Behavioural responses of Cape fur seals (*Arctocephalus pusillus*) to swim-with-seal tourism activities in the Robberg Marine Protected Area in South Africa

by

Rodashia Basson

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Supervisor: Dr Conrad Sparks

Co-supervisor: Prof Ken Findlay

Co-supervisor: Dr Stephen Kirkman

District Six, Cape Town

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DECLARATION

I, Rodashia Basson, declare that the contents of this thesis represent my unaided work and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

Chapters 4 and 5 are prepared for submission to academic journals. The student is the first author of all the chapters and had the main responsibility data collection, data analyses and manuscript preparation while the supervisors assisted with the conceptualising of ideas, planning, and commenting on the manuscript drafts.

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ABSTRACT

Marine mammal tourism is growing, and experiences that provide close-up encounters are becoming more popular. One of such activity is the swim-with-seal (SWS) activity, which occurs within two marine protected areas (MPAs) in the Western Cape Province of South Africa, namely at the Robberg MPA in Plettenberg Bay and at sites in the Table Mountain National Park MPA. Information regarding SWS activities and their impacts on Cape fur seal *Arctocephalus pusillus pusillus* colonies is limited. This study aimed to assess the impacts of swim-with-seal (SWS) tourism on the behaviour of seals at the seal colony in the Robberg MPA. This was conducted through a modified Before-After-Control-Impact (BACI) behavioural study designed for simultaneous observations of Impact and Control areas (site factor) Before, During and After SWS activities (phase factor). Observations were carried out from an elevation at distances from the experimental sites that precluded observer impacts, with sequential photography of the colony providing the basis for enumerating seals in different behavioural categories and comparing these between sites and between phases, as well as interactive effects of site and phase. Behavioural categories included "primary" behavioural categories (lying down, sitting, moving) and "secondary" behavioural categories (grooming, nourishing, interacting, alertness) that seals within one of the primary categories could be secondarily engaged with. Between November 2020 and October 2021, 54 SWS trips were observed. Concerning the primary behaviour categories, seals in the colony were mostly observed to be lying down (74%) in relation to sitting (23%) or moving in the colony (3%). While most seals were at rest during the tourist activity, it was clear that SWS activity and associated boat approaches brought about certain behavioural responses in the colony, as shown by changes in some behavioural categories. However, even where there were significant differences in behaviour between sites and/or phases that could be attributed to tourist activity, it was only a small proportion of animals in the study area that were affected. For example, whereas the proportion of animals sitting relative to the numbers lying down in the Impact site increased as SWS activities commenced, the numbers of animals showing a switch in this behavioural posture were only approximately 2% of the numbers of animals at the site, on average. Furthermore, although the proportion of animals in the Impact site that showed alert behaviour (a secondary behavioural category) in response to activity increased statistically compared with the earlier phases or versus the Control Site, it still represented only about half a percent of the animals at the Impact Site, on average. No extreme reactions by seals, such as stampedes, were observed throughout the study. Modelled responses of seals to the distances of the boat or swimmers to the colony, indicate that some responses (certain behavioural categories) decline with distance to the colony, suggesting that the seals respond mostly to the activity when they first become aware of the tourist presence but decline as they become used to it. Overall, the reactions of seals point to the habituation of the seals to the

tourist activity. The results also attest to the efficacy of the modus operandi adopted by the tourist operator during the study period, which is informed by legislation and a voluntary Code of Conduct, with the aims of avoiding disturbance to the colony and ensuring human safety.

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DEDICATION

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GLOSSARY

Term	**Definition/Explanation**
Disturbance	The disruption of the pattern of the ecosystem, mainly by external forces.
Ecotourism	An ecologically sustainable form of tourism that promotes appreciation, cultural and environmental understanding and conservation (Björk 2000).
Habituation	Habituation is defined as a decrease in response of an animal after repeatedly being exposed to a stimulus (Sternberg 1995).
Protected species	An organism that is under legal protection through specific laws, regulations, or conservation measures.
Seal raft	The gathering of seals in social groups at sea is called a raft.
Sensitisation	An increase in response intensity after exposure to aversive stimuli (Schakner and Blumstein 2013).

Abbreviations/Acronyms

ANOVA	Analysis of variance
BACI	Before-After-Control-Impact
CBD	Convention on Biological Diversity
Cfb	**C** = Warm temperate, **f** = Fully humid, **b** = Warm summer
DFFE	Department of Forestry, Fisheries and the Environment
MPA	Marine protected area
NEMBA	National Environmental Management: Biodiversity Act
NEMPAA	National Environmental Management: Protected Areas Act
PCoD	Population Consequences of Disturbance
SWS	Swim-with-seal
ToPS	Threatened or Protected Species

CHAPTER 1: GENERAL INTRODUCTION

1.1 Introduction

Ecotourism may be defined as ecologically sustainable form of tourism that promotes appreciation, cultural and environmental understanding, conservation and economic benefits (Björk 2000). It includes "responsible travel to natural areas that conserves the environment and sustains the wellbeing of local people". The goal of marine ecotourism is to initiate and maintain a relationship between the marine environment and tourism (Sakellariadou 2014), providing an educational platform that can adjust human behavioural patterns towards environmentally responsible attitudes (Cheung and Fok 2014; Sakellariadou 2014). Various forms of ecotourism exist, including marine non-consumptive tourism activities such as boat-based whale watching and shark cage diving activities that have proliferated in recent decades (Kirkwood et al. 2003; Bruce and Bradford 2013; Cowling et al. 2014).

The focus of marine ecotourism is generally on larger charismatic species that appear regularly in large numbers in certain areas and are easy to observe (Garrod and Wilson 2003). Marine mammals are charismatic animals and attract a great number of tourists throughout the world due to their behaviours, curious nature and diving and swimming abilities (Constantine 1999). Many countries offer tourists the opportunity to view marine mammals in their natural habitat from land or from boats, as well as more close-up interactions such as "swim-with" activities (Spradlin et al. 2001; Cowling et al. 2014; Back et al. 2018). This broad range of opportunities allows the interaction of tourists with marine mammals, contributing to the popularity of the industry, which further increases the demand for tourist encounters with these animals (Spradlin et al. 2001).

Sakellariadou (2014) advocates that marine ecotourism should be conducted in a manner in line with sustainability principles. When marine ecotourism is developed in a sustainable manner, it advances economic development in a way that is unlikely to have harmful effects on the cultural and natural environments in which it occurs (Garrod and Wilson 2003). Various conservation and socio-economic benefits may be associated with marine ecotourism if activities are carried out responsibly (Spradlin et al. 2001). For example, it can lead to more frequent income and employment during the year for coastal communities, while economic risks can be reduced as a result of a wider diversification of economic activities it provides (Tisdell 2011). Properly controlled ecotourism could also establish conditions that are needed to support conservation efforts through strategic planning and comprehensive management (Eber 1992; Drumm and Moore 2005). In a study on sea turtles and whales, Wilson and Tisdell (2002) found that direct encounters between visitors and these animals appeared to foster human empathy, increasing the likelihood that people would support their protection. While many benefits have been identified as arising from marine ecotourism, negative impacts have extensively been reported throughout the world (Cassini 2001; Back et al. 2018), including impacts on focal animals if activities are carried out irresponsibly (Cowling et al. 2014).

Cowling et al. (2014) identified that pinnipeds could possibly be the most reliable marine mammals on which to focus tourism. These animals make trips to sea and mostly return to the same haul-out location from which they departed to socialise, rest, reproduce or give care to their offspring (Cowling et al. 2014). Operations at moderate or long distances (either from land or boats) and close-up interactions such as kayaking are different forms of tourism activity focused on pinnipeds (Scarpaci et al. 2005; Cowling et al. 2014) in a rapidly growing marine wildlife tourism industry sector (Cassini 2001; Cate 2013; Cowling et al. 2014). In addition to boat and land-based approaches, swim-with-seal (SWS) ventures have become a popular tourist attraction worldwide (Constantine 1999; Scarpaci et al. 2005; Curtin and Garrod 2007).

Previous studies carried out on boat and land-based approaches have shown negative impacts of tourists on seals (Kovacs & Inness 1990; Cassini 2001; Boren et al. 2002). For example, the Hawaiian monk seal (*Monachus schauinslandi*) declined in numbers because of recreational disturbances on Green Island beaches (at Kure Atoll, Hawaii) on which the seals hauled out, with continuous visits to those beaches resulting in the seals abandoning their preferred sites (Gerrodette and Gilmartin 1990). The abandonment of such preferred sites for suboptimal sites can have detrimental effects on the population's health or fecundity (Gerrodette and Gilmartin 1990). Also, during an experimental boat-approach study at Kanowna Island, Australian fur seals (*Arctocephalus pusillus doriferus*) responded severely when boats approached the colony within 25 meters (Back et al. 2018). The seals became more active and fled into the water on approach, which resulted in changes to colony attendance. Time ashore is essential for fur seals to rest, breed and rear young (Gentry and Kooyman 1986; Riedman 1990). There is a notable gap in the literature concerning the positive effects of boat and land-based tourist approaches on seals.

In South Africa, SWS tourism has quickly become a popular tourist attraction at two Cape fur seal colonies (Nature's Valley Trust 2020). These colonies are at Duikerklip, near Cape Town within Table Mountain National Park Marine Protected Area (MPA), and the Robberg MPA at Plettenberg Bay (Kirkman and Arnould 2017), where these activities have occurred since 2009 and 2011, respectively (Nature's Valley Trust 2020). Information regarding SWS activities and their impacts on fur seals in the South African environment is limited. Whereas there were only two SWS operations in South Africa a decade ago, one at Plettenberg Bay and one at Cape Town, the industry is expanding and by 2020 (before the onset of the COVID-19 pandemic) three companies in Plettenberg Bay were actively conducting SWS, and up to ten companies in Cape Town, including SCUBA businesses who also offer SWS (M Malatji, DFFE, pers. comm.). There are management concerns about the potential deleterious impacts of the growing industry on the seal colonies (SP Kirkman pers. comm.), which ultimately could impact the sustainability of the industry itself.

The Cape fur seal is a protected species in South Africa in terms of the National Environmental Management: Biodiversity Act (NEMBA), Threatened or Protected Species list (DEA 2017). South Africa's Department of Forestry, Fisheries and the Environment (DFFE) has the mandate to manage and conserve marine resources in terms of NEMBA and other relevant legislation, such as the National Environmental Management: Protected Areas Act (NEMPAA). It is therefore the responsibility of DFFE to ensure that the swim-with-seal industry is managed to ensure its sustainability and minimise impacts on the focal seal colonies. This requires research that can inform policy and management decision-making regarding the activity.

1.2 Statement of research problem

Seal tourism activities including SWS ventures are growing in South Africa, and there is a need to evaluate the impacts of these activities on seal colonies, to enable evidence-based management of operations (see Kirkman et al. 2016). It is in the interests of both the industry and of DFFE, to avoid detrimental impacts on the seal colonies (including the well-being of animals in the colonies) which may have implications for the sustainability of the colony and therefore for the industry itself. There is consequently an immediate need for informed management and policy development and therefore research evidence to underpin these.

1.3 Aim and Objectives

This study aimed to determine the effects of SWS activities on Cape fur seal behaviour in the Robberg Marine Protected Area, within Plettenberg Bay, South Africa, and to advance evidence-based recommendations towards "sustainable industry practice" and effective regulation. The main objective of the study is:

> To scientifically determine the impacts of swim-with-seal activities on the behaviour of Cape fur seals in the colony through behavioural observations conducted using a Control-Impact study design,

with the following sub-objectives:

- To determine whether swim-with-seal activities alter the behaviour of seals in the colony.

- To assess potential environmental, operational or other influences on the responses of seals to swim-with-seal activities.

1.4 Structure of the thesis

This thesis consists of six chapters summarised below:

Chapter 1 introduces the thesis and provides a brief overview of the research focus and outlines the statement of the research problem and specific objectives of the study.

Chapter 2 provides a literature review on the life history and behaviour of Cape fur seals, and their distribution both globally and within South Africa. It also considers human interactions with Cape fur seals, with a focus on ecotourism and the relevance of marine protected areas.

Chapter 3 provides a description of the study area, the general methods, as well as the fieldwork operations.

Chapter 4 investigates whether SWS activities alter the behaviour of seals in the colony at the Robberg MPA within a Before, During and After investigative framework, consistent with a Before-After-Control-Impact (BACI) experimental design.

Chapter 5 investigates the drivers of any behavioural alteration caused by the seal swim activity identified in Chapter 4.

Chapter 6 provides general conclusions and recommendations for the management of SWS activities in South Africa.

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CHAPTER 2: LITERATURE REVIEW

2.1 Cape fur seal

2.1.1 *Life history and behaviour of Cape fur seals*

The Cape fur seal (*Arctocephalus pusillus*) is conspecific with the Australian fur seal (*A. p. doriferus*) (Arnould et al. 2003). These two subspecies are together referred to by the common name of 'brown seal' (Kirkman and Arnould 2017). Like all the other fur seal species, brown seals are sexually dimorphic, with adult males being longer and heavier than adult females (Rand 1956; Shaughnessy 1979); the former have a mean weight of approximately 245 kg and are 2-2.3 m long, compared to approximately 55 kg and 1-1.2 m for adult females (Kirkman et al. 2016; Kirkman and Arnould 2017).

It has been estimated that the yearly pregnancy rate of mature females of the species is 71% (Wickens and York 1997). Gestation is marked by delayed implantation which is followed by an active eight-month pregnancy to give birth 12 months after mating (Kirkwood and Arnould 2008). Prior to the delayed implantation of three to four months, the growth of the embryo is reduced, and it is believed that the delayed implementation process has evolved to allow seals to time mating and pupping co-incidentally (Kirkwood and Goldsworthy 2013), namely from November to January each year (Kirkwood and Goldsworthy 2013). Females normally give birth to a single pup, weighing about 6 kg at birth (Shaughnessy 1979). Compared to males, females reach sexual maturity at 3-6 years (Wickens and York 1997).

In terms of social organisation, brown seals are highly gregarious and can achieve very high densities at colonies partly because, unlike most other fur seal species, they are tolerant of high levels of bodily contact (being positively thigmotactic) (Warneke and Shaughnessy 1985; Kirkman and Arnould 2017). During the breeding season, however, they are less tolerant and more aggressive towards other individuals (IAATO 2021). Adult males arrive at colonies in advance of the November to January breeding season, from about October each year, to establish territories (Warneke and Shaughnessy 1985). Following antagonistic displays and fighting, the largest, most dominant males secure territories where females subsequently arrive to give birth and to mate (Warneke and Shaughnessy 1985). Breeding is polygynous, and a single territorial male may have a harem of up to thirty females, which he will defend aggressively against competing males (Kirkwood and Goldsworthy 2013).

Females normally deliver their offspring 1.5 to 2 days following their arrival at the colony, then after about another 6-7 days (during which they nourish their pup), they come into oestrus and mate (FAO 1978; Kirkman et al. 2016). The period soon after birth is critical for the female and her pup to become familiar with each other's calls and smell, as separation before they are adequately familiarised is disastrous for the pup in a dense colony (Kirkwood and Goldsworthy 2013). Adult females use their sense of smell to recognise their pups based on their distinctive scent, and a key way of communicating and recognising individuals is by nose-to-nose contact (Kirkwood and Goldsworthy 2013). Adult females will locate their pups using a distinctive call to which the pups will respond (Gili et al. 2018). After mating, the female will return to the sea to forage, abandoning the pup for its first bout of fasting (Warneke and Shaughnessy 1985) for up to 7-9 days (Rand 1949), reinforcing the need for familiarisation on return.

The peak of births is usually in early December, and most pups are born by mid-December, but some births may still occur in early January (Kirkwood and Goldsworthy 2013). At this stage, the harems begin to dissipate as exhausted males return to the sea to forage, having fasted for several weeks during the mating season. However, between the periods of parturition and weaning, the females engage in a pattern of alternating between feeding at sea and returning to the colony to nourish their pups until weaning in about September-October, with most pups fully independent by about 10 months after their birth (Warneke and Shaughnessy 1985). This ensures that a colony is inhabited year-round, with the lowest numbers usually occurring in about October, just before the breeding season. At this stage, most first-year animals are weaned and feeding independently at sea, most adult females are undergoing extended foraging trips in preparation for the forthcoming breeding season, and territorial males are beginning to arrive to stake their territories again (Warneke and Shaughnessy 1985; Gili et al. 2018).

Mortality rates are highest in the first few weeks after a seal pup is born. This is frequently due to starvation, but also can result from heat stress, drowning (pups cannot yet swim at this stage and will mostly drown if washed off the colony by storm waves), or, especially if colonies are situated on the mainland as opposed to an island (as is the case for several *Arctocephalus pusillus* colonies), predation by predators such as jackals (*Lupulella mesomelas*) (De Villiers and Roux 1992; Kolar 2005). After about six weeks to two months, the pups begin to learn to swim (Erdsack et al. 2013). Pups and older animals in the colony frequently enter the water to cool or play throughout the year; behaviour that is affected by the weather conditions (especially air temperature and wind) (Erdsack et al. 2013; Gili et al. 2018). For pups, such swimming provides essential learning and development in the water (Gili et al. 2018). By about June or July, pups are able to forage and supplement their milk diet (Warneke and Shaughnessy 1985). However, they are still relatively naïve in the water at this stage and are vulnerable to marine predators such as great white sharks (*Carcharodon carcharias*) (Kirkman et al. 2006).

2.1.2 *Distribution and abundance of the Cape fur seal population*

The Cape fur seal is the only seal that is native to Southern Africa, with its breeding range occurring from Ilha dos Tigres in southern Angola to Algoa Bay in South Africa (Balmeli and Wickens 1994; Winkler et al. 2019). According to Warneke and Shaughnessy (1985), the Cape fur seal is restricted to its immediate area and the seas of the continental shelf. Generally, seals forage within 93 km of the shore but also travel up to 220 km offshore to feed (Warneke and Shaughnessy 1985). Seals normally stay south of 18°S 12°E on the west coast but a few individuals do spread northward up to 11°S into the tropics (Stewardson 2001). On the east coast, individuals rarely travel further north than East London (Rand 1967), but a few Cape fur seals have been spotted following the Sardine Run to the north of East London during winter (O'Donoghue et al. 2010).

