strategy. This dissertation found that the managerial designs of both Aliwal Shoal and Trafalgar are futile in managing the identified pressures. Trafalgar's small geographical size yields its conservation efforts unsuccessful in managing its environmental threats. While Aliwal Shoals poor zonation does not adequately respond to the environmental pressures. However, the managerial design for Pondoland, particularly its large size and mixed

zonation was attributed for its success in managing the resource extraction in the area. The effectiveness of Pondoland in managing this pressure could be easily measured as the area is well monitored and studies have been done showing how certain fish species are benefitting from the size as well as the zonation of the MPA. Both Trafalgar and Pondoland do not however have a management strategy and the benefits of the establishment of a management plan could be reaped in the future. Contrary, Aliwal Shoal has a management plan that is detailed and thorough, but poor implementation yields it pointless. It is therefore concluded that for South Africa's MPAs to effectively respond to the pressures identified through the DPSIR framework, they must have competent managerial designs and strategies that work in unison to effectively manage South Africa's coastline.

Furthermore, two important findings must be further highlighted; jurisdiction and a lack of data. Three land-based pressures were identified through the framework that could potentially and negatively impact both Aliwal Shoal and Pondoland, namely, oil drilling, titanium sand mining and the Saiccor paper plant. The MPAs are ineffective in responding to these pressures as they are out of their area of management and jurisdiction. It has also been difficult to determine the impact certain pressures have or will have on the environment as no data studies have been done showing these interconnections. Furthermore, data showing species quantity and annual catch numbers, for Aliwal Shoal particularly, is lacking. Neither Trafalgar nor Aliwal Shoal have baseline data making it difficult to track the MPAs progress since its establishment. Therefore, because we cannot measure the amount of species in an area or how the loss of those species will impact the area, it is difficult to assume whether the MPAs is effectively managing the threat.

Based on the findings above, it can therefore be categorically stated that the three MPAs are by in large inadequate and inconsistent in responding to the environmental pressures identified through the framework. Under Operation Phakisa, 20 new MPAs have been declared and 2 expanded. Although these additional MPAs are welcomed and are a positive intervention in marine conservation, based on the conclusion above, South Africa should enter cautiously with these new MPAs as the management of our current MPAs remains questionable.

6.3 RECOMMENDATIONS

As argued in the above chapters, managerial strategies and designs highly determine the effectiveness of MPAs in responding to the pressures identified through the framework. The following recommendations are therefore made.

Firstly, for Aliwal Shoal, regulations need to be placed on boat activity in the shoal and shark chumming should be banned. Furthermore, their management plan needs to be implemented starting with policing the area, putting up signs and marking out the MPA. Secondly, for Trafalgar, the area needs to be rezoned and enlarged to meet their biodiversity goals. A management plan for the MPA needs to be drawn up urgently. Lastly, for Pondoland, the area's management needs to be approved and implemented to ensure clear demarcation and policing of the MPA to enhance and protect its future effectiveness.

Pondoland should serve as an example where research has been conducted and used to argue that the MPA has aided in conserving its resources. Monitoring programmes should be set up for each MPA where individuals, students or NGOs can work in conjunction with the managing authority. These studies and the data obtained from them can be used to determine whether the MPA has been successful or not.

Legislation needs to be adapted to allow for MPAs to have a say in matters that fall out of their jurisdiction but will impact negatively on them. Furthermore, educational programmes in schools and communities need to be encouraged to stress the importance of marine life.

Lastly, modern technology such as drones should be considered to police the MPAs. While their initial expense is high, it is a once off payment and would be cheaper to use in the long run. Not only is it economically more viable, but this is a more environmentally friendly option as the alternative would use boats to patrol the area. As argued in the chapters above, this can result in the release of heavy metals which negatively affect coral. Each MPA could be allocated a drone. Two officials for each MPA could then be trained and can use the device to patrol the area. This is of particular use for larger MPAs such as Pondoland where large areas can be surveilled in a short amount of time. Photographs could also be taken of any illegal activities or vessels in the area. These can be used as proof when enforcing the laws and issuing fines and penalties.