It is likely that the Cape fur seals historically bred on almost all the coastal islands off South Africa and Namibia (Kirkman et al. 2016). However, uncontrolled seal hunting and other human interference, such as the collection of guano or developments on the islands, resulted in the loss of seal colonies at most of the larger islands (Rand 1952; Shaughnessy 1984). Some of the seal colonies that were extirpated included those at Possession and Ichaboe Islands in Namibia, Robben and Dassen Islands on the west coast of South Africa, and Beacon Island in Plettenberg Bay (Rand 1972; Kirkman and Arnould 2017). Also, the colony that occurred at the point of the Robberg Peninsula, which was reportedly a non-breeding colony, was also extirpated by 1890 (Ross 1971; Huisamen et al. 2011).

By the beginning of the 19th century, the entire Cape fur seal population was reduced to less than 100 000 individuals, and breeding was restricted to small islands that were relatively inaccessible to seal hunters, but at some stage, seals also began to colonise some mainland locations in remote areas (Shaughnessy and Butterworth 1981). The recovery of the seal population during the twentieth century was mainly attributed to an increase in seal numbers at these mainland colonies (especially in restricted-access mining areas of South Africa and Namibia) (Rand 1972), with the population size estimated to be approximately 1.7 million individuals by the early 1990s (Butterworth et al. 1995). Seals have also recolonised some of the former island habitats from where they were historically displaced (e.g. Vondeling Island on the west coast of South Africa), following the discontinuation of guano collection at some of these locations so that there was no more permanent human presence (Kirkman et al. 2013). Seals have also returned to the Robberg Peninsula, where they began to haul out in numbers on the northern shore of the peninsula in the 1990s (Stewardson 2001). Seal numbers at Robberg increased constantly during the 2000s, with numbers reaching over 3 000 animals by about 2010 (Huisamen et al. 2011). Furthermore, the colony has been transitioning from a haul-out site to a breeding colony, where several hundred pups are now born each year (DFFE unpublished data).

2.1.3 *Diet*

Cape fur seals primarily feed on teleost fish and pelagic clupeoid fish such as anchovy (*Engraulis capensis*) and sardine (*Sardinops sagax*), as well as Cape horse mackerel (*Trachurus capensis*) and juvenile hakes (*Merluccius* spp.) (Shaughnessy 1985; David 1987a; Mecenero et al. 2006; Huisamen et al. 2011), caught mainly over the continental shelf (Stewardson 2001). Commercial fisheries also target these fish species but non-commercial fish species such as lantern fish (*Lampanyctodes hectoris*) and goby (*Sufflogobius bibarbatus*) also form part of seal diet in certain areas (Mecenero et al. 2006). The West Coast rock lobster (*Jasus lalandii*), as well as cephalopods such as the chokka squid (*Loligo vulgaris reynaudii*), are also present in the diet (David 1987a; Lipinski and David 1990). Certain seabird species (e.g. African Penguins (*Spheniscus demersus*) and Cape Cormorant (*Phalacrocorax capensis*)), are also occasionally preyed upon by Cape fur seals (Mecenero et al. 2005; Makhado et al. 2013).

2.1.4 *Human interactions with Cape fur seals, with a focus on ecotourism*

Interactions between humans and seals occur in several ways, resulting in costs to either the seals or the humans (Stewardson et al. 2008). The commercial hunting (commonly referred to as "sealing") of Cape fur seals began in the 17th century (Butterworth et al. 1995) and by the time seals were given some form of protection in 1893, more than 20 island colonies had been eradicated (Rand 1959; Best and Shaughnessy 1979; Shaughnessy 1984; Griffiths et al. 2004). Sealing was banned in South Africa in 1990, but it continues to be practiced in Namibia (Kirkman and Lavigne 2010; Kirkman et al. 2013).

Cape fur seals are considered pests by many fishermen (Wickens et al. 1992), who have suggested that the numbers of seals should be drastically reduced to decrease their interference with fishing operations and competition for fisheries resources (Harwood and Walton 2002). There have therefore been frequent calls for seal culls by fishermen in South Africa to reduce economic losses for their industry, especially since the cessation of seal harvesting in South Africa (Wickens et al. 1992).

The growth of seal-based tourism in South Africa and further afield provides a positive economic value to seals, countering the argument that they are merely pests (Kirkwood et al. 2003). The fact that Cape fur seals can be found resting ashore at breeding and haul-out sites throughout the year (David 1987b) makes fur seals easily accessible for viewing experiences by ecotourism operations. This includes operations that target seal viewing, but seal colonies also provide a guaranteed supplementary viewing experience for operations that target more elusive animals such as whales, dolphins or sharks (Kirkman et al. 2016). Seal colonies also underpin shark viewing operations because the colonies attract the sharks and cause them to aggregate conveniently for tourist viewing (Pfaff et al. 2019). Kirkwood et al. (2003) showed a gradual rise in seal-viewing tourists, boats, as well as operators in South Africa since the 1970s, possibly reflecting an increase in foreign tourists to South Africa. October to January (summer) and peak seasons such as Easter (in April) are reported as the busiest times for seal viewing in most areas in South Africa (Kirkwood et al. 2003). Data reported by Kirkwood et al. (2003) indicated that South Africa generated the highest value of seal viewing ticket sales out of 14 countries in 2001.

Worldwide, there has been a trend towards more interactive tourist experiences with marine animals, with growth of within-water activities (e.g. snorkelling) to view and interact with marine animals in addition to viewing from land, boats or kayaks (e.g. Barton et al. 1998; Spradlin et al. 2001; Gales et al. 2003; Kirkwood et al. 2003). In South Africa, swim- or dive-with-seal encounters are on offer at Hout Bay, Cape Town, and at Robberg, Plettenberg Bay. These and other types of ecotourism activities can both generate local income and job opportunities but also have an indirect contribution to awareness and conservation, as reported by Pfaff et al. (2019) for the False Bay area. For example, prior to the swim-with-seal (SWS) tours at both the Cape Town and Plettenberg Bay sites, tourists are informed about aspects of the history, life cycle and ecology of Cape fur seals and are educated on how to safely interact with the seals. At the Cape Cross seal colony in Namibia, a brochure was made available by the Ministry of Environment and Tourism soon after 1972 to educate visitors on how to reduce their impacts on the colony (Shaughnessy 1982).

At the commencement of this study, no formal permitting system for the SWS industry in South Africa was in place, comparable to the boat-based whale-watching or shark cage diving permitting systems. The only permitting required was a South African Maritime Safety Authority (SAMSA) permit to operate the boats. Thus, there was no formal regulation of activities – rather, operators were supposed to operate in terms of an agreed code of conduct that provides guidelines on the number of tourists that can participate at a time, and the behaviour of the operator and tourists (see Appendix A). Considering the increase in the number of operators and the potential for further growth, the DFFE may need to consider greater regulation of the activity. Research on the impacts or potential impacts of the activity would be essential to inform such regulation.

2.1.5 *Protection of Cape fur seals in South Africa*

Cape fur seals in South Africa were first afforded management protection by an Act of the Cape Parliament in 1893 (Shaughnessy 1984) and more recently under the Sea Birds and Seal Protection Act 46 of 1973 (SBSPA, 1973). The Policy on the Management of Seals, Seabirds and Shorebirds that was formulated in 2007 (DEAT 2007) in terms of the SBSPA, stated that regulation of disturbance to seals, seabirds and shorebirds was required and that “suitable restricted areas will be proclaimed around mainland colonies and breeding islands; however, provision will be made for sustainable tourism” (DEAT 2007). The Policy advised that speeding of recreational vessels close to breeding colonies should be limited and ecotourism vessels should be subjected to a code of conduct and associated permit conditions. The Policy recognised the increasing tourism attraction of colonies of seals, shorebirds and seabirds and thus has as one of its objectives "the sustainable, non-consumptive use of seals, shorebirds and seabirds to (sic) ecotourism, given that access to colonies and controlling or preventing disturbance to these animals is managed through the provisions of this policy". The Policy also recognised the need to undertake research and monitoring towards ensuring the conservation and sound management of seal, shorebird and seabird populations, as well as the sustainable non-consumptive usage of these animals and any ecosystem services that they supply.

Both the SBSPA and the associated Policy informed the development of the Threatened or Protected Species Regulations (ToPS Regulations 2017) under the National Environmental Management: Biodiversity Act (Act 10, 2004), in terms of which the Cape fur seal is listed as a Protected Species (as per the ToPS list of 2017). The purpose of the regulations is to control and permit activities that could potentially impact listed species. In the regulations, the harassment of seals and attraction of seals (for example, by baiting) is not allowed in terms of Section 57(2), except under permit exemption for management, scientific, conservation or rehabilitation purposes. Harassment is defined in the ToPS Regulations as: "behaviour or conduct that threatens, disturbs or torments a live specimen of a listed threatened or protected marine species". Activities considered as harassment to seals, as per the ToPS Regulations, include "approaching a seal colony with a vessel closer than 15 meters or any person approaching a colony closer than 5 meters". This regulation has implications for how tourist activities such as swim-with-seals can be conducted, including regarding approach distance to the colony and any disturbance that arises therefrom.

2.2 Behaviour as an indicator of disturbance, with an emphasis on seal ecotourism

Bishop et al. (2015) identified that behavioural observations (and any succeeding behavioural alterations stemming from human disturbance) are a common way to evaluate the impact of tourism on seals. Boren (2001) highlighted prime areas of concern regarding how seals or other wildlife may be affected by tourism, including behavioural shifts in response to a stimulus. According to Richardson et al. (1995), Barton et al. (1998) and Boren (2001), these shifts are not always constant within a species, as the behavioural reactions may vary by location or even between individuals within the same area.

Behavioural or physiological shifts in response to tourism have been demonstrated in some other groups of animals. Cate (2013) provided a hypothetical example of how different herds of bison (*Bison bison*) in the same nature reserve might respond to controlled tourist approaches towards the herds, including a herd's flight response, huddling to protect younger individuals or a habituated response. According to Culik and Wilson (1991), human presence at penguin breeding grounds may not have an obvious effect on their behaviour, but a change in the heart rate can provide a reliable indicator to quantify their stress level in the event of a disturbance. They showed that when breeding Adèlie penguins (*Pygoscelis adeliae*) were approached by a human, their heart rates increased by nearly 50%, and heart rates increased by 270% when the birds were captured and weighed (Culik and Wilson 1991). Penguins that were incubating large chicks deviated by 70 metres when approached by a person at a distance of 20 metres and fled when approached closer than six metres (Culik and Wilson 1991).

Marine mammal-based ecotourism can have conservation and socio-economic benefits if carried out responsibly; however, these ventures can impact animals adversely if not carried out in a responsible manner (Spradlin et al. 2001), which may then have implications for the sustainability of the industry. Constantine (2001) found that the responses of wild bottlenose dolphins (*Tursiops truncatus*) to swim-with tourism were mainly affected by the placement of swimmers. Most of the dolphins showed an avoidance response when swimmers were placed in their path, with mainly juveniles interacting with swimmers. It was concluded that the dolphins have become sensitised to the swim-with-dolphins activities as a result of regularly being exposed to the stimulus (Constantine 2001). Southern right whales (*Eubalaena australis*) in Patagonia reacted both negatively and positively in response to the oncoming boats (Argüelles et al. 2016). The whales responded positively (approaching the boat and attempting to make contact) or negatively (avoiding contact with the boat by moving away from it) when the boats approached the whales with the engines off or on, respectively. Fiori et al. (2019) studied the behavioural responses of humpback whales (*Megaptera novaeangliae*) to vessel and swimming tourism activities in Vava'u, Kingdom of Tonga, and found that the whales react negatively to both swimming and observing activities. Vertical avoidance responses were significantly demonstrated by mother-calf pairs, with the humpback whale mothers carrying out longer diving periods in the presence of swimmers and whale-watching vessels. Humpback whales near Isla de la Plata, Machalilla National Park, Ecuador, showed an increase in swim speed when approached by whale-watching vessels (Scheidat et al. 2004), and in Hawaii, humpback whales responded similarly when whale-watching boats were present, as reported by Au and Green (2001) and Bauer and Herman (1986). In a study done by Cassini (2001), South American fur seals (*Arctocephalus australis*) reacted strongly to tourist approaches on land, but it was mostly only when tourists approached the seals to within 10 meters. When the distance was kept at 10 meters or more, almost no response was observed. Tourist behaviour and attitude also played a role in the behavioural changes of these seals, in that seals showed nearly no response when tourists were calm but the responses increased when visitors were disorderly (Cassini 2001). In a study on grey seals (*Halichoerus grypus*) in the United

Kingdom, the results indicated that breeding colonies of the seals tended to be associated with areas of low tourist disturbance, indicating avoidance of most locations with higher disturbance (Lidgard 1996).

Although clear evidence of negative impacts on the survival and reproduction of seals and other marine taxonomy is lacking, many behavioural or physiological changes caused by disturbances are believed to lead to adverse effects. Irresponsible execution of tourism activities can lead to both short and long-term impacts on the target animals (Kirkman et al. 2016). Short-term behavioural responses are easy to detect but may also lead to long-term changes that might have negative effects on reproduction (Boren 2001), which ultimately may impact the species population demography (Ward and Beanland 1996). Behavioural modifications in response to a disturbance may bring about alterations in the activity budget for individual seals (Boren 2001). For example, seals are known to haul out or spend time resting onshore which is essential for thermoregulation and energy conservation (Boren 2001; Back et al. 2018). Any significant alteration to energy budgets by outside disturbance may decrease energy conservation and consequently affect the fitness of an individual (or the colony as a whole), and if this occurs during the breeding season, can impact the maternal investment by compromising the mother-pup bond, potentially leading to the abandonment of offspring (Kovacs and Innes 1990; Boren 2001; Boren et al. 2002). Even if pups are not abandoned, the efficiency with which mothers transfer energy to their pups can be affected by disturbance, affecting the growth and survival of pups (Boren 2001; French et al. 2011). While disturbance is most critical during the breeding season for young pups, it applies to the entire lactation period (Boren 2001). Heightened nervousness and aggression caused by a disturbance in the breeding season, which is when seals are most sensitive to disturbance, can also result in increased conflict between adults, consequently causing young seals to be crushed, smothered or wounded (Boren et al. 2002). Also, Cape fur seals typically flee from approaches by people when on land; therefore, human disturbance can result in stampeding injury or death, largely to pups (Mattlin 1978; Kirkman et al. 2016). This can be through crushing, or drowning if they are knocked into the water before they are able to swim. Furthermore, regular, excessive disturbance at a particular site may cause seals to make recurrent trips to sea and site avoidance in the long term (Boren 2001; Bejder et al. 2009). Although Barton et al. (1998) noted that it is rare for fur seals to abandon a site, this behaviour has been noted in harbour seals in response to frequent marine traffic (Newby 1971).

Alternatively, chronic disturbances that do not directly result in harm to animals can result in habituation. Sternberg (1995) considered habituation as an extreme behavioural modification of animals to outside disturbances. Seals may become habituated because of regularly being exposed to a stimulus to the point where they become oblivious to it and responses decrease as tolerance to threats increases. While habituation may be regarded as a benefit that could possibly contribute to the success of tourist encounters, it is an unnatural behavioural modification which can have significant consequences in terms of responses to real threats (Boren 2001). On the other hand, disturbance that has a traumatic effect on the animals can result in sensitisation, which is essentially an increase in response intensity after exposure to aversive stimuli (Schakner and Blumstein 2013). Examples of sensitisation in seals include increased flee response to intensive human disturbance as observed in the grey seal to frequent acoustic stimuli (Götz and Janik 2011). Sensitisation can also be caused by research activities (Boren et al. 2002); for example, some studies involve the handling and capturing of animals, which can result in significant disturbances (Boren et al. 2002). These disturbances could eventually lead to animals moving from favoured habitats (Gales et al. 2003; Newsome and Rodger 2007).

From the above, it is evident that there have been several studies of the impacts of swim-with or boat-based tourism on cetaceans (Corkeron 1995; Constantine 2001; Nowacek et al. 2001; Williams et al. 2002; Stockin et al. 2008) and of boat-based or land-based tourism on seals (Kovacs and Innes 1990; Cassini 2001; Boren et al. 2002; Back et al. 2018). However, there has been less research on behavioural responses of seals to swim-with-seal tourist activities (Boren et al. 2008), and behavioural research on the responses of Cape fur seals to tourism is generally lacking.

2.3 Marine Protected Areas and Tourism

Globally, marine protected areas (MPAs) have been established to manage marine areas for biodiversity and conservation (Attwood et al. 1997; Edgar et al. 2007; Edgar et al. 2014; Wilhelm et al. 2014; Pham 2020), with a significant increase in the number of MPAs being proclaimed in recent decades as countries attempt to address global targets for ocean protection set by the Convention on Biological Diversity (CBD) (Edgar et al. 2007; Kirkman et al. 2021). While different MPAs may vary in attributes such as their size and objectives, preventing overutilisation of ocean resources is the common goal of many (Pham 2020). However, there are frequently socio-economic costs arising out of MPA establishment, especially for local communities and stakeholders (Sanchirico et al. 2002; Mann-Lang et al. 2021). For example, limiting or restricting activities such as fishing can impact the livelihoods and wellbeing of local people (Sanchirico et al. 2002; VanIderstine 2019). Additional costs may include potential congestion costs for fishermen if they are moved to other areas, as well as opportunity costs (Sanchirico et al. 2002; VanIderstine 2019). Because of such costs, local communities often have little incentive to support MPAs. However, non-consumptive activities such as tourism in MPAs can provide an alternative livelihood and source of income for locals (Goodwin and Roe 2001;

Bushell and McCool 2007), and in well-managed MPAs, tourism can benefit local communities by improving socio-economic outcomes (Kenchington et al. 2003; Kirkman et al. 2023).

In South Africa, the establishment of MPAs has been used as a management tool since 1964, when the first MPA was declared (Lombard et al. 2020). The declaration of several other coastal MPAs followed, but by 2014, only approximately 0.5% of the national waters (territorial waters and exclusive economic zone of continental South Africa) was protected (Chadwick et al. 2014). Documented shortcomings with the MPA network included inadequate ecosystem representation especially for offshore ecosystems and biodiversity (e.g. Sink et al. 2012; Solano-Fernandez et al. 2012). Building on the findings of systematic conservation plans that were utilised to identify areas with gaps in protection (e.g. Clark and Lombard 2007; Sink et al. 2011; Chalmers 2012; Harris et al. 2012; Majiedt et al. 2013), MPA expansion was undertaken as part of the government's Operation Phakisa initiative, a strategy to support sustainable economic development in South Africa's oceans (DPME 2015; Sink 2016). Following extensive planning and consultation, 20 new MPAs were added in 2019, mostly offshore (Sink et al. 2019). The resulting increase in MPAs in national waters brings the number to 41 and the percentage of MPA coverage to 5.4% (Kirkman et al. 2021).

Ecotourism activities are offered in a number of MPAs in South Africa. In the Tsitsikamma MPA, the earliest declared MPA in South Africa (Sink et al. 2019), scuba diving, hiking and kayaking are some of the ecotourism opportunities on offer (Turpie et al. 2006). According to Kepe (2001), recreational fishing was the principal recreational activity of 47 percent of visitors to the Mkhambathi MPA, demonstrating the importance of fishing to tourism in some marine protected areas. Boat-based seal and whale watching, scuba diving, kayak tours, white shark cage diving and swimming with seals are among the other activities available within the Table Mountain National Park MPA (Pfaff et al. 2019). One of the goals of the Robberg MPA, which was established in 1998 in terms of the Marine Living Resources Act 2000 (Government Notice 21948), is the promotion of ecotourism opportunities that are non-consumptive (CapeNature 2006). Visitors to this MPA have the opportunity to enjoy hiking, recreational fishing, bird watching, whale and dolphin watching, kayaking, seal viewing from boats, and, more recently, swimming with seals.

2.4 Chapter outcomes

This chapter presents a discussion on the life history and behaviour of Cape fur seals, and their distribution both globally and within South Africa and considers human interactions with Cape fur seals, with a focus on ecotourism and the relevance of marine protected areas. With reference to Objective 1 of this thesis, the literature reviewed indicated that fur seal tourism activities can alter the behaviour of seals – various behavioural changes were observed in previous studies as a result of human disturbances on seal colonies. The majority of the literature reviewed provided information on the impacts of boat-based and land-based viewings on seals, with limited information on SWS activities and their effects on Cape fur seal behaviour.

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CHAPTER 3: FIELD MATERIALS AND METHODS

3.1 Study Area

This study was carried out on the northern shore of the Robberg Peninsula (Figure 3.1), which forms the southern extent of Plettenberg Bay (Schutte-Vlok et al. 2013). The peninsula is protected within the Robberg Nature Reserve, and the waters up to one nautical mile from the shore of the reserve have been declared a marine protected area (MPA) bounded by the latitudes 34°04’.916S and 34°07’.633S and the longitudes 023°22’.300E and 023°25’.967E (CapeNature 2006; Schutte-Vlok et al. 2013). Both the MPA and the nature reserve are managed by CapeNature and cover 2 241 ha and 185.3 ha, respectively (CapeNature 2006; Schutte-Vlok et al. 2013). Historically, two seal colonies occurred in Plettenberg Bay, at Beacon Island and at seal Point at Robberg (Shaughnessy 1982; Stewardson 1999). A governmental official's anecdotal record indicates that approximately 3,000 seals inhabited Robberg around 1833 before the seals were hunted to extinction (Ross 1971). Cape fur seals started to recolonise the Robberg Peninsula in the 1990s, where they began to haul out in numbers on the northern shore of the peninsula (Stewardson and Brett 2000). Whereas the colony was predominantly inhabited by non-breeding age classes in the early 2000s, the number of seal pups born yearly has been reported to be increasing (Huisamen et al. 2011). The colony is therefore transiting to a breeding colony, which given the available area could achieve a substantial size (Stewardson 2001).

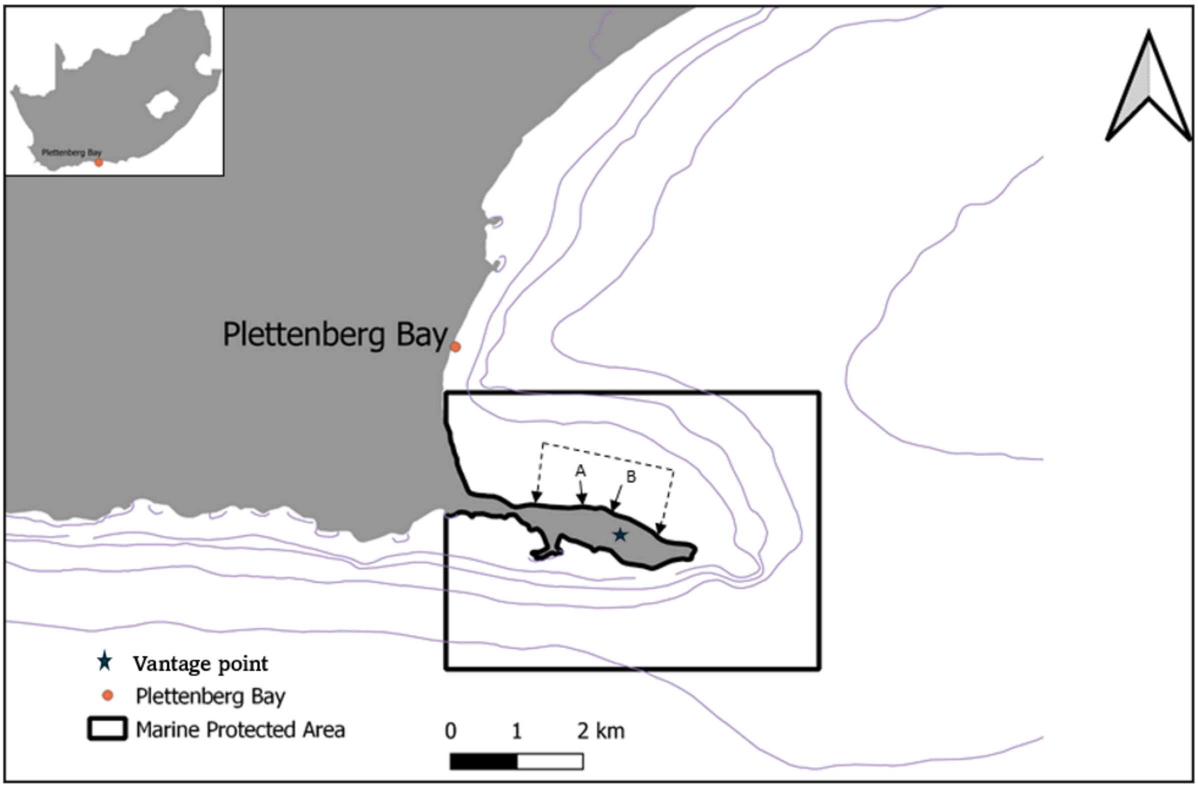

Figure 3.1: Map of the Robberg Peninsula showing the Robberg MPA and the two sites (A and B) where swim-with-seal activities occur. Site A and B are approximately 357 m and 160 m from the vantage point (at 33°6'12.2" S, 23°24'6.2" E). The current extent of the seal colony is indicated by the dashed lines

The Robberg Peninsula has a warm temperate climate and is classified under the temperate oceanic climate (Cfb) zone according to the Köppen classification (Schulze 1947) and experiences adequate precipitation throughout the year (Schulze 1947; CapeNature 2006). Inshore countercurrents and upwelling of colder water are occasionally caused by the fast-flowing Agulhas Current, particularly after periods of strong easterly winds (Schumann et al. 1982; Lutjeharms et al. 2000; Lutjeharms and Ansorge 2001), while warm water intrusions are a common occurrence (Goschen et al. 2012). In summer and winter, rough seas are typically associated with strong easterly winds and westerly cold fronts, respectively (van der Vyver and Conry 2020).

The MPA is currently open to line fishing from the shore but does not allow fishing from vessels or spearfishing (CapeNature 2006). The entire MPA is open to passing vessels and SCUBA diving activities (CapeNature 2006). Several tourist activities take place within the MPA such as SCUBA diving charters, kayaking, boat-based whale watching, viewing of dolphins and Cape fur seals, and SWS (CapeNature 2006).

Swim-with-seal operations and local site conditions were focused on the activities of the SWS ecotourism operator, Offshore Adventures, and on observing the seals' behavioural responses to these activities. Tourists are transported by the operator in an 8 m rigid hulled inflatable boat from Central Beach, Plettenberg Bay, to Robberg. The operator would select one of two sites (A or B; Figure 3.1 and Plate 3.1 or Figure 3.2) for the SWS operations, depending on conditions and/or the numbers of seals in the water at each site. Site A is a more exposed site than Site B, experiencing more choppy conditions at times. Site A was also larger and steeper than Site B, and both sites are only accessible to tourists by boat. The COVID-19 pandemic meant that normal operations were often restricted during the planned study period, and when allowed, were often limited due to a lack of tourists. With the cooperation of Offshore Adventures and facilitation by Natures Valley Trust (NVT), some "proxy operations" were undertaken whereby volunteers were used to mimic tourists in the water. This assisted in increasing the observational sample size and was necessary to compensate for the unanticipated impacts of COVID-19 on the study. Data collection assistance was provided by CapeNature and NVT volunteers and Department of Forestry, Fisheries and the Environment staff and interns throughout the study period.

3.2 Operations

Tourists were always informed by the operators about the biology and behaviour of the Cape fur seals and how to interact with the seals, either at Central Beach before embarkation, or on route to the seal colony. Within 200 m of the colony, the boat proceeded at a no-wake speed unless safety concerns arose. The boat would approach the colony towards site A and either dropped the swimmers there, or proceeded to site B, depending on conditions. The swimmers were dropped at between 50 and 100 m from the colony, dependent on weather and sea conditions, and where a seal raft (a group of seals in the water) was located. Once the swimmers were in the water, the boat would move away to between 20-70 m from the swimmers, and idle constantly for the duration of the swimming activity to avoid causing excess noise.

To adequately assess the possible impacts of the SWS activity, both an Impact site (an area that was exposed to SWS tourist activities) and a spatially distinct Control site (where no activity was occurring) were chosen to compare behavioural responses of the seals to the tourist activities. This requirement greatly affected the choice of study site, as it was important to be able to observe both an Impacted and a Controlled site concurrently from the same vantage point. Whichever site (A or B) was selected by the operator for SWS was the Impact site at the time, while the other site functioned as the Control site. In other words, it was necessary for the Impact and Control sites to be inter-changeable as the location of the Impact was operator determined. For convenience we refer to Site A as "Control West" when this site functioned as the control (meaning that Site B, in the east, was the Impact site at the time), and Site B as "Control East" when it functioned as control site (meaning that Site A, in the west, was the Impact site at that time). Observations of both sites were conducted Before, During and After tourist activities, constituting three different observational phases.

Figure 3.2: Detailed map of sites A and B (referred to as Control West and Control East, respectively, when either was used as Control site) and the vantage point (C) from where observations were conducted. Image from Google Earth copyright 2024 Airbus

3.3 Data collection

Data were collected in 2020 (10 November-27 November) and 2021 (3 April-28 September) from the cliff tops above the seal colony on the northern shore of Robberg Peninsula in the Robberg MPA (Table 3.1). The basis of data collection was sequences of photographs covering the Impact and Control areas of the colony at time intervals Before, During and After the SWS activity, and supplemented by videography and visual observations (using Pentax 7x50 Marine Binoculars). Photographs and video recordings were taken using a Nikon D7000 with a Tamron 150-600 zoom lens. Data collection took place during the day between 09h00 and 16h00 and was carried out by three to four observers from the vantage point above the seal colony (Figure 3.2). Typically, three sets of photographs were taken at 10-minute "counting intervals" Before the boat arrived and during the SWS activities. Two sets of photographs were taken "After" the boat departed. Some sets were taken in less than 10-minute intervals (mainly "Before" and "During"), if, for example, the boat was launched earlier than expected, requiring shorter intervals to be able to include sufficient sets of photographs. The Before sets of observations started approximately 30 minutes before the boat arrived, with the first “During” session commencing as soon as the boat approached the colony. Once the swimmers entered the water, the second session was started, and the third 10 minutes later. The “After” sessions commenced 10 minutes after the boat had left. Apart from the record of seals within the Impact and Control sites of the colony, the numbers of seals entering and leaving the water at each counting interval was also enumerated for the Impact and Control sites. While the two sites were not equally distant from the vantage point, the fact that the Impact and Control functions were alternated between the sites (see Figure 3.2) meant that these differences were not expected to affect the results.

The photographs provided information on the number of seals on land and allowed quantification of seals in different behavioural states. Although the age and sex of animals can affect the nature of response to disturbances (Barton et al. 1998; Shaughnessy et al. 2008; Holcomb et al. 2009), it proved difficult to determine age and sex on the photographic images taken from elevation. Thus, age and sex were disregarded in the analyses. Co-incident data were also collected on the numbers of swimmers in the water, the duration of activities, the presence of other boats and wildlife (e.g. dolphins, sharks, and the presence of an elephant seal), and the environmental conditions (air and seawater temperatures, swell height and direction, visibility, and cloud cover) at each 10-minute counting interval. Sea temperatures readings were done by the tour operator, Offshore Adventures, using a transducer that was connected to a GPS. Other distances that were estimated (using a Nikon Forestry Pro II Laser Rangefinder) were between: the vantage point to the boat, boat and Control site, boat and Impact site, boat and seal raft, swimmers and raft, swimmers and the Impact site (closest distance to shoreline at this site), the vantage point and the Impact site, the boat and the swimmers, and the vantage point and Control site. These distances were recorded once the boat came to a standstill after moving away from the swimmers. The rangefinder measured the distance from the boat to a designated “proxy rock” at the Impact and Control sites. This proxy rock was pre-identified at each site to serve as a fixed reference point for consistently measuring the distance between the boat and the site.

The classification of different behaviour types used in the study was partially based on the behavioural classes used by Boren (2001). Seals on land were classified from the photographs into one of three “primary” behavioural states based on their postures, namely lying down, sitting or moving. These three states were mutually exclusive to each other, in that seals could not be exhibiting more than one behaviour at a time. However, seals within these categories could also be displaying other behaviours. Thus, four more “secondary” behaviour types were recognised, namely grooming, nourishing, interacting (with other seals, but not inclusive of nourishing), or alertness (alert behaviour in the current study referred to seals that were sitting while looking with focused attention at the approaching boat and SWS activity, indicating that seals were not resting). The numbers of seals in the colony displaying each of the above behaviours were counted on the images using IrfanView software, version 4.56 (Irfan Skiljan, Graduate of Vienna University of Technology), with seals on the images marked using different colours according to behavioural type(s) and enumerated per behavioural types. Seals entering or leaving the water were also counted at the same intervals but counts of seals in the water were not possible. The focus of this thesis was on the terrestrial behaviour of seals, as their behaviour in the marine environment could not be examined. While marine behaviour was beyond the scope of this study, the emphasis on terrestrial interactions is particularly relevant. Seals are more vulnerable to human disturbance on land, where they have evolved an instinctive fear response. This heightened sensitivity to human presence is not as apparent when they are in the water.

Table 3.1: Gantt chart showing the distribution of observation effort during 2020 and 2021 (indicated in grey) (n = 38 days). No observations were conducted on the days indicated by the black shade due to bad weather conditions

Period	Day of the month																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
November 2020																															
April 2021																															
September 2021																															
October 2021																															

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CHAPTER 4: DO SWIM-WITH-SEAL ACTIVITIES ALTER THE BEHAVIOUR OF CAPE FUR SEALS IN THE ROBBERG COLONY?

4.1 Introduction

In recent decades, tourism has grown rapidly throughout the world (Stafford-Bell et al. 2012) and Miller (1990) and Orams (1995) found marine-related tourism to be one of the primary contributors to the growth of the tourism sector. In particular, marine tourism involving marine mammals has proliferated, with pinnipeds increasingly a target of guided tourism ventures, including "swim-with" programs (Hoyt 2001; Boren et al. 2002). In some parts of the world, such as New Zealand and Australia (Constantine 1999; Boren et al. 2002; Scarpaci et al. 2005), financially viable swim-with-seal (SWS) enterprises are common. However, scientific studies have shown that tourism activities can affect pinniped behaviour in noticeable ways (Kovacs and Innes 1990; Cassini 2001). Tourist activities have been shown to induce short-term behavioural changes such as changes in seal vocalisations (Terhune et al. 1979), a reduction in attendance by lactating mothers, in turn affecting pup behaviour (Kovacs and Innes 1990), and an increase in threat behaviours by seals associated with visitor proximity (Cassini 2001). Short-term changes are usually easily detectable (Kirkman et al. 2016) but they can lead to long-term changes that are more difficult to quantify and have not been quantified. These changes may have deleterious impacts on life history parameters including reproduction (Boren 2001). Impacts on reproduction may cause a reduction in population size as a result of decreased breeding success (Ward and Beanland 1996), which could affect the viability of seal-based tourism enterprises in the long run. Individual seals may alter their activity budgets as a result of behavioural changes in response to disturbances. Also, time spent ashore is essential for thermoregulation and energy conservation and if significantly altered by outside disturbances, could ultimately affect the fitness of an individual or colony (Boren 2001).

Swim-with-seal ventures have become a popular tourist attraction at two Cape fur seal colonies in South Africa (at Duikerklip and at the Robberg MPA) (Nature's Valley Trust 2020). The number of companies offering the activity has recently increased at both sites, and there is concern about the possible impacts of the activities on the seal colonies. Potential deleterious effects on seal behaviour (leading to longer term impacts) have implications for the Department of Forestry, Fisheries and the Environment (DFFE) in terms of their mandate to manage seals as a Protected Species under the National Environmental Management: Biodiversity Act (NEMBA), Threatened or Protected Species (ToPS) List. Adequate management of these activities requires research to determine their impacts for an informed and evidence-based approach to management decisions. The primary objective of this chapter is to determine whether SWS tourism at a Cape fur seal colony brings about behavioural changes in seals, through an adequately designed scientific study (the related objective of advancing evidence-based recommendations towards effective regulation and sustainable industry practice and effective regulation is expanded on in Chapter 6).

4.2 Data collection

4.2.1 *Research effort*

Swim-with-seal (SWS) observations were conducted for 54 swim-with-seal trips during 38 days between 10 November 2020 and 19 October 2021. Each SWS trip was thus equivalent to an observation session, comprising observations conducted during each of the three phases (Before, During and After) at both Control and Impact site. Observations were also conducted in 10-minute counting intervals, during which photographs were taken before the boat arrived and during the swim-with-seals activities. The total number of counting intervals across all phases was 406. The mean number of observation sessions per observation day was 1 (SD ± 0.55) and the mean number of counting intervals per observation day was 10.68 (SD ± 0.75). The number of observation sessions was similar between Control West (n = 26 for 22 days) and Control East (n = 28 for 21 days).