6.4 FUTURE RESEARCH

This dissertation focused on applying the DPSIR framework to three MPAs in South Africa to assess their effectiveness. During the study, various areas were identified that would be interesting for future research. Firstly, this study could be applied to other MPAs in South Africa to highlight differences and similarities across MPAs in South Africa. Secondly, more research into factors hampering effective management of MPAs in South Africa is needed. Thirdly, studies should be done that highlight the environmental impact land-based activities such as the proposed titanium mining will have on the marine environment. Fourthly, through this study it was found that foreign trawlers are often found in South African waters. No research has been done on the impact these trawlers have on the coastal areas, nor the politics behind them. Fifthly, throughout this study, a lack of data focusing on marine environments, their threats and pressures was highlighted. Future research should focus on gathering baseline data on species catch numbers and ecosystem changes due to various pressures. Lastly, as of the 27th of May 2019, under Operation Phakisa, 20 more MPAs have been declared around South Africa. A study focusing on this declaration, its zonation process and its potential effectiveness could yield interesting results.

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PERSONAL CORRESPONDENCE

Pers. Com, 2019a: Interview with a fisherman at Aliwal Shoal: 8:20, 2 April 2019

Pers. Com, 2019b: Interview with a fisherman at Aliwal Shoal: 8:40, 2 April 2019

Pers. Com, 2019c: Interview with a diver at Umkomaas: 13:00, 30 March 2019

Pers. Com, 2018d: Interview with a local conservationist at Sea Park: 10:00, 22 September 2018

Pers. Com, 2019e: Interview with a diver at Umkomaas: 13:15, 30 March 2019

Pers. Com, 2018f: Interview with a local conservationist at Sea Park: 10:30, 22 September 2018

Pers. Com, 2019g: Interview with a local conservationist at Southbroom: 15:00, 27 March 2019

Pers. Com, 2019h: Interview with researcher. Received via email: 20:00, 12 February 2019

Pers. Com, 2018i: Interview with a local conservationist at Sea Park: 10:28, 22 September 2018

Pers. Com, 2019j: Interview with researcher. Received via email: 12:20, 6 March 2019

Pers. Com, 2019k: Interview with researcher. Received via email: 12:20, 6 March 2019

Pers. Com, 2019l: Interview with researcher. Received via email: 12:20, 6 March 2019

Pers. Com, 2019m: Interview with researcher. Received via email: 12:20, 6 March 2019

Pers. Com, 2019n: Interview with researcher. Received via email: 14:20, 25 March 2019

Pers. Com, 2019o: Interview with researcher. Received via email: 14:20, 25 March 2019

8. APPENDIX

APPENDIX A

An outline of the email sent to the respondents asking for their involvement in the study:

Good day X

My name is Alexandra Dalziel. I am currently conducting research as part of my master's degree through the University of the Witwatersrand, focusing on Marine Protected Areas in KZN and the Eastern Cape. I am required to interview managers of marine protected areas, conservationists and researchers conducting work on the areas. Might I be able to schedule an interview with you. Alternatively, I can send you my interview transcript for you to fill out. Anonymity will be guaranteed, and a consent form will be provided. I can also send you my master's proposal if you wish to look this over.

Hoping to hear from you soon.

Kind regards,

Alexandra Dalziel
074 604 9942
803031@students.wits.ac.za

APPENDIX B:

Interview transcripts, consent forms and information sheets

Interview for mangers and MPA researchers:

Application of the DPSIR framework in the assessment of Marine Protected Areas (MPAs) in South Africa: a study of KwaZulu-Natal and Eastern Cape Provinces

1. What work are you involved in in either Trafalgar, Aliwal Shoal or Pondoland Marine Protected Areas?

   _____

   _____

2. Do you believe each MPA is clearly demarcated from surrounding areas?

   YES/NO

3. Do you believe the laws of MPAs are clearly visible and are public knowledge?

   YES/NO

4. Do you believe the MPAs are well managed? *Please specify which ones you are referring to*

   YES/NO

   a. **If yes**, what aspects of the areas are well managed?

      _____

      _____

      _____

   b. **If no**, what aspects could be improved in the areas?