4.2.2 *Data analysis*

Statistical analyses of the observation-data from the Control and Impact sites Before, During and After the swim-with-seal activity were conducted using STATISTICA software version 14.00.15 (StatSoft 2020). These analyses included the numbers and the associated percentages of seals counted within each of the primary (lying down, sitting or moving) and secondary behavioural categories (grooming, nourishing, interacting, and alert, hauling out of the water or entering the water) during each phase. Data were formatted in a design for a Two-factor Repeated Measures Analysis of Variance, with factors being Phase (Before, During, After) and Site (Impact, Control), and with Site as the Repeated-Measure factor. There was an equal number of cases between sites but not between phases; hence the design was unbalanced in this regard and Repeated Measures could not apply to Phase.

Prior to analysis, the data were assessed for normality (histogram, q-q plot and Shapiro-Wilks test for normality). Where the assumption of normality was not met, the data were transformed using the arcsine transformation (Zar 1984):

$$P' = \arcsin(\sqrt{p})$$

Where:

P'- arcsine transformed proportion

$\sqrt{p}$- square root of the proportion

Where the transformed data met normality, the Two-factor Repeated Measures Analysis of Variance was performed on the transformed dataset. Where the transformed data did not meet the assumptions of normality, distribution-free non-parametric tests were performed, namely single-factor, non-parametric Kruskal-Wallis H tests to test for differences between the phases for each site, and non-parametric Wilcoxon Matched Pairs Test being used to test differences between the Impact and Control sites. The significance level for all analyses was set at $p < 0.05$.

Data were also considered separately for analyses according to the identity of the Impact and Control sites, in particular whether Site A (Control West) or Site B (Control East) was used as the Control. This, of course, was determined by which site the SWS activity occurred in a session. This separation was motivated because it was noted that when the vessel approached the East to conduct activities at Site B, it had to pass by Site A, potentially affecting seal behaviour in passing and hence the quality of the Site A as a Control site.

4.3 Results

4.3.1 *Statistical analyses*

Primary behavioural categories

Of the primary behavioural categories, most of the animals in the colony were observed to be lying down (74%), followed by sitting (23%), followed by moving (3%) (Figure 4.1). These behavioural patterns were typical for both the Impact and Control sites irrespective of the location of the sites, and for each phase (Before, During, After). The proportion of animals lying down in the Control vs Impact and the Before vs During vs After (Figure 4.1), were consistent with a normal distribution (Table 4.1), and this was also the case when the Control East and Control West data were considered independently (Tables 4.2 and 4.3, respectively). For the Overall data, as well as when Control East and Control West data were considered independently, the data showed a significant difference in the proportion lying down between sites, but no significant differences in the proportion lying down between phases. However, for the Control East data only a significant interactive effect was evident, indicating that the proportion of animals lying down in the Impact site changed relative to the proportion in the Control site over the phases (Figure 4.2). This is corroborated by the Wilcoxon matched pair tests which found significant differences between Control and Impact in the Before and During phases, but no significant difference in the After phase (Table 4.2). By examining Figure 4.1B, the proportion of animals lying down in the Impact site declined relative to the Control site.

The proportion of animals sitting in Control vs Impact and Before vs During vs After, were also consistent with a normal distribution for the Overall data and for Control East and Control West data (Tables 4.1–4.3). For the Overall data and the Control West data, there was a significant difference in the proportion sitting between Control and Impact, but no significant difference between the phases, nor any significant interactive effect (Tables 4.1 and 4.3). For Control East on the other hand, no significant difference was found either between phases or between the sites, but there was a significant interactive effect, indicating that, as for lying down, the proportion of seals sitting in the Impact site changed relative to the proportion in the Control site over the phases (Figure 4.2). This was once again supported by the Wilcoxon matched pair tests, which found significant differences between Control and Impact in the Before phase, but no significant difference in the During and After phases (Table 4.2). By examining Figure 4.1B, the proportion of animals sitting at the Impact site increased relative to the Control site, between the Before and During phases.

For movement data, none of the datasets (Overall, Control East, and Control West) were consistent with a normal distribution, and so only non-parametric tests were applied. The patterns and statistical results for the movement data were somewhat contrary to expectations. In the Overall data, the Kruskal-Wallis test showed a significant difference in the proportion of seals moving between phases, but only at the Control site and not at the Impact site (Table 4.1). This was also the case with Control East data (Table 4.2), where the Wilcoxon matched pair tests also showed significant differences between Control and Impact in the proportion of animals that were moving for each of the phases. However, Figure 4.1B, shows that the greatest movement of animals occurred at the Control site. No significant differences in the proportion of seals moving were shown for the Control West data, across the phases or the sites (Table 4.3).

Table 4.1: Two-factor repeated measures Analysis of Variance on “Overall data”, or Kruskal-Wallis and Wilcoxon matched pairs tests performed to test for differences in the proportions of Cape fur seals in different behavioural categories. These analyses compared differences between sites (Control and Impact) and between phases (Before, During, After) in response to disturbances caused by swim-with-seal tourism. Selection of test (parametric ANOVA vs non-parametric Kruskal-Wallis or Wilcoxon tests) depended on the outcome of normality testing, namely the Shapiro-Wilk test for normality, performed for each behavioural category using first raw percentage values and then arcsin transformed values if the test indicated that the raw percentage values failed the normality test. According to the normality test, the data are consistent with the normal distribution only if p-values are > 0.05 (indicated as underlined). Results of two-factor repeated measures Analysis of Variance compare the percentages of seals (arcsin transformed values and raw percentages) in different behavioural states between sites and observation phases, with site as the repeated measures factor. Where the result is presented as n = 1, this indicates that the proportion of animals corresponding with a behavioural category was not enough to perform test statistics. Subscripts indicate degrees of freedom; results are significant at p < 0.05 (indicated by asterisks and in bold)

Behaviour	**Results of normality testing**		**Results of two-factor repeated measures Analysis of Variance**			**Kruskal-Wallis H Test**		**Wilcoxon Matched Pairs Test**		
	Raw numbers/ percentages	**Arcsine trans-formed**	**Phase**	**Site**	**Interaction**	**Control B:D: A**	**Impact B:D: A**	**Before C: I**	**During C: I**	**After C: I**
Lying down	p = < 0.0001	p = 0.0544	$F_{2.403}$= 0.09, p = 0.9169	$F_{1.403}$= 4.21, **p = 0.0408***	$F_{2.403}$= 1.46 p = 0.2341	$H_{2.406}$= 0.70, p = 0.7043	$H_{2,406}$= 1,35 p = 0,5091	Z = 0.62; n = 148 p = 0.5339	Z = 1.70; n = 150 p = 0.0893	Z = 2.04; n = 108 p = 0.409
Sitting	p = 0.0003	p = 0.0717	$F_{2.403}$= 0.12 p = 0.8902	$F_{1.403}$= 6.53 **p = 0.0110***	$F_{2.403}$= 0.69 p = 0.5031	$H_{2.406}$= 0.14 p = 0.9333	$H_{2,406}$= 1,05 p = 0,5912	Z = 0.04; n = 148 p = 0.9649	Z = 2.27; n = 150 **p = 0.0234***	Z = 1.77; n = 108 p = 0.0775
Moving	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.406}$= 6.88 **p = 0.0321***	$H_{2,406}$= 0,67 p = 0,7167	Z = 2.23; n = 148 **p = 0.0259***	Z = 0.66; n = 150 p = 0.5096	Z = 0.74; n = 108 p = 0.4620
Grooming	p = < 0.0001	p = 0.0034	-	-	-	$H_{2.406}$= 4.61 p = 0.0996	$H_{2,406}$= 5,20 p = 0,0742	Z = 0.73; n = 148 p = 0.4681	Z = 1.30; n = 150 p = 0.1938	Z = 0.64; n = 108 p = 0.5238
Nourishing	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.406}$= 4.65 p = 0.0978	$H_{2,406}$= 1,57 p = 0,4563	Z = 1.87; n = 41 p = 0.0611	Z = 1.89; n = 41 p = 0.0585	Z = 0.26; n = 16 p = 0.7960
Interacting	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.406}$= 9.20 **p = 0.0101***	$H_{2,406}$= 0,76 p = 0,6839	Z = 1.45; n = 148 p = 0.1473	Z = 0.84; n = 150 p = 0.3990	Z = 1.29; n = 107 p = 0.1982
Alert	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.406}$= 41.46 **p = < 0,0001***	$H_{2,406}$= 194,66 **p = < 0,0001***	Z = 1.34; n = 2 p = 0.1797	Z = 8.00; n = 101 **p = < 0.0001***	n = 1
Hauling out	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.406}$= 5.94 p = 0.0513	$H_{2.406}$= 13.33 **p = 0.0013***	Z = 1.88; n = 63 p = 0.0597	Z = 2.46; n = 96 p = 0.0138	Z = 0.30; n =45 p = 0.7648
Entering	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.406}$= 5.19 p = 0.0747	$H_{2.406}$= 22.54 **p = < 0.0001***	Z = 1.46; n = 47 p = 0.1442	Z = 1.92; n = 84 p = 0.0551	Z = 377.00; n = 41 p = 0.4881

Table 4.2: Two-factor repeated measures Analysis of Variance on "Control East data", or Kruskal-Wallis and Wilcoxon matched pairs tests performed to test for differences in the proportions of Cape fur seals in different behavioural categories. These analyses compared differences between sites (Control and Impact) and between phases (Before, During, After) in response to disturbances caused by swim-with-seal tourism. Selection of test (parametric ANOVA vs non-parametric Kruskal-Wallis or Wilcoxon tests) depended on the outcome of normality testing, namely the Shapiro-Wilk test for normality, performed for each behavioural category using first raw percentage values and then arcsin transformed values if the test indicated that the raw percentage values failed the normality test. According to the normality test, the data are consistent with the normal distribution only if p-values are > 0.05 (indicated as underlined). Results of two-factor repeated measures Analysis of Variance compare the percentages of seals (arcsin transformed values and raw percentages) in different behavioural states between sites and observation phases, with site as the repeated measures factor. Where the result is presented as n = 0, this indicates that the proportion of animals corresponding with a behavioural category was not enough to perform test statistics. Subscripts indicate degrees of freedom; results are significant at p < 0.05 (indicated by asterisks and in bold)

Behaviour	**Results of normality testing**		**Results of two-factor repeated measures Analysis of Variance**			**Kruskal-Wallis H Test**		**Wilcoxon Matched Pairs Test**		
	Raw numbers/ percentages	**Arcsine transformed**	**Phase**	**Site**	**Interaction**	**Control B:D: A**	**Impact B:D: A**	**Before C: I**	**During C: I**	**After C: I**
Lying down	p = <u>0.1786</u>	-	$F_{2,219}$= 0,11 p = 0,8969	$F_{1,219}$= 12,36 **p = 0,0005***	$F_{2.219}$= 7.15 **p = 0.0010***	$H_{2.222}$= 4.66 p = 0.0972	$H_{2.222}$= 2.67 p = 0.2630	Z = 4.63; n = 83 **p = < 0.0001***	Z = 2.57; n = 83 **p = 0.0100***	Z = 0.52; n = 56 p = 0.6016
Sitting	p = <u>0.0748</u>	-	$F_{2,219}$= 0,02 p = 0,9832	$F_{1,219}$= 0,03 p = 0,8535	$F_{2.219}$= 5.07 **p = 0.0070***	$H_{2.222}$= 2.67 p = 0.2630	$H_{2.222}$= 2.94 p = 0.2302	Z = 2.40; n = 83 **p = 0.0165***	Z = 0.63; n = 83 p = 0.5280	Z = 1.91; n = 56 p = 0.0563
Moving	p = < 0.0001	p = 0.0292	-	-	-	$H_{2.222}$= 12.37 **p = 0.0021***	$H_{2.222}$= 0.50 p = 0.7802	Z = 7.58; n = 83 **p = < 0.0001***	Z = 5.94; n = 83 **p = < 0.0001***	Z = 4.18; n = 56 **p = < 0.0001***
Grooming	p = < 0.0001	p = <u>0.9952</u>	$F_{2.219}$= 1.56 p = 0.2133	$F_{1.219}$= 112.29 **p = < 0.0001***	$F_{2.219}$= 2.13 p = 0.1214	$H_{2.222}$= 4.28 p = 0.1179	$H_{2.222}$= 1.29 p = 0.5257	Z = 6.19; n = 83 **p = < 0.0001***	Z = 5.48; n = 83 **p = < 0.0001***	Z = 4.32; n = 56 **p = < 0.0001***
Nourishing	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.222}$= 4.73 p = 0.0941	$H_{2.222}$= 3.55 p = 0.1695	Z = 4.03; n = 24 **p = < 0.0001***	Z = 3.62; n = 17 **p = 0.0003***	Z = 1.86; n = 7 p = 0.0630
Interacting	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.222}$= 13.19 **p = 0.0014***	$H_{2.222}$ = 3.34 p = 0.1882	Z = 7.12; n = 83 **p = < 0.0001***	Z = 6.39; n = 83 **p = < 0.0001***	Z = 5.61; n = 55 **p = < 0.0001***
Alert	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.222}$= 10.28 **p = 0.0059***	$H_{2.222}$= 102.17 **p = < 0.0001***	Z = 1.34; n = 2 p = 0.1797	Z = 5.98; n = 51 **p = < 0.0001***	n = 0
Hauling out	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.222}$= 3.83 p = 0.1472	$H_{2.222}$= 3.83 p = 0.1471	Z = 3.09; n = 40 **p = 0.0020***	Z = 3.59; n = 54 **p = 0.0003***	Z = 1.49; n = 27 p = 0.1363
Entering	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.222}$= 4.24 p = 0.1199	$H_{2.222}$= 6.91 **p = 0.0315***	Z = 1.41; n = 30 p = 0.1589	Z = 0.04; n = 45 p = 0.9685	Z = 0.52; n = 25 p = 0.5998

Table 4.3: Two-factor repeated measures Analysis of Variance on "Control West data", or Kruskal-Wallis and Wilcoxon matched pairs tests performed to test for differences in the proportions of Cape fur seals in different behavioural categories. These analyses compared differences between sites (Control and Impact) and between phases (Before, During, After) in response to disturbances caused by swim-with-seal tourism. Selection of test (parametric ANOVA vs non-parametric Kruskal-Wallis or Wilcoxon tests) depended on the outcome of normality testing, namely the Shapiro-Wilk test for normality, performed for each behavioural category using first raw percentage values and then arcsin transformed values if the test indicated that the raw percentage values failed the normality test. According to the normality test, the data are consistent with the normal distribution only if p-values are > 0.05 (indicated as underlined). Results of two-factor repeated measures Analysis of Variance compare the percentages of seals (arcsin transformed values and raw percentages) in different behavioural states between sites and observation phases, with site as the repeated measures factor. Where the result is presented as n = 1, this indicates that the proportion of animals corresponding with a behavioural category was not enough to perform test statistics. Subscripts indicate degrees of freedom; results are significant at p < 0.05 (indicated by asterisks and in bold)

Behaviour	**Results of normality testing**		**Results of two-factor repeated measures Analysis of Variance**			**Kruskal-Wallis H Test**		**Wilcoxon Matched Pairs Test**		
	Raw numbers/ percentages	**Arcsine trans-formed**	**Phase**	**Site**	**Interaction**	**Control B:D: A**	**Impact B:D: A**	**Before C: I**	**During C: I**	**After C: I**
Lying down	p = <u>0.1721</u>	-	$F_{2.181}$= 0.52 p = 0.5974	$F_{1.181}$= 61.71 **p = < 0.0001***	$F_{2.181}$= 2.30 p = 0.1031	$H_{2.184}$= 1.99 p = 0.3689	$H_{2.184}$= 3.24 p = 0.1980	Z = 4.22; n = 65 **p = < 0.0001***	Z = 5.03; n = 67 **p = < 0.0001***	Z = 2.54; n = 52 **p = 0.0111***
Sitting	p = <u>0.3766</u>	-	$F_{2.181}$= 0.47 p = 0.6239	$F_{1.181}$= 23.12 **p = < 0.0001***	$F_{2.181}$= 2.84 p = 0.0608	$H_{2.184}$= 1.97 p = 0.3741	$H_{2.184}$=3.77 p = 0.1519	Z = 2.78; n = 65 **p = 0.0054***	Z = 4.09; n = 67 **p = < 0.0001***	Z = 0.60; n = 52 p = 0.5478
Moving	p = < 0.0001	p = 0.0043	-	-	-	$H_{2.184}$= 3.11 p = 0.2113	$H_{2.184}$= 0.36 p = 0.8361	Z = 1.58; n = 65 p = 0.1130	Z = 1.58; n = 65 p = 0.1130	Z = 1.58; n = 65 p = 0.1130
Grooming	p = < 0.0001	p = 0.0224	-	-	-	$H_{2.184}$= 0.47 p= 0.7889	$H_{2.184}$= 7.65 **p = 0.0218***	Z = 6.12; n = 65 **p = < 0.0001***	Z = 6.84; n = 67 **p = < 0.0001***	Z = 5.22; n = 52 **p = < 0.0001***
Nourishing	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.184}$= 2.19 p = 0.3345	$H_{2.184}$= 3.00 p = 0.2226	Z = 2.49; n = 17 **p = 0.0129***	Z = 1.34; n = 24 p = 0.1793	Z = 1.60; n = 9 p = 0.1097
Interacting	p = < 0.0001	p = <u>0.1109</u>	$F_{2.181}$= 0.20 p = 0.8217	$F_{1.181}$= 343.37 **p = < 0.0001***	$F_{2.181}$= 1.48 p = 0.2295	$H_{2.184}$= 2.32 p = 0.3129	$H_{2.184}$= 2.67 p = 0.2632	Z = 6.44; n = 65 **p = < 0.0001***	Z = 6.79; n = 67 **p = < 0.0001***	Z = 6.05; n = 52 **p = < 0.0001***
Alert	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.184}$= 32.43 **p = < 0.0001***	$H_{2.184}$= 92.41 **p = < 0.0001***	n = 1	Z = 5.29; n = 49 **p = < 0.0001***	n = 1
Hauling out	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.184}$=2.39 p = 0.3020	$H_{2.184}$=11.57 **p = 0.0031***	Z = 1.28; n = 23 p = 0.2015	Z = 0.31; n = 42 p = 0.7593	Z = 2.11; n = 18 **p = 0.0347***
Entering	p = < 0.0001	p = < 0.0001	-	-	-	$H_{2.184}$= 1.47 p = 0.4802	$H_{2.184}$= 18.11 **p = 0.0001***	Z = 0.64; n = 17 p = 0.5228	Z = 2.55; n = 39 **p = 0.0107***	Z = 1.60; n = 16 p = 0.1089