      _____

      _____

      _____

5. What is the greatest environmental threat to Trafalgar?

Threat:	**Overexploitation**	**Pollution**	**Invasive Species**	**Other (Please Specify)**

a. With reference to the above, what causes this threat? (please tick)

Driver:	**Tourism**	**Development**	**Fisheries sector**	**Money**	**Other**

6. What is the greatest environmental threat to Aliwal Shoal?

Threat:	**Overexploitation**	**Pollution**	**Invasive Species**	**Other (Please Specify)**

a. With reference to the above, what causes this threat? (please tick)

Driver:	**Tourism**	**Development**	**Fisheries sector**	**Money**	**Other**

7. What is the greatest environmental threat to Pondoland?

Threat:	**Overexploitation**	**Pollution**	**Invasive Species**	**Other (Please Specify)**

a. With reference to the above, what causes this threat? (please tick)

Driver:	**Tourism**	**Development**	**Fisheries sector**	**Money**	**Other**

8. How do you feel the declaration of Trafalgar as a MPA has benefited the environment?

(Please list examples if possible)

_____

_____

9. How do you feel the declaration of Aliwal Shoal as a MPA has benefited the environment? *(Please list examples if possible)*

_____

_____

10. How do you feel the declaration of Pondoland as a MPA has benefited the environment?
(Please list examples if possible)

_____

_____

11. Pondoland is currently the largest MPA in South Africa. Do you feel the size of Pondoland MPA impacts the management of the area? *(Please elaborate if possible)*

_____

_____

12. Are you familiar with the proposal made by ENI and Sasol SA for the exploration drilling programme in block ER236 off the East coast of South Africa?

YES/NO

13. If yes, what impact do you think this will have on the area, particularly the newly proposed Protea Banks MPA and expanded Aliwal Shoal MPA?

_____

_____

_____

14. The World Wildlife Fund South Africa, recently declared Marine Protected Areas as the foundation for marine conservation in South Africa. Do you believe South Africa is moving in the correct direction in terms of marine conservation by using MPAs or are there alternatives?

_____

_____

_____

15. Is there anything extra you would like to add to this interview?

_____

___

_____

___ _____

Interview for scuba divers:

Application of the DPSIR framework in the assessment of Marine Protected Areas in South Africa: a study of

KwaZulu-Natal and Eastern Cape Provinces

1. How often do you visit this area?

   _____

2. Are you aware that this area is a Marine Protected Area? *(please circle)*

   YES/NO

3. Are you aware of the laws in this area?

   YES/NO

4. Do you believe the Marine Protected Area is clearly demarcated from surrounding areas?

   YES/NO

5. Do you believe the laws of the area are clearly visible and are public knowledge?

   YES/NO

6. Do you believe this area is well managed?

   YES/NO

   a. **If yes**, what aspects of the area are well managed?

      _____

      _____

   b. **If no**, what could be improved in this area?

      _____

      _____

7. What is the greatest environmental threat to this MPA (please tick one)

Threat:	Overexploitation	Pollution	Invasive Species	Coastal hypoxia (eutrophication)	Other (Please Specify)

a. With reference to the above, what causes this threat? (please tick)

Driver:	Tourism	Development	Fisheries sector	Money	Other

8. Do you feel the declaration of this area as a MPA has attracted more divers? Please elaborate.

_____

_____

9. Do you believe the MPA has had a positive impact on species numbers?

_____

_____

10. Are you familiar with the proposal made by ENI and Sasol SA for the exploration drilling programme in block ER236 off the East coast of South Africa?

YES/NO

11. If yes, what impact do you think this will have on the area, particularly the newly proposed Protea Banks MPA and expanded Aliwal Shoal MPA?

_____

_____

_____

12. Is there anything extra you would like to add to this interview?

_____

_____

Interview for fishermen:

Application of the DPSIR framework in the assessment of Marine Protected Areas (MPAs) in South Africa: a study of KwaZulu-Natal and Eastern Cape Provinces

1. How often do you visit this area?

   _____

2. What activities do you typically conduct in the area?

   _____

3. Are you aware that this area is a Marine Protected Area? *(please circle)*
   a. YES/NO

4. **If yes**, were you consulted about the MPA before it was declared?

   a. YES/ NO

5. Are you aware of the fishing laws and restrictions in this area?

   a. YES/NO

6. **If yes**, do you follow these laws?

   a. YES/NO

7. Do you believe the laws and restrictions of the area are clearly visible?

   a. YES/NO

8. Do you believe the Marine Protected Area is clearly demarcated from other surrounding areas?

   a. YES/NO

9. Do you believe this area is well managed?

   a. YES/NO

10. **If yes**, what aspects of the area are well managed?

_____

_____

11. **If no**, what could be improved in this area?

_____

_____

12. What environmental threats do you see in this area?

_____

13. What do you feel causes these threats?

_____

14. If you visited this area before it was declared a MPA, how do you feel the conservation of the area has changed?

_____

_____

15. Is there anything extra you would like to add to this interview?

_____

Consent form given to all respondents:

Research conducted under the clearance of the University of the Witwatersrand,
(011) 717 1000
1 Jan Smuts Avenue
Braamfontein 2000
Johannesburg, South Africa

Application of the DPSIR framework in the assessment of Marine Protected Areas in South Africa: a study of KwaZulu-Natal and Eastern Cape Provinces

I …… (Name) agree to participate in the research study stated above. I acknowledge that the research has been clearly explained to me. I understand what my participation will involve. I agree to the following (please circle):

I agree to be interviewed for the purpose of the Research project named above	YES	NO
I have read and understood the information sheet	YES	NO

I agree that my participation will remain anonymous YES NO

I agree that the researcher may use anonymous quotes
in her research report YES NO

I would like to receive a summary of the research after YES NO completion

Participant signature.....

Researcher signature.....

Date.....

Information sheet given to all respondents:

Research conducted under the clearance of the University of the Witwatersrand,
(011) 717 1000
1 Jan Smuts Avenue
Braamfontein 2000
Johannesburg, South Africa
University Human Research Ethics Committee (non-medical) contact details:
Shaun Schoeman, committee secretary, Shaun.Shoeman@wits.ac.za, Tel (011) 717-1408

Title of research: Application of the DPSIR framework in the assessment of Marine Protected Areas in South Africa: a study of KwaZulu-Natal and Eastern Cape Provinces.

Good day Sir/Madam

My name is Alexandra Dalziel and I am a masters student studying Geography at the University of the Witwatersrand. My degree entails the completion of a dissertation. I am currently investigating the effectiveness of Marine Protected Areas in the Eastern Cape and KZN provinces through the application of the DPSIR framework. My study has two aims. Firstly, to investigate the extent to which the DPSIR framework can be applied in the effective management of Marine Protected Areas. The second aim is to investigate the ways in which current management approaches are effective in the management of marine resources.
As part of this study I would like to invite you to take part in an interview. The interview will involve filling out a consent form and answering a few questions relating to MPAs, gaps in its management and threats to the area. It will take around 20 minutes to complete.

It is important to note that you will not receive any direct benefits from participating in this study. If you wish to not participate, please note that there are no disadvantages or penalties. Questions may be left out and you may withdraw at any time. With reference to the consent form that will be provided to you, the interview will be completely confidential and anonymous. The information you give to me will be held securely and not disclosed to anyone else.

If you have any questions afterwards, feel free to contact me.

Yours sincerely,

Alexandra Dalziel, 803031@students.wits.ac.za , 074 6049942

Supervisor: Professor Danny Simatele, Danny.Simatele@wits.ac.za, 083 383 6884

APPENDIX C: Primary field data

Tables:

Table i: Table indicating the pressures facing Aliwal Shoal as identified by the respondents. (Source: field-based research 2019)

ALIWAL SHOAL PRESSURES	
Factor:	Frequency:
Overexploitation	**8**
Pollution	**6**
Invasive Species	**1**
Other: Shark chumming Oil User conflict	**7** 1 5 1
Total:	**22**

Table ii: Table indicating the driving forces facing Aliwal Shoal as identified by the respondents. (Source: field-based research 2019)

ALIWAL SHOAL DRIVING FORCES	
Factor:	Frequency:
Development	**6**
Tourism	**8**
Fisheries sector	**8**
Other	**0**
Total:	**22**

Table iii: Table indicating how frequently the local fishermen visit Aliwal Shoal. (Source: fieldbased research 2019).