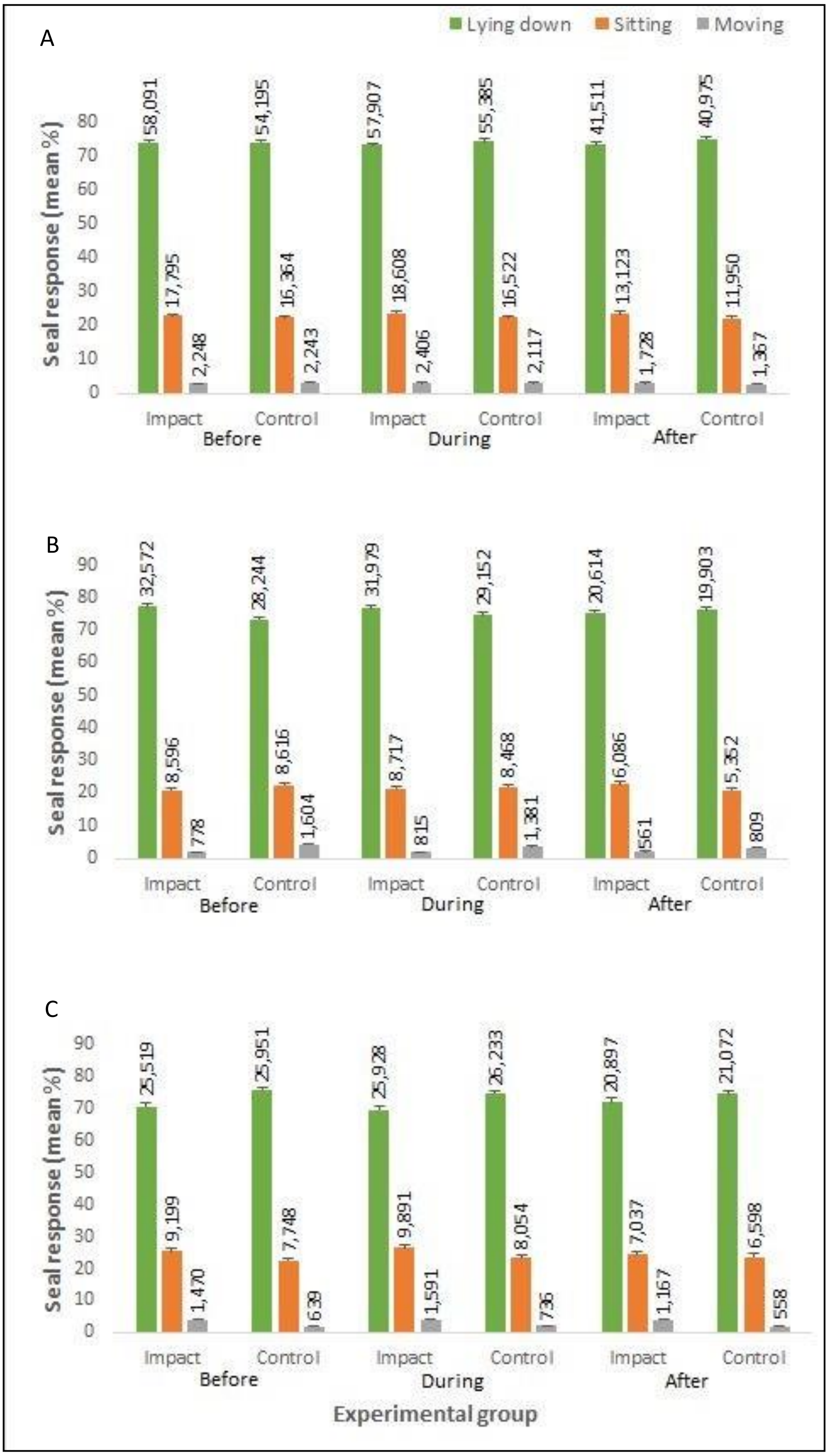

Figure 4.1: **Comparison of seal responses as different primary behavioural categories (lying down, sitting, and moving) between Impact and Control sites, Before, During and After SWS activities in (A) the Overall, (B) Control East and (C) Control West datasets. Data labels show the total number of counted seals (n) in each category (all observations across the entire study), and the error bars represent the standard error of the mean**

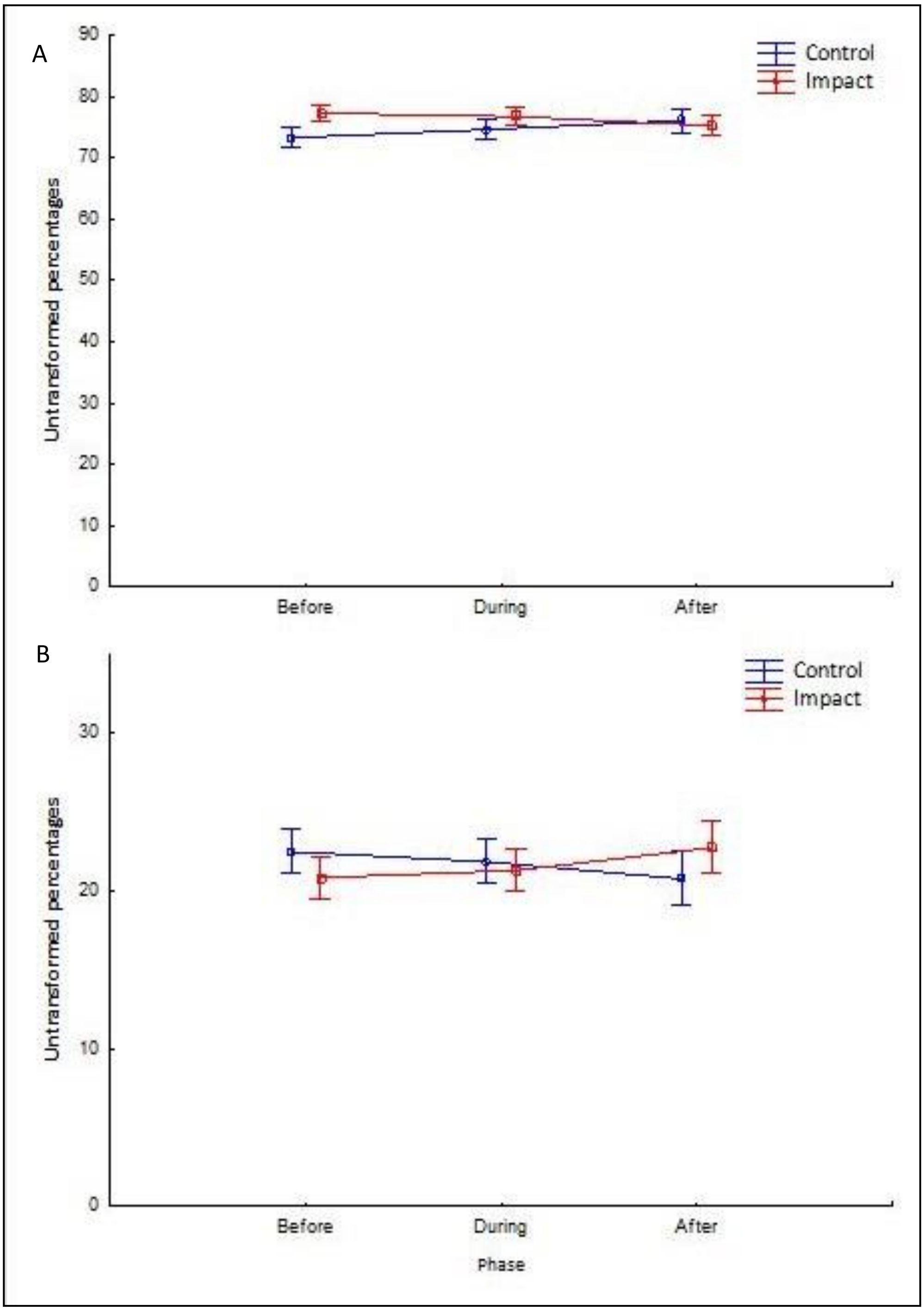

Figure 4.2: Changes in the proportions of animals (A) lying down and (B) sitting Before, During and After the swim-with-seal activity, between the Impact and Control sites. The error bars represent the standard error of the mean

Secondary behavioural categories (Groom, nourish, interact, alert)

Of the secondary behavioural categories, grooming and interacting were consistently the most prevalent, irrespective of the location of the Control site (Figure 4.3). For grooming, the only significant differences found were between sites (Tables 4.2 and 4.3) with no differences between phases and no interactive effect (Tables 4.1–4.3; Figure 4.3), except that at Control West, where a significant difference was found between phases for the Impact site only. Significant differences were shown for grooming between sites, but this was only when Control East and Control West were considered independently and not for the Overall data. No significant interactive effects or significant differences between phases were found, except that there was a significant difference in the proportion of animals grooming between the phases for Control West data for the Impact site (Kruskal-Wallis test: $H_{2.184}$ = 7.65, p = 0.0218 – Table 4.3; Figure 4.3).

There were no clear patterns for nourishing when considering the different datasets. Although significant differences were found between Impact and Control for some of the phases when the Control East and Control West datasets were considered independently (Tables 4.2, 4.3), the patterns found contrasted between the two datasets (Figure 4.4).

The proportion of seals showing varying levels of alertness (Tables 4.1–4.3; Figure 4.4), showed a significant difference between the phases (Kruskal-Wallis test), with a spike in alertness in the During phase. This was evident both for Control and Impact sites, irrespective of whether all data were considered or Control East and Control West separately. Wilcoxon patched pair tests showed that there was a significant difference between sites (Control and Impact) in the During phase and that this was the case for all the datasets, with greater alertness in the Impact site in each case (see Figure 4.4). Alert responses decreased after the SWS activity.

There was an increase in the numbers of animals both hauling out from or entering the water from the Before to the During phase (Figure 4.5). These differences were only significant for the Impact site (Tables 4.1–4.3). When the Control East and Control West datasets were considered separately, significant differences were found between the Control and Impact sites. Such differences occurred in the During phase for both Control East and Control West, but as seals hauling out of the water for the former (Table 4.2) and entering the water for the latter (Table 4.3). In each case, the response was greater at the Impact site than the Control site (Figure 4.5). For Control East, a significant difference in the numbers of seals hauling out was evident between Control and Impact in the Before phase (Wilcoxon Matched Pairs Test: Z = 3.09, p = 0.0020).

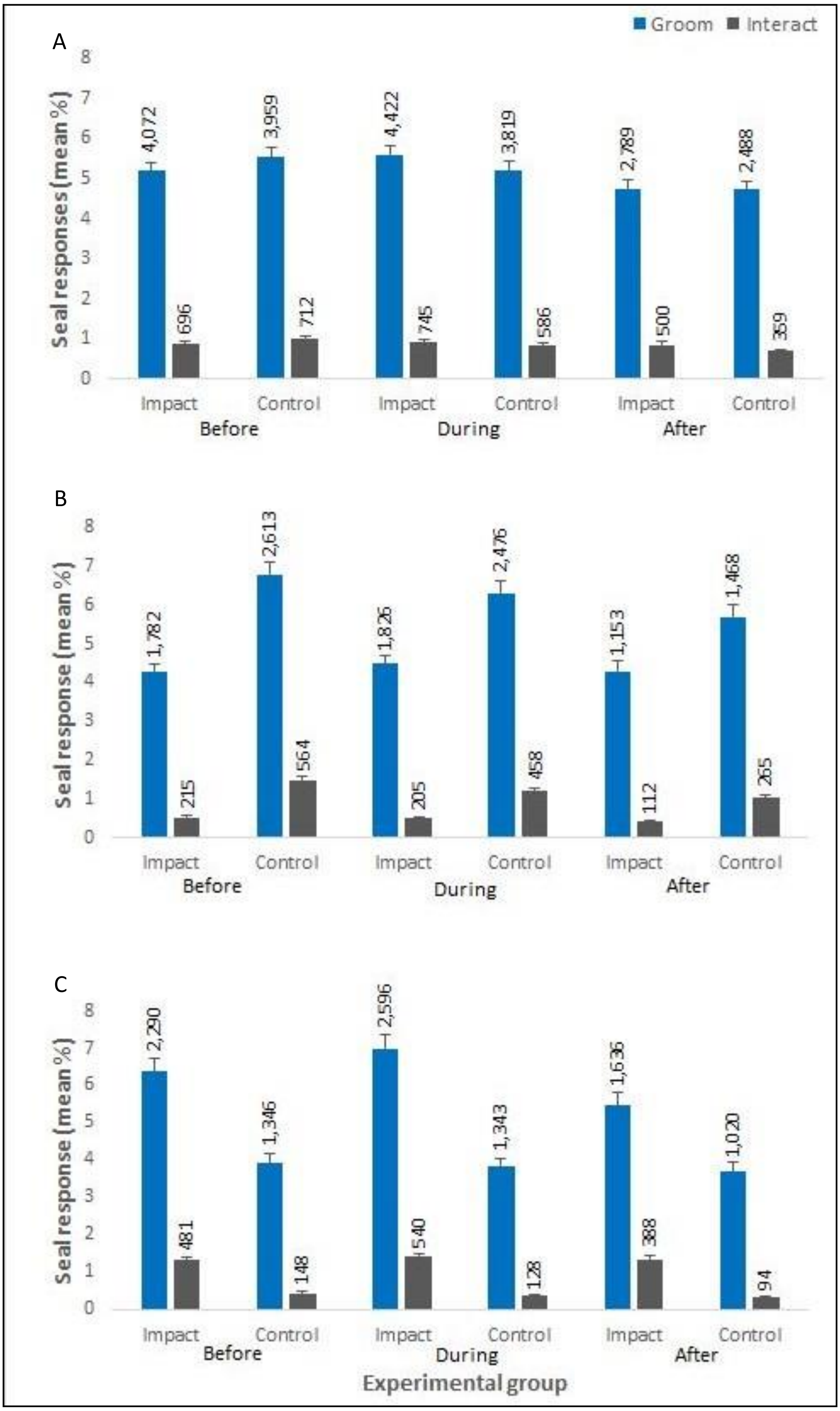

Figure 4.3: Comparison of (A) the Overall, (B) Control East and (C) Control West seal responses for different behavioural categories (groom, interact) between Impact and Control areas, Before, During and After SWS activities. Data labels show the total number of counted seals (n) in each category (all observations across the entire study), and the error bars represent the standard error of the mean

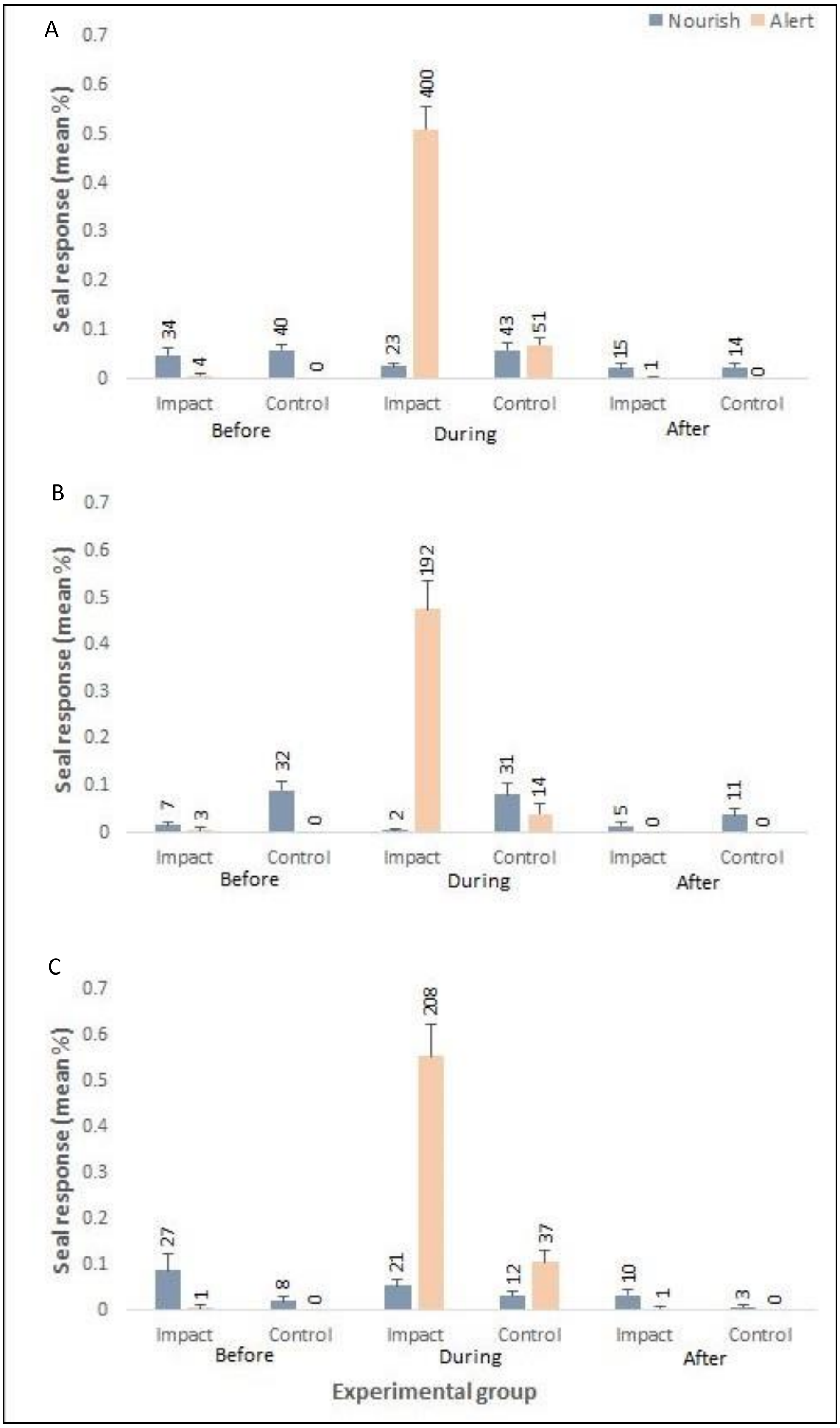

Figure 4.4: Comparison of (A) the Overall, (B) Control East and (C) Control West seal responses for different behavioural categories (nourish, alert) between Impact and Control areas, Before, During and After SWS activities. Data labels show the total number of counted seals (n) in each category (all observations across the entire study), and the error bars represent the standard error of the mean