ALIWAL SHOAL LOCAL FISHERMEN	
Visit:	Frequency:
Everyday	**1**
Every Saturday and Sunday	**1**
Once a week	**3**
Total:	**5**

Table iv: Table indicating the pressures facing Trafalgar as identified by the respondents. (Source: field-based research 2019)

TRAFALGAR PRESSURES	
Factor:	Frequency:
Overexploitation	**6**
Pollution	**1**
Invasive Species	**0**
Other: Oil No management Locals harvesting	**3** 1 1 1
Total:	**10**

Table v: Table indicating the driving forces facing Trafalgar as identified by the respondents. (Source: field-based research 2019)

TRAFALGAR DRIVING FORCES	
Factor:	Frequency:
Development	**1**
Tourism	**1**
Fisheries sector	**6**
Other Poverty Government	**2** 1 1
Total:	**10**

Table vi: Table indicating respondents answers on whether they felt the MPA was clearly demarcated from surrounding areas (Source: field-based research 2019)

	Well demarcated		Not well demarcated	
	Number of respondents	Percentage	Number of respondents	Percentage
Aliwal Shoal	7/22	32%	15/22	68%
Trafalgar	8/10	80%	2/10	20%
Pondoland	3/8	37%	5/8	63%

Table vii: Table indicating respondents answers on whether they felt the laws of the MPA were clearly visible (Source: field-based research 2019)

	Yes		No	
	Number of respondents	Percentage	Number of respondents	Percentage
Aliwal Shoal	7/22	32%	15/22	68%
Trafalgar	8/10	80%	2/10	20%
Pondoland	3/8	37%	5/8	63%

Table viii: Table indicating respondents answers on whether they felt the MPA was well managed (Source: field-based research 2019)

	Yes		No	
	Number of respondents	Percentage	Number of respondents	Percentage
Aliwal Shoal	9/22	41%	13/22	59%
Trafalgar	7/10	70%	3/10	30%
Pondoland	6/8	75%	2/8	25%

Images:

Image 1: Image showing inshore sanctuary zone of Pondoland MPA as well as red dunes where mining will occur. 31°10'52"S, 30°07'03.8"E

Image 2: Image showing inshore sanctuary zone of Pondoland MPA as well as red dunes where mining will occur. 31°11'47"S, 30°05'59,8"E

Image 3: Image showing demarcation marker indication the start or end of the inshore controlled/ restricted area of Pondoland MPA. 31°17'01"S, 30°01'01"E

Image 4: Image showing demarcation marker indication the start or end of the inshore controlled/ restricted area of Pondoland MPA. 31°17'44"S, 30°00'34"E

Image 5: Image showing demarcation marker indication the start or end of the inshore controlled/ restricted area of Pondoland MPA. 31°19'24"S, 29°58'00.7"E

Image 6: Image showing fishermen fishing in the controlled zone of Pondoland MPA. 31°35'23.3"S, 29°36'34.7"E

Appendix D- Ethics

University of the Witwatersrand ethics certificate:

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Dalziel

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H18/06/12**
PROJECT TITLE	Application of the DPSIR framework in the assessment of Marine Protected Areas: A study of KwaZulu-Natal and Eastern Cape provinces
INVESTIGATOR(S)	Miss A Dalziel
SCHOOL/DEPARTMENT	GAES/
DATE CONSIDERED	22 June 2018
DECISION OF THE COMMITTEE	Approved
EXPIRY DATE	23 July 2021
DATE 24 July 2018	**CHAIRPERSON** (Professor J Knight)

cc: Supervisor : Professor D Simatele

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

_____ ____/____/____
Signature **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Agreement between Eastern Cape Parks and Tourism Authority (ECPTA) and the Researcher's supervisor, Prof Mulala Danny Simatele. Pages 1-9 shown below

AGREEMENT

BETWEEN

EASTERN CAPE PARKS & TOURISM AGENCY
herein represented by Vuyani Dayimani
in his capacity as Chief Executive Officer
(hereinafter referred to as "ECPTA")