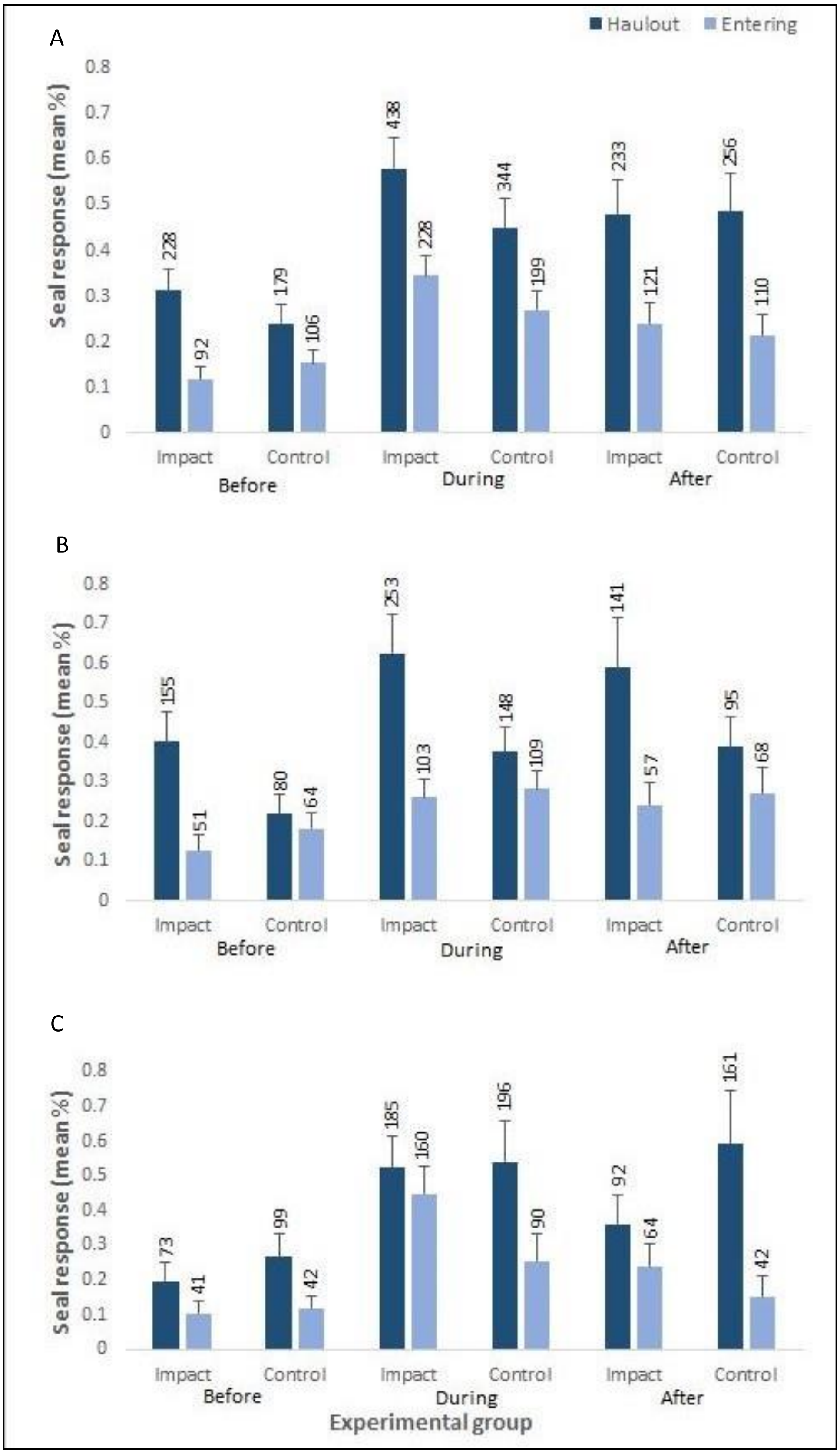

Figure 4.5: Comparison of (A) the Overall, (B) Control East and (C) Control West seal responses for different behavioural categories (haul-out, entering) between Impact and Control areas, Before, During and After SWS activities. Data labels show the total number of counted seals (n) in each category (all observations across the entire study), and the error bars represent the standard error of the mean

4.4 Discussion

The primary objective of this chapter was to determine the impacts of SWS tourism on the behaviour of seals in the Cape fur seal colony in the Robberg MPA, through a modified Before-After-Control-Impact (BACI) behavioural study designed as simultaneous observations of Impact and Control areas. The survey design had several potential limitations in that:

A) To be able to observe two sites from the same vantage point, the sites were in relatively close proximity to each other, resulting in the potential for the Control site to be disturbed by SWS activity, especially by the activity of the boat. The data supported this, in that alert behaviour in response to SWS activity was identified for the Control site, albeit at a much lower level than for the Impact site.

B) The Impact and Control sites needed to be interchangeable to accommodate the selection of the best site for the activity by the tourism operator based on factors such as sea conditions and seal numbers in the water. When the East site was the focus of the activity (the Impact site), the vessel would need to pass by the West site (the Control), potentially resulting in some disturbance and compromising its strict efficacy as a Control site. The same did not apply when activities took place at the West site (Control East). In an attempt to take this into account, “Control West” and “Control East” data were analysed separately, in addition to the analysis of the combined (“Overall”) data.

Three main results provide evidence that the SWS activities elicit certain behavioural responses from the seals in the colony. Firstly, the proportion of animals lying down decreased and the proportion of animals sitting increased in the Impact site relative to the Control site when SWS activities commenced. This was statistically significant only for the Control East dataset (Figure 4.1; Table 4.2) and is indicative of a decreased state of restfulness or increased alertness. This result could possibly be reflective of the independence of the East site as a control site. Associated with these differences, the number of seals displaying alertness increased significantly when SWS activities commenced. This pattern was clear for all datasets, i.e. Overall, Control East and Control West (Figure 4.4; Tables 4.1–4.3), and while some alertness was evident for seals in the Control site, especially for Control West (Figure 4.4C – possibly reflective of the non-independence of this site), the response was most pronounced for the Impact site relative to the Control site. Finally, movements of seals to or from the water (from or to the colony) increased with the commencement of activities. There were differences between sites (Control West or Control East datasets as to whether these animals were mainly hauling out of the water or entering the water (Figure 4.5; Tables 4.1–4.3).

Human activity often causes behaviours associated with alertness or vigilance, which are described as animals' readiness to detect certain unpredictably occurring events in their environment (e.g. Yorio and Boersma 1992; Conomy et al. 1998; Giese 1998; Dyck and Baydack 2004). The possibility of such changes having any long-term effects is unknown, but Constantine et al. (2004) note that even minor changes in behaviour such as reduced resting might prove to be significant in long-lived species, affecting individual fitness, reproductive success and ultimately population size over time.

Similar to this study, van Polanen Petel (2005) found that Weddell seals (*Leptonychotes weddellii*) spent more time looking at pedestrian approaches, especially in the “During” phase, compared to the other phases, with cows spending less time resting and more time observing their surroundings when approached by tourist groups. In spite of the fact that the seals began resting once the tourists were out of sight, they remained alert (van Polanen Petel 2005). Lidgard (1996), investigating the behaviour of grey seals (*Halichoerus grypus*) in relation to boat approaches, noted that the majority of the seals altered their posture and stayed alert throughout the boat's visit compared to before the boat’s arrival. Cate (2013) found that a higher percentage of New Zealand fur seals (*Arctocephalus forsteri*) appeared alert as a vessel drew closer to the colony, and Cowling (2013) found that the alertness of the New Zealand fur seals peaked in the first minute as the boat approached, possibly as a result of boat noise. In the current study, some seals appeared alert as soon as the boat approached the colony, likely as a result of the engine noise or possibly the smell of engine fumes. Alertness continued while swimmers were in the water, usually within 15 m of the edge of the colony, as the vessel idled further out, suggesting that both the presence of the boat and the swimmers could induce alert behaviour. Boren (2001), who also investigated the impacts of tourist disturbance on New Zealand fur seals (e.g. boat approaches, land approaches and traffic observations), found activity levels of seals to be considerably higher at the impact site than at the control site, which was sheltered from tourist activities and where seals were mainly resting. Several other studies have also found that tourism impacts increase the activity of marine mammals (Constantine 1999; Boren 2001; Bauszus and Tandy 2002; Constantine et al. 2004; Markowitz et al. 2009). Constantine (2001), who investigated the avoidance responses of bottlenose dolphins during swim-with-dolphin activities (*Tursiops truncatus*), found that these responses increased when swimmers were placed in their path. Southern right whales (*Eubalaena australis*) in Patagonia reacted both positively and negatively to boats depending on whether the engines were off (approaching) or on (avoiding) (Argüelles et al. 2016). Humpback whales

(*Megaptera novaeangliae*) in Tonga also responded negatively to both swimming and whale-watching activities, with mother-calf pairs showing vertical avoidance and longer dive times (Fiori et al. 2019). Similarly, humpback whales in Ecuador and Hawaii increased their swim speed when approached by vessels (Scheidat et al. 2004; Au and Green 2001; Bauer and Herman 1986). No direct inferences could be drawn about whether the reactions of Cape fur seals in this study were greater or less than those of other species, due to variations in study methodologies and species-specific behaviours.

Importantly, in this study, seals in the colony were mostly at rest (at least 70% lying down on average; see Figure 4.1) throughout the phases of observation at both the Impact and Control sites. Even where changes of behaviour that were evident between phases and/or between sites were statistically significant, it was typically a very small proportion of the seals within the study area that was affected. Whereas the proportion of animals sitting relative to the numbers lying down in the Impact site increased as SWS activities commenced, the numbers of animals showing a switch in this behavioural posture was only approximately 2% of the numbers of animals at the site, on average. Furthermore, although the proportion of animals in the Impact site that showed alert behaviour in response to activity increased statistically compared with the earlier phases or versus the Control site, it still represented only about half a percent of the animals in the Impact site, on average.

The low proportion could mean that a) the SWS activities are performed carefully enough to result in minimal disturbance to the colony (as per the guidelines of a Code of Conduct), b) that seals are simply not impacted by the activity, or c) that the seals in the colony have habituated to the disturbance. Habituation is defined as a decrease in response of an animal after repeatedly being exposed to a stimulus (Sternberg 1995), and Boren et al. (2002) observed some New Zealand fur seals appearing to be habituated to tourist disturbance in that they responded less to boat and kayak approaches compared to approaches from land. As this study took place more than ten years after swim-with-seal activities commenced at Robberg, it was not possible to assess habituation, but investigating the habituation of seals to tourist activities should be a research priority if operations are initiated at a new location.

Of the primary behavioural categories, patterns in the movements of animals in the colony with respect to site and phase of disturbance were much less clear than the lying down and sitting categories and did not appear to be related to the tourist activities. However, there was an increase in the movement of animals between land and water associated with the tourist activities. Stafford-Bell et al. (2012) found that Australian fur seals (*Arctocephalus pusillus doriferus*) hauled out more often as a result of the number of swimmers and boats that were present and related to the distance of the operators to the seals. On the other hand, some studies have shown that seals are more inclined to enter the water as a result of boat disturbance. For example, Back et al. (2018) found that Australian fur seals reacted to boat approaches within 25 m from the colony by entering the water, which affected colony attendance. According to Henry and Hammill's (2001) observations on the effects of small boats on the behaviour of harbour seals, increased vessel traffic caused more seals to enter the water and make fewer attempts to get out again. Although the seals may be closer to boats while they are in the water, it is likely that their hesitation to haul out again (after entering) is caused by the animal's perception that their chances of escaping are higher when they are in the water (Stafford-Bell et al. 2012), because seals are more agile in water and can avoid a potentially dangerous situation from humans more easily than on land. This is evident by the number of times they have been found to enter the water as a consequence of disturbances (Barton et al. 1998; Young 1998; Born et al. 1999; Suryan and Harvey 1999). Since time spent on land is crucial for resting and avoiding predators, disturbances that elicit alert and flee responses might affect the energy budgets that seals need to survive and cause increased exposure to predation (Riedman 1990).

In the present study, however, the increased movement between land and water included both entering and hauling out in association with boat presence and SWS activities. While movement either from or into the water may represent avoidance, it is also possible that such movement can be stimulated by curiosity focused on the swimmers in the water. Once again, it is important to note that the numbers of animals entering or leaving the water during SWS activities at the Impact site were a small proportion of the numbers of animals present at the site.

According to Gill et al. (2001), it is challenging to understand when short-term behavioural changes resulting from human disturbance will lead to significant changes in population dynamics. Measuring these impacts is essential given the growing interest in human activities on wildlife and growing interactions due to tourism (McHuron et al. 2017). Behavioural changes typically occur as the initial reaction to disturbance, as noted by Hoffman and Parsons (1991). However, stressors can also induce physiological changes without necessarily triggering behavioural alterations (Weimerskirch et al. 2002). It is common for organisms to respond to a disturbance by either avoiding the source or altering their behavioural patterns (Carney and Sydeman 1999; Fortin and Andruskiw 2003; Williams et al. 2006). These responses often result in adjustments to how time is spent, and energy is allocated (Carney and Sydeman 1999; Fortin and Andruskiw 2003; Williams et al. 2006). The effects of disturbance on individuals' behaviour are evident in these cases, but the broader consequences are unclear (McHuron et al. 2017). One way to assess the

Population Consequences of Disturbance (PCoD) is by using a model approach, linking the alterations in the behaviour or physiology of the individual animal (caused by the disturbance) with the overall health, vital rates, and the dynamics of the population (New et al. 2014; King et al. 2015; Fleishman et al. 2016).

New et al. (2014) modelled the effects of short-term behavioural changes caused by a disturbance on the health of southern elephant seals (*Mirounga leonina*). The model showed a decrease in the fitness and population size of the seals when half of a female's foraging trip was interrupted in a year (New et al. 2014). Population Consequences of Disturbance models used by Hin et al. (2019), Moretti (2019) and Farmer et al. (2018) indicated that sexual maturity in the long-finned pilot whales (*Globicephala melas*), Blainville's beaked whales (*Mesoplodon densirostris*) and sperm whales (*Physeter macrocephalus*) may be delayed because of reductions in foraging opportunities. A disruption in foraging patterns may also lead to an increase in reproductive intervals, thereby impacting the reproductive output of females over their lifetime and eventually affecting the abundance of the population (Hin et al. 2019; Moretti 2019). It is also possible for a reduction in foraging to impair offspring's ability to grow (Christiansen et al. 2014) and affect their survival due to lower energy transfers before weaning (Villegas-Amtmann et al. 2015; Pirotta et al. 2019).

4.5 Conclusions

Overall, the SWS activity observed in this study appeared to have minimal effects on the Cape fur seals inhabiting the Robberg MPA, in terms of the overall number of seals from which responses were elicited. While the SWS activity and associated boat approaches brought about some behavioural changes in the colony, as shown by statistically significant changes in some behavioural categories, it was a relatively small number of seals that were affected. This may indicate that the activities are simply not very disturbing, or that the seals are largely habituated to the activities. Seals in this study spent most of their time resting, a behaviour observed at both Control and Impact sites, irrespective of the location of the Control site. Although resting behaviour was predominant, some seals became alert and were sitting more often in the presence of the vessel. Regarding movement between land and water, the results showed that some Cape fur seals responded by entering or leaving the water in the presence of the swimmers. These results were consistent when all datasets (Overall, Control East and Control West) were considered.

While this chapter provided a broad-scale analysis using averages across sessions to identify particular responses, the next chapter provides finer-scale analyses focused on these responses to investigate and identify any co-variates resulting in any greater or lesser extents of response (including, for example, the effects of swimmer group sizes, environmental parameters, and any other factors such as the distances of swimmers and boats to the colony that might have contributed to the observed changes). Such parameters are critical in any adaptive policy cycles to manage SWS activities that are based on best available information.

4.6 References

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CHAPTER 5: FACTORS INFLUENCING SEAL BEHAVIOURAL RESPONSES TO SWIM-WITH-SEAL ACTIVITIES

5.1 Introduction

Although seals are marine predators, they are amphibious in that they spend part of their life cycle on land (or on ice), which is essential for giving birth and rearing young, resting, and avoiding marine predators (Boulva & McLaren 1979; Gentry and Kooyman 1986; Riedman 1990). When on shore, seals use their hearing, sight, and smell to scan for and assess potential threats (Frid and Dill 2002; Nordstrom 2002). Ecotourism activities that involve viewing seals (or sea lions) close-up on land or in the adjacent water (Kirkwood et al. 2003) can bring about alterations in seal behaviour by triggering responses related to avoiding predation (Frid and Dill 2002). The extent of response may range, and in the case of a significant disturbance, seals may flee to the water (Cowling et al. 2015). Responses may differ according to age and sex classes of animals, as shown in some studies (Barton et al. 1998; Shaughnessy et al. 2008; Holcomb et al. 2009), and several studies have shown important adverse consequences associated with responses to disturbance (Marmion 1997; Boren et al. 2002; Shaughnessy et al. 2008). For example, Boren et al. (2002) observed that New Zealand fur seals (*Arctocephalus forsteri*) primarily altered their behaviour in response to land-based approaches compared to approaches by boat or kayak. Similarly, Shaughnessy et al. (2008) found that resting behaviour in fur seals at Montague Island decreased as boats approached the colony, resulting in increased movement among the seals. An animal's perception of risk may be influenced by behaviour of tourists, including the noise level, distance, speed, and direction of any human approach, further affecting its response (Kovacs & Inness 1990; Frid and Dill 2002; Shaughnessy et al. 2008).

Environmental factors have also been shown to influence behaviour of seals (Terhune and Almon 1983; Stewart 1984; Watts 1992; Roen and Bjorge 1995). For example, Watts (1992) found that the number of harbour seals (*Phoca vitulina*) hauled out on land was affected by several factors, including solar radiation, air temperature and wind speed. Similarly, Henry and Hammill (2001) showed that harbour seals at Mètis Bay, in Saint Lawrence Estuary, Canada, hauled out more often when air temperatures were warmer and when the wind was coming from a southwestern direction. Environmental factors can also affect seals' reactions to potential threats by affecting their likelihood of detecting threat stimuli. For example, a seal's ability to detect potential threats through smell or hearing might be affected by the strength and direction of the wind (Riedman 1990).

The previous Chapter found that the swim-with-seal (SWS) activities elicited certain behavioural responses, although only a small number of seals were affected. Seals were mostly found to be resting but significantly greater numbers were found to adopt a sitting position and/or show alertness when tourism activity was taking place, while movements between land and water were also found to increase in the presence of the swimmers and boats. Response levels also varied between observation sessions and days, suggesting that other factors may be influencing the response. In this chapter, the influences of several other (including environmental) factors on the variability in seal behavioural responses to SWS activity are considered using a modelling approach. These factors include time of day, environmental factors (air and seawater temperatures) and attributes of tourist behaviour. The objective of this chapter is therefore to determine if there are external or compounding factors that increase the probability of seals responding to behavioural disturbances associated with SWS activities.

5.2 Methods

5.2.1 *Data analysis*

Data analyses were conducted using Generalised Linear Models (GLMs), which have been proven to be an effective analytical tool since their introduction in 1972 (Nelder and Wedderburn 1972; Khuri et al. 2006). Primary and secondary behavioural categories were analysed separately. Of the several secondary behavioural categories that were analysed in Chapter 4, only the two that showed significant results were considered in this chapter, namely alert behaviour, and movement to and from the water. In Chapter 4, the latter was considered in separate categories for seals entering the water and seals hauling out of the water. Both showed significant responses to tourist activities, but the results were ambiguous as to which direction of movement was more likely (i.e. there was a difference in this regard between Control West and Control East datasets). Therefore, in this chapter, the two categories were combined as "movement-to-or-from-the-water" by summing the numbers of animals counted entering and leaving the water.

For the primary behavioural categories (lying down, sitting, and moving), a logistic GLM was used to model the relative influence of experimental site (Impact vs Control), phase (Before, During, After), the occurrence of SWS activities (presence of boat and swimmers), time of day (hours after sunrise) and environmental variables (air temperature, sea surface temperature), on seal behaviour. Then, to explore whether primary behaviour is influenced by differences in the nature of SWS activities, models were repeated using only the During phase (considering that the boats and swimmers were not present Before or After), and by including the following variables: distance of swimmers (nearest distance to site in meters), distance of boat (nearest distance to site in meters) and group size of swimmers (number of swimmers in the water at a time). For the distance of the boat, the distance to both Impact and Control sites were estimated in the field using a Range Finder. For the distance of swimmers, only the distance of the group to the Impact site was estimated in the field; the distance to the Control site was estimated post-hoc using Google Earth 2015, between the typical position of swimmer groups in front of the Impact site and the midpoint of the shore length of the Control site.

Logistic GLMs assume that data y_i were generated by a Bernoulli response ($y_i \sim Bernoulli(p_i)$), where p_i is the probability of exhibiting a behaviour and has a mean $\mu = p$ and variance $\sigma^2 = p(1-p)$. Thus:

$$E(y_i) = \eta(p_i) = logit\left(\frac{p_i}{1-p_i}\right) = \alpha + \sum_{n=1}^{N} X_{in} + \varepsilon$$

Where $\eta(p_i)$ is the link function and in this case the logit link function was used; α is the intercept term; and X_{in} indicates the linear effects of predictors, including experimental site (Control, Impact); phase (Before, During, After); time of day, and environmental variables (air temperature, sea surface temperature). Phase was included as factor in the first model only – the 2nd model focused only on the During phase – and human activities (distance of boat to site, distance of swimmers to site, group size of swimmers) were used only in the second model. The probability of exhibiting a behaviour was then obtained by taking the inverse of the logit link function:

$$P_i = \frac{e^{E(y_i)}}{1 + e^{E(y_i)}}$$

The prediction and confidence interval computation were first done in logit space, then transformed into probability as indicated above. The corresponding GLM for count data generated by the Poisson process can be written as follows:

$$y_i = poisson(\mu_i)$$

where μ_i is the expected values of Y $E[Y]$ which is also $var[Y]$

$$E(y_i) = \eta(\mu_i) = log(\mu_i) = \alpha + \sum_{n=1}^{N} X_{\beta_i} + \varepsilon$$

For the two secondary behavioural attributes (alert and movement-to-or-from-the-water), the modelling procedure was consistent with above, in that the proportion of secondary behaviour was modelled as a function of the same environmental and experimental-related predictors. The predictor variables for the model were chosen to explore whether the secondary behaviour is influenced by differences in the site (Control, Impact), time of day, environmental variables (air temperature, sea surface temperature) and the nature of human activities (distance of boat to site, distance of swimmers to site, group size of swimmers). Once again, only data for the During phase was considered.

All data analyses and visualisations were conducted using the statistical software package R, version 4.3.1 (R Core Team 2023), utilising multiple R packages for data processing, visualisation, analysis, and results summaries (Alathea 2015; Allaire et al. 2023; Robinson et al. 2023; Spinu et al. 2023; Wickham et al. 2023a, 2023b; Wickham and Henry 2023; Xie 2023).

5.3 Results

The statistics summarising the predictor variables used in the models are shown in Table 5.1.

Effects of environmental factors and the occurrence of tourist activities on seal behaviour

Results of logistic GLMs showed that all primary behavioural categories (lying down, sitting, and moving) were significantly affected by air and sea temperatures and time of day (hours after sunrise) (Table 5.2; rows 5–7, 14–16, 23–25). With higher sea temperatures, seals were significantly more likely to be lying down and less likely to be in a sitting position or moving around (Table 5.2; rows 6, 15, 24). More specifically, the probability of seals lying down increased by 1.1% for any unit increase in sea temperature, but correspondingly, the probability of seals sitting or moving in the colony decreased by 2.0% and 10%, respectively. The converse was true for air temperature; as air temperature increased, seals were significantly less likely to be lying down and more likely to be in a sitting position or moving around the colony (Table 5.2; rows 5, 14, 23). The models showed that for any unit increase in air temperature, the likelihood of seals lying down decreased by 1.2%, and the same increase in air temperature led to a 2.9% and 4.3% increase in the probability of seals sitting and moving, respectively (only the latter was significant). It might be expected that the relationship of primary behaviour with time of day (hours after sunrise) to be similar to that with air temperature, but the model showed that seals became less active with hours after sunrise, with significantly increased likelihood of being in a lying down position and significantly decreased likelihood of being in a sitting position or moving around in the colony (Table 5.2; rows 7, 16, 25).

With respect to the impacts of swim-with-seal activities, the interactive effects shown by the model between Site and Phase are of highest relevance. While seals were less likely to be lying down in the Impact site vs the Control site during the During and After phases vs the Before phase, the results were not significant (Table 5.2; rows 8–9). However, seals were significantly more likely to be in a sitting position in the Impact vs the Control site during the During phase vs the Before phase (3.8% greater probability; Table 5.2; row 17), as also shown in the comparisons of Chapter 4. A similar pattern was evident for the After phase relative to the Before phase, but the result was marginally non-significant (3.4% greater probability; P = 0.067; Table 5.2; row 18). For the remaining primary behavioural category, the model showed seals were significantly more likely to be moving around the colony in the Impact vs the Control site during both the During and the After phases, relative to the Before phase (12.8% and 26.6% greater probability, respectively; Table 5.2; rows 26–27).

Table 5.1: Summary statistics for the predictor variables used in the models, including environmental factors (air temperature, sea temperature, and hours after sunrise) and tourist activities influencing seal behaviour. The table provides an overview of the data range and central tendencies used in the analysis.

Variable	Min	Max	Median	Mean ± SD
Air temperature (°C)	11	34	19	18.90 ± 3.64
Sea temperature (°C)	11	19	16	15.46 ± 2.05
Hours after sunrise	3	10	5	5.32 ± 1.28
Boat to site (m)	35	214	91	91.63 ± 27.81
Swimmers to site (m)*	8	147	60	58.57 ± 27.42
Group size of swimmers in water	2	13	2	5.69 ± 2.65

* One outlying data point of 397 m was excluded from the dataset because the swimmers drifted away, with one swimmer encountering difficulty.

Table 5.2: Summary table for results of logistic Generalised Linear Models (GLMs) on the effects of environmental variables (air temperature, sea temperature, hours after sunrise) and tourist activities on seal behaviour, considering the three primary categories of behaviour (lying down, sitting, and moving). The models were compared between experimental sites (Control, Impact) and phase (Before, During, After). Results are significant at p < 0.05 (indicated by asterisks)

Row No.	Behaviour	Variable	Estimate	Std. error	Statistic	P-value
1	Lying down	Intercept	-0.247	0.020	-12.479	0.000*
2		Site - Impact	-0.002	0.008	-0.206	0.837
3		Phase - During	0.004	0.008	0.473	0.636
4		Phase - After	0.013	0.009	1.534	0.125
5		Air temperature (^{o}C)	-0.012	0.001	-14.686	0.000*
6		Sea temperature (^{o}C)	0.011	0.001	8.254	0.000*
7		Hours after sunrise	0.018	0.002	9.558	0.000*
8		Site - Impact: Phase - During	-0.017	0.011	-1.528	0.127
9		Site - Impact: Phase - After	-0.021	0.012	-1.714	0.087
10	Sitting	Intercept	-1.726	0.029	-58.957	0.000*
11		Site Impact	0.013	0.012	1.104	0.269
12		Phase During	-0.004	0.012	-0.344	0.731
13		Phase After	-0.020	0.013	-1.528	0.127
14		Air temperature (^{o}C)	0.029	0.001	25.727	0.000*
15		Sea temperature (^{o}C)	-0.020	0.002	-10.281	0.000*
16		Hours after sunrise	-0.057	0.003	-18.577	0.000*
17		Site - Impact: Phase - During	0.038	0.017	2.248	0.025*
18		Site - Impact: Phase - After	0.034	0.018	1.833	0.067
19	Moving	Intercept	-2.743	0.074	-37.230	0.000*
20		Site - Impact	-0.069	0.030	-2.273	0.023*
21		Phase - During	-0.073	0.031	-2.383	0.017*
22		Phase - After	-0.197	0.035	-5.660	0.000*
23		Air temperature (^{o}C)	0.043	0.003	15.375	0.000*
24		Sea temperature (^{o}C)	-0.102	0.005	-20.491	0.000*
25		Hours after sunrise	-0.052	0.008	-6.676	0.000*
26		Site - Impact: Phase - During	0.128	0.043	2.995	0.003*
27		Site – Impact: Phase - After	0.266	0.048	5.581	0.000*

Effects of variation in tourist activities on seal behaviour (During phase only)

Effects of variations in tourist behaviour, including distances of boats and swimmers from the colony and the number of swimmers in the water, were considered with respect to both primary and selected secondary behavioural categories. The model results indicated significant differences in the proportions of animals lying down, sitting, moving, and showing alert behaviour (Table 5.3; rows 2, 7, 12, 17) between the Impact and Control sites during the approaches. The animals were less inclined (10.1% lower probability) to be lying down in the Impact compared to the Control site, and more inclined to be sitting (27.2% greater probability), moving about (18.7% greater probability), or alert (222.9% greater probability) in the Impact site than in the Control site. However, while the distance of the boat (Table 5.3; rows 8, 13, 29) and swimmers (Table 5.3; rows 4, 9, 14) had significant effects on some of the categories of primary and secondary behaviour, the direction of the differences for some categories was the opposite of what was expected, in that the response increased with increasing distance of the boat or swimmers (Figure 5.1). Interestingly there appeared to be no significant impact of boat distance or swimmer distance on alert behaviour, and neither did group size of swimmers show a significant effect on alert behaviour (Table 5.3; rows 21–23). The number of swimmers in the water only significantly impacted movement-to-or-from-the-water, with the model showing that there was increased movement with an increased number of swimmers (7% increase, with increased unit of swimmers; Figure 5.2; Table 5.3, row 31). Movement-to-or-from-the-water declined significantly with increasing air temperature (6.9% decline with unit temperature increase) and increased significantly with increasing sea temperature (11.4% increase with unit temperature increase; Figure 5.2, Table 5.3; rows 26, 27), while alert behaviour also increased significantly with increasing sea temperature (25.7% with unit increase of sea temperature; Table 5.3; rows 26, 27). It could be expected that increased movement-to-or-from-the-water and alert behaviour with sea temperature increases, may also be related to a greater number of swimmers in the water, assuming there are more swimmers when the water is warmer. However, only movement-to-or-from-the-water was significantly related to swimmer numbers, and not alert behaviour.

Table 5.3: Summary table for results of logistic Generalised Linear Models (GLMs) of the effects of tourist behaviour (distances of boat and swimmers to site and group size of swimmers in the water) on seal behaviour, including the three primary categories of behaviour (lying down, sitting and moving) and two secondary categories (alert behaviour, movement-to-or-from-the-water). For the models concerning secondary behavioural categories, environmental variables (air temperature, sea temperature and hours after sunrise) were included, but they were excluded for the primary behavioural categories since they are considered in the previous model (Table 5.2). The models were compared between experimental sites (Impact, Control) but only for the During phase because tourist behaviour is not applicable for the other phases. Results are significant at $p < 0.05$ (indicated by asterisks)

Row No.	Behaviour	Variable	Estimate	Std. error	Statistic	P-value
1	Lying down	Intercept	-0.195	0.033	-5.900	0.000*
2		Site Impact	-0.101	0.025	-4.058	0.000*
3		Boat to site (m)	0.000	0.000	-1.704	0.088
4		Swimmers to site (m)	0.000	0.000	-2.088	0.037*
5		Group size of swimmers in water	0.002	0.003	0.746	0.456
6	Sitting	Intercept	-1.755	0.046	-37.746	0.000*
7		Site Impact	0.272	0.035	7.841	0.000*
8		Boat to site (m)	0.001	0.000	4.867	0.000*
9		Swimmers to site (m)	0.001	0.000	3.120	0.002*
10		Group size of swimmers in water	-0.006	0.004	-1.549	0.121
11	Moving	Intercept	-3.684	0.115	-32.048	0.000*
12		Site Impact	0.187	0.087	2.158	0.031*
13		Boat to site (m)	-0.001	0.000	-3.816	0.000*
14		Swimmers to site (m)	0.001	0.000	3.074	0.002*
15		Group size of swimmers in water	0.002	0.010	0.227	0.821
16	Alert	Intercept	-11.201	0.720	-15.553	0.000*
17		Site Impact	2.229	0.298	7.477	0.000*
18		Air temperature (^{o}C)	-0.006	0.016	-0.403	0.687
19		Sea temperature (^{o}C)	0.257	0.035	7.273	0.000*
20		Hours after sunrise	-0.038	0.054	-0.708	0.479
21		Boat to site (m)	0.000	0.002	-0.088	0.930
22		Swimmers to site (m)	0.000	0.002	0.041	0.967
23		Group size of swimmers in water	0.007	0.027	0.247	0.805
24	Movement-to-or-from-the-water	Intercept	-5.817	0.411	-14.140	0.000*
25		Site Impact	-0.019	0.196	-0.095	0.924
26		Air temperature (^{o}C)	-0.069	0.012	-5.755	0.000*
27		Sea temperature (^{o}C)	0.114	0.020	5.752	0.000*
28		Hours after sunrise	0.030	0.029	1.049	0.294

Row No.	Behaviour	Variable	Estimate	Std. error	Statistic	P-value
29		Boat to site (m)	0.003	0.001	5.640	0.000*
30		Swimmers to site (m)	-0.002	0.001	-1.571	0.116
31		Group size of swimmers in water	0.070	0.017	4.129	0.000*

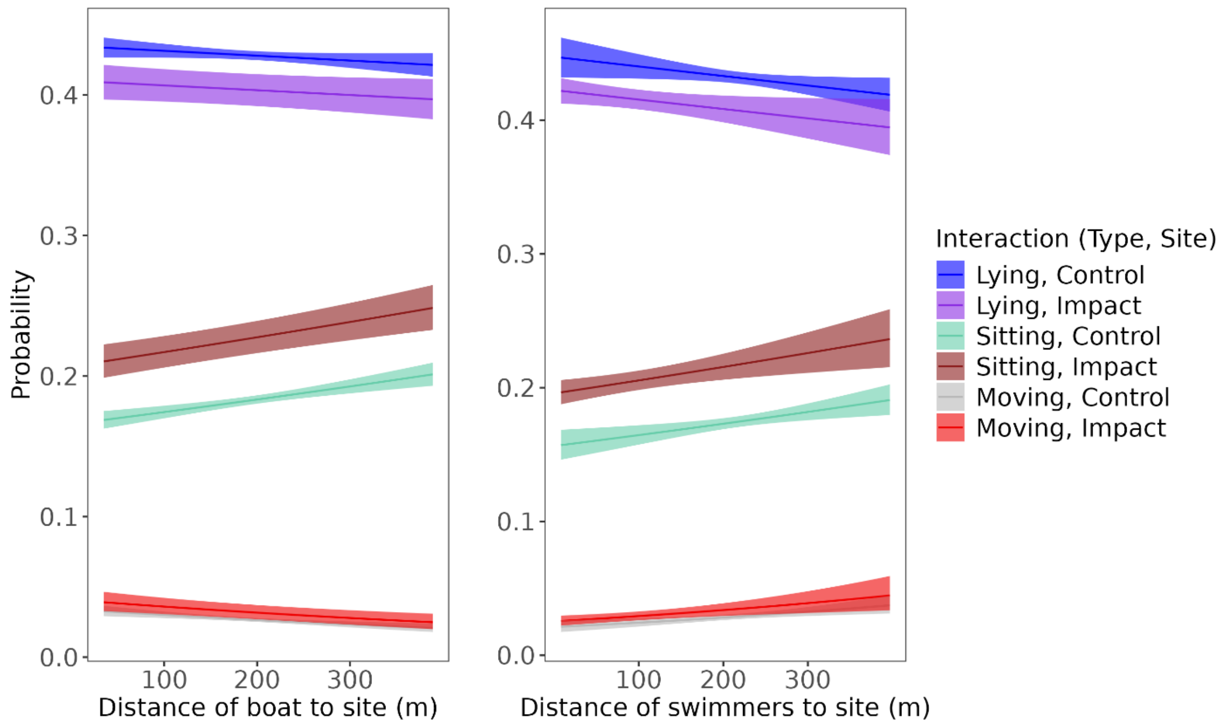

Figure 5.1: Changes in the probability of seals showing primary behavioural responses in relation to the distance of the boat and swimmers to the Impact and Control site