AND

Mulala Simatele
Identity No: GBR507856718
(hereinafter referred to as "the Researcher")

WHEREAS the Researcher submitted a research proposal to ECPTA to conduct research on Application of the DPSIR framework in the assessment of Marine Protected Areas in South Africa: a study of KwaZulu-Natal and the Eastern Cape Provinces (RA 0298)

AND WHEREAS ECPTA accepted the Researcher's proposal to conduct the abovementioned research subject to the terms and conditions as stipulated hereunder:

THE PARTIES AGREE AS FOLLOWS

1. PERIOD OF AGREEMENT

1.1. This agreement shall commence upon signature by both parties and shall continue up to the 31 December 2019.

1.2. Either party may terminate this agreement by giving the other party at least 2 (two) months written notice.

2. THE RESEARCH

2.1. The Researcher will be doing research Application of the DPSIR framework in the assessment of Marine Protected Areas in South Africa: a study of KwaZulu-Natal and the Eastern Cape Provinces in accordance with the research application and proposal attached hereto as Annexure A.

2.2. The research application and proposal attached as Annexure A shall for all intents and purposes be deemed to be part of this agreement.

3. THE RESEARCHER'S OBLIGATIONS

3.1. The Researcher acknowledges that he/she (assistant or team included) will work entirely at own risk.

3.2. The Researcher shall sign the agreement before the research can begin.

3.3. The Researcher and his co-workers shall carry a signed copy of this agreement when working in the protected area.

3.4. The Researcher agrees to abide by the rules and regulations of the reserves.

3.5. The Researcher agrees to conduct him/herself and the research in an orderly manner and not to be disruptive to management and/or visitors.

3.6. The Researcher agrees to make all the necessary logistical arrangements with the reserve manager/s and to always inform the reserve manager/s when he/she or members of his/her team will be on the reserve.

3.7. The Researcher agrees to restrict his/her activities to those detailed in the project proposal.

3.8. The Researcher will apply for and obtain any permits that may be required, by the Eastern Cape Department of Economic Development, Environmental Affairs and Tourism (DEDEAT), the Department of Agriculture, Forestry and Fisheries (DAFF), and/or the Department of Environmental Affairs (DEA).

3.9. The Researcher agrees to limit sample collection to the minimum required to give sufficient results and will not exceed the limits set in the project proposal or in any other permit/s.

3.10. It is agreed that where the project duration is longer than one year, an annual progress report will be submitted to the Scientific Services section of ECPTA by end November each year.

3.11. It is agreed that the Researcher will provide ECPTA with a final project report and a comprehensive and well organised copy of the raw data generated by no later than three (3) months from the completion date specified in clause 1.1.

3.12. It is agreed that the Researcher will provide the Scientific Services section of ECPTA with copies of all publications, reports or theses arising from this study. These documents will be submitted to ECPTA within one (1) month of completion.

3.13. It is agreed that the Researcher will acknowledge ECPTA and, where appropriate, any staff who have assisted. In

M.f

cases where staff of the ECPTA make a significant contribution to the research co-authorship should be considered.

3.14. It is agreed that research findings will not be released to the media without prior approval from the ECPTA, it being understood that the ECPTA will not prohibit the publication thereof in any scientific publication.

4. ECPTA OBLIGATIONS

4.1. ECPTA shall afford the researchers free park entry during the period stipulated in paragraph 1.1., provided such entry is for *bona fide* research purposes.

4.2. In reserves where official research accommodation facilities are available, the researcher may book and use these facilities. Bookings should be made through the reserve manager and a standard rate will be charged. Use of these facilities is subject to availability.

4.3. Accommodation in tourist facilities must be booked through the ECPTA reservations office and will be charged at 50% of tourist rates, subject to availability.

4.4. Where necessary, ECPTA shall provide a field ranger to accompany the Researcher(s) during field work, provided that this is arranged with the reserve manager at least two weeks prior to the date of such field work.

5. SPECIAL CONDITIONS

5.1 N/A

6. DATA OWNERSHIP

6.1. Existing ECPTA datasets may be made available to researchers. These datasets remain the property of ECPTA,

may only be used for the purpose of the specified research and may not be distributed further without the written approval of ECPTA.