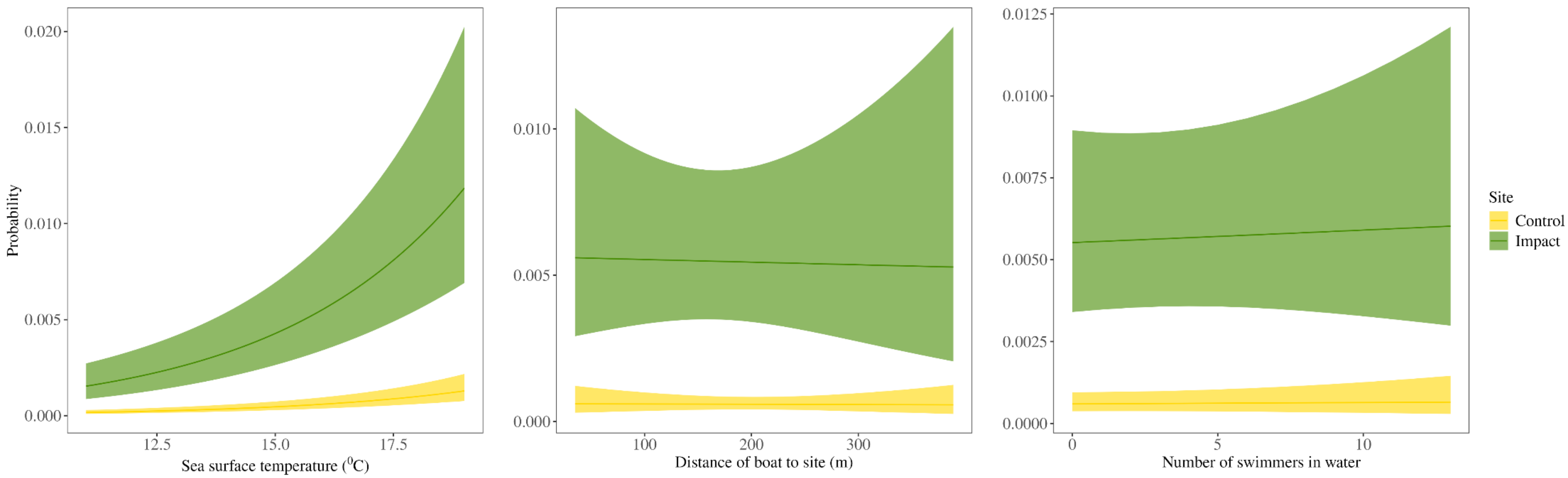

Figure 5.2: Changes in the probability of seals moving to or from the water in relation to the number of swimmers, the distance of the boat to the Impact and Control site, as well as sea surface temperature

5.4 Discussion

The previous chapter provided a broad-scale analysis of behavioural responses to SWS activities, using averages across observation sessions. The chapter highlighted certain behavioural responses in the colony, as shown by minor changes in some behavioural categories in the Impact vs the Control site and between phases, although a relatively small number of seals were affected. This chapter provided finer-scale analyses to investigate the effects of environmental factors and the characteristics of tourist activities on seal responses. This was conducted using Generalised Linear Models (GLMs).

Model results of the interaction between Site and Phase indicate that the presence of tourists caused a significant increase in seals in a sitting position, and significantly more so for the Impact than the Control, corroborating the results of the previous chapter. This change could be interpreted as a decreased state of restfulness. The models also showed that seals were significantly more likely to be moving in the colony when there were tourists present (During) but also after they left (After), and significantly more so for the Impact than the Control. Increasing air temperature also caused seals to be more active, similar to that shown previously in a study of the conspecific Australian fur seal *Arctocephalus pusillus doriferus* (Back et al. 2018). Several other studies on seals have found that warmer air temperatures resulted in fewer seals ashore (Gentry 1973; Bester 1982; Twiss et al. 2002; Stevens and Boness 2003; Garlepp et al. 2014) but in this study, air temperature did not affect seals' movement-to-or-from-the-water, according to the model. Instead, it was warmer sea temperatures that were found to result in an increase in movement-to-or-from-the-water and in alert behaviour. It may be that this was related to an increased number of swimmers when the water was warmer, with greater associated disturbance, although the model showed no significant effect of swimmer numbers on alert behaviour.

The model results showing little effects and, in some cases, significant effects on some primary or secondary behavioural responses were initially unexpected, especially since the direction of some responses were the opposite of what would be expected for a disturbance effect. That is, decreasing with decreased distance of the boat (sitting, movement-to-or-from-the-water) or swimmers from the colony (sitting, moving). According to Suryan and Harvey (1999), the way seals respond to disturbances can fluctuate, primarily based on the frequency, intensity, and closeness of the disturbance, and many studies have found that the distance of vessels contributed significantly to behavioural responses of seals (Pavez et al. 2011; Mathews et al. 2016; Back et al. 2018). For example, of the factors considered by Back et al. (2018), the only significant influences on how seals reacted to boat approaches were the proximity of the boat and the time of day. Among these factors, the proximity of the boat's approach had the most significant effect on the seals' ability to detect the boat and their perception of the risk it posed (Back et al. 2018). Pavez et al. (2011) found that when boats approached the colony closely, individual South American sea lions (*Otaria flavescens*) tended to flee from the colony into the water. While Pavez et al. (2011) did not directly assess whether this behaviour harms the animals, existing research indicates that such water escapes can lead to various adverse outcomes. For instance, in reproductive colonies, it can result in animals unintentionally trampling and killing newborn pups, as observed in the study done by Mattlin (1978). Moreover, fleeing into the water leads to increased energy expenditure due to the loss of body heat, potentially causing physiological stress and metabolic regulation issues (Castellini 2002). Additionally, the act of escaping and subsequently abandoning their site within the colony could negatively impact the reproductive success of individual animals (Cappozzo 2002). Therefore, such escapes and territory abandonment could directly harm the fitness of these individuals (Pavez et al. 2011).

No such extreme reactions by Cape fur seals, such as stampedes, were observed in this study, which occurred outside the seal breeding season (when stampedes may be more prevalent). It must also be noted (and reiterated from the previous chapter) that even where there were significant changes in primary or secondary behaviours according to tourist behaviour (or the presence of tourists; see also previous chapter), it was only a small percentage of seals in the study site that were affected. For example, even where there appeared to be a significant effect of changes in distance of boat or swimmers from the colony, it was not more than 3% of animals in the study area that was affected. Nevertheless, as pointed out by Machernis et al. (2018), even subtle changes in the natural behaviour of marine mammals due to interactions with tourists can have implications for survival or reproductive success by affecting the time that they allocate to vital activities.

At Robberg, the tourist ventures operate according to a voluntary Code of Conduct (see Appendix A) governing the speed of approach (wake speed within 200 m of the colony) and the number and behaviour of swimmers in the water (12 + 1 guide), while the boat does not approach closer than 30 m from the colony, a distance prescribed in the national Threatened or Protected Species (ToPS) Regulations (RSA 2015). Moreover, during all observations for this study, swimmers were not allowed to approach within 5 m of the shore of the colony by the guide, with the closest recorded distance being 8 m (Table 5.1). This is likely also a safety consideration to avoid dangerous surge adjacent to the rocky shore. The fact that certain seal responses decreased with decreasing distance of boat or swimmers from the colony, according to the model, may show that seals respond mostly to activity when they first become aware of the disturbance (when it is still at a distance), but may then become accustomed to it, with responses declining to closer distances. This behaviour may also be attributed to the habituation of the seals, resulting in a diminished response to disturbances once they have identified the source, which is more likely when the source is closer. However, the lack of acute responses in the colony to tourist activity in the water does point to the habituation of seals to tourists, as observed in other studies. Barton et al. (1998) highlighted similar patterns in interactions between tourists and New Zealand fur seals, Young (1998) explored seal-watching behaviour, and Born et al. (1999) examined the escape responses of hauled-out ringed seals (*Phoca hispida*) to aircraft disturbances. It likely also attests to the efficacy of the modus operandi followed by the operators (influenced by the Code of Conduct and the ToPS Regulations) at avoiding disturbance.

The only effect of the number of swimmers in the water, according to the model, was that there was greater seal movement-to-or-from-the-water with seals being more likely to haul out than to enter the water. However, it is uncertain whether this was causal – the movement-to-or-from-the-water was also positively related to sea temperature, and it is likely that the group sizes of swimmers in the water would also have increased with warmer water, so that any relationship between group sizes of swimmers and seal movement-to-or-from-the-water may have been an artefact of both seals and humans preferring warmer waters (Morgan et al. 2000). The actual numbers of seals in the water were not enumerated in this study, so this could not be tested in relation to water temperature data. However, it is also possible that a greater number of tourists in the water elicited greater interest from seals, which show curiosity and playfulness in the water around the swimmers, and this may have accounted for greater movement-to-or-from-the-water during the observations. Once again, numbers in the water in the During phase vs the Before Phase of the Impact vs the Control site would be needed to test this, but quantifying numbers in the water was beyond the scope of this study, which focused on responses within the colony. These are alternative hypotheses to increased swimmer numbers having a greater disturbance effect. Stafford-Bell (2012) noticed that one or two swimmers in the water caused Australian fur seals to haul out from the water onto land more often but hauling out responses decreased with an increasing number of swimmers, and other studies have also indicated habituation of seals associated with increased numbers of swimmers in the water including studies done by Martinez (2003) on the impacts of tourism on Australian sea lions (*Neophoca cinerea*) and Granquist and Sigurjonsdottir (2014) who assessed the effects of land-based seal watching tourism on the haul-out behaviour of harbour seals (*Phoca vitulina*).

5.5 Conclusions

This chapter has assessed the potential environmental, operational and other influences on the responses of seals at the Robberg seal colony to swim-with-seal activities, and results suggest that the presence of the boat and swimmers do cause short-term behavioural responses of Cape fur seals at Robberg, but these corroborate the findings of Chapter 4 in that responses were relatively minor positional changes (from lying down to sitting) of some seals, increased movement (around the colony or movement-to-or-from-the-water), or increased alert behaviour in the Impact vs the Control site. With the incorporation of environmental variables such as sea temperature, it was unclear whether responses such as increased movement-to-or-from-the-water were related to higher sea temperatures, an increased number of swimmers in the water, or both. While the occurrence of the tourist activities resulted in responses (significant differences in alert behaviour in Impact vs Control, or in proportions of seals lying down vs sitting or moving about in the colony), the distance of boat or swimmers from the colony had little effect or for some behavioural categories indicated a slight significant decline in response with decreasing distance from the colony (e.g. distance of boat to site on animals sitting in the colony or movement-to-or-from-the-water, or distance of swimmers to site and animal sitting or moving in the colony). Such relationships were opposite to what was expected and suggest that these responses maybe decline after the seals first become used to human presence, which is when the boat or swimmers are further from the colony. This and the lack of any extreme responses such as stampedes during the study period, point to both the immediate habituation of seals to the activity and to the efficacy of the modus operandi of the operators in the interest of preventing disturbance to the colony and ensuring human safety.

5.6 References

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CHAPTER 6: GENERAL CONCLUSIONS AND RECOMMENDATIONS

This study aimed to assess the impacts of SWS tourism on the behaviour of seals in the Cape fur seal colony in the Robberg MPA. It was conducted through a modified Before-After-Control-Impact (BACI) behavioural study designed for simultaneous observations of Impact and Control areas Before, During and After SWS activities. Observations were carried out from an elevation at distances from the experimental sites that precluded observer impacts, with sequential photography of the colony providing the basis for enumerating seals in different behavioural categories and comparing these between sites (Impact vs Control) and between phases (Before, During and After activities) and interactive effects of site and phase. Behavioural categories included "primary" behavioural categories (lying down, sitting, moving) and "secondary" behavioural categories (grooming, nourishing, interacting, alertness) that seals within one of the primary categories could be secondarily engaged with.

Despite some limitations of the study, its design and sample sizes (discussed in Chapter 4), it was clear that SWS activity and associated boat approaches brought about certain behavioural responses in the colony, as shown by changes in certain behavioural categories. However, even where there were significant differences in behaviour between experimental sites and/or phases that could be attributed to tourist activity, it was only a small proportion of animals in the study area that were affected. Importantly, in this study, seals in the colony were mostly at rest (at least 70% lying down on average) throughout the phases of observation, and no extreme reactions by seals, such as stampedes, were observed throughout the 54 observation sessions of this study. Modelled responses of seals to the distances of the boat or swimmers to the colony, indicate that some responses (certain behavioural categories) decline with distance to the colony, suggesting the response is most when seals first become aware of the tourist presence but decline as they become used to it. Overall, therefore, the reactions of seals point to some immediate habituation of the seals to the tourist activity. The results also attest to the efficacy of the modus operandi adopted by the tourist operator during the study period, which was informed by legislation (ToPS Regulations, RSA 2015) and a voluntary Code of Conduct (see Appendix A), with the aims of avoiding disturbance to the colony and ensuring human safety. It is possible that the modus operandi was influenced by the presence of the observers.

Regarding growth in the SWS industry, in terms of the numbers of tourists and operators, it must be kept in mind that even subtle changes in the natural behaviour of marine mammals due to interactions with tourists can have implications for survival or reproductive success by affecting the time that they allocate to vital activities (Ward and Beanland 1996; Boren 2001; Machernis et al. 2018). Although there is no direct evidence to support this, a precautionary approach is advisable until the potential effects on seal welfare, reproductive success, and survival are thoroughly assessed. While relatively small proportions of animals were observed to be affected in this study, the fact that responses were statistically significant is grounds for caution regarding the governance of the industry, in the interests of its sustainability and in the interests of preventing harassment of a species listed as a Protected Species (as per the ToPS list of 2017). With this in mind and the growth of seal-based tourism and the numbers of operators offering SWS activities both in Plettenberg Bay and elsewhere, permitting of the activity by the Department of Forestry, Fisheries and the Environment (as it does for boat-based whale watching and shark case diving tourism) might be advisable. This will prevent ad hoc, poorly guided, or unethical activity that could elevate seal stress responses and be to the detriment of industry sustainability and animal welfare.

The purpose of the ToPS Regulations is the control and permitting of activities that potentially impact listed species – in the Regulations, the harassment of seals and attraction of seals (using e.g. food) is not allowed in terms of Section 57(2), except under permit exemption for management, scientific, conservation or rehabilitation purposes. Harassment is defined in the ToPS Regulations as: "behaviour or conduct that threatens, disturbs or torments a live specimen of a listed threatened or protected marine species," and activities considered as harassment to seals include "approaching a seal colony with a vessel closer than 15 meters or any person approaching a colony closer than 5 meters." The modus operandi that was adhered to by the operator in this study, which was also informed by their Code of Conduct, is more conservative, limiting the boat approach to 30 m. It also considers the speed of approach (wake speed within 200 m of the colony) and specifics for the swimmers, including the number of swimmers in the water (12 + 1 guide), their behaviour, the distance to the colony that swimmers may approach (5 m), intervals between excursions (2 h), and behaviour of swimmers (noise levels). It is recommended that these and other guidelines contained in the Code of Conduct, should form the basis of permit conditions should the activity become a permitted operation. In terms of the conditions, no more than one operator should be able to operate at any one particular site within a colony at one time; intervals for operations would be site-specific, with alternative sites separated by distance allowing for more than one operator to operate at once at a colony such as Robberg. Determining a limit on the number of operators would need to consider the number of sites within the colony that are suitable for the activity, tourist demand and profit margins, all of which were beyond the scope of this study but present possible opportunities for further research.

This study did not include observations during the breeding season, at which time of year stress responses may be different from the rest of the year, and there are additional concerns for pup survival (Anderson et al. 1979; Kovacs and Innes 1990; Boren 2001), as well as human safety. To avoid these issues, the operator shifted activities to a more remote part of the colony during breeding season, which was unsuited to Control-Impact observations, hence the inability to do operations at this time. For the same rationale, it is recommended that this precaution be applied to any future permit conditions governing the activity, i.e. that the activity be limited in breeding areas during the breeding season (November to January). The effects of the presence or numbers of tourists in the water on seal numbers in the water could not be tested in this study because the focus was on the responses of the seals in the colony, and seal behaviour and numbers in the water were not qualified or enumerated. This, however, presents an interesting question for further research.

Additional factors that may influence permitting and regulation of SWS include other human safety issues, such as the emerging issue of seal aggression towards humans, including in the water (Engel 2024), as well as the risk of shark attacks, which have reportedly been on the increase in Plettenberg Bay (McMurray 2022).

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APPENDICES

Appendix A: Code of conduct used by swim-with-seal operator Offshore Adventures.

CODE OF CONDUCT

Seal swimming, snorkelling, scuba diving and eco-shark and seal viewing within Robberg Marine Protected Area

All vessels are registered with SAMSA.

All vessels and activities are covered with public liability.

Safety is our first priority.
- Shark shields (electronic shark deterrent) are used on all seal snorkels/dives trip when cage is not used.
- A qualified PADI dive master is present in the water with clients on all seal swims.
- All skippers are first aid level 3 qualified, & a shark attack first aid kit is available on all vessels
- No bait is used within the Robberg MPA.

All trips to Robberg MPA are radioed in and logged.

Within 200m of colony, all vessels travel at no wake speed unless safety becomes an issue.

All excursions are limited to 30 minutes in the water and to 12 people + 1 Guide.

No animals under any circumstances are fed or attracted by any means of food. They are completely free to approach and move away at own will.

A briefing is conducted prior to each excursion that clearly state that these are wild animals and should be respected, animals are not touched and noise needs to be kept to minimum, no one to approach the colony on land or attempt to go on land. If pictures are to be taken, no flashes are to be used. General Marine Protected Area rules are also made mention of, no littering or taking of any items.

Excursion only take place between 08h00-17h00, with 2hours between excursions.

All entangled and injured animals will be reported to Cape Nature. No attempt to approach or rescue will be made unless permitted by Cape Nature.

If whales are sighted, no approach within 300m will be made.

All unlawful activities by any other vessels sighted will be reported.

Assistance in all animal rescues and releases as well as data collection for research are offered.