6.2. All data generated through research on ECPTA reserves is considered to be public property. Researchers will be granted two (2) years lead time protection from the project completion date, specified in clause 1.1 above, to enable them to publish the results. Thereafter the data may be made available to other parties on request.

6.3. ECPTA may at their discretion and at any stage, deem any data or information gathered through research on ECPTA reserves to be confidential. Any such information may not be published, utilised or distributed without the prior written approval of ECPTA, it being understood that such approval shall not be unreasonably withheld.

6.4. It is agreed that research findings will not be released to popular media without prior approval from the ECPTA.

7. BREACH OF AGREEMENT

7.1. Should any party commit a breach of any of the provisions of this agreement and fail to remedy the breach within a period of 14 (fourteen) business days after receipt of the notice by the injured party to remedy the breach, the injured party shall at its discretion and without prejudice to any other rights be entitled to any of the following remedies:

7.1.1. terminate this agreement

7.1.2. claim compensation for damages

7.1.3. sue for any form of specific performance

7.1.4. claim for outstanding data

8. INDEMNITY

8.1. ECPTA shall not be liable for any claim for damages, including any claim resulting from the death of or injury to any of the researchers, and the Researcher accordingly hereby indemnifies ECPTA against any such claims.

9. AMENDMENT

9.1. This document constitutes the entire agreement between the parties and no amendment thereof shall have any effect unless reduced to writing and signed by both parties.

9.2. No indulgence on the part of either party shall constitute a waiver of rights in terms of this agreement.

9.3. Neither party may cede or assign any of its rights or obligations in terms of this Agreement, nor in any other way transfer any of its rights or obligations under this Agreement without the prior written consent of the other party.

10. DOMICILIUM CITANDI ET EXECUTANDI

10.1. The parties choose as their *domicilium citandi et executandi* for all purposes under this Agreement the following addresses:

ECPTA
Legal Services
17 Fleet Street
EAST LONDON
5200
Tel: (043) 705 4400
Fax: (086) 513 4646

The Researcher
Mulala Simatele
University of Witwatersrand
School of Geography, Archeology and Environmental Studies
Dept. of Geography and Env Studies, PB 3, Wits 2050
Bernard Price Building, Office 111
Braamfontein

Tel: 011 717 6516
Fax: N/A
Cell: 083 383 6884

10.2. Any notice or communication required or permitted to be given in terms of this agreement shall be valid and effective only if in writing.

10.3. Either party may by written notice to the other party change the physical address chosen as its *domicilium citandi et executandi* to another physical address where postal delivery occurs, provided that the change shall become effective on the 7th (seventh) business day from the receipt of the notice by the other party.

10.4. Any notice to a party –

10.4.1 Sent by prepaid registered post (by airmail if appropriate) in a correctly addressed envelope to it at the address chosen as its *domicilium citandi et executandi* to which post is delivered shall be deemed to have been received on the 5th (fifth) business day after posting (unless the contrary is proved);

10.4.2 Delivered by hand to a responsible person during ordinary business hours at the physical address that is *domicilium citandi et executandi* shall be deemed to have been received on the day of the delivery.

10.4.3 Sent by telefax, shall be deemed to have been received on the first business day following the date of transmission of such notice.

10.5. Notwithstanding anything to the contrary herein contained a written notice of communication actually received by a party

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shall be adequate written notice of communication to it notwithstanding that it was not sent to or delivered at its chosen *domicilium citandi et executandi*.

11. JURISDICTION

The parties consent to the jurisdiction of the Eastern Cape Division of the High Court of South Africa.

12. COSTS

Each party shall pay their own costs in respect of the drafting and finalisation of this agreement as well as all negotiations related thereto.

SIGNED AT EAST LONDON ON THIS 5th DAY

OF APRIL 2019

AS WITNESS: 1. _____

2. _____

_____

Chief Executive Officer

SIGNED AT WITS UNIVERSITY ON THIS 20 DAY

OF MAY 2019

AS WITNESS: 1. _____

2. _____

_____

Researcher

Email correspondence between researcher and Ezemvelo KZN. Research registration number shown in red